Review of Environmental Factors

Wills Street Sewage Treatment Plant Replacement Project, Broken Hill

July 2025

Project No. W101914

Essential Energy

essentialenergy.com.au

REVISION HISTORY

VERSION	NATURE OF REVISION
Draft01	Draft prepared for Essential Energy's Environmental Services review.
Final01	Final prepared for Essential Water management review
Final02	Final prepared for determination

This document shall remain the property of Essential Energy. The document may only be used for the purposes for which it was commissioned. Unauthorised use of this document in any form whatsoever is prohibited.

Contact: Brett Hayward

E: brett.hayward@essentialenergy.com.au

Essential Energy ABN 37 428 185 226

PO Box 5730

Port Macquarie NSW 2444

Table of Contents

Acronyms and Abbreviations ix

REF Approval Form xv

Declaration xvi

Executive Summary xviii

1. Introduction 1
1.1 The Proposal 1
1.2 Context and Justification of the Proposal 1
1.3 Proposal Objectives 2
1.4 Proposal Site 2
1.4.1 Existing Wills Street STP 5
1.4.2 Existing South STP Site 7
1.4.3 Proposed Rising Main Route 9
1.4.4 Existing Treated Effluent Discharge Pipe 9
1.4.5 Access 9
1.5 Study Area 10
1.6 Purpose of the REF 10

2. Description of the Proposal 11
2.1 Overview of the Proposal 11
2.1.1 Upgrade and Replacement of STP Infrastructure at Wills STreet 11
2.1.2 South STP Raw Sewage Transfer to Wills Street STP 12
2.2 Basis of Design 12
2.2.1 Design Horizon 12
2.2.2 Connected Population 12
2.2.3 Effluent Quality Requirements 12
2.2.4 Flow Loadings 14
2.2.5 Sewer Loadings 14
2.2.6 Sewage Fractions 16
2.2.7 Tankered Waste 17
2.2.8 Treated Effluent Reuse 17
2.2.9 Biosolids Management 19
2.2.10 Odour 19
2.2.11 Noise 19
2.2.12 Temperature 20
2.3 Design Description 20
2.3.1 Process Description 20
2.3.2 Hydraulic Design 25
2.3.3 Key Process Units 27
2.3.4 Foul Water Pump Station 42
2.3.5 Site Access 42
2.3.6 Stormwater Drainage 44
2.3.7 Bushfire 44
2.3.8 Landscaping 44
2.3.9 On-site Amenities, Administration Building, Laboratory and Parking 44
2.3.10 Access Platforms / Handrails 44
2.3.11 Power and Water 44
2.3.12 Photovoltaic System 45
2.3.13 Security, Fencing, Gate Access and CCTV 46
2.4 Construction Activities 46
2.4.1 Construction Methodology 46
2.4.2 Timing and work hours 46
2.4.3 Resources and Equipment 47
2.4.4 Impact Mitigation 47

2.5 Operation and Maintenance Requirements 47

3. Consultation 48
3.1 Overview 48
3.2 Agency Consultation 48
3.3 Engaging the Community 48
3.4 Consultation Requirements under the T&I SEPP 48

4. Project Alternatives 50
4.1 Do Nothing (Maintain Current Infrastructure) 50
4.2 Project Planning Options 50
4.2.1 Augmentation Options 50
4.2.2 Treatment Options 51
4.2.3 Concept Design 51
4.3 Detailed Design 51
4.3.1 Change to design peak instantaneous raw sewage flow 52
4.3.2 Abandonment of plan to use one of the existing trickling filters at South STP 52
4.3.3 Relocation of STP infrastructure at WIlls Street STP Site 52
4.3.4 Abandonment of the existing Tertiary pond 52
4.3.5 Replacement of existing effluent discharge pipeline 52
4.3.6 Improved effluent treatment for reuse 52
4.3.7 Sludge Management Options 53
4.3.8 Preferred Proposal 53

5. Environmental Legislation 54
5.1 Environmental Planning and Assessment Act, 1979 (EP&A Act) 54
5.2 Environmental Planning Instruments 54
5.2.1 State Environmental Planning Policies 54
5.2.2 Local Environmental Plans (LEP) 56
5.3 Key Legislation 56
5.3.1 Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth) (EPBC Act) 56
5.3.2 Native Title Act 1993 (Commonwealth) (NT Act) 57
5.3.3 Aboriginal Land Rights Act 1983 58
5.3.4 Biodiversity Conservation Act 2016 58
5.3.5 Biosecurity Act 2015 58
5.3.6 Commons Management Act 1989 59
5.3.7 Crown Land Management Act 2016 59
5.3.8 Heritage Act 1977 59
5.3.9 Local Government Act 1993 60
5.3.10 Local Land Services Act 2013 60
5.3.11 National Park and Wildlife Act 1974 60
5.3.12 Pipelines Act 1967 61
5.3.13 Protection of Environment Operations Act 1997 61
5.3.14 Roads Act 1993 61
5.3.15 Water Act 1912 62
5.3.16 Water Management Act 2000 62
5.4 Summary of Licences, Permits, Approvals and Notifications 64

6. Environmental Assessment 65
6.1 Air Quality and Greenhouse Gases 65
6.1.1 Existing Environment 65
6.1.2 Assessment of Impact 71
6.1.3 Environmental Mitigation Measures 74
6.1.4 Conclusion 74
6.2 Topography, Geology and Soils 74
6.2.1 Existing Environment 74
6.2.2 Assessment of Impact 81
6.2.3 Environmental Mitigation Measures 81
6.2.4 Conclusion 82

6.3 Water Quality and Hydrology 82
6.3.1 Existing Environment 82
6.3.2 Assessment of Impact 86
6.3.3 Environmental Mitigation Measures 89
6.3.4 Conclusion 90
6.4 Noise and Vibration 91
6.4.1 Existing Environment 91
6.4.2 Assessment of Impact 92
6.4.3 Environmental Mitigation Measures 109
6.4.4 Conclusion 110
6.5 Flora and Fauna 110
6.5.1 Existing Environment 110
6.5.2 Assessment of Impact 122
6.5.3 Environmental Mitigation Measures 125
6.5.4 Conclusion 126
6.6 Aboriginal Heritage 126
6.6.1 Existing Environment 126
6.6.2 Assessment of Impact 147
6.6.3 Environmental Mitigation Measures 149
6.6.4 Conclusion 149
6.7 Non-Aboriginal Heritage 150
6.7.1 Existing Environment 150
6.7.2 Assessment of Impact 150
6.7.3 Environmental Mitigation Measures 151
6.7.4 Conclusion 151
6.8 Contamination 151
6.8.1 Existing Environment 151
6.8.2 Assessment of Impact 155
6.8.3 Environmental Mitigation Measures 158
6.8.4 Conclusion 159
6.9 Hazards and Chemical Management 159
6.9.1 Assessment of Impact 159
6.9.2 Environmental mitigation measures 160
6.9.3 Conclusion 160
6.10 Visual and Aesthetics 161
6.10.1 Approach 161
6.10.2 Existing visual environment (landscape description) 162
6.10.3 Assessment of Impact 163
6.10.4 Summary of Potential Impacts 164
6.11 Waste 164
6.11.1 Assessment of Impact 164
6.11.2 Environmental Mitigation Measures 164
6.11.3 Conclusion 164
6.12 Bushfire 165
6.12.1 Existing Environment 165
6.12.2 Assessment of Impact 165
6.12.3 Environmental Mitigation Measures 165
6.13 Traffic and Access 165
6.13.1 Existing Environment 165
6.13.2 Assessment of Impact 165
6.13.3 Environmental Mitigation Measures 167
6.13.4 Conclusion 167
6.14 Land Use 167
6.14.1 Existing Environment 167
6.14.2 Assessment of Impact 168
6.14.3 Environmental Mitigation Measures 168
6.14.4 Conclusion 168
6.15 Social and Economic 170
6.15.1 Existing Environment 170
6.15.2 Assessment of Impact 170

6.15.3 Environmental Mitigation Measures 171
6.15.4 Conclusion 171
6.16 Cumulative Impacts 171
6.17 Summary of Environmental Mitigation Measures 172

7. Ecologically Sustainable Development 184
7.1 Precautionary Principle 184
7.2 Principle of Inter-generational Equity 185
7.3 Principle of Biological Diversity and Ecological Integrity 185
7.4 Improved Valuation of Environmental Resources 185

8. Environmental Management Plan 186
8.1 Construction Environmental Management Plan 186
8.2 Implementation of the CEMP 186
8.2.1 Auditing Schedule of the CEMP 187
8.3 Operational Environmental Management Plan 187

9. Environmental Checklist 188

10. Conclusion 192

11. References 193

Appendix A: Broken Hill WWTP Preliminary Concept Design Report

Appendix B: Odour Impact Assessment

Appendix C: Noise Impact Assessment

Appendix D: Ecological Impact Assessment

Appendix E: Aboriginal Heritage Due Diligence Assessment

Appendix F: EPBC Act National Heritage Place Significant Impact Assessment

Appendix G: Compliance with the Principles of the Crown Land Management Act

List of Figures

Figure 1: Proposal site in the regional context 3
Figure 2: Proposal site in the local context 4
Figure 3: Layout of the existing Wills Street STP site 6
Figure 4: Layout of the existing South STP site 8
Figure 5: Process flow diagram, proposed flow and monitoring points. 15
Figure 6: Process flow diagram A 22
Figure 7: Process flow diagram B 23
Figure 8: General arrangement for the proposed new BHSTP 24
Figure 9: Preliminary HGL for the Proposed New BHSTP 26
Figure 10: Proposed South STP transfer pump station wet well preliminary arrangement 27
Figure 11: Indicative site layout for the proposed new pump station at South STP 28
Figure 12: Preliminary 3D model of inlet works arrangement at the new Wills Street STP 29
Figure 13: Preliminary arrangement of proposed septage receival 30
Figure 14: Preliminary general arrangement of secondary treatment process. 31

Figure 15: Preliminary general arrangement of secondary effluent UV system 32
Figure 16: Existing and replacement treated effluent pipe alignment and existing and possible alternative discharge location for Wills Street / new BHSTP 34
Figure 17: Preliminary general arrangement of tertiary treatment area. 35
Figure 18: Preliminary arrangement of sludge dewatering and outloading area. 37
Figure 19: Preliminary arrangement of chemical storage and dosing area. 38
Figure 20: Preliminary arrangement of odour control system 41
Figure 21: Preliminary arrangement showing emergency storage pond. 42
Figure 22: Proposed new main site access point location 43
Figure 23: Existing and proposed site access 43
Figure 24: Amenities building preliminary arrangement 45
Figure 25: Proposed location of PV system 45
Figure 26: Wind rose for meteorological data at Broken Hill airport (July 2018 – June 2023) 67
Figure 27: Windrose for 5pm to 8pm (July 2018 – June 2023) 67
Figure 28: Odour concentration contours for the existing Wills Street STP 70
Figure 29: Odour concentration contours for the proposal 73
Figure 30: Approximate elevation profile of the Wills St STP site: (a) W-E, (b) N-S (Google Earth Pro 2024) 75
Figure 31: Approximate elevation profile of the South STP site: (a) W-E, (b) N-S (Google Earth Pro 2024) 75
Figure 32 Approximate elevation profile along the pipeline (Google Earth Pro 2024) 76
Figure 33 Approximate elevation profile along the pipeline (Google Earth Pro 2024) 76
Figure 34: Geological map of the project site (extracted from MinView website) 77
Figure 35: Mitchell landscapes relative to the proposal site 80
Figure 36: Waterways in the vicinity of the proposal site 83
Figure 37: Modelled Noise Sources 103
Figure 38: Noise Contours, Day Calm LAeq,15min 105
Figure 39: Noise Contours, Evening/Night Calm LAeq,15min 106
Figure 40: Noise Contours, Evening/Night Prevailing (Inversion and Wind), LAeq,15min 107
Figure 41: Received Noise Level Spectra to Receptors R1 and R2, LAeq,15min 108
Figure 42: BioNet records within the 1500m of the proposal site 113
Figure 43: NSW State Vegetation Mapping showing PCTs relative to the proposal site 114
Figure 44: Ground truthed PCTs within the proposal site 120
Figure 45: Results of extensive AHIMS search 130
Figure 46: Aboriginal sites within 600m of the proposal site 131
Figure 47: Southeastern section of the rising main development footprint covered with salt bush and low GSV 135
Figure 48: View of South STP highly disturb due to animal activities (rabbit burrows) 135
Figure 49: View of proposed rising main route disturbance due to graded fence line 135
Figure 50: View of proposed rising main route along eroded tracks 135
Figure 51: View of proposed rising main route disturbance due to power line easements and underground electric cabling 136
Figure 52: View of typical disturbed surface at Wills Street STP 136

Figure 53: Location of the newly recorded Aboriginal sites 137
Figure 54: Newly recorded Aboriginal sites within the vicinity of the rising main route and South STP site 138
Figure 55: Location of the newly recorded sites near the construction footprint of the new BHSTP 139
Figure 56: 50% GSV within the exposure, view to the south 140
Figure 57: Example of Broken Hill STP AS01 Quartz flakes closeup 140
Figure 58: Broken Hill STP AS01 Quartz core closeup 141
Figure 59: View south of Broken Hill STP AS02 showing exposures within the saltbush 142
Figure 60: Broken Hill STP AS02 view to west 142
Figure 61: Example of opaque quartz within Broken Hill STP AS02 142
Figure 62: View north across Broken Hill AS02 142
Figure 63: View west across AS03 143
Figure 64: Eastern side of the fenceline facing north 143
Figure 65: Example of artefacts within AS03 144
Figure 66: View south showing general location of AS04 145
Figure 67: View north showing general location of AS04 145
Figure 68: View south across IF01 146
Figure 69: Example of vegetation and GSV 146
Figure 70: View conchoidal opaque quartz flake 146
Figure 71: View west across IF04 146
Figure 72: Contaminated land in the vicinity of the proposal Site 152
Figure 73: Existing Biosolid Stockpile Locations 156
Figure 74: Location of historic fill material potentially containing ACM 157
Figure 75: Mapped bushfire prone land in the vicinity of the proposal 166
Figure 76: Land use in the vicinity of the proposal site 169

List of Tables

Table 1: Summary of Existing Environment Protection Licence Requirements for Each STP 12
Table 2: Proposed New EPL Effluent Discharge Licence Concentration Limits for new BHSTP 13
Table 3: Design Flows for the Upgraded Wills Street STP 14
Table 4: Typical Sewage Loading and Adopted Raw Sewage Characteristics for Design 16
Table 5: Adopted Raw Sewage Fractions 16
Table 6: Adopted Raw Sewage Fractions 17
Table 7: Current Recycled Water End Users 17
Table 8: LRV Targets Per Process Unit for the New BHSTP 19
Table 9: Matters of National Environmental Significance 57
Table 10: Summary of licences, Permits, Approvals and Notifications 64
Table 11: Summary of odour concentration and odour emission rates 68
Table 12: Summary of odour emission rates for the existing Wills Street STP 68
Table 13: Odour Assessment Criteria (99th percentile) 69
Table 14: Summary of odour emission rates for the proposal 72

Table 15: Typical subsurface profile at the existing Wills Street STP 78
Table 16: Typical subsurface profile at South STP 78
Table 17: Typical subsurface profile along western portion of the rising main route 79
Table 18: Typical subsurface profile along eastern portion of the rising main route 79
Table 19: ANZECC (2000) Default Trigger Values South-East Australia for Slightly Disturbed Ecosystems – Upland River 85
Table 20: Summary of the existing Wills Street STP typical discharge water quality data from July 2017 to February 2025 86
Table 21: Existing and Proposed Effluent Discharge EPL Limits 88
Table 22: Project Noise Criteria at Closest Receptors 98
Table 23: Percentage Occurrence of Prevailing Winds, BOM Broken Hill Airport 2018-2023. 100
Table 24: Modelled Weather Conditions 101
Table 25: Significant Noise Source Summary for the Proposed BHSTP 102
Table 26: Predicted Noise Levels and Noise Criteria, Wills Street STP, LAeq,15min 104
Table 27: Low Frequency Noise Level from Wills STP to Residential Receptors, Leq,15min 108
Table 28: EPBC Protected Matters Report Summary 111
Table 29: BioNet results within 1,500m assessment buffer 112
Table 30: NSW SVTM PCTs mapped in the vicinity of the proposal site 115
Table 31: Predicted TECs 115
Table 32: Additional TECs associated with PCTs identified in the broader landscape 116
Table 33: PCTs recorded within the proposal site 117
Table 34: PCTs recorded within the proposal site 118
Table 35: PCTs recorded within the proposal site 122
Table 36: Assessment of Significance, Migratory Birds 123
Table 37: Summary of database searches for Aboriginal Heritage 128
Table 38: Summary of database searches for Aboriginal Heritage 148
Table 39: Visual Impact Matrix 161
Table 40: Summary of Environmental Mitigation Measures 173
Table 41: Section 5.5 requirements 188
Table 42: Section 171 Checklist 188

Acronyms and Abbreviations

ACRONYM/ABBREVIATION	DETAIL
ADWF	Average Dry Weather Flow
AEP	Annual Exceedance Probability
AGWR	Australian Guidelines for Water Recycling
AHD	Australian Height Datum
AHIMS	Aboriginal Heritage Information Management System
AHIP	Aboriginal Heritage Impact Permit
ARI	Average Recurrence Interval
AS	Artefact Scatter
ASS	Acid Sulfate Soils
AASS	Actual Acid Sulfate Soils
AEMO	Australian Energy Market Operator
BHCC	Broken Hill City Council
BHP	Broken Hill Proprietary
BOD	Biological Oxygen Demand
BHSTP	Broken Hill Sewage Treatment Plant (i.e., the new STP that will replace both Wills Street and South STPS)
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene
BWL	Bottom Water Level
CCT	Chlorine Contact Tank
CCTV	Closed Circuit Television
CO_2-e	Carbon dioxide equivalent
COD	Carbon Oxygen Demand
CEMP	Construction Environmental Management Plan
Consequence	The outcome of an event expressed qualitatively or quantitatively, being a loss, injury, disadvantage or gain.
dB(A)	Decibels (A) weighted
DST	Dry Solid Tonnes
DCCEEW (Cth)	Department of Climate Change, Energy, the Environment and Water (Commonwealth)
DCCEEW (NSW)	Department of Climate Change, Energy, the Environment and Water (New South Wales)

ACRONYM/ABBREVIATION	DETAIL
DEC	Department of Environment and Conservation (former NSW Department)
dB	Decibels: a noise level unit based on a logarithmic scale of pascals of sound pressure above and below atmospheric pressure.
dBA	A-weighted decibels, where the A weighting means frequencies below 500Hz and above 10kHz are artificially reduced to approximate the frequency response of an average human ear. Most sound monitoring instruments include an A-weighting option, enabling direct measurement of noise levels in dBA
dBL	Linear decibels, the same as dB but used to explicitly define a decibel scale in the absence of any frequency weighting such as dBA
DO	Dissolved Oxygen
DoE	Department of Environment (former Commonwealth Department)
DPE	Department of Planning and Environment (former NSW Department)
DPHI	Department of Planning, Housing and Infrastructure
DP	Deposited Plan
DPI	Department of Primary Industries (NSW)
DWAS	Digested Waste Activated Sludge
EMF	Electric and Magnetic Fields
Environmental Aspect	Any element of an organisation's activities, products or services that can interact with the environment.
Environmental Impact	Any change in the environment whether adverse or beneficial, wholly or partially resulting from organisation activities, products or services.
EP	Equivalent Population
EPA	Environment Protection Authority (NSW)
EP&A Act	*Environmental Planning and Assessment Act 1979*
EP&A Reg	*Environmental Planning and Assessment Regulation 2000*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPHC	Environment Protection and Heritage Council
EPIs	Environmental Planning Instruments
EPL	Environment Protection Licence
ESD	Ecologically Sustainable Development
EWP	Elevated Work Platforms
Frequency	The rate of sound pressure fluctuations per second, expressed as cycles per second or hertz (Hz). Human ears in good

ACRONYM/ABBREVIATION	DETAIL
	condition can typically detect sound in the frequency range 20 Hz to 20,000 Hz (20 kHz), depending on sound level
FSC	Field Service Centre (Essential Energy)
FM Act	*Fisheries Management Act 1994*
g	Grams
GDE	Groundwater Dependent Ecosystem
GHG	Greenhouse Gas
GSV	Ground Surface Visibility
ha	Hectare
IBRA	Interim Biogeographic Regionalisation of Australia
IDEA	Intermittently Decanted Extended Aeration
IDEAT	Intermittently Decanted Extended Aeration Tanks
IF	Isolated Find
IPC	Independent Planning Commission
IPART	Independent Pricing and Regulatory Tribunal
IWCM	Integrated Water Cycle Management
KTP	Key Threatening Processes
kV	Kilovolts
kL	Kilolitre
L	Litre
L/EP/d	Litres per Equivalent Population per day
LALC	Local Aboriginal Land Council
LA1	The A-weighted noise level exceeded 1% of the time (which can be thought of as the loudest 1% of the time) over a measurement or assessment period of typically 15 minutes and commonly used to assess sleep disturbance at night
LA90	The A-weighted noise level exceeded 90% of the time (which can be thought of as the quietest 10% of the time) over a defined measurement period of 15 minutes excluding any noise from the project being considered, and widely accepted as the background noise level
Likelihood	A qualitative description of probability or frequency
LEP	Local Environmental Plan
LG Act	*Local Government Act 1993*
LGA	Local Government Area
LOR	Limits of Reporting

ACRONYM/ABBREVIATION	DETAIL
LRV	Log Removal Values
m	Metres
m^2	Square metre
MBR	Membrane Bio-reactor
MDWF	Minimum Dry Weather Flow
MLSS	Mixed Liquor Suspended Solids
mG	Milligauss
mg	Milligrams
mg/L	Milligrams per litre
mm	Millimetres
mL	Millilitres
ML	Megalitres
MNES	Matters of National Environmental Significance
MVA	Mega Volt Amps
NES	National Environmental Significance
NOX	Oxides of Nitrogen
NPW Act	*National Parks and Wildlife Act 1974*
NRMMC	Natural Resource Management Ministerial Council
NSW	New South Wales
OCPs	Organochlorine pesticides
OEH	Office of Environment and Heritage (former NSW Government Department)
OU	Odour Unit. The detectability of an odour is a sensory property that refers to the theoretical minimum concentration that produces an olfactory response or sensation. This point is called the odour threshold and defines one odour unit (OU)
OU/m^3	Odour Unit per cubic metre of air. The terms OU and OU/m^3 are used interchangeably.
$OU/m^2/s$	Odour Unit per square metre per second. It refers to the specific odour emission rate, which is a measurement of the odour released per unit area of a source per unit time.
PASS	Potential Acid Sulfate Soils
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PCT	Plant Community Type

ACRONYM/ABBREVIATION	DETAIL
PDWF	Peak Dry Weather Flow
PFTF	Peak Full Treatment Flow
PIF	Peak Instantaneous Flow
PLC	Programmable Logic Controllers
POEO Act	*Protection of the Environment Operations Act 1997*
PWA	Public Works Advisory
PWWF	Peak Wet Weather Flow
RAS	Return Activated Sludge
RE	Reclaimed Effluent
REF	Review of Environmental Factors
RF Act	*Rural Fires Act 1997*
Roads Act	*Roads Act 1993*
SCADA	Supervisory control and data acquisition. A computer-based system for gathering and analysing real-time data to monitor and control equipment that deals with critical and time-sensitive materials or events.
SEE	Statement of Environmental Effects
SEED	The Central Resource for Sharing and Enabling Environmental Data (SEED) in NSW
SEPP	State Environmental Planning Policy
Sewage	The waste matter itself (human waste, household wastewater)
Sewerage	The system of pipes, sewers, treatment plants that collects, transports, and treats sewage
SHI	State Heritage Inventory
SHR	State Heritage Register
Sound Pressure	Small air pressure variations above and below normal atmospheric pressure that are perceived by human ears as sound
Sound Power	Sound energy emitted by a source, measured in watts (W) or expressed on a decibel scale with 0 dB representing 1 picowatt (1 pW) of sound power.
SIS	Species Impact Statement
SPS	Sewage Pump Station
SOERs	Specific Odour Emission Rates
SOUR	Standard Oxygen Uptake Rate
STP	Sewage Treatment Plant
SRT	Sludge Retention Time

ACRONYM/ABBREVIATION	DETAIL
Supernatant Water	Water from which settleable solids have been removed in a settling pond, sludge lagoon, or by a similar method
SVTM	State Vegetation Type Mapping
SWMP	Soil and Water Management Plan
TDS	Total Dissolved Solid
TEC	Threatened Ecological Community
TfNSW	Transport for New South Wales
TKN	Total Kjeldahl Nitrogen
TN	Total Nitrogen
TOERs	Total Odour Emissions Rates
TP	Total Phosphorus
Treated Effluent	Wastewater that has undergone treatment at a treatment plant and is discharged as a cleaner form of water.
TSS	Total Suspended Solids
TWL	Top Water Level
µg/L	Micrograms per litre
UV	Ultraviolet
UVT	UV transmissivity
WAS	Waste Activated Sludge
WM Act	*Water Management Act 2000*
WM General Reg	*Water Management (General) Regulations 2018*

REF Approval Form

PROJECT AND PROPONENT DETAIL

REF Name	Wills Street Sewage Treatment Plant Replacement Project
Project Number	W101914
REF prepared by	Nathan Hegerty
Title	Environmental Senior Specialist
Qualifications	Bachelor of Environmental Science Master of Environmental Law
Proponent Name	Essential Energy
Proponent Address	8 Buller Street, Port Macquarie NSW 2444

This Review of Environmental Factors (REF) assesses the potential impacts that may result from the proposed activities as outlined in "Description of the Proposal" section of this report.

Essential Energy is a state-owned corporation and is a determining authority as defined in the *Environmental Planning and Assessment Act 1979* (EP&A Act). Essential Water is a business unit of Essential Energy, which provides water supply services to customers in Broken Hill, Menindee, Sunset Strip and Silverton. In addition, sewerage services are provided to Broken Hill. The proposal satisfies the definition of an 'activity' under the EP&A Act, and as such Essential Energy must assess and consider the environmental impacts of the proposal before determining whether to proceed. This REF has been prepared in accordance with Section 5.5 of the EP&A Act and Section 171 of the *Environmental Planning and Assessment Regulation 2021* (EP&A Reg). The EP&A Act requires Essential Energy to examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity. The EP&A Reg sets out environmental factors to be considered in making that assessment. If the activity is considered likely to significantly affect the environment, additional assessment requirements under the EP&A Act would be required.

Section 5.7 of the EP&A Act states that a determining authority shall not carry out an activity, or grant an approval in relation to an activity, that is likely to significantly affect the environment (including critical habitat) or threatened species, populations or ecological communities, or their habitats, unless the determining authority has examined and considered an Environmental Impact Statement or Species Impact Statement in respect of the activity.

The REF has addressed the matters that are required to be considered by Part 5, Division 5.1 of the EP&A Act, with the conclusion that if the activity is carried out as described, it is not likely to have a significant effect on the environment (including critical habitat) or threatened species, populations, ecological communities or their habitats, and accordingly an Environmental Impact Statement is not required. The mitigation strategies forming part of the activity are fully considered and discussed in the REF.

The activity was also assessed against the requirements of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act). As the proposed activity will not have, and is not likely to have, a significant impact on matters of national environmental significance, a referral to the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) is not required.

The proposed activity is permissible under all relevant state and federal legislation, including the EPBC Act and the *Biodiversity Conservation Act 2016* (NSW).

Under *State Environmental Planning Policy (Transport and Infrastructure) 2021* (T&I SEPP) the activity is classified as development for the purpose of, sewage treatment plants, which may be carried out without consent on land in a prescribed zone in the prescribed circumstance, and sewage reticulation systems, which may be carried out without consent on any land in the prescribed circumstances.

Declaration

The Review of Environmental Factors for the proposed activity has been assessed by Essential Energy.

Considering the assessment of the impacts, including Sections 1.7 and 5.5 of the *Environmental Planning and Assessment Act 1979* and Section 171 of the *Environmental Planning and Assessment Regulations 2021*, it is concluded that:

- There is not likely to be a significant environmental effect as a result of the construction, operation and maintenance of the activity and an Environmental Impact Statement is not required; and
- A Species Impact Statement (SIS), or Biodiversity Development Assessment Report (BDAR) is not required.

AUTHOR DECLARATION

I certify that I have reviewed and endorsed the contents of this REF document and, to the best of my knowledge, it is in accordance with the EP&A Act, the EP&A Regulation and the Guidelines approved under clause 170 of the EP&A Regulation, and the information it contains is neither false nor misleading

REF prepared by	Nathan Hegerty
Signature	Nathan Hegerty Digitally signed by Nathan Hegerty Date: 2025.07.21 10:12:52 +10'00'
Title	Environmental Senior Specialist
Date	

PEER REVIEW DECLARATION

I certify that I have reviewed and endorsed the contents of this REF document and, to the best of my knowledge, it is in accordance with the EP&A Act, the EP&A Regulation and the Guidelines approved under clause 170 of the EP&A Regulation, and the information it contains is neither false nor misleading

Peer Review by	Tim Haydon
Signature	Tim Haydon Digitally signed by Tim Haydon Date: 2025.07.21 10:40:08 +10'00'
Title	Environmental Senior Specialist
Date	

ESSENTIAL WATER REVIEW DECLARATION

The assessment has been reviewed and it is recommended that the Activity may now proceed subject to the implementation of the recommendations and mitigation measures contained in the REF documentation.

Essential Water Review by	Ross Berry
Signature	Ross Berry Digitally signed by Ross Berry Date: 2025.07.22 13:13:33 +09'30'
Title	Head of Water
Date	

DETERMINATION

1. Considering the assessment of the impacts, including Sections 1.7 and 5.5 of the *Environmental Planning and Assessment Act 1979* and Section 171 of the *Environmental Planning and Assessment Regulation 2021*, it is determined that there is not likely to be a significant environmental effect as a result of the construction, operation and maintenance of the Wills Street STP Replacement Project. Neither an Environmental Impact Statement (EIS), nor SIS, nor BDAR is required.
2. The Activity may now proceed subject to obtaining and complying with the relevant approvals as identified in the original REF and subject to the implementation of the recommendations and mitigation measures contained in the REF documentation.

Signature	Brett Hayward Digitally signed by Brett Hayward Date: 2025.07.22 14:25:00 +10'00'
Determining Authority	Brett Hayward
Title	Environmental Services Manager
Date	

Executive Summary

Background / Justification

The City of Broken Hill is currently serviced by two sewage treatment plants (STPs), the Wills Street STP and the Broken Hill South STP (herein referred to as the South STP). The plants are owned and operated by Essential Water, a business unit of Essential Energy.

The Wills Street STP was commissioned in 1939, upgraded in 1956 and again in the 1980's. This STP is at the end of its serviceable life and requires replacement to ensure ongoing compliance with the Environment Protection Licence (EPL) issued for the site by the New South Wales (NSW) Environment Protection Authority (EPA). Treated effluent from the Wills Street STP is reused by local mines, Broken Hill Golf Course, White Leeds artificial wetland, and several other end users. The South STP was built in the 1960's and is in a relatively poor condition reflecting of the age of the plant. This STP now requires significant remedial works to ensure reliable ongoing service and compliance with its EPL for discharges.

In 2009 GHD prepared the *Wills Street STP Risk Based Asset Renewal Strategy Report*, which identified the STP to be in fair to poor condition with a remaining serviceable life of between 5 and 10 years. Subsequently, GHD (2011) prepared the *Broken Hill Wastewater Treatment Strategy Options Assessment* and identified that both existing plants would need to be decommissioned within 10 to 20 years with a preferred option to decommission both existing STPs and construct a new STP at the Wills Street site, which would receive pumped transfer of sewage from the gravity sewerage system currently servicing the South STP.

Public Works Advisory (PWA) (2018a) prepared the *Broken Hill Sewerage Scheme Replacement of Wills Street and Southern STPs Options Study* which confirmed the preference of Essential Water to decommission both existing STPs and construct a new STP at the Wills Street site and identified the Intermittently Decanted Extended Aeration (IDEA) as the preferred secondary treatment process. The PWA (2019a) *Broken Hill Sewage Treatment Plant (STP) Augmentation Concept Development* provided an increased level of detail for the preferred option.

In late 2022, Beca HunterH2O were engaged to commence work on detailed design. As part of this process, in early 2024, Beca HunterH2O (2024a) finalised the *Broken Hill STP Design Basis and Preliminary Concept Design Review Report*, which further developed and refined the PWA (2019a) concept design, based on up-to-date information and stakeholder preferences, including preferred sludge management options. In December 2024 Beca HunterH2O completed the 30% detailed design milestone and accompanying *Broken Hill STP Preliminary Concept Design Report* (Beca HunterH2O, 2024b), which included a revision to the proposed siting and layout of the new STP infrastructure to avoid hard rock in the northwestern portion of the existing STP site. This REF has been prepared predominately based on the 30% detailed design milestone and associated information provided in Beca HunterH2O (2024b), and as updated by the *Broken Hill WWTP Design Basis and Proposed Design Approach* (Beca Hunter H2O, 2025a) and 85% detailed design plans (Beca HunterH2O, 2025b).

Construction, operation and maintenance of the Wills Street STP replacement project will ensure the local sewage treatment and sewerage reticulation infrastructure meets the current and future needs for City of Broken Hill. The upgraded infrastructure will thereby support existing and future residential and commercial/industrial development of the city, while minimising potential detrimental environmental and social impacts.

The Proposal

The proposed Wills Street STP Replacement Project is based on the preference of Essential Water to ultimately decommission both the existing Wills Street and South STP sites and construct a new Broken Hill STP (BHSTP) at the Wills Street site. The new BHSTP will be sized for the ultimate capacity of 24,000 Equivalent Population (EP) and service the entire city of Broken Hill. The preferred option at a high level is based on the *Broken Hill Sewage Treatment Plant (STP) Augmentation Concept Development* (PWA, 2019), and as further developed and refined by the 30% and 85% detailed design (Beca HunterH2O, 2024b; Beca Hunter H2O, 2025a; and Beca Hunter H2O, 2025b).

At a high level the proposal involves:

- Construction operation and maintenance of new STP infrastructure at the existing Wills Street STP, which will become the new BHSTP
- The new BHSTP will adopt Intermittently IDEA as the secondary treatment option and use aerobic digestion as the biological stabilisation process (i.e., sludge management option). The majority of the new BHSTP infrastructure will be positioned south of the existing Wills Street STP infrastructure, in place of the existing tertiary pond, which will be decommissioned as part of the proposal. Provision has been made for the inclusion of an appropriately sized photovoltaic system (i.e. solar farm) to offset electricity consumption and minimise greenhouse gas emissions from the new BHSTP
- Construction, operation and maintenance of a new sewer pump station at the existing South STP to collect the current South STP catchment sewage and pump it to the new BHSTP
- Construction, operation and maintenance of a new approximately 5.6 kilometre (km) long rising main between the South STP and the new BHSTP to transfer South STP catchment sewage to the new BHSTP
- Replacement of the existing treated effluent discharge pipe from the existing Wills Street STP to the existing licensed discharge point for a distance of approximately 1.2km.
- Decommissioning of redundant pieces of infrastructure at both former Wills Street and South STP sites.

Project Alternatives

One option would be to refrain from undertaking any upgrade of the existing Wills Street STP. The consequences of Essential Water doing nothing would be that the existing STP plant and equipment would continue to age, with a greater risk of faults and failure, ultimately leading to poorer water quality outcomes and likely not meeting licensed discharge limits. However, due to Essential Water's obligations to provide water and sewerage services that meet customers' needs for reliability, environmental protection and performance, including meeting the EPL requirements, the 'do nothing' option is not a viable alternative.

Essential Water has been planning for the upgrade and/or replacement of the existing Wills Street STP since 2009. A treatment plant augmentation options assessment was completed by GHD in 2011. Four options were considered, namely:

- Option 1 – Retain and refurbish both Wills Street and South STPs
- Option 2 – Decommission South STP and transfer its sewage to a refurbished Wills Street STP
- Option 3 – Decommission South STP and transfer its sewage to a new Wills Street STP
- Option 4 – Refurbish South STP and construct a new STP adjacent to the existing Wills Street STP

Option 3 was chosen as the preferred augmentation option, based on a newly constructed STP having improved service reliability levels over the existing STP infrastructure with refurbishment. A new STP would also provide the greatest flexibility for future upgrades to meet more stringent effluent treatment and workplace health and safety requirements.

In 2018 Public Works Advisory (PWA) investigated different treatment process options to replace/augment the existing STPs based on Augmentation Option 3 (GHD, 2019). Five different treatment option were considered, namely:

- Option 1: Intermittently Decanted Extended Aeration (IDEA)
- Option 2: Sequencing batch reactor
- Option 3: Continuous activated sludge
- Option 4: Membrane Bio-reactor (MBR)
- Option 5: "Nereda" technology.

PWA (2019) recommended an IDEA system as the preferred treatment option, due to it:

- Being able to meet the effluent quality requirements for the proposed reuse application
- Being robust and able to handle large variations in flow and influent quality
- Being relatively simple to operate compared to the MBR and continuous activated sludge processes
- Having a relatively small footprint and could be accommodated at the existing site
- Having low capital and operating cost
- Being a proven technology in NSW country towns.

In 2019 PWA prepared the *Broken Hill STP Augmentation Concept Development report* (PWA 2019) to present concept detail of sizing, design criteria, layout and operational features of the augmentation works based on the preferred augmentation and treatment options chosen above. The concept had proposed the new STP infrastructure be built to the east of the existing STP infrastructure.

Following on from concept development, Beca HunterH2O were engaged to prepare the detailed design for the proposal. As part of their preliminary review of the concept design, Beca HunterH2O interrogated the existing concept design based on up-to-date information and stakeholder preferences, resulting in several changes to the original concept design (PWA, 2019), including but not limited to:

- Adoption of aerobic digestion, significantly reducing potential methane (a potent greenhouse gas) emissions
- Abandonment of the existing tertiary pond, which currently leaks and is subject to algae growth that deteriorates effluent quality
- Relocation of new STP infrastructure to the south, avoiding encroachment further east towards residential receptors and challenging geotechnical conditions (i.e., hard rock) in the northwestern portion of the site.

The final overall preferred proposal, predominately based on 30% detailed design and as updated by the 85% detailed design, subject to assessment in this REF, is as follows:

- Replace the aging STP infrastructure at the existing Wills Street STP site with new STP infrastructure, decommission the South STP and transfer its sewage to the new BHSTP (Augmentation Option 3)
- Adopt an IDEA as the secondary treatment option (Treatment Option 1)
- Use aerobic digestion as the biological stabilisation process
- Relocate the majority of new STP at the new BHSTP, south of the existing STP infrastructure in place of the existing tertiary pond, which will be decommissioned.

The preferred proposal is based on delivering a safe, reliable, efficient and cost effective STP, that will enable sufficient sewage treatment for the entire City of Broken Hill, while meeting contemporary effluent discharge and effluent reuse criteria. The preferred proposal through design and implementation has the added benefits of retiring the South STP, minimising odour and greenhouse emissions, and other potential environmental impacts, while maximising social and economic impacts.

Statutory Planning and Legislation

State Environmental Planning Policy (Transport and Infrastructure) 2021 (T&I SEPP) consolidates and updates the planning process for transport and infrastructure projects. Clause 2.126(2) of the T&I SEPP allows development for the purpose of sewage treatment plants to be carried out without consent on land in a prescribed zone in the prescribed circumstances. The existing Wills Street and South STP sites are located within a prescribed zone, being Zone SP2 Infrastructure, according to the *Broken Hill Local Environmental Plan 2013* (Broken Hill LEP), and will be undertaken in prescribed circumstances, being carried out by or on behalf of a public authority.

Clause 2.126(6) of the T&I SEPP also allows for the development for the purpose of sewage reticulation systems to be carried out without consent on any land in the prescribed circumstances. Construction of the

proposed rising main and replacement of existing treated effluent discharge pipe will be carried out in the prescribed circumstances.

As the activity does not require development consent, Essential Energy is the designated determining authority. Additionally, whilst Essential Energy does not require development consent to undertake the proposed activity, it has an obligation under Part 5, Division 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) to consider the environmental impacts of the activity. Specifically, Essential Energy has a statutory obligation to examine and take into account, to the fullest extent possible, all matters affecting or likely to affect the environment by reason of this activity. This REF has been prepared to facilitate the determination through consideration of the relevant factors specified in Section 5.5 of the EP&A Act and Section 171 of the *Environmental Planning and Assessment Regulation 2021* (EP&A Reg).

Environmental Impact Assessment

A number of potential environmental impacts associated with the project have been avoided or reduced to acceptable levels during the design development and assessment stages. However, the project may still result in some impacts including air quality (odour and dust), noise and vibration, soil, water, vegetation, traffic, waste generation, and visual amenity during construction and operation, as outlined in **Section 6**. Management and mitigation measures to alleviate these impacts have been developed as part of this REF and would be implemented during construction and operation of the proposal. Cumulative impacts associated with other nearby developments, have been considered.

Considering the assessment of the impacts detailed in this REF, it is concluded that the proposed activity is not likely to have a significant impact on the environment. On balance, the project is justified on the basis of supporting a critical upgrade to the local sewage treatment and sewage reticulation network to meet the current and future needs for City of Broken Hill. The upgraded plant will ensure treatment of wastewater to a standard consistent with contemporary water quality targets, whilst minimising environmental and social impacts.

1. Introduction

1.1 The Proposal

This REF assesses the potential environmental impacts associated with the proposed Wills Street Sewage Treatment Plant (STP) Replacement Project ("the proposal"), which entails:

- Construction, operation and maintenance of new STP infrastructure at the existing Wills Street STP, which will become the new Broken Hill Sewage Treatment Plant (BHSTP)
- Construction, operation and maintenance of a new pumping station at the existing Broken Hill South STP (herein referred to as South STP)
- Construction, operation and maintenance of a new approximately 5.6 kilometre (km) long rising main between the South STP and the new BHSTP
- Replacement of the existing treated effluent discharge pipe from the existing Wills Street STP to the existing licensed discharge point for a distance of approximately 1.2km
- Decommissioning of redundant pieces of infrastructure, where required, at both STP sites.

The significance of impact has been determined and appropriate mitigation measures recommended.

1.2 Context and Justification of the Proposal

According to the 2021 census, the City of Broken Hill had a usual resident population of 17,588 people. It is currently serviced by two STPs, the Wills Street STP and the South STP. The plants are owned and operated by Essential Water, a business unit of Essential Energy.

The Wills Street STP was commissioned in 1939, upgraded in 1956 and again in the 1980's. This STP is at the end of its serviceable life and requires replacement to ensure ongoing compliance with the Environment Protection Licence (EPL) issued for the site by the New South Wales (NSW) Environment Protection Authority (EPA). Treated effluent from the Wills Street STP is reused by local mines, Broken Hill Golf Course, White Leeds artificial wetland, and several other end users. The South STP was built in the 1960's and is in a relatively poor condition reflecting of the age of the plant. This STP now requires significant remedial works to ensure reliable ongoing service and compliance with its EPL for discharges.

GHD (2009) prepared the *Wills Street STP Risk Based Asset Renewal Strategy Report*, which identified the STP to be in fair to poor condition with a remaining serviceable life of between 5 and 10 years. Subsequently, GHD (2011) prepared the *Broken Hill Wastewater Treatment Strategy Options Assessment* and identified that both existing plants would need to be decommissioned within 10 to 20 years, with a preferred option to decommission both existing STPs and construct a new STP at the Wills Street site, which would receive pumped transfers from the gravity sewage system currently discharging into the South STP.

Public Works Advisory (PWA) (2018a) prepared the *Broken Hill Sewerage Scheme Replacement of Wills Street and Southern STPs Options Study*, which confirmed the preference of Essential Water to decommission both existing STPs and construct a new STP at the Wills Street site and identified the Intermittently Decanted Extended Aeration (IDEA) as the preferred secondary treatment process. The PWA (2019a) *Broken Hill Sewage Treatment Plant (STP) Augmentation Concept Development* provided an increased level of detail for the preferred option, as did the PWA (2019b) *Broken Hill Sewerage Wills Street Sewage Treatment Plant Upgrade Geotechnical Investigation*.

In late 2022, Beca HunterH2O were engaged to commence work on detailed design. As part of this process, in early 2024, Beca HunterH2O (2024a) finalised the *Broken Hill STP Design Basis and Preliminary Concept Design Review Report*, which further developed and refined the PWA (2019a) concept design, based on up-to-date information and stakeholder preferences, including preferred sludge management options. In December 2024 Beca HunterH2O completed the 30% detailed design milestone and accompanying *Broken*

Hill STP Preliminary Concept Design Report (Beca HunterH2O, 2024b), which included revision of the proposed site layout to avoid hard rock in the northwestern portion of the existing STP site. This REF has been prepared largely based on the 30% detailed design milestone, with accompanying information provided in Beca HunterH2O (2024b), and as updated by the *Broken Hill WWTP Design Basis and Proposed Design Approach* (Beca Hunter H2O, 2025a) and 85% detailed design plans (Beca HunterH2O, 2025b).

Construction, operation and maintenance of the Wills Street STP replacement project will ensure the local sewage treatment infrastructure meets the current and future needs for City of Broken Hill. The modern plant will thereby support existing and future residential and commercial/industrial development of the city. The upgraded plant will ensure treatment of wastewater to a standard consistent with contemporary water quality targets, whilst minimising environmental and social impacts.

1.3 Proposal Objectives

The primary objectives of the proposal are to:

- Replace an 80 year old asset at the end of its useful life with a modern facility with additional capacity. The additional capacity at the new BHSTP will provide the opportunity to retire the much smaller, 65 year old South STP site
- Provide sufficient treatment to meet the NSW EPA effluent discharge and effluent reuse criteria
- Ensure that odour, aerosols and noise from the STP are appropriately controlled and managed to minimise their impact on workers and neighbours
- Ensure that the plant capacity is adequate for the projected population (load)
- Be cost effective when assessed on a life cycle cost basis
- Be capable of being constructed cost efficiently and within time constraints
- Provide durability and reliability of the intended function
- Maximise social and economic benefits
- Minimise the environmental and social impacts.

1.4 Proposal Site

The proposal site encompasses the existing Wills Street and South STPs, as well and the proposed route of the new rising main to be constructed to pump sewage from a proposed new pumping station at the South STP, the latter of which will be decommissioned and replaced by a pump station. The proposal site also includes the replacement of the existing treated effluent discharge pipe from the new BHSTP to the existing licensed discharge point south of Pinnacles Road, as well as upgrades to existing access roads, including construction access at the new BHSTP.

The proposal site is located in the southwestern and southern outskirts of Broken Hill, and entirely within the Broken Hill Local Government Area (LGA). Refer to **Figure 1** for the location of the proposal site within the regional context and **Figure 2** for the location of the proposal site in the local context.

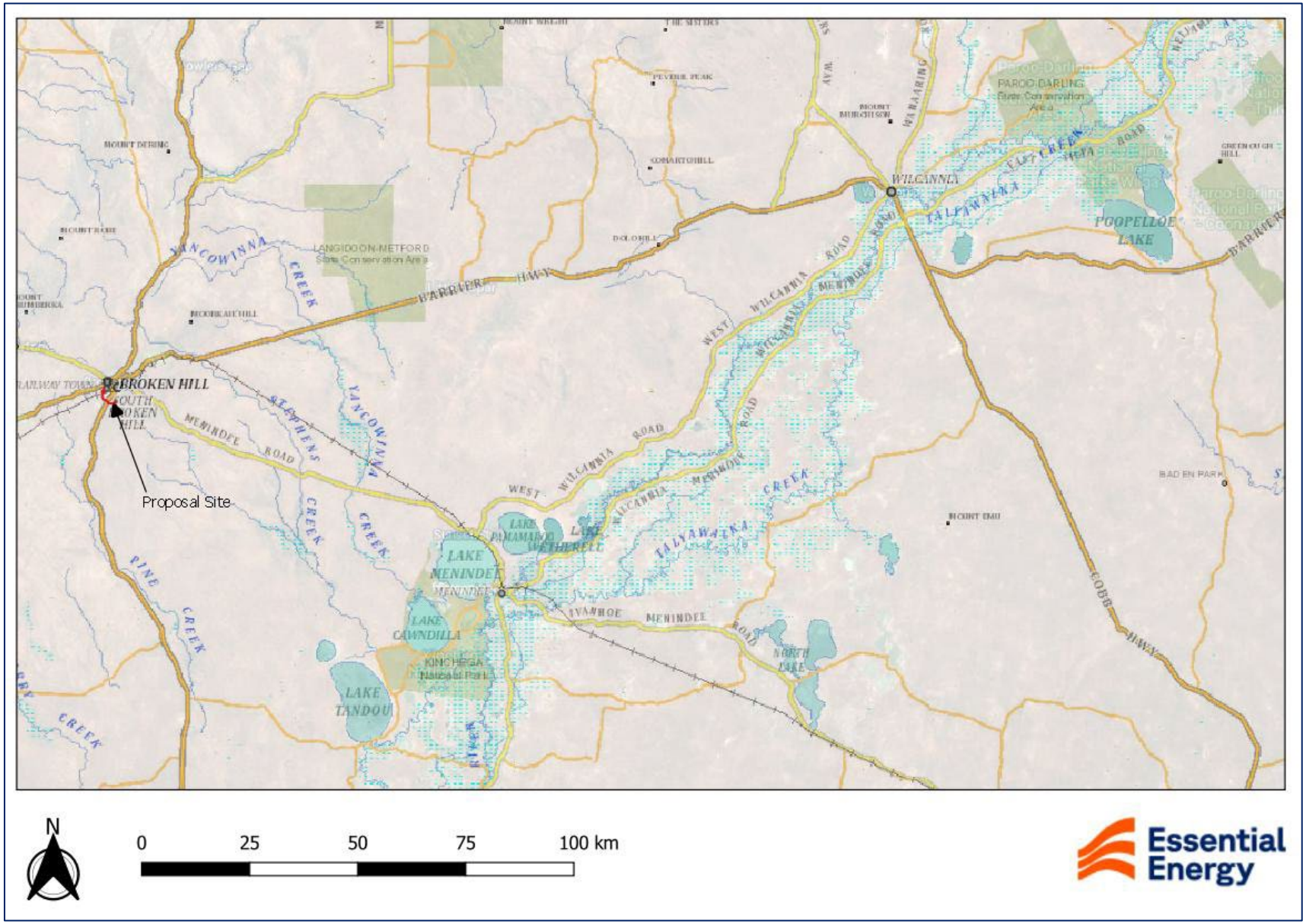


Figure 1: Proposal site in the regional context

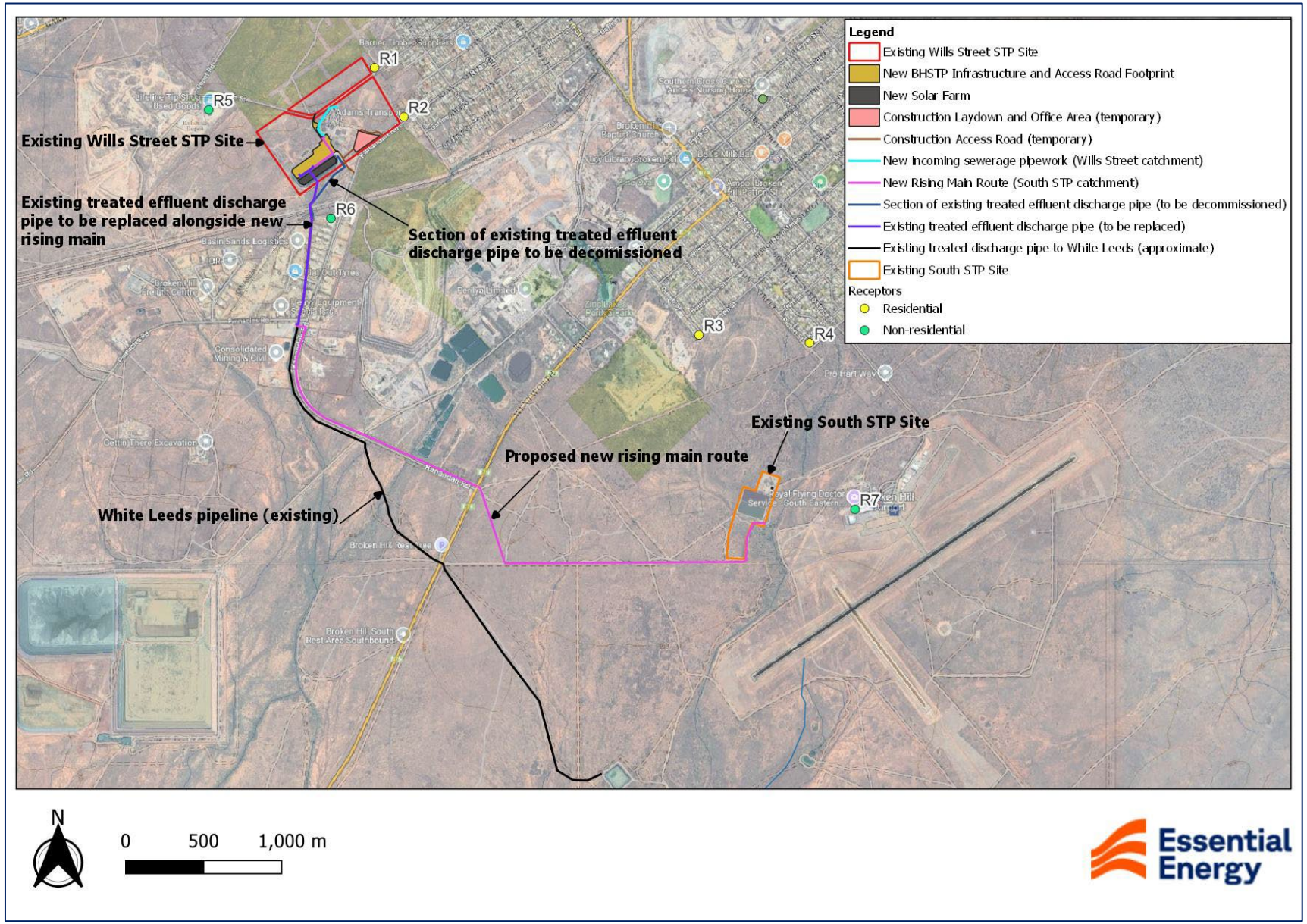


Figure 2: Proposal site in the local context

1.4.1 EXISTING WILLS STREET STP

The Wills Street STP is located at 33 Wills Street, Broken Hill, NSW. The site is owned by Essential Energy and is formally recognised as Lot 100 DP1136508. The lot is effectively split in two portions by Wills Street, which serves as the main access to the site. The portion south of Wills Street contains the main operational area of the existing STP.

The STP currently utilises a trickling filter with secondary treatment processes, comprising of:

- Manually raked screens
- Grit removal
- Primary sedimentation
- Trickling filtration
- Secondary sedimentation
- Anaerobic sludge digestion (i.e., open drying beds).

Tertiary treatment via residence time in a tertiary treatment pond, supplemented by additional ultraviolet (UV) treatment provides the final current effluent treatment prior to discharge.

Sewage is transferred to the STP by a conventional gravity sewerage system.

Most of the treated effluent produced at the existing Wills Street STP is supplied to reuse customers (for further details refer **Section 2.2.8**). The residual treated effluent is licensed for discharge to the ephemeral drainage line via an existing discharge pipe from the Wills Street STP to south of Pinnacles Road near the intersection with Kanandah Road.

A series of stormwater conveyance structures have been installed to separate on-site stormwater from the existing STP infrastructure and stormwater retention basins to manage stormwater flows off-site.

Refer to **Figure 3** for an overview of the existing Wills Street STP and **Figure 16** for the alignment of the existing treated effluent discharge pipe and licensed discharge point.

The immediate surrounding landscape of Wills Street STP comprises:

- Undeveloped large residential lots located immediately to the north, with undeveloped land beyond
- A mix of undeveloped lots and residential premises immediately to the east with further residential premises beyond
- Crown Land containing existing water and sewerage infrastructure and Kanandah Road immediately to the south, with Peterborough Broken Hill Railway and an industrial area beyond
- Crown Land immediately to the west, with the Broken Hill City Council (BHCC) Landfill and Waste Receival Facility beyond.

The Crown Land to the south and west forms part of the Willyama common. The common was established in 1888 for local people to graze their livestock close to their homes. It extended around the township for 8,700 ha. Part of the common was set aside as regeneration reserves in 1936 to protect the town and the mines from sand drift and dust storms. BHCC commissioned a Plan of Management for the Willyama Common in 2002 to facilitate integrating land management for conservation into their daily operational activities.

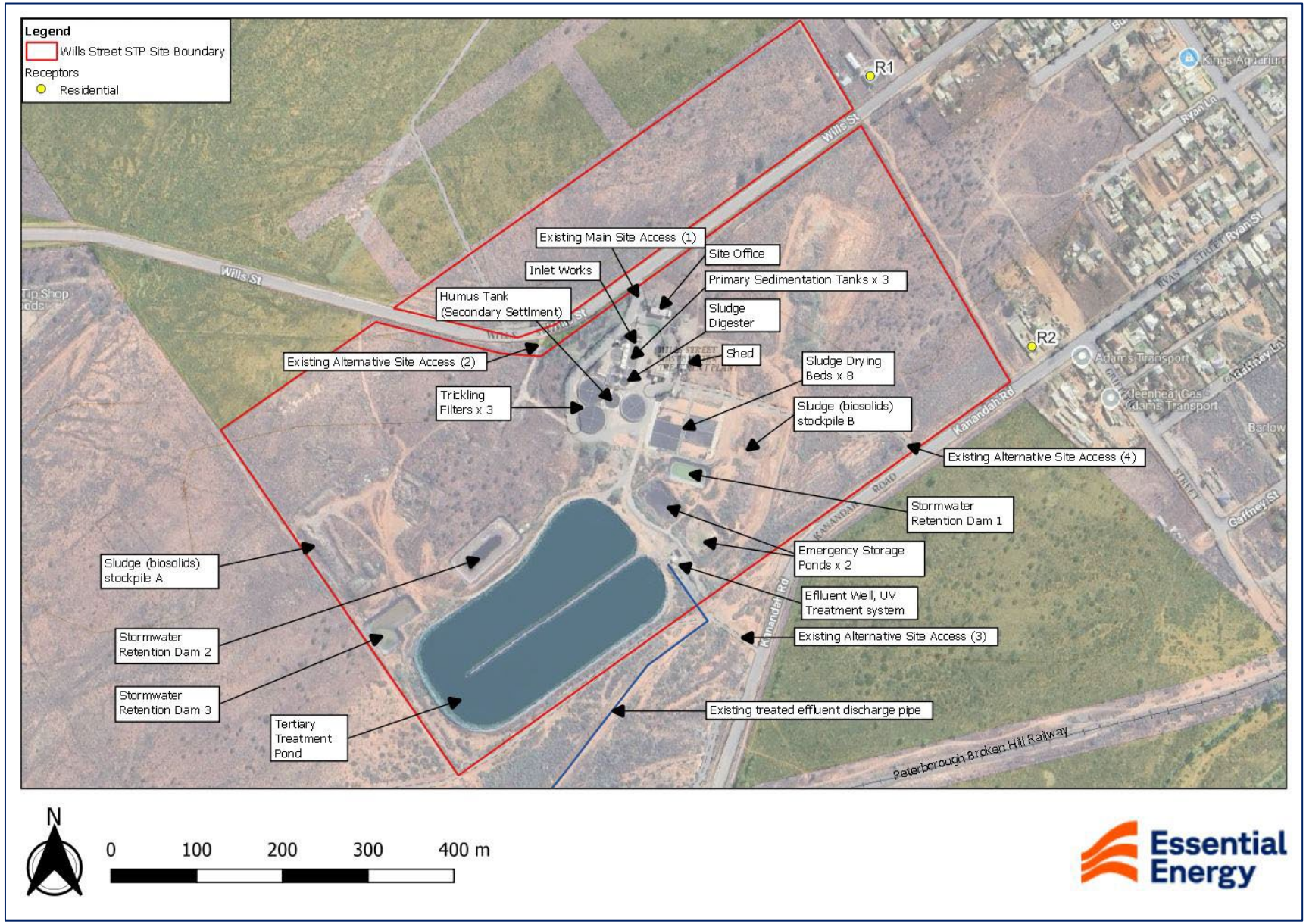


Figure 3: Layout of the existing Wills Street STP site

The closest sensitive (residential) receivers to the Wills Street STP are:

- 46 Wills Street located approximately 360m northeast of the existing Wills Street STP entrance and approximately 400m northeast of the existing STP inlet works (R1)
- 4 Ryan Street located approximately 450m southeast of the existing Wills Street STP entrance and approximately 350m east of the existing STP sludge drying beds (R2).

Both residential receivers are located approximately 30m east of the Wills Street STP lot boundary (refer **Figure 3**).

Non-residential receptors closest to the existing Wills Street STP site include:

- The Broken Hill Community Recycling Centre located at the western end of Wills Street, approximately 760m west of the Wills STP entrance and approximately 480m northeast of the STP sludge (biosolids) Stockpile A. A used goods shop is attached to the Recycling Centre which would be considered a commercial development (R5)
- Various light industrial properties on Kanandah Road, with the nearest of these properties located approximately 670m south of the existing Wills STP entrance, and approximately 240m southeast of the existing STP tertiary pond (R6)

Refer **Figure 2**.

The closest identified waterways to the Wills Street STP site are unnamed ephemeral drainage lines (Strahler first and second order streams), located approximately 160m south of the Wills Street STP's southern boundary on the opposite side of the Peterborough Broken Hill Railway. These drainage lines feed into Acacia Creek, approximately 2km south at its closest point.

1.4.2 EXISTING SOUTH STP SITE

The South STP is located at the southern outskirts of the Broken Hill township, west of the airport. The site is owned by Essential Energy and is formally recognised as Lot 1, 2 and 3 DP767329. Access is via a dedicated access road that commences at the end of Picton Road.

Similar to the Wills Street STP, the South STP is also currently utilising a trickling filter, with secondary treatment processes, comprising of:

- Manually raked screens
- Grit removal
- Primary sedimentation
- Trickling filtration
- Secondary sedimentation
- Anaerobic sludge digestion (open unheated tanks).

Tertiary treatment via residence time in tertiary ponds 1 and 2, provides the final current effluent treatment prior to discharge.

Sewage is transferred to the STP by a conventional gravity sewerage system.

Most of the treated effluent produced at the existing South STP is supplied to White Leeds. Residual treated effluent is licensed for discharge via an existing discharge pipe from tertiary pond 2 to an ephemeral drainage line approximately 60m east of the eastern lot boundary.

Refer to **Figure 4** for an overview of the existing South STP site and licensed discharge point.

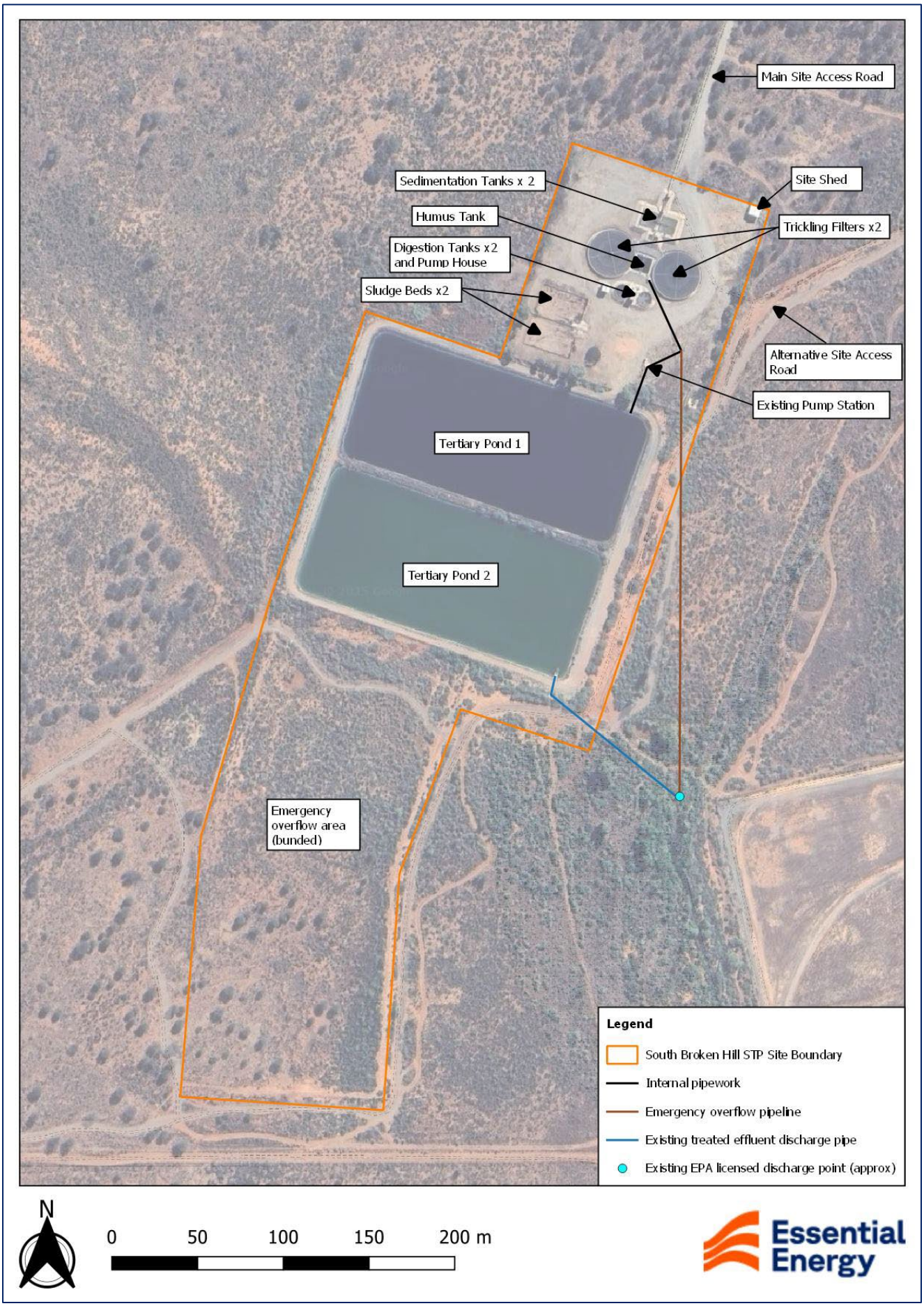


Figure 4: Layout of the existing South STP site

The immediate surrounding landscape of the South STP comprises predominately Crown Land (i.e., the Willyama Common), with the Broken Hill Airport boundary approximately 300m to the east.

The closest sensitive (residential) receivers to the existing South STP are:

- 1 Queen Street located approximately 1000m northwest of the existing South STP entrance and inlet works (R3)
- 55 Knox Street located approximately 560m northeast of the existing South STP entrance and inlet works (R4)

Non-residential receptors closest to the existing South STP site include:

- The Royal Flying Doctor Service adjacent to the airport approximately 570m southeast of the existing STP entrance and inlet works (R7).

Refer **Figure 2**.

The closest identified waterways to the South STP site are unnamed ephemeral drainage line (Strahler second stream), located approximately 70m east of the STP's eastern boundary at its closest point. This drainage line feeds into Acacia Creek, approximately 1.8km south of the southern boundary of the STP at its closest point.

1.4.3 PROPOSED RISING MAIN ROUTE

The proposed route of the rising main to be constructed between the existing South STP and new BHSTP, will follow an existing unsealed road within the Willyama Common, as it exits the South STP, heading in a southern and then westerly direction, before joining with Kanandah Road, at the intersection with the Silver City Highway. From here the route follows Kanandah Road northwest and north before heading west along Kanandah Place in the industrial estate, then entering a drainage easement and heading north to the new BHSTP. Within the drainage easement, the rising main will largely follow the existing treated effluent discharge pipeline from the current Wills Street STP, which will also be replaced. The proposed new rising main route will be approximately 5.6km long.

Refer **Figure 2** for an overview of the proposed route of the new raising main.

1.4.4 EXISTING TREATED EFFLUENT DISCHARGE PIPE

The existing treated effluent pipe from the Wills Street STP to the current licensed discharge point will be upgraded and replaced with a DN630 pipe (i.e., 630mm diameter) from a current average diameter of approximately 300mm, to service to the new BHSTP, largely in its current location for an approximate distance of 1.2km.

Refer **Figure 3** and **Figure 16** for an overview of the existing and proposed effluent discharge pipe routes. Further discussion on the existing and proposed upgrades to the discharge pipe and route is provided in **Section 2.3.3.6**.

1.4.5 ACCESS

The proposal site can be accessed via the existing road network, including sealed roads of Wills Street, Kanandah Road, Silver City Highway and Picton Street, and unsealed roads with the Willyama common. Both the existing Wills Street and South STP's have dedicated existing site access roads, which will be maintained during construction and demolition phases. It is proposed to upgrade existing alternative site access roads at Wills Street STP to facilitate construction access, and future operational access for the new BHSTP.

Refer **Section 2.3.5** and **Section 6.13** for further information and assessment of impact on access and traffic.

1.5 Study Area

The broader study area includes the surrounding predominately cleared and disturbed residential, industrial and rural areas of Broken Hill. Sensitive environmental areas within the broader region include waterways, wetlands, areas with biodiversity values, Aboriginal and non-Aboriginal heritage, and other environmental values, that form part of the immediate surrounding landscape.

1.6 Purpose of the REF

The purpose of this REF is to document the assessment of potential environmental impacts of the proposal and identify if there are likely to be any significant environmental impacts. It informs Essential Energy's determination of the proposal under Part 5, Division 5.1 of the EP&A Act.

2. Description of the Proposal

2.1 Overview of the Proposal

The proposed Wills Street STP Replacement Project is based on the preference of Essential Water to ultimately decommission both the existing Wills Street and South STP sites and construct a new STP at the Wills Street site (i.e., the new BHSTP). The new BHSTP will be sized for the ultimate capacity of 24,000 EP and service the entire city of Broken Hill. The preferred option at a high level is based on the Broken Hill Sewage Treatment Plant Augmentation Concept Development (PWA, 2019a). This has been further developed and refined by the 30% detailed design and accompanying *Broken Hill WWTP Preliminary Concept Design Report* (Beca HunterH2O, 2024b) and as updated by the *Broken Hill WWTP Design Basis and Proposed Design Approach* (Beca Hunter H2O, 2025a) (refer **Appendix A**) and 85% detailed design plans (Beca HunterH2O, 2025b).

The new BHSTP plant will be constructed separately to the existing Wills Street STP infrastructure to enable the existing Wills Street STP to operate during the construction of the new BHSTP infrastructure.

Key aspects of the proposal are summarised as follows:

2.1.1 UPGRADE AND REPLACEMENT OF STP INFRASTRUCTURE AT WILLS STREET

- Preliminary Treatment – screening and grit removal, including screening and grit washing and dewatering. The new inlet works structure will contain an inlet receival chamber (receives flow from the rising mains, the foul water pump station, septage pump station and emergency return pumping), automatic and manual bypass screen channels, a vortex grit chamber, and a flow distribution chamber
- Secondary Treatment – two Intermittent Decanted Extended Aeration Tanks (IDEAT) bioreactors for organics oxidation, biological nitrogen removal and phosphorus removal (through microorganism growth and chemical precipitation by alum dosing). Sodium hydroxide dosing is provided for pH correction
- Space on-site will also be allowed for an external carbon dosing system
- An effluent balance tank for attenuation of high IDEAT decanted effluent flows with a lift pump system to feed the treated effluent UV disinfection system for disinfection
- Outfall discharge-Disinfected effluent from the effluent UV system and the UV bypass flow (likely occurring during wet weather season) will be delivered to White Leeds and/or the existing open earth discharge location through upgraded pipelines via gravity
- Tertiary Treatment – a portion of the secondary treatment effluent will be further treated via a pre-validated UV system and a chlorine contact tank (CCT) to provide recycled water quality suitable for site service water and the existing end users' applications
- Excess sludge generated by the secondary process will be wasted to a three-cell aerobic digester for stabilisation via the waste activated sludge (WAS) pumps. A floating decanter is fitted in the first cell of the aerobic digester to achieve some level of sludge thickening. The digested sludge will be dewatered via a mechanical dewatering facility
- Emergency Storage Pond – an emergency pond is provided for any unintended situations (screens or grit removal maintenance, failure of effluent decanters, overflow of effluent balance tank, poor treated effluent water quality), an emergency flow return pump station shall be provided to return the emergency flow to the head of the plant for further treatment
- Odour control- an odour control unit to be provided to treat foul air from the headspace of the inlet works
- The existing gravity main to current Wills Street STP will be diverted to the new Preliminary Treatment inlet works.
- Discharge pipeline – replacement of the existing treated effluent discharge pipeline.
- Decommissioning of redundant assets, where required, at the current Wills Street STP.

2.1.2 SOUTH STP RAW SEWAGE TRANSFER TO WILLS STREET STP

- A sewer pump station is to be provided to collect the current South STP catchment sewage and transfer it to the new BHSTP inlet receival chamber via a new rising main. The new pump station and associated pipework is proposed to be located within the disturbed footprint of the existing South STP, likely near the existing site shed in the northeastern portion of the STP site and along the eastern boundary (refer **Section 2.3.3.1**)
- Construction of an approximately 5.6km, mostly underground (approximately 1m-1.5m deep) 200mm diameter new rising main between Will Street STP and the decommissioned South STP
- Decommissioning of redundant assets at the South STP.

2.2 Basis of Design

The adopted design criteria for the proposal is largely based on the 30% detailed design and accompanying *Broken Hill WWTP Preliminary Concept Design Report* (Beca HunterH2O, 2024b), and as updated by the *Broken Hill WWTP Design Basis and Proposed Design Approach* (Beca Hunter H2O, 2025a) (refer **Appendix A**). The basis of design is summarised in the following sections.

2.2.1 DESIGN HORIZON

The proposed project design horizon is to provide capacity for projected 2048 loads.

2.2.2 CONNECTED POPULATION

The STP catchment population projections have been established by Essential Water and form part of the Integrated Water Cycle Management Strategy (IWCMS) (PWA, 2022) and also defined in the PWA (2018a) *Broken Hill Sewerage Scheme Replacement of Wills Street and Southern STPs Options Study.*

From Billing data analysis, the connected Equivalent Population (EP) to Wills Street STP and South STP is estimated at 18,465 and 4,879 respectively, with the combined total EP of 23,344 (PWA, 2018a).

A catchment loading of 24,000 EP has been adopted for the design, consistent with the PWA (2018a). Selecting a design loading so close to the current loading was proposed as the population in Broken Hill has been stable or decreasing for at least the last 20 years.

2.2.3 EFFLUENT QUALITY REQUIREMENTS

2.2.3.1 Current Environmental Protection Licence (EPL) Requirements

The Wills Street and South STPs operate under the following licences:

- EPL 3925 Wills Street Wastewater Treatment Plant
- EPL 5067 South Wastewater Treatment Plant

Table 1 summarises the concentration and load limits for each STP.

Table 1: Summary of Existing Environment Protection Licence Requirements for Each STP

PARAMETER	UNITS	WILLS STREET STP (EPL 3925)	SOUTH STP (EPL 5067)
Effluent Quality Requirements			
Biochemical Oxygen Demand (BOD)	mg/L	50	50
Faecal Coliforms	cfu/100mL	-	600
Nitrogen (Ammonia)	mg/L	-	-
Nitrogen (Total)	mg/L	-	-

PARAMETER	UNITS	WILLS STREET STP (EPL 3925)	SOUTH STP (EPL 5067)
Oil and Grease	mg/L	10	10
pH	pH units	6.5-8.5	6.5-8.5
Phosphorus	mg/L	-	-
Total Suspended Solids (TSS)	mg/L	50	50
Effluent load Limits			
BOD	kg/annum	14,900	2,400
Nitrogen (Total)	kg/annum	27,558	5,000
Oil and Grease	kg/annum	3,300	1,000
Phosphorus (Total)	kg/annum	10,800	2,450
TSS	kg/annum	37,450	4,900

The EPL for Wills Street STP will be updated as part of the proposal. The South STP will be decommissioned and replaced with a pump station. All effluent will be directed to the new BHSTP. Preliminary advice received from the EPA in 2022 indicated there would be just one EPL, for the new BHSTP, which will include the augmented sewerage infrastructure connecting to it from the former South STP.

The licensed discharge volumes are 18,150 kilolitre (kL)/day and 3,628kL/day for the existing Wills Street STP and South STP, respectively.

2.2.3.2 Proposed Water Quality Discharge Requirements

The PWA (2019a) concept development report proposed revised effluent quality criteria for the new BHSTP. The limits presented in the PWA (2019a) concept design were reported to represent the accepted modern technology criteria for discharge to inland waters. It is important that reasonable limits are implemented that protect the environment and receiving water, while facilitating the practical operation of the STP. These limits are presented in **Table 2**. Ultimately the licence limits will be set by the NSW EPA.

Table 2: Proposed New EPL Effluent Discharge Licence Concentration Limits for new BHSTP

PARAMETER	UNITS	100TH PERCENTILE LIMIT
Biochemical Oxygen Demand (BOD)	mg/L	20
Total Suspended Solids (TSS)	mg/L	30
Ammonium Nitrogen, NH3-N	mg/L	5
Total Nitrogen, TN	mg/L	20
Total Phosphorus, TP	mg/L	2
Oil and Grease, O&G	mg/L	10
pH	pH unit	6.5-8.5
Faecal Coliforms	Org/100mL	600

The design intent of the new BHSTP is to achieve the 100th percentile limits up to nominally three times ADWF. When the inflow is greater than three times ADWF, as would occur in a wet weather event, the level of treatment is reduced which may lead to contaminant concentrations more than the 100th percentile

limits shown in **Table 2**. It is understood that the NSW EPA recognises that a STP will from time to time exceed its licence limits, including during wet weather events. Demonstration of this recognition will be sought in the revised EPL for the new BHSTP.

A process flow diagram showing the proposed flow and quality monitoring points for the new BHSTP is provided in **Figure 5**.

2.2.4 FLOW LOADINGS

Design flow loadings have been established utilising existing data and projections based upon standard ratios between average dry weather flow (ADWF), peak dry weather flow (PDWF), peak wet weather flow (PWWF) and peak instantaneous flow (PIF). Any hydraulic flow distribution has been sized for the adopted design EP.

A summary of the design flows for the new BHSTP is provided in **Table 3**. Detailed analysis provided by Beca HunterH2O (2025a) (refer **Appendix A**).

Table 3: Design Flows for the Upgraded Wills Street STP

PARAMETER	UNITS	VALUES
Hydraulic Contribution	L/EP/d	200
Current EP	EP	23,344
Current Average Dry Weather Flow (ADWF)	kL/d	3,694
Design EP	EP	24,000
Design Average Dry Weather Flow (ADWF)	kL/d	4,800
PDWF: ADWF	-	1.8
Design Peak Dry Weather Flow (PDWF)	kL/d	8,640
Fully treatment plant influent flow: ADWF		3.0
Fully treatment plant influent flow	kL/d	14,400
PIF: ADWF	-	8
Design Peak Instantaneous Flow (PIF)	L/s	444

2.2.5 SEWER LOADINGS

Limited historical raw sewage sampling data was available for review. A 72-hour raw sewage flow monitoring and composite sampling program was undertaken by PWA during August of 2018, the results of which are presented in Beca HunterH2O (2025a) (refer **Appendix A**), and summarised in **Table 4** (referred to as EW Data 2018).

Beca HunterH2O (2025a) review of this data indicated that the BOD testing result was much lower than what would be anticipated for typical domestic sewage. Although this can be encountered in sewage catchments where there are trade waste contributions, no significant trade waste contributors are known for the catchments. Further, the Total Kjeldahl Nitrogen (TKN) per EP contribution appears to be typical for domestic sewage.

Chemical Oxygen Demand (COD) is important to complete the nitrogen removal cycle. Typical domestic sewage will generally have a COD:TKN ratio of at least 10. If COD is limited in the raw sewage, then removal of oxidised nitrogen is difficult. The sampling data on day 3 shows a COD:TKN ratio of 8.9. With a low COD:TKN ratio of 7.5 it would be expected that the current treatment process would struggle to achieve the TN licence limit of 10 mg/L without external carbon dosing. A footprint will be provided within the new BHSTP for incorporating an external carbon storage and dosing system if it is deemed required in the future.

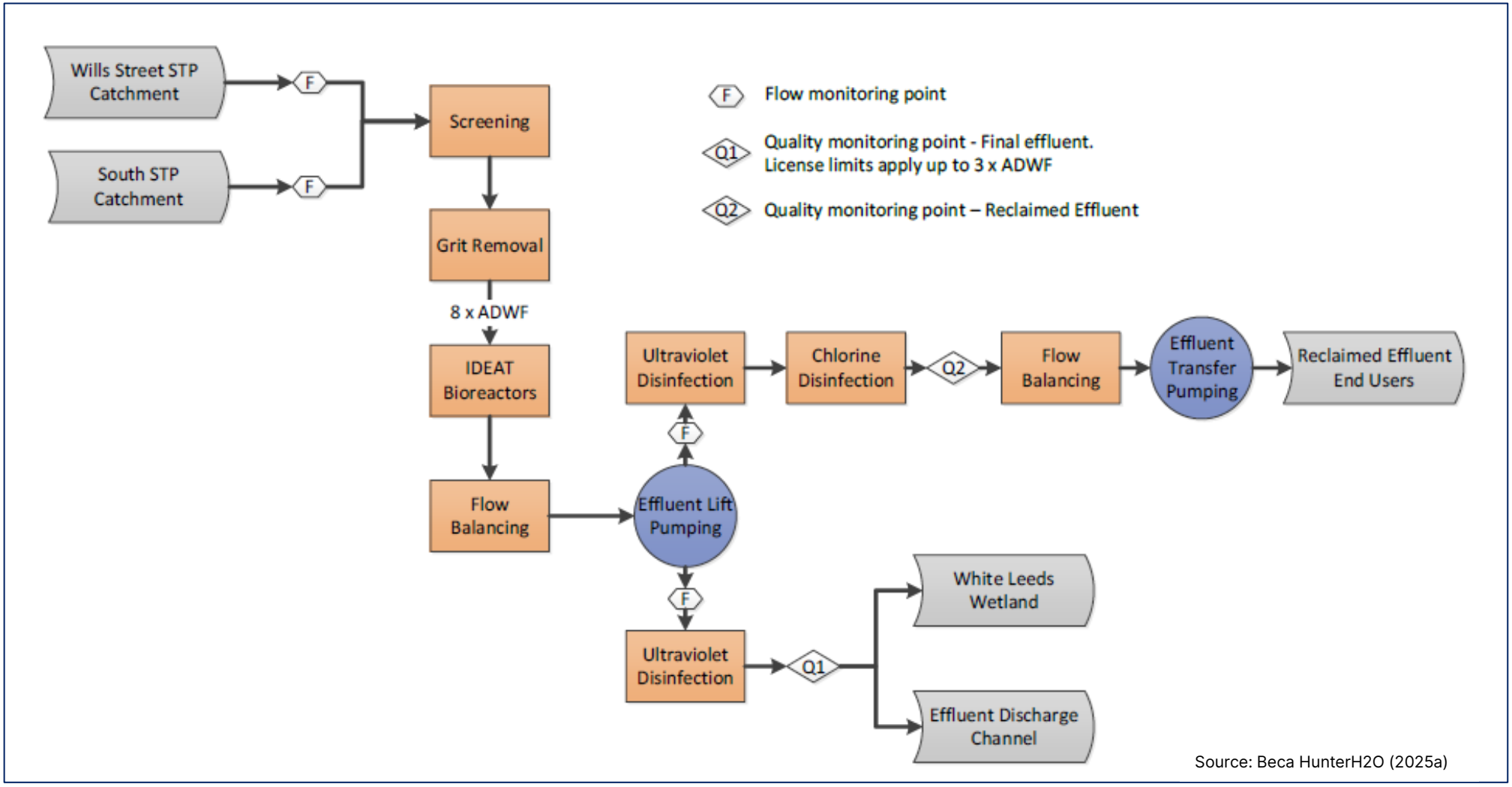


Figure 5: Process flow diagram, proposed flow and monitoring points.

The calculated sewage loading was lower than the typical sewage loading. However, considering there is only 3 days sampling/testing available and uncertainty of the testing results, a more typical sewage loading with higher per EP loads has been adopted for the design as summarised in **Table 4.**

In the absence of longitudinal data, a peak monthly loading factor of 1.2 has been adopted for the calculation of peak aeration demand and sludge production (Beca HunterH2O, 2025a).

Table 4: Typical Sewage Loading and Adopted Raw Sewage Characteristics for Design

PARAMETER	TYPICAL DOMESTIC SEWAGE (g/EP/day)	EW DATA 2018 (mg/L)	EW DATA 2018 (g/EP/day)	ADOPTED FOR DESIGN (g/EP/day)	EQUIVALENT CONC. (mg/L)[1]
Number of Samples	-	18	18	-	-
Chemical Oxygen Demand (COD)	120 – 150	618	98	125	625
Biological Oxygen Demand (BOD5)	50 – 70	183	29	58	290
Total Suspended Solids (TSS)	60 – 70	349	55	65	325
Total Kjeldahl Nitrogen (TKN)	10-15	67	10.6	13.4	67
Ammonia Nitrogen	7.5-12	49.3	-	10	50
Total Phosphorus (TP)	1.8-2.5	12.5	2.0	2.2	11
Alkalinity[2]	-	426	-	-	425

1. The equivalent concentration was calculated based on the flow loading of 200L/EP/d.
2. Essential Water advised there was changeover of the source water for the Mica Street Water Treatment Plant from the Darling River to the Murray River in 2019. The treated alkalinity, which used to be between 150 to 200mg/L, dropped down to below 50mg/L. To make sure that the caustic dosing is not undersized, a 220mg/L inlet alkalinity was used in the design.

2.2.6 SEWAGE FRACTIONS

Modern design practices and process modelling require sewage characteristics to be broken into fractions and ratios. In the absence of additional raw sewage data and characterisation, the values developed and presented in **Table 5** below were adopted as the basis for the process design.

Table 5: Adopted Raw Sewage Fractions

CHARACTERISTIC	KNOWN AS	ADOPTED RATIO	COMMENTS
Fraction of COD which particulate and non-biodegradable	fup	<=0.20	Typical. Higher values will increase sludge production
Fraction of COD which biodegradable and soluble)	fbs	>=0.15	Typical. Higher values improve nitrogen removal
Unbiodegradable soluble nitrogen	fnus	<=0.020	Typical
COD/TKN		>=9.3	Calculated from the 3 days sampling results

The design has assumed the raw sewage doesn't contain any toxic substances that could inhibit the biological metabolic process and nitrification.

2.2.7 TANKERED WASTE

The current Wills Street STP does not receive tankered waste. Essential Water wish to provide facilities to receive tankered waste. In the absence of monitoring data, septage characteristics for the purpose of design have been adopted and are presented in **Table 6** below.

Table 6: Adopted Raw Sewage Fractions

PARAMETER	UNITS	VALUE	COMMENTS
Flow (daily) Flow (weekly)	m^3/d $m^3/week$	10 50	Maximum daily receival flow. Maximum weekly receival flow
COD	mg/L	25,000	The composition of septic waste can be extremely varied, with contaminant concentrations ranging from very dilute to extremely high, a typical characteristic is adopted and assumed to be very similar to other council areas
BOD	mg/L	4,000	
TSS	mg/L	20,000	
ISS	mg/L	6,000	
TKN	mg/L	1,200	
TP	mg/L	500	
Fup	ratio	<=0.75	Non-biodegradable particulate COD to total COD ratio

2.2.8 TREATED EFFLUENT REUSE

2.2.8.1 Current Reuse Scheme

Most of the treated effluent produced at the existing Wills Street STP is supplied to reuse customers. The residual treated effluent is licensed for discharge to the ephemeral drainage line south of the existing Wills Street STP.

There are eight recycled water customers, details of which are summarised in **Table 7**. The daily average and 95%ile daily recycled water consumptions (excluding White Leeds water usage) were 1,397kL/d and 2,176kL/d respectively based on historical flow data (2011-2022).

Table 7: Current Recycled Water End Users

RECYCLED WATER CUSTOMER	MAXIMUM ANNUAL VOLUME SUPPLY (ML)	WATER USE PURPOSE	FLOW REQUIREMENTS
White Leeds	Up to 750*	Visual amenity wetlands and education. Garden Watering (Subsurface irrigation).	Target (<23L/s). Alert (>23L/s). Critical (>35L/s). .
Perilya Mines	100	Open space irrigation, ovals and picnic areas.	Mines 1: Daily average of 426kL/d and 95%ile 595kL/d. Mines 2: Daily average of 79kL/d and 95%ile 348kL/d.
Broken Hill Golf Club	270	Open space golf course irrigation.	Varied from 600-1,430kL/d

RECYCLED WATER CUSTOMER	MAXIMUM ANNUAL VOLUME SUPPLY (ML)	WATER USE PURPOSE	FLOW REQUIREMENTS
			821kL/d at average 1,357kL/d at 95%ile from flow analysis.
Broken Hill Racetrack	10	Open space lawn watering. Dust control on racetrack. Caravan camping on lawns.	
Picton Plants	10	Wholesale / retail plant nursery disability employment.	
Rogers Horse Stud	10	Irrigation of horse paddocks.	
Broken Hill Council	10	Dust suppression at tip.	
Cristal Mineral Sands (Bemax)	30	Sand processing / washing Irrigation of trees.	71kL/d at average. 199kL/d at 95%ile from flow analysis

* White Leeds receives up to 750ML/year from a combination of Wills Street and South STPs

The treated effluent reuse system has been designed with the capacity to suit the current end users (excluding White Leeds), site service water and provision for future filtration backwash water applications.

The treated effluent discharged to White Leeds wetland system needs to meet pathogen requirement as shown in **Table 8**. Discharges to White Leeds and the licensed discharge do not require chlorination under typical operating conditions. Treatment process and on-site end-use controls (or non-treatment barriers) implemented for the current reuse scheme should comply with the Australian Guidelines for Water Recycling (AGWR) specified water quality for municipal open space and/or dust suppression.

2.2.8.2 Future Reuse Scheme

The new BHSTP and associated treated effluent reuse scheme will require approval. The scheme will need to comply with the NSW Department of Climate Change, Energy, The Environment and Water (DCCEEW) requirements. The requirements include a risk assessment, based on the framework from the AGWR, which would include the scheme stakeholders including staff from Essential Water (management and operations personnel), end users NSW Health, DPE, and NSW EPA.

2.2.8.3 Treated Effluent Reuse Quality

Guidelines for recycled water quality, critical control points Log Removal Values (LRV) credits for the various treatment process units are provided in the *Australian Guidelines for Water Recycling* (EPHC et al, 2006) and *Recycled Water Guidance Document Recycled Water Management Systems* published by the NSW Department of Primary Industries (DPI), Office of Water (2015). The most appropriate LRV targets for the Broken Hill scheme have been based on a "Municipal irrigation with uncontrolled access" scenario.

A dedicated recycled water facility including a pre-validated UV system and CCT will be provided to achieve the LRV targets as shown in **Table 8**. A minimum design UV Transmissivity of 40% has been adopted. This represents a conservative figure compared to secondary effluent produced from other similar STP plants (e.g., Parkes and Cowra STPs).

Table 8: LRV Targets Per Process Unit for the New BHSTP

PARAMETER	PROTOZOA (P)	VIRUS (V)	BACTERIA (B)
Unrestricted Municipal Reuse LRV Target	**3.7**	**5.2**	**4.0**
Process Units			
Achieved Through Biological Process	0.5	0.5	1.0
Achieved Through Validated UV Disinfection*	3.5	1.0	4.0
Achieved Through Chlorination**	0.0	4.0	4.0
Achieved By Process	**4.0**	**5.5**	**9.0**

*LRV target with turbidity <2NTU and minimum of UVT 40%.
**LRV target with CCT value of 16mg/L/min (assume turbidity <2NTU, pH<=8, Temperature>=10°C)

2.2.9 BIOSOLIDS MANAGEMENT

The new BHSTP will target NSW EPA (2000) *Environmental Guidelines Use and Disposal of Biosolids Products* stabilisation Grade B for the biosolids produced.

As the result of optioneering and analysis, aerobic digestion for sludge stabilisation with permanent mechanical dewatering of sludge was chosen as the preferred biosolids management option. The aerobic digestion process will be designed to meet the Standard Oxygen Uptake Rate (SOUR) requirement of 1.5mgO_2/h/gTS. It is noted that the aerobically digested sludge may still be odorous, especially if it is stored on-site for an extended period, during its transfer for off-site disposal, or in the wet season when the sludge is wet. Additional contingency in the design aerobic digester residence time has been applied to help manage the risk of odour.

Provided the contamination grade exceeds Class C, the produced biosolids will be suitable for agricultural reuse. If they do not exceed Class C, the biosolids produced by the plant will need to be stockpiled on an existing constructed concrete containment slab before off-site disposal.

2.2.10 ODOUR

An odour impact assessment (Environ Odour, 2025) was completed for the new BHSTP. Several scenarios were modelled which reflected various sludge management options initially being considered. The odour contour modelling results indicated that the existing Wills Street STP and all sludge management scenarios are within the adopted odour assessment criteria of 5 Odour Units (OU). However, the aerobic digester option, the preferred sludge management option adopted for the proposal, has the least odour impact. The odour impact from the preferred sludge management option, and positioning of the STP infrastructure over the existing tertiary ponds, is considerably smaller than that currently being produced by the existing STP infrastructure.

Further discussion and assessment of odour impacts is provided in **Section 6.1**, and **Appendix B.**

2.2.11 NOISE

A noise impact assessment (Bridges Acoustics, 2025) was completed for the new BHSTP. Noise modelling showed predicted operational noise levels to be substantially lower than the noise criteria during all time periods, including the effect on noise propagation of temperature inversions and winds during the evening and night periods. Low frequency, tonal, and sleep disturbance noise impacts are unlikely to occur at any receptor. Some construction noise impacts are likely but can be managed through implementation of reasonable and feasible mitigation and control measures.

Further discussion and assessment of noise impacts is provided in **Section 6.4**, and **Appendix C**.

2.2.12 TEMPERATURE

The minimum reactor temperature is critical to ensure the ammonia-n limits are achieved in winter. Broken Hill experiences cold winters and is located inland and approximately 400km away from the South Australian coastline, with an average minimum temperature of as low as 4.8 degrees Celsius (BOM, 1991-2020). A conservative minimum value of 14 degrees Celsius has been adopted which is consistent with data available from comparable locations in the same region. A sludge retention time (SRT) of 25 days will be adopted in the design to promote process stability and achieve ammonia limits at minimum mixed liquor temperature.

2.3 Design Description

2.3.1 PROCESS DESCRIPTION

The new inlet receival chamber at the new BHSTP will receive gravity flow from the existing catchment, pumped flow from the new South SPS, and foul water return flow, tankered septage waste, and emergency storage pond return flow. All the flows will pass through two mechanical screens for screenings removal. The screened raw sewage would then flow into a vortex grit chamber for grit removal. The screened and de-gritted raw sewage from the grit chamber outlet passes to a flow distribution chamber where the flow is distributed between two IDEAT via a fixed equal-length weir.

Screenings from each screen are washed via inbuilt spray nozzles, compacted via its compaction head and discharged into a common screenings bin via a screw conveyor. The collected grit is intermittently transferred from the grit chamber to a grit classification system for grit washing and cleaning.

The IDEAT treatment process comprises three distinct phases:

- Aeration – the tanks are aerated to provide sufficient Dissolved Oxygen (DO) for bacteria to nitrify influent ammonia, and ensure inflows are thoroughly mixed with the biomass and phosphorus precipitation chemicals.
- Settle – aeration ceases, and biomass begins to settle to the base of the reactor. Residual DO is consumed and bacteria commence denitrification of nitrates generated in the aeration phase.
- Decant – effluent is decanted from the top of the liquid column while the biomass is retained within the reactor. Denitrification continues until aeration recommences at the conclusion of the decant phase.

The IDEATs are designed to accommodate all possible flow scenarios. Under dry weather conditions, the IDEAT cycles are governed by fixed phase lengths. The cycle times are designed to be out of phase (i.e., decants occur halfway through the other tank's cycle). This assists with flow attenuation within the effluent balance tank by preventing simultaneous decanting during dry weather flow conditions.

During wet weather events, the cycle length must be reduced to provide adequate treatment at higher flows. A 'storm level switch' initiates the Settle Phase for that tank once triggered and this provides sufficient sludge settling time prior to decant to limit biomass scouring.

Aeration is provided by a series of four low-speed surface aerators per tank. Surface aerators are a proven technology in small scale intermittent processes and offer low capital and maintenance costs compared with other technologies (for example diffused aeration systems). Variable speed drives on the aerators enable the oxygen transfer rate and power usage to be adjusted to suit increasing plant loads. Dual DO probes within each tank are used to control aerator operation and monitor plant performance.

The aeration system is designed to cater for diurnal peaks in oxygen demand that occurs during periods of high dry weather flow. It is expected the plant still meets the required effluent quality when one aerator (per tank) is unavailable.

Two rotary decanters will be mounted at the end of each IDEAT. The decant weir is variable speed and moves at full speed from the park position above the Top Water Level (TWL) to the liquid level (as indicated by a switch mounted to the decanter) once the decant phase commences. Once the liquid height is reached, the decanter speed is adjusted to achieve the Bottom Water Level (BWL) at the conclusion of the

decant phase. The decanter then returns at maximum speed to the park position. Secondary treated effluent enters the decanters and discharges into the effluent balance tank.

To improve sludge settleability and overall nitrogen removal performance, a bio-selector is included for each IDEAT. The bio-selector receives screened and de-gritted raw sewage and returned mixed liquor via Return Activated Sludge (RAS) pump stations. A coarse bubble mixing system will be supplied to provide pulse mixing in the bio-selector. Alum and Caustic will be dosed to each IDEA reactor for phosphorus removal and pH correction respectively.

Clear supernatant water from each IDEATs discharges into the effluent balance tank through decanters. The balance tank provides sufficient volume to attenuate decant flows without bypass. The balance tank discharge is controlled by effluent lift pump stations (tertiary feed pump station and UV feed pump station). The discharge flow rate will be regulated to ensure the balance tank drains prior to the commencement of the next decant cycle. This limits the number of starts required by the UV disinfection system and ensures sufficient storage volume is available to prevent bypass.

Flow up to three times Average Dry Weather Flows (3x ADWF) will be fully disinfected by the effluent UV disinfection system and the disinfected effluent will be delivered to the White Leeds and excess flow bypassed to the open earthen channel through the upgraded effluent pipeline via gravity. When then UV inlet flow is more than 3x ADWF, with higher hydraulic flows up to 6x ADWF (supplier dependant), it still passes through the UV system, however, it achieves reduced pathogen reduction.

All flows from the UV system, along with any overflow from the emergency storage pond (during extended wet weather events), will be delivered to White Leeds and/or the open earthen discharge point through upgrade effluent discharge pipes via gravity.

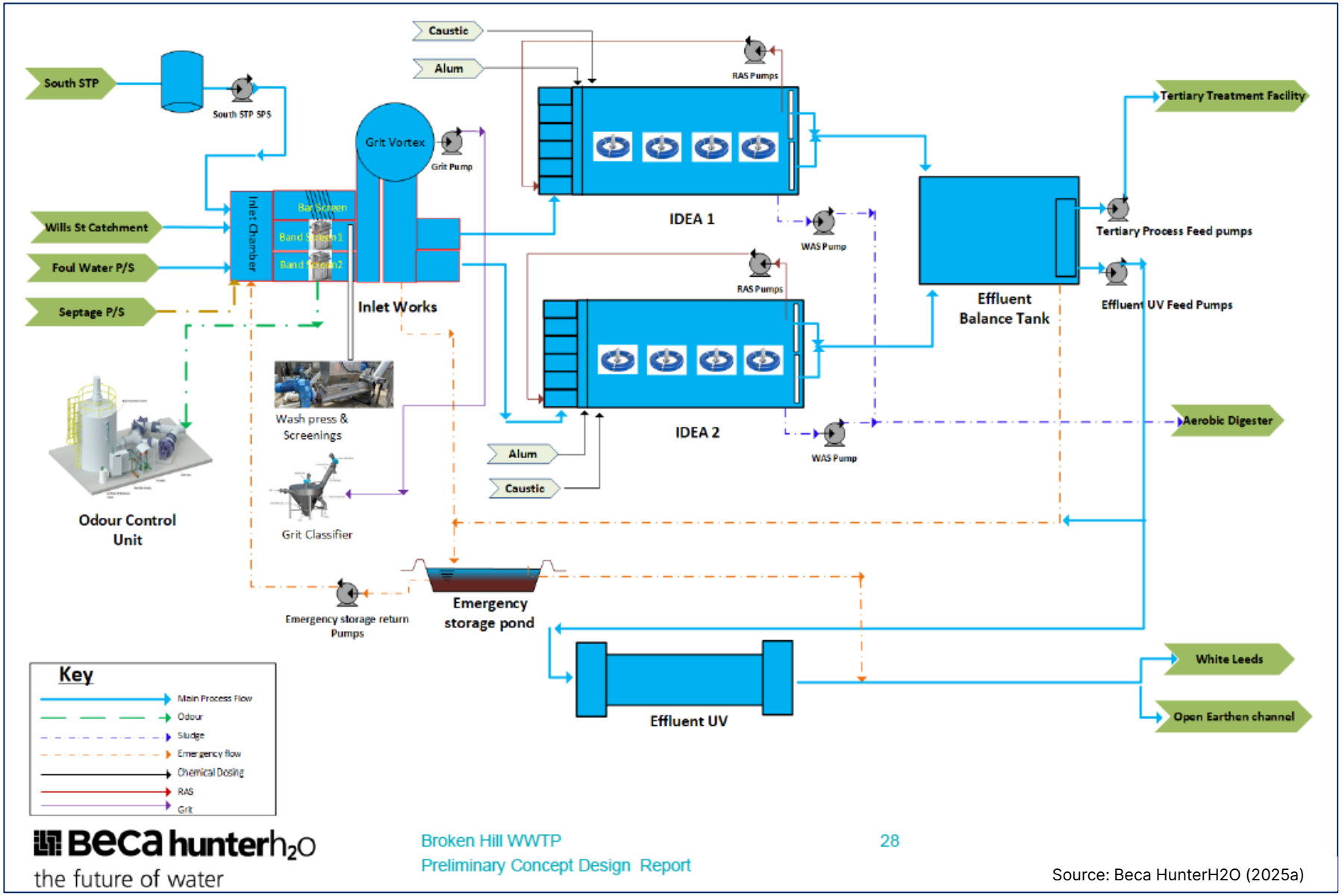
A portion of the secondary treated effluent flow will pass through an inline UV system and CCTs for further disinfection to achieve the required pathogen Log Removal Values (LRVs) to achieve the Australian Guidelines for Water Recycling (AGWR) specified water quality for municipal open space. A filtration system may be required if the secondary treatment effluent turbidity doesn't meet the guideline required standards to claim the required LRVs from each process units. The disinfected effluent will be stored in a storage tank for on-site service water application. The existing effluent reuse pumps will be replaced and relocated to the tertiary treatment system building to withdraw recycled water from the tank and deliver it to the current end users.

Sludge is intermittently wasted from each reactor (during the settling phase) to maintain the target Sludge Retention Time (SRT) of 25 days. The settled Waste Activated Sludge (WAS) is transferred to an aerobic digester for sludge stabilisation. A floating decanter in the digester would be used to achieve further thickening in the aerobic digester. The digested sludge will be dewatered via a mechanical dewatering system, with the sludge cake discharged onto a hardstand. It will then be picked up by the plant operator to the site's existing stockpile area or transferred to a trailer or truck via sludge conveyors for off-site disposal.

In the event of a failure of the decanter boot, one of the IDEAs is not available or the treated effluent is off specification, one emergency storage pond is provided for emergency situations, and the collected flow will be returned to the head of the plant for further treatment via an emergency return pump station.

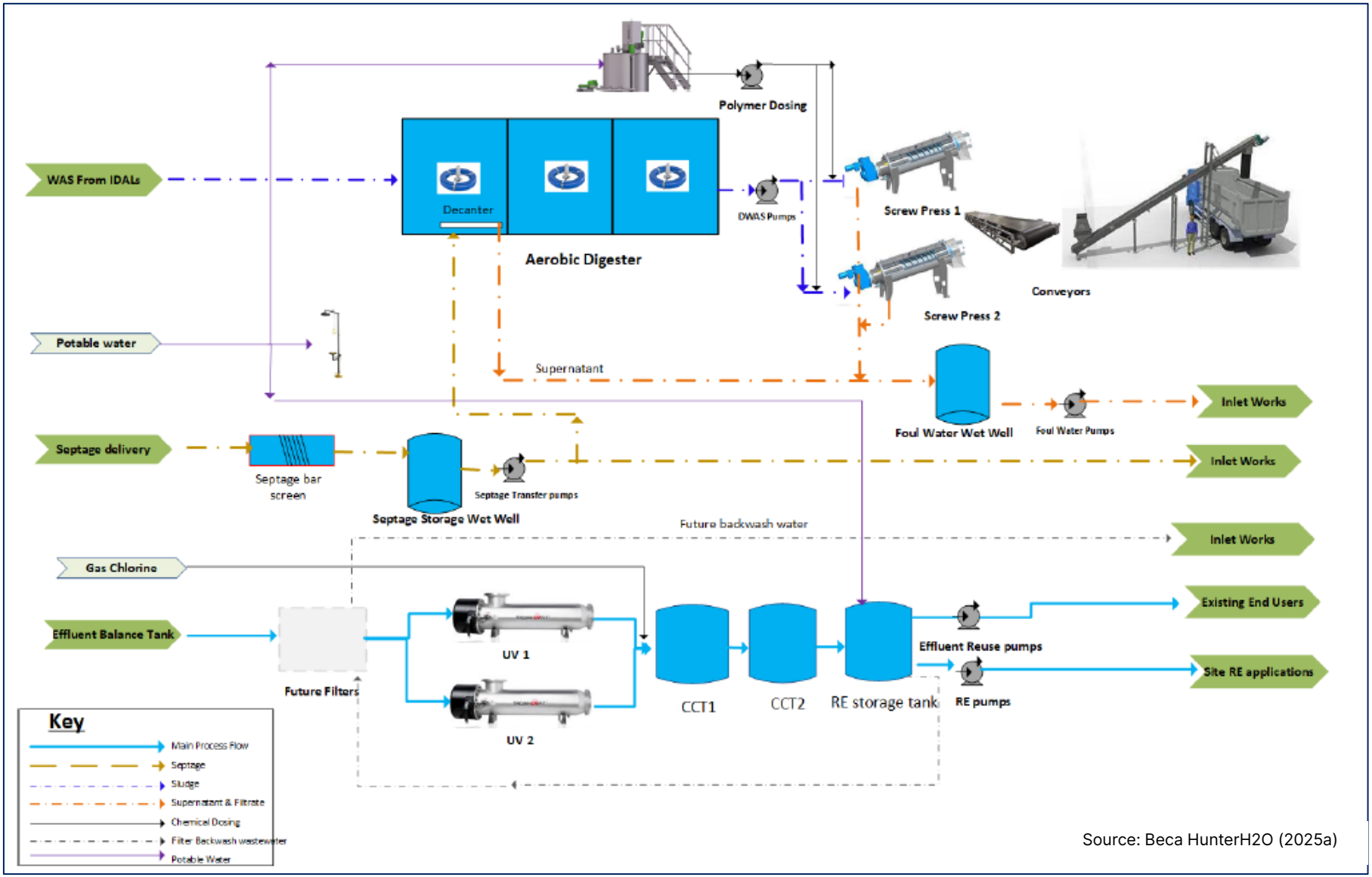
Odour control is to be implemented at the inlet works. The inlet works will be covered, and odorous gases from the headspace will be extracted via a ventilation fan and delivered into a bio-trickling filter for treatment before discharging into the atmosphere via an exhaust stack.

The proposed process configuration, general arrangement for the new BHSTP, and proposed rising main route are illustrated in **Figure 6**, **Figure 7, Figure 8** and **Figure 2**, respectively.



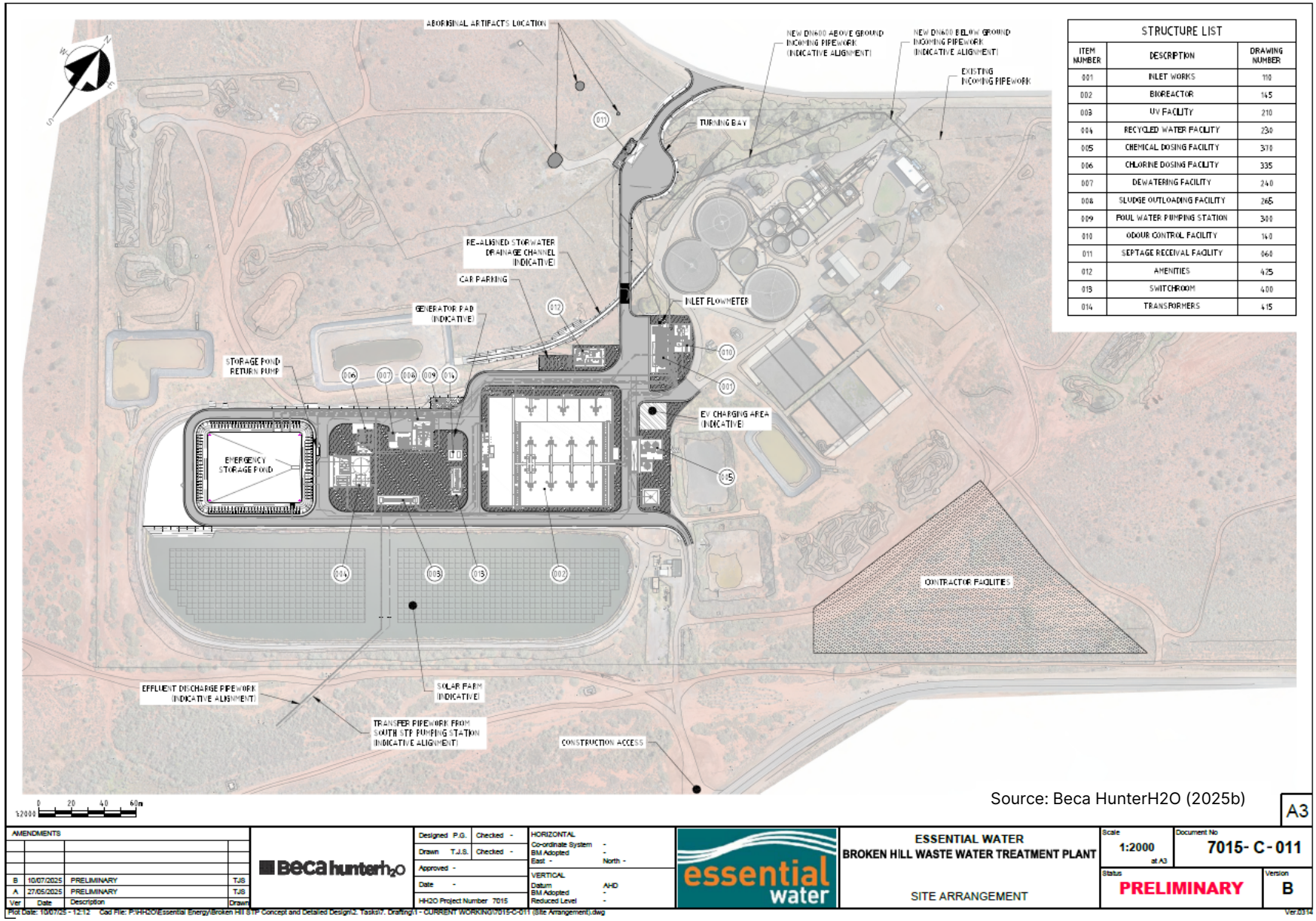
Source: Beca HunterH2O (2025a)

Figure 6: Process flow diagram A



Source: Beca HunterH2O (2025a)

Figure 7: Process flow diagram B



Source: Beca HunterH2O (2025b)

Figure 8: General arrangement for the proposed new BHSTP

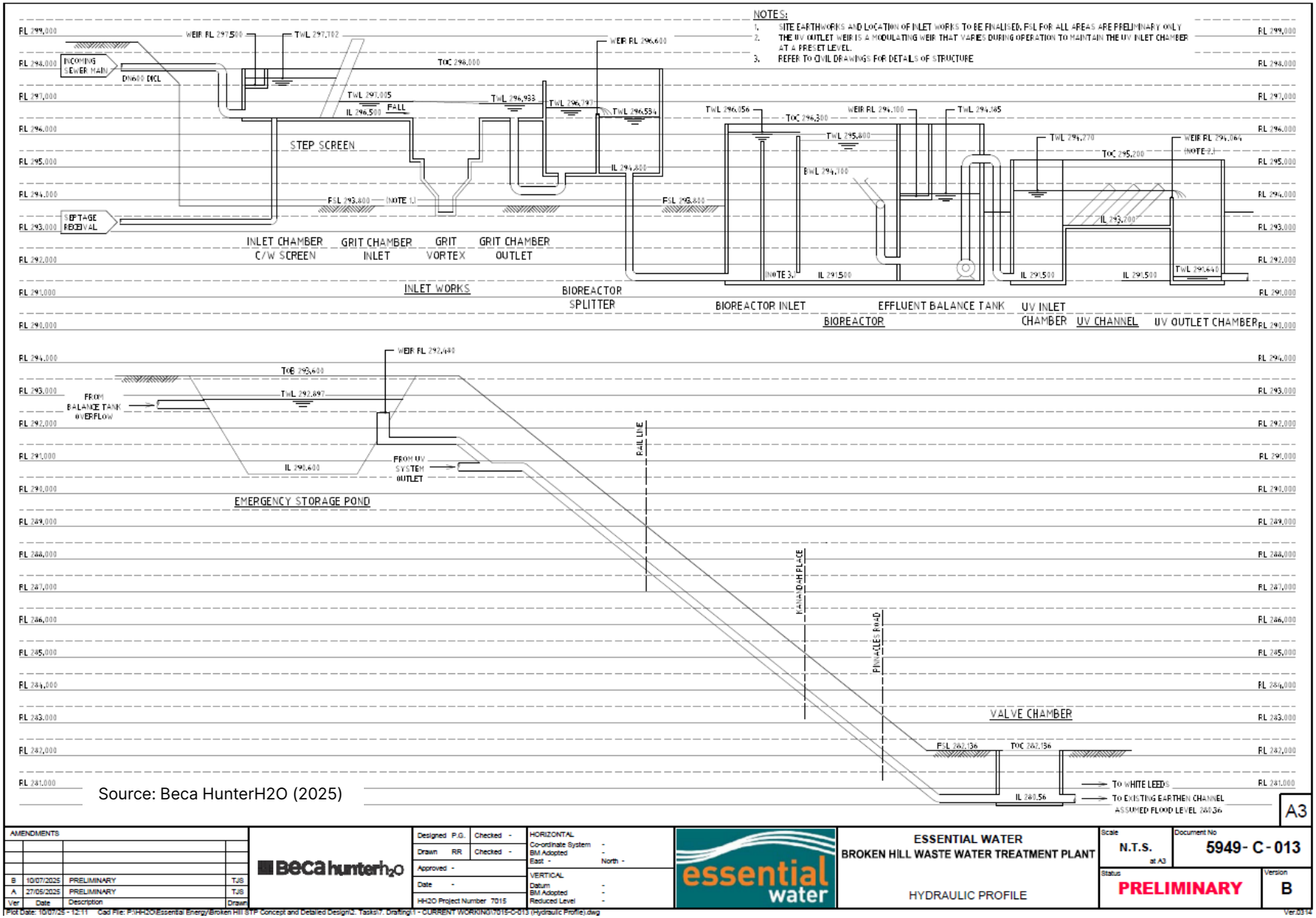
2.3.2 HYDRAULIC DESIGN

The new BHSTP design is based on connecting raw sewage from the current Wills Street STP catchment to the new site by gravity. Raw sewage from the South STP catchment area will be connected to the new BHSTP site via a rising main.

Key components of the hydraulic design are summarised below:

- Primary and secondary infrastructure will be sized at 8xADWF (444L/s) to accept all inflow from the sewage catchment areas.
- The effluent balance tank discharge infrastructure is sized at a flow factor of 8xADWF.
- The effluent UV Feed pumps and UV channel system will be hydraulically sized to maximise throughput, allowing partial treatment. The UV system performance would however be based on achieving performance requirements at 3 x ADWF.
- Allowance has been made to bypass maximum decant flow to the emergency storage pond if failures of the effluent UV feed pumps occur.
- Allowance has been made to overflow the emergency storage pond to the effluent outfall if the emergency storage pond water level reaches its overflow level at the effluent outfall delivery capacity.
- The new effluent outfall is sized to deliver maximum flow rate of 483L/s (8xADWF plus rainfall) via gravity.
- The design has assumed the invert level of the open earthen effluent discharge point to be at approximately 280.56m Australian Height Datum (AHD) and free discharge and no submergence during wet weather event.
- Allowance has been made to accommodate internal recycled flows (Supernatant, foul water, Emergency flow return).
- The new BHSTP is designed to be able to hydraulically accommodate the contribution from an annual exceedance probability (AEP) of 1% at 1-hour rainfall (57.9mm/h) falling on hard stands and open tanks. The site drainage system will also be sized to accommodate the design storm
- Operational freeboard allowance for the IDEA of 300mm from the Top Water Level (TWL) to the top of structures for the unaerated zone is provided to mitigate surcharge risks, while 500mm freeboard for the aerated zone.
- The inlet works will be an elevated structure to allow screened and de-gritted treated sewage to gravitate to the IDEA Tanks. Maintaining a gravity system significantly minimises the likelihood of uncontrolled discharges during power outages.
- A flow distribution structure evenly distributes inflow between the two IDEATs with the use of fixed weirs. An emergency bypass has been provided within the inlet works structure. If a single IDEA is isolated for planned maintenance or the bioreactor needs to be isolated for a very short period, the operator can manually open and adjust the bypass penstock to direct some or all flow to the emergency storage lagoon.
- In the event that the inlet works mechanical screens block, a bypass weir has been installed upstream of the screens to overflow incoming sewage to a screen bypass channel containing a manually raked coarse bar screen. The bypass channel discharges to the main channel prior to the grit chamber.
- Excess activated sludge is wasted to the aerobic digester via the WAS pumps, supernatant in the aerobic digester Cell 1, filtrate from the dewatering system, and site drainage will return to the inlet works via the foul water pump station.

Figure 9, presents a preliminary hydraulic grade line (HGL) based on achieving full gravity flow from the existing Wills Street STP catchment area for the new BHSTP.



Source: Beca HunterH2O (2025)

Figure 9: Preliminary HGL for the Proposed New BHSTP

2.3.3 KEY PROCESS UNITS

2.3.3.1 South Sewage Pump Station

The sewage transfer pump station to be constructed at the South STP will be designed to transfer a peak flow event which is sufficiently high enough that the risk to the environment and public health is acceptable.

Investigations to date indicate that the 1 in 2 year ARI storm flow would be 56 L/s, less than the peak instantaneous flow which is known to be greater than 67 L/s. The remaining flows would overflow a manhole upstream of the pump station and discharge to the receiving environment, as per other Essential Water owned network pump stations.

The sewage pump station design includes a split well, each portion of the well including a submersible pump. Each portion of the well can also be isolated for maintenance. The preliminary 3D model of the proposed wet well is shown in **Figure 10**.

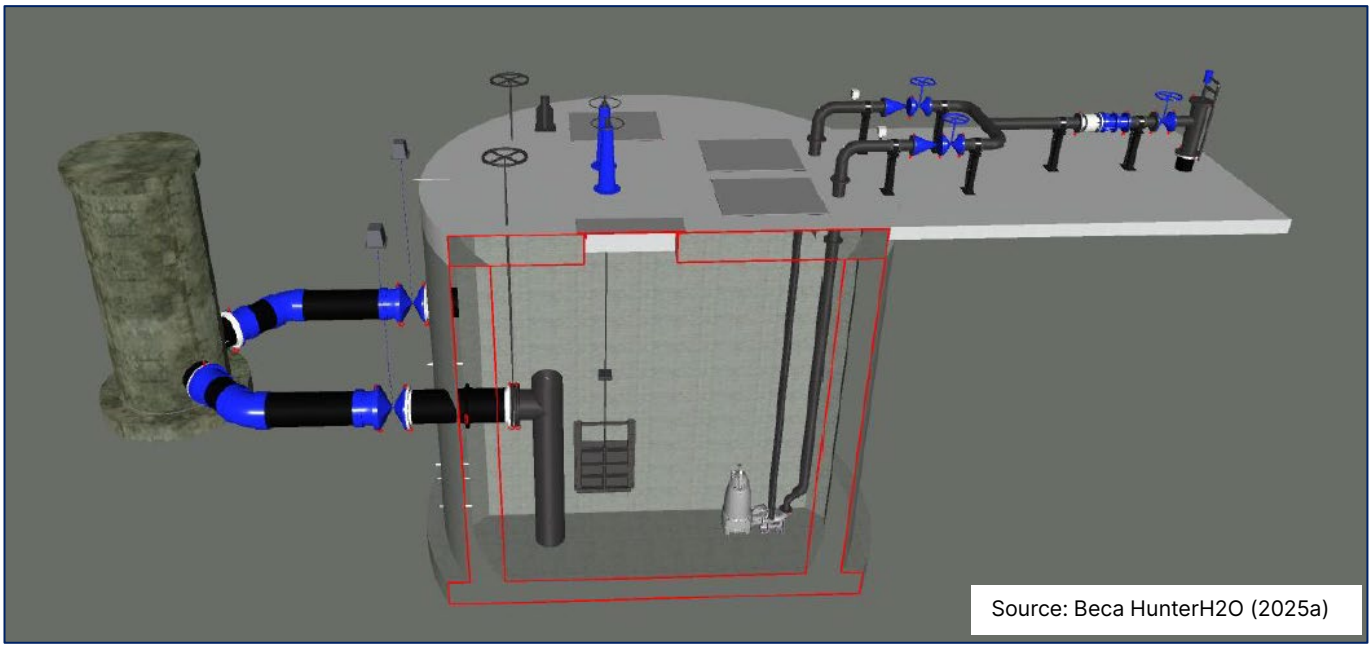
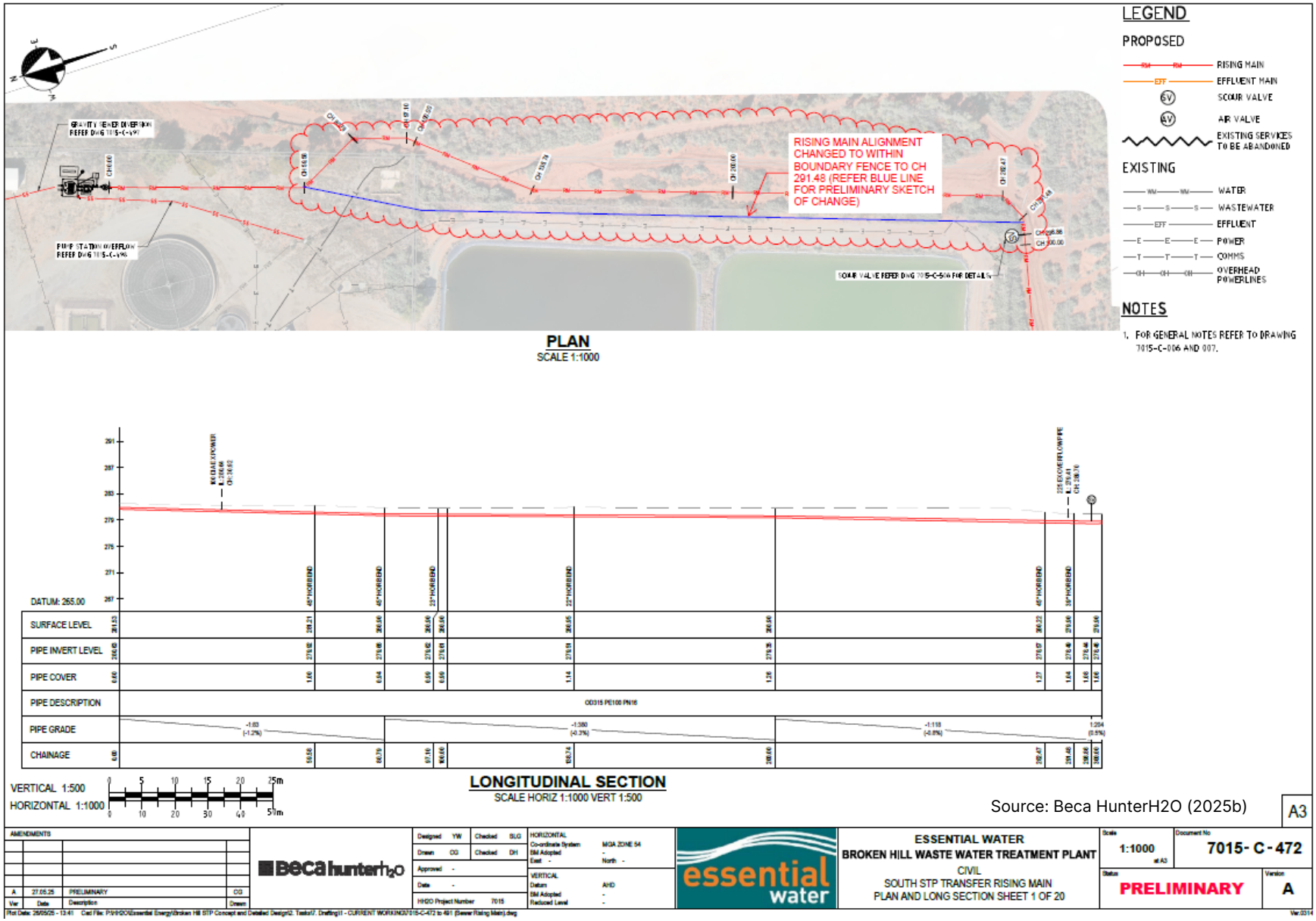


Figure 10: Proposed South STP transfer pump station wet well preliminary arrangement

The proposed alignment for the new rising main to transfer raw sewage from the new Sewage Pump Station at the South STP site to the new BHSTP is provided in **Figure 2**.

An approximate construction footprint of 10m by 10m is anticipated for the new pump station with excavation four to five metres deep. While the exact positioning of the pump station is yet to be finalised, design to date indicates it would be installed within the previously disturbed footprint of the northeastern portion of the existing South STP site, near the existing site shed in the northeastern corner. Installation of associated pipework within northern portion and along the eastern boundary of the existing South STP site will also be required to connect the new pump station to the existing incoming raw sewage pipeline, and to the new rising main to transfer the raw sewage to the new BHSTP. These areas have had a high degree of previous disturbance from STP construction and maintenance activities.

An indicative site layout is presented in **Figure 11**.



Source: Beca HunterH2O (2025b)

Figure 11: Indicative site layout for the proposed new pump station at South STP

2.3.3.2 Preliminary Treatment at the new BHSTP Inlet Works

The preliminary treatment infrastructure at the new BHSTP site includes the following key items:

- Flow monitoring
- Receival chamber
- Site Foul water return
- Septage waste receival
- Emergency storage pond water return
- Automatic screening
- Coarse screening of automatic screen bypass flow
- Screenings washing and dewatering
- Grit removal
- Grit washing and dewatering
- Flow distribution

The location of the proposed inlet work in the context of the overall site layout is provided in **Figure 8**. A snapshot of the preliminary 3D model of the inlet works is **Figure 12**.

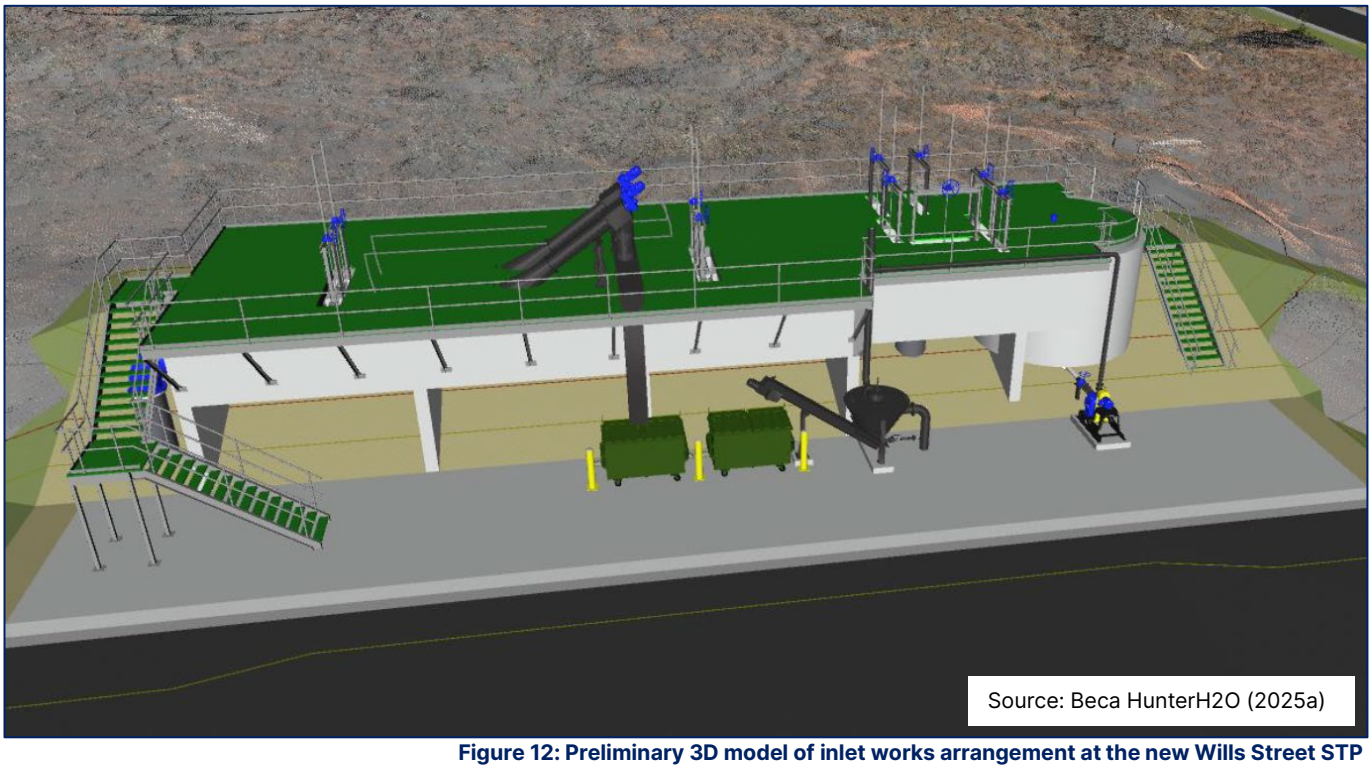


Figure 12: Preliminary 3D model of inlet works arrangement at the new Wills Street STP

Further detail on each aspect of the preliminary treatment is provided in Beca HunterH2O (2025a) (refer **Appendix A**).

2.3.3.3 Septage and Other Tankered Waste

Nominally the new BHSTP will receive tankered waste from two sources:

- Septic tank pump outs which will be managed through the proposed septage receival system
- Pump station pump outs.

It has been identified that the pump station pump outs will include some liquid sewage and some grit. Beca Hunter H2O (2025a) have indicated that the denser grit portion of the pump-outs may not be suitable for receipt in the septage receival system. Essential Water has indicated that the grit from the pump stations could be discharged onto the existing and recently constructed drying beds. If this option is chosen, the existing drying bed subnatant pump station would be retained, and this pump station would continue to transfer subnatant to the existing raw sewage gravity main to the STP.

The septic receival station will be located near the new entry to the BHSTP site (refer **Figure 8**). The preliminary arrangement of the septic receival station is depicted in **Figure 13**.

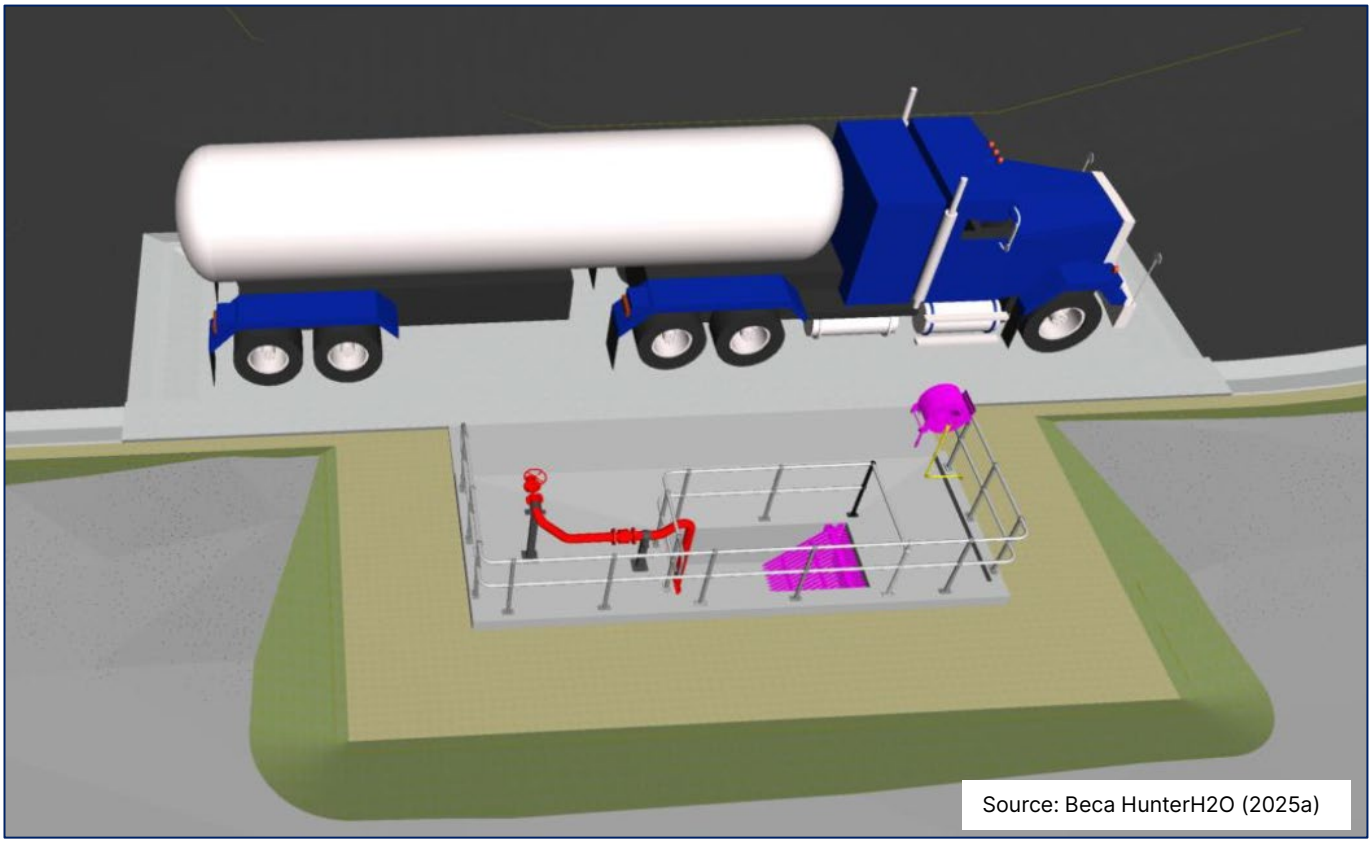


Figure 13: Preliminary arrangement of proposed septage receival

2.3.3.4 Secondary Treatment (IDEATs)

Screened and de-gritted raw sewage from the inlet works will be evenly distributed to the two IDEATs. The IDEATs are to be constructed as semi-buried reinforced concrete water retaining structures. The tanks include vertical walls to optimise aeration and settling performance.

A snapshot of the preliminary general arrangement of the bioreactor is provided in **Figure 14**.

Sizing

The IDEATs are constructed in a 2.3:1 length to width ratio. This promotes plug flow conditions that limit short-circuiting risks as the influent moves from one end of the reactor to the other end of the decant weirs. According to the 30% design (Beca Hunter H2O, 2024), the approximate dimensions of each IDEATs are 58m long by 25m wide by 4.8m deep.

Operation Cycle

The treatment process comprises of three distinct phases (aeration, settle and decant, as described in **Section 2.3.1**.

IDEAT 1 will operate on the same aerate, settle and decant cycle times as IDEAT 2 but 180 degrees out of phase. This means that peak aeration and decanting for the two IDEATs should not occur at the same time. This control helps to reduce STP peak power demand and prevents peak flow loadings to the effluent balance tank.

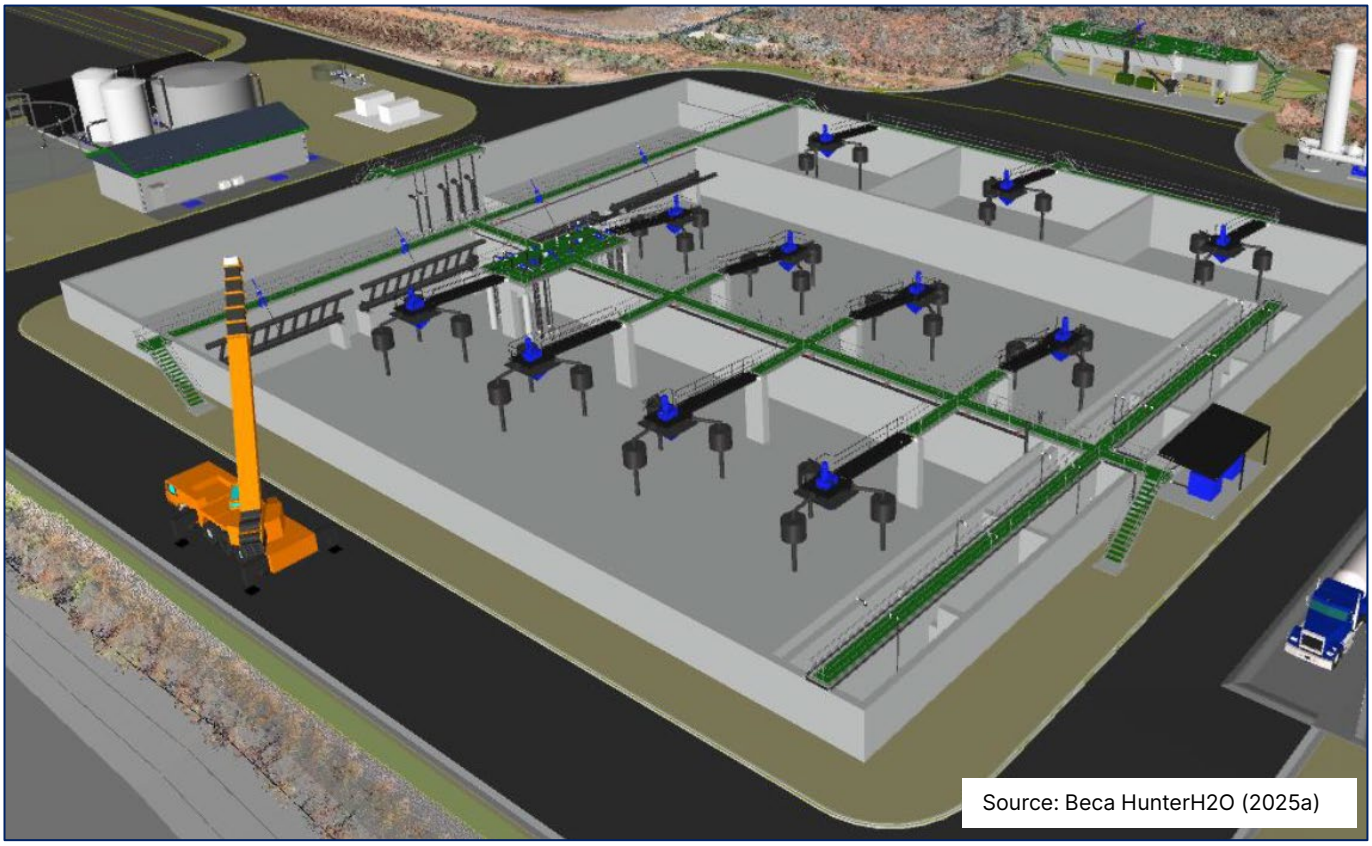


Figure 14: Preliminary general arrangement of secondary treatment process.

Aeration

During aeration phase, each IDEAT is aerated to provide sufficient DO for bacteria to oxidise organic waste and nitrify influent ammonia via low-speed surface aerator. The aerators also ensure inflows are thoroughly mixed with the biomass and phosphorus precipitation chemicals.

Each IDEAT is equipped with four aerators. One aerator is needed during minimum aeration demand, and most likely two aerators are required during normal operation, with three aerators needed for peak oxygen demand. However, during the peak month with maximum oxygen demand, all four aerators may be required.

Bio-selector

Each IDEAT will also incorporate a bio-selector at the inlet of the reactor. The bio-selector consists of six small discrete reactor volumes designed primarily for carbon absorption in which activated sludge organisms are exposed to a high substrate concentration for a relatively short time. Each cell of the bio-selector is equipped with coarse bubble diffusers. Two aeration mixing blowers, configured as duty/standby, provide compressed air for intermittently pulsed mixing of the mixed liquor and influent raw sewage to prevent biomass settling.

Pump Stations

There are two return activated sludge (RAS) pumps per bioreactor. The failure of the duty RAS pump will start the standby pump automatically. The duty RAS pump continuously returns mixed liquor from the end of each bioreactor to the inlet of the bio-selector, where RAS is mixed with the raw sewage influent flow delivered from the inlet works.

Decanter and Effluent Balance Tank

At end of settling phase, the treated supernatant can be removed effectively with minimal carry over of solids by the rotary decanter without disturbing the sludge blanket. Each IDEAT is fitted with two rotary decanters. During normal operation, if one of the decanters fails, the other decanter still can be in operation without shutdown the relevant IDEAT. The rotary decanter consists of a decant trough, weir, floating scum buffer, carrier pipes, rotary collection pipe, submersible support bearings and a drive mechanism.

Further detail on each of the aforementioned aspects of the IDEATs is provided in Beca HunterH2O (2025a) (refer **Appendix A**).

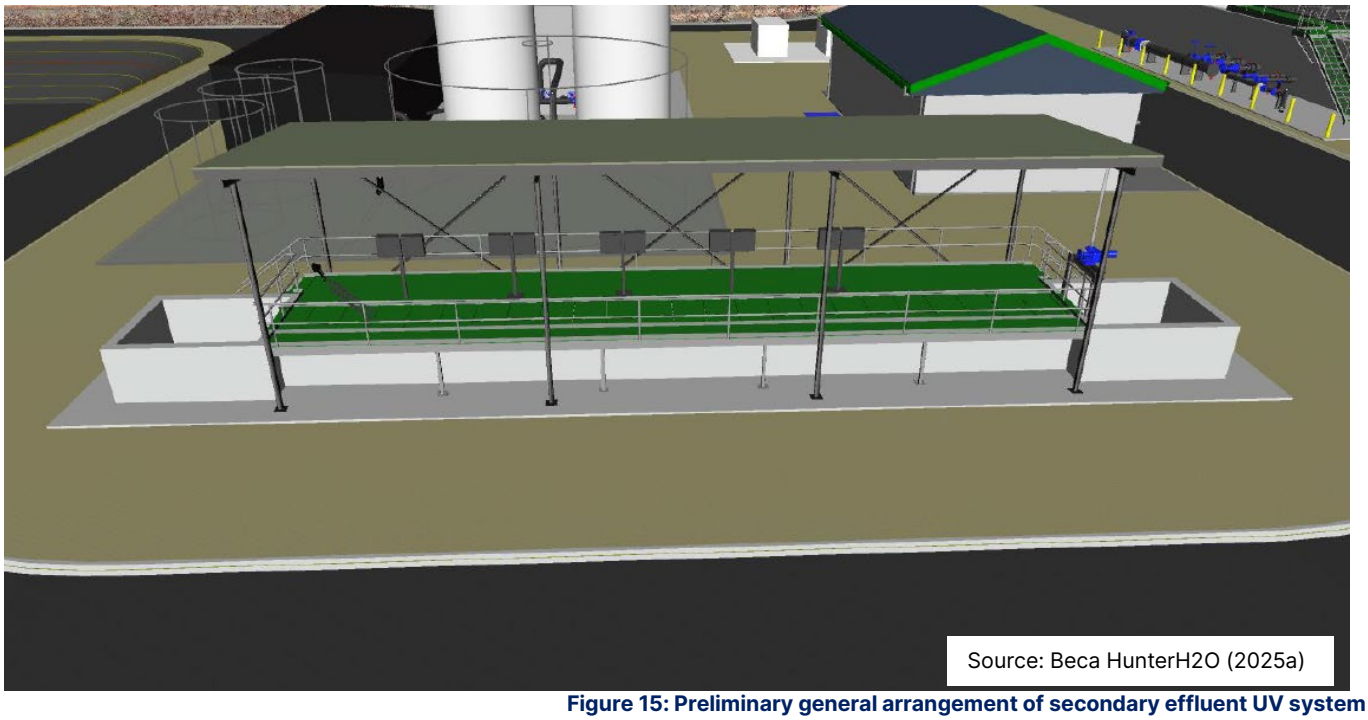
2.3.3.5 Effluent UV Feed Pumps and Effluent UV Disinfection

Secondary treated effluent from the effluent balance tank is delivered via an effluent UV feed pump station and disinfected via a low-pressure in-channel UV system. It is estimated that the UV system would be provided with ten banks in series. The sizing details will need to be adopted based on the final selection of equipment.

The UV system would be designed to achieve the pathogen reduction targets for up to 3xADWF with higher hydraulic flows up to 6xADWF (or as developed in conjunction with the UV supplier) passing through the UV system but achieving a pathogen reduction. UV disinfected flow will be collected in a UV outlet pit. All the treated effluent will be delivered to the existing open earthen channel and the White Leeds via an upgraded effluent outfall.

Further detail on UV disinfection is provided in Beca HunterH2O (2025a) (refer **Appendix A**).

A preliminary layout showing the secondary effluent UV disinfection channel system is provided in **Figure 15**.



Source: Beca HunterH2O (2025a)

Figure 15: Preliminary general arrangement of secondary effluent UV system

2.3.3.6 Effluent Discharge

Treated effluent from the existing Wills Street STP is currently discharged via a pipeline to the south of the STP. This discharge pipeline transports treated effluent from the current Wills Street STP to a property referred to as "White Leeds" approximately 4km south of the existing Wills Street STP site (refer **Figure 2**). White Leads, a treated effluent reuse customer, receives the vast majority (up to 750ML) of discharged treated effluent for use at an artificial wetland system on the property. Any excess treated effluent that cannot be received at White Leeds is discharged to the ephemeral drainage line via a valve and short section of pipe from the same discharge pipeline, approximately 1.2km south of the current Wills Street STP, on the southern side of Pinnacles Road, near the intersection with Kanandah Road (refer **Figure 16)**. This is the licensed discharge point for the purposes of the EPL. It is currently located on private property.

The existing effluent discharge pipe (average diameter approximately 300mm) from the current Wills Street STP to the existing discharge point requires upgrading to convey additional flow from the new BHSTP. As such construction of a new DN630 (i.e., 630mm diameter) High-density polyethylene (HDPE) pipe to transfer the effluent up to Peak Instantaneous Flow (PIF) via gravity has been chosen as the preferred option for the effluent outfall.

While an approximately 1.2km section of the existing treated effluent pipe will be replaced, the existing alignment will largely remain the same, though an approximately 500m section of the existing treated effluent discharge pipe located within an existing water/sewer easement on the land parcel immediately south of the existing Wills Street STP site will be decommissioned as a result of the replacement pipe.

At the time of the preparation of this report the existing licensed discharge point to the ephemeral drainage line, south of Pinnacles Road, near the intersection with Kanandah Road, is proposed to remain the same. However, consideration is being given to an option that would extend the discharge point approximately 500m south along the existing White Leeds discharge pipe, into the same ephemeral drainage line (refer **Figure 16**). This option has the advantage of moving the current licensed discharge point outside of private property and further downstream from existing properties located along Kanandah Road. If this option is chosen, it would also likely involve replacement of the existing discharge pipe with the same DN630 HDPE pipe proposed above, in the same alignment or immediately adjacent to the existing pipeline that continues to transport treated effluent to White Leeds, up to the point of the possible alternative discharge point. A new release valve, headwall and scour protection would be installed at the alternative discharge point within the same ephemeral drainage line, further downstream.

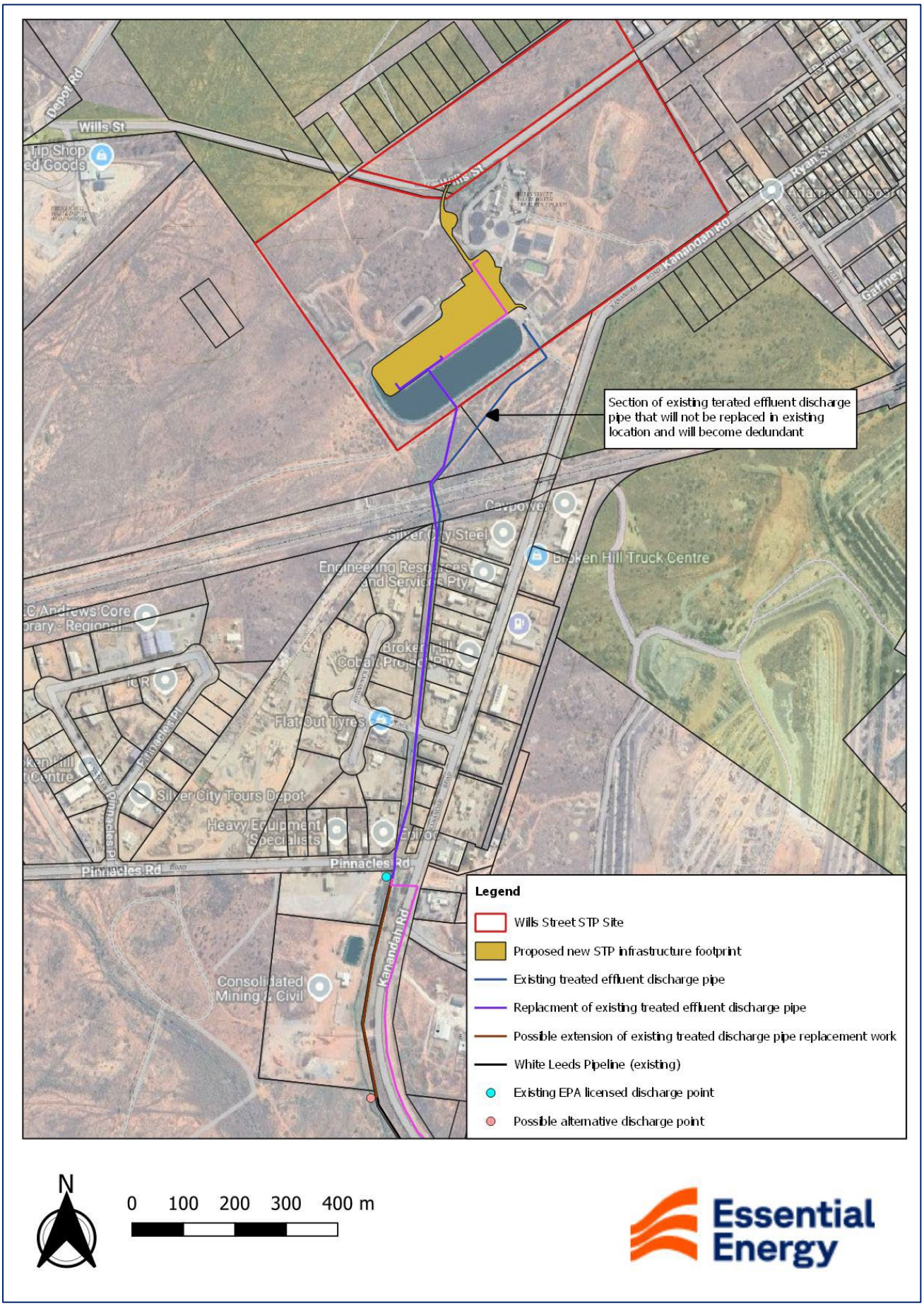


Figure 16: Existing and replacement treated effluent pipe alignment and existing and possible alternative discharge location for Wills Street / new BHSTP

2.3.3.7 Tertiary Treatment

A portion of the secondary treatment flow will be delivered to a tertiary treatment facility and disinfected to meet the recycled water quality standards. The tertiary treatment infrastructure includes the following key items:

- Tertiary treatment feed pump station which will be located in the balance tanks which accept effluent from the IDEATs
- Tertiary filtration system (provision shall be made for the system if deemed necessary, including the allowance for footprint, backwash water usage, backwashed wastewater return, maximum power demand and switchboard design).
- Pre-validated in-line UV systems.
- Chlorine contact tank in the form of above ground FRP tanks with internal baffles.
- Reclaimed effluent (RE) storage tank to supply on site uses and future filtration system backwash water if required.
- Gas chlorine storage and dosing system.
- Relevant instrumentation and valves.
- Space for additional future effluent reuse storage tanks.

A preliminary general arrangement of the tertiary treatment area is provided in **Figure 17**.

Reuse pumps and inline UV systems are shown within the open section of the building. The chlorine storage and dosing is located within the closed section of the building to the left of the shed. The taller white tanks are for chlorine contacting and the larger tank is the RE storage tank. The grey area to the right of the snapshot is area for future expansion of the tertiary treatment process.

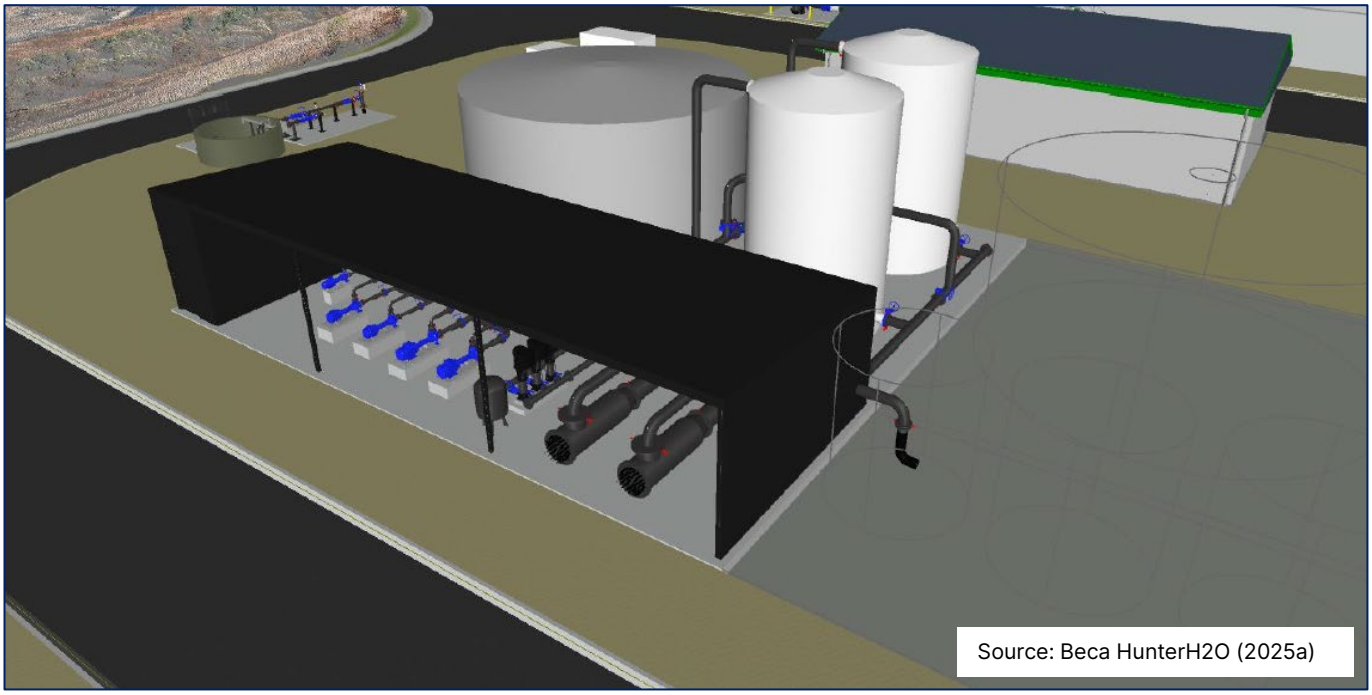


Figure 17: Preliminary general arrangement of tertiary treatment area.

Tertiary Process Feed Pumps and Inline UV System

There will be two tertiary process feed pumps situated in the effluent balance tank that supply secondary treatment effluent to the tertiary treatment process. Should the duty pump fail, the standby pump will start automatically. The duty pump will commence automatically when the recycled water tank level drops to its predetermined setpoint, and it will stop when the tank reaches its high level setpoint. Typically, the pump

operates at a fixed flow rate and is designed to run continuously to avoid frequent starts and stops of the inline UV system.

The UV system feed pump control will also include the ability to:

- Hold effluent in the balance tank if effluent reuse needs to be maximised.
- Vary the tertiary throughput based on the demand and level in the recycled water tank.

Two inline UV reactors will be provided for targeted pathogen removal, with the UV reactors configured as duty/standby. In the event of a failure of the duty UV reactor, the standby reactor will start automatically.

Chlorine Contact Tanks (CCT)

The treated effluent, disinfected with UV, will be sent to two CCTs for additional disinfection to meet the pathogen removal standards for recycled water application.

Gas chlorine is dosed automatedly before the CCTs, and the free chlorine levels in the water after the CCTs are monitored automatically. The two tanks can be operated in series or in parallel, and one of the tanks can be taken offline for manual cleaning when necessary.

Recycled Water Tank

CCT disinfected effluent will flow into a recycled water tank via gravity. The recycled water tank provides buffer capacity for end users recycled water, site service water or RE, and current end users recycled water applications. A footprint is allowed in the site general arrangement to duplicate the recycled water tank and supply backwash water if the tertiary filtration process is deemed necessary.

There are a number of uses for service water around the STP site. These are:

- Spray and wash water for the inlet works (screen and git units)
- Sprays for the bioreactors
- Hose points at various locations for hosing down and cleaning
- Dewatering system washing & cleaning.

Rather than use potable water for these purposes, it is preferred to source it from fully treated and disinfected effluent. RE is drawn from this tank through a proprietary RE pumping system that includes a number of RE pumps (likely to be three) and a pressure vessel. The pumps are pressure controlled. This system discharges to a pressurised ring main around the site.

Effluent Reuse Pump Station

There are currently three pump sets discharging recycled water to their respective end users:

- Golf Club pumps
- Perilya pumps
- Tronox (Bemax) pump.

A like-for-like replacement of the existing effluent reuse pump stations are proposed, with relocation to the tertiary treatment area to withdraw RE from the recycled water tank instead of the existing effluent reuse pit.

2.3.3.8 Waste Sludge and Biosolids Handling

The sludge handling system includes the following key items:

- Aerobic digester
- Floating decanter
- Dewatering screw presses

- Sludge conveyors
- Polymer preparation and dosing system

A preliminary arrangement showing the proposed dewatering and outloading area is provided in **Figure 18**.

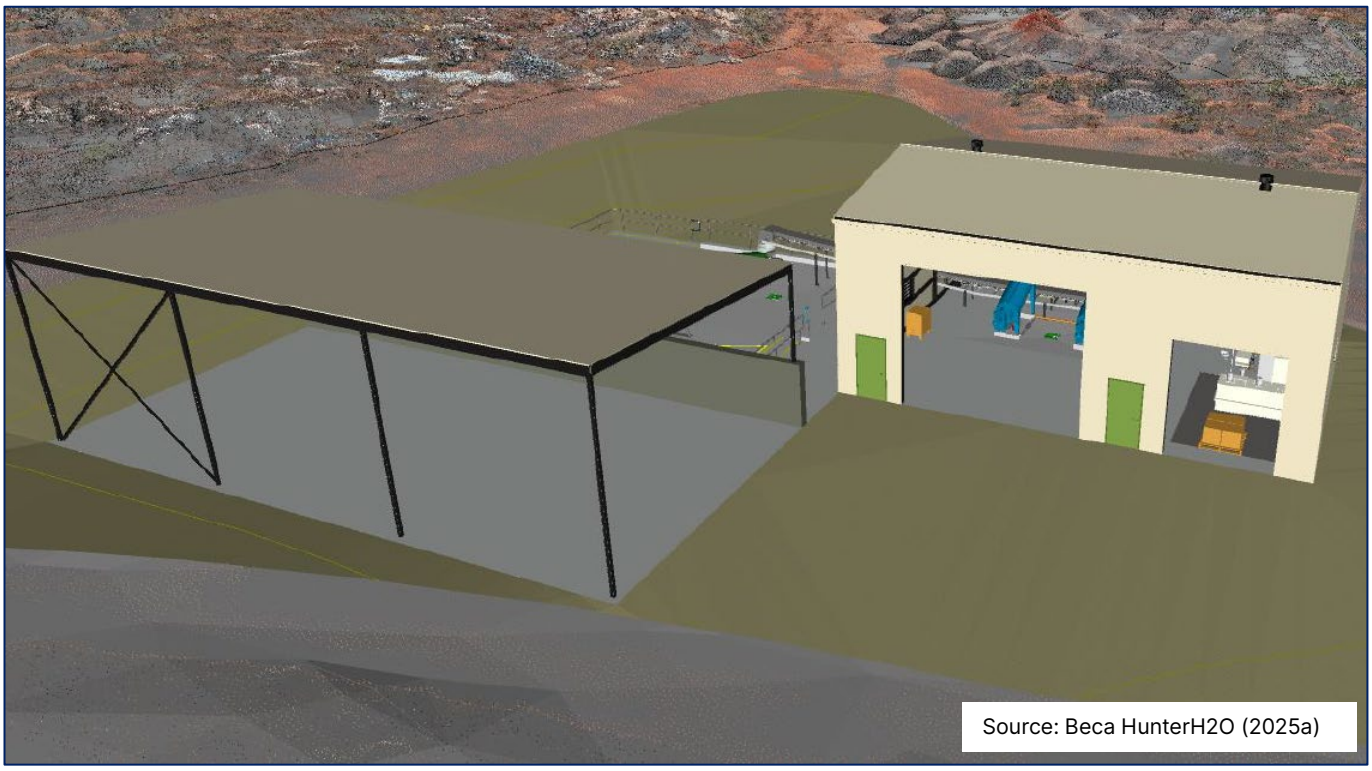


Figure 18: Preliminary arrangement of sludge dewatering and outloading area.

Aerobic Digester

Thickened WAS during the settling phase or unthickened WAS from the aeration phase from each IDEAT will be pumped into the aerobic digester. The WAS can bypass the digester to the dewatering unit if required for emergencies (such as during equipment maintenance or failure).

The aerobic digester, the structure of which is integrated with the bioreactor, contains 3 cells. Pre-thickened WAS enters Cell 1, passes through Cell 2, and ends in Cell 3. The digested WAS (DWAS) will then be removed via a mechanical dewatering system. There is one floating decanter installed inside the aerobic digester Cell 1, the digester operational Mixed Liquor Suspended Solids (MLSS) is further thickened with decanting supernatant flow after settling phase.

Further information on daily digester feed volume, aeration cycles and other operation requirements of the aerobic digestor is provided in Beca HunterH2O (2025a) (refer **Appendix A**).

Dewatering system

DWAS will be drawn from the aerobic digester and dewatered through two dewatering trains. Wasting DWAS while digester Cell 3 is mixed also allows DWAS flow and volume to be used to control the digester sludge age. This results in stable digestion performance, aeration demand and DWAS thickness, all of which are critical to optimised digestion and dewatering.

The aerobic digester includes three days storage capacity to allow for long weekends when the dewatering system is not in operation.

Each dewatering train is composed of the following components:

- DWAS pump
- Polymer dosing pump

- Screw press.

Each dewatering train can be operated independently or concurrently with the other train. Dewatered biosolids fall from the end of each press onto a fixed speed horizontal conveyor. The horizontal conveyor delivers the biosolids to an inclined conveyor that subsequently lifts the biosolids into a truck trailer. Flexibility would be provided to allow biosolids to be discharged onto the trailer hardstand if required. The inclined conveyor is fitted with a separate, fixed speed, reversible slewing drive and position switches. The inclined conveyor pivots around a vertical axis, filling the trailer length more evenly. The dewatering filtrate will be returned to the head of inlet works via the foul water pump station.

The dewatering system is very simple to operate based on a pre-populated operational schedule. It only needs the following operator input:

- Chose the dewatering date (Mon to Friday).
- Enter the dewatering start time and run time.
- Set DWAS operation flow rate or speed.

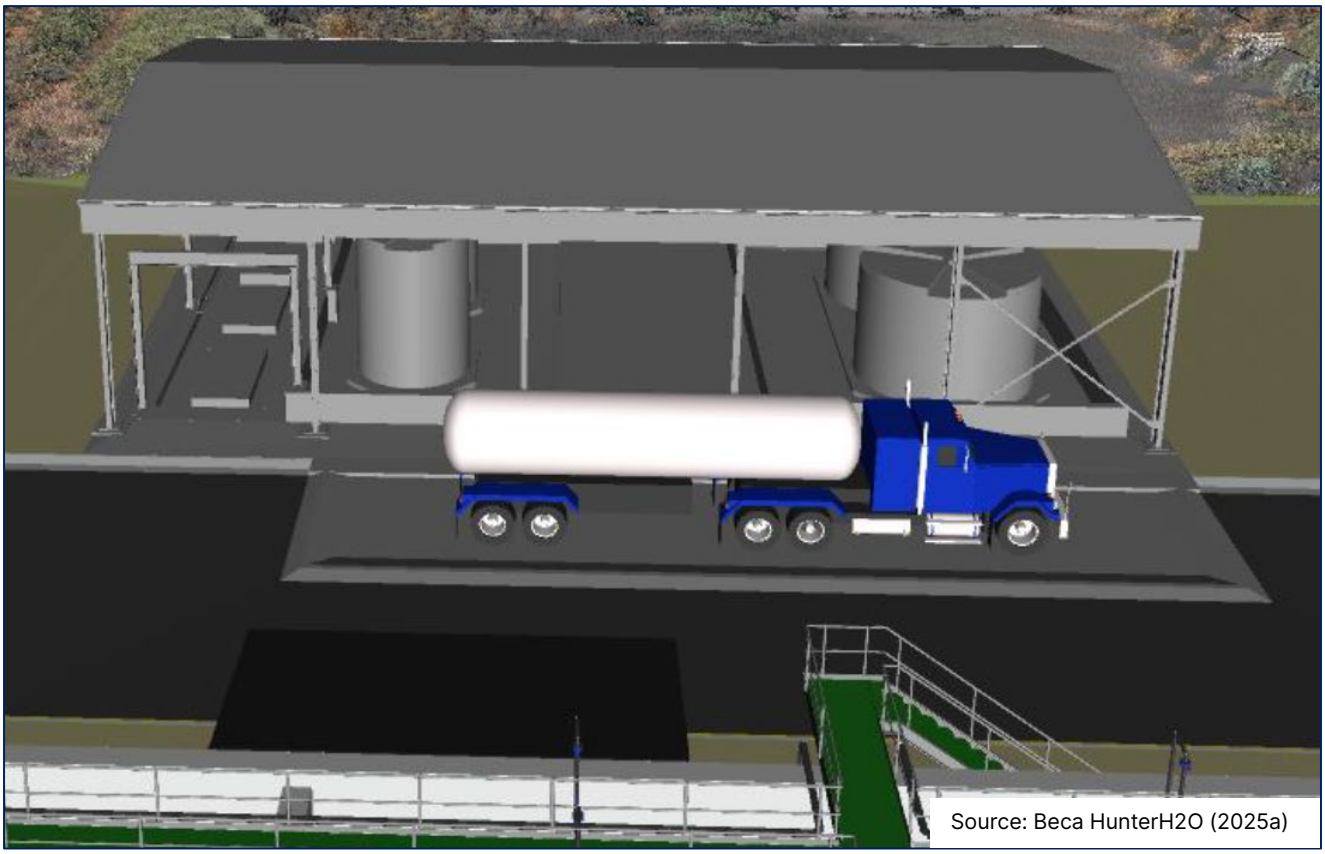
Further information on the proposed dewatering system is provided in Beca HunterH2O (2025a) (refer **Appendix A**).

2.3.3.9 Chemical Dosing System

Three chemicals will be used for the BHSTP upgrade:

- Aluminium sulphate (47% Alum): For phosphorus precipitation (soluble phosphorus removal).
- Sodium hydroxide (25% NaOH): To offset alkalinity consumption associated with chemical phosphorus removal.
- Chlorine Gas: Chlorine disinfection, dosing upstream of the CCTs.

A preliminary general arrangement of the liquid chemical area is inclusive of alum and caustic dosing and with space for expansion is provided in **Figure 19**.



Source: Beca HunterH2O (2025a)

Figure 19: Preliminary arrangement of chemical storage and dosing area.

Alum Storage and Dosing System

Alum is delivered by tanker and stored in alum storage tanks. Level alarms indicate when the storage tank nears empty so that a delivery can be ordered. Deliveries arrive by tanker and are pumped from the tanker to the storage tanks.

The storage tank and dosing pumps are located within a bunded area. This is sized to contain more than the volume of the storage tank in case of tank or pipe rupture. The bunded area contains a sump. A portable sump pump can be used to extract and manage spills.

Each IDEA bioreactor will have dedicated alum dosing pumps configured in duty/standby. The rate of dose can be varied. Typically, the dose rate varies with the influent flow (flow paced) so that the alum dose matches the phosphorus mass to be removed. The dose can be capped to prevent overdosing during wet weather. The design assumes alum is dosed into at inlet of each IDEAT. Flush points are provided for each pump and dosing line. Chemicals should be flushed from the lines prior to maintenance. An eyewash and shower are located in the unloading area, within the bund and near the dosing pumps.

The alum storage and dosing system consists of the following mechanical equipment and instruments.

- Two alum storage tanks and associated instruments
- One level switch in the alum dosing bund sump
- One eyewash and shower flow switch on the common eyewash and shower supply main
- Two variable speed alum dosing pumps (duty/standby) for each IDEA tank
- One no flow switch on each dosing pump
- Alum chemical dosing skid and relevant ancillaries
- One level switch for double containment pipe.

Caustic Storage and Dosing system

The use of Alum and other phosphorus precipitation chemicals consumes alkalinity. This can cause the depletion of alkalinity in the process and treated effluent, leading to pH suppression. This is managed through caustic dosing. An increase in alum dosing can lead to the need to increase caustic dosing.

Caustic will be stored in a single 10 kL tank to allow for bulk delivery. The caustic storage tank and dosing system will be installed inside secondary containment consisting of a concrete bund. A factory assembled dosing skid will be installed inside the bund.

The bund will be roofed with a prefabricated skillion roof to prevent the collection of rainfall in the bund. Entry to into the bund will be via access steps. The bund construction also should consider the ease of access for unloading the alum to the storage tank.

The required caustic storage and dosing works include:

- A prefabricated skillion roofed concrete bund
- Storage tank with level instruments
- Connection for filling via road tanker
- Dosing pump skid including duty/standby digital dosing pumps for each IDEA reactor
- Interconnecting pipework and valves
- Dosing lines and dosing line containment
- Safety shower/eyewash station
- Electrical and control connections
- Supervisory Control and Data Acquisition (SCADA) and Programmable Logic Controllers (PLC).

Gas Chlorine Storage and Dosing System

The purpose of the gas chlorine storage and dosing system is to store gas chlorine, used for chlorine contact tank (CCT) chlorination and pathogen disinfection.

The gas chlorine is delivered by truck in 920kg drums. One spare drum would be stored in a chlorine room. Two gas drums will be connected to the dosing system, once one of the drums reaches a specific low level, an automatic changeover module switches to the available full drum.

Each drum that is connected to the chlorine manifold shall have an emergency shutoff device (Chlorshield or approved equivalent) mounted on it so that supply from the container can be terminated in the event of a leak being detected.

Each drum is fitted with vacuum regulators, and two chlorinators and ejectors are provided and arranged as duty and standby. The chlorinator will adjust the chlorine dosing rate based on the CCT inlet flow. Service water will be used as carry water with passing through ejector to deliver the chlorine to the dosing point for disinfection.

The gas chlorine storage and dosing system consists of the following mechanical equipment and instruments.

- A chlorine building to store one spare drum
- Vacuum regulators shall have a heated drip leg fitted
- All online cylinders shall have automatic shut off valves fitted
- Automatic changeover capability
- Trolley for moving drums
- Two chlorinators
- Two ejectors
- Service water supply for the chlorine dosing required carry water
- Chlorine gas filters and accessories
- Chlorine gas leak detectors in both the storage and dosing rooms
- Chlorine gas valves
- Flexible connection hoses
- Scales shall have a digital readout with 4-20 output to SCADA that will enable trending
- Safety equipment
- Natural ventilation with cross flow ventilation
- Safety shower/eyewash station
- Electrical and control connections
- SCADA and PLC programming.

2.3.3.10 Odour Control

The inlet works will be covered, and odorous gases from the headspace will be extracted via a ventilation fan and delivered into a bio-trickling filter for treatment before discharging into the atmosphere via an exhaust stack.

A preliminary general arrangement of the odour control system is shown in **Figure 20**. It is noted that the odour control system shown includes activated carbon. Activated carbon may not be required pending selection of the odour system based on performance requirements.

Further details are provided in Beca HunterH2O (2025a).

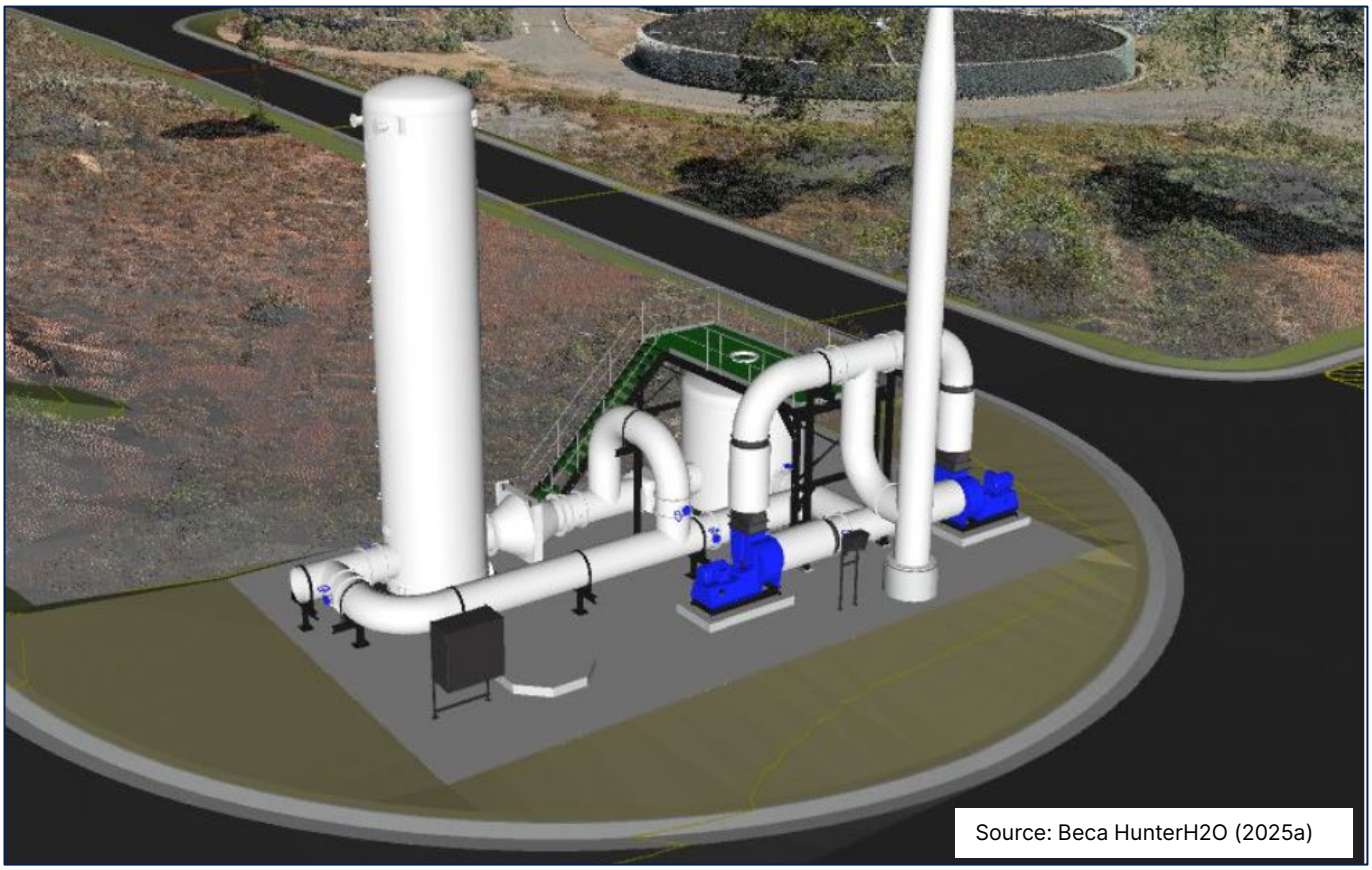


Figure 20: Preliminary arrangement of odour control system

2.3.3.11 Emergency Storage Pond and Return

One lined emergency storage pond will be provided and will be used for the following conditions:

- Inlet works emergency bypass
- Emergency storage of effluent balance tank overflow
- Emergency storage if there is a failure of the effluent decanter
- Emergency storage if one of the IDEATs is not available
- Emergency storage if the secondary effluent is off-specification (off-spec).

It is not intended to use the emergency storage pond in wet weather. The emergency storage pond would be used where off-spec effluent is produced and / or there is a major process / equipment failure.

The emergency storage pond contents will be returned to the head of the plant for further treatment via a self-priming pump station.

If the emergency storage pond reaches full capacity during prolonged wet weather, the excess will flow into the effluent outfall by gravity in a controlled manner to avoid UV effluent pit overflow. The emergency storage pond is to be fitted with an emergency overflow pipe to prevent the pond from overtopping if the plant inlet flow is higher than the expected PIF. This pipe will be connected to the treated effluent discharge pipe.

The emergency storage pond will be constructed as in in ground lagoon type structure to suit hydraulic requirements. It will have a capacity of 4,800m^3, with one day retention time at ADWF. Further details are provided in Beca HunterH2O (2025a).

A preliminary arrangement showing the emergency storage pond is shown in **Figure 21**.

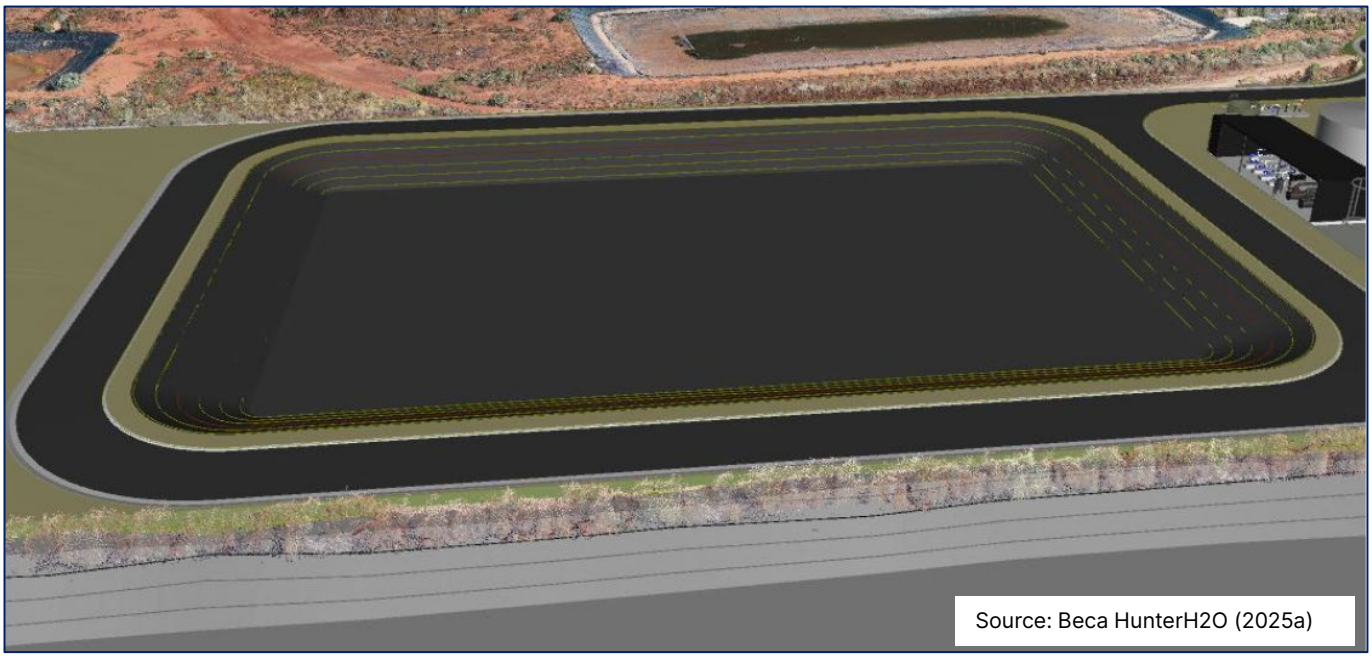


Figure 21: Preliminary arrangement showing emergency storage pond.

2.3.4 FOUL WATER PUMP STATION

The FWPS collects supernatant, foul water and contaminated stormwater from several processes around the STP for transfer to the inlet works. These are:

- Supernatant from the aerobic digester
- Filtrate from sludge dewatering system
- Foul water from the odour control irrigation water
- Contaminated stormwater and washdown water from the odour control area
- Contaminated stormwater and washdown water from the DWAS Pump station and sludge pickup bay
- Foul water and contaminated rainwater from the inlet works area
- Foul water and contaminated rainwater from the grit removal system
- Drains from the tertiary treatment area

Contaminated drains from hard stands are sized to service an annual exceedance probability (AEP) of 1% with 1-hour rainfall of 57.9mm/h.

Further details on process sizing associated with the foul water pumping station is presented in Beca HunterH2O (2025a) (refer **Appendix A**).

2.3.5 SITE ACCESS

There are four existing site access points for the Wills Street STP. The existing main site access (1) is from Wills Street. It is proposed to upgrade an existing alternative site access (2) from Wills Street, west of the existing main site access, to become the new main site access for the new BHSTP (**Figure 22** and **Figure 23**). The new main access will provide access to septage receival without the need for tankers to traverse the operational area of the new STP and ensures entry to the site is via the area of the new administration building.

The proposed pavement material for this new main access is asphaltic cement for straight sections of road, concrete for turning areas, crane set up areas, and the drive on chemical unloading bund. It is proposed to use unsealed surfaces for access road surrounding the emergency storage lagoon. The sealed roads are proposed to be provided with cross fall towards kerb and guttering that will consist of inlet pits to capture stormwater runoff.

Figure 22: Proposed new main site access point location

Existing site access (4) off Kanandah Road along the southern boundary will serve as the main access during the construction phase. While the final existing site access (3), further to the west along Kanandah Road, may also be used during the construction phase (refer **Figure 23**). Both alternative access roads from Kanandah Road (3 and 4) will minimise interactions between the construction activities for the new BHSTP and the operation of the existing Wills Street STP.

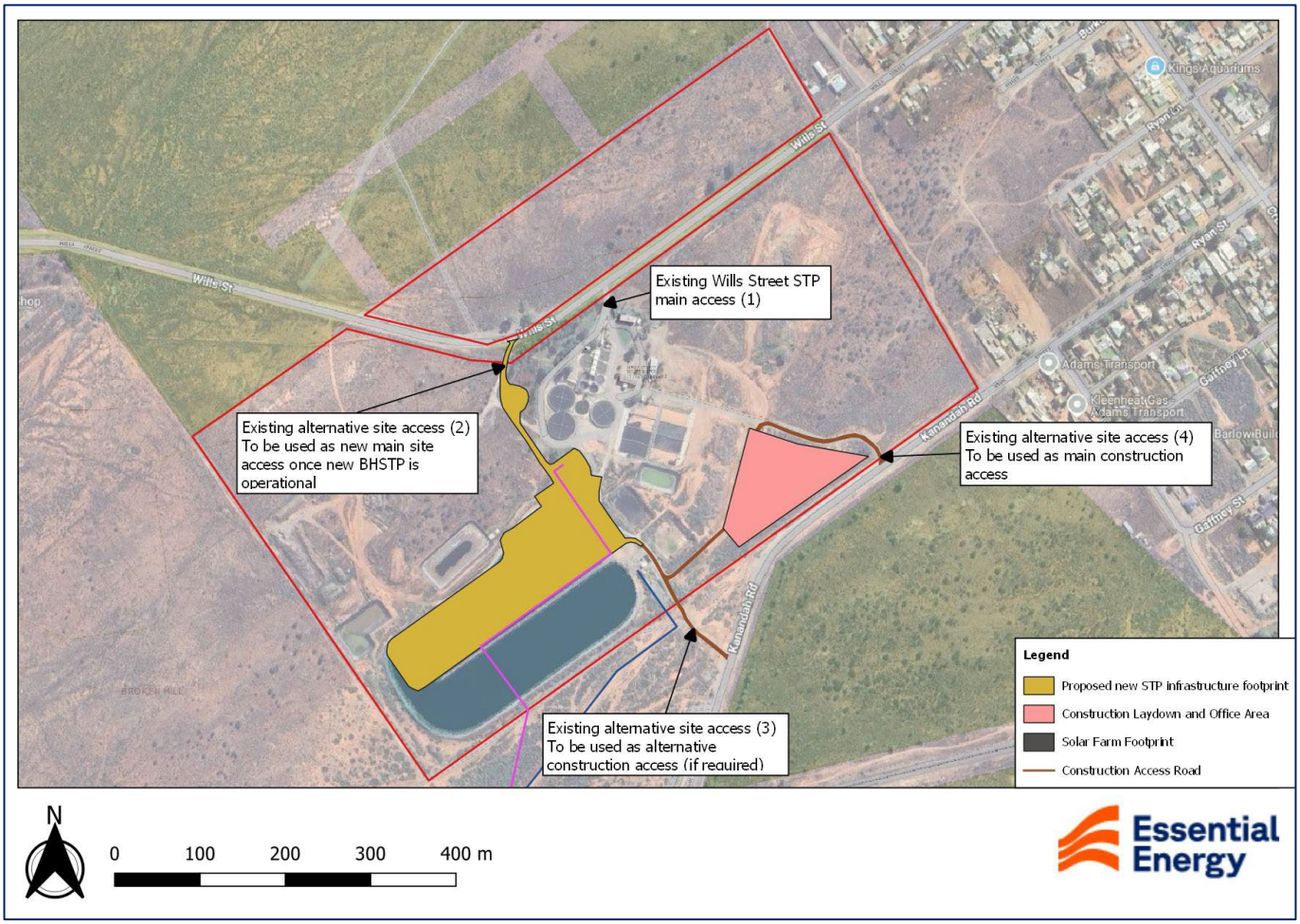


Figure 23: Existing and proposed site access

2.3.6 STORMWATER DRAINAGE

Site stormwater collected from proposed and existing buildings (i.e., amenities, switchroom and chemical facility) and roadworks will be directed to on-site stormwater drainage system discharging to the existing stormwater detention ponds.

The stormwater drainage hydrologic assessment will be developed during the detailed design and will follow the requirements of the Australian Rainfall Runoff (ARR) method for a 5% Annual Exceedance Probability (AEP). The adoption of the 5% AEP peak design flow indicates that there is a 5% chance every year that design flows through the catchment will be exceeded. Implementing a 5% AEP (Average Recurrence Interval or ARI = 20 years) has been taken from *AS 3500.3:2003 Plumbing and drainage - Stormwater drainage*.

There is an existing site stormwater treatment system which will require amending as part of the upgrade. Further assessment of site stormwater treatment during the upgrade and post upgrade will likely be required.

2.3.7 BUSHFIRE

All firefighting requirements will be identified and addressed as per the relevant Australian standards or BCA during detailed design.

2.3.8 LANDSCAPING

Backfilling of all excavated areas is to be carried out in such a way that the site will be returned to pre-construction conditions where possible. All disturbed soil areas will be replanted to minimise erosion. Vegetation will be left where possible, or revegetation conducted to maintain a visual screen around the sites.

2.3.9 ON-SITE AMENITIES, ADMINISTRATION BUILDING, LABORATORY AND PARKING

The existing amenities will be retained as part of the upgrade. However, a new administration building will be included in the upgrade, as shown in the plant's general arrangement. Adequate parking for operational site and visitors will be provided. A limited number Electric vehicle (EV) charging points will also be made available either at the proposed new administrative building or an alternative suitable location.

A snapshot of the proposed amenities building internal arrangement is shown in **Figure 24**.

2.3.10 ACCESS PLATFORMS / HANDRAILS

Access platforms and handrails are required to all structures and equipment and shall be compliant with AS1657.

Platforms shall be provided to allow personnel access to all equipment without the need for any special equipment. Ladders are not an acceptable means of accessing any part of the facility.

Stairs are required to access the inlet works and the IDEA tanks. Access stairs / platforms are required to access the Balance Tank from the IDEA tanks without descending to ground level. This will enable the operator to be able to walk throughout the major process unit structures without the need to repeatedly ascend and descend to the ground level.

2.3.11 POWER AND WATER

A new high voltage power and potable water supply will be required to service the new BHSTP. Details of the electrical and control components of the site to be developed in the next stages of detailed design. It is understood that a new potable water connection to a larger water main on Kanandah Road will be required. The capacity of the connection will be reviewed as part of subsequent design phases.

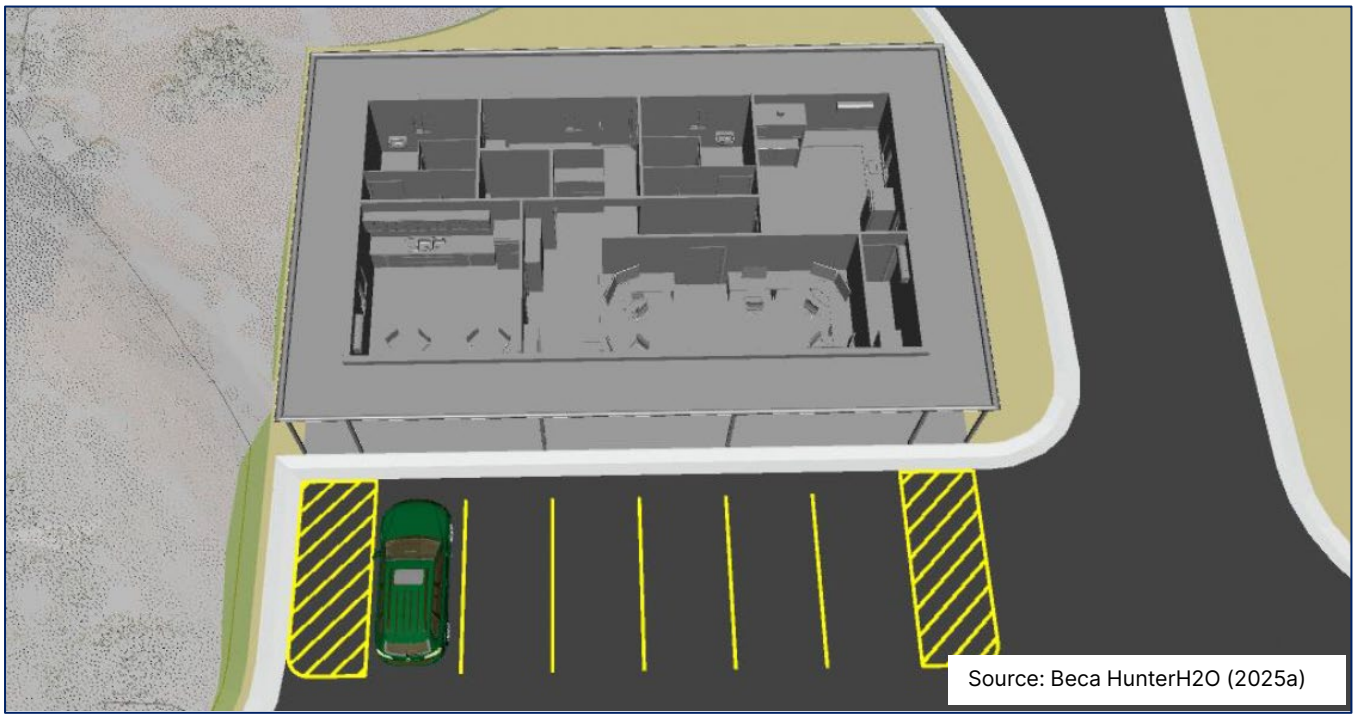


Figure 24: Amenities building preliminary arrangement

2.3.12 PHOTOVOLTAIC SYSTEM

To offset electricity consumption and minimise greenhouse gas emissions from the new BHSTP, it is proposed to construct operate and maintain a new photovoltaic (PV) system.

Based on the available land and all design inputs and assumptions a solar PV concept design was carried out and a 412.5 kW solar farm has been proposed for the new STP site. The proposed PV system will require approximately 20,000m^2 of available land. It is proposed to construct the new PV system on the southern portion of the existing tertiary treatment pond (refer **Figure 25**), which is to be decommissioned and back-filled as part of construction works for the new BHSTP. Any excess generation will be exported to the network via the existing connection. However, the design has aimed for minimal export to the grid.

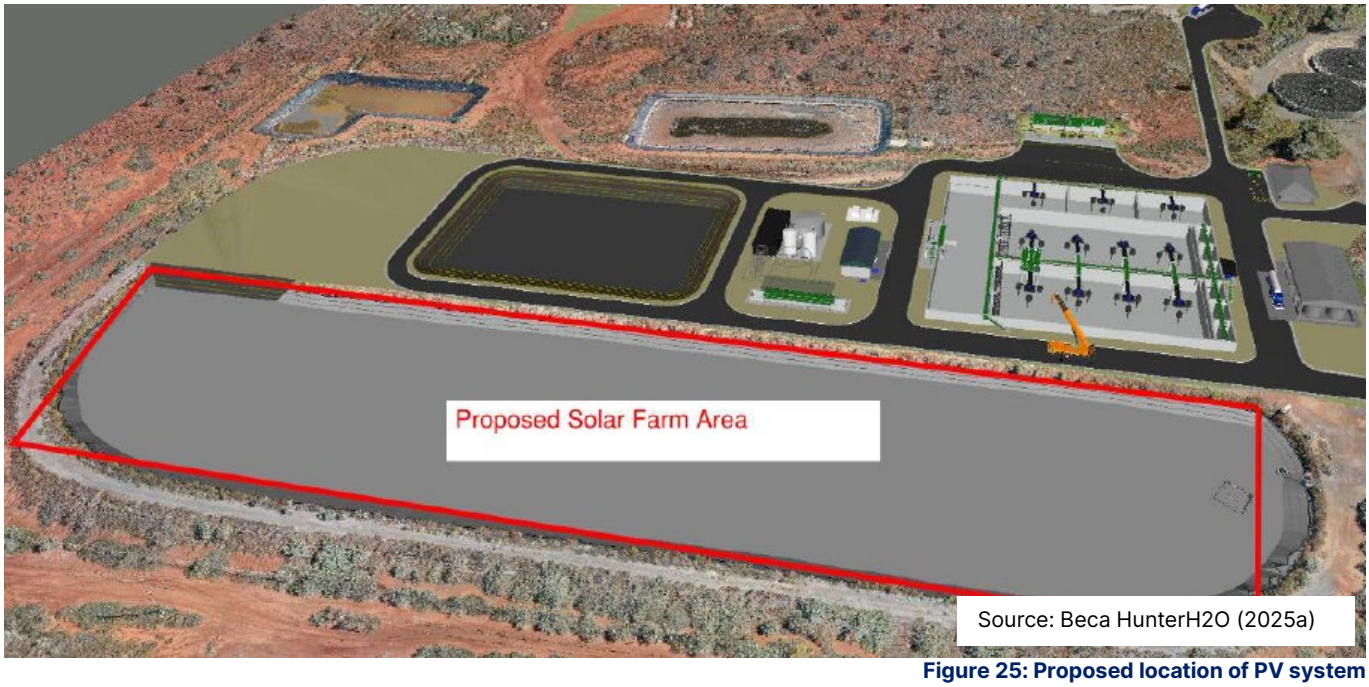


Figure 25: Proposed location of PV system

2.3.13 SECURITY, FENCING, GATE ACCESS AND CCTV

A back to base security system will be included (or extension of the existing system). This will arm the services building and also include inputs for the detection of smoke.

Adequate security fencing will be provided. The fence will be designed in accordance with Essential Water's security fencing requirements.

An automatic sliding gate will be included, with the ability for Essential Water to operate from portable actuators and also from the Supervisory Control and Data Acquisition (SCADA) both internally and across the Wide Area Network (WAN).

A closed circuit television (CCTV) camera system (including PC based hardware/software) will provide surveillance over the plant. The Cameras will be located in strategic locations including access gate and key process areas.

2.4 Construction Activities

2.4.1 CONSTRUCTION METHODOLOGY

The exact construction methodology would be determined by the successful contractor. A general construction rationale is outlined below:

- Implement appropriate temporary drainage, site run-off and other construction environmental control measures at the site that are necessary for the construction of the plant augmentation
- Take tertiary pond offline and redirect flows to existing emergency storage dams and treatment via existing UV system. Additional chlorine dosing may be required to meet discharge requirements
- Dewater and de-sludge the tertiary pond
- Undertake earthworks to achieve requisite design levels
- Construct treatment facilities and associated works (roads, pipelines etc.) within the proposed new BHSTP infrastructure footprint area
- Commissioning of new treatment facilities with diversion of influent sewage to the new inlet works
- Restoration of the overall STP site, including topsoiling and grassing to design level/grades to include surface drainage of stormwater

Delivery of the proposed construction works whilst maintaining effective operation of the existing STP's presents unique challenges and associated risks. Effective management of these risks would be required to successfully complete the proposal. A high level staging plan, allowing construction and commissioning of the STP whilst providing continued operation and effective interfacing with existing infrastructure will be developed further as part of detailed design.

2.4.2 TIMING AND WORK HOURS

Construction work is expected to commence in the first half of 2026 and is expected to take approximately 18 to 24 months to complete, weather dependant.

Generally, audible construction work hours at the nearest sensitive receiver would be between 7am and 6pm Monday to Friday, and 8am and 1pm on Saturday. On occasions, works outside these hours may be undertaken where the following requirements are met:

- Neighbours (and other sensitive receivers) adjacent to the works or the local council or the Environment Protection Authority (EPA) have been notified; and
- The works are justified on the basis that they are emergency works, or, because of supply security network outages or construction limitations, it is deemed that the works can only be achieved outside these hours.

2.4.3 RESOURCES AND EQUIPMENT

The following equipment is likely to be used at the proposal site to complete construction work:

- Excavators
- Truck mounted auger
- Backhoe
- Air compressors
- Underbore rig and associated transport vehicles and equipment
- Dewatering equipment (e.g. pumps, filters)
- Rock breaker
- Crane
- Concrete agitators and pumps
- Water trucks
- Skid steers
- Rollers
- Dump trucks
- Bitumen truck
- Front end loaders
- Light vehicles and trailers

2.4.4 IMPACT MITIGATION

The mitigation measures as detailed in **Section 6** form part of the proposed activity and will be implemented, as required, as part of the construction and operational phases.

2.5 Operation and Maintenance Requirements

Once the project is constructed, periodic maintenance will be required. Operational monitoring and maintenance of the STP is important to maintain effective and efficient sewage treatment operations and reduce operation and maintenance costs. An ongoing program of systematic inspections, preventative maintenance and equipment overhaul is required for the proposed infrastructure to operate efficiently and effectively, and achieve adequate service life (PWA, 2019a).

A detailed Operations Manual will be produced once the new BHSTP is constructed.

It is expected that the newly constructed BHSTP operation will require the services of the equivalent of a full time operator competent in undertaking routine operation, maintenance and process monitoring tasks.

There will be limited need for staff or contractors at the South STP on a permanent basis, once the site is decommissioned. However, regular inspection and maintenance of the new pumping station and the rising main will be required, along with vegetation maintenance when required.

3. Consultation

3.1 Overview

Community consultation defines the processes we use to seek views or provide information about projects. The term consultation can describe processes ranging from simply delivering information to residents, community information displays, or holding meetings with community representatives designed to actively seek feedback from local communities into a particular project.

The population as a whole is more aware than ever of their social, environmental and economic needs. They want to know about what is planned for their area and how it would impact on them.

Incorporating community consultation as a key business practice is both a necessary and a desirable path for Essential Energy to take. It must be undertaken in good faith and be transparent in all activities.

3.2 Agency Consultation

Essential Energy, Essential Water and its appointed project management and design consultants have engaged in extensive and ongoing consultation with the NSW Department of Climate Change Energy, the Environment and Water (DCCEEW) and the EPA, to ensure the proposal meets statutory obligations regarding safety, human health and the environment, is fit for purpose and economically feasible. This has included regular design progress meetings, and a Hazard and Operability (HAZOP) workshop, which included a Construction Hazard Assessment Implication Review (CHAIR) undertaken in line with NSW Workcover guidelines (CHAIR, Safety in Design Tool). The purpose of the CHAIR was to identify issues, associated risks, mitigation strategies to be adopted and responsible persons. The HAZOP forms an integral part of the Safety in Design process.

3.3 Engaging the Community

Essential Energy has in place a policy for community consultation on all major projects. The policy ensures that the community is informed about proposed development and that concerns and issues are taken into consideration.

Essential Water is currently engaging with customers to develop its 2026-31 Pricing Proposal which outlines investments and prices over this period and is scheduled to be submitted to the NSW Independent Pricing and Regulatory Tribunal (IPART) in September 2025 for approval. Through this process, Essential Water has met with its Customer Panel and outlined that compliance with environmental obligations is driving the need to replace the existing, aging Wills Street STP. The Customer Panel had no specific feedback on the project but has identified the need for Essential Water to share information regarding the project with customers

Treated effluent reuse customers will be consulted with prior to construction work commencing advising of periods where flows of treated effluent may be restricted or unavailable.

3.4 Consultation Requirements under the T&I SEPP

Under the EP&A Act, Essential Energy is the determining authority for certain developments defined under *State Environmental Planning Policy (Transport and Infrastructure) 2021* (T&I SEPP) as being permissible without consent. While the nature of work being undertaken does not require council consent, Division 1 of the T&I SEPP does provide consultation requirements with the local council where works are anticipated to impact upon council infrastructure, local heritage items, flood liable land and certain land within the coastal zone. In addition, consultation may be required with the State Emergency Service (flood liable land) and other specified public authorities in certain circumstances.

The existing Wills Street and South STP sites include their own site drainage and stormwater management system. Stormwater flow within the proposed rising main pipeline corridor will likely be overland towards the nearby ephemeral drainage lines, or where it is located within the Kanandah Road and Pinnacles place

commercial/industrial areas towards roadside stormwater drains or constructed drainage channels. The proposal is unlikely to have a substantial impact on the local council's stormwater system. While some disruption to local roads may occur during the delivery of large plant and equipment, the works, are considered to be minor and inconsequential, and will not involve significant disruption of pedestrian or vehicle traffic, or strain the capacity of the local road system. Essential Water (a business unit of Essential Energy) is the local water supply and sewage treatment authority, not the local council. Consultation with the local council is therefore not triggered under Clause 2.10 of the T&I SEPP.

The proposal site is not located within a mapped area of local heritage, according to the *Broken Hill Local Environmental Plan 2013* (Broken Hill LEP). Consultation with the local council is therefore not triggered under Clause 2.11 of the T&I SEPP.

There is no publicly available flood liable land mapping for Broken Hill. The majority of the plant and equipment at both the new BHSTP and South STP sites are located on more elevated parts of each site, respectively, and not known to be subject to inundation by floodwaters. Therefore, the proposal is unlikely to change flood patterns. Some parts of the proposed rising main pipeline route are located in low lying land and therefore may be subject to localised flooding. However, given the nature of the activity (i.e., installation of predominately below ground pipeline) it is not expected to change flood patterns more than a minor extent. Therefore, consultation with the local council under Clause 2.12 of the T&I SEPP is not required.

The proposal is not a relevant provision in accordance with Clause 2.13(2), and therefore consultation with the State Emergency Service is not required under clause 2.13 of the T&I SEPP.

The proposal is not located within the coastal zone, therefore consultation with the local council is not triggered under Clause 2.14 of the T&I SEPP.

The proposal is not located on land, or adjacent to land, that would trigger consultation with other specified public authorities under Clause 2.15 of the T&I SEPP.

The proposal is not a development type listed in Clause 2.16(1) of the T&I SEPP, and therefore there is no requirement to consider Planning for Bushfire Protection guide.

In addition to consultation requirements, additional notification and approval requirements are outlined in **Table 10**.

4. Project Alternatives

4.1 Do Nothing (Maintain Current Infrastructure)

One option would be to refrain from undertaking any upgrade of the existing Wills Street STP. The consequences of Essential Water doing nothing would be that the existing STP plant and equipment would continue to age, with a greater risk of faults and failure, ultimately leading to poorer water quality outcomes and likely not meeting licensed discharge limits.

Due to Essential Water's obligations to provide water and sewerage services that meet customers' needs for reliability, environmental protection and performance, including meeting the EPL requirements, the 'do nothing' option is not a viable alternative.

4.2 Project Planning Options

Essential Water has been planning for the upgrade and/or replacement of the existing Wills Street STP since 2009. Several augmentation and treatment options have been considered, which culminated in an augmentation concept development in 2019.

4.2.1 AUGMENTATION OPTIONS

A treatment plant augmentation options assessment was completed by GHD in 2011. Four options were considered, namely:

Option 1 – Retain and refurbish both Wills Street and South STPs

Option 2 – Decommission South STP and transfer its sewage to a refurbished Wills Street STP

Option 3 – Decommission South STP and transfer its sewage to a new Wills Street STP

Option 4 – Refurbish South STP and construct a new STP adjacent to the existing Wills Street STP

There is insufficient treatment capacity for the existing Wills Street STP to treat the design sewage flows and therefore Option 2 was considered to be unfeasible and was discounted from the financial assessment. A multi-criteria assessment of options 1, 3 and 4 was undertaken to determine the preferred sewerage option for Broken Hill. Criteria and weighting were developed by GHD to enable each option to be ranked according to:

- Service Reliability Risk
- Occupational Health and Safety (OHS)
- Simplicity and robustness of the process
- Ability to upgrade for more stringent standards
- Capital Cost
- Whole of life costs

The multi-criteria assessment indicated that Option 1 had the lowest capital and whole of life cost followed by Option 3 and then Option 4. The primary advantage of refurbishing the Wills Street and South STPs in the short term was that it deferred the capital cost of constructing a new STP. Although Option 1 was calculated to be the lowest cost, the multi-criteria analysis determined that Option 3 is the preferred option for the following reasons:

- A newly constructed STP would have improved service reliability levels over the existing STP infrastructure, even with refurbishment
- The existing STPs require substantial upgrades to meet modern OHS requirements

- The new BHSTP has the greatest flexibility for future upgrade (e.g. to meet more stringent effluent treatment requirements such as nutrient removal)

Option 3 was chosen by Essential Water as the preferred augmentation option.

4.2.2 TREATMENT OPTIONS

Essential Water then engaged PWA to investigate different treatment process options to replace/augment the existing STPs based on augmentation Option 3 (GHD, 2011). An Options Study was completed by PWA (2018a) to assess potential STP sites and STP types for the augmentation, namely:

Option 1: Intermittently Decanted Extended Aeration (IDEA)

Option 2: Sequencing batch reactor

Option 3: Continuous activated sludge

Option 4: Membrane Bio-reactor (MBR)

Option 5: "Nereda" technology.

Each option was assessed against a range of criteria, including:

- Ability to meet proposed effluent quality
- Footprint
- Complexity in operation
- Proven performance
- Operator skill required
- Proprietary skill required
- 30- year present value cost

PWA (2018a) recommended an IDEA system as the preferred treatment option for the following reasons:

- Meet the effluent quality requirements for the proposed reuse application
- Is robust and can handle large variations in flow and influent quality
- Is relatively simple to operate compared to the MBR and continuous activated sludge processes
- Has a small footprint and could be accommodated at the existing site
- Has a low capital and operating cost
- Is a proven technology in NSW country towns.

Option 1 (IDEA) was chosen by Essential Water as the preferred treatment option.

4.2.3 CONCEPT DESIGN

In 2019, PWA prepared the *Broken Hill STP Augmentation Concept Development* report (PWA 2019a) to present concept detail of sizing, design criteria, layout and operational features of the augmentation works based on the preferred augmentation and treatment options chosen above. The concept had proposed the new STP infrastructure be built to the east of the existing STP infrastructure.

4.3 Detailed Design

In late 2022 Beca HunterH2O were engaged to prepare the detailed design for the proposal. As part of their preliminary review of the concept design (PWA, 2019a), Beca HunterH2O interrogated the existing concept based on up-to-date information and stakeholder preferences. Several changes to the original concept design (PWA, 2019a) were proposed, as discussed below.

4.3.1 CHANGE TO DESIGN PEAK INSTANTANEOUS RAW SEWAGE FLOW

The methodology used for the estimation of peak instantaneous flow (PIF) within the original concept design was suitable for a high-level assessment only. A thorough review of available data was conducted, including pump station capacities. The result of the review was a significant reduction in the peak flow to the transfer pump station at South STP and a significant reduction in the peak flow received at the existing Wills Street STP (Beca HunterH2O, 2025a).

4.3.2 ABANDONMENT OF PLAN TO USE ONE OF THE EXISTING TRICKLING FILTERS AT SOUTH STP

During the progression of the design basis, it was determined that the existing trickling filters are unlikely to be suitable for reuse as buffer storage. The trickling filters are aged and not designed to be water retaining structures. Modifying the trickling filters to be used for said storage, especially considering any impacts on the existing plant operation was deemed unlikely to provide any cost benefit (Beca HunterH2O, 2025a).

4.3.3 RELOCATION OF STP INFRASTRUCTURE AT WILLS STREET STP SITE

The original concept design (PWA, 2019a) had proposed the new STP infrastructure be built to the east of the existing STP infrastructure at the Wills Street STP site. Essential Water and other project stakeholders had raised concerns that this location was unlikely to be favourable due to its proximity to nearby receptors (i.e., potential noise and odour risk). Through collaborative stakeholder workshops, it was initially decided to relocate the new STP infrastructure to the west of the existing infrastructure at the Wills Street STP site to provide greater buffer distances. However, unfavourable geotechnical conditions (i.e. hard to very hard rock) to the west and northwest of the existing STP infrastructure meant this location was no longer feasible. Through further collaborative stakeholder workshops it was decided that situating the bulk of the new STP infrastructure within the tertiary pond that is proposed to be decommissioned to the south existing STP infrastructure would be most preferred. This location avoids the hard rock to the west and northwest, makes use of an already significantly disturbed area of the site, and avoids the proposed STP infrastructure encroaching further east towards the residential receivers (Beca HunterH2O,2025a).

4.3.4 ABANDONMENT OF THE EXISTING TERTIARY POND

The existing tertiary pond provides some benefits as it attenuates wet weather flows and provides some additional pathogen removal. However, groundwater monitoring indicates the pond leaks and algae growth within the pond deteriorates the effluent quality to the point where there is increased risk of breach of the proposed licence limits. Through collaborative stakeholder workshops, it was decided to abandon the existing tertiary pond.

4.3.5 REPLACEMENT OF EXISTING EFFLUENT DISCHARGE PIPELINE

Assessment of the hydraulic capacity of the existing treated effluent discharge pipeline was not included in the concept design reporting. Preliminary assessment indicates that the existing discharge pipeline is unlikely to be sufficient to convey the peak flows (Beca HunterH2O, 2025a). 85% detailed design has indicated the new pipe will need to be a DN630 (i.e., 630mm diameter pipe), increasing from an average existing diameter of approximately 300mm. The replacement pipe will largely follow the alignment of the existing pipeline (refer in **Figure 16**).

4.3.6 IMPROVED EFFLUENT TREATMENT FOR REUSE

Concerns were raised regarding the suitability of the treated effluent produced by the proposed process without filtration for reuse purposes. In particular, the assertion that the effluent produced is suitable for *Unrestricted Municipal Reuse as defined in the Australian Guidelines for Water Recycling* (AGWR).

Through collaborative stakeholder workshops, it was decided to defer the filtration construction by applying the following approaches:

- Investigate end-use controls in lieu of filtration to reduce public exposure, guided by Essential Water
- Operate initially without filtration and rely on good upstream control of the secondary process. Online turbidity analysers are to be provided upstream of UV and chlorine contact tank (CCT) with automatic

flow diverting away from the recycled water facility if turbidity or UV transmissivity (UVT) is out of the pre-validation operational window, reuse is only provided when the plant is performing well

- Provision shall be made for the filtration system if deemed necessary in the future (such as footprint, backwash water usage, backwashed wastewater return, maximum power demand and switchboard)

(Beca HunterH2O, 2025a).

For further details, refer to Appendix B: Technical Memo – Tertiary Treatment Options Discussion for Broken Hill STP Upgrade Project of Beca HunterH2O (2025a).

4.3.7 SLUDGE MANAGEMENT OPTIONS

Sludge lagoons provide a simple and typically low operational input solution for sludge management in small STPs. The proposed site presents challenging geotechnical conditions with hard rock close to the surface in a number of locations which significantly increased the cost of providing sludge lagoons. The sludge lagoons have a larger odour footprint and have the potential to impact nearby sensitive receptors, particularly if located to the east of the existing STP.

The sludge lagoons emit methane which contributes significant Scope 1 emissions. Installation and removing sludge from the lagoons of the size and number required for the proposed STP would be operationally complex and potentially present a safety risk.

Aerobic digestion was proposed and approved as an alternative process. Although aerobic digestion requires more frequent operation and monitoring, the required input aligns well with that required for the new intermittent process. Further aerobic digestion in this instance would require reduced manual intervention.

Aerobic digestion can be provided at either a similar or lower cost than the sludge lagoon options and would produce significantly less Scope 1 GHG emissions. Aerobic digestion and dewatering will have a significantly smaller odour footprint than sludge lagoons and thus would be less likely to impact nearby receptors. The use of aerobic digestion is also more aligned with future regulatory changes (Beca HunterH2O, 2025a).

For further details refer to Appendix C: Technical Memo -Sludge Management Options Discussion for Broken Hill STP Upgrade Project of Beca HunterH2O (2025a).

4.3.8 PREFERRED PROPOSAL

The final overall preferred proposal, based on 30% detailed design and as update by 85% design plans, subject to assessment in this REF, is therefore as follows:

- Replace the aging STP infrastructure at the existing Wills Street STP site with new STP infrastructure, decommission the South STP and transfer its sewage to the new BHSTP (Augmentation Option 3)
- Adopt an IDEA as the secondary treatment option (Treatment Option 1)
- Use aerobic digestion as the biological stabilisation process (preferred sludge management option)
- Relocate the majority of new STP at the new BHSTP, south of the existing STP infrastructure in place of the existing tertiary pond, which will be decommissioned (refer **Figure 8**).

The preferred proposal is based on delivering a safe, reliable, efficient and cost effective STP, that will enable sufficient sewage treatment for the entire City of Broken Hill, while meeting contemporary effluent discharge and effluent reuse criteria. The preferred proposal through design and implementation has the added benefits of retiring the South STP, minimising odour and greenhouse emissions, and other potential environmental impacts, while maximising social and economic impacts.

5. Environmental Legislation

The following section addresses the regulatory and statutory context of the proposed activity including its definition, land use permissibility, and compliance with the relevant environmental planning instruments (EPIs).

5.1 Environmental Planning and Assessment Act, 1979 (EP&A Act)

The EP&A Act is the primary piece of legislation regulating land use planning in NSW. It provides the framework for the development of state and local planning instruments which, through their hierarchy, determine the statutory process for environmental impact assessment. Under the EP&A Act there are two distinct processes, which are:

- Part 4 - 'development' proposals which require consent, including state significant development; and
- Part 5, which regulates 'activities' and requires an approval by a determining authority (e.g. Essential Energy). Part 5 also includes an assessment pathway (Division 5.2) for state significant infrastructure.

The proposal can proceed under Part 5, Division 5.1 of the EP&A Act, given the proposal:

- May be carried out without development consent
- Is not exempt development
- Would be carried out by a determining authority or requires the approval of a determining authority.

A determining authority, for the purposes of this activity, is defined in Part 5 of the EP&A Act to include, but not be limited to, a state-owned corporation within the meaning of the *State Owned Corporations Act 1989*. Essential Energy is listed as a state-owned corporation, and would therefore be the determining authority for the activity covered by this REF.

In accordance with state and local EPIs (described below), this REF has been prepared under Part 5, Division 5.1 of the EP&A Act to assess the possible environmental outcomes of the proposed activity. In determining the proposal and degree of impact, Essential Energy is required to consider Section 5.5 of the EP&A Act and Section 171 of the EP&A Reg which are summarised in **Section 9** of this REF.

In accordance with Section 171(4) of the EP&A Reg, Essential Energy is required to publish this REF on the NSW planning portal prior to the activity commencing, as the capital value of the proposal will exceed $5 million, and it requires an update to the EPL.

5.2 Environmental Planning Instruments

EPIs regulate the permissibility to undertake an activity and the type of assessment process that is required. EPI's comprise state environmental planning policies, and local environmental plans (LEPs). EPIs that apply to this development are outlined below.

5.2.1 STATE ENVIRONMENTAL PLANNING POLICIES

5.2.1.1 State Environmental Planning Policy (Transport and Infrastructure) 2021

State Environmental Planning Policy (Transport and Infrastructure) 2021 (T&I SEPP) consolidates and updates the planning process for transport and infrastructure projects. Clause 2.126(2) of the T&I SEPP allows development for the purpose of sewage treatment plants to be carried out without consent on land in a prescribed zone in the prescribed circumstances. The existing Wills Street and South STP sites are located within a prescribed zone, being Zone SP2 Infrastructure, according to the *Broken Hill Local Environmental Plan 2013* (Broken Hill LEP), and will be undertaken in prescribed circumstances, being carried out by or on behalf of a public authority. Clause 2.126(6) of the T&I SEPP also allows for the

development for the purpose of sewage reticulation systems to be carried out without consent on any land in the prescribed circumstances. Construction of the proposed rising main, establishment of the pump station at the decommissioned South STP and replacement of existing treated effluent discharge pipe will be carried out in the prescribed circumstances.

The proposed construction, operation and maintenance of the proposed BHSTP falls within the scope of Clause 2.126 of the T&I SEPP as the activity is classified as development for the purpose of a sewage treatment plant and sewer reticulation system, undertaken in the prescribed zone and by or on behalf of a public authority, and is hence permitted on the land without the requirement for development consent.

Consultation requirements under the Infrastructure SEPP are addressed in **Section 3.4** of this REF.

5.2.1.2 State Environmental Planning Policy (Planning Systems) 2021

State Environmental Planning Policy (Planning Systems) 2021 (Planning Systems SEPP) consolidates and updates three former SEPPs relating to state and regional development, Aboriginal land, and concurrences and consents.

Chapter 2 of the Planning Systems SEPP identifies land and development types which are State Significant Development (SSD), State Significant Infrastructure (SSI), Critical State Significant Infrastructure (CSSI), and Regionally Significant Development (RSD). Clause 2.6(1) of the Plannings Systems SEPP declares development to be SSD, pursuant to Section 4.36 of the EP&A Act, if:

(a) the development on the land concerned is, by the operation of an environmental planning instrument, not permissible without development consent under Part 4 of the Act, and

(b) the development is specified in Schedule 1 or 2.

While the proposed new BHSTP does meet development specified in Schedule 1 (sewerage systems), the proposal is permissible without consent pursuit to the T&I SEPP, as discussed in **Section 5.2.1.1** of this REF. For a development to be declared SSD, the requirements of both Clause 2.6(1)(a) *and* 2.6(1)(b) need to be satisfied. The proposal therefore does not meet the requirements to be declared SSD.

Clause 2.13(1) of the Planning Systems SEPP declares development to be SSI, pursuant to Section 5.12(2) of the EP&A Act, if:

(a) the development on the land concerned is, by the operation of a State environmental planning policy, permissible without development consent under Part 4 of the Act, and

(b) the development is specified in Schedule 3.

In addition, Clause 2.14 declares development to be SSI, pursuant to Section 5.12(4) of the EP&A Act, if the development is specified in Schedule 4 of the Plannings Systems SEPP.

The proposal is permissible without consent under Part 5 (Division 5.1) of the EP&A Act, however, the proposal is not specified in Schedule 3 or 4 of the Planning Systems SEPP. The proposal therefore does not meet the requirements to be declared SSI.

Clause 2.15 of the Planning Systems SEPP declares development to be CSSI if the development is specified in Schedule 4 of the Planning Systems SEPP —

(a) may be carried out without development consent under Part 4 of the Act, and

(b) is declared to be State significant infrastructure for the purposes of the Act if it is not otherwise so declared, and

(c) declared to be critical State significant infrastructure for the purposes of the Act

The proposal does not meet the requirements to be declared CSSI.

Clause 2.19 declares development to be RSD, pursuant to Section 4.5(b) of the EP&A Act, if the development is specified in Schedule 6. The proposal is likely to be meet the requirements of general

development over $30 million, noted in Schedule 6 of the SEPP, however, as development consent is not required, pursuant to Clause 2.19(2)(b), the proposal is not declared to be RSD.

5.2.1.3 State Environmental Planning Policy (Resilience and Hazards) 2021

State Environmental Planning Policy (Resilience and Hazards) 2021 (Resilience and Hazards SEPP) consolidates and updates three former SEPPs related to, land use planning controls within the coastal zone, hazardous and offensive development, and the remediation of contaminated land.

Chapter 2 of the Resilience and Hazards SEPP aims to promote an integrated and co-ordinated approach to land use planning in the coastal zone in a manner consistent with the objects of the Coastal Management Act 2016. Clause 2.7(1) of the Resilience and Hazards SEPP specifies that certain types of development carried out on land identified as "coastal wetlands" or "littoral rainforest" on the Coastal Wetlands and Littoral Rainforests Area Map, may only be undertaken with development consent, and that development (other than environmental protection works) is declared to be designated development. The proposal site is not located within a mapped area of coastal wetland or littoral rainforest. Development consent for the proposal is not required.

Chapter 3 of the Resilience and Hazards SEPP contains a systematic approach for assessing development proposals for potentially hazardous and offensive industry or storage. The SEPP includes definitions of 'hazardous' and 'offensive', relating to risk, and sets out specific assessment requirements for such proposals. The development consent provisions of the Resilience and Hazards SEPP apply to proposals that are assessed under Part 4 of the EP&A Act. The proposal is permissible without consent pursuit to the T&I SEPP, as discussed in **Section 5.2.1.1** of this REF.

Chapter 4 of the Resilience and Hazards SEPP provides for a statewide planning approach to the remediation of contaminated land. In particular, the chapter establishes when consent is required for remediation work, requires all remediation work to comply with standards and ensures that local councils are notified prior to remediation works being carried out. The development consent provisions of the Resilience and Hazard SEPP apply to proposals that are assessed under Part 4 of the EP&A Act. The proposal is permissible without consent pursuit to the T&I SEPP, as discussed in **Section 5.2.1.1** of this REF.

5.2.2 LOCAL ENVIRONMENTAL PLANS (LEP)

LEPs are developed by councils (they become law only after Ministerial approval) and guide planning decisions for local government areas. According to the Department of Planning, Industry and Environment (DPIE), LEPs through zoning and development controls, allow councils to regulate the ways in which land is used. Council LEPs also list heritage items that are of local heritage significance.

The application of the T&I SEPP overrides the need to consider zoning controls, as development for the purposes of sewage treatment plants on land in a prescribed zone in the prescribed circumstances, and for sewage reticulation systems in the prescribed circumstances, as is the case with the proposal, are permissible without consent. However, the T&I SEPP provides consultation and notification provisions where activities are likely to substantially impact upon council related infrastructure or items of local heritage significance.

5.3 Key Legislation

5.3.1 ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999 (COMMONWEALTH) (EPBC ACT)

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) requires the approval of the Commonwealth Minister for the Environment for actions that may have a significant impact on matters of national environmental significance (MNES). Approval from the Commonwealth is in addition to any approvals under NSW legislation.

The EPBC Act lists nine matters of NES which must be addressed when assessing the impacts of a project. An assessment of how the project may impact on matters of NES is provided in **Table 9**.

Table 9: Matters of National Environmental Significance

MATTER OF NATIONAL ENVIRONMENTAL SIGNIFICANCE	IMPACT
World heritage properties	There are no world heritage properties proximate to the proposed development, or that would potentially be affected by the proposal
National heritage places	The proposal is located within the Broken Hill LGA, a listed National Heritage Place.
Wetlands of international importance	There are no Ramsar wetlands proximate to the proposed development, and the proposal is not likely to have a significant impact on the ecological character of a Ramsar wetland.
Commonwealth listed threatened species and ecological communities	The proposal is not expected to have any significant impact on threatened species, populations or ecological communities listed within Commonwealth (or State) legislation (refer **Section 6.5** of this REF)
Great Barrier Reef Marine Park	The proposal would not result in any impacts to the Great Barrier Reef Marine Park
Commonwealth listed migratory species	The proposal is not expected to have an impact on listed migratory species (refer **Section 6.5** of this REF)
Nuclear action	The proposal would not result in any nuclear action, nor would the activity require any nuclear action to be undertake
Commonwealth marine areas	There are no Commonwealth marine areas proximate to the proposed development, or that would potentially be affected by the proposal
Impacts on water resources resulting from large coal mining and coal seam gas developments	The proposal is not related to any large coal mining or coal seam gas developments. The project would not impact on water resources

Although the proposal is located within the Broken Hill LGA and therefore within the bounds of a National Heritage Place, it is unlikely that it will impact on the heritage values of that place (refer **Section 6.7** and **Appendix F** of this REF**)**

Given that the project would not significantly impact on MNES and would not be carried out on Commonwealth land, the EPBC Act is not triggered and approval from the Commonwealth Minister for the Environment is not required.

5.3.2 NATIVE TITLE ACT 1993 (COMMONWEALTH) (NT ACT)

The *Native Title Act 1993* (Cth) (NT Act) as validated by the *Native Title (New South Wales) Act 1994* was part of the Commonwealth Government's response to the High Court's decision in Mabo v Queensland, which found that Australian common law can recognise the rights and interests over land and water possessed by Indigenous people in Australia under traditional laws and customs – 'native title'. The High Court rejected the doctrine that Australia was terra nullius (land belonging to no-one) at the time of European settlement and said that native title can continue to exist:

- Where Aboriginal and Torres Strait Islander people have maintained their connection with the land through the years of European settlement; and
- Where their title has not been extinguished by valid acts of Imperial, Colonial, State, Territory or Commonwealth Governments.

The decision does not give native title primacy over valid interests in land granted by governments. A validly granted freehold title would extinguish native title.

In relation to development on land subject to a successful native title claim or Indigenous Land Use Agreement, certain future acts are valid to the extent that they are ".....acts involving facilities for services to the public (Section 24KA)....."

The native title holders and any registered native title claimants or parties to an Indigenous Land Use Agreement (ILUA), in relation to land concerned, have a procedural right for their interests to be considered. Therefore, where land is subject to native title or an Indigenous Land Use Agreement, they are required to be notified of the proposed "future act" and are entitled to have matters considered including their native title rights and interests in the land.

The proposal site is located within the boundary of native title claim known as Barkandji Traditional Owners #8 (Part A) (Tribunal ID NCD2015/001), registered on 16 June 2015. The claim has been determined (refer Federal Court No. NSD6084/1998), with native title determined to not exist, exist both exclusively and non-exclusively, and be extinguished on certain parcels of land with the broader claim area. The proposal site is entirely located on land which native title has been extinguished. Written notice of the proposed works to the claimant and NTSCORP, in accordance with s 24KA of the NT Act, is therefore not required.

5.3.3 ABORIGINAL LAND RIGHTS ACT 1983

The *Aboriginal Land Rights Act 1983* (ALRA) was introduced to compensate Aboriginal people in NSW for dispossession of their land. The ALRA enables LALCs to claim Crown Land, that is, land in NSW that is owned and managed by the State Government. LALCs can have land transferred to them in freehold title if at the time of the claim the land meets certain requirements. Successful claims result in the transfer of land in freehold title to the claimant LALC. Land acquired under the land claims process is held in freehold title and is subject to all prevailing planning, environmental management, and cultural heritage legislation.

The parcel of Crown Land (Lot 302 DP1242250), immediately south of the existing Wills Street STP site, in which the proposed rising main and replacement of existing treated effluent pipe will pass through is subject to a land claim (ALC No. 51567) lodged by the NSW Aboriginal Land Council (NSWALC). However, the proposed route of both pipelines will be confined within existing easement/interests for water supply and wastewater conveyance that are in place over this land parcel. Consultation with the NSWALC is therefore not required.

5.3.4 BIODIVERSITY CONSERVATION ACT 2016

The *Biodiversity Conservation Act 2016* (BC Act) provides the process for listing threatened species, threatened ecological communities, and areas of outstanding biodiversity value, and details the process for assessing impacts on those matters.

Section 1.7 of the EP&A Act requires that assessment of an activity must consider its impact on threatened species, threatened populations, and threatened ecological communities or their habitats in accordance with Part 7 of the BC Act. The assessment for determining whether a proposed development or activity is likely to significantly affect threatened species or ecological communities, or their habitats, referred to in Section 7.3 of the BC Act, determines whether the proposed works are likely to have a significant impact. If a significant impact is determined, a species impact statement (SIS) is required, or if the proponent so elects, a Biodiversity Development Assessment Report (BDAR) can be prepared.

The proposal site is not located within a declared area of outstanding biodiversity value. While there may be some direct impacts on vegetation, and indirect impacts on threatened fauna species, these impacts are isolated, small in scope and generally confined to already highly disturbed patches of remnant vegetation. A significant impact on threatened species, populations, ecological communities, or their habitats as a result of the proposal is considered unlikely (refer to **Section 6.5** and **Appendix D** of this REF).

5.3.5 BIOSECURITY ACT 2015

The *Biosecurity Act 2015* (Biosecurity Act) provides for the prevention, elimination, minimisation and management of biosecurity risks posed by biosecurity matter, dealing with, and other activities that involve biosecurity matter, carriers or potential carriers. Section 22 of the Biosecurity Act requires that

any person who deals with biosecurity matter, or a carrier, and who knows, or ought reasonably to know, the biosecurity risk posed or likely to be posed by the biosecurity matter, carrier or dealing, has a biosecurity duty to ensure that, so far as is reasonably practicable, the biosecurity risk is prevented, eliminated or minimised. This obligation is referred to elsewhere within the Biosecurity Act as the "general biosecurity duty".

Given the excavation and disturbance of surface and sub soils associated with the proposed activity, Essential Energy has a general biosecurity duty to ensure the biosecurity risks posed by the potential for the introduction of weed species are prevented, eliminated or minimised.

5.3.6 COMMONS MANAGEMENT ACT 1989

The *Commons Management Act 1989* (CM Act) provides for the establishment of trusts in relation to commons and the election of trust boards, and in certain cases the appointment of local authorities or administrators. The CM Act also aims to manage the affairs of those trusts and to provide for the care, control and management of commons.

A small section of the rising main route and treated effluent discharge pipe located on land immediately south of Will Street STP, and a larger section of the rising main route east of the Silver City Highway as it extends to the South STP site, are located on land designated as the Willyama Common. The Willyama Common is administered by the Willyama Common Trust, established under the provisions of the CM Act. BHCC has been appointed by the Minister to manage the affairs of the Trust and has statutory responsibilities for care, control and management of the Common.

As per Section 4.7 of the Management Plan for the Willyama Common, prepared in accordance with Section 25 of the CM Act, a license will be required for sections of the proposal located on land designated as the Willyama Common.

5.3.7 CROWN LAND MANAGEMENT ACT 2016

The *Crown Land Management Act 2016* (CLM Act) consolidates several pieces of legislation, including the repeal of the *Crown Lands Act 1989*, the C*rown Lands (Continued Tenures) Act 1989*, the *Western Lands Act 1901* and certain other legislation. Existing leases, licences or permits issued under previous legislation will continue for its agreed term. From 1 July 2018, all new leases, licences and permits will be issued under the new legislation.

The proposed work areas at each of the two existing STP sites (Wills Street and South) are located on land privately owned by Essential Energy. Wherever possible the proposed rising main route has been located within existing easements for water/sewerage pipeline infrastructure and road reserves. However, new easements under Section 2.18 of the Act will be required for portions of the proposed rising main route located on Crown Land (i.e., the Willyama Common) where no current easements exist.

While portions of the pipeline route are located on Crown Land, the proposed works are to be lawfully carried out under Part 5, Division 5.1 of the EP&A Act and therefore are a lawful use on Crown land. An assessment of the proposal's compliance with the six 'principles of Crown land management', as set out in section 1.4 of the CLM Act, is provided in **Appendix G** of this REF.

5.3.8 HERITAGE ACT 1977

The *Heritage Act 1977* (Heritage Act) provides for the protection of heritage items of local and state significance. Such items may include places, buildings, works, relics, moveable objects, or precincts with historical, scientific, cultural or aesthetic value to the state. Where works are likely to impact upon an item listed on the State Heritage Inventory (SHI), approval may be required under two sections of the Heritage Act:

- Section 60 approval relating to impacts on items listed on the SHI; and
- Section 140 approval requiring an excavation permit for activities with potential to excavate or disturb a relic.

As described in **Section 6.7.2** of this REF there is no foreseeable likelihood that an item listed on the SHI would be impacted by the proposal, therefore further assessment and a permit from the Department is not required. Further discussion of potential impacts and measures to minimise impacts to items of local heritage significance is provided in **Section 6.7**.

5.3.9 LOCAL GOVERNMENT ACT 1993

The *Local Government Act 1993* (LG Act) implements a commitment made under Section 51 of the NSW *Constitution Act 1902* that requires the continuance of local government. The LG Act provides the legislative framework in which local councils operate, and encourages local participation in the affairs of local government.

Whilst the central focus of the LG Act is about the governance of local councils and the participation of the local community in its affairs, the LG Act also includes provisions for approval of certain works. In areas outside of the operation of the Sydney and Hunter Water Boards, and Essential Water (as a business unit of Essential Energy), local councils have the responsibility for the regulation of water supply, sewerage and stormwater drainage work.

Essential Water (a business unit of Essential Energy) is the water and sewer authority for Broken Hill. Application of Section 68 of the LG Act as it relates to water and sewer connections to a local council therefore does not apply. For the same reasons, Division 2 of Chapter 6 relating to sewerage works does not apply to the proposal.

5.3.10 LOCAL LAND SERVICES ACT 2013

The *Local Land Services Act 2013* (LLS Act) established Local Land Services, a government agency with the responsibility for providing advice on biosecurity, natural resources and agricultural advisory services in NSW. The LLS Act includes provisions for the regulation of native vegetation including the approval of certain activities.

Under the LLS Act, approval is required from the Minister for the Environment or delegate to clear native vegetation (exemptions apply). Exemptions include, but are not limited to, urban areas, electricity line maintenance and Part 5 activities under the EP&A Act.

The LLS Act is administered by the various local land services under delegated authority by the Minister for the Environment.

Given that the proposal will be assessed under Part 5, Division 5.1 of the EP&A Act, the provisions relating to the LLS Act are not applicable.

5.3.11 NATIONAL PARK AND WILDLIFE ACT 1974

The *National Parks and Wildlife Act 1974* (NPW Act) provides for the management of all national parks, historic sites, nature reserves, reserves, Aboriginal areas and state game reserves. It also provides for the protection and care of native flora and fauna, and Aboriginal places and objects throughout NSW. Under the NPW Act it is an offence, without authorisation, to:

- Harm an Aboriginal object or place without consent
- Pick or harm any plant or animal that is protected or is a threatened species, population or ecological community, or
- Damage any critical habitat, or habitat of a threatened species, an endangered population or an endangered ecological community or reserved land.

When an activity is likely to harm an Aboriginal object or place, approval under Section 90 is required.

The NPW Act also serves to direct the management and protection of reserved land. In relation to utility installations, the Minister for the Environment may grant easements or rights of way through reserved land for sewage reticulation.

The proposal site is not located on reserved land. Approval under the NPW Act is not required in respect of the proposed activity.

As described in **Section 6.6.2** of this REF, based on the design, and mitigation measures, the proposal is not likely to impact upon Aboriginal objects.

5.3.12 PIPELINES ACT 1967

The *Pipelines Act 1967* governs the construction, operation, and maintenance of pipelines in NSW. A licence to construct and operate a pipeline is required under Part 3 of the Act. However, Part 1, Section 5(1) of the Act outlines certain exemptions to the licencing requirements under Part 3. These include:

(b) a pipeline constructed or to be constructed by a public authority

.....

(d) a pipeline constructed or to be constructed is for the purpose of the supply of water (including for irrigation), the drainage of land or the conveyance of waste water, mine water, aqueous slurries of minerals, mineral concentrates or mineral tailings,

The proposed rising main route will be constructed by or on behalf of Essential Energy (a public authority), and will be for the purposes of transporting waste water (i.e., sewage). A licence under Part 3 of the *Pipelines Act 1967* is therefore not required.

5.3.13 PROTECTION OF ENVIRONMENT OPERATIONS ACT 1997

The *Protection of the Environment Operations Act 1997* (POEO Act) provides a framework for the licencing of activities that have potential to result in pollution of the environment. Both the existing Wills Street and South STPs have existing Environment Protection Licences (EPLs) in place (EPL 3925, and 5067, respectively). One of the main drivers of the proposal is to upgrade the existing Wills Street STP in order to provide sufficient treatment to meet the NSW EPA effluent discharge and effluent reuse criteria. Both EPLs will require updating to reflect the new BHSTP operation. Preliminary advice from the EPA, indicated that the EPL for the South STP could eventually be surrendered once it is decommissioned and the replacement pump station infrastructure be captured as part of the EPL for the new BHSTP.

In addition to licencing requirements, the following restrictions apply:

- The proposal must not pollute waters
- Waste must not be transported to a place that cannot lawfully be used as a waste facility for that waste
- Waste from the works must not be wilfully or negligently disposed of in a manner that harms or is likely to harm the environment
- There must be no litter in or on a public place or an open private place caused by workers
- Any environmental incident that involves actual or potential harm to the health or safety of human beings or to ecosystems must be reported to the Environment Protection Authority (EPA).

During construction, there is the potential for generation of sediment laden runoff. Mitigation measures as outlined in **Sections 6.2.3** and **6.3.3** of this REF will be implemented to manage the risk of soil and water pollution from construction activities.

5.3.14 ROADS ACT 1993

The *Roads Act 1993* (Roads Act) provides for the ownership and management of public roads and also requires the consent of the appropriate road's authority for various works in respect of certain public roads.

Section 138 of the Roads Act requires the consent of the appropriate road's authority for various works in respect of public roads and classified roads.

The proposal involves work within the road reserves of several local roads, and crossing of the Silver City Highway, a classified road, and so will require Section 138 approvals from BHCC and TfNSW, respectively.

5.3.15 WATER ACT 1912

Under the *Water Act 1912* (Water Act), for any temporary or permanent works not defined in a gazetted water sharing plan under the *Water Management Act 2000* (WM Act), a licence or permit is required to:

- Extract water from a stream, river or water course via a pump or other work; or
- Extract groundwater via any type of bore, well, spear point or groundwater interception scheme (including dewatering).

The proposal site is located on land to which *Water Sharing Plan for the Lower Murray-Darling Unregulated River Water Source 2024*. A licence or permit under the Water Act is therefore not required. Assessment of applicable licences, work or use approvals under the WM Act is provided in the following section.

5.3.16 WATER MANAGEMENT ACT 2000

The *Water Management Act 2000* (WM Act) governs the issue of new water licences and the trade of water licences and allocations for those water sources (rivers, lakes and groundwater) in NSW where water sharing plans have commenced. Under the WM Act, should water need to be extracted from a surface water or groundwater source, defined in gazetted water sharing plan, then four licence/approvals may apply, including:

- An access licence to obtain access to a share of the water source
- A water use approval to obtain permission for how the water would be used
- A water management works approval to obtain permission to install and use the works for water supply, drainage or flood mitigation work
- An activity approval, namely a controlled activity approval and/or aquifer interference approval.

The proposed activity would not trigger the need to obtain a water use approval or a water management works approval.

The proposal does not involve the taking of water from a surface water or groundwater source, however, a water licence is required whether water is taken for consumptive use or whether it is taken incidentally by the aquifer interference activity. For example, dewatering of groundwater during building construction activity requires a water licence (unless an exemption applies) even where that water is not being used consumptively as part of the activity's operation.

The WM Act defines an aquifer interference activity as involving any of the following:

(a) the penetration of an aquifer,

(b) the interference with water in an aquifer,

(c) the obstruction of the flow of water in an aquifer,

(d) the taking of water from an aquifer in the course of carrying out mining, or any other activity prescribed by the regulations,

(e) the disposal of water taken from an aquifer as referred to in paragraph (d).

An aquifer is defined as, a geological structure or formation, or an artificial landfill, that is permeated with water or is capable of being permeated with water.

Based on a previous hydrogeological investigation (Tonkin 2014) and more recent geotechnical investigation undertaken (Intrax Land 2024 and Beca 2024), and depending on the prevailing weather

conditions prior to construction, groundwater within an upper alluvial (perched) aquifer may be encountered during excavation activities for the new BHSTP and potentially along the western portion of the proposed rising main route. It is unlikely groundwater will be encountered at the South STP site, or along the eastern portion of the rising main route. Based on these findings, it is possible that penetration of an aquifer will occur for part of the proposal, and as such meet the definition of an aquifer interference activity.

However, Clause 7 in Schedule 4 of the *Water Management (General) Regulation 2018* (WM General Regulation) provides an exemption for the taking of up to 3 megalitres (ML) of groundwater from a groundwater source by one or more of those activities in a water year, if the taking of that groundwater is not for the purpose of its consumption or supply and the activity is in in connection with an authorised project. The taking of groundwater as it relates to the proposal is incidental by the aquifer interference activity, and not for the purposes of consumption or supply. An authorised project includes an activity to which Division 5.1 of the EP&A Act applies. The proposal is an authorised project under Division 5.1 of the EP&A Act. It is anticipated that 3ML or less of groundwater would be intercepted from the water source in a reporting year, therefore the water access licence exemption would apply.

A controlled activity approval confers a right on its holder to carry out a specified controlled activity at a specified location in, on or under waterfront land. Under the WM Act, a controlled activity means:

a) the erection of a building or the carrying out of a work (within the meaning of the Environmental Planning and Assessment Act 1979), or

b) the removal of material (whether or not extractive material) or vegetation from land, whether by way of excavation or otherwise, or

c) the deposition of material (whether or not extractive material) on land, whether by way of landfill operations or otherwise, or

d) the carrying out of any other activity that affects the quantity or flow of water in a water source.

Waterfront land means—

(a) the bed of any river, together with any land lying between the bed of the river and a line drawn parallel to, and the prescribed distance inland of, the highest bank of the river, or

(a1) the bed of any lake, together with any land lying between the bed of the lake and a line drawn parallel to, and the prescribed distance inland of, the shore of the lake, or

(a2) the bed of any estuary, together with any land lying between the bed of the estuary and a line drawn parallel to, and the prescribed distance inland of, the mean high water mark of the estuary, or

(b) if the regulations so provide, the bed of the coastal waters of the State, and any land lying between the shoreline of the coastal waters and a line drawn parallel to, and the prescribed distance inland of, the mean high water mark of the coastal waters,

where the prescribed distance is 40 metres or (if the regulations prescribe a lesser distance, either generally or in relation to a particular location or class of locations) that lesser distance. Land that falls into 2 or more of the categories referred to in paragraphs (a), (a1) and (a2) may be waterfront land by virtue of any of the paragraphs relevant to that land.

While some portions of the proposal site are within 40m of waterfront land, in accordance with Section 41 of the Water Management (General) Regulation 2018, Essential Energy, a public authority, is exempt from Section 91E (1) of the WM Act in relation to all controlled activities that it carries out in, on, or under waterfront land. A controlled activity approval is therefore not required.

Section 292 of the WM Act outlines the functions of a water supply authority. These functions include constructing, maintaining, and operating water management works including water treatment and sewage works. The proposal will require approval from the Minister under Section 292(1)(a) of the WM Act to construct, maintain and operate the new BHSTP.

5.4 Summary of Licences, Permits, Approvals and Notifications

Specific approvals required for the construction, maintenance and operation of the proposal are outlined in **Table 10**.

Table 10: Summary of licences, Permits, Approvals and Notifications

LEGISLATION	AUTHORITY	REQUIREMENT
Commons Management Act 1989	BHCC	Willyama Common Trust License for any works within the Willyama Common.
Crown Land Management Act 2016 (NSW)	NSW Crown Lands	New easements required under Section 2.18 for portions of proposed rising main pipeline located on Crown Land, where there are no existing easements in place.
Protection of the Environment Operations Act 1997 (NSW)	NSW EPA	Updated EPL required for the new BHSTP, with the eventual surrender of South STP EPL.
Roads Act 1993 (NSW)	TfNSW, BHCC	Section 138 approval for work within the road reserve of Silver City Highway and several local roads.
Water Management Act 2000	NSW DCCEEW	Section 292(1) approval for the construction, maintenance, and operation of water management works (including sewage works).

6. Environmental Assessment

6.1 Air Quality and Greenhouse Gases

6.1.1 EXISTING ENVIRONMENT

The proposal site is located in the southwestern and southern outskirts of Broken Hill, comprising of the existing Wills Street and South STPs, as well as the construction of a new rising main between the two STPs and replacement of the treated effluent discharge pipe from the existing Wills Street STP.

The immediate surrounding landscape of the existing Wills Street STP includes:

- Undeveloped large residential lots located immediately to the north, with undeveloped land beyond
- A mix of undeveloped lots and residential premises immediately to the east with further residential premises beyond
- Crown Land containing existing water and sewerage infrastructure and Kanandah Road immediately to the south, with Peterborough Broken Hill Railway and an industrial area beyond
- Crown Land immediately to the west, with the BHCC Landfill and Waste Receival Facility beyond.

The immediate surrounding landscape of the South STP comprises predominately Crown Land (i.e., the Willyama common) with the Broken Hill Airport boundary approximately 300m to the east.

The closest sensitive (residential) receivers are:

- 46 Wills Street located approximately 360m northeast of the existing Wills Street STP entrance and approximately 400m northeast of the existing STP inlet works (R1)
- 4 Ryan Street located approximately 450m southeast of the existing Wills Street STP entrance and approximately 350m east of the existing STP sludge drying beds (R2).
- 1 Queen Street located approximately 1000m northwest of the existing South STP entrance and inlet works (R3)
- 55 Knox Street located approximately 560m northeast of the existing South STP entrance and inlet works (R4)

Refer **Figure 2** and **Figure 3**.

Non-residential receptors closest to the project include:

- The Broken Hill Community Recycling Centre located at the western end of Wills Street, approximately 760m west of the Wills STP entrance and approximately 480m northeast of the STP sludge (biosolids) Stockpile A. A used goods shop is attached to the Recycling Centre which would be considered a commercial development (R5)
- Various light industrial properties on Kanandah Road, with the nearest of these properties located approximately 670m south of the existing Wills STP entrance, and approximately 240m southeast of the existing STP tertiary pond (R6)
- The Royal Flying Doctor Service adjacent to the airport approximately 570m southeast of the existing STP entrance and inlet works (R7).

Refer **Figure 2**.

The proposed rising main route follows an existing unsealed road within the Willyama Common, as it exits the South STP, before joining with Kanandah Road, at the intersection with the Silver City Highway. From here the route follows Kanandah Road to the industrial estate, before entering a drainage easement and onto the Will Street STP (refer **Figure 2**).

The main air quality influences on the existing environment would be odour emissions from the two existing STPs, and the landfill and waste receival facility to the north of the existing Wills Street STP. Transport exhaust emission sources from vehicles utilising local roads, dust generated from unsealed roads and areas with sparse vegetation coverage, as well as other commercial, industrial, mining and domestic sources would also contribute to local air quality within the vicinity of the proposal site.

6.1.1.1 Odour

EnvironOdour Australia Pty Ltd (EnvironOdour) (2025) was engaged to prepare an air quality (odour) impact assessment for the proposal. The new BHSTP site (i.e., the existing Wills Street STP) was the focus of the odour assessment as that is where the new STP plant and equipment would be located, and therefore the potential for changes in odour impacts to occur. The eventual decommissioning of the South STP (and replacement with a pump station) was considered likely to improve odour emissions at that site. Sewage in the new proposed rising main will be largely sealed (with only a limited number of air relief valves), and as such odour impacts are anticipated to be negligible. The key findings of the odour impact assessment are summarised in the following sections. The report is presented in **Appendix B**.

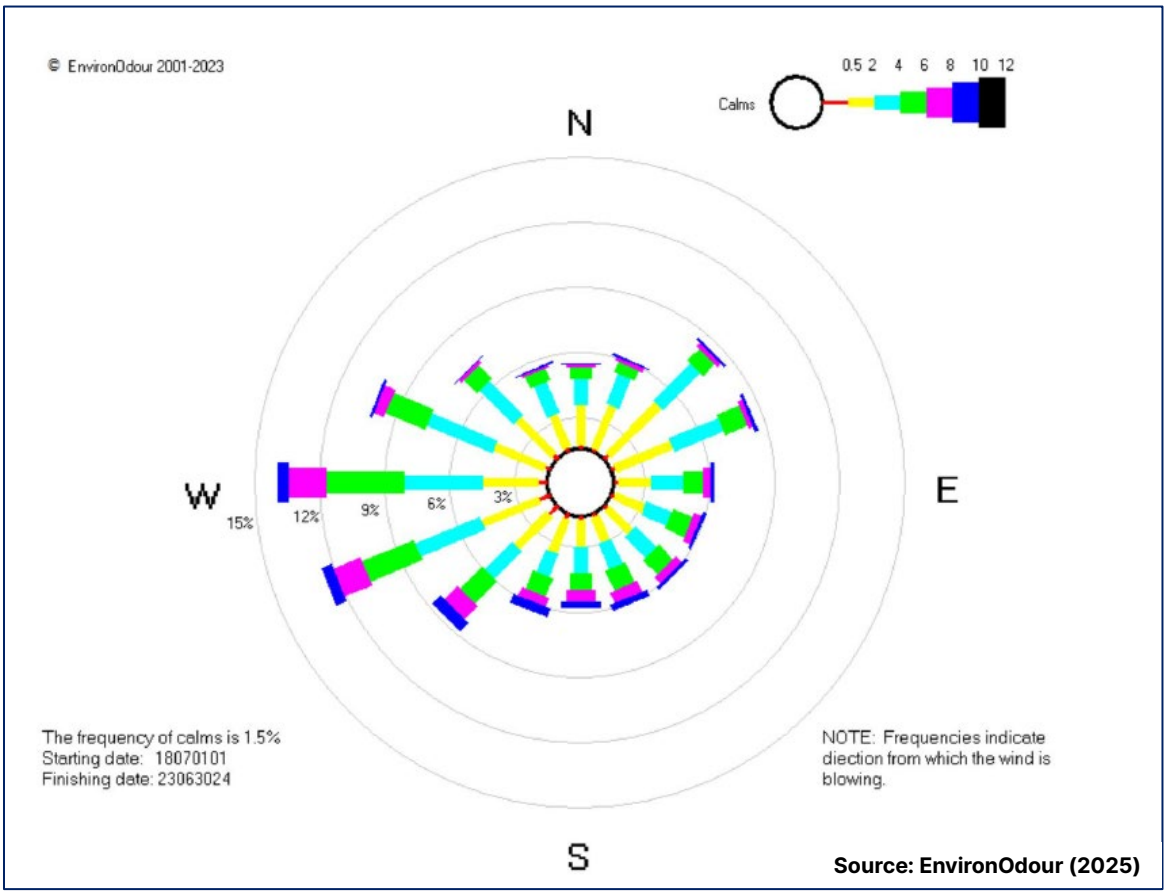
The scope of the odour assessment included the following:

- Collection of odour samples at the existing Wills Street STP using a flux chamber following *Australian Standard 4323.4*
- Obtaining meteorological data from the Bureau of Meteorology (BOM) weather observation station and formatting them into an Ausplume air dispersion model compatible file
- Carrying out a Level 3 odour impact assessment using Ausplume air dispersion modelling following NSW EPA's *Technical Framework Assessment and Management of Odour from Stationary Sources in NSW*
- Preparation of an odour impact assessment report per NSW EPA's *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*.

As part of the assessment, EnvironOdour (2025) undertook an analysis of local meteorological data (Broken Hill Airport) over a five year observation period, between July 2018 to June 2023. The prevailing wind direction in the observation period was west, west-southwest and west-northwest. The next most prominent wind direction was north-east and east-northeast. During the hours of 5pm to 8pm, when people are home from work in the evening, the wind mainly blows from the west, west-northwest and west-southwest. The prevailing wind directions are shown in the wind roses of **Figure 26** and **Figure 27**.

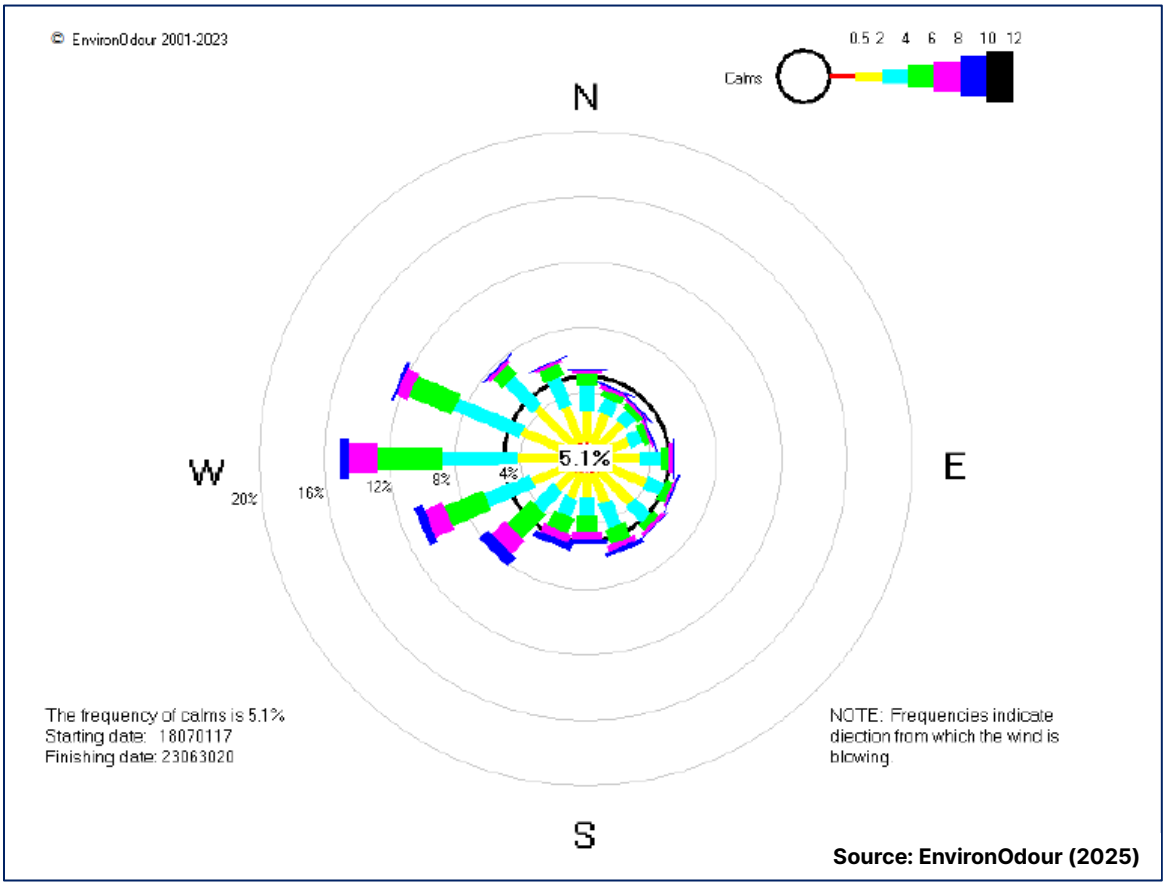
Modelling of Existing Wills Street STP

An odour emission survey of the existing Wills Street STP site was undertaken by EnvironOdour on 27 July 2023. A total of 6 source samples were taken and analysed in the EnvironOdour odour laboratory on 28 July 2023.



Source: EnvironOdour (2025)

Figure 26: Wind rose for meteorological data at Broken Hill airport (July 2018 – June 2023)



Source: EnvironOdour (2025)

Figure 27: Windrose for 5pm to 8pm (July 2018 – June 2023)

Table 11 summarises the odour emission sources included in the Ausplume air dispersion modelling and the measured Specific Odour Emission Rates (SOERs) from the odour emission survey.

Table 11: Summary of odour concentration and odour emission rates

SAMPLE ID	SOURCE DESCRIPTION	ODOUR CONCENTRATION (OU/m^3)	SPECIFIC ODOUR EMISSION RATES ($OU/m^2/s$)
6517	Trickling Filter	185	0.12
6518	Sludge Drying Bed	93	0.06
6519	Digester	1465	0.97
6520	Humus Tanks	622	0.41
6521	Primary Sedimentation Tank	8379	5.6
6522	Inlet Channel	34184	22.7

OU = Odour Unit.
The detectability of an odour is a sensory property that refers to the theoretical minimum concentration that produces an olfactory response or sensation. This point is called the odour threshold and defines one odour unit (OU)
The terms OU and OU/m3 are used interchangeably.

The odour emission from the tertiary treatment ponds was also added for the existing operation. The SOER for the tertiary treatment pond was assumed to be 0.04 OU/m^2s, based on observations at similar sites.

The approximate dimensions and areas of the above odour emission sources, and corresponding SOERs and Total Odour Emissions Rates (TOERs) for the existing Wills Street STP site are displayed in **Table 12**. Modelled odour contours for the existing STP are displayed in **Figure 28**. The nearest sensitive receiver (4 Ryan Street) is denoted by a blue plus sign. The adopted odour performance criterion of 5 odour units (OU) (refer below) is displayed by the red contour, indicating the existing STP currently complies with the relevant odour performance criteria.

Table 12: Summary of odour emission rates for the existing Wills Street STP

NO.	DESCRIPTION	ELEVATION (m)	LENGTH/ DIAMETER (m)	WIDTH (m)	AREA (m^2)	SOER ($OU/m^2/s$)	TOER (OU/s)
1	Inlet channel	1	6	0.6	3.6	22.7	82
2	Inlet channel		40	0.6	24	22.7	544
3	Primary Sedimentation Tank 1	1	17.5		240	5.6	1336
4	Primary Sedimentation Tank 2	1	10	10	100	5.6	556
5	Primary Sedimentation Tank 3	1	10	10	100	5.6	556
6	Trickling filter 1	1	30		707	0.40	283
7	Trickling filter 2	1	30		707	0.40	283
8	Trickling filter 3	1	30		707	0.40	283
9	Humus Tank	1	16		201	0.41	83
10	Sludge digester 1	1	10		79	0.97	76
11	Sludge digester 2	1	10		79	0.97	76

NO.	DESCRIPTION	ELEVATION (m)	LENGTH/ DIAMETER (m)	WIDTH (m)	AREA (m^2)	SOER ($OU/m^2/s$)	TOER (OU/s)
12	Sludge digester 3	1	10		79	0.97	76
13	Sludge digester 4	1	10		79	0.97	76
14	Sludge drying bed	0	60	60	3600	0.06	222
15	Maturation (tertiary) pond	0	135	290	39150	0.04	1566
						Total Odour Emission Rate	**6098**

Odour Assessment Criteria

As outlined in *Technical framework: assessment and management of odour from stationary sources in NSW* produced by the Department of Environment and Conservation (NSW DEC) in 2006, odour assessment criteria need to be designed to take into account the range in sensitivities to odours within the community, and provide additional protection for individuals with a heightened response to odours. This can be done using a statistical approach which depends upon the size of the affected population. As the affected population size increases, the number of sensitive individuals is also likely to increase, which suggests that more stringent criteria is necessary in these situations. Therefore, the odour assessment criteria allow for population size, cumulative impacts, anticipated odour levels during adverse meteorological conditions and community expectations of amenity. A summary of odour assessment criteria for various population densities is shown in **Table 13**.

There is considerable buffer distance between odour generating activity and equipment at the existing Wills Street STP to the site boundary. The closest resident to currently active piece of STP infrastructure (i.e., drying beds) is approximately 350m to the east. The closest commercial properties are located approximately 240m south and southeast of the existing tertiary pond at the Wills Street STP site. There are no schools or hospitals in the surrounding area. The population of the potentially affected community is therefore less than 30. It is expected that the assumption of one-hour averaged odour performance criterion of 5 OU/m^3 at 99th percentile for modelling emissions from the site will give a conservative estimate of odour impacts for the local community (refer **Table 13**).

Table 13: Odour Assessment Criteria (99th percentile)

POPULATION OF AFFECTED COMMUNITY	ODOUR ASSESSMENT CRITERIA (OU/m^3)
Urban area (≥ 2000) and/or schools and hospitals	2.0
~ 500	3.0
~ 125	4.0
~ 30	5.0
~ 10	6.0
Single residence (≤ 2)	7.0

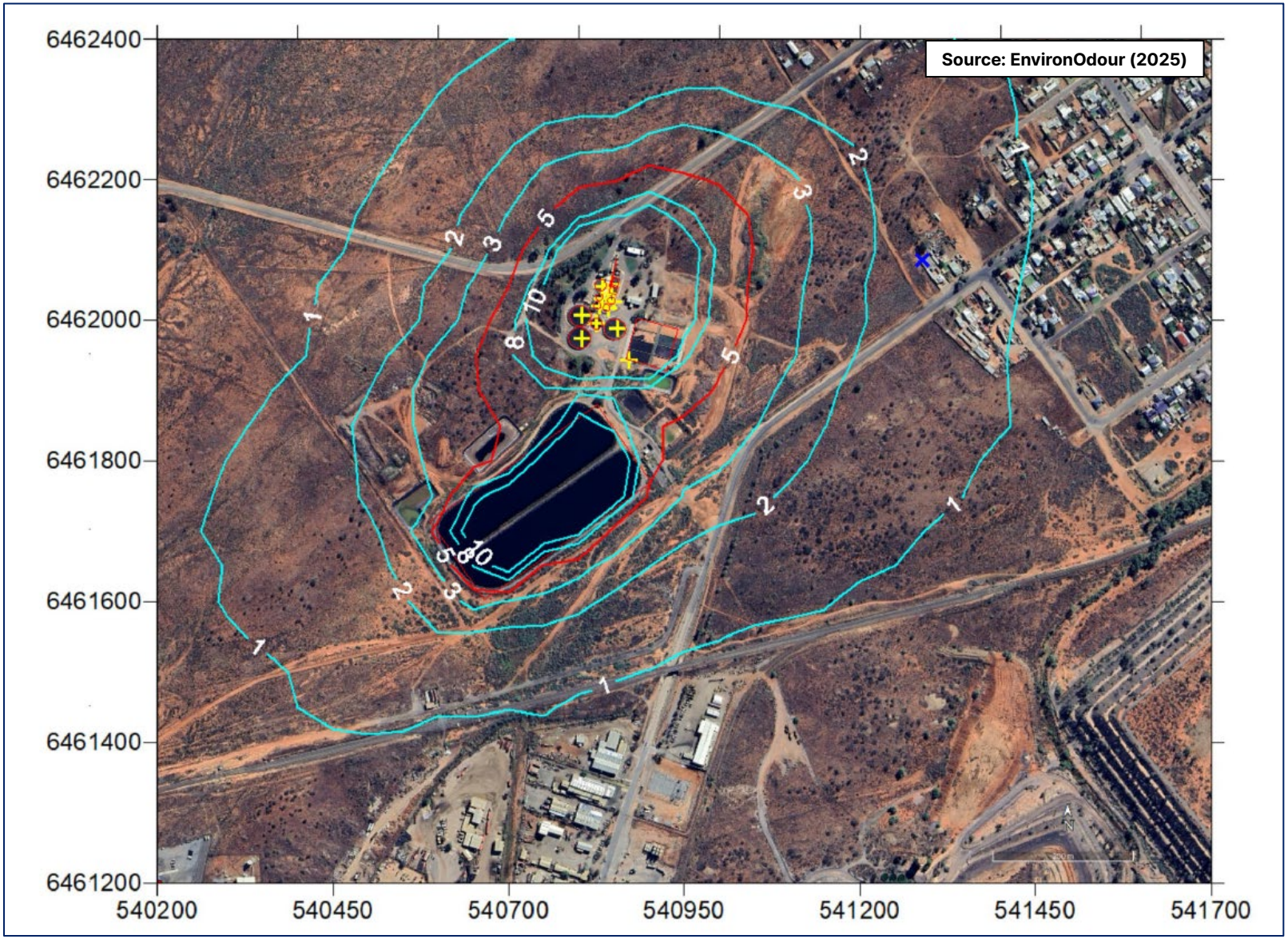


Figure 28: Odour concentration contours for the existing Wills Street STP

6.1.2 ASSESSMENT OF IMPACT

6.1.2.1 Air quality during construction

It is expected that minor amounts of dust may be generated during excavation activities required for installation of footings and concrete slabs for new plant and equipment at the new BHSTP site, and for the new pump station at the South STP site. Minor dust generation may also occur through the importation of fill, where required, at the STP sites. Any surplus excavated material may be spread on site or be taken off-site for disposal.

Similarly minor quantities of dust may be generated through trenching and underbore activities required for the installation of the rising main and the upgraded discharge pipeline. Any surplus soil material removed from the trenching works would be backfilled and compacted where possible, or taken off-site for disposal (refer **Section 6.2.3**).

There would be minimal exhaust emissions from vehicles. Exhaust emissions from construction equipment are likely to include nitrogen oxides (NOx), carbon monoxide (CO), sulphur oxides (SO2), hydrocarbons and total suspended particulates. All vehicles would be fitted with approved exhaust systems to maintain vehicle exhaust emissions within accepted standards.

The majority of works will be of short duration and low impact in any one location. Works will be limited and localised to each defined work area, both at each existing STP sites and along the rising main route. Disturbed areas from trenching and underbore work required for the installation of the rising main and discharge pipeline upgrade will be reinstated as work progressively moves on to the next section.

It is unlikely that there would be a significant odour impact during construction work.

6.1.2.2 Air quality during operation

Odour

As part of preliminary detailed design work, odour modelling was undertaken by EnvironOdour (2023) to assess the impacts of the various sludge management options being considered (refer **Section 4.3.7** and Beca HunterH2O, 2025a). The site's existing operation was modelled and the result was used as a benchmark (refer **Figure 28**). Four additional odour model scenarios were assessed based on each of the sludge management options being considered at the time of the 2023 modelling. The preferred location of the new STP infrastructure at the time of 2023 odour modelling was to the west of the existing STP infrastructure.

The odour contour modelling results indicated that the existing Wills Street STP and all four sludge management scenarios are within the adopted odour assessment criteria of 5 OU/m^3. However, the aerobic digester option, the preferred sludge management option adopted for the proposal, has the least odour impact.

Updated modelling by EnvironOdour (2025) assessed the preferred sludge management option (i.e., aerobic digester), but for the updated layout and positioning of the new STP infrastructure over the existing tertiary pond, south of the existing STP infrastructure. A summary of the odour emissions sources used and odour contour modelling for the preferred sludge management option (i.e., aerobic digester) and updated STP infrastructure location, are presented in **Table 14** and **Figure 29**, respectively.

Table 14: Summary of odour emission rates for the proposal

NO.	DESCRIPTION	ELEVATION (m)	LENGTH/ DIAMETER (m)	WIDTH (m)	AREA (m^2)	SOER ($OU/m^2/s$)	TOER (OU/s)
1	Biotrickling Filter	4					833
2	IDEAT (x2)	3.2	60	50.4	3024	0.5	1224
3	Effluent Balance Tank	3.2	64.6	15.2	982	0.5	491
4	Aerobic Digester	3.2	60	14.6	876	0.97	851
5	Sludge dewatering building (volume)	5	14	10			486
					Total Odour Emission Rate		**3885**

As shown in **Table 14** and **Figure 29**, the odour impact from the preferred sludge management option, and positioning of the STP infrastructure over the existing tertiary pond, is within the property boundary, with TOER and odour impact footprint considerably smaller than that currently being produced by the existing STP infrastructure. The proposal complies with the adopted odour performance criteria of 5 OU/m^3.

Greenhouse Gas Emissions (GHG)

Operation of the proposed new STP will generate Scope 1, 2 and 3 GHG emissions. Scope 3 emissions will occur due to use of transportation for operations and maintenance activities as well as in the production and transport of chemicals used in operation. The design has been developed to minimise chemical usage and the need for operator attendance through use of automated systems. These design elements help to reduce Scope 3 GHG emissions.

Aeration of the bioreactor and aerobic digester will result in considerably more energy use, through electricity consumption (Scope 2 emissions). The proposed photovoltaic system is intended to offset a significant portion of this additional demand. Equipment will be also selected to maximise energy efficiency and as such reduce the overall site power demand and Scope 2 GHG emissions. The design of the process has also been selected to minimise the need for pumping to reduce power usage and hence Scope 2 GHG emissions.

The majority of Scope 1 GHG emissions will be via nitrous oxide emissions from the bioreactor and in the discharged effluent. Preliminary estimation of Scope 1 emissions was provided by Beca HunterH2O (2023), using the document “Guidance for Estimating Greenhouse Gas Emissions by NSW Water Utilities” published in 2019. Emissions are based on Tables 1 to 5 of the *Australian Government Department of the Environment and Energy "National Greenhouse Accounts (NGA) Factors*".

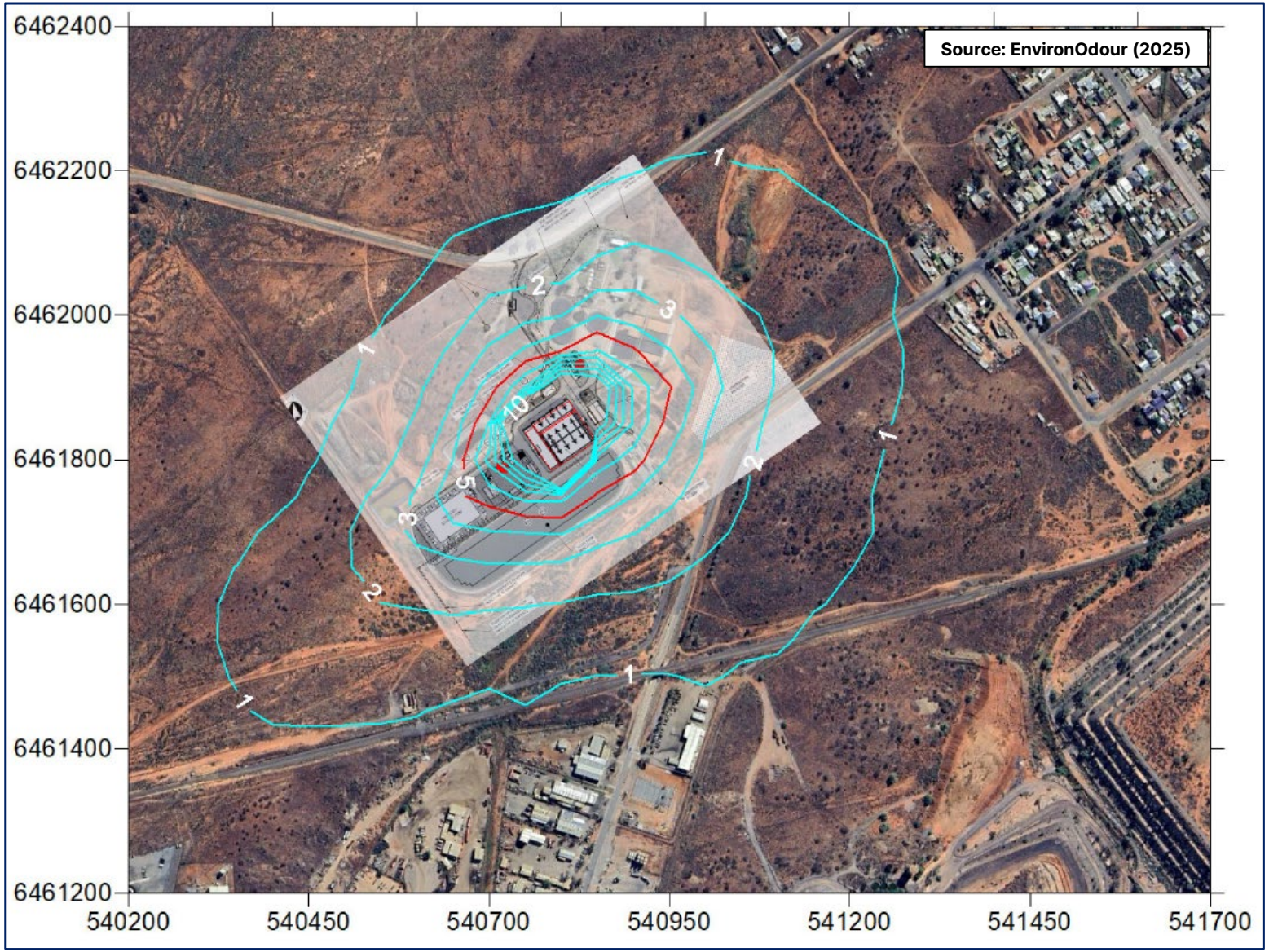


Figure 29: Odour concentration contours for the proposal

An ultimate design Scope 1 emission of 202 Tonnes of CO_2-e per annum has been estimated Beca HunterH2O (2023). The calculated emissions are likely to be lower than that of the existing South and Wills Street STPs, combined, which utilise open anaerobic tanks for digestion, a significant source of GHG emissions (related to methane production). The proposed design has also been altered to incorporate aerobic digestion instead of sludge lagoons for waste sludge stabilisation. Sludge lagoons produce methane, a GHG. Through the adoption of aerobic digestion, which does not produce methane, these emissions will be avoided.

6.1.2.3 Air quality during decommissioning

It is expected that minor amounts of dust may be generated during decommissioning activities at both the existing Wills Street and South STPs. This may occur during demolition of existing plant, equipment and buildings and through vehicle and machinery movement on unsealed areas of the site during decommissioning activities

There would be minimal exhaust emissions from vehicles. Exhaust emissions from decommissioning equipment are likely to include nitrogen oxides (NOx), carbon monoxide (CO), sulphur oxides (SO2), hydrocarbons and total suspended particulates. All vehicles would be fitted with approved exhaust systems to maintain vehicle exhaust emissions within accepted standards.

The majority of works will be of short duration, low impact, and confined to the immediate areas of decommissioning work at each STP location. Disturbed areas would be reinstated.

It is unlikely that there would be a significant odour impact during decommissioning work.

6.1.3 ENVIRONMENTAL MITIGATION MEASURES

Design has limited potential odour impacts and greenhouse gas emissions as far as reasonably practicable. The following minimisation measures will be implemented to prevent air quality impacts:

- Any potential dust-borne materials transported to and from the activity site will be covered at all times during transportation
- Any exposed surfaces or temporary stockpiles of surplus excavated material will be covered or wet down during dry and windy conditions
- All vehicles and machinery will be maintained according to manufacturer requirements to ensure emissions are kept within acceptable limits.

6.1.4 CONCLUSION

The proposal is not anticipated to result in substantial or uncontrollable dust or exhaust emissions in the area during construction or operation. Any air quality impacts would be short term and minor during construction or future maintenance. Odour modelling indicates the preferred sludge management option of an aerobic digester has the least odour impacts during operation, and well within the adopted odour assessment criteria. The aerobic digester option also results in significantly less Scope 1 GHG emissions. Increased Scope 2 emissions can be offset by the commissioning of an appropriately sized solar system. Given the mitigation measures outlined in this assessment the overall environmental risk to air quality is considered to be low.

6.2 Topography, Geology and Soils

6.2.1 EXISTING ENVIRONMENT

A geotechnical investigation was undertaken by Intrax Land, who also prepared an associated *Geotechnical Factual Report* (Intrax Land, 2024). Based on the geotechnical data collected and reported by Intrax Land (2024), Beca (2024) prepared a *Geotechnical Interpretive Report*. The following presents the key findings of Beca (2024) and other supporting information relative to the proposal.

6.2.1.1 Topography

The elevation profile derived from Google Earth and the topographic map of the proposal site indicates that the proposal site is predominantly flat, with no significant directional slope. Elevations at the existing Wills Street STP site range from approximately 293m to 302m AHD, with the maximum gradient of 5.8% in the west-east orientation and 4.8% in the north-south orientation. The South STP site shows elevations from about 283m to 287m AHD, with the steepest slopes recorded at 2.8% west-east and 3.1% north-south. Elevation of the proposed rising main route varies between 281m and 298m AHD, with the greatest slope measuring 4.8%. The elevation profiles for these sites, as extracted from Google Earth, are presented in **Figure 30** to **Figure 32**, and the topographic map of the proposal site is shown in **Figure 33**. The provided slope values are indicative and limited only to the specified orientations and lines (Beca, 2024).

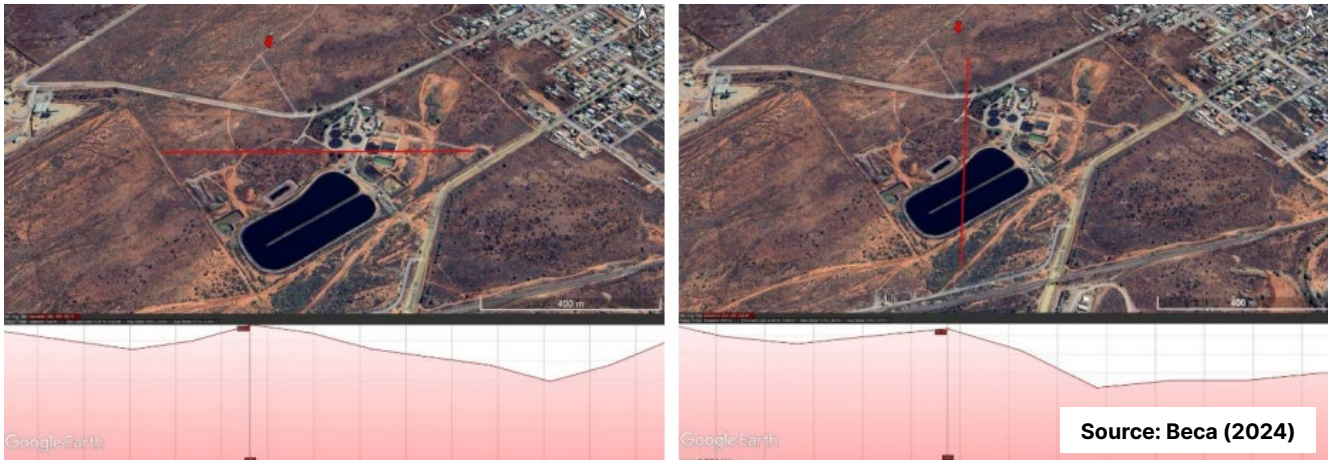


Figure 30: Approximate elevation profile of the Wills St STP site: (a) W-E, (b) N-S (Google Earth Pro 2024)

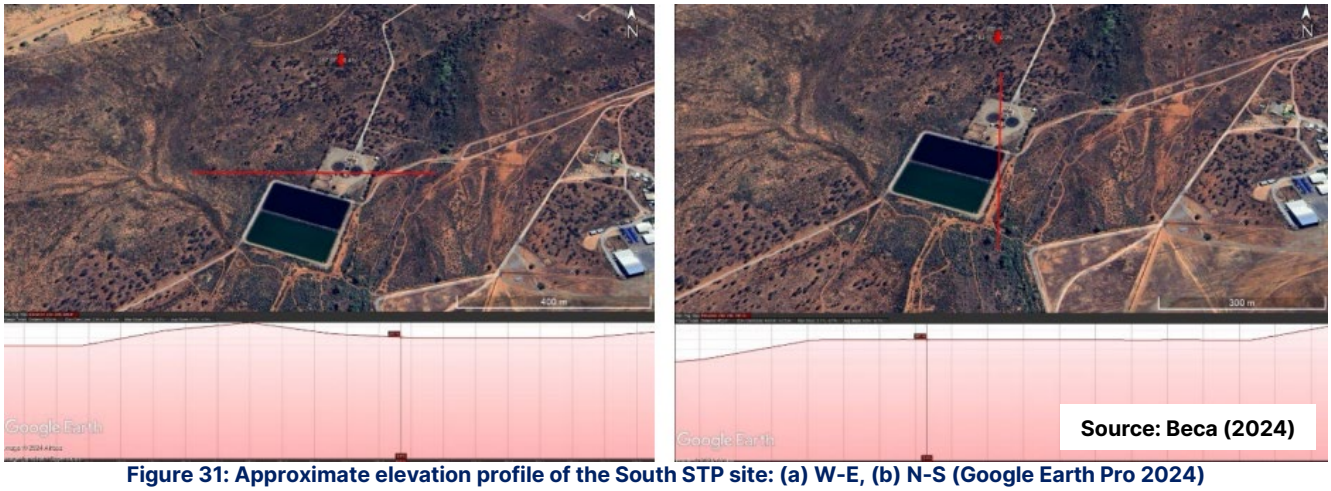


Figure 31: Approximate elevation profile of the South STP site: (a) W-E, (b) N-S (Google Earth Pro 2024)

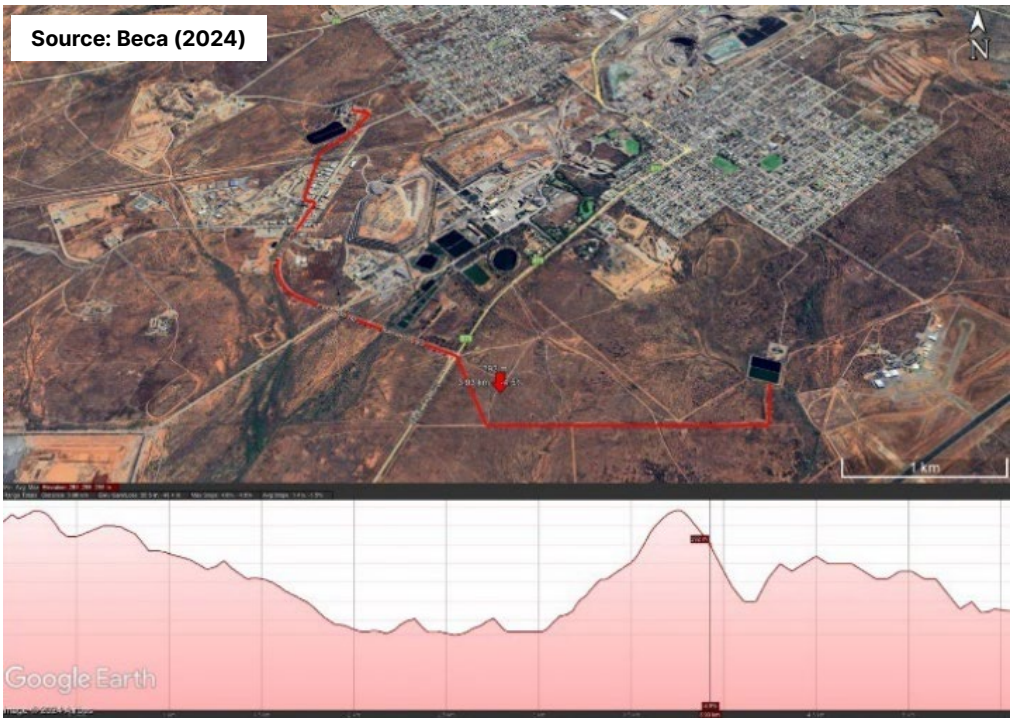


Figure 32 Approximate elevation profile along the pipeline (Google Earth Pro 2024)

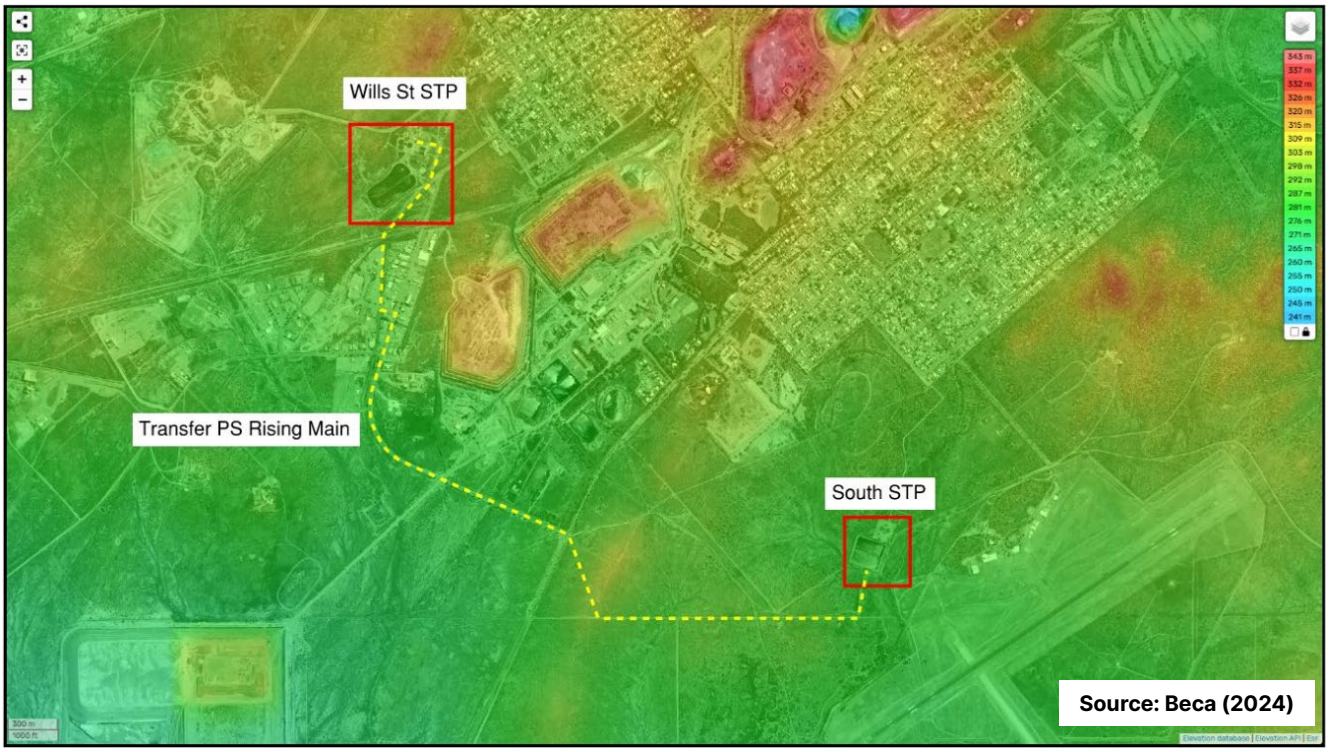


Figure 33 Approximate elevation profile along the pipeline (Google Earth Pro 2024)

6.2.1.2 Geology

The proposal site is situated within the Willyama subgroup as per the available geological map (Broken Hill 1:25,000, sheet 7134-II-S and Pinnacles 1:25,000, sheet 7133-I-N, published by the New South Wales Geological Survey). According to the map, most of the site is covered by Cainozoic sediments, which consist of sand, gravel, and clay, underlain by Gneiss (Beca, 2024).

The geological units are shown on **Figure 34**.

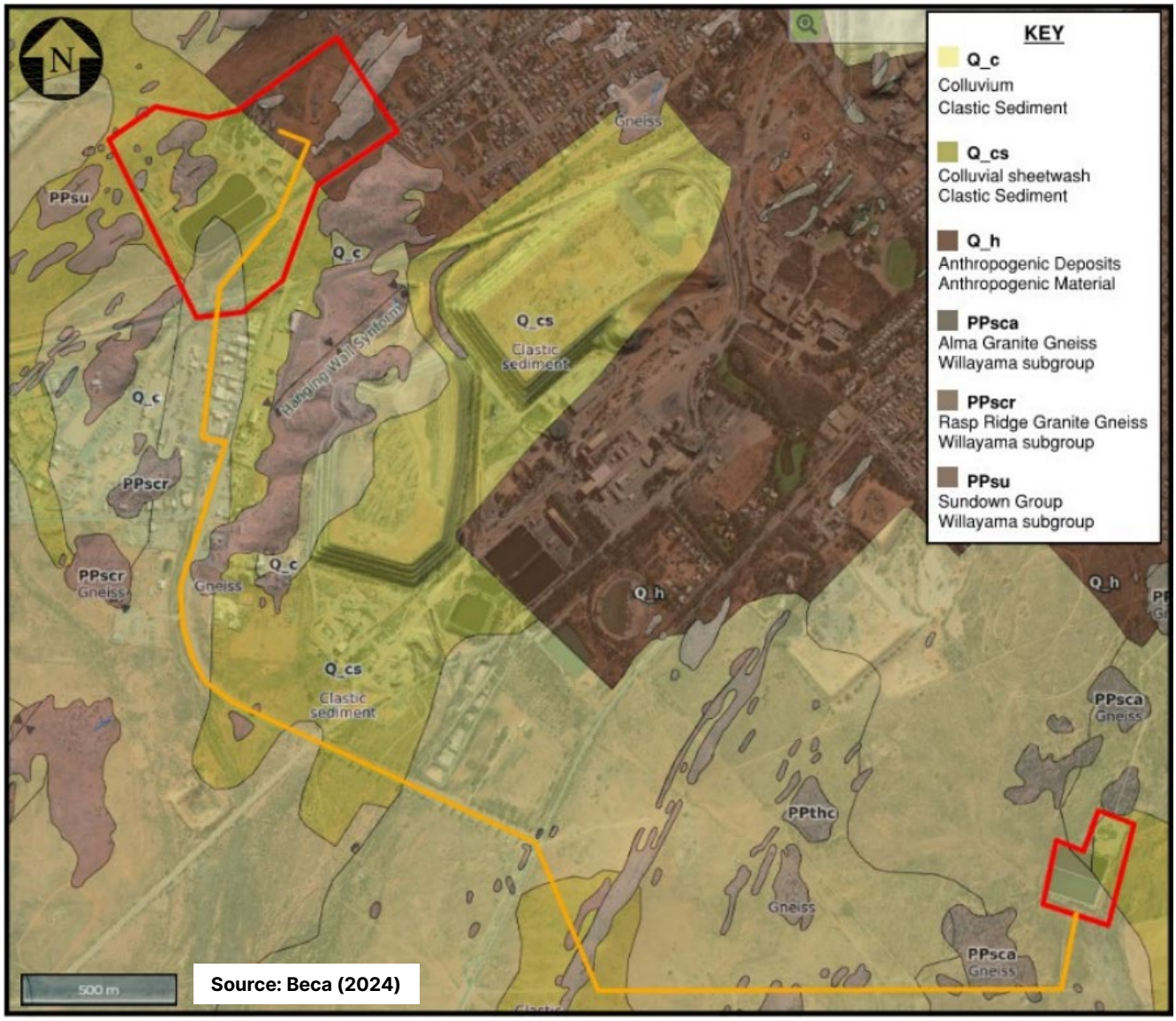


Figure 34: Geological map of the project site (extracted from MinView website)

Gneiss is a type of high-grade metamorphic rock. According to the NSW Geology Simplified layer, viewed from the NSW Government's Central Resource for Sharing and Enabling Environment Data in NSW (SEED) website, these rocks were mostly deposited as sediments in a basin over a 60 million year period approximately 1.7 billion years ago. Approximately 1.6 billion years ago, the rocks were subjected to extreme pressure and temperature resulting of metamorphism and deformation of the sequence to schists and gneisses. Volcanic activity at the top of the Broken Hill Group was contemporaneous with the formation of the giant Broken Hill lead-silver ore body.

Existing Wills Street STP Site

At the existing Wills Street STP site, fill was identified in the majority of boreholes and test pits, underlain by both cohesive and non-cohesive residual soils. Highly to moderately weathered gneiss was encountered at depths ranging from approximately 2m to 6m below ground level (bgl), with moderately to slightly weathered gneiss extending to the maximum depth investigated (Beca, 2024).

A summary of the subsurface profile at the existing Wills Street STP is presented in **Table 15**.

Table 15: Typical subsurface profile at the existing Wills Street STP

UNIT	GEOLOGICAL UNIT	DEPTH (m)	DESCRIPTION
Unit 1	Fill	0.0-0.5	Clayey/Silty SAND – medium dense to dense.
Unit 2a	Residual Soil (Cohesive)	0.5-15	Silty/Sandy/Gravelly CLAY – stiff to hard, low to medium plasticity.
Unit 2b	Residual Soil (Non-cohesive)	1.5-2.0	Sandy GRAVEL – dense to very dense
Unit 3	HW-MW GNEISS	2-6	Highly to moderately weathered GNEISS
Unit 4	MW-SW GNEISS	6->12	Moderately to slightly weathered GNEISS.

HW – Highly weathered
MW – Moderately weathered
SW – Slightly weathered

South STP

At the South STP site, fill and non-cohesive residual soils were not encountered in the three BHs near the site. Instead, an average of approximately 2m of cohesive residual soil was found from the ground surface. Highly to moderately weathered gneiss was encountered at depths between 2m and 4m bgl, with moderately to slightly weathered gneiss extending to the maximum depth investigated (Beca, 2024).

A summary of the typical subsurface profile at the South STP is presented in **Table 16**.

Table 16: Typical subsurface profile at South STP

UNIT	GEOLOGICAL UNIT	DEPTH (m)	DESCRIPTION
Unit 2a	Residual Soil (Cohesive)	0.0-2.0	Silty/Sandy/Gravelly CLAY – stiff to hard, low to medium plasticity.
Unit 3	HW-MW GNEISS	2-4	Highly to moderately weathered GNEISS
Unit 4	MW-SW GNEISS	4->12	Moderately to slightly weathered GNEISS.

HW – Highly weathered
MW – Moderately weathered
SW – Slightly weathered

Rising Main Alignment

For the western portion of the proposed rising main alignment, along Kanandah Road, the investigation revealed a thin layer of fill underlain by cohesive residual soil extending to approximately 5m bgl. Highly to moderately weathered gneiss was encountered at depths between 5m and 6m bgl, with stronger rock predicted beyond 6m bgl (Beca, 2024).

For the eastern portion of the proposed alignment, east of Silver City Highway, a thin fill layer over non-cohesive residual soil, extending to 0.6m bgl was encountered. Test pits reached refusal at very shallow depths. Highly to moderately weathered gneiss was encountered up to 6m bgl, with stronger rock anticipated beyond this depth (Beca, 2024).

A summary of the subsurface profiles along the western and eastern portion of the rising main alignment are presented in **Table 17** and **Table 18**, respectively.

Table 17: Typical subsurface profile along western portion of the rising main route

UNIT	GEOLOGICAL UNIT	DEPTH (m)	DESCRIPTION
Unit 1	Fill	0.0-0.8	Clayey/Silty SAND – medium dense to dense.
Unit 2a	Residual Soil (Cohesive)	0.8-5.0	Silty/Sandy/Gravelly CLAY – stiff to hard, low to medium plasticity.
Unit 3	HW-MW GNEISS	5-6	Highly to moderately weathered GNEISS
Unit 4	MW-SW GNEISS	6-Unknown	Moderately to slightly weathered GNEISS.

HW – Highly weathered
MW – Moderately weathered
SW – Slightly weathered

Table 18: Typical subsurface profile along eastern portion of the rising main route

UNIT	GEOLOGICAL UNIT	DEPTH (m)	DESCRIPTION
Unit 1	Fill	0.0-0.3	Clayey/Silty SAND – medium dense to dense.
Unit 2b	Residual Soil (Non-cohesive)	0.3-0.6	Silty/Sandy/Gravelly CLAY – stiff to hard, low to medium plasticity.
Unit 3	HW-MW GNEISS	0.6-6.0	Highly to moderately weathered GNEISS
Unit 4	MW-SW GNEISS	6-Unknown	Moderately to slightly weathered GNEISS.

HW – Highly weathered
MW – Moderately weathered
SW – Slightly weathered

6.2.1.3 Soils

Review of the Mitchell Landscapes Mapping V3 (Department of Environment, Climate Change and Water [DECCW] 2010a) indicates that the proposal site is predominately situated within the Barrier Downs landscape, a complex landscape of the low strike ridges of rock outcrop, slopes and outwash areas of the Barrier Ranges. The landscape is characterised by steeply rolling lowlands on pre-Cambrian dolomite and calcareous shale and steeply dipping Devonian sandstone and conglomerate, with dense incised drainage and relief to 30m. Soils comprise lithosols or shallow calcareous sandy loams on ridges, contour banded slopes of alternating stony red desert loams and stone-free red clays or solonized brown soils on long slopes. Dunes are characterised by deep clayey sand, while stony reddish-brown calcareous sandy loams are found along drainage tracts and alluvial flats with brown self-mulching cracking clays.

A small section of the proposed rising main route intersects with the Barrier Ranges landscape, comprising densely dissected ranges mainly of lower to middle Proterozoic metamorphic rocks including several varieties of gneiss, schist, amphibolite and pegmatites with north-east structural trends. Steep, partly bevelled, asymmetric strike ridges on associated dipping upper Proterozoic quartzite, sandstone and shales. Relief is 30 to 200m, with trellised drainage patterns, narrow and incised in higher relief country. Rock outcrop and lithosols are present on upper slopes, with red texture-contrast soils, locally calcareous, and contour banded steps on lower slopes. Shallow reddish-brown calcareous stony loamy sands are found on calcareous sandstone. Drainage tracts are characterised by reddish brown and yellowish-brown texture-contrast soils with coarse sands in channels.

Figure 35 depicts the relevant soil landscapes in relation to the proposal.

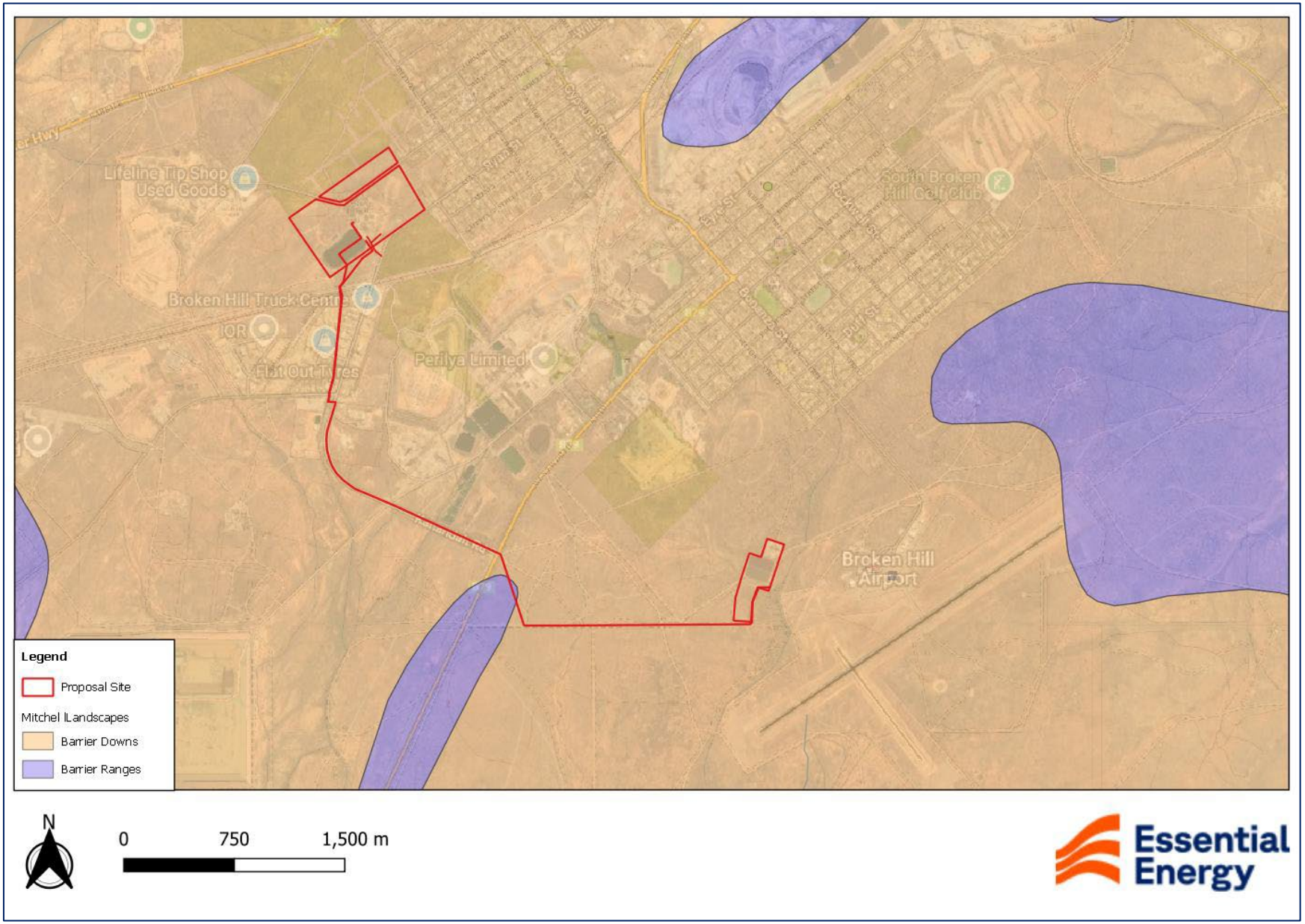


Figure 35: Mitchell landscapes relative to the proposal site

6.2.2 ASSESSMENT OF IMPACT

6.2.2.1 Geotechnical Considerations

In their *Geotechnical Interpretive Report*, Beca (2024) noted that the soil layers and extremely weathered material could be excavated using conventional earthmoving machinery, such as hydraulic excavator with bucket attachment. However, possibly hard ripping to extremely hard ripping would be required to excavate the moderately weathered to Fresh GNEISS, and that blasting may even be required to excavate the rock from 7 to 10m. This was most evident at the existing Wills Street STP site, west of the existing STP infrastructure, where preliminary detailed design initially proposed to locate the new STP infrastructure. This was identified as a significant risk for the project.

Due to the risks associated with excavating, and possibly blasting into hard rock, further collaborative stakeholder workshops were undertaken to revise the design. Ultimately it was decided that situating the bulk of the new STP infrastructure within the to be decommissioned tertiary pond to the south of the majority of existing STP infrastructure would be most preferred. This location avoids the hard rock to the west and northwest, makes use of an already significantly disturbed area of the site, and avoids the STP infrastructure encroaching further east towards the residential receivers.

6.2.2.2 Construction Impacts

Earthworks and general ground disturbances associated with the construction works could result in sediment and other materials leaving the site via wind or water movement. Aspects of the proposal identified as potentially impacting soil stability and erosion, include:

- Desludging of tertiary pond and decommissioning of earth batters
- Filling /levelling of tertiary pond
- Excavation for foundations, site levelling and installation of pipework at each of the STP sites
- Excavation and trenching for installation of underground components of the rising main and discharge pipeline
- Stockpiling of excess spoil

At the time of the preparation of this report Essential Water were assessing two main options for desludging the tertiary pond – dredging the pond, or dewatering the pond and adding a polymer to thicken the sludge for removal with earth moving equipment. A third option, also involving dewatering the pond, but allowing it to naturally dry out, was considered, however was not deemed to be feasible, due to the time required for the pond to fully dry out. Potential impacts associated with dewatering, and management, reuse and/or disposal of sludge is discussed further in **Sections 6.3.2.1** and **6.8.2**, respectively.

The construction contractor would establish appropriate controls to stabilise active work sites and prevent or minimise the likelihood of erosion, and the risk of discharging sediment-laden off-site. The proposed upgrade works have been designed to keep the existing STP components operational during construction.

6.2.2.3 Operational and decommissioning impacts

The STP site would be appropriately stabilised and landscaped post construction, and decommissioning activities, to minimise potential for soil erosion and sediment laden run-off.

6.2.3 ENVIRONMENTAL MITIGATION MEASURES

The following mitigation measures will be employed to manage erosion and sedimentation:

- Risks associated with sediment and erosion will be managed in accordance with The Blue Book – *Managing Urban Stormwater: Soils and Construction* (Landcom 2004). In particular, controls including, but not limited to the following, will be implemented:

- Diversion of upslope runoff around the proposal site in a way that minimises erosion, to be developed prior to bulk earthworks
- Sediment control fences or other measures shall be installed at the downslope perimeter of disturbed areas, including any temporary stockpiles.
- Maintenance of all erosion control measures at operational capacity until land is stabilised.

- Disturbed areas will be progressively stabilised as soon as practicable following construction activities
- A site specific Soil and Water Management Plan shall be included as part of the civil contractor's Construction Environmental Management Plan (CEMP)
- Essential Energy's CEOP8064 Management of Excavated Material; Guideline for Construction Sites will be consulted to determine the most appropriate beneficial reuse or disposal method for any surplus excavated materials.

6.2.4 CONCLUSION

The proposal is not anticipated to have any adverse impacts on the topography, geology and soils of the environment. Given the mitigation measures outlined in this assessment, the overall environmental risk is considered to be low. Further potential impacts to water quality are discussed in the following section.

6.3 Water Quality and Hydrology

6.3.1 EXISTING ENVIRONMENT

6.3.1.1 Catchment and Local Hydrology

The proposal site is situated within the Pine Creek catchment, an inland, endorheic basin ultimately discharging into Kudgee Lake, approximately 78km southeast of the proposal site. The Pine Creek catchment is located within the broader Murray-Darling Basin catchment.

The closest identified waterways to the existing Wills Street STP site are unnamed ephemeral drainage lines (Strahler first and second order streams), located approximately 160m south of the existing Wills Street STP's southern boundary on the opposite side of the Peterborough Broken Hill Railway. The current licensed discharge point for the Wills Street STP is located in one of these ephemeral drainage lines, south of Pinnacles Road, near the intersection with Kanandah Road (refer **Figure 16**). These drainage lines feed into Acacia Creek, approximately 2km south of the STP at its closest point.

The closest identified waterway to the South STP site is an unnamed ephemeral drainage line (Strahler second order stream), located approximately 70m east of the STP's eastern boundary at its closest point. The current licensed discharge point for the South STP is located within this ephemeral drainage line (refer **Figure 4**). This drainage line feeds into another arm of Acacia Creek, approximately 1.8km south of the southern boundary of the STP at its closest point.

The proposed rising main route intersects with several Strahler first order ephemeral drainage lines as it traverses land to the east and west of the Silver City Highway. It also follows the path of a Strahler first order ephemeral drainage line, which has been modified as a stormwater channel as it passed through the Kanandah Place industrial area, approximately 160m south of the existing Wills Street STP site. These ephemeral drainage lines all flow into Acacia Creek approximately 2.5km south.

Acacia Creek feeds into Kelly's Creek approximately 4.5km southwest, Sterling Vale Creek approximately 10km southwest and Pine Creek approximately 12km southwest of the proposal site respectively.

Figure 36 shows the waterways in the vicinity of the proposal site.

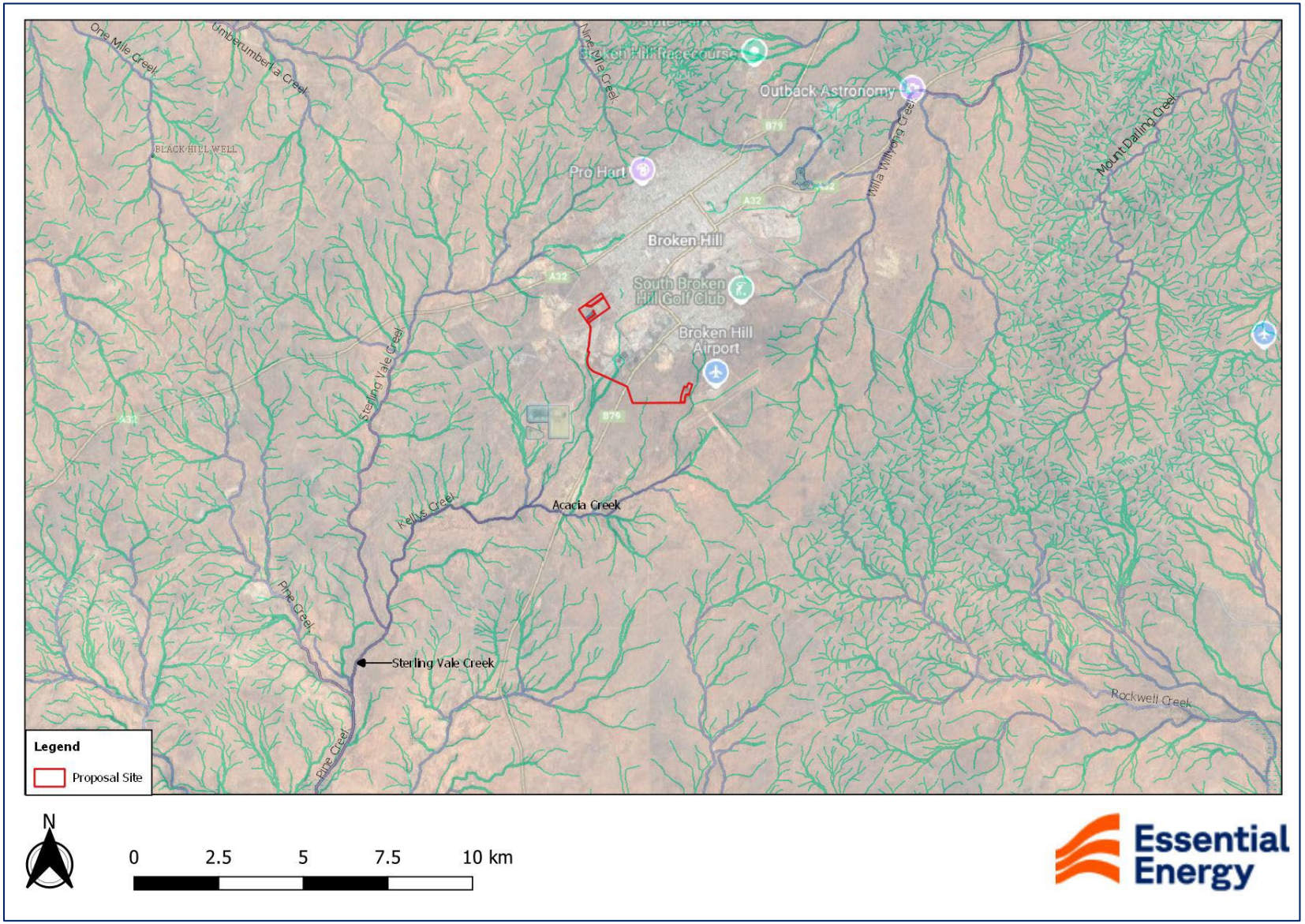


Figure 36: Waterways in the vicinity of the proposal site

6.3.1.2 Groundwater

A hydrogeological study completed by Tonkin (2014) for the existing Wills Street STP indicates two groundwater flow systems are present at the site and where there is sufficient depth of alluvial materials there is also two aquifers in the southwestern portion of the site and off-site to the southwest. Groundwater within the upper alluvial aquifer is considered to be part of a local 'shoestring' flow or perched system, which has been shown to flow in a southwesterly direction following the topography of the site and the region. Recharge of this aquifer is likely to be from surface water sources and, the water treatment process including tertiary lagoon and treatment tanks

With increasing depth, groundwater is associated with a deeper, local fractured rock aquifer which is recharged at outcropping weathered bedrock and from the alluvial aquifer above and not likely to be directly connected to the Murray Geological Basin regional flow system. At the up-gradient point of the site in the vicinity of the water treatment facility, the alluvial aquifer appears to be predominantly recharging from the activities of the treatment facility, interconnectivity with the fractured rock aquifer where it outcrops or rainfall infiltration. At the down gradient (both piezometric and topographic) southern end of the site near the tertiary pond, the alluvial and potentially the fractured rock aquifer gain water from the lagoon and/or overland surface flows during periods of high precipitation (Tonkin, 2014).

The Tonkin (2014) study indicated depth to groundwater varies across the site, but is approximately 1m bgl in the northern part of the site in the vicinity of the existing main STP infrastructure, and approximately 6m below ground level towards the southern part of the existing Wills Street STP site.

A more recent geotechnical investigation by Intrax (2024) and summarised by Beca (2024), which included the installation and monitoring of several new groundwater monitoring wells and observations from existing groundwater monitoring wells indicated groundwater levels of 1.5m bgl for Wills Street STP site and 4m bgl for South STP and the proposed rising main route.

6.3.1.3 Stormwater

The existing Wills Street STP site generally falls from west to east (maximum gradient of 5.8%) and north to south (maximum gradient of 4.8%) (Beca, 2024). Natural stormwater flows are expected to generally follow those grade lines. Stormwater is also managed on-site through a series of earthen bunds, drains and retention basins, in accordance with the *Wills Street Wastewater Treatment Plant Stormwater Management Plan* (Tonkin, 2015). Development and implementation of the stormwater management plan was a requirement of a previous EPA licence variation, which also incorporated a review of sludge stockpile activities and sludge cells. One of the main objectives of the stormwater management plan is to redirect and minimise the interaction of stormwater flows with sludge management activities and other key pieces of existing STP infrastructure. It also aims to retain potential sediment-laden flows on-site, prior to stormwater discharge off-site. The existing stormwater detention basins are shown on **Figure 3**.

The South STP is a relatively flat site, with the steepest slopes recorded at 2.8% west to east and 3.1% north to south, respectively (Beca, 2024). Natural stormwater flows are expected to generally follow those grade lines. No formal stormwater management is in place at the South STP.

The majority of the proposed rising main route is relatively flat, with the exception of a rolling hill to the east of Kanandah Road. Stormwater runoff is expected to follow overland flow, generally from north to south along much of the proposed alignment. Local variation in flow may occur due to site specific topography and existing drainage channels, including the drainage easement in which the existing treated effluent discharge pipe traverses.

6.3.1.4 Flooding

While Essential Energy understands BHCC is currently preparing a flood study for Broken Hill, no publicly available flood mapping or data is currently available for the proposal site.

6.3.1.5 Water Quality

No publicly available water quality data is available for waterways in the vicinity Broken Hill.

The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG) (ANZECC 2000) were developed to provide a nationally consistent approach to water quality management based on the principle of ecological sustainable development of water resources. The guidelines contain a set of tools for the assessment and management of water quality across a range of water resource types based on designated environmental values. The ANZG are ambient water quality guidelines, appropriate for the assessment of water quality discharging from the Site.

Since the proposal site is located within the Murray-Darling Basin catchment, it is subject to the water quality objectives for this regional drainage division. However, the ANZG have not yet defined default guideline values for physical and chemical stressors across this drainage division and therefore recommend that the default trigger values set out in the Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000) guidelines are adopted.

The relevant default trigger values for upland rivers (150m altitude) are presented in **Table 19**.

Table 19: ANZECC (2000) Default Trigger Values South-East Australia for Slightly Disturbed Ecosystems – Upland River

PARAMETER	UNIT	TRIGGER VALUE
Chlorophyll a (Chl a)	µg/L	na[a]
Total Phosphorus (TP)	µg/L	20[b]
Filterable Reactive Phosphate (FRP)	µg/L	15[c]
Total Nitrogen (TN)	µg/L	250[d]
NO_x (Oxides of Nitrogen)	µg/L	15[e]
NH_4^+ (Ammonium)	µg/L	13[f]
Dissolved Oxygen (DO)	% Saturation	90-1110
pH	pH Units	6.5-7.5[g]

na not applicable
a. monitoring of periphyton and not phytoplankton biomass is recommended in upland rivers — values for periphyton biomass (mg Chl a m-2) to be developed.
b. values are 30 µgL-1 for Qld rivers, 10 µgL-1 for Vic. alpine streams and 13 µgL-1 for Tas. Rivers.
c. value is 5 µgL-1 for Vic. alpine streams and Tas. Rivers.
d. values are 100 µgL-1 for Vic. alpine streams and 480 µgL-1 for Tas. rivers
e. value is 190 µgL-1 for Tas. rivers
f. value is 10 µgL-1 for Qld. rivers
g. Values for NSW upland rivers are 6.5–8.0, for NSW lowland rivers 6.5–8.5, for humic rich Tas. lakes and rivers 4.0-6.5.

However, the ANZECC (2000) trigger values for upland rivers are for slightly disturbed ecosystems, and unlikely to provide realistic background water quality values for a heavily disturbed ephemeral drainage line, such as the receiving waterway from the existing Wills Street STP. Water quality of this ephemeral drainage line, particularly during dry periods, is likely dominated by the water discharged from the existing Wills Street STP, from other industrial premises, and runoff from roads located in the Kanandah Place and Pinnacles Place industrial areas. It is therefore likely to be of considerably poorer quality than the ANZECC (2000) default trigger values for upland rivers in slightly disturbed ecosystems.

In lieu of any publicly available water quality monitoring data available for this ephemeral drainage line, a review of available discharge water quality data from the existing Wills Street STP between July 2017 and February 2025 was undertaken. A summary of this data is presented in **Table 20** below.

Table 20: Summary of the existing Wills Street STP typical discharge water quality data from July 2017 to February 2025

PARAMETER	UNITS	TYPICAL EXISTING DISCHARGE QUALITY[1]
Biochemical Oxygen Demand (BOD)	mg/L	10.51
Cadmium	mg/L	0.0001
Chlorophyll a	mg/L	157.67
Chlorophyll b	mg/L	24.95
Lead	mg/L	0.00
Nitrate + Nitrite (oxidised nitrogen)	mg/L	4.06
Oil and Grease	mg/L	2.08
pH	pH Units	8.11
Phosphorus (Total)	mg/L	6.61
Total Dissolved Solids (TDS)	mg/L	686.28
Total Kjeldahl Nitrogen	mg/L	16.74
Total Suspended Solids (TSS)	mg/L	14.03

1. Average result for the period July 2017 to February 2025, sourced from Essential Water (2025)

While the background water quality in the ephemeral drainage line is not solely influenced by the effluent discharged water from Wills Street STP, the typical existing discharge water quality from the STP is likely to provide a fairer representation of expected background water quality in the ephemeral drain given the STP is one of the primary inputs to the ephemeral drain, particularly during drier periods.

6.3.2 ASSESSMENT OF IMPACT

6.3.2.1 Construction Impacts

Water Quality

The following activities have the potential to impact on water quality during the construction of the proposal:

- Earthworks, including benching, excavations and trenching
- Concreting works
- Fuel or oil leaks from construction and maintenance equipment

These activities have the potential to negatively affect the water quality in the area by the introduction of sediment laden runoff or contaminants within runoff. In consideration of the disturbance areas at the new BHSTP and South STPs being restricted to within the existing STP sites themselves, and the location away from immediate receiving waterways, any potential impacts to surface water flows are likely be negligible upon implementation of proposed mitigation measures.

Groundwater

Based on previous hydrogeological (Tonkin, 2014) and more recent geotechnical investigation (Intrax, 2024 and Beca, 2024) undertaken, and depending on the prevailing weather conditions prior to construction, groundwater within the upper alluvial (perched) aquifer may be encountered during excavation activities for the new BHSTP and potentially along the western portion of the proposed rising main route. It is unlikely groundwater will be encountered at the South STP site, or along the eastern portion of the rising main route

Where groundwater is encountered during the construction works, it would need to be managed so that it does not result in pollution, including sedimentation, of any local waterways. Groundwater devoid of sediment or contaminants would be disposed of in a way that does not cause erosion. If groundwater is encountered during the works, dewatering, settling, treating and filtering techniques would be required to be implemented. A dewatering procedure (for groundwater should it be intercepted) would be developed as part of the CEMP.

Should 3ML or less of dewatering be required for the proposal per water year (1 July to 30 June the following year), a water access licence exemption applies for an aquifer interference activity. If more than 3ML of groundwater dewatering is required during construction works, a water access licence would need to be obtained for the aquifer interference activity.

Flooding

The existing Wills Street and South STP sites are not known to be impacted by flooding. Parts of the rising main route, particularly as it traverses the modified drainage line south of the Peterborough Broken Hill Railway, will be impacted by water rises from local rainfall events, but given annual low rainfall and arid nature of the area, are not likely to be inundated for extended periods of time.

Dewatering of Tertiary Pond

The tertiary treatment pond at the Wills Street STP will require dewatering prior to commencement of bulk earth works and construction for the new BHSTP. It is proposed to undertake a controlled discharge of the pond's water through the existing discharge pipe over a several week period. Treated effluent water quality and flow volumes would continue to be monitored to ensure compliance with the existing EPL requirements. A dewatering procedure would be developed as part of the CEMP to ensure adequate safeguards and mitigation measures are put in place to protect the environment and human health during dewatering of the tertiary pond.

By-Pass of Tertiary Treatment Pond

The tertiary treatment pond will be taken offline during construction and would become redundant piece of infrastructure for the new BHSTP. As the remainder of the existing Wills Street STP will continue to operate while the new BHSTP infrastructure is being constructed, it is proposed to utilise the two emergency storage dams located immediately adjacent to the northeast of the tertiary pond to provide initial tertiary treatment (albeit with a limited residence time of one to two days), plus additional tertiary treatment through the existing UV treatment plant.

Water quality monitoring would continue to be undertaken to ensure discharge water quality is meeting the existing EPL requirements. If monitoring indicates discharge water quality is not meeting the existing EPL requirements during construction, the need for further tertiary treatment, including chlorine dosing for example, may be required. An appropriate additional tertiary treatment process, if required, would be discussed and confirmed with the NSW EPA prior to implementing.

6.3.2.2 Operational Impacts

Stormwater

Site stormwater collected from proposed buildings (i.e., amenities, switchroom and chemical facility) and roadworks will be directed to on-site stormwater drainage system discharging to the existing stormwater detention ponds.

The stormwater drainage hydrologic assessment will be developed during refinements to the detailed design and will follow the requirements of the Australian Rainfall Runoff (ARR) method for a 5% Annual Exceedance Probability (AEP). The adoption of the 5% AEP peak design flow indicates that there is a 5% chance every year that design flows through the catchment will be exceeded. Implementing a 5% AEP (Average Recurrence Interval or ARI = 20 years) has been taken from *AS 3500.3:2003 Plumbing and drainage - Stormwater drainage*.

Stormwater at the new BHSTP site would continue to be managed largely consistent with the stormwater management plan (Tonkin 2015). The earthen bund and swale drain feeding into stormwater retention basin

2 will require some modification to continue to direct stormwater flows around the new BHSTP infrastructure. Further assessment of site stormwater management, post upgrade, may be required.

Groundwater

There is limited potential for the proposed BHSTP operations to impact groundwater. Decommissioning of existing STP infrastructure, particularly the primary and secondary treatment tanks, sludge drying beds and the tertiary pond, which Tonkin (2014) considered to be likely contributing to elevated nutrient and heavy metal concentrations in groundwater above background levels due to leakages (refer **Section 6.8**), will likely result in improved outcomes for groundwater quality.

Provided there are no significant overflows or spills, no adverse impact to groundwater quality are predicted.

Water Quality

The new BHSTP infrastructure is expected to provide a more consistent and reliable treated effluent discharge water quality.

The PWA (2019) concept development report proposed a revised effluent quality criteria for the new BHSTP. The proposed limits presented in the PWA (2019) concept design were reported to represent the accepted modern technology criteria for discharge to inland waters. It is important that reasonable limits are implemented that protect the environment and receiving water, while facilitating the practical operation of the STP. **Table 21** provides a comparison between the existing and proposed new licence limits.

Table 21: Existing and Proposed Effluent Discharge EPL Limits

PARAMETER	UNITS	EXISTING LICENCE LIMITS FOR WILLS STREET STP (EPL 3925)	PROPOSED NEW EPL EFFLUENT DISCHARGE LICENCE LIMITS FOR THE NEW BHSTP
Biochemical Oxygen Demand (BOD)	mg/L	50	20
Total Suspended Solids (TSS)	mg/L	50	30
Ammonium Nitrogen, NH3-N	mg/L	-	5
Total Nitrogen, TN	mg/L	-	20
Total Phosphorus, TP	mg/L	-	2
Oil and Grease, O&G	mg/L	10	10
pH	pH unit	6.5-85	6.5-8.5
Faecal Coliforms	Org/100mL	-	600

As indicated in **Table 21**, it has been proposed to reduce limits for biochemical oxygen demand (BOD) and Total Suspended Solids (TSS) from current limits, and include new licence limits for nutrients (i.e., nitrogen and phosphorus) and faecal coliforms. These revisions align the new BHSTP to modern industry standards.

The EPL for the new BHSTP would be revised prior to commissioning of the new plant. Ultimately the licence limits will be set by the NSW EPA.

It is important to note that the treated effluent from both Wills Street and South STP currently discharge into ephemeral drainage lines that ultimately flow into the same creek system, Acacia Creek, approximately 2km and 1.8km south of each STP respectively. It is therefore considered unlikely that the proposed new BHSTP (even with minor additional load from South STP) will result in a significant increase in the existing effluent load to Acacia Creek. In fact, improved effluent discharge quality is likely to result in an improvement in water quality in Acacia Creek, downstream of the new BHSTP.

Treated Effluent Reuse

Most of the treated effluent produced at both the existing Wills Street and South STP sites is supplied to reuse customers. There are eight recycled water customers, details of which are summarised in **Table 7**. The residual treated effluent is licensed for discharge to an adjacent watercourse (refer previous section). This approach will remain largely the same for the new BHSTP infrastructure.

The treated effluent reuse system has been designed with the capacity to suit the current end users (excluding White Leeds), site service water and provision for future filtration backwash water applications.

The treated effluent discharged to White Leeds wetland system needs to meet pathogen requirement as shown in **Table 8**. Treatment process and on-site end-use controls (or non-treatment barriers) implemented for the current reuse scheme should comply with the AGWR specified water quality for municipal open space and/or dust suppression.

The new BHSTP and associated treated effluent reuse scheme will require consolidation, updating, and approval from NSW EPA. The scheme will need to comply with the NSW DCCEEW requirements. The requirements include a risk assessment, based on the framework from the AGWR, which will include the scheme stakeholders including staff from Essential Water (management and operations personnel), end users, NSW Health, DPE, and NSW EPA.

Provided the recycled water reuse scheme operates in accordance with all best practice guidelines, management plans and within EPL limits, no adverse impacts to surface or groundwaters are anticipated.

Discharge Volumes

Following commissioning of the new BHSTP, residual treated effluent (not subject to reuse – refer above) produced at the new STP would continue to be discharged to the existing licensed discharge point within the ephemeral drainage channel to the south of Pinnacles Road, near the intersection with Kanandah Road (refer **Figure 16**). Currently Wills Street STP is licensed to discharge 18,150kL/day (18.15ML), which equates to 6,624,750kL/year (6,624.75ML/year). The South STP has a licence limit of 3,628kL/day, equating to 1,324,220kL/year (1,324.22ML/year)

Discharge monitoring data provided by Essential Water from information supplied to the EPA in Annual Return documentation indicates the average annual discharge for Wills Street STP over the last 5 reporting periods (i.e., 2019-2020 to 2023-2024) is 584.18ML, with a peak year in 2021-2022 of 772.87ML. This is significantly less (an order of magnitude less in fact) than the limit allowed for by the EPL (6,624.75ML). Discharge monitoring data for South STP for a similar period indicates an average annual discharge of 241.3ML, with a peak of 271.24ML, which again is significantly less than the licence limit of 1,324.22ML/year. This basic water balance analysis suggests there is significant capacity (at least 5,852ML) for additional discharge volumes at the new BHSTP, following the transfer of raw sewage from the South STP. Even taking a conservative approach and accounting for the peak discharge volumes currently discharged from South STP, being transferred to the new BHSTP, discharge volumes from the new BHSTP are likely to be considerably less than the current licence limit. In reality the raw sewage transfer from South STP is likely to generate less discharge volume as current stormwater contribution from rainfall infiltration at the current South STP will be negated.

6.3.3 ENVIRONMENTAL MITIGATION MEASURES

The following mitigation measures will be applied:

Construction

- A Soil and Water Management Plan will be included as part of the CEMP
- Disturbed areas will be managed in accordance with the requirements of the Blue Book to minimise potential impacts to waterways. Sediment fencing will be erected, where required, downslope of disturbed areas, and impacts would be minimised where practicable. The use of filter bags may be required to discharge collected sediment-laden water where there are insufficient grassed areas available

- Appropriate scour protection would be installed at the discharge point to prevent erosion
- All areas where ground disturbance has occurred would be progressively stabilised following completion of works.
- Any water collected in excavations and trenches during rainfall and surface water ingress should be pumped to a grassed area on-site (where a suitable area is available) to allow for infiltration, reused for dust suppression, or pumped to stormwater using a sediment sock. All options should be conducted in a manner that does not result in turbid water entering the stormwater system or nearby waterway.
- Appropriate dewatering procedure for both the controlled discharge of the tertiary pond and from open excavations will be included as part of the CEMP
- It is anticipated that 3ML or less of groundwater will be taken via an aquifer interference activity. As such a water access licence exemption applies. While no application is needed to rely on the exemption, the water taken under the exemption must be recorded on the approved recording and reporting form at the end of each period of take no later than 24 hours after the water is taken, for each water year in which an exemption is claimed. The form must be provided to the Minister's representative within 28 days of the end of the water year in which the water was taken. The approved form is available here: https://www.waternsw.com.au/__data/assets/pdf_file/0005/160952/Recording-and-reporting-take-under-WAL-exemptions-form.pdf
- Any disposal of wastewater or fluids generated as part of construction works would be undertaken in a manner that does not cause water pollution. The CEMP would document an appropriate off-site disposal facility for treatment and disposal.
- A site-specific spill management plan would be prepared and include the following requirements:
  - Emergency spill kits are to be kept at the site (vehicle kits).
  - Refueling of machinery to be undertaken in a dedicated area within the construction compound appropriately protected as outlined in the spill management plan.
  - Workers would be trained in the spill management plan and the use of the spill kits.

Operation

- The existing EPL is to be amended and the new BHSTP operated in accordance with EPL conditions. Monitoring of effluent discharge will be undertaken in accordance with the EPL requirements.
- The existing Recycled Water Management Plans for Wills Street and South STPS will require consolidation, updating and approval prior to commissioning of the new BHSTP.
- Routine maintenance of the new BHSTP is to be undertaken in accordance with the Operations and Maintenance manual prepared for the new plant.
- The Operation Environmental Management Plan (OEMP) for the new BHSTP would be updated to detail appropriate actions in the event of equipment or power failure. The OEMP would be periodically reviewed to assess the efficacy of all management procedures. Identified shortcomings would be remedied to ensure these continue to be effective.
- Appropriate signage is to be maintained where chemicals are stored.
- The community would be notified of any incident with the potential to result in public health impacts.

6.3.4 CONCLUSION

The proposal will result in the construction of a new sewerage treatment plant using improved technology and treatment processes over the current aged facility. Water quality discharges will, consequently, improve leading to an overall net positive impact on water quality.

The proposal is not anticipated to have any significant impact upon the water quality or hydrological conditions in the area. Any impacts that might occur would be short-term and minor. Given the mitigation measures outlined in this assessment, the overall environmental risk is considered to be low.

6.4 Noise and Vibration

6.4.1 EXISTING ENVIRONMENT

The proposal site is located in the southwestern and southern outskirts of Broken Hill, comprising of the existing Wills Street and South STPs, as well as the construction of a new rising main between the two STPs and replacement of the treated effluent discharge pipe from the existing Wills Street STP.

The immediate surrounding landscape of the existing Wills Street STP includes:

- Undeveloped large residential lots located immediately to the north, with undeveloped land beyond
- A mix of undeveloped lots and residential premises immediately to the east with further residential premises beyond
- Crown Land containing existing water and sewerage infrastructure and Kanandah Road immediately to the south, with Peterborough Broken Hill Railway and an industrial area beyond
- Crown Land immediately to the west, with the BHCC Landfill and Waste Receival Facility beyond.

The immediate surrounding landscape of the South STP comprises predominately Crown Land (i.e., the Willyama common), with the Broken Hill Airport boundary approximately 300m to the east.

- 46 Wills Street located approximately 360m northeast of the existing Wills Street STP entrance and approximately 400m northeast of the existing STP inlet works (R1)
- 4 Ryan Street located approximately 450m southeast of the existing Wills Street STP entrance and approximately 350m east of the existing STP sludge drying beds (R2).
- 1 Queen Street located approximately 1000m northwest of the existing South STP entrance and inlet works (R3)
- 55 Knox Street located approximately 560m northeast of the existing South STP entrance and inlet works (R4).

Refer **Figure 2** and **Figure 3**.

Non-residential receptors closest to the project include:

- The Broken Hill Community Recycling Centre located at the western end of Wills Street, approximately 760m west of the Wills STP entrance and approximately 480m northeast of the STP sludge (biosolids) Stockpile A. A used goods shop is attached to the Recycling Centre which would be considered a commercial development (R5)
- Various light industrial properties on Kanandah Road, with the nearest of these properties located approximately 670m south of the existing Wills STP entrance, and approximately 240m southeast of the existing STP tertiary pond (R6)
- The Royal Flying Doctor Service adjacent to the airport approximately 570m southeast of the existing STP entrance and inlet works (R7).

Refer **Figure 2**.

The proposed rising main route follows an existing unsealed road within the Willyama Common, as it exits the South STP, before joining with Kanandah Road, at the intersection with the Silver City Highway. From here the route follows Kanandah Road to the industrial estate, before entering a drainage easement and onto the Will Street STP (refer **Figure 2**).

The main contributors to the existing noise environment at the proposal site would be noise emissions associated with:

- Operation of the existing STPs
- Operation of the waste management centre to the northwest of the current Wills Street STP

- Operations commercial and industrial businesses from the Kanandah Road and Pinnacles Place industrial areas to the south of the current Wills Street STP.
- Trains from operation of the Peterborough Broken Hill Railway to the south of the current Wills Street STP
- Domestic activities from residential areas east of the current Wills Street STP
- Road traffic from vehicles travelling on Kanandah Road, Wills Street and the Silver City Highway
- Air traffic from the Broken Hill Airport to the east of the existing South STP.

The existing noise environment at the proposal site would be characterised as a moderate to low noise environment.

6.4.2 ASSESSMENT OF IMPACT

Essential Energy engaged Bridges Acoustics (2025) to prepare a Noise Impact Assessment (NIA) for the proposal. The key findings of the NIA are summarised in the following sections. The report is presented in **Appendix C**.

6.4.2.1 Noise during construction

Assessment Criteria

The *Interim Construction Noise Guideline* (ICNG) (EPA, 2009) recommends a quantitative construction noise assessment for potentially significant projects. A less detailed qualitative assessment method is recommended for smaller projects, primarily involving temporary maintenance works rather than construction, that are not likely to produce significant noise at a receptor for more than 3 weeks. Based on this guidance, a quantitative construction noise assessment is appropriate for this project.

Table 2 of the ICNG recommends the following construction noise management levels to be applied at residential receptors during normal construction hours of 7 am to 6 pm Monday to Friday and 8 am to 1 pm Saturday:

- A Noise Affected level set 10 dBA above the Rating Background Level (RBL). The noise affected level represents the point above which there may be some community reaction to noise. Predicted construction noise over this level triggers a recommendation that all feasible and reasonable mitigation measures be applied during the construction period
- A Highly Noise Affected level set at 75db(A) LAeq. The highly affected level represents the point above which there may be a strong community reaction to noise and requires consideration of respite periods considering community feedback regarding sensitive times in each day and other relevant factors.

Based on the minimum threshold background noise level of 35db(A) LA90,15min for the day period, a noise affected level of 45dB(A) LAeq,15min has been adopted for this assessment.

Should construction work occur outside the normal construction hours, the ICNG recommends a noise affected level equal to the NPI recommended levels for operation of the project.

Calculated Construction Noise Levels

Construction noise levels were calculated considering only distance, reflection off hard ground and atmospheric absorption to assessed receptors.

Construction of the project would require a wide range of processes and equipment and would vary significantly from time to time depending on the tasks being completed. The entire construction period is expected to include the following major tasks, although many of these tasks will be completed in parallel in different areas of each site:

- Bulk earthworks to fill the existing ponds, level and grade the site
- Detailed earthworks to construct trenches, pits and foundations, particularly for partly buried tanks and similar infrastructure

- Concrete formwork and pouring
- Mechanical installation including buried and above-ground pipelines
- Electrical installation including buried cables and above ground equipment
- Road construction, landscaping and other surface finishes
- Installation of a buried rising main from South STP to Wills STP and the new discharge pipeline from the BHSTP
- Commissioning and testing followed by permanent diversion of sewage flow to the new facilities
- Decommissioning and demolishing existing STP components
- Rehabilitation of disturbed areas.

Tasks with the greatest potential to produce significant noise at receptors include bulk earthworks and demolishing existing STP infrastructure, therefore these tasks have been assessed in more detail in the NIA (**Appendix C**).

Bulk Earthworks

This construction task is assumed to include the following equipment:

- Two excavators (113 dBA sound power each)
- Two trucks (108 dBA sound power each)
- Dozer (114 dBA sound power)
- Two rollers (105 dBA sound power each)
- Grader (108 dBA sound power)
- Two skid steers (103 dBA sound power each).

The assumed equipment would produce a combined sound power level of 120 dBA. A more likely total sound power level in the range 117 to 119 dBA would occur with a subset of the assumed equipment operating at any one time.

A reasonable worst case sound power level of 120 dBA would result in a received noise level, considering distance attenuation over reflective ground and atmospheric absorption, of up to:

- 54 LAeq,15min at R1
- 56 LAeq,15min at R2
- 52 LAeq,15min at R3
- 53 LAeq,15min at R4.

This construction task is therefore likely to exceed the ICNG's recommended noise affected level of 45 LAeq,15min during busy times at the closest residential receptors. An assessment of noise mitigation and management measures is therefore appropriate and are outlined in **Section 6.4.3**.

Concrete Pouring

This construction task is assumed to include the following equipment:

- Concrete pump (111 dBA sound power)
- Two concrete trucks (108 dBA sound power each)
- Air compressor (103 dBA sound power).

The assumed equipment would produce a combined sound power level of 114 dBA and a received noise level, considering distance attenuation over reflective ground and atmospheric absorption, of up to:

- 51 LAeq,15min at R1

- 52 LAeq,15min at R2
- 46 LAeq,15min at R3
- 47 LAeq,15min at R4.

This construction task is therefore likely to exceed the ICNG's recommended noise affected level of 45 LAeq,15min during each concrete pour. An assessment of noise mitigation and management measures is therefore appropriate and are outlined in **Section 6.4.3**.

Mechanical and Electrical

This construction task includes installation of mechanical and electrical equipment, requiring the following construction equipment:

- Delivery truck (105 dBA average sound power)
- Mobile crane (103 dBA average sound power)
- Impact wrenches (100 dBA sound power).

The assumed equipment would produce a combined sound power level of 109 dBA and a received noise level, considering distance attenuation over reflective ground and atmospheric absorption, of up to:

- 46 LAeq,15min at R1
- 47 LAeq,15min at R2
- 41 LAeq,15min at R3
- 42 LAeq,15min at R4.

This construction task is expected to slightly exceed the ICNG's recommended noise affected level of 45 LAeq,15min for short periods of time to unload heavy equipment off a delivery truck at the new BHSTP. Noise levels are likely to remain below the noise affected level for the majority of the time. An assessment of noise mitigation and management measures remains appropriate and are outlined in **Section 6.4.3**.

Road Construction at new BHSTP

This construction task is assumed to include the following equipment:

- Excavator (105 dBA sound power)
- Grader (108 dBA sound power)
- Two rollers (105 dBA sound power each)
- Aggregate truck (103 dBA average sound power)
- Bitumen truck (103 dBA average sound power)
- Skid steer (103 dBA sound power).

The assumed equipment would produce a combined sound power level of 113 dBA and a received noise level, considering distance attenuation over reflective ground and atmospheric absorption, of up to:

- 50 LAeq,15min at R1
- 51 LAeq,15min at R2.

This construction task is therefore likely to exceed the ICNG's recommended noise affected level of 45 LAeq,15min during road pavement construction. An assessment of noise mitigation and management measures is therefore appropriate and are outlined in **Section 6.4.3**.

Rising Main Construction and Replacement of Treated Effluent Discharge Pipe

This construction task is assumed to include the following equipment, and generally progress along the route, including:

- An excavator to construct and backfill a trench (108 dBA sound power)
- A truck to deliver pipe sections (103 dBA average sound power)
- A truck to deliver bedding sand (103 dBA average sound power)
- A backhoe to deposit a sand bed and install pipe sections (103 dBA sound power)
- A skid steer for rehabilitation (103 dBA sound power).

The assumed equipment would produce a combined sound power level of 112 dBA and a received noise level, considering distance attenuation over reflective ground and atmospheric absorption, of up to:

- 45 LAeq,15min at R1 and R2
- 44 LAeq,15min at R3 and R4.

This construction task is expected to meet the ICNG's recommended noise affected level of 45 LAeq,15min at all residences.

Higher noise levels are expected at Kanandah Road light industrial properties adjacent to the route. As light industrial properties are not highly sensitive to noise and each property should expect to receive significant noise for only a few days as the construction fleet passes, no specific noise mitigation measures are recommended.

Demolition of Existing Infrastructure

This 'construction' task including removal of the existing Wills STP and SBHSTP is assumed to include the following equipment:

- Excavator and concrete breaker (120 dBA sound power)
- Excavator and ripper (113 dBA sound power)
- Truck (108 dBA sound power)
- Skid steer (103 dBA sound power).

The assumed equipment would produce a combined sound power level of 121 dBA and a received noise level, considering distance attenuation over reflective ground and atmospheric absorption, of up to:

- 61 LAeq,15min at R1 and R2
- 53 LAeq,15min at R3
- 54 LAeq,15min at R4.

This construction task is expected to be the loudest at receptors due to the excavator-mounted hydraulic hammer assumed to be required to remove existing concrete structures.

This task will exceed the ICNG's recommended noise affected level of 45 LAeq,15min. An assessment of noise mitigation and management measures is therefore appropriate and are outlined in **Section 6.4.3**.

Construction Noise Impact Summary

A number of construction tasks are likely to result in noise levels over the noise affected level recommended in the ICNG. Noise mitigation and management measures have therefore been recommended for the majority of construction tasks including prior preparation of a Construction Noise Management Plan (CNMP) and implementation during construction.

6.4.2.2 Road traffic noise

Assessment Criteria

Section 2.3 of the *NSW Road Noise Policy* (RNP) (DECCW, 2011) specifies road traffic noise criteria from public roads to both residential and non-residential land uses. For existing residences affected by additional traffic on existing roads due to land-use developments, the RNP recommends:

- 55 LAeq,15hr during the day (7 am to 10 pm) and 50 LAeq,9hr during the night (10 pm to 7 am) from arterial and sub-arterial roads to 1 m from the external façade of residences
- 55 LAeq,1hr during the day and 50 LAeq,1hr during the night from local roads to 1 m from the external façade of residences.

Construction traffic is expected to access the existing Wills STP site via Kanandah Road which can be considered a sub-arterial road, while future operational traffic will access the new BHSTP via Wills Street and the new pump station at South STP site via Picton Street which are both local roads. As the status of Kanandah Road is uncertain, the local road noise criteria will be applied to project-related traffic on all access routes.

Calculated Road Traffic Noise Levels

Similar to construction noise, traffic noise levels were calculated considering only distance, reflection off hard ground and atmospheric absorption to assessed receptors. As required by the Road Noise Policy (RNP), traffic noise calculations also considered reflection from the exposed residential façade

Operational Traffic

The existing Wills STP and South STP require regular staff visits, generating less than 10 vehicle movements per day on Wills Street, Picton Street and other feeder roads.

The replacement BHSTP is expected to require similar staffing levels and will therefore generate similar daily vehicle movements on Wills Street and other nearby roads. In contrast, the new pump station at the South STP will generally operate without staff intervention, eliminating staff vehicle movements on Picton Street and nearby roads for the majority of days.

Given no significant change in vehicle movements to Wills STP and a reduction in vehicle movements to the South STP site, a detailed operational traffic noise assessment is not required.

Construction Traffic

Construction of the project would require a number of additional vehicle movements to and from each site including light vehicles for personnel and heavy vehicles to deliver materials and equipment. Light vehicle movements would primarily occur in the morning and afternoon while heavy vehicle movements would be more evenly distributed throughout the day.

While vehicle movements would vary from day to day, reasonable worst case heavy vehicle movements may occur during the following two construction tasks:

- Bulk earthworks, assuming significant quantities of fill are imported or exported resulting in up to 20 trucks (40 movements) per day and up to 4 trucks (8 movements) per hour
- Concrete pouring, requiring up to 5 trucks (10 movements) per hour.

Noise from the assumed worst case heavy vehicle movements and an assumed maximum of 20 light vehicle movements per hour has been calculated to residences located 15 m and 20 m from the haul route to and from each site, resulting in:

- 55 LAeq,1hr from 20 car and 8 truck movements at 15 m from the road
- 54 LAeq,1hr from 20 car and 8 truck movements at 20 m from the road
- 56 LAeq,1hr from 20 car and 10 concrete truck movements at 15 m from the road
- 55 LAeq,1hr from 20 car and 10 concrete truck movements at 20 m from the road

Calculated noise levels indicate reasonable worst case construction traffic will most likely reach the traffic noise criterion for the day period. Traffic noise mitigation measures recommended for the construction period are outlined **Section 6.4.3**.

6.4.2.3 Vibration during construction

The use of construction equipment has the potential to cause some vibration impacts. The vibration generated from construction works would vary depending on the level and type of activity carried out at each site during each activity. Potential vibration impacts to receivers for the works would be dependent on separation distances, the intervening soil and rock strata, dominant frequencies of vibration and the receiver structure.

Dominant vibration generating plant include:

- Excavator
- Compactor/rollers
- Truck movements along unsealed roads.

The re-positioning of the majority of the new STP infrastructure to the tertiary pond, will mean blasting that may have been required for when encountering hard rock at depth will be avoided. Similarly, any potential vibratory impacts associated with rock hammers is likely to be greatly minimised, if not avoided altogether.

Given the distance from sensitive receivers and the relatively low intensity the remaining construction methods, there is not expected to be potential for cosmetic damage to residential dwellings.

6.4.2.4 Noise during operation

Assessment Criteria

The most relevant NSW Government noise policy for industrial facilities is the *Noise Policy for Industry* (NPI) (EPA, 2017). The EPA intended the NPI to apply to major industrial projects, generally those which are assessed and approved by the NSW Department of Planning, Housing & Infrastructure (DPHI). However, the NPI is also widely acknowledged as the most appropriate policy to assess noise from other industrial developments in NSW including sewage treatment plants, sewage pumping stations and other water infrastructure.

The NPI does not specify mandatory noise limits and has no legal force. Legally enforceable noise limits can only be set by a regulatory authority as part of a development consent or other formal project approval, or by the EPA in an EPL. The NPI instead recommends “project noise trigger levels” which are project-specific and, if exceeded, are intended to trigger investigations into noise mitigation or management measures to avoid potentially unacceptable noise impacts to sensitive properties such as private residences. The project noise trigger levels are primarily intended to guide regulatory authorities and assist them in setting enforceable limits. Notwithstanding the above, regulatory authorities typically adopt the recommendations of the NPI as noise limits in development consents unless there are compelling reasons to adopt alternative limits for particular projects.

The NPI is not intended to result in all industrial noise sources being inaudible at all sensitive receivers. Rather, it recognises the value industrial activity provides to the community and the inherently noisy nature of most industries. It also recognises the community’s need to be protected from excessive or unreasonable noise. While an appropriate balance between these competing desires may be debated, the NPI is widely recognised as an appropriate policy for the majority of situations.

Background Noise Levels

The NPI recommends minimum threshold background noise levels of:

- 35 LA90,15min during the day
- 30 LA90,15min during the evening and night.

Where the measured background noise level in any time period is lower than the recommended minimum threshold level for that period, the minimum threshold level is adopted rather than the measured levels for the purpose of setting the project intrusive levels.

Background noise levels at residential and other receptors closest to each facility have not been measured as part of this assessment. Sources of background noise typically include local and regional road traffic, insects, birds and wind, however, these sources are considered unlikely to result in background levels above the minimum threshold levels during any time period. The minimum threshold levels have therefore been adopted for this assessment.

Project Noise Levels

The NPI recommends two main project noise levels:

- Project intrusive levels set 5 dBA above the background noise level in each of the day, evening and night periods in which the industrial development operates. The intrusive levels only apply to residential receptors and are intended to limit the relative audibility of the industrial source at each receptor
- Project amenity levels in each time period are set according to the character of the receptor area. The project amenity levels apply to residential, commercial and other receptor categories and are intended to limit the cumulative noise level from all industrial sources in the area. In most cases, the project amenity levels (that apply to noise from the project alone) are set 5 dBA lower than the amenity levels (that apply to noise from all sources of industrial noise in the area).

The adopted minimum threshold background levels lead to project intrusive levels of 40 LAeq,15min during the day and 35 LAeq,15min during the evening and night at all residential receptors near both the new BHSTP and new pump station at the South STP.

Project amenity levels for residential receptors differ for rural, suburban and urban residences. Residences near the project are best described as suburban residences and, according to Table 2.2 of the NPI, are assigned recommended amenity levels of 55 LAeq,11hr during the day, 45 LAeq,4hr for the evening and 40 LAeq,9hr for the night period. Project amenity levels are set 5 dBA lower.

Amenity levels for commercial and industrial developments recommended in Table 2.2 in the INP are 65 and 70 LAeq respectively. Project amenity levels are set 5 dBA lower.

Table 22 presents a summary of noise criteria at closest receptors.

Table 22: Project Noise Criteria at Closest Receptors

RECEPTOR	PROJECT INTRUSIVE LEVEL, DAY/EVENING/NIGHT, LAeq,15MIN	PROJECT AMENITY LEVEL, DAY/EVENING/NIGHT, LAeq,PERIOD
R1, 46 Wills Street	40 / 35 / 35	50 / 40 / 35
R2, 4 Ryan Street	40 / 35 / 35	50 / 40 / 35
R3, 1 Queen Street	40 / 35 / 35	50 / 40 / 35
R4, 55 Knox Street	40 / 35 / 35	50 / 40 / 35
R5, Recycling Centre	N/A[1]	60 / 60 / 60
R6, Kanandah Road	N/A[1]	65 / 65 / 65
R7, Royal Flying Doctor Service	N/A[1]	60 / 60 / 60

1. Project intrusive levels only apply to residential receptors

The lowest of the intrusive or amenity levels are adopted as the limiting criteria at each receptor. The project intrusive levels are therefore adopted as the limiting criteria for residential receptors and the project amenity criteria apply at commercial and industrial receptors.

Modifying Factors

A modifying factor or annoying noise characteristic as defined in the NPI is a special noise character that makes it more noticeable to a human ear. Modifying factors include:

- Tonal noise, which means a noise source produces most of its sound energy in a narrow frequency range and is therefore more audible. Typical examples include vehicle reverse alarms and emergency vehicle sirens which are specifically designed to attract attention, however other sources including pumps and fans can also produce tonal noise. If tonal noise is present at one or more receptors, a +5 dBA correction is required to predicted noise levels before comparison with relevant criteria
- Low frequency noise, defined in the NPI as the frequency range 10 to 160 Hz, which passes through the façade of buildings more efficiently than higher frequencies and can cause noticeable resonances within occupied rooms. If low frequency noise levels exceed a threshold spectrum defined in the NPI then one of the following corrections is required:
  - +2 dBA if the industrial source is up to and including 5 dBA above the low frequency threshold spectrum in any 1/3 octave band, or
  - +5 dBA if the industrial source is above 5 dBA above the low frequency threshold spectrum in any 1/3 octave band.
- Intermittent noise, which is defined in the NPI as a regular change of more than 5 dBA at the receptor and the change is clearly audible. Vehicle reverse alarms and emergency vehicle sirens are typical examples of intermittent noise.

The project is unlikely to produce intermittent noise, however, tonal and low frequency noise is considered in the assessment.

Sleep Disturbance

Sleep can be disturbed by noise, although the level and character of noise required to disturb sleep varies considerably from person to person. Section 2.5 of the NPI points to Section 5.4 of the RNP for a summary of current research findings, concluding further research is required to definitively set noise limits to minimise sleep disturbance. The NPI further suggests any noise during the night that exceeds:

- An average level of 40 LAeq,15min or the intrusive level, whichever is greater, and/or
- A maximum level of 52 dBA or 15 dBA above the background noise level, whichever is greater,

may not necessarily cause sleep disturbance but should trigger a maximum noise level assessment. Such an assessment would consider the maximum level, the extent the maximum level exceeds the background level, and the number of times this is expected to occur during the night period.

Noise Modelling

The predicted environmental noise levels from future operation of the new BHSTP have been calculated using RTA Technology's Environmental Noise Model (ENM) software. ENM is a general purpose noise modelling package that combines terrain and noise source information with other input parameters such as weather conditions to predict noise levels at specific receiver locations or as contours over a specified receiver area. It is recognised as one of the most appropriate choices of model software for situations involving complex topography and a large number of individual noise sources, and where a detailed assessment of the effects of atmospheric conditions on noise propagation is required.

Atmospheric Conditions

A review of atmospheric conditions that occur in the vicinity of the project site was completed to determine the effect of such conditions on noise propagation from the project. Parameters such as air temperature, relative humidity, wind speed profile and vertical temperature gradient can significantly influence noise levels from a source, with wind and vertical temperature gradient being the dominant factors.

The NPI recommends the following weather conditions should be considered in any noise assessment:

- A 3°C/100m inversion during the night where inversions occur for at least 30% of the time during winter evenings and nights plus a 2m/s drainage flow from source to receiver where the source is on higher ground than the receiver with no intervening hills

- A gradient wind of up to 3 m/s from source to receiver where such a wind occurs for at least 30% of the time in any season or time period.

Weather data from the Bureau of Meteorology's Broken Hill Airport automatic weather station (Station 47048) was used for analysis. Supplied data included air temperature, wind speed and wind direction in 10 minute intervals from 1 July 2018 to 30 June 2023, a total period of five years.

Temperature Gradients

The Bureau of Meteorology does not directly measure temperature gradients as temperature sensors are only positioned at the standard height of 10 m above the ground. However, negative temperature gradients can be confidently predicted during the day and positive gradients can be confidently assumed during the majority of nights. Temperature inversions are therefore assumed to occur and the NPI default 3 °C/100m has been adopted for the evening and night periods.

Prevailing Winds

Analysis of supplied weather data to determine the occurrence and direction of prevailing winds was completed according to the procedure recommended in the INP:

- Sort the data by season and time period (day, evening and night)
- For each season and time period, separate the data into 16 compass directions
- For each compass direction, sum the occurrence of vector wind speeds in the range 0.5 to 3 m/s, considering winds up to 45° from the compass direction, and express the result as a percentage of the total time in that season and time period.

The result of this process is the percentage occurrence of potentially noise enhancing winds in each season, time period and direction, as presented in **Table 23**. Shaded values exceed 30% and are therefore considered significant enough to require consideration in this assessment according to the NPI.

Table 23: Percentage Occurrence of Prevailing Winds, BOM Broken Hill Airport 2018-2023.

WIND DIRECTION	OCCURRENCE OF NOISE ENHANCING WINDS, % OF SEASON AND TIME PERIOD											
	DAY				EVENING				NIGHT			
	Sum	Aut	Win	Spr	Sum	Aut	Win	Spr	Sum	Aut	Win	Spr
N	6	11	14	9	8	19	28	18	12	22	26	17
NNE	7	11	13	9	10	21	27	17	11	19	22	15
NE	8	11	12	9	12	23	26	18	11	19	20	16
ENE	9	13	13	10	14	26	25	20	16	23	22	19
E	10	15	13	12	19	**30**	23	22	23	**30**	25	25
ESE	11	16	13	14	19	28	23	22	25	28	20	26
SE	12	16	12	14	15	25	21	20	22	25	14	22
SSE	10	15	12	12	15	24	18	19	18	23	14	20
S	9	14	12	11	16	25	20	19	16	24	17	19
SSW	9	16	12	11	17	26	20	19	17	24	20	18
SW	10	16	14	12	17	24	21	19	18	24	21	18
WSW	10	17	15	12	13	19	23	17	17	23	21	17
W	9	15	15	11	8	16	23	16	13	21	22	16

WNW	7	12	14	9	7	15	26	16	8	17	21	13
NW	6	12	14	9	7	15	27	15	10	18	26	17
NNW	6	12	14	9	7	17	26	16	13	23	**29**	20

Shaded values indicate gradient winds occur over, or close to, 30% of the time

Table 23 shows easterly gradient winds are significant during autumn evenings and nights. Winds from the north-north-west occur for 29% of the time during winter nights and, while they do not reach the 30% threshold recommended in the NPI, have been conservatively included in the assessment.

It is noted that the prevalence of easterly winds during autumn evenings and nights presented In **Table 23** appears to be at odds with the prevalence of westerly winds identified in the wind roses prepared as part of the odour assessment, and presented in **Section 6.1.1.1** of this REF**.** Bridges Acoustics (pers comm 21 May 2025) indicated the reason for this is likely due the wind speed of westerly winds often exceeding 3m/s and as such were excluded from the wind analysis for the noise assessment. Wind speeds greater than 3m/s cause turbulence and increases background noise levels due to wind agitating trees and other structures near receptors. Both of these effects do not enhance audible noise from an industrial source, and therefore a source to receptor wind vector component above 3 m/s is excluded from the noise assessment. This resulted in a greater percentage of calmer easterly winds being captured as noise enhancing winds for the noise assessment, as presented in **Table 23**.

Modelled Weather Conditions

Table 24 presents modelled weather conditions based on the assumptions and wind analysis results described above.

Table 24: Modelled Weather Conditions

TIME PERIOD, SCENARIO	TEMP °C	RELATIVE HUMIDITY %	WIND SPEED m/s	WIND DIRECTION	VERT. TEMP. GRADIENT °C/100m
Day Calm	25	60	0	-	-2
Evening / Night Calm	20	70	0	-	0
Evening / Night Inversion	10	70	0	-	3
Evening / Night Wind	10	70	3	East	0
	10	70	3	NNW	0

As the evening and night periods include similar prevailing weather conditions, these two periods have been combined in the noise model. Calculated noise levels and noise contours have been presented for the following three scenarios:

- Day calm
- Evening/night calm
- Evening/night prevailing weather (worst case of inversion, east wind and NNW wind scenarios).

Operational Noise Sources

The location of significant process equipment and noise levels produced by that equipment have been determined by the following data sources:

- Supplied plans showing the currently proposed location of significant process components
- *Broken Hill WWTP Preliminary Concept Design Report* (Beca HunterH2O, 2024b)

- Previous noise measurements around similar process equipment on other STP sites, primarily in the Hunter Valley region.

Table 25 presents a summary of significant noise sources including the component source code for correlation with **Figure 37** and total dBA sound power level of each source.

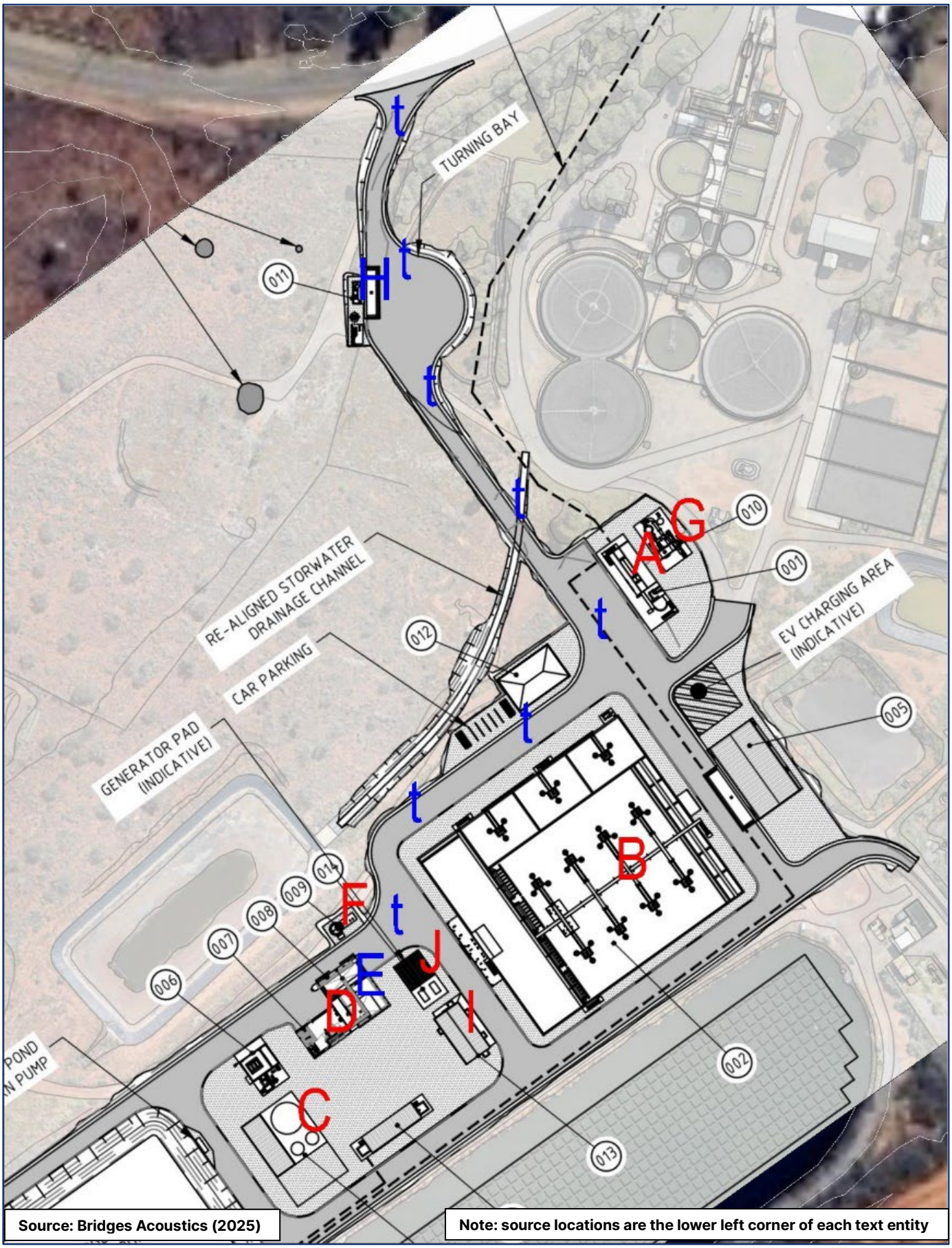
Occasional septage and sludge truck movements have been modelled assuming each truck travels within the site at low speed and requires relatively low engine speed and power. As sludge trucks travel further within the site than a septage truck, noise from one sludge truck movement in a 15 minute period has been distributed over 8 representative locations between the STP entrance and the sludge outloading facility. **Table 25** includes a sound power level for the entire truck movement and a sound power level for partial truck noise at each modelled location along the truck route.

Table 25: Significant Noise Source Summary for the Proposed BHSTP

SOURCE CODE	COMPONENT (MAJOR SOURCES)	SOUND POWER LEVEL, dBA	NUMBER OF SOURCES
A	Inlet works (covered screens, screenings compactor, grit tank agitator and pump)	84	1
B	Bioreactor (surface aerators, pumps)	88	1
C	Recycled water system (pump)	73	1
D	Dewatering (pump, belt press)	73	1
E	Sludge outloading (pump)	73	1
F	Foul water (pump)	73	1
G	Odour control (fan)	81	1
H	Septage receival (pump)	73	1
I	Switchroom (fan)	79	1
J	Power transformers (fans)	79	1
T	Septage or sludge truck (25% of 15 min period, low speed)	86	0
t	Septage or sludge truck (per location along route)	77	8

The new pump station at South STP will be located some distance from the new BHSTP and has not been included in the noise model. The new pump station is anticipated to include the following noise sources:

- Submersible pumps operating below water level in a wet well. Noise data are not available for submersible pumps as they are much quieter than dry well pumps and are often inaudible or barely audible at ground level directly above the wet well
- A reflux (one-way) valve in the rising main, assumed to be located on or near the surface close to the new pump station. A reflux valve produces a brief impact noise as it closes each time the pump switches off, with this noise rarely audible beyond 5 to 10 m from the valve.



Source: Bridges Acoustics (2025)

Note: source locations are the lower left corner of each text entity

Figure 37: Modelled Noise Sources

Operating Noise Levels – New BHSTP

A summary of calculated noise levels is shown in **Table 26** for receptors near the existing Wills Street STP, along with the adopted noise criteria from **Table 22**. **Figure 38**, **Figure 39** and **Figure 40** show noise contours for calculated LAeq,15min noise levels from the proposed new BHSTP for the day and combined evening/night periods.

Table 26: Predicted Noise Levels and Noise Criteria, Wills Street STP, LAeq,15min

RECEPTOR	DAY CALM[1]		EVENING / NIGHT CALM[2]		EVENING / NIGHT PREVAILING[3]	
	PREDICTED	CRITERIA	PREDICTED	CRITERIA	PREDICTED	CRITERIA
R1, 46 Wills St	15	40	16	35	19	35
R2, 4 Ryan St	16	40	17	35	21	35
R5, Recycling Centre	12	60	13	60	25	60
R6, Kanandah Rd	22	65	22	65	31	65

1. Refer **Figure 38**
2. Refer **Figure 39**
3. Refer **Figure 40**

Table 26 shows calculated LAeq,15min levels, however project amenity levels for receptors R5 and R6 are noise levels averaged for an entire day, evening or night rather than over a 15 minute period. Project amenity levels to R5 and R6 have not been calculated separately and are conservatively assumed to be equal to the LAeq,15min levels.

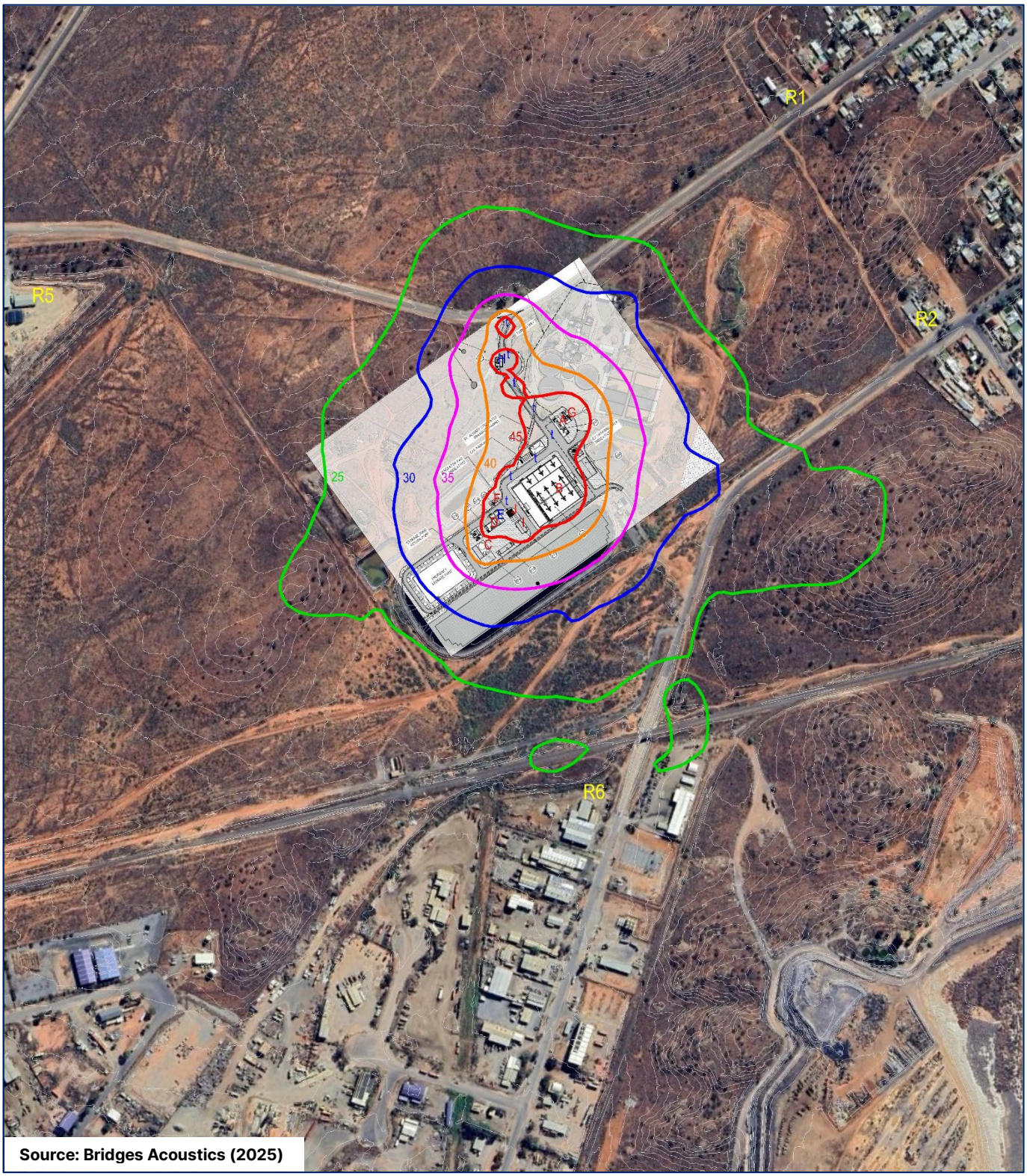
Predicted noise level are substantially lower than the noise criteria in all time periods, including the effect on noise propagation of temperature inversions and winds during the evening and night periods.

Low Frequency Noise Levels

Low frequency noise levels at residential receptors R1 and R2 have been calculated by:

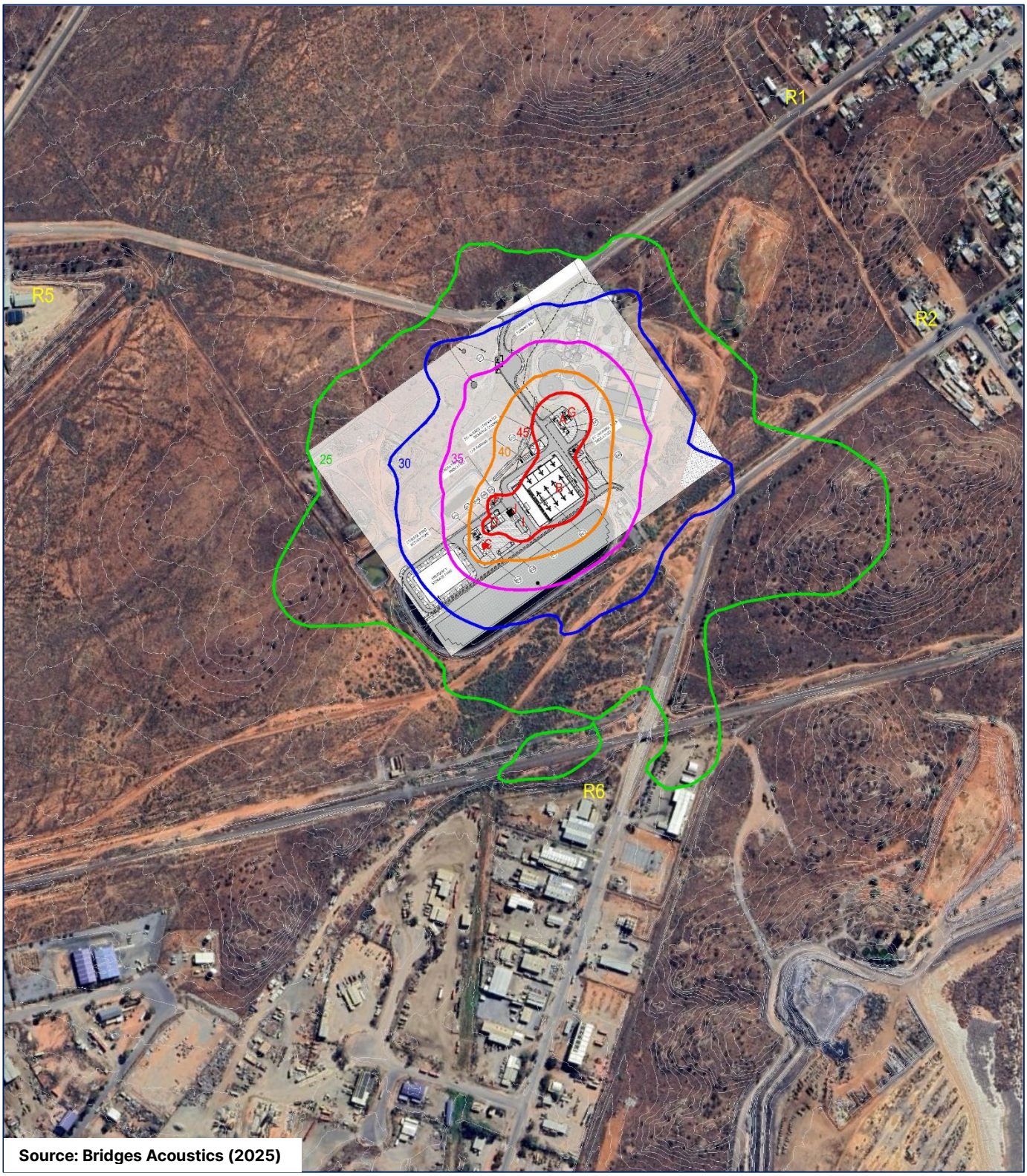
- Taking the received noise levels for the frequency range 25 Hz to 160 Hz supplied by the noise model
- Comparing source sound power levels with received noise levels to determine the total attenuation in each frequency band
- Applying the same attenuation determined for the 25 Hz band to the component sound power levels in the lower frequency bands 10 to 20 Hz that the noise model does not include, to calculate received noise levels in those lower bands
- Comparing received noise levels over the entire low frequency range to the NPI recommended low frequency threshold spectrum.

Results from this procedure, expressed as dBL rather than dBA levels for direct comparison with the NPI recommended low frequency threshold spectrum, are presented in **Table 27.** dBL (linear decibels) and dBA (A-weighted decibels) are both units for measuring sound levels, but dBA is adjusted to reflect how humans perceive loudness. dBL measures all frequencies equally, while dBA de-emphasizes low and high frequencies, aligning with the human ear's sensitivity.



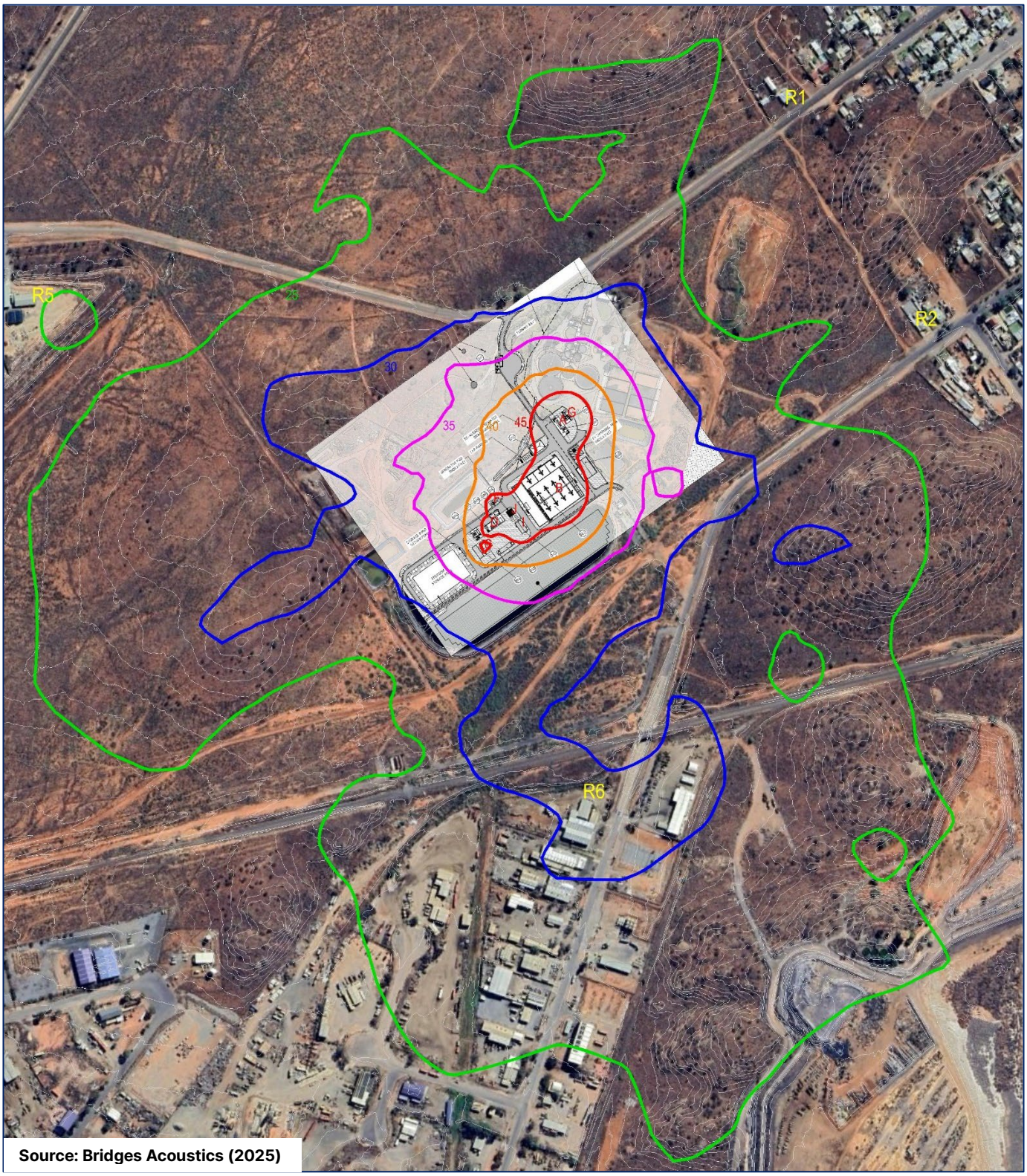
Source: Bridges Acoustics (2025)

Figure 38: Noise Contours, Day Calm LAeq,15min



Source: Bridges Acoustics (2025)

Figure 39: Noise Contours, Evening/Night Calm LAeq,15min



Source: Bridges Acoustics (2025)

Figure 40: Noise Contours, Evening/Night Prevailing (Inversion and Wind), LAeq,15min

Table 27: Low Frequency Noise Level from Wills STP to Residential Receptors, Leq,15min

FREQUENCY BAND, HZ	10	12	16	20	25	31	40	50	63	80	100	125	160
RECEPTOR	RECEIVED NOISE LEVEL AND THRESHOLD LEVEL, DBL												
R1, 46 Wills St	17	17	16	15	16	18	20	21	23	19	19	16	11
R2, 4 Ryan St	17	17	16	15	16	18	20	21	24	19	19	17	12
Low frequency threshold	92	89	86	77	69	61	54	50	50	48	48	46	44

Table 27 indicates low frequency noise levels are expected to remain at least 20 dBL below the recommended low frequency threshold spectrum. Low frequency noise impacts are therefore unlikely to occur at any receptor.

Tonal Noise Assessment

A tonal noise as defined in the NPI refers to a noise source that produces dominant noise in a relatively narrow frequency range such as a single 1/3 octave frequency band. Inspection of a source sound power spectrum indicates a tonal source, with a distinct peak in the spectrum compared to adjacent frequency bands, while inspection of a received noise spectrum indicates tonal noise at a receptor.

According to the NPI, tonal noise is assessed at the receptor and is identified by a noise level at least:

- 15 dBL above adjacent frequency bands in the range 25 – 125 Hz
- 8 dBL above adjacent frequency bands in the range 160 – 400 Hz
- 5 dBL above adjacent frequency bands in the range 500 – 10000 Hz.

Inspection of sound power data for proposed sources indicates no sources produce noise that would be defined in the NPI as tonal. In addition, a review of the received noise level spectra at residential receptors R1 and R2 indicates calculated noise levels for the new BHSTP are not tonal, as shown in **Figure 41**.

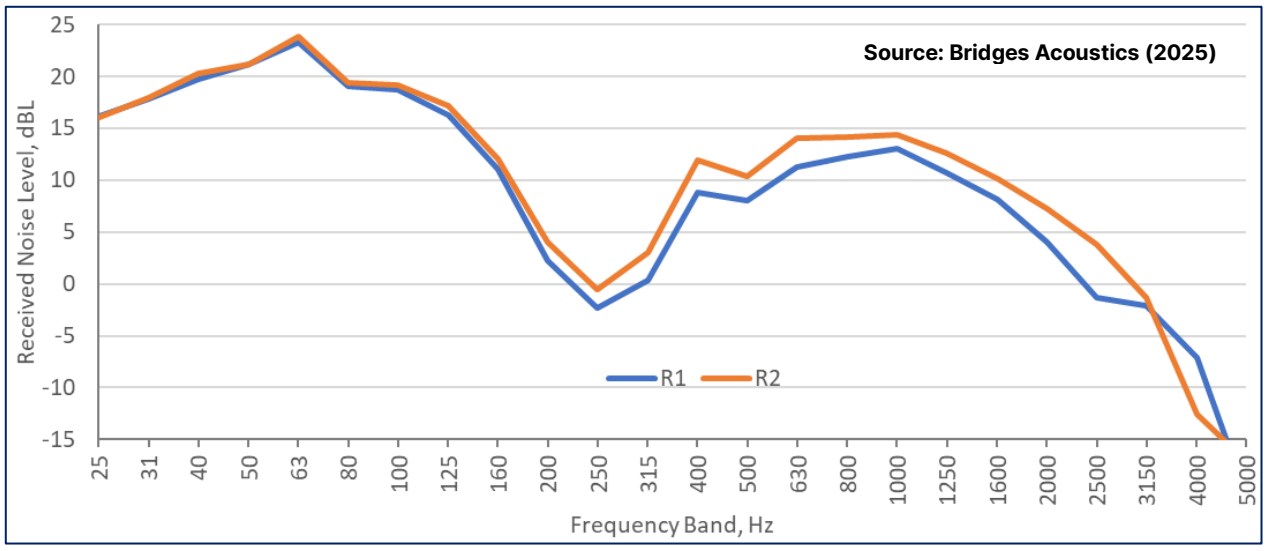


Figure 41: Received Noise Level Spectra to Receptors R1 and R2, LAeq,15min

Sleep Disturbance

Sleep disturbance can occur due to a short, sharp noise that intrudes above the background noise level during the period 10 pm to 7 am, or to 8 am on Sundays and public holidays.

An STP has little potential to disturb sleep during the night assuming no significant staff activity and heavy vehicle movements occur at night. A detailed sleep disturbance assessment for normal operation is therefore not justified.

Emergency maintenance staff callouts may occasionally be required at night due to critical equipment breakdown. Such callouts are assumed to involve a light vehicle, or at worst a medium truck, with staff primarily using hand tools to repair equipment. More extensive work, including work requiring a crane or other heavy equipment, would normally occur during the day.

A brief training program for maintenance staff is recommended to raise awareness of sleep disturbance issues and to determine and adopt practical methods of minimising noise during the occasional night callout.

Maintenance vehicles should be fitted with the quietest possible reverse alarms, ideally using a broadband sound rather than distinct frequencies. Alternatively, an override switch may be fitted to maintenance vehicles to disable the audible reverse alarm and activate a visible reversing flasher for night operation.

Operating Noise Levels – New Pump Station at South STP

Sewage pumping stations are typically located within suburban areas adjacent to residences. Submersible pumps operate under the water level and are typically inaudible or barely audible at a distance of 5m from the station, and reflux valves are similarly inaudible at a distance of 5 to 10m from the station. The only other surface facilities associated with a pumping station are electrical controls and power supplies, which produce insignificant noise.

The pump station installed at the South STP will be located close to the existing STP infrastructure at least 560m from R4 which is the nearest residential receptor and 570m from the nearest commercial receptor R7. There are no reasonable circumstances that would result in audible noise from operation of the pump station, apart from occasional visits by Essential's maintenance staff which would occur during the day.

Based on this review of the new pump station at the South STP, detailed noise calculations are not required to demonstrate compliance with the operating noise criteria.

6.4.2.5 Vibration during operation

The commissioning and operation of the new STP and rising main pipeline will not result in any significant vibration causing activities.

6.4.3 ENVIRONMENTAL MITIGATION MEASURES

Predicted operational noise levels are substantially lower than the noise criteria in all time periods, including the effect on noise propagation of temperature inversions and winds during the evening and night periods. No specific mitigation measures for operation noise levels are therefore proposed.

The following measures will be implemented where feasible and reasonable to minimise construction, demolition and road traffic noise:

- Minimise the number of machines operating simultaneously, particularly the louder machines such as excavators and the dozer
- Ensure all machines are maintained in good condition with a particular focus on the engine and exhaust system to minimise noise from these components
- Operate each machine in a manner that avoids excessive noise, including switching a machine off rather than extended periods of unnecessary idling between periods of activity
- Operate all machines at moderate engine power and speed where full power is not required
- Avoid starting construction tasks, or any heavy vehicles arriving or operating on the site, before 7am
- Construction work that has the potential to create audible noise at the nearest sensitive receiver, will be between 7am and 6pm Monday to Friday and 8 am to 1 pm Saturday. On occasions works outside these hours may be undertaken where the following requirements are met:
  - Neighbours (and other sensitive receivers) adjacent to the works or the local council or the NSW Environment Protection Authority (EPA) have been notified; and

- The works are justified on the basis that they are emergency works, or, because of supply security network outages or construction limitations, it is deemed that the works can only be achieved outside these hours.

- Any noise complaint will be investigated with additional control measures put in place if required
- A Noise Management Plan be prepared as part of the CEMP, and Demolition Plan prior to construction / demolition activities commencing and implemented throughout the duration of construction / demolition phases of the project.

6.4.4 CONCLUSION

The proposal will have acoustic and vibration impacts during construction. The acoustic and vibration impacts during the construction phase will be medium term and moderate, whilst operational noise generated by the proposal will be negligible and unlikely to impact on the closest sensitive receivers. Given the mitigation measures outlined in this assessment, the impacts can be effectively managed, and the overall environmental risk is considered to be low to moderate.

6.5 Flora and Fauna

AREA Environmental and Heritage Consultants (AREA) (2025a) was engaged to undertake an Ecological Impact Assessment for the proposal. The key findings of this assessment are presented below, with the full assessment report attached to this REF as **Appendix D**.

The figures presenting the subject land (i.e., the proposal site) in this section do not include the pump station and associated pipework at the South STP site, as the exact location of the infrastructure was yet to be determined at the time of the site survey. However, the construction footprint, being located within the northeastern corner, and along the eastern boundary of the STP operational area was surveyed. These areas were noted to be in a heavily modified and disturbed condition as a result of the previous construction, operation and maintenance of the South STP and associated sheds, pipework and access tracks. Impacts to vegetation in this area would be limited to regrowth groundcover vegetation and the removal and/or trimming of several trees. Vegetation in this area is mostly likely representative of a very degraded form of PCT 155 due to due to the Old Man Saltbush (*Atriplex nummularia*) dominating the area and the presence of *Eucalyptus coolabah subs coolabah* scattered in the surrounding area with matching mid and ground stratum species.

6.5.1 EXISTING ENVIRONMENT

6.5.1.1 Desktop Assessment

Landscape Context

The landscape context of the subject land was considered when assessing potential impact of the proposal. The proposal site is located in the Broken Hill Complex IBRA (Interim Biogeographic Regionalisation of Australia) bioregion – Barrier Range IBRA subregion, at approximately 302m AHD.

Mulga (*Acacia aneura*) communities coupled with chenopod shrubland composed of saltbush and bluebush communities (Benson, 2009) characterise the vegetation of the bioregion. Belah (*Casuarina cristata*), rosewood (*Alectryon oleifolius*), white cypress pine (*Callitris glaucophylla*) and mallee communities also occur throughout the bioregion (Dunn and Shaukar, 2003).

The landscape in which the proposal occurs primarily contains a mixture of previously disturbed native and non-native and vegetation. Parts of the proposal site supports mulga and bluebush communities where native vegetation exists.

Ecological Context

An EPBC Protected Matters Report generated for this proposal considered environmental matters within a 1,500m buffer of the proposal. This report is provided in ecological impact assessment (**Appendix D**) and summarised in **Table 28**.

Potential impacts to species and communities highlighted are considered in the following sections of this report.

Table 28: EPBC Protected Matters Report Summary

MNES	RESULT
World Heritage Properties	None
National Heritage Places	1
Wetlands of International Importance	None
Great Barrier Reef Marine Park	None
Commonwealth Marine Area	None
Listed Threatened Ecological Communities	None
Listed Threatened Species	17
Listed Migratory Species	8
Commonwealth Land	3
Commonwealth Heritage Places	None
Listed Marine Species	13
Whales and Other Cetaceans	None
Critical Habitats	None
Commonwealth Reserves Terrestrial	None
Australian Marine Parks	None
Habitat Critical to the survival of Marine Turtles	None
State and Territory Reserves	None
Regional Forest Agreements	None
Nationally Important Wetlands	None
EPBC Act Referrals	6
Key Ecological Features (Marine)	None
Biologically Important Areas	None
Bioregional Assessments	None
Geological and Bioregional Assessments	None

Predicted Species

Desktop results using the IBRA Barrier Range subregion threatened species search, identified a total of 69 EPBC Act and or BC Act listed species predicted to occur in the subregion where the proposal site is located.

Of these, 10 species have previously been recorded within 1,500m of the proposal (refer **Table 29** and **Figure 42**).

A full of list of threatened species with potential to occur in the subject land is provided in the ecological impact assessment (**Appendix D**).

Table 29: BioNet results within 1,500m assessment buffer

SCIENTIFIC NAME	COMMON NAME	NSW STATUS	CTH STATUS
Aves			
Aphelocephala leucopsis	Southern Whiteface	V	V
Artamus cyanopterus cyanopterus	Dusky Woodswallow	V	NL
Certhionyx variegatus	Pied Honeyeater	V	NL
Epthianura albifrons	White-fronted Chat	V	NL
Falco subniger	Black Falcon	V	NL
Hieraaetus morphnoides	Little Eagle	V	NL
Lophochroa leadbeateri	Pink Cockatoo	V	NL
Pyrrholaemus brunneus	Redthroat	V	NL
Reptiles			
Pseudonaja modesta	Ringed Brown Snake	V	NL
Tiliqua occipitalis	Western Blue-tongued Lizard	E	NL

V = Vulnerable E = Endangered CE = Critically Endangered M = Migratory NL = Not Listed

Plant Community Types

According to the NSW State Vegetation Type Mapping (SVTM), nine PCTs including not native vegetation were mapped as potentially occurring within 1,500m of the subject land described in **Table 30** and **Figure 43**.

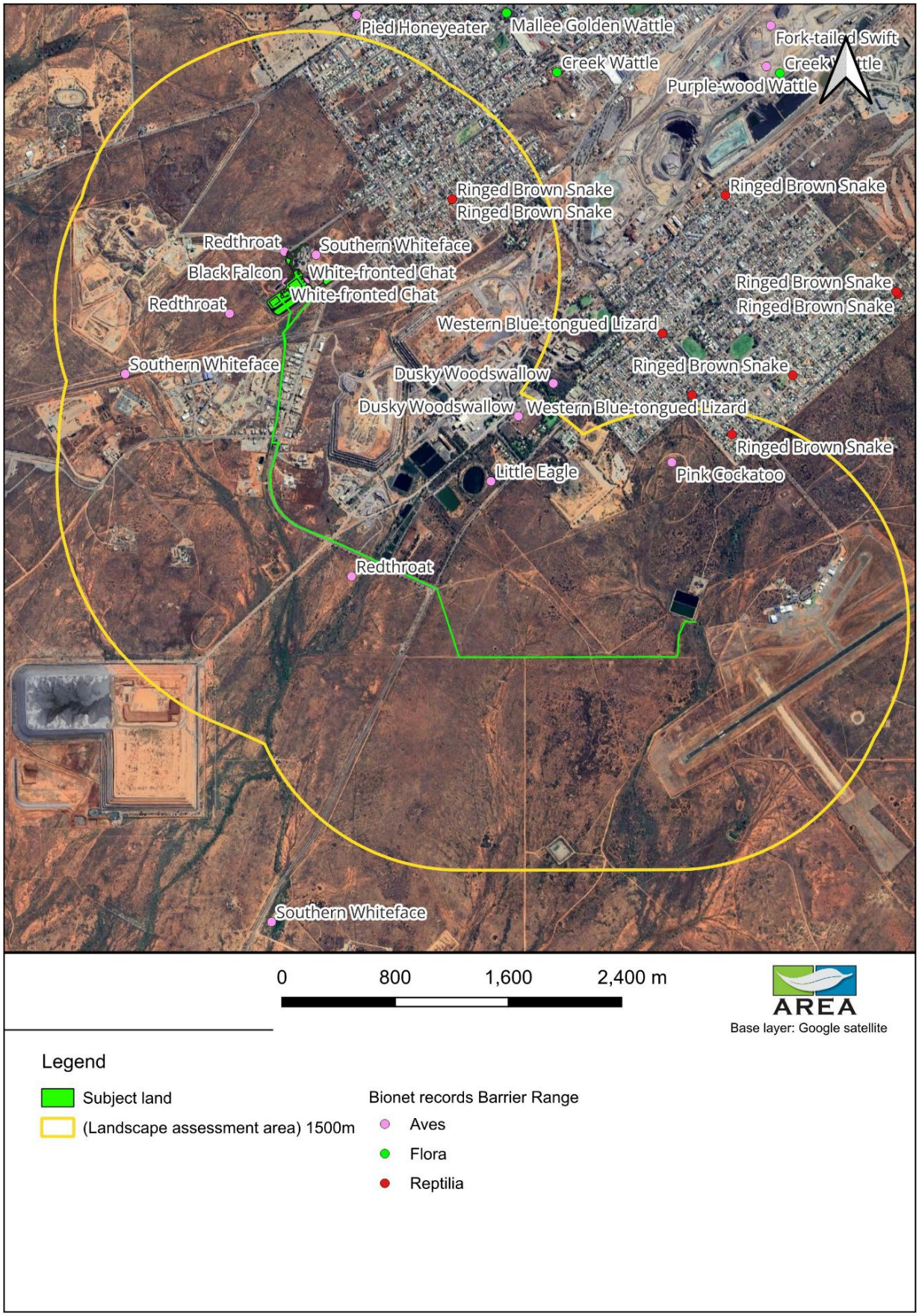


Figure 42: BioNet records within the 1500m of the proposal site

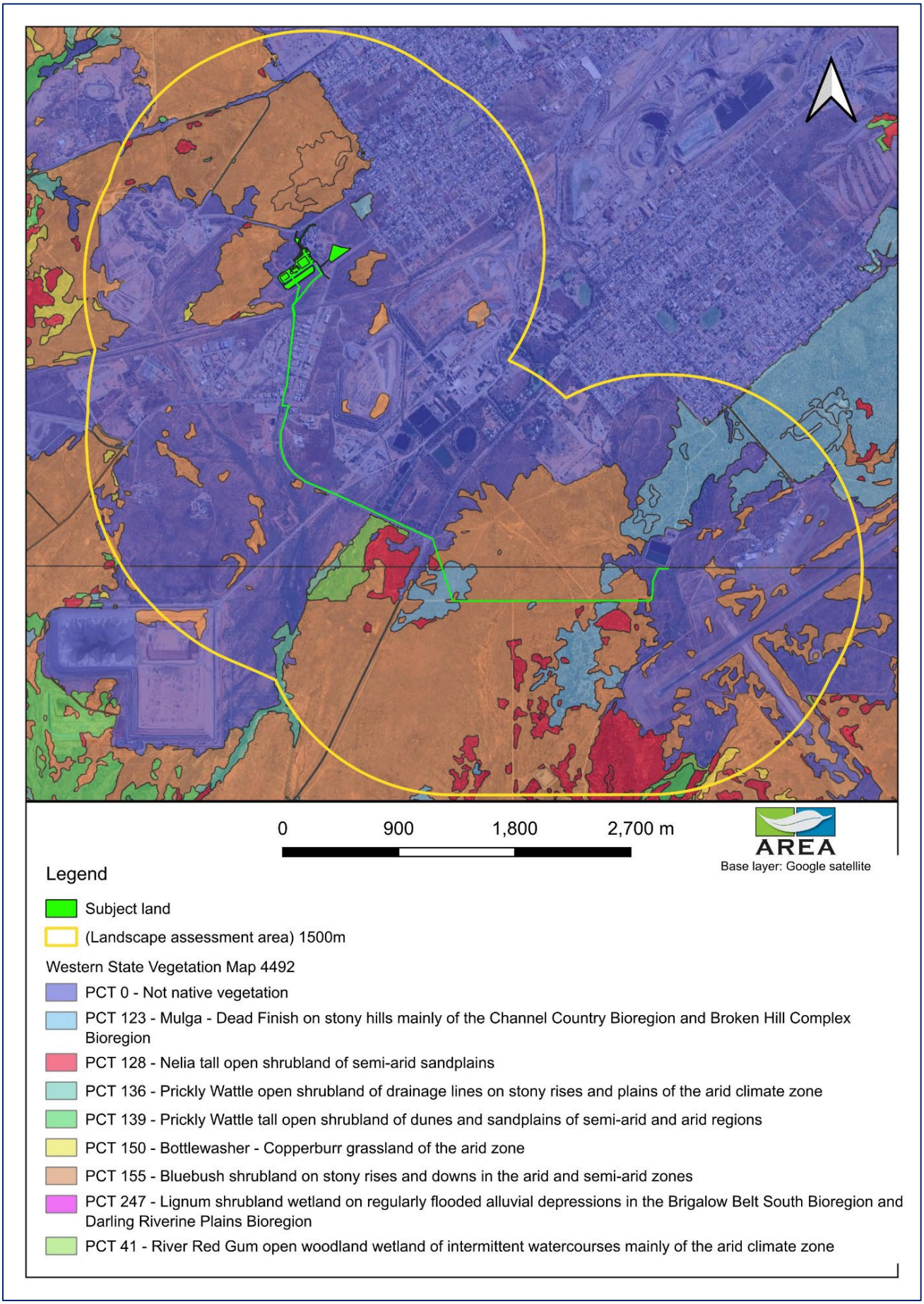


Figure 43: NSW State Vegetation Mapping showing PCTs relative to the proposal site

Table 30: NSW SVTM PCTs mapped in the vicinity of the proposal site

PCT ID	PCT NAME	FORMATION	CLASS
0	Not Native	Not Native	Not Native
41	River Red Gum open woodland wetland of intermittent watercourses mainly of the arid climate zone	Semi-arid Woodlands (Grassy sub-formation)	North-west Floodplain Woodlands
123	Mulga - Dead Finish on stony hills mainly of the Channel Country Bioregion and Broken Hill Complex Bioregion	Arid Shrublands (Acacia sub-formation)	Stony Desert Mulga Shrublands
128	Nelia tall open shrubland of semi-arid sandplains	Arid Shrublands (Acacia sub-formation)	Sand Plain Mulga Shrublands
136	Prickly Wattle open shrubland of drainage lines on stony rises and plains of the arid climate zone	Arid Shrublands (Chenopod sub-formation)	Gibber Chenopod Shrublands
139	Prickly Wattle tall open shrubland of dunes and sandplains of semi-arid and arid regions	Arid Shrublands (Acacia sub-formation)	Sand Plain Mulga Shrublands
150	Bottlewasher - Copperburr grassland of the arid zone	Arid Shrublands (Chenopod sub-formation)	Gibber Chenopod Shrublands
155	Bluebush shrubland on stony rises and downs in the arid and semi-arid zones	Arid Shrublands (Chenopod sub-formation)	Gibber Chenopod Shrublands
247	Lignum shrubland wetland on regularly flooded alluvial depressions in the Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion	Freshwater Wetlands	Inland Floodplain Shrublands

Generally, the vegetation within the proposal site reflects historic ground surface disturbance and is altered from prior clearing activities. Native and not native vegetation exists throughout the proposal site.

Threatened Ecological Communities

IBRA and MNES database searches identified two TECs as potentially occurring in the proposal site (refer **Table 31**).

Table 31: Predicted TECs

TEC	NSW STATUS	CTH STATUS
Porcupine Grass Red Mallee Gum Coolabah hummock grassland/low sparse woodland in the Broken Hill Complex Bioregion	Critically Endangered Ecological Community	Not Listed
Acacia loderi shrublands	Endangered Ecological Community	Not Listed

Two additional TECs associated with PCTs mapped within the broader landscape assessment area (within 1,500m) were highlighted during the desktop assessment (refer **Table 32**).

Table 32: Additional TECs associated with PCTs identified in the broader landscape

TEC	NSW STATUS	CTH STATUS
Acacia melvillei Shrubland in the Riverina and Murray-Darling Depression bioregions	Endangered Ecological Community	Not Listed
Artesian Springs Ecological Community in the Great Artesian Basin	Endangered Ecological Community	Not Listed

Field survey combined with desktop assessment results determined if any TEC are present and likely to be impacted by the proposal.

Biodiversity Values Map

The proposal does not intersect any land mapped as Biodiversity values on the NSW Biodiversity Values Map (refer **Appendix D**).

Key Fish Habitat

The proposal does not intersect areas mapped as Key Fish Habitat.

Groundwater dependant ecosystems

The Bureau of Meteorology (BoM, 2024b) Atlas of Groundwater Dependant Ecosystems map was checked for Groundwater Dependent Ecosystems (GDEs). Results are provided in the ecological impact assessment (**Appendix D**).

The terrestrial groundwater dependence map shows areas of both low and high potential for GDEs occurring within the immediate surrounding area. A small area of high potential terrestrial GDE is also mapped as occurring within the existing Wills Street STP site, near the tertiary pond.

No aquatic groundwater dependent ecosystems are mapped as occurring at the proposal site or immediate surrounding area.

No subterranean groundwater dependent ecosystems are mapped as occurring at the proposal site or the or the immediate surrounding area.

6.5.1.2 Field Assessment

Fieldwork was undertaken on 9 and 10 May 2023 using methods detailed in **Appendix D**.

The survey included a 50m wide corridor along the proposed rising main route. The proposed location of upgrades at the new BHSTP were also assessed. The actual area of potential impact has been reduced through detailed design.

Areas of the proposal comprising highly disturbed land such are existing tracks, where impacts to native vegetation and biodiversity values were determined unlikely, were not assessed in detail.

Vegetation Communities

PCTs mapped according to the NSW SVTM as occurring within the proposal site were corrected based on field observations of mid, upper, ground stratum species and landform. PCTs confirmed as occurring within proposal site are outlined in **Table 33** and**Figure 44**.

Table 33: PCTs recorded within the proposal site

PCT ID	PCT NAME	CLASS	ASSOCIATED TEC
0	Not-Native – areas comprising largely exotic species/areas used for agriculture or unvegetated areas e.g., existing roads, tracks etc.	Non-Native	NA
41	River Red Gum open woodland wetland of intermittent watercourses mainly of the arid climate zone	North-west Floodplain Woodlands	No associated TEC
123	Mulga - Dead Finish on stony hills mainly of the Channel Country Bioregion and Broken Hill Complex Bioregion	Stony Desert Mulga Shrublands	No associated TEC
155	Bluebush shrubland on stony rises and downs in the arid and semi-arid zones	Gibber Chenopod Shrublands	Acacia loderi shrublands, listed as endangered under the BC Act
158	Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)	Riverine Chenopod Shrublands	Artesian Springs Ecological Community in the Great Artesian Basin, listed as critically endangered under the BC Act.

The state vegetation map was used to determine which PCTs were present in the proposal site during the field survey. Characteristics such as bluebush chenopod shrublands with no mulga were used to determine the presence of PCT 155: Bluebush shrubland on stony rises and downs in the arid and semi-arid zones. The presence of PCT 123: Mulga - Dead Finish on stony hills mainly of the Channel Country Bioregion and Broken Hill Complex Bioregion was identified by the presence of Mulga (*Acacia aneura*), Dead finish (*Acacia tetrogonophylla*) and chenopod ground stratum species.

The Northern section of the subject land at the proposed location of new incoming pipework is located within an area of PCT 41 River Red Gum open woodland wetland of intermittent watercourses mainly of the arid climate zone. Multiple River red Gum trees are likely to be impacted and removed within this 10-metre-wide disturbance footprint.

A section of the proposed rising main alignment follows a drainage easement for approximately 720 meters from the southern side of the railway corridor, south of Wills Street STP until intersecting with Kanandah Road. Vegetation within this area is predominantly Cooba (*Acacia salicina*) (some of which will require removal) with scattered River Red Gums (*Eucalyptus camaldulensis*) surrounding both remnant and revegetated since prior clearing. The ground stratum is generally weedy within this area, however, meets the characteristic of PCT 41 where upper and middle stratum species occur. The location of the drainage line in this area is also characteristic of PCT 41.

Multiple Planted (*Eucalyptus camaldulensis*) River Red Gum trees and native ground cover were also identified as occurring and potentially being impacted along Kanandah Road in the southern section of the alignment; therefore, these areas have also been classified as PCT 41.

The far southeastern section of the rising main connecting the alignment to the South Broken Hill STP was identified as PCT 158: Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry)

and arid climate zones (north-western NSW). This PCT was identified as best fit for this section of the subject land due to the Old Man Saltbush (*Atriplex nummularia*) dominating the area and the presence of *Eucalyptus coolabah subs coolabah* scattered in the surrounding area with matching mid and ground stratum species.

The PCT descriptions were assessed in conjunction with site photos collected during the field survey for each PCT (refer **Table 34**). Areas of the subject land which met the characteristics for each PCT were allocated as ground truthed vegetation (refer **Figure 44**).

Table 34: PCTs recorded within the proposal site

PCT	REPRESENTATIVE PHOTO
PCT 41: River Red Gum open woodland wetland of intermittent watercourses mainly of the arid climate zo	
PCT 123 Mulga - Dead Finish on stony hills mainly of the Channel Country Bioregion and Broken Hill Complex Bioregion	

PCT	REPRESENTATIVE PHOTO
PCT 155 Bluebush shrubland on stony rises and downs in the arid and semi-arid zones	
PCT 158 Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)	

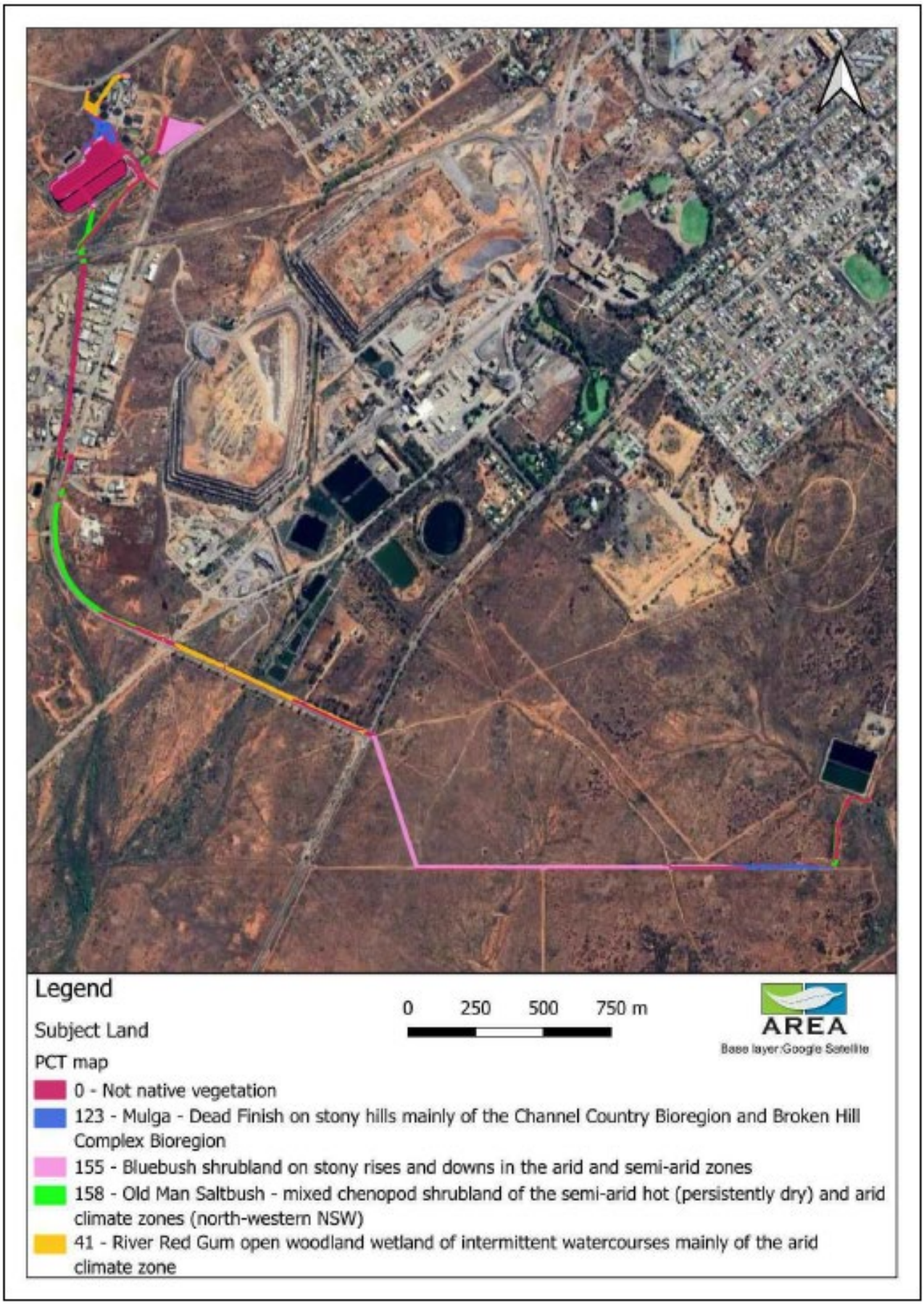


Figure 44: Ground truthed PCTs within the proposal site

Threatened Ecological Communities

Of the four TECs identified on predictive database searches (**Section 6.5.1.1**), one (*Acacia loderi* shrublands) is associated with PCT 155 Bluebush shrubland on stony rises and downs in the arid and semi-arid zones and was identified as potentially present within the proposal site prior to historical clearing.

Porcupine Grass Red Mallee Gum Coolabah hummock grassland/low sparse woodland in the Broken Hill Complex Bioregion is not associated with any PCTs identified within the proposal site. No Mallee species or porcupine grass consistent with this TEC were identified in the proposal site during the field survey.

Acacia melvillei Shrubland in the Riverina and Murray-Darling Depression bioregions is not associated with any PCTs identified within the proposal site, nor was there any evidence of *Acacia melvillei* detected during the field survey.

Artesian Springs Ecological Community in the Great Artesian Basin is not associated with any PCTs identified within the proposal site, as the proposal site does not occur in the Great Artesian Basin. No Spring sediment mounds were recorded in the proposal site during the field survey.

Presence of TECs with potential to occur has been assumed using the precautionary principle and assessed under Test of significance for BC Act and EBPC Act (**Appendix D**).

Habitat

Within the Wills St STP Site major works have previously been carried out over the lifetime of the plant leaving large areas of heavily disturbed ground with small areas of regrowth or contained planted revegetation.

A number of regrowth mulga shrubs were identified as present and would require removal to construct the new STP infrastructure for the new BHSTP site.

No hollow bearing trees were recorded within the assessed area of the proposed new BHSTP site.

The rising main route connection to the South STP is located on the eastern fence line of the STP and is heavily disturbed and dominated with Old Man Saltbush (*Atriplex nummularia*) and sparse scattered Prickly Wattle (*Acacia victoriae*) shrubs. This section of the alignment has been identified as PCT 158 Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW).

Threatened Species

No listed flora or fauna species were recorded during the field assessment. Predicted listed species are assumed to occur in the subject land where suitable habitat exists and where the survey was not sufficient to confirm the species was not present.

No habitat of tree hollows, logs or waterways was recorded in the subject land. Listed species that require these habitat features and unlikely to be present.

Aquatic communities

The proposal intersects three unnamed waterways, two Strahler Second Order drainage lines and one Strahler First Order drainage line. All drainage lines are ephemeral and likely form a part of the Darling River catchment.

Pests, weeds and disease

Two high threat exotic species were recorded in the proposal site

- Galenia (*Galenia pubescens*), at the existing Wills Street STP site only
- Wards Weed (*Carrichtera annua*), at both the existing Wills Street and South STP sites.

6.5.2 ASSESSMENT OF IMPACT

6.5.2.1 Direct Impact

Direct impacts are a direct result of construction activities. Direct impacts predicted to occur by the development are considered in the following sections. Safeguards and mitigation measures to reduce potential impacts are outlined in **Section 6.5.3**.

Habitat, connectivity, and fragmentation

All native vegetation mapped with the proposal site has some role in habitat connectivity. However, vegetation in the surrounding landscape is already highly fragmented from previous disturbances and infrastructure such as existing tracks and the existing sewage treatment plants. The proposal will further contribute to fragmentation of a patch of native vegetation within the proposed rising main route, a 10-metre-wide corridor.

No habitat constraints or evidence of threatened species were recorded during the field survey. Vegetation within and surrounding the subject land is predominantly chenopod shrubland therefore fragmentation from surrounding habitat will unlikely be exacerbated.

The proposal site occurs inside, and adjacent to, previously disturbed and fragmented landscape. Given the location of the patch within the broader landscape, it is unlikely to act as an important corridor for the movement of fauna.

Some obstacles to wildlife movement may exist during the construction phase of the proposal as created by machinery and construction activities. These will be temporary and where an individual's movement may be disrupted this will not exclude the animal from habitat or its ability to move through the subject land during or post construction.

Connectivity will not be significantly reduced by the proposal.

Native Vegetation

Small areas of native vegetation will be impacted by the construction of the proposal. Impacts to native vegetation could result in the following outcomes:

- Cause death or harm to fauna present in habitat during clearing
- Remove ground layer foraging, nesting and feeding habitat for native species.

Up to 5.17 hectares (ha) of native vegetation, in four PCTs would be impacted, as shown in **Table 35**.

Table 35: PCTs recorded within the proposal site

PCT ID	PCT NAME	IMPACT (ha)[1]
0	Non-native vegetation	4.98
41	River Red Gum open woodland wetland of intermittent watercourses mainly of the arid climate zone	0.90
123	Mulga - Dead Finish on stony hills mainly of the Channel Country Bioregion and Broken Hill Complex Bioregion	0.58
155	Bluebush shrubland on stony rises and downs in the arid and semi-arid zones[2]	2.61
158	Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)	1.08
	Total	**10.15**
	Total impact to native vegetation	**5.17**

1. The impact areas were calculated based on disturbance areas at each STP, and assuming a direct 10-metre-wide disturbance corridor along the length of the rising main route. Replacement of the existing treated effluent discharge pipe would largely be within this 10-metre corridor.
2. PCT associated with the *Acacia loderi Shrublands TEC.*

Threatened Ecological Communities

Assessments of significance under the BC Act and EPBC Act, for *Acacia loderi Shrublands* TEC determined this proposal is unlikely to result in a significant impact to this TEC (**Appendix D**).

Mitigation measures outlined in **Section 6.5.3** further aim to minimise any impacts to TEC.

Threatened species

The likelihood of impact to threatened species identified by database searches (IBRA, MNES and BioNet) and field survey was considered in the predicted threatened species assessment (Appendix C of the Ecological Impact Assessment, attached to this REF as **Appendix D**). This assessment indicated a total of 30 threatened fauna and six threatened flora species have the potential to be impacted by the proposal.

Tests / Assessments of significance undertaken in accordance with the BC Act and EPBC Act (Appendix C of the Ecological Impact Assessment, attached to this REF as **Appendix D**) show a significant impact to threatened species from the proposal is considered unlikely.

Migratory species

A significant impact to migratory bird species under the EPBC Act is considered unlikely.

Eight EPBC listed migratory birds' species were identified as potentially occurring in the proposal site (**Appendix D**) and have been considered against the significance criteria in **Table 36**.

Table 36: Assessment of Significance, Migratory Birds

AN ACTION IS LIKELY TO HAVE A SIGNIFICANT IMPACT ON A MIGRATORY SPECIES IF THERE IS A REAL CHANCE OR POSSIBILITY THAT IT WILL:	
CRITERIA	**RESPONSE**
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species	There is little evidence to suggest that the proposal site supports 'important habitat' for migratory species given the absence of permanent water and high disturbance levels within the landscape. The lack of proximity of wetlands of international importance reduces the likelihood that habitat in the proposal site is 'important habitat'. The proposal is therefore unlikely to substantially modify, alter, destroy or isolate important habitat for migratory species.
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or	The local area has a history of habitat modification for infrastructure. The proposal is unlikely to further contribute to establishment of invasive species beyond that which may already exist.
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	The proposal site is not an area of 'important habitat' for migratory birds, whether they are wetland or terrestrial species. It is unlikely that an ecological significant proportion of migratory birds would rely on habitat in the proposal site.

Impact to groundwater dependent communities

A small area of high potential terrestrial GDE occurs within the existing Wills Street STP site, near the tertiary pond. However, given the level of disturbance already present at the existing Wills Street STP site

and considering that the majority of the proposal will be constructed above ground, the proposal is not expected to place any component of groundwater-dependent communities at risk of local extinction.

No aquatic GDEs are mapped as occurring in the proposal site.

No subterranean GDEs are mapped as occurring in the proposal site.

Impact to hollow bearing trees

No hollow bearing trees were recorded in the proposal site.

Soils and drainage

Soils will be disturbed during construction and maintenance. Disturbed soils have the potential to move off the proposal site and impact watercourses if not appropriately managed. Unnamed ephemeral drainage lines intersected along the proposal, have potential to be impacted by soil disturbance and runoff (**Section 6.3**). Soil disturbance will be managed using standard processes to avoid long term impacts (**Sections 6.2.3** and **6.3.3**).

Weeds

Inappropriate weed management can lead to the dissemination of weeds across the environment. Processes such as clearing vegetation, removing and transporting topsoil, importing and exporting soil and mulch, as well as the movement of vehicles, are all activities that could contribute to the spread of weeds.

Novel biota and their impact on biodiversity is listed as a KTP under the EPBC Act. 'Novel biota' refers to organisms that are new to an ecosystem whether by natural or human introduction (Australian Government, DCCEEW 2021).

Direct impact from novel biota is unlikely if environmental safeguards and mitigation measures in **Section 6.5.3** are implemented.

6.5.2.2 Indirect Impacts

Indirect impacts are those which are not a direct result of the proposal, often produced away from, or as a result of, a complex impact pathway. Indirect impacts are considered in the following sections and mitigation measures outlined in **Section 6.5.3**.

Injury to wildlife

Injury to wildlife is unlikely, but possible, during the construction phase of this proposal. Contact with wildlife and suitable habitat will be avoided wherever possible. Local wildlife rescue organisation should be contacted in the event wildlife requires rescue or removal.

Changes to hydrology and groundwater dependent ecosystems

Given the small section of high potential for groundwater interaction occurs at the site of the existing Wills Street STP, changes to hydrology for GDEs within the proposal site is unlikely. Surface hydrology may be impacted by this proposal due to the construction of a rising main, upgrades to access road and any new hard stand areas changing the course of water runoff. Given the arid nature of the area, it is unlikely that changes to hydrology and groundwater would result in a significant impact on threatened species, populations and communities.

Noise, light and vibration

Construction noise, light and vibration may disturb fauna or prevent them using habitat in the subject land. This impact would be moderate term. The operation of the new BHSTP will not have any noise, light and vibration impacts greater than what already exists at the existing Wills Street STP. The rising main pipeline which will be used to transport sewage catchment from the South STP to the New BHSTP will not produce and significant noise, or light emissions and not result in any vibration impacts.

Spread of pests, weeds and disease

Removal of native vegetation, soil disturbance, and the movement of people, vehicles, and machinery has the potential to result in the introduction or spread of weeds through the proposal site. Essential Energy has a general biosecurity duty under the *Biosecurity Act 2015* to prevent, eliminate or minimise biosecurity risk so far as is reasonably practicable. The mitigation measures presented in **Section 6.5.4** will minimise the risk of weed colonisation at the proposal site.

Impact on Key Threatening Processes

Key Threatening Processes (KTPs) listed under the BC Act, EPBC Act and FM Act were reviewed by AREA (**Appendix D**). Five will be negligibly exacerbated by the proposal:

- BC Act: Anthropogenic Climate Change
- BC Act: Clearing of native vegetation
- BC Act: Invasion of native plant communities by exotic perennial grasses
- EPBC Act: Land clearance
- EPBC Act: Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases.

The KTPs can be minimised and managed by the mitigation measures in **Section 6.5.3**.

Cumulative Impact

Impacts from the proposal are considered unlikely to result in a permanent cumulative impact to native species, populations and communities given the activity will largely occur in an historically cleared and degraded landscape and a range of measures will be taken to avoid, minimise and mitigate potential impacts as set out in **Section 6.5.3.**

6.5.3 ENVIRONMENTAL MITIGATION MEASURES

The following impact avoidance and minimisation measures have been implemented in the design phase of this proposal:

- The proposal is largely located within previously cleared derived chenopod shrublands or previously cleared and disturbed land associated with the existing STP sites, drainage lines, road reserves and unsealed dirt tracks
- The proposal will avoid removal of native vegetation where practical.

The following mitigation measures will be applied to further lower the potential impact of the proposal:

- Any change in design affecting land outside the areas assessed in this report will need to be considered against the current ecological survey effort, to determine if additional survey is required or an assessment can be made on current information.
- The extent of the clearing footprint is to be confined to the assessed areas as described in this REF
- Ensure groundcover disturbance is kept to a minimum and within the assessed areas
- Where possible, vegetation to be removed would be mulched on-site and re-used to stabilise disturbed areas
- Erosion and Sediment Control measures would be installed and maintained in accordance with Landcom's *Managing Urban Stormwater, Soils & Construction Guidelines* (The Blue Book) (Landcom 2004)
- Soil excavated within the proposal site will be used to back fill the excavation areas, enabling mid and lower stratum species quickly re-establish.
- Stockpile and compound sites would be located using the following criteria:
  - At least 40 m away from the nearest waterway

- In areas of low ecological conservation significance (i.e. previously disturbed land)
- On relatively level ground
- Stockpiling materials and equipment and parking vehicles would be avoided within the dripline (extent of foliage cover) of any tree.

- Essential Energy has a general biosecurity duty under the *Biosecurity Act 2015* to prevent, eliminate or minimise biosecurity risk so far as is reasonably practicable. Field crews shall follow procedures as outlined in Essential Energy's *Operational Guideline: Biosecurity Risk Management (CERM1000.96)* to prevent, eliminate or minimise biosecurity risk so far as is reasonably practicable, with particular reference to vehicle and equipment hygiene practises
- Any fallen timber, dead wood and bush rock (if present) encountered on site would be left in situ, or relocated to a suitable place nearby
- Do not refuel, store or decant chemicals within 50m of a waterway
- Immediately prior to commencement of any vegetation removal involving machinery and/or tree-felling the area of clearing work is to be inspected for fauna
- If fauna is detected, the animal is to be allowed to leave the site without any coercion, or a local wildlife rescue service is to be contacted to facilitate the safe removal of the animal from the worksite.

6.5.4 CONCLUSION

While there may be some disturbance to native vegetation and TECs, and indirect impacts on threatened fauna species, these impacts will be narrow in scope, some temporary (i.e., rising main), and generally confined to already highly disturbed patches of remnant vegetation. The proposal is unlikely to have a significant impact on any TECs, populations, or species that may use the vegetation proposed to be removed or disturbed areas associated with the proposal. The environmental risk is considered to be low.

6.6 Aboriginal Heritage

AREA Environmental and Heritage Consultants (AREA) (2025b) was engaged to undertake an Aboriginal heritage due diligence assessment of the proposal. The key findings of this assessment are presented below, with the full Aboriginal Heritage Due Diligence Assessment attached to this REF as **Appendix E**.

The figures presenting the study area (i.e., the proposal site) in this section do not include the pump station and associated pipework at the South STP site, as the exact location of the infrastructure was yet to be determined at the time of the site survey. However, the construction footprint, being located within the northeastern corner, and along the eastern boundary of the STP operational area was surveyed. These areas were noted to be in a heavily modified and disturbed condition as a result of the previous construction, operation and maintenance of the South STP and associated sheds, pipework and access tracks, and thus met the definition of disturbed land in accordance with *the Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales* (DECCW, 2010).

6.6.1 EXISTING ENVIRONMENT

6.6.1.1 Landscape Features

A review of the landscape of the proposal site and surrounds allows for comparison with other archaeologically investigated areas. It also assists in assessing existing and previous disturbances which may have affected the integrity of archaeological remains. Environmental features such as landforms, topography, water sources, geology, soils, and vegetation are also relevant for an archaeological assessment.

Landforms and topography

The Broken Hill Complex Bioregion is geologically unique, with the western half composed of ancient basement rocks of the Adelaide Fold Belt, and the eastern half is the edge of the much younger rocks of the Tasman Fold Belt. Many of the rocks and minerals found in the region are of considerable interest and economic importance, and geology exerts strong controls on the landscape (Dunn and Shaukar, 2003).

Characteristic landforms within the Barrier Range subregion include steep, low rocky ranges oriented to bedrock structure, with prominent fault scarps. The proposal site is relatively flat at 280m AHD, with a small crest along the rising main route, with elevations of 300m AHD.

Waterways

The proposal site is located in the Upper Darling catchment area, with the Darling River being the closest major river, about 100km southeast of Broken Hill. The nearest non-perennial waterways are Acacia Creek, approximately 2.5km south. Acacia Creek feeds into Kelly's Creek approximately 4.5km southwest, Sterling Vale Creek approximately 10km southwest and Pine Creek approximately 12km southwest of the proposal site respectively.

Geology and soils

The Barrier Ranges are a prominent landscape feature within the subregion and located 50km north of the proposal site. They are a triangular block of metamorphic and deformed sedimentary rocks forming a series of northeast and northwest trending ridges rising up to 300m above the surrounding plains (Dunn and Shaukar, 2003). The geology within the Barrier Range subregion is comprised of ancient gneiss, schists, amphibolite, granites and pegmatites with north-east structural trends. These are overlain by Cambrian sediments with northwest trends (Dunn and Shaukar, 2003).

Soils in the proposal site are typically rocky outcrops with shallow stony soil on the crests. Soils become deeper and finer downslope. Texture contrast profiles are common, and quality differs according to rock type (Dunn and Shaukar, 2003).

Vegetation

The bioregion is comprised of limited mulga, dead finish and bluebush on the ridges. Denser shrubs including belah, whitewood, turpentine, prickly wattle, punty bush with bluebush, grasses and forbs on the lower slopes. River red gum line larger creeks, shrubs and grasses increase on the outwash fans. Curly mallee on limestone outcrops.

Climate

The Broken Hill Complex Bioregion generally has a hot, dry climate and lies within the NSW arid zone and is dominated by a hot, persistently dry desert climate (Stern & et al, 2000) Patches of semi-arid climate in the centre of the bioregion complement the arid climate prevalent in most of the bioregion. Broken Hill experiences hot dry summers, cool winters and wet autumns (BoM, 2024a). Broken Hill has a mean rainfall of 249 millimeters (mm) annually.

Historical context and land use history

The region now known as Broken Hill was first visited by non-Aboriginal people in the form of explorers. Charles Sturt was recorded as the first European to explore the Broken Hill region. He first traversed the northern region of the Darling River in 1829, then ventured slightly west of the junction of the Bogan and Darling Rivers, some 500km east of Broken Hill. In 1835, Major Thomas Mitchell's expedition followed Sturt's route from Sydney but continued along the Darling River around Menindee Lakes, almost following the confluence of the Murray River. Sturt's 1844 expedition into Australia's interior followed the Murray River to its junction with the Darling River, then northwards to Stephens Creek and further north into the Barrier Ranges (Kearns, 1976). Once Sturt returned to Adelaide in 1846, the news of the lands along the Darling River inspired squatters to quickly take up various runs along the River within the same year (Kearns, 1976).

Broken Hill got its name from the rocky outcrop visible above the plains and was founded by boundary rider Charles Rasp in 1883. Charles Rasp along with David James and James Poole pegged the first mining lease, and were later joined by George McCulloch, Phillip Charley, George Urquart and George Lind. These men founded the Syndicate of Seven in 1885, the company would then develop into Australia's largest industrial organisation, the Broken Hill Proprietary (BHP) company limited (Kearns 1951). The first post office was opened in 1886, hospital in 1887 and theatre, church and police lockup in 1888. In 1888 the Municipality of Broken Hill was incorporated with a population of 11,000 and a railway connected to the South Australian railway head at Cockburn. BHP ceased mining in Broken Hill in 1939 and since then 14 different companies have mined the area.

6.6.1.2 Archaeological Context

Regional ethnohistoric context

The archaeological record can provide evidence Aboriginal people have been present in Australia for approximately 60,000 years and provides evidence of a dynamic culture coupled with a long occupation of the land. The proposal area is within the traditional lands of the Barkindji (Paakantyi, or Barkandji) peoples. The name is derived from the word for the Darling River paaka and means river people. The lands of the Barkindji extend along the Darling River from near Bourke down to Wentworth, and the lower end of the Paroo and Warrego rivers.

The Wilyakali and Barkindji peoples are encompassed in NC2015/001 - Barkandji Traditional Owners #8 Determined Native Tite Claim. The Wilyakali are distinct but closely related Aboriginal groups whose traditional lands are located in western NSW, particularly around the Broken Hill, Menindee, and Darling River regions. Their relationship is based on shared boundaries, cultural exchange, kinship, and trade, rather than a unified identity. Wilyakali is considered a language group of the Western Desert language family, possibly a dialect of Wilyakali/Wilyagali. Barkindji (or Paakantji) is a distinct language, part of the Darling Riverine language groups.

The Barkindji today were derived from several dialects, all speaking variations of the same language. Historically these dialects were distinctive groups, but with colonisation, these groups are more singularly recognised as Barkindji today. The Barkindji spoke with the language (Paakantyi palku) and had intermarriage connections linking smaller dialect groups together as far as far western NSW (Hercus, 1982 and Hercus, 1993).

According to Sarah Martin, author of the *Cobar Rock Art Management Study* (1991), the Study Area is within the Parindji (Barindji) dialect (Martin, 1991). The Parindji occupied the scrub country east of the Darling River. They adapted to the dry sandplains, dune fields and hills of the edge of the Darling Basin and were thought to have differed from the Barkindji for their lack of swimming skills (Martin, 1988).

Local archaeological context

Database searches

Searches of the local and state heritage databases provides an archaeological context and identification of any previously recorded Aboriginal sites located within or near the proposal site. The results of these searches are summarised in **Table 37** and presented in **Appendix E**.

Table 37: Summary of database searches for Aboriginal Heritage

DATABASE	DATE OF SEARCH	PARAMETERS	RESULTS
Aboriginal Heritage Information Management System (AHIMS) Client ID: 778311	27/03/2025	GDA Zone 54 537723 – 545388 mE 6457231 – 6463737 mN	66 Aboriginal sites were recorded within the search area (within approximately 3km of the proposal site). No sites are recorded within the proposal site, however, there are 15 sites located within 600m.
Broken Hill LEP	27/03/2025	Schedule 5: Environmental Heritage	No items relating to Aboriginal heritage are recorded on the local heritage register within the proposal site. One Aboriginal place, the Pinnacles is located 10 km south west of the proposal site.
Native Title Vision https://nntt.maps.arcgis.com/	27/03/2025	NSW	The proposal site is within the NC2015/001 - Barkandji Traditional Owners #8 (Part A) determination

State Heritage Register http://www.environment.nsw.gov.au/heritageapp/heritagesearch.aspx	27/03/2025	Broken Hill LGA	No items relating to Aboriginal heritage are recorded on the State heritage register within the proposal site

An extensive search of the NSW AHIMS database was initially conducted on 3 May 2023 and updated on 27 March 2025 (Client ID 778311). The searches showed there were 66 sites within approximately 3km of the proposal site. The distribution of recorded Aboriginal sites is shown in **Figure 45**. No sites were located within the proposal site, however, there are 15 sites located within 600m (refer **Figure 46**). The majority of the sites recorded were stone artefacts or had stone artefacts with other site features (n=64), followed by stone quarries (n=8), and hearth (n=4), with one stone arrangement and one Aboriginal resource place.

6.6.1.3 Previous Investigations

Previous archaeological reports have been conducted in the Broken Hill region. Most of these reports were completed either as a result of compliance projects or due diligence assessments associated with infrastructure development applications. Below is a summary of some of these archaeological reports.

Blantyre Seismic Survey for BHP Petroleum (Thompson, 1986)

Thompson (1986) conducted a survey of the seismic line within the Teryawynia area as a due diligence assessment for petroleum exploration activities in PEL 246. Teryawynia is located about 170km east of the proposal site. During this survey, 56 Aboriginal sites along the seismic line traversed were identified and recorded.

Mineral Separation Plant, Broken Hill, NSW: Aboriginal and Non Aboriginal Heritage Assessment (Heritage Search, 2001)

Heritage Search conducted a heritage assessment for BeMax Resources NL on a one square kilometre area where a new Mineral Separation Plant (MSP) was planned on land within the general vicinity of the proposal site. The survey recorded seven quartz quarries, eight open campsites, and one additional quartz quarry in the railway reserves, three meters north of the northern boundary of the MSP Study Area. The Aboriginal sites had limited archaeological value because they contained very few artefacts, and many had been displaced by erosion. The report suggested that these sites have low scientific importance and recommended that BeMax Resources NL obtain an AHIP to salvage any Aboriginal sites that would be affected by the MSP construction.

Silverton Wind Farm, NSW: Stages 2 and 3 and Powerline Route (Broken Hill to Red Cliffs) Aboriginal Heritage and Non Indigenous Heritage (New South Wales Archaeology Pty Ltd, 2007)

New South Wales Archaeology Pty Ltd was commissioned to compile an archaeological and heritage review of the proposed overhead transmission line between Broken Hill and Red Cliffs.

Silverton Wind Farm Developments proposed to build a wind farm near Silverton, northwest of Broken Hill, over 682 square kilometres (km^2) of land. Silverton is located approximately 25km northwest of the proposal site.

The Study Area was divided into four sections for the AHIMS search: Pine Creek (45 sites), Ana Branch (85 sites), Darling River (61 sites), and Buronga Gol Gol (72 sites).

Broken Hill Solar Plant Environmental Assessment Vol.7 Appendix F to Appendix H (Ozark Environmental and Heritage Management Pty Ltd, 2012)

Sinclair Knight Mertz, on behalf of AGL Energy and with help from OzArk Environmental and Heritage Pty Ltd, commissioned an archaeological survey of a 200-hectare site located between the Barrier Highway and the Broken Hill railway line. The Broken Hill Solar Plant is located about four kilometres west of the proposal site.

The survey identified 14 Aboriginal sites. Further consultation with Aboriginal community stakeholders through an Aboriginal Heritage Management Plan (AHMP) was needed to manage these sites.

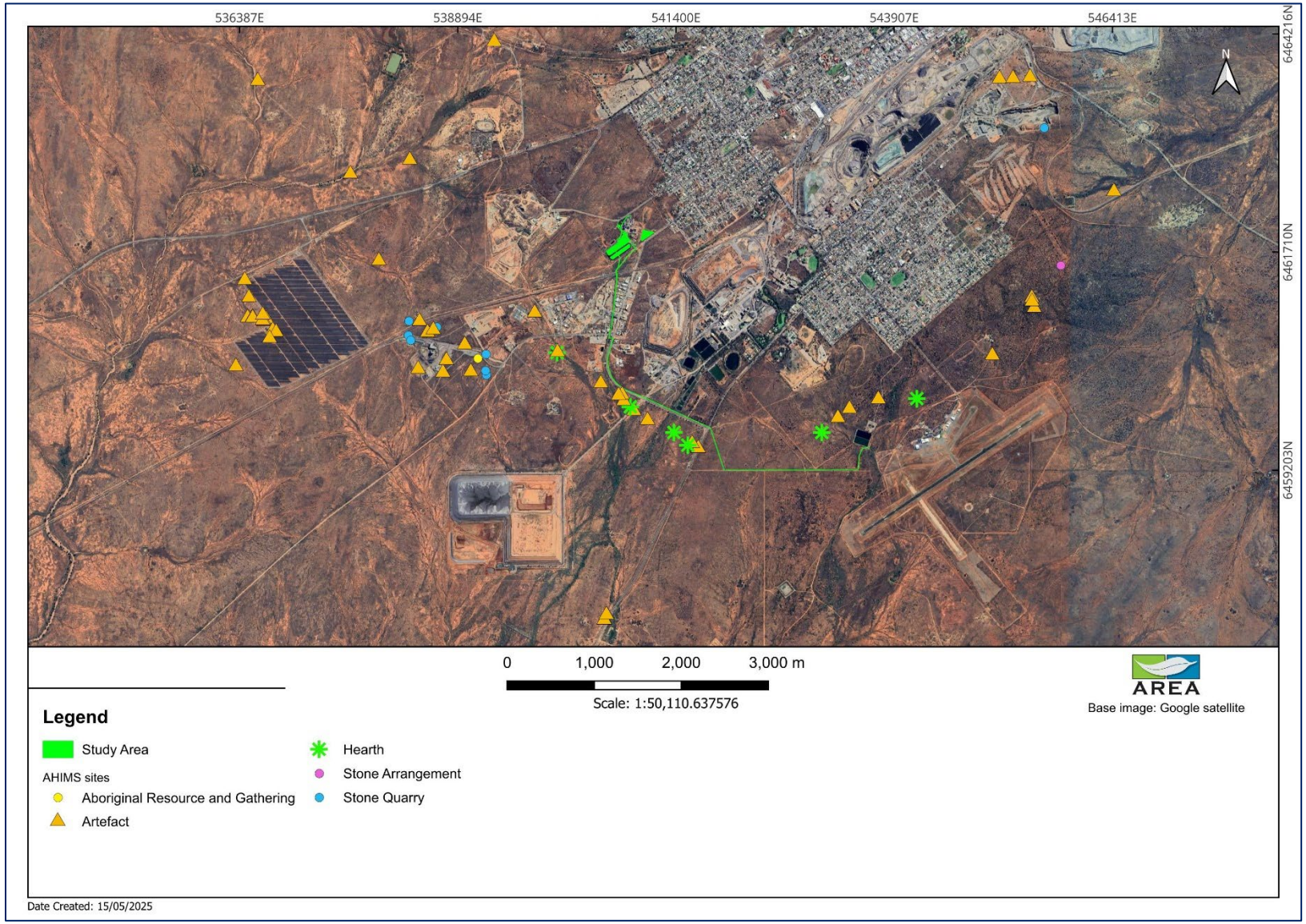


Figure 45: Results of extensive AHIMS search

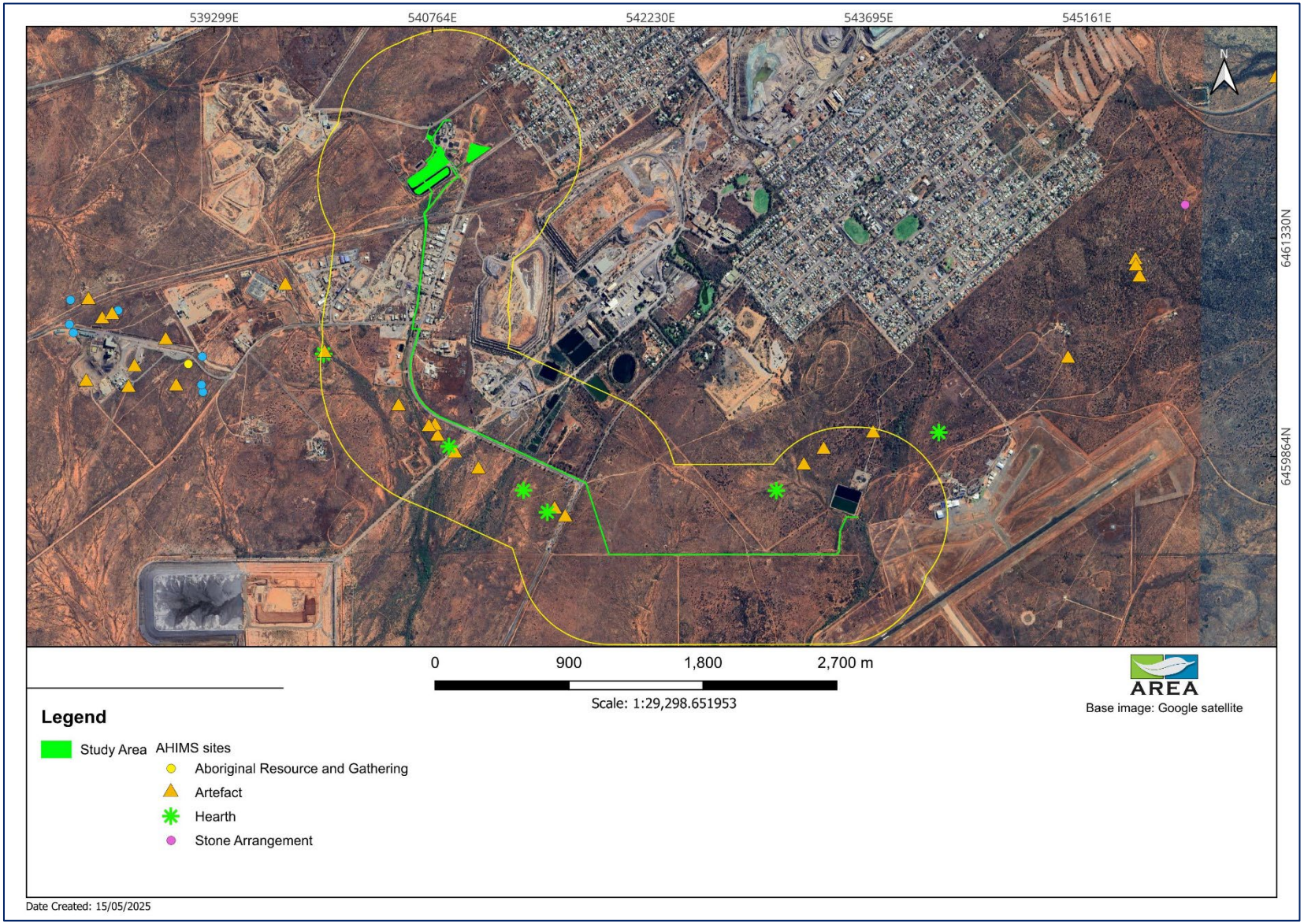


Figure 46: Aboriginal sites within 600m of the proposal site

A Review of Environmental Factors (REF) prepared for Essential Water for White Leeds Pipeline, Broken Hill, NSW (Envirokey Pty Ltd., 2013)

Envirokey engaged Onsite Cultural Heritage Management (OSCHM) Pty Ltd. to undertake an Aboriginal heritage investigation for the proposed works.

The field survey revealed that a historic glass bottle fragment (from circa 1920s – 1930s) was located approximately 50m east of an ephemeral creek and 25m northeast of the proposed pipeline at its closest point and suggests historical activities associated with early mining.

A search of the AHIMS database identified a total of 27 Aboriginal sites within a 10km by 10km of the search area. None of these sites were located within the pipeline corridor. During the field survey, OSCHM (2013) identified an artefact scatter of 20 artefacts in a disturbed context due to traffic and extensive water erosion.

Aboriginal Cultural Heritage Assessment Report prepared for AGL Energy Limited under Broken Hill Battery Energy Storage System Project, Broken Hill, NSW (AECOM Australia Pty Ltd, 2021)

AECOM Australia Pty Ltd (AECOM) was commissioned by AGL Energy Limited (AGL) to undertake an Aboriginal cultural heritage assessment for the construction of a battery storage facility at Broken Hill. The proposed facility is located 700 meters west of the proposal site at its closest point.

The field survey was undertaken in conjunction with Broken Hill Local Aboriginal Land Council (Broken Hill LALC), the Wilyakali Aboriginal Corporation and Barkandji #8 Native Title Determinants.

No Aboriginal sites or areas of Potential Archaeological Deposit were identified during the survey. Overall, the survey identified a predominately disturbed landscape where topsoils had been graded and levelled. RAPs present during the survey also noted that land within the Study Area had been subjected to significant ground disturbances. As such, the potential for intact Aboriginal subsurface sites was assessed as low.

Broken Hill Battery Energy Storage System Project Modification Aboriginal Cultural Heritage Assessment Report (AECOM, 2022)

During a site survey in November 2021, one artefact scatter comprising of at least 20 artefacts was identified. The artefact scatter was assessed as having low scientific significance due to its disturbed context. The site was later salvaged before the proposed works could be constructed.

Two Proposed Trenches for New Underground 22Kv Electricity Communication and Earth Bond Cables Aboriginal Heritage Due Diligence Assessment Report (AREA Environmental and Heritage Consultants, 2024)

AREA was commissioned by Essential Energy to carry out an Aboriginal Heritage Due Diligence Assessment for a project to install new underground 22kV electricity, communication, and earth bond cables. These would link the Pinnacles Place Zone Substation to the TransGrid Broken Hill Substation. No Aboriginal objects or sites with archaeological potential were found as a result of this assessment.

Aboriginal Cultural Heritage Test Excavation Report, Pinnacles Place (OzArk Environment and Heritage, 2025)

OzArk was commission by Essential Energy to carry out an archaeological test excavation program for the above-mentioned underground cable project. The archaeological test excavation program was agreed to as part of easement negotiations with Broken Hill LALC to enable construction of the cables across a section of Crown Land subject to an Aboriginal Land Claim. The archaeological test excavation found no surface or subsurface Aboriginal objects or subsurface archaeological deposits in the excavated areas within the study area. Test excavation

results indicate that Aboriginal objects in the study area were unlikely. No further archaeological investigation or site monitoring was recommended.

Previous studies discussion

56 Aboriginal sites were located in Teryawynia, which comprises of a mainly flat and dry landform. The Mineral Separation Plant project identified quartz quarries, and open campsites, suggesting an association of sites and resource rich areas. These sites were also affected by erosion, indicating they were found in areas prone to surface water movement or wind erosion. Stone artefacts were located near to an ephemeral creek during a due diligence survey for the White Leeds Pipeline area. Artefact scatters were also identified during the surveys for the Battery Energy Storage System and transmission line corridor. This indicates that even in altered or developed landscapes can still contain remnants of Aboriginal heritage. These previous assessments suggests that Aboriginal sites are often associated with resource availability (e.g. quartz deposits), proximity to water sources (creeks or rivers). Erosion and human activities have significantly impacted the preservation of the sites.

6.6.1.4 Predictive Model

A predictive model combines the archaeological context of the proposal site, with landscape data to suggest probable Aboriginal site types, their distributions, and their levels of preservation that might occur in the region.

Areas of archaeological potential are regarded as any high-risk landforms that have remained reasonably intact and undisturbed. The definition of disturbance follows Part 5, Division 2, Section 58 of the *National Parks and Wildlife Regulation 2019* (NPWR, 2019). Sensitive landforms follow the definitions supplied in the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW* (DECCW, 2010b):

- Within 200m of waters
- Located within a sand dune system
- Located on a ridge top, ridge line or headland
- Located within 200m below or above a cliff face
- Within 20m of or in a cave, rock shelter, or a cave mouth.

The nearest named waterway (Acacia Creek) is located 2.5km south of the proposal site. Three unnamed ephemeral waterway intersects the proposal site.

The proposal site located within a highly disturbed road corridors and access tracks, drainage easements and within the operational footprints of the existing Wills Street and South STP sites, therefore there is a low likelihood of intact Aboriginal sites occurring in the proposal site.

6.6.1.5 Archaeological Survey

The due diligence survey was conducted in accordance with the *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (DECCW, 2010c). A pedestrian survey was led by Kim Newman (Heritage Consultant) of AREA over two days: 9 and 10 May 2023, together with Chris Quayle representing Barkandji Traditional Owners.

Methodology

The aim of the survey was to ground truth any previously recorded sites, identify any new Aboriginal sites, and assess the proposal site for the potential of subsurface deposits. The ground surfaces were examined for any Aboriginal objects (stone artefacts, imported shell, or other traces of Aboriginal occupation) and all mature trees were examined for signs of cultural scarring or marking.

A handheld GPS was used to ensure the entirety of the proposal site was surveyed. Pedestrian tracks were recorded, the location of any new sites was photographed and detailed, written records of landscape features relevant to archaeological potential were taken. Features recorded include disturbance levels, Ground Surface Visibility (GSV) and landforms of high archaeological potential.

Survey Results

The South STP site is heavily disturbed and modified due to the construction and operation of the existing STP infrastructure. The landscape to the northwest and west of the South STP site shows less signs of disturbance. The proposed new pump station would be installed within the disturbed footprint of the existing South STP site.

The southeastern section of the rising main development footprint comprised of a flat landform covered in red sandy soils, granite fragments and was thickly covered with saltbush. GSV was very low in areas that were densely covered in saltbush, with other exposed areas at 50%. The section towards South STP, was noted as heavily disturbed. Disturbances noted were rabbit warrens, spoil heaps, earth mounds, access tracks, and gravelled surfaces (refer **Figure 47** and **Figure 48**).

The section of the proposed rising main route east of the Silver City Highway was covered with regenerated chenopod shrubland, consisting primarily of Bluebush (*Maireana sp.*), and naturally fractured ironstone. This section was highly disturbed due to the grading in relation to the fence line and an access track extending to Silver City Highway and Wentworth Road. GSV on the track was 80% and 20% off the track (refer **Figure 49** and **Figure 50**).

The eastern end of Kanandah Road (west of the Silver City Highway) was covered with dense saltbush vegetation GSV was between 0% and 5%. The ground in this area had been impacted by activities relating to the construction of power line easements, underground electric cabling, and Telstra cable installations along the road (refer **Figure 51**). Additionally, the installation of a larger drainage pipeline at the road culverts had caused further surface disturbance within the road corridor and rising main development footprint.

The drainage easement in which the route of the proposed rising main extends in a northerly direction from approximately the Pinnacles Road to the railway corridor is a highly modified and disturbed ephemeral drainage line. It serves both as a modified stormwater drain and utility corridor, containing the existing treated effluent discharge pipe from the existing Wills Street STP and other underground utilities.

After crossing the railway line, the rising main development footprint follows an existing pipeline easement for a former rising main with a nearby heavily disturbed graded track, before entering the Wills Street STP site. The proposed rising main and discharge pipeline footprint was assessed as unlikely to contain any intact Aboriginal sites.

The BHSTP construction footprint area was in a highly disturbed landform due to the existing Wills Street STP. The central section of the facilities was disturbed due to construction of various ponds, earth mounds, and fill near the existing water treatment plant (refer **Figure 52**). The new BHSTP infrastructure will be constructed at the site of the existing large tertiary treatment pond, a heavily disturbed and modified portion of the existing Wills Street STP site.

Figure 47: Southeastern section of the rising main development footprint covered with salt bush and low GSV

Figure 48: View of South STP highly disturb due to animal activities (rabbit burrows)

Figure 49: View of proposed rising main route disturbance due to graded fence line

Figure 50: View of proposed rising main route along eroded tracks

Figure 51: View of proposed rising main route disturbance due to power line easements and underground electric cabling

Figure 52: View of typical disturbed surface at Wills Street STP

Five additional Aboriginal sites were recorded during the survey, four artefact scatters and one isolated find (refer **Figure 53**). Three artefact scatters were situated in the southeastern extent of the proposal site, to the west of the rising main route and existing South STP site (refer **Figure 54**). The fourth artefact scatter and isolated find were identified at the existing Wills Street STP site, but outside the new BHSTP construction footprint, near the unsealed track (refer **Figure 55**).

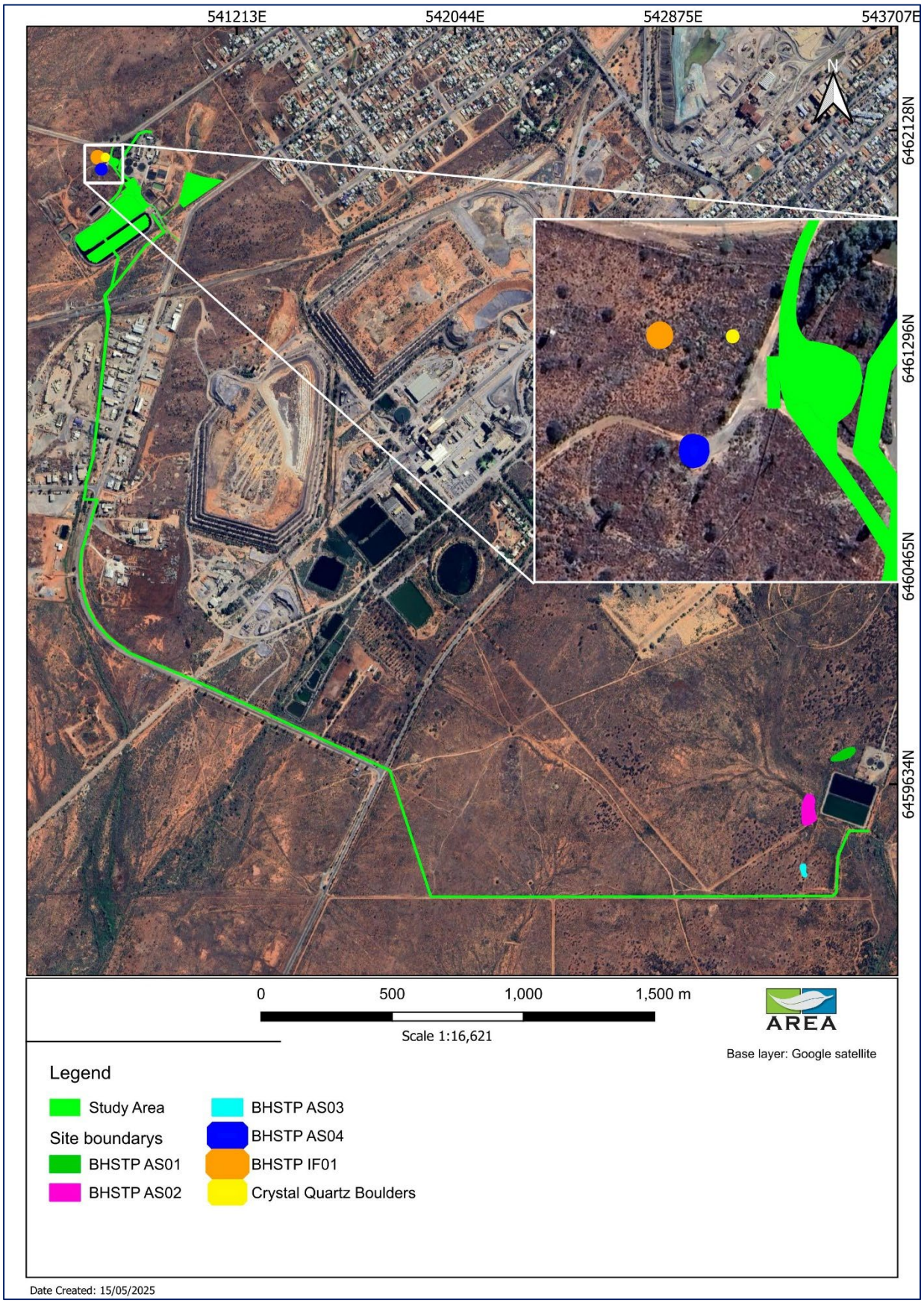


Figure 53: Location of the newly recorded Aboriginal sites

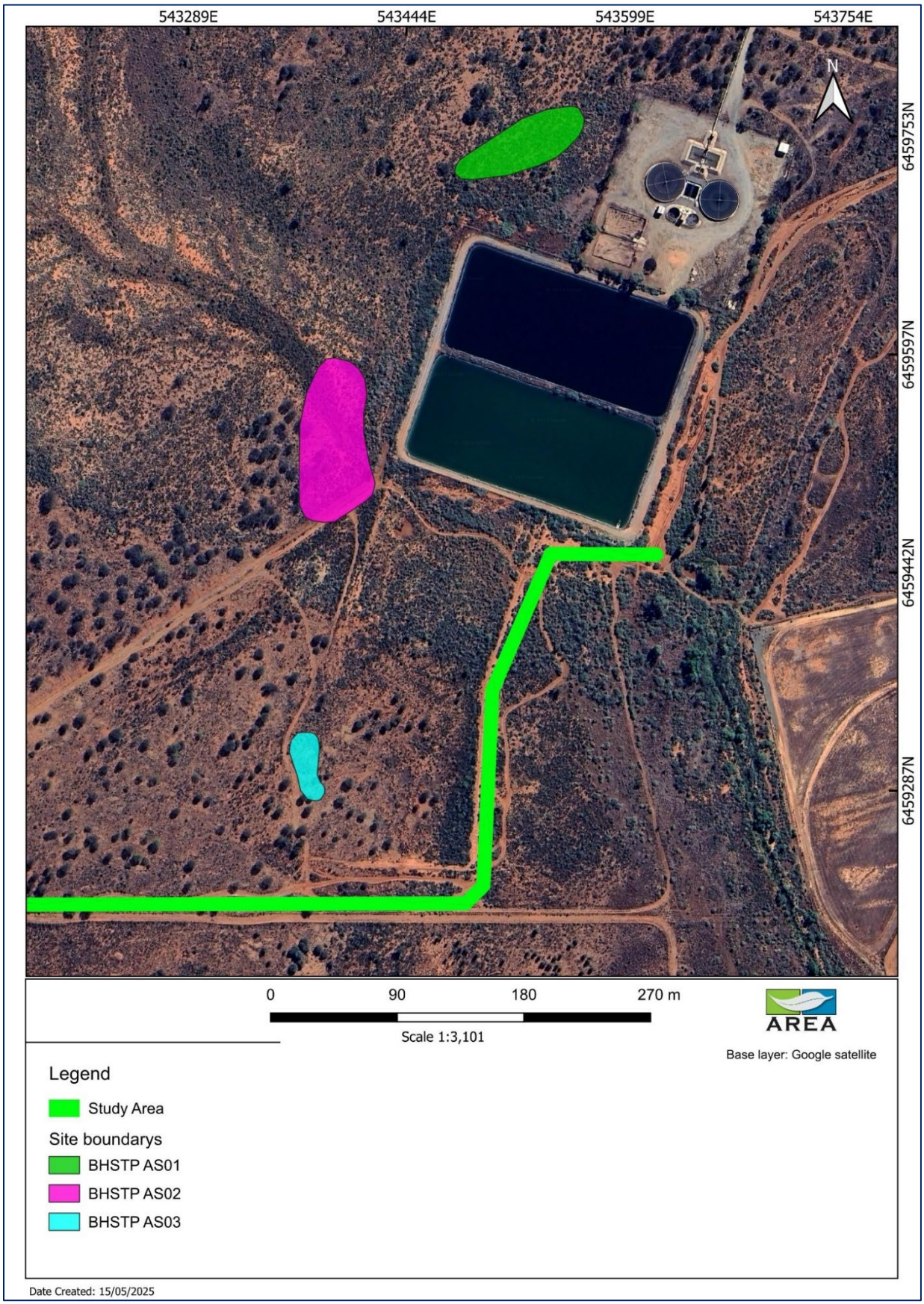


Figure 54: Newly recorded Aboriginal sites within the vicinity of the rising main route and South STP site

Figure 55: Location of the newly recorded sites near the construction footprint of the new BHSTP

Aboriginal Sites Recording During Field Survey

Broken Hill STP AS01 (AHIMS ID Pending)

Site type: Stone artefact Scatter

Centroid: GDA 20 Zone 54 543527 mE, 6459745 mN

Site length: 100m

Site width: 35m

Broken Hill STP AS01 is a low-density artefact scatter containing four opaque quartz flakes (refer **Figure 57**) and two opaque quartz cores (refer **Figure 58**). The cores were bipolar and showed no visible signs of early flaking. The artefacts were found in exposures between the dense saltbush vegetation.

Broken Hill STP AS01 was located on a flat landform characterised by red sandy soil and granite fragments. The nearest unnamed non-perennial waterway was approximately 280 meters east of Broken Hill STP AS01. The site was located approximately 40m west of the western boundary of the northern portion of the current South STP.

The extent of the scatter measured approximately 100m east to west and 35m north to south. GSV was limited due to the salt bush vegetation in the surrounding area. The site was found in an exposed area with 50% GSV (refer **Figure 56**).

Broken Hill STP AS01 is located outside the proposal site and harm will be **avoided.**

Figure 56: 50% GSV within the exposure, view to the south

Figure 57: Example of Broken Hill STP AS01 Quartz flakes closeup

Figure 58: Broken Hill STP AS01 Quartz core closeup

Broken Hill STP AS02 (AHIMS ID Pending)

Site type: Stone artefact Scatter

Centroid: GDA 20 Zone 54 543389 mE, 6459539 mN

Site length: 118m

Site width: 53m

Broken Hill STP AS02 is an artefact scatter consisting of approximately 50 to 100 artefacts manufactured from a mix of opaque and clear crystal quartz. The clear crystal quartz is culturally significant to the Barkandji people, used for men's business. Out of respect for the traditions of the community, photographs were not taken of any clear crystal quartz artefacts.

Broken Hill STP AS02 is located on flat landform with red sandy soil. The nearest unnamed non-perennial waterway is approximately 300 meters east of the site. The artefact scatter is located on the western side of the existing South STP, approximately 140m east from the rising main development footprint (located on the eastern side of the South STP). The site extent measures 118m from north to south and 53m from east to west (refer **Figure 59** and **Figure 60**). GSV at the time of recording the site was limited due to salt bush vegetation in the surrounding area. GSV in the exposed areas where the artefacts were found had 50% GSV.

Broken Hill STP AS02 is partially exposed due to a small drainage depression that divides it into two sections. Artefacts were visible among the native grass and saltbush. The site had been highly disturbed by previous land use activities, including construction of an earth bund, an unsealed track to the south, and an artificial ridge with a planted boundary. The eastern boundary of the site is marked by a fence line along the western edge of South STP ponds, while the southern boundary is defined by an unsealed track (**Figure 61** and **Figure 62**).

Broken Hill STP AS02 is located outside the proposal site and harm will be **avoided**.

Figure 59: View south of Broken Hill STP AS02 showing exposures within the saltbush

Figure 60: Broken Hill STP AS02 view to west

Figure 61: Example of opaque quartz within Broken Hill STP AS02

Figure 62: View north across Broken Hill AS02

Broken Hill STP AS03 (AHIMS ID Pending)

Site type: Stone artefact Scatter

Centroid: GDA 20 Zone 54 543372 mE, 6459305 mN

Site length: 50m

Site width: 23m

Broken Hill STP AS03 is an artefact scatter that contains at least 20 opaque quartz cores and flakes (refer **Figure 65**) found near the fence line towards the southwestern corner of the existing South STP site. Most of the artefacts were found to the west of the fence line, except for three flakes that were located on the eastern side.

Broken Hill STP AS03 is located on a flat landform with red sandy soils. The nearest unnamed non-perennial waterway is located 300 metre east of the site. Disturbances included a graded fence line and animal burrows.

The site extends 50 meters from north to south and 23 meters from west to east and runs parallel to an unsealed track aligned north to south. Vegetation comprised of native grasses and small clusters of saltbushes (refer **Figure 63** and **Figure 64**).

The artefacts on the eastern side of the fence line may have been displaced due to animal activities.

Broken Hill STP AS03 is located outside the proposal site and harm will be **avoided**.

Figure 63: View west across AS03

Figure 64: Eastern side of the fenceline facing north

Figure 65: Example of artefacts within AS03

Broken Hill STP AS04 (AHIMS ID Pending)

Site type: Stone artefact Scatter

Centroid: GDA 20 Zone 54 540697 mE, 6461977 mN

Site length: Six metres

Site width: Five metres

Broken Hill STP AS04 is located 90m south of Wills Street and along the southern edge of an unsealed access track within the existing Wills Street STP site. The site is a small artefact scatter consisting of five crystal quartz fragments. The surrounding area is highly disturbed due to the construction of the existing Wills Street STP and existing access track. Stockpiles of broken concrete and granite fragments were observed in the general area (refer **Figure 66** and **Figure 67**).

Broken Hill AS04 located outside the proposal site and harm will be **avoided**.

Figure 66: View south showing general location of AS04

Figure 67: View north showing general location of AS04

Broken Hill STP IF01 (AHIMS ID Pending)

Site type: Isolated find

Centroid: GDA 20 Zone 54 540682 mE, 6462024 mN

Site length: Two metres

Site width: Two metres

Broken Hill STP IF01 (refer **Figure 70**) is an isolated find, situated on a flat landscape with red silty sand and a deflated siting. Broken Hill STP IF01 is located about 70 meters north of the main construction footprint for the new BHSTP. The site is located 50 meters north of BHSTP AS 04, 50 meters south of Wills Street and 40 meters west of the proposed septage receival area and new main access road, forming part of the new the BHSTP construction footprint. Vegetation within Broken Hill STP IF01 comprised of saltbush and tufts of grasses. GSV was moderate with the artefact found within an exposure (refer **Figure 69** and **Figure 71**).

The ground surface near Broken Hill STP IF01 was heavily disturbed, with the surrounding area serving as a dumping zone for large boulders of crystal quartz and granite, piled together approximately 30 meters east of the site (refer **Figure 68**).

The site is located outside proposal site and harm will be **avoided**.

Figure 68: View south across IF01

Figure 69: Example of vegetation and GSV

Figure 70: View conchoidal opaque quartz flake

Figure 71: View west across IF04

Ground Surface Disturbance

The entire proposal site was assessed as being previously subjected to significant ground disturbances. In the southeastern part of the proposed rising main route towards the South STP, evidence of ground disturbance from animal activities (such as rabbit burrows and animal paths) and human activities, including earth mounds, dirt tracks, and gravel surfaces (refer **Figure 48**) was noted.

The central and northern sections of the proposed rising main route, running parallel to Kanandah Road, are subject to significant ground disturbance due to existing pipeline installations, a graded fence line, eroded tracks, powerline easements, and the installation of underground electric and Telstra cables (refer **Figure 49** to **Figure 51**). Additionally, a road project that was underway at the time of the survey, near the Pinnacles Road and Kanandah Road intersections, involved replacing a culvert in the drainage easement which the proposed new rising main route and existing treated effluent pipeline traverse, which has further disturbed the surface at this location.

The new BHSTP construction footprint and the replacement discharge pipeline are similarly disturbed from the construction and operation of the existing STP infrastructure and discharge pipeline (refer **Figure 52**).

Discussion

The proposal site is located on land subjected to significant ground disturbances from works associated with:

- The construction and operation of the existing STPs
- Graded fence lines
- Vehicles tracks
- Overhead powerline corridors
- Underground electricity and Telstra cables
- Sewer and water pipeline installations
- Road construction, including the replacement of the culvert beneath Pinnacles Road near the intersection with Kanandah Road.

No intact Aboriginal objects or sites were uncovered in these disturbed areas and given the level of existing disturbance it is considered unlikely that any objects or sites would be encountered during construction works.

The sites BHSTP AS01, BHSTP AS02, and BHSTP AS03 are located on less disturbed land to the west and north of the existing South STP site and outside the rising main footprint in the southeastern section of the of the proposal site. This section is thickly covered by saltbush, and the sites were recorded in exposed areas with 50% GSV. BHSTP AS04 and BHSTP IF01 are located on a less disturbed land within the Wills Street STP site, but outside the proposed construction footprint of the new BHSTP.

6.6.2 ASSESSMENT OF IMPACT

Significance forms the basis for the management of Aboriginal cultural heritage. There are four main criteria for assessing the significance of Aboriginal cultural heritage sites listed in the document *Guide to investigating, assessing, and reporting on Aboriginal cultural heritage in NSW* (OEH 2011). These are Social or Cultural significance, Aesthetic significance, Historic significance, and Scientific significance.

Each criteria of significance are rated low, moderate, or high. The following questions can be asked to help guide this rating (OEH 2011):

- Research potential: does the evidence suggest any potential to contribute to an understanding of the area and/or region and/or state's natural and cultural history?
- Representativeness: how much variability (outside and/or inside the subject area) exists, what is already conserved, how much connectivity is there?

- Rarity: is the subject area important in demonstrating a distinctive way of life, custom, process, land-use, function or design no longer practised? Is it in danger of being lost or of exceptional interest?
- Education potential: does the subject area contain teaching sites or sites that might have teaching potential?

The level of significance of each site is summarised in **Table 38**.

Table 38: Summary of database searches for Aboriginal Heritage

SITE ID	SOCIAL SIGNIFICANCE	AESTHETIC SIGNIFICANCE	HISTORIC SIGNIFICANCE	SCIENTIFIC SIGNIFICANCE	OVERALL ARCHAEOLOGICAL SIGNIFICANCE
BHSTP AS01 (AHIMS ID Pending)	Low	Moderate	Nil	Low	Low
BHSTP AS02 (AHIMS ID Pending)	Low	Moderate	Nil	Low	Low
BHSTP AS03(AHIMS ID Pending)	Low	Moderate	Nil	Low	Low
BHSTP AS04(AHIMS ID Pending)	Low	Moderate	Nil	Low	Low
BHSTP IF01(AHIMS ID Pending)	Low	Moderate	Nil	Low	Low

6.6.2.1 Social or cultural significance

Social or cultural value refers to the spiritual, traditional, historical, or contemporary associations and attachments the place or area has for Aboriginal people (OEH 2011). It relates to contemporary connections that Aboriginal people have with events that have taken place in that location or in the general area. In general, presence of Aboriginal sites provides evidence of connection to country and therefore is likely to be considered as important and significant regardless of its condition or representativeness.

Clear crystal quartz has significant cultural values associated with men's business irrespective of being an Aboriginal object (a stone tool) or not.

All Aboriginal sites located near waterways are significant to Aboriginal people which has an elevated potential

6.6.2.2 Aesthetic significance

This refers to the sensory, scenic, architectural, and creative aspects of the place. It is often closely linked with the social values. It may consider form, scale, colour, texture and material of the fabric or landscape, and the smell and sounds associated with the place and its use (Australian ICOMOS1988, as cited in OEH 2011).

The stone artefact scatters contain a variety of artefact types including flakes and cores, with the raw materials including mix of opaque, clear crystal quartz and milky quartz. These sites have moderate aesthetic significance.

Culturally modified trees inherently have some aesthetic value. Mature trees have some level of aesthetic appeal, and the cultural scars provide a clear link to the Aboriginal use of the area. The culturally modified trees vary in size and shape which may indicate different functions. These sites have moderate aesthetic significance.

6.6.2.3 Historic significance

Historic value refers to the associations of a place with a historically important person, event, phase, or activity in an Aboriginal community. Historic places do not always have physical evidence of their historical importance (OEH 2011).

There are no known historical associations between the proposal site and the local Aboriginal community. Therefore, there is nil historic significance of the development footprint and sites within them.

6.6.2.4 Scientific significance

This refers to the importance of a landscape, area, place or object because of its rarity, representativeness, and the extent to which it may contribute to further understanding and information (Australian ICOMOS 1988, as cited in OEH 2011).

The distribution of the sites conformed to the predictive model. On this level, the recorded sites are considered to be representative of these site types but are not rare. The scientific significance of the identified sites is rated as low.

6.6.2.5 Impact Summary

Five Aboriginal sites were recorded during the site survey for the proposal (refer **Figure 53** to **Figure 55**). All sites are located outside the proposed construction footprint. As such direct impact to these sites will be avoided, but the sites will require management to prevent inadvertent impact.

6.6.3 ENVIRONMENTAL MITIGATION MEASURES

The following mitigation is required to reduce the potential for inadvertent impact to Aboriginal sites recorded within and outside the proposal site.

- Site supervisors, and construction work crews be made aware of the locations of Broken Hill STP AS04 and Broken Hill STP IF01 at the existing Wills Street STP. It is recommended that the sites are identified.
- BHSTP AS01, BHSTP AS02, and BHSTP AS03 to the northwest and west of the existing South STP site, are located at an adequate distance away from the proposed construction activities and do not require additional controls. Site supervisors and construction work crews would be made aware of their location.
- All staff working must be made aware of the legislative protection offered for all cultural heritage sites under the NPW Act.

In addition to these mitigation measures, the following general recommendations are made:

- If any objects of suspected Aboriginal heritage origin be encountered during the proposed works, activity in the area of the find should cease and the unexpected finds protocols (Appendix B of the Aboriginal Heritage Due Diligence Report, attached as **Appendix E** of this REF) should be implemented.
- If changes are made to the proposal which could impact locations outside of the current disturbance footprint, further archaeological investigation may be required.
- If suspected human remains are located during any stage of the proposed works, work must stop immediately, and the NSW police must be notified.

6.6.4 CONCLUSION

The proposal is not anticipated to have any impact upon the Aboriginal heritage in the area. Given the mitigation measures outlined in this assessment, the overall environmental risk is considered to be low.

6.7 Non-Aboriginal Heritage

6.7.1 EXISTING ENVIRONMENT

Non-Aboriginal heritage refers to any deposit, object or material evidence which relates to the settlement of New South Wales, not being Aboriginal settlement, and is of state or local heritage significance (Section 4 of the Heritage Act).

Broken Hill City has a strong mining history, beginning as a small mining village in the 1800s. The city became the birthplace of BHP in 1885, when it began mining the massive ore body containing the world's richest source of silver, lead and zinc.

A desktop search of Australia's World Heritage List (Commonwealth DCCEEW, 2025a), National Heritage List (Commonwealth DEECCW, 2025b), NSW State Heritage Inventory (Heritage NSW, 2025), and Broken Hill LEP 2013 was conducted to determine the extent of non-Aboriginal heritage in the vicinity of the proposal. No items of State or local heritage significance were identified at, or nearby the proposal site. However, the proposal site is situated within the City of Broken Hill National Heritage Place, a matter of national environmental significance (MNES) under the EPBC Act.

6.7.2 ASSESSMENT OF IMPACT

Under the EPBC Act, an action that has, will have, or is likely to have, a "significant impact" upon a MNES must be referred to the Australian Government Minister for the Environment and Energy for approval.

The *Matters of National Environmental Significance Significant impact guidelines 1.1* (significant impact guidelines) specify that approval under the EPBC Act is required for any action occurring within, or outside, a National Heritage place that has, will have, or is likely to have a significant impact on the National Heritage values of the National Heritage place. The significant impact guidelines specify that an action is likely to have a significant impact on the National Heritage values of a National Heritage place if there is a real chance or possibility that it will cause:

- One or more of the National Heritage values to be lost
- One or more of the National Heritage values to be degraded or damaged, or
- One or more of the National Heritage values to be notably altered, modified, obscured or diminished.

The proposed action involves:

- Construction operation and maintenance of new STP infrastructure at the existing Wills Street STP, to become the new BHSTP site
- Construction, operation and maintenance of a new pumping station at the existing South STP
- Construction, operation and maintenance of a new rising main between the South and Will Street STPs
- Replacement of the existing effluent discharge pipe from the existing Wills Street STP to the existing discharge point
- Decommissioning of redundant pieces of infrastructure at both STPs.

The proposed action will take place on land already used for sewage treatment, or in the case of the proposed rising main, will following existing roadways and tracks. The proposal site is located away from areas of identified ore body, mining areas, or culturally or aesthetically important areas of Broken Hill. A full assessment of the proposed action against the National Heritage values of the City of Broken Hill is provided in **Appendix F**.

Based on the significant impact assessment presented in **Appendix F**, it is unlikely that the proposal will result in the National Heritage Values of the City of Broken Hill being lost, degraded, damaged, notably altered, modified, obscured or diminished, as a result of the proposal. Therefore, the proposal is not considered likely to have a significant impact upon a National Heritage place (i.e. relevant MNES) and there is no requirement for the proposal to be referred to the Commonwealth Minister for approval.

6.7.3 ENVIRONMENTAL MITIGATION MEASURES

The following mitigation measures would be applied:

- All construction work would be undertaken within the assessed areas of the proposal site only
- In the unlikely event that a previously unknown heritage site or object is located during construction of the proposal, works would cease immediately in that area and a representative from Essential Energy's Environmental Services would be notified. Works with the potential to disturb the object would not resume until the object had been properly identified, and appropriate action taken.

6.7.4 CONCLUSION

The proposal is unlikely to have a significant impact upon non-Aboriginal heritage in the area. Given the mitigation measures outlined in this assessment, the overall environmental risk is considered to be low.

6.8 Contamination

6.8.1 EXISTING ENVIRONMENT

6.8.1.1 Desktop Assessment

A search of the NSW EPA 'Contaminated Land – Record of Notices' (EPA, 2025a) and 'List of NSW Contaminated Sites Notified to EPA' (EPA, 2025b) did not identify any contaminated sites located within, or intersected by, the proposal site. However, the following sites were identified within general vicinity of the proposal:

- Former Caltex Depot at 3 Kanandah Road, located approximately 325m southeast and 175m east of the existing Wills Street STP site, and proposed rising main route, respectively
- Tasco Petroleum (former Mobil Depot) at 5 Kanandah Road, located approximately 370m southeast and 150m east of the existing Wills Street STP site, and proposed rising main route, respectively
- Former Mobil aviation refuelling facility at the Broken Hill Airport, located approximately 525m east of the existing South STP

The above sites do not require regulation under the *Contaminated Land Management Act 1997* (CLM Act).

A search of NSW Department of Primary Industries (DPI) Cattle Tick Dip Site Locator did not indicate any tick dips sites within the vicinity of the proposal.

Figure 72 illustrates the location of the above known contaminated sites relevant to the proposal.

Current land uses within the subject site may have resulted in the contamination of soils. Potential contaminants of concern in soil could include hydrocarbons, metals, herbicides, pesticides. organic contaminants (i.e. nitrates) and asbestos.

6.8.1.2 Previous Investigations

Wills Street Wastewater Treatment Plant Hydrogeological Study (Tonkin Consulting, 2014)

Tonkin Consulting (2014) completed a Hydrological Study, which indicated the potential site- specific sources of contamination on-site could include:

- Leakage of primary and secondary treatment tanks
- Sludge drying and management on-site both current and historical
- Leakage from the tertiary lagoon
- Leakage or incomplete decommissioning of the former septic tank and system at the former on-site residence.

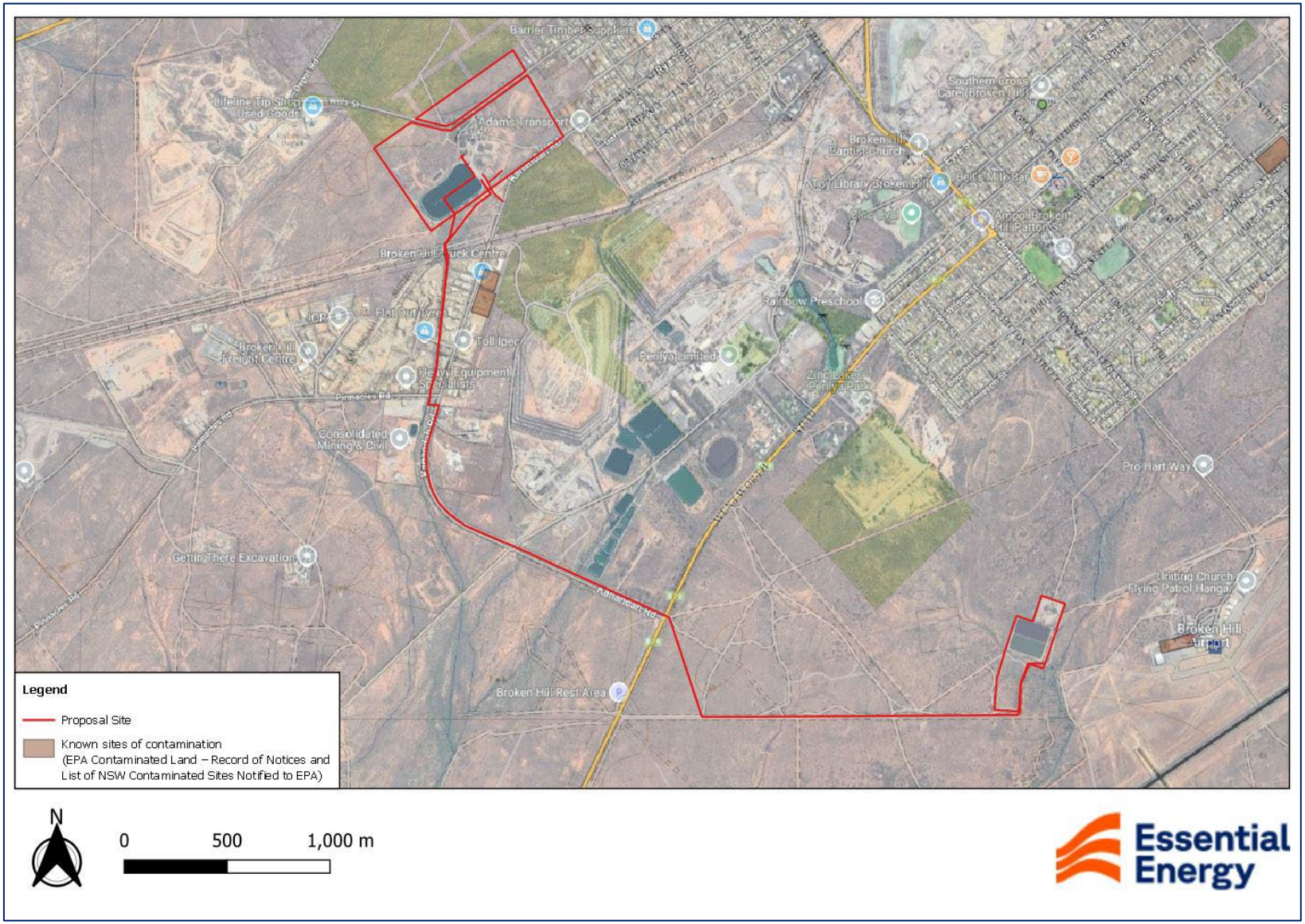


Figure 72: Contaminated land in the vicinity of the proposal Site

Tonkin Consulting (2014) concluded that nitrate, cadmium, lead and mercury concentrations in groundwater were reported at concentrations exceeding the adopted ANZECC freshwater aquatic ecosystem guideline and above the nominated background concentrations. Tonkin Consulting (2014) considered it likely that these contaminants are associated with site activities such as primary and secondary wastewater treatment tanks and sewage sludge handling practices including drying and stockpiling.

Broken Hill Sewerage Wills Street Sewage Treatment Plant Upgrade Preliminary Contamination Investigation (PWA, 2018)

A preliminary contamination investigation of the existing Wills Street STP site was prepared by PWA (2018b) to inform the concept design (PWA, 2019a). Key findings of this report are summarised below

- Based on the title search information, the STP lies within the land that has been owned by Essential Energy since 2012. Between 2009 and 2012, the land was owned by Country Energy. Prior to 2009, the land was Crown Land
- A review of four historical aerial photographs (years 1924, 1954, 1995 and 2006) indicated that the site has been used as a wastewater treatment plant site since the early 1900s. The existing large 'reuse water storage dam' was constructed in the early 1990s
- A copy of the Essential Energy Asbestos Register, provided by Essential Water at the time (2017) identified the presence of asbestos at the external pipes of the dosing tank at the existing Wills Street STP
- Based on the currently available historical information and site observations, apart from the wastewater treatment activities, there is no strong evidence of any other present or former industrial or intensive land cultivation activities occurring within the existing Wills Street STP site
- Areas of potential environmental concern within the STP site were identified as follows:
  - Leaking of existing STP units and on-site activities
  - Burial of demolition debris associated with former reconstruction of the old sludge drying bed
  - Existing stockpiles within the area proposed for the new sludge lagoons, which were yet to be constructed at the time of the investigation
  - Existing fill across the site.
- The 2016 Tonkin investigation revealed heavy metal (cadmium and lead) groundwater contamination, and concluded that these contaminates are associated with on-site sewage treatment activities and management practices of sewage sludge.
- A limited number of soil samples from the site were screened for the common contaminants of potential concern - heavy metals (arsenic, cadmium, chromium, copper, lead, nickel, zinc and mercury); total recoverable hydrocarbons (TRH); Benzene, toluene, ethylbenzene, xylenes (BTEX); Polycyclic aromatic hydrocarbons (PAHs); organochlorine pesticides (OCPs); and total Polychlorinated Biphenyls (PCBs)
- Subsurface profiles east of the existing STP infrastructure, in the vicinity of the existing drying beds comprised of a layer of fill / natural soil of various thickness, underlain by gneiss bedrock at shallow depths within the northern part of the area, then becoming deeper towards the south. The fill encountered in the test pits generally comprises silty sand with traces of gravel / sandy silt to gravelly sandy/clayey silt.
- Subsurface profiles west and south of the existing STP infrastructure, indicated gneiss bedrock was encountered at a shallow depth. Fill was not encountered in this area.
- At the time of fieldwork, groundwater was not encountered within the investigation depths of excavation (maximum of 4.2m)
- In all of the samples analysed from the preliminary investigation, the concentrations of heavy metals were either not detected above the Limits of Reporting (LORs), or were below both the health screening levels (HIL D). Also, TRH, BTEX, PAHs, OCPs and PCBs were either not detected above the LORs or were below the health threshold levels (HIL D / HSL D)

- In the fill sample from test pit TP5 (0.6m-0.7m), located at the western corner of the existing sludge pond and in the vicinity of the existing sludge drying beds, the detected concentration of mercury (3.8mg/kg) was above the PPIL (1mg/kg), but was well below the HIL D. Exceedance of PPIL (provisional phytotoxicity-based investigation level) could present a potential risk to terrestrial ecosystems
- Based on the limited findings of the preliminary contamination investigation, PWA (2018b) considered that the existing Wills Street STP site was suitable for the future, continuous use as a wastewater treatment plant, subject to the implementation of the several recommendations:
  - Undertake additional investigation (including soil sampling and analysis) in the area around test pit TP5, in order to determine the extent of mercury contamination in this area prior to construction activities commencing
  - Prior to demolition of the existing STP structures and buildings for future development, a detailed hazardous material (including asbestos) survey of these structures/buildings should be conducted.
  - Upon demolition of the existing structures and the removal of existing stockpiles affected by the development, the footprints of the demolished structures and the removed stockpiles should be assessed for the presence of any contamination.
  - The number of additional environmental sampling points in the future investigation (Stage 2) should be in accordance with the *Sampling Design Guidelines* (NSW EPA, 1995).
  - Any material (including existing stockpiles) that is to be excavated and disposed of in a NSW EPA licensed landfill should be assessed and classified (with Toxicity Characteristics Leaching Procedure (TCLP) testing, where appropriate) in accordance with the *Waste Classification Guidelines* (NSW EPA, 2014) and relevant legislation
  - Any imported material should be validated in accordance with the *Sampling Design Guidelines* (NSW EPA, 1995), the *Guidelines for the NSW Site Auditor Scheme* (NSW DEC, 2017) and *National Environment Protection (Assessment of Site Contamination) Measure 1999* as amended (NEPC, 2013). The fill material should not contain asbestos, and not be acid sulfate soil or saline soil. The imported fill material should be 'virgin excavated natural material' (VENM) or 'excavated natural material' (ENM), as defined in the *Waste Classification Guidelines* (NSW EPA, 2014) because of their low risk of contamination.
  - In view of groundwater contamination as identified by the environmental consultants (Tonkin), it is prudent that continuous groundwater monitoring is to be undertaken and assessed accordingly

Broken Hill Wastewater Treatment Plant - Biosolid Assessment (Kleinfelder, 2024)

Kleinfelder Pty Ltd (Kleinfelder) (2024) was engaged by Essential Energy to undertake an assessment of existing biosolids stockpiles that have accumulated at the existing Wills Street STP site. The biosolids stockpiles include material that has accumulated between 1995 and 2022, generated through the wastewater treatment process.

Currently stabilised biosolids are stockpiled on-site in two stockpile locations, which Kleinfelder (2024) designated as Biosolids Stockpile A (BSA), located to the west of the majority of the existing STP infrastructure, and Biosolids Stockpile B (BSB), to the east of the of the majority of the existing STP infrastructure. Each stockpile is shown in **Figure 73**.

Composite samples were collected from two stockpiles; BSA (containing approximately 1700 dry solid tonnes (dst) of biosolids material) and BSB (containing approximately 5100 dst). Based on the investigation completed by Kleinfelder, in accordance with NSW EPA (2000) *Environmental Guidelines Use and Disposal of Biosolids Products*, both biosolids stockpiles are classified as 'Not Suitable for Use', due to:

- A contaminant grade of E being applied based on the calculated concentrations of lead.
- A stabilisation grade of B being applied based on the Broken Hill STP treatment processes.
- BSB was classified as Not Suitable for Use

Based on the NSW EPA (2000) guidelines both stockpiles were classified as 'Not Suitable for Use'. The only allowable land application uses for this biosolids material are:

- Landfill disposal
- Surface land disposal (applied within the boundaries of the existing Wills Street STP site).

Asbestos Containing Material

According to Essential Energy's Property Asbestos Register Asbestos Containing Material (ACM) is noted to present at several pits, and bonded asbestos pipes associated with the dosing tank at the Wills Street STP site. There is also potential for historic fill material which may have included ACM along the southern boundary of the site in the vicinity of the proposed construction laydown area. The location of the fill material is donated as the "Tree Planting Area" on **Figure 74**.

No ACM are known to be present at the South STP site.

6.8.2 ASSESSMENT OF IMPACT

Given the distance of the known sites of contamination from the proposal site, and the fact contamination at these sites is not significant enough to warrant regulation under the CLM Act, it is unlikely these sites pose a significant contamination risk to the proposal site.

While no known areas of significant contamination have been identified at the proposal site, the historic use of the existing Wills Street STP site is likely to have resulted in potential contamination of surface and sub soils, as well as groundwater as indicated by Tonkin Consulting (2014). The preliminary contamination investigation completed by PWA (2018b), indicated the concentrations of heavy metals, hydrocarbons, OCPs and total PCBs were either not detected above the Limits of Reporting (LORs), or were below both the HIL D and EIL for commercial/industrial land use, with the exception of one fill sample. This sample was from test pit TP5 (0.6m-0.7m), located at the western corner of the existing sludge pond and in the vicinity of the existing sludge drying beds, which the detected concentration of mercury (3.8mg/kg) was above the PPIL (1mg/kg). The construction footprint of the new STP infrastructure will avoid any substantial disturbance and earthworks in this area.

Based on Kleinfelder (2024) assessment both existing biosolids stockpiles are classified as 'Not Suitable for Use'. The only allowable land application uses for this biosolids material are landfill disposal, or surface land disposal (applied within the boundaries of the site).

The proposed activity involves the excavation for the installation of the various pieces of new STP infrastructure at the Wills Street STP site, predominately south of the existing STP infrastructure, and the progressive decommissioning and removal of the old STP plant and equipment. It is unlikely that the excavations for construction will intercept groundwater, however, the excavations could potentially uncover previously unknown contaminated soil at the Wills Street STP site. At the time of the preparation of the REF, no sampling of the sediments within the tertiary pond has been undertaken, primarily due to the difficulties obtaining samples while the pond contains water. Following dewatering of the pond, any sludge material that is required to be removed and disposed of off-site prior to backfilling should be assessed against NSW EPA (2000) *Environmental Guidelines Use and Disposal of Biosolids Products* or classified and disposed of in accordance with the NSW *Waste Classification Guidelines* (EPA, 2014).

Given the area known to contain ACM according to the property register (i.e., pits and asbestos pipes associated with the existing dosing tanks at the Wills Street STP site), is located outside the construction footprint of the new BHSTP, it is unlikely ACM will be disturbed during construction and operational activities of the new BHSTP. Any asbestos removal works during decommissioning of the old STP infrastructure would be undertaken by an appropriately licensed asbestos removalist.

The area containing fill material with the potential to contain ACM along the southern boundary is partially located in the area designated for construction laydown. No excavation is anticipated in this area at this stage, and would rather be used for laydown of plant and equipment. A layer of crushed aggregate may be applied to this area to provide a firm base to reduce the potential for vehicles to disturb the ground. If significant surface disturbance or excavation is required, further investigation would be required to confirm the presence of ACM. If confirmed, an asbestos management plan would be required to be prepared and implemented.

Figure 73: Existing Biosolid Stockpile Locations

Figure 74: Location of historic fill material potentially containing ACM

No previous contamination assessment has been undertaken at the South STP site. However, given the relatively small disturbance footprint for the installation of the new pump station, it is not expected that construction activities would encounter significant areas of contamination. Contamination of surface or subsoils may be encountered by the progressive decommissioning and removal of the old STP plant and equipment at this site.

The proposed rising main route traverses predominately previously disturbed land, associated with road reserves. Potential contaminates of concern in these areas would include primarily hydrocarbons and heavy metals.

Spillage of diesel, lubricating oils or other chemicals could occur during refuelling and/or maintenance of construction plant/equipment and vehicles, whilst leakage of fuels or oils could occur from poorly maintained construction plant/equipment and vehicles. Any on-site chemical spill or leak could adversely affect the water quality of surrounding waterways.

Water quality outside of the project area could also be affected during the transportation of hazardous materials to and from the site. The risk of chemical spills and leaks is expected to be minor, provided that adequate mitigation measures are implemented (refer **Section 6.8.3**).

While contamination of surface and subsoils may be encountered during construction and decommissioning activities, it is unlikely to be significant and could be managed through appropriate testing, classification and disposal, where it is encountered.

It is expected that the construction and operation of the new BHSTP infrastructure at the existing Wills Street STP site and the improvement of management practice of on-site activities would help in minimising migration of contaminates from the new STP site into the groundwater.

6.8.3 ENVIRONMENTAL MITIGATION MEASURES

The following mitigation measures will be adopted if and where required:

- It is intended to reuse surplus spoil beneficially on site, unless contamination is confirmed or suspected above land use thresholds during ground disturbance works (indicated by odours/staining/presence of hazardous materials)
- The existing groundwater monitoring program would continue in line with licence requirements to continue to monitor any trends in groundwater levels and quality at the site
- Essential Energy's *CEOP8064 Management of Excavated Material; Guideline for Construction Sites* will be consulted to determine the most appropriate beneficial reuse or disposal method for excavated materials
- Following dewatering of the tertiary pond, any sludge material that is required to be removed and disposed of off-site prior to backfilling should be assessed against NSW EPA guidance for the *Use and Disposal of Biosolids Products*, or classified and disposed of in accordance with the NSW *Waste Classification Guidelines* (EPA, 2014)
- In the event of encountering any suspected contamination in the work area, it will be separated and contained on site until it can be classified in accordance with the EPA (2014) *Waste Classification Guidelines* and then disposed of at a facility that is lawfully able to accept the waste
- Prior to the demolition of the existing STP structures and buildings for the purpose of future development, a hazardous material (including asbestos) survey of these structures/buildings should be conducted
- If work is proposed within an area where ACM are known to be present, a risk assessment should be undertaken before proceeding. Any removal of ACM should be undertaken by an appropriately licensed asbestos removalist

- A layer of crushed aggregate is recommended to be applied to the identified fill area noted to potentially include ACM along the southern boundary of the site in the vicinity of the proposed lay down area to provide a firm base, and separate layer to reduce the potential for vehicles to disturb the ground. If significant surface disturbance or excavation is required in this area, further investigation would be required to confirm the presence of ACM. If confirmed, an asbestos management plan would be required to be prepared and implemented.
- Upon demolition of the existing structures and the removal of existing stockpiles affected by the development, the footprints of the demolished structures and the removed stockpiles should be assessed for the presence of any contamination
- Control measures will be implemented to manage risks associated with the handling of fuel through using spill trays when undertaking in field re-fuelling (although avoid and use service station where practicable)
- Sediment and erosion control structures will be established and maintained in accordance with The Blue Book to minimise potential impacts on receiving watercourses.

6.8.4 CONCLUSION

The proposal is not anticipated to have any impact upon contamination in the area. If contamination is encountered during construction, contaminated material will be removed, managed and disposed of appropriately. Given the mitigation measures outlined in this assessment, the overall environmental risk is considered to be low.

6.9 Hazards and Chemical Management

6.9.1 ASSESSMENT OF IMPACT

6.9.1.1 HAZOP

As part of the design process, a Hazard and Operability (HAZOP) Study was completed, and a Construction Hazard Assessment Implication Review (CHAIR) 1 workshop was conducted. The CHAIR 1 process is a preliminary review conducted during the concept phase of the project. It is noted that further safety and design review is required to capture continued design refinements.

The CHAIR 1 process utilises a series of guide words to systematically explore significant risks to health, safety or the environment during the construction and operation of the upgrade. The CHAIR 1 also develops a series of possible solutions / safeguards within a workshop environment that will be employed or included within the design to reduce risks associated with identified hazards to acceptable levels. Although the tool doesn't explicitly detail environmental risk assessment, it will be included in the process.

The CHAIR 1 workshop was undertaken in line with NSW Workcover guidelines (CHAIR, Safety in Design Tool). A draft CHAIR report was generated from the workshop. The report acts to summarise the review process and lists identified issues, associated risks, mitigation strategies to be adopted and responsible persons. The report forms an integral part of the Safety in Design process.

A follow-up CHAIR 2/3 Workshop was undertaken following completion of the 85% design. The CHAIR 2/3 workshop was undertaken to collectively identify and reduce construction, maintenance repair and demolition safety risks associated with the design. The risks identified were then formally listed for action by the appropriate stakeholders of the project.

Outcomes from the CHAIR process will be incorporated into the final BHSTP design where appropriate or noted for action as the design and procurement progresses.

6.9.1.2 Chemical Storage and Dosing Systems

Three chemical storage and dosing systems will be used for the upgraded STP:

- Alum Storage and Dosing System
- Caustic Storage and Dosing system

- Sodium Hypochlorite Storage and Dosing System.

Accidental spills of these chemicals have the potential to impact human health and the environment, both on and off-site, if not stored and handled correctly. The design features of the proposed chemical storage and dosing systems are detailed in **Section 2.3.3.9**. These design features, include, but are not limited to, positioning the chemical storage tanks under skillion roofs, inside concrete bunds, with dosing pumps, sump pump, safety shower and eyewash facilities would reduce the likelihood of impacts to human health and the environment. Procedures would be implemented to ensure that any chemical spills are cleaned up without any discharges to surface water.

Other chemicals that may be used at the STP include:

- Cleaning chemicals
- Fuel and lubricant for machinery
- Herbicides for on-site weed management.

All chemicals would be handled in accordance with the manufacturer's recommendations and Safety Data Sheets. Safety Data Sheets would be available on site at all times. The risks associated with chemical management and use at the plant are considered low. No off-site impacts in regard to the use or handling of chemicals are anticipated to occur. Emergency response plans and procedures would be incorporated into the upgraded STP Operational Management Plan.

6.9.2 ENVIRONMENTAL MITIGATION MEASURES

- The new BHSTP is to operate in accordance with EPL conditions including any chemical storage limits or other requirements.
- The Pollution Incident Response Management Plan (PIRMP) for the existing Wills Street and South STP sites (CEOP8202) would be updated to reflect the new BHSTP
- Routine maintenance of the new BHSTP is to be undertaken in accordance with the Operations and Maintenance manual prepared for the plant.
- The transport and handling of any chemicals used in the operation of new BHSTP would be undertaken in accordance with all relevant SafeWork NSW guidelines
- Notification to the EPA in accordance with Part 5.7 of the POEO Act is to be undertaken where a pollution incident occurs in the course of an activity so that material harm to the environment is caused or threatened.
- Liquid chemical storage and filling areas would be located in bunded areas
- Storage tanks would be regularly inspected and maintained to ensure their integrity. Plant personnel would be trained for proper and safe operation of these facilities.
- Specific requirements for the management of chemicals associated with the new BHSTP would be detailed in an Operational Management Plan.
- All hazardous substances are to be listed in a register together with the relevant Safety Data Sheets. Employees are to have access to this register at all times.
- Fuel and lubricants for machinery maintenance are to be stored and managed appropriately.
- Appropriate signage is to be maintained where chemicals are stored.

6.9.3 CONCLUSION

Given the design and mitigation measures proposed, the overall risk to human health and the environment is considered to be low.

6.10 Visual and Aesthetics

6.10.1 APPROACH

The following visual amenity assessment approach was applied to evaluate the potential visual impacts associated with the project. It is based on a professionally recognised system developed by the United States Forest Service (1974), and similar methods adopted by the Forestry Commission of Tasmania (1983) and the NSW Department of Planning (1980).

The approach used in this assessment is as follows:

- The existing visual environment of the site is described (in terms of landscape character, scenic quality, visual and landscape sensitivity and major view points)
- A brief description is made of the proposed visual changes
- An impact assessment is then undertaken, assessing both the changes to the site itself, and any impacts to views from surrounding areas.

The visual impact of the proposed activity has been determined though the interaction of visual modification and visual sensitivity. These are discussed in more detail in the following sections. The 'visual impact matrix', illustrated in **Table 39** is used to determine the potential visual impact of the proposed activity by combining a ranking of high, medium and low for both visual modification and visual sensitivity.

Table 39: Visual Impact Matrix

		VISUAL SENSITIVITY		
		HIGH	MEDIUM	LOW
VISUAL MODIFICATION	HIGH	High Impact	High Impact	Moderate Impact
	MEDIUM	High Impact	Moderate Impact	Minor Impact
	LOW	Moderate Impact	Minor Impact	Minor Impact

6.10.1.1 Visual modification

Visual modification expresses the visual interaction between the proposal and the existing visual environment. It is the visual contrast between pre and post-development, and is a combination of the appearance of the development (size, form, colour, texture), absorptive capacity of the landscape setting, and the distance from which the development is viewed. Visual modification is expressed here as high, medium or low.

High visual modification

A high degree of visual modification would result if the proposed developments are a major element and contrast strongly with the existing landscape. The contrast is likely to occur if there is little or no natural screening or integration created by vegetation, or if there is an open plain.

Medium visual modification

A medium degree of visual modification would result if the proposed developments are visible and contrast with the landscape but are integrated to some degree. This would happen if the surrounding vegetation and/or topography provide some measure of visual screening, backgrounding or other form of visual integration of the development with its setting.

Low visual modification

A low degree of visual modification occurs if there is minimal visual contrast and a high level of integration of size, form, colour or texture between the development and the environment. This would occur if there is

a high degree of visual integration of the development into the existing landscape or a low level of visual modification of the existing visual setting is achieved. A low visual modification may reflect a situation where the development may be noticeable, but it does not markedly contrast with the existing landscape.

Throughout the study area, the degree of visual modification is highly dependent on the distance the viewer is from a new development. As the distance from the new development to the viewing location increases, the development becomes less prominent, and therefore its visual modification is less.

Visual modification is also affected by the angle at which a new development is viewed. In general, the visual modification when viewing the new development at right angles is less than when viewing in parallel, depending on the distance from the new development.

6.10.1.2 Visual Sensitivity

Visual sensitivity is a measure of how critically a change to the existing landscape would be viewed from various viewpoints. This is dependent on a number of viewer characteristics, such as the number of viewers affected, land use, existing vegetation patterns, distance of the development from viewers, and the visibility of the development from critical viewing locations.

High visual sensitivity

High visual sensitivity would apply to occupiers of residential properties with long viewing periods adjacent or within close proximity to the proposal. High sensitive areas can also apply to users of outdoor recreational areas, including reserved land or nature recreation such as walking, swimming, fishing or trail riding. This is particularly the case where their attention is focussed, in part, on the landscape and amenity that is being affected by the proposed development.

Medium visual sensitivity

Medium sensitivity would apply to circumstances in which viewers have intermittent exposure, such as outdoor workers and outdoor recreation users, however, for the recreational user, attention is focussed predominantly on the activity they are viewing, such as a sporting event, rather than the proposed development. In addition, medium sensitivity would also apply to occupiers of residential properties with long viewing periods at a distance from or partially screened from the proposed development or project area.

Low visual sensitivity

Low sensitivity viewers include predominantly those groups that have a short term view of the proposed development. This would be limited to mainly road users, trains or transport routes that are passing through or adjacent to the study area. Low sensitivity would also apply where viewers are adequately screened from the proposed development, so that their viewing periods are limited to short periods.

6.10.2 EXISTING VISUAL ENVIRONMENT (LANDSCAPE DESCRIPTION)

The proposal site is located in the south-western and southern outskirts of the City of Broken Hill, in a landscape dominated by industrial and mining activities, intersected with electricity, road and rail infrastructure. The immediate surrounding landscape of the existing Wills Street STP comprises:

- Undeveloped large residential lots located immediately to the north, with undeveloped land beyond
- A mix of undeveloped lots and residential premises immediately to the east with further residential premises beyond
- Kanandah Road and undeveloped land immediately to the south, with Peterborough Broken Hill Railway and an industrial area beyond
- Undeveloped land immediately to the west, with the BHCC Landfill and Waste Receival Facility beyond.

The existing Wills Street STP site itself also neighbours the Willyama common to the northwest and south.

The closest sensitive receiver to the existing Wills Street STP is a residential property located at 4 Ryan Street (Lot 5270 DP757298) (R2), approximately 30m east of the Wills Street STP lot boundary (refer **Figure 2** and **Figure 3**). The residence is located approximately 350m east of the closest piece of active STP infrastructure (a sludge drying bed) at the site, with limited views of the site.

The South STP is located at the southern outskirts of the Broken Hill township, west of the airport. The immediate surrounding landscape of the South STP comprises predominately the Willyama common, with the Broken Hill Airport boundary approximately 300m to the east. The closest sensitive receiver to the existing South STP is a residential property located at 55 Knox Street (Lot 5230 DP757298) (R4), approximately 560m northeast of the existing South STP entrance and inlet works (refer **Figure 2**), with no direct views to the STP site.

The proposed rising main route will follow an existing unsealed road within the Willyama Common, as it exits the South STP, heading in a southern and then westerly direction, before joining with Kanandah Road, at the intersection with the Silver City Highway. From here the route follows Kanandah Road northwest and north to before heading west along Kanandah Place in the industrial estate, before entering a drainage easement and heading north following the route of the existing treated effluent discharge pipe, beneath the Peterborough Broken Hill Railway, across Crown Land (Willyama Common) and into the existing Will Street STP site (refer **Figure 2**). Along its proposed route, the rising main traverses a mixture of manufacturing and industrial, grazing and other minimal use (rehabilitation) lands, but is predominately located within the road reserves of adjoining road networks or follows existing, disturbed access tracks in these areas. The closest sensitive receiver to the proposed rising main route is a rural-residential receiver, located approximately 100m east of the proposed route as it follows a bend in Kanandah Road, south of its intersection with Pinnacle Place.

6.10.3 ASSESSMENT OF IMPACT

6.10.3.1 Visual modification

The new BHSTP infrastructure will have a high degree of integration with existing Wills Street STP infrastructure, will be of a smaller overall footprint and located further away from residential receivers. This will result in a positive visual change. Over the longer term, there would be a low level of visual change, as the new BHSTP infrastructure replaces the existing infrastructure at the Wills Street STP site. The addition of the new PV system (i.e., solar farm) at the new BHSTP site will result in a visual change, as this is not a typical piece of STP infrastructure. However, given the industrial visual vista of the current sewerage treatment plant, the panels will have a high degree of visual integration.

At the South STP, there will be low levels of visual change in the short term from the installation of the new pump station, as the new pump station will have a high degree of integration with existing STP infrastructure. In the longer term there will be a moderate to high level of visual change as the existing STP infrastructure is decommissioned and removed from the site. This would result in a longer term positive visual change.

Construction activities along the proposed route of the rising main and treated effluent discharge pipe will result in medium to high level of visual change in the short term, as civil work (excavations and underbores where required) is undertaken to progressively install pipe infrastructure. Over the longer term, some sections of the pipelines that will be visible above ground, are expected to result in a medium visual change to the landscape. Where the pipelines will be installed underground, there is expected to be no long term visual change.

6.10.3.2 Visual sensitivity

The proposal is generally located away from sensitive residential receivers, being located in a landscape dominated by industrial and mining activities, intersected with existing electricity, road, water/sewerage pipeline, and rail infrastructure. The closest sensitive receiver is a residential property located at 4 Ryan Street (Lot 5270 DP757298), approximately 30m east of the existing Wills Street STP lot boundary, or approximately 350m east of the closest piece of active STP infrastructure (a sludge drying bed) at the site. This receiver will be located more than 500m from the nearest major new piece of STP infrastructure at the new BHSTP site, following decommissioning of the old STP infrastructure.

The nearest sensitive receiver to the South STP site, is approximately 560m to the northeast with no direct views. Nothing will change following installation of the new pump station at the site.

The majority of the proposed rising main route passes through undeveloped, or commercial / industrial land, without nearby sensitive receivers. The closest sensitive receiver to the proposed rising main route is a rural-residential receiver, located approximately 100m east of the proposed route as it follows a bend in Kanandah Road, south of its intersection with Pinnacle Place.

Given the low number of sensitive receivers along the proposed rising main route, and distance from the proposal site to nearest sensitive receivers, visual sensitive is assessed as low.

6.10.4 SUMMARY OF POTENTIAL IMPACTS

Visual modification has been assessed as being medium in the short term, whilst low in the longer term. Visual sensitivity is considered to be low. In accordance with the visual impact matrix, the proposed activity is likely to result in a minor visual impact.

6.11 Waste

6.11.1 ASSESSMENT OF IMPACT

Waste material generated from construction of the proposal would generally comprise the following:

- General construction waste including but not limited to cardboard, paper, wood, mesh, steel, concrete, and other damaged or excess construction materials
- General refuse generated by personnel including putrescible wastes, food scraps, packaging and other domestic wastes
- Surplus excavated soil material from cut and fill (although not expected), sludge from tertiary pond if it cannot be reused on-site, and trenching and underbore work from pipeline installation works
- Potential ACM waste from decommissioning activities, and if ACM is confirmed to be present within the historic fill area along southern boundary of the site, should excavation in this area be required.

Operation of the proposal will result in treated effluent being used by several different end users in accordance with relevant guidelines (refer **Section 2.2.8** and **Section 6.3**) and discharged to the environment in accordance with a revised EPL conditions.

6.11.2 ENVIRONMENTAL MITIGATION MEASURES

The following mitigation measures will be employed to minimise and manage impacts to waste:

- Any surplus soil that cannot be reused on site will be assessed against the virgin excavated natural material (VENM) criteria, any relevant waste exemption and order, or classified and disposed of at a facility lawfully able to accept the waste
- All wastes that are generated as a result of the project that cannot be reused will be classified in accordance with the *Waste Classification Guidelines* (EPA, 2014)
- All waste material will be reused, recycled, or disposed of at a facility lawfully capable of receiving the waste.

6.11.3 CONCLUSION

The proposal is not anticipated to generate a large quantity of waste. Given the mitigation measures outlined in this assessment, the overall environmental risk is considered to be low.

6.12 Bushfire

6.12.1 EXISTING ENVIRONMENT

The main operational areas of the existing Wills Street and South STPs, and sections of the proposed rising main and treated effluent discharge pipe as it traverses the Kanandah Road industrial area, are not located on land mapped as bushfire prone. Other parts of the existing STP sites and much of the rising main route is located on, or intersects with, land mapped as bushfire prone land, comprising of either Category 3 vegetation, or vegetation buffer (refer **Figure 75**).

6.12.2 ASSESSMENT OF IMPACT

The risk from, or starting of bushfires, is considered low given the majority of the work is being undertaken either within the existing operational areas of Wills Street or South STP sites, which are not mapped as bushfire prone and have vegetation buffers. The proposed rising main route traverses through areas mapped as category 3 vegetation, but follows existing tracks which are largely devoid of vegetation. Given the rising main will be largely constructed below ground, and of materials that will resist significant damage from bushfires, impact from bushfire is considered negligible. The rising main does not generate an electric current, and so does not pose a risk of igniting a bushfire.

6.12.3 ENVIRONMENTAL MITIGATION MEASURES

During construction, activities with the potential to generate a spark will be avoided, where possible, in the bushfire prone areas, during times of heightened bushfire risk. Ongoing vegetation maintenance would occur to ensure safe clearance distances are maintained around the new STP and pipeline infrastructure.

6.13 Traffic and Access

6.13.1 EXISTING ENVIRONMENT

The main access (1) to the existing Wills Street STP site is from a dedicated entry from Wills Street near the existing administration building. There are several alternative accesses to the site, including one to the west of the main access on Wills Street (2), which will become the new main site access once the new BHSTP plant is operational . Two additional alternative access roads (3 and 4) are provided from Kanandah Road to the south of the existing Wills Street STP site (refer **Figure 22** and **Figure 23**).

Access to the South STP site is via a dedicated access road that commences at the end of Picton Road.

The proposed rising main route will follow an existing unsealed road within the Willyama Common, as it exits the South STP, heading in a southern and then westerly direction, before joining with Kanandah Road, at the intersection with the Silver City Highway. From here the route follows Kanandah Road northwest and north to before heading west along Kanandah Place in the industrial estate, before entering a drainage easement and heading north following the route of the existing treated effluent discharge pipe, beneath the Peterborough Broken Hill Railway, across Crown Land (Willyama Common) and into the existing Will Street STP site (refer **Figure 2**).

Access to the proposal site can be gained from the existing road network and drainage easements.

6.13.2 ASSESSMENT OF IMPACT

A new access road (2) into the new BHSTP from Wills Street will be constructed to service the new septage receival, STP infrastructure and administration building. The new access road will provide access to septage receival without the need for tankers to traverse the operational area of the new STP and ensures entry to the site is via the area of the new administration building (refer **Figure 22**).

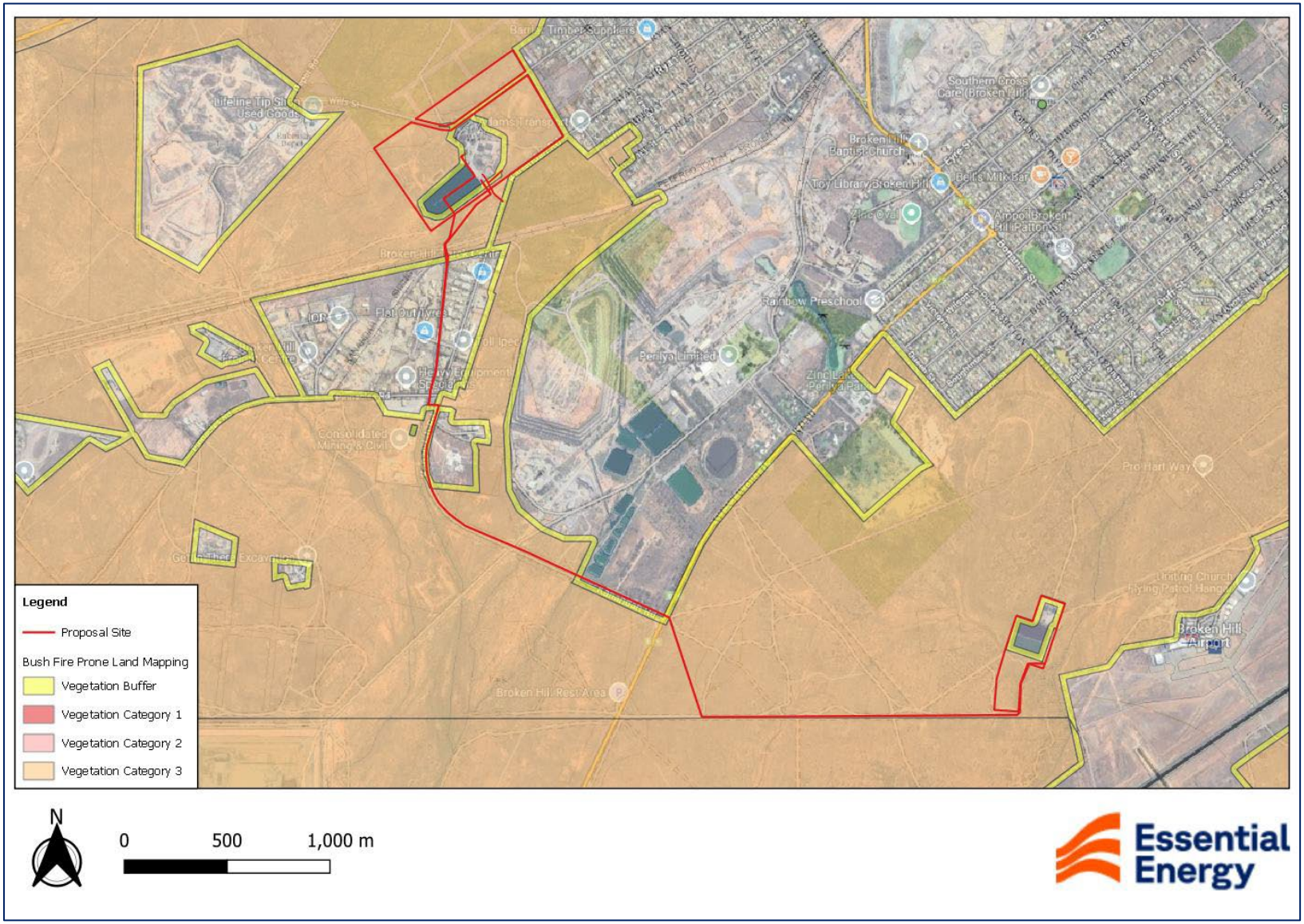


Figure 75: Mapped bushfire prone land in the vicinity of the proposal

The proposed pavement material for this new main access is asphaltic cement for straight sections of road, concrete for turning areas, crane set up areas, and the drive on chemical unloading bund, and unsealed for access road surrounding the emergency storage lagoon. The roads are proposed to be provided with cross fall towards kerb and guttering that will consist of inlet pits to capture stormwater runoff.

One of the existing site accesses (4) off Kanandah Road along the southern boundary will serve as the main access during the construction phase. A further existing site access (3), further to the west along Kanandah Road, may also be used during the construction phase (refer **Figure 23**). Both alternative access roads from Kanandah Road will minimise interactions between the construction activities for the new BHSTP and the operation of the existing Wills Street STP.

All other works sites, including access to the existing South STP and along the rising main route would be accessed via existing local roads.

During construction, work sites will receive multiple vehicle movements per day ranging from light utility vehicles through to heavy commercial machinery and trucks. The roads that will mostly be affected are Kanandah Road, the Silver City Highway and Wills Street during construction of the new BHSTP at the current Wills Street STP site, the discharge pipe replacement and the section of the new rising main west of the Silver City Highway. Picton Road will also experience some minor increase in traffic to complete the work at South STP, while the dirt access tracks on Crown Land (Willyama Common) will experience increased traffic during construction of the rising main east of the Silver City Highway. Users of these local roads may be subject to minor delays during the delivery of equipment or materials along the proposal site. Any impacts will be relative short and unlikely to create an unreasonable strain on the local road network.

The proposal involves work within the road reserves of several local roads, and crossing of the Silver City Highway, a classified road, and so will require Section 138 approvals from BHCC and TfNSW, respectively.

During operation, the proposal would only be accessed irregularly by maintenance personnel. The proposal would not strain the capacity of the road system.

6.13.3 ENVIRONMENTAL MITIGATION MEASURES

The following mitigation measure will be employed:

- The need for a traffic management plan (TMP) for various aspects of the work would be determined and, if required, completed prior to works commencing. The TMP would outline requirements for the safe and continued use of local transport corridors during construction
- Consultation will be undertaken with BHCC and TfNSW regarding proposed work within the road reserves of local roads, and the Silver City Highway, respectively.

6.13.4 CONCLUSION

The proposal would have traffic and access impacts during construction and maintenance operations. The impacts would be short term and minor. Given the mitigation measures outlined in this assessment, the overall environmental risk is considered to be low.

6.14 Land Use

6.14.1 EXISTING ENVIRONMENT

The proposal is located on, or passes through, the following land uses as mapped on the NSW Government layer NSWLanduse2017v1.5:

- Waste Treatment and disposal (sewage/sewerage)
- Reservoir/dam
- Manufacturing and industrial (major industrial complex)

- Services (commercial)
- Grazing native vegetation
- Other minimal use (rehabilitation).

Refer **Figure 76.**

6.14.2 ASSESSMENT OF IMPACT

Given the majority of the work is being undertaken either within the existing Wills Street or South STP sites, the proposal will not significantly change the land use. The proposed rising main route traverses several different land uses (manufacturing/industrial, grazing native vegetation, and other minimal use) comprised predominately of existing roadways and access tracks. Access to, and use of these tracks, and the road reserves will be temporarily disrupted during construction of the rising main. If required, alternative, safe access around the work areas will be made available. On completion of works, the tracks and road reserves will be returned as closely as practicable to their original condition.

The portion of the treated effluent discharge pipe to be replaced is predominately located on land subject to previous disturbance for the installation of the existing discharge pipe and other services. It will be located within existing easements for water/sewerage reticulation and traverses through the industrial areas to the south of the existing Wills Street site.

The new STP infrastructure, being located near the centre-south of the existing Wills Street STP site, has avoided the potential for odour and noise producing activities from encroaching further east towards residential receivers.

6.14.3 ENVIRONMENTAL MITIGATION MEASURES

The following measures should be adhered to during the construction phase of the proposed activity:

- Work sites along the proposed rising main route will be risk assessed to determine their level of potential interaction with the community. Potential mitigation may include fencing the worksite or some other obvious delineation to prevent public access
- Work sites along the rising main route should be left in a tidy condition at the conclusion of construction activities, and any damage to private property repaired.

6.14.4 CONCLUSION

Proposed work at the STP sites will be contained within the STP boundaries. Any impacts on land use along the rising main route are likely to be short term and minor. Given the nature of existing land uses, the overall environmental risk is considered to be low.

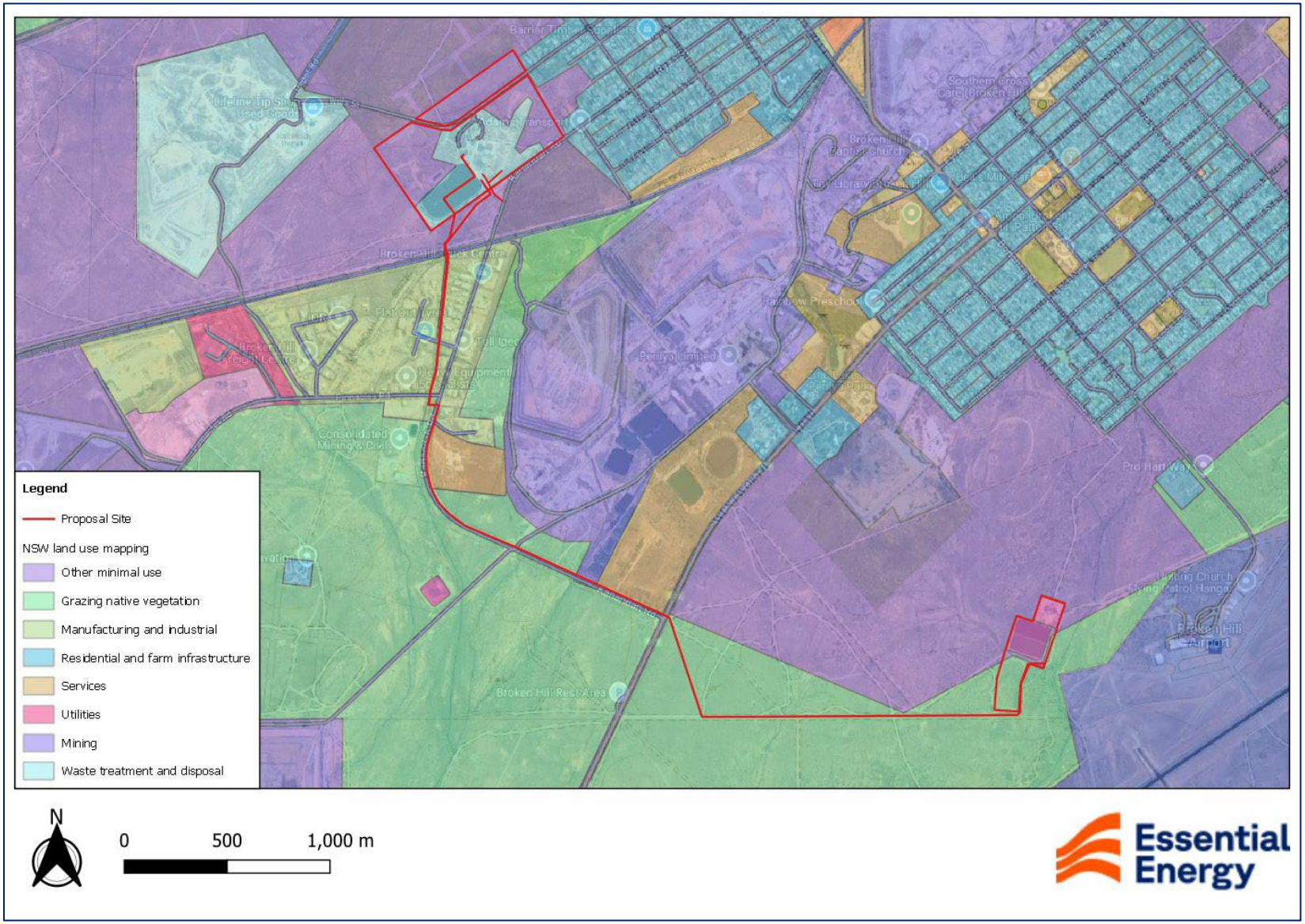


Figure 76: Land use in the vicinity of the proposal site

6.15 Social and Economic

6.15.1 EXISTING ENVIRONMENT

The proposal site is located in the BHCC LGA. The city of Broken Hill is the largest regional centre in the western half of NSW. It lies in the centre of the sparsely settled NSW outback, close to the South Australian border and midway between the Queensland and Victorian borders. The nearest population base is Mildura in Victoria, 300km to the south on the Murray River. The nearest capital city is Adelaide, approximately 500km to the southwest. Broken Hill is connected by air, rail and road to Sydney, Adelaide and Melbourne. The Far West NSW region relies heavily on Broken Hill for essential services and connectivity (BHCC, 2022).

In 2021, Broken Hill City had a usual resident population of 17,588 people, living in 9,585 dwellings with an average household size of 2.14. In 2021, Broken Hill City had lower proportion of children (under 18) and a higher proportion of persons aged 60 or older than Regional NSW. The largest age group in Broken Hill City was 60 to 64 year olds. The group that changed the most since 2016 was 55 to 59 year olds, decreasing by 186 people. The three largest ancestries in Broken Hill City in 2021 were Australian, English and Australian Aboriginal. In 2021, 5.1% of people in Broken Hill City were born overseas, compared with 12.2% in Regional NSW. 901 people who were living in Broken Hill City in 2021 were born overseas, and 24% arrived in Australia within 5 years prior to 2021 (id consulting pty ltd, 2021).

In 2021, 7,172 people living in Broken Hill City were employed, of which 62% worked full-time and 30% part-time. Health care and social assistance, and mining were the two biggest employing sectors in 2021, accounting for 21.8%, and 11%, respectively. Professionals, and community and personal service workers were the two most common occupations in Broken Hill City, making up 16.5% and 16.4% of the workforce in 2021 (id consulting pty ltd, 2021).

Broken Hill City has a strong mining history, beginning as a small mining village in the 1800s. The city became the birthplace of BHP in 1885, when it began mining the massive ore body containing the world's richest source of silver, lead and zinc. Broken Hill became Australia's first heritage listed city in 2015 (BHCC, 2024).

6.15.2 ASSESSMENT OF IMPACT

An improvement to the sewage treatment and reticulation network provides many benefits to the broader community through a safe and efficient means of transporting wastewater and treatment prior to reuse or disposal. The majority of construction and decommissioning activities will take place at the existing Wills Street and South existing STP sites, owned and operated by Essential Energy. Installation of the proposed rising main route, and replacement of the treated effluent discharge pipe, will also be partly located on Essential Energy owned land; partly on Crown Land, but largely within existing road and pipeline corridors.

Without upgrading the existing sewage treatment facilities in the area there is an increased risk of plant and equipment failure as the years passed. This would detrimentally impact on economic and social development of the region, and potentially prove to be very disruptive to existing commercial enterprises and to residences throughout the local area, and potentially result in widespread negative public health and environmental impacts.

Research of water conservation techniques and recycling will be important into the future to maintain scarce water resources as identified in the *Broken Hill Local Strategic Planning Statement (LSPS) 2020-2040* (BHCC, 2020). Wastewater facilities are identified as important enabling infrastructure related to several key action items in the *Far West Regional Plan 2036* (DPE, 2022b), while water and its management is identified as infrastructure priorities in the *Far West Regional Economic Development Strategy 2018-2022* (Balmoral Group Australia, 2018). Reuse of wastewater playing an important role in reducing demands on potable water supplies is also acknowledged in the *Regional Water Strategy: Western* (DPE, 2022c). The proposal, in part, supports these statements and priorities, through the continued supply of recycled water to mines and other major reuse customers in the local area.

The proposed new BHSTP infrastructure will be constructed and operational prior to the decommissioning of existing Wills Street or South STP sites. The proposal is therefore unlikely to affect community resources including existing sewage treatment facilities. Use of other community infrastructure, such as roads, water, and waste management services are unlikely to be significantly affected by the proposal. The proposal is unlikely to cause substantial change or disruption to the community through loss of neighbourhood cohesion, access to facilities, community identity, or cultural character.

Sewage reticulation and treatment is an essential service in the human environment, by virtue of enhancing productivity, comfort, safety, health and the economy. The benefits of safe and reliable sewage reticulation and treatment services are evident in every aspect of our lives. The proposal would benefit the local community through an upgraded, safe and reliable sewage reticulation and treatment services. The new STP infrastructure has been designed to improve the standard of treatment, resulting in improved water quality for reuse and discharge to the environment. Potential negative social impacts, such as odour and noise have been minimised as far as reasonably practical by design and mitigation measures outlined in this chapter. It is unlikely the proposal will result in any medium or long term negative impacts upon the community.

6.15.3 ENVIRONMENTAL MITIGATION MEASURES

The following mitigation measures will be employed to manage and minimise potential negative social and economic impacts:

- Management of construction traffic in the vicinity of construction works, including communication with local residents and road users
- Management of pedestrian traffic in urban and commercial areas
- Signs and barriers would be erected around construction work sites, where appropriate, to minimise the possibility of personnel injuries and prevent placing the public at risk.

6.15.4 CONCLUSION

Construction will be temporary in nature, and apart from some changes to the visual amenity and traffic volumes, long-term impacts are not expected.

Negative social impacts would be short-term and minor. Longer term positive impacts are expected due to the proposal improving the standard of water treatment, whilst minimising operational odour and noise impacts. Given the mitigation measures outlined in this assessment, the overall environmental risk is considered to be low.

6.16 Cumulative Impacts

Cumulative impacts may be experienced due to the interaction of elements within the proposal, or with other existing or proposed developments within the locality. Essential Energy is aware of two projects, one recently completed, and the other at project planning stage in the Pinnacles Place industrial estate approximately 800m southeast of the southern extent of the existing Wills Street STP site.

The first is the Broken Hill Battery Energy Storage System (BESS) Project, which includes the installation of new underground high voltage cables between the BESS and TransGrid's Broken Hill Substation. This project is currently under construction in the near vicinity of the proposal site, and near completion. Environmental impacts identified for the BESS development included dust, noise, vibration and water quality impacts during construction; biodiversity; Aboriginal and non-Aboriginal heritage; and hazardous materials.

The second is an Essential Energy project, involving an upgrade to the Pinnacles Place Zone Substation (ZS) and augmentation of the existing 22 kilovolt (kV) network between Essential Energy's Pinnacles Place ZS and TransGrid's Broken Hill 132kV Substation approximately 230m west of the Pinnacles Place ZS. Works also include the installation of earth bond and communication cables between the two substations. Potential environmental impacts identified for the Pinnacles Place ZS upgrade and associated works include dust, noise, water quality, biodiversity and visual impacts during construction.

Based on the range of environmental impacts associated with the proposal subject to assessment in this REF, and the known existing and proposed developments in the locality, the potential for cumulative impacts related to the proposal include dust, noise, visual amenity; and water quality impacts during construction. However, given the majority of the works will be limited to inside existing STP sites, timing and the localised extent of potential impacts during construction and operational phases of the proposal, the potential cumulative impact to other environmental factors during construction and operation of the proposal has been minimised to the greatest extent possible, and would not be significant. Any residual, minor impacts identified in this section of the REF can be mitigated and managed through the range of measures outlined in this section and summarised in **Table 40**.

6.17 Summary of Environmental Mitigation Measures

The environmental mitigation measures outlined in this document would be incorporated into the Project Construction Environmental Management Plan (CEMP). These safeguards would minimise any potential adverse impacts arising from the proposed works on the surrounding environment. The mitigation measures are summarised in **Table 40**.

Table 40: Summary of Environmental Mitigation Measures

ASPECT	ENVIRONMENTAL MITIGATION MEASURE	TIMING
General	▸ All environmental mitigation measures must be incorporated within the Construction Environmental Management Plan (CEMP), or relevant works plan as applicable for the proposed works.	Pre-works.
General	▸ Environmental awareness training must be provided to all field personnel, contractors and subcontractors.	Pre-works and during works as required.
Consultation	▸ Essential Energy, Essential Water and its appointed project management and design consultants have engaged in extensive and ongoing consultation with the NSW Department of Climate Change Energy, the Environment and Water (DCCEEW) and the EPA, to ensure the proposal meets statutory obligations regarding safety, human health and the environment. This consultation will continue through to the construction and operational phases of the project.	Project planning, pre-works and during works.
	▸ Essential Water is currently engaging with customers to develop its 2026-31 Pricing Proposal which outlines investments and prices over this period and is scheduled to be submitted to the NSW Independent Pricing and Regulatory Tribunal (IPART) in September 2025 for approval. Through this process, Essential Water has met with its Customer Panel and outlined that compliance with environmental obligations is driving the need to replace the existing, aging Wills Street STP. The Customer Panel had no specific feedback on the project but has identified the need for Essential Water to share information regarding the project with customers	Project planning, pre-works and during works.
	▸ Treated effluent reuse customers will be consulted with prior to construction work commencing advising of periods where flows of treated effluent may be restricted or unavailable.	Pre-works and during works.
Licences, Permits, Approvals and Notifications	▸ Willyama Common Trust License obtained from BHCC for any works within the Willyama Common in accordance with the *Commons Management Act 1989*.	Prior to construction of the rising main commencing.

ASPECT	ENVIRONMENTAL MITIGATION MEASURE	TIMING
	▸ New easements required under Section 2.18 of the *Crown land Management Act 2016* for portions of proposed rising main pipeline located on Crown Land, where there are no existing easements in place. ▸ Updated EPL required for the new BHSTP in accordance with the *Protection of the Environment Operations Act 1997*, with the eventual surrender of South STP EPL. ▸ Section 138 approval under the *Roads Act 1993* from TfNSW and BHCC for work within the road reserve of Silver City Highway and several local roads, respectively. ▸ Section 292(1) approval under the *Water Management Act 2000* for the construction, maintenance, and operation of water management works (including sewage works).	Prior to construction of the rising main commencing. Prior to the commissioning of the new BHSTP. Prior to work commencing in road reserves. Prior to construction, maintenance and operation of the new BHSTP.
Air Quality	▸ Any potential dust-borne materials transported to and from the activity site will be covered at all times during transportation ▸ Any exposed surfaces or temporary stockpiles of surplus excavated material will be covered or wet down during dry and windy conditions ▸ All vehicles and machinery will be maintained according to manufacturer requirements to ensure emissions are kept within acceptable limits.	During construction works.
Geology and Soil	▸ Risks associated with sediment and erosion will be managed in accordance with The Blue Book – Managing Urban Stormwater: Soils and Construction (Landcom 2004). In particular, controls including, but not limited to the following, will be implemented: › Diversion of upslope runoff around the proposal site in a way that minimises erosion, to be developed prior to bulk earthworks › Sediment control fences or other measures shall be installed at the downslope perimeter of disturbed areas, including any temporary stockpiles. › Maintenance of all erosion control measures at operational capacity until land is stabilised. ▸ Disturbed areas will be progressively stabilised as soon as practicable following construction activities ▸ A site specific Soil and Water Management Plan shall be included as part of the civil contractor's Construction Environmental Management Plan (CEMP)	Prior to and during construction works.

ASPECT	ENVIRONMENTAL MITIGATION MEASURE	TIMING
	▸ Essential Energy's CEOP8064 Management of Excavated Material; Guideline for Construction Sites will be consulted to determine the most appropriate beneficial reuse or disposal method for any surplus excavated materials.	
Water Quality and Hydrology	Construction: ▸ A Soil and Water Management Plan will be included as part of the CEMP ▸ Disturbed areas will be managed in accordance with the requirements of the Blue Book to minimise potential impacts to waterways. Sediment fencing will be erected, where required, downslope of disturbed areas, and impacts would be minimised where practicable. The use of filter bags may be required to discharge collected sediment-laden water where there are insufficient grassed areas available ▸ Appropriate scour protection would be installed at the discharge point to prevent erosion ▸ All areas where ground disturbance has occurred would be progressively stabilised following completion of works. ▸ Any water collected in excavations and trenches during rainfall and surface water ingress should be pumped to a grassed area on-site (where a suitable area is available) to allow for infiltration, reused for dust suppression, or pumped to stormwater using a sediment sock. All options should be conducted in a manner that does not result in turbid water entering the stormwater system or nearby waterway. ▸ Appropriate dewatering procedure for both the controlled discharge of the tertiary pond and from open excavations will be included as part of the CEMP ▸ It is anticipated that 3ML or less of groundwater will be taken via an aquifer interference activity. As such a water access licence exemption applies. While no application is needed to rely on the exemption, the water taken under the exemption must be recorded on the approved recording and reporting form at the end of each period of take no later than 24 hours after the water is taken, for each water year in which an exemption is claimed. The form must be provided to the Minister's representative within 28 days of the end of the water year in which the water was taken. The approved form is available here: https://www.waternsw.com.au/__data/assets/pdf_file/0005/160952/Recording-and-reporting-take-under-WAL-exemptions-form.pdf	Prior to and during construction works.

ASPECT	ENVIRONMENTAL MITIGATION MEASURE	TIMING
	▸ Any disposal of wastewater or fluids generated as part of construction works would be undertaken in a manner that does not cause water pollution. The CEMP would document an appropriate off-site disposal facility for treatment and disposal. ▸ A site-specific spill management plan would be prepared and include the following requirements: › Emergency spill kits are to be kept at the site (vehicle kits). › Refueling of machinery to be undertaken in a dedicated area within the construction compound appropriately protected as outlined in the spill management plan. › Workers would be trained in the spill management plan and the use of the spill kits. Operation: ▸ The existing EPL is to be amended and the new BHSTP operated in accordance with EPL conditions. Monitoring of effluent discharge will be undertaken in accordance with the EPL requirements. ▸ The existing Recycled Water Management Plans for Wills Street and South STPS will require consolidation, updating and approval prior to commissioning of the new BHSTP. ▸ Routine maintenance of the new BHSTP is to be undertaken in accordance with the Operations and Maintenance manual prepared for the new plant. ▸ The Operation Environmental Management Plan (OEMP) for the new BHSTP would be updated to detail appropriate actions in the event of equipment or power failure. The OEMP would be periodically reviewed to assess the efficacy of all management procedures. Identified shortcomings would be remedied to ensure these continue to be effective. ▸ Appropriate signage is to be maintained where chemicals are stored. ▸ The community would be notified of any incident with the potential to result in public health impacts. ▸	Prior to and during operation and maintenance
Noise and Vibration	▸ Minimise the number of machines operating simultaneously, particularly the louder machines such as excavators and the dozer	During construction works.

ASPECT	ENVIRONMENTAL MITIGATION MEASURE	TIMING
	▸ Ensure all machines are maintained in good condition with a particular focus on the engine and exhaust system to minimise noise from these components ▸ Operate each machine in a manner that avoids excessive noise, including switching a machine off rather than extended periods of unnecessary idling between periods of activity ▸ Operate all machines at moderate engine power and speed where full power is not required ▸ Avoid starting construction tasks, or any heavy vehicles arriving or operating on the site, before 7am ▸ Construction work that has the potential to create audible noise at the nearest sensitive receiver, will be between 7am and 6pm Monday to Friday and 8 am to 1 pm Saturday. On occasions works outside these hours may be undertaken where the following requirements are met: › Neighbours (and other sensitive receivers) adjacent to the works or the local council or the NSW Environment Protection Authority (EPA) have been notified; and › The works are justified on the basis that they are emergency works, or, because of supply security network outages or construction limitations, it is deemed that the works can only be achieved outside these hours. ▸ Any noise complaint will be investigated with additional control measures put in place if required ▸ A Noise Management Plan be prepared as part of the CEMP, and Demolition Plan prior to construction / demolition activities commencing and implemented throughout the duration of construction / demolition phases of the project.	Prior to construction and demolition works.
Flora and Fauna	The following impact avoidance and minimisation measures have been implemented in the design phase of this proposal: ▸ The proposal is largely located within previously cleared derived chenopod shrublands or previously cleared and disturbed land associated with the existing STP sites, drainage lines, road reserves and unsealed dirt tracks ▸ The proposal will avoid removal of native vegetation where practical.	Project planning and pre-works

ASPECT	ENVIRONMENTAL MITIGATION MEASURE	TIMING
	The following mitigation measures will be applied to further lower the potential impact of the proposal: ▸ Any change in design affecting land outside the areas assessed in this report will need to be considered against the current ecological survey effort, to determine if additional survey is required or an assessment can be made on current information. ▸ The extent of the clearing footprint is to be confined to the assessed areas as described in this REF ▸ Ensure groundcover disturbance is kept to a minimum and within the assessed areas ▸ Where possible, vegetation to be removed would be mulched on-site and re-used to stabilise disturbed areas ▸ Erosion and Sediment Control measures would be installed and maintained in accordance with Landcom's Managing Urban Stormwater, Soils & Construction Guidelines (The Blue Book) (Landcom 2004) ▸ Soil excavated within the proposal site will be used to back fill the excavation areas, enabling mid and lower stratum species quickly re-establish. ▸ Stockpile and compound sites would be located using the following criteria: ▸ At least 40 m away from the nearest waterway ▸ In areas of low ecological conservation significance (i.e. previously disturbed land) ▸ On relatively level ground ▸ Stockpiling materials and equipment and parking vehicles would be avoided within the dripline (extent of foliage cover) of any tree. ▸ Essential Energy has a general biosecurity duty under the Biosecurity Act 2015 to prevent, eliminate or minimise biosecurity risk so far as is reasonably practicable. Field crews shall follow procedures as outlined in Essential Energy's Operational Guideline: Biosecurity Risk Management (CERM1000.96) to prevent, eliminate or minimise biosecurity risk so far as is reasonably practicable, with particular reference to vehicle and equipment hygiene practises ▸ Any fallen timber, dead wood and bush rock (if present) encountered on site would be left in situ, or relocated to a suitable place nearby	During construction works

ASPECT	ENVIRONMENTAL MITIGATION MEASURE	TIMING
	▸ Do not refuel, store or decant chemicals within 50m of a waterway ▸ Immediately prior to commencement of any vegetation removal involving machinery and/or tree-felling the area of clearing work is to be inspected for fauna ▸ If fauna is detected, the animal is to be allowed to leave the site without any coercion, or a local wildlife rescue service is to be contacted to facilitate the safe removal of the animal from the worksite.	
Aboriginal Heritage	The following mitigation is required to reduce the potential for inadvertent impact to Aboriginal sites recorded within and outside the proposal site: ▸ Site supervisors, and construction work crews be made aware of the locations of Broken Hill STP AS04 and Broken Hill STP IF01 at the existing Wills Street STP. It is recommended that the sites are identified. ▸ BHSTP AS01, BHSTP AS02, and BHSTP AS03 to the northwest and west of the existing South STP site, are located at an adequate distance away from the proposed construction activities and do not require additional controls. Site supervisors and construction work crews would be made aware of their location. ▸ All staff working must be made aware of the legislative protection offered for all cultural heritage sites under the NPW Act.	Pre-works.
	In addition to these mitigation measures, the following general recommendations are made: ▸ If any objects of suspected Aboriginal heritage origin be encountered during the proposed works, activity in the area of the find should cease and the unexpected finds protocols (Appendix B of the Aboriginal Heritage Due Diligence Report, attached as Appendix E of this REF) should be implemented. ▸ If changes are made to the proposal which could impact locations outside of the current disturbance footprint, further archaeological investigation may be required. ▸ If suspected human remains are located during any stage of the proposed works, work must stop immediately, and the NSW police must be notified.	During constructions works
Non-Aboriginal Heritage	▸ All construction work would be undertaken within the assessed areas of the proposal site only	During construction works.

ASPECT	ENVIRONMENTAL MITIGATION MEASURE	TIMING
	▸ In the unlikely event that a previously unknown heritage site or object is located during construction of the proposal, works would cease immediately in that area and a representative from Essential Energy's Environmental Services would be notified. Works with the potential to disturb the object would not resume until the object had been properly identified, and appropriate action taken.	
Contamination	▸ It is intended to reuse surplus spoil beneficially on site, unless contamination is confirmed or suspected above land use thresholds during ground disturbance works (indicated by odours/staining/presence of hazardous materials) ▸ The existing groundwater monitoring program would continue in line with licence requirements to continue to monitor any trends in groundwater levels and quality at the site ▸ Essential Energy's CEOP8064 Management of Excavated Material; Guideline for Construction Sites will be consulted to determine the most appropriate beneficial reuse or disposal method for excavated materials ▸ Following dewatering of the tertiary pond, any sludge material that is required to be removed and disposed of off-site prior to backfilling should be assessed against NSW EPA guidance for the Use and Disposal of Biosolids Products, or classified and disposed of in accordance with the NSW Waste Classification Guidelines (EPA, 2014) ▸ In the event of encountering any suspected contamination in the work area, it will be separated and contained on site until it can be classified in accordance with the EPA (2014) Waste Classification Guidelines and then disposed of at a facility that is lawfully able to accept the waste ▸ Prior to the demolition of the existing STP structures and buildings for the purpose of future development, a hazardous material (including asbestos) survey of these structures/buildings should be conducted ▸ If work is proposed within an area where ACM are known to be present, a risk assessment should be undertaken before proceeding. Any removal of ACM should be undertaken by an appropriately licensed asbestos removalist ▸ A layer of crushed aggregate is recommended to be applied to the identified fill area noted to potentially include ACM along the southern boundary of the site in the vicinity of the proposed lay down area to provide a firm base, and separate layer to reduce the potential for vehicles to	During construction and operation works.

ASPECT	ENVIRONMENTAL MITIGATION MEASURE	TIMING
	disturb the ground. If significant surface disturbance or excavation is required in this area, further investigation would be required to confirm the presence of ACM. If confirmed, an asbestos management plan would be required to be prepared and implemented. ▸ Upon demolition of the existing structures and the removal of existing stockpiles affected by the development, the footprints of the demolished structures and the removed stockpiles should be assessed for the presence of any contamination ▸ Control measures will be implemented to manage risks associated with the handling of fuel through using spill trays when undertaking in field re-fuelling (although avoid and use service station where practicable) ▸ Sediment and erosion control structures will be established and maintained in accordance with The Blue Book to minimise potential impacts on receiving watercourses.	
Hazards and Chemical Management	▸ The new BHSTP is to operate in accordance with EPL conditions including any chemical storage limits or other requirements. ▸ The Pollution Incident Response Management Plan (PIRMP) for the existing Wills Street and South STP sites (CEOP8202) would be updated to reflect the new BHSTP ▸ Routine maintenance of the new BHSTP is to be undertaken in accordance with the Operations and Maintenance manual prepared for the plant. ▸ The transport and handling of any chemicals used in the operation of new BHSTP would be undertaken in accordance with all relevant SafeWork NSW guidelines ▸ Notification to the EPA in accordance with Part 5.7 of the POEO Act is to be undertaken where a pollution incident occurs in the course of an activity so that material harm to the environment is caused or threatened. ▸ Liquid chemical storage and filling areas would be located in bunded areas ▸ Storage tanks would be regularly inspected and maintained to ensure their integrity. Plant personnel would be trained for proper and safe operation of these facilities. ▸ Specific requirements for the management of chemicals associated with the new BHSTP would be detailed in an Operational Management Plan.	Project planning, pre-works and during construction and operation works.

ASPECT	ENVIRONMENTAL MITIGATION MEASURE	TIMING
	▸ All hazardous substances are to be listed in a register together with the relevant Safety Data Sheets. Employees are to have access to this register at all times. ▸ Fuel and lubricants for machinery maintenance are to be stored and managed appropriately. ▸ Appropriate signage is to be maintained where chemicals are stored.	
Visual	▸ Siting of the new BHSTP within the existing Wills Street STP site and as far as reasonably practicable from nearby sensitive receivers to the east has minimised potential visual impacts. ▸ Construction of the new rising main predominately below ground will minimise potential visual impacts	Project planning and design.
Waste	▸ Any surplus soil that cannot be reused on site will be assessed against the virgin excavated natural material (VENM) criteria, any relevant waste exemption and order, or classified and disposed of at a facility lawfully able to accept the waste ▸ All wastes that are generated as a result of the project that cannot be reused will be classified in accordance with the Waste Classification Guidelines (EPA, 2014) ▸ All waste material will be reused, recycled, or disposed of at a facility lawfully capable of receiving the waste.	During construction and operation works.
Bushfire	▸ During construction, activities with the potential to generate a spark will be avoided, where possible, in the bushfire prone areas, during times of heightened bushfire risk. ▸ Ongoing vegetation maintenance would occur to ensure safe clearance distances are maintained around the new STP and pipeline infrastructure.	During construction works. During operation and maintenance work.
Traffic and Access	▸ The need for a traffic management plan (TMP) for various aspects of the work would be determined and, if required, completed prior to works commencing. The TMP would outline requirements for the safe and continued use of local transport corridors during construction ▸ Consultation will be undertaken with BHCC and TfNSW regarding proposed work within the road reserves of local roads, and the Silver City Highway, respectively.	Pre-works and during construction works.

ASPECT	ENVIRONMENTAL MITIGATION MEASURE	TIMING
Land Use	▸ Work sites along the proposed rising main route will be risk assessed to determine their level of potential interaction with the community. Potential mitigation may include fencing the worksite or some other obvious delineation to prevent public access ▸ Work sites along the rising main route should be left in a tidy condition at the conclusion of construction activities, and any damage to private property repaired.	During construction works.
Social and Economic	▸ Management of construction traffic in the vicinity of construction works, including communication with local residents and road users ▸ Management of pedestrian traffic in urban and commercial areas ▸ Signs and barriers would be erected around construction work sites, where appropriate, to minimise the possibility of personnel injuries and prevent placing the public at risk.	Pre-works and during construction works.

7. Ecologically Sustainable Development

Ecologically sustainable development (ESD) is an attempt to provide the best outcomes for the human and natural environments both now and into the indefinite future. One of the most often cited definitions of sustainability is development that "meets the needs of the present without compromising the ability of future generations to meet their own needs". Sustainability relates to the continuity of economic, technical, social, institutional and environmental aspects of human society, as well as the non-human environment.

The existing environment has been described throughout **Section 6** of this REF for the various aspects of the natural environment assessed as part of this proposed activity.

The proposal has been assessed against the following four principles of ESD listed in the Protection of the Environment Administration Act 1991.

The four principles of ESD are:

- The precautionary principle: Section 6(2)(a)(i)(ii)
- The principle of inter-generational equity: Section 6(2)(b)
- The principle of biological diversity and ecological integrity: Section 6(2)(c)
- The principle of improved valuation of environmental resources: Section 6(2)(d)(i)(ii)(iii).

An assessment of the proposal against the principles is provided below.

7.1 Precautionary Principle

The precautionary principle states that:

'If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

In the application of the precautionary principle, public and private decisions should be guided by:

1) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment; and

2) an assessment of the risk weighted consequence of various options.'

For the precautionary principle to be applicable, two pre-conditions must be satisfied; "*first it is not necessary that serious or irreversible environmental damage has actually occurred – it is the threat of such damage that is required. Secondly, the environmental damage threatened must attain the threshold of being serious or irreversible*"[1].

If there is no threat of serious or irreversible environmental damage, there is no basis upon which the precautionary principle can apply.

Environmental investigations, including a quantitative ecological, Aboriginal heritage due diligence assessment, noise and odour impact assessments have been undertaken during the preparation of this REF to ensure that the potential environmental impacts are understood with a high degree of certainty. The spatial scale of impacts would be local and isolated to the immediate construction and operational areas. Therefore, it can be concluded that this proposal will not result in a threat of serious or irreversible damage.

Mitigation measures have also been proposed in this REF to minimise the identified potential impacts of the project. A Construction Environmental Management Plan (CEMP) will be developed and implemented as a precautionary measure, and no mitigation measures have been deferred due to a lack of scientific certainty. The proposal is therefore consistent with the precautionary principle.

[1] Telstra Corporation Limited v Hornsby Shire Council [2006] NSWLEC 133, Preston CJ at 129

7.2 Principle of Inter-generational Equity

The principle of inter-generational equity states that:

'The present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.'

To the extent possible, all environmental impacts and appropriate mitigation measures have been identified. The proposal would not harm the health, diversity and productivity of the environment to such an extent that future generations would not be able to benefit.

The proposal is therefore consistent with the principle of inter-generational equity.

7.3 Principle of Biological Diversity and Ecological Integrity

The principle of biological diversity and ecological integrity states that:

'*Conservation of biological diversity and ecological integrity should be a fundamental consideration.*'

The proposal comprises the upgrade of STP infrastructure at existing disturbed STP sites, construction of a new rising main and replacement of the existing treated effluent discharge pipe from the existing Wills Street STP. A quantitative ecological assessment has been prepared, which concluded the proposal will not result in a significant impact to the ecological values present in the proposal site. Impacts upon ecological integrity would therefore be negligible, as described in **Section 6.5.**

7.4 Improved Valuation of Environmental Resources

The principle of improved valuation of environmental resources states that:

'*Environmental factors should be included in the valuation of assets and services such as:*

- *Polluter pays – that is, those who generate pollution and waste should bear the cost of containment, avoidance and abatement*
- *The users of goods and services should pay prices based on the full life cycle of costs of providing those goods and services, including the use of natural resources and assets and the ultimate disposal of any waste*
- *Environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms that enable those best placed to maximise benefits or minimise cost to develop their own solutions and responses to environmental problems.'*

The proposal has been designed taking into consideration the least possible impact on the environment. All costs associated with the containment, avoidance and abatement of pollution have been factored into the design of this proposal. The new STP infrastructure and rising main will result in an improvement to the sewage treatment and reticulation network, providing many benefits to the broader community through a safe and efficient means of transporting wastewater, prior to treatment, reuse or discharge to the environment.

8. Environmental Management Plan

8.1 Construction Environmental Management Plan

A Construction Environmental Management Plan (CEMP) outlines the environmental objectives of a project, the environmental mitigation measures to be implemented, the timing of implementation, responsibilities for implementation and management, and a review process to determine the effectiveness of the strategies.

The construction contractor(s) would be required to develop a project-specific CEMP that addresses the scope of works to be undertaken. The CEMP would detail how the works would be undertaken to comply with all environmental laws, Essential Energy's environmental policy, and the environmental mitigation measures described in this REF.

The key objectives of the CEMP would include:

- Ensuring that the works are carried out in accordance with legislative requirements and relevant non-statutory policies
- Ensuring that the works are carried out in accordance with the requirements detailed in this REF, including all requirements outlined in any relevant approvals, permits or licences and the mitigation measures described in **Section 6**
- Ensuring that employees engaged to undertake the works comply with the conditions detailed in the CEMP
- Identifying management responsibilities and reporting requirements to demonstrate compliance with the CEMP

It is also noted that the CEMP would be a working document and may be amended over the course of the project.

If a particular activity falls outside the scope of the REF and CEMP, and it would increase the environmental impact, the activity is not permitted to continue without an appropriate environmental assessment under the EP&A Act.

8.2 Implementation of the CEMP

The CEMP would be a working document and would be amended should strategies initially implemented be found to be inadequate to manage environmental impacts. The CEMP would typically:

- Establish environmental goals and objectives
- Detail the conditions of approval
- List actions, timing and responsibilities for implementation that arise from the mitigation measures recommended in this REF
- Detail statutory requirements
- Provide a framework for reporting on relevant matters on an ongoing basis
- Detail training requirements for personnel in environmental awareness and best practice environmental management systems
- Outline emergency procedures, including contact names and corrective actions
- Detail process surveillance and auditing procedures
- List complaint handling procedures
- Detail quality assurance procedures.

8.2.1 AUDITING SCHEDULE OF THE CEMP

Auditing of the proposal would be undertaken to establish whether the contractor is conducting activities in accordance with their current environmental management plans and whether the management plans are providing an effective tool to control adverse environmental impacts.

The following activities are proposed to achieve the audit's purpose:

- Review the on-site implementation of the contractor's CEMP
- Review the documentation process to determine if planned works have received endorsement to proceed
- Monitor the compliance of construction activities with the project determination and environmental legislation
- Review the outcomes of any previous audit(s) and determine if there has been any change in the environmental performance of the construction contractor
- Identify opportunities to improve on-site environmental management practices.

The benefits of conducting the environmental audit are to allow:

- Feedback on the CEMP implementation process to assist both the contractor and project manager to improve the future preparation of site environmental management documentation
- Improve the planning of construction projects through documentation and impact assessment to ensure best environmental management practices are implemented on site
- Improve environmental management processes on site.

8.3 Operational Environmental Management Plan

Prior to commissioning of the new plant and equipment at both the existing Wills Street and South STP sites, an Operational Environmental Management Plan (OEMP) is to be developed and implemented during the operational and maintenance phases of the project.

9. Environmental Checklist

In accordance with Section 5.5 of the EP&A Act and Section 171 of the EP&A Reg when assessing the environmental impact of an activity on the environment, Essential Energy must consider the factors identified in **Table 41** and **Table 42** below.

Table 41: Section 5.5 requirements

REQUIREMENT	SECTION REFERENCE
For the purpose of attaining the objects of this Act relating to the protection and enhancement of the environment, a determining authority in its consideration of an activity shall, notwithstanding any other provisions of this Act or the provisions of any other Act or of any instrument made under this or any other Act, examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity.	Section 2, 6, 7 and 8.
Without limiting the above, a determining authority shall consider the effect of an activity on any wilderness area (within the meaning of the *Wilderness Act 1987*) in the locality in which the activity is intended to be carried on.	N/A – there are no wilderness areas within or close to the activity area.

Table 42: Section 171 Checklist

SECTION 171	REF SECTION REFERENCE
The environmental impact on a community *The new STP infrastructure will be located within the existing, disturbed and highly modified Wills Street and South STP sites. The proposed new rising main route and discharge pipe replacement traverses disturbed and modified environments, associated with existing roads, tracks, easements used for water and sewage pipeline infrastructure and railway corridors. Impacts on the community have been considered by this REF. These include noise, dust, odour, social and visual impacts. With the exception of construction noise and visual, these have been assessed to be low. Noise and visual impacts have been assessed as moderate in the short term and low/minor over the long term.*	Sections 6.1, 6.2, 6.3, 6.4, 6.6, 6.7, 6.8, 6.9, 6.10, 6.11, 6.12, 6.13 6.14 and 6.15.
The transformation of a locality *In the short term there will be a degree of visual change associated with site preparatory works, civil works and construction of the new STP infrastructure at the new BHSTP site, and along the rising main route. Over the longer term the new STP infrastructure at the new BHSTP will represent a permanent visual change, however, a high degree of integration with existing STP infrastructure at the existing STP site will occur and is not considered significant. Similarly, there will be a degree of visual change associated with site preparatory works, civil works and construction for the addition of the new pump station at South STP, but over the longer term there will be a high degree of integration with existing STP infrastructure. The proposed rising main will be constructed predominately below ground. Once excavated areas associated with the below ground sections of the rising main and discharge pipeline are reinstated, no long term visual impacts are expected. Any above*	Sections 6.10, 6.14 and 6.15.

SECTION 171	REF SECTION REFERENCE
ground sections of the rising main will result in a longer term visual modification, however these sections will be considerable distances from sensitive visual receivers and unlikely to have a significant visual impact.	
The environmental impact on the ecosystems of the locality *The majority of the proposal site will be located within the existing cleared, heavily modified and disturbed land. Impacts to threatened species, populations and ecological communities from the construction, operation and maintenance of the proposal have been assessed in this REF, and not likely to result in a significant impact.*	Sections 6.5 and 7, Appendix D.
Reduction of the aesthetic, recreational, scientific, or other environmental quality or value of a locality *An overall reduction in aesthetic and recreational quality of the locality is unlikely to occur during the proposed works. Localised impacts may occur at the construction work sites, however, these impacts will be temporary and of short duration, and can be managed through implementation of mitigation measures in this REF.*	Sections 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 6.8, 6.9, 6.10, 6.14, 6.15 and 6.16.
The effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations *No sites of Aboriginal heritage will be impacted by the proposal. An Aboriginal heritage due diligence assessment was undertaken in accordance with the Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales (NSW DECCW, 2010). This assessment concluded that considering the highly disturbed nature of the proposal site, and the design which avoids harm to identified Aboriginal objects, the proposal is not likely to impact Aboriginal heritage.* *A review of non-Aboriginal heritage databases, registers and LEPs indicated no sites of world state or local heritage significance were identified at, or nearby the proposal site. However, the proposal site is situated within the City of Broken Hill National Heritage Place, a matter of national environmental significance (MNES) under the EPBC Act. The proposed action will take place on land already used for sewage treatment, or in the case of the proposed rising main, will largely follow existing roadways and tracks. The proposal site is located away from areas of identified ore body, mining areas, or culturally or aesthetically important areas of Broken Hill. It is unlikely that the proposal will result in the National Heritage Values of the City of Broken Hill being lost, degraded, damaged, notably altered, modified, obscured or diminished, as a result of the proposal.*	Sections 6.6, 6.7, Appendix E, Appendix F.
The impact on the habitat of protected fauna (within the meaning of the *Biodiversity Conservation Act 2016*) *An ecological impact assessment was prepared for the proposal. The assessment concluded that the proposed activity is not likely to significantly impact threatened fauna species and their habitat.*	Section 6.5

SECTION 171	REF SECTION REFERENCE
The endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air *It is not anticipated that the proposal will endanger any species of animal, plant or other form of life, whether living on land, in water, or in the air.*	Section 6.5, Appendix D.
Long-term effects on the environment *Long-term adverse environmental effects are not anticipated.*	Sections 6 and 7.
Degradation of the quality of the environment *This risk is considered low with the implementation of the management measures included in this REF.*	Sections 6.1, 6.2, 6.3, 6.5 and 6.8.
Risk to the safety of the environment *There is the potential risk to the environment from spillage of materials during construction of the proposal. Implementation of the mitigation measures contained in **Section 6** of this REF will ensure that potential environmental risks are minimised.*	Sections 6.1, 6.2, 6.3, 6.8, 6.11, 6.12, 6.13, 6.14 and 7.
Reduction in the range of beneficial uses of the environment *No long-term reduction in the range of beneficial uses of the environment is anticipated as a result of the proposal.*	Section 6 and 7.
Pollution of the environment *Risk of pollution to the environment is considered low and can be managed with implementation of mitigation measures provided in this REF.*	Section 6.
Environmental problems associated with the disposal of waste *Waste generated by the proposed works will be minor. All wastes that are generated by the project will be appropriately disposed of in accordance with the Waste Classification Guidelines (EPA, 2014).* *Any surplus excavated soil that cannot be reused on site will be assessed against the virgin excavated natural material (VENM) criteria, any relevant waste order and exemption, or classified and disposed of at a facility lawfully able to accept the waste.* *Operation of the proposal will result in treated effluent being used by several different end users in accordance with relevant guidelines and discharged to the environment in accordance with a revised EPL.*	Sections 6.11, 6.3, 2.2.8, 5.3.10.
Increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply *The proposal is unlikely to increase demands upon rare natural resources.*	Section 6.

SECTION 171	REF SECTION REFERENCE
The cumulative environmental effect with other existing or likely future activities *Based on the range of environmental impacts associated with the proposal subject to assessment in this REF, and the known existing and proposed developments in the locality, the potential for cumulative impacts related to the proposal include dust, noise, visual amenity; and water quality impacts during construction. However, given the majority of the works will be limited to inside existing STP sites, timing and the localised extent of potential impacts during construction and operational phases of the proposal, the potential cumulative impact to other environmental factors during construction and operation of the proposal has been minimised to the greatest extent possible, and would not be significant. Any residual, minor impacts identified in the REF can be mitigated and managed through the range of measures outlined in this section and summarised in **Table 40**.*	Section 6.16.
The impact on coastal processes and coastal hazards, including those under projected climate change conditions *The proposal is not located on the coast.*	Section 3.4.
Applicable local strategic planning statements, regional strategic plans or district strategic plans made under the Act, Division 3.1 *Research of water conservation techniques and recycling will be important into the future to maintain scarce water resources as identified in the Broken Hill Local Strategic Planning Statement (LSPS) 2020-2040 (BHCC, 2020). Wastewater facilities are identified as important enabling infrastructure related to several key action items in the Far West Regional Plan 2036 (DPE, 2022b), while water and its management is identified as infrastructure priorities in the Far West Regional Economic Development Strategy 2018-2022 (Balmoral Group Australia, 2018). Reuse of wastewater playing an important role in reducing demands on potable water supplies is also acknowledged in the Regional Water Strategy: Western (DPE, 2022c).* *The proposal, in part, supports these statements and priorities, through the continued supply of recycled water to mines and other major reuse customers in the local area.*	Section 6.15.
Other relevant environmental factors *No other relevant environmental factors have been identified during the preparation of this REF*	N/A.

10. Conclusion

This REF has been prepared to assess the environmental impacts associated with the construction, operation and maintenance of the Wills Street STP replacement project. Essential Energy is a determining authority as defined in the EP&A Act. As such, the activity has been assessed under Part 5, Division 5.1 of the EP&A Act.

The proposal would enable the upgrade of the local sewage treatment and reticulation network, which among other things, will improve treated effluent discharge quality, ensure that the plant capacity is adequate for the projected population (load), be cost effective when assessed on a life cycle cost basis, and provide durability and reliability of the intended function.

The proposal complies with the provisions of Section 5.5 of the EP&A Act and Section 171 of the EP&A Reg as shown in **Section 9**.

The proposal and its associated environmental impacts are unlikely to have a significant impact on the environment. The proposal would improve sewage treatment and reticulation services in Broken Hill, maximising the social and economic benefits, whilst minimising any adverse environmental impacts.

11. References

- AECOM. (2022). Broken Hill Battery Energy Storage System Project Modification Aboriginal Cultural Heritage Assessment Report, Sydney, AECOM Australia Pty Ltd.
- AECOM Australia Pty Ltd. (2021). Broken Hill Battery Energy Storage System Project Aboriginal Cultural Heritage Assessment Report, Sydney, AECOM Australia Pty Ltd.
- AREA Environmental & Heritage Consultants Pty Ltd (AREA), 2025a, Ecological Impact Assessment Wills Street Sewage Treatment Plant (STP) Upgrade Project, AREA, May 2025
- AREA, 2025b, Aboriginal Due Diligence Report Wills Street Sewage Treatment Plant (STP) Upgrade Project, AREA, May 2025
- AREA Environmental and Heritage Consultants, 2024, Two Proposed Trenches for New Underground 22Kv Electricity Communication and Earth Bond Cables Aboriginal Heritage Due Diligence Assessment Report
- Australian Government, Department of Climate Change, Energy, the Environment and Water (DCCEEW), 2025a, Australia's World Heritage List, https://www.dcceew.gov.au/parks-heritage/heritage/places/world-heritage-list, Accessed 23 April 2025.
- Australian Government, DCCEEW, 2025b, Australia's National Heritage List, https://www.dcceew.gov.au/parks-heritage/heritage/places/national-heritage-list, Accessed 23 April 2025.
- Australian Government, DCCEEW, 2021, Novel biota and their impact on biodiversity Retrieved from Novel biota and their impact on biodiversity, https://www.dcceew.gov.au/environment/biodiversity/threatened/key-threatening-processes/novel-biota-impact-on-biodiversity
- Australian Government, Department of the Environment (DoE), 2013, Matters of National Environmental Significance - Significant impact guidelines 1.1 - Environment Protection and Biodiversity Conservation Act 1999. Department of the Environment. Canberra, ACT: Commonwealth of Australia, http://www.environment.gov.au/system/files/resources/42f84df4-720b-4dcf-b262-48679a3aba58/files/nes-guidelines_1.pdf
- Balmoral Group Australia (BGA), 2018, Far West Regional Economic Development Strategy 2018-2022, BGA, 2018
- Beca Hunter H2O, 2025a, Broken Hill WWTP Design Basis and Proposed Design Approach, May 2025
- Beca Hunter H2O, 2025b, Essential Water Broken Hill Waste Water Treatment Plant Beca HunterH2O Project No. – 7015, Preliminary Drawings (85% Design), 27 May 2025
- Beca HunterH2O, 2024a, Broken Hill STP Design Basis and Preliminary Concept Design Review Report, June 2024
- Beca HunterH2O, 2024b, Broken Hill STP Preliminary Concept Design Report, December 2024
- Beca, 2024, Geotechnical Interpretive Report Broken Hill Sewage Treatment Plants (STPs) and Pipeline Upgrade, Beca, 26 November 2024.
- Beca HunterH2O, 2023, Technical Memo – Greenhouse Gas Emissions, September 2013
- Benson, J., 2009, New South Wales Vegetation Classification and Assessment, NSWVCA database. Sydney, NSW Department of Environment and Conservation
- Bureau of Meteorology (BoM), 2024a, Climate Statistics for Australian Locations: Broken Hill Airport AWS. Retrieved from http://www.bom.gov.au/climate/averages/tables/cw_047048.shtml
- BoM, 2024b, Groundwater Dependent Ecosystem Atlas, Retrieved from http://www.bom.gov.au/water/groundwater/gde/map.shtml
- Bridges Acoustics, 2025 Wills Street Sewage Treatment Plant Replacement Noise Impact Assessment Report J0182-12-R1, 19 13 June 2025

- Broken Hill Local Environmental Plan 2013
- Broken Hill City Council (BHCC), 2020, Broken Hill Local Strategic Planning Statement 2020-240, BHCC 2020.
- BHCC, 2024, History, https://www.brokenhill.nsw.gov.au/Community/About-the-city/History, Accessed 13 June 2024)
- Cupper, M., 2015, Aboriginal Cultural Heritage Due Diligence Assessment: Broken Hill Water Treatment Plant. Merbein: LandSkape Natural and Cultural Heritage Management.
- Department of Environment and Conservation (DEC), 2004, Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities. Sydney, NSW, NSW DEC
- Department of Climate Change, Energy, the Environment and Water (DCCEEW) (NSW), 2024, Threatened biodiversity profile search, Retrieved from https://threatenedspecies.bionet.nsw.gov.au/
- DCCEEW (Commonwealth) 2025a, Australia's World Heritage List, https://www.dcceew.gov.au/parks-heritage/heritage/places/world-heritage-list, Accessed 23 April 2025.
- DCCEEW (Commonwealth) 2025b, Australia's National Heritage List, https://www.dcceew.gov.au/parks-heritage/heritage/places/national-heritage-list, Accessed 23 April 2025.
- Department of Environment and Climate Change (DECC), 2009, Interim Construction Noise Guideline, DECC, July 2009.
- Department of Environment, Climate Change and Water (DECCW), 2011 NSW Road Noise Policy, DECCW, March 2011.
- DECCW, 2010a, Mitchell Landscapes NSW OEH v3 2011. Bioregional Assessment Source Dataset.
- DECCW, 2010b, Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales, DECCW, 13 September 2010.
- DECCW, 2010c, Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales, DECCW, 24 September 2010.
- Department of Planning and Environment (DPE), 2022a, Guidelines for Division 5.1 assessments, DPE, June 2022.
- DPE, 2022b, Far West Regional Plan 2036, DPE, 2017.
- DPE, 2022c, Regional Water Strategy: Western, DPE, December 2022.
- Dunn, I., & Shaukar, R., 2003, The Bioregions of New South Wales, their Biodiversity, conservation and history. Hurstville: NSW National Parks and Wildlife Services.
- Eco Logical Australia, 2022, Broken Hill BESS: High Voltage Power Easement (Stage 2) Heritage. Eco Logical Australia.
- EnviroKey Pty Ltd, 2013, Review of Environmental Factors White Leeds Pipeline, Broken Hill, NSW, Tathra, EnviroKey Pty Ltd.
- EnvironOdour Australia Pty Ltd, 2023, Consulting Report on Air Quality Impact Assessment for Wills Street STP Replacement, Broken Hill, EnvionOdour, 12 September 2023.
- EnvironOdour Australia Pty Ltd, 2025, Consulting Report on Air Quality Impact Assessment for Wills Street STP Replacement, Broken Hill, EnvionOdour, 13 March 2025.
- Environmental Protection Authority (EPA), 2014, Waste Classification Guidelines, Sydney, NSW EPA, November 2014.
- EPA, 2025a, Contaminated land - record of notices, https://app.epa.nsw.gov.au/prclmapp/searchregister.aspx, Accessed 23 April 2025.
- EPA, 2025b, List of NSW contaminated sites notified to EPA, https://www.epa.nsw.gov.au/your-environment/contaminated-land/notified-and-regulated-contaminated-land/list-of-notified-sites, Accessed 23 April 2025.
- EPA, 2017, Noise Policy for Industry, EPA, October 2017

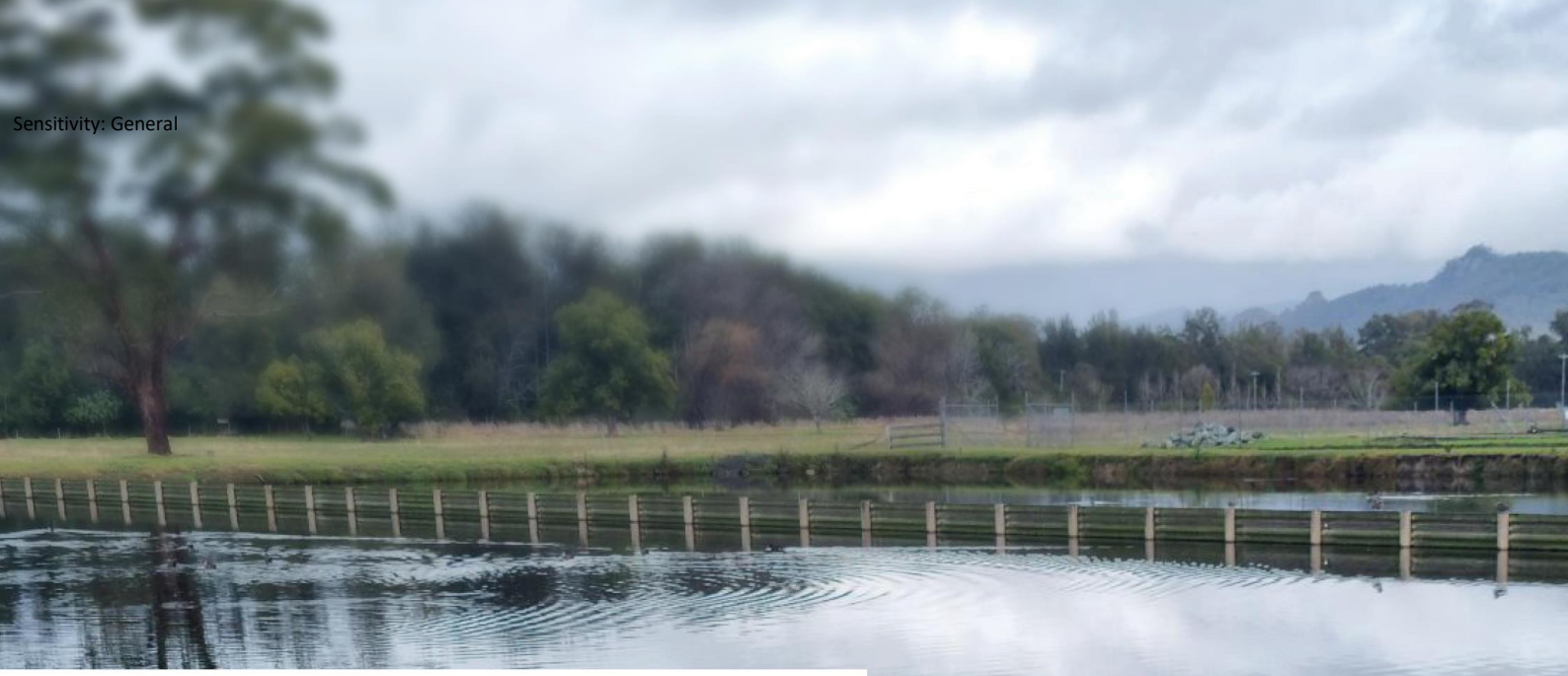
- EPA, 2000, Environmental Guidelines Use and Disposal of Biosolids Products, December 2000.
- Environment Protection and Heritage Council (EPHC), the Natural Resource Management Ministerial Council (NRMMC) and the Australian Health Ministers' Conference, 2006, National Water Quality Management Strategy - Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1), November 2006
- Essential Water, 2025, Wills Street Waste Water Treatment Plant Environmental Protection License No: 3925, Essential Water, Accessed 1 April 2025, https://essentialwater.com.au/water-insights/waste-water-treatment-plant-monitoring-data/wills-street-waste-water-treatment-plant/
- Heritage NSW, 2025, State Heritage Inventory, https://www.environment.nsw.gov.au/topics/heritage/search-heritage-databases/state-heritage-inventory, Accessed 23 April 2025.
- Forestry Commission of Tasmania, 1983, Visual Management System.
- GHD, 2019, Broken Hill Wastewater Treatment Strategy Options Assessment, GHD, August 2019
- Hercus, L. A., 1982, The Bagandji Language Pacific Linguistic Series B - No 67.
- Hercus, L. A., 1993, Barkandji Dictionary. Canberra: AIATSIS
- Heritage Search, 2001, Mineral Separation Plant, Broken Hill, NSW: Aboriginal and Non Aboriginal Heritage Assessment, Bulli: Resource Strategies.
- Kearns, R. H., 1951, Book Collectors' Society of Australia. (1947). Biblionews Vol. 4 No. 8. Retrieved from National Library of Australia: http://nla.gov.au/nla.obj-2987602660
- Kearns, R. H., 1976, Broken Hill Volume 4 1940-1973 Towards the Century. Broken: The Broken Hill Historical Society.
- Kleinfelder Pty Ltd, 2024, Broken Hill Wastewater Treatment Plant - Biosolid Assessment 1 Wills Street, Broken Hill, NSW 2880, Kleinfelder, Ref: 25001557.001A, 24 October 2024
- Landcom 2004, Managing Urban Stormwater: Soils and Construction, 4th edition.
- Martin, S. 1988., Archaeological Survey of Proposed Telecom Tower Sites near Ivanhoe Central Western NSW. A Report to Telecom Australia.
- Martin, S., 1991, Cobar Rock Art Management Study. A Report to the NSW NPWS. Sydney.
- Mitchell, P., 2008, Descriptions for NSW (Mitchell) Landscapes. Department of Environment and Climate Change.
- New South Wales Archaeology Pty Ltd, 2007, Silverton Wind Farm, NSW: Stages 2 and 3 and Powerline Route (Broken Hill to Red Cliffs) Aboriginal Heritage and Non Indigenous Heritage. Central Tilba: Silverton Wind Farm Development.
- NSW Government, 2024, Transitional native vegetation regulatory map viewer. Retrieved from https://www.lmbc.nsw.gov.au/Maps/index.html?viewer=NVRMap
- Office of Environment and Heritage (OEH), Guide to investigating, assessing, and reporting on Aboriginal cultural heritage in NSW, OEH, April 2011
- OzArk Environment and Heritage, 2025, Aboriginal Cultural Heritage Test Excavation Report, Pinnacles Place, OzArk, 2025
- Ozark Environmental and Heritage Management Pty Ltd, 2012, Broken Hill Solar Plant Environmental Assessment. Dubbo, Ozark Environmental and Heritage Management Pty Ltd.
- Public Works Advisory (PWA), 2018a, Broken Hill Sewerage Scheme Replacement of Wills Street and Southern STPs Options Study, Report Number: WSR 18063, PWA, October 2018.
- PWA, 2018b, Broken Hill Sewerage Wills Street Sewage Treatment Plant Upgrade Preliminary Contamination Investigation, Report Number: ISR18086/B November 2018
- PWA, 2019a, Broken Hill Sewage Treatment Plant (STP) Augmentation Concept Development, Report Number: WSR 18067, PWA, February 2019.

- PWA, 2019b, Broken Hill Sewerage Wills Street Sewage Treatment Plan Upgrade Geotechnical Investigation, Report Number: ISR18086/A, PWA, April 2019.
- PWA, 2022, Integrated Water Cycle Management Strategy, Report Number: ISR22022, June 2022
- Standards Australia, 1995, Australian standard AS 4323.1 Stationary source emissions, method 1: selection of sampling positions, Sydney Australia.
- Standards Australia, 2001, Australian/New Zealand Standard AS/NZS 4323.3:2001, Stationary source emissions – Part 3: Determination of odour concentration by dynamic olfactometry, Sydney, Australia.
- Standard Australia, 2009, Australian/New Zealand Standard AS/NZS 4323.4:2009 Stationary source emissions Area source sampling - Flux chamber technique (Reconfirmed 2020)
- Stern, H., & et al., 2000, Objective Classification of Australian Climates, Australian Meteorological Magazine 49.
- Thompson, P., 1986, Blantyre seismic survey, Sydney: BHP Petroleum.
- Tonkin Consulting, 2015, Wills Street Wastewater Treatment Plant Stormwater Management Plan, Tonkin Consulting, January 2015, Ref No. 20130630FR3A
- Tonkin Consulting, 2014, Wills Street Wastewater Treatment Plant Hydrogeological Study, Tonkin Consulting, December 2014, Ref No. 20130630FR24
- United States Department of Agriculture Forest Service, 1974, National Forest Landscape Management, Volume 2.

Appendix A: Broken Hill WWTP Design Basis and Proposed Design Approach

(BECA HunterH2O, 2025a)

Sensitivity: General



Report

Broken Hill WWTP

Design Basis and Proposed Design Approach

Essential Water

May 2025

Beca HunterH2O | ABN 16 602 201 552

Beca hunterh2o
the future of water

Report Details

Project Title	Broken Hill WWTP: Design Basis and Proposed Design Approach
Project No	
Document Location	P:\HH2O\Essential Energy\Broken Hill STP Concept And Detailed Design\2. Tasks\10. Design Basis\Concept Design Report\Broken Hill STP_Design Basis & Preliminary Concept_REV4.Docx
Enquiries	Project Manager
	obert.moyo@beca.com.au

Beca HunterH2O is committed to the delivery of this project within the timeframes detailed in this proposal, however as Essential Water would appreciate, the current COVID-19 event may have an impact on these timeframes. Beca HunterH2O values its record of strong delivery of projects and will keep Essential Water informed of any actual impacts throughout the project's delivery.

Document History and Status

Revision	Report Status	Prepared By	Reviewed By	Approved By	Issue Date
A	Draft	J. Ball B. Ma	P. Greenhalgh	R. Ferguson	22/11/2023
1	Updated	B. Ma	P. Greenhalgh	Obert Moyo	31/05/2024
2	Updated	B. Ma	P. Greenhalgh	R. Ferguson	05/06/2024
3	Updated	B. Ma	P. Greenhalgh	R. Ferguson	06/06/2024
4	updated	B. Ma	P. Greenhalgh	O. Moyo	13/12/2024
5	85% submission	B. Ma	P. Greenhalgh	O. Moyo	27/5/2025

Copyright © Hunter H2O Holdings Pty Limited 2025
The concepts and information contained in this document are the property of Hunter H2O Holdings Pty Limited for the sole use of the nominated client. Use or copying of this document without the written permission of Hunter H2O constitutes an infringement of copyright.

Contents

1 Glossary of Terms 1
2 Introduction 2
2.1 Background 2
2.2 Project Objectives 3
2.3 Project Scope 3
2.4 Purpose of the Report 3
2.5 Concept Refinement 3
2.6 Safety in Design and Design Standards 5
3 Design Basis 7
3.1 Design Horizon 7
3.2 Connected Population 7
3.3 Effluent Quality Requirements 7
3.3.1 Current Environmental Discharge Quality 7
3.3.2 Proposed Effluent Quality Requirements 8
3.4 Flow Loadings 10
3.4.1 Hydraulic Contribution and Average Dry Weather Flow 10
3.4.2 Peak Dry Weather Flow 10
3.4.3 Peak Wet Weather Flow 11
3.4.4 Peak Instantaneous Flow 12
3.4.5 Design Flow Summary 15
3.5 Domestic Sewage 15
3.5.1 Sewage Characteristics 15
3.5.2 Sewage Fractions 17
3.6 Tankered Waste 18
3.7 Effluent Reuse 18
3.7.1 Current Reuse Scheme 18
3.7.2 Effluent Reuse Quality 20
3.8 Biosolids Management 22
3.9 Odour 22
3.10 Noise 23
3.11 Temperature 24
4 Design Description 25
4.1 Process Description 25
4.2 Hydraulic Design 32
4.3 Key Process Units 36
4.3.1 South STP Sewage Pump Station 36
4.3.2 Preliminary Treatment (Inlet Works) 37

4.3.3 Secondary Treatment 45
4.3.4 Effluent UV Feed Pumps & Effluent UV Disinfection 53
4.3.5 Effluent Outfall 55
4.3.6 Tertiary Treatment 55
4.3.7 Waste Sludge and Biosolids Handling 61
4.3.8 Chemical Dosing System 67
4.3.9 Odour Control 71
4.3.10 Emergency Storage Pond and Return 72
4.3.11 Foul Water Pump Station 74
4.4 Site Access 75
4.5 Storm Water Drainage 75
4.6 Bushfire 76
4.7 Landscaping 76
4.8 Onsite Amenities and Laboratory 76
4.9 Access Platforms / Handrails 76
4.10 Power and Water 77
4.11 Solar System Investigation 77
4.12 Control System 78
4.12.1 PLC 78
4.12.2 SCADA 78
4.13 Security 79
4.14 Sliding Access Gate 79
4.15 CCTV 79
5 Capital Cost Estimation 80

Figures

Figure 2-1: The layout of the existing Wills St STP and South STP 2
Figure 3-1: Process flow diagram, proposed flow and monitoring points. 9
Figure 3-2: Total daily flows to Wills St and South STPs and the calculated total ADWF (2011-2023) 10
Figure 3-3: Broken Hill STP Diurnal Profile from 6-10th of August 2018 11
Figure 3-4 Broken Hill Combined influent flow as a function of ADWF 12
Figure 3-5: Preliminary odour contour map, courtesy Environ Odour (2023) 23
Figure 4-1:Process Flow Diagram for the Proposed BHWWTP Upgrade 29
Figure 4-2: General Arrangement for the Proposed BHWWTP Upgrade 31
Figure 4-3: Preliminary HGL for the Proposed BHWWTP Upgrade 35
Figure 4-4: South STP transfer pump station wet well preliminary arrangement. 36
Figure 4-5: Preliminary #D model of inlet works arrangement. 38
Figure 4-6: Typical Screw Screen (CST Wastewater solutions) 39

Figure 4-7: Screw Screen Screenings discharge 39
Figure 4-8: Typical Vortex Grit Chamber and Grit Washer (VOR-Environmental)....40
Figure 4-9: Preliminary arrangement of proposed septage receival. .... **Error! Bookmark not defined.**
Figure 4-10: Preliminary general arrangement of secondary treatment process. 45
Figure 4-11: Operating cycle change between normal dry weather and wet weather cycles 47
Figure 4-12: Preliminary decanter and balance tank arrangement. 51
Figure 4-13: Preliminary general arrangement of secondary effluent UV system.....53
Figure 4-14: Preliminary general arrangement of tertiary treatment area. 56
Figure 4-15: Example inline UV disinfection system 57
Figure 4-16: Preliminary arrangement of sludge dewatering and outloading area. 61
Figure 4-17: Example of floating decanter system (courtesy Liquitek Water and Wastewater)....62
Figure 4-18: Preliminary arrangement of aerobic digestion process.....63
Figure 4-19: Screw Press (Huber, Q-PRESS)....64
Figure 4-20: Example of powder polymer storage and dosing system courtesy Tomal (2023). 65
Figure 4-21: Preliminary arrangement of chemical storage and dosing area. 68
Figure 4-22: Preliminary arrangement of odour control system. 72
Figure 4-23: Preliminary arrangement showing emergency storage pond. 73
Figure 4-24: Proposed new site access point location. 75
Figure 4-25: Amenities building preliminary arrangement section. 76
Figure 4-26: Location of proposed solar system. 78

Tables

Table 1-1: Glossary of Terms 1
Table 3-1: Wills St and South STP Effluent Quality Requirements (100%ile)....8
Table 3-2: Wills St STP and South STP Effluent Load Limits 8
Table 3-3: Revised Effluent Quality for the Broken Hill STP Augmentation 9
Table 3-4: Loading assessment summary....13
Table 3-5: Design Flows for the BHWWTP 15
Table 3-6: Average Raw Sewage Quality for Wills St STP (72hour Monitoring Period) 16
Table 3-7: Typical Sewage Loading and Adopted Raw Sewage Characteristics for Design 17
Table 3-8: Adopted Raw Sewage Fractions 17
Table 3-9 Adopted Tankered Waste Characteristics and Loading for BHWWTP Upgrade 18
Table 3-10: Current Recycled Water End Users 19
Table 3-11: Current Reuse Scheme LRV Estimation 20
Table 3-12: LRV targets and process capabilities as per PWC's concept design 21
Table 3-13: LRV targets with proposed process units for Broken Hill STP 21
Table 4-1: Inlet works preliminary process sizing....43
Table 4-2: Secondary Treatment preliminary design information....45

Table 4-3: IDEAs Cycle Setup 47
Table 4-4: IDEA tanks aeration design information 48
Table 4-5: Bio-selector design information 49
Table 4-6: RAS and WAS design information 50
Table 4-7: Decanter and effluent balance tank preliminary design information 52
Table 4-8: Effluent UV System and effluent discharge Preliminary Design Summary 54
Table 4-9: Tertiary Process Feed Pumps and Inline UV System Preliminary Design Summary 57
Table 4-10: CCT Preliminary Design Summary 58
Table 4-11: Recycled Water Tank Preliminary Design Summary 59
Table 4-12: Preliminary design information for the effluent reuse pump station 60
Table 4-13: Sludge handling preliminary process sizing 66
Table 4-14: Chemical storage and dosing process sizing 70
Table 4-15: Odour Control preliminary process sizing 71
Table 4-16: Emergency storage pond and return preliminary process sizing 74
Table 4-17: Foul water pumping station process sizing 74

Appendices

Appendix A. Loadings Assessment and Capacity Review
Appendix B. Technical Memo – Tertiary treatment Options Discussion for Broken Hill STP Upgrade Project
Appendix C. Technical Memo -Sludge Management Options Discussion
Appendix D. Option Odour Modelling Report
Appendix E. P&IDs
Appendix F. Technical Memo – New site location
Appendix G. Technical Memo – Effluent Outfall
Appendix H. Cost Estimate
Appendix I. 3D Preliminary Model
Appendix J. CHAIR 1 Report

1 Glossary of Terms

Table 1-1: Glossary of Terms

Acronym	Definition
ADWF	Average Dry Weather Flow
AEP	annual exceedance Probability
AGWR	Australian Guidelines for Water Recycling
BHCC	Broken Hill City Council
BHWWTP	Broken Hill Sewage Treatment Plant
BOD	Biological Oxygen Demand
BWL	Bottom Water Level
CCT	Chlorine Contact Tank
COD	Carbon Oxygen Demand
DPE	Department Planning and Environment
EP	Equivalent Population
EPA	Environmental Protection Authority
EPL	Environmental Protection Licence
ET	Equivalent Tenement
EW	Essential Water
IDEA	Intermittently Decanted Extended Aeration
IWCM	Integrated Water Cycle Management
LGA	Local Government Area
LRV	Log Removal Values
MDWF	Minimum Dry Weather Flow
PDWF	Peak Dry Weather Flow
PFTF	Peak Full Treatment Flow
PIF	Peal Instantaneous Flow
PWA	Public Works Advisory
PWWF	Peak Wet Weather Flow
REF	Review of Environmental Factors
SPS	Sewage Pump Station
SOUR	Standard Oxygen Uptake Rate
STP	Sewage Treatment Plant
SRT	Sludge Retention Time
TKN	Total Kjeldahl Nitrogen
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
TWL	Top Water Level
UV	Ultraviolet
UVT	UV transmissivity
WSAA	Water Services Association of Australia

2 Introduction

Section 2 describes the background, project objectives and project scope for the upgrade.

It is noted that this report is intended to confirm the key treatment process elements only. Where design values are provided, they are preliminary only and will be refined as site investigations progress.

2.1 Background

Broken Hill is in far-western NSW, near the South Australian border. The town, which currently has an urban population of about 17,500, lies within Broken Hill City Council's (BHCC) Local Government Area (LGA). The town has two sewage treatment plants (STP's), the Wills Street and South STP's, with both owned and operated by Essential Water (EW).

The Wills Street STP was commissioned in 1939, upgraded in 1956, and again in the 1980s. This STP is at the end of its useful life and should be replaced urgently. Treated effluent from the Wills Street STP is reused by local mines, the Broken Hill Golf Course, the White Leeds wetland, and other end users. Excess effluent is discharged to the open earthen channel via gravity.

The South STP was built in the 1960's and is in a relatively poor condition reflecting of the age of the plant. This STP now requires significant remedial works to ensure reliable ongoing service.

The layout of the treatment facilities at the existing STP sites is shown in Figure 2-1.

Figure 2-1: The layout of the existing Wills St STP and South STP

A treatment plant augmentation options assessment was completed by GHD in 2011. The report found that decommissioning South STP and transferring its influent sewage to a new Wills St STP named as Broken Hill wastewater treatment plant (BHWWTP).

Following this, an options study was completed in October 2018 by Public Works Advisory (PWA) to assess potential WWTP sites for the new WWTP construction. EWs preferred augmentation option is to construct a new Intermittently Decanted Extended Aeration (IDEA) type activated sludge plant within the existing Wills St STP site. As a separate project, sewage from the South STP catchment will be pumped to an augmented Wills St STP. A business case was developed by PWA in 2019 to support the design and construction of the new STP.

EW commissioned Beca Hunter H_2O to develop a revised concept design, then detailed design and provide the necessary tender documentation required to deliver 'value for money' infrastructure via a primarily Construct Only Contract.

2.2 Project Objectives

The project aims to achieve the following key drivers established by EW:

- Replace an 80-year-old asset at the end of its useful life with a modern facility with additional capacity. The additional capacity at the Wills St STP will provide the opportunity to later retire the much smaller South STP.
- Provide sufficient treatment to meet the NSW EPA effluent discharge and effluent reuse criteria.
- Ensure that odour, aerosols and noise from the STP are appropriately controlled and managed to minimise their impact on workers and neighbours.
- Ensure that the plant capacity is adequate for the projected population (load) increases expected over the next 30 years (to the year 2048).
- Provide Council sufficient detail within the detailed design package to enable Council to tender for a complete construction package.
- Be delivered within the budget and on time.
- Maintain effective treatment during construction.

2.3 Project Scope

There are four phases to the delivery of the detailed design.

- Project Preliminaries – This involves information review, development of project management plans and site visits.
- Design Development – This involves further development of the existing concept design to confirm major structure sizes and locations. This process includes a series of workshops with EW. stakeholders, allowing input and to assist in risk mitigation.
- Detailed Design – This phase requires development of civil, mechanical, electrical, structural, architectural and process detailed design drawings. This detailed design report summarises development of these design packages.
- Construction Tender Documentation – This phase involves the development of technical specifications and supporting documentation for the construction tender. EW will be responsible for then preparing the final tender packages to enable delivery via a construct only Contract.

2.4 Purpose of the Report

This report provides the BHWWTP upgrade design basis and the proposed design approach.

2.5 Concept Refinement

As part of the design process, the existing concept design was interrogated based on up-to-date information and stakeholder preferences. This section discusses the key deviations from the original concept design.

1) The design peak instantaneous raw sewage flow has changed

The methodology used for the estimation of peak instantaneous flow within the original concept design was suitable for a high-level assessment only. A thorough review of available data including, where available pump station capacities was conducted. The result of the review was a significant reduction in the peak flow

to the transfer pump station at South STP and a significant reduction in the peak flow received at Wills Street STP.

Refer to Appendix A for the Loadings Assessment and Capacity Review

2) Abandonment of plan to use one of the existing trickling filters at South STP for buffering peak wet weather flows.

During the progression of the design basis, it was determined that the existing trickling filters are unlikely to be suitable for reuse as buffer storage. The trickling filters are aged and not designed to be water retaining structures. Modifying the trickling filters to be used for said storage, especially considering any impacts on the existing plant operation was deemed unlikely to provide any cost benefit. Through collaborative stakeholder engagement, it was decided a new South STP transfer pumping station will be constructed with a maximum transfer capacity of 56L/s.

3) The new Broken Hill STP has moved to the decommissioned maturation pond

EW had initially noted that the placement of the new STP within the original concept was unlikely to be favourable due to its proximity to nearby receptors (noise and odour risk). Through collaborative stakeholder workshops, it was decided to change the location to the west of the existing Will Street STP infrastructure to provide greater buffer distances. This decision has been supported through the procurement of odour modelling as part of a separate project. Further changes of plant location include situating the bulk of the WWTW infrastructure in the to be decommissioned maturation pond. This decision was driven by unfavourable geotechnical conditions in the previously selected site.

4) Abandonment of the existing maturation ponds

The existing maturation pond provides some benefits as it attenuates wet weather flows and provides some additional pathogen removal. Groundwater monitoring indicates the pond leaks and algae growth within the pond deteriorates the effluent quality to the point where there is a significant risk of breach of the proposed effluent licence limits. Through collaborative stakeholder workshops, it was decided to abandon the existing maturation pond.

5) The need for a new effluent outfall pipeline

The effluent outfall capacity assessment indicates that the existing outfall pipeline is unlikely to be sufficient to convey the peak flows described in this report. Through collaborative stakeholder engagement, it was decided to abandon the existing effluent outfall pipeline with construction a new gravity pipeline to suit the peak effluent discharge flow.

Refer to effluent outfall technical Memo for more details.

6) The need for improved effluent treatment for reuse

Concern was raised regarding the suitability of the effluent produced by the proposed process without filtration for reuse purposes. In particular, the assertion that the effluent produced is suitable for Unrestricted Municipal Reuse as defined in the Australian Guidelines for Water Recycling (AGWR).

Refer to Appendix B: Technical Memo – Tertiary Treatment Options Discussion for Broken Hill STP Upgrade Project for more details.

Through collaborative stakeholder workshops, it was decided to defer the filtration construction by applying the following approaches:

- Investigate end-use controls in lieu of filtration to reduce public exposure, this would need to be guided by EW to determine the required end-use controls to reduce risk.
- Operate initially without filtration and rely on good upstream control of the secondary process. Online turbidity analysers are to be provided upstream UV and chlorine contact tank (CCT) with automatic flow diverting away from the recycled water facility if turbidity or UV transmissivity (UVT)

is out of the pre-validation operational window, reuse is only provided when the plant is performing well.

- Provision shall be made for the filtration system if deemed necessary in the future (such as footprint, backwash water usage, backwashed wastewater return, maximum power demand and switchboard).

7) Change from sludge lagoons using existing drying beds for sludge management to aerobic digestion with mechanical dewatering.

Sludge lagoons provide a simple and typically low operational input solution for sludge management in small STPs. The proposed site presents challenging geotechnical conditions with hard rock close to the surface in a number of locations which significantly increased the cost of providing sludge lagoons. The sludge lagoons have a larger odour footprint and have the potential to impact nearby sensitive receptors, particularly if located to the east of the existing STP.

The sludge lagoons emit methane which contributes significant Scope 1 emissions. Installation and removing sludge from the lagoons of the size and number required for the proposed STP would be operationally complex and potentially present a safety risk.

Aerobic digestion was proposed and approved as an alternative process. Although aerobic digestion requires more frequent operation and monitoring, the required input aligns well with that required for the new intermittent process. Further aerobic digestion in this instance would require reduced manual intervention.

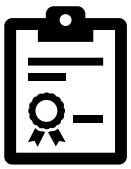
Aerobic digestion can be provided at either a similar or lower cost than the sludge lagoon options and would produce significantly less Scope 1 GHG emissions. Aerobic digestion and dewatering will have a significantly smaller odour footprint than sludge lagoons. Less likely to impact nearby receptors. The use of aerobic digestion is also more aligned with future regulatory changes.

Refer to Appendix C: Technical Memo -Sludge Management Options Discussion for Broken Hill STP Upgrade Project for more details.

2.6 Safety in Design and Design Standards

The design has been developed to comply with all relevant industry standards and regulations. Noting that the design is at the 30% details / concept level, further refinement to confirm continued compliance is required. This continued compliance includes Beca Hunter H2O quality management systems and the development of thorough specification documents to guide the construction contract.

Beca HunterH2O has an integrated Business Management System including triple certification with Quality certified to ISO 9001, Work Health & Safety certified to ISO 45001 and Environmental Management System certified to ISO 14001. Beca HunterH2O is also accredited to the NSW Government's WHS Audit Guidelines 5th edition. The Quality Management, Safety Management and Environmental Management System's registration scope covers the provision of Engineering and Consulting Services to the water and wastewater industry and associated fields, including management consulting, planning, environmental, survey, design, construction, project management, commissioning and operational services.



Beca HunterH2O is committed to providing our clients with products and services that are produced to a high quality and meet our clients' needs.

Beca HunterH2O's safety objective is to have no harm at work and support our commitment to the health and wellbeing of our people through the provision of safe and healthy working conditions.

Beca HunterH2O's environmental vision is to minimise our environmental footprint including prevention of pollution by working in a responsible manner.

Each of these systems is prominent in the project planning for each project and as such a project plan is developed to ensure the process meets the management system requirements, and therefore the final product meets the requirements of our customer.

Beca HunterH2O's QMS0105 HSEQ Management System Manual defines the processes that contribute to the achievement of a product or service that meets customer and legal requirements, as well as our own internal requirements, including performing work in a safe and environmentally responsible manner. It also includes provisions for maintaining these processes under controlled and defined conditions in order to maintain organisational knowledge and to achieve continual improvement.

As part of the design process, a Construction hazard assessment implication review (CHAIR) 1 was conducted on the 28th of November. The CHAIR 1 process is a preliminary review conducted during the concept phase of the project. A Hazard and Operability Study (HAZOP) was conducted on the 6th of November. It is noted that further safety and design review is required to capture continued design changes. A key example being the change to using 920 kg chlorine gas drums and the inclusion of a new effluent outfall pipeline.

The CHAIR 1 process utilises a series of guide words to systematically explore significant risks to health, safety or the environment during the construction and operation of the upgrade. The CHAIR 1 also develops a series of possible solutions / safeguards within a workshop environment that will be employed or included within the design to reduce risks associated with identified hazards to acceptable levels. Although the tool doesn't explicitly detail environmental risk assessment, it will be included in the process.

The CHAIR 1 workshop was undertaken in line with NSW Workcover guidelines (CHAIR, Safety in Design Tool). A draft CHAIR report was generated from the workshop (Appendix F). The report acts to summarise the review process and lists identified issues, associated risks, mitigation strategies to be adopted and responsible persons. The report forms an integral part of the Safety in Design process and will append the detailed design report. A final version of the report inclusive of EW review is provided with this report.

HAZOP studies use a series of guide words to systematically explore abnormal operation modes within process lines (as detailed on draft P&ID drawings within the design development package) and identify the hazards associated with process operation. The control philosophy detailed within this report was be used to inform the intended operation of the plant. Similar to the CHAIR process, a HAZOP report was prepared and submitted in draft form and then updated based on EW comments.

3 Design Basis

The adopted design criteria for the Broken Hill STP detailed design details the following items.

- Design Horizon
- Connected Population
- Flow Loadings
- Raw Sewage Characteristics
- Environmental Discharge Requirements
- Effluent Reuse Quality
- Biosolids Requirement
- Odour
- Noise
- Temperature

Each item is discussed in further detail below.

3.1 Design Horizon

The proposed project design horizon is to provide capacity for 2048 loads per the project brief.

3.2 Connected Population

The STP catchment population projections have been established by EW and form part of the Integrated Water Cycle Management (IWCM) and also defined in the NSW Public Works Advisory (PWC) provided concept design report (PWC, 2018).

From Billing data analysis, the connected Equivalent Population (EP) to Wills Street STP and South STP is estimated at 18,465 and 4,879 respectively, with the combined total EP of 23,344 (PWA, 2018).

A catchment loading of 24,000 EP has been adopted for the design the same as the PWC concept design report. Selecting a design loading so close to the current loading was proposed as the population in Broken Hill has been stable or decreasing for at least the last 20 years. Loadings were challenged as part of this project however there has been no change to the design loading as a result.

3.3 Effluent Quality Requirements

3.3.1 Current Environmental Discharge Quality

The Wills St and South STPs operate under the following licences:

- Environmental Protection Licence (EPL) 3925 Wills St Wastewater Treatment Plant
- EPL 5067 South Wastewater treatment plant

Table 3-1 summarises the concentration limits for each STP, and Table 3-2 presents the load limits for each STP.

Table 3-1: Wills St and South STP Effluent Quality Requirements (100%ile)

Parameter	Units	Wills St	South
Biochemical Oxygen Demand (BOD)	mg/L	50	50
Faecal Coliforms	cfu/100mL	-	600
Nitrogen (Ammonia)	mg/L	-	-
Nitrogen (Total)	mg/L	-	-
Oil & Grease	mg/L	10	10
pH	-	6.5 – 8.5	6.5 – 8.5
Phosphorus (Total)	mg/L	-	-
Total Suspended Solids	mg/L	50	50

Table 3-2: Wills St STP and South STP Effluent Load Limits

Pollutant	Wills St STP Annual Load (kg/annum)	South STP Annual Load (kg/annum)
Biochemical oxygen demand (BOD)	14,900	2,400
Nitrogen (Total)	27,558	5,000
Oil & Grease	3,300	1,000
Phosphorus (Total)	10,800	2,450
Total Suspended Solids	37,450	4,900

The Wills St STP EPL5067 also provides the following license requirements:

- All flows up to 95 L/s must receive screening, degritting, primary sedimentation, trickling filtration, secondary sedimentation, final ponding and ultraviolet disinfection
- With flows between 95 and 144 L/s requiring screening, degritting, primary sedimentation, trickling filtration, secondary sedimentation and final ponding
- The volume/mass limit at point 2 (flowmeter at the effluent flume) must not exceed 18,150kL/d

The South STP EPL3925 also provides the following license requirements:

- All flows up to 400 L/s must receive primary and secondary sedimentation, screening and aeration
- With flows between 400 and 800 L/s requiring screening, degritting, primary sedimentation and disinfection
- The volume/mass limit at point 10 (flow meter at front of premises of South STP) must not exceed the limit of 3,628kL/d

There appears some conflict regarding the flow range for both Wills St and South STPs. It is believed the current EPLs will not apply for the new Broken Hill STP.

3.3.2 Proposed Effluent Quality Requirements

With endorsement from NSW EPA, the BHWWTP proposed will be designed to achieve the new Environmental Protection Authority (EPA) effluent quality requirements as shown in Table 3-3.

Table 3-3: Revised Effluent Quality for the Broken Hill STP Augmentation

Parameter	Units	100th Percentile Limit
Biological Oxygen Demand, BOD5	mg/L	20
Total Suspended Solids, TSS	mg/L	30
Ammonium Nitrogen, NH_3-N	mg/L	5
Total Nitrogen, TN	mg/L	20
Total Phosphorus, TP	mg/L	2
Oil and Grease, O&G	mg/L	10
pH	Unit	6.5-8.5
Faecal Coliforms	Org/100mL	600

The design intent of the proposed Broken Hill STP is to achieve the 100th percentile limits up to nominally 3 x ADWF. When the inflow is greater than 3 x ADWF, as would occur in a wet weather event, the level of treatment is reduced which may lead to contaminant concentrations more than the 100th percentile limits shown in Table 3-3.

It is understood that the NSW EPA recognises that an STP will from time to time exceed its licence limits, including during wet weather events. Demonstration of this recognition through the inclusion of a note in the EPL would be beneficial for future licencing discussions.

A process flow diagram showing the proposed flow and quality monitoring points for the STP are presented in Figure 3-1.

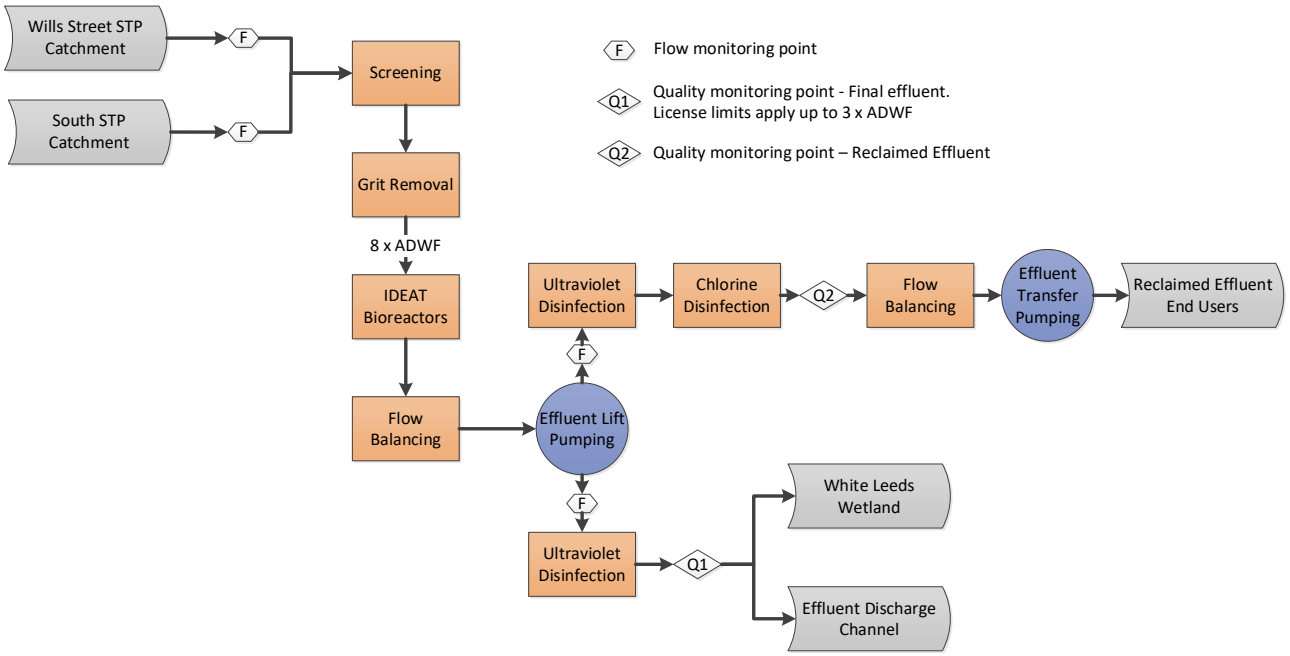


Figure 3-1: Process flow diagram, proposed flow and monitoring points.

3.4 Flow Loadings

Design flow loadings have been established utilising existing data and projections based upon standard ratios between average dry weather flow (ADWF), peak dry weather flow (PDWF), peak wet weather flow (PWWF) and peak instantaneous flow (PIF).

The peaking factors apply to all populations. Any hydraulic flow distribution has been sized for the adopted design EP.

3.4.1 Hydraulic Contribution and Average Dry Weather Flow

The hydraulic contribution was investigated in the development of the concept design (PWC, 2019). The outcomes of this investigation resulted in a flow loading of 200 L/EP/day being adopted.

Based on the design EP of 24,000, this gives an average dry weather flow (AWDF) of 4,800 kL/d.

Inflow to both South and Wills Street STPs has been analysed, with an ADWF of 3,612 kL/d, giving a current flow loading of 196L/EP/d which is in line with the adopted flow loading of 200L/EP/d. Figure 3-2 shows the historical flows to both STPs and the calculated ADWF.

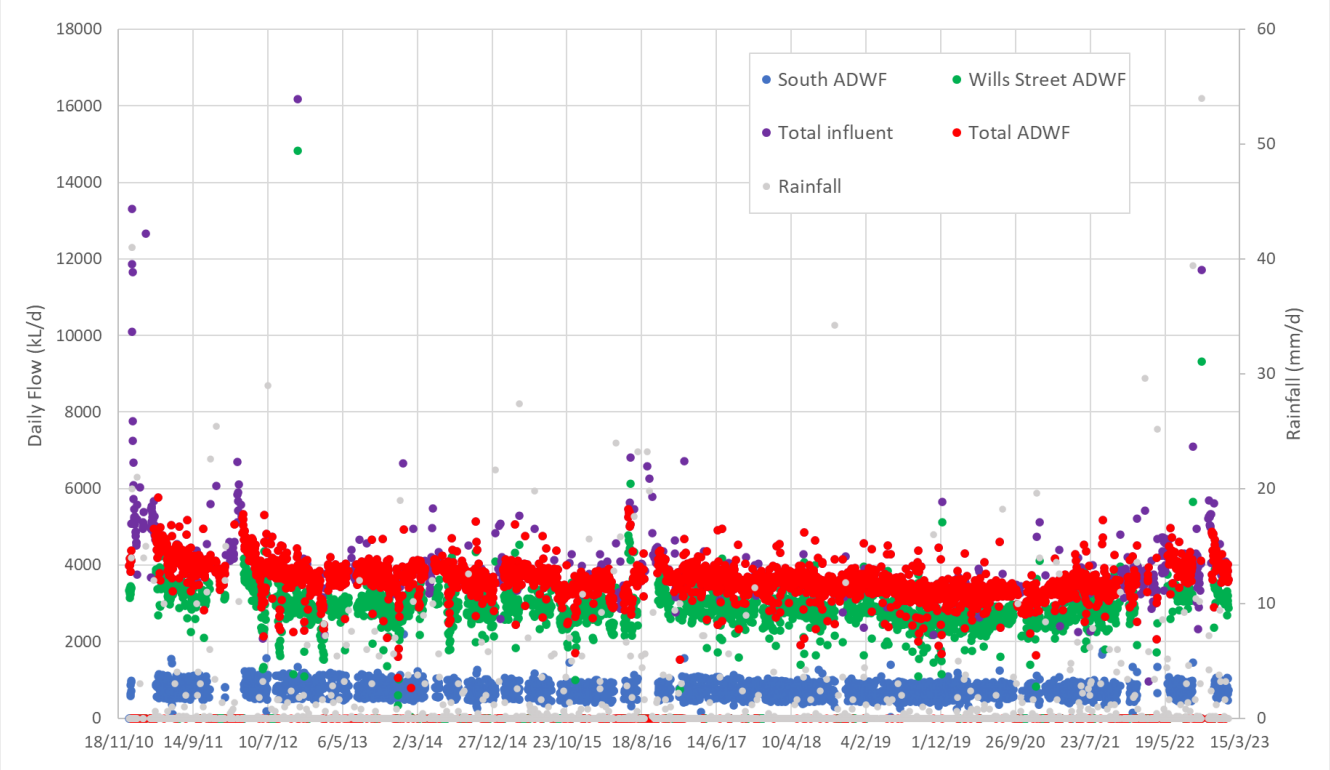


Figure 3-2: Total daily flows to Wills St and South STPs and the calculated total ADWF (2011-2023)

3.4.2 Peak Dry Weather Flow

The Peak Dry Weather Flow (PDWF) is the peak hourly flow that is received at any time during a typical dry day. This forms the basis for mass load peaking and is used to size the aeration and chemical dosing systems.

Instantaneous flow data from the plant inlet works flowmeter during the period of 6-10th of August 2018, was normalised into an hourly average to determine the plant diurnal curve. Determination of the diurnal curve excluded rain effected flow periods (flows that included rainfall in the previous 72 hours were excluded). Figure 3-3 shows the diurnal flow trend for the BHWWTP.

The profile shows a peak dry weather flow in the order of 1.8 times ADWF, and a minimum dry weather flow (MDWF) factor of 0.3 times ADWF.

The NSW Public Works Sewer Design Manual was used to validate the data analysis output. The manual considers flow peaking factors as a function of catchment ET as summarised below:

$$r = (1.74 + \frac{56}{ET^{0.4}})^{0.5} \; for \; ET > 30$$

Where:

- r = PDWF / ADWF
- ET = Equivalent Tenement

This theoretical equation was used to estimate the dry weather peaking factor for BHWWTP with the current 2021 estimated ET of 9,484, The calculated peaking factor is 1.78.

For the infrastructure sizing a PDWF flow factor of 1.8 times ADWF has been adopted to align with both theoretical and observed figures. This approach is consistent with many similar sized catchments in NSW and provides some conservatism to manage short term tourist load increases which are likely to be variable. A minimum dry weather flow (MDWF) factor of 0.3 times ADWF has also been adopted to align with the observed values.

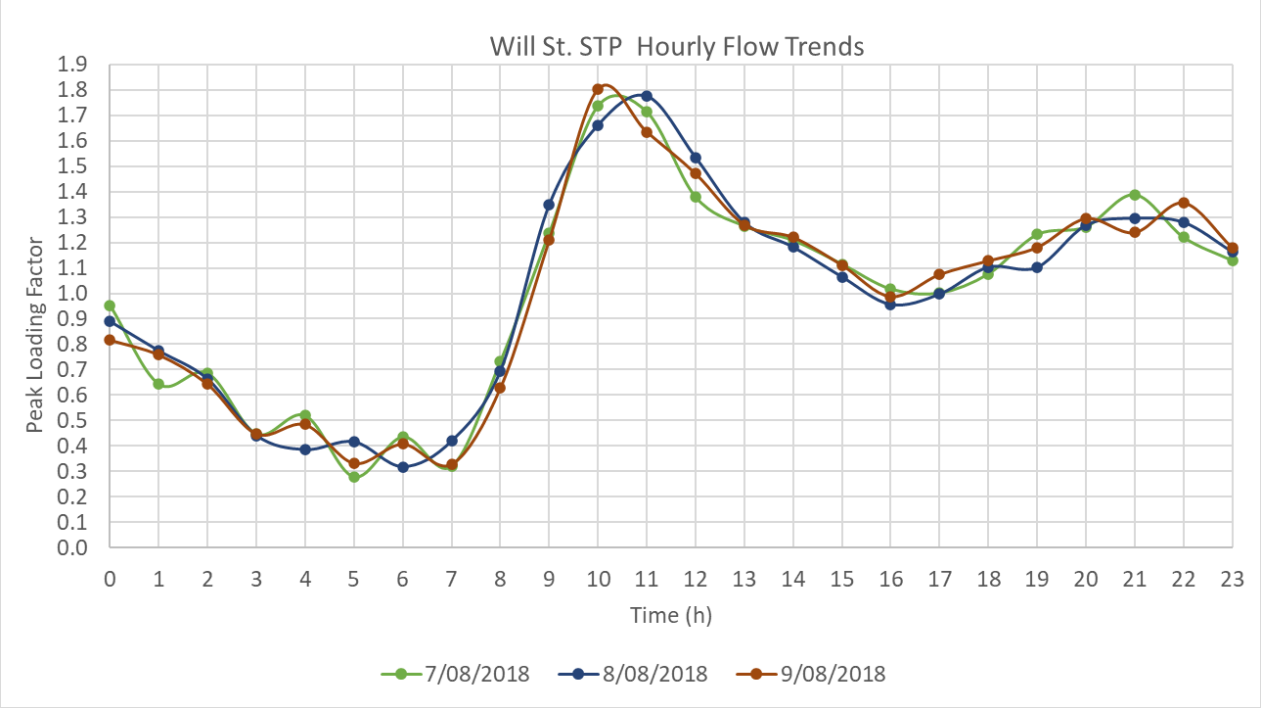


Figure 3-3: Broken Hill STP Diurnal Profile from 6-10th of August 2018

3.4.3 Peak Wet Weather Flow

The Peak Wet Weather Flow (PWWF) is the highest daily raw sewage volume that arrives at the STP.

A peak wet weather event was taken from the plant inflow data during the period of January 2011 to January 2023. The highest recorded influent flow occurred on 6th Nov 2012 with a combined (Wills Street STP plus South STP) influent flow rate of 16,172kL/d which is equivalent to 4.5xADWF, however, this data point does not correlate with rainfall and may be in error. The second highest influent flow of 13,303kL/d was recorded on 13 Jan 2011 which is equivalent to 3.7xADWF, corresponding to 41mm rainfall on the day and 75mm rainfall in the previous 3 days.

The daily influent flow to the determined ADWF trend is presented in Figure 3-4.

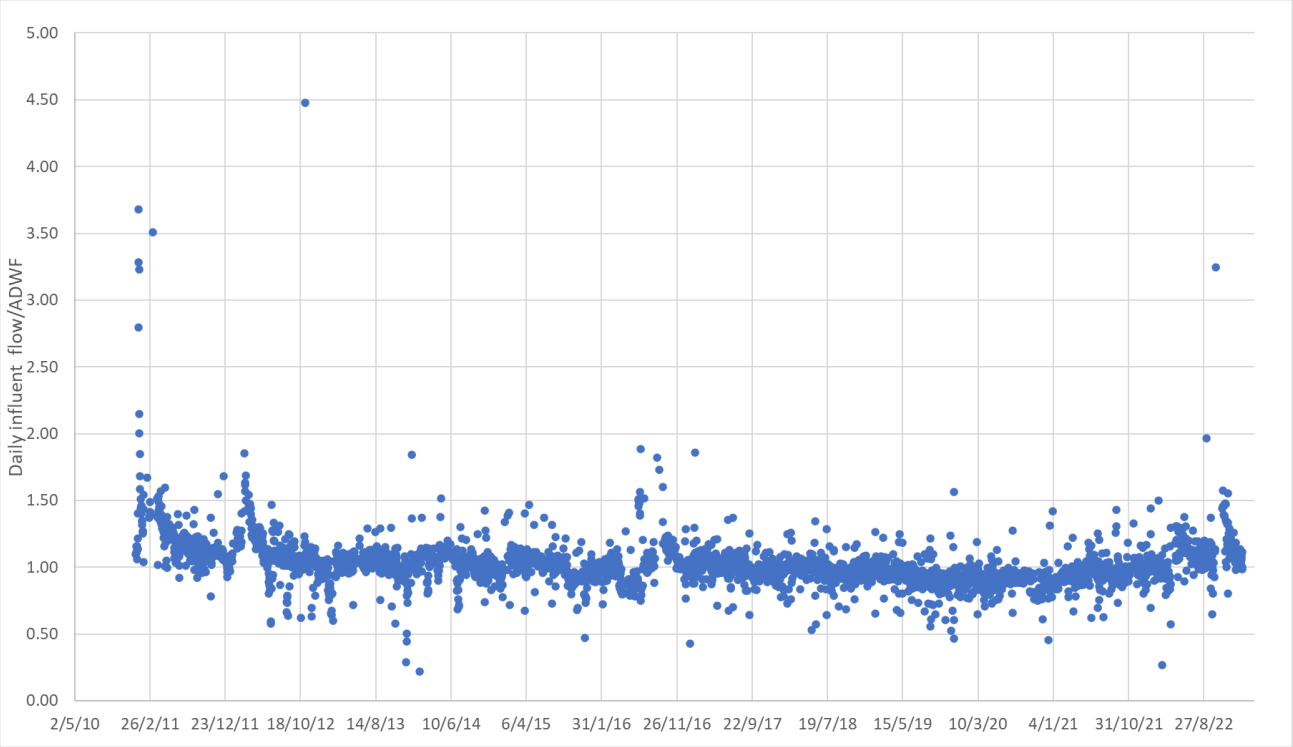


Figure 3-4 Broken Hill Combined influent flow as a function of ADWF

3.4.4 Peak Instantaneous Flow

A loadings assessment and capacity review were undertaken to provide a more robust understanding of the wastewater loadings and design flow estimates to be adopted for the design of the proposed Broken Hill STP, replacing the existing Wills Street and South Broken Hill STPs that are to be decommissioned.

The assessment was limited by the information provided by Essential Water. Where gaps and missing information were presented, assumptions were made to enable evaluation. Key assumptions comprised asset information/location, connection data (category type, location of property connections) and pump data. It is recommended that Essential Water review the missing data and assumptions made to ensure no further information is available for this assessment to gain higher confidence in the results being presented.

The theoretical design flow estimates were calculated using the information provided by EW and the methodology outlined in WSA 02-2014. Validation of these estimates was made by using other available data including calculated pump duties, observed STP inflow data and values presented in PWA's Concept Design Report.

A comparison of the design flow estimates for ADWF and PWWF from different sources is presented in Table 3-4. Further details can be found in Appendix A.

Table 3-4: Loading assessment summary.

SPS Catchment	Contributing SPS	Pump Duty (L/s)	ADWF Design Inflow (L/s)			PWWF Design Inflow (L/s)			
			WSAA[2]	**Observed**	**PWA**	**WSAA[2] (1-in-2 yr)**	**Observed (1-in-2 yr)**	**Observed (Max)**	**PWA**
Slag St (Gravity)	-	27.1	2.0	-	-	12.6	-		-
Rakow St (Gravity)	-	16.9	5.1	-	-	31.0	-		-
Kaolin St (Gravity)	-	0.2	0.4	-	-	3.4	-		-
Racecourse Trust (Gravity)	-	29.4[1]	0.2	-	-	9.5	-		-
Racecourse Rd (Gravity)	-	5.1	0.0	-	-	0.5	-		-
Racecourse Rd (Cumulative)	Racecourse Trust	5.1	0.2	-	-	10.0	-		-
Pinnacles Rd (Gravity)	-	2.2	0.1	-	-	2.6	-		-
Kanandah Rd (Gravity)	-	5	0.5	-	-	9.2	-		-
Kanandah Rd (Cumulative)	Pinnacles Rd	5	0.5	-	-	11.8	-		-
South Rd (Gravity)	-	0.9[1]	0.0	-	-	0.2	-		-
Warren St (Gravity)	-	124.6	26.9	87[3]	-	83.1	135[4]		-
Warren St (Cumulative)	Racecourse Rd, Kaolin St	124.6	27.5	87[3]	-	96.4	135[4]	142	-
Wills St STP (Gravity)	-	-	5.3	-	-	28.6	-		-
Wills St STP (Cumulative)	Rakow St, South Rd, Slag St, Kanandah Rd, Warren St	-	40.4	-	-	180.6	-		-
TOTAL - Wills St STP		-	**40.4**	***33.8***	***46.6***	**180.6**	***126[5]***	***> 200[6]***	***650***
King St (Gravity)	-	19.3	0.8	-	-	6.2	-		-
Wentworth Rd (Gravity)	-	0.3	0.1	-	-	2.7	-		-
South STP (Gravity)	-	-	7.8	-	-	47.3	-		-
South STP (Cumulative)	King St, Wentworth Rd	-	8.7	-	-	56.3	-		-
TOTAL – South STP		**-**	**8.7**	***8.7***	***9.0***	**56.3**	***35.9[5]***	***67.13[6]***	***186***

TOTAL	**-**	**49.1**	**42.5**	**55.6**	**237**	**161.9**	**> 267.13**	**836**

[1]No pump model or curve provided for pump capacity assessment

[2]Calculation based on catchment cumulative design flow estimates

[3]Duty pump only

[4]Duty/assist pumping

[5]Daily inflow data converted to instantaneous flowrate based on correlation to 1-in-2 year ARI rainfall event

[6]Maximum instantaneous inflow recorded between 2020-2023 observed from STP chart recordings provided by Essential Energy

Although the quality of information for the design basis has been improved, there is still significant uncertainty in the estimations. What can be determined is:

- The peak flow to Wills Street STP can be greater than 200 L/s in major wet weather events. Considering known peak flows from Warren Street SPS of 142 L/s and the proportion of the catchment Warren Street SPS services (>50%), a high-level estimate of the actual PIF received at Wills Street may be in the order of 280 L/s. This is equivalent to less than 8 x the observed ADWF.
- The PIF which can be received at South STP is greater than 67 L/s with the chart recorder limit being exceeded during peak wet weather flow events. 67 L/s is equivalent to 7.7 x ADWF and is higher than the 1 in 2 year ARI for the South STP catchment of 56 L/s.
- The PWWF is much lower than the PIF indicating that the flow peak is typically short in duration.

Noting the uncertainty in peak flows, a raw sewage PIF of 8 x ADWF has been assumed. This equates to a raw sewage PIF of 444L/s.

3.4.5 Design Flow Summary

A summary of the design flows for the BHWWTP can be found in Table 3-5.

During normal operation, there will be no wet weather bypass around the inlet works and bioreactors, however, when the influent flow increases above 3.0 x ADWF, the bioreactor storm cycle will be triggered, and the effluent quality likely deteriorates. For the IDALs, the wet weather cycle has been designed assuming the plant receiving PIF flow continuously.

Table 3-5: Design Flows for the BHWWTP

Parameter	Values	Units
Hydraulic Contribution	200	L/EP/d
Current EP	23,344	EP
Current Average Dry Weather Flow (ADWF)	3,694	kL/d
Design EP	24,000	EP
Design Average Dry Weather Flow (ADWF)	4,800	kL/d
PDWF: ADWF	1.8	-
Design Peak Dry Weather Flow (PDWF)	8,640	kL/d
Fully treatment plant influent flow: ADWF	3.0	
Fully treatment plant influent flow	14,400	kL/d
PIF: ADWF	8	-
Design Peak Instantaneous Flow (PIF)	444	L/s

3.5 Domestic Sewage

3.5.1 Sewage Characteristics

There is limited historical raw sewage sampling data available.

A 72-hour raw sewage flow monitoring and composite sampling program was undertaken by PWA during August of 2018 where the flows for those days were 2,893m^3/d, 2,961m^3/d and 2,940m^3/d. These samples were taken every four hours and tested. Based on the flow in those 4 hours, a load was determined. These

were then added together to get a kg/d. Based on the daily flow an equivalent concentration was determined. The 3-day average load and equivalent concentration are shown in Table 3-6.

Table 3-6: Average Raw Sewage Quality for Wills St STP (72hour Monitoring Period)

Parameter	Average Daily mass load (kg/d)	Average Daily Concentration (mg/L)
Chemical Oxygen Demand (COD)	1,810	618
Biological Oxygen Demand (BOD5)	537	183
Total Suspended Solids (TSS)	1024	349
Total Kjeldahl Nitrogen (TKN)	195	66.7
Ammonia Nitrogen	145	49.3
Total Phosphorus (TP)	36	12.4
PO4-P	27	9.3
Alkalinity	1248	426

The BOD testing results were much lower than would be anticipated for typical domestic sewage. Although this can be encountered in sewage catchments where there are trade waste contributions, no significant trade waste contributors are known for the catchments. This does suggest a testing and analysis issue with the BOD results. EW carried out two additional raw sewage BOD tests, and the BOD values were higher than the 72-hour monitoring testing data, more in line with typical domestic sewage.

Chemical Oxygen Demand (COD) is important to complete the nitrogen removal cycle. Typical domestic sewage will generally have a COD:TKN ratio of at least 10. The sampling data on day 3 shows a COD:TKN ratio of 8.9. With a low COD:TKN ratio of 7.0 it would be expected that the proposed treatment process may struggle to achieve the TN licence limit of 20 mg/L (at maximum) without external carbon dosing. A footprint will be provided for incorporating an external carbon storage and dosing system if it is deemed required in the future.

The calculated sewage loading was lower than the typical sewage loading. However, considering there is only 3 days sampling/testing available and uncertainty of the testing results, a more typical sewage loading with higher per EP loads has been adopted for the design as summarised in Table 3-7.

Table 3-7: Typical Sewage Loading and Adopted Raw Sewage Characteristics for Design

Parameter	Typical Domestic Sewage (g/EP/day)	Sample data from 2018 (mg/L)	Sample data from 2018 (g/EP/day)	Adopted for Design* (g/EP/day)	Equivalent conc. (mg/L) *
Number of Samples	-	18	18	-	-
Chemical Oxygen Demand (COD)	120 – 150	618	98	125	625
Biological Oxygen Demand (BOD5)	50 – 70	183	29	58	290
Total Suspended Solids (TSS)	60 – 70	349	55	65	325
Total Kjeldahl Nitrogen (TKN)	10-15	67	10.6	13.4	67
Ammonia Nitrogen	7.5-12	49.3	-	10	50
Total Phosphorus (TP)	1.8-2.5	12.5	2.0	2.2	11
Alkalinity**	-	426			220

* The equivalent concentration was calculated based on the flow loading of 200L/EP/d.

** EW has informed that there was a changeover of the source water for the Mica St WTP from the Darling River to the Murray River in 2019. The treated alkalinity, which used to be between 150 to 200mg/L, dropped down to below 50mg/L. To make sure that the caustic dosing is not undersized, a 220mg/L inlet alkalinity was used in the design.

In the absence of longitudinal data, a peak monthly loading factor of 1.2 has been adopted for the calculation of peak aeration demand and sludge production.

3.5.2 Sewage Fractions

Modern design practices and process modelling require sewage characteristics to be broken into fractions and ratios.

In the absence of additional raw sewage data and characterisation, the values developed and presented below have been used as our basis for the process design.

Table 3-8: Adopted Raw Sewage Fractions

Characteristic	Known As	Adopted ratio	Comment
Fraction of COD which particulate and non-biodegradable	fup	<=0.20	Typical, higher values will increase sludge production
Fraction of COD which biodegradable and soluble	fbs	>=0.15	Typical. Higher values improve nitrogen removal
Unbiodegradable soluble nitrogen	fnus	<=0.020	Typical
COD/TKN		>=9.3	Calculated from the 3 days sampling results

For the BHWWTP upgrade, it is assumed the raw sewage doesn't contain any toxic substances that could inhibit the biological metabolic process and nitrification.

3.6 Tankered Waste

It is understood the current Wills Street STP doesn't receive tankered waste. EW wish to provide facilities to receive tankered waste. In the absence of monitoring data, septage characteristics for the purpose of design have been adopted and are presented in Table 3-9 below.

Table 3-9 Adopted Tankered Waste Characteristics and Loading for BHWWTP Upgrade

Parameter	Units	Value	Comments
Flow	m^3/d	10	Maximum daily receival flow
	$m^3/week$	50	Maximum weekly receival flow
COD	mg/L	25,000	
BOD	mg/L	4,000	The composition of septic waste can be extremely varied, with contaminant concentrations ranging from very dilute to extremely high, a typical characteristic is adopted and assumed to be very similar to other council areas
TSS	mg/L	20,000	
ISS	mg/L	6000	
TKN	mg/L	1200	
TP	mg/L	500	
Fup	ratio	<=0.75	Non-biodegrable particulate COD to total COD ratio

3.7 Effluent Reuse

3.7.1 Current Reuse Scheme

The majority of the effluent produced from the Wills Street STP is supplied to reuse customers. The residual effluent is licensed for discharge to an adjacent water course.

There are eight recycled water customers, details of which are summarised in Table 3-10. The daily average and 95%ile daily recycled water consumptions (excluding White Leeds water usage) were 1,397kL/d and 2,176kL/d respectively based on historical flow data (2011-2022).

Table 3-10: Current Recycled Water End Users

Recycled Water Customers	Max. annual volume of supply (ML)	Purposes	Flow requirements
White Leeds	Up to 750*	Visual amenity wetlands and education Garden Watering (Subsurface irrigation)	Target (<23L/s) Alert (>23L/s) Critical (>35L/s) As RWMP
Perilya Mines	100	Open space irrigation, ovals and picnic areas	Mines 1: Daily average of 426kL/d and 95%ile 595kL/d Mines 2: Daily average of 79kL/d and 95%ile 348kL/d
Broken Hill Golf Club	270	Open space golf course irrigation	Varied from 600-1,430kL/d 821kL/d at average 1,357kL/d at 95%ile from flow analysis
Broken Hill Racetrack	10	Open space lawn watering Dust control on racetrack Caravan camping on lawns	
Picton Plants	10	Wholesale / retail plant nursery disability employment	
Rogers Horse Stud	10	Irrigation of horse paddocks	
Broken Hill Council	10	Dust suppression at tip	
Cristal Mineral Sands (Bemax)	30	Sand processing / washing Irrigation of trees	71kL/d at average 199kL/d at 95%ile from flow analysis

* White Leeds receives up to 750ML/year from a combination of Wills St and South STPs

The effluent reuse system has been designed with the capacity to suit the current end users (excluding White Leeds), site service water and provision for future filtration backwash water applications.

The treated effluent discharged to White Leeds wetland system needs to meet pathogen requirement as shown in Table 3-3. Treatment process and on-site end-use controls (or non-treatment barriers) implemented for the current reuse scheme should comply with the Australian Guidelines for Water Recycling (AGWR) specified water quality for municipal open space and/or dust suppression. The Log Removal Values (LRVs) estimation is shown in Table 3-11.

Table 3-11: Current Reuse Scheme LRV Estimation

Treatment process	Protozoa	Virus	Bacteria
Overall target minimum	**3.5**	**5.0**	**4.0**
Primary treatment	0.0	0.0	0.0
Secondary treatment	0.5	0.5	1.0
Lagoon Storage	1.0	1.0	1.0
Ultraviolet (UV) disinfection	3.0	1.0	2.0
Total Treatment LRV	**4.5**	**2.5**	**4.0**
No public access during irrigation	2.0	2.0	2.0
Withholding periods (1–4 hours)	1.0	1.0	1.0
Total LRV (Treatment/ onsite control)	**7.5**	**5.5**	**7.0**
Subsurface irrigation *	2.0	2.0	2.0

* Subsurface irrigation only applies to CBH Pastoral (White Leeds) Garden Watering

This effluent management strategy is expected to continue with the treated effluent that is produced by the upgraded BHWWTP. However, required effluent quality still requires confirmation with the EPA.

3.7.2 Effluent Reuse Quality

EW will be required to obtain approval for the WWTP and the effluent reuse scheme for which the scheme will need to comply with the NSW Department Planning and Environment (DPE) requirements. The requirements include a risk assessment, based on the framework from the AGWR.

As per the AGWR, the risk assessment will need to be undertaken which will include the scheme stakeholders including staff from EW (management and operations personnel), end users NSW Health, DPE, NSW EPA and PWA.

Guidelines for recycled water quality, critical control points LRV credits for the various treatment process units are provided in the Australian Guidelines for Water Recycling (NHMRC,2006) and recycled water guidelines published by DI Water *(DPI, 2015).* The most appropriate LRV targets for the Broken Hill scheme have been based on a “Municipal irrigation with uncontrolled access” scenario. The target pathogen LRVs as well as the pathogen LRVs assumed to be achieved by the process described in the PWC’s Concept Design reproduced as shown in Table 3-12.

Table 3-12: LRV targets and process capabilities as per PWC's concept design

Parameter	Protozoa (P)	Virus (V)	Bacteria (B)
Unrestricted Municipal Reuse LRV Target	3.7	5.2	4.0
Total Achieved by Process	3.7	5.5	9.0
Achieved Through Biological Process	0.5	0.5	1.0
Achieved Through Validated UV Disinfection	3.2	2.0*	4.0*
Achieved Through Chlorination	0.0	3.0*	4.0*

*Nominal depending on validated LRV for UV and the chlorine dose rate and contact time.

The process pathogen removal performance in Table 3-12 infers that achieving compliance with the state and national reuse guidelines requires a validated UV system. When the IDEA process is operating, there are likely process disturbances that causes high effluent TSS concentrations. It appears unreasonable to adopt the AGWR UV LRVs in the absence of a filtration step without further validation information.

There are two opportunities to reduce effluent reuse pathogen risk:

- **End Use Restrictions** – Work with end users on enhancing end use restrictions at all sites to ensure that a lower quality of effluent (as would be produced by the process described in the concept) can be provided. Enhanced end use restrictions would require investigation per site and liaison per end use stakeholder to ensure properly on-site end-use controls are in place.
- **Filtration** – Provide filtration upstream of UV disinfection to ensure that the risk of TSS and particle size outside of the range likely to be accepted by the UV supplier is minimised.

Through consultation with EW and DPE, the following options were proposed:

- Investigate end-use controls in lieu of filtration to reduce public exposure, this would need to be guided by EW to determine the required end use controls to reduce risk.
- Operate initially without filtration and rely on good upstream control of the secondary process, a footprint to be provided for the filtration system as a future retrofit. Online turbidity analysers are to be provided upstream UV and chlorine contact tank (CCT) with automatic flow diverting away from the recycled water facility if turbidity or UV transmissivity (UVT) is out of the pre-validation operational window, reuse is only provided when the plant is performing well.

A dedicated recycled water facility including a pre-validated UV system and CCTs will be provided to achieve the LRV targets as shown in Table 3-13. A minimum design UV Transmissivity of 40% has been adopted. This represents a conservative figure compared to secondary effluent produced from other similar installations (e.g., Parkes STP and Cowra STP adopted a minimum UVT of 45%).

Table 3-13: LRV targets with proposed process units for Broken Hill STP

Parameter	Protozoa (P)	Virus (V)	Bacteria (B)
Unrestricted Municipal Reuse LRV Target	**3.7**	**5.2**	**4.0**
Process Units			
Achieved Through Biological Process	0.5	0.5	1.0
Achieved Through Validated UV Disinfection*	3.5	1.0	4.0
Achieved Through Chlorination	0.0	4.0	4.0
Achieved By Process	**4.0**	**5.5**	**9.0**

*LRV target with turbidity <2NTU and minimum of UVT 40%.

Provision shall be made for the filtration system to facilitate implementation if deemed necessary in the future (such as footprint, backwash water usage, backwashed wastewater return, maximum power demand and switchboard).

3.8 Biosolids Management

Broken Hill STP will target NSW EPA Biosolids Guidelines stabilisation Grade B for the biosolids produced.

As the result of optioneering and analysis, aerobic digestion for sludge stabilisation with permanent mechanical dewatering of sludge was chosen as the preferred biosolids management option. The aerobic digestion process will be designed to meet the Standard Oxygen Uptake Rate (SOUR) requirement of 1.5mgO_2/h/gTS. It is noted that the aerobically digested sludge may still be odorous, especially if it is stored on-site for an extended period, during its transfer for off-site disposal, or in the wet season when the sludge is wet. Additional contingency in the design aerobic digester residence time has been applied to help manage the risk of odour.

Provided the contamination grade exceeds Class C, the produced biosolids will be suitable for agricultural reuse. However, as stated in the concept design report, the biosolids are likely contaminated, from a groundwater study, it has been identified the biosolids produced by the plant need to be stockpiled on an existing constructed concrete containment slab before off-site disposal.

3.9 Odour

An odour study has been completed for the existing Wills Street STP and for the new STP. The odour study, completed by others, can be found in Appendix D. An odour contour map for the new STP at the final site layout, developed by Environ Odour, is presented in Figure 3-5.

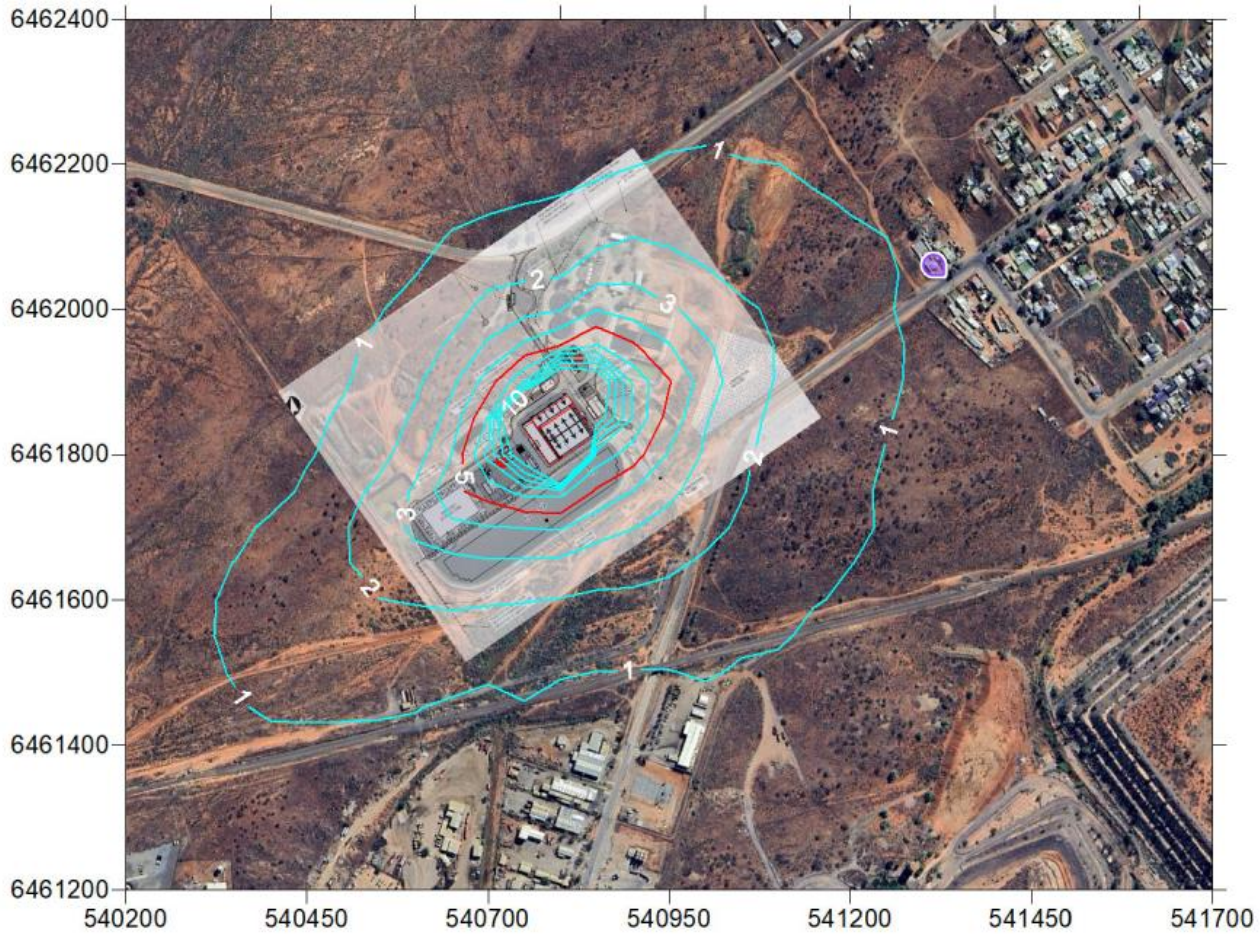


Figure 3-5: Preliminary odour contour map, courtesy Environ Odour (2023)

Key outcomes of the odour study include:

- The need for covering and odour control of the inlet works.
- The treated odour concentration is limited to 1000 OU/m3 at minimum. The discharge height needs to be at least 4 meters with a minimum air flow of 10 m/s..

Another driver for covering and odour control of the inlet works is the potential implementation of Workplace Exposure Standards for new lower limits for H_2S.

To note, the odour study doesn't include the septage receival facility. The odour emissions are only from the nominated odour sources stated in the air quality impact assessment report.

The odour assessment will form part of the Review of Environmental Factors (REF) which is being procured separately to this engagement by EW.

3.10 Noise

An acoustic assessment will be undertaken as part of the REF by EW.

The STP is to be constructed to the west of the existing treatment process to minimise social / odour risk. There will be more than 400m away from the nearest receptor. No noise impacts would be expected to arise from the operation of the upgraded plant and as such no specific controls are proposed at this stage of the design. No specialist allowance for noise attenuation will be provided unless nominated as part of the REF assessments.

However, noise control required for safe work practices for operational and maintenance staff will be considered. This noise will be mitigated by standard acoustic enclosures, buildings the plant layout and screening where it is practical and possible.

3.11 Temperature

The minimum reactor temperature is critical to ensure the ammonium-N limits are achieved in winter. Broken Hill experiences cold winters and is located inland and approx. 400km away from the coastline, with an average minimum temperature of as low as 4.8 degrees Celsius (BOM, 1991-2020). A conservative minimum bioreactor temperature of 14 degrees Celsius has been adopted which is consistent with data available from comparable locations in the same region. A sludge retention time (SRT) of 25 days will be adopted in the design to promote process stability and achieve ammonia limits at minimum mixed liquor temperature.

4 Design Description

The section provides the proposed BHWWTP upgrade design approach based on the information from design basis (Section 3) and concept refinement (Section 1).

- Process general description,
- Hydraulic design,
- Key process units summary,
- Site access,
- Storm water drainage,
- Bushfire risk discussion,
- Site landscaping,
- Onsite amenities and laboratory,
- Power and water supply,
- Solar power,
- Control system,
- Site security,
- Site access,
- Site surveillance,

4.1 Process Description

The design approach is summarised in the process flow diagram in Figure 4-1. The treatment process at the new BHWWTP will include:

- South SPS-A sewer pump station is to be provided to collect the current South STP catchment sewage and transfer it to the BHWWTP inlet receival chamber via a new rising main. The existing gravity main to Wills Street STP will be diverted to the new Preliminary Treatment inlet works.
- Preliminary Treatment – Screening and grit removal, including screening and grit washing and dewatering. The inlet works structure will contain an inlet receival chamber (receives flow from the rising mains, the foul water pump station, septage pump station and emergency return pumping), automatic and manual bypass screen channels, a vortex grit chamber, and a flow distribution chamber.
- Secondary Treatment – Two IDEAT bioreactors for organics oxidation, biological nitrogen removal and phosphorus removal (through microorganism growth and chemical precipitation by alum dosing). Sodium hydroxide dosing is provided for pH correction.
- Space onsite will also be allowed for an external carbon dosing system.
- An effluent balance tank for attenuation of high IDEAT decanted effluent flows with a lift pump system to feed the treated effluent UV disinfection system for disinfection.
- Outfall discharge-Disinfected effluent from the effluent UV system and the UV bypass flow (likely occurring during wet weather season) will be delivered to White Leeds and/or the existing open earth discharge location through upgraded pipelines via gravity
- Tertiary Treatment – A portion of the secondary treatment effluent will be further treated via a pre-validated UV system and a CCT chlorination system to provide recycled water quality suitable for site service water and the existing end users' applications.
- Excess sludge generated by the secondary process will be wasted to a 3-cell aerobic digester for stabilisation via the WAS pumps. A floating decanter is fitted in the first cell of the aerobic digester to achieve some level of sludge thickening. The digested sludge will be dewatered via a mechanical dewatering facility.
- Emergency Storage Pond-An emergency pond is provided for any unintended situations (Screens or grit removal maintenance, failure of effluent decanters, overflow of effluent balance tank, poor treated effluent water quality), an emergency flow return pump station shall be provided to return the emergency flow to the head of the plant for further treatment.
- Odour control- an odour control unit to be provided to treat foul air from the headspace of the inlet works.

The inlet works inlet recevial chamber receives gravity flow from Will Street STP catchment, pumped flow from the new South SPS, and foul water return flow, septage waste, emergency storage pond return flow. All the flows will pass through two mechanical screens for screenings removal, the screened raw sewage would then flow into a vortex grit chamber for grit removal. The screened and de-gritted raw sewage from the grit

chamber outlet passes to a flow distribution chamber where the flow is distributed between two IDEA tanks via a fixed equal-length weir.

Screenings from each screen are washed via inbuilt spray nozzles, compacted via its compaction head and discharged into a common screenings bin via a screw conveyor. The collected grit is intermittently transferred from the grit chamber to a grit classification system for grit washing and cleaning.

The IDEAT treatment process comprises three distinct phases:

- Aeration – the tanks are aerated to provide sufficient Dissolved Oxygen (DO) for bacteria to nitrify influent ammonia, and ensure inflows are thoroughly mixed with the biomass and phosphorus precipitation chemicals.
- Settle – aeration ceases, and biomass begins to settle to the base of the reactor. Residual DO is consumed and bacteria commence denitrification of nitrates generated in the aeration phase.
- Decant – effluent is decanted from the top of the liquid column while the biomass is retained within the reactor. Denitrification continues until aeration recommences at the conclusion of the decant phase.

The IDEATs are designed to accommodate all possible flow scenarios. Under dry weather conditions, the IDEA tank cycles are governed by fixed phase lengths. The cycle times are designed to be out of phase (i.e., decants occur halfway through the other tank's cycle). This assists with flow attenuation within the effluent balance tank by preventing simultaneous decanting during dry weather flow conditions.

During wet weather events, the cycle length must be reduced to provide adequate treatment at higher flows. A 'storm level switch' initiates the Settle Phase for that tank once triggered and this provides sufficient sludge settling time prior to decant to limit biomass scouring.

Aeration is provided by a series of 4 low-speed surface aerators per tank. Surface aerators are a proven technology in small scale intermittent processes and offer low capital and maintenance costs compared with other technologies (for example diffused aeration systems). Variable speed drives on the aerators enable the oxygen transfer rate and power usage to be adjusted to suit increasing plant loads. Dual DO probes within each tank are used to control aerator operation and monitor plant performance.

The aeration system is designed to cater for diurnal peaks in oxygen demand that occurs during periods of high dry weather flow. It is expected the plant still meets the required effluent quality when one aerator (per tank) is unavailable.

Two rotary decanters will be mounted at the end of each IDEAT. The decant weir is variable speed and moves at full speed from the park position above the Top Water Level (TWL) to the liquid level (as indicated by a switch mounted to the decanter) once the decant phase commences. Once the liquid height is reached, the decanter speed is adjusted to achieve the Bottom Water Level (BWL) at the conclusion of the decant phase. The decanter then returns at maximum speed to the park position. Secondary treated effluent enters the decanters and discharges into the effluent balance tank.

To improve sludge settleability and overall nitrogen removal performance, a bio-selector is included for each IDEAT. The bio-selector receives screened and de-gritted raw sewage and returned mixed liquor via RAS pump stations. A coarse bubble mixing system will be supplied to provide pulse mixing in the bio-selector. Alum and Caustic will be dosed to the inlet of bio-selector of each IDEA reactor for phosphorus removal and pH correction respectively.

Clear supernatant from each IDEATs discharges into the effluent balance tank through decanters. The balance tank provides sufficient volume to attenuate decant flows without bypass. The balance tank discharge is controlled by effluent lift pump stations (tertiary feed pump station and UV feed pump station). The discharge flow rate will be regulated to ensure the balance tank drains prior to the commencement of the next decant cycle. This limits the number of starts required by the UV disinfection system and ensures sufficient storage volume is available to prevent bypass.

Flow up to 3xADWF will be fully disinfected by the effluent UV disinfection system and the disinfected effluent will be delivered to the White Leeds and excess flow bypassed to the open earthen channel through the upgraded effluent pipeline via gravity. When then UV inlet flow is more than 3xADWF, with higher hydraulic flows up to 6xADWF (supplier dependant), it still passes through the UV system, however, it achieves reduced pathogen reduction.

All flows from the UV system, along with any overflow from the emergency storage pond (during extended wet weather events), will be delivered to White Leeds and/or the open earthen discharge point through upgrade effluent discharge pipes via gravity.

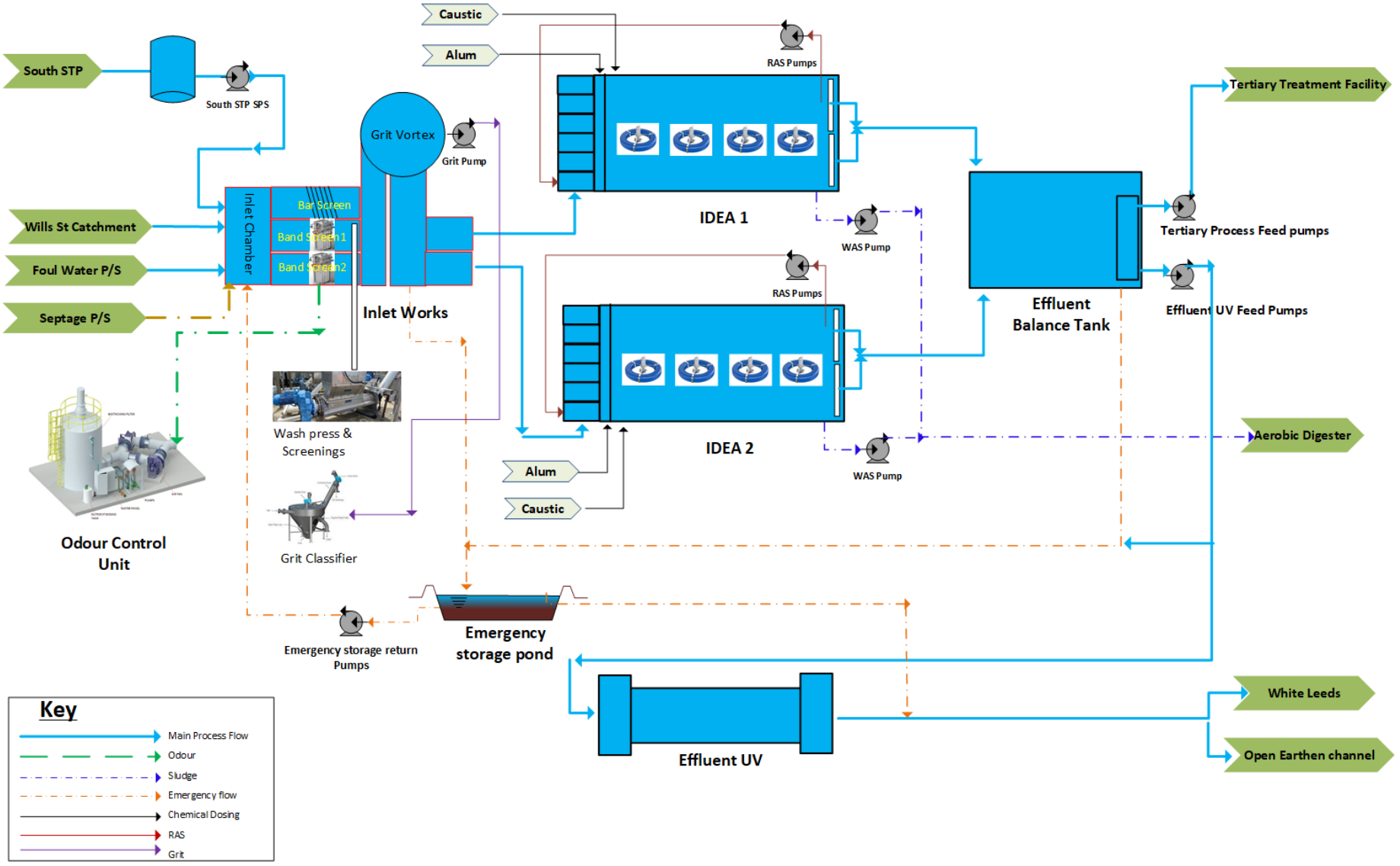
A portion of the secondary treated effluent flow will pass through an inline UV system and CCTs for further disinfection to achieve the required pathogen Log Removal Values (LRVs) to achieve the Australian Guidelines for Water Recycling (AGWR) specified water quality for municipal open space. A filtration system may be required if the secondary treatment effluent turbidity doesn't meet the guideline required standards to claim the required LRVs from each process units. The disinfected effluent will be stored in a storage tank for onsite service water application. The existing effluent reuse pumps will be replaced and relocated to the tertiary treatment system building to withdraw recycled water from the tank and deliver it to the current end users.

Sludge is intermittently wasted from each reactor (during the settling or reaction phase) to maintain the target Sludge Retention Time (SRT) of 25 days. The settled Waste Activated Sludge (WAS) is transferred to an aerobic digester for sludge stabilisation. A floating decanter in the digester would be used to achieve further thickening in the aerobic digester. The digested sludge will be dewatered via a mechanical dewatering system, with the sludge cake discharged onto a trailer or truck via sludge conveyors. It will then be transferred to the site's existing stockpile area or off-site disposal.

In the event of a failure of the decanter boot, one of the IDEAs is not available or the treated effluent is off specification, one emergency storage pond is provided for emergency situations, and the collected flow will be returned to the head of the plant for further treatment via an emergency return pump station.

Odour control is to be implemented at the inlet works. The inlet works will be covered, and odorous gases from the headspace will be extracted via a ventilation fan and delivered into a bio-trickling filter for treatment before discharging into the atmosphere via an exhaust stack.

The most recent concept level design general arrangement for the proposed BHWWTP upgrade is shown in Figure 4-2. The 3D model is provided as Appendix I. It should be noted that the design development, using the most recent site survey data and 3D modelling, indicates that the excavation cost and time risk, due to the presence of hard rock, for constructing on the site identified in the design basis is significantly higher than expected. As a result, the site has been relocated to the left half of the existing maturation pond. For more details, refer to the technical memo detailing the new site location.


Caustic
Alum
South STP
South STP SPS
Grit Vortex
Grit Pump
RAS Pumps
Tertiary Treatment Facility
Wills St Catchment
Foul Water P/S
Septage P/S
Inlet Chamber
Bar Screen
Band Screen1
Band Screen2
Inlet Works
IDEA 1
WAS Pump
Tertiary Process Feed pumps
RAS Pumps
Effluent Balance Tank
Effluent UV Feed Pumps
Wash press & Screenings
IDEA 2
Aerobic Digester
Alum
Caustic
WAS Pump
Odour Control Unit
Grit Classifier
Emergency storage return Pumps
Emergency storage pond
Effluent UV
White Leeds
Open Earthen channel
Key
Main Process Flow
Odour
Sludge
Emergency flow
Chemical Dosing
RAS
Grit

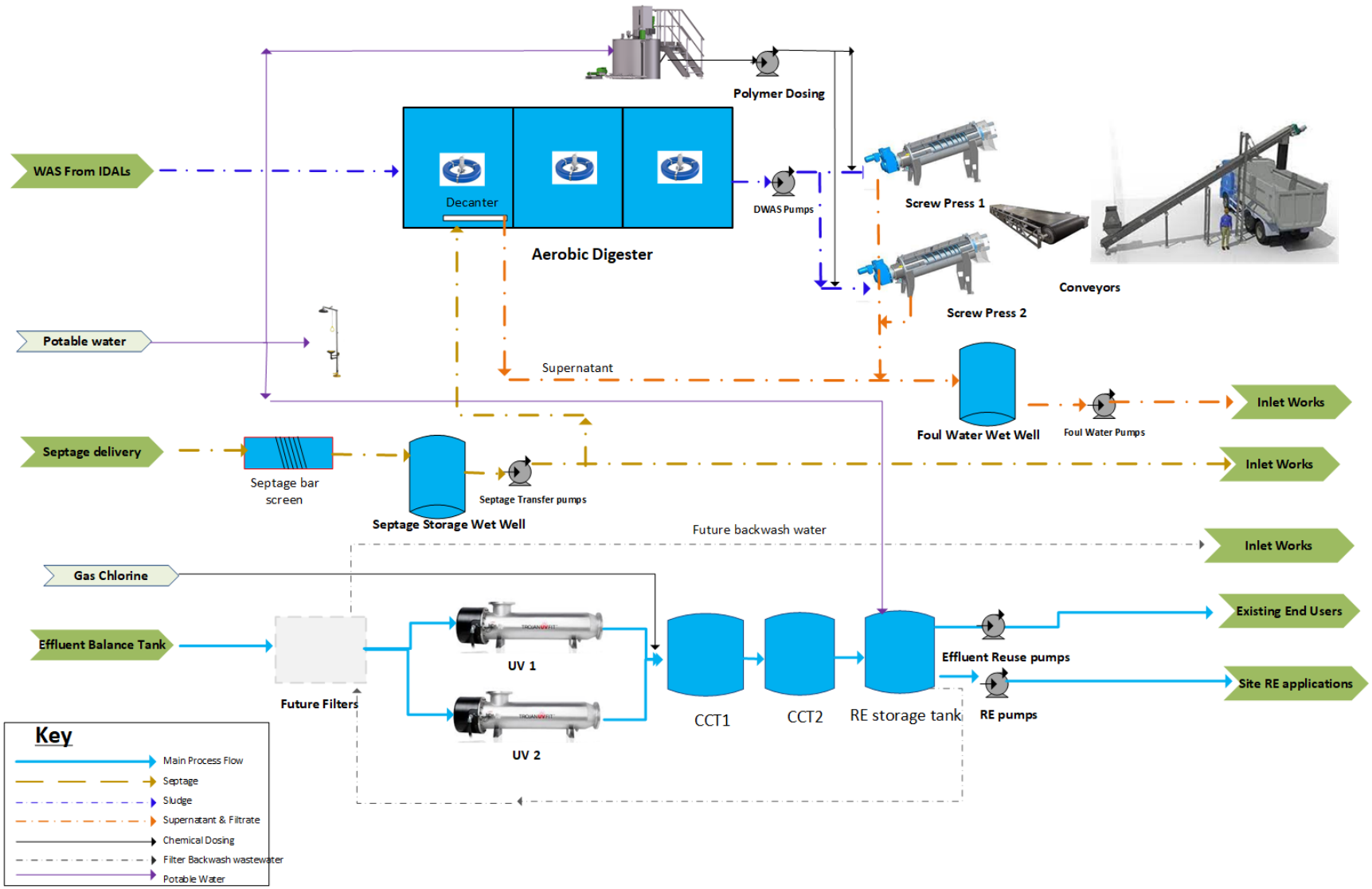


Figure 4-1:Process Flow Diagram for the Proposed BHWWTP Upgrade

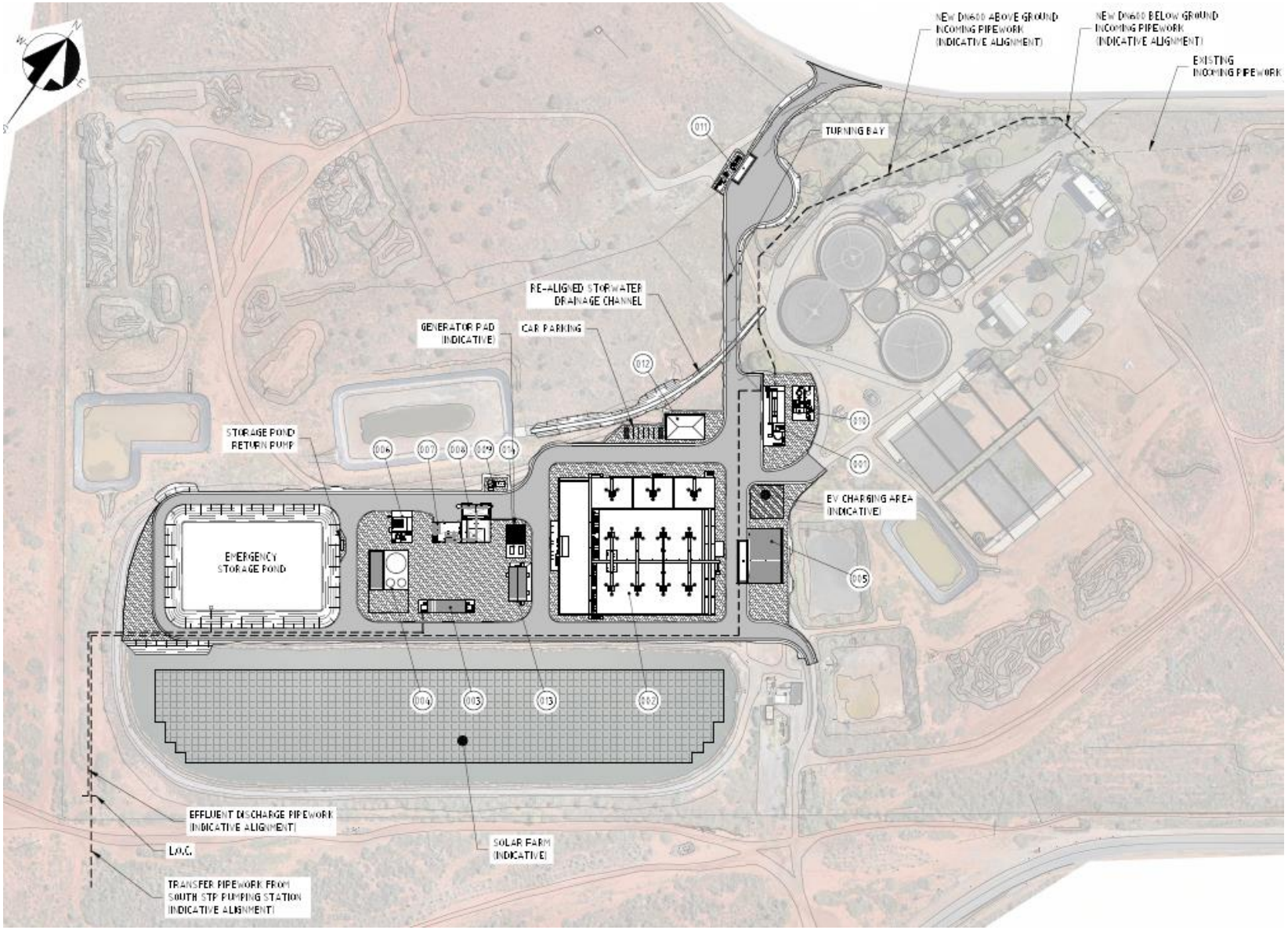

NEW DN600 ABOVE GROUND INCOMING PIPEWORK (INDICATIVE ALIGNMENT)
NEW DN600 BELOW GROUND INCOMING PIPEWORK (INDICATIVE ALIGNMENT)
EXISTING INCOMING PIPEWORK
TURNING BAY
011
RE-ALIGNED STORMWATER DRAINAGE CHANNEL
GENERATOR PAD (INDICATIVE)
CAR PARKING
012
STORAGE POND RETURN PUMP
006
007
008
009
014
010
001
EV CHARGING AREA (INDICATIVE)
EMERGENCY STORAGE POND
005
004
003
013
002
EFFLUENT DISCHARGE PIPEWORK (INDICATIVE ALIGNMENT)
L.O.C.
SOLAR FARM (INDICATIVE)
TRANSFER PIPEWORK FROM SOUTH STP PUMPING STATION (INDICATIVE ALIGNMENT)

Figure 4-2: General Arrangement for the Proposed BHWWTP Upgrade

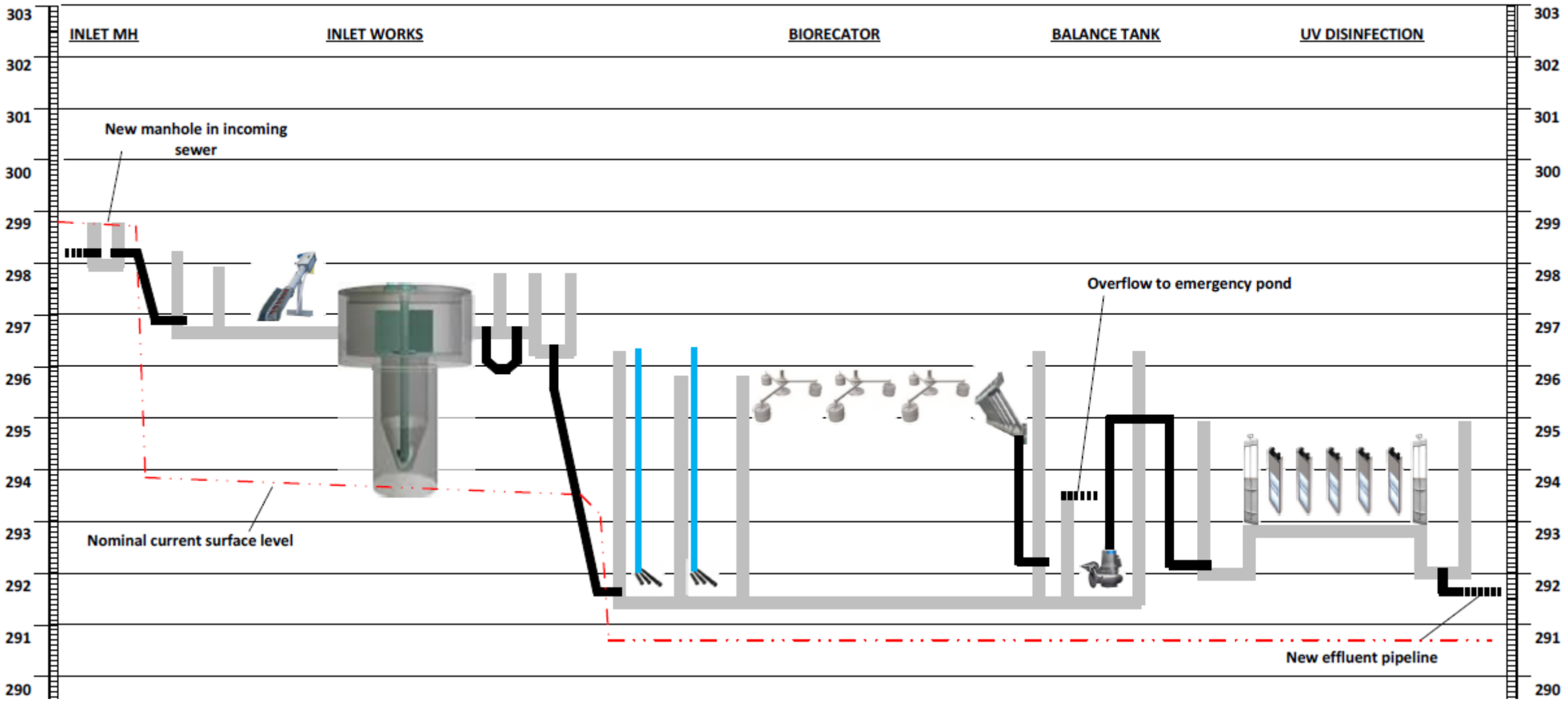
4.2 Hydraulic Design

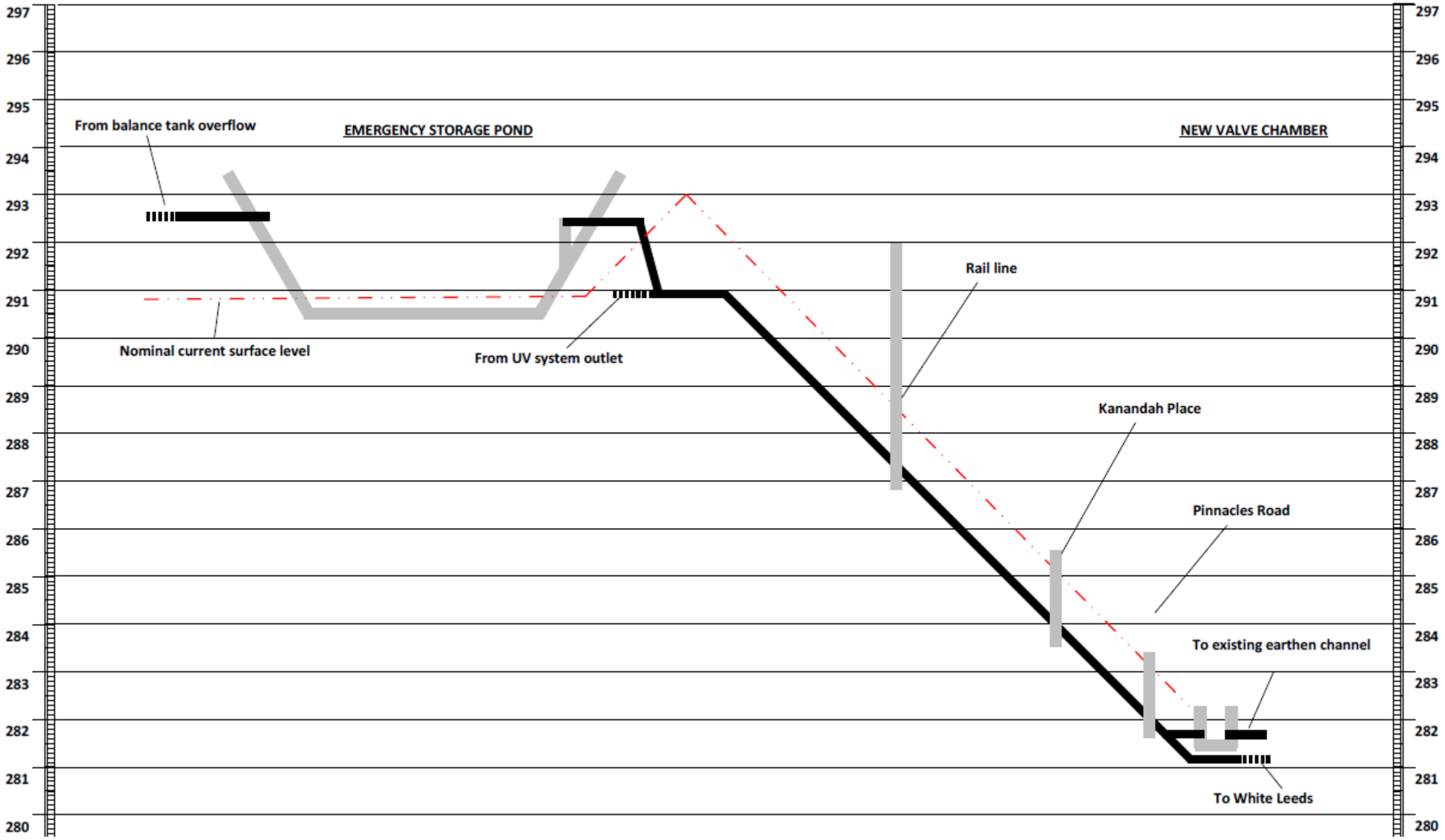
The WWTP design is based on connecting raw sewage from the current Wills Street STP catchment to the new site by gravity. Raw sewage from the South STP catchment area will be connected to the new site via a rising main.

Key components of the hydraulic design are summarised below:

- It is assumed the top of existing inlet manhole for Will St raw sewage cut-ins is at RL 298.82.
- Primary and secondary infrastructure will be sized at 8xADWF (444L/s) to accept all inflow from the sewage catchment areas.
- The effluent balance tank discharge infrastructure is sized at a flow factor of 8xADWF (444L/s).
- The effluent UV Feed pumps and UV channel system will be hydraulically sized to maximise throughout, allowing partial treatment. The UV system performance would however be based on achieving performance requirements at 3 x ADWF.
- Allowance has been made to bypass maximum decant flow to the emergency storage pond if failures of the effluent UV feed pumps.
- Allowance has been made to overflow the emergency storage pond to the effluent outfall if the emergency storage pond water level reaches its overflow level at the effluent outfall delivery capacity.
- The new effluent outfall is sized to deliver maximum flow rate of 483L/s (8xADWF plus rainfall) via gravity.
- The design has assumed the invert level of the open earthen effluent discharge point to be at approximately 280.56 AHD and free discharge and no submergence during wet weather event. A freeboard of 200mm at the discharge point has been allowed for in addition to the estimated flood level of RL280.56 AHD.
- Allowance has been made to accommodate internal recycled flows (Supernatant, foul water, Emergency flow return).
- The new WWTP is designed to be able to hydraulically accommodate the contribution from an annual exceedance probability (AEP) of 1% at 1-hour rainfall (57.9mm/h) falling on hard stands and open tanks. The site drainage system will also be sized to accommodate the design storm.
- Operational freeboard allowance for the IDEA of 300mm from the Top Water Level (TWL) to the top of structures for the unaerated zone is provided to mitigate surcharge risks, while 500mm freeboard for the aerated zone.
- The inlet works will be an elevated structure to allow screened and de-gritted treated sewage to gravitate to the IDEA Tanks. Maintaining a gravity system significantly minimises the likelihood of uncontrolled discharges during power outages.
- A flow distribution structure evenly distributes inflow between the two IDEATs with the use of fixed weirs. An emergency bypass has been provided within the inlet works structure. If a single IDEA is isolated for planned maintenance or the bioreactor needs to be isolated for a very short period, the operator can manually open and adjust the bypass penstock to direct some or all flow to the emergency storage lagoon.
- In the event that the inlet works mechanical screens block, a bypass weir has been installed upstream of the screens to overflow incoming sewage to a screen bypass channel containing a manually raked coarse bar screen. The bypass channel discharges to the main channel prior to the grit chamber.
- Excess activated sludge is wasted to the aerobic digester via the WAS pumps, supernatant in the aerobic digester Cell 1, filtrate from the dewatering system, and site drainage will return to the inlet works via the foul water pump station.
- It is assumed that if a future filtration system is installed, it will not be operational during peak weather. This assumption is based on the expectation that no effluent reuse will occur on wet weather days. Additionally, the quality of the secondary treated effluent would decline during wet weather.

Figure 4-3 presents a preliminary hydraulic grade line based on achieving full gravity flow from the Wills St. STP catchment area for the proposed Broken Hill STP upgrade.


INLET MH
INLET WORKS
BIORECATOR
BALANCE TANK
UV DISINFECTION
303
302
301
300
299
298
297
296
295
294
293
292
291
290
New manhole in incoming sewer
Nominal current surface level
Overflow to emergency pond
New effluent pipeline


297
296
295
294
293
292
291
290
289
288
287
286
285
284
283
282
281
280
From balance tank overflow
EMERGENCY STORAGE POND
NEW VALVE CHAMBER
Rail line
Nominal current surface level
From UV system outlet
Kanandah Place
Pinnacles Road
To existing earthen channel
To White Leeds

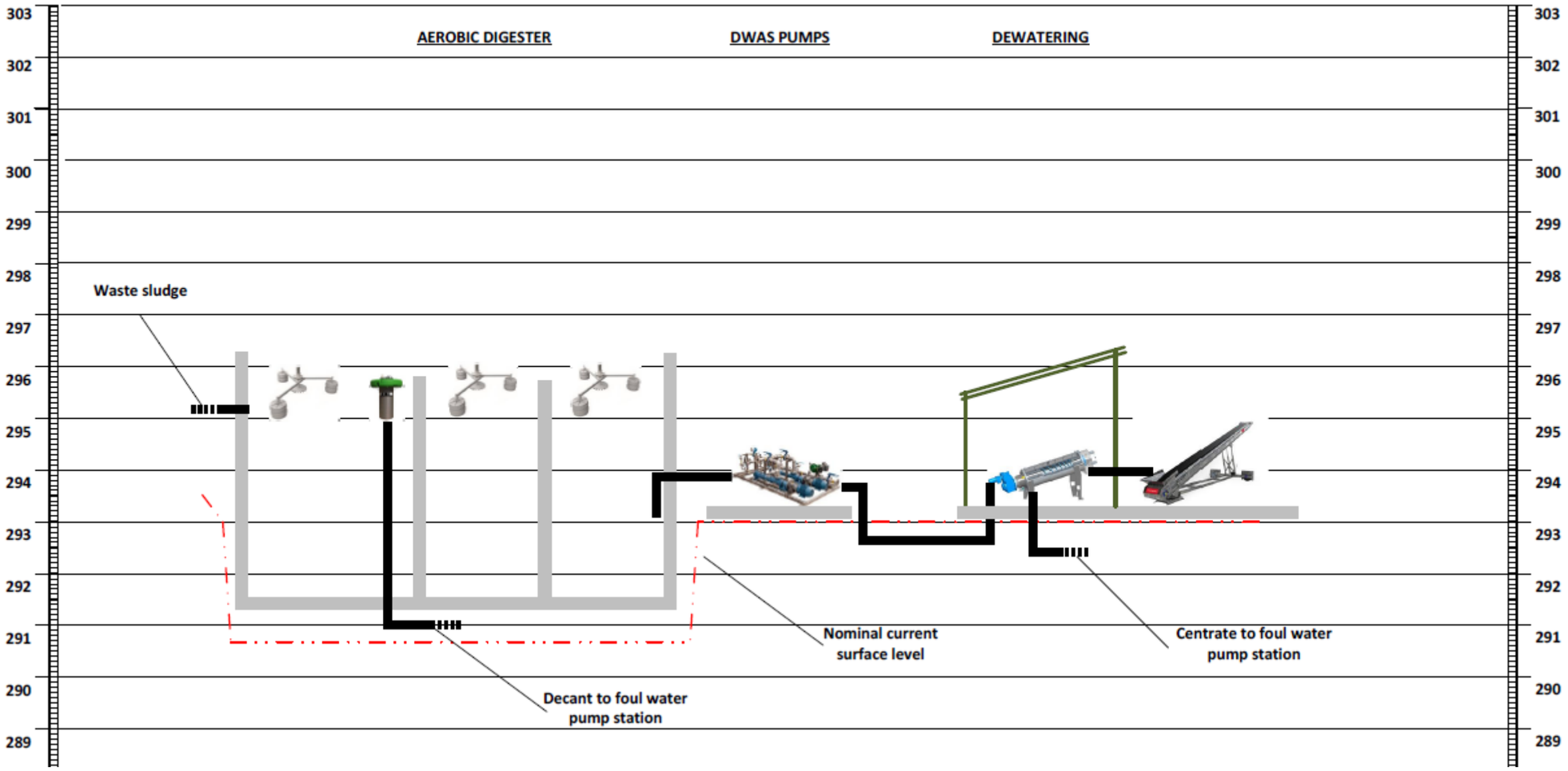


Figure 4-3: Preliminary HGL for the Proposed BHWWTP Upgrade

4.3 Key Process Units

The following sections provide additional detail for each of the key process units required as part of the new WWTP.

4.3.1 South STP Sewage Pump Station

The South STP transfer pump station will be designed to transfer a peak flow event which is sufficiently high enough that the risk to the environment and public health is acceptable.

Investigations to date indicate that the 1 in 2 year ARI storm flow would be 56 L/s, less than the peak instantaneous flow which is known to be greater than 67 L/s. The remaining flows would overflow a manhole upstream of the pump station and discharge to the receiving environment, as per other EW owned network pump stations.

The sewage pump station design includes a split well, each portion of the well including a submersible pump. Each portion of the well can also be isolated for maintenance. The preliminary 3D model of the proposed wet well is shown in Figure 4-4.

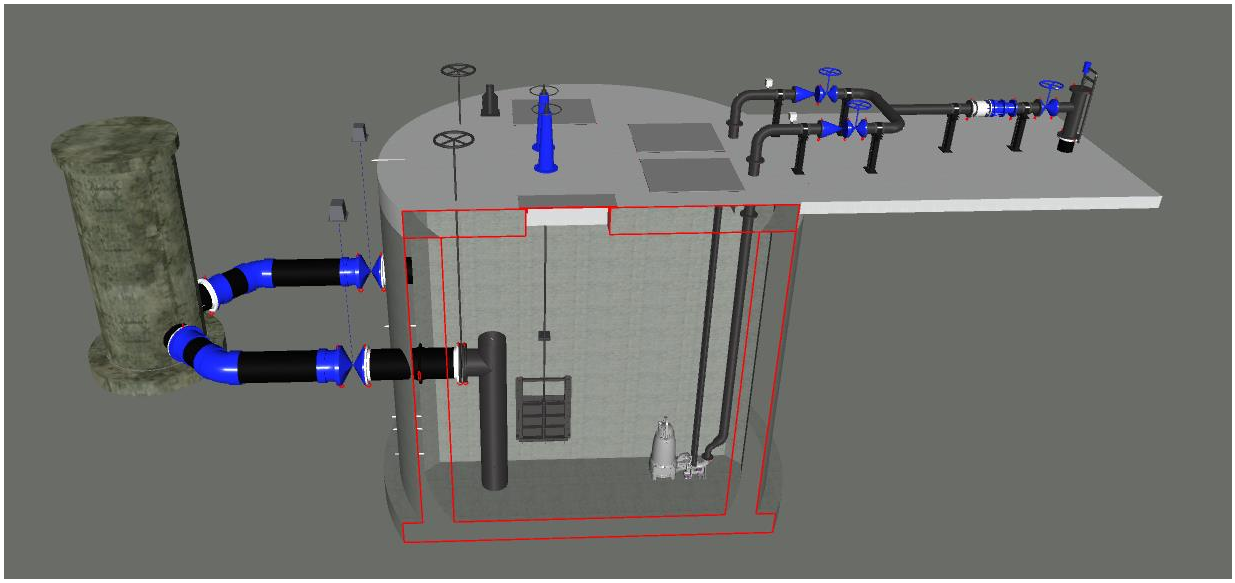


Figure 4-4: South STP transfer pumping station wet well preliminary arrangement.

Preliminary design information for the south STP transfer pumping station is presented in Table 4-1.

Table 4-1: South STP transfer pumping station preliminary process sizing

Item	Value	Unit	Comment
Pumps			
Number	2	No.	Duty/Standby
Type	Submersible sewage pump		
Capacity (each)	56	L/s	6.3xADWF
Pumping Well			

Cell	2	No.	The sewage pump station design includes a split well, each portion of the well including a submersible pump. Each portion of the well can also be isolated for maintenance
Capacity of each cell	xx	m3	

Preliminary estimates indicate that a sewer main residence time of greater than 4 hours may occasionally occur, which could present an odour risk. However, based on available sulphate information, it seems that odour septicity is unlikely to be a major concern, considering that the inlet works in Will St. are covered for odour control and only approximately 25% raw sewage is contributed from South STP. Nevertheless, a footprint has been allowed in the design to accommodate ferric chloride storage and dosing if suppressing odour production becomes necessary in the future.

The proposed alignment for the new South STP transfer main is provided in Appendix G.

Brief Control Philosophy

The two variable speed pumps operate in duty/standby configuration. Each portion of the well contains a level element and two-level switches.

The two variable-speed pumps operate in a duty/standby configuration. Each portion of the well contains a level element and two-level switches.

The pump can operate either at a fixed operational speed or a target flow rate set point. To minimise pump wear and tear, it is recommended to operate the pump at a fixed operational speed; however, the operator can choose either operation mode from the SCADA system.

- The duty pump starts when the level reaches a start-level set point. Once started, the duty pump either modulates its operational speed to maintain a target flow rate set point (adjustable) or operates at a fixed operational speed (adjustable).
- The duty pump stops if the level falls to a stop-level set point.

In case of failure of the level transmitter, The duty pump starts and stops based on the high- and low-level switches.

The common discharge main for the two pumps is fitted with a flow meter, which is used for monitoring, recording, and control.

4.3.2 Preliminary Treatment (Inlet Works)

The primary treatment infrastructure includes the following key items:

- Flow monitoring
- Receival chamber
- Site Foul water return
- Septage waste receival
- Emergency storage pond water return
- Automatic screening
- Coarse screening of automatic screen bypass flow
- Screenings washing and dewatering
- Grit removal
- Grit washing and dewatering
- Flow distribution

A snapshot of the preliminary 3D model of the inlet works is Figure 4-5.

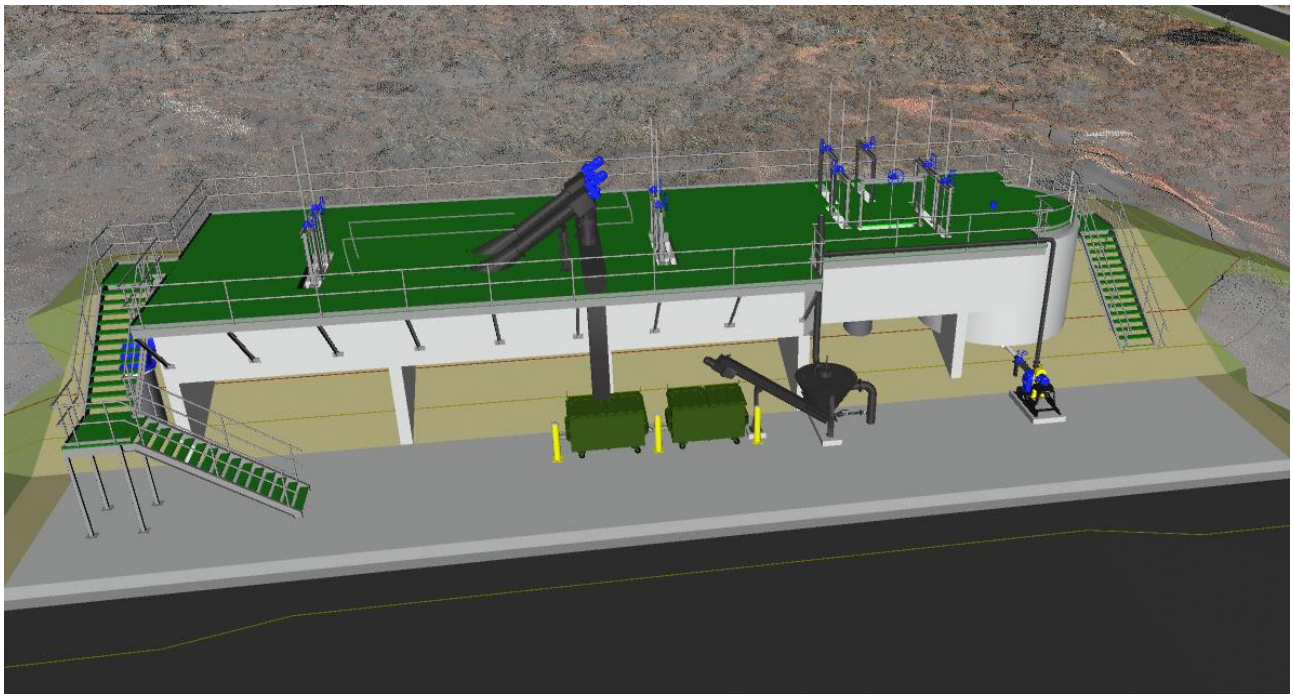


Figure 4-5: Preliminary 3D model of inlet works arrangement.

4.3.2.1 Flow Monitoring and Receival Chamber

The receival chamber receives flows from the rising mains, including the South STP transfer pump station, the emergency storage lagoon return pump station, the septage waste transfer pump station and the foul water pump station, and the gravity flow from the Will Street STP catchment

An electromagnetic flow meter is to be installed on each rising main to record all inflows to the treatment plant. An electromagnetic flowmeter will also be provided for the Wills Street STP inlet diversion gravity main.

The South STP rising main discharges vertically through a standard bellmouth positioned 100 mm above the top water level. This ensures that the rising main discharges at a constant head. The chamber provides a point of connection for the main and some hydraulic conditioning before the flow is distributed to the automatic screens. The chamber is to have a benched floor to limit the deposition of grit.

4.3.2.2 Automatic Screen

Automatic screening is provided by a pair of 5 mm aperture screw screens operating in a duty/ duty arrangement for PIF flow. However, the two screens can operate in a duty/standby arrangement and alternate during dry weather.

It is noted that step screens are a robust lower cost alternative to band screens. Step screens have a significantly lower screenings capture rate than screw screens meaning that debris will collect in the IDEAT and in the biosolid removed from site. Therefore, although step screens may also be suitable, there is a preference for screw screens to reduce screenings debris in the system.

A typical screw screen is shown in Figure 4-6.

Figure 4-6: Typical Screw Screen (CST Wastewater solutions)

Operation of the screens is governed by upstream and downstream level elements as well as an upstream high-level switch which alarms in even of automatic screen bypassing. Process water for the screens is supplied by the onsite reclaimed effluent (RE).

ach screen is fitted with a compaction head for screenings washing and compaction. The compacted screenings from each screen then fall into a dedicated screw compactor for enhanced washing and compaction (Figure 4-7).

Figure 4-7: Screw compactor

Individual automatic screens can be isolated if required, with the automatic operation of the inlet penstocks and manual insertion of the outlet penstocks.

4.3.2.3 Bypass Screen

In the event that both automatic band screens are unavailable, or one is offline, and the inflow exceeds screen capacity, the water level upstream of the screens will increase until excess flows overtop a weir and

enter the automatic screen bypass channel. This event will be detected by the level element and high-level switch.

The bypass channel is fitted with a manually raked 20 mm aperture 316SS coarse bar screen. Collected screenings are manually raked by the operator onto a perforated drip plate before being shovelled to a waiting wheelie bin via a discharge chute.

The bypass channel and screen are designed to accept peak inlet works flows, but if the bypass screen becomes blocked, the screen will operate as a weir and peak flow can overtop the bypass screen without surcharging.

4.3.2.4 Grit Removal

A concrete vortex grit chamber is provided to facilitate grit removal. Screened sewage enters the grit chamber tangentially and flows around the tank to the outlet creating flow conditions that allow grit to settle. A central vertical mounted impellor agitates grit as it settles toward the chamber hopper to resuspend organic matter for discharge via the outlet channel. The impellor runs continuously.

Collected grit is intermittently removed from the hopper via a fixed speed grit pump. A water sparge is provided to agitate grit prior to transfer. The sparge is connected to the site recycled water system.

It is possible to isolate / bypass the grit chamber for maintenance through manipulation of three manually inserted penstocks (inlet, outlet and bypass).

A typical vortex grit chamber and grit washer are shown in Figure 4-8.

Figure 4-8: Typical Vortex Grit Chamber and Grit Washer (VOR-Environmental)

4.3.2.5 Grit Handling

It is proposed that grit pumping be accomplished using a recessed impeller pump which is highly effective and robust in this application. The pump would transfer grit from the base of the grit trap to the grit washing system (Figure 4-8). The grit washing system consists of a cone which allows the heavy grit to settle and a screw which is used to lift the grit out of the classifier to the bin for removal from site.

Foul water from the grit washing system would flow to the foul water pump station.

4.3.2.6 Flow Distribution

Screened and de-gritted sewage flows from the grit chamber outlet to a flow distribution chamber via gravity. Backwash wastewater from future filtration (if implemented) will also return to the flow distribution chamber.

Equal length weirs within the distribution chamber distribute flow between two IDEATs. During dry weather, each tank can be isolated if required with the installation of a manual penstock at the weir.

In case of need, the emergency bypass allows for redirecting a portion or all flows to the emergency storage. The plant operator manually opens the bypass penstock, and the flow can be adjusted by opening or closing it. The bypass is likely to be used when the inlet to one of the IDEA tanks is isolated or temporarily stops feeding the bioreactors.

All flow splitting weirs are adjustable so that heights and level can be fine-tuned during commissioning to optimise performance. Once set the weirs are intended to remain fixed in place until design changes occur.

The base of the flow splitting chamber is fitted with a scour pipeline and valve which allows accumulated grit to be removed.

4.3.2.7 Brief Control Philosophy

Flow monitoring

Sewage flow will be monitored continuously via the inlet mag flow meters. Flow will be recorded and displayed separately for each of the mains monitored and totalised for the total sewage inflow. The integrated volume since midnight and for the previous day will calculated and displayed.

The sewage rolling average flow is used for the control the grit extraction sequence. If the sewage flow (level) element fails, then the grit extraction reverts to timer control. Otherwise, there is no consequence for sewage flow element failure.

An alarm is generated if the rolling average sewage flow exceeds a high level and the emergency return pump station will be inhibited.

Screening

There are two mechanical screens, they are normally operating in duty/standby configuration during dry weather, however, during high inlet flow or wet weather period, both of the screens need to operate. The wash water to each screen is fitted with a solenoid valve and flow switch. If the flow switch in the screen wash-water is not activated within a delay time after the solenoid opens, then an alarm is generated, and the screen is failed.

Each screen inlet is equipped with an electrically actuated penstock. The penstock must open when the corresponding screen is operated. Each screen is fitted with a compactor, and the compacted, washed screenings will be collected by a common screw conveyor and transferred to a screenings bin.

There is a separate solenoid valve and flow switch on the screen sluice water. If the flow switch in the screen sluice water is not activated within a delay time after the solenoid opens, then an alarm is generated but the screening sequence continues as normal.

The level in the screen inlet chamber is monitored with a level element and high-level switch. These are used for the control of the screens and alarming.

Once triggered (start level), the screens will run until the sequence expires. If the trigger condition no longer applies then the sequence ends. If the trigger condition still applies then the sequence is repeated. The screen sequence can also be triggered by the operator or based on timer.

The upstream level element and switch alarms mechanical screen bypasses. A separate level switch alarms overtopping of the manual bypass screen.

There is a low pressure switch in the RE supply line to the inlet works (screening and grit system). An alarm is generated if low pressure is detected in the inlet works RE supply.

The screens are designed to operate concurrently. Once a screen sequence is triggered, the following occurs.

- The duty screen starts, the sluice water solenoid valve opens (if enabled), the corresponding screen spray water solenoid valve opens and the run timer starts.
- When the run timer expires, the screen stops and the spray water run on timer starts.
- When the spray water run on timer expires, the screen spray water valve closes.
- The assist screen and corresponding screen spray water solenoid valve opens and the run timer starts. When the run timer expires, the screen stops and the spray water run on timer starts. When the spray water run on timer expires, the screen spray water and sluice valve close.
- The duty sequence for the screen then rotates (i.e. duty becomes assist and assist duty)

Grit Removal

The grit paddle operates continuously. An alarm is generated if the grit paddle fails, but the grit extraction sequence is not suspended.

The sparge line is fitted with a flow switch. If no flow is detected with the open switch active, then an alarm is generated. A sparge alarm (valve failure or no flow) suspends the extraction sequence (fail and latch pump).

There is a single duty grit pump only. The grit pump normally operates at a fixed speed to delivery flow to the grit classifier. The grit pump is fitted with a flow switch. The pump is failed and latched if no flow is detected after a time delay after the pump starts.

There is solenoid valve on the grit wash line into the agitator tank of the classifier. This is fitted with a flow switch. An alarm is generated unless the flow switch is activated within a time out period after the solenoid opens. There is no automated response to a wash alarm.

There is a fixed speed grit wash agitator. There is no automated response to agitator failure.

There is a separate, variable speed, reversible screw classifier drive. This includes a high torque switch. If the high torque is activated then the screw reverses for an operator set time, then switches back to forward direction and continues. If this occurs for a number of cycles, then the screw fails.

The following conditions lead to the grit extraction sequence being suspended:

- Grit sparge failed (no flow).
- Grit pump failed (drive, no flow).
- Grit classifier screw failed (drive or over-torque).

The grit extraction sequence is triggered based on elapsed sewage volume, or elapsed time, whichever occurs first. The elapsed time setpoint is used to start the grit extraction sequence if the sewage flow element is failed.

When the volume or time has elapsed, the following sequence occurs.

- The grit sparge valve opens and RE is used to sparge the grit in the grit tank.
- The grit classifier wash water solenoid valve opens and fluidises the grit bed in the classifier.
- After a delay, the grit wash agitator starts.
- After a delay, and with the sparge and agitator still running, the grit pump starts and pumps the grit slurry to the classifier.
- Once the extract time expires, the grit tank sparge valve closes and the grit pump stops.
- After a delay, the agitator stops.
- After a delay the grit wash solenoid closes.

The grit classifier screw operation is not linked directly to the grit extraction sequence. The screw drive is triggered based on a high pressure set point in the grit agitator tank. The following sequence then occurs.

- The classifier screw starts.
- After a run period has expires, the classifier screw drive stops.

The screw drive is inhibited from operating for a dwell time. Thereafter, the high pressure set point can restart the sequence.

4.3.2.8 Summary

A summary of preliminary design information for the inlet works is presented in Table 4-2.

Table 4-2: Inlet works preliminary process sizing

Item	Value	Unit	Comment
Flow Measurement	In-pipe		Installed on incoming main-electromagnetic type
Mechanical Screen			
Number	2	No.	Duty/Duty for PIF Duty/standby for PFTF
Type	Screw		
Aperture	5	mm	2 dimensional
Capacity (each)	~350	L/s	6.3xADWF
Screenings treatment	Screen compactor provided		Each screen is fitted with a screen compactor for screenings washing and compaction
Average Screenings Production	0.50	m^3/week	Based on similar catchments in the Hunter Valley
Manual Screen			
Number	1	No.	Duty only
Spacing	20	mm	
Capacity	480	L/s	
Grit removal			
Number	1	No.	Duty only
Type	Vortex		Concrete construction
Capacity	480	L/s	
Grit vortex Size	3.65	m	
Performance	95% Capture		Particles sg 2.65 > 0.3 mm
Grit Transfer	Grit Pump		1 Duty plus 1 uninstalled standby
Average Grit production	0.84	m^3/week	Based on similar catchments in the Hunter Valley
Grit Pump capacity	10	L/s	
Grit Classifier			Fluidised Bed
Number	1	No.	Duty only
Capacity	10	L/s	

4.3.3 Septage and Other Tankered Waste

Nominally the WWTP will receive tankered waste from two sources; septic tank pump outs which will be managed through the proposed septage receival system and pump station pump outs. It has been identified

that the pump station pump outs will include some liquid sewage and some grit. The denser grit portion of the pump-outs may not be suitable for receipt in the septage receival system (Figure 4-9).

For septic tank pump outs and sewage, tankers would pump or unload via gravity through a manually rakes screen. The inlet to the screen would include a flowmeter for monitoring. A spray and local hose real would be used for flushing the screen channel and hosing down debris. A pump station, with duty/standby pumps would then either convey the liquid waste to the inlet works or the aerobic digester. Selection of the discharge location would be based on an operator assessment of the risk.

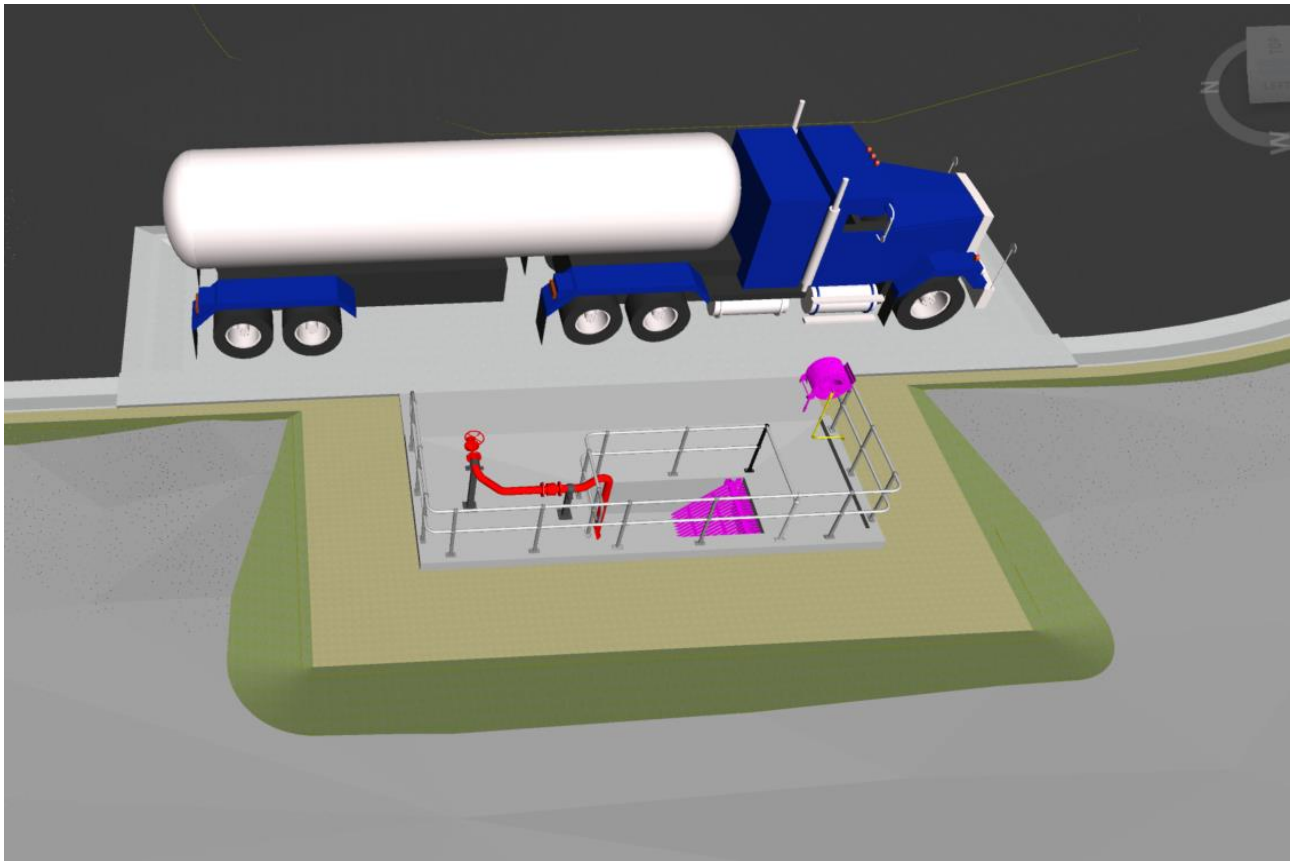


Figure 4-9: Preliminary arrangement of proposed septage receival.

The septage pumping station operates under a traditional fill and draw regime in accordance with setpoints as measured by a radar level element. Level switches (one high, one low) provide redundancy in the event of level element unavailability. Duty pump change over occurs each time the duty pump stops.

A septage receival panel provides indication of the pump station level and includes visual and audible alarms if the pump station is at a high level or the screen is unavailable. If the alarms are functioning, septage should not be discharged.

It is noted that there may be an opportunity to remove the septage pump station and allow flow via gravity to the inlet works or aerobic digester. If this change is implemented, the pump station would be replaced with a wet well to allow storage and management (i.e. review of trade waste risk upon receipt) of the liquid waste.

It has been proposed through discussion with EW that the grit from the pump stations would be discharged onto the existing and recently constructed drying beds. The operator would need to carefully manage the risk of odour. The existing drying bed supernatant pump station will be retained, allowing it to continue transferring supernatant to the existing cut-in manhole, where it will mix with raw sewage before gravity feeding to the WWTP.

4.3.4 Secondary Treatment

Screened and de-gritted raw sewage from the inlet works is evenly distributed to the two IDEATs. The IDEATs are to be constructed as semi-buried reinforced concrete water retaining structures. The tanks include vertical walls to optimise aeration and settling performance.

A snapshot of the preliminary general arrangement of the bioreactor is provided in Figure 4-10 (inlet to the right of the picture).

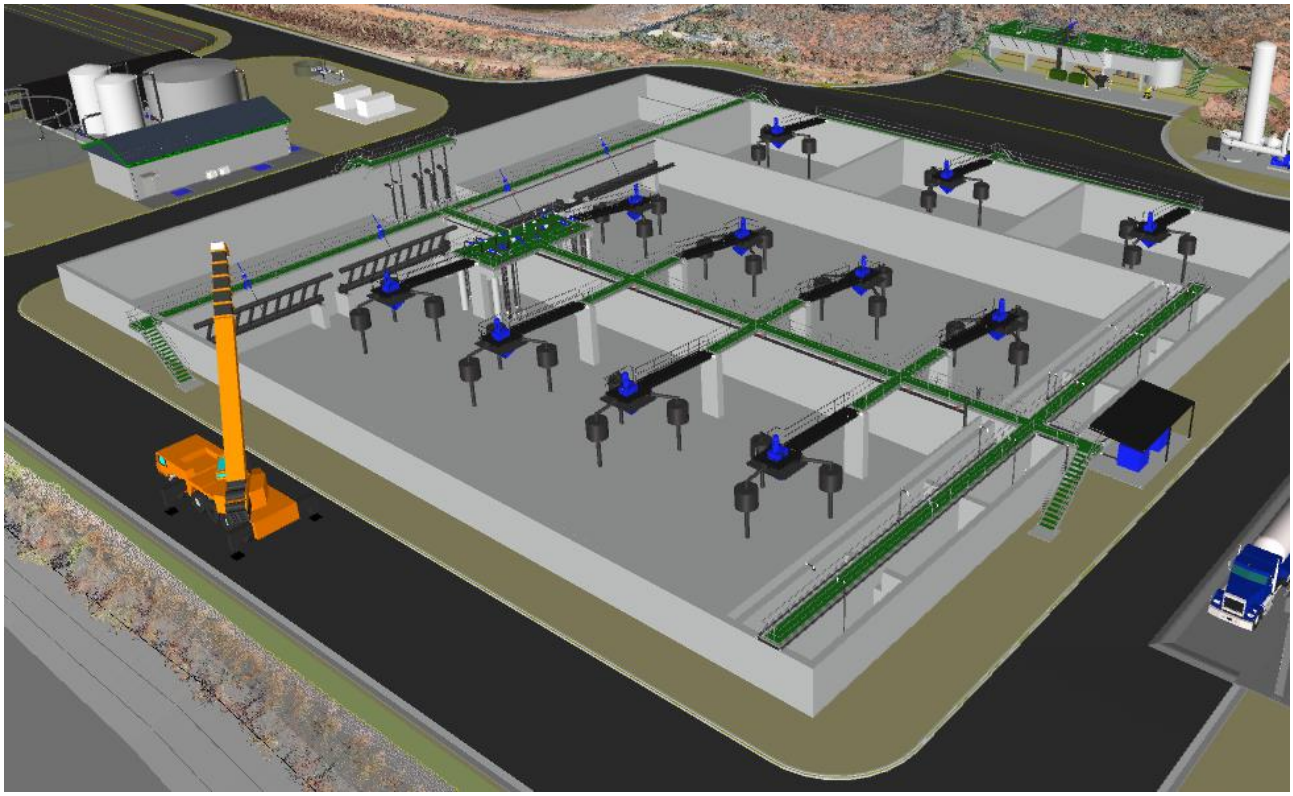


Figure 4-10: Preliminary general arrangement of secondary treatment process.

4.3.4.1 IDEAT Tank Size

The IDEATs are constructed in a 2.3:1 length to width ratio. This promotes plug flow conditions that limit short-circuiting risks as the influent moves from one end of the reactor to the other end of the decant weirs. The size of the reactor allows for the following:

- Sludge Retention Time (SRT) of 25 days to promote process stability
- Mixed Liquor Suspended Solids (MLSS) concentration of ~4,000mg/L at BWL
- Sludge Settling
  - Vo: 5.9m/h, maximum sludge settling velocity
  - n: 0.43l/g, calculated settling parameter

A summary of bioreactor size is presented in Table 4-3.

Table 4-3: Secondary Treatment preliminary design information

Item	Value	Unit	Comment
Number	2	No.	Duty/Duty

Volume	4.6	ML	Each, @BWL
Tank Depth	4.8	m	500mm freeboard
TWL	4.3	m	
BWL	3.2	m	
Length	58	m	Per reactor
Width	25	m	Per reactor
Mixed liquor Temperature	14	ºC	Minimum winter temperature
SRT	25	days	
MLSS	4.0	g/L	@BWL
Vo	5.9	m/h	Maximum sludge settling velocity
n	0.43	l/g	calculated settling parameter

4.3.4.2 IDEAT Operation Cycle

The treatment process comprises of three distinct phases.

- Aeration – the tanks are aerated to provide sufficient Dissolved Oxygen (DO) for bacteria to nitrify influent ammonia, ensure inflows are thoroughly mixed with the biomass and phosphorus precipitation chemicals.
- Settle – aeration ceases, and biomass begins to settle to the base of the reactor. Residual DO is consumed and bacteria commence denitrification of nitrates generated in the aeration phase.
- Decant – effluent is decanted from the top of the liquid column while the biomass is retained within the reactor. Denitrification continues until aeration recommences at the conclusion of the decant phase.

IDEAT 1 will operate on the same aerate, settle and decant cycle times as IDEAT 2 but 180 degrees out of phase. This means that peak aeration and decanting for the two IDEATs should not occur at the same time. This control helps to reduce WWTP peak power demand and prevents peak flow loadings to the effluent balance tank.

Level switches in the IDEATs will be used to indicate to the control system that the storm water switch has been reached and to activate the storm cycle when there are high inflows.

In wet weather, the aeration time will be shortened to ensure each IDEAT can process more flow. The cycle time clock will then be corrected to the equivalent point in the other IDEAT to re-establish the offset between the IDEAT cycles. The trigger for aeration to cease and settling to begin in peak flow is a high-level switch in the IDEAT. If the IDEAT fails to reach a minimum level in the aeration cycle, decanting will be inhibited, and the cycle will continue.

An example of how the operating cycle may change between peak and dry weather flows for both DEATs is shown in Figure 4-11.

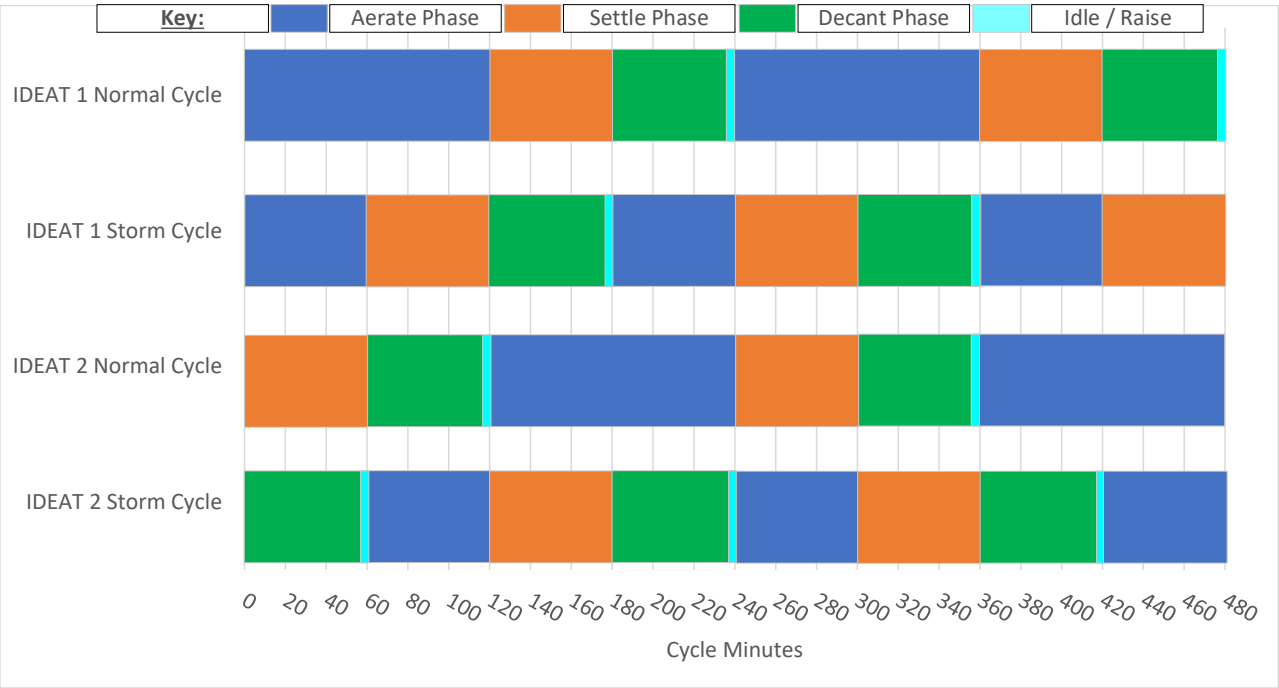


Figure 4-11: Operating cycle change between normal dry weather and wet weather cycles

A summary of IDEAs operation is presented in Table 4-4.

Table 4-4: IDEAs Cycle Setup

Item	Value	Unit	Comment
Dry Weather Cycle			
Aeration/reaction Phase	120	minutes	
Settle phase	60	minutes	
Decant phase	60	minutes	2-3 minutes idle time included
Total cycle duration	240	minutes	6 cycles per day for each reactor
Maximum treated flow	3.5	xADWF	
Expected maximum water level	3.92	m	At end of settling phase
Weir approaching velocity	1.25	cm/s	At 3.5xADWF influent
Wet Weather Cycle			
Storm water switch setup level	3.75	m	Initiate wet weather cycle if the water level reaches 3.75m during aeration phase
Aeration/reaction Phase	60	minutes	
Settle phase	60	minutes	
Decant phase	60	minutes	2-3 minutes idle time included

Total cycle duration	180	minutes	3 cycles per day for each reactor
Maximum treated flow	8	xADWF	
Weir approaching velocity	2.1	cm/s	<2.5cm/s at 8xADWF influent

4.3.4.3 IDEAT Aeration

During aeration phase, each IDEAT is aerated to provide sufficient DO for bacteria to oxidise organic waste and nitrify influent ammonia via low-speed surface aerator. The aerators also ensure inflows are thoroughly mixed with the biomass and phosphorus precipitation chemicals.

Each IDEA tank is equipped with 4 aerators. One aerator is needed during minimum aeration demand, and most likely two aerators are required during normal operation, with three aerators needed for peak oxygen demand. However, during the peak month with maximum oxygen demand, all four aerators may be required.

Two DO sensors will be provided for each IDEAT. In general, the number of operating aerators and or aerator speed will be modified to target a DO set point within the reactor. The operator will be able to select which DO probes are used for monitoring and control (or an average of multiple). A low DO will be controlled to stimulate simultaneous nitrification and denitrification (SND) during the start-up period (0-30mins). The DO will gradually climb during the following reaction phase to maximise nitrogen removal.

A summary of the aeration system design information is presented in Table 4-5.

Table 4-5: IDEA tanks aeration design information

Item	Value	Unit	Comment
Aerator per Tank	4	No.	Per IDEA tank
Type	Surface aerator		Low speed
Aerator size	55	kW	
DO Setpoint	2	mg/L	
Operational Hours	12	hours	
Alpha Factor	0.80		
Beta Factor	0.95		
Aeration Peaking Factor	1.55		COD and Nitrogen peaking factor of 2 during diurnal peaks
SOTR Average	174	kg O_2/hour	Per reactor
SOTR Max	270	kg O_2/hour	Per reactor

The aerators can operate in either Dissolved Oxygen (DO) control mode or scheduled speed control mode.

In DO control mode, the operational speed of all online aerators will vary to maintain the bioreactor's actual DO (averaged from two DO probe readings) at a target DO setpoint. The DO setpoint can be a single value or a scheduled value, adjustable for each hour of the day. If both DO probes fail, or if the plant operator chooses the speed control mode, the aerators will operate at a specified operational speed or a scheduled operational speed (up to 24, adjustable for each hour).

For DO control mode, two aerators will initially start operation. More aerators will be activated if the DO reading remains below its target setpoint for an extended duration, and vice versa—fewer aerators will be

needed if the target is exceeded. It is recommended that at least two aerators remain online during the aeration phase. In speed control mode, it is recommended that three aerators are online.

During normal operation, the fourth aerator is typically not required, so an aerator duty changeover occurs each cycle to ensure relatively equal operation duration daily.

Five to ten minutes (operator adjustable) before starting the settling phase, the aerators will operate with a high DO setpoint or high operational speed with three aerators in operation.

4.3.4.4 Bio-selector

Achieving and maintaining good biomass settling characteristics is a critical process design objective for any activated sludge wastewater treatment plant. Each IDEA reactor incorporates a bio-selector at the inlet of the reactor. The bio-selector consists of 6 small discrete reactor volumes designed primarily for carbon absorption in which activated sludge organisms are exposed to a high substrate concentration for a relatively short time.

Each cell of the bio-selector is equipped with coarse bubble diffusers. Two aeration mixing blowers, configured as duty/standby, provide compressed air for intermittently pulsed mixing of the mixed liquor and influent raw sewage to prevent biomass settling.

A summary of bio-selector is presented in Table 4-6.

Table 4-6: Bio-selector design information

Item	Value	Unit	Comment
Bio-selector cells	6	No.	Each bio-selector consists of 6 cells
Cell width	2	m	
Cell length	8.1	m	
Cell volume	69.7	m^3	At TWL of 4.3m
Bio-selector volume	418	m^3	At TWL of 4.3m
$V_{Bioselector}/V_{reactor}$	6.8	%	
Mixing	Coarse bubble mixing		Intermittently pulsed operation
Blower Type	Positive displacement		Duty/standby
Blower capacity	270	m^3/h	0.6L/s/m^2
Blower pressure	47	kpa	At maximum water level of 4.3m

The duty mixing blower normally operates at an operator-adjustable speed and follows an on/off cycle (adjustable). Once the blower's off period for its relevant bio-selector expires, it starts for an operator-adjustable on period before stopping again. The duty blower feeds only one bio-selector at a time, controlled by an electric actuated valve.

4.3.4.5 Pump Stations

There are two RAS pumps per bioreactor. The failure of the duty RAS pump will start the standby pump automatically. The duty RAS pump continuously returns mixed liquor from the end of each bioreactor to the inlet of the bio-selector, where RAS is mixed with the raw sewage influent flow delivered from the inlet works.

The RAS pumps are fitted with variable speed drive. The RAS pump can be operated flow-paced to the IDEA's inlet flow rate or at a fixed operational speed.

There are two WAS pumps per bioreactor. The failure of the duty WAS pump will start the standby pump automatically. WAS transfer can be initiated during the settling/Decant phase or aeration phase The WAS pumping duration will be adjusted based on the mixed liquor concentration to maintain a target design SRT. If WAS wasting occurs during the aeration phase, the WAS wasting sequence begins 5 minutes (adjustable) after the aerator sequence starts. The sequence stops once the accumulated "WAS volume per cycle-reaction" has been reached, as measured by the WAS flow meter.

If WAS wasting occurs during the settling/decant phase, the WAS volume per cycle will be adjusted based on the actual measured Mixed Liquor Suspended Solids (MLSS) in the relevant phase.

The failure of the WAS flow element results in the WAS pumps switching to timer control. Wasting will continue to occur.

The WAS pumps are fitted with variable speed drive, however during normal operation the duty pump may operate at a fixed speed. It is the wasting duration, not flow that varies each cycle and as such turndown is managed through changing the run time. Furthermore, WAS wasting is based on the bioreactor volume, not the wastewater flow or loading.

A summary of pump station is presented in Table 4-7.

Table 4-7: RAS and WAS design information

Item	Value	Unit	Comment
WAS Pumps			
Required Volume	420	m^3/d	Assuming waste during the aeration phase, the flow rate includes 96% solids recovery from WAS thickening and 95% solids recovery from dewatering
Waste duration	60	minutes	Per cycle (assuming reaction phase) Wasting can also occur during the decanting or settling phase with much thickener WAS
Required Capacity	10.0	L/s	Per pump
Number of pumps	2	No.	Duty /standby
Type of pump	Submersible centrifugal		
RAS Pumps			
Capacity	1.8	xADWF	Per pump
	50	L/s	Per pump
Number of pumps	2	No.	Duty /standby
Type of pump	Submersible centrifugal		
Operation	Continuously or intermittent		Expected operate continuously

4.3.4.6 Decanter and Effluent Balance Tank

At end of settling phase, the treated supernatant can be removed effectively with minimal carry over of solids by the rotary decanter without disturbing the sludge blanket. Each IDEAT is fitted with two rotary decanters. During normal operation, if one of the decanters fails, the other decanter still can be in operation without shutdown the relevant IDEAT. The rotary decanter consists of a decant trough, weir, floating scum buffer, carrier pipes, rotary collection pipe, submersible support bearings and a drive mechanism.

A preliminary arrangement showing the decanters in one of the IDEATs is provided in Figure 4-12.

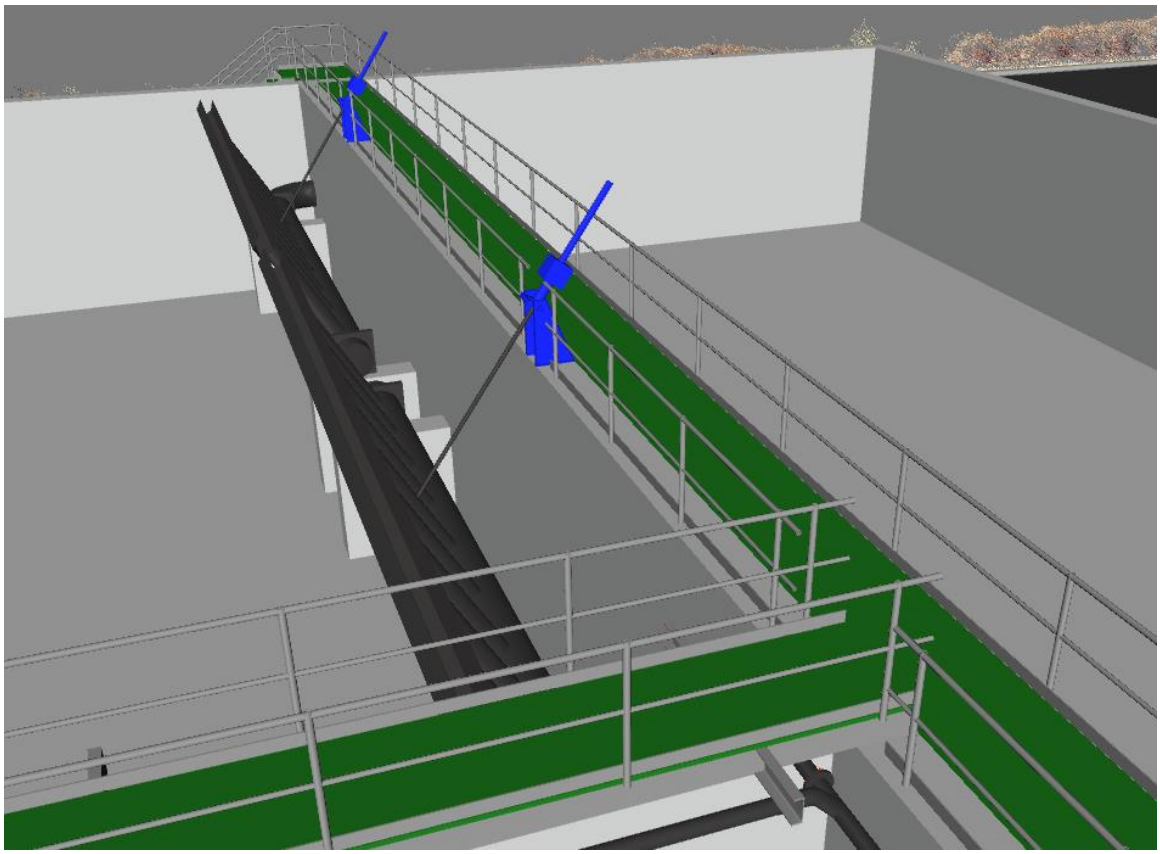


Figure 4-12: Preliminary decanter and balance tank arrangement.

In operation, the drive mechanism extends and retracts a drive shaft which actuates an eccentric link arm that rotates the trough up or down in an arc into the supernatant. The trough, carrier and collection pipes are supported at both ends by submersible bearings. The bearings are secured inside bearing housings which are bolted to concrete plinths. The supernatant discharge rate can be controlled over the weir by variable speed control to maintain optimum flow. The floating scum baffles prevents scum from approaching the weir.

The decanter drive mechanism consists of an electric motor, gearbox, jack mechanism and screwed drive shaft. The drive is typically fitted with internally actuated position indicators that allow drive limits to be set for BWL, top park position and over limit safety stops. Optionally positioned transponders can also be fitted. The drive mechanism is normally installed at the end of the tank.

The bioreactors store flows for up to four hours, and then discharge the accumulated volume in less than an hour. This acts to multiply peak flows and creates a decant flow much higher than the peak inflow to the IDEATs. Failure to store and attenuate these high decant flows would result in the oversizing of downstream facilities (UV).

The decanters from the two bioreactors discharge to an effluent balance tank. Secondary effluent stored in this tank is pumped to the tertiary treatment system for the production of recycled water for on-site washing water and offsite recycled water end users' application, the remaining flow is pumped to an effluent UV channel for disinfection before discharging into the environment and/or White Leeds. Failure of the feed

pumps, or UV units could result in a loss of capacity. This can lead to the level in the decant storage tank rising to and overflowing a fixed weir that bypasses tertiary treatment to the emergency storage pond.

The effluent balance tank will be covered by Colourbond shed to minimise Algae growth.

Note: it has been identified that shade cloth for covering of the balance tank is not a robust solution. Options such as covering the balance tank with a Colourbond roof are the subject of further investigation at the time of writing this report.

A summary of the preliminary design information for the decanter and effluent balance tank is presented in Table 4-8. The design of the decanter may vary depending on the final equipment selection and supplier preferences.

Table 4-8: Decanter and effluent balance tank preliminary design information

Item	Value	Unit	Comment
Decanter			
Number of Decanter	2	No.	Duty/duty, per bioreactor
Length per decanter	11.5	m	Single sided discharge
Max Lowering Speed	20	mm/min	Decant during wet weather
Min Lowering Speed	5	mm/min	Decant during dry weather
Rising rate	5.0	m/h	
Decant Flow PWWF	690	L/s/tank	713L/s if including rainfall
Dry weather maximum weir loading rate	18.4	L/s/m	At 3.5xADWF
Peak weir loading rate	31.4	L/s/m	The design has been based on a relatively conservative approach, assuming a continuous 8xADWF influent flow throughout the cycle. However, from the flow analysis, it is evident that the likelihood of the 8xADWF is very low. The likely maximum influent flow rate may be around 6xADWF, with the expected weir loading rate of 23.5 L/s/m.
Peak weir approach velocity	2.2	m/s	At Peak decanting flow and MLSS concentration at BWL.
Effluent Balance Tank			
Volume	2,500	m^3	Assuming two decants occurred one after the other without emergency overflow, plus a two-hour rainfall

			allowance
Length	65	m	
Width	15.1	m	
Top water level	2.55	m	During normal operation
Overflow weir level	2.65	m	
Maximum water level during overflow	2.76	m	At maximum decant flow of 690L/s
Overflow weir length	10	m	

4.3.5 Effluent UV Feed Pumps & Effluent UV Disinfection

Secondary treated effluent from the effluent balance tank is delivered via an effluent UV feed pump station and disinfected via a low-pressure in-channel UV system. It is estimated that the UV system will consist of ten banks in series , based on preliminary design information from xylem using Wedeco Duron UV system. However, the UV channel arrangement may differ if an alternative supplier is selected. The sizing details will need to be adopted based on the final selection equipment.

A preliminary layout showing the secondary effluent UV disinfection channel system is provided in Figure 4-13.

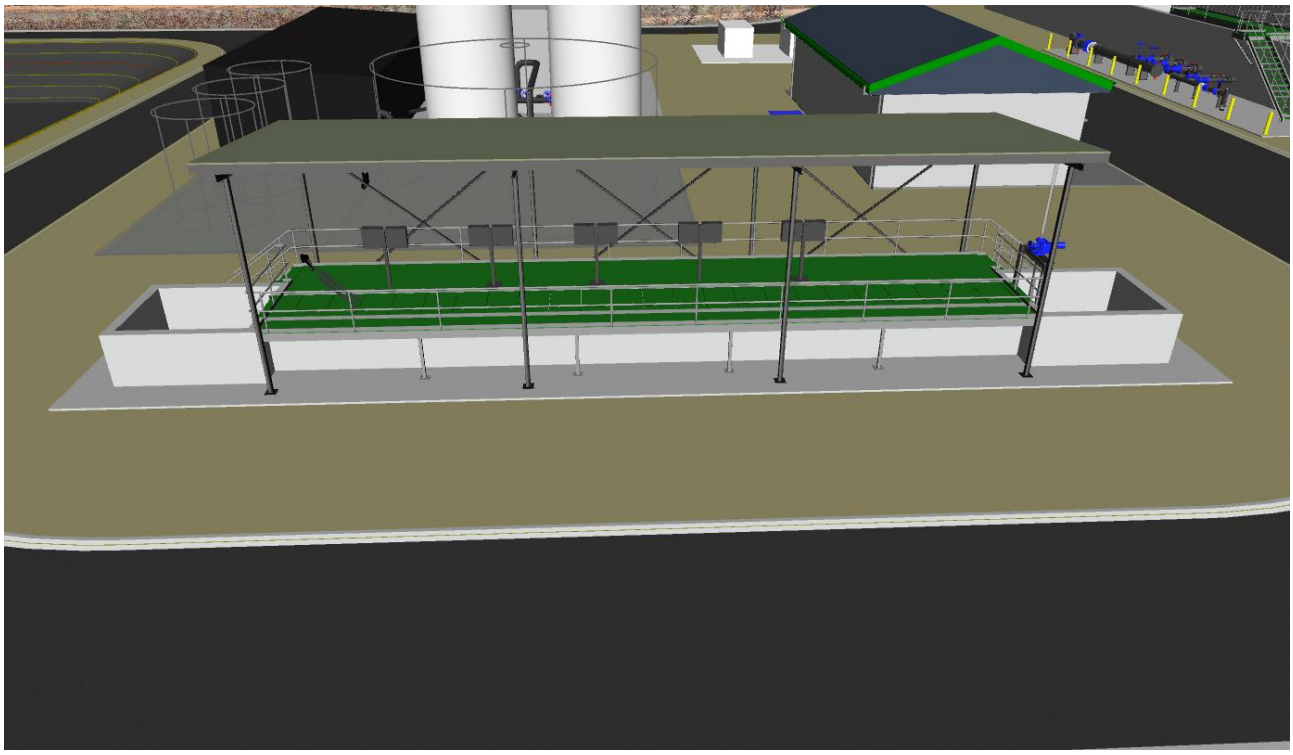


Figure 4-13: Preliminary general arrangement of secondary effluent UV system.

It is noted that the hydraulic capacity of the UV disinfection system is also inherently linked to the UV performance and equipment selection. Nominally however, the UV system will be selected to maximise hydraulic throughput in wet weather, providing partial treatment.

The current iteration of the UV system is designed to achieve

- 90th Percentile 200 cfu/100 mL, and
- 100 percentile 600 cfu /100 mL

- UV inlet flows at 3xADWF, and
- UV Transmissivity is 40%
- Suspended solids of 30 mg/L (Maximum)

The UV system would be designed to achieve the pathogen reduction targets for up to 3xADWF with higher hydraulic flows up to 6xADWF (or as developed in conjunction with the UV supplier) passing through the UV system but achieving reduced pathogen reduction. A high level switch will be installed in the UV inlet channel to stop effluent UV feed pumps if it is triggered, to prevent surcharging of the UV inlet channel.

Secondary effluent UV Transmissivity is measured by an online analyser sampling from the UV inlet channel.

The flow rate through the UV system will be monitored by the effluent UV feed pump station flow meter or can be calculated by the UV system controller that considers the position of a modulating discharge penstock on the channel outlet and the channel water height as measured by a level element. Lamp cleaning is facilitated by an automatic wiping system.

UV disinfected flow will be collected in a UV outlet pit. All the treated effluent will be delivered to the existing open earthen channel and the White Leeds via an upgraded effluent outfall.

A summary of key preliminary design information for the effluent UV feed pump station and UV disinfection system is presented in Table 4-9.

Table 4-9: Effluent UV System and effluent discharge Preliminary Design Summary

Item	Value	Unit	Comment
Effluent UV system			
Type	Low Pressure In Channel		
Model No.	Duron 20i		Wedeco
No. of Banks	10	No.	
Peak Disinfection Flow Rate	180	L/s	3xADWF+12L/s contingency
Minimum UV Transmissivity	40%		
Suspended Solids	30	mg /L	At maximum, average 10mg/L
Inlet E. coli	$1x10^6$	cfu / 100mL	At maximum
Effluent E. coli	200/ 600	cfu / 100mL	90%ile/ Maximum
Maximum hydraulic flow	<371	L/s	6xADWF+38L/s rainfall
Channel length	13.4	m	
Channel width	1,230.0	mm	
Channel depth	2,000.0	mm	
Upstream water level	1,070.0	mm	
Effluent UV Feed Pump Station			
Number	3	No.	Duty/Assist/standby
Total capacity	371	L/s	6xADWF+38L/s rainfall
Capacity (each)	186	L/s	Per Pump

Pump Type	Submerged centrifugal pump

The UV system is controlled by it's own proprietary controller (housed within the air conditioned local switchboard). The controller adjusts lamp output to maintain target UV dose rates dependent on system flow, bank intensity and UV transmissivity. The controller also modulates the effluent penstock to maintain a target channel water level. If the UV position element fails, the UV actuated penstock will switch to Backup mode and adopt an operator-set fixed position. The UVT analyser trims UV outputs and alarms against low values.

There are two operating modes for the UV feed pump station, these are:

4.3.6 Effluent Outfall

From a preliminary analysis, significant modifications to the existing effluent transfer pipe from the STP to convey additional flow to the existing effluent discharge location. To transfer treated effluent up to PIF through the provision of an effluent pump station is not seen as overall beneficial due to the additional cost and complexity of a new pump station. From consultation with EW, building a new DN630 HDPE pipe to transfer the effluent up to PIF via gravity has been chosen as the preferred option for the effluent outfall. Refer to Effluent outfall Technical Memo (Appendix G) for further details.

The alignment of the new outfall is also provided in Appendix G.

4.3.7 Tertiary Treatment

A portion of the secondary treatment flow will be delivered to a tertiary treatment facility and disinfected to meet the recycled water quality standards. The tertiary treatment infrastructure includes the following key items:

- Tertiary treatment feed pump station which will be located in the balance tanks which accept effluent from the IDEATs
- Tertiary filtration system (Provision shall be made for the system if deemed necessary, including the allowance for footprint, backwash water usage, backwashed wastewater return, maximum power demand and switchboard design).
- Pre-validated in-line UV systems.
- Chlorine contact tank in the form of above ground FRP tanks with internal baffles.
- RE storage tank to supply on site uses and future filtration system backwash water if required.
- Gas chlorine storage and dosing system.
- Relevant instrumentation and valves.
- Space for additional future effluent reuse storage tanks.

A preliminary general arrangement of the tertiary treatment area is provided in Figure 4-14. Reuse pumps and inline UV systems are shown within the open section of the building. The Chlorine storage and dosing is located within the closed section of the building to the left of the shed. The taller white tanks are for chlorine contacting and the larger tank is the effluent storage tank. The grey area to the right of the snapshot is area for future expansion of the tertiary treatment process.

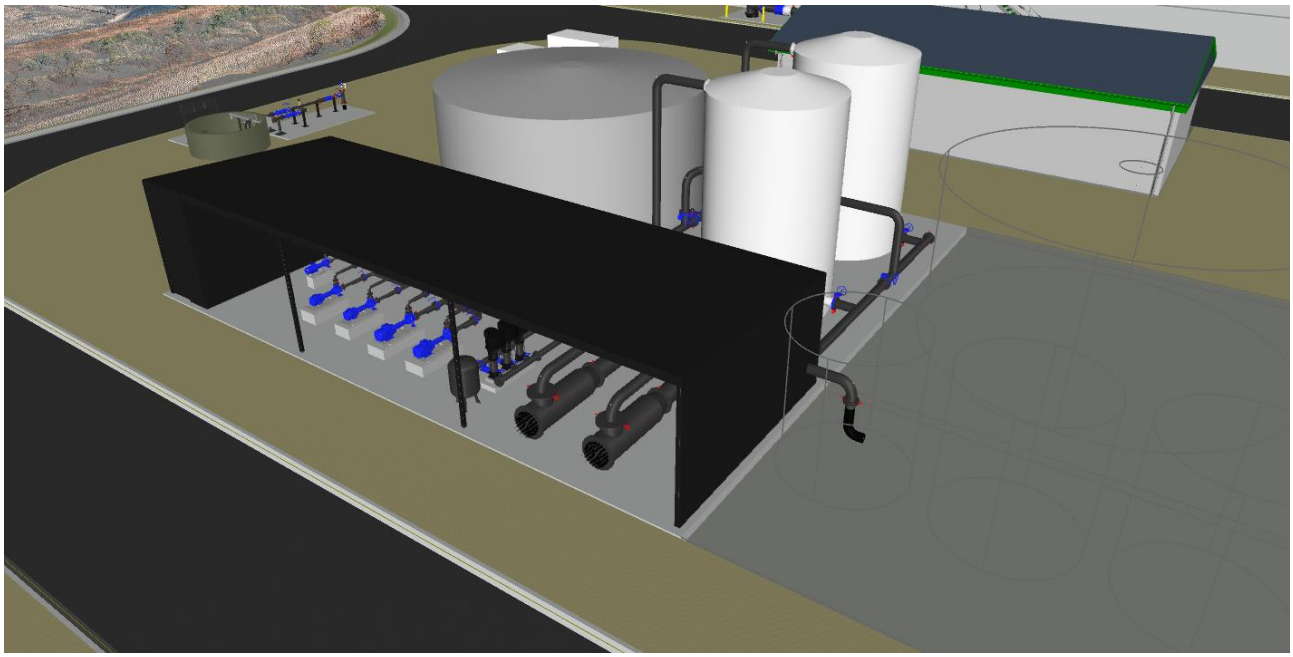


Figure 4-14: Preliminary general arrangement of tertiary treatment area.

4.3.7.1 Tertiary Process Feed Pumps and Inline UV System

There are two tertiary process feed pumps situated in the effluent balance tank that supply secondary treatment effluent to the tertiary treatment process. Should the duty pump fail, the standby pump will start automatically. The duty pump will commence automatically when the recycled water tank level drops to its predetermined setpoint, and it will stop when the tank reaches its high level setpoint. Typically, the pump operates at a fixed flow rate and is designed to run continuously to avoid frequent starts and stops of the inline UV system.

The UV system feed pump control will also include the ability to:

- Hold effluent in the balance tank if effluent reuse needs to be maximised.
- Vary the tertiary throughput based on the demand and level in the recycled water tank.

Two inline UV reactors will be provided for targeted pathogen removal, with the UV reactors configured as duty/standby. In the event of a failure of the duty UV reactor, the standby reactor will start automatically.

One online turbidity analyser and one (1) inline UVT (UV Transmissivity) analyser will be installed upstream of the UV system. If the turbidity or UV transmissivity is beyond the pre-determined operational range, the feed of secondary treated effluent to the recycled water facility will be automatically halted. Reuse is only allowed when the plant is functioning optimally.

An example of a typical inline UV system layout is shown in Figure 4-11 (TROJANUV, Courtesy of Aquatec Maxcon).

Figure 4-15: Example inline UV disinfection system

A summary of key preliminary design information for the tertiary process feed pump station and the inline UV disinfection system is presented in Table 4-9.

Table 4-10: Tertiary Process Feed Pumps and Inline UV System Preliminary Design Summary

Item	Value	Unit	Comment
Tertiary Process Feed Pump Station			
Number	2	No.	Duty/standby
Capacity (each)	39	L/s	
Type	Submersible centrifugal pump		
Recycled Water Usage	2,500	m^3/d	95%ile daily usage of 2,176kL/d and allowed 15% contingency for data error or potential future changes
Onsite service water usage	500	m^3/d	
UV			
Type	Inline		Pre-validated system
Model	LBX1000		Wedeco
Number	2	No.	Duty/standby
Peak Design Flow Rate	39	L/s	

Minimum UV Transmissivity	50	%	Based on well performed secondary treatment process
Turbidity	2	NTU	Online turbidity will be provided to control feed to the tertiary treatment plant
LRV target	4.0	Log	Protozoa (Cryptosporidium and Giardia)
	1.0	Log	Virus (Adenovirus)
	4.0	Log	Bacteria (E.Coli)
UV Dosage	58	MJ/cm^2	USEPA UVDGM 2006
UV lamp life	14000	h	
UV start/stop	4	Times/day	Average times to maintain the warranty
Minimum feed flow	15	m^3/h	To avoid overheat

4.3.7.2 Chlorine Contact Tanks (CCT)

The treated water, disinfected with UV, will be sent to two chlorine contact tanks (CCT) for additional disinfection to meet the pathogen removal standards for recycled water application.

Gas chlorine is dosed automatedly before the CCTs, and the free chlorine levels in the water after the CCTs are monitored automatically. Additionally, the C.T. value is calculated automatically, and an alarm will be triggered if the actual C.T. value falls below the required level for pathogen reduction. The two tanks can be operated in series or in parallel, and one of the tanks can be taken offline for manual cleaning when necessary.

The tanks are made of fiberglass-reinforced plastic, and each one has two horizontal baffles at different levels to improve retention. The site effluent reuse pumps have the functionality to recycle the treated effluent back to the inlet of the chlorine contact tanks to ensure sufficient residual is maintained. It is assumed this process would be semi-automated whereby the operator initiates the process of recirculation which then completes automatically to achieve the desired chlorine residual concentration.

A summary of key preliminary design information for the CCT is presented in Table 4-11.

Table 4-11: CCT Preliminary Design Summary

Item	Value	Unit	Comment
Peak Design Flow Rate	39	L/s	
Required C.T. Value	23	mg.min/L	Turbidity <5NTU, pH<=8, Temperature>=10°C 4 log virus removal
Free chlorine residual	1	mg/L	
CCT baffle factor	0.4		USEPA Disinfection Profiling and Benchmarking Manual 1999, Table D-5
Required CCT tank volume	133	m^3	
Tank Type	Above		FRP Tank

	ground Tank		
Tank Number	2	No.	In series or in parallel, one of the tanks can be isolated for cleaning
Each Tank volume	67	m^3	
Tank Diameter	4.0	m	
Tank Height	6.0	m	

4.3.7.3 Recycled Water Tank

CCT disinfected effluent will flow into a recycled water tank via gravity. The recycled water tank provides buffer capacity for end users recycled water, site service water or reclaimed effluent (RE), and current end users recycled water applications. A footprint is allowed in the site general arrangement to duplicate the recycled water tank and supply backwash water if the tertiary filtration process is deemed necessary.

There are a number of uses for service water around the STP site. These are:

- Spray and wash water for the inlet works (screen and git units).
- Sprays for the bioreactors.
- Hose points at various locations for hosing down and cleaning.
- Dewatering system washing & cleaning.

Rather than use potable water for these purposes, it is preferred to source it from fully treated and disinfected effluent. There is no automated shutdown of this system in response to UV failure. The inlet works must continue to always receive a supply of spray and wash water. Other uses can be suspended by the operator if disinfection is considered sub-standard due to poor effluent quality performance such as may occur in wet weather.

RE is drawn from this tank through a proprietary RE pumping system that includes a number of RE pumps (likely to be three) and a pressure vessel. The pumps are pressure controlled. This system discharges to a pressurised ring main around the site. The flow of RE is monitored but this is not used for control or alarming.

A summary of key preliminary design information for the recycled water tank is presented in Table 4-12.

Table 4-12: Recycled Water Tank Preliminary Design Summary

Item	Value	Unit	Comment
Recycled Water Tank			
Capacity	250	m^3	Assuming 90mins buffer capacity for site service water and golf course pumps in operation
Type	Panel		PE liner tank
Number	1	No.	
Estimated Tank Diameter	9.5	m	
Estimated water level	5.0	m	Assuming maximum BWL of 1.0m
Reclaimed effluent Pump Station			
Type	Booster pressure		Vertical multistage pump

	system		
Number	3	No.	Duty/Assist/Standby
Design Capacity	24	L/s	
Discharge Pressure	6.5	bar	

4.3.7.4 Effluent Reuse Pump Station

There are currently three pump sets discharging recycled water to their respective end users:

- Golf Club pumps:

Two pumps with soft starters in a duty/standby arrangement. The duty pump withdraws water from the recycled water tank and delivers it to the Wyman St effluent storage tank. Reuse customers take water from the tank via gravity, mainly during night-time. The pump's start/stop is controlled by the Wyman St effluent storage tank level through a radio telemetry system. A magnetic flowmeter is installed in the discharge line to monitor the flow rate.

- Perilya pumps:

Two pumps with soft starters in a duty/duty arrangement, each with its dedicated discharge line and magnetic flow meter. The pumps are start/stop controlled by the external site storage tank level over a wireless link.

- Tronox (Bemax) pump:

Includes a pressure booster system with a single pump and fitted with a VSD starter. The pump operates via a pressure transmitter with a set point of 6 bar. Additionally, the pump is fitted with a magnetic flow meter.

EW has requested a like-to-like replacement of the existing effluent reuse pump station and relocation to the tertiary treatment area to withdraw water from the recycled water tank instead of the existing effluent reuse pit. It is assumed the existing pump sets meet the end users' needs, and that the 80m^3 recycled water buffer capacity allowance is sufficient.

The preliminary information on the effluent reuse pumps provided by EW is presented in Table 4-13. The accuracy of the information is to be verified during the detailed design stage.

Table 4-13: Preliminary design information for the effluent reuse pump station

Item	Value	Unit	Comment
Golf Club pump			
Number	2	No.	Duty/standby
Capacity	21	L/s	Estimated
Motor size	45	kW	
Type	End suction centrifugal		
Perilya pumps			
Number	2	No.	Duty/Duty
Capacity	15	L/s	Estimated
Type	TBA		

Tronox (Bemax) pump			
Number	1	No.	Duty/Duty
Capacity	4	L/s	Estimated
Discharge pressure	6	bar	Estimated
Motor size	4	kW	
Type	pressure booster		

4.3.8 Waste Sludge and Biosolids Handling

The sludge handling system includes the following key items:

- Aerobic digester
- Floating decanter.
- Dewatering screw presses
- Sludge conveyors
- Polymer preparation and dosing system

A preliminary arrangement showing the proposed dewatering and outloading area is provided in Figure 4-16.

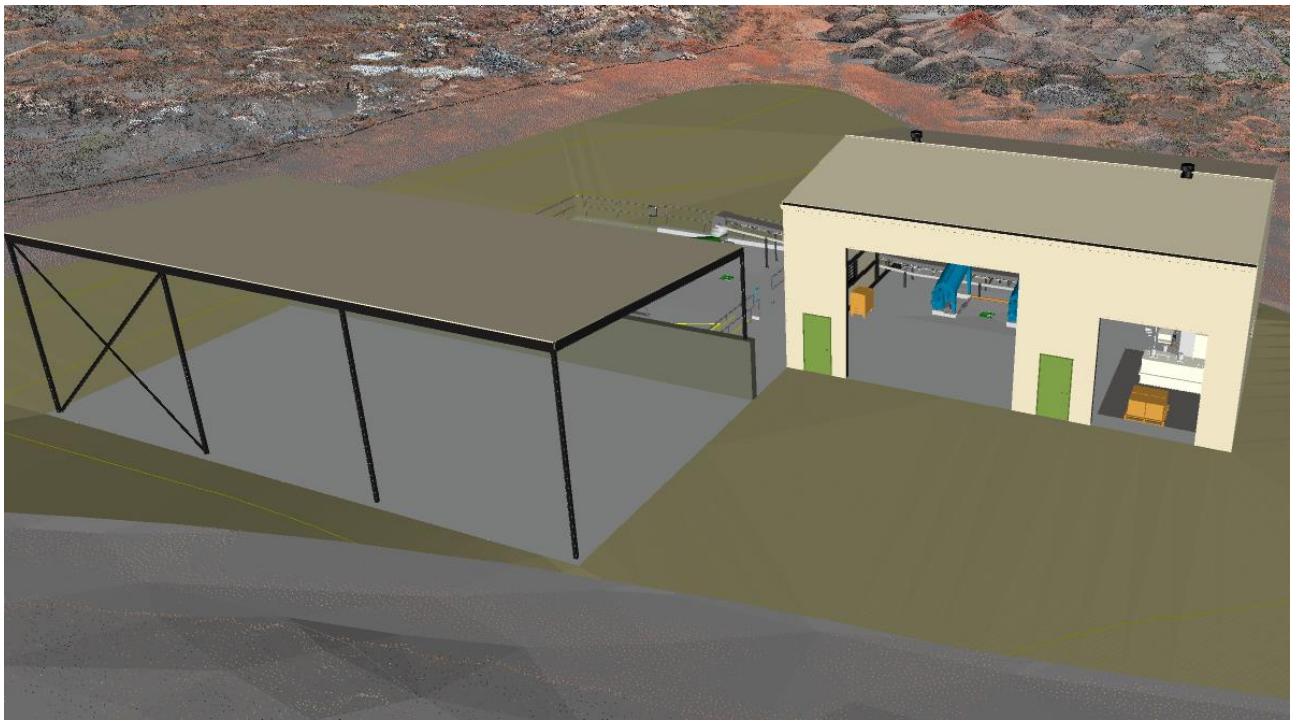


Figure 4-16: Preliminary arrangement of sludge dewatering and outloading area.

4.3.8.1 Aerobic Digester

Thickened WAS during the settling phase or unthickened WAS from the aeration phase from each IDEAT is pumped into the aerobic digester. The WAS can bypass the digester to the dewatering unit if required for emergencies (such as during equipment maintenance or failure).

The aerobic digester, the structure of which is integrated with the bioreactor, contains 3 cells, Pre-thickened WAS enters Cell 1, passes through Cell 2, and ends in Cell 3. The digested WAS (DWAS) will then be removed via a mechanical dewatering system. There is one floating decanter installed inside the aerobic

digester Cell 1, the digester operational MLSS is further thickened with decanting supernatant flow after settling phase.

An example of a floating decanter which could be used in the aerobic digester is shown below (Figure 4-17), courtesy of Liquitek Water and Wastewater Treatment (2023).

Figure 4-17: Example of floating decanter system (courtesy Liquitek Water and Wastewater)

The daily digester feed volume is calculated by subtracting the supernatant flow volume from the WAS volume (or only WAS volume if there is no further thickening from the floating decanter). A rolling seven-day volume will be calculated to assist the operator in settling weekly dewatering run volumes. The digester feed volume needs to match the DWAS volume over time for the digester to remain stable operational volume. The digester level will fill slightly between dewatering runs, then slowly lower again while dewatering is occurring.

Each digester cell is fitted with a surface aerator which will operate intermittently. The number of cycles per day and the length of each phase in the cycle is set by the operator in the SCADA. There are two phases in each cycle:

- Aerate – The contents are mixed through mechanical aeration and organic components of the WAS and scum are broken down. Ammonia is released as the solids break down. This is converted to oxidised nitrogen (mainly nitrate) in a process known as nitrification.
- Non-aerate– In this phase, the aerator in each cell stops most of most time and pulse running only to maintain mixed liquor in suspension. Nitrate removal (denitrification) occurs once the remnant dissolved oxygen (DO) is depleted.

To further thicken the mixed liquor operational concentration, the supernatant can be withdrawn from aerobic digester Cell 1 via a floating decanter. When the thickening is initiated, the aerator will stop operation and into the settle phase, once the settle phase expires, automatically open the supernatant control valve and start decanting until the pre-set flow or run duration expires. The system will then return to aerate and non-aerate cycles.

The operator selects the start time of the day of the first cycle. The start time of each phase is then calculated and mapped by the SCADA for the whole day. This is referred to as the digester cycle timetable. In the event of recovery from power failure, the digester will restart automatically in the phase that it should be in at that time of day. The digester cycle timetable is remapped if the operator changes the cycle or phase timing via the SCADA.

The DWAS pump operation is also linked to the digester cycle timetable. The intent is to pump DWAS to the dewatering flocculation tank during the aerate phase only, when the digester is fully mixed and the DWAS is

at a known and constant concentration. It may also be possible to run the digester aerator at low speed during dewatering such that mixing is provided but minimal to no aeration.

There is only one digester. All mechanical maintenance can be undertaken without draining the digester. The digester can be bypassed if it needs to be drained for any reason. This has no impact on effluent quality, however, the resulting dewatered biosolids will need to be reprocessed or sent to landfill.

There is a single DO element in each digester cell. This is used for monitoring and control if required. A pH and temperature element are also provided in cell 3 for monitoring an alarming. There is also a level transmitter installed in cell 3 to monitor the digester level and used for process control. The real time DO, pH and temperature, plus the average results for today and yesterday are monitored, calculated, displayed and recorded.

A preliminary sketch of the aerobic digester with surface aerators, is shown in Figure 4-18.

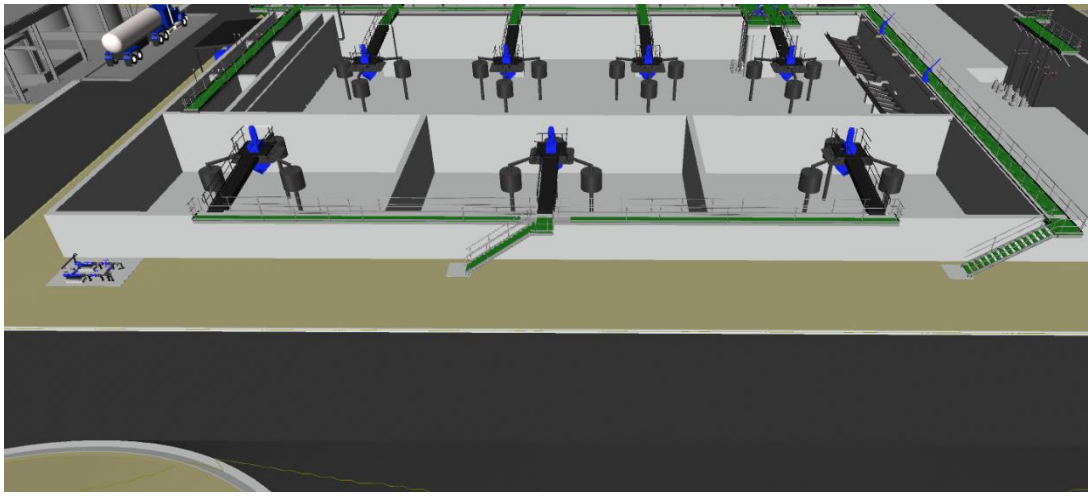


Figure 4-18: Preliminary arrangement of aerobic digestion process.

4.3.8.2 Dewatering system

DWAS is drawn from the aerobic digester and dewatered through two dewatering trains. It is important to maintain a near constant solids concentration in the dewatering feed. Sudden changes in concentration can lead to sub-optimal polymer dosing, solids recovery and biosolids moisture content. It is therefore important to waste DWAS from the digester only when it is fully mixed (aerated).

Wasting DWAS while digester Cell 3 is mixed also allows DWAS flow and volume to be used to control the digester sludge age. This results in stable digestion performance, aeration demand and DWAS thickness, all of which are critical to optimised digestion and dewatering.

The aerobic digester includes three days storage capacity to allow for long weekends when the dewatering system is not in operation.

Each dewatering train is composed of the following components:

- DWAS pump
- Polymer dosing pump
- Screw press

Each dewatering train can be operated independently or concurrently with the other train. Dewatered biosolids fall from the end of each press onto a fixed speed horizontal conveyor. The horizontal conveyor delivers the biosolids to an inclined conveyor that subsequently lifts the biosolids into a truck trailer. Flexibility would be provided to allow biosolids to be discharged onto the trailer hardstand if required. The included conveyor is fitted with a separate, fixed speed, reversible slewing drive and position switches. The inclined

conveyor pivots around a vertical axis, filling the trailer length more evenly. The dewatering filtrate will be returned to the head of inlet works via the foul water pump station.

The dewatering system is very simple to operate based on a pre-populated operational schedule, it only needs the following operator input:

- Chose the dewatering date (Mon to Friday).
- Enter the dewatering start time and run time.
- Set DWAS operation flow rate or speed.

The dewatering system will start automatically once triggering the pre-set start time if all the start-up conditions met. The dewatering system will automatically work out the daily run duration or dewatering volume to meet the rolling weekly digester feed volume, alternatively, the operator can enter the daily run duration or dewatering volume to override the calculated values.

The screw press has a single drive, a wash water solenoid and an air compressor (to be determined during detailed design). The air compressor operates continuously to maintain design pressures. The compressed air creates a back pressure on the biosolids, which can be adjusted in the field. Dewatering feed (DWAS) is mixed with diluted polymer before entering the screw press.

The screw press contains an auger and a filter basket. The auger is a screw with tightening gaps. As the sludge moves up the screw, it is compressed. The amount that it is compressed is influenced by the compressed air pressure setting. Filtrate that is squeezed from the sludge, flows out through the filter basket and is collected within the unit. It flows via gravity to the filtrate main, gravitating to the FWPS. RE is used to intermittently clean the filter basket during operation, and then to clean the press during shutdown. This RE spray water returns with the filtrate.

A typical screw press is shown in Figure 4-19.

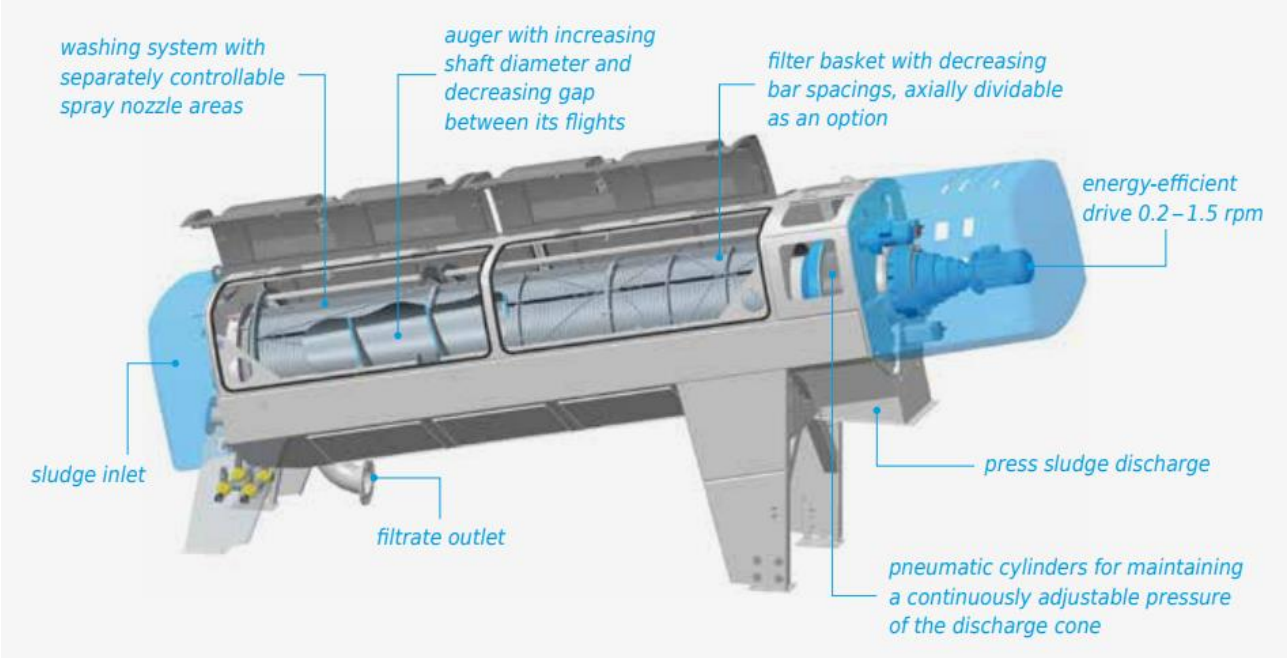


Figure 4-19: Screw Press (Huber, Q-PRESS)

The dewatering system acts as a 'slave' to the DWAS control system. If Available (usual), then the dewatering system will automatically undergo a start-up sequence if the level in the aerobic digester is above a dewatering start level. The dewatering system will commence a shutdown sequence once the run duration expires or accumulated dewatering volume reaching pre-set target, the dewatering feed pump stops, and a time out period expires. However, a shut-down sequence will also be initiated (after a time out delay) if the dewatering feed pump stops for any other reason (such as various equipment failures).

Polymer helps to flocculate particles through additional binding and bridging with the long-chained, charged polymers. This improves dewatering performance (solids recovery and biosolids solids content). An example of a powder polymer storage and dosing system courtesy of Tomal (2023) follows (Figure 4-20).

Figure 4-20: Example of powder polymer storage and dosing system courtesy Tomal (2023).

Solids recovery is the mass of dry solids in the biosolids cake compared to the dewatering feed. The difference is solids lost in the filtrate. Poor recovery results in solids recycling through the STP, increasing the bioreactor MLSS and reducing the secondary treatment capacity, digester and even the dewatering facility itself. Improving the recovery through appropriate polymer dosing is therefore a critical objective.

The control of the polymer dosing pumps is interlocked with the operation of the DWAS pumps. The dosing rate is fixed by the operator based on the dewatering feed flow and solids content.

A summary of preliminary design information for the sludge handling system is presented in Table 4-14.

Table 4-14: Sludge handling preliminary process sizing

Item	Value	Unit	Comment
Aerobic digester			
Number	1	No.	3 cells
Design SRT	24	days	Including 3 days buffer capacity for long weekend when dewatering system is not running
Thickened WAS concentration	11	g/L	WAS could be wasted during the settling and decanting phase. Additionally, it could be further thickened using a floating decanter in aerobic digester cell 1, if required
Capacity	3400	m^3	
Cell length	19.4	m	
Cell width	14	m	
BWL	3.68	m	
TWL	4.2	m	
Wall height	4.8	m	0.5m freeboard +0.10m rainfall allowance
Cell 1 Peak SOTR	68	kgO_2/h	
Cell 2 Peak SOTR	45	kgO_2/h	
Cell 3 Peak SOTR	31	kgO_2/h	
Aerator size (cell 1)	45	kW	
Aerator size (cell 2)	30	kW	
Aerator size (cell 3)	30	kW	
Sludge Thickening Decanter			
Number	1	No.	
Type	Floating		Gravity discharge
Capacity	13	L/s	
Control	Flow control valve		
DWAS Pumps			
Number	2	No.	Duty/standby
Type	Positive displacement		
Capacity	8	L/s	Normal operation capacity of 6L/s

			5days per week, 9 hours per day
Screw Press			
Number	2	No.	Duty/Standby
Capacity (per machine)	25	m^3/h	45 hours/weekly, 9hours/day for Duty/standby operational mode Two screw presses can operate concurrently if reduced operation duration is necessary
	220	Kg/h	average capacity (1%)
	300	Kg/h	Peak capacity (1.2%)
Polymer system			
Number	1	No.	
Type	Powder		polymer preparation system
Capacity	3	Kg/h	Preparation of 0.25% solution
Model Number	PolyRex3.0		Tomal system
Polymer dosing pumps			
Number	2	No.	Duty/standby
Type	Positive displacement		
Capacity	300-1,500	L/h	

4.3.9 Chemical Dosing System

Three chemicals will be used for the BHWWTP upgrade:

- Aluminium sulphate (47% Alum): For phosphorus precipitation (soluble phosphorus removal).
- Sodium hydroxide (25% NaOH): To offset alkalinity consumption associated with chemical phosphorus removal.
- Chlorine Gas: Chlorine disinfection, dosing upstream of the CCT tanks.

A preliminary general arrangement of the liquid chemical area is inclusive of alum and caustic dosing and with space for expansion is provided in Figure 4-21.

Figure 4-21: Preliminary arrangement of chemical storage and dosing area.

4.3.9.1 Alum Storage and Dosing System

Alum is delivered by tanker and stored in alum storage tanks. Level alarms indicate when the storage tank nears empty so that a delivery can be ordered. The level elements are based on pressure. This means that they need a specific gravity input. This must be updated is the specific gravity of the chemical changes.

Deliveries arrive by tanker and are pumped from the tanker to the storage tanks. The delivery filling pump is powered by a local panel at the filling station. The power to the pump is automatically inhibited once the alum tank is full (switch), preventing overflows. The local level indicator panel also assists the tanker delivery operator with filling. Any spills that occur are captured in a bunded area on the road and associated chemical pit. Arrangements must then be made to transfer this chemical spill to a tanker for disposal or back to the storage tank.

The storage tank and dosing pumps are located within a bunded area. This is sized to contain more than the volume of the storage tank in case of tank or pipe rupture. The bunded area contains a sump. A portable sump pump can be used to extract and manage spills.

Each IDEA bioreactor will have dedicated alum dosing pumps configured in duty/standby. The rate of dose can be varied. Typically, the dose rate varies with the influent flow (flow paced) so that the alum dose matches the phosphorus mass to be removed. The dose can be capped to prevent overdosing during wet weather. The design assumes alum is dosed into at inlet of each IDEAT. Flush points are provided for each pump and dosing line. Chemicals should be flushed from the lines prior to maintenance. An eyewash and shower are located in the unloading area, within the bund and near the dosing pumps.

The alum storage and dosing system consists of the following mechanical equipment and instruments.

- Two (2) alum storage tanks and associated instruments
- One (1) level switch in the alum dosing bund sump.
- One (1) eyewash and shower flow switch on the common eyewash and shower supply main.

- Two (2) variable speed alum dosing pumps (duty/standby) for each IDEA tank.
- One (1 no flow switch on each dosing pump.
- Alum chemical dosing skid and relevant ancillaries.
- One (1) level switch for double containment pipe.

4.3.9.2 Caustic Storage and Dosing system

The use of Alum and other phosphorus precipitation chemicals consumes alkalinity. This can cause the depletion of alkalinity in the process and treated effluent, leading to pH suppression. This is managed through caustic dosing. An increase in alum dosing can lead to the need to increase caustic dosing.

From calculations, it appears caustic dosing is likely not required if the influent alkalinity is at the specified concentration of 375mg/L, however, the caustic system has been provided for the scenarios when the plant influent alkalinity is lower than the expected level.

Caustic will be stored in a single 10 kL tank to allow for bulk delivery. The caustic storage tank and dosing system will be installed inside secondary containment consisting of a concrete bund. A factory assembled dosing skid will be installed inside the bund.

The bund will be roofed with a prefabricated skillion roof to prevent the collection of rainfall in the bund. Entry to into the bund will be via access steps. The bund construction also should consider the ease of access for unloading the alum to the storage tank.

The required chlorination storage and dosing works include:

- A prefabricated skillion roofed concrete bund.
- Storage tank with level instruments.
- Connection for filling via road tanker.
- Dosing pump skid including duty/standby digital dosing pumps for each IDEA reactor.
- Interconnecting pipework and valves.
- Dosing lines and dosing line containment.
- Safety shower/eyewash station.
- Electrical and control connections.
- SCADA and PLC programming.

4.3.9.3 Gas Chlorine Storage and Dosing System

The purpose of the gas chlorine storage and dosing system is to store gas chlorine, used for chlorine contact tank chlorination and pathogen disinfection.

The gas chlorine is delivered by truck in 920kg drums, it is assumed 1 spare drum will be stored in a chlorine room. Two gas drums will be connected to the dosing system, once one of the drums reaches a specific low level, an automatic changeover module switches to the available full drum.

Each drum that is connected to the chlorine manifold shall have an emergency shutoff device (Chlorshield or approved equivalent) mounted on it so that supply from the container can be terminated in the event of a leak being detected.

Each drum is fitted with vacuum regulators, and two chlorinators and ejectors are provided and arranged as duty and standby, the chlorinator will adjust the chlorine dosing rate based on the CCT tank inlet flow. Service water will be used as carry water with passing through ejector to deliver the chlorine to the dosing point for disinfection.

The gas chlorine storage and dosing system consists of the following mechanical equipment and instruments.

- A chlorine building to store one pare drum.
- Vacuum regulators shall have a heated drip leg fitted
- All online cylinders shall have automatic shut off valves fitted
- Automatic changeover capability
- Trolley for moving drums
- Two chlorinators
- Two ejectors
- Service water supply for the chlorine dosing required carry water
- Chlorine gas filters and accessories
- Chlorine gas leak detectors in both the storage and dosing rooms

- Chlorine gas valves
- Flexible connection hoses
- Scales shall have a digital readout with 4-20 output to SCADA that will enable trending.
- Safety equipment
- Natural ventilation with cross flow ventilation
- Safety shower/eyewash station.
- Electrical and control connections.
- SCADA and PLC programming.

4.3.9.4 Chemical Usage Summary

Details of the preliminary process sizing can be found in Table 4-15.

Table 4-15: Chemical storage and dosing process sizing

Item	Number	Configuration	Comment
Alum			
Aluminium Content	4.24	% w/w	
Specific Gravity	1.3		
Al: P molar ratio	2.3		
Influent TP	11	mg/L	
Secondary effluent TP	0.7	mg/L	At Median (PO4-P at 0.5mg/L)
Number of Storage Tanks	2	No.	
Alum Tank Volume	27	m^3	Per tank
Number of days storage	35	days	
Total Average Alum Usage	1,310	L/d	Estimated
Number of Alum pumps	4	No.	Duty/standby for each IDEA tank
Alum pump capacity	0-120	L/h	DDA 120-7
Caustic Dosing			
Caustic solution	25	%	@1.25kg/L
Influent Alkalinity	220	mg/L $CaCO_3$	
Required Alkalinity Addition	67	mg/L	To achieve 70 mg/L Alkalinity in the final effluent
Caustic Storage Tank	1	No.	
Caustic Tank Volume	27	m^3	
Number of days storage	28	days	
Average Caustic Usage	823	L/d	At the estimated influent alkalinity

			concentration
Number of Caustic pumps	4	No.	Duty/standby for each IDEA tank
Caustic pump capacity	0-60	L/h	DDA 60-10
Gas Chlorine			
Type	Gas chlorine		
Average chlorine dosage	6	mg/L	
Gas chlorine cylinders	3	No.	2 x online and one spare
Number of days storage	70-80	days	Estimated
Expected daily average usage	12	kg/d	at an average recycled water production of 2ML/d
Number of chlorinators	2	No.	Duty/standby
Chlorinator capacity	0-2.1	kg/h	

4.3.10 Odour Control

Odour control is to be implemented at the inlet works based on the odour modelling study from EW. The odour model is in the process of being updated as part of the 30% design based on the revised site layout. The inlet works will be covered, and odorous gases from the headspace will be extracted via a ventilation fan and delivered into a bio-trickling filter for treatment before discharging into the atmosphere via an exhaust stack.

A summary of key concept design information for the odour control system is presented in Table 4-16.

Table 4-16: Odour Control preliminary process sizing

Item	Value	Unit	Comment
Number	1	No.	Duty Only
Type	Bio-trickling filter		
Capacity	3,000	m^3/h	20x Head space volume
Ventilation Fan	2	No.	Duty/standby

A preliminary general arrangement of the odour control system is shown in Figure 4-22. It is noted that the odour control system shown includes activated carbon. Activated carbon may not be required pending selection of the odour system based on performance requirements.

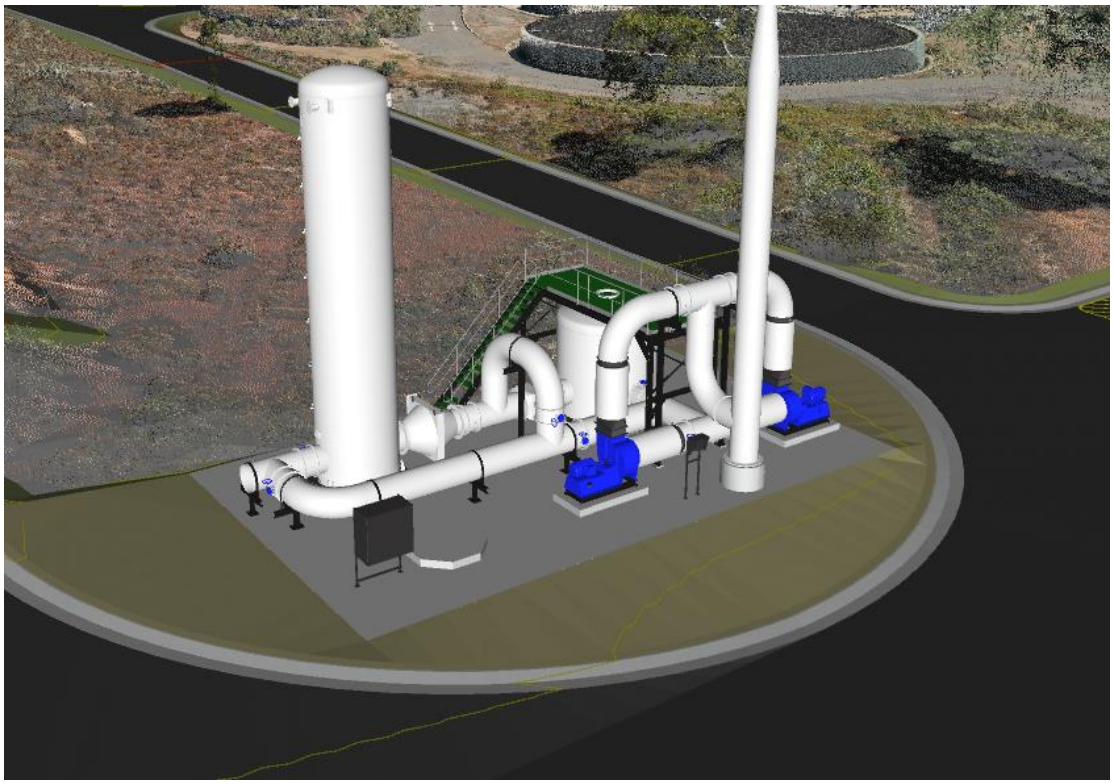


Figure 4-22: Preliminary arrangement of odour control system.

Extracted air is drawn through a biotrickling filter counter-current to effluent sprays which support the growth of bacteria that consume odorous gasses such as H_2S. Nutrient liquid can be dosed to the effluent sprays to ensure there is sufficient organics to support biomass growth. This is typically only on start-up though as nutrients are typically sufficient within the effluent used for the sprays.

Effluent spray water collects in the base of the biotrickling filter where it is drawn by a recirculation pump and recycled back to the inlet during commissioning, the recirculation pump operation can be disconnected after commissioning depending on the suppliers and their proprietary system. Recirculation effluent is periodically wasted to prevent low pH which can adversely impact bacteria required for odour removal.

Duty / standby odour extraction fans draw air from the biotrickling filter and then discharge the foul air through a dispersion stack. The duty odour extraction blower operates continuously. The odour extraction blowers shall rotate duty on a SCADA adjustable time basis.

The biotrickling filter would be required to remove at least 95% of the H2S passing through the odour treatment system.

4.3.11 Emergency Storage Pond and Return

One lined emergency storage pond is provided for the BHWWTP upgrade, the pond will be used for the following conditions:

- Inlet works emergency bypass
- Emergency storage of effluent balance tank overflow
- Emergency storage if there is a failure of the effluent decanter
- Emergency storage if one of the IDEATs is not available
- Emergency storage if the secondary effluent is off-spec.

It is not intended to use the emergency storage pond in wet weather. The emergency storage pond would be used where out of spec effluent is produced and / or there is a major process / equipment failure.

The emergency storage pond contents will be returned to the head of the plant for further treatment via a self-priming pump station.

If the emergency storage pond reaches full capacity during prolonged wet weather, the excess will flow into the effluent outfall by gravity in a controlled manner to avoid UV effluent pit overflow. The emergency storage pond is to be fitted with an emergency overflow path to the south of the site to prevent the pond from overtopping if the plant inlet flow is higher than the expected PIF.

A preliminary arrangement showing the emergency storage pond is shown in Figure 4-23.

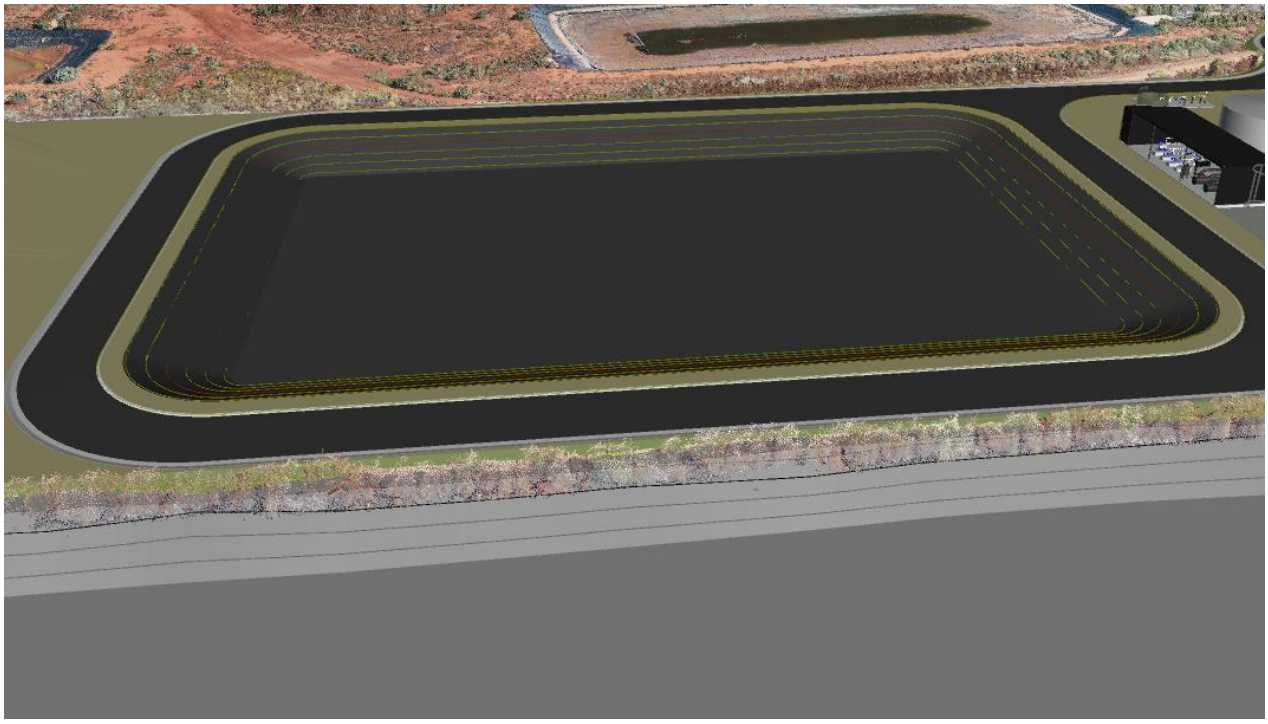


Figure 4-23: Preliminary arrangement showing emergency storage pond.

It is noted that the location of the emergency storage pond and presence of protection for the liner at the top of the pond (e.g. Tilex) is the subject of further design discussion.

A summary of key concept design information for the emergency storage and return pump is presented in Table 4-17.

Table 4-17: Emergency storage pond and return preliminary process sizing

Item	Value	Unit	Comment
Emergency storage Pond			
Number	1	No.	Duty Only
Type	lagoon		In ground lagoon to suit hydraulic requirement
Capacity	4,800	m^3	Assuming 1 day retention time at ADWF
Emergency return P/S			
Number	1	No.	Duty only
Type	Self-priming		
Capacity	28	L/s	0.5xADWF

4.3.12 Foul Water Pump Station

The FWPS collects supernatant, foul water and contaminated stormwater from several processes around the STP for transfer to the inlet works. These are:

- Supernatant from the aerobic digester
- Filtrate from sludge dewatering system
- Foul water from the odour control irrigation water
- Contaminated stormwater and washdown water from the odour control area
- Contaminated stormwater and washdown water from the DWAS Pump station and sludge pickup bay
- Foul water and contaminated rainwater from the inlet works area
- Foul water and contaminated rainwater from the grit removal system
- Drains from the tertiary treatment area

Contaminated drains from hard stands are sized to service an annual exceedance probability (AEP) of 1% with 1-hour rainfall of 57.9mm/h.

Process sizing associated with the foul water pumping station is presented in Table 4-18.

Table 4-18: Foul water pumping station process sizing

Item	Value	Unit	Comment
Number of Foul Water Return Pumps	2	No.	Duty / Standby
Foul Water Return Pump Capacity	28	L/s	Screen + screenings washing + grit transfer + WAS flow
Working Depth	2.8	m	To be confirmed during detailed design
Concrete Well Depth	4.0	m	To be confirmed during detailed design
Diameter	2.8	m	To be confirmed during detailed design

4.4 Site Access

It is proposed to retain the existing site access from Wills Street. It is further proposed to create another access to the new STP to the West of the existing Will Street STP site access (Figure 4-24). This new access point will minimise interactions between the construction activities of the new STP and the operation of the existing STP.

The access provides access to septage receival without the need for tankers to traverse the operational site. The access also ensures entry to the site is via the area of the administration building.

There are objects of cultural significance in the region of the proposed access track. The alignment of the access track will need to be developed in such a way as to prevent any interaction with these objects.

Figure 4-24: Proposed new site access point location.

Although there is a small access track from Wills Street at the nominal location of the proposed access, the access point will need to be upgraded to allow for semi-trailer access to the site and a generally significant increase in traffic through this point. There are also areas of cultural heritage significance near the access which will need to be avoided.

The proposed pavement material is asphaltic cement (AC) for straight sections of road, concrete for turning areas, crane set up areas, and the drive on chemical unloading bund, and unsealed for access road surrounding the emergency storage lagoon.

The roads are proposed to be provided with cross fall towards kerb and guttering that will consist of inlet pits to capture stormwater runoff.

4.5 Storm Water Drainage

Site storm water collected from buildings (i.e., amenities, switchroom and chemical facility) and roadworks will be directed to a storm water drainage system discharging to the existing stormwater detention ponds.

The storm water drainage hydrologic assessment will be developed during the detailed design and will follow the requirements of the Australian Rainfall Runoff (ARR) method for a 5% Annual Exceedance Probability (AEP). The adoption of the 5% AEP peak design flow indicates that there is a 5% chance every year that design flows through the catchment will be exceeded. Implementing a 5% AEP (Average Recurrence Interval or ARI = 20 years) has been taken from AS 3500.3:2003 Plumbing and drainage - Stormwater drainage.

There is an existing site stormwater treatment system which may need to be amended as part of the upgrade. Further assessment of site stormwater treatment during the upgrade and post upgrade is required.

4.6 Bushfire

According to the NSW Government Rural Fire Service, the STP site is within bushfire prone land. It is requested that EW confirm this designation noting the lack of vegetation surrounding the site and based on any historical evidence.

All firefighting requirements will be identified and addressed as per the relevant Australian standards or BCA during detailed design.

4.7 Landscaping

Backfilling of all excavated areas is to be carried out in such a way that the site will be returned to pre-construction conditions where possible. All disturbed soil areas will be replanted to minimise erosion. Vegetation will be left where possible, or revegetation conducted to maintain a visual screen around the sites.

4.8 Onsite Amenities and Laboratory

The existing amenities will be retained as part of the upgrade. However, a new administration building will be included in the upgrade, as shown in the plant's general arrangement. A snapshot of the proposed amenities building internal arrangement is shown in Figure 4-25.

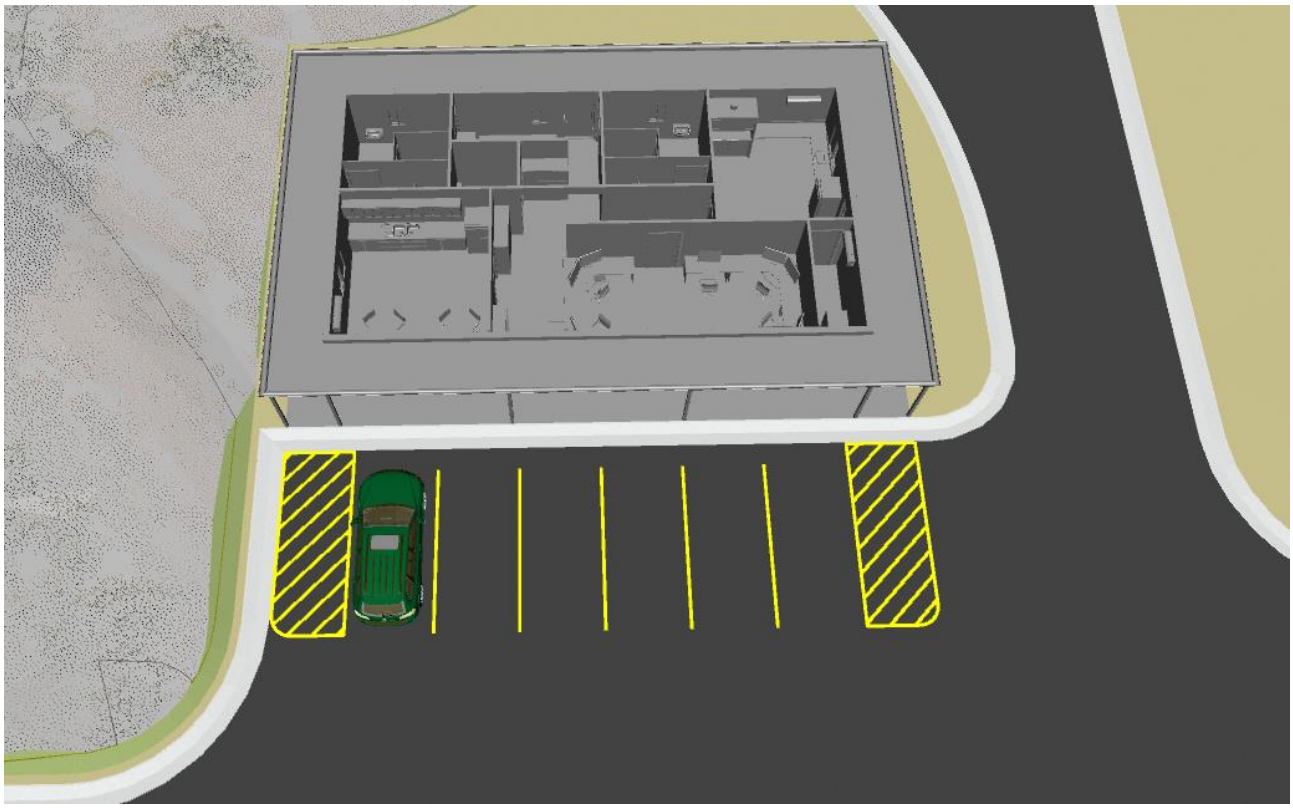


Figure 4-25: Amenities building preliminary arrangement section.

4.9 Access Platforms / Handrails

Access platforms and handrails are required to all structures and equipment and shall be compliant with AS1657.

Platforms shall be provided to allow personnel access to all equipment without the need for any special equipment. Ladders are not an acceptable means of accessing any part of the facility.

Stairs are required to access the inlet works and the IDEA tanks. Access stairs / platforms are required to access the Balance Tank from the IDEA tanks without descending to ground level. This will enable the operator to be able to walk throughout the major process unit structures without the need to repeatedly ascend and descend to the ground level.

4.10 Power and Water

A new high voltage power supply will be required for the new WWTP. Details of the power supply are provided in the electrical design package separate to this report.

A new potable water supply is required to service the new WWTP. It is understood that a new connection to a larger water main on Kanandah Road will be required. The capacity of the connection will be reviewed as part of subsequent design phases.

Nominally, a supply capacity of 2.5L/s @3bar and/or fire flow capacity are required. A water meter and backflow prevention devices complying with EW requirements will be installed at the access location.

A potable ring main around the site (~500m) will connect to safety showers, amenities, hose reels and dewatering hardstand area.

Additional details of the electrical and control components of the site to be developed in the next stages of design include:

- Incoming Power
- Onsite generator
- Switchroom
- Main Switchboard/ Motor Control Centre
- Cabling
- Lighting
- Power Outlets
- Lightning Protection
- Control System
- Remote Communications
- Security

4.11 Solar System Investigation

Due to proceeding with the aerobic digestion option for sludge management, there is significant area to the west and east of the site which could be used for installation of solar panels. Assuming EW wish to offset the power usage at the STP with solar, determining the size of the solar system will require confirmation of the STP average and peak demand. The STP average and peak demand calculations are in the process of being developed and will be refined as the site hydraulic grade line and hence need for pumping is refined.

The solar system design package, delivered separately to this report, identified the need for a 400 kW solar system. There is sufficient space to the west of the proposed STP for installation of the solar panels however, due to the presence of objects of cultural heritage significance, an alternate location was sought. The preferred location for the solar system is in the south side of the maturation pond per Figure 4-26.

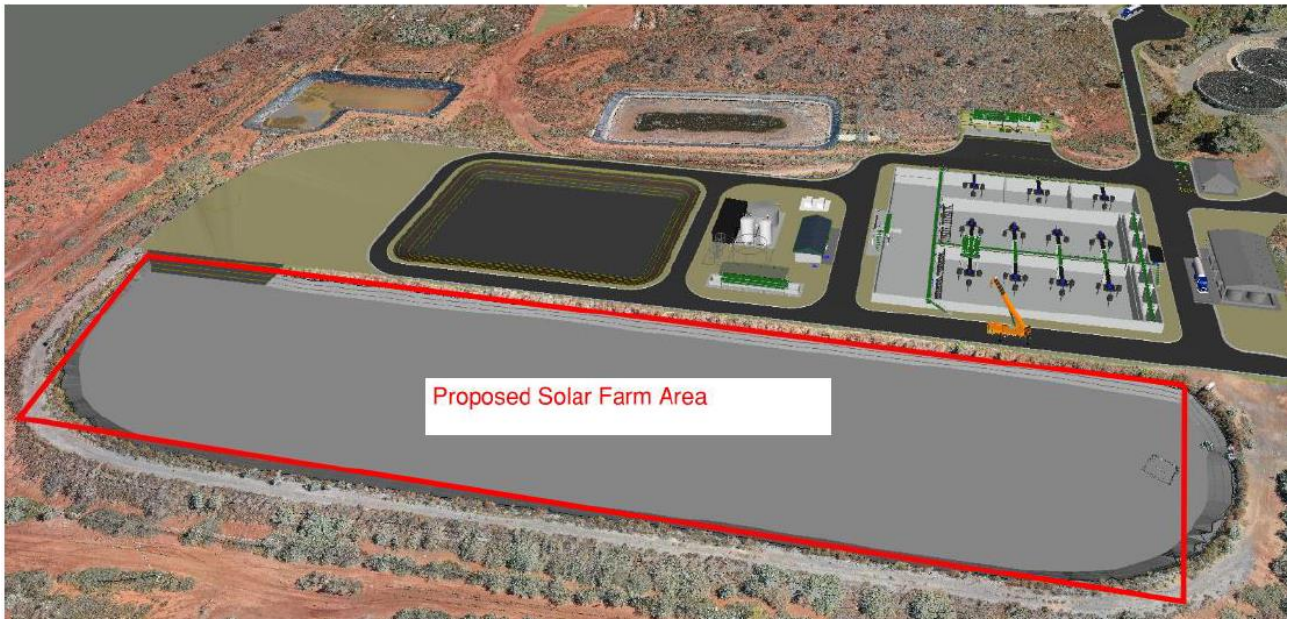


Figure 4-26: Location of proposed solar system.

The Solar energy production will vary significantly due to many factors including:

- Solar radiation exposure
- Temperature (Min and Max)
- Location, shading, orientation, tilt
- Efficiency losses such as dirty panels, cable transmission, inverter
- Manufacturers tolerances

Hence further detail will be developed as the site power demands are confirmed.

4.12 Control System

The STP will be a fully automated site and exhibit the following equipment and functionality.

4.12.1 PLC

The new centralised CPU PLC rack will be located within a dedicated compartment of the Main MCC and be responsible for the control and automation of the entire STP. At this stage of the design, the size and layout of the site does not lend itself to the inclusion of any remote PLC racks.

The PLC shall communicate with the UV system PLC's and also SCADA via over an Ethernet connection utilising the PLC proprietary network protocol of the chosen PLC. Fibre optic cabling shall be utilised for all runs external to a building.

4.12.2 SCADA

As part of the upgrade works, a new SCADA system is to be installed for monitoring, control, alarm management and report generation for the upgraded STP.

The SCADA system shall include a single server this would be housed within a communications rack in the switchroom, which provides a secure and controlled atmosphere.

The Operators workstation, located in the control room (reuse of existing to be confirmed) would be connected to the SCADA server. A separate PC would be provided for the corporate workstation (that for intranet, emails etc.) This strategy creates segregation, which will maintain a dedicated, robust and secure control system network.

The local SCADA system will include the following functionality:

- Mimic screens of the new equipment; in alignment with the P&I drawings

- Analogue values for all process variables such as flow, level, and pressure
- The status of all major process equipment such as pumps, blowers, compressors, etc.
- The status of all process variables or equipment monitored or controlled by a PLC
- The status of field limit switches
- Motor speed and current for all variable speed devices
- Valve and gate position for all gates and valves
- All safety indicators (e.g., gas detection, fire detection, security intruder detection, etc.)
- Alarm screen; for alarm display and acknowledgement
- Trends screen; for trending of analogue values
- Generation of custom operational reports

Council staff will have the ability to access the SCADA system remotely via their secure corporate network. The method and rules surrounding remote access would be further developed following liaison with EW.

4.13 Security

A back to base security system will be included (or extension of the existing system). This will arm the services building and also include inputs for the detection of smoke. Door reed switches and PIR's within the services building will be included.

Point smoke detectors will be installed within each building and also concealed roof spaces.

In any remote buildings, the smoke and security detectors will report directly back digital inputs with an interface to the security system for alarming to a third-party provider. These alarms will also be transmitted for alarming and management.

4.14 Sliding Access Gate

An automatic sliding gate will be included, with the ability for EW to operate from portable actuators and also from the SCADA both internally and across the WAN.

The gate will be powered from the UPS in order to maintain emergency egress during a power outage. Other features will include the activation of selected site lighting when the gate is opened during night hours and also monitoring of the gate position by the STP control system to alert EW staff that the gate may have malfunctioned and could be left open after hours.

4.15 CCTV

A CCTV camera system (including PC based hardware/software) will provide surveillance over the plant. The Cameras will be located in strategic locations including access gate and key process areas. A quantity of approximately four (4) cameras will cover the site

Centralised video surveillance and recording will be provided by an IP based video surveillance system. The CCTV software shall be located on a corporate PC within the Control Room, which is separate from the control network.

The final exact locations for all cameras shall be confirmed by the Contractor by performing site trials to determine the optimum locations to provide the specified coverage.

5 Capital Cost Estimation

Refer to Appendix H.

Appendix A. Loadings Assessment and Capacity Review

Sensitivity: General

Beca hunterH2O
the future of water

Report

Broken Hill STP Detailed Design

Loadings Assessment and Capacity Review

Essential Water

October 2023

Beca HunterH2O | ABN 16 602 201 552

Report Details

Project Title	Broken Hill STP Detailed Design: Loadings Assessment and Capacity Review
Project No.	7015
Document Location	P:\HH2O\Essential Energy\Broken Hill STP Concept And Detailed Design\2. Tasks\8. Loadings Assessment & Capacity Review\4. Reporting\Loadings Assessment And Capacity Review - Report_FINAL.Docx
Enquiries	Rennie Ferguson +61 2 4941 5000 Rennie.Ferguson@Beca.com

Document History and Status

Revision	Report Status	Prepared By	Reviewed By	Approved By	Issue Date
A	Draft	Rhys Johns	Daniel Alexander	Rennie Ferguson	3/10/2023
B	Final	Flynn Lutkie	Rhys Johns	Rennie Ferguson	6/11/2023

Copyright © Hunter H2O Holdings Pty Limited 2023
The concepts and information contained in this document are the property of Hunter H2O Holdings Pty Limited for the sole use of the nominated client. Use or copying of this document without the written permission of Hunter H2O constitutes an infringement of copyright.

Contents

1 Introduction 1
1.1 General 1
1.2 Background 1
1.3 Broken Hill Sewer System 2
2 Review of Background Information 3
2.1 Requested Information 3
2.2 Supplied Information 3
2.3 Summary of Review 3
3 Loadings Assessment 5
3.1 Sewer Loadings 5
3.2 Key Assumptions 6
3.3 SPS Catchment Connection Details 7
4 Validation 8
4.1 Design Flow and Containment Objectives 8
4.2 Rainfall Data 8
4.3 STP Inflow Data 9
4.3.1 Daily Inflow 9
4.3.2 Chart (Instantaneous) Data 11
4.4 Warren Street SPS 11
4.5 PWA Report 11
5 Capacity Assessment 13
6 Conclusions and Recommendations 14

Figures

Figure 1-1: Broken Hill Sewer System Schematic (Essential Water, 2020) 2
Figure 4-1: Design Rainfall Event 20/09/2016 Broken Hill Airport AWS 9

Tables

Table 3-1: Sewer Loadings Summary 5
Table 3-2: Table of assumptions 6
Table 3-3: Wills St STP SPS Catchment Details 7
Table 3-4: South Broken Hill STP SPS catchment Details 7
Table 4-1: Rainfall Data Details 8
Table 4-2: Wills Street STP Inflow Data 10
Table 4-3: South Broken Hill STP Inflow Data 10
Table 4-4: Inflow v Rainfall Data 11
Table 4-5: Warren Street SPS Measured Flows 11
Table 5-1: SPS Pump v System Curve Analysis Summary 13
Table 6-1: Comparison of Design Flow Estimates 1

Appendices

Appendix A. **Broken Hill Sewerage System**
Appendix B. **Wills Street STP Chart Data (29-04-2022)**
Appendix C. **SPS Information**

1 Introduction

Essential Water has engaged Beca HunterH2O to undertake the Detailed Design and Documentation for Wills Street (Broken Hill) Sewage Treatment Plant (STP) Replacement.

The services under this agreement includes preparation of a detailed design based on and in consideration of the Broken Hill STP Augmentation – Concept Development by Public Works Advisory (PWA) in 2019 for the construction of the new Wills Street STP and a new sewage pumping station (SPS) and rising main at the existing South Broken Hill STP site (the current Wills St STP and South Broken Hill STP are to be decommissioned).

1.1 General

The city of Broken Hill has an urban population of approximately 17,800 and is currently serviced by two STPs, the Wills Street STP and the South Broken Hill STP. The plants are owned and operated by Essential Water (EW), a subsidiary of Essential Water.

The Wills Street STP was commissioned in 1939, upgraded in 1956 and again in the 1980's. This STP is at the end of its serviceable life and requires replacement to ensure compliance with its Environmental Protection Agency (EPA) Licence for discharges. Treated effluent from the Wills Street STP is reused by local mines and the Broken Hill Golf Course. Excess effluent is piped to the White Leeds artificial wetland. The South Broken Hill STP was built in the 1960's and is in a relatively poor condition reflecting of the age of the plant. This STP now requires significant remedial works to ensure reliable ongoing service and compliance with its EPA Licence for discharges.

GHD prepared the Wills St STP Risk Based Asset Renewal Strategy Report (October 2009) which identified the STP to be in fair to poor condition with a remaining serviceable life of between 5 and 10 years. Subsequently, GHD prepared the Broken Hill Wastewater Treatment Strategy Options Assessment (August 2011) and identified that both existing plants would need to be decommissioned within 10 to 20 years (the estimated increase to asset life following optional refurbishments, which were not pursued), with a preferred option to decommission both existing STPs and construct a new STP at the Wills Street site (that would receive pumped transfers from the gravity sewage system currently discharging into South Broken Hill STP).

PWA prepared the Broken Hill Sewerage Scheme Replacement of Wills Street and Southern STPs Options Study (October 2018) which confirmed the preference of EW to decommission both existing STPs and construct a new STP at the Wills Street site and identified the Intermittently Decanted Extended Aeration (IDEA) as the preferred secondary treatment process. The PWA Broken Hill Sewage Treatment Plant (STP) Augmentation Concept Development (February 2019) provided an increased level of detail for the preferred option, as did the PWA Broken Hill Sewerage Wills Street Sewage Treatment Plant Upgrade Geotechnical Investigation (April 2019).

The preferred option and schedule were chosen to enable EW to achieve EPA discharge requirements by 2025, whilst also minimising life cycle costs of sewer treatment in Broken Hill. The preferred option will be sized for an ultimate capacity of 24,000 EP.

1.2 Background

As part of this engagement, and from a review of existing documentation, including the PWA Broken Hill STP Augmentation Concept Development, it is understood that the peak instantaneous flow (PIF) estimates for South and Wills Street STP's are preliminary only.

Analysis of available chart recorder provided by Essential Water indicates that the preliminary estimates may be conservative in nature. As such, utilising the values presented in the concept development may lead to oversized infrastructure and hence higher than required capital expenditure. Further, especially for the transfer from South Broken Hill STP, sewer septicity and increased odour is a higher risk from oversized rising mains.

Furthermore, it was agreed in a meeting between Beca HunterH2O, Essential Water and NSW Department of Planning and Environment (DPE) that the option within the Concept to utilise the existing tricking filter at South Broken Hill STP as a balancing storage vessel for the proposed diversion SPS is not suitable. This warrants

additional work to investigate a suitable alternative design for the proposed diversion SPS from South Broken Hill STP to the proposed STP site near Wills Street STP.

Therefore, it is proposed to undertake a revised loadings assessment of both STP catchments as well as high-level capacity review. This will assist with selecting an appropriate design flow to adopt for the transfer SPS from South Broken Hill STP to the proposed STP, as well as quantify PIF to the proposed STP by evaluating Wills St STP catchment.

Essential Water accepted a variation (V003) under the principal engagement for the Detailed Design and Documentation for Wills Street STP Replacement to undertake a loadings assessment and capacity review of the Broken Hill sewer system. The assessment undertaken is outlined in this report.

1.3 Broken Hill Sewer System

The Broken Hill sewerage network consists of a series of gravity sewer mains, SPSs and rising mains that convey sewage to either the Wills Street or South Broken Hill STP.

There is a total of nine (9) SPS catchments draining to Wills Street STP and two (2) SPS catchments draining to South Broken Hill STP. A schematic of the sewerage network is shown in Figure 1-1.

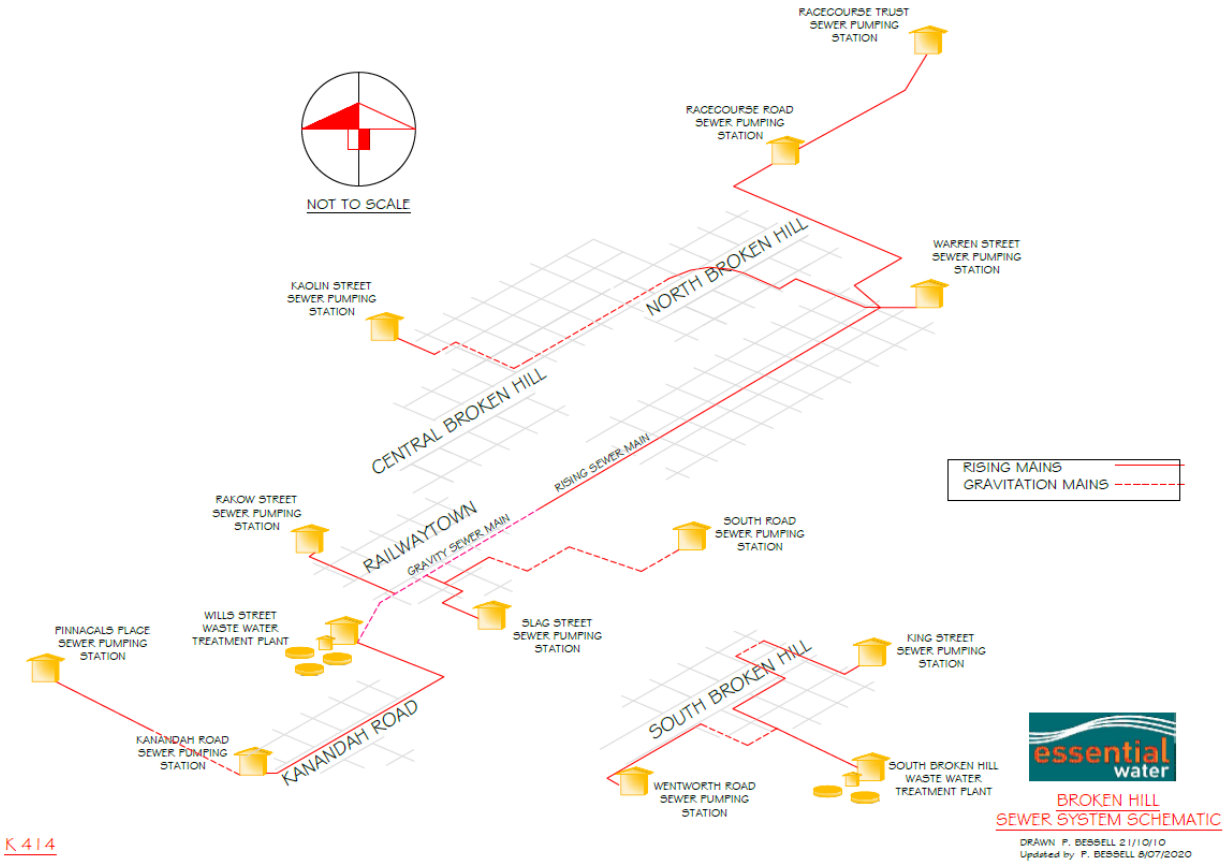


Figure 1-1: Broken Hill Sewer System Schematic (Essential Water, 2020)

The Broken Hill sewerage network is also shown in Appendix A.

2 Review of Background Information

2.1 Requested Information

As outlined in the scope of services offer for variation request V003, the following information was requested:

- Connection data including lot size, development type (Res, Com, Ind), water consumption data, SPS catchment.
- Rainfall data over previous 10 years using flip-bucket rain gauge data, recorded at minimum 15 min interval, to determine rainfall intensity over different storm durations.
- SPS information including pump curves, work-as-constructed (WAC) information, rising main sizes, duty flowrates, confirm operation philosophy i.e. duty/standby, duty/assist etc. Note: it is generally recommended to conduct SPS drop tests to determine the actual flow being delivered by each pump in the network. We did not allow for carrying out the pump station drop tests and it is assumed the data was not available. It is however suggested that this information is captured in the future (details of pump information requested is appended to this document).

2.2 Supplied Information

Essential Water provided the following information as part of the engagement:

- General data
    - Renewal schedule, water reticulation in .xlsx format
- Drawings, Maps, Geographic Information System (GIS) or CAD information
    - 1999 Cadastral & Water.dwg
    - AA Master Cadastral Sewer Sheets.dwg
    - Sewer Map 2022.dwg
    - King Street and Wentworth Road SPS locations in .jpg format from SixMaps
    - Drawings of Broken Hill sewer reticulation in plan view in .pdf format
- Loadings and pump data
    - Water consumption data in .xlsx format noting unmatched to sewer connection data
    - Sewer connection data in .xlsx format
    - SPS information in .xlsx format aligning with format requested in Appendix C, with missing data
    - Warren St SPS flow and level data from SCADA in .xlsx format
- Relevant Reports
    - Broken Hill STP Augmentation Concept Development, PWA 2019
    - Integrated Water Cycle Management Strategy, PWA 2022
    - Asset Renewal Plan for Water Supply and Sewerage Services in Broken Hill Region, JWP 2007
- STP data
    - Chart recordings of STP inflow data
    - Daily influent readings for both STPs in .xlsx format from 2011 to 2023

2.3 Summary of Review

Review of the supplied information demonstrated gaps in the following areas:

- GIS data of existing sewerage network, including but not limited to, location of linear (pipe) assets and associated asset information (size, length, material, class etc.) in particular for rising mains, maintenance holes (MH) level information (i.e. invert and surface). It is noted that information was provided in CAD format which has limitations in information that is contained, in comparison to GIS data in shapefile format

(preferred). Appendix A outlines the provided GIS information and gaps in information where assumptions on alignment and location were made.

- SPS information including pump curves, WAC information, level data, duty flowrates. Please note that pump model numbers, impeller diameter and power rating information was provided which enabled searching for pump data sheets using Xylem's (Flygt) 'Xylect' pump selection tool, however the majority of the data provided did not match search criteria and assumptions were made to select an appropriate pump for the pump v system curve analysis.
- Water consumption data was not easily matched to property addresses due to the property information supplied in the database not having a locatable address (Approx. 700 not matched and required manual processing). Additionally, the sewer connection data was not matched to the water consumption data.
- Sewer connection data included a residential and non-residential category, with further sub-categorisation of 'house' and 'unit' for residential properties. Sub-categorisation and discharge factors were supplied for 21% of non-residential properties which was used for the reassessment of loadings, noting that supplied discharge factors for the vet, RSPCA and charcoal chicken shop are 0.
- It is recommended that Essential Water invest in developing gaps in the abovementioned information to better understand their asset database, renewals and operations and maintenance registers.

Gaps and missing information required assumptions and inferences to be made to provide satisfactory outcomes from this assessment. Assumptions made are documented in this report and should be cross-checked by Essential Water to confirm the accuracy of this assessment.

3 Loadings Assessment

3.1 Sewer Loadings

Theoretical sewer loadings or flow estimation for each SPS and STP catchment has been calculated using the methodology outlined in the Water Services Association of Australia's (WSAA) Sewerage Code of Australia WSA 02-2014.

Theoretical loadings have been expressed in terms of an equivalent person (EP) for both residential and non-residential property connections. Residential EP's were estimated from current connection data and the occupancy rate of 2.04 persons per household or Estimated Tenement (ET) from the 2021 census (Australian Bureau of Statistics, 2021). For non-residential properties, sewer loadings were estimated based on provided historical water consumption adjusted by assumed discharge factors.

Loadings were calculated for the theoretical 1-in-6 month and 1-in-2 year Average Recurrence Interval (ARI) design storm events. The 1-in-2 year ARI design storm was adopted as the containment standard and represents the peak wet weather flow (PWWF).

The methodology used to calculate the theoretical sewer loadings is:

- Average Dry Weather Flow (ADWF) = 0.0021 L/s per Equivalent Person (EP) [A]
- Peak Dry Weather Flow (PDWF) = "d" [B] x ADWF
- Design Flow = Peak Wet Weather Flow (PWWF) = PDWF + GWI [C] + RDI [D]

Notes:

A. Residential EP only. Non-residential properties calculated using historical water consumption data and discharge factors
B. "d" is a dry weather peaking factor and is a function of the gross development area
C. GWI = ground water infiltration = Gross Area (A) x Portion Wet 'P_{Wet}'
D. RDI = peak (rainfall dependent) inflow and infiltration) is a function of the Effective Area 'A_{Eff}', Leakage Severity Coefficient 'C' and Rainfall Intensity 'I'

A summary of theoretical wastewater loadings for the existing Broken Hill sewer system for each SPS catchment is shown in Table 3-1.

Table 3-1: Sewer Loadings Summary

SPS Catchment	Catchment Area (ha)	EP	ADWF (L/s)	PWWF[1] (L/s)	EP	ADWF (L/s)	PWWF[1] (L/s)
		Catchment Only			Cumulative		
Slag St	46.2	963	2.02	12.62	963	2.02	12.62
Rakow St	137.0	2413	5.07	31.04	2413	5.07	31.04
Kaolin St	9.4	194	0.41	3.43	194	0.41	3.43
Racecourse Trust	79.9	82	0.17	9.46	82	0.17	9.46
Racecourse Rd	3.9	18	0.04	0.49	100	0.21	9.95
Pinnacles Rd	12.0	28	0.06	2.56	28	0.06	2.56
Kanandah Rd	42.0	217	0.46	9.25	245	0.51	9.25
South Rd	0.3	4	0.01	0.15	4	0.01	0.15
Warren St	454.9	12816	26.91	83.05	13110	27.53	96.44
Wills St STP Gravity	109.3	2511	5.27	28.57	19247	40.42	180.63
TOTAL Wills St STP	*894.8*	*19247*	*40*	*181*	*19247*	*40*	*181*

SPS Catchment	Catchment Area (ha)	EP	ADWF (L/s)	PWWF[1] (L/s)	EP	ADWF (L/s)	PWWF[1] (L/s)
		Catchment Only			Cumulative		
King St	17.5	402	0.8	6.24	402	0.84	6.24
Wentworth Rd	15.1	53	0.1	2.74	53	0.11	2.74
South STP Gravity	400.9	3691	7.8	47.32	4145	8.71	56.30
TOTAL South STP	*433.4*	*4145*	*8.7*	*56.3*	*4145*	*9*	*56*
TOTAL[2]	1328.3	23392	49.1	236.9	23392	49	237

[1]PWWF adopted the 1-in-2 year average recurrence interval (ARI)

[2]Corresponds to the total flow estimates for all sewered connections in Broken Hill

3.2 Key Assumptions

In developing the wastewater loadings for each SPS catchment as shown in Table 3-1, the following key assumptions apply:

- Properties connected to sewer were spatially located based on address field provided in the sewer connection data. Properties that could not be matched to a property address (e.g. no property address number, no locatable street etc.) were given an assumed SPS catchment based on available information.
- Lot areas were obtained from SixMaps. For properties that were unable to be spatially location (see above point), the average lot area (Table 3-2) was adopted for the purposes of this assessment.
- For properties with multiple water meters present at the same address/lot, lot size was divided by the number of meters present.
- SPS catchments were derived manually based on the sewer pipe layout information provided.
- Portion impervious assumed to be 50% for all residential properties and non-residential properties < 3 ha.
- Where there was no information on non-residential property category type (79% of properties), these connections were classified as park/garden or commercial/industrial based on aerial imagery. For properties that were unable to be spatially located, category type was assumed as commercial/industrial and discharge factors applied appropriately.
- Non-residential EP estimates were based on water consumption data and discharge factors.

A table summarising the key assumptions and parameter values adopted for the assessment are outlined in Table 3-2.

Table 3-2: Table of assumptions

Parameter	Value	Unit	Source/Reference
Hydraulic Loading Rate	0.0021	L/s/EP	WSA 02-2024-3.1 (WSAA)
Broken Hill Population	17,588	Persons	Broken Hill Census (ABS, 2021)
Occupied Dwellings Connected to Sewer	8,609	Dwellings	Calculated (Assumed Occupied if Average Water Consumption > 10 kL/yr 2018-2022)
Occupancy Rate	2.04	EP/ET	Calculated
Average House Lot Area	845	m^2	Calculated
Average Unit Lot Area	495	m^2	Calculated
Average Non-Residential Lot Area	1,000	m^2	Assumed
Non-Residential Discharge Factor (Commercial/Industrial)	0.9	-	Benchmarking of Typical Discharge Factors

Parameter	Value	Unit	Source/Reference
Non-Residential Discharge Factor (Parks/Gardens)	0.2	-	Benchmarking of Typical Discharge Factors
Portion^{wet}	0.5	-	Portion of pipe inverts below groundwater table, assumed
$I_{1,39.35}$	17.14	mm	1 hour duration rainfall intensity at the location, for an annual exceedance probability (AEP) of 39.35% (BOM, Design Rainfall Data System (2016))

3.3 SPS Catchment Connection Details

A summary of the total property connections and split of residential and non-residential per SPS catchment for both Wills St STP and South Broken Hill STP are shown in Table 3-3 and Table 3-4, respectively.

Table 3-3: Wills St STP SPS Catchment Details

SPS Catchment	EP	Total Property Connections	Residential	Non-Residential
Slag St	963	473	99%	1%
Rakow St	2413	957	95%	5%
Kaolin St	194	93	99%	1%
Racecourse Trust	82	4	25%	75%
Racecourse Rd	18	9	100%	0%
Pinnacles Rd	28	16	56%	44%
Kanandah Rd	217	35	14%	86%
South Rd	4	3	67%	33%
Warren St	12816	5174	92%	8%
Wills St STP Gravity	2511	1017	94%	6%
TOTAL	19247	7781	92%	8%

Table 3-4: South Broken Hill STP SPS catchment Details

SPS Catchment	EP	Total Property Connections	Residential	Non-Residential
King St	402	197	100%	0%
Wentworth Rd	53	3	33%	67%
South STP Gravity	3691	1627	96%	4%
TOTAL	4145	1827	96%	4%

4 Validation

The validation exercise is to use available and observed data to verify the theoretical sewer loadings or design flow estimates (Section 3.1).

4.1 Design Flow and Containment Objectives

Design flow estimates are required for designing pipe networks and input to pump station designs. Design flow is the peak flow to be contained within the sewer system (WSA 02-2014).

For the purposes of this assessment and in accordance with WSA 02-2014, a containment objective of 1-in-2 years has been adopted.

4.2 Rainfall Data

Rainfall data was acquired from the Bureau of Meteorology (BoM) to be able to correlate observed wastewater inflow readings provided with design rainfall events. Details of the rainfall information purchased from BoM is shown in Table 4-1.

Table 4-1: Rainfall Data Details

Station Name	ID	Time Step	Start Date	End Data
Broken Hill Airport AWS	047048	1-minute	1/15/2009	25/09/2023

This rainfall information was used for the validation assessment to correlate inflow data against design rainfalls by estimating the intensity frequency duration (IFD) curve for observed rainfall events to understand the annual exceedance probability (AEP).

This enables a coarse appreciation of how the Broken Hill sewer system responds to certain rainfall events to compare against an appropriate containment objective to adopt for design purposes.

Australian Rainfall and Runoff (AR&R) terminology has changed in recent times due to release of the 2016 design rainfalls compared to the superseded ARR87 IFD's. Conversion of different rainfall estimate terminology for the adopted 1-in-2 year containment objective is outlined below:

- 2 year ARI
- 39.35% AEP
- 0.5 exceedances per year (EY)

Review of rainfall data found that the rainfall event recorded on 20th September 2016 matched closely for durations ranging from 45 mins to 2 hrs with the 0.5 EY IFD curve generated for frequent to infrequent events at the Broken Hill location from BoM's website, see Figure 4-1. This design rainfall event is referenced for this validation exercise.

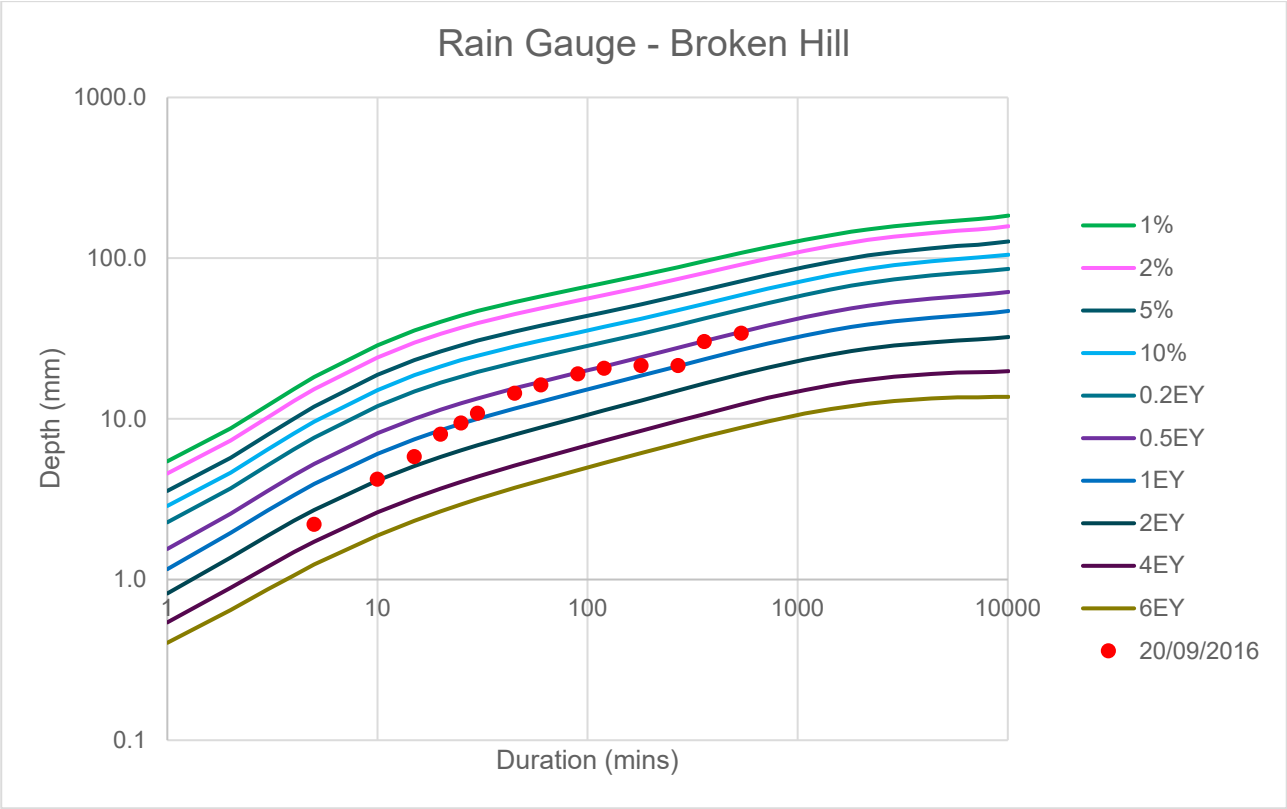


Figure 4-1: Design Rainfall Event 20/09/2016 Broken Hill Airport AWS

Essential Water should consider undertaking flow gauging of the sewerage network and conducting a calibration to better understand how the system responds to rainfall with respect to rainfall dependent inflow and infiltration (RDII).

4.3 STP Inflow Data

4.3.1 Daily Inflow

Essential Water provided daily inflow data for both the Wills Street and South Broken Hill STPs from 2011 to 2023. The inflow data was used to validate the design flow estimates outlines in Section 3.1.

A summary of the inflow data for Wills Street STP is outlined in Table 4-2.

Table 4-2: Wills Street STP Inflow Data

Year	ADWF[1] (kL/day)	50th %ile	90th %ile	100th %ile	Maximum Daily Flow (L/s)	Peaking Factor (100% / 50%)
		Daily Inflow (kL/day)				
2011	3499.0	3428.0	5265.8	13844.0	160.2	4.0
2012	3315.8	3139.5	5175.3	14698.0	170.1	4.7
2013	2793.0	2918.5	3155.3	4000.0	46.3	1.4
2014	2936.8	3023.0	3396.2	5244.0	60.7	1.7
2015	2899.4	2939.0	3320.2	4809.0	55.7	1.6
2016	3014.5	2969.5	3725.4	10887.0	126.0	3.7
2017	2882.8	2876.0	3164.0	4179.0	48.4	1.5
2018	2831.4	2851.0	3051.0	4086.0	47.3	1.4
2019	2683.7	2680.0	3013.8	5478.0	63.4	2.0
2020	2456.4	2570.5	2822.2	4733.0	54.8	1.8
2021	2748.2	2754.0	3033.6	5777.0	66.9	2.1
2022	3172.4	3220.0	4351.6	11537.0	133.5	3.6
TOTAL	2922.0	2909.5	3601.8	14698.0	170.1	5.1

[1]ADWF was calculated as average of inflow data where no rainfall from rainfall gauge ID047048 was recorded 7 days prior

The recorded daily inflow to Wills Street STP on 20th September 2016 (design rainfall event) was 10,887 kL/day or approx. 126 L/s when converted to an instantaneous flowrate.

A summary of the inflow data for South Broken Hill STP is outlined in Table 4-3.

Table 4-3: South Broken Hill STP Inflow Data

Year	ADWF[1] (kL/day)	50th %ile	90th %ile	100th %ile	Maximum Daily Flow (L/s)	Peaking Factor (100% / 50%)
		Daily Inflow (kL/day)				
2011	823.2	822.0	1121.9	2953.0	34.2	3.6
2012	835.1	835.0	1122.2	3096.0	35.8	3.7
2013	803.5	801.0	1041.0	1612.0	18.7	2.0
2014	778.1	770.5	983.5	3810.0	44.1	4.9
2015	735.7	743.0	945.6	1466.0	17.0	2.0
2016	727.9	738.0	967.8	3605.0	41.7	4.9
2017	778.5	749.5	982.2	4734.0	54.8	6.3
2018	703.7	705.0	916.9	1263.0	14.6	1.8
2019	682.4	680.0	909.2	1401.0	16.2	2.1
2020	707.2	704.0	890.0	1252.0	14.5	1.8
2021	707.8	693.0	912.0	2799.0	32.4	4.0
2022	741.7	748.5	1020.0	2271.0	26.3	3.0
TOTAL	751.0	744.0	982.0	4734.0	54.8	6.4

[1]ADWF was calculated as average of inflow data where no rainfall from rainfall gauge ID047048 was recorded 7 days prior

The recorded daily inflow to South Broken Hill STP on 20th September 2016 (design rainfall event) was 753 kL/day or approx. 9 L/s when converted to an instantaneous flowrate. It is apparent that this STP daily inflow recording aligns more closely with dry weather flow estimates and has not been used for this assessment.

4.3.2 Chart (Instantaneous) Data

Essential Water posted hard copies of the actual chart recorder observations for both the Wills Street and South Broken Hill STPs from 2020 to present. An example of chart recordings from Wills Street STP is provided in Appendix B and shows a maximum instantaneous influent observation > 200 and reading beyond the chart x-axis – noting units were assumed to be in L/s as they were not provided on chart recordings.

Rainfall data which was evaluated in conjunction with the chart recording data to estimate the design rainfall event and AEP corresponding to observed inflows. This data is evaluation is presented in Table 4-4.

Table 4-4: Inflow v Rainfall Data

Rainfall Event	Start Date	Total Rainfall Depth (mm)	AEP (%)	Recorded Peak Inflow (L/s)	
				South BH STP	Wills St STP[1]
1	19/09/2020	41.4	18.13% (0.2 EY)	26	>200
2	29/01/2022	86.7	5%	67	>200
3	14/03/2022	101.6	10%	68	75
4	26/04/2022	55.6	63.2% (1 EY)	28	75
5	13/10/2022	64.8	63.2% (1 EY)	24	125
6	19/10/2022	43.4	95.02% (3 EY)	53	>200
7	29/01/2023	30.5	95.02% (3 EY)	35	91

[1]Maximum chart recorder x-axis is 200

4.4 Warren Street SPS

Essential Water provided SCADA outputs for the Warren Street SPS from 2020 to 2022. The information provided included flow and wet well level data.

The flow data represents the observed flow measured through a flow meter installed on the discharge side of the pumps located on the rising main. It is understood that the Warren Street SPS is a triplex station that operates as duty/assist/assist.

Assessment of the information found that the pump delivers the approximate flows, as presented in Table 4-5.

Table 4-5: Warren Street SPS Measured Flows

Pumps	Measured Flows (L/s)
Duty Pump Only	~85
Duty/Assist Pumping	~135

4.5 PWA Report

The following design flow estimates and parameters adopted for the Broken Hill STP Augmentation – Concept Development (PWA, 2019) are below:

- Total capacity = 24,000 EP
- Hydraulic loading rate = 200 L/EP/day
- ADWF = 4,800 kL/day or 55.6 L/s
- Design Dry Weather Flow (DDWF) = 4.5 x ADWF = 250 L/s

- Design Wet Weather Flow (DWWF) = 7 x ADWF = 389 L/s
- PWWF = 12.4 x ADWF = 650 L/s (Wills St) and 29 L/s (South BH)

Section 4.2 of PWA's report discusses the South Broken Hill Raw Sewage Transfer to Wills Street STP. The following information was presented with reference to the IWCM Study and design flow estimates developed using Public Works Department's Design Manual:

- ADWF = 9.7 L/s
- PDWF = 19.5 L/s
- PWWF = 186 L/s

PWA's report also documented peak daily inflows of 3.1 ML/d (or 3,100 kL/d) on 2/02/2012 and is approx. 35.9 L/s when converted to an instantaneous flowrate. This peak value was found to correspond with rainfall recorded on 28/02/2012 which was found to be a 1-in-2 yr design rainfall event based on rainfall data detailed in Section 4.2.

Furthermore, the PWA report documented ADWF is typically around 780 kL/d, which compares well to observed dry weather flows recorded at South BH STP from Table 4-3 which estimated ADWF to be approx. 750 Kl/d.

5 Capacity Assessment

Pump information was provided by Essential Water which was used to determine the pump capacity of SPS's in the Broken Hill sewerage network. The information requested to determine the pump capacity, in order of priority, is listed below:

- Draw down field test i.e. test administered on site.
- Pump v system curve analysis using pump curve data provided.
- Draw down theoretical test i.e. using pump run times from SCADA to determine pump capacity.
- Nameplate or quoted duty point from various information sources.

Essential Water did not provide any draw down field tests, drop down theoretical tests, nameplate data; therefore, information provided was used to determine the pump capacity by evaluating the pump v system curve analysis method only.

A summary of the information requested by Essential Water to be able to conduct a pump v system curve analysis is provided in Appendix C, with explanation on what information was supplied, calculated, inferred (or assumed) and missing. It is advised that Essential Water review this table and look to rectify missing or inferred information, where possible, to ensure results are represented with higher confidence.

A summary of the pump capacities from different sources of information is outlined in Table 5-1. Where duty flow estimates are greater or lesser than the design flow estimates, table values are highlighted green and red, respectively.

Table 5-1: SPS Pump v System Curve Analysis Summary

SPS Name	Design Flow (L/s)[2]	Duty Flowrate (L/s)	Duty Head (m)	Indicative Power Required (kW)	Flow to meet Velocity of 1.5 m/s (L/s)[3]
Slag St	12.62	27.1	20.5	8	44.8
Rakow St	30.79	16.9	17.4	4.5	44.8
Kaolin St	3.43	0.2	32.1	0.5	0.9
Racecourse Trust[1]	9.46	-	-	-	29.4
Racecourse Rd	9.95	5.1	10.32	1	29.4
Pinnacles Rd	2.58	2.2	23.0	1	3.3
Kanandah Rd	9.66	5	38.9	-	6.8
South Rd[1]	0.52	-	-	-	0.9
Warren St	98.70	124.6	37.6	67	177.4
King St	6.24	19.3	24.0	7	25.8
Wentworth Rd	2.74	0.27	22.1	0.5	0.9

[1]No pump model or curve provided for pump capacity assessment

[2]Design flow = PWWF (Cumulative) from Table 3-1

[3]Flowrate calculated using rising main internal diameter in Appendix C

Outcomes of the pump capacity assessment should be considered preliminary estimates only due to the lack of available information and assumptions made on the gaps. The duty flow and head values presented should be accepted with low confidence.

6 Conclusions and Recommendations

This loadings assessment and capacity review was undertaken to provide a more robust understanding of the wastewater loadings and design flow estimates to be adopted for the design of the proposed Broken Hill STP, replacing the existing Wills Street and South Broken Hill STPs that are to be decommissioned.

The assessment was limited by the information provided by Essential Water. Where gaps and missing information was presented, assumptions were made to enable evaluation. Key assumptions comprised asset information/location, connection data (category type, location of property connections) and pump data. It is recommended that Essential Water review the missing data and assumptions made to ensure no further information is available for this assessment to gain higher confidence in the results being presented.

The theoretical design flow estimates were calculated using information provided by Essential Water and methodology outlined in WSA 02-2014 (Section 3.1). Validation of these estimates were made by using other available data including calculated pump duties (Section 5), observed STP inflow data (Section 4.3) and values presented in PWA's Concept Design Report (Section 4.5).

A comparison of the design flow estimates for ADWF and PWWF from different sources is presented in Table 6-1.

Table 6-1: Comparison of Design Flow Estimates

SPS Catchment	Contributing SPS	Pump Duty (L/s)	ADWF Design Inflow (L/s)			PWWF Design Inflow (L/s)			
			WSAA[2]	Observed	PWA	WSAA[2] (1-in-2 yr)	Observed (1-in-2 yr)	Observed (Max)	PWA
Slag St (Gravity)	-	27.1	2.0	-	-	12.6	-		-
Rakow St (Gravity)	-	16.9	5.1	-	-	31.0	-		-
Kaolin St (Gravity)	-	0.2	0.4	-	-	3.4	-		-
Racecourse Trust (Gravity)	-	29.4[1]	0.2	-	-	9.5	-		-
Racecourse Rd (Gravity)	-	5.1	0.0	-	-	0.5	-		-
Racecourse Rd (Cumulative)	Racecourse Trust	5.1	0.2	-	-	10.0	-		-
Pinnacles Rd (Gravity)	-	2.2	0.1	-	-	2.6	-		-
Kanandah Rd (Gravity)	-	5	0.5	-	-	9.2	-		-
Kanandah Rd (Cumulative)	Pinnacles Rd	5	0.5	-	-	11.8	-		-
South Rd (Gravity)	-	0.9[1]	0.0	-	-	0.2	-		-
Warren St (Gravity)	-	124.6	26.9	87[3]	-	83.1	135[4]		-
Warren St (Cumulative)	Racecourse Rd, Kaolin St	124.6	27.5	87[3]	-	96.4	135[4]		-
Wills St STP (Gravity)	-	-	5.3	-	-	28.6	-		-
Wills St STP (Cumulative)	Rakow St, South Rd, Slag St, Kanandah Rd, Warren St	-	40.4	-	-	180.6	-		-
TOTAL - Wills St STP		-	**40.4**	***33.8***	***46.6***	**180.6**	***126[5]***	***> 200[6]***	***650***
King St (Gravity)	-	19.3	0.8	-	-	6.2	-		-
Wentworth Rd (Gravity)	-	0.3	0.1	-	-	2.7	-		-
South STP (Gravity)	-	-	7.8	-	-	47.3	-		-
South STP (Cumulative)	King St, Wentworth Rd	-	8.7	-	-	56.3	-		-
TOTAL – South STP		**-**	**8.7**	***8.7***	***9.0***	**56.3**	***35.9[5]***	***67.13[6]***	***186***
TOTAL		-	49.1	42.5	55.6	237	161.9	> 267.13	836

[1]No pump model or curve provided for pump capacity assessment

[2]Calculation based on catchment cumulative design flow estimates

[3]Duty pump only

[4]Duty/assist pumping

[5]Daily inflow data converted to instantaneous flowrate based on correlation to 1-in-2 year ARI rainfall event

[6]Maximum instantaneous inflow recorded between 2020-2023 observed from STP chart recordings provided by Essential Energy

It is recommended that the loadings assessment and capacity review undertaken should be taken into consideration when adopting flow estimates for the design of sewerage infrastructure for the Broken Hill STP Detailed Design project.

Appendix A. Broken Hill Sewerage System

Legend

- WWTP
- SPS (Supplied Location)
- Rising Main (Assumed)
- Gravity Main (Assumed)
- Rising Main (Supplied)
- Gravity Main (Supplied)
- SPS Catchments

Racecourse Trust
Racecourse Rd
Kaolin St
Warren St
Rakow St
Wills Gravity
South Rd
Wills Street WWTP
Slag St
King St
South Gravity
Pinnacles Rd
Kanandah Rd
Wentworth Rd
South Broken Hill WWTP

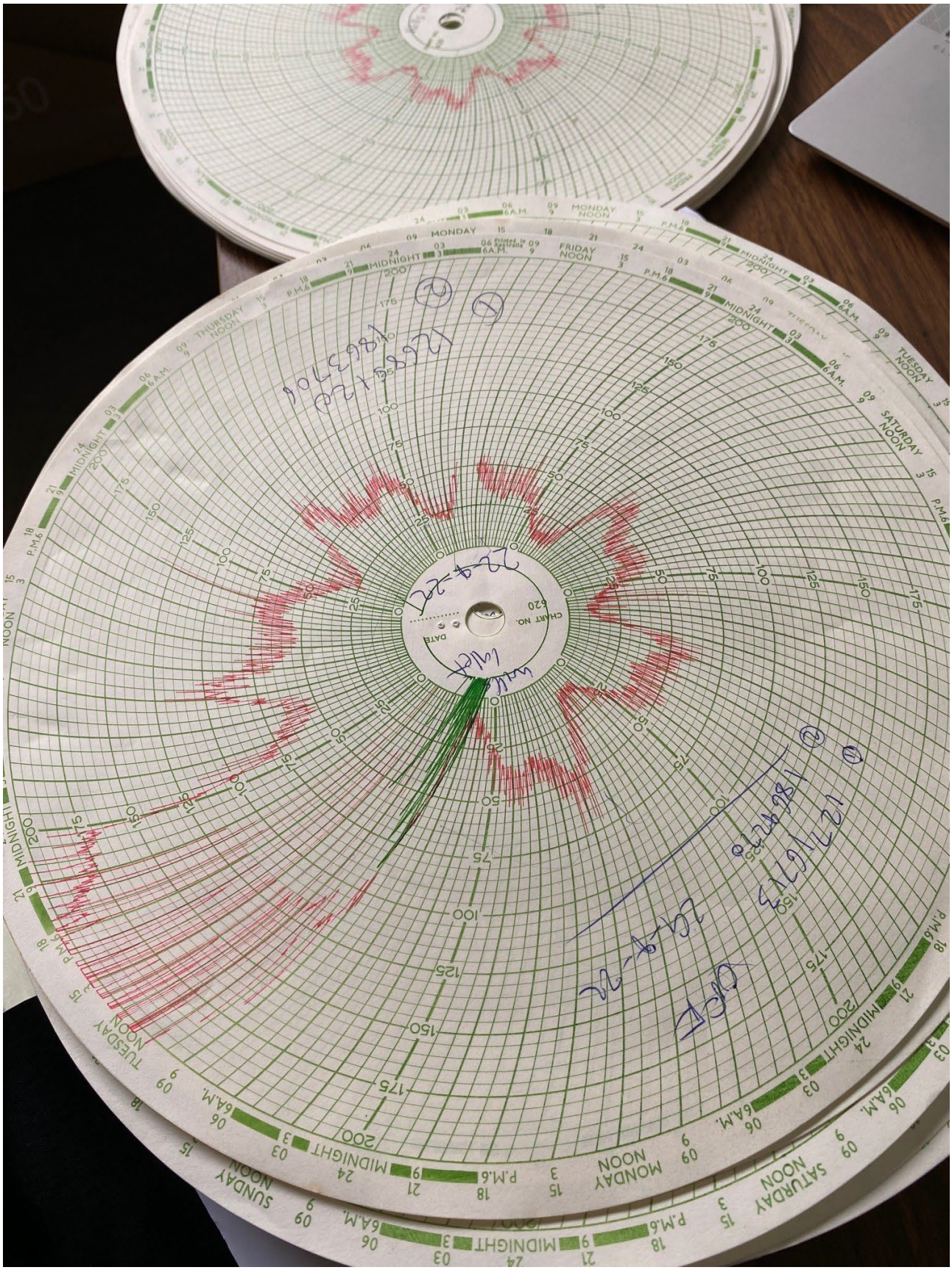
beca hunterh2O

Broken Hill Sewage System

SCALE: 28,000		PROJECT No: 7015	**EXHIBIT 1** A3
DRN: FL	CHK: RJ	DATE: 27 SEPT 2023	
File Name: Exhibit 1		© Map Data Tamworth Regional Council 2015	

Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

Appendix B. Wills Street STP Chart Data (29-04-2022)



Appendix C. SPS Information

SPS Name	TWL	BOC	Discharge IL	Surface Level (ELVIS)	Flood Level	RM Diam	RM Material	RM Internal Diam	RM Length (Supplied)	RM Length (GIS)	Pump Model	Pump Rated Power (kW)	Impeller No.	Pump Curve
Kaolin St	320.937[1]	319.787	332	323.437	323.441	32	uPVC	27	1628	301.90[6]	Flygt 3085.1725	2.4	253	Found
Racecourse Trust	275.387[1]	-	285[2]	277.887	277.887[3]	150	uPVC	157.9	305	1479.71[7]	Flygt 3102.180			
Racecourse Rd	284.565[1]	249.719	290	287.065	287.065[3]	150/100	uPVC	157.9	420.6/965	1803.51[7]	Flygt NP3102.160	3.1	420	Found
South Rd	305.705[1]	304.034	313	308.205	307.945	32	uPVC[5]	27	331	299.76[6]				
Rakow St	296.052	293.04	312	299.048	299.036	200	Cast Iron	195	565.65	574.97[6]	Flygt 3153.350	9	455	Supplied
Slag St	288.066	285.576	305	291.074	291.05	200	Cast Iron	195	612.31	612.32[6]	Flygt 3153.181	13.5	453	Supplied
Warren St	281.098	275.585	311.09	283.760	283.662	375	DICL	388	3242.6	3246.84[6]	Flygt 3301.180	55	454	Found
Pinnacles Pl	278.388[1]	-	280.845[2]	280.888	280.8879[3]	63[4]	PE100	53	-	628[7]	Flygt 3069.170	1.7	254	Found
Kanandah Rd	280.852[1]	279.215	289.1[2]	283.352	283.177	90	uPVC	76	330.96/40	1300[7]	Flygt 3127.170	7.4	252	Supplied
Wentworth Rd	288.933[1]	-	304	291.433	291.433[3]	32	HDPE	27	308	406.47[7]	Flygt NP 3127.161	5.9	487	Supplied
King St	284.506[1]	-	297	287.006	287.006[3]	150	Cast Iron	148	524.44	528.42[6]	Flygt NP 3127.161	7.5[8]	487	Found

Supplied
Inferred
Missing

[1]Surface level -2.5 m

[2]Assumed discharge based on GIS and surface level

[3]Taken as surface level (ELVIS)

[4]Assumed rising main diameter to achieve 1 m/s based on theoretical loadings, Q

[5]Assumed pip material based on diameter of pipe provided

[6]Length of rising main using supplied GIS

[7]Measured from assumed rising main alignment, see Appendix A

[8]Supplied value does not align with pump model and data sheet acquired and pump curve selected using reasonable judgement and should be verified by utility

Acronyms:

TWL – Top Water Level

BOC – Bottom of Concrete (or wet well)

IL – invert level

RM – Rising main

Appendix B. Technical Memo – Tertiary treatment Options Discussion for Broken Hill STP Upgrade Project

To:	John Chalmers Project Manager Broockmann Water Advisory	From:	Peter Greenhalgh Principal process engineer Beca HunterH2O
Copy to:	Bob Ma Senior process engineer Beca HunterH2O	Date:	22 November 2023
Subject:	Technical Memo – Tertiary Treatment Options Discussion for Broken Hill STP Upgrade Project		

Background

Beca Hunter H2O has been engaged by Essential Water to complete a detailed design of a new Sewage Treatment Plant (STP) at Wills Street to replace two existing STP's (Wills St STP and South STP). The existing treatment plants were built in the 1930's and comprise a simple sedimentation, clarifier and trickling filter process that no longer provides the level of treatment required to meet contemporary environmental and effluent reuse requirements, as well they are at the end of asset life.

A Concept Design was completed by NSW Public Works for the new treatment plant based on an Intermittently Decanted Aerated Lagoon (IDAL) process with Ultraviolet (UV) disinfection followed by chlorination for reuse.

Inception meeting

At the Project Inception meeting concern was raised regarding the suitability of the effluent produced by the proposed process for reuse purposes. In particular, the assertion that the effluent produced is suitable for Unrestricted Municipal Reuse as defined in the Australian Guidelines for Water Recycling (AGWR).

It was agreed that additional information on pathogen removal risk would be provided subsequent to the workshop. This memo presents data on pathogen risk as relevant to the proposed process.

Discussion of Concept Pathogen Barriers

The STP Process Flow Diagram (PFD) as derived from the Concept Design provided within the project brief is per Figure 1. Note: not all process flows are shown for clarity.

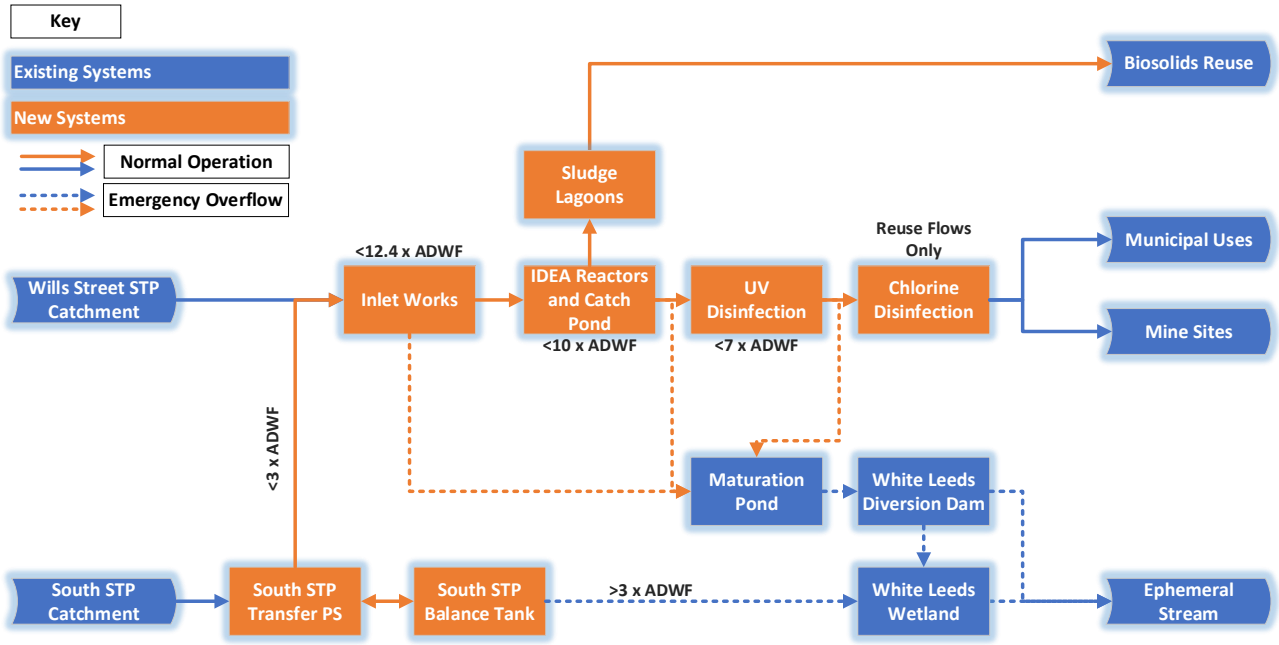


Figure 1: Flow management approach for the Broken Hill STP augmentation in the concept

Note: UV = Ultraviolet Disinfection

The target pathogen Log Removal Values (LRVs) as well as the pathogen LRV assumed to be achieved by the process described in the Concept Design follows in Table 1.

Target LRVs are per the NSW guidance document for recycled water management as referenced in the project brief (and similar to the AGWR).

Table 1: LRV target performance and actual per concept.

Parameter	Protozoa (P)	Virus (V)	Bacteria (B)
Unrestricted Municipal Reuse LRV Target	**3.7**	**5.2**	**4.0**
Achieved By Process	**3.7**	**5.5**	**9.0**
Achieved Through Biological Process	0.5	0.5	1.0
Achieved Through Validated UV Disinfection	3.2	2.0*	4.0*
Achieved Through Chlorination	0.0	3.0*	4.0*

*nominal depending on validated LRV for UV and the chlorine dose rate and contact time.

The process pathogen removal performance in Table 1 infers that achieving compliance with the state and national reuse guidelines requires a validated UV system. When suppliers provide a validated UV system, it is validated against specific operational and installation conditions.

The operational conditions required to claim the validated pathogen LRV include:

- Minimum Ultraviolet Transmissivity (UVT) of the effluent (i.e. how clear the effluent is).
- The maximum Total Suspended Solids (TSS) concentration the UV system will need to perform at.
- The maximum flow that the UV system will need to achieve the required performance.
- The maximum particle size of solids passing through the UV reactor.

When the IDAL process is operating, there may be process upsets which cause high effluent TSS concentrations. It is impractical to determine what the likely solids particle size range would be in the IDAL effluent under different operational conditions.

There is also no efficient means of continuously measuring TSS and particle size in the effluent from the IDAL, although online UVT measurement can and would be used. In some instances, however, turbidity may be accepted as a surrogate for TSS and particle size (this would potentially require discussion with NSW Health).

LRVs in the Concept design were sourced from the AGWR which it is understood source (or derive) UV LRVs from the *US Design Guidance Manual (USDGM)* under the *Final long term 2 enhanced surface water treatment rule*.

In regard to the UV LRVs per the USDGM, the Victorian EPA reached the following conclusion in their document *Guidelines for validating treatment processes for pathogen reduction Supporting Class A recycled water schemes in Victoria*:

"*In establishing the UV dose requirements, the US EPA examined research studies on filtered water, high quality unfiltered water, laboratory water and low turbidity reclaimed wastewater. The US EPA restricted it's evaluation to water with turbidity values less than or equal to 1 NTU (U.S. EPA 2003).*

Therefore, published UV dose–response values can only be applied to treated wastewater with turbidity values less than or equal to 1.0 NTU. This turbidity is readily achievable with appropriately designed and operated filtration systems……

Where turbidity exceeds 1 NTU in the feedwater to the UV disinfection system, the scheme proponent must conclusively demonstrate that the feedwater matrix (under worst case operating conditions) will not adversely impact on the validated UV dose determined by table 1.4 of the UVDGM."

In reference to the above discussion, it appears unreasonable to adopt the AGWR UV LRVs in the absence of a filtration step without further validation information. The project team are also unaware of any recent unrestricted municipal reuse schemes in NSW where LRVs have been accepted for a UV system installed immediately downstream of an IDAL.

Also of note is the recently constructed process at Parkes in NSW which includes a tertiary clarifier (with coagulant dosing) and strainer following the IDAL and immediately upstream of the UV disinfection system.

Discussion of Opportunities

Three opportunities to reduce effluent reuse pathogen risk are considered in this section viz:

- **End Use Restrictions** – Work with end users on enhancing end use restrictions at all sites to ensure that a lower quality of effluent (as would be produced by the process described in the concept) can be provided.
- **Media Filtration** – Provide media filtration upstream of UV disinfection to ensure that the risk of TSS and particle size outside of the range likely to be accepted by the UV supplier is minimised.
- **Membrane Filtration** – Provide tertiary membrane filtration with online pathogen removal validation in place of UV disinfection.

Enhanced end use restrictions would require investigation per site and liaison per end use stakeholder. Enhanced end use restrictions are not considered further by Beca Hunter H_2O in this memo. The project team can pursue this option if requested by and in conjunction with EW.

Membrane filtration is a suitable technology for application in reuse systems. The project team does however have the following concerns relating to adopting tertiary membrane filtration at Broken Hill STP:

- Membrane filtration processes are more complex compared to other options which would increase operational and maintenance complexity. Increased complexity of membrane systems is in part related to the need for frequent membrane cleaning using chemicals such as citric acid and sodium hydroxide, with the storage and dosing of the chemicals also adding to the system complexity. Membrane systems also have significant numbers of automated valves, pumps and sensors which will need to be serviced.
- Membrane filtration processes are likely to incur a higher cost than other options when considering the need for ancillary systems. Membrane pre-filtration (if required) as well as cleaning chemicals, compressors and the facility building are likely to incur a higher capital cost than media filtration.

Further, the membranes will need to be replaced every 7-10 years which also increases the system maintenance cost and operational burden.

- There are only likely to be two membrane suppliers with long track records of operating membrane systems in Australia in the application of effluent treatment. In comparison, there are a large number of pressure media filter suppliers which, if that option is pursued, could act to increase competition and reduce cost.

If the option of media filtration followed by UV disinfection is pursued, then it is noted that:

- Media filtration followed by UV disinfection and chlorination has been implemented by NSW Councils for similar end use applications (municipal only as there is uncertainty regarding the end use health risk for mine site uses).
- EW have experience with media filtration and as such minimal to no upskilling would be required to implement this process.

From the above discussion, it appears that a process consisting of media filtration, UV disinfection and chlorination would be the most suitable solution for Broken Hill STP. The above process would only be required for effluent transferred to municipal and mine site uses. That is assuming effluent suitable for unrestricted municipal reuse is also suitable for use at the mine sites.

A basic PFD showing how the addition of media filtration would be configured follows (Figure 1).

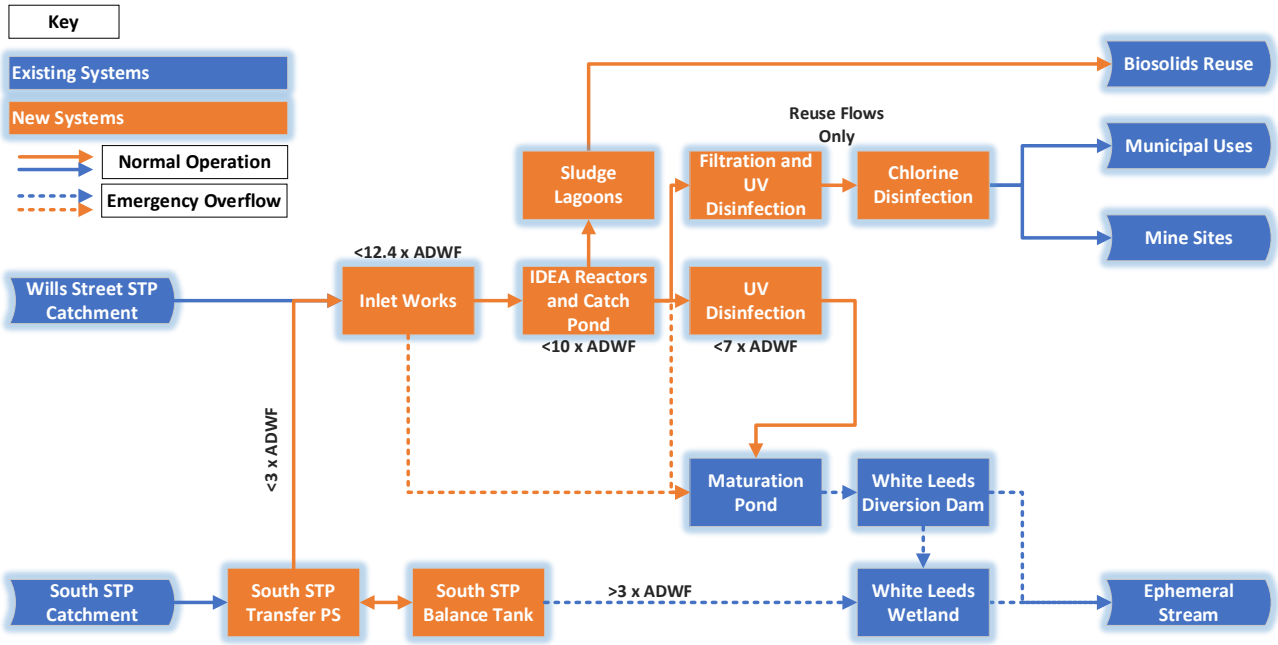


Figure 2: Broken Hill STP PFD incorporating media filtration.

Note; the process change may require the use of a separate UV disinfection system for flows passing to White Leeds wetlands and discharge to receiving waters. It is assumed effluent transferred to these locations would not require filtration.

Way Forward

It is requested that EW review the discussion provided in this document and comment on the discussion herein.

The project team will then either expand the investigation options or further develop the preferred option described in this memo.

Regards

Peter Greenhalgh
Principal Process Engineer
+61 2 4941 5000
peter.greenhalgh@beca.com

Appendix C. Technical Memo -Sludge Management Options Discussion

To:	John Chalmers Project Manager Broockmann Water Advisory	From:	Peter Greenhalgh Principal process engineer Beca HunterH2O
Copy to:	Bob Ma Senior process engineer Beca HunterH2O	Date:	27 July 2023
		Revision	1
Subject:	Technical Memo –Sludge Management Options Discussion for Broken Hill STP Upgrade Project		
Document	**Technical Memo**		**TM-004**

1 Background

Beca Hunter H_2O has been engaged by Essential Water (EW) to complete a detailed design of a new Broken Hill Sewage Treatment Plant (BHSTP) at Wills Street to replace two existing STP's (Wills St STP and South STP).

The existing treatment plants were built in the 1930's and comprise of a simple sedimentation, clarifier and trickling filter process that no longer provides the level of treatment required to meet contemporary environmental and effluent reuse requirements, as well they are at the end of asset life.

As part of project delivery, optioneering is required to refine specific process types and selection for BHSTP. Once optioneering has been completed, a basis of design will be prepared which presents the preferred process systems, capacities, and function of BHSTP.

A key component of the BHSTP subject to optioneering is sludge management. The driver for optioneering of sludge management is uncertainty regarding the suitability from a cost and non-cost perspective of the process as described in the original concept.

1.1 Purpose of Technical Memo

The purpose of this technical memo is to inform EW and provide an opportunity to decide on a key process area (and high-cost component) ahead of other plant options being finalised.

It is understood that EW has limited direct experience in the operation and maintenance of sludge lagoons and aerobic digestion processes, and it was felt that a fulsome discussion of both would assist it in understanding and allow for further discussion on option selection before progressing to a preliminary design.

This standalone technical memo has been developed as Beca HunterH_2O needs further information on catchment inflows (as highlighted in V002) to enable further progress on design options that are reliant on that data i.e., South Transfer PS.

Sludge management is a discrete process area that can be largely isolated from other process areas such that consideration of the two options presented in this memo can form the basis of decisions to guide design development ahead of other options being presented.

This memo provides a description, costs (Capital& NPV) and comparison of potential sludge management options to assist EW in consideration of sludge management options and provides an opportunity for decision making ahead of other elements of the plant design being finalised.

2 Sludge Management Comparison

The biological process at BHSTP will continually generate excess sludge which will need to be removed from the bioreactor (the IDEAs) to ensure the process can continue to operate effectively. These waste solids contain biodegradable organics which, if not further processed pose an odour risk. This further processing is also called sludge stabilisation.

The original concept for the new BHSTP included sludge lagoons for sludge stabilisation followed by transfer of the stabilised sludge to the existing and new additional drying beds. Through the process of site investigations, it has been determined that the capital, operating and environmental risk of using sludge lagoons may be higher than previously thought with further review of the cost estimates as well as confirmation that the identified location would not comply with guidelines for proximity to nearby properties.

An alternative sludge stabilisation process previously discussed with EW was the use of aerobic digestion. Following further engagement with the Dept. of Planning and Environment (DPE), it was determined that consideration should also be being given to sludge lagoons with 1) Contract dewatering 2) an EW owned mobile dewatering system.

The following descriptions of sludge management have been developed through preliminary design using data from the Concept Design provided with the project brief. Options described in this memo include:

- Option 1A – The use of lagoons for sludge stabilisation with drying beds (existing and new) for drying of sludge.
- Option 1B – The use of lagoons for sludge stabilisation with procurement of an external dewatering contractor when required to dewater the sludge lagoons.
- Option 1C – The use of lagoons for sludge stabilisation with procurement of a mobile dewatering system by EW for dewatering of the sludge lagoons.
- Option 2A – Aerobic digestion for sludge stabilisation with permanent mechanical dewatering of sludge.
- Option 2B – As per Option 2A but without sludge thickening so the digester is slightly larger.

Alternative sludge management options such as incineration, gasification and pyrolysis have been excluded as they are unlikely to be suitable for this scale of project.

2.1 Option 1A - Sludge Lagoons + Drying Beds

For the option, the sludge lagoons would include a Polyethylene (PE) liner installed on compacted fill similar to the construction of the stormwater management lagoons at Wills Street STP. A concrete apron with handrail would be provided around the top of each sludge lagoon per the Concept Design provided with the project brief. A geotextile liner would aid bank stability under the PE liner during construction.

The slope and rock levels in the area proposed for the lagoons vary significantly. Discussion on the cost and risk of location and depth is provided in the costing section.

Operation of the sludge lagoons would include the following:

- For each Lagoon, there would be 4 months feed, 6 months storage for sludge stabilisation, and 2 months dewatering before starting to feed the lagoon again.
- In normal operation, the waste sludge would be fed into the Online lagoon where it would settle and stabilise. The clear supernatant would overflow an outlet to a supernatant pump station which would return the supernatant to the inlet works.
- Filling of the lagoons will occur sequentially. As such for the lagoons not receiving waste sludge, one lagoon will be undergoing stabilisation and the other lagoon will be ready for dewatering. Due to the high evaporation in the area, treated effluent would be used to top up the lagoons not being filled to keep them from drying out.
- When a lagoon is ready to be dewatered, a pontoon mounted submersible pump would be craned into the lagoon. A system of cables would be used to position the pontoon mounted pump for the removal of sludge. The operator would move the pontoon mounted pump using the cables (Figure 2-1), traversing the lagoon to remove the sludge to the drying beds (as per other STPs with sludge lagoons of this size and design).

Figure 2-1: UAT Sludge Rat Dewatering Pontoon Mounted Pump.

- Due to the significant distance from the lagoons to the drying beds and the variable concentration of sludge from the pontoon mounted pump, it is proposed to provide a small mixed concrete buffer tank closer to the existing drying beds. The pontoon pump would transfer sludge to the buffer tank, the sludge would then be transferred by a set of duty/standby pumps to the drying beds. It is assumed that the management of the sludge transfer pumps would be manual.
- Each sludge lagoon to be dewatered would have in the order of 3-4 ML of sludge to be removed at an average concentration in the order of 3.5 % w/w solids.
- It is envisaged that the operator would sequentially fill each of the drying beds, swapping between them as the pontoon mounted sludge pump is guided up and down the lagoon. Depending on how fast effluent drains from the sludge, consideration could be given to topping up the drying beds, otherwise the sludge would be left to dry for ~15-20 days before being removed. It is assumed removal would be via bobcat or front-end loader to the sludge stockpile area.
- It is likely that during dewatering two operators would be required so that one can manage the sludge pumping pontoon movement and the other is filling the drying beds. Each drying bed would take in the order of 3-4 hours to fill before moving to the next drying bed. With 11 drying beds (estimated existing plus proposed) it would take approximately one week to fill all drying beds assuming normal working hours.
- There would be insufficient drying bed area to remove all sludge from one full lagoon. Removal of sludge from one lagoon would require approximately 3 drying bed drying cycles (i.e., filling and drying). The above process would be repeated as each sludge lagoon needs dewatering. In total therefore, emptying sludge from one lagoon, drying and removal of the sludge would take approximately 2-3 months.

Besides maintaining the core civil structures, this option would only require maintenance of pumps used to transfer sludge and supernatant.

Core elements to the sludge processing for this option include:

- WAS pumps.
- Sludge lagoons, handrails and cable mounts for pump pontoon.
- Supernatant return pumping station and pipework.
- Pontoon mounted pump system.
- Small sludge buffer tank with mixer and sludge transfer pumps.
- Laydown slab for pontoon pump.
- Pipework to existing drying beds (assuming they are not too big an odour risk).
- Expanded sludge drying bed area.
- Service water system connections.
- Earthmoving equipment for sludge transfer to stockpile area.
- Expansion of stormwater management area to allow for larger construction area.

The process flow diagram (PFD) for the sludge lagoon options is shown in Figure 2-2.

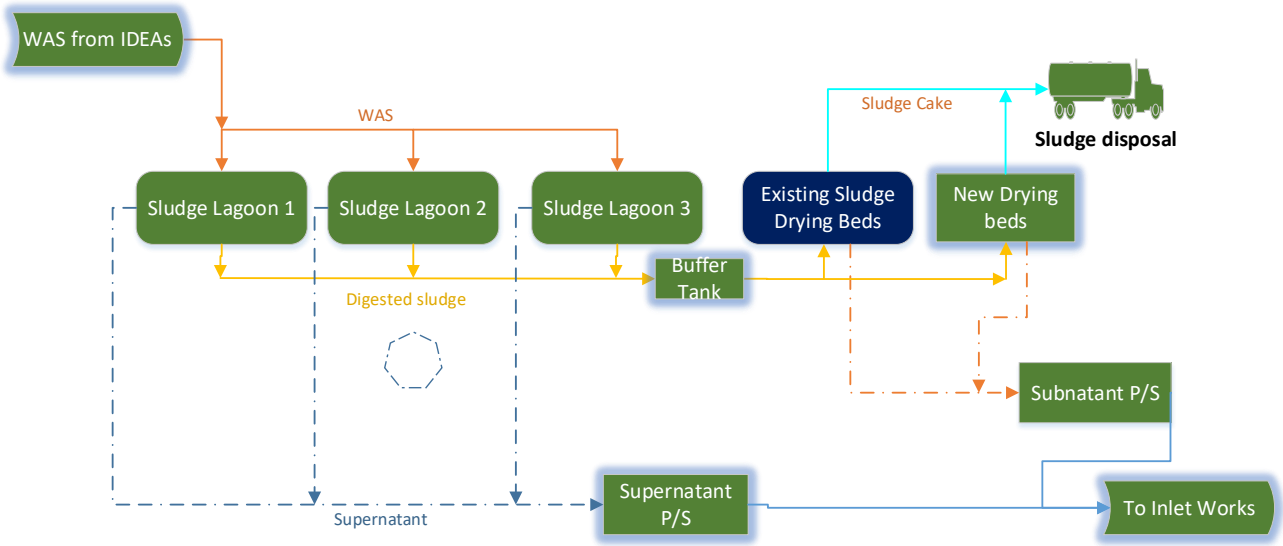


Figure 2-2: Process flow diagram for sludge lagoons sludge handling option

The proposed site layout for the sludge lagoon option (Option 1A) is shown in Figure 2-3.

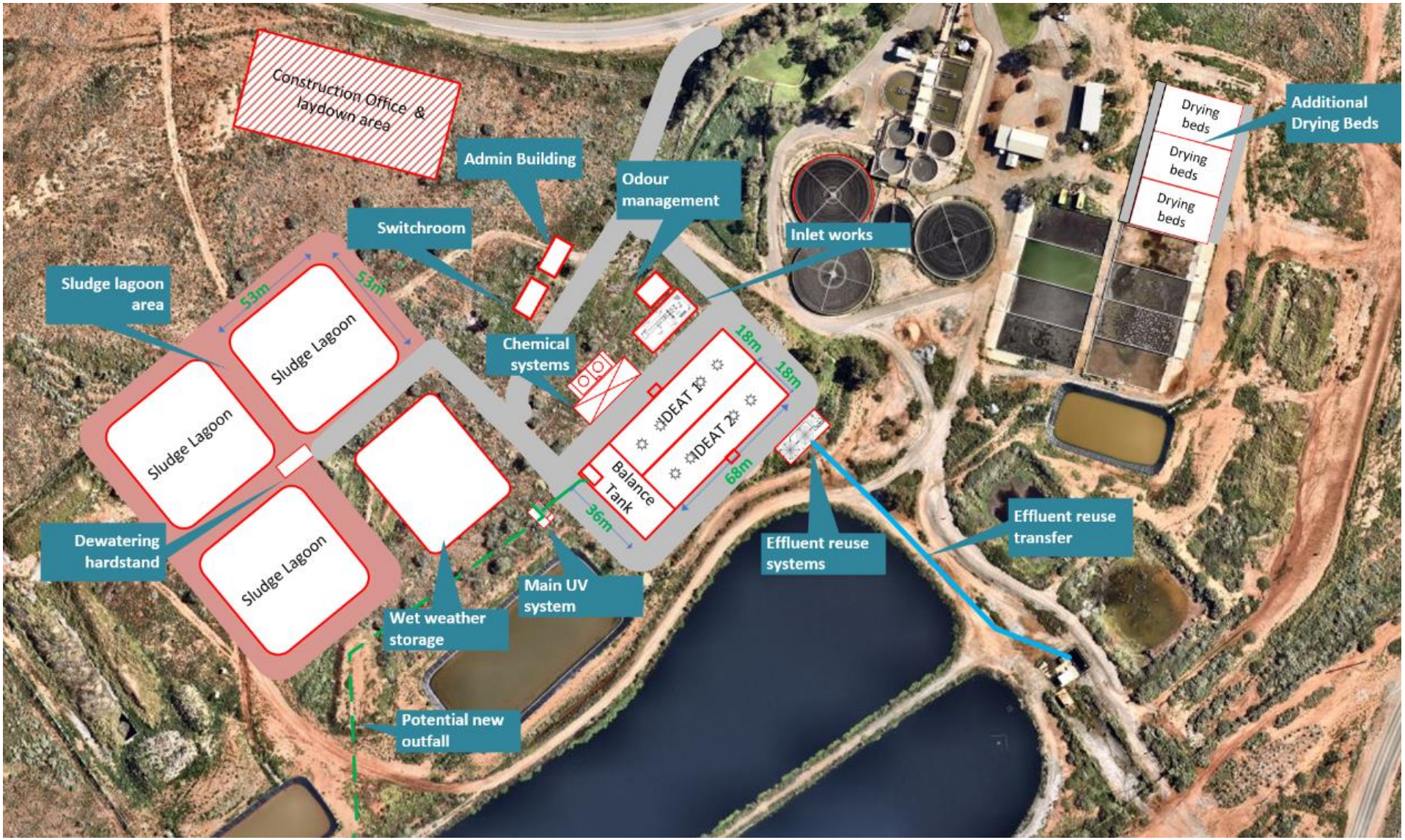


Figure 2-3: General layout – Option 1A, Sludge Lagoons with sludge drying beds dewatering

2.2 Option 1B and Option 1C

In addition to the sludge lagoon Option 1A, instead of using sludge drying beds for the anaerobically digested (sludge lagoon) sludge dewatering, a mechanical dewatering system could be utilised. The following two sub-options with mechanical dewatering are further investigated and compared with the original proposed Option 1A:

- Option 1B (Sludge Lagoons + Hiring Mobile Dewatering) - Compared with Option 1A, the sludge drying bed dewatering would be replaced with a contract mobile dewatering system while still constructing sludge lagoons for sludge stabilisation.
- Option 1C (Sludge Lagoons + Mobile Dewatering) - This option is very similar to Option 1B, instead of a contract mobile dewatering system, EW would purchase a mobile dewatering system and use it for this site or other sites' dewatering.

2.2.1 Sequence of Lagoon Operation

Sludge lagoons release nutrients as the biomass decays. This leads to an elevated concentration of ammonium-N in the supernatant and, if a lot of supernatant is returned to the head of the plant within a short period, the total nitrogen received by the IDEA may lead to a breach of the discharge licence.

For Option 1B, each lagoon dewatered is likely to be emptied within 10 -14 days with the actual rate dependant on the capacity of the dewatering contractors system. During dewatering, ~4,500m^3 supernatant would be returned to the IDEA which would be equivalent to 30-50% of the typical influent nitrogen loading. It is therefore proposed that a small lagoon be constructed (in addition to the 3 sludge lagoons) to reduce the peak dewatering centrate/filtrate return flow. We have allowed for a nominal 3,500 m^3 lagoon to buffer these return flows.

For Option 1C, the use of large sludge lagoons can make it difficult to remove sludge as the sludge is distributed over a broader area. It is therefore proposed that for Option 1C, a greater number of smaller lagoons be constructed (5 instead of 3). For both Option 1B and 1C, the dewatered solids would be trucked to the existing biosolids storage bund for stockpiling prior to removal from site.

The sludge lagoons phase operation with 3 (Options 1A and 1B) and 5 sludge lagoons (Options 1C) is shown in Figure 2-4.

3 sludge lagoons phase operation

5 sludge lagoons phase operation

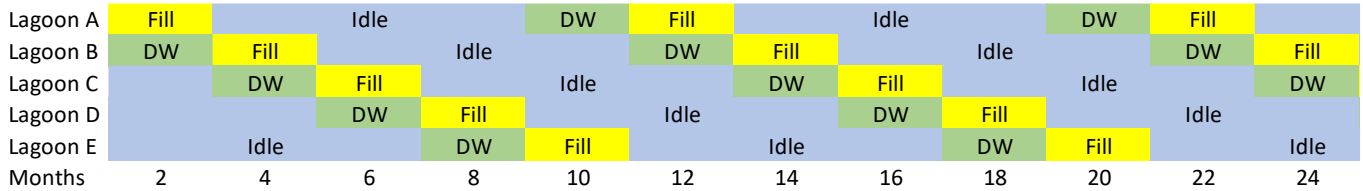


Figure 2-4: Three and five Sludge lagoons phase operation

2.2.2 Sludge Lagoon Options Components

The major components and operating procedures for the sludge lagoon Options 1B and Option 1C are summarised in Table 2-1 below.

Table 2-1: Sludge lagoon Option 1B and 1C summary

Parameter	Option 1B	Option 1C
Components	▪ Three sludge lagoons. ▪ A supernatant buffer lagoon (3,500m^3). ▪ Supernatant return pump station & pipework. ▪ Laydown slab for pontoon pump ▪ Hardstand for mobile dewatering system. ▪ Power and water connections.	▪ Five sludge lagoons (2500m^3, sludge volume) ▪ Pontoon mounted pump system ▪ Small sludge buffer tank with mixer ▪ Mobile dewatering feed pumps ▪ Laydown slab for pontoon pump ▪ Hardstand for mobile dewatering system ▪ A mobile dewatering system include: ○ A centrifuge ○ Sludge conveyor ○ Polymer preparation system ○ Polymer dosing pumps ○ Local control panel ○ Container ○ Truck or trailer for transferring biosolids to stockpile area ○ Pipework ○ Valve & instrumentation ▪ Power and water connections
Operation procedures	▪ The sludge lagoon sequence of operation is the same as Option 1A. ▪ When a lagoon is ready for dewatering, a mobile dewatering contractor will be called in and parked in the dewatering system hardstand. ▪ A pontoon-mounted submersible pump would be craned into the lagoon with service water, potable water and power connected to the mobile dewatering system. ▪ It is envisaged that each sludge lagoon is to be dewatered within 10-14 days. The sludge supernatant will flow into a supernatant buffer lagoon where it would be gradually returned to the head of the plant for further treatment. ▪ It is assumed the dewatered biosolids will be sent to the existing stockpile area via a truck or trailer. ▪ It is likely that during dewatering one operator would be required to supervise the mobile dewatering contractor. ▪ Each sludge lagoon will dewater once per year, with a total of three lagoons dewatered per year at maximum loading.	▪ The sludge lagoon sequence of operation is shown in Figure 2-4. ▪ When a lagoon is ready for dewatering, the permanent mobile dewatering will be relocated to the plant and parked in the dewatering system hardstand. ▪ A pontoon-mounted submersible pump would be craned into the lagoon with service water, potable water and power connected to the mobile dewatering system. ▪ Sludge from the lagoons would be pumped to a small mixed buffer tank from which the dewatering system would draw. ▪ It is envisaged that each sludge lagoon is to be dewatered approx. 4 weeks (40hours per week) to smoothly return supernatant to the head of the plant. ▪ It is assumed the dewatered biosolids will be sent to the existing stockpile area via a truck or trailer. ▪ It is likely that during dewatering two operators would be required. ▪ As shown in Figure 2-4, there will be total of six mobile dewatering mobilisations.

Preliminary layouts for the sludge lagoon Options 1B and 1C are shown in Figure 2-3 and Figure 2-6 respectively.

Figure 2-5: General layout – Option 1B, Sludge Lagoons+ Hire Mobile dewatering system

Figure 2-6: General layout – Option 1C, Sludge Lagoons+ Permanent Mobile dewatering system

2.3 Option 2A – Sludge Thickener + Aerobic Digester

For this option, WAS would be pumped to a sludge thickener (a small circular clarifier similar to the existing humus tanks). The thickened sludge (1.5 % w/w solids) from the base of the thickener would be pumped to the aerobic digester. The clear supernatant from the thickener would flow to the inlet works via a site foul water pump station.

The aerobic digester is a concrete tank with at least three cells which are interconnected. Sludge flows through each cell in series with the cells being intermittently aerated to assist digestion. Aeration would be via surface aerators although diffused aeration can also be used. Surface aeration is discussed in this document as it would be similar to the type of aeration proposed for the bioreactor (IDEAs).

The digested sludge from last cell of the aerobic digester would be pumped to a dewatering unit via a digested waste activated sludge (DWAS) pumps. The dewatering unit (example screw press shown in Figure 2-7) would dewater and then drop the dewatered sludge onto a series of conveyors (one horizontal and one inclined) to deposit the dewatered sludge in a trailer. The filtrate (i.e., liquid squeezed out of the digested sludge) would be transferred back to the inlet works along with the gravity thickener supernatant. Polymer would be dosed to the inlet of the dewatering unit to promote thickening.

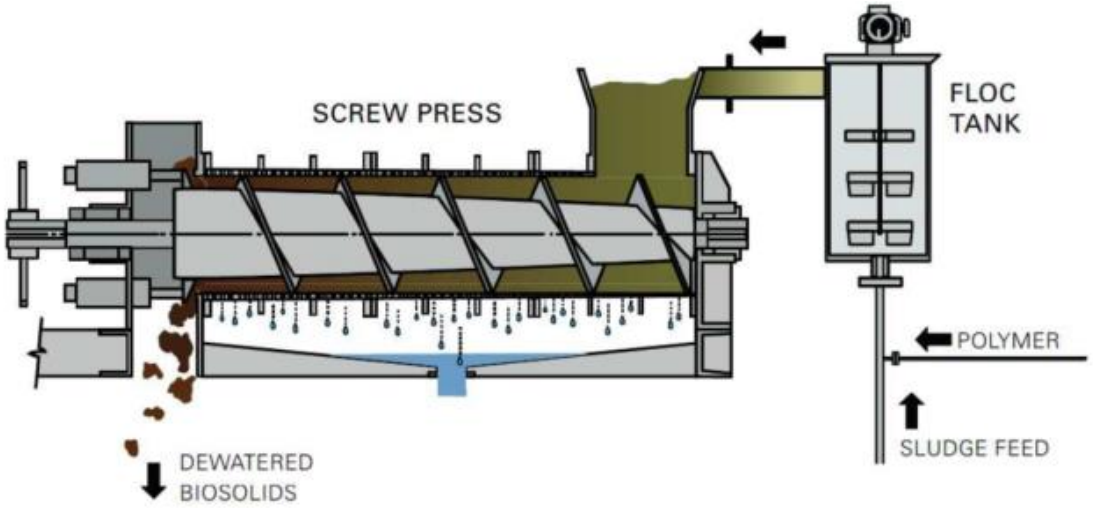


Figure 2-7: Example Screw Press Courtesy FKC.

The dewatered sludge (also called biosolids) would be transferred to the stockpile area when the truck trailer is full. The existing sludge drying beds could be retained for emergency backup if the sludge dewatering is off-line for maintenance. It is suggested that even if a standby dewatering system is not provided, space be provided for one to be installed in the future.

In normal operation the dewatering system would operate at least three times per week. Frequency will dictate final size of dewatering unit noting some Councils dewater sludge every day. The dewatering sequence would be initiated by the operator through the SCADA and then would be fully automated. Key operator input during the dewatering process includes:

- Testing the concentration of solids and dissolved oxygen content in the digester periodically (similar to what will be required for the bioreactor).
- Adjusting the dewatering system run time and frequency.
- Viewing the dewatered solids and adjusting the polymer dose rate to maximise dryness of the dewatered solids.
- Monitoring how full the biosolids trailer is to determine how much longer the dewatering process will operate.
- Transferring the biosolids to the stockpile area when the truck trailer if full.
- Hose down any biosolids spilled from the conveyor.

Core elements to the sludge processing for this option include:

- WAS pumps.
- Gravity thickener with thickened sludge transfer pumps
- Aerobic digester with surface aerators.
- Supernatant / filtrate return pumping station and pipework.
- Dewatering building.
- Dewatering concrete hardstand area.
- Dewatering unit.
- Biosolids conveyors.
- Polymer dosing unit.
- Service water system.
- Compressed air system.
- Truck or trailer for transferring biosolids to stockpile area.

The only system requiring specialised maintenance (e.g., apart from aerators pumps and conveyors) is likely to be the dewatering unit. Frequency and type of maintenance will depend on final selection.

The process flow diagrams (PFD) for the aerobic digester option is shown in Figure 2-8.

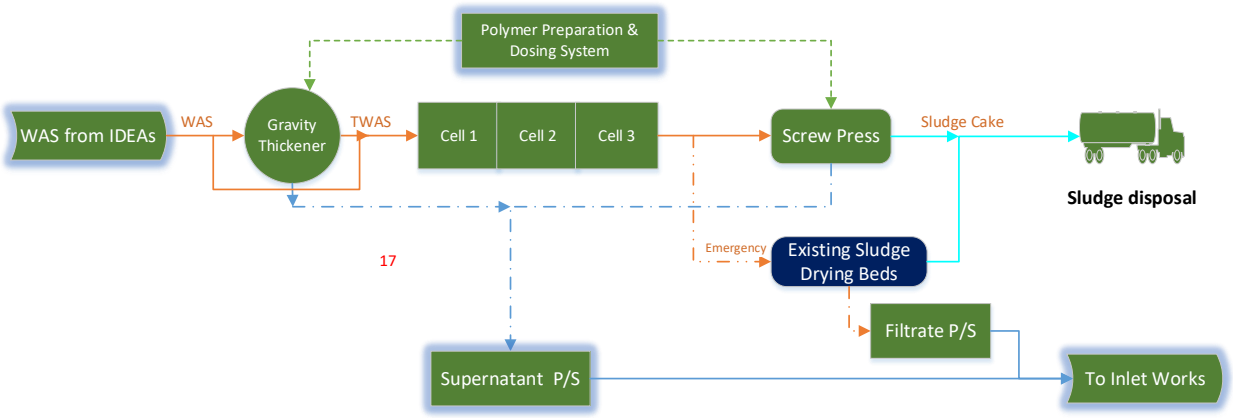


Figure 2-8: Process flow diagram for aerobic digester sludge handling option

The proposed site layouts for the aerobic digester (Option 2A) option are shown in Figure 2-9.

Figure 2-9: General layout – Option 2A, Aerobic Digestion

2.4 Option 2B (Aerobic digester only)

In this option, Thickened Waste Activated Sludge (TWAS) during the IDEA's settling phase will be pumped to the aerobic digester directly without using the sludge thickener system described for Option 2A. A floating decanter in the digester would be used to maintain the thickness at just under 1% to ensure the digester is not too large.

Core elements to the sludge processing for this option include:

- WAS pumps.
- Aerobic digester with surface aerators and a small floating decanter.
- Supernatant / filtrate return pumping station and pipework.
- Dewatering building.
- Dewatering concrete hardstand area.
- Dewatering unit.
- Biosolids conveyors.
- Polymer dosing unit.
- Service water system.
- Compressed air system.
- Truck or trailer for transferring biosolids to stockpile area.

3 Cost Analysis

This section provides a summary of the cost estimates for each option. The level of cost estimating at this stage is for the purpose of options comparison only.

3.1 Capital Cost Estimate

Costs developed for all the options include only those elements of the upgrade directly related to or impacted by sludge management. i.e., the bulk of the remainder of the plant has been excluded so that a discrete assessment can be made of the options.

The preliminary capital costs developed include:

- A high-level allowance of $500 K as a base cost has been made for stormwater management for Options 1A, 1B and 1C to allow for the greater area covered. i.e., existing site stormwater management plan would need to be expanded.
- Electrical works are different to account for the different electrical design and equipment requirements for each, with allowances of:
    - 15% of direct capital costs (aerobic digester options)
    - 2% of direct capital costs (sludge lagoon options)
    - Noting the aerobic digester options will require significantly more electrical works,
- Commissioning costs are different for both options with allowances of:
    - 4% of direct capital costs (aerobic digester options)
    - 1.5% (sludge lagoon options) of direct capital costs.
    - The aerobic digester option will be more complex to commission.
- A contingency of 20% of the total indirect and direct costs.
- Contractor's on-site costs of 2% of the total direct costs.
- Contractor's offsite overhead and margin of 8% of the total direct costs.
- Costs have been based on recent construction estimates and comparison with the recent stormwater management and drying bed construction procurement costs for Wills Street STP provided by EW.

Items not costed for the sludge lagoon option (Option 1A-C) include:

- For Option 1A, no allowance has been made for construction of new drying beds if abandoning the existing drying beds is required to comply with odour limits in the environmental approval. **This could add further significant cost if construction of 11 drying beds is required to the north-west side of the site.**
- Impact on the IDEA aeration demand. The ammonium-N return from the sludge lagoons will impart some minimal additional aeration demand on the bioreactor (IDEAs). No allowance in capital or operating cost (i.e., it would be slightly higher) has been made in the assessment.
- No allowance for contaminated land management is included in the sludge lagoon options.

The civil earthworks cost risk for the sludge lagoons (Options 1A/1B/1C) is significant at this stage of the project. Site data (Wills Street STP Geotechnical Report Number ISR18086/A prepared by Public Works) indicates rock depths are highly variable and there are a limited number of bore holes available to guide optimal sludge lagoon location and depth. We have therefore provided a range of costs for the sludge lagoons which include:

- A low-cost estimate which assumes that on average hard rock is not encountered until 2 m on average (total sludge lagoon depth is 4.2 m). The estimate also assumes that excavated fill can be used in the construction of the walls of the lagoons.
- A higher-cost estimate which assumes that on average hard rock is not encountered until 1 m on average. The estimate assumes that excavated fill cannot be used in the construction of the walls of the lagoons.

The capital costs and for sludge handing options including a range based on the earthworks cost risk follows (Figure 3-1).

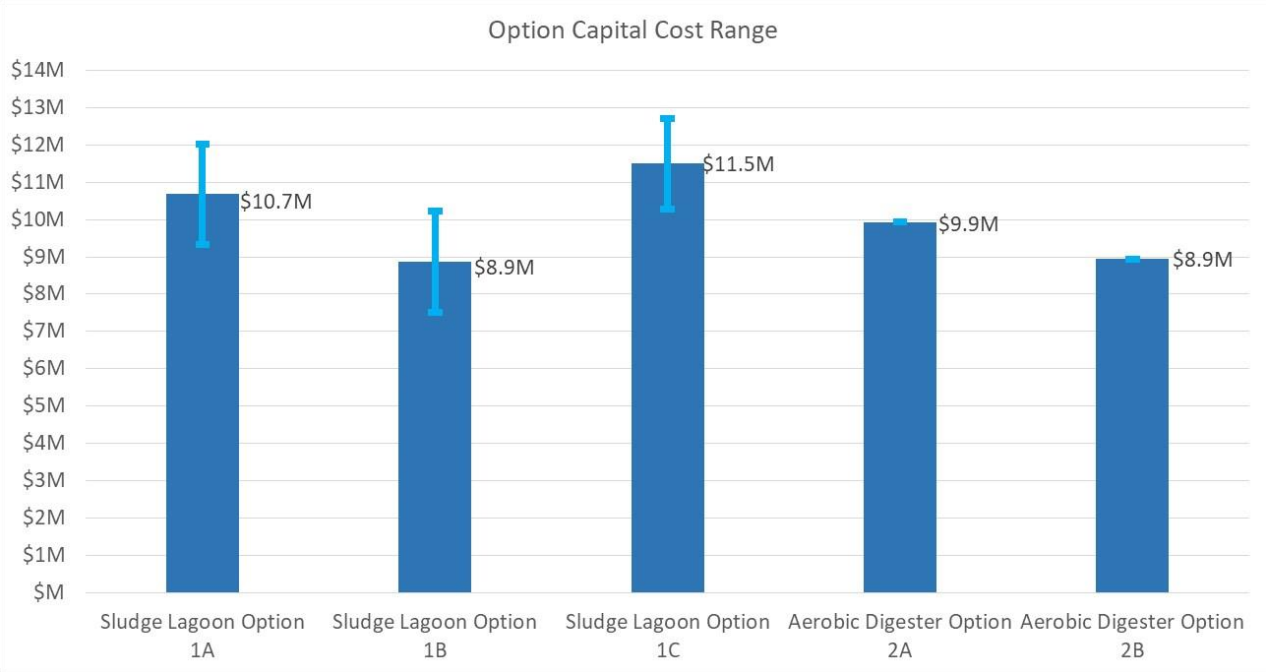


Figure 3-1: Sludge handling Options Capital and NPV Costs

It is noted that the Option 1A cost is not directly comparable to the estimating review of the original concept design. Additional scope items have been identified since the previous BHSTP upgrade estimate submitted by Beca Hunter H_2O, these are largely related to the site relocation and include:

- Stormwater management (to divert through and around the new plant location)
- Imported soil allowance.
- Rock excavation allowance

3.2 Lifecycle Cost Estimate

Assumptions used in development of the lifecycle are summarised in Table 3-1.

Table 3-1: Operational and maintenance rates for BHSTP sludge handling life cycle cost analysis

Parameter	Rate	Comments
Power cost	0.21$/kwh	
Polymer (Dry)	$10/kg	
Polymer Usage Rate for WAS thickening	3 kg/Tonne dry solid	Option 2A only
Polymer Usage Rate for screw press dewatering	7 kg/Tonne dry solid	Option 2A/2B
Polymer Usage Rate for centrifuge dewatering	10 kg/Tonne dry solid	Option 1C
Contract dewatering system rate	Minimum $90/Wet tonne biosolids Maximum $150/Wet tonne biosolids	Option 1B. Range provided due to uncertainty due to remote location.
Civil Maintenance %	0.3% of capital per annum	
Operational Labour Cost	$72/hour	
Mechanical Maintenance %	2.5% of capital per annum	
Electrical Maintenance %	2.5% of capital per annum	

Operator labour costs estimates assume:

- Option 1A - 8 hours/day, 90 days/year
- Option 1B – 250h/year, one operator attendance during dewatering
- Option 1C – two operators attending during dewatering
- Option 2A/2B - 1.5 hours/ day, 4 days/week

Operation and Maintenance (O&M) costs for each option are presented in Figure 3-2. A cost range is provided for each option to allow for the range of maintenance costs (as maintenance is a percentage of capital cost) and to allow for the range of contract dewatering costs for Option 1B per Table 3-1.

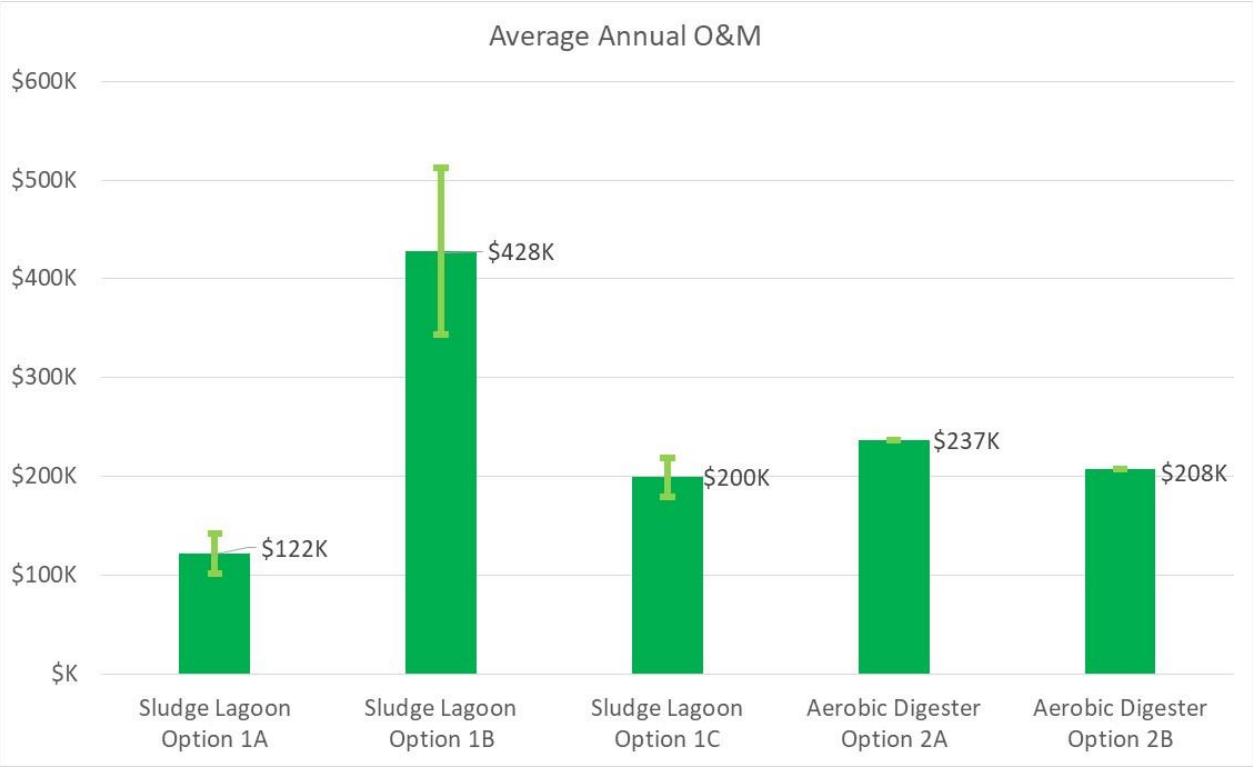


Figure 3-2: Sludge handling options O&M comparison with estimate range.

The resulting lifecycle cost estimate for each option, allowing for the range of capital and operating costs is presented in Figure 3-3.

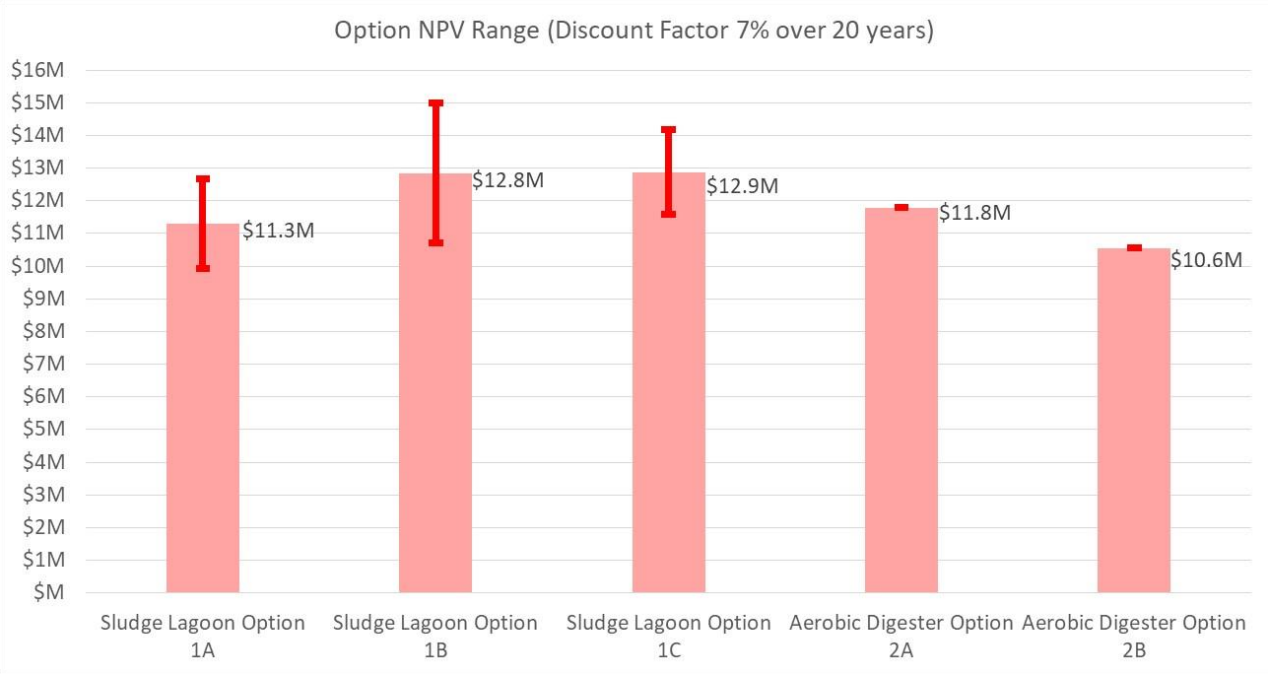


Figure 3-3: Sludge handling options lifecycle cost comparison with range.

3.3 Cost Summary

From the cost assessment presented above, it is concluded that:

- The use of sludge lagoons with drying beds (Option 1A) has the potential to provide the lowest lifecycle cost if site geotechnical conditions are favourable. There is a risk that the lifecycle cost for Option 1A would be greater than that for the aerobic digestion options (2A and 2B) if unfavourable geotechnical conditions are encountered.
- Contract dewatering (Option 1B) has the potential to provide the lowest capital cost assuming favourable geotechnical conditions are encountered.
- The use of an EW owned dewatering system (Option 1C) has the potential to incur the highest capital cost. Other option capital costs (Option 1A, 2A and 2B) are similar within the error of the estimate.
- Contract dewatering (Option 1B) has the highest operational cost uncertainty due to the remote location of the site considering the potential need to attract dewatering contractors.
- In general, the sludge lagoon options (Option 1A-C) have the highest capital cost risk due to uncertainty regarding the site geotechnical conditions.

4 Greenhouse Gas Emissions

High level estimates of Greenhouse Gas (GHG) emissions for the process described within the concept documentation in the project brief follow. These estimates are based on National Greenhouse and Energy Reporting (NGER) documentation provided by the Clean Energy Regulator.

The emissions reported are divided into:

- Scope 1 Emissions: Direct emissions of GHG from processes (e.g., CH_4 and N_2O).
- Scope 2 Emissions: Emissions from the generation of electricity used in the processes.
- Scope 3 Emissions: Indirect emissions were not reported

Emissions were calculated using the document “Guidance for Estimating Greenhouse Gas Emissions by NSW Water Utilities” published in 2019. Emissions are based on Tables 1 to 5 of the Australian Government Department of the Environment and Energy "National Greenhouse Accounts (NGA) Factors".

Emissions calculations utilised the following assumptions:

- Sludge lagoons if utilised would equate to “Anaerobic Deep Lagoons” per Table G of the NGERs accounting factors.
- Scope 3 emissions were excluded from the assessment.
- Nitrous oxide emissions from the secondary treatment process were excluded.
- All waste solids would be disposed of to landfill.
- Scope 1 emissions only are included (i.e., direct emissions of GHG from processes including methane).
- Scope 2 emissions (electricity) were calculated using the latest NSW emissions factor from the Clean Energy Regulator.

The resulting Scope 1 and Scope 2 emissions for each option are presented in Table 4-1.

Table 4-1: Indicative GHG emissions for sludge handling options

Parameter	Sludge Lagoon Options (Tonnes CO_2-e/annum)	Aerobic Digester Options (Tonnes CO_2-e/annum)
Scope 1 Emissions	4,246	0
Scope 2 Emissions	<10 option dependent	225
Total Emissions	4,251	225

5 Options Comparison

Comparison of the five sludge handling options is provided in Table 5-1.

Table 5-1: Comparison of sludge handling options for BHSTP upgrade

Discussion Point	Sludge Lagoon Option 1A	Sludge Lagoon Option 1B	Sludge Lagoon Option 1C	Aerobic Digester Option 2A	Aerobic Digester Option 2B
Safety	Installation and moving pontoon and operation of drying beds (opening and closing inlet valves) has slight increase in safety risk compared to other option.	Removes the potential safety risk with drying beds. Safety risk managed through dewatering contractor.	Risk with lagoons (moving pontoon) still exist. More frequent dewatering is required Dewatering System is more compact to allow transport. Design to minimise safety risk.	Minimal manual handling for normal operation (hose down). Design to minimise safety risks.	Minimal manual handling for normal operation (hose down). Design to minimise safety risks.
Greenhouse Gas (GHG) emissions	Sludge lagoons emit methane which contribute significant Scope 1 emissions.	Same as Option 1A.	Same as Option 1A.	Minimal Scope 1 emissions (i.e., direct emission of gases.) Scope 2 emissions related to significantly higher use of electricity for aeration. It is noted that many Councils and water authorities around Australia offset Scope 2 emissions by constructing a solar field.	Same as Option 2A
Maintainability	Minimal day to day maintenance. Sludge lagoon liner damage is a risk, but careful materials selection and construction management can mitigate. Drying beds sand needs top up periodically. More mechanical equipment to maintain for Option 1b	Same as Option 1A.	Per Option 1A but need to maintain dewatering equipment. This can be more difficult as mobile dewatering units are typically space constrained making access more difficult. More mechanical equipment to maintain	More mechanical equipment to maintain. Through careful equipment selection, maintenance can be simplified / reduced. For example, use of a screw press with no internal wipers can reduce need for maintenance. A screw press has a low rotational speed reducing wear. Alternative dewatering systems such	Improved Maintainability due to Less mechanical equipment compared to Option 2A

			Regularly requires vendor service	as belt filter presses and centrifuges can be more complex.	
Operability	Significantly less frequent operator input. Input when required will be much more intensive and hands on when dewatering occurs. Frequent operator input during mobile dewatering period, especially for Option 1b.	The Operator will need to manage centrate returns to the biological process. Otherwise very little input is required besides organising a dewatering contractor.	Experience with these systems indicates they can be difficult to operate due to varying feed quality as sludge is transferred from lagoons. Compact nature typically decreases operability. Less frequent dewatering is required than for aerobic digestion, but still likely 5-7 months duration.	More frequent operator input for shorter periods. Input in the form of monitoring processes, adjustment of polymer dose rate and dewatering system settings.	Same as Option 2A. Likely regularly WAS concentration testing
Future flexibility	Likely less readily aligns with future net zero emissions and sustainability strategy of Essential Energy due to high Scope 1 GHG emissions.	Same as Option 1A.	Same as Option 1A.	There is pressure on water authorities and corporations to reduce GHG emissions. As more and more electricity is supplied by renewable energy, there is greater pressure to reduce Scope 1 emissions as opposed to Scope 2. Therefore, the use of aerobic digestion is more aligned with future regulatory changes.	Same as Option 2A.
Odour and noise risk	Much larger odour footprint and higher potential for impact on nearby sensitive receptors. Option may be more acceptable if abandoning existing drying beds although this would be at additional cost.	Reduced odour with abandoning drying beds, however the supernatant buffer lagoon would add odour emissions	Similar to Option 1A however due to the smaller lagoons which enables mixing of the contents may result in a spike in odour.	The majority of the site odour footprint will relate to the inlet works and sludge management. Aerobic digestion and dewatering will have a significantly smaller odour footprint than sludge lagoons. Less likely to impact nearby receptors.	Same as Option 2A.

				Noise from the aeration of the aerobic digester will need to be assessed and managed. Similar management is required to IDEA aerators.	
Impact on Secondary Treatment Process (i.e., IDEAs)	The ammonium-nitrogen return load when large volumes of lagoon are dewatered may impact IDEA performance. This is a risk that is managed well in other STPs but will need to be considered in operation and design.	Same as Option 1A. A supernatant buffer lagoon is provided to manage the supernatant return	Same as Option 1A. Five sludge lagoons are proposed to manage the supernatant return	Aerobic digestion provides nitrification and denitrification which, with more frequent operation has minimal impact on the IDEA nutrient removal performance.	Same as Option 2A. Sludge settleability likely impacts the WAS concentration and IDEAs operational SRT.

6 Next Steps

In order to progress review, discussion and potential decision on the options presented for Sludge Management the following steps are suggested:

- Essential Water review the technical and consider the options presented
- Essential Water meet with Beca HunterH_2O and DPE Water
- Essential Water provide direction

Attachments

- A: Cost estimation for both sludge handling options

Attachment A – Cost estimation for all sludge handling options

Appendix D. Option Odour Modelling Report

1 Introduction

EnvironOdour Australia Pty Ltd (EnvironOdour) has been engaged by Essential Energy to carry out an air quality impact assessment which would be used to inform a Part 5 assessment (REF), which Essential Energy will prepare in accordance with the Environmental Planning and Assessment Act 1979 (EP&A Act). Public Works Advisory (PWA) prepared the Broken Hill Sewerage Scheme Replacement of Wills Street and Southern Sewage Treatment Plants (STPs) Options Study (October 2018) which confirmed the preference of Essential Energy to decommission both existing STPs and construct a new STP at the Wills Street site. It also identified the Intermittently Decanted Extended Aeration (IDEA) as the preferred secondary treatment process.

Essential Energy is required to assess the construction and operational air quality impacts of the proposal and to minimise the Company's liability in relation to the requirements of the EP&A Act, Protection of the Environment Operations Act 1997 (POEO Act), Protection of the Environment Operations (Clean Air) Regulation 2021 (Clean Air Regulation) and other relevant legislation.

This report describes the methods in odour sample collection, olfactometry analysis and calculation of the odour impact using Ausplume dispersion model in accordance with the approved methods for the modelling and assessment of air pollutants in NSW (NSW DEC 2005), the technical framework for the Assessment and Management of Odour from Stationary Sources in NSW (DECC, 2006a), and the assessment and management of odour from stationary sources in NSW (NSW DEC 2006b).

2 Scope of the work

The scope of the work involves the following:

- Collecting odour samples at the existing STP using a flux chamber following Australia standard 4323.4.
- Purchasing meteorological data from BOM weather observation station and formatting them into an Ausplume air dispersion model compatible file
- Carrying out a Level 3 odour impact assessment using Ausplume air dispersion modelling following NSW EPA's 'Technical Framework Assessment and Management of Odour from Stationary Sources in NSW'
- Prepare the odour report per NSW EPA's 'Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales'.

3 Site Description

The Wills STP is situated at the outskirt of the southwest corner of Broken Hill, NSW. The aerial view (see Figure 1) covers an area of 1200 meters by 1500 meters. There are several scattered residents on the eastern side of the site. The closest neighbour is about 350 metres away from the nearest sludge drying bed. The dense urban area is also on the eastern and north-eastern sides. The existing STP floor plan is shown in Figure 2.

Figure 1 The aerial view of Wills STP (dated April 2023)

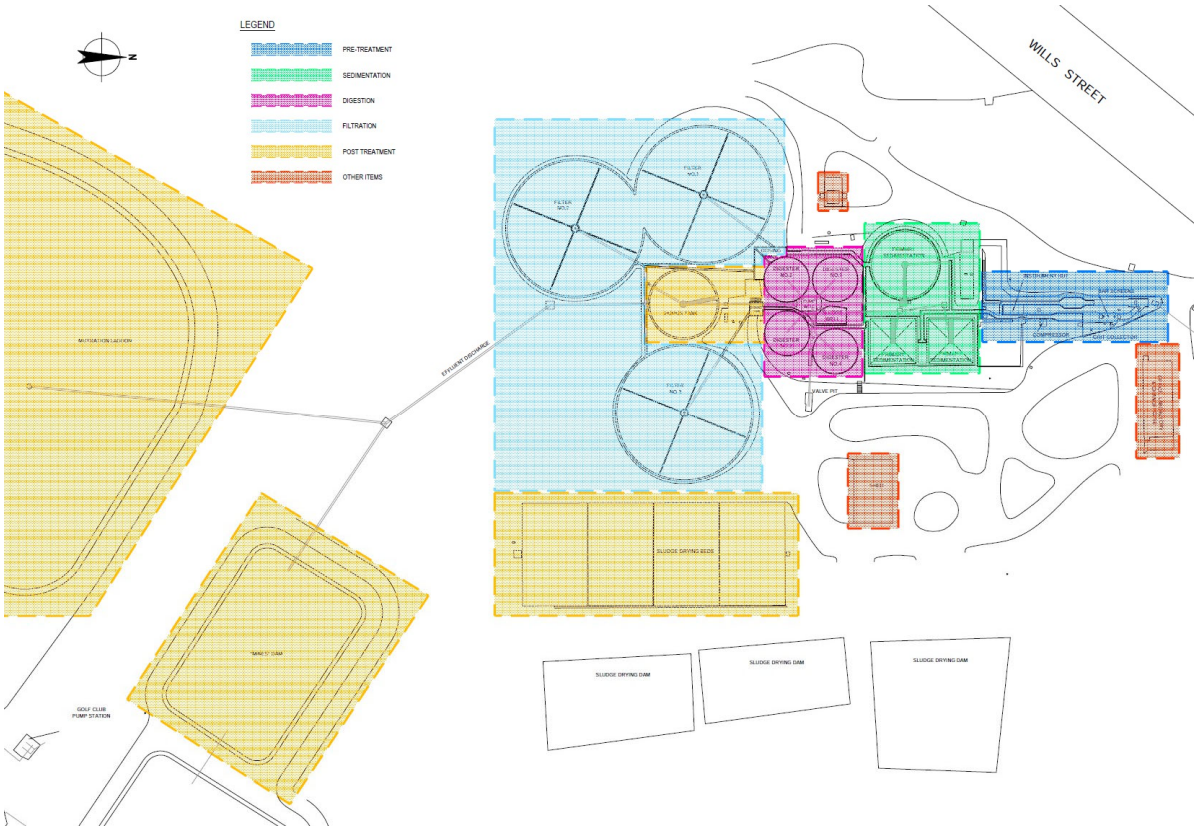


Figure 2 Existing STP floor plan

Table 1 lists the odour emission sources at the Wills STP. The emission type and the releasing pattern are also listed.

Table 1 Odour emission sources

ID	Description	Type	Pattern
1	Trickling filter	Surface	Continuously
2	Sludge drying bed	Surface	Continuously
3	Digester	Surface	Continuously
4	Humus tank	Surface	Continuously
5	Primary sedimentation tank	Surface	Continuously
6	Inlet channel	Surface	Continuously

4 The upgrade

In 2019 PWA prepared the Broken Hill STP Augmentation Concept Development report (PWA 2019), which presented the concept detail of sizing, design criteria, layout and operational features of the augmentation works based on the preferred augmentation and treatment options identified in the earlier PWA (2018) Options Report.

Following the concept development, work has commenced on the detailed design for the proposal. As part of a preliminary review of the concept design, several alternative options for sludge management, a key process area and high cost component of the overall design, were explored, as follows:

- Option 1A – The use of lagoons for sludge stabilisation with drying beds (existing and new) for drying of sludge.
- Option 1B – The use of lagoons for sludge stabilisation with procurement of an external dewatering contractor when required to dewater the sludge lagoons.
- Option 1C – The use of lagoons for sludge stabilisation with procurement of a mobile dewatering system by EW for dewatering of the sludge lagoons.
- Option 2A – Aerobic digestion for sludge stabilisation with permanent mechanical dewatering of sludge.
- Option 2B – As per Option 2A but without sludge thickening so the digester is slightly larger.

To assess the odour impacts of the various sludge management options, as well the location and positioning of various pieces of plant and equipment, four odour model scenarios were assessed, as presented in the following table (Table 2), and discussed further below.

Table 2 Modelling scenarios

Scenario	Relationship with Sludge Management Options
Scenario 1	Reflects Sludge Lagoon Options 1A.
Scenario 2	Reflects Sludge Lagoon Options 1A, however, assesses the option of relocating the drying beds to the western side of the site.
Scenario 3	Reflects Sludge Lagoon Option 2A. The difference in odour generation between Options 2A and 2B is likely to be minimal and a non-material change. Although Option 2A includes a gravity thickener which is in additional to 2B, the digester in Option 2B is slightly bigger which is likely to offset the addition of the gravity thickener in 2A.
Scenario 4	Generally reflects Sludge Lagoon Options 1B and 1C. Although Option 1B includes 3 sludge lagoons and 1 supernatant tank, and Option 1C includes 5 sludge lagoons, the odour generating capacity of both is considered similar, with the five lagoon option (1C) potentially having a slightly higher odour generating capacity, and hence it was used as a worst case scenario. The only remaining difference between 1B and 1C, is whether the mobile dewatering system is brought to site by a contractor (1B) or is EW owned (1C). Again, this is considered to have minimal, non-material changes in odour generating capacity.

Scenario 1: Sludge lagoons with expansion of existing drying beds

In this scenario, Waste Activated Sludge (WAS) would be pumped from two Intermittently Decanted Extended Aeration Tanks (IDEATs) to one of the proposed three sludge lagoons. One lagoon would be fed, whilst the other two lagoons would be either idle awaiting dewatering or providing time for sludge stabilisation. To dewater the lagoons, a pontoon mounted pump would be used to traverse the lagoons, transferring the sludge to the existing and proposed new drying beds. Sludge in the drying beds would be allowed to dry (a process that typically takes 15-20 days) before being removed and stockpiled onsite in the existing drying area.

Figure 3 Scenario 1 layout

Scenario 2: Sludge lagoons with all new drying beds to the west

This scenario is as per Scenario 1 with the exception that sludge drying would occur in new drying beds to the west of the site. The existing drying beds would be abandoned to increase the distance between operational processes and the nearest receptor.

Figure 4 Scenario 2 layout

Scenario 3: Aerobic digestion and mechanical dewatering

In this scenario, WAS would be pumped to a small thickener / clarifier. The clarifier supernatant would be pumped back to the IDEATs whilst the thickened sludge would be pumped to an aerobic digester with three hydraulically connected cells. Surface aerators in the aerobic digester would operate at a set cycle (~one hour on and one hour off) to stabilise the sludge. Digested sludge from the final cell of the digester would be pumped to be dewatered. Dewatering would comprise of a single enclosed screw press with outloading conveyors. The dewatering equipment would be located in a Colourbond building with ventilation ports and a roller door. Dewatered sludge would be deposited in a trailer where it would remain until being removed for stockpiling onsite in the existing drying area.

Figure 5 Scenario 3 layout

Scenario 4: Larger sludge lagoons with expansion of existing drying beds

This scenario is essentially the same as Scenario 2, only the footprint of the sludge lagoons will be larger (5 smaller lagoons instead of the proposed 3 lagoons in Scenario 2).

Figure 6 Scenario 4 layout

5 Methodology

The predominant factors, which affect the extent of the odour impact, are the odour emission rates and wind conditions. Since more of the odour emission sources are area sources, a flux hood was used to collect the emission. The samples are analysed for their odour concentrations. The Specific Odour Emission Rates (SOERs) are calculated and entered into the model.

The study uses the Ausplume air dispersion model to predict the offsite odour impact at the nearby residential area. By changing the input conditions (different layouts) the offsite odour impact can be predicted and studied.

5.1 Isolation flux chamber

In order to capture the odour emissions from the liquid surface, an isolation flux chamber (Method No OM-8), as recommended in the *Approved methods for the sampling and analysis of air pollutants in New South Wales 2000,* was used to determine the odour emission rates. This is also the Australian standard (AS4323.4) which has fully adopted the US EPA's design.

The isolation flux chamber used in the study has the same configuration as described in the US EPA's user's guide (US EPA, 1986). The schematic of the chamber is shown in Figure 7. The diameter of the chamber base cylinder is 400 mm, and it has a height of 150 mm. The dome has a height of 100 mm. Both sections are joined using a flange and

gasket to prevent any leakage during sampling. The effective volume of the chamber is about 24 litres.

The principle of the chambers is based on the two-film model that is frequently used to explain the experimental phenomenon of the volatilisation of organic compounds from water in the laboratory. All the sampling procedures strictly follow the US EPA's guidelines. The isolation flux chamber is placed over the source and purged with Nitrogen gas (BOC gases, greater than 99.9% in nitrogen). The Nitrogen gas flows at a rate of 5 Litres per Minute (LPM) and enters the hood via four small holes that point downwards and are evenly distributed on the circular distribution tubing. After 24 minutes of purging, the sampling tubing is connected to the DynaDrum inlet and the sample is taken at a rate of 2 LPM. Appendix 2 shows the actual setup of isolation chamber at each odour source in the study.

An important modification was made to the US EPA isolation flux chamber design. The sampling tubing is perforated along the length of the sampling tubing in this original design. It was found that a short circuit had occurred since the distance between the distribution tubing and the top holes of the sampling tubing were much closer than the distance between the distribution tubing and the bottom holes. A modification was made so that the enter point of sampling tubing (at the tip of the tubing) had an equal distance to the small holes of the distribution tubing.

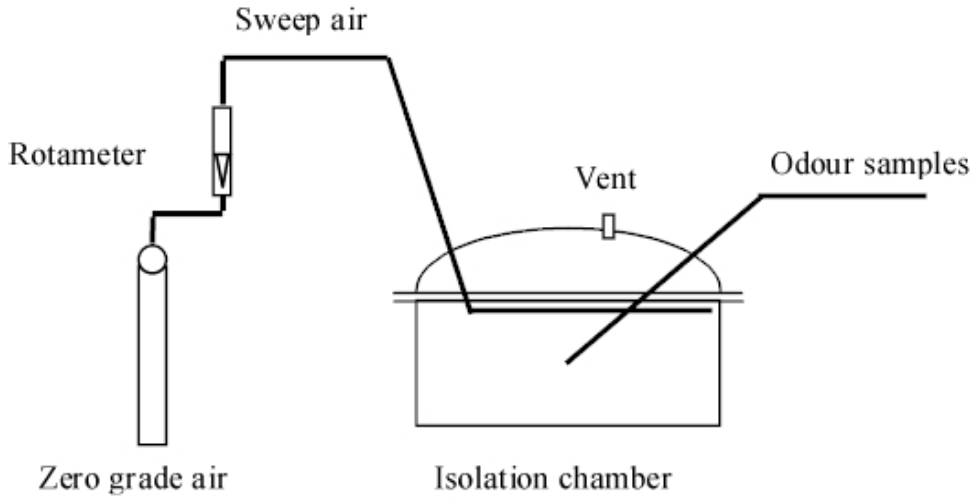


Figure 7 Schematic of the flux hood

Specific odour emission rate is calculated using the following equation:

$$E = \frac{Q \cdot OC}{A}$$

where

E: specific odour emission rate, OU/m^{2}s
Q: the sweep nitrogen gas flow rate, m^3/s; the sweep flow is controlled to be 8.3×10^{-5} m^3/s (= 5 L/min)
OC: the odour concentration, OU/m^3

A: the area covered by the enclosure, m^2; the isolation flux chamber has a cover area of 0.1256 m^2

5.2 Odour sample collection

All odour samples were collected in odour-free Nalophan™ sampling bags using a DynaDrum sampling drum (see Figure 8). These sampling bags were attached to the sampling port of the DynaDrum. The sampling rate is set at 2 LPM. The sampling volume is about 4 litres for each sample.

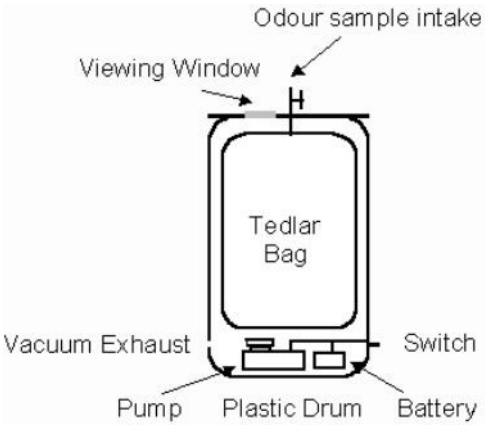


Figure 8 Schematic of the DynaDrum sampling system

All sampling equipment used in the study was constructed using stainless steel, PTFE or Nalophan. The sampling bags were constructed out of Nalophan and were valid for a single use only. This ensured that cross-contamination did not occur between samples. A new sampling tube was used for each sampling point.

Where practical, all sources were sampled and measured for temperature and relative humidity. At the same time, the physical locations of the sources were photographed for record purposes.

All the source odour samples were collected in the morning and transported back to the EnvironOdour laboratory for olfactometry testing (of odour concentration) in the afternoon. All odour samples were tested the following morning.

5.3 Olfactometry testing

Odour testing was carried out using dynamic olfactometry in accordance with the Australian standard AS/NZS 4323.3:2001 *Determination of odour concentration by dynamic olfactometry*. The strength of an environmental odour is determined as an 'odour concentration', which is the number of times a sample needs to be diluted to arrive at the odour threshold. By definition the odour threshold corresponds to an odour concentration of one odour unit per cubic metre (i.e. 1 OU/m^3).

Odour measurement is performed using the DynaScent digital olfactometer. The odour samples were tested using a triangular mode with a dilution factor of 2. A panel of six trained panellists each assessed the odour samples. The odorous gas sample is presented at decreasing dilutions to one of three sniffing ports at random while the others release only odourless air. At each dilution ratio, each panellist sniffs all three ports and chose one of the three ports as being the one with the odorous sample (i.e. making a

'forced choice'). In addition to their forced choice between the three ports, the panellists are required to indicate whether their confidences are based on a 'guess', 'inkling' or 'certainty'. The process is then repeated with doubling odour strength present at the sniffing ports until all panellists chose the correct port with certainty. This is one round. For the purpose of measuring odour concentration, two rounds are required for each sample.

5.4 Ausplume dispersion modelling

The Ausplume computer model is used to predict ground level concentrations of odours from the facilities. Ausplume is a Gaussian dispersion model developed by the Environment Protection Authority of Victoria (EPAV, 1999). The model has undergone continual revisions since then and is widely used throughout Australia to assess air quality impacts from industrial and other sources. The model is a default air dispersion model in NSW. The Ausplume version used in the study is 6.0.

Ausplume requires a meteorological data file that typically consists of 1-hour averaged values such as wind speed, wind direction, sigma theta, temperature, mixing heights and stability class. Ausplume calculates the ground level concentration of the nominated pollutant each hour at each receptor. As required in the NSW EPA's document, a minimum of 5 years of representative meteorological data is required for the Level 3 odour impact assessment. Finally, the 99th highest odour concentrations are used to plot the odour concentration contour. The predicted odour contour can then be compared to applicable odour performance criteria.

Ausplume has many user-selectable options for the adjustment of dispersion parameters. The options considered most appropriate for the circumstances are selected. Special issues are discussed in the remainder of this section.

5.4.1 Source characterisation

The modelled odour emission sources at the site are the area sources. The model uses a numerical integration approach for modelling impacts. This approach allows shapes such as rectangles, circles and polygons to be selected. Rectangular areas may also have a rotation angle specified relative to a north-south orientation. Both the southwest corner and the orientation angle of the rectangle is specified in the model to define the source location and in the modelling results. Circle sources are defined by the centre position and radius.

The odour emission rates are assumed to be a constant throughout the study.

5.4.2 Meteorological data

The meteorological data was prepared using the observation data recorded at Broken Hill Airport over the period of the 1 July 2018 to the 30 June 2023 by Bureau of Meteorology. The weather station is approximately 4 km away in the southeast. All the data was supplied as 10 minute averaged values and reformatted to Ausplume requirements.

5.4.3 Roughness height

The site is considered to be flat in the north, west and south. The urban residential area is located in the northeast and east of the site. A conservative estimate of the roughness height in these circumstances is flat rural (0.1 metres), which is consistent with a predominantly rural environment.

5.4.4 Topography

The surrounding area is relative flat. The terrain of site was not considered in the study.

5.4.5 Receptor grid

The receptor grid was defined in local (arbitrary) coordinates at 50 metre intervals over an area of 1500 m x 1200 m. The fine grid results in a slightly smoother odour contour.

One discrete receptor, representing the sensitive receptor, was also added so that the location could be displayed in the dispersion modelling results.

5.4.6 Building wake effect

No building wake effects were modelled in the study since no point source is in the calculation.

5.4.7 Odour performance criteria for acceptable odour impact

Odour performance criteria was documented in “Technical framework: assessment and management of odour from stationary sources in NSW” produced by the Department of Environment and conservation (NSW DEC 2006). These are shown in Table 2.

The closest resident is about 350 meters away in the east. The closest commercial property is about 250 meters in the south. There are no schools or hospitals in the surrounding area.

There is considerable buffer distance between odour generating activity and equipment on-site to the site boundary. The population of the potentially affected community adjacent to the site boundary is therefore less than 30. There are no schools or hospitals near the site. This means the relevant odour performance criterion is 5 OU/m^3 as a nose response time (see Table 3).

For a one-hour averaged value, the peak-to-mean ratios shown in Table 4 must be used to convert the nose response averages to one hour averaged value (P/M60) as Ausplume dispersion model uses (NSW DEC 2006).

For the area source at the site, the applicable P/M60 ratio is 2.3 and 2.5 for near-field receptors and 1.9 and 2.3 for far-field receptors under different atmospheric stability classes. In the study, the P/M60 ratio is 2.5 for all the stabilities and distances. It is expected that the assumption of one-hour averaged odour performance criterion of 5 OU/m^3 at 99^{th} percentile for modelling emissions from the site will give a conservative estimate of odour impacts for the local community.

Table 3 Odour performance criteria (99th percentile)

Population of affected community	Impact assessment criteria for complex mixtures of odorous air pollutants (OU/m^3)
Urban area (≥ 2000) and/or schools and hospitals	2.0
~ 500	3.0
~ 125	4.0
~ 30	5.0
~ 10	6.0
Single residence (≤ ~ 2)	7.0

Table 4 P/M60 ratios for estimating peak concentrations in flat terrain

Source type	Pasquill–Gifford stability class	Near-field P/M60*	Far-field P/M60*
Area	A, B, C, D	2.5	2.3
	E, F	2.3	1.9
Line	A–F	6	6
Surface wake-free point	A, B, C	12	4
	D, E, F	25	7
Tall wake-free point	A, B, C	17	3
	D, E, F	35	6
Wake-affected point	A–F	2.3	2.3
Volume	A–F	2.3	2.3

* Ratio of peak 1-second average concentrations to mean 1-hour average concentrations

6 Results and Discussion

The odour emission survey was carried out on 27 July 2023. A total of 6 source samples were taken and analysed in the EnvironOdour odour laboratory. Their results are presented and summarised below.

The meteorological data was acquired and formatted to the Ausplume requirements. The analysis of the meteorological data has been performed and discussed here.

The Ausplume dispersion model was used to predict the odour concentrations around the plant under the existing and four proposed scenarios at ground level.

6.1 Odour concentration and odour emission results

Olfactometry testing was carried out at EnvironOdour testing laboratory on 28 July 2023. The testing report is listed in Appendix 1.

Figure 16 in Appendix 2 shows the isolation chamber was used to sample the odour emission over the sludge dry bed. Figure 16 shows the isolation chamber for the trickling filter. Figure 17 shows the chamber for the sludge digester. Figure 19 shows the chamber over primary sedimentation tank. Figure 19 shows the chamber over inlet channel.

Table 5 summarises the odour emission sources included in the Ausplume air dispersion modelling and the measured SOERs.

The odour emission from maturation ponds has also been added for the existing operation. Their SOER was assumed to be 0.04 OU/m^{2}s.

Table 5 Summary of odour concentration and odour emission rates

Sample ID	Description	OC	SOER
		OU/m^3	OU/m^{2}s
6517	Trickling Filter	185	0.12
6518	Sludge Drying Bed	93	0.06
6519	Digester	1465	0.97
6520	Humus Tanks	622	0.41
6521	Primary Sedimentation Tank	8379	5.6
6522	Inlet Channel	34184	22.7

6.2 Analysis of meteorological data

The overall summary of meteorological data is summarised in Table 6.

Table 6 Summary of meteorological data

Starting Date:	18070101	Ending Date:	23063024
Days:	1826	Hours:	43824
Progessed Lines:	43824	Processed Days:	1819
Min. Wind Speed:	0	Max. Wind Speed:	16.4
Min Temp:	0	Max Temp:	45
Min Mixing Height:	50	Max Mixing Height:	2857
Min StDev:	0	Max StDev:	112

The more detailed statistics of the meteorological data can be found in Appendix 3. The frequency distribution of atmospheric stability class versus wind direction is shown in Table 12. Frequency distribution of atmospheric stability class versus wind speed is shown in Table 13. Frequency distribution of stability class distribution versus the time of the day is listed in Table 14. Frequency distribution of wind speed versus wind direction is listed in Table 15. Wind speed, wind direction, atmospheric stability class, ambient temperature,

mixing height distribution and sigma-theta (wind direction standard deviation) are also shown in Figure 21 - Figure 26 respectively.

Generally, odour does not disperse and mix as readily at night as it does during the day. Atmospheric stability refers to the potential of air to disperse and is defined using the Pasquill Gifford scheme where the atmosphere is categorised from unstable (category A) to stable (category F). Ideal odour dispersion occurs under unstable conditions. In simpler terms, the lower the stability class (closer to A), the greater the odour dispersion and hence, the lower the potential for odour nuisance.

The maximum ground level concentrations occur when the wind speed is low, such as 0.5 m/s. The low wind speeds are often associated with more stable atmospheric conditions (D, E, F). The combined effects result in less atmospheric dispersion and therefore a high ground concentration.

The wind pattern plays an important role in dissipating the odour. The prevailing wind direction in the observation period was west, west-southwest and west-northwest. The next most prominent wind direction was north-east and east-northeast. During the hours of 5 pm – 8 pm, the wind mainly blows from the west, west-northwest and west-southwest. This is unfavourite wind direction which pushes the odour from the STP towards residents.

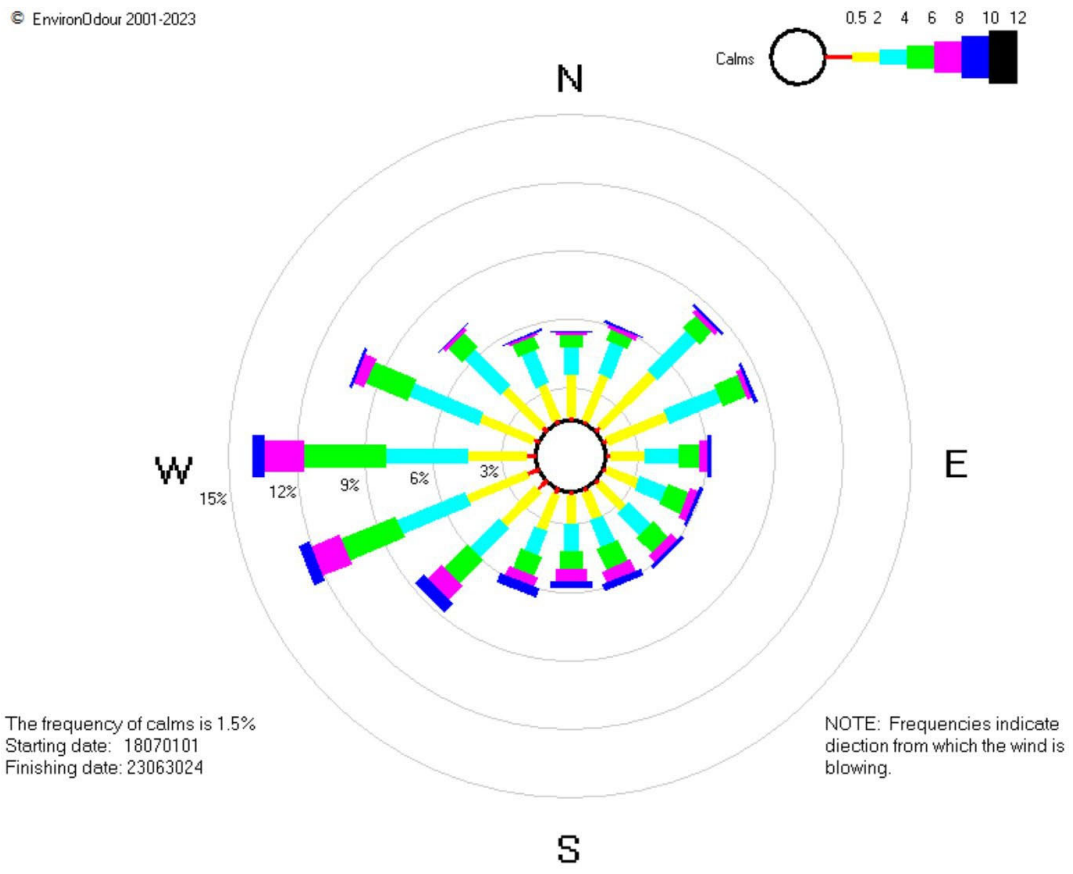


Figure 9 Wind rose for meteorological data at Broken Hill airport (July 2018 – June 2023)

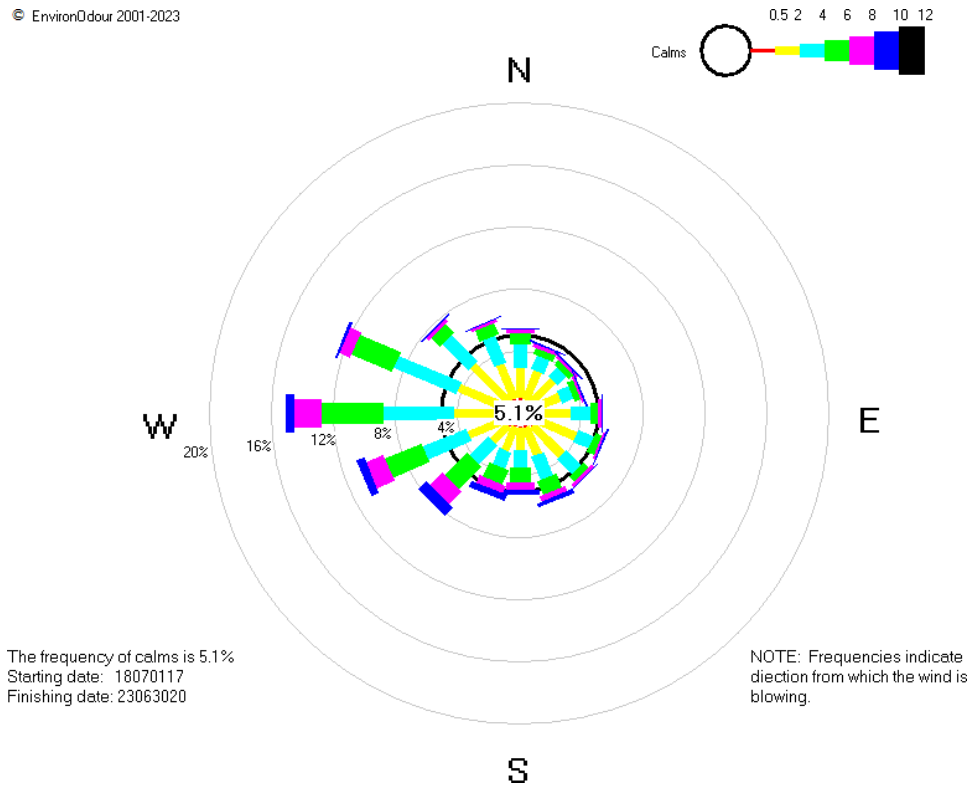


Figure 10 Windrose for 17:00 – 20:00

6.3 Odour impact assessment

The site's existing operation was modelled and the result was used as a benchmark. The four additional design scenarios were also modelled:

- Scenario 1: Sludge lagoons with expansion of existing drying beds
- Scenario 2: Sludge lagoons with all new drying beds to the west
- Scenario 3: Aerobic digestion and mechanical dewatering
- Scenario 4: Sludge lagoons with expansion of larger existing drying beds will be (5-smaller lagoons instead of the existing 3).

6.3.1 Odour impact from the existing STP

The shapes and dimensions of these odour emission sources, SOERs and TOERs are displayed in Table 7. Odour impact from the existing STPs is shown in Figure 11. The sensitive receptor is shown in the east (marked as a blue plus sign). The odour impact area (in red) is located within the property boundary.

The Ausplume configuration file is listed in Appendix 4.

Table 7 Summary of odour emission rates

No	Description	Elevation	Length/ Diameter	width	Area	SOER	TOER
		m	m	m	m^2	OU/m^2s	OU/s
1	Inlet channel	1	6	0.6	3.6	22.7	82
2	Inlet channel		40	0.6	24	22.7	544
3	Primary Sedimentation Tank 1	1	17.5		240	5.6	1336
4	Primary Sedimentation Tank 2	1	10	10	100	5.6	556
5	Primary Sedimentation Tank 3	1	10	10	100	5.6	556
6	Trickling filter 1	1	30		707	0.40	283
7	Trickling filter 2	1	30		707	0.40	283
8	Trickling filter 3	1	30		707	0.40	283
9	Humus Tank	1	16		201	0.41	83
10	Sludge digester 1	1	10		79	0.97	76
11	Sludge digester 2	1	10		79	0.97	76
12	Sludge digester 3	1	10		79	0.97	76
13	Sludge digester 4	1	10		79	0.97	76
14	Sludge drying bed	0	60	60	3600	0.06	222
15	Maturation pond	0	135	290	39150	0.04	1566
Total Odour Emission Rate							6098

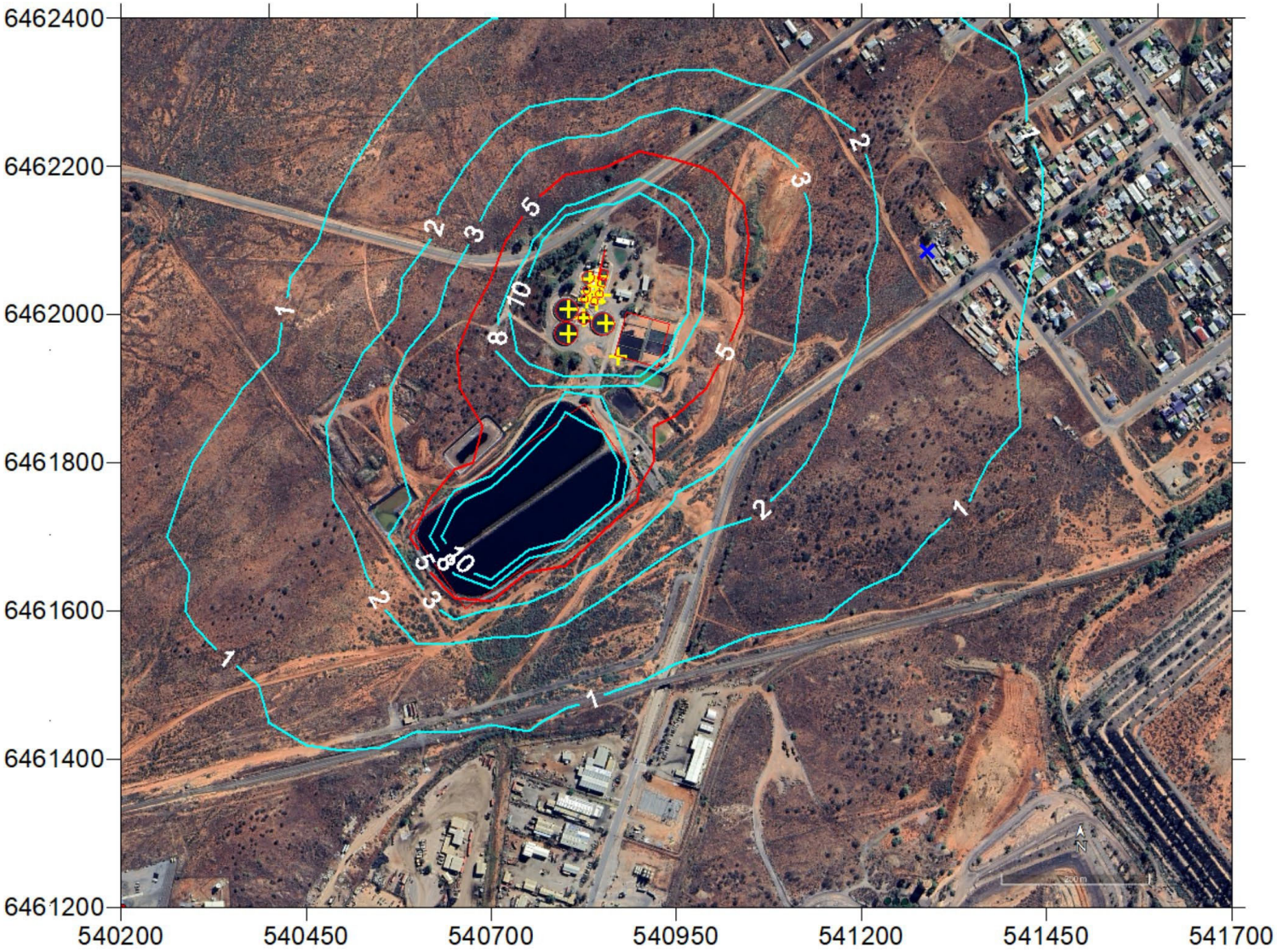


Figure 11 Odour impact from existing plant

A review of odour complaints associated with the existing STP, provided by Essential Energy was undertaken. With the exception of a defined period over the summer of 2021/22, when operational deficiencies with the existing drying beds led to offsite odour complaints, no historical odour complaints associated with the STP were identified. Apart from this one defined event, the lack of historical odour complaints is supported by the modelling undertaken for the existing STP, which shows odour concentrations less than 5 OU/m^3 at the closest sensitive receiver, which is generally consistent with no detectable odour.

6.3.2 Odour impact for scenario 1

Odour impact from the proposed STPs in scenario 1 is shown in Figure 12. The odour impact area (in red) is overlayed above the processing units. The sensitive receptor is shown in the east (marked by a blue plus sign).

The Ausplume configuration file is listed in Appendix 5.

Table 8 Summary of odour emission (Scenario 1)

No	Description	Elevation	Length/ Diameter	width	Area	SOER	TOER
		m	m	m	m^2	OU/m^2s	OU/s
1	IDEAT (x2)	4	68	36	2448	0.50	1224
2	Balance Tank	4	36	20	720	0.50	360
3	Soil bed	0.5	20	12	240	1.0	240
4	Sludge Lagoon 1	0	53	53	2809	0.41	1152
5	Sludge Lagoon 2	0	53	53	2809	0.41	1152
6	Sludge Lagoon 3	0	53	53	2809	0.41	1152
7	Biomass pans	0	66	15	990	0.06	61
8	Sludge Beds (existing x8)	0	60	60	3600	0.06	222
9	Sludge beds (new x3)	0	45	30	1350	0.06	83
Total Odour Emission Rate							5646

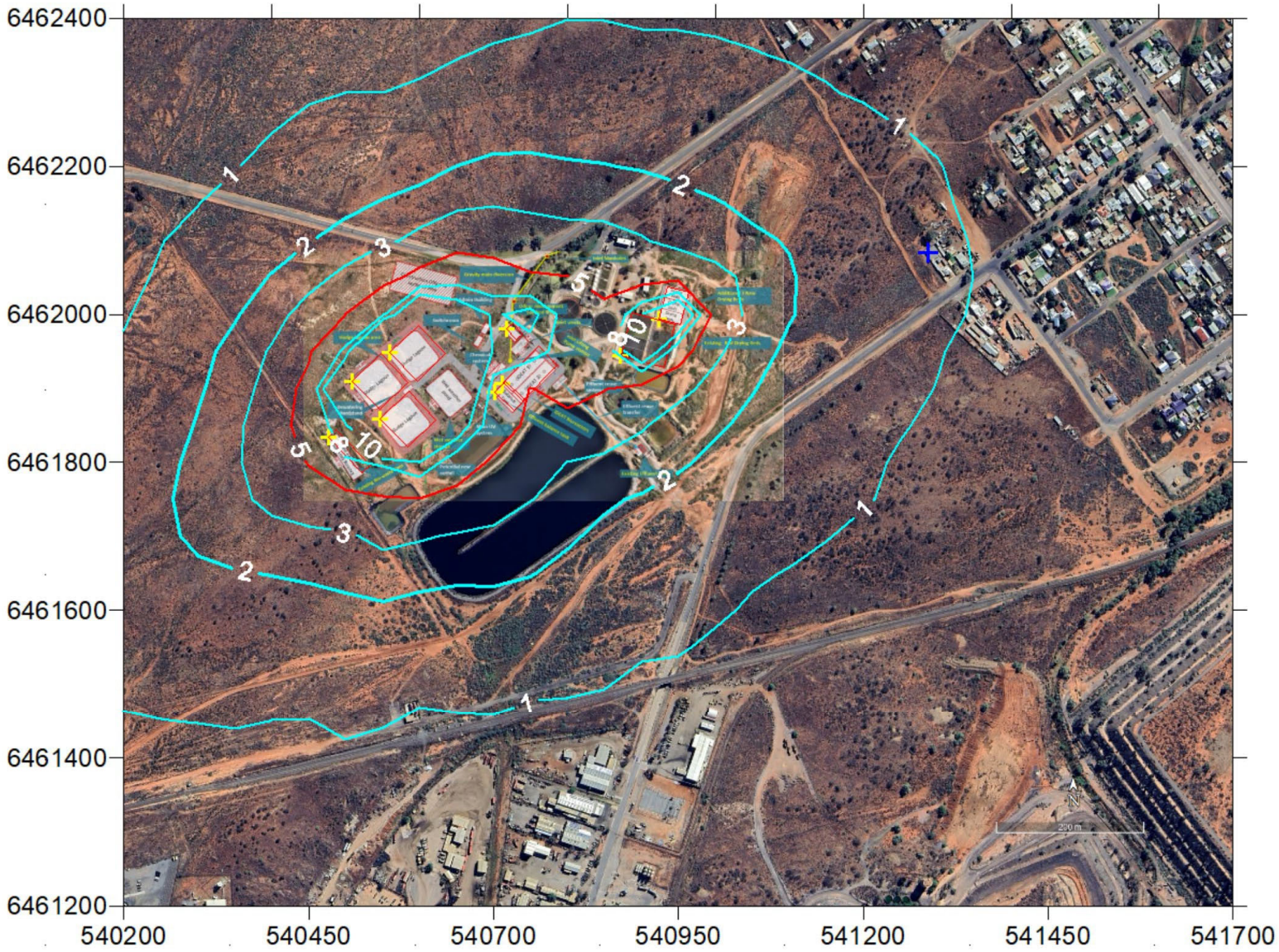


Figure 12 Odour concentration contour for scenario 1

6.3.3 Odour impact for Scenario 2

The odour impact from the proposed STPs in scenario 2 has been modelled using the odour emission data collected from the site. Figure 13 shows the odour impact area (in red) is within the property boundary. The sensitive receptor is shown in the east (marked by a blue plus sign).

The Ausplume configuration file is listed in Appendix 6.

Table 9 Summary of odour emission (Scenario 2)

No	Description	Elevation	Length/ Diameter	width	Area	SOER	TOER
		m	m	m	m^2	$OU/m^2 s$	OU/s
1	IDEAT (x2)	4	68	36	2448	0.5	1224
2	Balance Tank	4	36	20	720	0.5	360
3	Soil bed	0.5	20	12	240	1.00	240
4	Sludge Lagoon 1	0	53	53	2809	0.41	1152
5	Sludge Lagoon 2	0	53	53	2809	0.41	1152
6	Sludge Lagoon 3	0	53	53	2809	0.41	1152
7	Biomass pans	0	66	15	990	0.06	61
8	Sludge drying beds (x12)	0	100	65	6500	0.06	401
Total Odour Emission Rate							5741

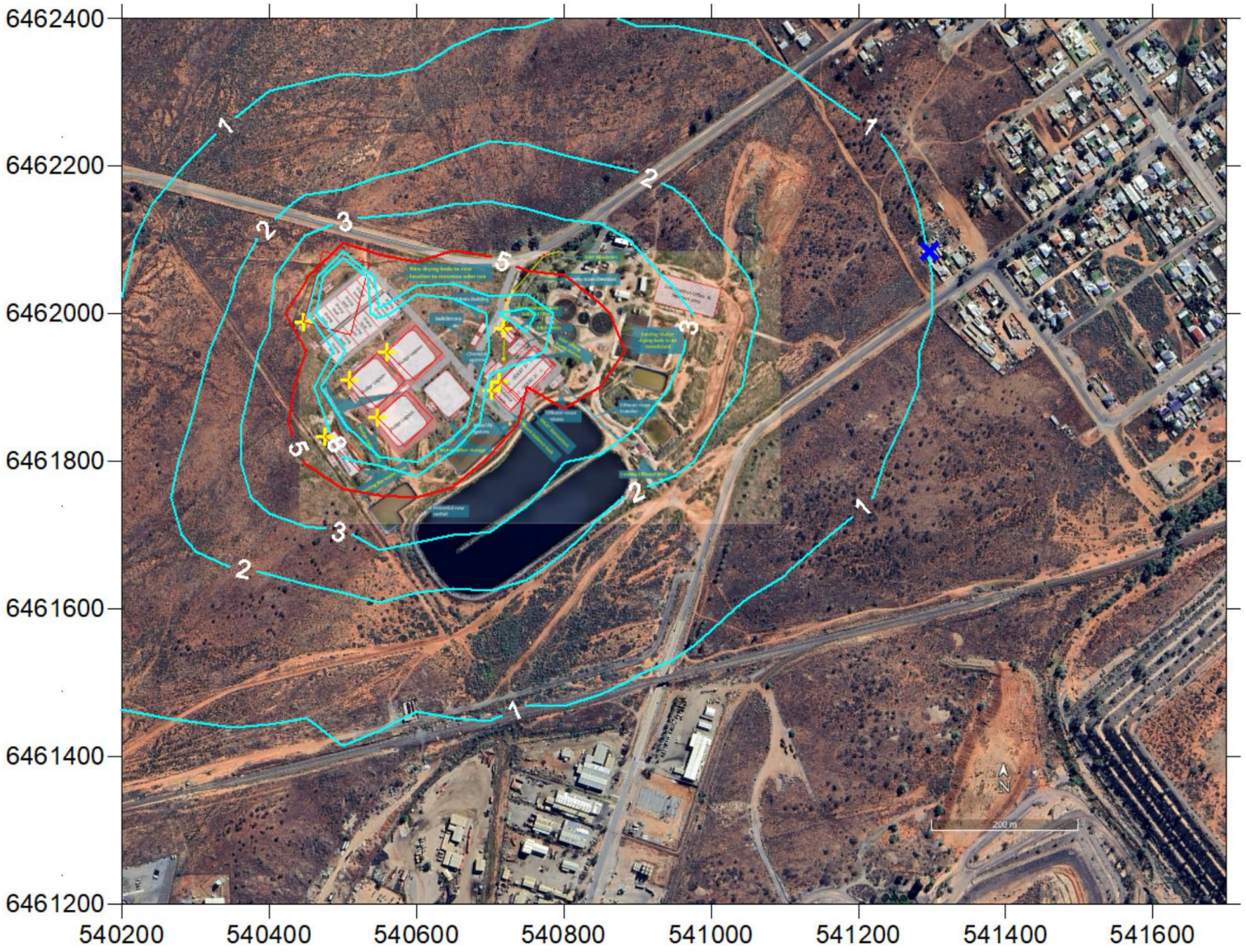


Figure 13 Odour concentration contour for scenario 2

6.3.4 Odour impact for Scenario 3

The odour impact from the proposed STPs in scenario 3 has been modelled using the odour emission data collected from the site. Figure 14 shows the odour impact area (in red) is within the property boundary. The sensitive receptor is shown in the east (marked by a blue plus sign).

The odour concentration for the building source is assumed to be 500 OU/m^3. The air exchange rate of the building is assumed to be 5 times per hour.

The Ausplume configuration file is listed in Appendix 7.

Table 10 Summary of odour emission (Scenario 3)

No	Description	Elevation	Length/ Diameter	width	Area	SOER	TOER
		m	m	m	m^2	OU/m^2s	OU/s
1	IDEAT (x2)	4	68	36	2448	0.5	1224
2	Balance Tank	4	36	20	720	0.5	360
3	Soil bed	0.5	20	12	240	1.00	240
4	Sludge thickener	1	9.5		71	0.97	69
5	Aerobic digester	1	25		491	0.97	477
6	Sludge dewatering building	5	12	8	96	5	333
7	Biomass pans	0	66	15	990	0.06	59
Total Odour Emission Rate							2762

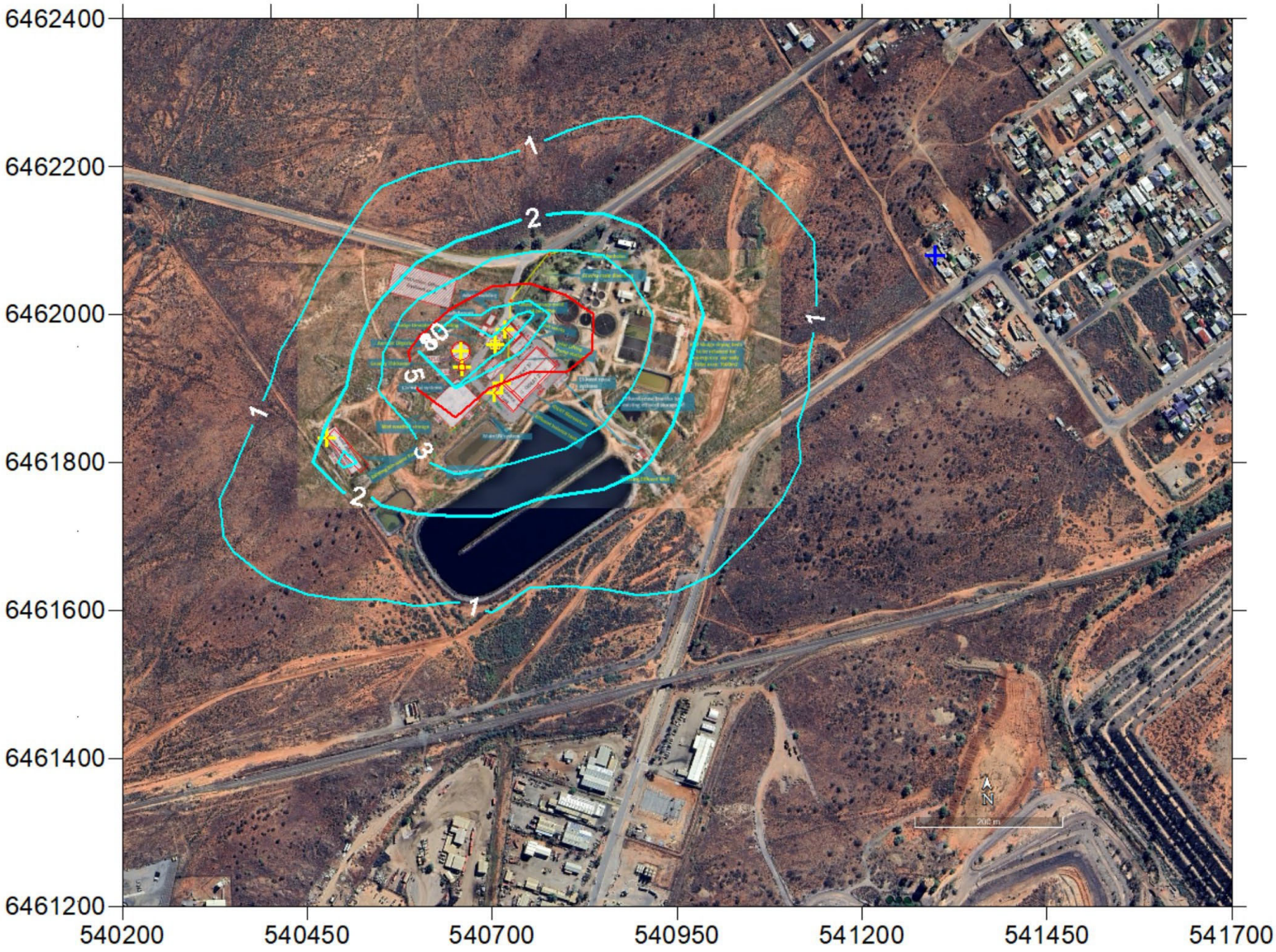


Figure 14 Odour concentration contour for scenario 3

6.3.5 Odour impact for Scenario 4

The odour impact from the proposed STPs in scenario 4 has been modelled using the odour emission data collected from the site. Figure 15 shows the odour impact area (in red) is within the property boundary.

The Ausplume configuration file is listed in Appendix 8.

Table 11 Summary of odour emission (Scenario 4)

No	Description	Elevation	Length/ Diameter	width	Area	SOER	TOER
		m	m	m	m^2	OU/m^2s	OU/s
1	IDEAT (x2)	4	68	36	2448	0.50	1224
2	Balance Tank	4	36	20	720	0.50	360
3	Soil bed	0.5	20	12	240	1.0	240
4	Sludge Lagoon 1	0	39.5	39.5	1560	0.41	640
5	Sludge Lagoon 2	0	39.5	39.5	1560	0.41	640
6	Sludge Lagoon 3	0	39.5	39.5	1560	0.41	640
7	Sludge Lagoon 4	0	39.5	39.5	1560	0.41	640
8	Sludge Lagoon 5	0	39.5	39.5	1560	0.41	640
9	Biomass pans	0	66	15	990	0.06	59
Total Odour Emission Rate							5082

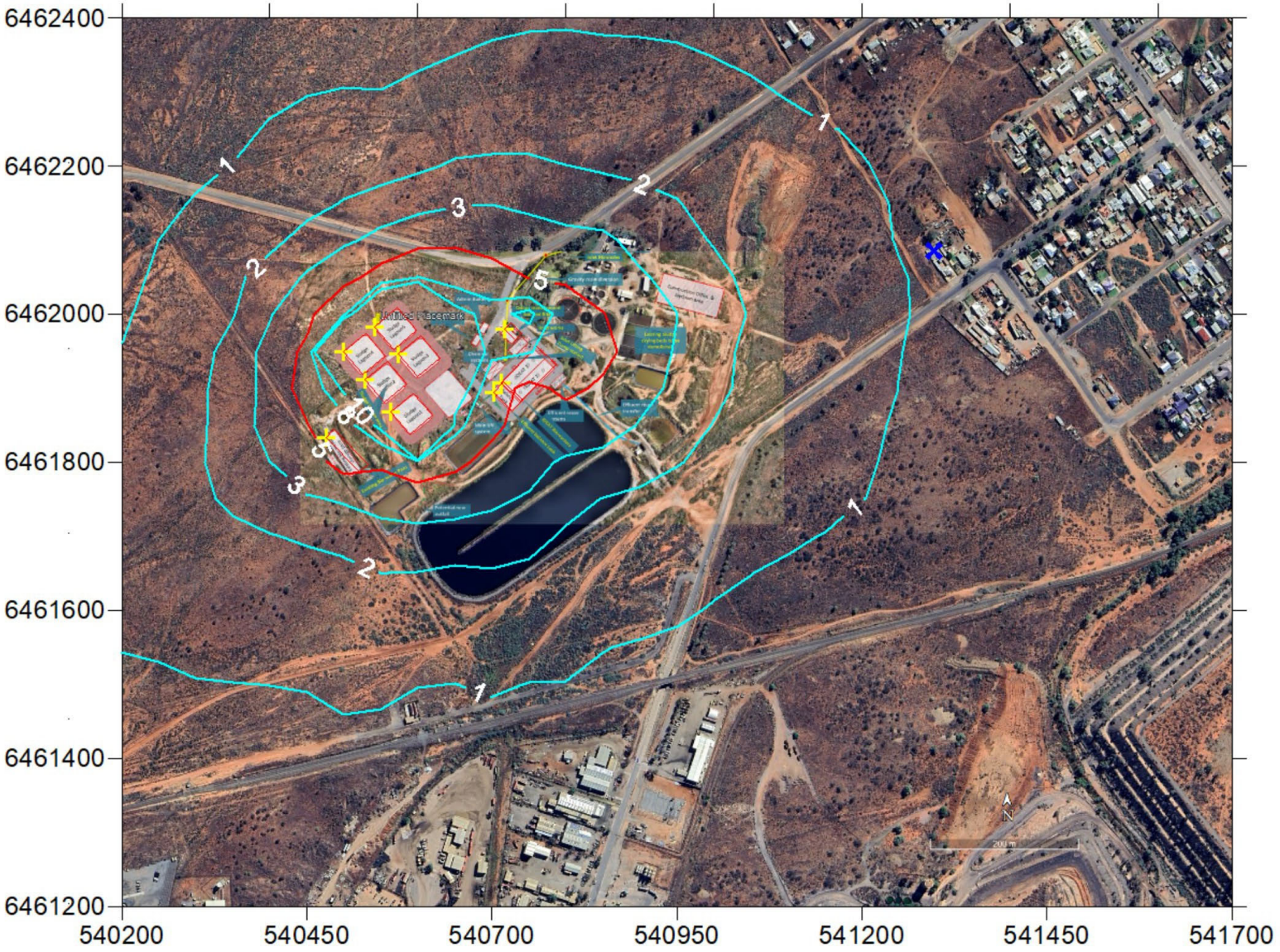


Figure 15 Odour concentration contour for scenario 4

7 Conclusions

Odour emissions were sampled using isolation flux chamber at the Wills Sewage Treatment Plant at Broken Hill, NSW. The odour samples were analysed for odour concentrations to prepare the odour emission rates for Ausplume odour dispersion modelling.

The meteorological data at Broken Hill airport, supplied by the Bureau of Meteorology, was formatted for Ausplume requirements. The meteorological data confirms a calm condition (1.5%) at the site. The analysis of the meteorological data confirmed the wind pattern around the site with westerly breeze in the afternoon.

The odour impact from the site was modelled using the nearby airport meteorological data. The odour performance criteria were selected as 5 OU/m^3.

The odour impact area for the existing plant is within the property boundary. In normal operational conditions, all scenarios comply with NSW EPA odour performance criteria of 5 OU/m^3. Scenario 3 design has the less impact distance.

8 References

Standards Australia (1995) Australian standard AS 4323.1 Stationary source emissions, method 1: selection of sampling positions, Sydney Australia.

Standards Australia (2001) Australian/New Zealand Standard AS/NZS 4323.3:2001, Stationary source emissions – Part 3: Determination of odour concentration by dynamic olfactometry, Sydney, Australia.

Standard Australia (2009) Australian/New Zealand Standard AS/NZS 4323.4:2009 Stationary source emissions Area source sampling - Flux chamber technique (Reconfirmed 2020)

NSW Environment Protection Authority, Approved methods - for the Modelling and Assessment of Air Pollutants in New South Wales, Department of Environment & Climate Change, August 2005

NSW Environment Protection Authority, Approved methods for the sampling and analysis of air pollutants in New South Wales, 2000

NSW Environment Protection Authority, Technical framework Assessment and management of odour from stationary sources in NSW, Department of Environment & Climate Change, November, 2006

Appendix 1. Olfactometry testing report

Environodour AUSTRALIA PTY LTD

We make scents of odour

EnvironOdour Australia Pty Ltd ABN: 83 003 175 705 ACN: 103 510 685 Email: admin@environodour.com.au

Odour Testing Report (Odour Concentration)

Client: Essential Energy **Job No:** EJ515 **Session:** S230728-1 **Testing Date:** Fri, 28 Jul 2023

Odour testing was carried out using the DynaScent digital dynamic olfactometer and fully complies with Australia Standard AS/NZS4323.3:2001. The olfactometer was calibrated against mass flow on 22/1/2023 Odour Concentration (OC) was calculated using a retrospective screening procedure and based upon 'certain and correct' criteria. Pre-Dilution Ratio (PDR) has been applied to the results (if applicable).

The butanol threshold for the current session is 0 ppb. The butanol threshold for the past ten sessions is 29 ppb. The sensory performance criteria is between 20-80 ppb. The precision of the laboratory is 1.636 (< 0.477). The accuracy of the laboratory is 0.259 (< 0.217).

Sample ID	Test ID	Source	Collecting Date and Time	Testing date and time	PDR	OC (OU/m^3)
6517	103118	Trickling filter	27/07/2023 07:50	28/07/2023 10:48	1.0	185
6518	103119	Sludge drying bed	27/07/2023 08:40	28/07/2023 10:55	1.0	93
6519	103120	Digester	27/07/2023 09:30	28/07/2023 11:11	1.0	1465
6520	103121	Humus tank	27/07/2023 10:10	28/07/2023 11:22	1.0	622
6521	103122	Primary sedimentation tank	27/07/2023 10:45	28/07/2023 11:35	1.0	8379
6522	103123	Inlet channel	27/07/2023 11:15	28/07/2023 11:51	1.0	34184
Butanol	B2307281	B-20221	28/07/2023 10:35	28/07/2023 10:35	1.0	1451

(The following space is intentionally left empty.)

Comments:

Issued by: _____ Date: _____

Printed on Monday, 31 July 2023

Page 1 of 1

Appendix 2. Site photos

Figure 16 Drying bed

Figure 17 Trickling filter

Figure 18 Sludge digester

Figure 19 Primary sedimentation tank

Figure 20 Inlet channel

Appendix 3. Analysis of meteorological data

Table 12 Frequency distribution of atmospheric stability class versus wind direction

WD \ AS	A	B	C	D	E	F	Sum
N	0.1%	0.3%	0.3%	1.8%	1.1%	0.3%	4.0%
NNE	0.1%	0.2%	0.2%	2.1%	1.6%	0.3%	4.5%
NE	0.1%	0.2%	0.2%	3.5%	2.5%	0.6%	7.1%
ENE	0.1%	0.2%	0.3%	3.7%	2.2%	0.4%	6.9%
E	0.1%	0.2%	0.3%	3.1%	0.6%	0.3%	4.6%
ESE	0.1%	0.2%	0.6%	2.7%	0.5%	0.2%	4.4%
SE	0.1%	0.2%	0.7%	2.7%	0.5%	0.3%	4.5%
SSE	0.1%	0.2%	0.6%	2.8%	0.7%	0.2%	4.6%
S	0.1%	0.2%	0.4%	2.6%	0.6%	0.3%	4.3%
SSW	0.1%	0.2%	0.5%	2.8%	0.8%	0.5%	4.9%
SW	0.2%	0.3%	0.7%	4.5%	1.2%	0.6%	7.4%
WSW	0.2%	0.4%	1.0%	7.3%	1.8%	0.6%	11.2%
W	0.2%	0.4%	1.5%	8.4%	1.7%	0.4%	12.6%
WNW	0.1%	0.4%	1.2%	4.4%	2.2%	0.4%	8.7%
NW	0.1%	0.3%	0.7%	2.6%	1.8%	0.4%	6.0%
NNW	0.1%	0.2%	0.4%	1.9%	1.2%	0.3%	4.2%
Sum	2.0%	4.2%	9.8%	56.9%	21.1%	6.0%	100.0%

Table 13 Frequency distribution of atmospheric stability class versus wind speed

WS \ AS	A	B	C	D	E	F	Sum
< 0.5	0.0%	0.0%	0.0%	0.5%	0.2%	1.1%	1.8%
1.54	0.1%	0.0%	0.0%	0.4%	0.3%	0.6%	1.4%
3.09	1.9%	0.7%	0.0%	5.6%	5.0%	4.3%	17.6%
5.14	0.0%	3.4%	3.3%	15.6%	15.6%	0.0%	37.8%
8.23	0.0%	0.0%	5.7%	26.3%	0.0%	0.0%	32.0%
10.5	0.0%	0.0%	0.8%	6.9%	0.0%	0.0%	7.7%
> 10.8	0.0%	0.0%	0.0%	1.7%	0.0%	0.0%	1.7%
Sum	0.8%	1.5%	2.7%	19.7%	9.0%	2.3%	100.0%

Table 14 Frequency distribution of atmospheric stability class versus time of day

Time \ AS	A	B	C	D	E	F	Sum
1-2	0.0%	0.0%	0.0%	3.3%	3.9%	1.1%	8.3%
3-4	0.0%	0.0%	0.0%	3.4%	3.8%	1.2%	8.3%
5-6	0.0%	0.0%	0.0%	5.7%	1.9%	0.7%	8.3%
7-8	0.1%	0.1%	0.0%	8.2%	0.0%	0.0%	8.3%
9-10	0.3%	0.4%	0.6%	7.1%	0.0%	0.0%	8.3%
11-12	0.6%	1.1%	2.6%	4.0%	0.0%	0.0%	8.3%
13-14	0.5%	1.2%	3.1%	3.5%	0.0%	0.0%	8.3%
15-16	0.3%	0.9%	2.4%	4.6%	0.0%	0.0%	8.3%
17-18	0.1%	0.4%	1.0%	6.8%	0.0%	0.0%	8.3%
19-20	0.0%	0.0%	0.0%	4.1%	3.4%	0.9%	8.3%
21-22	0.0%	0.0%	0.0%	3.1%	4.2%	1.1%	8.3%
23-24	0.0%	0.0%	0.0%	3.2%	4.0%	1.1%	8.3%
Sum	2.0%	4.2%	9.8%	56.9%	21.1%	6.0%	100.0%

Table 15 Frequency distribution of wind speed versus wind direction

WD \ WS	0	0 - 2	2 - 4	4 - 6	6 - 8	8 - 10	>10	Sum
N	0.18%	0.44%	2.58%	3.61%	3.56%	1.73%	0.53%	12.65%
NNE	0.1%	0.28%	2.5%	3.28%	1.99%	0.5%	0.08%	8.73%
NE	0.13%	0.26%	2.29%	2.23%	0.85%	0.18%	0.02%	5.95%
ENE	0.06%	0.18%	1.68%	1.53%	0.59%	0.12%	0.01%	4.16%
E	0.07%	0.21%	1.83%	1.21%	0.55%	0.1%	0.04%	4.02%
ESE	0.04%	0.13%	2.18%	1.45%	0.51%	0.18%	0.03%	4.53%
SE	0.08%	0.21%	3.3%	2.4%	0.79%	0.21%	0.07%	7.06%
SSE	0.04%	0.19%	2.81%	2.5%	1.08%	0.24%	0.09%	6.93%
S	0.05%	0.18%	1.52%	1.5%	0.92%	0.37%	0.11%	4.63%
SSW	0.04%	0.13%	1.47%	1.25%	0.99%	0.35%	0.11%	4.36%
SW	0.07%	0.19%	1.5%	1.36%	0.92%	0.43%	0.09%	4.55%
WSW	0.08%	0.18%	1.24%	1.26%	1.%	0.53%	0.27%	4.56%
W	0.09%	0.19%	1.29%	1.15%	0.8%	0.52%	0.26%	4.3%
WNW	0.12%	0.29%	1.65%	1.12%	0.9%	0.45%	0.37%	4.91%
NW	0.2%	0.53%	2.17%	1.75%	1.45%	0.82%	0.5%	7.43%
NNW	0.19%	0.54%	2.87%	3.2%	2.59%	1.35%	0.48%	11.23%
Sum	1.54%	4.13%	32.89%	30.8%	19.48%	8.08%	3.08%	100.%

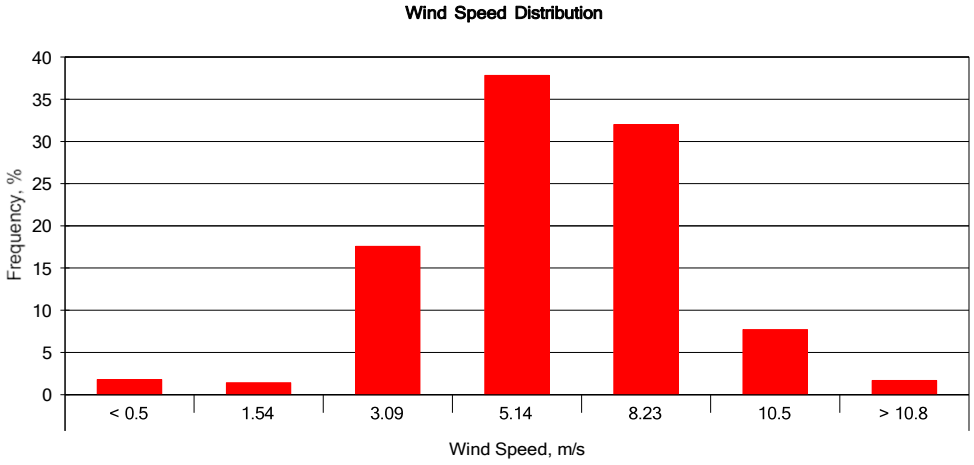


Figure 21 Wind speed distribution

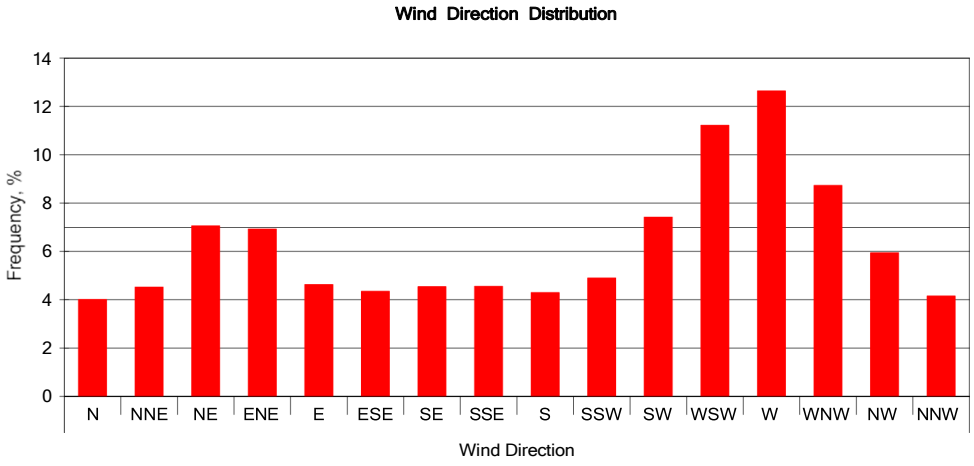


Figure 22 Wind direction distribution

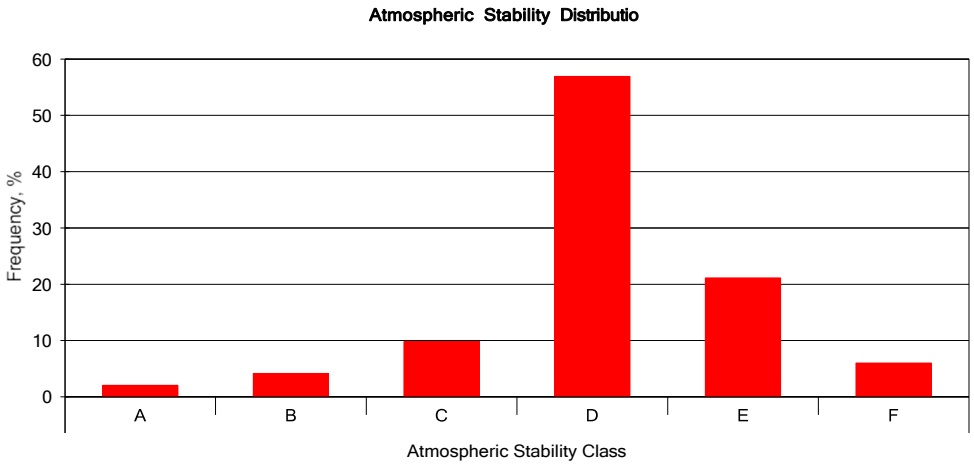


Figure 23 Atmospheric stability class distribution

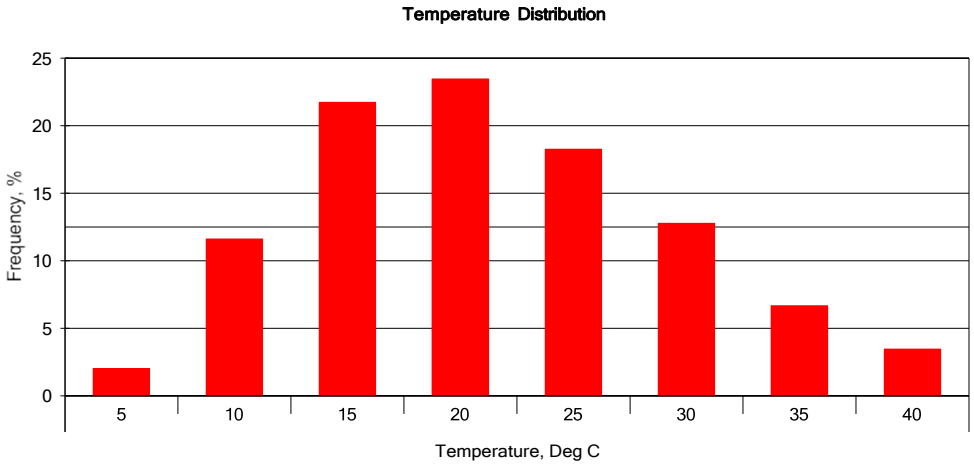


Figure 24 Ambient temperature distribution

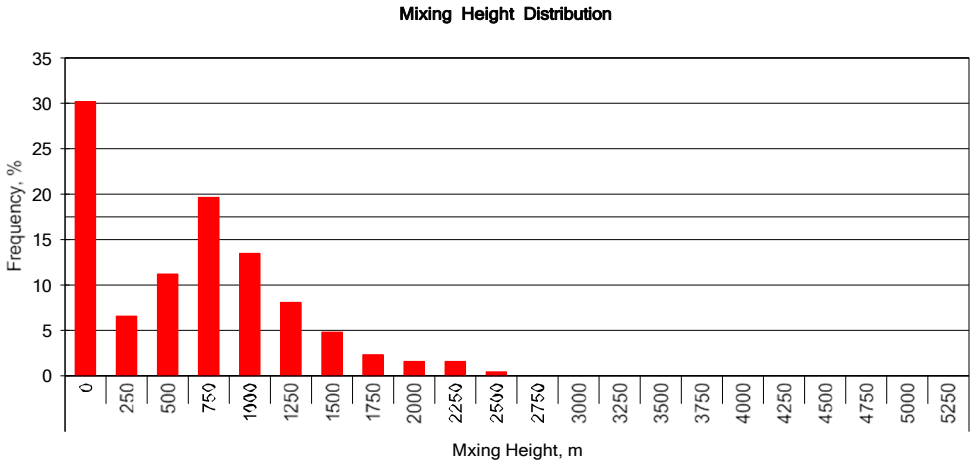


Figure 25 Mixing height distribution

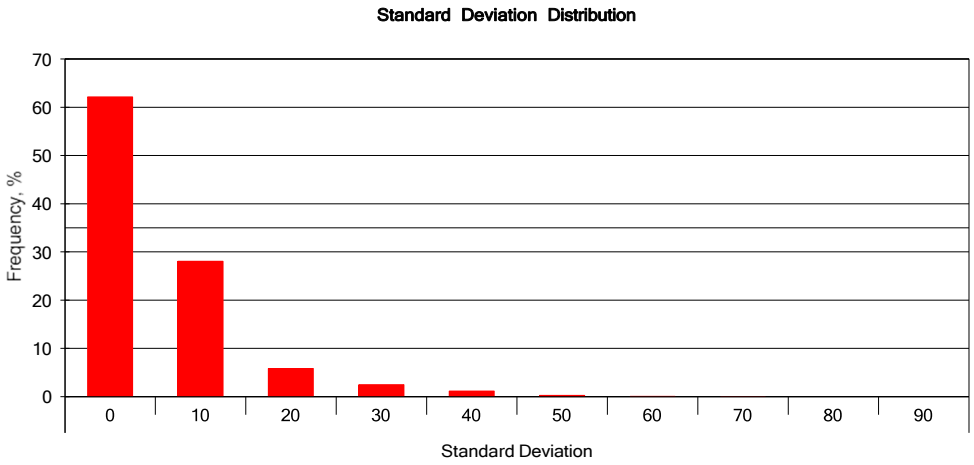


Figure 26 Sigma-Theta (wind direction standard deviation) distribution

Appendix 4. Ausplume configuration file (Existing)

1

Wills STP Existing

Concentration or deposition Concentration
Emission rate units OUV/second
Concentration units Odour_Units
Units conversion factor 1.00E+00
Constant background concentration 0.00E+00
Terrain effects None
Smooth stability class changes? No
Other stability class adjustments ("urban modes") None
Ignore building wake effects? Yes
Decay coefficient (unless overridden by met. file) 0.000
Anemometer height 10 m
Roughness height at the wind vane site 0.300 m
Use the convective PDF algorithm? No
Averaging time for sigma-theta values 60 min.

DISPERSION CURVES
Horizontal dispersion curves for sources <100m high Sigma-theta
Vertical dispersion curves for sources <100m high Pasquill-Gifford
Horizontal dispersion curves for sources >100m high Briggs Rural
Vertical dispersion curves for sources >100m high Briggs Rural
Enhance horizontal plume spreads for buoyancy? Yes
Enhance vertical plume spreads for buoyancy? Yes
Adjust horizontal P-G formulae for roughness height? Yes
Adjust vertical P-G formulae for roughness height? Yes
Roughness height 0.100m
Adjustment for wind directional shear None

PLUME RISE OPTIONS
Gradual plume rise? Yes
Stack-tip downwash included? Yes
Building downwash algorithm: PRIME method.
Entrainment coeff. for neutral & stable lapse rates 0.60,0.60
Partial penetration of elevated inversions? No
Disregard temp. gradients in the hourly met. file? No

and in the absence of boundary-layer potential temperature gradients
given by the hourly met. file, a value from the following table
(in K/m) is used:

Wind Speed Category	Stability Class A	B	C	D	E	F
1	0.000	0.000	0.000	0.000	0.020	0.035
2	0.000	0.000	0.000	0.000	0.020	0.035
3	0.000	0.000	0.000	0.000	0.020	0.035
4	0.000	0.000	0.000	0.000	0.020	0.035
5	0.000	0.000	0.000	0.000	0.020	0.035
6	0.000	0.000	0.000	0.000	0.020	0.035

WIND SPEED CATEGORIES
Boundaries between categories (in m/s) are: 1.54, 3.09, 5.14, 8.23, 10.80

WIND PROFILE EXPONENTS: "Irwin Urban" values (unless overridden by met. file)

AVERAGING TIMES
1 hour

1

Wills STP Existing

SOURCE CHARACTERISTICS

INTEGRATED AREA SOURCE: 21

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540713	6461908	0m	36m	68m	44deg	1m	4m

(Constant) emission rate = 1.25E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 22

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540702	6461895	0m	36m	20m	44deg	1m	4m

(Constant) emission rate = 1.25E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 31

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540717	6461980	0m	20m	12m	46deg	0m	1m

(Constant) emission rate = 2.50E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 41

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540509	6461910	0m	53m	53m	46deg	0m	0m

(Constant) emission rate = 1.00E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 42

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540560	6461948	0m	53m	53m	46deg	0m	0m

(Constant) emission rate = 1.00E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 43

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540547	6461859	0m	53m	53m	46deg	0m	0m

(Constant) emission rate = 1.00E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 51

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540476	6461834	0m	66m	15m	46deg	0m	0m

(Constant) emission rate = 1.50E-01 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 61

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540872	6461944	0m	60m	60m	15deg	0m	0m

(Constant) emission rate = 1.50E-01 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 71

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540924	6461994	0m	30m	45m	15deg	0m	0m

(Constant) emission rate = 1.50E-01 OUV/second per square metre
No gravitational settling or scavenging.

1

Wills STP Existing

RECEPTOR LOCATIONS

The Cartesian receptor grid has the following x-values (or eastings):
540200.m 540250.m 540300.m 540350.m 540400.m 540450.m 540500.m
540550.m 540600.m 540650.m 540700.m 540750.m 540800.m 540850.m
540900.m 540950.m 541000.m 541050.m 541100.m 541150.m 541200.m
541250.m 541300.m 541350.m 541400.m 541450.m 541500.m 541550.m
541600.m 541650.m 541700.m

and these y-values (or northings):
6461200.m 6461250.m 6461300.m 6461350.m 6461400.m 6461450.m 6461500.m
6461550.m 6461600.m 6461650.m 6461700.m 6461750.m 6461800.m 6461850.m
6461900.m 6461950.m 6462000.m 6462050.m 6462100.m 6462150.m 6462200.m
6462250.m 6462300.m 6462350.m 6462400.m

DISCRETE RECEPTOR LOCATIONS (in metres)

No.	X	Y	ELEVN	HEIGHT	No.	X	Y	ELEVN	HEIGHT
1	540712	6461907	0.0	0.0	6	540547	6461859	0.0	0.0
2	540702	6461895	0.0	0.0	7	540476	6461834	0.0	0.0
3	540717	6461980	0.0	0.0	8	540871	6461944	0.0	0.0
4	540509	6461910	0.0	0.0	9	540924	6461994	0.0	0.0
5	540560	6461948	0.0	0.0	10	541287	6462084	0.0	0.0

METEOROLOGICAL DATA : st,047048,47 ,BROKEN HILL AIRPORT AWS,01/1947,

Appendix 5. Ausplume configuration file (Scenario 1)

1

Wills STP Scenario 1

Concentration or deposition	Concentration
Emission rate units	OUV/second
Concentration units	Odour_Units
Units conversion factor	1.00E+00
Constant background concentration	0.00E+00
Terrain effects	None
Smooth stability class changes?	No
Other stability class adjustments ("urban modes")	None
Ignore building wake effects?	Yes
Decay coefficient (unless overridden by met. file)	0.000
Anemometer height	10 m
Roughness height at the wind vane site	0.300 m
Use the convective PDF algorithm?	No
Averaging time for sigma-theta values	60 min.

DISPERSION CURVES

Horizontal dispersion curves for sources <100m high	Sigma-theta
Vertical dispersion curves for sources <100m high	Pasquill-Gifford
Horizontal dispersion curves for sources >100m high	Briggs Rural
Vertical dispersion curves for sources >100m high	Briggs Rural
Enhance horizontal plume spreads for buoyancy?	Yes
Enhance vertical plume spreads for buoyancy?	Yes
Adjust horizontal P-G formulae for roughness height?	Yes
Adjust vertical P-G formulae for roughness height?	Yes
Roughness height	0.100m
Adjustment for wind directional shear	None

PLUME RISE OPTIONS

Gradual plume rise?	Yes
Stack-tip downwash included?	Yes
Building downwash algorithm:	PRIME method.
Entrainment coeff. for neutral & stable lapse rates	0.60,0.60
Partial penetration of elevated inversions?	No
Disregard temp. gradients in the hourly met. file?	No

and in the absence of boundary-layer potential temperature gradients
given by the hourly met. file, a value from the following table
(in K/m) is used:

Wind Speed Category	Stability Class A	B	C	D	E	F
1	0.000	0.000	0.000	0.000	0.020	0.035
2	0.000	0.000	0.000	0.000	0.020	0.035
3	0.000	0.000	0.000	0.000	0.020	0.035
4	0.000	0.000	0.000	0.000	0.020	0.035
5	0.000	0.000	0.000	0.000	0.020	0.035
6	0.000	0.000	0.000	0.000	0.020	0.035

WIND SPEED CATEGORIES
Boundaries between categories (in m/s) are: 1.54, 3.09, 5.14, 8.23, 10.80

WIND PROFILE EXPONENTS: "Irwin Urban" values (unless overridden by met. file)

AVERAGING TIMES
1 hour

1

Wills STP Scenario 1

SOURCE CHARACTERISTICS

INTEGRATED AREA SOURCE: 21

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540713	6461908	0m	36m	68m	44deg	1m	4m

(Constant) emission rate = 1.25E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 22

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540702	6461895	0m	36m	20m	44deg	1m	4m

(Constant) emission rate = 1.25E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 31

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540717	6461980	0m	20m	12m	46deg	0m	1m

(Constant) emission rate = 2.50E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 41

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540509	6461910	0m	53m	53m	46deg	0m	0m

(Constant) emission rate = 1.00E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 42

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540560	6461948	0m	53m	53m	46deg	0m	0m

(Constant) emission rate = 1.00E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 43

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540547	6461859	0m	53m	53m	46deg	0m	0m

(Constant) emission rate = 1.00E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 51

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540476	6461834	0m	66m	15m	46deg	0m	0m

(Constant) emission rate = 1.50E-01 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 61

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540872	6461944	0m	60m	60m	15deg	0m	0m

(Constant) emission rate = 1.50E-01 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 71

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540924	6461994	0m	30m	45m	15deg	0m	0m

(Constant) emission rate = 1.50E-01 OUV/second per square metre
No gravitational settling or scavenging.

1

Wills STP Scenario 1

RECEPTOR LOCATIONS

The Cartesian receptor grid has the following x-values (or eastings):
540200.m 540250.m 540300.m 540350.m 540400.m 540450.m 540500.m
540550.m 540600.m 540650.m 540700.m 540750.m 540800.m 540850.m
540900.m 540950.m 541000.m 541050.m 541100.m 541150.m 541200.m
541250.m 541300.m 541350.m 541400.m 541450.m 541500.m 541550.m
541600.m 541650.m 541700.m

and these y-values (or northings):
6461200.m 6461250.m 6461300.m 6461350.m 6461400.m 6461450.m 6461500.m
6461550.m 6461600.m 6461650.m 6461700.m 6461750.m 6461800.m 6461850.m
6461900.m 6461950.m 6462000.m 6462050.m 6462100.m 6462150.m 6462200.m
6462250.m 6462300.m 6462350.m 6462400.m

DISCRETE RECEPTOR LOCATIONS (in metres)

No.	X	Y	ELEVN	HEIGHT	No.	X	Y	ELEVN	HEIGHT
1	540712	6461907	0.0	0.0	6	540547	6461859	0.0	0.0
2	540702	6461895	0.0	0.0	7	540476	6461834	0.0	0.0
3	540717	6461980	0.0	0.0	8	540871	6461944	0.0	0.0
4	540509	6461910	0.0	0.0	9	540924	6461994	0.0	0.0
5	540560	6461948	0.0	0.0	10	541287	6462084	0.0	0.0

METEOROLOGICAL DATA : st,047048,47 ,BROKEN HILL AIRPORT AWS,01/1947,

Appendix 6. Ausplume configuration file (Scenario 2)

1

Wills STP Scenario 2

Concentration or deposition	Concentration
Emission rate units	OUV/second
Concentration units	Odour_Units
Units conversion factor	1.00E+00
Constant background concentration	0.00E+00
Terrain effects	None
Smooth stability class changes?	No
Other stability class adjustments ("urban modes")	None
Ignore building wake effects?	Yes
Decay coefficient (unless overridden by met. file)	0.000
Anemometer height	10 m
Roughness height at the wind vane site	0.300 m
Use the convective PDF algorithm?	No
Averaging time for sigma-theta values	60 min.

DISPERSION CURVES

Horizontal dispersion curves for sources <100m high	Sigma-theta
Vertical dispersion curves for sources <100m high	Pasquill-Gifford
Horizontal dispersion curves for sources >100m high	Briggs Rural
Vertical dispersion curves for sources >100m high	Briggs Rural
Enhance horizontal plume spreads for buoyancy?	Yes
Enhance vertical plume spreads for buoyancy?	Yes
Adjust horizontal P-G formulae for roughness height?	Yes
Adjust vertical P-G formulae for roughness height?	Yes
Roughness height	0.100m
Adjustment for wind directional shear	None

PLUME RISE OPTIONS

Gradual plume rise?	Yes
Stack-tip downwash included?	Yes
Building downwash algorithm:	PRIME method.
Entrainment coeff. for neutral & stable lapse rates	0.60,0.60
Partial penetration of elevated inversions?	No
Disregard temp. gradients in the hourly met. file?	No

and in the absence of boundary-layer potential temperature gradients
given by the hourly met. file, a value from the following table
(in K/m) is used:

Wind Speed Category	Stability Class A	B	C	D	E	F
1	0.000	0.000	0.000	0.000	0.020	0.035
2	0.000	0.000	0.000	0.000	0.020	0.035
3	0.000	0.000	0.000	0.000	0.020	0.035
4	0.000	0.000	0.000	0.000	0.020	0.035
5	0.000	0.000	0.000	0.000	0.020	0.035
6	0.000	0.000	0.000	0.000	0.020	0.035

WIND SPEED CATEGORIES
Boundaries between categories (in m/s) are: 1.54, 3.09, 5.14, 8.23, 10.80

WIND PROFILE EXPONENTS: "Irwin Urban" values (unless overridden by met. file)

AVERAGING TIMES
1 hour

1

Wills STP Scenario 2

SOURCE CHARACTERISTICS

INTEGRATED AREA SOURCE: 21

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540713	6461908	0m	36m	68m	44deg	1m	4m

(Constant) emission rate = 1.25E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 22

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540702	6461895	0m	36m	20m	44deg	1m	4m

(Constant) emission rate = 1.25E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 31

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540717	6461980	0m	20m	12m	46deg	0m	1m

(Constant) emission rate = 2.50E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 41

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540509	6461910	0m	53m	53m	46deg	0m	0m

(Constant) emission rate = 1.00E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 42

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540560	6461948	0m	53m	53m	46deg	0m	0m

(Constant) emission rate = 1.00E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 43

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540547	6461859	0m	53m	53m	46deg	0m	0m

(Constant) emission rate = 1.00E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 51

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540476	6461834	0m	66m	15m	46deg	0m	0m

(Constant) emission rate = 1.50E-01 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 61

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540447	6461988	0m	65m	100m	15deg	0m	0m

(Constant) emission rate = 1.50E-01 OUV/second per square metre
No gravitational settling or scavenging.

1

Wills STP Scenario 2

RECEPTOR LOCATIONS

The Cartesian receptor grid has the following x-values (or eastings):
540200.m 540250.m 540300.m 540350.m 540400.m 540450.m 540500.m
540550.m 540600.m 540650.m 540700.m 540750.m 540800.m 540850.m
540900.m 540950.m 541000.m 541050.m 541100.m 541150.m 541200.m
541250.m 541300.m 541350.m 541400.m 541450.m 541500.m 541550.m
541600.m 541650.m 541700.m

and these y-values (or northings):
6461200.m 6461250.m 6461300.m 6461350.m 6461400.m 6461450.m 6461500.m
6461550.m 6461600.m 6461650.m 6461700.m 6461750.m 6461800.m 6461850.m
6461900.m 6461950.m 6462000.m 6462050.m 6462100.m 6462150.m 6462200.m
6462250.m 6462300.m 6462350.m 6462400.m

DISCRETE RECEPTOR LOCATIONS (in metres)

No.	X	Y	ELEVN	HEIGHT	No.	X	Y	ELEVN	HEIGHT
1	540712	6461907	0.0	0.0	5	540560	6461948	0.0	0.0
2	540702	6461895	0.0	0.0	6	540547	6461859	0.0	0.0
3	540717	6461980	0.0	0.0	7	540476	6461834	0.0	0.0
4	540509	6461910	0.0	0.0	8	540447	6461988	0.0	0.0

METEOROLOGICAL DATA : st,047048,47 ,BROKEN HILL AIRPORT AWS,01/1947,

Appendix 7. Ausplume configuration file (Scenario 3)

1

Wills STP Scenario 3

Concentration or deposition	Concentration
Emission rate units	OUV/second
Concentration units	Odour_Units
Units conversion factor	1.00E+00
Constant background concentration	0.00E+00
Terrain effects	None
Smooth stability class changes?	No
Other stability class adjustments ("urban modes")	None
Ignore building wake effects?	Yes
Decay coefficient (unless overridden by met. file)	0.000
Anemometer height	10 m
Roughness height at the wind vane site	0.300 m
Use the convective PDF algorithm?	No
Averaging time for sigma-theta values	60 min.

DISPERSION CURVES

Horizontal dispersion curves for sources <100m high Sigma-theta
Vertical dispersion curves for sources <100m high Pasquill-Gifford
Horizontal dispersion curves for sources >100m high Briggs Rural
Vertical dispersion curves for sources >100m high Briggs Rural
Enhance horizontal plume spreads for buoyancy? Yes
Enhance vertical plume spreads for buoyancy? Yes
Adjust horizontal P-G formulae for roughness height? Yes
Adjust vertical P-G formulae for roughness height? Yes
Roughness height 0.100m
Adjustment for wind directional shear None

PLUME RISE OPTIONS

Gradual plume rise? Yes
Stack-tip downwash included? Yes
Building downwash algorithm: PRIME method.
Entrainment coeff. for neutral & stable lapse rates 0.60,0.60
Partial penetration of elevated inversions? No
Disregard temp. gradients in the hourly met. file? No

and in the absence of boundary-layer potential temperature gradients
given by the hourly met. file, a value from the following table
(in K/m) is used:

Wind Speed Category	Stability Class A	B	C	D	E	F
1	0.000	0.000	0.000	0.000	0.020	0.035
2	0.000	0.000	0.000	0.000	0.020	0.035
3	0.000	0.000	0.000	0.000	0.020	0.035
4	0.000	0.000	0.000	0.000	0.020	0.035
5	0.000	0.000	0.000	0.000	0.020	0.035
6	0.000	0.000	0.000	0.000	0.020	0.035

WIND SPEED CATEGORIES
Boundaries between categories (in m/s) are: 1.54, 3.09, 5.14, 8.23, 10.80

WIND PROFILE EXPONENTS: "Irwin Urban" values (unless overridden by met. file)

AVERAGING TIMES
1 hour

1

Wills STP Scenario 3

SOURCE CHARACTERISTICS

INTEGRATED AREA SOURCE: 21

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540713	6461908	0m	36m	68m	44deg	1m	4m

(Constant) emission rate = 1.25E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 22

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540702	6461895	0m	36m	20m	44deg	1m	4m

(Constant) emission rate = 1.25E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 31

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540717	6461980	0m	20m	12m	46deg	0m	1m

(Constant) emission rate = 2.50E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 51

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540476	6461834	0m	66m	15m	46deg	0m	0m

(Constant) emission rate = 1.50E-01 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED CIRCULAR AREA SOURCE: 41

X0(m)	Y0(m)	Ground El	Radius	No. Vertices	Ver. spread	Height
540659	6461929	0m	5m	20	0m	0m

(Constant) emission rate = 2.40E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED CIRCULAR AREA SOURCE: 61

X0(m)	Y0(m)	Ground El	Radius	No. Vertices	Ver. spread	Height
540657	6461951	0m	13m	20	0m	0m

(Constant) emission rate = 2.40E+00 OUV/second per square metre
No gravitational settling or scavenging.

VOLUME SOURCE: 71

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
540704	6461960	0m	5m	3m	1m

(Constant) emission rate = 7.67E+02 OUV/second
No gravitational settling or scavenging.

1

Wills STP Scenario 3

RECEPTOR LOCATIONS

The Cartesian receptor grid has the following x-values (or eastings):
540200.m 540250.m 540300.m 540350.m 540400.m 540450.m 540500.m
540550.m 540600.m 540650.m 540700.m 540750.m 540800.m 540850.m
540900.m 540950.m 541000.m 541050.m 541100.m 541150.m 541200.m
541250.m 541300.m 541350.m 541400.m 541450.m 541500.m 541550.m
541600.m 541650.m 541700.m

and these y-values (or northings):
6461200.m 6461250.m 6461300.m 6461350.m 6461400.m 6461450.m 6461500.m
6461550.m 6461600.m 6461650.m 6461700.m 6461750.m 6461800.m 6461850.m
6461900.m 6461950.m 6462000.m 6462050.m 6462100.m 6462150.m 6462200.m
6462250.m 6462300.m 6462350.m 6462400.m

DISCRETE RECEPTOR LOCATIONS (in metres)

No.	X	Y	ELEVN	HEIGHT	No.	X	Y	ELEVN	HEIGHT
1	540712	6461907	0.0	0.0	5	540659	6461929	0.0	0.0
2	540702	6461895	0.0	0.0	6	540657	6461951	0.0	0.0
3	540717	6461980	0.0	0.0	7	540649	6461881	0.0	0.0
4	540476	6461834	0.0	0.0					

METEOROLOGICAL DATA : st,047048,47 ,BROKEN HILL AIRPORT AWS,01/1947,

Appendix 8. Ausplume configuration file (Scenario 4)

1

Wills STP Scenario 4

Concentration or deposition	Concentration
Emission rate units	OUV/second
Concentration units	Odour_Units
Units conversion factor	1.00E+00
Constant background concentration	0.00E+00
Terrain effects	None
Smooth stability class changes?	No
Other stability class adjustments ("urban modes")	None
Ignore building wake effects?	Yes
Decay coefficient (unless overridden by met. file)	0.000
Anemometer height	10 m
Roughness height at the wind vane site	0.300 m
Use the convective PDF algorithm?	No
Averaging time for sigma-theta values	60 min.

DISPERSION CURVES

Horizontal dispersion curves for sources <100m high Sigma-theta
Vertical dispersion curves for sources <100m high Pasquill-Gifford
Horizontal dispersion curves for sources >100m high Briggs Rural
Vertical dispersion curves for sources >100m high Briggs Rural
Enhance horizontal plume spreads for buoyancy? Yes
Enhance vertical plume spreads for buoyancy? Yes
Adjust horizontal P-G formulae for roughness height? Yes
Adjust vertical P-G formulae for roughness height? Yes
Roughness height 0.100m
Adjustment for wind directional shear None

PLUME RISE OPTIONS

Gradual plume rise? Yes
Stack-tip downwash included? Yes
Building downwash algorithm: PRIME method.
Entrainment coeff. for neutral & stable lapse rates 0.60,0.60
Partial penetration of elevated inversions? No
Disregard temp. gradients in the hourly met. file? No

and in the absence of boundary-layer potential temperature gradients
given by the hourly met. file, a value from the following table
(in K/m) is used:

Wind Speed Category	Stability Class A	B	C	D	E	F
1	0.000	0.000	0.000	0.000	0.020	0.035
2	0.000	0.000	0.000	0.000	0.020	0.035
3	0.000	0.000	0.000	0.000	0.020	0.035
4	0.000	0.000	0.000	0.000	0.020	0.035
5	0.000	0.000	0.000	0.000	0.020	0.035
6	0.000	0.000	0.000	0.000	0.020	0.035

WIND SPEED CATEGORIES
Boundaries between categories (in m/s) are: 1.54, 3.09, 5.14, 8.23, 10.80

WIND PROFILE EXPONENTS: "Irwin Urban" values (unless overridden by met. file)

AVERAGING TIMES
1 hour

1

Wills STP Scenario 4

SOURCE CHARACTERISTICS

INTEGRATED AREA SOURCE: 21

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540713	6461908	0m	36m	68m	44deg	1m	4m

(Constant) emission rate = 1.25E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 22

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540702	6461895	0m	36m	20m	44deg	1m	4m

(Constant) emission rate = 1.25E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 31

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540717	6461980	0m	20m	12m	46deg	0m	1m

(Constant) emission rate = 2.50E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 51

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540476	6461834	0m	66m	15m	46deg	0m	0m

(Constant) emission rate = 1.50E-01 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 41

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540564	6461868	0m	40m	40m	50deg	0m	0m

(Constant) emission rate = 1.00E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 42

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540529	6461911	0m	40m	40m	50deg	0m	0m

(Constant) emission rate = 1.00E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 43

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540574	6461946	0m	40m	40m	50deg	0m	0m

(Constant) emission rate = 1.00E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 44

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540500	6461949	0m	40m	40m	50deg	0m	0m

(Constant) emission rate = 1.00E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 45

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540542	6461983	0m	40m	40m	50deg	0m	0m

(Constant) emission rate = 1.00E+00 OUV/second per square metre
No gravitational settling or scavenging.

1

Wills STP Scenario 4

RECEPTOR LOCATIONS

The Cartesian receptor grid has the following x-values (or eastings):
540200.m 540250.m 540300.m 540350.m 540400.m 540450.m 540500.m
540550.m 540600.m 540650.m 540700.m 540750.m 540800.m 540850.m
540900.m 540950.m 541000.m 541050.m 541100.m 541150.m 541200.m
541250.m 541300.m 541350.m 541400.m 541450.m 541500.m 541550.m
541600.m 541650.m 541700.m

and these y-values (or northings):
6461200.m 6461250.m 6461300.m 6461350.m 6461400.m 6461450.m 6461500.m
6461550.m 6461600.m 6461650.m 6461700.m 6461750.m 6461800.m 6461850.m
6461900.m 6461950.m 6462000.m 6462050.m 6462100.m 6462150.m 6462200.m
6462250.m 6462300.m 6462350.m 6462400.m

DISCRETE RECEPTOR LOCATIONS (in metres)

No.	X	Y	ELEVN	HEIGHT	No.	X	Y	ELEVN	HEIGHT
1	540712	6461907	0.0	0.0	6	540529	6461911	0.0	0.0
2	540702	6461895	0.0	0.0	7	540574	6461946	0.0	0.0
3	540717	6461980	0.0	0.0	8	540500	6461949	0.0	0.0
4	540476	6461834	0.0	0.0	9	540542	6461983	0.0	0.0
5	540564	6461868	0.0	0.0					

METEOROLOGICAL DATA : st,047048,47 ,BROKEN HILL AIRPORT AWS,01/1947,

Appendix E. P&IDs

ESSENTIAL WATER

BROKEN HILL WASTEWATER TREATMENT PLANT

PROCESS AND INSTRUMENTATION DRAWINGS
CONCEPT DESIGN

NOT FOR CONSTRUCTION

DECEMBER 2024

Beca hunterh2o
the future of water

ESSENTIAL WATER	
BROKEN HILL WASTEWATER TREATMENT PLANT CONCEPT DESIGN	
DRAWING NUMBER	DESCRIPTION
7015-004-P-000	TITLE SHEET
7015-004-P-001	DRAWING INDEX
7015-004-P-002	INDEX SHEET 01
7015-004-P-003	INDEX SHEET 02
7015-004-P-004	INDEX SHEET 03
7015-004-P-005	INDEX SHEET 04
7015-004-P-006	PROCESS FLOW DIAGRAM
7015-004-P-007	MASS BALANCE
7015-004-P-008	NOT USED
7015-004-P-009	NOT USED
7015-004-P-010	SOUTH WWTP TRANSFER PS
7015-004-P-011	NOT USED
7015-004-P-012	INLET WORKS SEPTAGE RECEIVAL
7015-004-P-013	INLET WORKS RECEIVAL CHAMBER
7015-004-P-014	INLET WORKS SCREW SCREENS
7015-004-P-015	INLET WORKS GRIT REMOVAL
7015-004-P-016	NOT USED
7015-004-P-017	INLET WORKS ODOUR CONTROL SYSTEM
7015-004-P-018	FOUL WATER PUMPING STATION
7015-004-P-019	NOT USED
7015-004-P-020	INTERMEDIATELY DECANTED EXTENDED AERATION BIOREACTOR 01
7015-004-P-021	INTERMEDIATELY DECANTED EXTENDED AERATION BIOREACTOR 02
7015-004-P-022	EFFLUENT BALANCE TANK
7015-004-P-023	RECYCLED WATER TREATMENT
7015-004-P-024	RECYCLED WATER CHLORINE CONTACT TANKS
7015-004-P-025	SERVICE WATER SYSTEM
7015-004-P-026	POTABLE WATER SYSTEM
7015-004-P-027	EFFLUENT UV DISINFECTION
7015-004-P-028	EFFLUENT REUSE PUMPS
7015-004-P-029	EMERGENCY STORAGE POND
7015-004-P-030	AEROBIC DIGESTER
7015-004-P-031	SLUDGE DEWATERING 01
7015-004-P-032	SLUDGE DEWATERING 02
7015-004-P-033	SLUDGE DEWATERING 03

ESSENTIAL WATER	
BROKEN HILL WASTEWATER TREATMENT PLANT CONCEPT DESIGN	
DRAWING NUMBER	DESCRIPTION
7015-004-P-034	NOT USED
7015-004-P-035	NOT USED
7015-004-P-036	NOT USED
7015-004-P-037	NOT USED
7015-004-P-038	NOT USED
7015-004-P-039	NOT USED
7015-004-P-040	ALUM DOSING SYSTEM
7015-004-P-041	SODIUM HYDROXIDE DOSING SYSTEM
7015-004-P-042	DEWATERING POLYMER BATCHING
7015-004-P-043	DEWATERING POLYMER DOSING
7015-004-P-044	CHLORINE DOSING SYSTEM
7015-004-P-045	CHLORINE BUILDING MANAGEMENT
7015-004-P-046	NOT USED
7015-004-P-047	NOT USED
7015-004-P-048	NOT USED
7015-004-P-049	NOT USED
7015-004-P-050	CHEMICAL DELIVERY BUND

NOT FOR CONSTRUCTION

AMENDMENTS

Ver	Date	Description	Drawn
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB

beca hunterh2o the future of water

Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
DRAWING INDEX

Scale	Document No
NTS at A3	7015-004-P-001
Status: PRELIMINARY	Version: C

Plot Date: 10/12/24 - 09:30 Cad File: P:\HH2O\Essential Energy\Broken Hill STP Concept and Detailed Design\PID DWGS\1 - CURRENT WORKING\7015-004 BROKEN HILL STP CD\PID DWG\DWGs\7015-004-P-001 DRAWING INDEX.dwg

Ver.1.00

LINE SYMBOLS

- PROCESS LINE MAJOR
- PROCESS LINE MINOR
- EXISTING PROCESS LINE MAJOR
- EXISTING PROCESS LINE MINOR
- INSTRUMENT SUPPLY OR CONNECTION TO PROCESS
- UNDEFINED SIGNAL
- PNEUMATIC SIGNAL
- ELECTRICAL SIGNAL
- ELECTRIC BINARY SIGNAL
- HYDRAULIC SIGNAL
- LIMIT OF VENDOR SUPPLY
- OPEN CHANNEL OR HYDRAULIC LINK
- EXISTING OPEN CHANNEL OR HYDRAULIC LINK
- JACKETED LINE (DOUBLE CONTAINMENT)
- INSULATED LINE
- FLOW ARROW
- LIMIT OF VENDOR SUPPLY
- SEGMENT BREAKER SPEC/AREA/ABOVE-BELOW GROUND

PIPE FITTINGS

- BELLMOUTH
- DISMANTLING JOINT
- DRAIN
- END CAP SCREWED
- EXPANSION BELLOWS
- FLANGED JOINT
- FLEXIBLE HOSE
- HOSE COUPLING
- OPEN VENT
- REDUCER
- SPRAY NOZZLE
- VENT c/w SCREEN

SELF ACTUATED REGULATORS AND VALVES

- AIR VALVE
- COMBINED PRESSURE/VACUUM RELIEF VALVE
- COMBINED VACUUM REGULATOR c/w PRESSURE RELIEF
- COMBINED VACUUM REGULATOR c/w PRESSURE RELIEF c/w DRIP LEG FILTER/HEATER
- FLOAT VALVE
- PRESSURE REGULATING VALVE
- PRESSURE RELIEF VALVE
- PRESSURE SUSTAINING VALVE
- REDUCED PRESSURE ZONE DEVICE
- TEMPERATURE RELIEF VALVE

VALVE FITTINGS

- HAND ACTUATED OR HANDWHEEL
- ELECTRIC ACTUATOR
- FLOAT
- MANUAL GEARBOX
- PNEUMATIC ACTUATOR
- SOLENOID ACTUATOR
- SPRING - FOR PRESSURE RELIEF OR SAFETY VALVE ONLY
- WEIGHT

PIPING VALVES

NORMALLY OPEN	NORMALLY CLOSED	
		ANGLE
		BALL
	N/A	BLOCK AND BLEED
		BUTTERFLY
	N/A	CHECK (NON-RETURN)
	N/A	DAMPER
		DIAPHRAGM
		GATE
		GENERAL
		GLOBE
	N/A	INJECTION
	N/A	MUD
		NEEDLE
		PINCH
		PLUG
	N/A	ROTARY
	N/A	SLIDEGATE
		THREE-WAY

EQUIPMENT, BLOWERS

- AXIAL
- CENTRIFUGAL
- GENERAL
- RADIAL
- ROOTS

EQUIPMENT, COMPRESSORS

- GENERAL
- LIQUID RING
- RECIPROCATING
- ROTARY VANE
- SCREW
- TURBO

EQUIPMENT, CONVEYORS

- BELT
- SCREW
- SLUICE

EQUIPMENT, DRIERS

- AIR DRYER, GENERAL

EQUIPMENT, FILTERS

- BAND SCREEN
- BAR SCREEN
- CENTRIFUGE
- CLARIFIER
- CYCLONE SEPARATOR
- DRUM SCREEN, HORIZONTAL
- DRUM SCREEN, INCLINED
- ELECTROLYSIS CELL
- GRIT CLASSIFIER
- ROTARY SCREW THICKENER
- STEP SCREEN

EQUIPMENT, HEAT EXCHANGERS

- COILED TUBE
- FINNED TUBE

EQUIPMENT, MISCELLANEOUS

- AUDIBLE ALARM
- BEACON
- CHEMICAL DELIVERY CONTROL PANEL
- CRANE/HOIST
- DIFFUSER
- FLARE
- HEATER, ELECTRIC
- INSTRUMENT (REFER INDEX SHEET 4)
- LOUVER
- MACERATOR
- SAFETY SHOWER c/w EYE WASH
- SCUM HARVISTER
- SLUDGE SCRAPER
- STACK
- UV BANK
- VIBRATOR
- WASH PRESS

EQUIPMENT, MIXING

- AGITATOR
- INLINE MECHANICAL MIXER

EQUIPMENT, PUMPS

- CENTRIFUGAL
- DIAPHRAGM
- DIAPHRAGM SOLENOID DRIVE
- GEAR
- GENERAL
- HELICAL ROTOR
- LOBE
- PERISTALTIC
- PROPELLER
- RECIPROCATING
- SCREW

EQUIPMENT, MOTORS

- ELECTRIC MOTOR (REFER INDEX SHEET 4)

NOT FOR CONSTRUCTION

AMENDMENTS

Ver	Date	Description	Drawn
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB

Beca hunterH2O the future of water

Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
INDEX SHEET 01

Scale: NTS at A3

Document No: **7015-004-P-002**

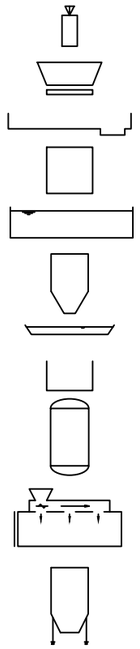
Status: **PRELIMINARY**

Version: **C**

Plot Date: 10/12/24 - 09:30 Cad File: P:\HH2O\Essential Energy\Broken Hill STP Concept and Detailed Design\PID DWGS\1 - CURRENT WORKING\7015-004 BROKEN HILL STP CD\PID DWG\DWGs\7015-004-P-002 INDEX SHEET 01.dwg

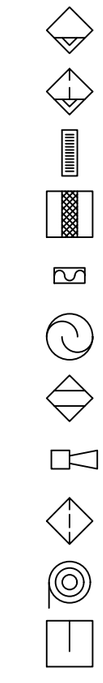
Ver.1.00

EQUIPMENT, TANKS



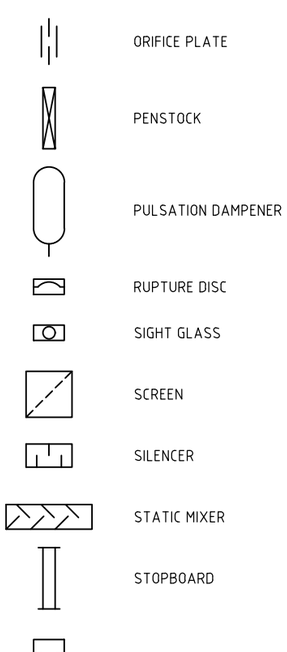
BAG
BIN
BUND
CLOSED
CONCRETE
HOPPER
LAGOON
OPEN
PRESSURE VESSEL
SELF LEVELING SOLIDS HANDLING BIN
SILO

INLINE EQUIPMENT



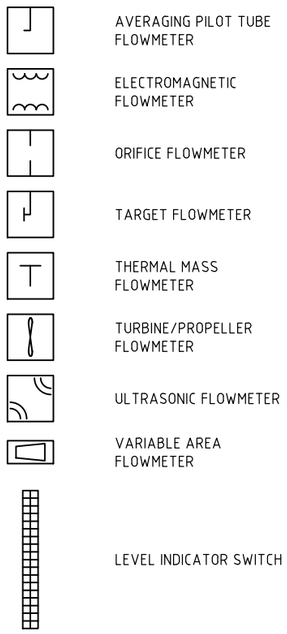
AUTOMATIC CONDENSATE TRAP
AUTOMATIC CONDENSATE TRAP c/w FILTER
CALIBRATION CYLINDER
CARBON FILTER
DIAPHRAGM SEAL
DOSING LANCE/SIPHON
AIR DRYER, CARTRIDGE
EDUCTOR/EJECTOR
FILTER
HOSE REEL
OIL-WATER SEPARATOR

INLINE EQUIPMENT



ORIFICE PLATE
PENSTOCK
PULSATION DAMPENER
RUPTURE DISC
SIGHT GLASS
SCREEN
SILENCER
STATIC MIXER
STOPBOARD
SUCTION LANCE
STRAINER, Y
WEIR
VEHICLE, FORKLIFT
VEHICLE, LOADER
VEHICLE, TANKER
VEHICLE, TRUCK
WINDSOCK

INLINE INSTRUMENTS



AVERAGING PILOT TUBE FLOWMETER
ELECTROMAGNETIC FLOWMETER
ORIFICE FLOWMETER
TARGET FLOWMETER
THERMAL MASS FLOWMETER
TURBINE/PROPELLER FLOWMETER
ULTRASONIC FLOWMETER
VARIABLE AREA FLOWMETER
LEVEL INDICATOR SWITCH
FLOAT SWITCH
HYDROSTATIC LEVEL SENSOR
ULTRASONIC/RADER LEVEL SENSOR ELEMENT
POWER, GPO 240V
POWER, 415 V 3 Ph.

NOT FOR CONSTRUCTION

AMENDMENTS			
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB
Ver	Date	Description	Drawn

beca hunterh2o
the future of water

Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
INDEX SHEET 02

Scale	Document No
NTS at A3	7015-004-P-003
Status: PRELIMINARY	Version: C

EQUIPMENT AND FUNCTIONAL ABBREVIATIONS

CODE	EQUIPMENT
ACD	AUTOMATIC CONDENSATE DRAIN
ACDF	AUTOMATIC CONDENSATE DRAIN WITH FILTER
ACO	AUTOMATIC CHANGE OVER SYSTEM
AD	AIR DRYER
AG	AGITATOR OR MIXER
AH	ANTI-ARCHING HAMMER
AM	AUDIBLE ALARM
AS	AUTO SAMPLER
AV	AIR RELEASE VALVE
BA	BIN ACTIVATOR
BAG	BAG
BAS	BAND SCREEN
BC	BELT CONVEYOR
BD	BURSTING DISC
BE	VISUAL BEACON
BN	BIN
BL	BLOWER
BS	BAR SCREEN
BTF	BIOTRICKLING FILTER
CAB	CABINET
CC	CALIBRATION COLUMN / TUBE
CDP	CHEMICAL DELIVERY CONTROL PANEL
CE	CENTRIFUGE
CF	CARBON FILTER
CL	CHLORINATOR
CLF	CLARIFIER
CNF	CARBON FILTER
CO	CONTROL PANEL
COA	COALESCENT AUTOMATIC CONDENSATE TRAP
CP	COMPRESSOR
CR	CRANE
CV	CONTROL VALVE
CYC	CYCLONE SEPARATOR
DE	DUST EXTRACTOR
DEB	DEBUBBLER
DF	DUST FILTER
DIF	DIFFUSER
DN	DRAIN / BUND / HARDSTAND
DPS	DIAPHRAGM SEAL
DSL	DOSING LANCE/SIPHON
DSN	DRUM SCREEN / DRUM SCREW SCREEN
DW	DECANTER WEIR
EJ	EJECTOR/EDUCTOR/INJECTOR
ELC	ELECTROLYSIS CELL
ESD	EMERGENCY / AUTOMATIC SHUTDOWN
EV	ELECTRIC VALVE (CHLORINATOR)
FA	FAN / EXTRACTION FAN
FCV	FLOW CONTROL VALVE
FDC	FLOW DISTRIBUTION CHAMBER
FI	FILTER
FE	FLARE
FL	FLOCCULATOR
FM	FLOW METER
GW	GRIT WASHER
HEX	HEAT EXCHANGER
HJ	ELECTRIC HOIST
HP	HOPPER
HR	HOSE REEL
HS	HAND SWITCH

EQUIPMENT AND FUNCTIONAL ABBREVIATIONS

CODE	EQUIPMENT
HT	HEATER
IV	INJECTION VALVE
IT	INCLINED TROUGH
JA	JET AERATOR
KL	KAMLOCK FITTING
LG	LAGOON / POND
LVR	LOUVER
MC	MACERATOR
MD	MUD VALVE
MF	MOTOR FIXED SPEED
MFR	MOTOR FIXED SPEED REVERSING
MPN	MOTORISED PENSTOCK
MS	MOTOR SOFT START
MV	MOTORISED VALVE
MVS	MOTOR VARIABLE SPEED
MVR	MOTOR VARIABLE SPEED REVERSING
MX	MIXER
NR	NON RETURN VALVE
OP	ORIFICE PLATE
OT	OVER TORQUE
OWS	OIL-WATER SEPARATOR
PD	PULSATION DAMPENER
PG	PRESSURE GAUGE / INDICATOR
PN	PENSTOCK
PNV	PNEUMATIC ACTUATED VALVE
PGV	PRESSURE REGULATOR / REGULATING
PRF	PRESSURE RELIEF VALVE
PV	PRESSURE VESSEL
PVRV	PRESSURE VACUUM RELIEF VALVE
PSV	PRESSURE SUSTAINING VALVE /LOADING VALVE
PTT	PIT
PU	PUMP
PNV	PNEUMATIC VALVE
PPK	PNEUMATIC PENSTOCK
RD	RAKE DRIVE
ROT	ROTAMETER
RP	PRESSURE VESSEL
RPZ	REDUCED PRESSURE ZONE VALVE
RS	RADAR SENSOR
RST	ROTARY SCREW THICKENER
RTU	RADIO TELEMETRY UNIT
RV	ROTARY VALVE
SA	SURFACE AERATOR
SAF	EYEWASH / SAFETYSHOWER
SCV	SCREW CONVEYOR
SD	SOLENOID VALVE
SLD	SLUDGE DETECTOR
SLT	SLUDGE THICKENER
SCN	SCREEN
SCP	SCRAPER
SF	SCREW FEEDER
SG	SLIDE GATE
SGL	SIGHT GLASS
SGLG	SIGHT GLASS GAUGE
SH	SCUM HARVESTER
SIR	SILENCER
SL	SUCTION LANCE
SLC	SLUICE

EQUIPMENT AND FUNCTIONAL ABBREVIATIONS

CODE	EQUIPMENT
SMX	STATIC MIXER
SN	SPRAY NOZZLE
SP	SCREW PRESS
SR	SEPTAGE RECEIVAL WITH MANUAL BAR SCREEN
SS	STEP SCREEN
SSC	SLUDGE SCRAPER
SSD	SIDE STREAM DOSING ASSEMBLY
SSL	SPEED SWITCH LOW
STB	STOP BOARD
STR	STRAINER / Y-STRAINER
STK	STACK
SU	SURGE VESSEL
TA	TANK
TAR	TURBO AERATOR
TRV	TEMPERATURE RELIEF VALVE
US	ULTRASONIC SENSOR
UV	UV BANK / REACTOR
VA	GENERAL / HAND VALVE
VB	STOPBOARD
VE	VENTURI
VI	VIBRATOR
VL	VACUUM LOADER
VPK	VENDOR PACKAGE
VPR	VACUUM RELIEF VALVE
WR	WEIR

INSTRUMENTATION IDENTIFICATION LETTER CODE FOR USE WITH INSTRUMENTS AND CONTROL

LETTER	FIRST LETTER MEASURED VALUE	SECOND LETTER MODIFIER	THIRD LETTER DISPLAY OR OUTPUT
A	ANALYSIS	ALARM	ALARM
B	BURNER, FLAME	---	STATE OR STATUS DISPLAY
C	CONDUCTIVITY	CONTROL	CONTROL
D	DENSITY	DIFFERENCE	---
E	VOLTAGE	SENSING ELEMENT	SENSING ELEMENT
F	FLOW	RATIO	---
G	GAUGE POSITION OR LENGTH	GAUGE	GLASS
H	HAND OPERATED	HIGH	HIGH
I	CURRENT	INDICATING	INDICATOR
J	POWER	SCAN	---
K	TIME	---	BARRIER
L	LEVEL	LOW	LOW
M	MOISTURE AND HUMIDITY	INTERMEDIATE	---
N	LRV	---	---
O	---	---	---
P	PRESSURE OR VACUUM	PRESSURE OR VACUUM	TEST POINT CONNECTION
Q	QUANTITY	INTEGRATE OR TOTALIZE	INTEGRATING OR SUMMATING
R	RADIOACTIVITY	---	RECORDING
S	SPEED OR FREQUENCY	SWITCH	SWITCH
T	TEMPERATURE	TRANSMITTER	TRANSMITTER
U	MULTIVARIABLE	---	MULTIFUNCTION UNIT
V	VIBRATION	VALVE	VALVE, DAMPER, LOUVRE
W	WEIGHT OR FORCE	---	WELLS
X	---	---	CATHODE RAY TUBE, ETC
Y	EVENT	CONVERTER	COMPUTING RELAY, RELAY
Z	POSITION	---	EMERGENCY AND SAFETY ACTING

INSTRUMENT AND FUNCTIONAL ABBREVIATIONS

CODE	EQUIPMENT
AIT	ANALYSER INDICATOR TRANSMITTER
ANE	ANALYSER ELEMENT
AT	ANALYSER TRANSMITTER
FE	FLOW ELEMENT
FIT	FLOW INDICATING TRANSMITTER
FLI	FLOW INDICATOR
FQ	FLOW TOTALISER
FS	FLOW SWITCH
FSH	FLOW SWITCH - HIGH
FSHH	FLOW SWITCH - HIGH HIGH
FSL	FLOW SWITCH - LOW
FSLL	FLOW SWITCH - LOW LOW
FT	FLOW TRANSMITTER
HC	HAND CONTROL MODULATING
HS	HAND SWITCH
LC	LEVEL CONTROLLER
LE	LEVEL ELEMENT
LIT	LEVEL INDICATING TRANSMITTER
LSH	LEVEL SWITCH - HIGH
LSHH	LEVEL SWITCH - HIGH HIGH
LSL	LEVEL SWITCH - LOW
LSLL	LEVEL SWITCH - LOW LOW
LSW	LEVEL SWITCH
LT	LEVEL TRANSMITTER
MD	MOISTURE DETECTION
PDE	PRESSURE DIFFERENTIAL ELEMENT
PDI	PRESSURE DIFFERENTIAL INDICATION
PDIT	PRESSURE DIFFERENTIAL INDICATOR TRANSMITTER
PDS	PRESSURE DIFFERENTIAL SWITCH
PDT	PRESSURE DIFFERENTIAL TRANSMITTER
PE	PRESSURE ELEMENT
PG	PRESSURE INDICATOR/GAUGE
PIT	PRESSURE INDICATING TRANSMITTER
PRS	PRESSURE SWITCH
PRSH	PRESSURE SWITCH - HIGH
PSHH	PRESSURE SWITCH - HIGH HIGH
PRSL	PRESSURE SWITCH - LOW
PSLL	PRESSURE SWITCH - LOW LOW
PT	PRESSURE TRANSMITTER
SS	SPEED SWITCH
SSH	SPEED SWITCH - HIGH
SSL	SPEED SWITCH - LOW
TE	THEMPERATURE ELEMENT
TIT	TEMPERATURE INDICATING TRANSMITTER
TS	TEMPERATURE SWITCH
TSH	TEMPERATURE SWITCH - HIGH
TSHH	TEMPERATURE SWITCH - HIGH HIGH
TSL	TEMPERATURE SWITCH - LOW
TSLL	TEMPERATURE SWITCH - LOW LOW
TT	TEMPERATURE TRANSMITTER
WE	WEIGHT ELEMENT
WI	WEIGHT INDICATING
WIT	WEIGHT INDICATING TRANSMITTER
WQ	WEIGHT TOTALISER
WS	WEIGHT/TORQUE SWITCH
WSH	WEIGHT/TORQUE SWITCH - HIGH
WSHH	WEIGHT/TORQUE SWITCH - HIGH HIGH

INSTRUMENT AND FUNCTIONAL ABBREVIATIONS

CODE	EQUIPMENT
WSL	WEIGHT/TORQUE SWITCH - LOW
WSLL	WEIGHT/TORQUE SWITCH - LOW LOW
WT	WEIGHT/TORQUE TRANSMITTER
ZH	POSITION SWITCH HIGH
ZHH	POSITION SWITCH HIGH HIGH
ZIT	POSITION INDICATING TRANSMITTER
ZL	POSITION SWITCH LOW
ZLL	POSITION SWITCH LOW
ZS	POSITION SWITCH
ZSB	POSITION SWITCH - BACKWARD
ZSC	POSITION SWITCH - CLOSE
ZSF	POSITION SWITCH - FORWARD
ZSL	POSITION SWITCH - LEFT
ZSO	POSITION SWITCH - OPEN
ZSP	POSITION SWITCH - PARKED
ZSR	POSITION SWITCH - RIGHT

NOT FOR CONSTRUCTION

ANALYSER AND FUNCTIONAL ABBREVIATIONS

CODE	ANALYSER
NH3	AMMONIA
COD	CHEMICAL OXYGEN DEMAND
CL2	CHLORINE
CL2 FREE	CHLORINE RESIDUAL FREE
CL2 TOTAL	CHLORINE RESIDUAL TOTAL
COND	CONDUCTANCE
DO	DISSOLVED OXYGEN
EC	ELECTRICAL CONDUCTIVITY
FL	FLUORIDE
FC	FAECAL COLIFORMS/E.COIL
H2S	HYDROGEN SULPHIDE
IRON	IRON (SOLUBLE)
MN	MANGANESE (SOLUBLE)
CHLOR AMINE	MONOCHLORAMINE NH2CL
NOX	NITRATE
O3	OZONE
OP	ORTHO PHOSPHORUS
PH	PH
ORP	REDOX POTENTIAL
RTN	ROTATION
SB	SLUDGE BLANKET
SCM	STREAMING CURRENT
SS	SUSPENDED SOLIDS
TEMP	TEMPERATURE
TN	TOTAL NITROGEN
TP	TOTAL PHOSPHORUS
TURB	TURBIDITY
UVI	UV INTENSITY
UVT	UV TRANSMISSIVITY
VIB	VIBRATION

AMENDMENTS

Ver	Date	Description	Drawn
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB

beca hunterh2o the future of water

Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
INDEX SHEET 03

Scale: NTS at A3

Document No: **7015-004-P-004**

Status: **PRELIMINARY**

Version: **C**

PLANT SPECIFICATION CODES

CODE	DESCRIPTION
DICL	DUCTILE IRON CEMENT LINED TO AS2280. REFER WSA PS 200 PIPE (PN20/35)/ WSA PS 201 FITTINGS (MIN PN16) / WSA202 (PIPE AND FITTINGS – METRIC) TO SUIT APPLICATION. SEAL COATING TO CEMENT LINING. FOR SEWAGE / PRIMARY SLUDGE, LINING TO BE CALCIUM ALUMINATE CEMENT.
DIEL	DUCTILE IRON EPOXY LINED TO AS2280. REFER WSA PS 200 PIPE (PN20/35)/ WSA PS 201 FITTINGS (MIN PN16) / WSA202 (PIPE AND FITTINGS – METRIC) TO SUIT APPLICATION. EPOXY LINING TO WSA 201.
GRP	GLASS REINFORCED PLASTIC PRESSURE PIPES & FITTINGS TO WSA PS-205 AND WSA PS-205S, AS APPLICABLE. GRP PIPES & FITTINGS FOR OTHER APPLICATIONS TO AS3571. SN5000 OR SN10000 CLASS TO SUIT APPLICATION.
HDPE	HIGH DENSITY POLYETHYLENE PE100 PN16 TO WSA PS-207 (PIPE), WSA PS-208/WSA PS-216 (FITTINGS) and AS/NZS 4130. CLASS TO SUIT APPLICATION. COMPLY WITH THE POLYETHYLENE PIPELINE CODE WSA 01—2004 THIRD EDITION. FITTINGS TO AS/NZS 4129
HDPEAIR	HIGH DENSITY POLYETHYLENE PE100 PN20 TO AS/NZS 4130 FITTINGS TO AS/NZS 4129 HDPE PIPE FOR COMPRESSED AIR TO SERIES 1 PIPE REQUIREMENTS OF AS/NZS 4130
MSCL	MILD STEEL, CEMENT LINED TO WSA PS-203 (PIPE) AND WSA PS-204 (FITTINGS), AS 1281 & AS1579. EXTERNAL COATING TO BE FUSION BONDED POLYETHYLENE (SINTAKOTE) TO AS 4321. PROVIDE SEAL COATING TO THE CEMENT LINING. FOR SEWAGE, LINING TO BE CALCIUM ALUMINATE CEMENT.
MSSL	MILD STEEL TO WSA PS-203 (PIPE) AND WSA PS-204 (FITTINGS). EXTERNAL COATING TO BE FUSION BONDED POLYETHYLENE (SINTAKOTE) TO AS 4321. INTERNAL LINING SYSTEM TO BE FUSION BONDED POLYETHYLENE LINING (SINTAPIPE).
DWV	UPVC to AS1260, SN10 for DN100, SN8 >DN100. SOLVENT CEMENT OR RUBBER RING JOINTS TO SUIT APPLICATION.
PVCO	PVC-O PIPING, PN16, SERIES 2 TO AS 4441. PIPE JOINTS TO BE RUBBER RING JOINTS (RRJ). FITTINGS TO BE DI TO AS2280, FBE COATED. FLANGED FITTINGS PER AS4087 Fig. B5 (PN16).
PVCS80	PVC-U ASTM D1785 SCHEDULE 80 PIPES & FITTINGS TO COMPLY WITH ASTM CLASS 12454-B (PVC TYPE 1 GREY) AS DEFINED IN ASTM SPECIFICATION D1785
RC	REINFORCED CONCRETE TO AS4058 CLASS 2,3 OR 4 TO SUIT APPLICATION. RUBBER RING JOINTED.
SS316S10	STAINLESS STEEL GRADE 316 SCHEDULE 10. STAINLESS STEEL PIPES AND FITTINGS TO BE SEAM WELDED, MANUFACTURED FROM GRADE 316L OR GRADE 316 STAINLESS STEEL PIPES, COMPLYING WITH ANSI/ASME B36.19M AND B16.9, RESPECTIVELY. ALL WELDS TO AS4041, BUTT WELDS TO BE FULL PENETRATION TO AS1554.1.
SS316S40	STAINLESS STEEL GRADE 316 SCHEDULE 40. STAINLESS STEEL PIPES AND FITTINGS TO BE SEAM WELDED, MANUFACTURED FROM GRADE 316L OR GRADE 316 STAINLESS STEEL PIPES, COMPLYING WITH ANSI/ASME B36.19M AND B16.9, RESPECTIVELY. ALL WELDS TO AS4041, BUTT WELDS TO BE FULL PENETRATION TO AS1554.1.
SS316SW	STAINLESS STEEL GRADE 316 SPIRAL WOUND. SW STAINLESS STEEL PIPES TO BE FABRICATED FROM GRADE 316 STAINLESS STEEL, MANUFACTURED IN ACCORDANCE WITH THE REQUIREMENTS SET OUT IN AS 4041 FOR CLASS 3 PIPING OR OTHER AGREED MANUFACTURERS STANDARDS. ALL WELDS TO AS4041, BUTT WELDS TO BE FULL PENETRATION TO AS1554.1.
SS316TUB	STAINLESS STEEL GRADE 316 TUBING (AIR). TUBING WILL BE MANUFACTURED FROM GRADE 316 STAINLESS STEEL SEAMLESS TUBE AND FITTINGS. SUITABLE FOR USE WITH PROPRIETARY COMPRESSION FITTINGS.

PLANT SERVICE CODES - PROCESS

CODE	DESCRIPTION
CMA	COMPRESSED AIR
AEA	AERATION/BLOWER AIR
ASC	AIR SCOUR
ASW	AIR SATURATED WATER
BWW	BACKWASH WATER
CEN	CENTRATE
DGG	DIGESTER GAS
DGS	DIGESTED SLUDGE
DRN	DRAIN
DSN	DIGESTER SUPERNATANT
EF	EFFLUENT
FIL	FILTRATE
FIW	FILTERED WATER
FWS	FIRE WATER SERVICE / HYDRANT SUPPLY
FLA	FOUL AIR
FTW	FOUL WATER
GAS	NATURAL GAS
GSL	GRIT SOLUTION
GSN	GRIT SUPERNATANT
HTW	HOT WATER
INA	INSTRUMENT AIR
MLQ	MIXED LIQUOR
MLR	MIXED LIQUOR RETURN
PER	PERMEATE
PRW	SERVICE WATER (PROCESS WATER)
PTW	POTABLE WATER
RAS	RETURN ACTIVATED SLUDGE
RAW	RAW WATER
REW	RECYCLED WATER / REUSE WATER
SCM	SCUM
SCN	SCREENINGS
SW	RAW SEWAGE
SLG	SLUDGE
SSN	SLUDGE SUPERNATANT
SRS	SCREENED RAW SEWAGE
STW	STORMWATER
WWW	WASTE WASHWATER
WAS	WASTE ACTIVATED SLUDGE
OF	OVERFLOW
VEN	VENT
DRA	DRAIN
BR	BRINE
MIT	MIT AIR
NS	NEUTRALISED SOLUTION
OS	OFF / OUT SPEC WATER
IW	PLANT SERVICE WATER (INDUSTRIAL WATER)

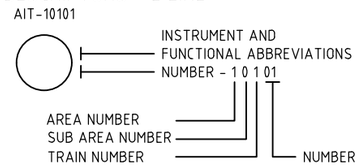
PLANT SERVICE CODES - CHEMICAL

CODE	DESCRIPTION
PAC	POWDER ACTIVATED CARBON
ACS	ACTIVATED CARBON SLURRY
ALC	ALUMINIUM CHLOROHYDRATE
ALS	ALUMINIUM SULPHATE (ALUM)
CI	CITRIC ACID
CDG	CARBON DIOXIDE GAS
CLG	CHLORINE GAS
CLL	CHLORINE LIQUID
CLS	CHLORINE SOLUTION
ETS	ETHANOL SOLUTION
ETL	ETHANOL LIQUID
FE	FERRIC OR FERROUS CHLORIDE SOLUTION
FSA	FLUOROSILIC ACID (HYDROFLUOROSILIC)
FLP	SODIUM FLUORIDE POWDER
FLS	SODIUM FLUORIDE SOLUTION
FA	FORMIC ACID
HCA	HYDROCHLORIC ACID
HLP	HYDRATED LIME POWDER
LIS	LIME SOLUTION
MHL	MAGNESIUM HYDROXIDE LIQUID
MO	MOLASSESS
NA	SODIUM HYDROXIDE (CAUSTIC SODA)
NUT	NUTRIENT (PROPRIETARY)
PHA	PHOSPHORIC ACID
POS	POLYMER SOLUTION
QLIP	QUICK LIME POWDER
SBI	SODIUM BISULPHATE
SH	SODIUM HYPOCHLORITE
SUA	SULPHURIC ACID
SUC	SUCROSE (SUGAR)
SBA	SODIUM BISULPHATE
PP	POTASSIUM PERMANGANATE

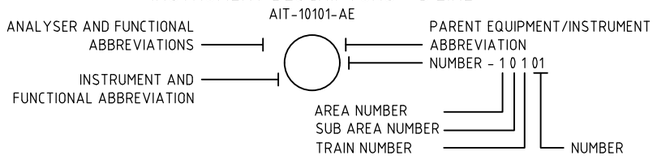
PLANT AREA CODES

CODE	DESCRIPTION	CODE	DESCRIPTION
0	GENERAL	0	GENERAL
		1	STORM POND AND PUMPING STATION
		2	COMPRESSED AIR
		3	SERVICE WATER
		4	POTABLE WATER
		5	BUNDS
		6	ODOUR CONTROL
		7	SOUTH STP TRANSFER PS
1	PRELIMINARY TREATMENT	0	SEPTAGE RECEIVAL
		1	INLET WORKS RECEIVAL CHAMBER
		2	INLET WORKS SCREENING
		3	INLET WORKS GRIT REMOVAL
		4	INLET WORKS SCREENINGS WASHING
		5	FOUL WATER PUMPING STATION
2	SECONDARY TREATMENT	0	BIOREACTOR
		1	EFFLUENT BALANCE TANK
		2	MIXED LIQUOR RETURN
		3	BIO-SELECTOR BLOWERS
3	TERTIARY TREATMENT	0	RECYCLED WATER TREATMENT
		1	CHLORINE CONTACT TANKS
		2	EFFLUENT UV DISINFECTION
6	SLUDGE DIGESTION	0	WASTE ACTIVATED SLUDGE
		1	AEROBIC DIGESTER
7	BIOSOLIDS	0	DWAS FEED PUMPING STATION
		1	DEWATERING SCREW PRESSES
		2	SLUDGE OUTLOADING
8	CHEMICALS	0	ALUM
		1	SODIUM HYDROXIDE
		2	CHLORINE
		3	DEWATERING POLYMER

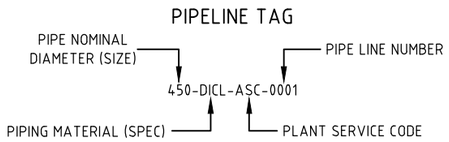
INSTRUMENT DESCRIPTORS - 2 LINE



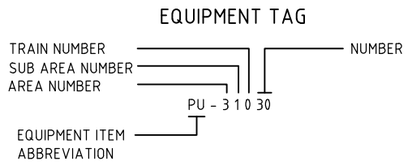
INSTRUMENT DESCRIPTORS - 3 LINE



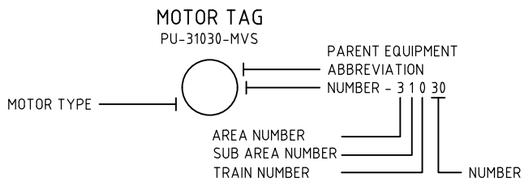
PIPELINE TAG



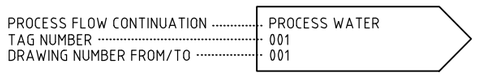
EQUIPMENT TAG



MOTOR TAG



PAGE CONNECTORS



NOT FOR CONSTRUCTION

AMENDMENTS			
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB
Ver	Date	Description	Drawn

beca hunterh2o the future of water

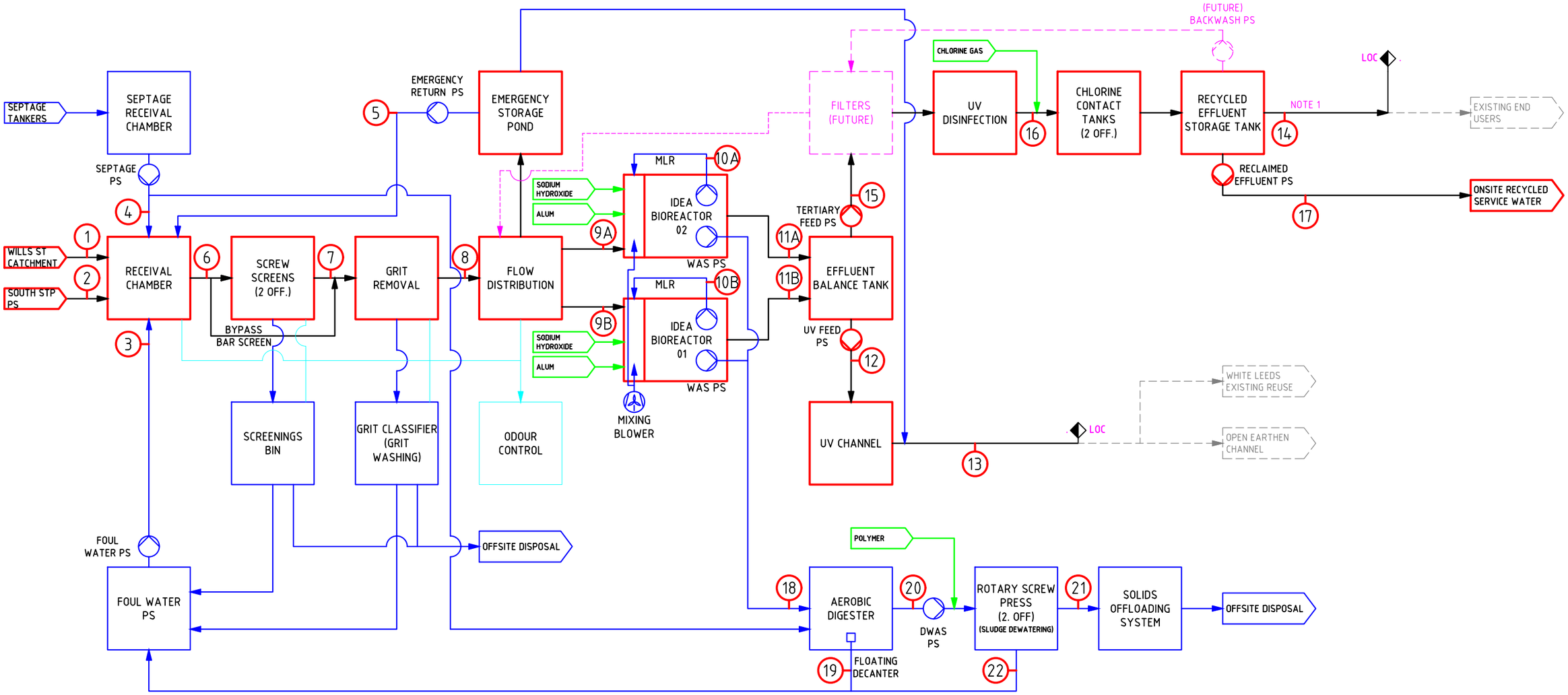
Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
INDEX SHEET 04

Scale	Document No
NTS at A3	7015-004-P-005
Status: PRELIMINARY	Version: C

NOTES:
1. EFFLUENT REUSE PUMPS TAKE EFFLUENT FROM THE RECYCLED EFFLUENT STORAGE TANK DIRECTLY.



CHEMICAL DOSING SYSTEM
PRIMARY TREATMENT PROCESS
WASTE/ANCILLARY PROCESS
FUTURE
ODOUR CONTROL
EXISTING

NOT FOR CONSTRUCTION

AMENDMENTS			
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB
Ver	Date	Description	Drawn

beca hunterh2o the future of water

Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN

PROCESS FLOW DIAGRAM

Scale	Document No
NTS at A3	7015-004-P-006
Status: PRELIMINARY	Version: C

Plot Date: 10/12/24 - 09:30 Cad File: P:\HH2O\Essential Energy\Broken Hill STP Concept and Detailed Design\PID DWGS\1 - CURRENT WORKING\7015-004 BROKEN HILL STP CD\PID DWG\DWGs\7015-004-P-006 PROCESS FLOW DIAGRAM.dwg

Ver.1.00

NO.		1	2	3	4	5	6	7	8	9A	9B	10A	10B	11A	11B	12	13	14	15	16	17	18	19	20	21	22	23
STREAM DESCRIPTION	UNITS	WILL STREET INLET FLOW	SOUTH WWTP SPS INLET FLOW	FWPS	SEPTAGE TRANSFER FLOW	EMERGENCY RETURN FLOW	SCREEN INLET FLOW	GRIT INLET FLOW	FLOW DISTRIBUTIO N INLET	IDEA 1 INLET FLOW	IDEA 2 INLET FLOW	IDEA 1 RAS	IDEA 2 RAS	IDEA1 DECANT FLOW	IDEA2 DECANT FLOW	EFFLUENT UV INLET CHANNEL	EFFLUENT OUTFALL	RECYCLED EFFLUENT	TERTIARY FEED FLOW	CCT INLET FLOW	SERVICE WATER FLOW	WAS FLOW	AEROBIC DIGESTER SUPERNATAN T	DWAS FLOW	SLUDGE CAKE PRODUCTION	SLUDGE DEWATERING FILTRATE	BIO-SELECTOR MIXING BLOWER
DESIGN FLOW																											
MAX INSTANTANEOUS	L/s	388	**56**	28	8	28	480	480	480	240	240	50	50	713	713	371	483	39	39	39	24	10	13	6	0.4	10	75
ADWF	m^3/d	3,792	1,008	578	10	-	5,388	5,388	5,388	2,694	2,694	2,400	2,400	2,484	2,484	2,299	2,299	2,502	2,815	2,815	312	421	279	142	8	201	
PWWF	m^3/d	30,336	8,064	676	-	-	39,076	39,076	39,076	19,538	19,538	4,320	4,320	19,263	19,263	38,392	38,392	-	500	500	500	549	407	142	8	201	
ESTIMATED COMMISSIONING FLOW (DRY WEATHER PERIOD)																											
INSTANTANEOUS FLOW	L/s	66.1	28	28	8	-	130	130	130	65	65	50	50	174.1	174.1	53.0	53.0	-	22.0	22.0	24	10	13	6	-	10	75
ADWF	m^3/d	3172.4	741.7	578	10	-	4,502	4,502	4,502	2,251	2,251	1,957	1,957	2,041	2,041	2204.7	2204.7	1,397.0	1709.4	1709.4	312	421	279	142	8	201	-

ASSUMPTIONS:

1. IT IS ASSUMED THAT THE FILTRATION SYSTEM WILL NOT BE OPERATIONAL DURING PEAK WEATHER DAYS IF IT IS PROVIDED IN THE FUTURE DUE TO THE DECLINE IN THE QUALITY OF THE TREATED EFFLUENT WATER. NO EFFLUENT REUSE IS EXPECTED DURING WET WEATHER DAYS. THEREFORE, ADDITIONAL POTABLE WATER IS NEEDED FOR SERVICE WATER APPLICATION.
2. WE HAVE ASSUMED A RAINFALL EVENT OF 59MM PER HOUR FOR THE MAXIMUM INSTANTANEOUS DECANTING FLOW CALCULATION. THE UV FEED PUMP STATION HAS BEEN SIZED AT 6XADWF PLUS THE RAINFALL FROM ONE OF THE REACTORS AND THE EFFLUENT BALANCE TANK.
3. WAS FLOW HAS BEEN ASSUMED TO BE WASTED DURING THE REACTION PHASE OF EACH CYCLE, AND THE ACTUAL WAS FLOW WOULD BE LESS IF WASTING OCCURS DURING THE SETTLING AND DECANTING PHASE, AND THE ACTUAL WAS FLOW IS VARIED DEPENDING ON THE THICKENED WAS CONCENTRATION.

NOT FOR CONSTRUCTION

AMENDMENTS

Ver	Date	Description	Drawn
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB

beca hunterh2o the future of water

Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN

MASS BALANCE

Scale: NTS at A3

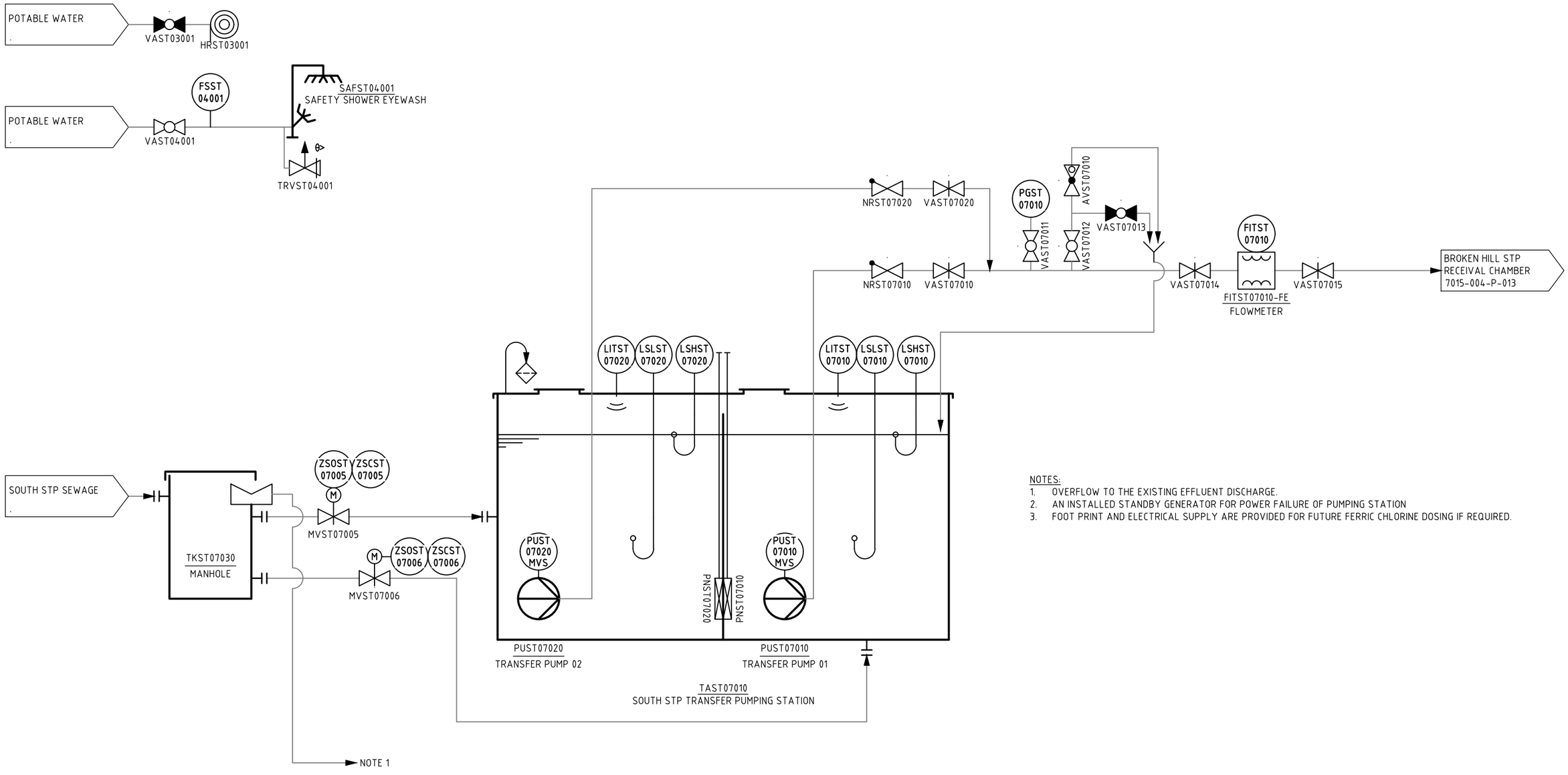
Document No: **7015-004-P-007**

Status: **PRELIMINARY**

Version: **C**

Plot Date: 10/12/24 - 09:30 Cad File: P:\HH2O\Essential Energy\Broken Hill STP Concept and Detailed Design\PID DWGS\1 - CURRENT WORKING\7015-004 BROKEN HILL STP CD\PID DWG\DWGs\7015-004-P-007 MASS BALANCE.dwg

Ver.1.00



NOTES:
1. OVERFLOW TO THE EXISTING EFFLUENT DISCHARGE.
2. AN INSTALLED STANDBY GENERATOR FOR POWER FAILURE OF PUMPING STATION
3. FOOT PRINT AND ELECTRICAL SUPPLY ARE PROVIDED FOR FUTURE FERRIC CHLORINE DOSING IF REQUIRED.

NOT FOR CONSTRUCTION

AMENDMENTS			
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB
Ver	Date	Description	Drawn

beca hunterh2o the future of water

Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

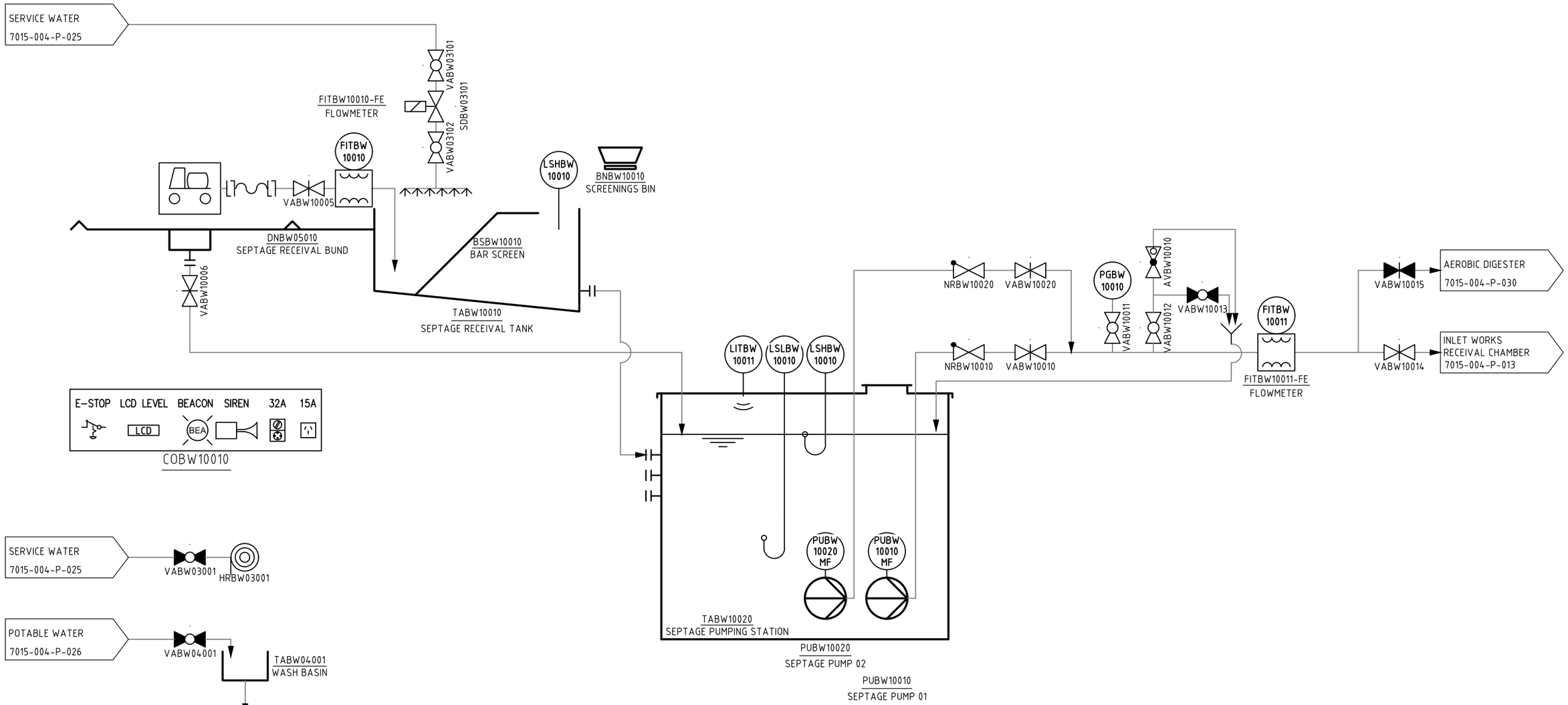
essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
SOUTH WWTP TRANSFER PUMPING STATION

Scale	Document No
NTS at A3	7015-004-P-010
Status: PRELIMINARY	Version: C

Plot Date: 10/12/24 - 09:30 Cad File: P:\HH2O\Essential Energy\Broken Hill STP Concept and Detailed Design\PID DWGS\1 - CURRENT WORKING\7015-004 BROKEN HILL STP CD\PID DWG\DWGs\7015-004-P-010 SOUTH WWTP TRANSFER PS.dwg

Ver.1.00



NOT FOR CONSTRUCTION

AMENDMENTS			
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB
Ver	Date	Description	Drawn

beca hunterh2o
the future of water

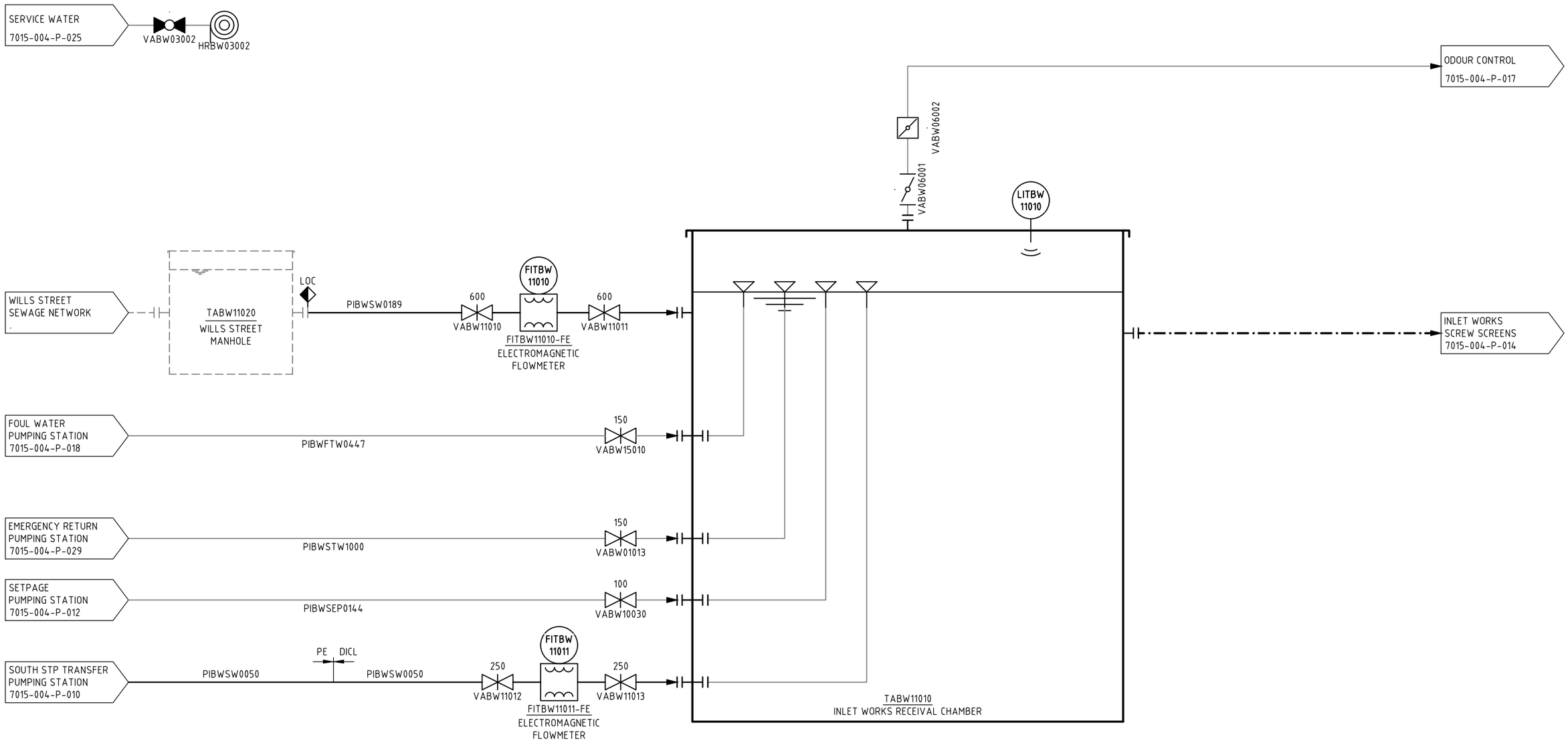
Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
INLET WORKS SEPTAGE RECEIVAL

Scale	Document No
NTS at A3	7015-004-P-012
Status: PRELIMINARY	Version: C

Plot Date: 10/12/24 - 09:30 Cad File: P:\HH2O\Essential Energy\Broken Hill STP Concept and Detailed Design\PID DWGS\1 - CURRENT WORKING\7015-004 BROKEN HILL STP CD\PID DWG\DWGs\7015-004-P-012 INLET WORKS SEPTAGE RECEIVAL.dwg



NOT FOR CONSTRUCTION

AMENDMENTS			
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB
Ver	Date	Description	Drawn

beca hunterh2O
the future of water

Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
INLET WORKS RECEIVAL CHAMBER

Scale	Document No
NTS at A3	7015-004-P-013
Status: PRELIMINARY	Version: C

Plot Date: 10/12/24 - 09:30 Cad File: P:\HH2O\Essential Energy\Broken Hill STP Concept and Detailed Design\PID DWGS\1 - CURRENT WORKING\7015-004 BROKEN HILL STP CD\PID DWG\DWGs\7015-004-P-013 INLET WORKS RECEIVAL CHAMBER.dwg

Ver.1.00

POTABLE WATER BACKUP
7015-004-P-026

50 VABW04008 50 RPZBW04008 PIBWPTW0247

ZSOBW 04008 / ZSCBW 04008
M NC
50 MVBW04008

SERVICE WATER
7015-004-P-025

PIBWPRW0250

PRSLBW 03110

SERVICE WATER GRIT REMOVAL
7015-004-P-015

PIBWPRW0216 — 25x80 25 VABW03110 — FSLBW 03110 — 25 SDBW03110
PIBWPRW0207 — 25x80 25 VABW03111 — FSLBW 03111 — 25 SDBW03111
PIBWPRW0219 — 25x80 25 VABW03120 — FSLBW 03120 — 25 SDBW03120
PIBWPRW0205 — 25x80 25 VABW03121 — FSLBW 03121 — 25 SDBW03121

INLET WORKS RECIEVAL CHAMBER
7015-004-P-013

LITBW 12010

LSHBW 12010 NOTE 1

INLET WORKS ODOUR CONTROL
7015-004-P-017

PGBW 03110 — VABW06003 — PGBW 03111 — DSNBW 12010 MVS — WSHBW 12010
PGBW 03120 — VABW06005 — PGBW 03121 — DSNBW 12020 MVS — WSHBW 12020

ZSOBW 12010 / ZSCBW 12010 — M — STBBW12010 — MPKBW12010 — DSNBW12010 SCREW SCREEN 01 — ZSOBW 12011 / ZSCBW 12011 — M — MPKBW12011 — STBBW12011

ZSOBW 12020 / ZSCBW 12020 — M — STBBW12020 — MPKBW12020 — DSNBW12020 SCREW SCREEN 02 — ZSOBW 12021 / ZSCBW 12021 — M — MPKBW12021 — STBBW12021

NOTES:
1. OVERFLOW WEIR WITH INTEGRATED BAR SCREEN.

SCVBW 12010 MFR — WSHBW 12030 — SCVBW12010 SCREW CONVEYOR — BNBW12010 SCREENINGS BIN

LITBW 12011

INLET WORKS GRIT REMOVAL
7015-004-P-015

SERVICE WATER
7015-004-P-025

VABW03003 — HRBW03003
VABW03004 — HRBW03004
VABW03005 — HRBW03005

NOT FOR CONSTRUCTION

AMENDMENTS			
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB
Ver	Date	Description	Drawn

beca hunterh2O the future of water

Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

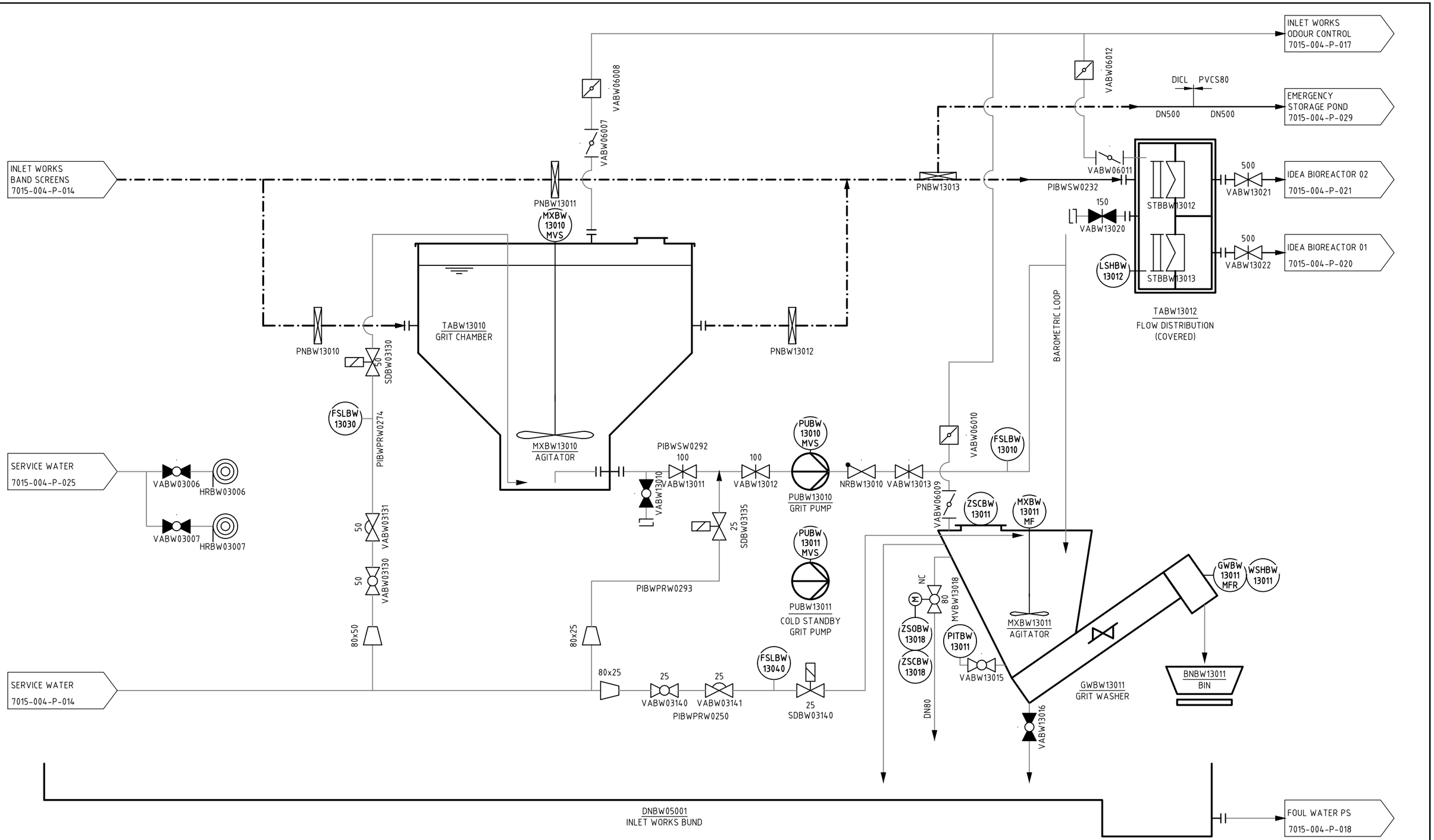
essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
INLET WORKS SCREW SCREENS

Scale: NTS at A3
Document No: 7015-004-P-014
Status: PRELIMINARY
Version: C

Plot Date: 10/12/24 - 09:30 Cad File: P:\HH2O\Essential Energy\Broken Hill STP Concept and Detailed Design\PID DWGS\1 - CURRENT WORKING\7015-004 BROKEN HILL STP CD\PID DWG\DWGs\7015-004-P-014 INLET WORKS SCREW SCREENS.dwg

Ver.1.00



NOT FOR CONSTRUCTION

AMENDMENTS			
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB
Ver	Date	Description	Drawn

beca hunterh2o
the future of water

Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

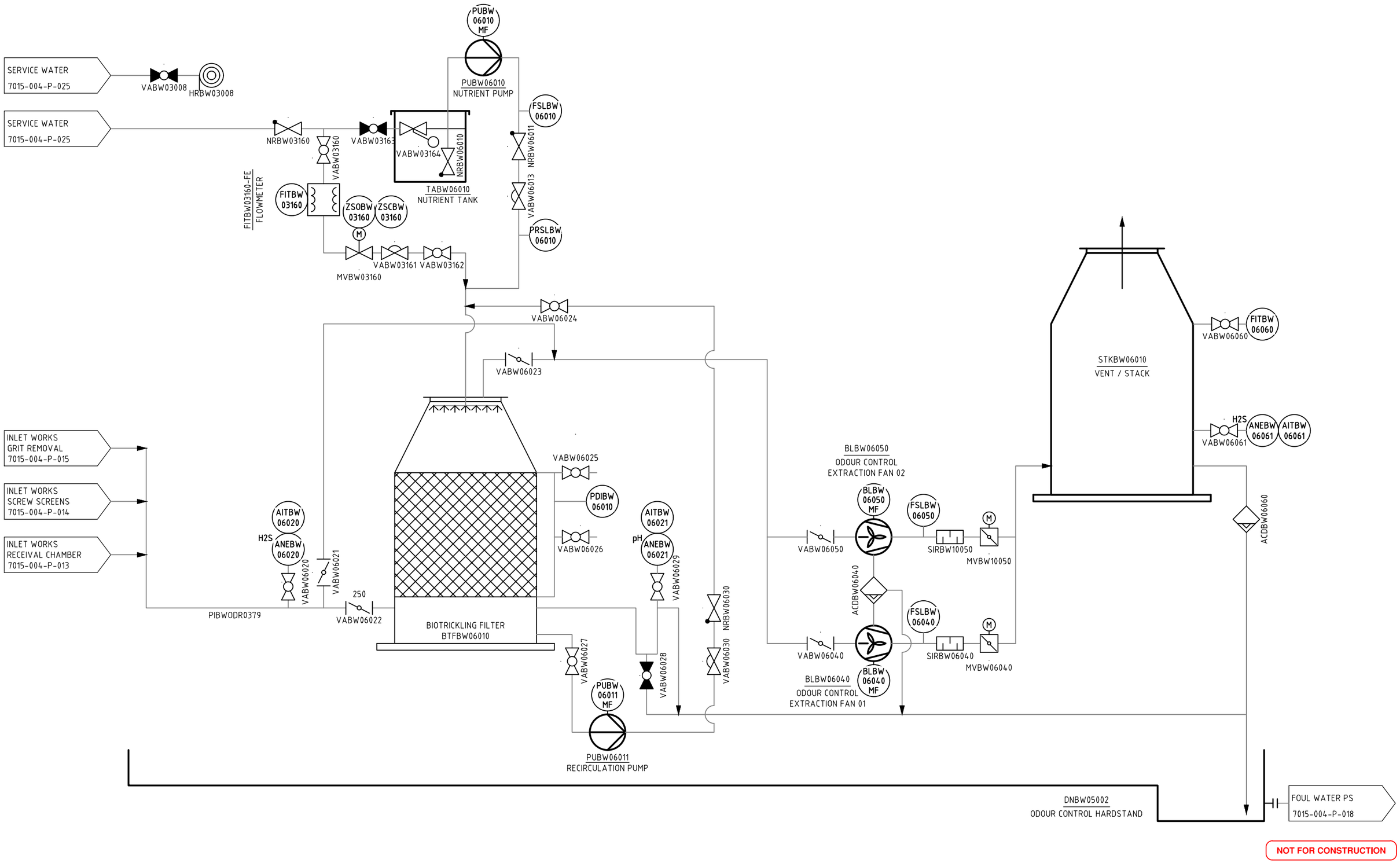
essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
INLET WORKS GRIT REMOVAL

Scale	Document No
NTS at A3	7015-004-P-015
Status: PRELIMINARY	Version: C

Plot Date: 10/12/24 - 09:30 Cad File: P:\HH2O\Essential Energy\Broken Hill STP Concept and Detailed Design\PID DWGS\1 - CURRENT WORKING\7015-004 BROKEN HILL STP CD\PID DWG\DWGs\7015-004-P-015 INLET WORKS GRIT REMOVAL.dwg

Ver.1.00



NOT FOR CONSTRUCTION

AMENDMENTS			
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB
Ver	Date	Description	Drawn

beca hunterh2o
the future of water

Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
INLET WORKS ODOUR CONTROL SYSTEM

Scale	Document No
NTS at A3	7015-004-P-017
Status: PRELIMINARY	Version: C

Plot Date: 10/12/24 - 09:30 Cad File: P:\HH2O\Essential Energy\Broken Hill STP Concept and Detailed Design\PID DWGS\1 - CURRENT WORKING\7015-004 BROKEN HILL STP CD\PID DWG\DWGs\7015-004-P-017 INLET WORKS ODOUR CONTROL SYSTEM.dwg

Ver.1.00

BIO SELECTOR MIXING BLOWERS

BLBW23211 CABINET FAN
PRSLBW 23210
BLBW 23210 MVS
PRSHBW 23210
PGBW 23210
SIRBW23211
TSHBW 23210
PRFBW23210
VABW23210
VABW23211
VABW23212
FIBW23210
SIRBW23210
BLBW23210 MIXING BLOWER 02
VPKBW23210 VENDOR PACKAGE 02
NRBW23210
BLBW 23211 MF

BLBW23111 CABINET FAN
PRSLBW 23110
BLBW 23110 MVS
PRSHBW 23110
PGBW 23110
SIRBW23111
TSHBW 23110
PRFBW23110
VABW23110
VABW23111
VABW23112
FIBW23110
SIRBW23110
BLBW23110 MIXING BLOWER 01
VPKBW23110 VENDOR PACKAGE 01
NRBW23110
BLBW 23111 MF

ZSCBW 23210
ZSOBW 23210
100 MVBW23210
PIBWAEA0511
BIO-SELECTOR MIXING BIOREACTOR 02 7015-004-P-021

ZSCBW 23110
ZSOBW 23110
100 MVBW23110

PIBWAEA0511

SODIUM HYDROXIDE DOSING SYSTEM 7015-004-P-041
VABW81105
PSVBW81105

ALUM DOSING SYSTEM 7015-004-P-040
VABW80105
PSVBW80105

SERVICE WATER 7015-004-P-025
VABW03010
HRBW03010
VABW03011
HRBW03011
VABW03012
HRBW03012

50 VABW23115
50 VABW23116
50 VABW23117
50 VABW23118
50 VABW23119
50 VABW23120
VABW80106
VABW81106
MXBW 20110 MVS

AITBW 20110
LITBW 20110
pH ANEBW 20110
MXBW 20111 MVS
AITBW 20110
DO ANEBW 20110
AITBW 20111
DO ANEBW 20111
MXBW 20112 MVS
LSHBW 20110
LSLBW 20110
LSHHBW 20110
MXBW 20114 MVS

ZHHBW 20112
ZLBW 20112
ZHBW 20112
ZLLBW 20112
WSHBW 20112
TABW 20112 MVR
LSWBW 20112
TABW20112 ROTARY DECANTER A

ZHHBW 20111
ZLBW 20111
ZHBW 20111
ZLLBW 20111
WSHBW 20111
TABW 20111 MVR
LSWBW 20111
TABW20111 ROTARY DECANTER B

MXBW20110 SURFACE AERATOR 01
MXBW20111 SURFACE AERATOR 02
MXBW20112 SURFACE AERATOR 03
MXBW20114 SURFACE AERATOR 04

EFFLUENT BALANCE TANK 7015-004-P-022
EFFLUENT BALANCE TANK 7015-004-P-022

INLET WORKS FLOW DISTRIBUTION 7015-004-P-015
FITBW 20110
PIBWSW0300 500
VABW20110
FITBW20110-FE IDAL BIOREACTOR 01 INLET FLOWMETER

BIO-SELECTOR

TABW20110 IDEA BIOREACTOR 01

PUBW 22120 MVS
PUBW22120 RAS PUMP 02
PUBW 22110 MVS
PUBW22110 RAS PUMP 01
PUBW 60110 MVS
PUBW60110 WAS PUMP 01
PUBW 60120 MVS
PUBW60120 WAS PUMP 02

PGBW 22120
VABW22120
200 200 VABW22121 NRBW22120
PGBW 22110
VABW22110
200 200 VABW22111 NRBW22110
PGBW 60120
VABW60110
100 100 VABW60111 NRBW60110
PGBW 60110
VABW60120
100 100 VABW60121 NRBW60120

AEROBIC DIGESTER OVERFLOW WEIR 7015-004-P-030

PIBWMLR0539
200 VABW22113
FITBW 22110
200 VABW22112
FITBW22110-FE RAS RECYCLE FLOWMETER

PIBWWAS0541
100 VABW60112
FITBW 60110
100 VABW60113
FITBW60110-FE WAS FLOWMETER

AEROBIC DIGESTER 7015-004-P-030

NOT FOR CONSTRUCTION

AMENDMENTS			
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB
Ver	Date	Description	Drawn

beca hunterh2o the future of water

Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

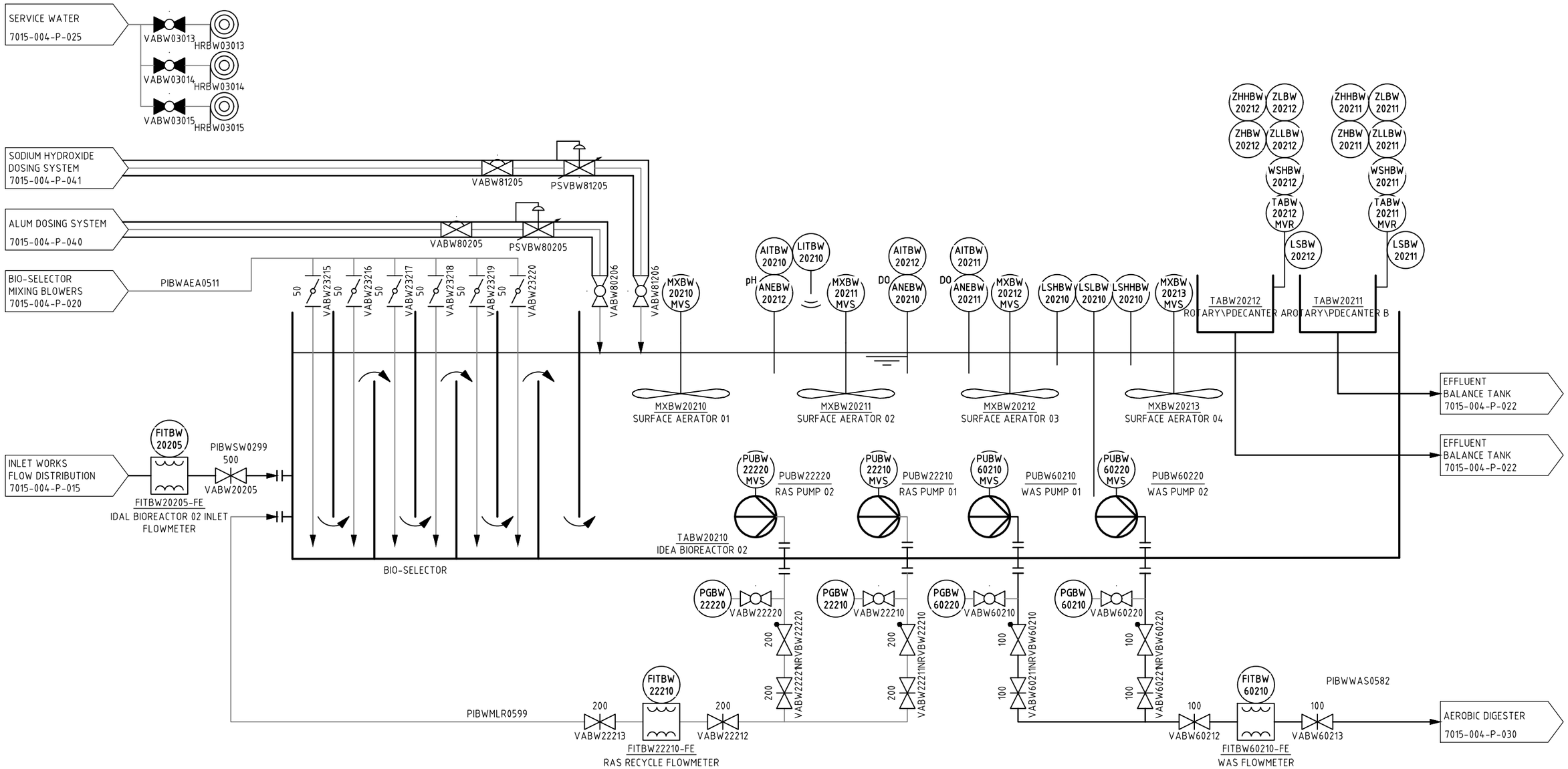
essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
IDEA BIOREACTOR 01

Scale: NTS at A3
Document No: 7015-004-P-020
Status: PRELIMINARY
Version: C

Plot Date: 10/12/24 - 09:30 Cad File: P:\HH2O\Essential Energy\Broken Hill STP Concept and Detailed Design\PID DWGS\1 - CURRENT WORKING\7015-004 BROKEN HILL STP CD\PID DWG\DWGs\7015-004-P-020 IDEA BIOREACTOR 01.dwg

Ver.1.00



NOT FOR CONSTRUCTION

AMENDMENTS			
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB
Ver	Date	Description	Drawn

beca hunterh2o
the future of water

Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

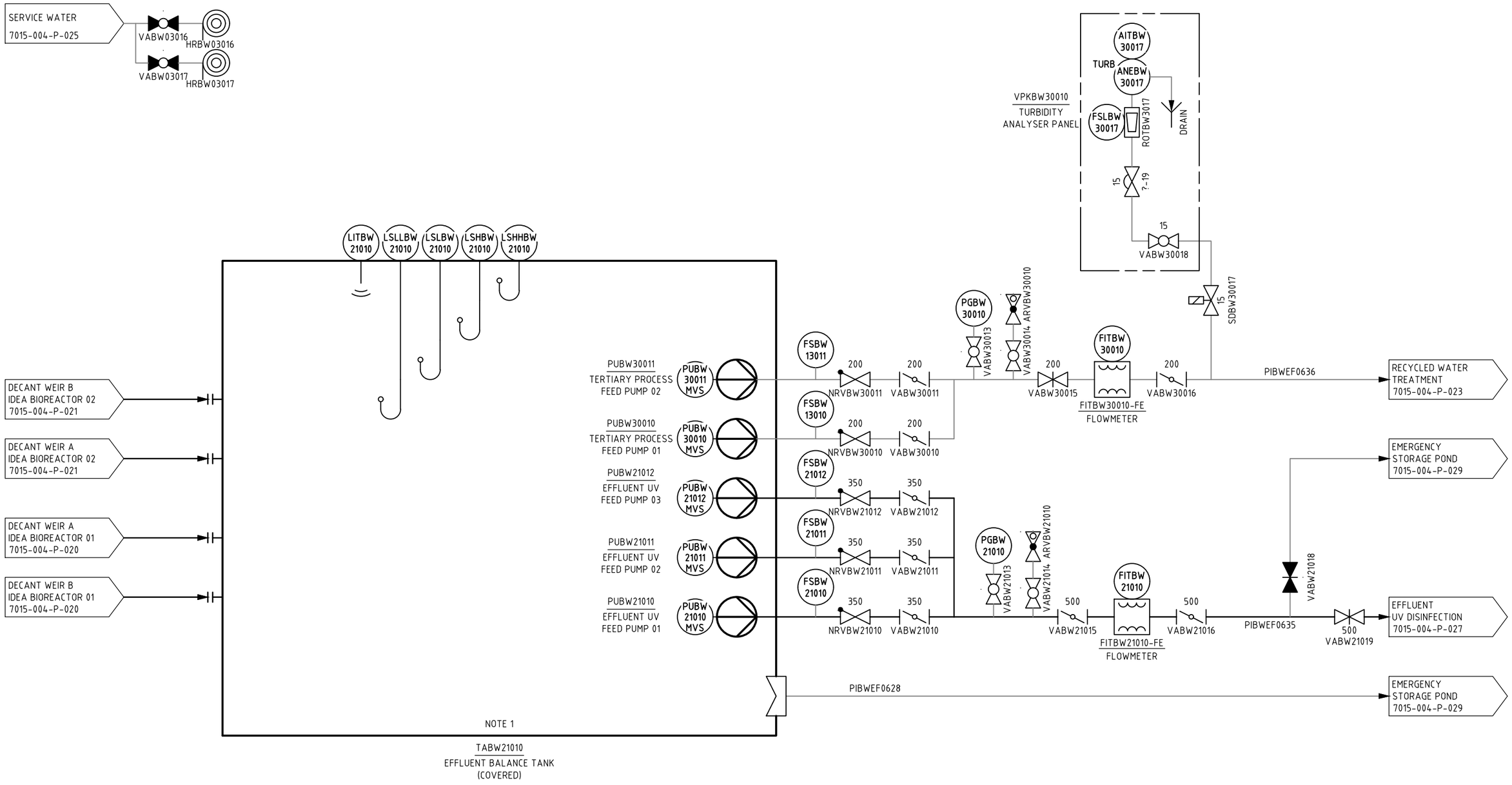
essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
IDEA BIOREACTOR 02

Scale	Document No
NTS at A3	7015-004-P-021
Status: PRELIMINARY	Version: C

Plot Date: 10/12/24 - 09:30 Cad File: P:\HH2O\Essential Energy\Broken Hill STP Concept and Detailed Design\PID DWGS\1 - CURRENT WORKING\7015-004 BROKEN HILL STP CD\PID DWG\DWGs\7015-004-P-021 IDEA BIOREACTOR 02.dwg

Ver.1.00



NOTES:
1. EFFLUENT BALANCE TANK IS COVERED WITH A SUN SHADE TO MINIMISE ALGAE GROWTH.

NOT FOR CONSTRUCTION

AMENDMENTS			
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB
Ver	Date	Description	Drawn

beca hunterh2o
the future of water

Designed	BM	Checked	PG
Drawn	SRB	**Checked**	
Approved			
Date			
HH2O Project Number	7015-004		

essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
EFFLUENT BALANCE TANK

Scale	Document No
NTS at A3	7015-004-P-022
Status: PRELIMINARY	Version: C

CHLORINE
DOSING SYSTEM
7015-004-P-044

SERVICE WATER
7015-004-P-025

VABW03018

HRBW03018

AITBW 41201
UVI
ANEBW 41201

25
VABW41202

25
AVBW41201
NOTE 2

ZSCBW 41201
ZSOBW 41201
M

50
VABW41203

PIBWEF0693

200
VABW41201

200x400

50
VABW41204

UVBW41201
UV REACTOR 02

400x200

200
MVBW41201

PIBWEF0684

200
VABW41206

50
VABW41205

AITBW 41001
UVT
ANEBW 41001

25
VABW41001

NOTE 1

EFFLUENT
BALANCE TANK
7015-004-P-022

200
VABW41101

PIBWEF0694

AITBW 41101
UVI
ANEBW 41101

25
VABW41102

25
AVBW41101
NOTE 2

50
VABW41103

200x400

50
VABW41104

UVBW41101
UV REACTOR 01

400x200

ZSCBW 41101
ZSOBW 41101
M

200
MVBW41101

PIBWEF0683

200
VABW41106

250
NRBW41101

25
VABW62001

DSLBW62001

SMXBW41101

CHLORINE CONTACT
TANKS
7015-004-P-024

VABW41010

50
VABW41105

NOTE 1

VPKBW41110
VENDOR PACKAGE

RECYCLED WATER PS
7015-004-P-025

NOTES:
1. A SITE FOOTPRINT HAS BEEN PROVIDED FOR A FUTURE FILTRATION SYSTEM IS REQUIRED.

NOT FOR CONSTRUCTION

AMENDMENTS			
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB
Ver	Date	Description	Drawn

Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
RECYCLED WATER TREATMENT

Scale: NTS at A3

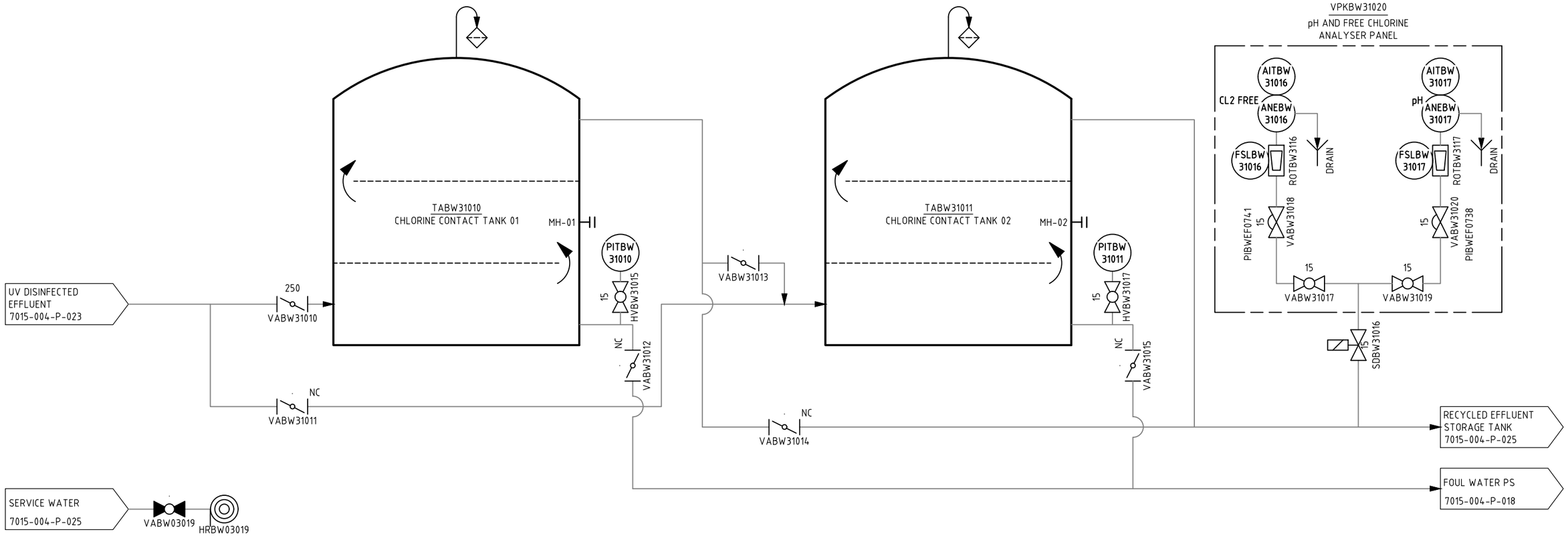
Document No: 7015-004-P-023

Status: PRELIMINARY

Version: C

Plot Date: 10/12/24 - 09:30 Cad File: P:\HH2O\Essential Energy\Broken Hill STP Concept and Detailed Design\PID DWGS\1 - CURRENT WORKING\7015-004 BROKEN HILL STP CD\PID DWG\DWGs\7015-004-P-023 RW TREATMENT.dwg

Ver.1.00



NOT FOR CONSTRUCTION

AMENDMENTS			
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB
Ver	Date	Description	Drawn

beca hunterh2O
the future of water

Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

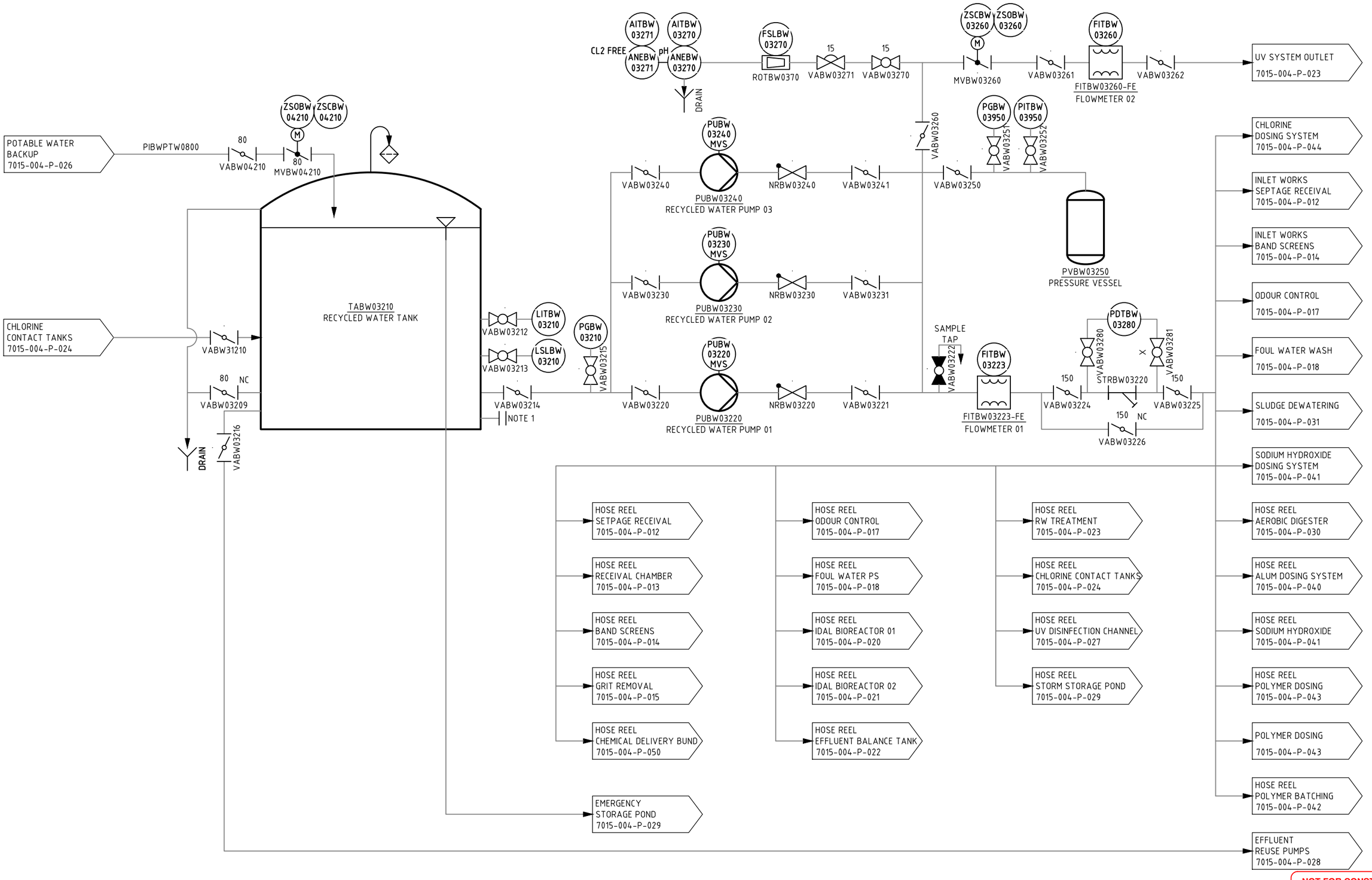
essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
RECYCLED WATER CHLORINE CONTACT TANKS

Scale	Document No
NTS at A3	7015-004-P-024
Status: PRELIMINARY	Version: C

Plot Date: 10/12/24 - 09:30 Cad File: P:\HH2O\Essential Energy\Broken Hill STP Concept and Detailed Design\PID DWGS\1 - CURRENT WORKING\7015-004 BROKEN HILL STP CD\PID DWG\DWGs\7015-004-P-024 RW CHLORINE CONTACT TANKS.dwg

Ver.1.00



AMENDMENTS			
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB
Ver	Date	Description	Drawn

beca hunterh2o the future of water

Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

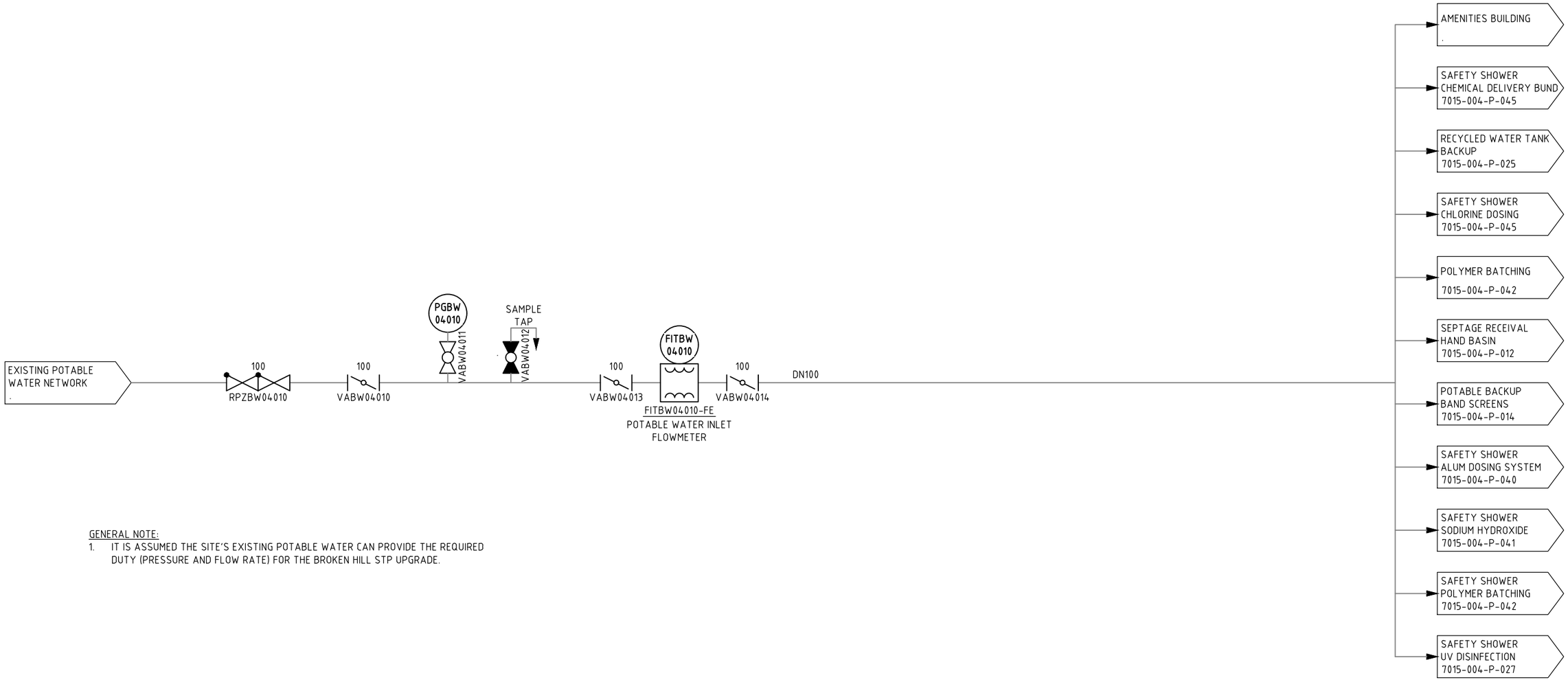
essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
SERVICE WATER SYSTEM

Scale	Document No
NTS at A3	7015-004-P-025
Status: PRELIMINARY	Version: C

Plot Date: 10/12/24 - 09:30 Cad File: P:\HH2O\Essential Energy\Broken Hill STP Concept and Detailed Design\PID DWGS\1 - CURRENT WORKING\7015-004 BROKEN HILL STP CD\PID DWG\DWGs\7015-004-P-025 SERVICE WATER SYSTEM.dwg

Ver.1.00



GENERAL NOTE:

1. IT IS ASSUMED THE SITE'S EXISTING POTABLE WATER CAN PROVIDE THE REQUIRED DUTY (PRESSURE AND FLOW RATE) FOR THE BROKEN HILL STP UPGRADE.

NOT FOR CONSTRUCTION

AMENDMENTS			
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB
Ver	Date	Description	Drawn

beca hunterh2O the future of water

Designed	BM	Checked	PG
Drawn	SRB	**Checked**	
Approved			
Date			
HH2O Project Number	7015-004		

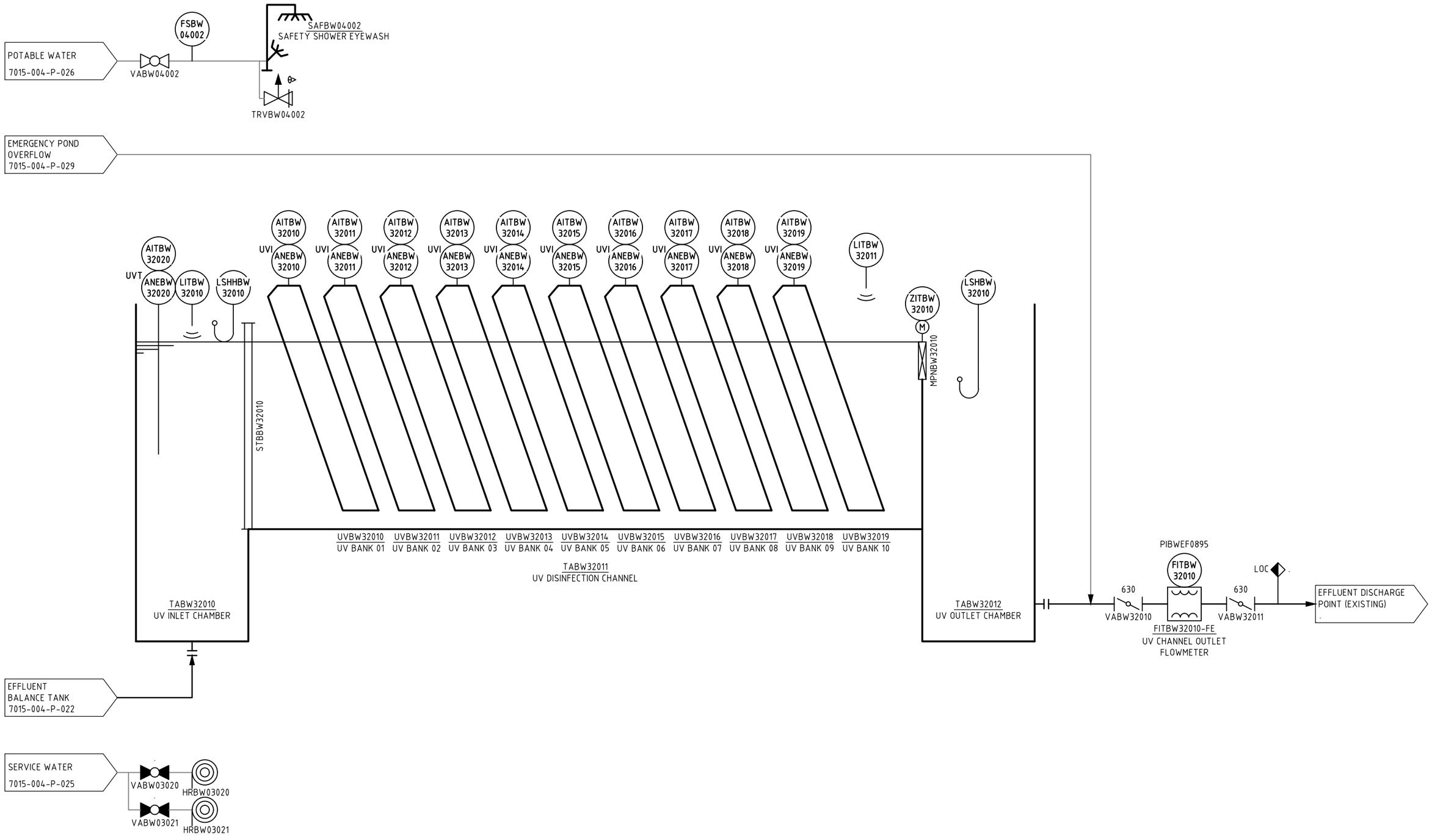
essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
POTABLE WATER SYSTEM

Scale	Document No
NTS at A3	7015-004-P-026
Status: **PRELIMINARY**	Version: **C**

Plot Date: 10/12/24 - 09:30 Cad File: P:\HH2O\Essential Energy\Broken Hill STP Concept and Detailed Design\PID DWGS\1 - CURRENT WORKING\7015-004 BROKEN HILL STP CD\PID DWG\DWGs\7015-004-P-026 POTABLE WATER SYSTEM.dwg

Ver.1.00



NOT FOR CONSTRUCTION

AMENDMENTS			
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB
Ver	Date	Description	Drawn

beca hunterh2o
the future of water

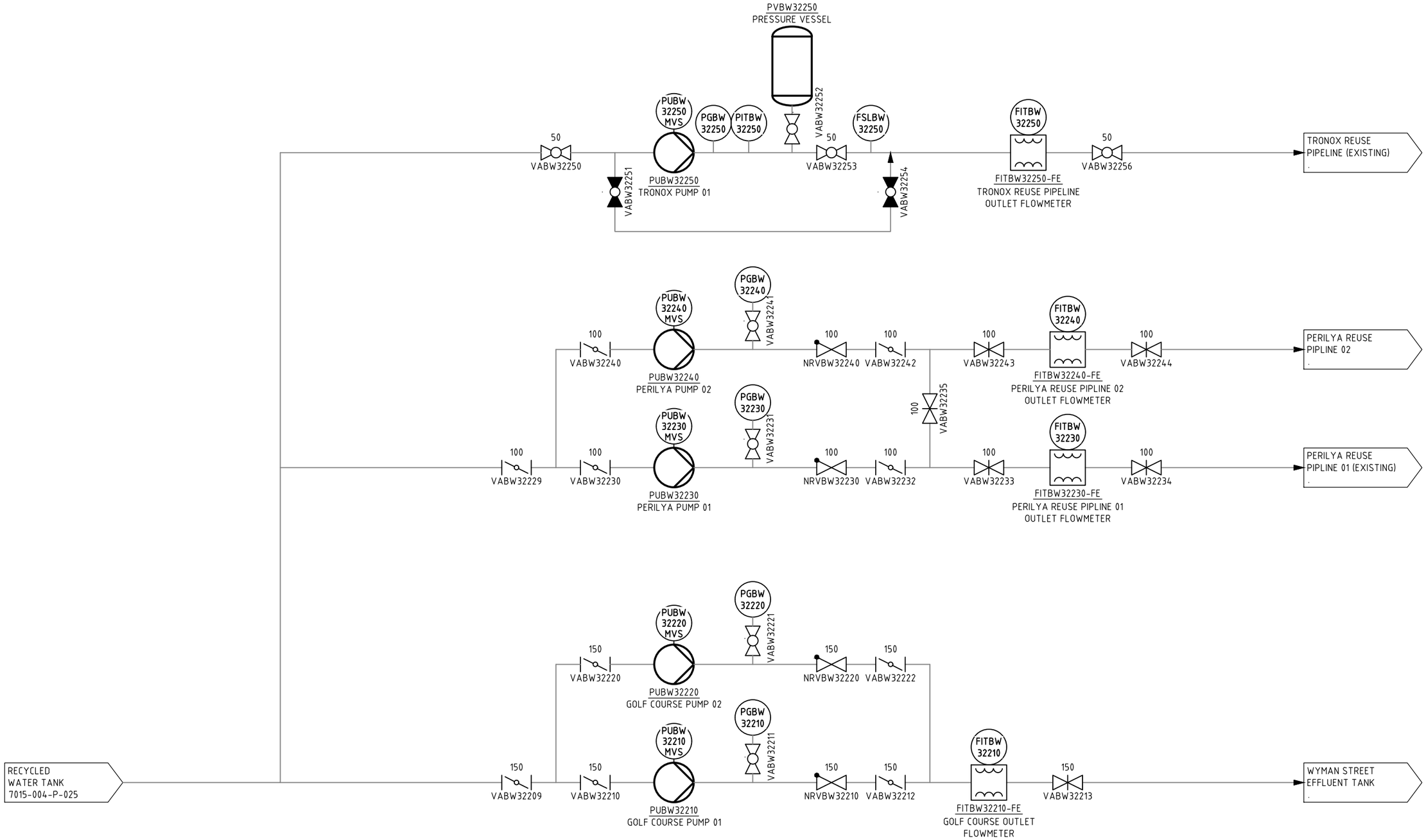
Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
EFFLUENT UV DISINFECTION

Scale	Document No
NTS at A3	7015-004-P-027
Status: PRELIMINARY	Version: C

Plot Date: 10/12/24 - 09:31 Cad File: P:\HH2O\Essential Energy\Broken Hill STP Concept and Detailed Design\PID DWGS\1 - CURRENT WORKING\7015-004 BROKEN HILL STP CD\PID DWG\DWGs\7015-004-P-027 EFFLUENT UV DISINFECTION.dwg
Ver.1.00



NOT FOR CONSTRUCTION

AMENDMENTS			
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB
Ver	Date	Description	Drawn

beca hunterh2o
the future of water

Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

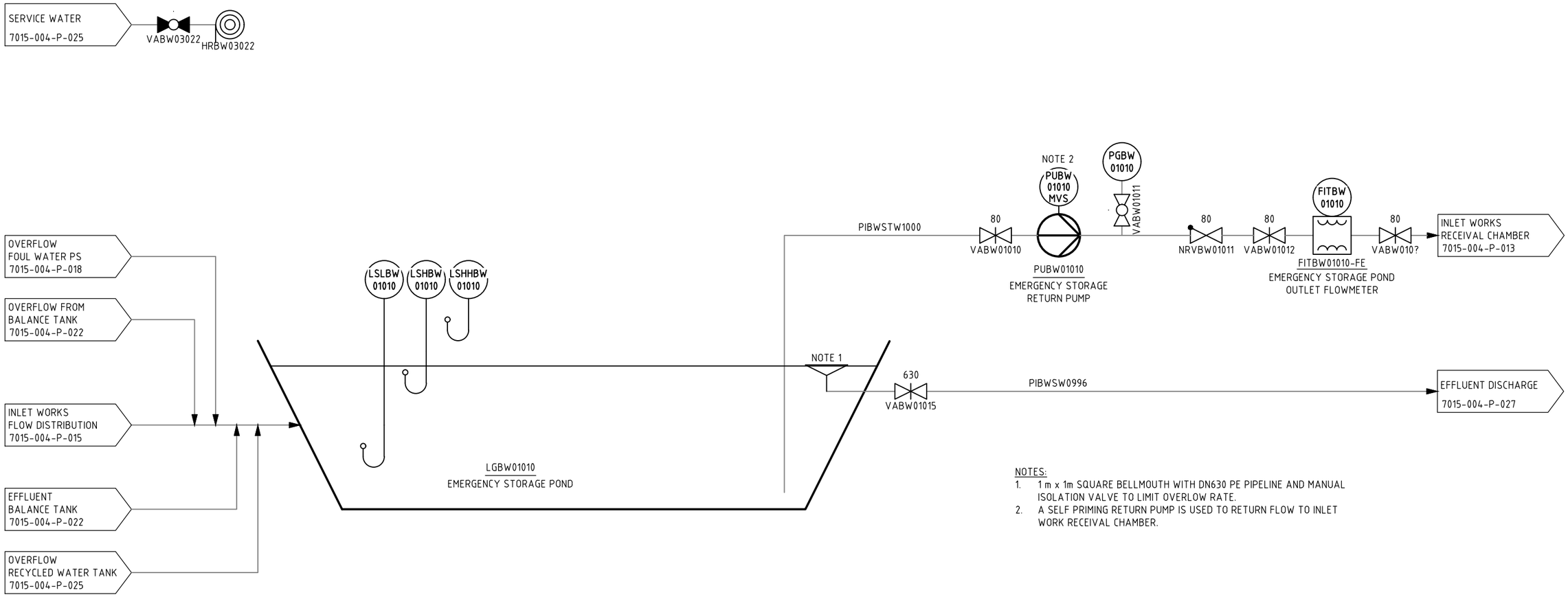
essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
EFFLUENT REUSE PUMPS

Scale	Document No
NTS at A3	7015-004-P-028
Status: PRELIMINARY	Version: C

Plot Date: 10/12/24 - 09:31 Cad File: P:\HH2O\Essential Energy\Broken Hill STP Concept and Detailed Design\PID DWGS\1 - CURRENT WORKING\7015-004 BROKEN HILL STP CD\PID DWG\DWGs\7015-004-P-028 EFFLUENT REUSE PUMPS.dwg

Ver.1.00



NOTES:
1. 1 m x 1m SQUARE BELLMOUTH WITH DN630 PE PIPELINE AND MANUAL ISOLATION VALVE TO LIMIT OVERLOW RATE.
2. A SELF PRIMING RETURN PUMP IS USED TO RETURN FLOW TO INLET WORK RECEIVAL CHAMBER.

NOT FOR CONSTRUCTION

AMENDMENTS			
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB
Ver	Date	Description	Drawn

beca hunterh2o the future of water

Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

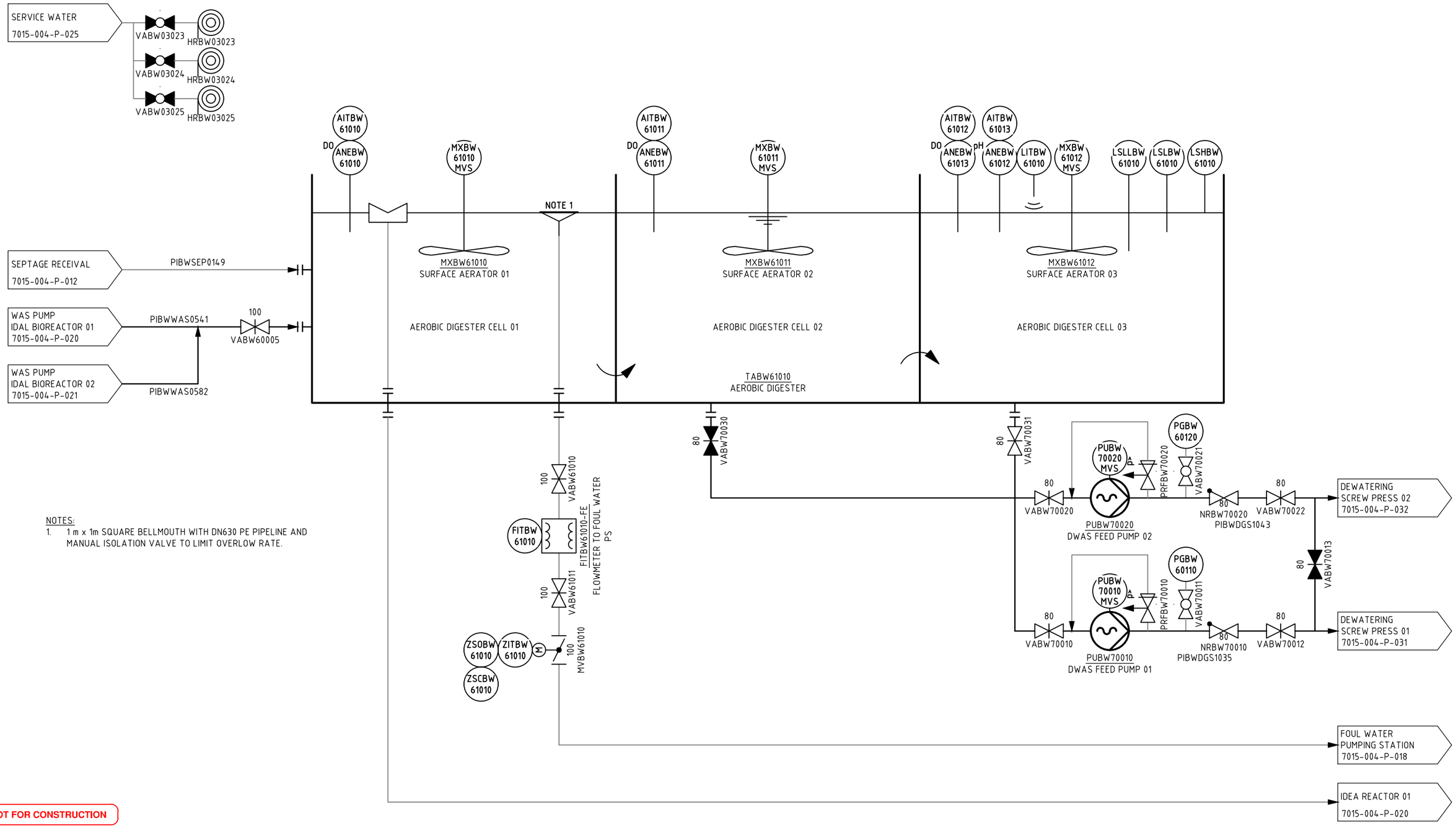
essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
EMERGENCY STORAGE POND

Scale	Document No
NTS at A3	7015-004-P-029
Status: PRELIMINARY	Version: C

Plot Date: 10/12/24 - 09:31 Cad File: P:\HH2O\Essential Energy\Broken Hill STP Concept and Detailed Design\PID DWGS\1 - CURRENT WORKING\7015-004 BROKEN HILL STP CD\PID DWG\DWGs\7015-004-P-029 EMERGENCY STORAGE POND.dwg

Ver.1.00



NOTES:
1. 1 m x 1m SQUARE BELLMOUTH WITH DN630 PE PIPELINE AND MANUAL ISOLATION VALVE TO LIMIT OVERLOW RATE.

NOT FOR CONSTRUCTION

AMENDMENTS			
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB
Ver	Date	Description	Drawn

beca hunterh2o
the future of water

Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

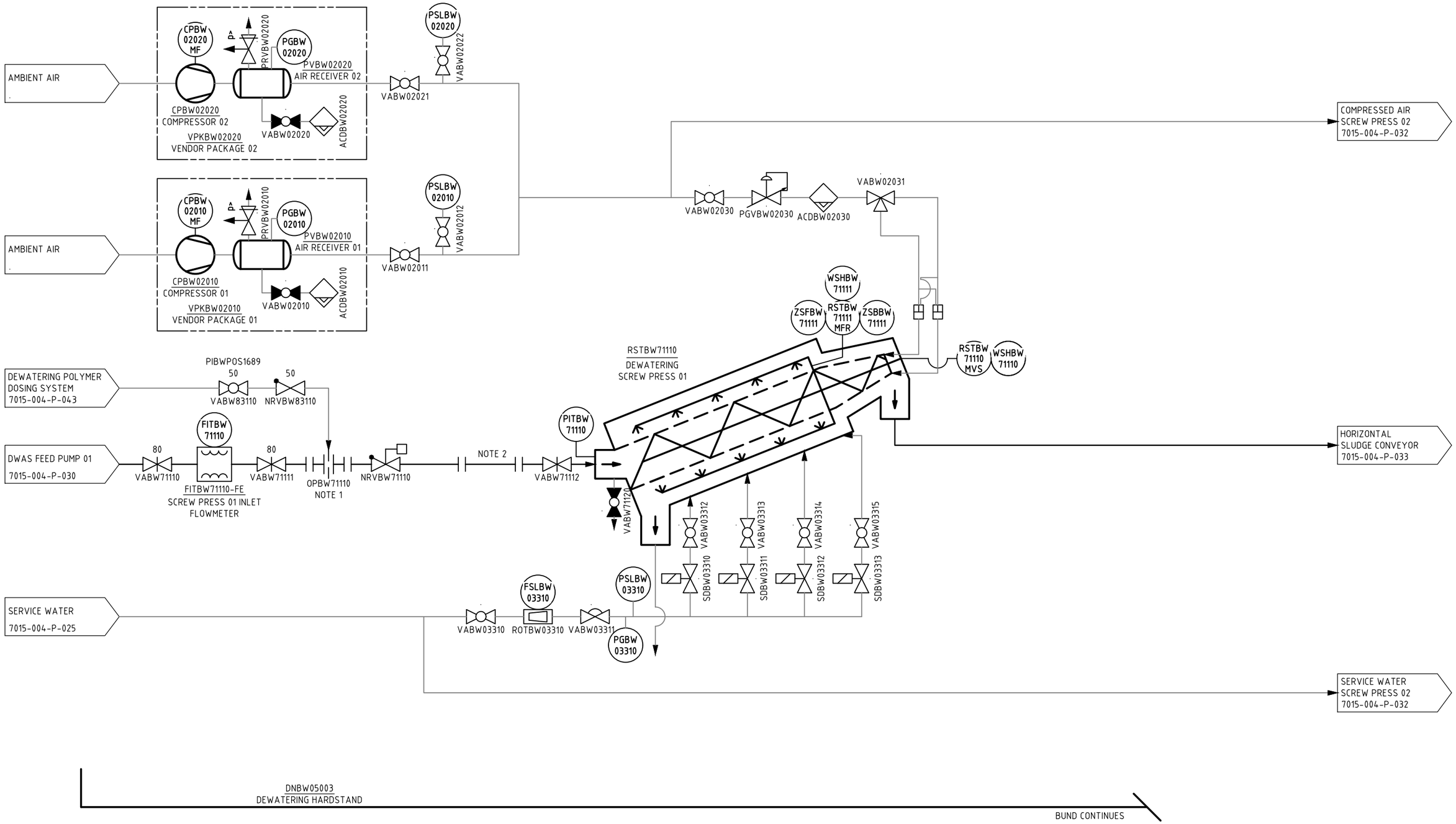
essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
AEROBIC DIGESTER

Scale	Document No
NTS at A3	7015-004-P-030
Status: PRELIMINARY	Version: C

Plot Date: 10/12/24 - 09:31 Cad File: P:\HH2O\Essential Energy\Broken Hill STP Concept and Detailed Design\PID DWGS\1 - CURRENT WORKING\7015-004 BROKEN HILL STP CD\PID DWG\DWGs\7015-004-P-030 AEROBIC DIGESTER.dwg

Ver.1.00



NOTES:
1. INJECTION RING.
2. FLOCCULATION TUBE.

NOT FOR CONSTRUCTION

AMENDMENTS			
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB
Ver	Date	Description	Drawn

beca hunterh2o
the future of water

Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

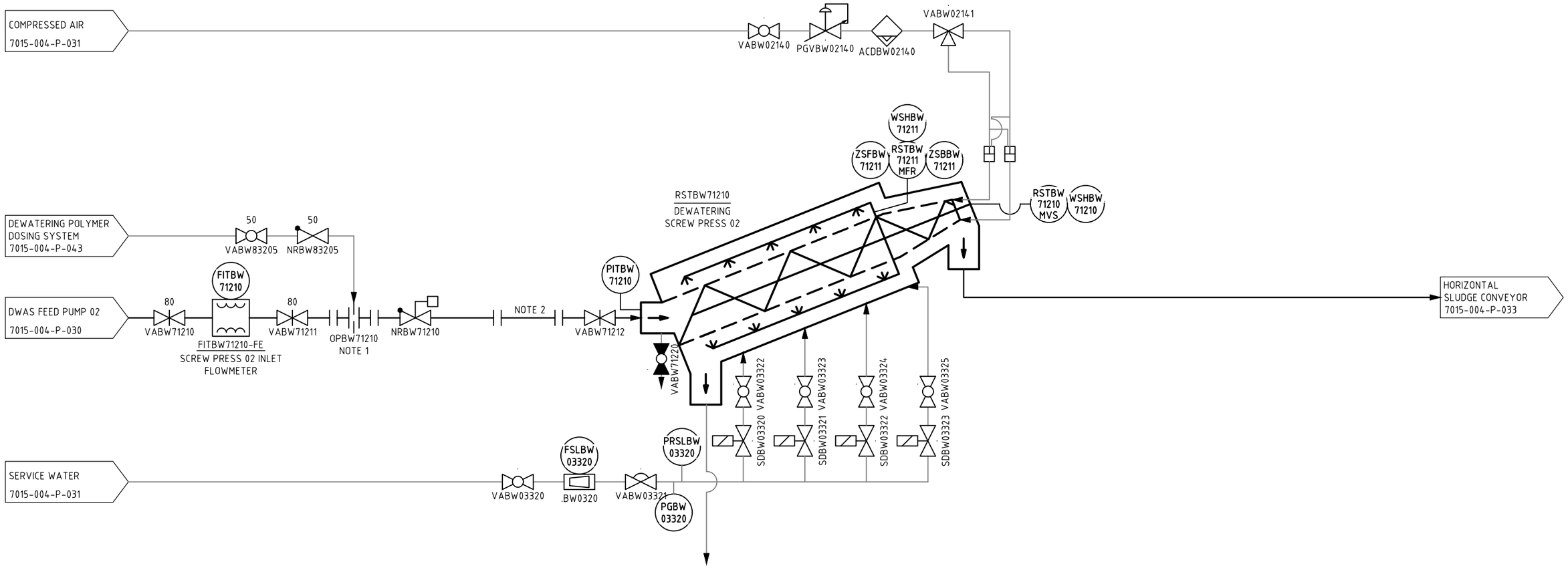
essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
SLUDGE DEWATERING 01

Scale	Document No
NTS at A3	7015-004-P-031
Status: PRELIMINARY	Version: C

Plot Date: 10/12/24 - 09:31 Cad File: P:\HH2O\Essential Energy\Broken Hill STP Concept and Detailed Design\PID DWGS\1 - CURRENT WORKING\7015-004 BROKEN HILL STP CD\PID DWG\DWGs\7015-004-P-031 SLUDGE DEWATERING 01.dwg

Ver.1.00



NOTES:
1. INJECTION RING.
2. FLOCCULATION TUBE.

NOT FOR CONSTRUCTION

AMENDMENTS			
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB
Ver	Date	Description	Drawn

beca hunterh2O the future of water

Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

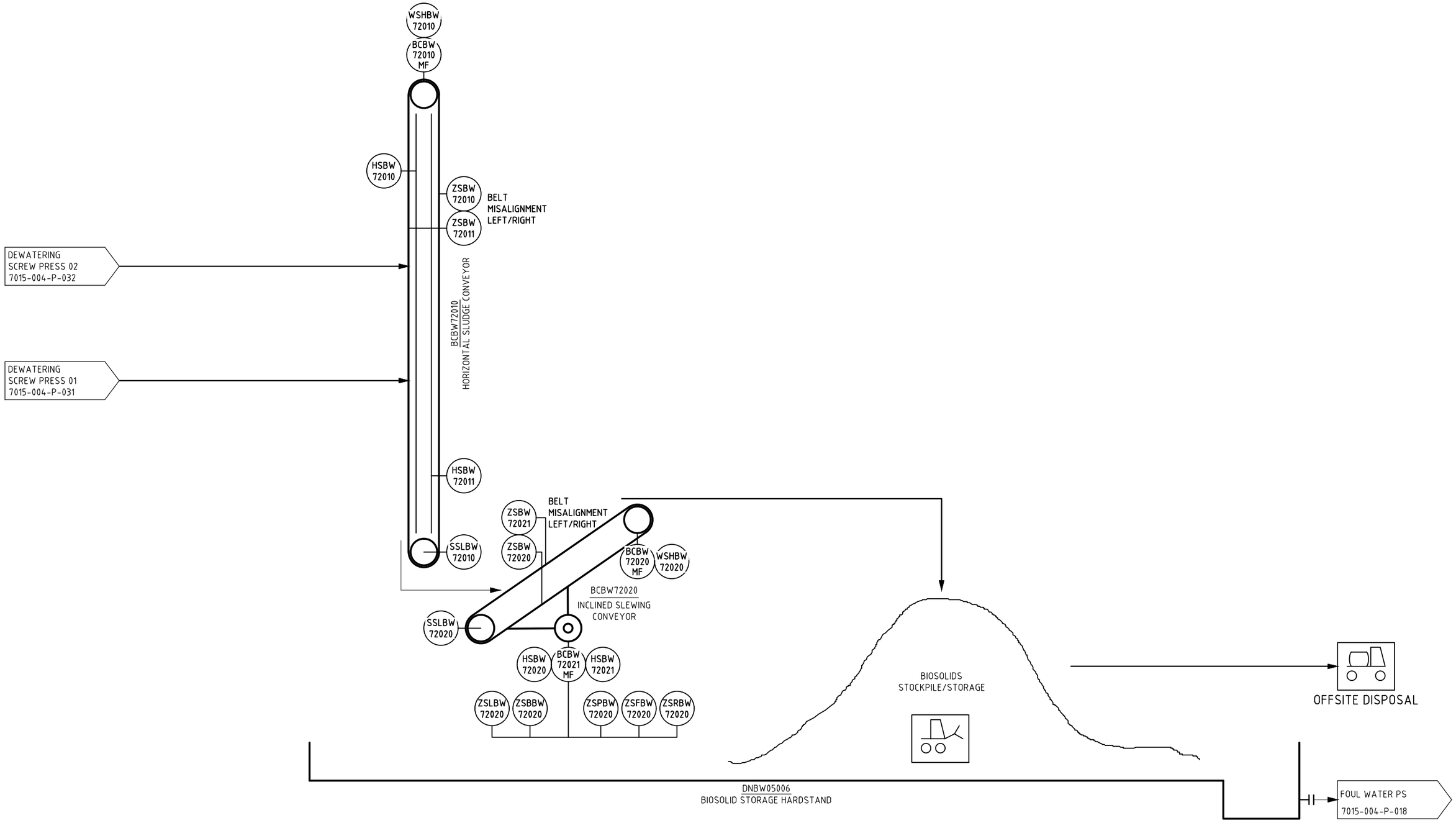
essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
SLUDGE DEWATERING 02

Scale	Document No
NTS at A3	7015-004-P-032
Status: **PRELIMINARY**	Version: **C**

Plot Date: 10/12/24 - 09:31 Cad File: P:\HH2O\Essential Energy\Broken Hill STP Concept and Detailed Design\PID DWGS\1 - CURRENT WORKING\7015-004 BROKEN HILL STP CD\PID DWG\DWGs\7015-004-P-032 SLUDGE DEWATERING 02.dwg

Ver.1.00



NOT FOR CONSTRUCTION

AMENDMENTS			
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB
Ver	Date	Description	Drawn

beca hunterh2o the future of water

Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
SLUDGE DEWATERING 03

Scale	Document No
NTS at A3	7015-004-P-033
Status: PRELIMINARY	Version: C

Plot Date: 10/12/24 - 09:31 Cad File: P:\HH2O\Essential Energy\Broken Hill STP Concept and Detailed Design\PID DWGS\1 - CURRENT WORKING\7015-004 BROKEN HILL STP CD\PID DWG\DWGs\7015-004-P-033 SLUDGE DEWATERING 03.dwg

Ver.1.00

SERVICE WATER
7015-004-P-025

BIOSOLIDS
STORAGE HARDSTAND
7015-004-P-033

SLUDGE DEWATERING
HARDSTAND
7015-004-P-032

CHLORINE
CONTACT TANKS
7015-004-P-024

ODOUR CONTROL
HARDSTAND
7015-004-P-017

GRIT REMOVAL
HARDSTAND
7015-004-P-015

AEROBIC DIGESTER
DECANT WEIR
7015-004-P-030

TABW15010
FOUL WATER
COLLECTION PIT

250
VABW15011

PIBWFTW0444

PIBWPRW0440

25 VABW03170
25 SDBW03170
25 VABW03171

LITBW 15020
LSLBW 15020
LSHBW 15020

NRBW15030
VABW15030

PGBW 15020
VABW15021
AVBW15020
VABW15022
VABW15023

150 NRBW15020
150 VABW15020

PIBWFTW0447

FITBW 15020
FITBW15020-FE
FLOWMETER

150 VABW15024

INLET WORKS
RECEIVAL CHAMBER
7015-004-P-013

OVERFLOW
EMERGENCY POND
7015-004-P-029

PUBW 15030 MF
PUBW 15020 MF

TABW15020
FOUL WATER PUMPING STATION

PUBW15030
FW PUMP 02

PUBW15020
FW PUMP 01

SERVICE WATER
7015-004-P-025
VABW03009
HRBW03009

NOT FOR CONSTRUCTION

AMENDMENTS			
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB
Ver	Date	Description	Drawn

beca hunterh2o
the future of water

Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

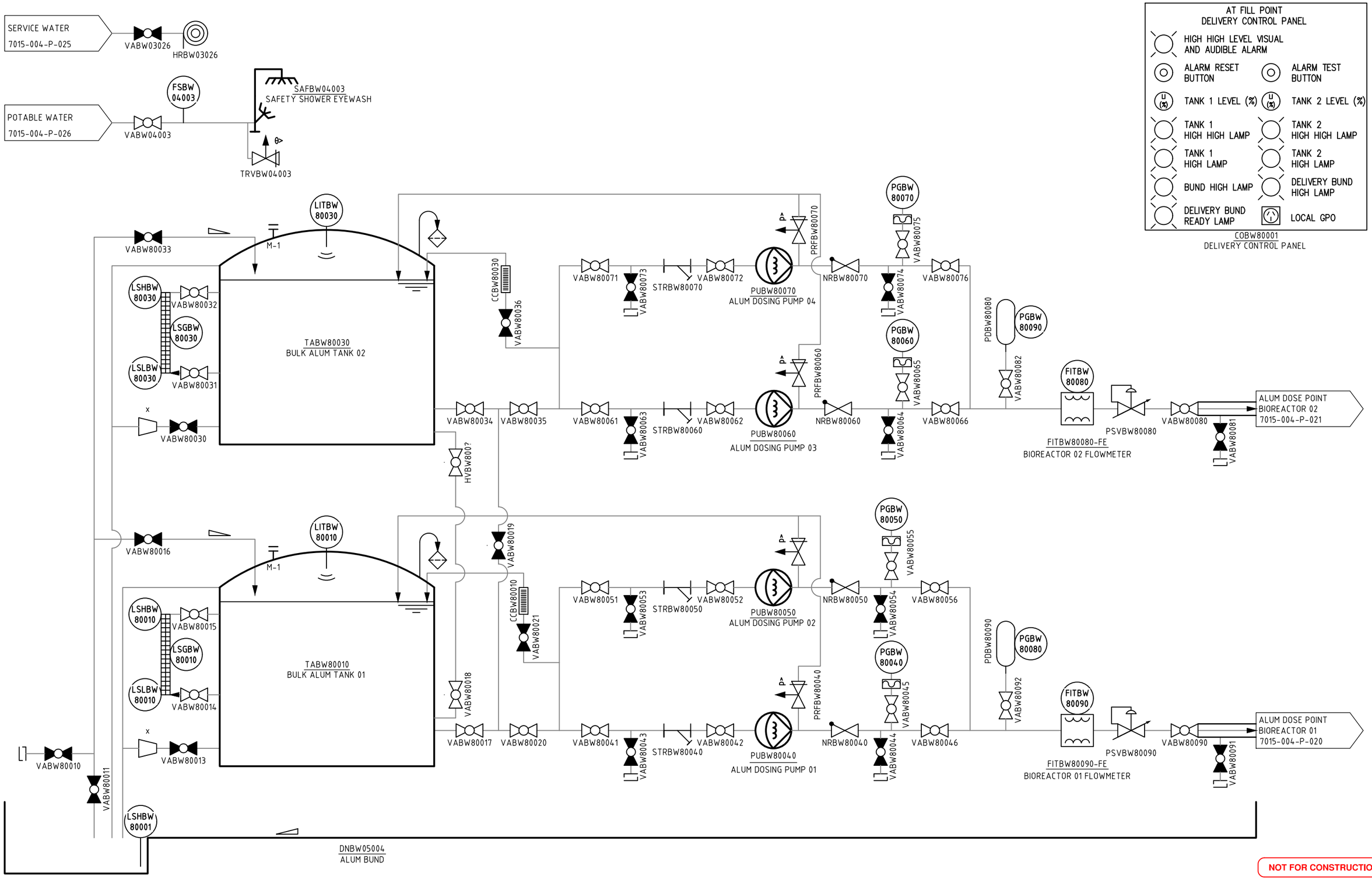
essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
FOUL WATER PUMPING STATION

Scale: NTS at A3
Document No: 7015-004-P-035
Status: PRELIMINARY
Version: C

Plot Date: 10/12/24 - 09:31 Cad File: P:\HH2O\Essential Energy\Broken Hill STP Concept and Detailed Design\PID DWGS\1 - CURRENT WORKING\7015-004 BROKEN HILL STP CD\PID DWG\DWGs\7015-004-P-035 FOUL WATER PUMPING STATION.dwg

Ver.1.00



NOT FOR CONSTRUCTION

AMENDMENTS			
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB
Ver	Date	Description	Drawn

beca hunterh2o
the future of water

Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
ALUM DOSING SYSTEM

Scale	Document No
NTS at A3	7015-004-P-040
Status: PRELIMINARY	Version: C

Plot Date: 10/12/24 - 09:31 Cad File: P:\HH2O\Essential Energy\Broken Hill STP Concept and Detailed Design\PID DWGS\1 - CURRENT WORKING\7015-004 BROKEN HILL STP CD\PID DWG\DWGs\7015-004-P-040 ALUM DOSING SYSTEM.dwg

Ver.1.00

SERVICE WATER
7015-004-P-025

VABW03527

HRBW03527

POTABLE WATER
7015-004-P-026

FSBW 04004

VABW04004

SAFBW04004
SAFETY SHOWER EYEWASH

TRVBW04004

AT FILL POINT
DELIVERY CONTROL PANEL

- HIGH HIGH LEVEL VISUAL AND AUDIBLE ALARM
- ALARM RESET BUTTON
- TANK LEVEL (%)
- TANK HIGH HIGH LAMP
- TANK HIGH LAMP
- BUND HIGH LAMP
- DELIVERY BUND READY LAMP

COBW65001
DELIVERY CONTROL PANEL

VABW03520 PVBW03520 SDBW03520

HVBW03521

FSBW 03520

ROBW03520

NRVBW03520

VABW03522

PGBW 81060

VABW81065

PRFBW81060

CCBW81011

VABW81021

VABW81061 VABW81063 STRBW81060 VABW81062

PUBW81060
SODIUM HYDROXIDE
DOSING PUMP 04

NRBW81060

VABW81064

VABW81066

PGBW 81050

PDBW81050

VABW81045?

FITBW 81050

PRFBW81050

VABW81055

VABW81020 VABW81051 VABW81053 STRBW81050 VABW81052

PUBW81050
SODIUM HYDROXIDE
DOSING PUMP 03

NRBW81050

VABW81054

VABW81056

FITBW81050-FE PSVBW81050
BIOREACTOR 02 FLOWMETER

VABW81057

VABW81058

SODIUM HYDROXIDE
DOSE PT. BIOREACTOR 02
7015-004-P-021

PGBW 03510

VABW03511

SERVICE WATER
7015-004-P-025

HVBW03510

VABW03530 PVBW03530 SDBW03530

HVBW03531

FSBW 03530

ROBW03530

NRVBW03530

VABW03532

PGBW 81040

VABW81045

PRFBW81040

VABW81016

LITBW 81010

M-1

LSHBW 81010

VABW81015

LSGBW 81010

LSLBW 81010

VABW81014

TABW81010
SODIUM HYDROXIDE TANK

CCBW81010

VABW81019

VABW81041 VABW81043 STRBW81040 VABW81042

PUBW81040
SODIUM HYDROXIDE
DOSING PUMP 02

NRBW81040

VABW81044

VABW81046

PGBW 81030

PDBW81030

VABW81045?

FITBW 81030

PRFBW81030

VABW81035

VABW81017 VABW81018 VABW81031 VABW81033 STRBW81030 VABW81032

PUBW81030
SODIUM HYDROXIDE
DOSING PUMP 01

NRBW81030

VABW81034

VABW81036

FITBW81030-FE
BIOREACTOR 01 FLOWMETER

PSVBW81030

VABW81037

SODIUM HYDROXIDE
DOSE PT. BIOREACTOR 01
7015-004-P-020

VABW81010

VABW81011

x

VABW81013

LSHBW 81001

DNBW05005
CHEMICAL BUND

NOT FOR CONSTRUCTION

AMENDMENTS

Ver	Date	Description	Drawn
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB

beca hunterh2o
the future of water

Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
SODIUM HYDROXIDE DOSING SYSTEM

Scale	Document No
NTS at A3	7015-004-P-041
Status: PRELIMINARY	Version: C

Plot Date: 10/12/24 - 09:31 Cad File: P:\HH2O\Essential Energy\Broken Hill STP Concept and Detailed Design\PID DWGS\1 - CURRENT WORKING\7015-004 BROKEN HILL STP CD\PID DWG\DWGs\7015-004-P-041 SODIUM HYDROXIDE DOSING SYSTEM.dwg

Ver.1.00

CALIBRATION TUBE
RETURN
7015-004-P-043

VLBW83010
VACUUM LOADER

BAGBW83010
15 kg POLYMER BAGS

HPBW83010
DEWATERING POLYMER
HOPPER

LSHBW
83010

LSLBW
83010

100
VABW83010

HTBW83010
HEATER

SCVBW
83010
MF

SCVBW83010
SCREW CONVEYOR

OPBW04650

04 83
AREA

PGVBW04610

PGBW
04110

FSLBW
04110

RPZBW04610

VABW04610

SDBW04210

SDBW04211

EJBW03020

POTABLE WATER
SYSTEM
7015-004-P-026

SERVICE WATER
7015-004-P-025

VABW03028

HRBW03028

VABW03029

HRBW03029

FSBW
04005

SAFBW04005
SAFETY SHOWER
EYEWASH

VABW04005

TRVBW04005

LSHBW
83001

DNBW65005
DEWATERING POLYMER BUND

NOTE 1 — AT FILL POINT
DELIVERY CONTROL PANEL

- HIGH LEVEL VISUAL AND AUDIBLE ALARM
- ALARM RESET BUTTON
- ALARM TEST BUTTON
- HOPPER LEVEL (%)
- HOPPER HIGH LAMP
- DELIVERY BUND HIGH LAMP
- HOPPER LOW LAMP
- DELIVERY BUND READY LAMP
- BUND HIGH LAMP
- LOCAL GPO

COBW83001
DELIVERY CONTROL PANEL

ZSCBW
83020

MXBW
17020
MF

LITBW
83020

LITBW
83021

M-1

NRBW83020

VABW83020

VABW83021

TABW83020
DEWATERING POLYMER
MIXING TANK

MXBW83020
AGITATOR

ZSOBW
83021

ZSCBW
83021

VABW83022

PNVBW83020

VABW83023

ZSCBW
83030

LITBW
83030

LITBW
83031

TABW83030
DEWATERING POLYMER
DOSING TANK

VABW83030

VABW83050

VABW83051

VABW83052

STRBW83050

VABW83053

VABW83054

VABW83055

VABW83040

VABW83041

VABW83042

STRBW83040

VABW83043

VABW83044

VABW83045

VABW83046

DEWATERING
POLYMER DOSING
7015-004-P-043

BUND CONTINUES

NOTES:
1. LEVEL MANAGEMENT AND SAFE FILL VOLUME TO BE DISPLAYED AT DELIVERY CONTROL PANEL IN BOTH L AND % AUDIBLE ALARM AND BEACON TO BE PROVIDED FOR OVERFILL. LOCAL TANKER PUMP GPO TO CUT OUT ON OVERFILL.

NOT FOR CONSTRUCTION

AMENDMENTS			
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB
Ver	Date	Description	Drawn

beca hunterH2O
the future of water

Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

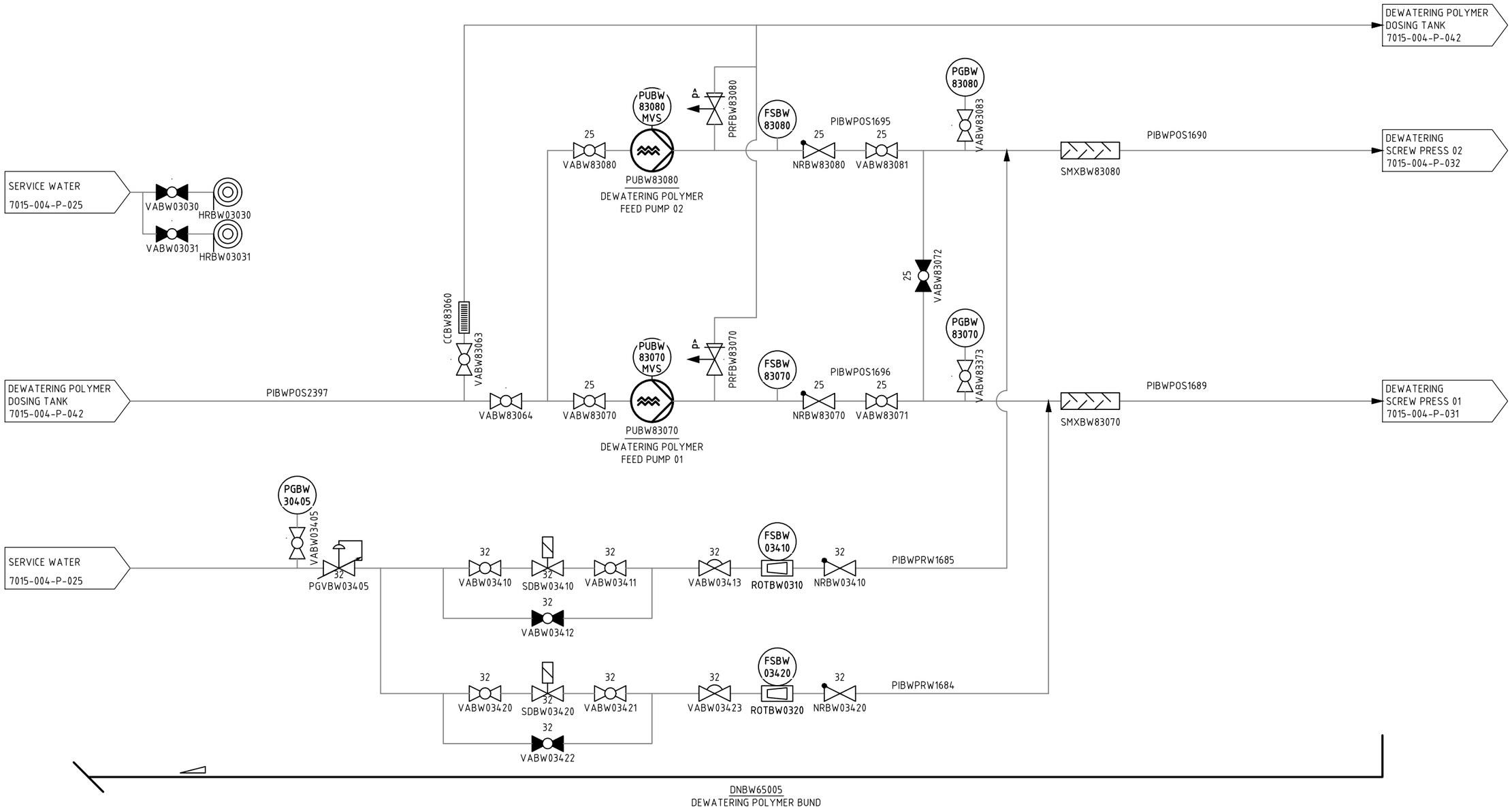
essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
DEWATERING POLYMER BATCHING

Scale	Document No
NTS at A3	7015-004-P-042
Status: PRELIMINARY	Version: C

Plot Date: 10/12/24 - 09:31 Cad File: P:\HH2O\Essential Energy\Broken Hill STP Concept and Detailed Design\PID DWGS\1 - CURRENT WORKING\7015-004 BROKEN HILL STP CD\PID DWG\DWGs\7015-004-P-042 DEWATERING POLYMER BATCHING.dwg

Ver.1.00



NOT FOR CONSTRUCTION

AMENDMENTS			
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB
Ver	Date	Description	Drawn

beca hunterh2o
the future of water

Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

essential water

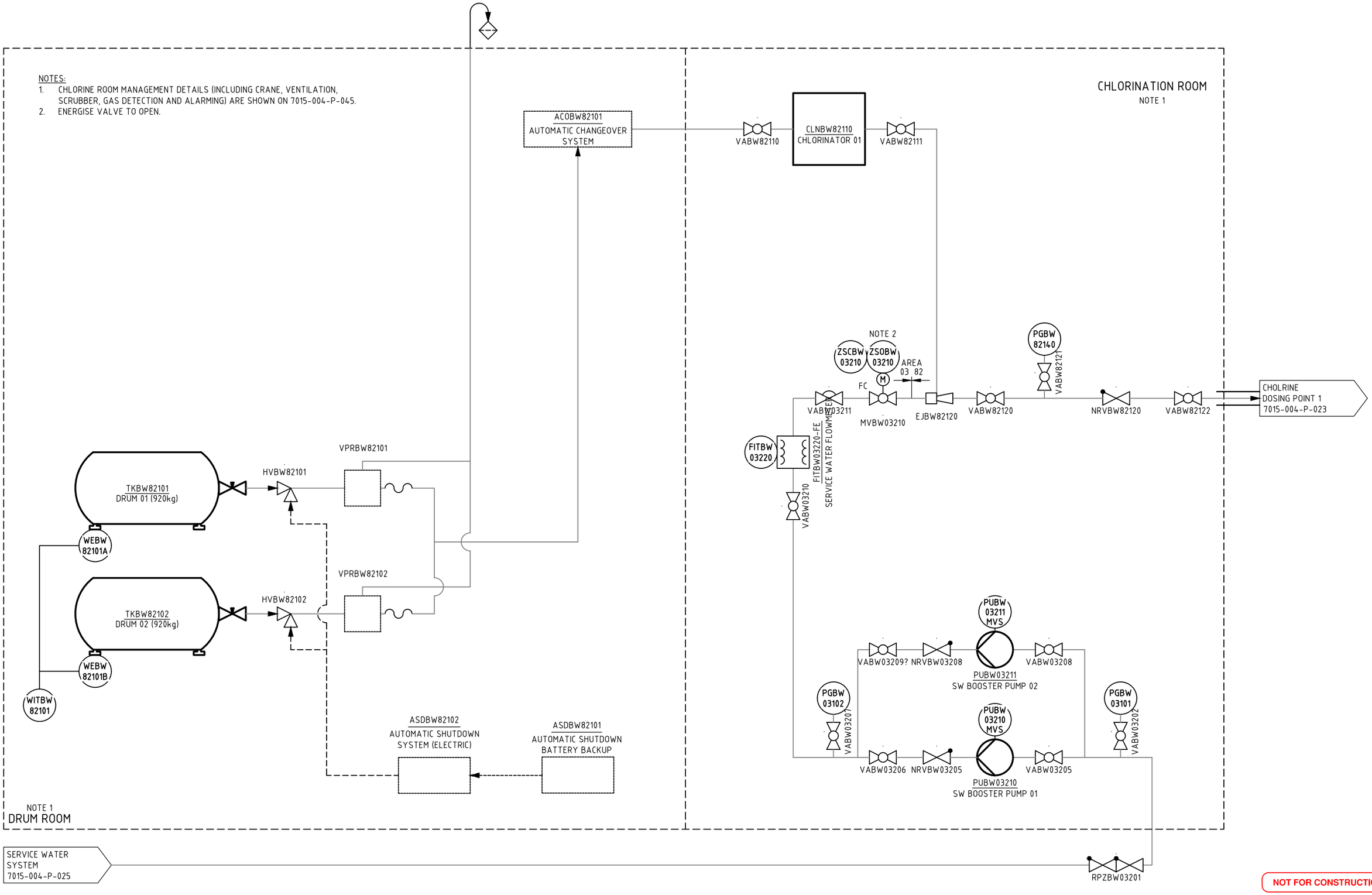
ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
DEWATERING POLYMER DOSING

Scale	Document No
NTS at A3	7015-004-P-043
Status: PRELIMINARY	Version: C

Plot Date: 10/12/24 - 09:31 Cad File: P:\HH2O\Essential Energy\Broken Hill STP Concept and Detailed Design\PID DWGS\1 - CURRENT WORKING\7015-004 BROKEN HILL STP CD\PID DWG\DWGs\7015-004-P-043 DEWATERING POLYMER DOSING.dwg

Ver.1.00

NOTES:
1. CHLORINE ROOM MANAGEMENT DETAILS (INCLUDING CRANE, VENTILATION, SCRUBBER, GAS DETECTION AND ALARMING) ARE SHOWN ON 7015-004-P-045.
2. ENERGISE VALVE TO OPEN.



NOT FOR CONSTRUCTION

AMENDMENTS			
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB
Ver	Date	Description	Drawn

beca hunterh2o the future of water

Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
CHLORINE DOSING SYSTEM

Scale	Document No
NTS at A3	7015-004-P-044
Status: PRELIMINARY	Version: C

Plot Date: 10/12/24 - 09:31 Cad File: P:\HH2O\Essential Energy\Broken Hill STP Concept and Detailed Design\PID DWGS\1 - CURRENT WORKING\7015-004 BROKEN HILL STP CD\PID DWG\DWGs\7015-004-P-044 CHLORINE DOSING SYSTEM.dwg

Ver.1.00

NOTES:
1. NUMBER, SIZE AND LOCATION OF LOUVRES TO BE DETERMINED DURING DETAILED DESIGN.
2. CHLORINE LEAK DETECTORS POSITIONED AT LOW LEVEL, AT LOCATIONS DETERMINED IN DETAILED DESIGN.
3. SCRUBBER INTAKE LOUVRE ALWAYS OPEN.
4. NUMBER OF INTAKE AND OUTLET LOUVRES TO BE DETERMINED IN DETAILED DESIGN.
5. EACH OUTLET LOUVRE TO HAVE OWN FAN AND OWN STACK TO ATMOSPHERE.
6. WIND SOCK TO BE INSTALLED AT LEAST 2m ABOVE CHLORINE FACILITY.
7. DIGITAL DISPLAY OF AMBIENT CHLORINE LEVEL IN THE DRUM AND CHLORINATOR ROOM.
8. NUMBER OF SAFETY SHOWERS AND LOCATION TO BE CONFIRMED IN DETAILED DESIGN.

POTABLE WATER SYSTEM 7015-004-P-026
25 VABW04008?
FSBW 04008
NOTE 8
SAFBW04008 SAFETY SHOWER EYEWASH 01
25 TRVBW04008
25 VABW04009
FSBW 04009
NOTE 8
SAFBW04009 SAFETY SHOWER EYEWASH 02
25 TRVBW04008

ROLLER DOOR 01
ZSOBW 82201
ZSCBW 82201
ROLBW 82201 MFR
HSBW 82201
LVRBW82262 MOTORISED LOUVER 01 NOTE 4
HSBW 82204
ZSOBW 82262
ZSCBW 82262
LVRBW 82262 MF
ZSBW 82204
DOOR
CPBW82206 LCD PANEL 02 NOTE 7
LCD
LVRBW82264 MOTORISED LOUVER 02 NOTE 4
ZSOBW 82264
ZSCBW 82264
LVRBW 82264 MF
GLASS WINDOW
GLASS WINDOW
CHLORINATION ROOM
CRBW 82210 MVR
CRBW82210 CRANE/HOIST
BUILDING EXTERNAL LEAK DETECTION NOTE 2
AITBW 82201
AEBW 82201B
AEBW 82201A
DRUM ROOM
DRUM ROOM LEAK DETECTION NOTE 2
AITBW 82202
AEBW 82202B
AEBW 82202A
AMBW82201 AUDIBLE ALARM 01
BEA
BEBW82201 BEACON 01
GLASS WINDOW
GLASS WINDOW
AMBW82202 AUDIBLE ALARM 02
BEA
BEBW82202 BEACON 02
CHLORINATION ROOM LEAK DETECTION NOTE 2
AITBW 82203
AEBW 82203B
AEBW 82203A

PERSONAL ACCESS DOOR LOCAL CONTROL PANEL
SAFE TO ENTER LAMP
DO NOT ENTER LAMP
BEA LEAK ALARM BEACON
LEAK AUDIBLE ALARM
HS START FAN
CPBW82201 ACCESS DOOR CONTROL PANEL 01

PERSONAL ACCESS DOOR LOCAL CONTROL PANEL
SAFE TO ENTER LAMP
DO NOT ENTER LAMP
BEA LEAK ALARM BEACON
LEAK AUDIBLE ALARM
HS START FAN
CPBW82202 ACCESS DOOR CONTROL PANEL 02

PERSONAL ACCESS DOOR LOCAL CONTROL PANEL
SAFE TO ENTER LAMP
DO NOT ENTER LAMP
BEA LEAK ALARM BEACON
LEAK AUDIBLE ALARM
HS START FAN
CPBW82203 ACCESS DOOR CONTROL PANEL 03

PERSONAL ACCESS DOOR LOCAL CONTROL PANEL
SAFE TO ENTER LAMP
DO NOT ENTER LAMP
BEA LEAK ALARM BEACON
LEAK AUDIBLE ALARM
HS START FAN
CPBW82204 ACCESS DOOR CONTROL PANEL 04

LOCATED AT EACH PERSONAL ENTRY DOOR

AMBW82203 AUDIBLE ALARM 03
BEA BEBW82203 BEACON 03
EXTERNAL LEAK ALARMS LOCATED AT STRATEGIC POINT ON SITE

NOTE 6
ROLLER DOOR 02
ZSCBW 82202
ZSOBW 82202
ROLBW 82202 MFR
HSBW 82202
ZSCBW 82260
ZSOBW 82260
SCRUBBER INTAKE LOUVER(S) NOTE 3
LVRBW82260 MANUAL LOUVER 01
ZSCBW 82261
ZSOBW 82261
DRUM ROOM OUTLET LOUVER(S) LVRBW82261 NOTE 4 NOTE 5
MANUAL LOUVER 02
ZSBW 82203
DOOR
HSBW 82203
BLBW 82261 MF
BLBW82261 AXIAL BLOWER 02
BLBW 82262 MF
BLBW82262 AXIAL BLOWER 03
FSLBW 82261
STKBW82261 STACK 02
LCD
NOTE 7
CPBW82205 LCD PANEL 01
ZSBW 82205
DOOR
HSBW 82205
ZSCBW 82263
ZSOBW 82263
CHLORINATION ROOM OUTLET LOUVER(S) LVRBW82263 NOTE 4 NOTE 5
MANUAL LOUVER 03
LSHBW 82211
TKBW82210 ROOM SUMP
BLBW 82263 MF
BLBW82263 AXIAL BLOWER 04
BLBW 82264 MF
BLBW82264 AXIAL BLOWER 05
FSLBW 82263
STKBW82263 STACK 03
PDEBW 82260
PDTBW 82260
CFBW82260 Chlorine Building Scrubber
BLBW 82260 MF
BLBW82260 AXIAL BLOWER 01
CL2
AEBW 82260
AITBW 82260
FSLBW 82260
STKBW82260 STACK 01

NOT FOR CONSTRUCTION

AMENDMENTS			
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB
Ver	Date	Description	Drawn

beca hunterh2o the future of water

Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

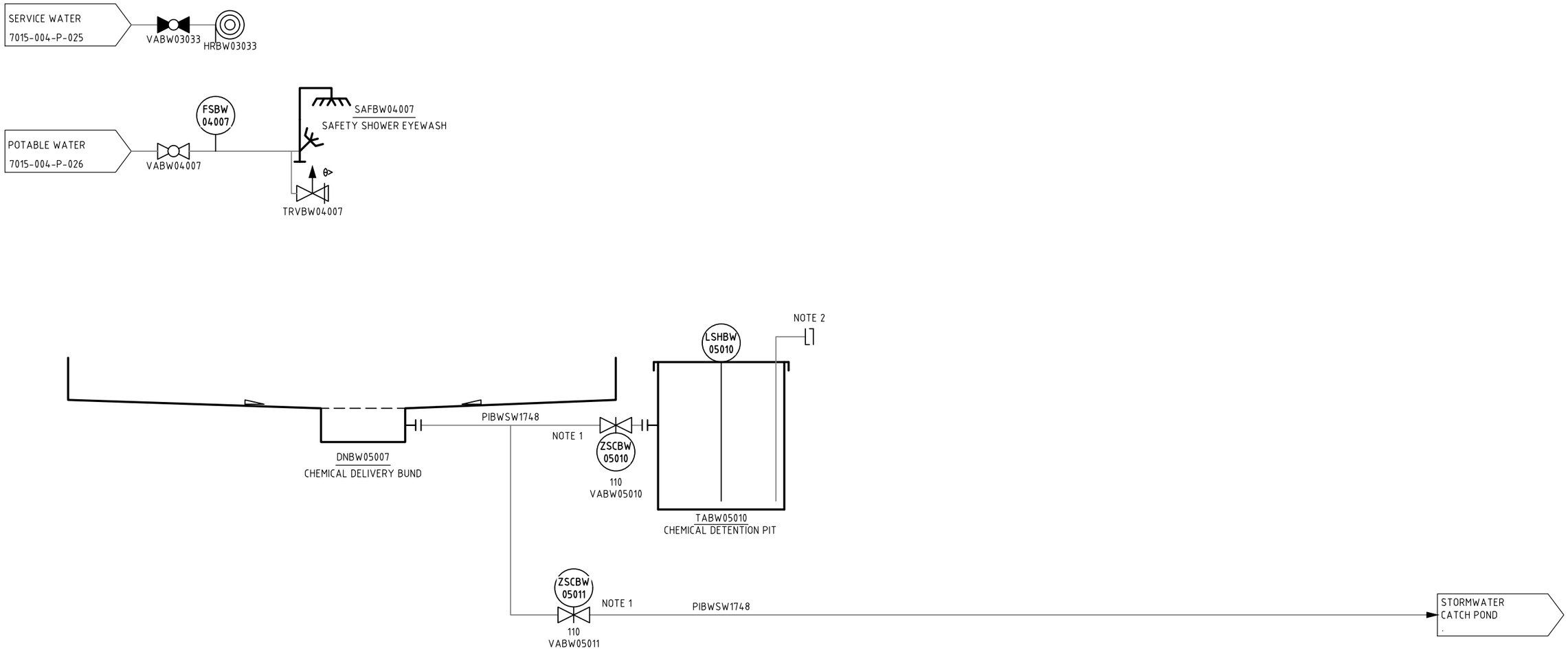
essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
CHLORINE BUILDING MANAGEMENT

Scale	Document No
NTS at A3	7015-004-P-045
Status: PRELIMINARY	Version: C

Plot Date: 10/12/24 - 09:31 Cad File: P:\HH2O\Essential Energy\Broken Hill STP Concept and Detailed Design\PID DWGS\1 - CURRENT WORKING\7015-004 BROKEN HILL STP CD\PID DWG\DWGs\7015-004-P-045 CHLORINE BUILDING MANAGEMENT.dwg

Ver.1.00



NOTES:
1. DRAINS TO BE CLOSED DURING CHEMICAL DELIVERY. MANUAL VALVE HANDLES TO BE ACCESSIBLE ABOVE GROUND AND OUTSIDE THE DELIVERY BUNDS.
2. CONNECTION FOR PUMP-OUT OF BELOW GROUND TANK BY SUCKER TRUCK.

NOT FOR CONSTRUCTION

AMENDMENTS

Ver	Date	Description	Drawn
C	10/12/24	POST HAZOP REVISIONS	SRB
B	28/10/24	REVISED EW TAGGING CONVENTION	SRB
A	01/10/24	PRELIMINARY	SRB

beca hunterh2o the future of water

Designed	BM	Checked	PG
Drawn	SRB	Checked	
Approved			
Date			
HH2O Project Number	7015-004		

essential water

ESSENTIAL WATER
BROKEN HILL WASTEWATER TREATMENT PLANT
CONCEPT DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
CHEMICAL DELIVERY BUND

Scale: NTS at A3
Document No: 7015-004-P-050
Status: PRELIMINARY
Version: C

Plot Date: 10/12/24 - 09:30 Cad File: P:\HH2O\Essential Energy\Broken Hill STP Concept and Detailed Design\PID DWGS\1 - CURRENT WORKING\7015-004 BROKEN HILL STP CD\PID DWG\DWGs\7015-004-P-050 CHEMICAL DELIVERY BUND.dwg

Ver.1.00

Appendix F. Technical Memo – New site location

To:	Stanley Kommo Project Manager Broockmann Water Advisory	From:	Peter Greenhalgh Principal process engineer Beca HunterH2O
Copy to:	Bob Ma Senior process engineer Beca HunterH2O	Date:	10 September 2024
Subject:	Technical Memo – New site location		

This memo provides discussion on the benefit of moving treatment infrastructure from the site proposed in the design basis to the northern side of the existing maturation pond.

A brief synopsis of discussion includes:

- Design development using the most recent site survey data and 3D modelling indicates the excavation cost and time risk (noting the presence of hard rock) of constructing on the site identified in the design basis is significantly higher than expected.
- Constructing within the northern side of the existing maturation pond would significantly reduce the excavation cost and time risk by avoiding mostly or completely hard rock excavation.
- The existing maturation pond leaks to groundwater and algal growth contaminates effluent and reduces the effectiveness of Ultraviolet (UV) disinfection.
- There is the ability to utilise alternate ponds and retain the UV system in service whilst removing the maturation pond from service.
- Although the maturation pond has been removed from service before, approval from the EPA is likely required to proceed regardless of the benefit.
- More work is required to determine the cost of remediating the area if the maturation pond is completely decommissioned. It is noted however that the base of the maturation pond is higher than the surface level to the south of the site. As such minimal fill may be required for free surface drainage from the area.

It is requested that EW review this memo and confirm the suitability of pursuing design of treatment infrastructure located in the northern side of the existing maturation pond.

Background

A preliminary site location was selected in the design basis to provide:

- Separation distance from nearby sensitive receptors
- Minimal impact on the existing operating processes during construction stage.
- The ability for gravity flow through the process.

The selected site was to the north of the existing maturation pond as shown in Figure 1.

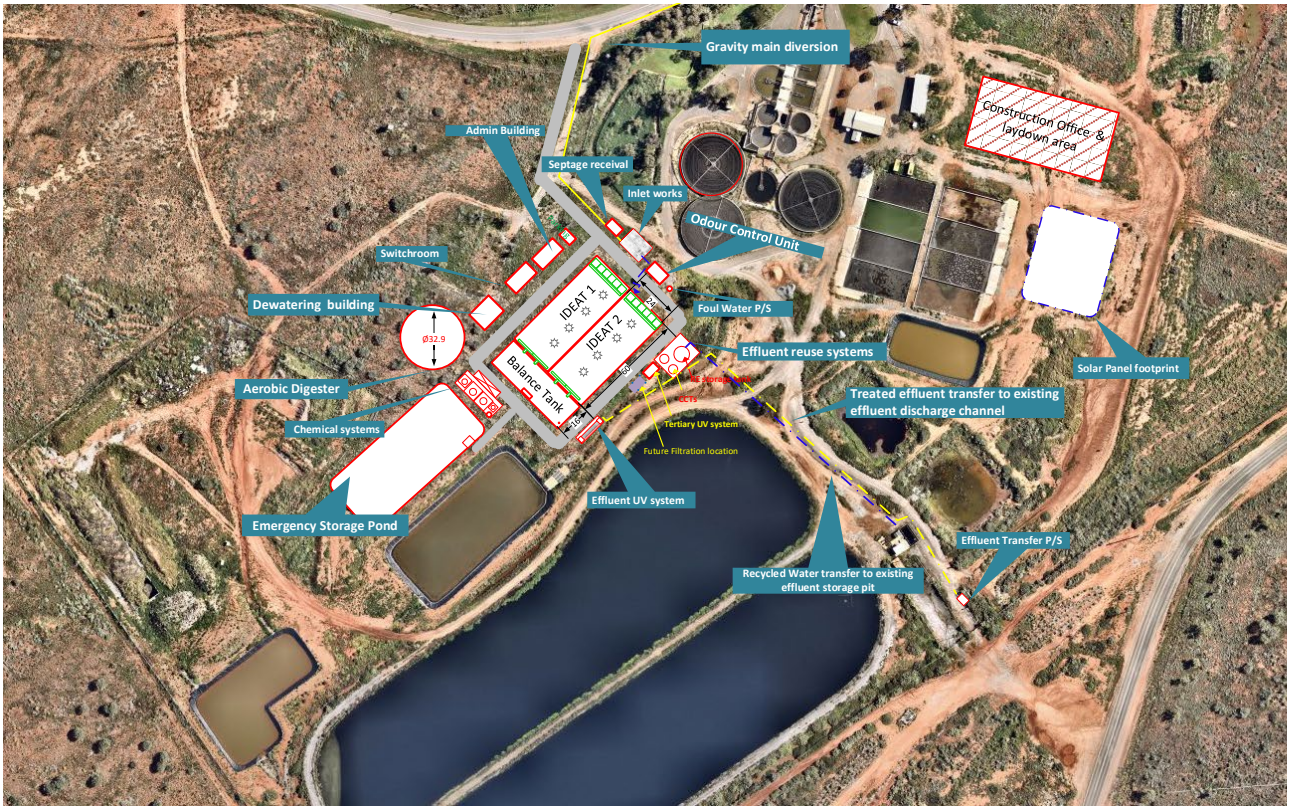


Figure 1: Site location used in the design basis report.

Recent survey data and preliminary 3D modelling has been used to refine the site layout. Please see Figure 2

The 3D modelling has allowed the project team to better understand the earthworks required to site the infrastructure per Figure 1 and Figure 2. Preliminary results indicate the required excavation depth to the north of the proposed bioreactor would be significantly deeper than first thought.

Terrain in this area is known to include hard rock and the greater excavation depth increases the construction cost and time risk significantly. The estimated excavation is presented in Table 1.

Table 1: Estimated excavation for the design basis site location

Area	Design Criteria adopted	Estimated excavation material (m3)
IDAL/Balance tank area	Tank TOC RL: 296.300 Tank Floor Upstream RL: 291.050 Finished pad RL: Varies 295.750 to 296.200 External batter slope: 1V:3H Excavation zone: 4m wide around perimeter of tank	~40,400
Emergency storage lagoon	Pond top of bank RL: 293.200 Pond base RL: 290.700 Freeboard: 0.5m Internal batter slope: 1V:3H External batter slope: 1V:3H Length: 87m	~14,180

	Width: 41m Required volume: 4.8ML Road allowance: 4m	
TOTAL		**~54,580**

Note: No allowance has been made for bulking factors, unsuitable material, topsoil stripping, road materials, service trenching or minor structures.

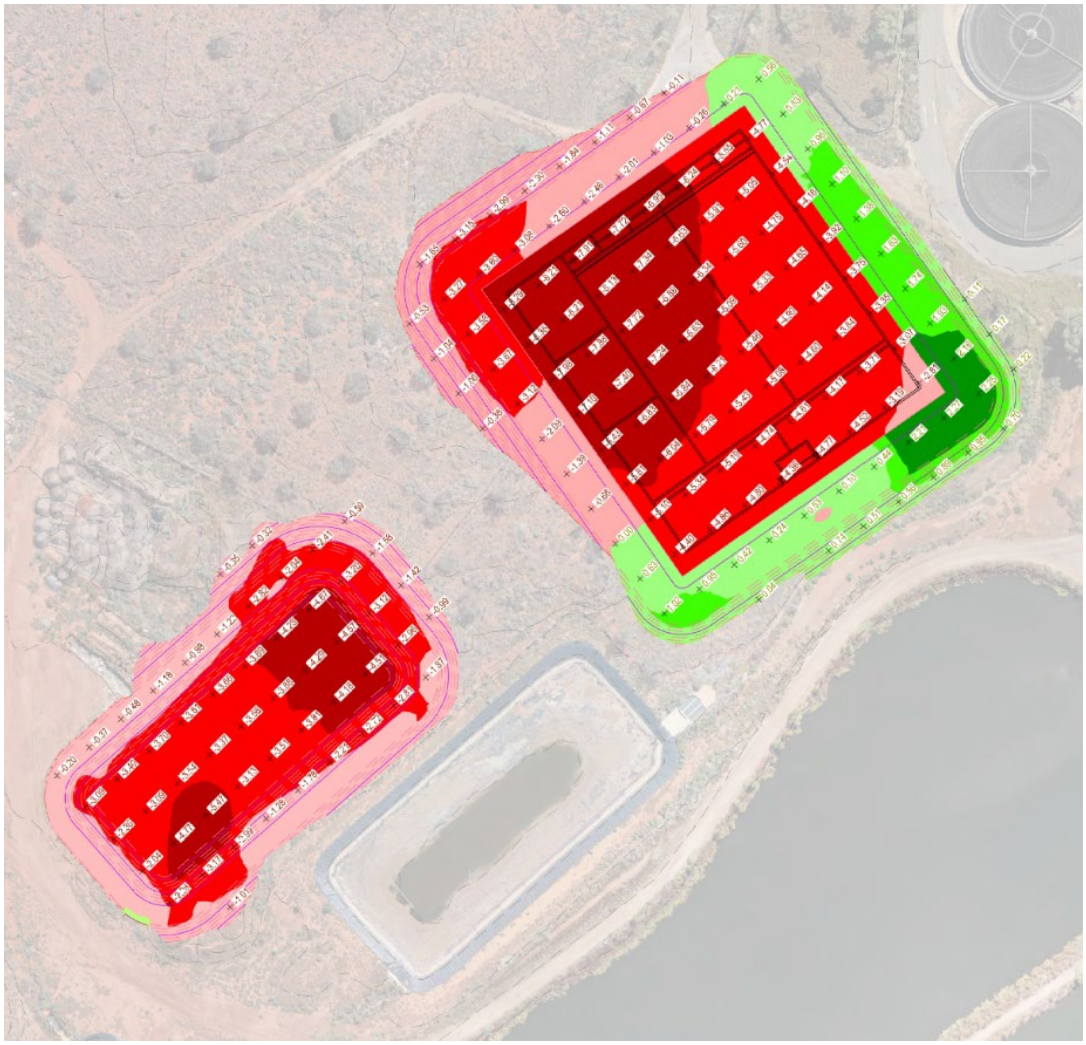


Figure 2: Site location visualised in 3D model.

The red colour tones indicate areas of cut whilst the green colour tones indicate areas of fill.

Preliminary geotechnical information indicates the presence of hard rock close to the surface in the area proposed for the bioreactor in the design basis report. This means that a significant portion of the excavated material is expected to be hard rock, and due to the construction cost and time risk, the project team has sought to refine the positioning of structures to reduce construction cost and time risk.

Proposed New Location

It has been discussed in previous project team meetings the possibility of constructing within the existing maturation pond. EW have also noted that the maturation pond has been removed from service in the past for maintenance.

It is now proposed to utilise the northern side of the existing maturation pond to site treatment process structures as shown in Figure 4.

Figure 3: Proposed new treatment process general location.

Survey and 3D modelling have now been used to review the site layout.

The basis of the new location appears to allow:

- The ability to gravity flow raw sewage from the existing Wills Street STP catchment through the inlet works to the new bioreactor.
- An effluent pump station would be required to lift effluent up to the UV disinfection system. Effluent would then flow via gravity through the upgraded effluent discharge pipeline. See the effluent discharge pipeline options memo for discussion.

The design generally aligns with the proposal in the design basis report.

The benefits of the proposed change

Benefits of the proposed change in location include:

- Minimal hard rock excavation risk for major structures compared to the previously selected location. The new bioreactor would be less than 0.5 m above the base of the existing maturation pond (assuming the existing pond base level of RL291.1, the new bioreactor floor level of RL 291.8, and concrete wall thickness of 450mm). Infill would instead be required to site the IDAL bioreactor in the order of 2500m^3.
- The new location provides similar distances to nearby receptors considering noise and odour risk potential from the treatment process.
- With more land available on a similar grade (i.e. the extents shown in Figure 4), there is the potential to integrate the aerobic digester into the bioreactor. Use of a common wall for the aerobic digester and bioreactor reduces concrete quantities and hence cost and Scope 3 GHG emissions (embedded carbon emissions).
- If the tertiary pond is not used for construction of the treatment plant, it may require remediation regardless to remove sludge and manage rainwater ingress. This action may help to solve a future risk that EW would need to deal with.
- The new location would minimise the construction cost and time risk for the proposed emergency storage lagoon. The emergency storage lagoon could be constructed on the base of the existing maturation pond.
- The new location is closer to the South STP transfer main and effluent discharge location, reducing inlet and discharge pipe lengths. The inlet pipework from Will St. to the inlet works or bioreactor may be longer however.

The Residual Risks of the proposed change

Two key risks are discussed in this section at a high level: 1) approvals risk and 2) remediation risk.

Approvals risk specifically refers to the risk that, during construction of IDAL reactor, the maturation pond will be removed from service and as such the existing treatment process configuration will change.

The maturation pond provides some additional nutrient, organics and pathogen removal as well as flow balancing. Discussion with and approval from the EPA would likely be required to enable the maturation pond to be taken offline to allow construction of the new IDAL process infrastructure.

Immediate benefits in removing the maturation pond from service which should be addressed in discussions with the EPA include:

- The maturation pond leaks and contaminates groundwater. Removal of the pond from service would reduce the risk of groundwater contamination.
- Algal growth in the maturation pond increases concentration of effluent total suspended solids and BOD. The algal solids also act to shield pathogens, reducing the effectiveness of Ultraviolet disinfection.

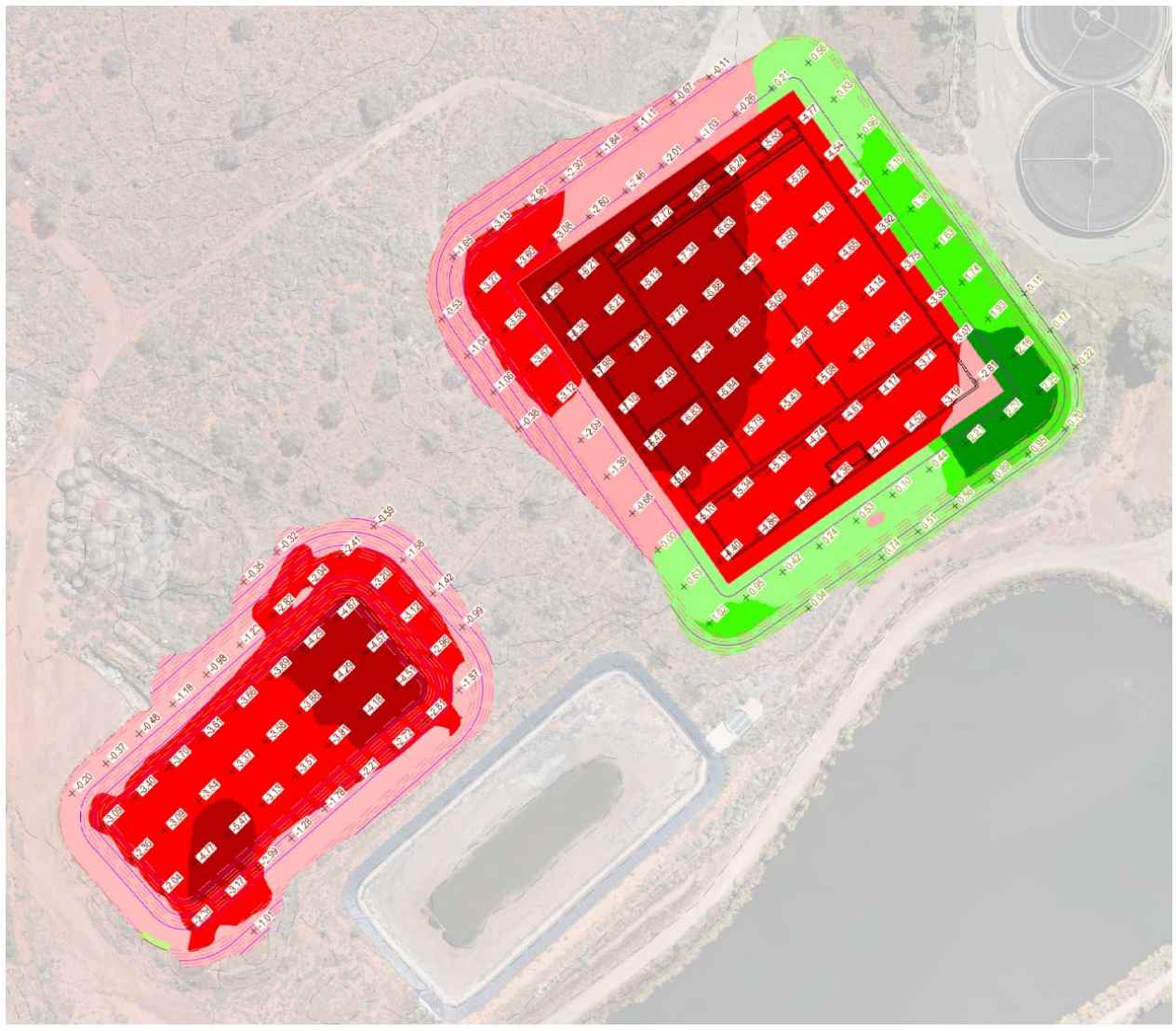
Discussions with the project team on 12th August 2024 identified there is a risk in retaining part of the maturation pond in service. As the maturation pond leaks, effluent could flow under the new structures destabilising the base. Therefore, if part of the maturation pond is to be returned to or retained for service, proper lining or isolation from the new structures would be required.

If instead of retaining part of the pond, the site may be remediated and returned to its original or an improved state.

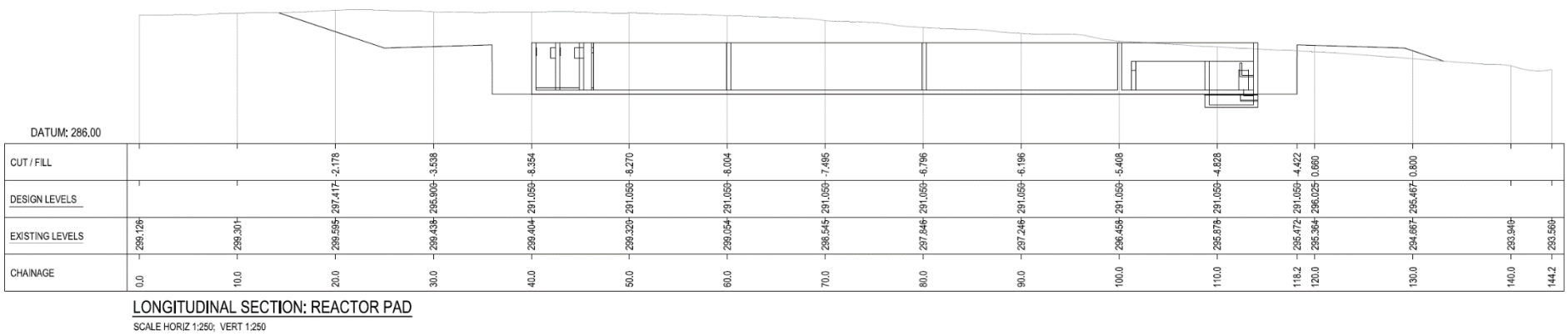
Historic pond survey data combined with more recent drone survey data indicates that the southern corner of the site may be lower than the base of the maturation pond. This means that removal of the southern wall of the pond may allow the area to freely drain to stormwater, reducing the need to fill in the maturation pond.

Further investigation of site stormwater management practices is required to confirm if stormwater detention infrastructure would also be required for the remediated area.

Appendix A – Original Site Location

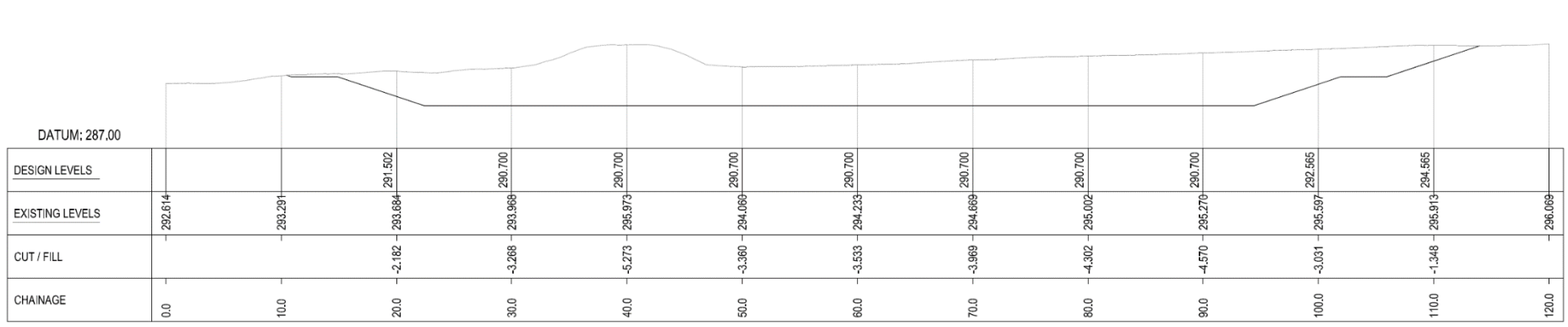


The red colour tones indicate areas of cut whilst the green colour tones indicate areas of fill.



LONGITUDINAL SECTION: REACTOR PAD

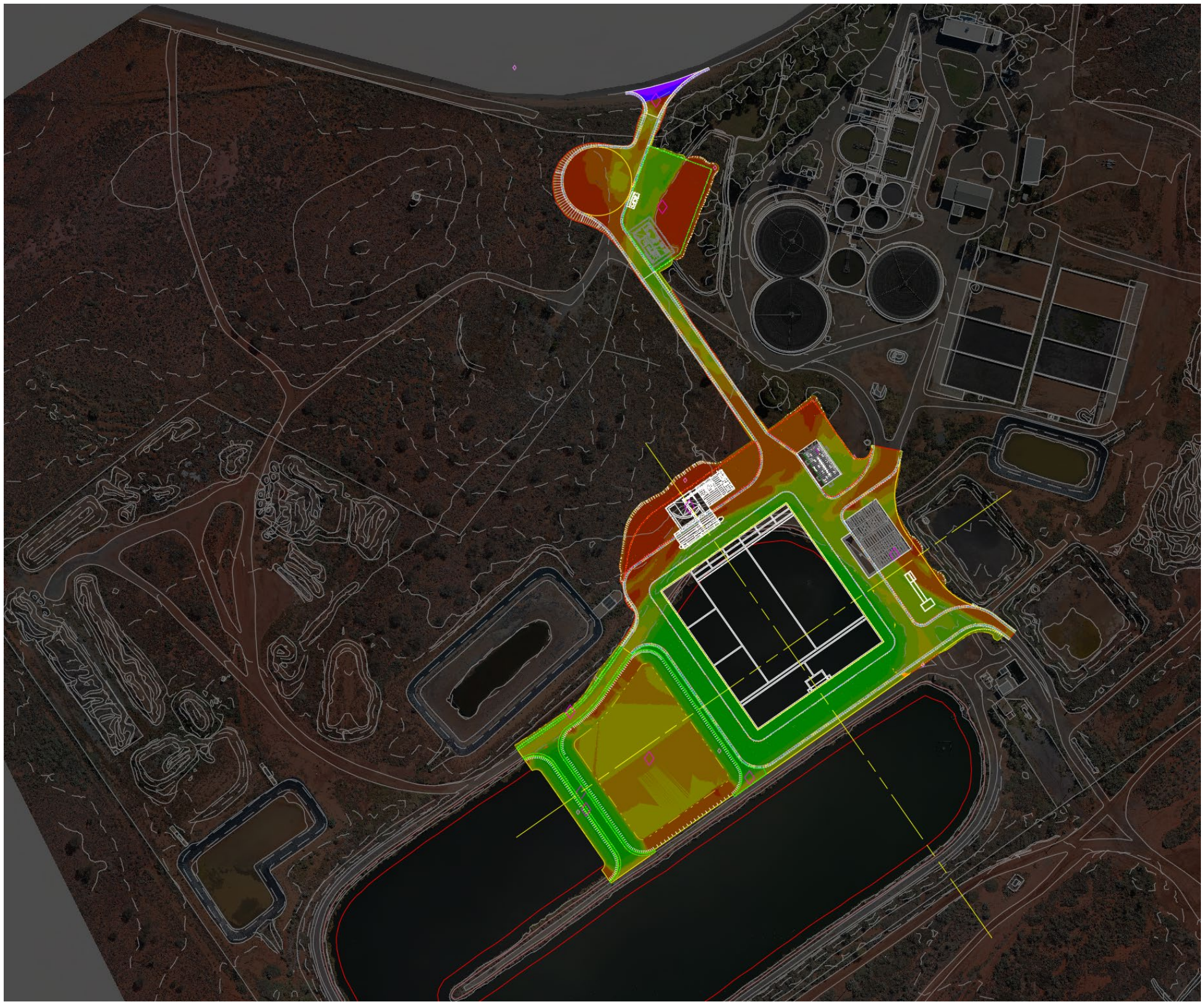
SCALE HORIZ 1:250; VERT 1:250



LONGITUDINAL SECTION: EMERGENCY STORAGE POND

SCALE HORIZ 1:250; VERT 1:250

Appendix B - Proposed New Location



The red colour tones indicate areas of cut whilst the green colour tones indicate areas of fill.

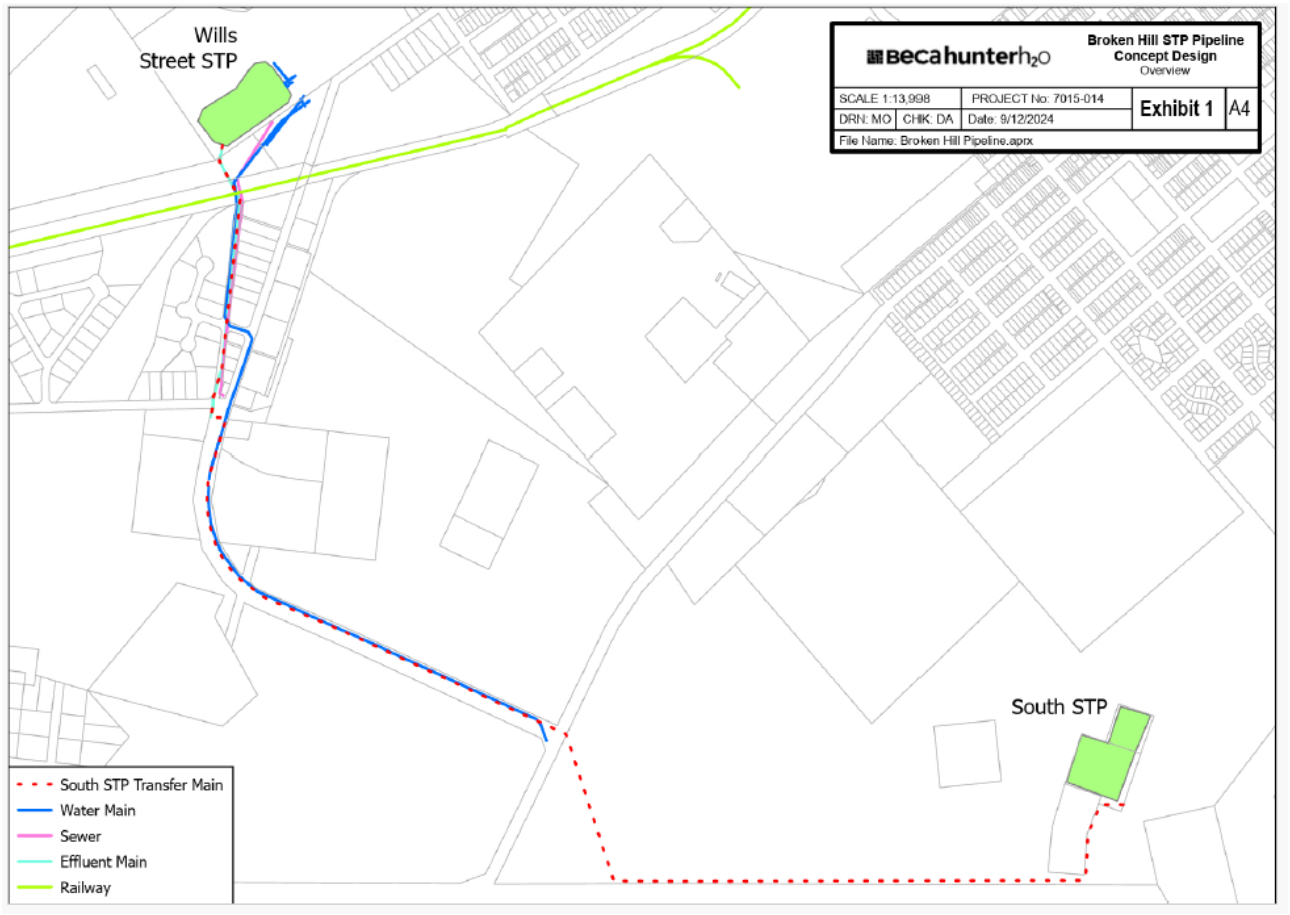
Note: The proposed new layout is subject to further refinement

Appendix C - Preliminary Geotechnical Information

BH ID	BH Depth (m bgl)	Depth of Fill (m)	Depth of Residual Soil (m)	Depth to Rock (m)	Rock Weathering Condition	Remarks
BH101	8.05	0.2	1.2	1.4	MW-SW	
BH102	8.65	0	0.9	0.9	MW-SW	
BH103	10.9	0	4.3	4.3	HW-SW	
BH104	10.1	0	0.5	0.5	MW	
BH105	7.7	0	0.3	0.3	SW	
BH106	8.5	0	2	2	Not provided	GNEISS: dark grey, fine grained.
BH107	8.55	0	0.2	0.2	SW-F	
BH108	9.2	0.1	0.8	0.9	SW-F	Ground water encountered at 7.2m bgl.
BH109	2.42	0	0.5	0.5	MW-SW	
BH110	8.65	1.5	0	1.5	MW-SW	
BH111	9.4	0	1.0	1.0	MW-F	
BH112	12.9	0.5	0.8	1.3	Not provided	
BH113	12.14	0.1	2.5	2.6	XW-SW	
BH114	8.2	0	0.4	0.4	MW-F	
BH115	5.55	0.7	0	0.7	Not provided	
BH116	88.646	0	0.1	0.1	Not provided	GNEISS: light grey and grey, fine grained.
TP201	1.8	0.1	1.7	1.8	Not provided	
TP202	1.85	0.2	1.65	1.85	Not provided	
TP203	1.95	0	1.8	1.8	Not provided	

Note: *Rock Weathering Condition is based off AS1726:2017*

Appendix G. Technical Memo – Effluent Outfall



To:	Stanley Kommo Project Manager Broockmann Water Advisory	From:	Peter Greenhalgh Principal process engineer Beca HunterH2O
Copy to:	Bob Ma Senior process engineer Beca HunterH2O	Date:	15 December 2024
Subject:	Technical Memo – Effluent Outfall (Draft 2)		

This memo provides discussion of the need to upgrade the existing effluent transfer pipe from Wills Street STP to convey additional flow and the potential strategies to achieve this.

This memo includes:

- Relevant data on existing outfall infrastructure.
- Discussion on the minimum flow which should pass to the outfall.
- Development of the minimum upgrades to the effluent outfall which would be required considering risks such as condition and design.
- A brief comparison of upgrade options to achieve discharge of Peak Instantaneous Flow (PIF) through the outfall.
- Discussion on the potential new discharge location which may be required to reduce health risk and how this may align with South STP transfer main to reduce cost.
- A brief summary and list of risk.

It is requested that EW review this memo and confirm:

- If pursuing a discharge location downstream of the existing discharge to reduce health risk is required?
- If discharge of PIF to the outfall should be pursued or would some bypass to stormwater be acceptable?
- If pumping of effluent through the outfall should be further pursued?

What is our understanding of the current infrastructure?

The existing effluent pipeline has been divided into sections to allow assessment. A summary of the current outfall infrastructure follows in Table 1.

Table 1: Existing pipe data.

Section	Description	Pipe Type	Internal diameter (mm)	Length (m)	Comment
1	New section of pipe to connect to existing	DN630 HDPE PN6.3 (to be confirmed)	570	375	Size and length to be confirmed pending further design.
2	Existing pipe from the existing outlet to the railway bridge.	DN450 UPVC PN6	477	295	Newer section of pipe, assumed to be in good condition.
3	Existing pipe bends at entry to railway tunnel.	DN450 DICL	486	~2	Assumed PN20. New pipe (2014), assumed to be in good condition.
4	Existing pipe through the railway tunnel.	DN400 PN10 HDPE	340	40	Newer section of (2014), assumed

					to be in good condition.
5	Short section of existing connecting pipe at outlet of the railway tunnel	DN375 DICL	406	20	Assumed PN20. Newer section of (2014), assumed to be in good condition.
6	Existing pipe from railway tunnel to Kanandah Place	Listed as 470 mm OD PN3.2 HDPE (diameter uncertain)	450	365	470 OD pipe doesn't appear to exist? Assumed iD. Pipe known to be in poor condition needing replacement
7	Existing pipe under Kanandah Place	DN355 HDPE PN6.3	320	50	Sleeved in old steel pipe.
8	Existing pipe between Kanandah Place and Pinnacles Road	DN500 HDPE PN6.3	452	225	Newer section of pipe. Likely good condition.
9	Existing pipe under Pinnacles Road	~DN400 MSCL pipe	445	35	Pipe corroded. Needs to be replaced.
10	Existing pipe from Pinnacles Road to valve pit	DN500 HDPE PN6.3	452	25	Newer section of pipe. Likely good condition.
11	Existing pipe from valve pit to scour pit.	DN300 PN20	325	2	Newer section of pipe, assumed to be in good condition.

Pipe sections described above are also shown in Figure 1 below.

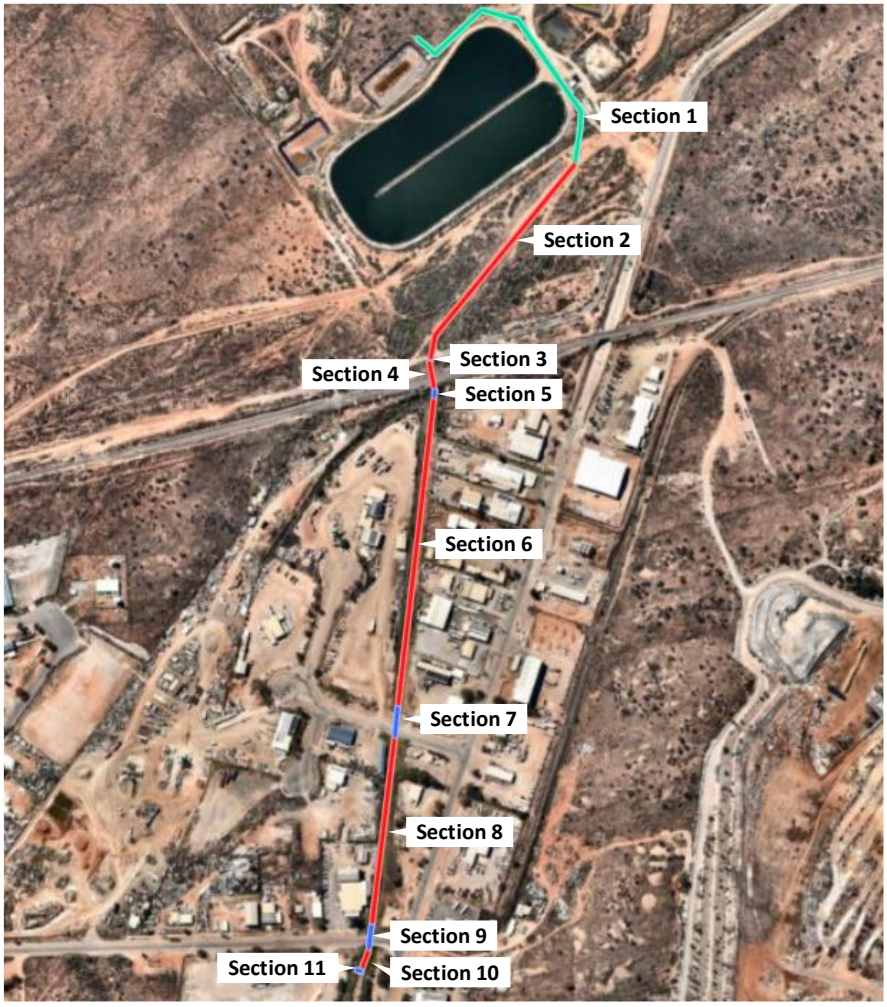


Figure 1: Existing pipe identification.

In regard to design levels, the outlet of the new UV system will have a Top Water Level (TWL) of approximately 292 m RL. The outlet TWL developed is based on the most recent site layouts.

In flooded conditions, it is believed that the effluent outfall at Pinnacles Road would be discharging to a flooded head of ~ 282 m RL which gives a total driving head for gravity flow in the order of 10 m.

What would be an acceptable flow to pass through the outfall?

In the current iteration of the design, flow not able to pass through the outfall would overflow to the small emergency storage pond which would then overflow to the stormwater system.

The flow path of stormwater is uncertain. Anecdotal evidence suggests stormwater may flow from the STP in the same railway bridge the effluent pipe runs in then through the industrial estate also following the effluent pipe alignment. Better understanding of the stormwater flow path is required to understand the risk.

There is also some residual uncertainty regarding what peak flows will be received at the new STP, at commissioning and in the future.

To enable this review, it has been assumed that:

- Discharge of effluent to stormwater does not appear to have been a feature of the existing system and not from a regulatory perspective. There may be some reticence of the regulator to allow discharge of effluent to stormwater.

- If the effluent pipeline capacity is less than ~6 x ADWF, there is a higher risk that effluent will enter the stormwater system in each rain event. This comment is based on work done to date assessing flows to Wills Street STP and South STP.
- If the effluent pipeline capacity is greater than ~6 x ADWF, there is a lower risk that effluent will enter the stormwater system in each rain event.
- Use of the existing maturation pond would not be pursued noting it needs to be relined.

The above statement considers the potential balancing in the STP, the emergency storage volume and uncertainty in peak flow estimation.

What are the hydraulic capabilities and risks of the existing pipeline?

Table 2 shows, for a number of flow scenarios, the estimated total headloss and velocity through each pipe section.

As a high level estimate, considering uncertainty regarding pipe condition and restraint / support type, operating at sustained velocities of greater than 3 m/s may be problematic. For each section, values greater than 3 m/s are shown in red.

Table 2: Existing pipe velocity estimation.

Pipe Section	5 x ADWF (m/s)	6 x ADWF (m/s)	7 x ADWF (m/s)	PIF (m/s)
1	1.2	1.4	1.7	1.9
2	1.7	2.1	2.4	2.7
3	1.6	2.0	2.3	2.6
4	**3.4**	**4.0**	**4.7**	**5.4**
5	2.4	2.8	**3.3**	**3.8**
6	1.9	2.3	2.7	**3.1**
7	**3.8**	**4.6**	**5.3**	**6.1**
8	1.9	2.3	2.7	3.0
9	2.0	2.4	2.8	**3.1**
10	1.9	2.3	2.7	3.0
11	**3.7**	**4.4**	**5.2**	**5.9**
Total Headloss (m)	**11**	**15**	**20**	**26**

For Table 2, it is noted that:

- Gravity flow above 4 x ADWF is unlikely within the error in the estimation considering the likely driving head available (10m). The error of estimation considers potential pooling around the outlet and uncertainty regarding final plant construction level.
- Pipe sections In the railway tunnel (Section 4), under Kanandah Place (Section 7) and the final outlet (Section 11) would need to be replaced to cater for all but the lowest pipe flows due to high velocities at higher flows.

To better understand which sections of pipe are the most restrictive to conveying flow, the headloss through each section of pipe is shown in Table 3.

Table 3: Existing pipe headloss estimation.

Pipe Section and units	5 x ADWF	6 x ADWF	7 x ADWF	PIF
1 (mm headloss / m of pipe)	2	3	4	5
2 (mm headloss / m of pipe)	5	7	9	12
3 (mm headloss / m of pipe)	66	94	126	164
4 (mm headloss / m of pipe)	35	50	67	87
5 (mm headloss / m of pipe)	21	31	42	55
6 (mm headloss / m of pipe)	6	8	11	14
7 (mm headloss / m of pipe)	30	43	57	74
8 (mm headloss / m of pipe)	6	8	11	14
9 (mm headloss / m of pipe)	11	16	22	28
10 (mm headloss / m of pipe)	7	10	14	18
11 (mm headloss / m of pipe)	530	758	1,027	1,337

For Table 3 it is noted that:

- The majority of the headloss per unit length occurs in Sections 3, 4 and 5 (railway tunnel), 7 (under Kanandah Place) and 11 (the outlet pipe).

What are the minimum upgrade requirements for the pipeline?

As a preliminary assumption, a scenario where the effluent pipeline must convey at least 6 x ADWF plus rainfall loading has been assessed.

In this scenario, replacement of pipe Sections 4, 5, 7 and 11 is proposed due to the high velocities in these sections of pipe. Velocities above 3 m/s risk flow surging which can increase pressures and lead to pipe or support damage. Noting that the pipes were designed to convey in most cases less than 2 m/s, velocities above 3 m/s may represent a high risk.

Section 3 is the small length of pipe and bends which transitions the effluent pipe under the railway tunnel. It is assumed this short transition piece would also need to be replaced if Sections 4 and 5 of pipe in the railway tunnel are replaced.

Section 9 is the pipe under Pinnacles Road. This pipe is known to be in poor condition with the majority of the steel in the pipe having rusted away. Replacement of this pipe is understood to be complex noting the criticality of maintaining access via this road to industrial estates. Given the condition and criticality of this section of pipe, replacement would be recommended.

Therefore, the minimum effluent outfall pipe upgrade is seen as:

- Replace pipe Sections 3, 4, 5, 7 and 9 with DN630 PE pipe (actual pipe size to be determined).
- Replacement of the short 2-3 m section of pipe at the outlet into the existing earthen channel to minimise headloss / velocity and to protect the channel from erosion. It is assumed that this section would be replaced with a DN 600 DICL pipe or equivalent (actual pipe size to be determined).

With the above works, a preliminary assessment indicates that gravity flow could be achieved for just over 6 x ADWF or 390 L/s. A summary of the minimum upgrade changes are shown in Table 4.

Table 4: Minimum pipe upgrade assessment.

Section	Status	Pipe Type	Velocity	Comment
1	New	DN630 PN 6.3	1.6	Pipe size and type to be confirmed
2	Retain Existing	DN450 UPVC PN6	2.2	
3	New	DN630 PN 6.3	1.6	Pipe size and type to be confirmed
4	New	DN630 PN 6.3	1.6	Pipe size and type to be confirmed
5	New	DN630 PN 6.3	1.6	Pipe size and type to be confirmed
6	Retain Existing	Listed as 470 mm OD PN3.2 HDPE	2.5	Consider replacing. Pipe in poor condition.
7	New	DN630 PN 6.3	1.6	Pipe size and type to be confirmed
8	Retain Existing	DN500 HDPE PN6.3	2.5	
9	New	DN630 PN 6.3	1.6	Pipe size and type to be confirmed
10	Retain Existing	DN500 HDPE PN6.3	2.5	
11	New	DN600 DICL	1.2	Pipe size and type to be confirmed

How can you achieve higher flows?

Section 6, the pipe from the railway tunnel and Kanandah Place is known to be in poor condition and in need of replacement. It is proposed that pumping to increase flow to 7 x ADWF and greater should occur in conjunction with replacement of pipe Section 6.

Assuming the need to discharge PIF, the following scope of works would be required:

- Minimum upgrades per previous section.
- Replace Section 6 pipeline from the railway tunnel to Kanandah Place with nominally DN630 PN6.3 HDPE pipe.
- Condition assessment of existing, to be retained pipes and review of design (this has not yet been provided) to ensure it can manage the significantly higher velocity. Additional / modified thrust restraints may be required.
- Install a pump well downstream of the proposed UV system which includes duty / standby 20 kW submersible pumps.
- Provide an automated penstock on the wet well outlet such that when gravity flow is insufficient, the penstock closes to allow the duty pump to pressurise the outfall main.
- Provide instrumentation and controls to allow pump function.

If instead of pumping as described above, Section 2 **OR** 8 pipe is replaced, it is likely that gravity flow of PIF is feasible.

This means that achieving PIF through the effluent pipeline can either be achieved through provision of an effluent pump station or an additional 225 m of DN630 HDPE pipe. As such the additional cost and complexity of a new effluent pump station is not seen as overall beneficial.

Potential alternate discharge location

The existing effluent discharge is into an earthen channel which runs through properties not owned by EW. There may be benefit in extending the outfall beyond the properties to reduce health risk posed by potential contact with effluent. The earthen channel conveying effluent through said properties is highlighted in Figure 2

Figure 2: Existing earthen channel through properties.

If discharge of effluent beyond the properties shown in Figure 2 is requested by EW, consideration should be given to constructing the new outfall in the same alignment as the South STP transfer pipeline. The nominal alignment of the relevant portion of the South STP pipeline is shown in Figure 3.

Figure 3: Nominal South STP transfer pipeline route.

If the alternate discharge location is pursued, there are likely to be some cost savings in following the same route as the South STP transfer pipeline.

Nominally, this change in discharge location would then include duplication of the existing effluent pipeline from the northern side of the railway tunnel to the new discharge location as shown in Figure 4. Nominally this pipe would be DN630 HDPE And have a length of 1,325 m.

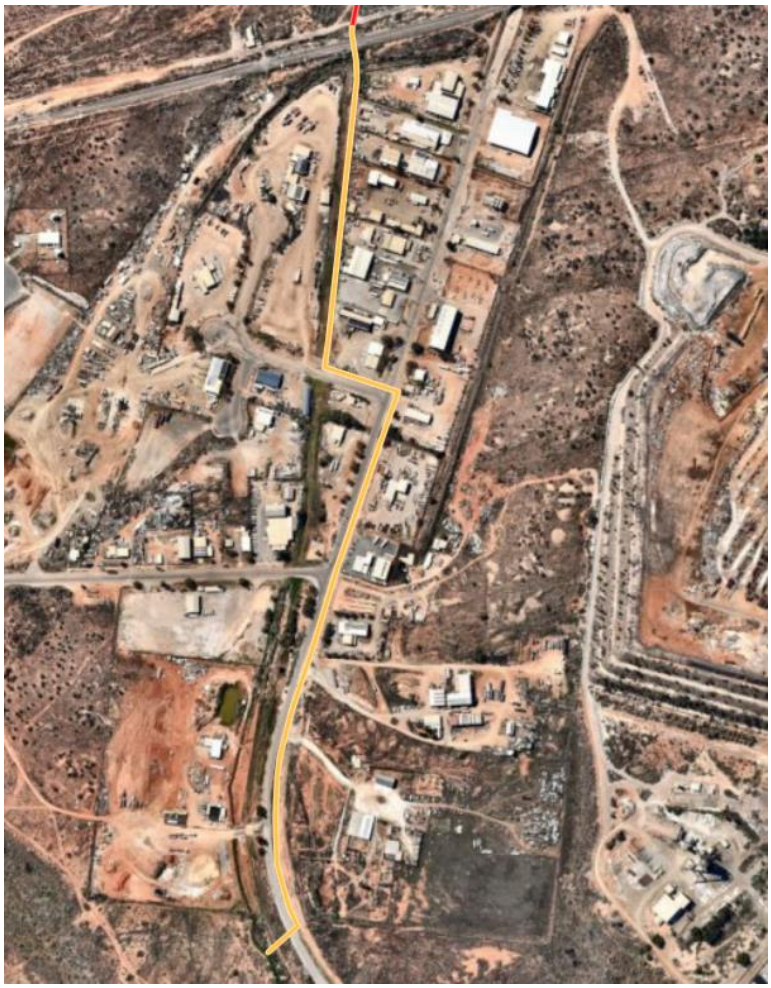


Figure 4: Pipe route to new discharge point.

Noting the above, only 295 m of the existing effluent main would then remain (Section 2). Consideration should then be given to complete replacement of the pipe, noting the existing pipe may be retained just to supply White Leeds.

Summary

Significant modifications to the effluent outfall are likely to be required for all options. These modifications would include at a minimum replacement of pipe Sections 3, 4, 5, 7, 9 and 11. These modifications have the potential to allow flows in the order of 6 x ADWF to pass to the outfall via gravity.

To achieve PIF, consideration should be given to replacing pipe Section 6 from the railway tunnel to Kanandah Place. This pipe is in poor condition and is understood to be in need of replacement. The risk to this pipe would be exacerbated by the higher flows.

With the above works (replacement of Sections 3-7, 9 and 11), pumping would be required to transfer PIF to the outfall. Gravity flow of PIF could also be achieved by replacing pipe Sections 3-9 and 11. This is an additional 225 m of DN630 HDPE. As the cost and risk of pumping would be compared with providing 225 m of pipe, pumping effluent does not appear to provide an overall benefit.

If EW wish to pursue a new discharge location further to the south to reduce health risk, consideration should be given to using the same alignment as the South STP transfer pipeline to reduce costs.

Key Risks

- Uncertainty regarding condition of the existing pipework, especially Section 4
- Uncertainty in the ultimate design of the railway bridge crossing.
- Uncertainty in the hydraulic capacity of the final effluent channel.
- Uncertainty in the design flood levels for the effluent channel.
- Uncertainty regarding the potential health and environmental impact if effluent is discharged to stormwater.

To:	Stanley Kommo Project Manager Broockmann Water Advisory Essential Water	From:	Patrick Kane / Ben Golding Beca HunterH2O
Copy to:	Obert Moyo / Peter Greenhalgh Beca HunterH2O	Date:	15 December 2024
Subject:	Technical Memo – Broken Hill STP Pipeline Alignment		

1 Introduction

Beca Hunter H2O has been engaged by Essential Water to complete a detailed design of a new Wastewater Treatment Plant (WWTP) at Wills Street to replace two existing STP's (Wills St STP and South STP). The existing treatment plants were built in the 1930's and comprise a simple sedimentation, clarifier and trickling filter process that no longer provides the level of treatment required to meet contemporary environmental and effluent reuse requirements, as well they are at the end of asset life.

The proposed upgrades include a new sewage transfer pump station and pipeline connecting the de-commissioned South STP to the new Broken Hill WWTP. The pipe route for the South STP to Broken Hill WWTP sewage transfer proposed in the original concept design is shown in Figure 1.

Figure 1: Pipe route from original concept design (Figure4-5, PWA, 2019)

During the design process it was identified that a replacement effluent outfall pipeline was required to convey the anticipated design flows. The route of the existing effluent pipeline from Wills Street STP to the outfall is in Figure 2 represented by a teal coloured line.

Figure 2: Pipe route for existing outfall from Wills Street STP,

A high-level investigation is required of the proposed alignment of both sewage transfer and effluent outfall. This brief memo has been developed to:

- Discuss interactions of the proposed pipe route with current services alignment with existing lot boundaries.
- Describe the proposed pipe alignments for the raw sewage transfer and effluent outfall and options for crossing the rail corridor.

2 Service Interactions

2.1 Services Description

Existing services within the proposed pipe corridor have been identified via service location and recorded in a CAD file. This CAD file was imported into ArcGIS Pro to assess the feasibility of the proposed pipe alignment.

Key services within the vicinity of the pipe alignment which need to be considered include:

- The existing effluent outfall from Wills Street STP to just south of Pinnacles Road, which is of varying pipe type and diameter, a summary of which is provided in the Attachments (shown as a light blue pipe).
- A sewage pump station on Pinnacles Road which transfers sewage through a DN32 PVC rising main to Wills Street STP (shown as a lilac pipe).
- The OD 762 MSCL Wentworth to Broken Hill raw water main which runs along Kanandah Road and adjacent to the existing Broken Hill STP effluent main (shown as a blue pipe).
- The likely new pipe entry / exit point from the new BHWWTP is to the south of the site and is shown as a dotted red and light blue line.
- Power and communications services both above and below ground.

The services discussed are shown in Figure 3.

Figure 3 Extent Showing Proximity of Services

A zoomed in section of the corridor showing approximate clearances is shown in Figure 4 below. Note – these clearances are based on GIS analysis only and are required to be confirmed in the field. The approx. width of the easement is 20 – 22 m. It is noted that the Wentworth to Broken Hill pipeline runs along the western side of the easement, with other services to the east.

Figure 4 Services within Corridor

Locations of power poles along the South STP raw sewage transfer pipe alignment were also mapped georeferencing data from Look Up and Live and plotted to check clearances. Refer to Figure 5.

Figure 5 Power Pole Locations Along Alignment

2.2 Lot Boundaries

The pipe routes discussed follow existing road and pipe easements. There are also land parcels the proposed pipelines would traverse. It is assumed that EW will conduct the necessary investigations and works to procure the identified easements.

The proposed pipe route crosses DP1242250/302 upon exit of the WWTP site boundary. The pipe route then crosses the rail corridor DP533250/1 before entering the easement in which the existing effluent outfall pipe is installed (Figure 6).

Figure 6: Northern pipe alignment boundary interactions.

For the proposed South STP transfer pipeline southeast of Silver City Highway, the pipeline would traverse DP1220372/4 and then run on the boundary of DP1220372/4 and DP1083729/3 and then DP1220372/4 and DP769318/6498. The pipe route would then run a short distance through DP1220372/4 before entering EW land on DP767329/3/2/1 (Figure 7).

Discussion of pipe easements and access will be required for the aforementioned sections of the south STP sewage transfer pipeline.

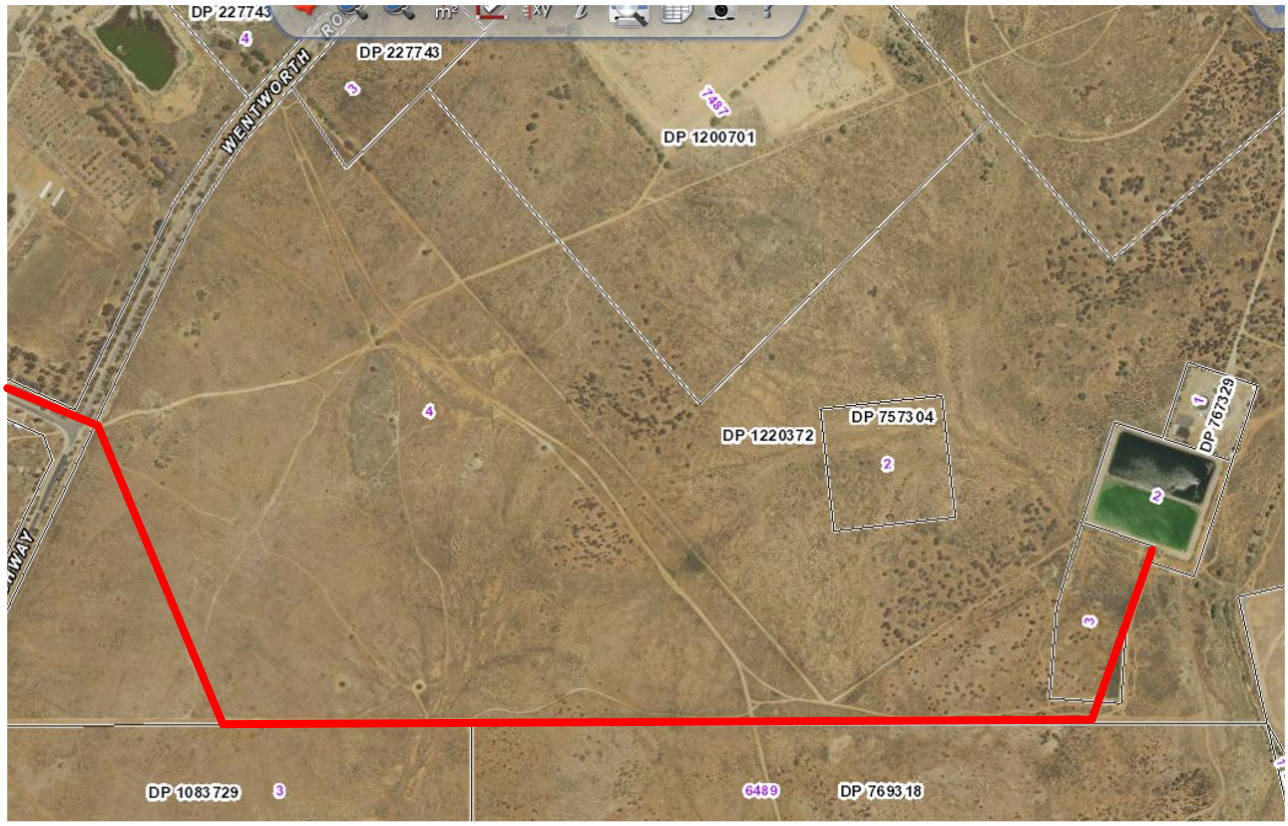


Figure 7: Southern pipe alignment boundary interactions.

3 Pipeline Alignment

It is proposed that the South STP sewage transfer pipeline follows the same route as the proposed effluent main replacement to the south of Pinnacles Road. This proposal is guided by:

- The presence of a significant number of services to the east of Kanandah Road, including the Wentworth to Broken Hill pipeline and the presence of overhead power lines.
- Excavation works will be required to replace the outfall pipeline. There are likely to be efficiencies gained through common works, including reduced impact on the community by installing both pipelines in the same area.

The easement to the north of Kanandah Place up to the rail corridor is narrow, containing multiple services. There are requirements (discussed below) for separation distances between services which it is recommended to maintain.

3.1 Clearances

Pipeline clearance allowances are specified in WSA Water Supply Code of Australia. Table 1 below is taken directly from Section 5.12 Obstructions and Clearances and provides a guideline for allowable clearances between water mains and existing services.

Table 1 WSA Clearances Between Water Mains and Underground Services Table 5.5.

Utility (Existing or proposed service)	Minimum horizontal clearance mm (New main size ≤DN 200)	Minimum horizontal clearance mm (New main size >DN 200)	Minimum vertical clearance mm
Water mains[2]	600	600	300
>DN 375	600	600	300
Water mains ≤DN 375	300[3]	600	150
Gas mains	300[3]	600	150
Telecommunication conduits and cables	300[3]	600	150
Electricity conduits and cables	500	500	225[4]
Stormwater drains	300[3]	600	150[4]
Sewers – gravity	1000[5]/600	1000[5]/600	500[4]
Sewers – pressure and vacuum	600	600	300
Kerbs	150	600[6]	150 (where possible)

Notes:

1. Vertical clearances apply where water mains cross one another and other utility services, except in the case of sewers where a vertical separation shall always be maintained, even when the main and sewer are parallel. The main should always be located above the sewer to minimize the possibility of backflow contamination in the event of a main break.
2. Water mains include mains supplying drinking water and non-drinking water (refer to Drawing WAT–1810 Main Arrangement for Dual Water Supply Systems).
3. Clearances can be further reduced to 150 mm for distances up to 2 m where mains are to be laid past installations such as concrete bases for poles, pits and small structures, providing the structure will not be destabilized in the process. The clearance from timber poles should be at least 200 mm and preferably 300 mm.

4. Water mains should always cross over sewers and stormwater drains. For cases where there is no alternative and the main must cross under the sewer, the design shall nominate an appropriate trenchless construction technique in accordance with 5.5 TRENCHLESS TECHNOLOGY or other water main construction and protection treatment, effectively joint-free in the vicinity of the sewer.
5. Where a parallel sewer is at the minimum vertical clearance lower than the water main (500 mm), maintain a minimum horizontal clearance of 1000 mm. This minimum horizontal clearance can be progressively reduced to 600 mm as the vertical clearance is increased to 750 mm.
6. Clearance from kerbs shall be measured from the nearest point of the kerb. For water mains ≤DN 375 clearances from kerbs can be progressively reduced until the minimum of 150 mm is reached for mains ≤DN 200.
7. An additional clearance from high voltage electrical installations should be maintained above the conduits or cables to allow for a protective barrier and marking to be provided.

Noting the above, careful consideration in the design will be required for:

- Separation between the proposed effluent and sewer mains and the Wentworth to Broken Hill pipeline.
- Interactions between the new effluent and sewer main the existing mains in the pipe corridor.
- The need for the new effluent and sewer main to cross the Wentworth to Broken Hill pipeline twice.
- Interactions between the proposed effluent and sewer mains and electrical and communications cables.

From a high level assessment, separation distances appear achievable, however further thought is required on the methodology for pipe intersections (e.g. crossing the Wentworth to Broken Hill pipeline).

Further, the ability to cease discharge from the existing Wills Street STP for periods of time during construction will be critical. The duration of the stoppages of discharge will need to be developed in conjunction with further design work. In particular, determination of the trench width and depth through the easement will help determine the likely interactions with existing services.

3.2 Railway Crossing

Further design development is required to determine the best way for the sewer and effluent mains to cross the rail line. The existing effluent main and other services have been installed in a stormwater pipe/ culvert under the existing rail line (Figure 13). The Wentworth to Broken Hill pipeline was installed under the rail corridor using horizonal directional drilling (HDD). Figure 8 includes an aerial image of the under-bore courtesy of google earth.

On the north side of the rail corridor, both the South STP sewage transfer pipe and new effluent main will need to cross the Wentworth to Broken Hill pipeline. Work as executed drawings show the top of pipe for the Wentworth to broken Hill pipe at approximately 1.8 m below ground level to the north of the rail line. Further design development is required to determine how these pipes will intersect.

Figure 8: Wentworth to Broken Hill pipe under-bore of rail corridor.

Noting the above, there are two options for the proposed pipelines to cross the railway. Option 1 involves HDD under the railway. Option 2 involves leveraging the existing stormwater culvert.

HDD under the railway will require geotechnical investigations and pre-planning to ensure sufficient clearances from existing services as well as suitable setup and site access to both sides of the railway. Approximately 60 m of HDD will be required as shown in Figure 9.

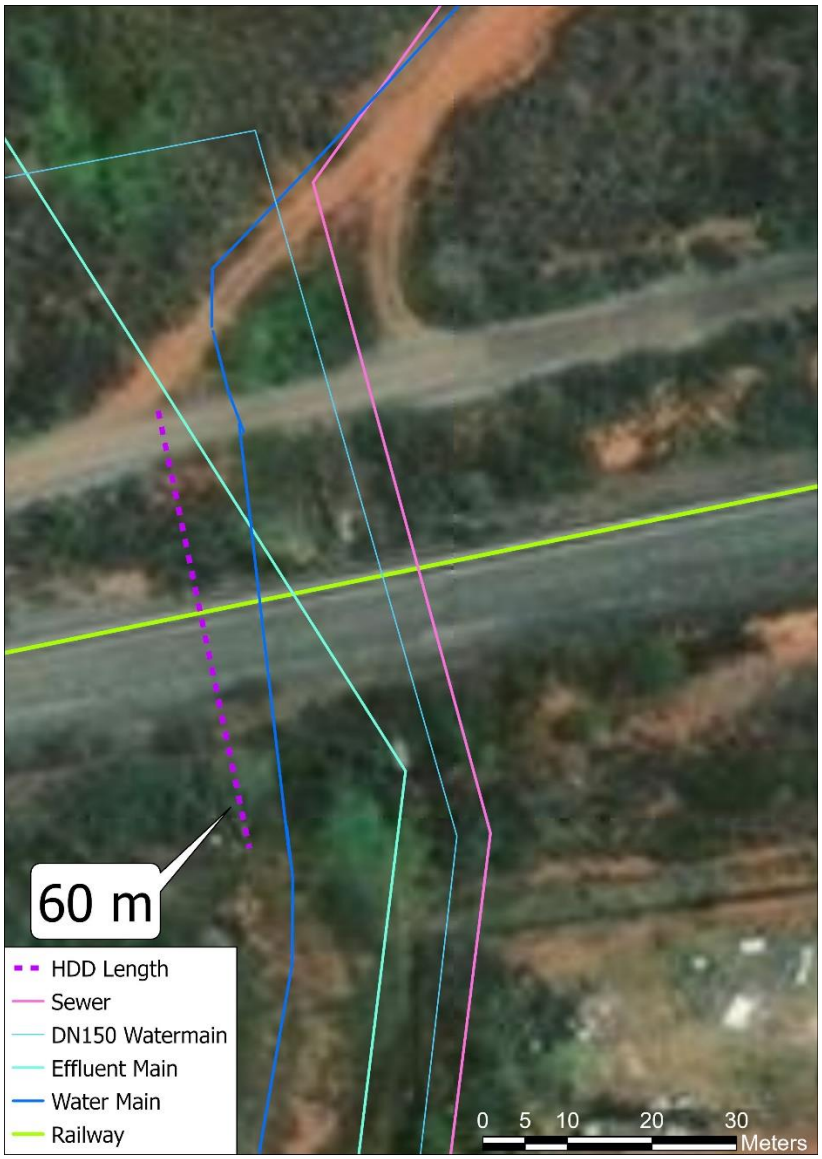


Figure 9 HDD Railway Crossing

As ARTC will have to give approval for HDD, launch and retrieval pits for the machinery may need to be outside of their land. This will increase the required distance for the HDD.

The key benefit of installing pipelines using HDD is the ability to reduce impact on stormwater flows under the rail culvert. Removing pipes from the stormwater culvert would also help to reduce damage to pipelines from flood debris. If pipes were to be installed in the stormwater pipe / culvert, options to elevate the pipes off the base of the stormwater pipe should be investigated to reduce impact on the culvert hydraulic capacity.

3.3 Summary

Noting the risk involved in installing pipework within the existing stormwater pipe / culvert, the preferred approach is to HDD pipes under the rail corridor, pending further design development.

Geotechnical investigations will be required and pre-planning to ensure sufficient clearances from existing services as well as suitable setup and site access to both sides of the railway.

The proposed new effluent main (shown in light blue) and South STP sewage transfer main (dotted red line) approximate alignments are shown in Figure 10 along with existing services.

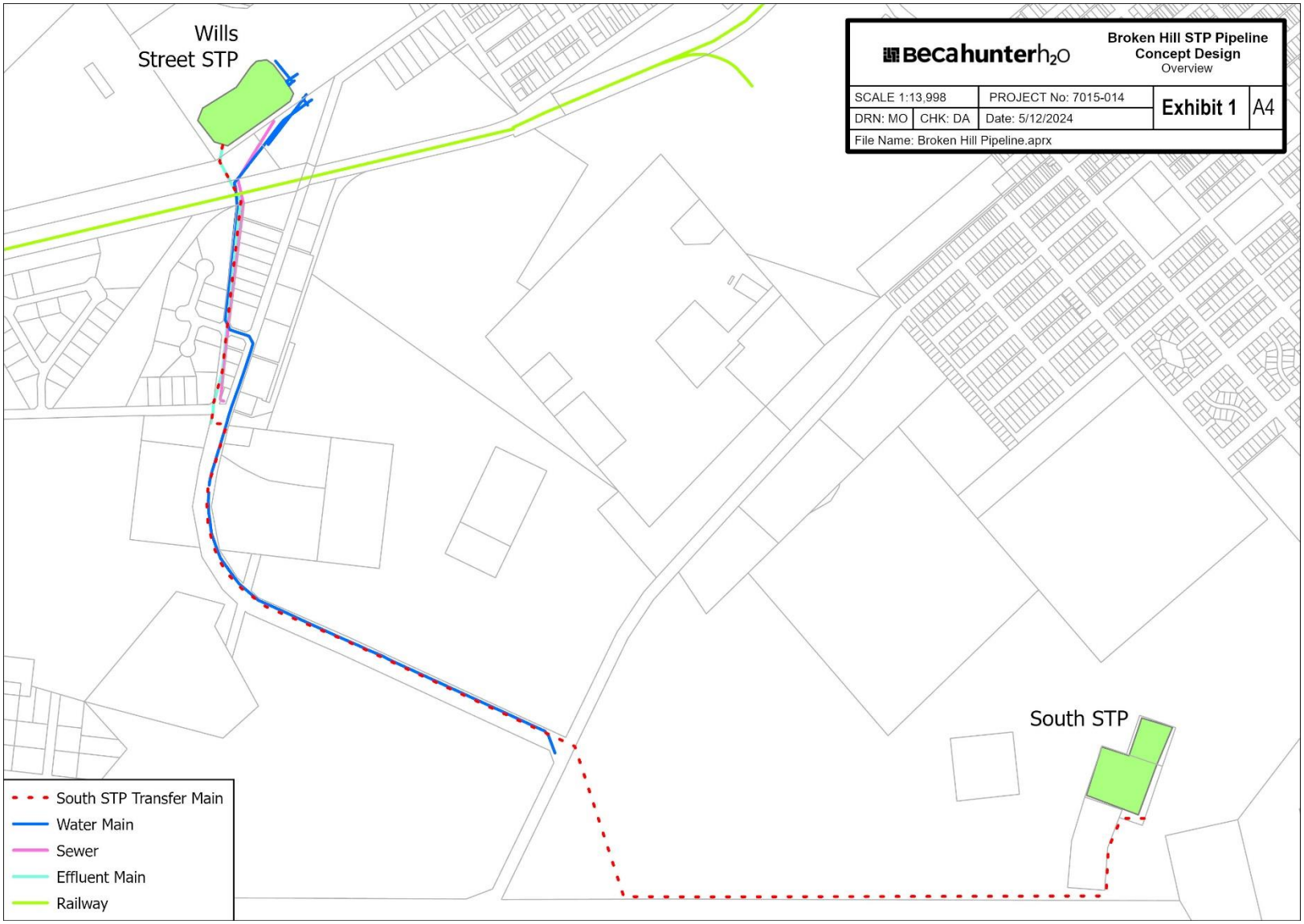


Figure 10 Proposed Effluent and Transfer Main Alignment

An elevation profile of the proposed new effluent main and South STP sewage transfer main is shown in Figure 11 (Broken Hill WWTW to the left and South STP transfer SPS to the right). The approximate end of the existing and proposed effluent main is circled in red.

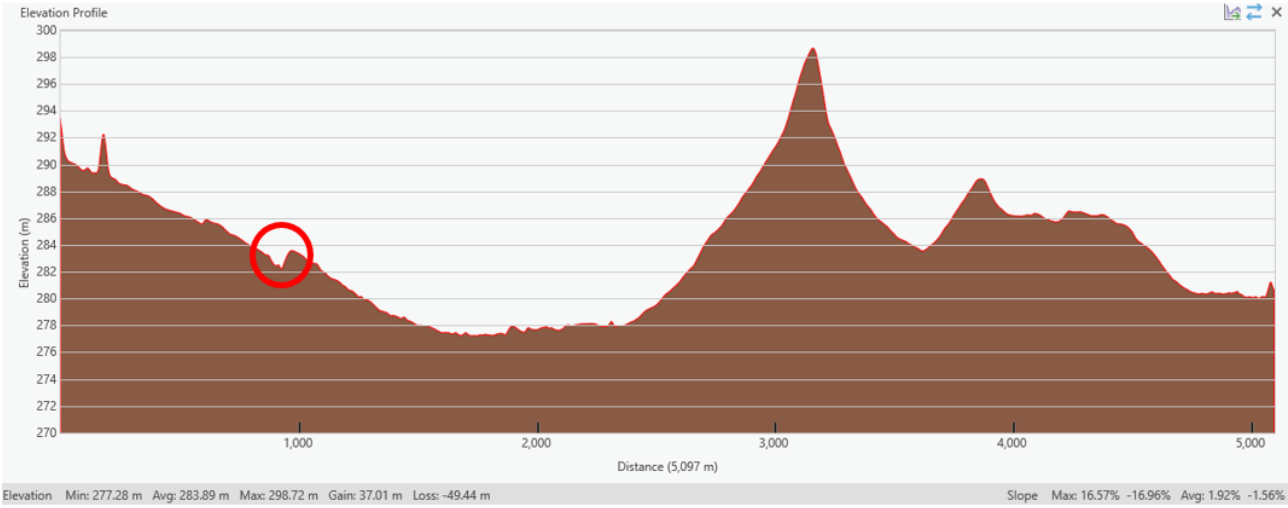


Figure 11 Elevation Profile of Proposed Alignment

The originally proposed South STP sewage transfer main alignment which connected into the northeastern section of Wills Street STP is presented in Figure 12.

Copyright © Hunter H2O Holdings Pty Limited 2024
The concepts and information contained in this document are the property of Hunter H2O Holdings Pty Limited for the sole use of the nominated client. Use or copying of this document without the written permission of Hunter H2O constitutes an infringement of copyright.

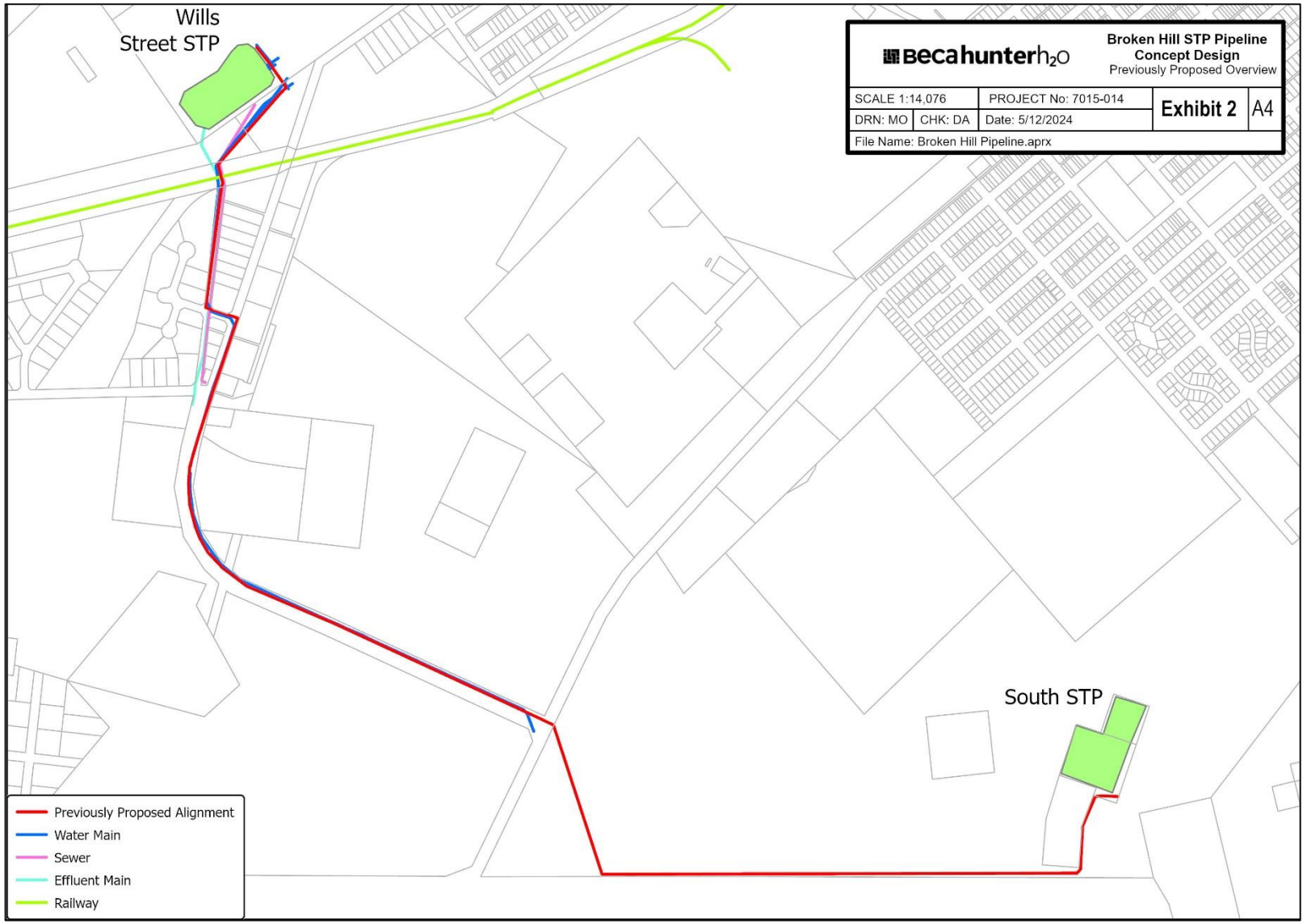


Figure 12 Originally Proposed Effluent and Transfer Main Alignment

Attachments

The existing effluent pipeline has been divided into sections to allow assessment. A summary of the current outfall infrastructure follows in Table 2.

Table 2: Existing pipe data.

Section	Description	Pipe Type	Internal diameter (mm)	Length (m)	Comment
1	Existing pipe from the existing outlet to the railway bridge.	DN450 UPVC PN6	477	295	Newer section of pipe, assumed to be in good condition.
2	Existing pipe bends at entry to railway tunnel.	DN450 DICL	486	~2	Assumed PN20. New pipe (2014), assumed to be in good condition.
3	Existing pipe through the railway tunnel.	DN400 PN10 HDPE	340	40	Newer section of (2014), assumed to be in good condition.
4	Short section of existing connecting pipe at outlet of the railway tunnel	DN375 DICL	406	20	Assumed PN20. Newer section of (2014), assumed to be in good condition.
5	Existing pipe from railway tunnel to Kanandah Place	Listed as 470 mm OD PN3.2 HDPE (diameter uncertain)	450	365	470 OD pipe doesn't appear to exist? Assumed iD. Pipe known to be in poor condition needing replacement
6	Existing pipe under Kanandah Place	DN355 HDPE PN6.3	320	50	Sleeved in old steel pipe.
7	Existing pipe between Kanandah Place and Pinnacles Road	DN500 HDPE PN6.3	452	225	Newer section of pipe. Likely good condition.
8	Existing pipe under Pinnacles Road	~DN400 MSCL pipe	445	35	Pipe corroded. Needs to be replaced.
9	Existing pipe from Pinnacles Road to valve pit	DN500 HDPE PN6.3	452	25	Newer section of pipe. Likely good condition.
10	Existing pipe from valve pit to scour pit.	DN300 PN20	325	2	Newer section of pipe, assumed to be in good condition.

Services in the stormwater culvert under the railway line are shown in Figure 13.

Figure 13 Railway Culvert with Existing Services

Appendix H. Cost Estimate

Appendix I. 3D Preliminary Model

Appendix J. CHAIR 1 Report

Sensitivity: General

Beca hunterH2O
the future of water

Report

Broken Hill WWTP Concept Design

CHAIR 1 Draft Report

Essential Water

December 2024

Beca HunterH2O | ABN 16 602 201 552

Report Details

Project Title	Broken Hill WWTP Concept Design: CHAIR 1 Draft Report
Project No.	7015
Document Location	Https://Becagroup-My.Sharepoint.Com/Personal/Peter_Greenhalgh_Beca_Com/Documents/Current Working/BH/Workshop 8 - CHAIR 1/7015-REP-0- CHAIR 1 Report_Draft.Docx
Enquiries	Project Manager Obert Moyo +612 49 41 4820 obert.moyo@beca.com

Document History and Status

Revision	Report Status	Prepared By	Reviewed By	Approved By	Issue Date
A	Draft	Peter Greenhalgh	Bob Ma	Obert Moyo	03/12/24
0	Final				

Copyright © Hunter H2O Holdings Pty Limited 2024
The concepts and information contained in this document are the property of Hunter H2O Holdings Pty Limited for the sole use of the nominated client. Use or copying of this document without the written permission of Hunter H2O constitutes an infringement of copyright.

Contents

1 Introduction 1
2 Background of CHAIR Process 2
2.1 Codes of Practice 4
3 Construction Hazard Assessment Implications Review (CHAIR) 5
3.1 Introduction 5
3.2 CHAIR Process 5
3.3 Hierarchy of Controls 6
3.4 Generic CHAIR Guidewords 7
3.5 CHAIR 1 Workshop Guidewords 8
4 CHAIR Outcomes 11
4.1 Attendance 11
4.2 CHAIR 1 Report 12

Figures

Figure 2-1: Safety in Design Legislation 2
Figure 2-2: Location of the Codes of Practice 4
Figure 2-3: Example of SafeWork Code of Practice: Safe Design of Structures 4
Figure 3-1: Phases of the CHAIR Process 5
Figure 3-2: Hierarchy of Controls 6

Tables

Table 2-1: Roles and Responsibilities of Those Undertaking Design 3
Table 3-1: Generic CHAIR Guidewords 7
Table 3-2: Guideword Specific to the CHAIR 1 Workshop 8
Table 4-1: CHAIR Attendance 11
Table 4-2: CHAIR 1 Review Outcomes 12

Appendices

No table of contents entries found.

1 Introduction

Beca Hunter H2O has been engaged by Essential Water to complete a detailed design of a new Wastewater Treatment Plant (WWTP) at Wills Street to replace two existing STP's (Wills St STP and South STP). The existing treatment plants were built in the 1930's and comprise a simple sedimentation, clarifier and trickling filter process that no longer provides the level of treatment required to meet contemporary environmental and effluent reuse requirements, as well they are at the end of asset life.

There have been multiple interim discussions and memos aimed at refining the design of the new Broken Hill WWTP (BHWWTP). The design has now progressed to include a draft concept and draft 30% design.

A Construction Hazard Assessment Implications Review (CHAIR) 1 was undertaken on the preliminary design. The CHAIR workshop was undertaken to collectively identify and reduce construction, maintenance repair and demolition safety risks associated with the concept design. The risks identified were then formally listed for action by the appropriate stakeholders of the project. The CHAIR 1 workshop was held virtually via MS Teams on the 28th November 2024.

The CHAIR workshop was facilitated by Beca HunterH2O and attended by representatives from the following stakeholders:

- Beca HunterH2O design team
- Essential Water (EW)
- Essential Energy (EE)
- Department of Climate Change, Energy, the Environment and Water (DCCEEW)
- Brockmann Water Advisory (BWA)

This report provides an outline of the CHAIR minutes/reports and includes:

- Background of the CHAIR process
- Generic and CHAIR guidewords
- CHAIR worksheet

Outcomes from the CHAIR process will be incorporated into the final BHWWTP design where appropriate or noted for action by EW as the design and procurement progresses.

2 Background of CHAIR Process

As shown in Figure 2-1~~Figure 2-1~~, the Work Health and Safety Act 2011 (**the Act**), establishes the overarching roles and responsibilities for safety in design.

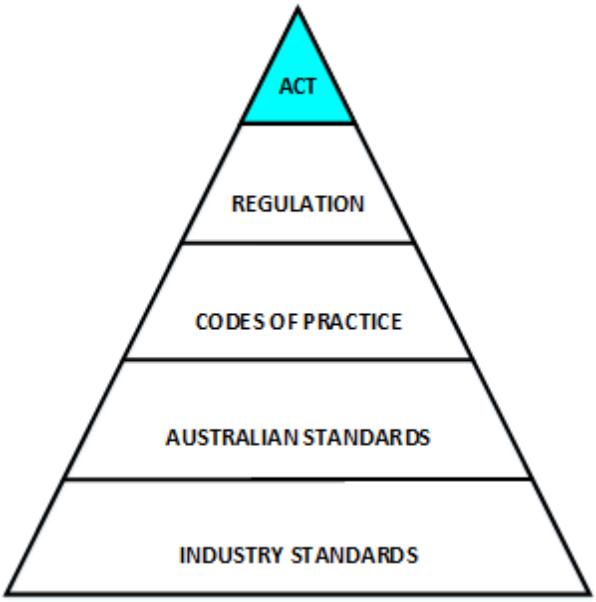


Figure 2-1: Safety in Design Legislation

The following sections of the act outlined in Table 2-1~~Table 2-1~~ highlight the roles and responsibilities of those undertaking design.

Table 2-1: Roles and Responsibilities of Those Undertaking Design

Part 6.2 Duties of designer of structure and person who commissions construction work	
294 Person who commissions work must consult with designer	1. A person conducting a business or undertaking that commissions construction work in relation to a structure must, so far as is reasonably practicable, consult with the designer of the whole or any part of the structure about how to ensure that risks to health and safety arising from the design during the construction work are: a. eliminated, so far as is reasonably practicable, or b. if it is not reasonably practicable to eliminate the risks, minimised so far as is reasonably practicable Maximum penalty: in the case of an individual – $3,600, or in the case of a body corporate – $18,000 Consultation must include giving the designer any information that the person who commissions the construction work has in relation to the hazards and risks at the workplace where the construction work is to be carried out.
295 Designer must give safety report to person who commissions design	1. The designer of a structure or any part of a structure that is to be constructed must give the person conducting a business or undertaking who commissioned the design a written report that specifies the hazards relating to the design of the structure that, so far as the designer is reasonably aware: a. create a risk to the health or safety of persons who are to carry out any construction work on the structure or part, and b. are associated only with the particular design and not with other designs of the same type of structure Maximum penalty: in the case of an individual – $3,600, or in the case of a body corporate – $18,000 2. If the person…"did not commission the design of the construction project, the person must take all reasonable steps to obtain a copy of the written report referred to..." Maximum penalty: in the case of an individual – $3,600, or in the case of a body corporate – $18,000
296 Person who commissions project must give information to principal contractor	"…..the person must give the principal contractor any information the person has in relation to hazards and risks at or in the vicinity of the workplace…" The maximum penalty for not undertaking this process can include: in the case of an individual – $3,600, or in the case of a body corporate – $18,000

Note: the following link can be used to access the full legislation: http://www.legislation.nsw.gov.au/#/view/regulation/2011/674/chap6/part6.2

2.1 Codes of Practice

The following section is from the Safe Design of Structures Code of Practice (July 2014, pg. 2):

"An approved code of practice is a practical guide to achieving the standards of health, safety and welfare required under the WHS Act and the Work Health and Safety Regulations (the WHS Regulations).

A code of practice applies to anyone who has a duty of care in the circumstances described in the code. In most cases, following an approved code of practice would achieve compliance with the health and safety duties in the WHS Act, in relation to the subject matter of the code. Like regulations, codes of practice deal with particular issues and do not cover all hazards or risks which may arise. The health and safety duties require duty holders to consider all risks associated with work, not only those for which regulations and codes of practice exist."

Note: Codes of practice do not replace legislation in the Act.

Codes of practice are located beneath the Act and regulations as shown in Figure 2-2~~Figure 2-2~~, an example of the relevant code of practice is shown in Figure 2-3~~Figure 2-3~~:

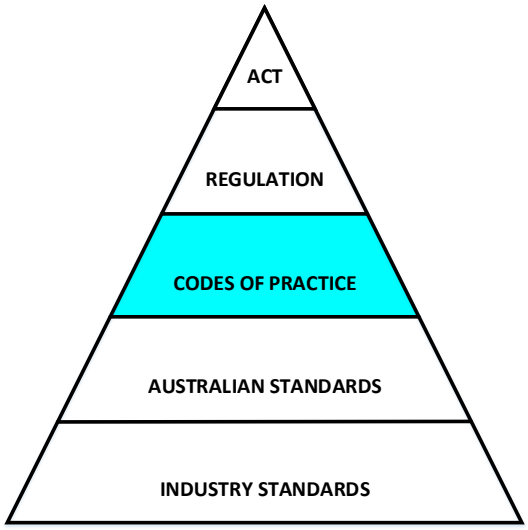


Figure 2-2: Location of the Codes of Practice

Figure 2-3: Example of SafeWork Code of Practice: Safe Design of Structures

3 Construction Hazard Assessment Implications Review (CHAIR)

3.1 Introduction

The Construction Hazard Assessment Implication Review or CHAIR is a tool used to assist designers, constructors, clients, and other key stakeholders to come together to reduce construction, maintenance, repair, and demolition safety risks associated with design. The CHAIR - Safety in Design Tool can be found using the link below:

https://www.safedesignaustralia.com.au/wp-content/uploads/2018/10/CHAIR_Safety_in_Design_Tool_WorkCoverNSW.pdf

The following sections have been extracted from the CHAIR Safety in Design Tool 2001, pg. 4, 5.

CHAIR provides a framework for a facilitated discussion stimulated by guidewords or prompts. These prompts assist the key stakeholders to collectively identify and reduce construction, maintenance repair and demolition safety risks associated with a design. Those risks are then formally listed for action by the appropriate stakeholders.

The primary aim of a CHAIR is to identify and eliminate or minimise risks in a design as soon as possible in the life of a project.

There are three phases of CHAIR:

- *CHAIR 1 (**this report**): is performed at the conceptual stage of a design, which is the best opportunity to make fundamental change, even though much of the design is still to be determined.*
- *CHAIR 2: focuses on construction and demolition issues and is performed just prior to construction, when the full detailed design is known.*
- *CHAIR 3: focuses on maintenance and repair issues and is performed at the same time as the CHAIR 2 study.*

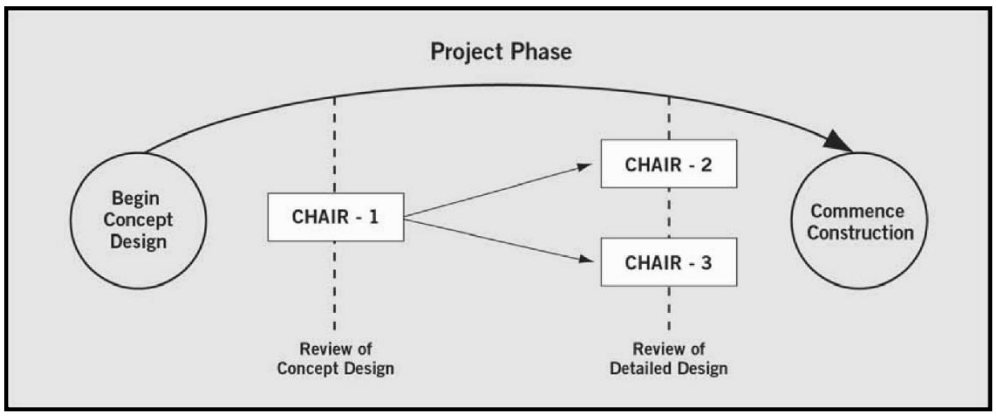


Figure 3-1: Phases of the CHAIR Process

3.2 CHAIR Process

The CHAIR process consists of the following steps:

1. *Assemble a CHAIR study team (include all stakeholders)*
2. *Define the objectives and the scope of the study*
3. *Agree on a set of guidewords / prompts to assist brainstorming process*
4. *Partition the design (CHAIR-1, CHAIR-3) or construction process (CHAIR-2) into logical blocks of appropriate size*

5. *For each logical block, use various guidewords to assist with the identification of safety aspects/issues*
6. *Discuss associated risks and determine if the safety risk can be eliminated*
7. *If the safety risk cannot be eliminated, determine how it might be reduced*
8. *Assess whether the proposed risk controls (i.e. expected safeguards, etc.) are appropriate (is the risk as low as reasonably practicable)*
9. *Document comments, actions and recommendations – determine appropriate method for design issues still to be resolved*

Extracted from the CHAIR Safety in Design Tool 2001, pg. 8.

3.3 Hierarchy of Controls

In addition to identifying risks, CHAIR participants use the hierarchy of controls as shown in Figure 3-2~~Figure 3-2~~ to suggest mitigation measures or safeguards that can be used to address residual risks identified in the CHAIR process.

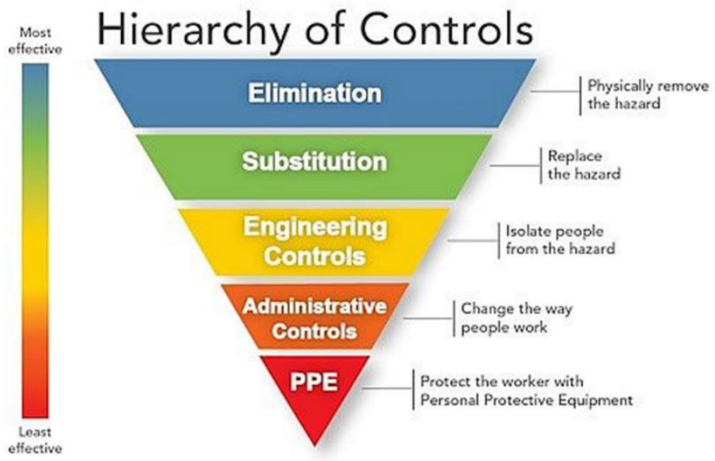


Figure 3-2: Hierarchy of Controls

3.4 Generic CHAIR Guidewords

Generic CHAIR guidewords that can be used for all CHAIR workshops are included in Table 3-1~~Table 3-1~~

Table 3-1: Generic CHAIR Guidewords

Generic Guideword	Deviation	Generic Guideword	Deviation
Size	▪ Too large ▪ Too small ▪ Too long ▪ Too wide ▪ Too short ▪ Too narrow	**Load / Force**	▪ High / Excess ▪ Low / Insufficient ▪ Additional loads during construction, commissioning, demolition ▪ Dynamics ▪ Temporary weakness (insufficient propping)
Heights / Depths	▪ Working at heights ▪ Falls / Struck by falling objects ▪ Scaffolding (shape, space to fit, etc.) ▪ Confined space ▪ Access / Egress	**Energy**	▪ Low / High energy ▪ Tension / Compression ▪ Potential / Kinetic ▪ Inertia / Moment
Position Location	▪ Too high ▪ Too low ▪ Too far ▪ Misaligned ▪ Wrong position	**Timing**	▪ Too late, too early ▪ Too short, too long ▪ Incorrect sequence ▪ Extended delays (e.g. Capping partial designs)
Poor Ergonomics	▪ Posture / Manual handling injuries ▪ Repetitive strain injury / Discomfort / Fatigue / Stress ▪ Effect of personal protective equipment	**Egress / Access**	▪ Number of exit points ▪ Emergency egress ▪ Size - width, height, length ▪ Obstructions

	▪ Visibility (lighting, sightlines, blind spots)
	▪ Slips, trips, falls
			▪ Lighting
			▪ People and equipment movements
			▪ Entry / Exit points
			  ○ Location
			  ○ Arrangement
			▪ External impacts
			▪ Maintenance

Movement / Direction	▪ Stability compression ▪ Physical damage ▪ Vibration ▪ Friction / Slip ▪ Rotation ▪ Upwards ▪ Downwards ▪ Reverse ▪ Expansion / Tension ▪ Roll over	Maintenance	▪ Posture / Manual handling ▪ Size / Width ▪ Access / Egress heights ▪ Dropped objects ▪ Weight ▪ Discomfort / Stress / PPE (personal protective equipment) ▪ Visibility / Slips / Trips ▪ Rotating equipment ▪ Other?

3.5 CHAIR 1 Workshop Guidewords

The guidewords used for the CHAIR 1 workshop are included in Table 3-2~~Table 3-2~~.

Table 3-2: Guideword Specific to the CHAIR 1 Workshop

	Generic Guideword	Deviation		Generic Guideword	Deviation
1	Size	▪ Too large ▪ Too small ▪ Too long ▪ Too short ▪ Too wide ▪ Too narrow	12	External Safety Interfaces	▪ Members of the public ▪ Traffic ▪ Adjacent property / Buildings ▪ Power / Services locations ▪ External fire / Emergency plans ▪ Day / night, weekday / weekend

	Generic Guideword	Deviation		Generic Guideword	Deviation
2	**Height / Depths**	▪ Working at heights Falls/struck by falling objects ▪ Scaffolding (shape, space to fit) ▪ Confined space ▪ Access / Egress	13	**Toxicity**	▪ Lead / Asbestos ▪ Handling procedures ▪ Precautions ▪ Ventilation
3	**Position / Location**	▪ Too high ▪ Too low ▪ Too far ▪ Misaligned ▪ Wrong position	14	**Fire / Explosion**	▪ Prevention systems ▪ Detection systems ▪ Fire protection ▪ Emergency isolation systems ▪ Inert atmosphere ▪ Emergency procedures
4	**Poor Ergonomics**	▪ Too high ▪ Too low ▪ Too far ▪ Misaligned ▪ Wrong position	15	**Environmental Impact**	▪ Vapour emissions ▪ Dust emissions ▪ Effluent ▪ Noise ▪ Ground seepage ▪ Waste minimisation
5	**Movement / Direction**	▪ Stability ▪ Compression ▪ Physical damage ▪ Vibration ▪ Friction / slip ▪ Rotation ▪ Upwards / Downwards ▪ Reverse ▪ Expansion / Tension ▪ Rollover	16	**Utilities and Services**	▪ Lighting ▪ Air / water ▪ Oxygen ▪ Water
6	**Load / Force**	▪ High / excess ▪ Low / insufficient	17	**Timing**	▪ Too late / early ▪ Too short / long

	Generic Guideword	Deviation		Generic Guideword	Deviation
		▪ Additional loads (construction) ▪ Dynamic ▪ Insufficient temporary support			▪ Incorrect sequence ▪ Extended delays
7	Energy	▪ Gravity ▪ Chemical ▪ Potential (springs etc.) ▪ Mechanical ▪ Radiation ▪ Biological	18	Safety Equipment	▪ Personnel protection ▪ Safety showers ▪ Barriers / guards
8	Timing	▪ Too late / early ▪ Too short / long ▪ Incorrect sequence ▪ Extended delays	19	National Hazards	▪ Earthquake ▪ Flooding ▪ Thunderstorm (lightning protection) ▪ High winds
9	Egress /Access	▪ Number/size/location ▪ Emergency egress ▪ People/equipment	20	Inspection Testing	▪ Eliminating ▪ Isolation ▪ Access ▪ Inspection and testing
10	Maintenance / Repair	▪ Posture / manual handling ▪ Size/width ▪ Access/Egress	21	Demolition	▪ Ease ▪ Issues ▪ Documentation
11	Environmental Conditions	▪ Extreme weather (wind, rain, hail, light) ▪ Temperature (hot, cold, heat, fire) ▪ Ground (geotechnical properties, contamination, etc.) ▪ Noise ▪ Water	22	Construction Equipment	▪ Sequence ▪ Timing, access

4 CHAIR Outcomes

4.1 Attendance

The CHAIR commenced at 9:00 am and ended at approximately 12:30 pm on the 28th of November 2024. Representatives from Beca HunterH2O, EW, EE, BWA and DCCEEW attended the workshop, and the attendance has been summarised in Table 4-1~~Table 4-1~~.

Table 4-1: CHAIR Attendance

Attendee	Company	Attendance
Ross Berry	Essential Water	Online
Aron Molloy	Essential Water	Apologies
Jade Stanley	Essential Water	Online
Toby Mcallister	Essential Water	Online
Steve Tonkin	Essential Energy	Online
Nathan Hegerty	Essential Energy	Online
Carl Broockmann	Brockmann Water Advisory	Online
John Chalmers	Brockmann Water Advisory	Online
Stanley Kommo	Brockmann Water Advisory	Online
Larry Greentree	Department of Climate Change, Energy, the Environment & Water	Online
Jose Pante	Department of Climate Change, Energy, the Environment & Water	Online
Robert Mitchell	Department of Climate Change, Energy, the Environment & Water	Apologies
Obert Moyo	Beca Hunter H2O	Online
Grant Gerrish	Beca Hunter H2O	Online
Peter Greenhalgh	Beca Hunter H2O	Online
Bob Ma	Beca Hunter H2O	Online
Richard Bray	Beca Hunter H2O	Online

The CHAIR workshop was facilitated using the 3D model developed for the upgrade.

4.2 CHAIR 1 Report

Table 4-2 provides a summary of the CHAIR outcomes.

Table 4-2: CHAIR 1 Review Outcomes

Module and Item Number	Deviation / Guideword	Sub Guideword / Prompt	Risk Issue(s)	Cause(s)	Consequence(s)	Safeguards(s)	Action(s)	Responsibility
1	Egress / Access	People/Equipment movements	People walking on the roads and potential interaction with vehicles.	Lack of adequate footpaths.	Potential injury from vehicle impact.	Signage (speed limits), site induction. Area around structures is typically compacted gravel (DGB20) which can be walked on easily.	Ensure design includes easily accessible ground / walkways between structures so people don't need to walk on roads.	Beca Hunter H2O
2	Position / Location	Wrong position	Where the inlet works is shown, there is a significant stormwater channel which captures significant runoff from the north of the plant. Diversion of this stormwater channel would be difficult / costly.	Interaction between proposed structures and existing stormwater flows.	Cost for diversion of the stormwater channel.	The existing design process.	Consider moving the inlet works to the east such the existing stormwater channel does not need to be diverted.	Beca Hunter H2O
3	Heights / Depth	Access/Egress/Heights	The south side of the maturation pond appears to be lower than the north built up area. Cars could drive into the low area.	Location or road and design of earthworks.	Vehicle accident	The existing design process.	Consider decreasing the batter slope or providing guardrails if the steep slope is to remain. Ensure the width/breadth of the road between the reactors and southern oxidation pond is wide and adequate to allow enough space to turn, and vehicles to pass each other safely. (to be confirmed by EW) Include clear speed limit signs.	Beca Hunter H2O
4	Timing	Extended delays	The maturation ponds may take some time to dry out increasing the construction timeline	Maturation ponds taken offline in winter which would mean the ponds take longer to dry out.	The construction timeline is extended.	The existing design process.	Note to remain for construction sequencing. A biosolids management plan for the oxidation pond sludge is required. Consider sequencing of taking the oxidation pond offline, such as during the summer period such that the sludge will dry quicker. Interim process controls for management of flows to White Leeds need to be considered.	Brockmann/EW/BECA Hunter H20.
5	Timing	Extended delays	Sludge in the maturation pond will need to be removed and managed	Sludge in the pond will need to be removed to improve construction outcomes	Suitability of geotechnical conditions	The existing design process.	EW will need to identify a methodology for removal and management of excess and waste sludge from the ponds and plant in general.	EW
6	Timing	Incorrect sequence	The existing effluent outfall pipeline lacks	The maturation pond will need to be removed from	Potential unlicenced discharge of effluent	The existing design process.	The new effluent pipeline could be constructed first to improve capacity	Brockmann/EW

Module and Item Number	Deviation / Guideword	Sub Guideword / Prompt	Risk Issue(s)	Cause(s)	Consequence(s)	Safeguards(s)	Action(s)	Responsibility
			capacity if the maturation pond is removed from service	service to construct the works				
7	Construction Equipment	Other?	The existing effluent outfall pipeline lacks capacity if the maturation pond is removed from service	The maturation pond will need to be removed from service to construct the works	Potential unlicenced discharge of effluent	The existing design process.	The new effluent pipeline could be constructed first to improve capacity	Brockmann/EW
8	Egress / Access	Entry/Exit points	Single site access causing interactions with current operations	The existing site access which could be used for construction goes through the centre of the existing STP	Interactions with operating plant.	The existing design process.	It is proposed to use access from the Kanandah Road for the duration of construction. Likely not permanent road due to the need to gain easements	Brockmann/EW
9	Environmental Conditions	Effluent Quality	Production of poor effluent quality from the STP	No seed sludge is available for commissioning so performance will be poor during commissioning	Risk to health and environment from poor effluent quality	The existing design process.	Provide the ability to control diversion of sewage from old to new process to enable the process to slowly improve performance	Beca Hunter H2O
10	Environmental Conditions	Effluent Quality	Production of poor effluent quality from the STP	No seed sludge is available for commissioning so performance will be poor during commissioning	Risk to health and environment from poor effluent quality	The existing design process.	Consider ability to recycle effluent from new or old plant to the head of the trickling filters to improve performance	Beca Hunter H2O
11	Other	Reputational	Lack of supply to reuse customers during construction	Need to isolate feed pipework to customers for short period of time. Potential poor effluent quality may restrict ability.	Reputational risk of loss of supply	The existing design process.	Consider temporary supply of potable or raw water. Work with customers to manage risk of quality through end use controls. Early engagement with the golf club is required.	EW
12	Egress / Access	Entry/Exit points	HDPE emergency storage pond walls are slippery, and Kangaroos / people could fall in	HDPE banks of lagoons are slippery due to the type of material.	People / animals may be unable to get out. Potential injury.	N/A	Provide a fence around the lagoon. Provide access ladders etc round the lagoon. Consider concrete matting (Tiltex) around top of lagoon to improve access.	Beca Hunter H2O
13	Maintenance / Repair	Posture / manual handling	The need to move equipment to washdown areas	Washdown areas away from equipment to be maintained	Potential injury / manual handling risk from double handling onto truck	The existing design process.	Provide washdown area adjacent to the inlet works for screen washing	Beca Hunter H2O
14	Position / Location	Wrong position	The dewatering building too far from sludge stockpile, difficult access in wet weather	Preliminary location of dewatering facility	increased time taken for operation of the dewatering system. Poor access in wet weather	The existing design process.	Move the dewatering facility to the footprint of the maturation ponds next to the bioreactor and other structures (layout to be developed).	Beca Hunter H2O
15	Size	Too small	Insufficient space for generator	Preliminary location of switchgear	Poor site ergonomics	The existing design process.	Ensure sufficient space is available for a permanent generator with a minimum of 12 hours of storage	Beca Hunter H2O
16	Size	Too small	Insufficient space for generator	Preliminary location of switchgear	Poor site ergonomics	The existing design process.	Ensure sufficient space is available for a permanent generator with a minimum of 12 hours of storage	Beca Hunter H2O

Module and Item Number	Deviation / Guideword	Sub Guideword / Prompt	Risk Issue(s)	Cause(s)	Consequence(s)	Safeguards(s)	Action(s)	Responsibility
17	Position / Location	Wrong position	Cover over effluent balance tank may restrict access to pumps for removal.	Location / height of the effluent balance tank roof	Manual handling required. Difficult lift.	The existing design process.	Review design of balance tank and placement of effluent lift pumps.	Beca Hunter H2O
18	Poor Ergonomics	Posture / manual handling	UV has covers to allow walking over the system during operation, however, covers will be required to be lifted for maintenance	Location and weight of covers could make lifting access difficult	Potential for manual handling injury	The existing design process.	Future design phases to consider how to lift walkway cover pieces and size them in smaller pieces for manual handling	Beca Hunter H2O
19	Size	Too short	Potential inability for complete draining of the emergency pond	Emergency pond shown without grade or sump	Stagnant water sitting in the storm pond creating additional water storage hazard onsite	The existing design process.	Consider grade or sump in emergency pond.	Beca Hunter H2O
20	Poor Ergonomics	Slips/trips/falls	Spilt polymer in dosing area	Slips, trips or falls due to polymer composition	Potential for injury to personnel	Bund floor provided with FRP grating.	Review design ergonomics moving forward. Ensure FRP grating on floor is incorporated into design.	Beca Hunter H2O
21	Position / Location	Wrong position	Chlorine dosing and storage too close to protected areas, particularly considering use of larger 920 kg drums,	Chlorine dosing system location has not yet been confirmed.	Reliance on other site controls for managing chlorine leak risk.	The existing design process.	Review location of chlorine storage. Consider locating next to new reuse pumps which is close to the dose point and separated from the administration building.	Beca Hunter H2O
22	Other	Cost	Unnecessary spend on decommissioning of plant.	Decommissioning scope of works has not been confirmed.	Poor allocation of funds	The existing design process.	Consider separable portion for decommissioning with different "levels" of removal from make safe to return to natural levels	EW
23	Energy	Gravity	Insufficient potable water pressure for site use and fire fighting	Current small size of incoming potable water main.	Lack of potable water pressure / supply for safety and firefighting. Does not comply	The existing design process.	Consider connection to potable main to the south of plant along Kanandah Road. EW to provide details of flow and pressure. Alternative would be to provide break tank and pumps.	EW
24	Egress / Access	Entry/Exit points	Grade too steep or difficult for forklift access to the polymer area	Design not suitable for forklift access for polymer loading	Need for manual handling if poor forklift access	The existing design process.	Ensure design allows for loading of polymer chemicals using the site forklift. EW to provide details	EW to provide details of forklift type. Beca to incorporate in design
25	Other	Biosolids Transport	Design not suitable for biosolid removal and transport	EW preference is to move biosolids to stockpile area using a trailer.\	Difficulty in moving dewatered biosolids	The existing design process.	Ensure design allows for loading into a parked biosolids trailer. EW to provide details	EW to provide details of trailer type. Beca to incorporate in design
26	Position / Location	Wrong position	Hose reals not ideally located for hosing emergency storage lagoon and balance tank	Poor positioning of hose reels	More intensive maintenance to clear debris	The existing design process.	Review location of hose reels. Confirm with EW operations on final location	Beca Hunter H2O

Appendix B: Odour Impact Assessment (EnvironOdour, 2025)

Environodour AUSTRALIA PTY LTD

We make scents of odour

Consulting Report

on

Air Quality Impact Assessment for Wills St STP Replacement, Broken Hill

By

John Jiang

13 March 2025

Essential Energy

8 Buller Street

Port Macquarie NSW 2444

Disclaimer and Limitation

EnvironOdour Australia Pty Ltd has acted in all professional matters as a faithful adviser to the Client and exercised all reasonable skill and care in the provision of its professional services.

This report has been prepared on behalf of and for the exclusive use of the Client, and is subject to and issued in accordance with the agreement between the Client and EnvironOdour Australia Pty Ltd. EnvironOdour Australia Pty Ltd accepts no liability or responsibility whatsoever for it in respect of any use of or reliance upon this report by any third party.

This report is based on the scope of services defined by the Client, budgetary and time constraints requested by the Client, the information supplied by the Client (and its agents), and methods consistent with the preceding.

EnvironOdour Australia Pty Ltd has not attempted to verify the accuracy or completeness of the information supplied.

Copying of this report or parts of this report is not permitted without the authorisation of the Client or EnvironOdour Australia Pty Ltd.

Client: Essential Energy

Job No: EJ515	Version	Prepared by	Proofread by	Submitted to Client	
Status				Copies	Date
Draft	1	JJ	RJ	pdf email	12/9/2023
Final	1	JJ	--	Pdf email	10/10/2023
Rev 1	1	JJ	--	Pdf email	13/3/2025

EnvironOdour Australia Pty Ltd

http://www.environodour.com.au

ABN: 83 003 175 705
ACN: 103 510 685

Table of Contents

1 Introduction **1**
2 Scope of the work **1**
3 Site Description **1**
4 The upgrade **3**
5 Methodology **8**
5.1 Isolation flux chamber 8
5.2 Odour sample collection 10
5.3 Olfactometry testing 10
5.4 Ausplume dispersion modelling 11
5.4.1 Source characterisation 11
5.4.2 Meteorological data 11
5.4.3 Roughness height 12
5.4.4 Topography 12
5.4.5 Receptor grid 12
5.4.6 Building wake effect 12
5.4.7 Odour performance criteria for acceptable odour impact 12
6 Results and Discussion **13**
6.1 Odour concentration and odour emission results 13
6.2 Analysis of meteorological data 14
6.3 Odour impact assessment 16
6.3.1 Odour impact from the existing STP 16
6.3.2 Odour impact for scenario 1 19
6.3.3 Odour impact for Scenario 2 21
6.3.4 Odour impact for Scenario 3 23
6.3.5 Odour impact for Scenario 4 25
6.3.6 Odour impact for Scenario 5 27
7 Conclusions **29**
8 References **29**
Appendix 1. Olfactometry testing report **30**
Appendix 2. Site photos **31**
Appendix 3. Analysis of meteorological data **36**
Appendix 4. Ausplume configuration file (Existing) **40**
Appendix 5. Ausplume configuration file (Scenario 1) **43**
Appendix 6. Ausplume configuration file (Scenario 2) **46**
Appendix 7. Ausplume configuration file (Scenario 3) **49**

Appendix 8. Ausplume configuration file (Scenario 4) **52**
Appendix 9. Ausplume configuration file (Scenario 5) **55**

Table of Tables

Table 1 Odour emission sources 3
Table 2 Modelling scenarios 4
Table 3 Odour performance criteria (99th percentile) 13
Table 4 P/M60 ratios for estimating peak concentrations in flat terrain....13
Table 5 Summary of odour concentration and odour emission rates....14
Table 6 Summary of meteorological data 14
Table 7 Summary of odour emission rates 17
Table 8 Summary of odour emission (Scenario 1)....19
Table 9 Summary of odour emission (Scenario 2)....21
Table 10 Summary of odour emission (Scenario 3)....23
Table 11 Summary of odour emission (Scenario 4)....25
Table 12 Summary of odour emission (Scenario 5)....27
Table 13 Frequency distribution of atmospheric stability class versus wind direction....36
Table 14 Frequency distribution of atmospheric stability class versus wind speed....36
Table 15 Frequency distribution of atmospheric stability class versus time of day 36
Table 16 Frequency distribution of wind speed versus wind direction 37

Table of Figures

Figure 1 The aerial view of Wills STP (dated April 2023) 2
Figure 2 Existing STP floor plan 2
Figure 3 Scenario 1 layout 5
Figure 4 Scenario 2 layout 5
Figure 5 Scenario 3 layout 6
Figure 6 Scenario 4 layout 7
Figure 7 Scenario 5 the preferred layout 8
Figure 8 Schematic of the flux hood 9
Figure 9 Schematic of the DynaDrum sampling system 10
Figure 10 Wind rose for meteorological data at Broken Hill airport (July 2018 – June 2023) 15
Figure 11 Windrose for 17:00 – 20:00 16
Figure 12 Odour impact from existing plant 18
Figure 13 Odour concentration contour for scenario 1 20
Figure 14 Odour concentration contour for scenario 2 22
Figure 15 Odour concentration contour for scenario 3 24
Figure 16 Odour concentration contour for scenario 4 26
Figure 17 Odour concentration contour for scenario 5 28
Figure 18 Drying bed 31
Figure 19 Trickling filter 32
Figure 20 Sludge digester 33
Figure 21 Primary sedimentation tank 34
Figure 22 Inlet channel 35
Figure 23 Wind speed distribution 37
Figure 24 Wind direction distribution 38
Figure 25 Atmospheric stability class distribution 38
Figure 26 Ambient temperature distribution 38
Figure 27 Mixing height distribution 39
Figure 28 Sigma-Theta (wind direction standard deviation) distribution 39

1 Introduction

EnvironOdour Australia Pty Ltd (EnvironOdour) has been engaged by Essential Energy to carry out an air quality impact assessment which would be used to inform a Part 5 assessment (REF), which Essential Energy will prepare in accordance with the Environmental Planning and Assessment Act 1979 (EP&A Act). Public Works Advisory (PWA) prepared the Broken Hill Sewerage Scheme Replacement of Wills Street and Southern Sewage Treatment Plants (STPs) Options Study (October 2018) which confirmed the preference of Essential Energy to decommission both existing STPs and construct a new STP at the Wills Street site. It also identified the Intermittently Decanted Extended Aeration (IDEA) as the preferred secondary treatment process.

Essential Energy is required to assess the construction and operational air quality impacts of the proposal and to minimise the Company's liability in relation to the requirements of the EP&A Act, Protection of the Environment Operations Act 1997 (POEO Act), Protection of the Environment Operations (Clean Air) Regulation 2021 (Clean Air Regulation) and other relevant legislation.

This report describes the methods in odour sample collection, olfactometry analysis and calculation of the odour impact using Ausplume dispersion model in accordance with the approved methods for the modelling and assessment of air pollutants in NSW (NSW DEC 2005), the technical framework for the Assessment and Management of Odour from Stationary Sources in NSW (DECC, 2006a), and the assessment and management of odour from stationary sources in NSW (NSW DEC 2006b).

2 Scope of the work

The scope of the work involves the following:

- Collecting odour samples at the existing STP using a flux chamber following Australia standard 4323.4.
- Purchasing meteorological data from BOM weather observation station and formatting them into an Ausplume air dispersion model compatible file
- Carrying out a Level 3 odour impact assessment using Ausplume air dispersion modelling following NSW EPA's 'Technical Framework Assessment and Management of Odour from Stationary Sources in NSW'
- Prepare the odour report per NSW EPA's 'Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales'.

3 Site Description

The Wills STP is situated at the outskirt of the southwest corner of Broken Hill, NSW. The aerial view (see Figure 1) covers an area of 1200 meters by 1500 meters. There are several scattered residents on the eastern side of the site. The closest neighbour is about 350 metres away from the nearest sludge drying bed. The dense urban area is also on the eastern and north-eastern sides. The existing STP floor plan is shown in Figure 2.

Figure 1 The aerial view of Wills STP (dated April 2023)

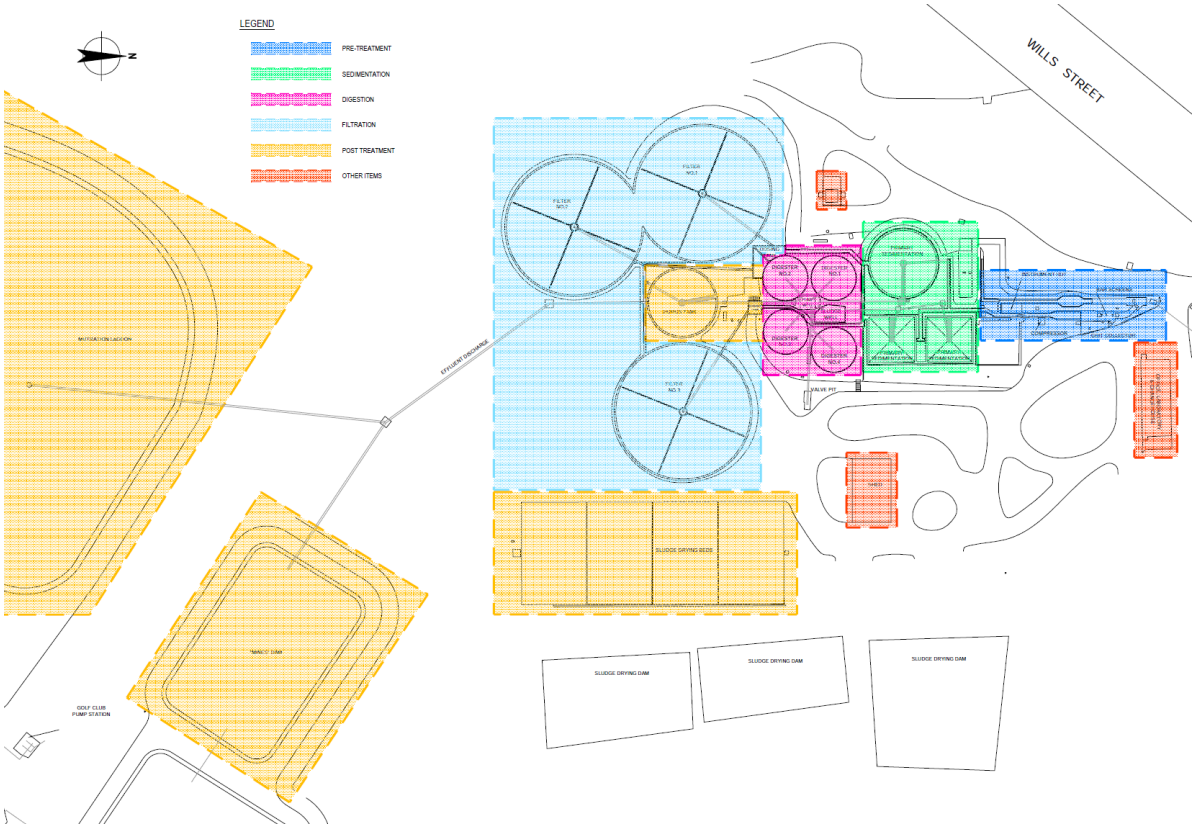


Figure 2 Existing STP floor plan

Table 1 lists the odour emission sources at the Wills STP. The emission type and the releasing pattern are also listed.

Table 1 Odour emission sources

ID	Description	Type	Pattern
1	Trickling filter	Surface	Continuously
2	Sludge drying bed	Surface	Continuously
3	Digester	Surface	Continuously
4	Humus tank	Surface	Continuously
5	Primary sedimentation tank	Surface	Continuously
6	Inlet channel	Surface	Continuously

4 The upgrade

In 2019 PWA prepared the Broken Hill STP Augmentation Concept Development report (PWA 2019), which presented the concept detail of sizing, design criteria, layout and operational features of the augmentation works based on the preferred augmentation and treatment options identified in the earlier PWA (2018) Options Report.

Following the concept development, work has commenced on the detailed design for the proposal. As part of a preliminary review of the concept design, several alternative options for sludge management, a key process area and high cost component of the overall design, were explored, as follows:

- Option 1A – The use of lagoons for sludge stabilisation with drying beds (existing and new) for drying of sludge.
- Option 1B – The use of lagoons for sludge stabilisation with procurement of an external dewatering contractor when required to dewater the sludge lagoons.
- Option 1C – The use of lagoons for sludge stabilisation with procurement of a mobile dewatering system by EW for dewatering of the sludge lagoons.
- Option 2A – Aerobic digestion for sludge stabilisation with permanent mechanical dewatering of sludge.
- Option 2B – As per Option 2A but without sludge thickening so the digester is slightly larger.
- Option 3 – Aerobic digestion for sludge stabilisation with permanent mechanical dewatering of sludge.

To assess the odour impacts of the various sludge management options, as well the location and positioning of various pieces of plant and equipment, five odour model scenarios were assessed, as presented in the following table (Table 2), and discussed further below.

Table 2 Modelling scenarios

Scenario	Relationship with Sludge Management Options
Scenario 1	Reflects Sludge Lagoon Options 1A.
Scenario 2	Reflects Sludge Lagoon Options 1A, however, assesses the option of relocating the drying beds to the western side of the site.
Scenario 3	Reflects Sludge Lagoon Option 2A. The difference in odour generation between Options 2A and 2B is likely to be minimal and a non-material change. Although Option 2A includes a gravity thickener which is in additional to 2B, the digester in Option 2B is slightly bigger which is likely to offset the addition of the gravity thickener in 2A.
Scenario 4	Generally reflects Sludge Lagoon Options 1B and 1C. Although Option 1B includes 3 sludge lagoons and 1 supernatant tank, and Option 1C includes 5 sludge lagoons, the odour generating capacity of both is considered similar, with the five lagoon option (1C) potentially having a slightly higher odour generating capacity, and hence it was used as a worst case scenario. The only remaining difference between 1B and 1C, is whether the mobile dewatering system is brought to site by a contractor (1B) or is EW owned (1C). Again, this is considered to have minimal, non-material changes in odour generating capacity.
Scenario 5	This scenario is essentially the same as Scenario 3, only the footprint of the the new STP infrastructure has been moved slightly south to be positioned over the tertiary treatment ponds, which will be decommissioned. The man change is that odour from the inlet works will be extracted and treated in a Bio-trickling filter. The treated odour will be released into the atmosphere through the bed via a vent stack.

Scenario 1: Sludge lagoons with expansion of existing drying beds

In this scenario, Waste Activated Sludge (WAS) would be pumped from two Intermittently Decanted Extended Aeration Tanks (IDEATs) to one of the proposed three sludge lagoons. One lagoon would be fed, whilst the other two lagoons would be either idle awaiting dewatering or providing time for sludge stabilisation. To dewater the lagoons, a pontoon mounted pump would be used to traverse the lagoons, transferring the sludge to the existing and proposed new drying beds. Sludge in the drying beds would be allowed to dry

(a process that typically takes 15-20 days) before being removed and stockpiled onsite in the existing drying area.

Figure 3 Scenario 1 layout

Scenario 2: Sludge lagoons with all new drying beds to the west

This scenario is as per Scenario 1 with the exception that sludge drying would occur in new drying beds to the west of the site. The existing drying beds would be abandoned to increase the distance between operational processes and the nearest receptor.

Figure 4 Scenario 2 layout

Scenario 3: Aerobic digestion and mechanical dewatering

In this scenario, WAS would be pumped to a small thickener / clarifier. The clarifier supernatant would be pumped back to the IDEATs whilst the thickened sludge would be pumped to an aerobic digester with three hydraulically connected cells. Surface aerators in the aerobic digester would operate at a set cycle (~one hour on and one hour off) to stabilise the sludge. Digested sludge from the final cell of the digester would be pumped to be dewatered. Dewatering would comprise of a single enclosed screw press with outloading conveyors. The dewatering equipment would be located in a Colourbond building with ventilation ports and a roller door. Dewatered sludge would be deposited in a trailer where it would remain until being removed for stockpiling onsite in the existing drying area.

Figure 5 Scenario 3 layout

Scenario 4: Larger sludge lagoons with expansion of existing drying beds

This scenario is essentially the same as Scenario 2, only the footprint of the sludge lagoons will be larger (5 smaller lagoons instead of the proposed 3 lagoons in Scenario 2).

Figure 6 Scenario 4 layout

Scenario 5: Aerobic digestion and mechanical dewatering

This scenario is essentially the same as Scenario 3, only the footprint of the new STP infrastructure has been moved slightly south to be positioned over the tertiary treatment ponds, which will be decommissioned. The main change is that odour from the inlet works will be extracted and treated in a Bio-trickling filter. The treated odour will be released into the atmosphere through the bed via a vent stack.

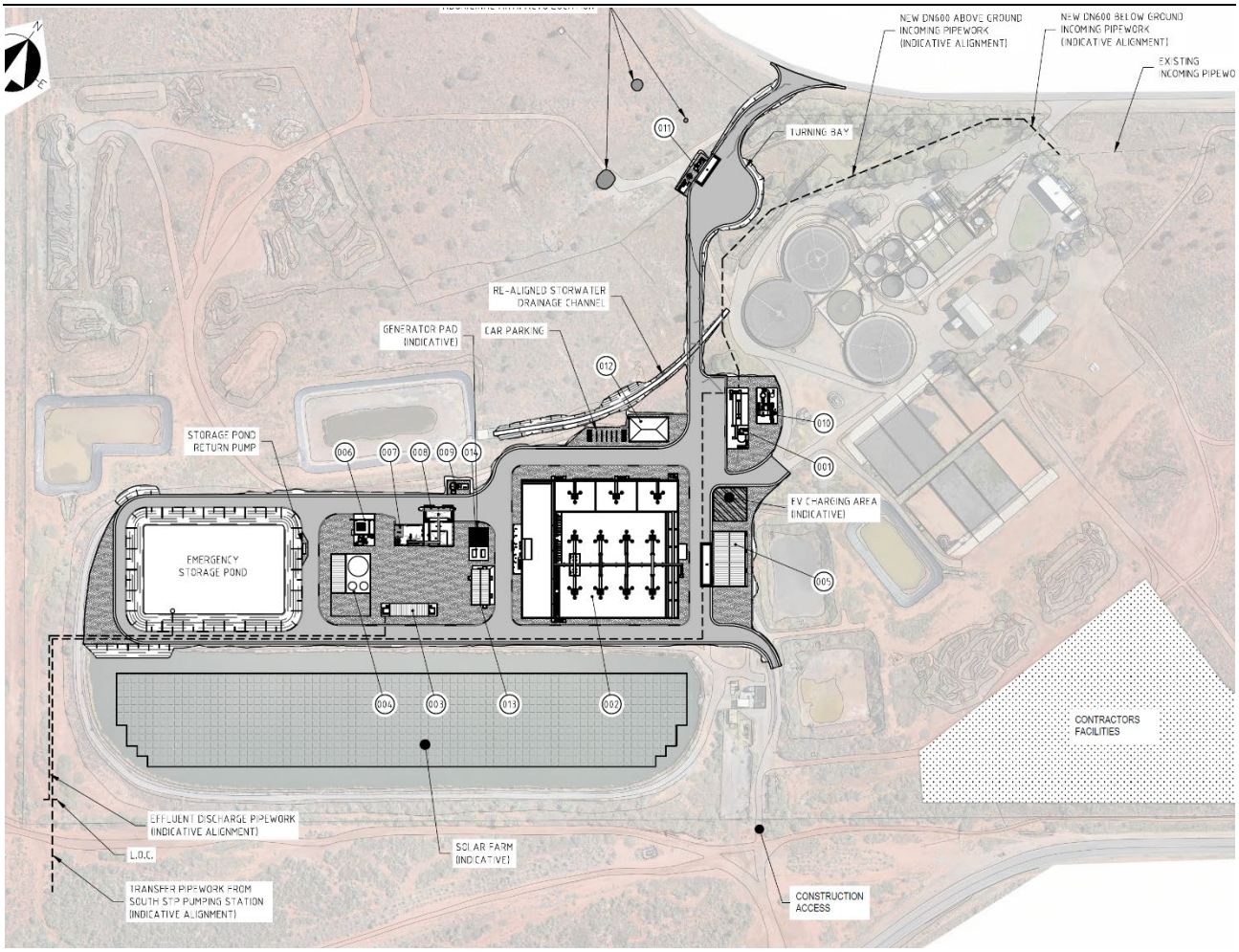


Figure 7 Scenario 5 the preferred layout

5 Methodology

The predominant factors, which affect the extent of the odour impact, are the odour emission rates and wind conditions. Since more of the odour emission sources are area sources, a flux hood was used to collect the emission. The samples are analysed for their odour concentrations. The Specific Odour Emission Rates (SOERs) are calculated and entered into the model.

The study uses the Ausplume air dispersion model to predict the offsite odour impact at the nearby residential area. By changing the input conditions (different layouts) the offsite odour impact can be predicted and studied.

5.1 Isolation flux chamber

In order to capture the odour emissions from the liquid surface, an isolation flux chamber (Method No OM-8), as recommended in the *Approved methods for the sampling and analysis of air pollutants in New South Wales 2000,* was used to determine the odour emission rates. This is also the Australian standard (AS4323.4) which has fully adopted the US EPA's design.

The isolation flux chamber used in the study has the same configuration as described in the US EPA's user's guide (US EPA, 1986). The schematic of the chamber is shown in

Figure 7. The diameter of the chamber base cylinder is 400 mm, and it has a height of 150 mm. The dome has a height of 100 mm. Both sections are joined using a flange and gasket to prevent any leakage during sampling. The effective volume of the chamber is about 24 litres.

The principle of the chambers is based on the two-film model that is frequently used to explain the experimental phenomenon of the volatilisation of organic compounds from water in the laboratory. All the sampling procedures strictly follow the US EPA's guidelines. The isolation flux chamber is placed over the source and purged with Nitrogen gas (BOC gases, greater than 99.9% in nitrogen). The Nitrogen gas flows at a rate of 5 Litres per Minute (LPM) and enters the hood via four small holes that point downwards and are evenly distributed on the circular distribution tubing. After 24 minutes of purging, the sampling tubing is connected to the DynaDrum inlet and the sample is taken at a rate of 2 LPM. Appendix 2 shows the actual setup of isolation chamber at each odour source in the study.

An important modification was made to the US EPA isolation flux chamber design. The sampling tubing is perforated along the length of the sampling tubing in this original design. It was found that a short circuit had occurred since the distance between the distribution tubing and the top holes of the sampling tubing were much closer than the distance between the distribution tubing and the bottom holes. A modification was made so that the enter point of sampling tubing (at the tip of the tubing) had an equal distance to the small holes of the distribution tubing.

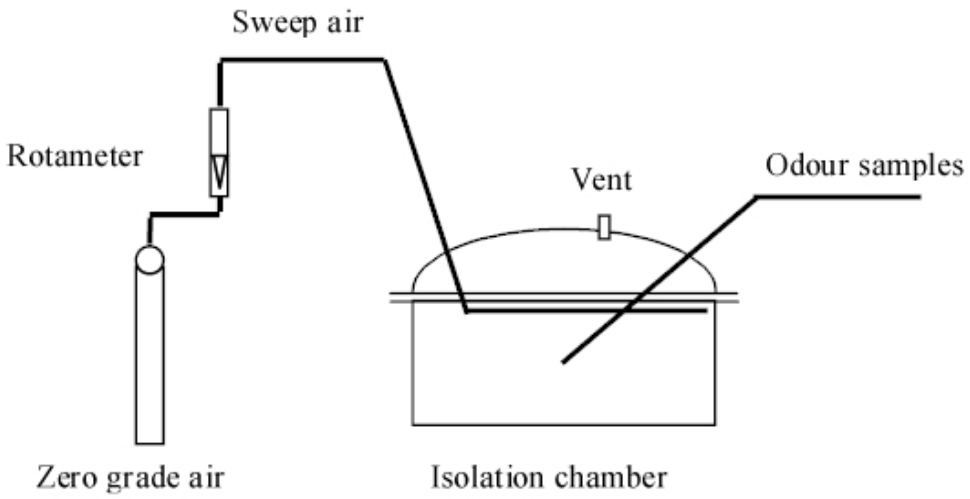


Figure 8 Schematic of the flux hood

Specific odour emission rate is calculated using the following equation:

$$E = \frac{Q \cdot OC}{A}$$

where

E: specific odour emission rate, OU/m^{2}s

Q: the sweep nitrogen gas flow rate, m^3/s; the sweep flow is controlled to be 8.3×10^{-5} m^3/s (= 5 L/min)

OC: the odour concentration, OU/m^3

A: the area covered by the enclosure, m^2; the isolation flux chamber has a cover area of 0.1256 m^2

5.2 Odour sample collection

All odour samples were collected in odour-free Nalophan™ sampling bags using a DynaDrum sampling drum (see Figure 8). These sampling bags were attached to the sampling port of the DynaDrum. The sampling rate is set at 2 LPM. The sampling volume is about 4 litres for each sample.

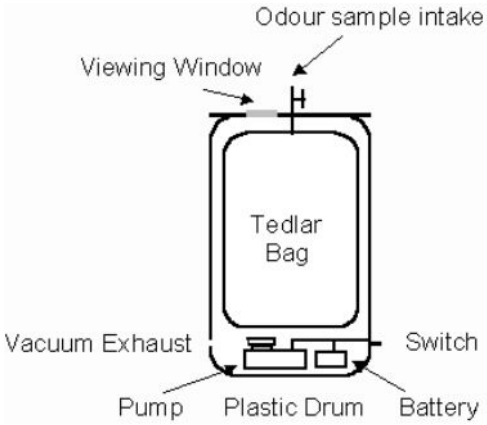


Figure 9 Schematic of the DynaDrum sampling system

All sampling equipment used in the study was constructed using stainless steel, PTFE or Nalophan. The sampling bags were constructed out of Nalophan and were valid for a single use only. This ensured that cross-contamination did not occur between samples. A new sampling tube was used for each sampling point.

Where practical, all sources were sampled and measured for temperature and relative humidity. At the same time, the physical locations of the sources were photographed for record purposes.

All the source odour samples were collected in the morning and transported back to the EnvironOdour laboratory for olfactometry testing (of odour concentration) in the afternoon. All odour samples were tested the following morning.

5.3 Olfactometry testing

Odour testing was carried out using dynamic olfactometry in accordance with the Australian standard AS/NZS 4323.3:2001 *Determination of odour concentration by dynamic olfactometry*. The strength of an environmental odour is determined as an 'odour concentration', which is the number of times a sample needs to be diluted to arrive at the odour threshold. By definition the odour threshold corresponds to an odour concentration of one odour unit per cubic metre (i.e. 1 OU/m^3).

Odour measurement is performed using the DynaScent digital olfactometer. The odour samples were tested using a triangular mode with a dilution factor of 2. A panel of six trained panellists each assessed the odour samples. The odorous gas sample is presented at decreasing dilutions to one of three sniffing ports at random while the others release only odourless air. At each dilution ratio, each panellist sniffs all three ports and

chose one of the three ports as being the one with the odorous sample (i.e. making a 'forced choice'). In addition to their forced choice between the three ports, the panellists are required to indicate whether their confidences are based on a 'guess', 'inkling' or 'certainty'. The process is then repeated with doubling odour strength present at the sniffing ports until all panellists chose the correct port with certainty. This is one round. For the purpose of measuring odour concentration, two rounds are required for each sample.

5.4 Ausplume dispersion modelling

The Ausplume computer model is used to predict ground level concentrations of odours from the facilities. Ausplume is a Gaussian dispersion model developed by the Environment Protection Authority of Victoria (EPAV, 1999). The model has undergone continual revisions since then and is widely used throughout Australia to assess air quality impacts from industrial and other sources. The model is a default air dispersion model in NSW. The Ausplume version used in the study is 6.0.

Ausplume requires a meteorological data file that typically consists of 1-hour averaged values such as wind speed, wind direction, sigma theta, temperature, mixing heights and stability class. Ausplume calculates the ground level concentration of the nominated pollutant each hour at each receptor. As required in the NSW EPA's document, a minimum of 5 years of representative meteorological data is required for the Level 3 odour impact assessment. Finally, the 99th highest odour concentrations are used to plot the odour concentration contour. The predicted odour contour can then be compared to applicable odour performance criteria.

Ausplume has many user-selectable options for the adjustment of dispersion parameters. The options considered most appropriate for the circumstances are selected. Special issues are discussed in the remainder of this section.

5.4.1 Source characterisation

The modelled odour emission sources at the site are the area sources. The model uses a numerical integration approach for modelling impacts. This approach allows shapes such as rectangles, circles and polygons to be selected. Rectangular areas may also have a rotation angle specified relative to a north-south orientation. Both the southwest corner and the orientation angle of the rectangle is specified in the model to define the source location and in the modelling results. Circle sources are defined by the centre position and radius.

The odour emission rates are assumed to be a constant throughout the study.

5.4.2 Meteorological data

The meteorological data was prepared using the observation data recorded at Broken Hill Airport over the period of the 1 July 2018 to the 30 June 2023 by Bureau of Meteorology. The weather station is approximately 4 km away in the southeast. All the data was supplied as 10 minute averaged values and reformatted to Ausplume requirements.

5.4.3 Roughness height

The site is considered to be flat in the north, west and south. The urban residential area is located in the northeast and east of the site. A conservative estimate of the roughness height in these circumstances is flat rural (0.1 metres), which is consistent with a predominantly rural environment.

5.4.4 Topography

The surrounding area is relative flat. The terrain of site was not considered in the study.

5.4.5 Receptor grid

The receptor grid was defined in local (arbitrary) coordinates at 50 metre intervals over an area of 1500 m x 1200 m. The fine grid results in a slightly smoother odour contour.

One discrete receptor, representing the sensitive receptor, was also added so that the location could be displayed in the dispersion modelling results.

5.4.6 Building wake effect

No building wake effects were modelled in the study since no point source is in the calculation.

5.4.7 Odour performance criteria for acceptable odour impact

Odour performance criteria was documented in “Technical framework: assessment and management of odour from stationary sources in NSW” produced by the Department of Environment and conservation (NSW DEC 2006). These are shown in Table 2.

The closest resident is about 350 meters away in the east. The closest commercial property is about 250 meters in the south. There are no schools or hospitals in the surrounding area.

There is considerable buffer distance between odour generating activity and equipment on-site to the site boundary. The population of the potentially affected community adjacent to the site boundary is therefore less than 30. There are no schools or hospitals near the site. This means the relevant odour performance criterion is 5 OU/m^3 as a nose response time (see Table 3).

For a one-hour averaged value, the peak-to-mean ratios shown in Table 4 must be used to convert the nose response averages to one hour averaged value (P/M60) as Ausplume dispersion model uses (NSW DEC 2006).

For the area source at the site, the applicable P/M60 ratio is 2.3 and 2.5 for near-field receptors and 1.9 and 2.3 for far-field receptors under different atmospheric stability classes. In the study, the P/M60 ratio is 2.5 for all the stabilities and distances. It is expected that the assumption of one-hour averaged odour performance criterion of 5 OU/m^3 at 99^{th} percentile for modelling emissions from the site will give a conservative estimate of odour impacts for the local community.

Table 3 Odour performance criteria (99th percentile)

Population of affected community	Impact assessment criteria for complex mixtures of odorous air pollutants (OU/m^3)
Urban area (≥ 2000) and/or schools and hospitals	2.0
~ 500	3.0
~ 125	4.0
~ 30	5.0
~ 10	6.0
Single residence (≤ ~ 2)	7.0

Table 4 P/M60 ratios for estimating peak concentrations in flat terrain

Source type	Pasquill–Gifford stability class	Near-field P/M60*	Far-field P/M60*
Area	A, B, C, D	2.5	2.3
	E, F	2.3	1.9
Line	A–F	6	6
Surface wake-free point	A, B, C	12	4
	D, E, F	25	7
Tall wake-free point	A, B, C	17	3
	D, E, F	35	6
Wake-affected point	A–F	2.3	2.3
Volume	A–F	2.3	2.3

* Ratio of peak 1-second average concentrations to mean 1-hour average concentrations

6 Results and Discussion

The odour emission survey was carried out on 27 July 2023. A total of 6 source samples were taken and analysed in the EnvironOdour odour laboratory. Their results are presented and summarised below.

The meteorological data was acquired and formatted to the Ausplume requirements. The analysis of the meteorological data has been performed and discussed here.

The Ausplume dispersion model was used to predict the odour concentrations around the plant under the existing and four proposed scenarios at ground level.

6.1 Odour concentration and odour emission results

Olfactometry testing was carried out at EnvironOdour testing laboratory on 28 July 2023. The testing report is listed in Appendix 1.

Figure 16 in Appendix 2 shows the isolation chamber was used to sample the odour emission over the sludge dry bed. Figure 16 shows the isolation chamber for the trickling filter. Figure 17 shows the chamber for the sludge digester. Figure 19 shows the chamber over primary sedimentation tank. Figure 19 shows the chamber over inlet channel.

Table 5 summarises the odour emission sources included in the Ausplume air dispersion modelling and the measured SOERs.

The odour emission from maturation ponds has also been added for the existing operation. Their SOER was assumed to be 0.04 OU/m^{2}s.

Table 5 Summary of odour concentration and odour emission rates

Sample ID	Description	OC	SOER
		OU/m^3	OU/m^{2}s
6517	Trickling Filter	185	0.12
6518	Sludge Drying Bed	93	0.06
6519	Digester	1465	0.97
6520	Humus Tanks	622	0.41
6521	Primary Sedimentation Tank	8379	5.6
6522	Inlet Channel	34184	22.7

6.2 Analysis of meteorological data

The overall summary of meteorological data is summarised in Table 6.

Table 6 Summary of meteorological data

Starting Date:	18070101	Ending Date:	23063024
Days:	1826	Hours:	43824
Progessed Lines:	43824	Processed Days:	1819
Min. Wind Speed:	0	Max. Wind Speed:	16.4
Min Temp:	0	Max Temp:	45
Min Mixing Height:	50	Max Mixing Height:	2857
Min StDev:	0	Max StDev:	112

The more detailed statistics of the meteorological data can be found in Appendix 3. The frequency distribution of atmospheric stability class versus wind direction is shown in Table 12. Frequency distribution of atmospheric stability class versus wind speed is shown in Table 13. Frequency distribution of stability class distribution versus the time of the day is listed in Table 14. Frequency distribution of wind speed versus wind direction is listed in Table 15. Wind speed, wind direction, atmospheric stability class, ambient temperature,

mixing height distribution and sigma-theta (wind direction standard deviation) are also shown in Figure 21 - Figure 26 respectively.

Generally, odour does not disperse and mix as readily at night as it does during the day. Atmospheric stability refers to the potential of air to disperse and is defined using the Pasquill Gifford scheme where the atmosphere is categorised from unstable (category A) to stable (category F). Ideal odour dispersion occurs under unstable conditions. In simpler terms, the lower the stability class (closer to A), the greater the odour dispersion and hence, the lower the potential for odour nuisance.

The maximum ground level concentrations occur when the wind speed is low, such as 0.5 m/s. The low wind speeds are often associated with more stable atmospheric conditions (D, E, F). The combined effects result in less atmospheric dispersion and therefore a high ground concentration.

The wind pattern plays an important role in dissipating the odour. The prevailing wind direction in the observation period was west, west-southwest and west-northwest. The next most prominent wind direction was north-east and east-northeast. During the hours of 5 pm – 8 pm, the wind mainly blows from the west, west-northwest and west-southwest. This is unfavourite wind direction which pushes the odour from the STP towards residents.

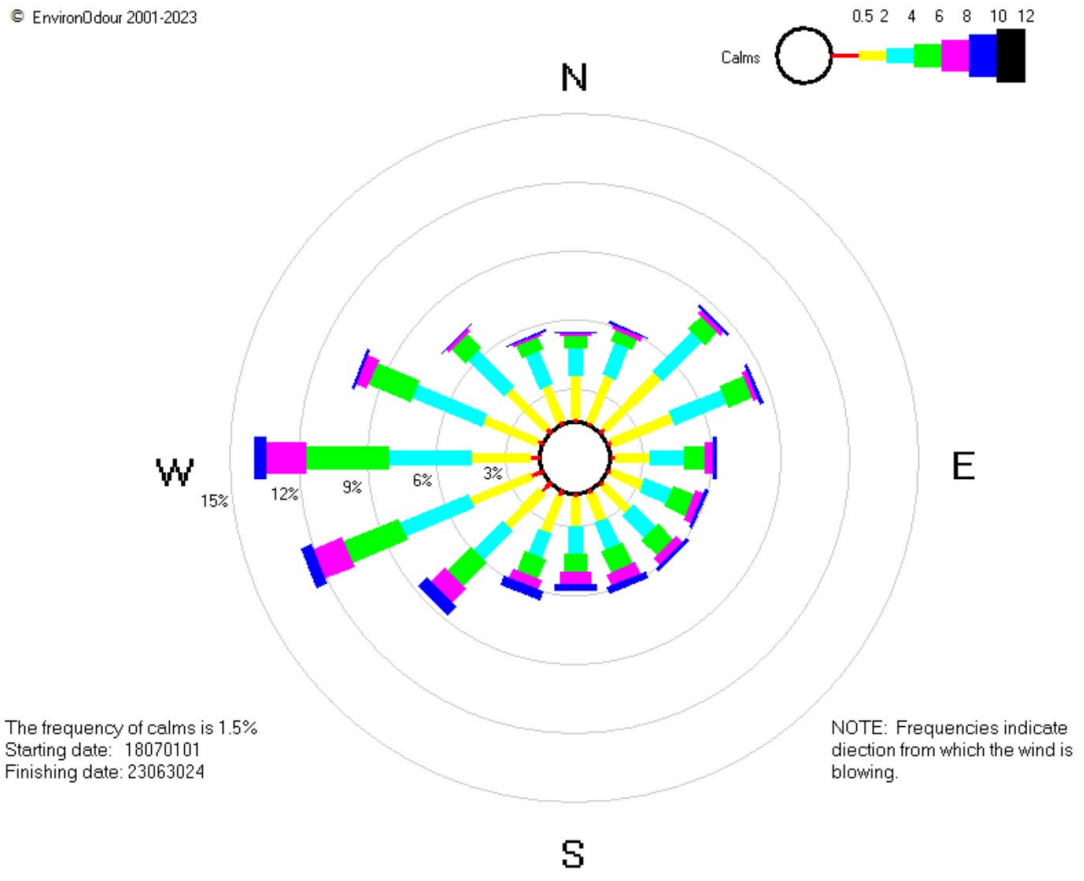


Figure 10 Wind rose for meteorological data at Broken Hill airport (July 2018 – June 2023)

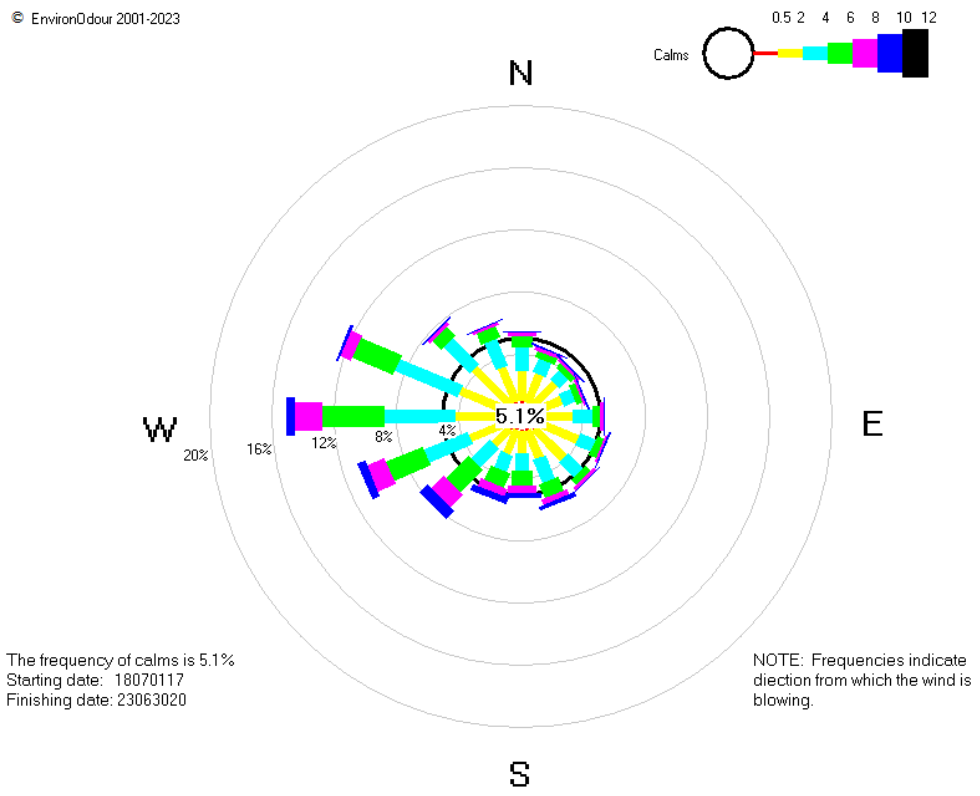


Figure 11 Windrose for 17:00 – 20:00

6.3 Odour impact assessment

The site's existing operation was modelled and the result was used as a benchmark. The four additional design scenarios were also modelled:

- Scenario 1: Sludge lagoons with expansion of existing drying beds
- Scenario 2: Sludge lagoons with all new drying beds to the west
- Scenario 3: Aerobic digestion and mechanical dewatering
- Scenario 4: Sludge lagoons with expansion of larger existing drying beds will be (5-smaller lagoons instead of the existing 3).

6.3.1 Odour impact from the existing STP

The shapes and dimensions of these odour emission sources, SOERs and TOERs are displayed in Table 7. Odour impact from the existing STPs is shown in Figure 11. The sensitive receptor is shown in the east (marked as a blue plus sign). The odour impact area (in red) is located within the property boundary.

The Ausplume configuration file is listed in Appendix 4.

Table 7 Summary of odour emission rates

No	Description	Elevation	Length/ Diameter	Width	Area	SOER	TOER
		m	m	m	m^2	OU/m^2s	OU/s
1	Inlet channel	1	6	0.6	3.6	22.7	82
2	Inlet channel		40	0.6	24	22.7	544
3	Primary Sedimentation Tank 1	1	17.5		240	5.6	1336
4	Primary Sedimentation Tank 2	1	10	10	100	5.6	556
5	Primary Sedimentation Tank 3	1	10	10	100	5.6	556
6	Trickling filter 1	1	30		707	0.40	283
7	Trickling filter 2	1	30		707	0.40	283
8	Trickling filter 3	1	30		707	0.40	283
9	Humus Tank	1	16		201	0.41	83
10	Sludge digester 1	1	10		79	0.97	76
11	Sludge digester 2	1	10		79	0.97	76
12	Sludge digester 3	1	10		79	0.97	76
13	Sludge digester 4	1	10		79	0.97	76
14	Sludge drying bed	0	60	60	3600	0.06	222
15	Maturation pond	0	135	290	39150	0.04	1566
Total Odour Emission Rate							6098

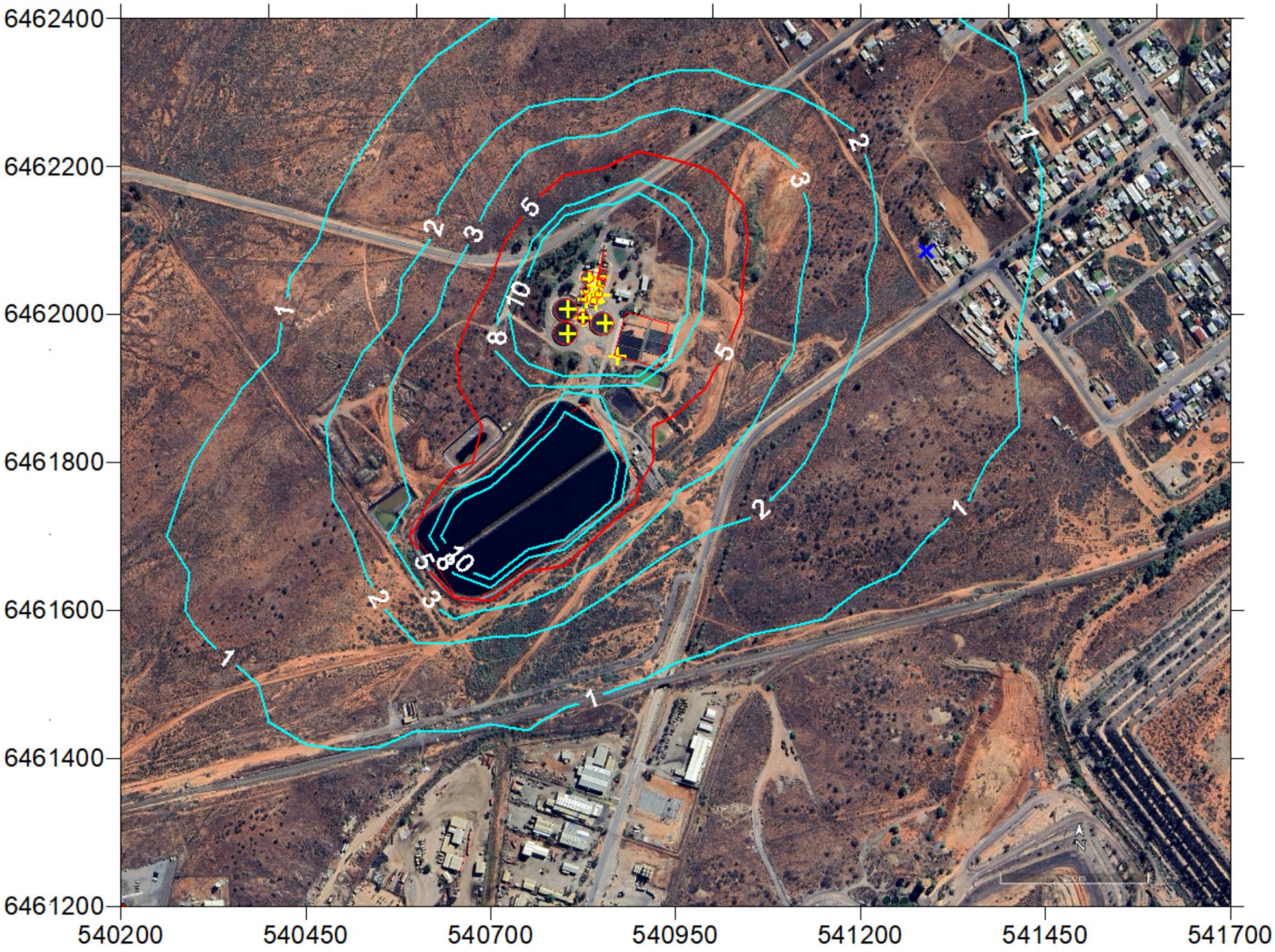


Figure 12 Odour impact from existing plant

A review of odour complaints associated with the existing STP, provided by Essential Energy was undertaken. With the exception of a defined period over the summer of 2021/22, when operational deficiencies with the existing drying beds led to offsite odour complaints, no historical odour complaints associated with the STP were identified. Apart from this one defined event, the lack of historical odour complaints is supported by the modelling undertaken for the existing STP, which shows odour concentrations less than 5 OU/m^3 at the closest sensitive receiver, which is generally consistent with no detectable odour.

6.3.2 Odour impact for scenario 1

Odour impact from the proposed STPs in scenario 1 is shown in Figure 12. The odour impact area (in red) is overlayed above the processing units. The sensitive receptor is shown in the east (marked by a blue plus sign).

The Ausplume configuration file is listed in Appendix 5.

Table 8 Summary of odour emission (Scenario 1)

No	Description	Elevation	Length/ Diameter	width	Area	SOER	TOER
		m	m	m	m^2	OU/m^2s	OU/s
1	IDEAT (x2)	4	68	36	2448	0.50	1224
2	Balance Tank	4	36	20	720	0.50	360
3	Soil bed	0.5	20	12	240	1.0	240
4	Sludge Lagoon 1	0	53	53	2809	0.41	1152
5	Sludge Lagoon 2	0	53	53	2809	0.41	1152
6	Sludge Lagoon 3	0	53	53	2809	0.41	1152
7	Biomass pans	0	66	15	990	0.06	61
8	Sludge Beds (existing x8)	0	60	60	3600	0.06	222
9	Sludge beds (new x3)	0	45	30	1350	0.06	83
Total Odour Emission Rate							5646

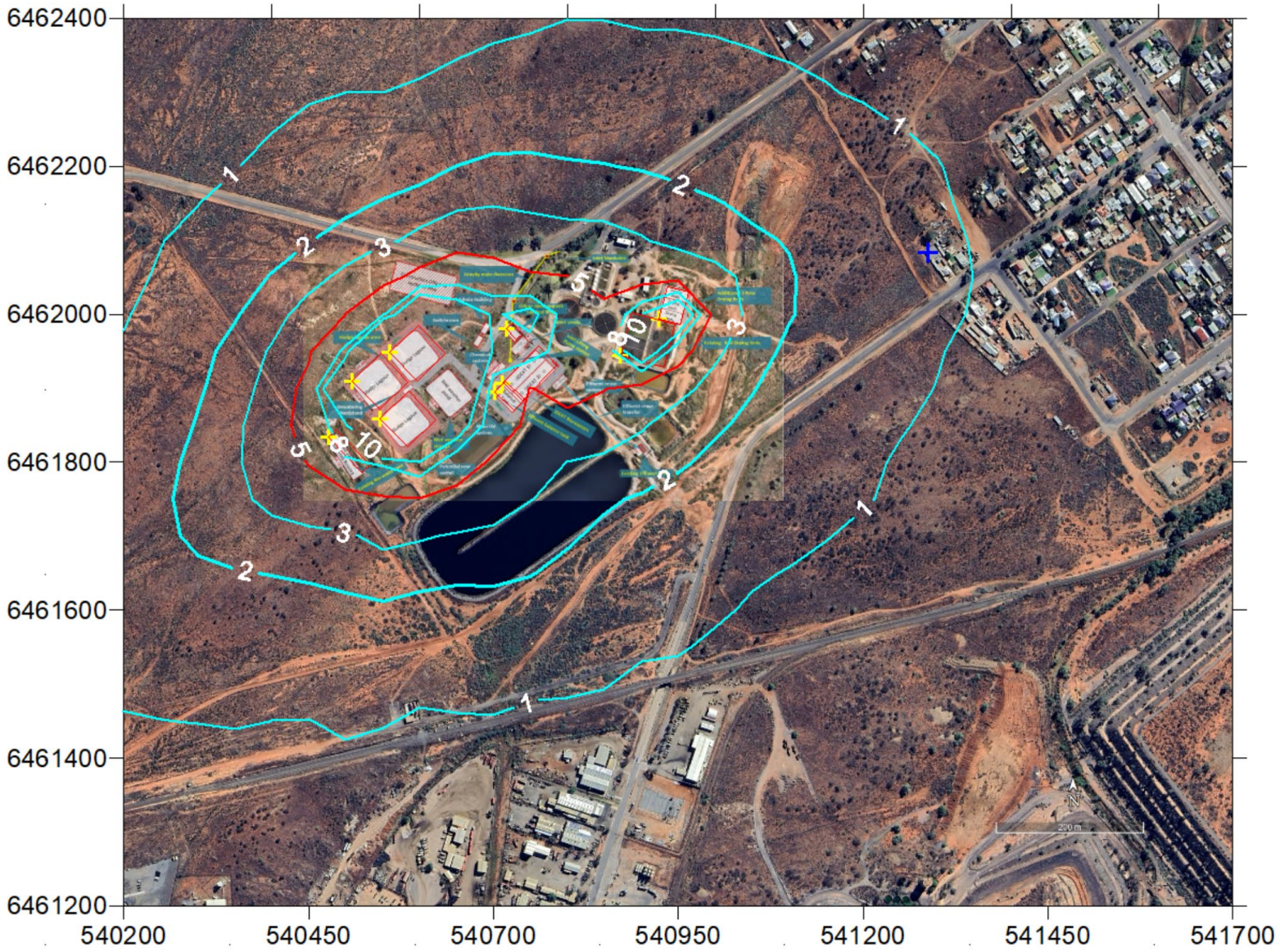


Figure 13 Odour concentration contour for scenario 1

6.3.3 Odour impact for Scenario 2

The odour impact from the proposed STPs in scenario 2 has been modelled using the odour emission data collected from the site. Figure 13 shows the odour impact area (in red) is within the property boundary. The sensitive receptor is shown in the east (marked by a blue plus sign).

The Ausplume configuration file is listed in Appendix 6.

Table 9 Summary of odour emission (Scenario 2)

No	Description	Elevation	Length/ Diameter	width	Area	SOER	TOER
		m	m	m	m^2	$OU/m^2 s$	OU/s
1	IDEAT (x2)	4	68	36	2448	0.5	1224
2	Balance Tank	4	36	20	720	0.5	360
3	Soil bed	0.5	20	12	240	1.00	240
4	Sludge Lagoon 1	0	53	53	2809	0.41	1152
5	Sludge Lagoon 2	0	53	53	2809	0.41	1152
6	Sludge Lagoon 3	0	53	53	2809	0.41	1152
7	Biomass pans	0	66	15	990	0.06	61
8	Sludge drying beds (x12)	0	100	65	6500	0.06	401
Total Odour Emission Rate							5741

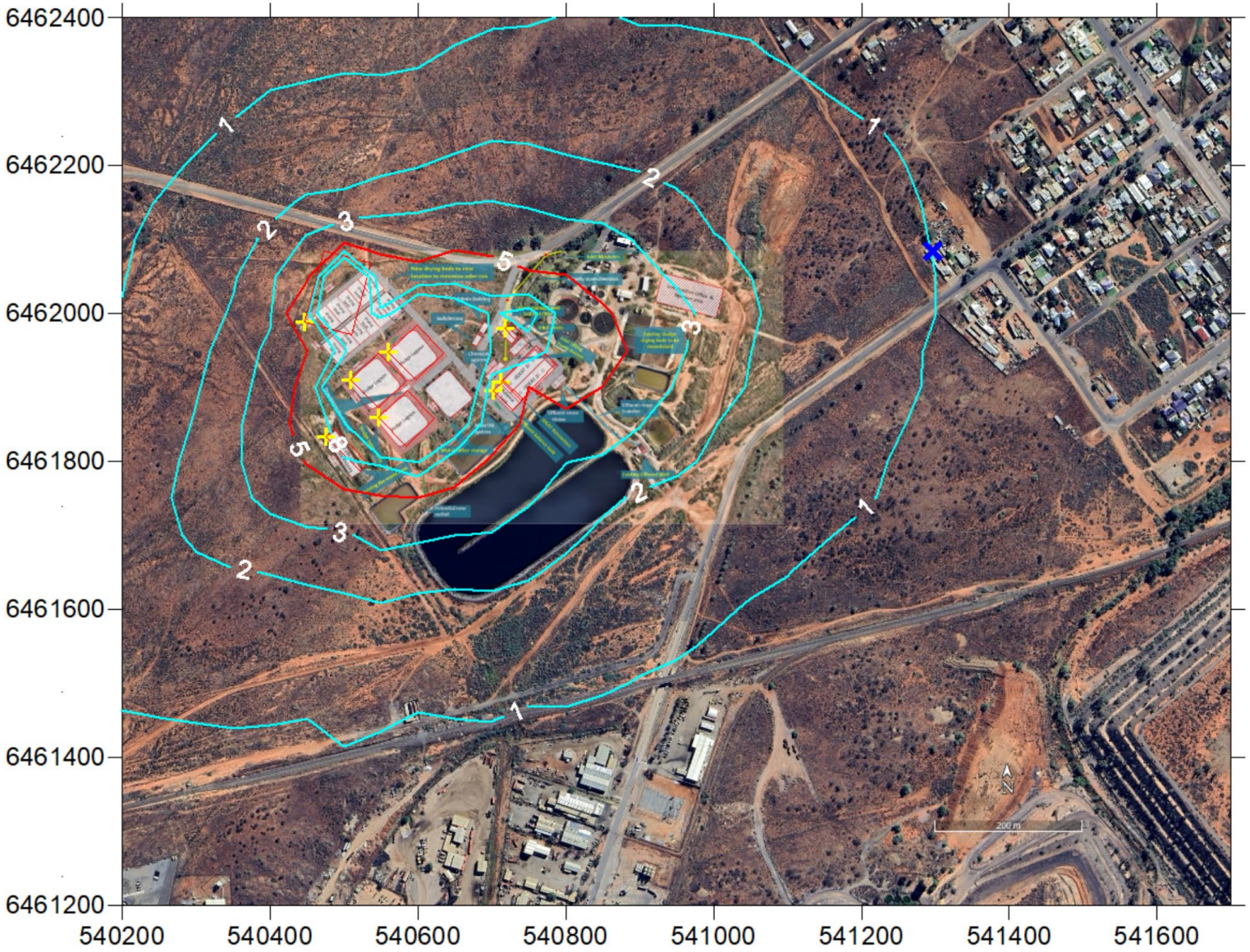


Figure 14 Odour concentration contour for scenario 2

6.3.4 Odour impact for Scenario 3

The odour impact from the proposed STPs in scenario 3 has been modelled using the odour emission data collected from the site. Figure 14 shows the odour impact area (in red) is within the property boundary. The sensitive receptor is shown in the east (marked by a blue plus sign).

The odour concentration for the building source is assumed to be 500 OU/m^3. The air exchange rate of the building is assumed to be 5 times per hour.

The Ausplume configuration file is listed in Appendix 7.

Table 10 Summary of odour emission (Scenario 3)

No	Description	Elevation	Length/ Diameter	width	Area	SOER	TOER
		m	m	m	m^2	OU/m^2s	OU/s
1	IDEAT (x2)	4	68	36	2448	0.5	1224
2	Balance Tank	4	36	20	720	0.5	360
3	Soil bed	0.5	20	12	240	1.00	240
4	Sludge thickener	1	9.5		71	0.97	69
5	Aerobic digester	1	25		491	0.97	477
6	Sludge dewatering building	5	12	8	96	5	333
7	Biomass pans	0	66	15	990	0.06	59
Total Odour Emission Rate							2762

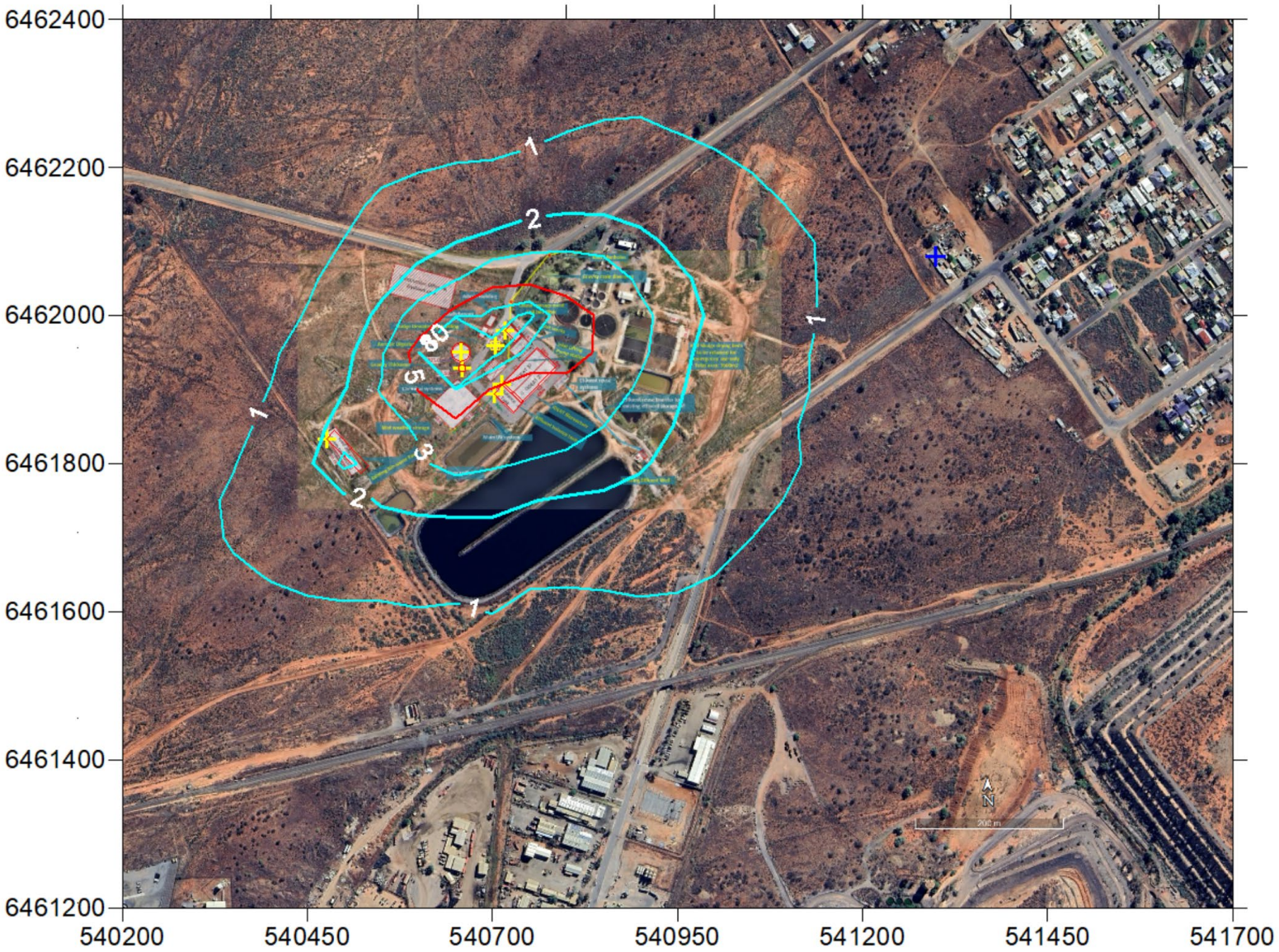


Figure 15 Odour concentration contour for scenario 3

6.3.5 Odour impact for Scenario 4

The odour impact from the proposed STPs in scenario 4 has been modelled using the odour emission data collected from the site. Figure 16 shows the odour impact area (in red) is within the property boundary.

The Ausplume configuration file is listed in Appendix 8.

Table 11 Summary of odour emission (Scenario 4)

No	Description	Elevation	Length/ Diameter	width	Area	SOER	TOER
		m	m	m	m^2	OU/m^2s	OU/s
1	IDEAT (x2)	4	68	36	2448	0.50	1224
2	Balance Tank	4	36	20	720	0.50	360
3	Soil bed	0.5	20	12	240	1.0	240
4	Sludge Lagoon 1	0	39.5	39.5	1560	0.41	640
5	Sludge Lagoon 2	0	39.5	39.5	1560	0.41	640
6	Sludge Lagoon 3	0	39.5	39.5	1560	0.41	640
7	Sludge Lagoon 4	0	39.5	39.5	1560	0.41	640
8	Sludge Lagoon 5	0	39.5	39.5	1560	0.41	640
9	Biomass pans	0	66	15	990	0.06	59
Total Odour Emission Rate							5082

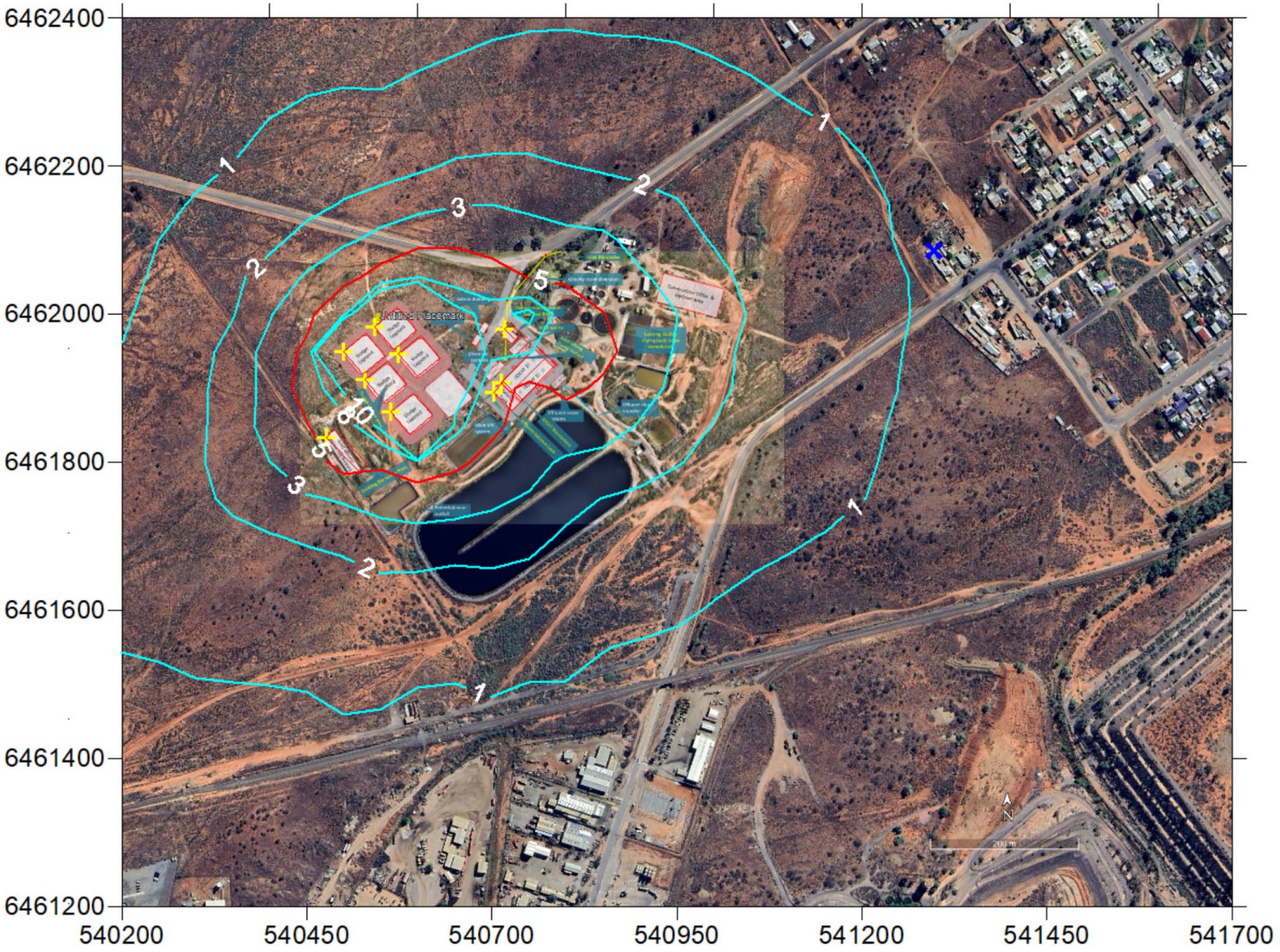


Figure 16 Odour concentration contour for scenario 4

6.3.6 Odour impact for Scenario 5

The odour impact from the proposed STPs in scenario 5 has been modelled using the odour emission data collected from the site. Figure 17 shows the odour impact area (in red) is within the property boundary. The sensitive receptor is shown in the east (marked by a blue plus sign).

Odour from the inlet works will be extracted and treated in a Bio-trickling filter. The treated odour will be released into atmosphere through the bed via a vent stack. The designed air flow rate is 3000 m^3/h. The treated odour concentration is limited to 1000 OU/m^3. The discharge height is assumed as 4 meters with a minimum air flow of 10 m/s.

The odour concentration for the building source is assumed to be 500 OU/m^3. The air exchange rate of the building is assumed to be 5 times per hour.

The Ausplume configuration file is listed in Appendix 9.

Table 12 Summary of odour emission (Scenario 5)

No	Description	Elevation	Length/ Diameter	width	Area	SOER	TOER
		m	m	m	m^2	OU/m^2s	OU/s
1	Biotrickling Filter (point)	4					833
2	IDEAT (x2)	3.2	60	50.4	3024	0.5	1224
3	Effluent Balance Tank	3.2	64.6	15.2	982	0.5	491
4	Aerobic digester	3.2	60	14.6	876	0.97	851
5	Sludge dewatering building (volume)	5	14	10			486
Total Odour Emission Rate							3855

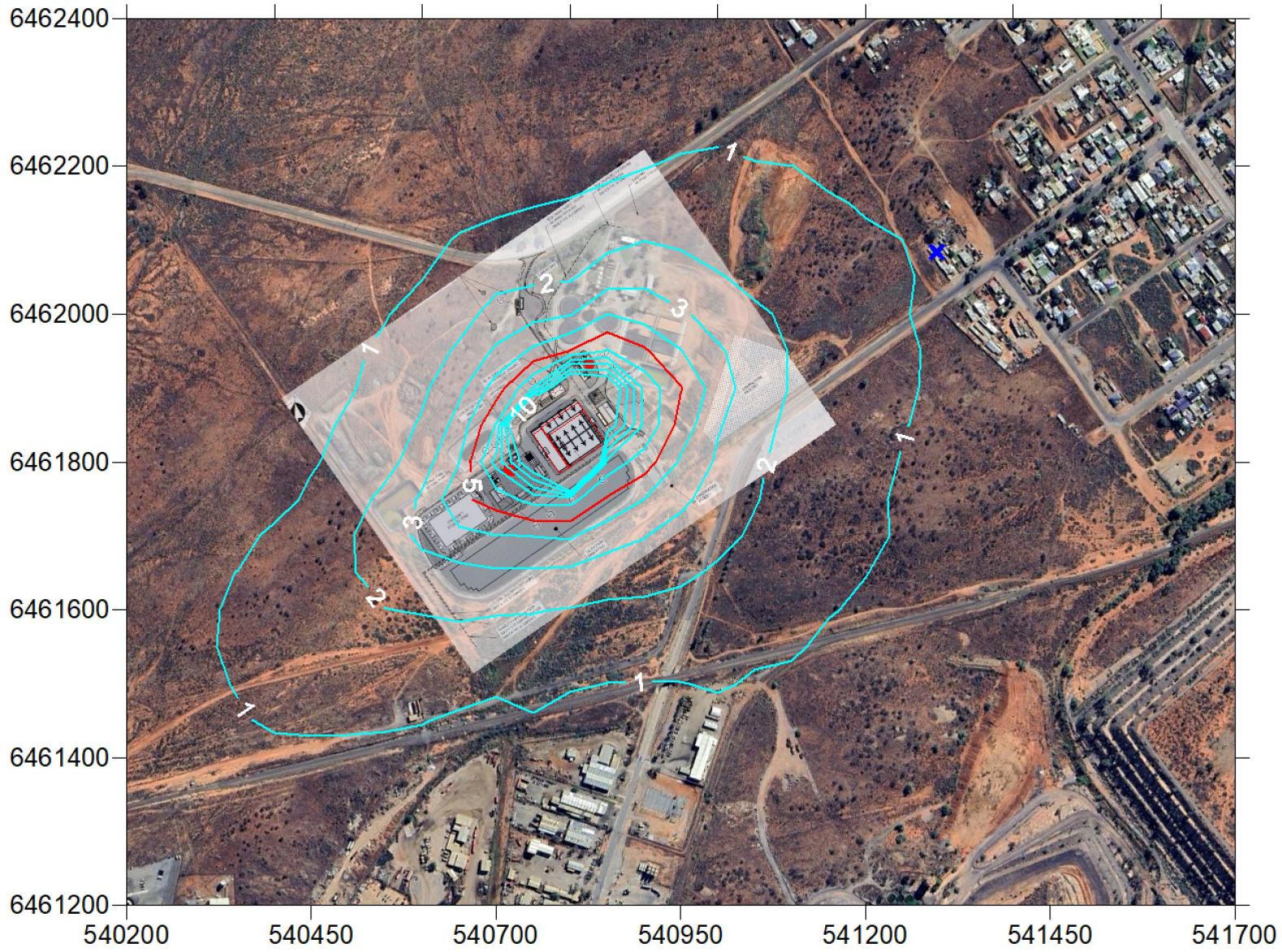


Figure 17 Odour concentration contour for scenario 5

7 Conclusions

Odour emissions were sampled using isolation flux chamber at the Wills Sewage Treatment Plant at Broken Hill, NSW. The odour samples were analysed for odour concentrations to prepare the odour emission rates for Ausplume odour dispersion modelling.

The meteorological data at Broken Hill airport, supplied by the Bureau of Meteorology, was formatted for Ausplume requirements. The meteorological data confirms a calm condition (1.5%) at the site. The analysis of the meteorological data confirmed the wind pattern around the site with westerly breeze in the afternoon.

The odour impact from the site was modelled using the nearby airport meteorological data. The odour performance criteria were selected as 5 OU/m^3.

The odour impact area for the existing plant is within the property boundary. In normal operational conditions, all scenarios comply with NSW EPA odour performance criteria of 5 OU/m^3.

The odour impact from Scenario 5 design (the preferred sludge management option and positioning of STP infrastructure) is within the property boundary with total odour emissions and impact area smaller than that currently produced by the existing STP infrastructure.

8 References

Standards Australia (1995) Australian standard AS 4323.1 Stationary source emissions, method 1: selection of sampling positions, Sydney Australia.

Standards Australia (2001) Australian/New Zealand Standard AS/NZS 4323.3:2001, Stationary source emissions – Part 3: Determination of odour concentration by dynamic olfactometry, Sydney, Australia.

Standard Australia (2009) Australian/New Zealand Standard AS/NZS 4323.4:2009 Stationary source emissions Area source sampling - Flux chamber technique (Reconfirmed 2020)

NSW Environment Protection Authority, Approved methods - for the Modelling and Assessment of Air Pollutants in New South Wales, Department of Environment & Climate Change, August 2005

NSW Environment Protection Authority, Approved methods for the sampling and analysis of air pollutants in New South Wales, 2000

NSW Environment Protection Authority, Technical framework Assessment and management of odour from stationary sources in NSW, Department of Environment & Climate Change, November 2006

Appendix 1. Olfactometry testing report

Environodour AUSTRALIA PTY LTD

We make scents of odour

EnvironOdour Australia Pty Ltd ABN: 83 003 175 705 ACN: 103 510 685 Email: admin@environodour.com.au

Odour Testing Report (Odour Concentration)

Client: Essential Energy **Job No:** EJ515 **Session:** S230728-1 **Testing Date:** Fri, 28 Jul 2023

Odour testing was carried out using the DynaScent digital dynamic olfactometer and fully complies with Australia Standard AS/NZS4323.3:2001. The olfactometer was calibrated against mass flow on 22/1/2023 Odour Concentration (OC) was calculated using a retrospective screening procedure and based upon 'certain and correct' criteria. Pre-Dilution Ratio (PDR) has been applied to the results (if applicable).

The butanol threshold for the current session is 0 ppb. The butanol threshold for the past ten sessions is 29 ppb. The sensory performance criteria is between 20-80 ppb. The precision of the laboratory is 1.636 (< 0.477). The accuracy of the laboratory is 0.259 (< 0.217).

Sample ID	Test ID	Source	Collecting Date and Time	Testing date and time	PDR	OC (OU/m^3)
6517	103118	Trickling filter	27/07/2023 07:50	28/07/2023 10:48	1.0	185
6518	103119	Sludge drying bed	27/07/2023 08:40	28/07/2023 10:55	1.0	93
6519	103120	Digester	27/07/2023 09:30	28/07/2023 11:11	1.0	1465
6520	103121	Humus tank	27/07/2023 10:10	28/07/2023 11:22	1.0	622
6521	103122	Primary sedimentation tank	27/07/2023 10:45	28/07/2023 11:35	1.0	8379
6522	103123	Inlet channel	27/07/2023 11:15	28/07/2023 11:51	1.0	34184
Butanol	B2307281	B-20221	28/07/2023 10:35	28/07/2023 10:35	1.0	1451

(The following space is intentionally left empty.)

Comments:

Issued by: _____ Date: _____

Printed on Monday, 31 July 2023

Page 1 of 1

Appendix 2. Site photos

Figure 18 Drying bed

Figure 19 Trickling filter

Figure 20 Sludge digester

Figure 21 Primary sedimentation tank

Figure 22 Inlet channel

Appendix 3. Analysis of meteorological data

Table 13 Frequency distribution of atmospheric stability class versus wind direction

WD \ AS	A	B	C	D	E	F	Sum
N	0.1%	0.3%	0.3%	1.8%	1.1%	0.3%	4.0%
NNE	0.1%	0.2%	0.2%	2.1%	1.6%	0.3%	4.5%
NE	0.1%	0.2%	0.2%	3.5%	2.5%	0.6%	7.1%
ENE	0.1%	0.2%	0.3%	3.7%	2.2%	0.4%	6.9%
E	0.1%	0.2%	0.3%	3.1%	0.6%	0.3%	4.6%
ESE	0.1%	0.2%	0.6%	2.7%	0.5%	0.2%	4.4%
SE	0.1%	0.2%	0.7%	2.7%	0.5%	0.3%	4.5%
SSE	0.1%	0.2%	0.6%	2.8%	0.7%	0.2%	4.6%
S	0.1%	0.2%	0.4%	2.6%	0.6%	0.3%	4.3%
SSW	0.1%	0.2%	0.5%	2.8%	0.8%	0.5%	4.9%
SW	0.2%	0.3%	0.7%	4.5%	1.2%	0.6%	7.4%
WSW	0.2%	0.4%	1.0%	7.3%	1.8%	0.6%	11.2%
W	0.2%	0.4%	1.5%	8.4%	1.7%	0.4%	12.6%
WNW	0.1%	0.4%	1.2%	4.4%	2.2%	0.4%	8.7%
NW	0.1%	0.3%	0.7%	2.6%	1.8%	0.4%	6.0%
NNW	0.1%	0.2%	0.4%	1.9%	1.2%	0.3%	4.2%
Sum	2.0%	4.2%	9.8%	56.9%	21.1%	6.0%	100.0%

Table 14 Frequency distribution of atmospheric stability class versus wind speed

WS \ AS	A	B	C	D	E	F	Sum
< 0.5	0.0%	0.0%	0.0%	0.5%	0.2%	1.1%	1.8%
1.54	0.1%	0.0%	0.0%	0.4%	0.3%	0.6%	1.4%
3.09	1.9%	0.7%	0.0%	5.6%	5.0%	4.3%	17.6%
5.14	0.0%	3.4%	3.3%	15.6%	15.6%	0.0%	37.8%
8.23	0.0%	0.0%	5.7%	26.3%	0.0%	0.0%	32.0%
10.5	0.0%	0.0%	0.8%	6.9%	0.0%	0.0%	7.7%
> 10.8	0.0%	0.0%	0.0%	1.7%	0.0%	0.0%	1.7%
Sum	0.8%	1.5%	2.7%	19.7%	9.0%	2.3%	100.0%

Table 15 Frequency distribution of atmospheric stability class versus time of day

Time \ AS	A	B	C	D	E	F	Sum
1-2	0.0%	0.0%	0.0%	3.3%	3.9%	1.1%	8.3%
3-4	0.0%	0.0%	0.0%	3.4%	3.8%	1.2%	8.3%
5-6	0.0%	0.0%	0.0%	5.7%	1.9%	0.7%	8.3%
7-8	0.1%	0.1%	0.0%	8.2%	0.0%	0.0%	8.3%
9-10	0.3%	0.4%	0.6%	7.1%	0.0%	0.0%	8.3%
11-12	0.6%	1.1%	2.6%	4.0%	0.0%	0.0%	8.3%
13-14	0.5%	1.2%	3.1%	3.5%	0.0%	0.0%	8.3%
15-16	0.3%	0.9%	2.4%	4.6%	0.0%	0.0%	8.3%
17-18	0.1%	0.4%	1.0%	6.8%	0.0%	0.0%	8.3%
19-20	0.0%	0.0%	0.0%	4.1%	3.4%	0.9%	8.3%
21-22	0.0%	0.0%	0.0%	3.1%	4.2%	1.1%	8.3%
23-24	0.0%	0.0%	0.0%	3.2%	4.0%	1.1%	8.3%
Sum	2.0%	4.2%	9.8%	56.9%	21.1%	6.0%	100.0%

Table 16 Frequency distribution of wind speed versus wind direction

WD \ WS	0	0 - 2	2 - 4	4 - 6	6 - 8	8 - 10	>10	Sum
N	0.18%	0.44%	2.58%	3.61%	3.56%	1.73%	0.53%	12.65%
NNE	0.1%	0.28%	2.5%	3.28%	1.99%	0.5%	0.08%	8.73%
NE	0.13%	0.26%	2.29%	2.23%	0.85%	0.18%	0.02%	5.95%
ENE	0.06%	0.18%	1.68%	1.53%	0.59%	0.12%	0.01%	4.16%
E	0.07%	0.21%	1.83%	1.21%	0.55%	0.1%	0.04%	4.02%
ESE	0.04%	0.13%	2.18%	1.45%	0.51%	0.18%	0.03%	4.53%
SE	0.08%	0.21%	3.3%	2.4%	0.79%	0.21%	0.07%	7.06%
SSE	0.04%	0.19%	2.81%	2.5%	1.08%	0.24%	0.09%	6.93%
S	0.05%	0.18%	1.52%	1.5%	0.92%	0.37%	0.11%	4.63%
SSW	0.04%	0.13%	1.47%	1.25%	0.99%	0.35%	0.11%	4.36%
SW	0.07%	0.19%	1.5%	1.36%	0.92%	0.43%	0.09%	4.55%
WSW	0.08%	0.18%	1.24%	1.26%	1.%	0.53%	0.27%	4.56%
W	0.09%	0.19%	1.29%	1.15%	0.8%	0.52%	0.26%	4.3%
WNW	0.12%	0.29%	1.65%	1.12%	0.9%	0.45%	0.37%	4.91%
NW	0.2%	0.53%	2.17%	1.75%	1.45%	0.82%	0.5%	7.43%
NNW	0.19%	0.54%	2.87%	3.2%	2.59%	1.35%	0.48%	11.23%
Sum	1.54%	4.13%	32.89%	30.8%	19.48%	8.08%	3.08%	100.%

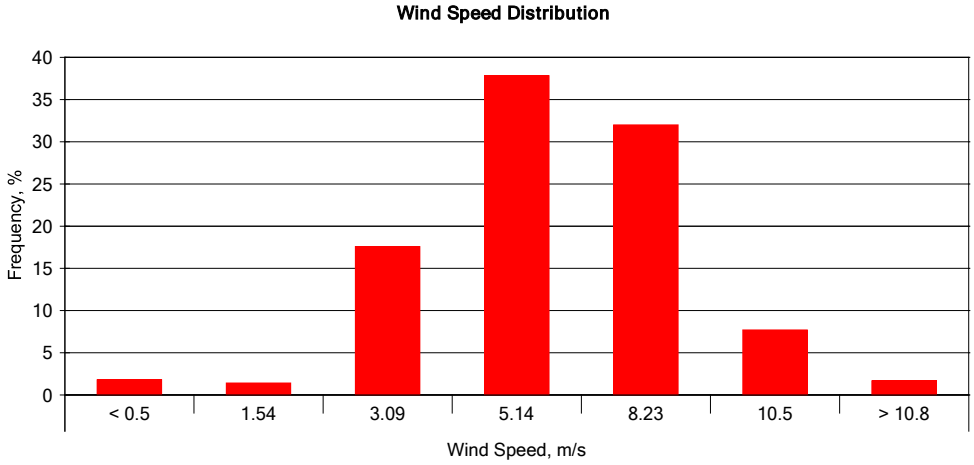


Figure 23 Wind speed distribution

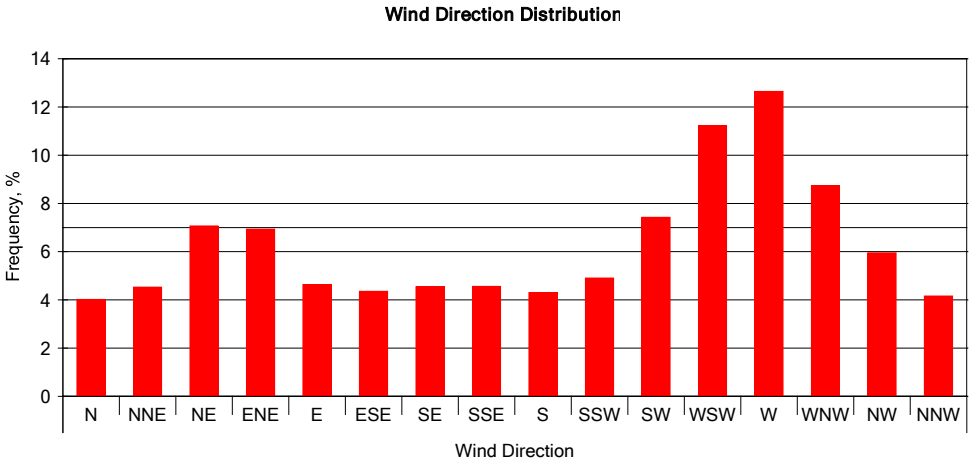


Figure 24 Wind direction distribution

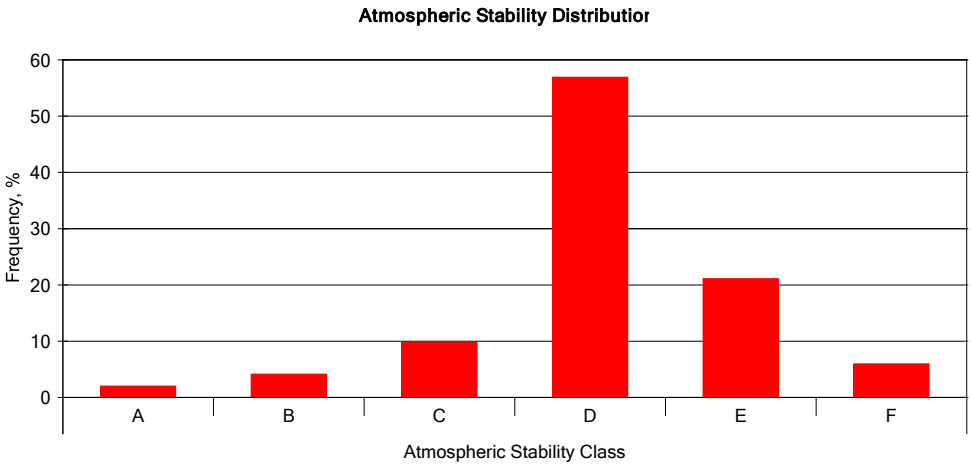


Figure 25 Atmospheric stability class distribution

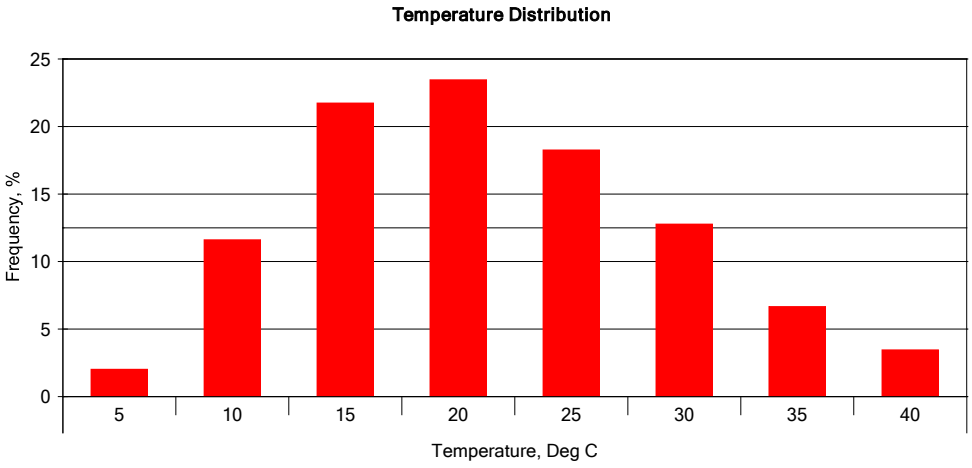


Figure 26 Ambient temperature distribution

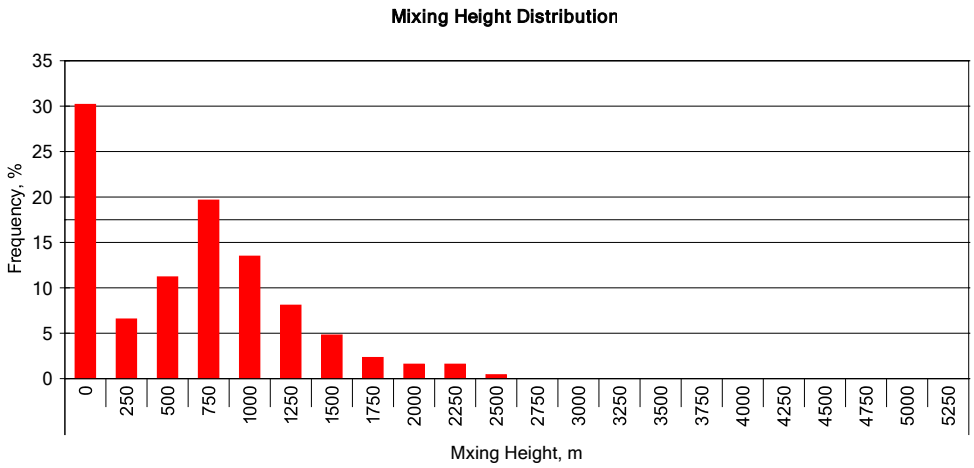


Figure 27 Mixing height distribution

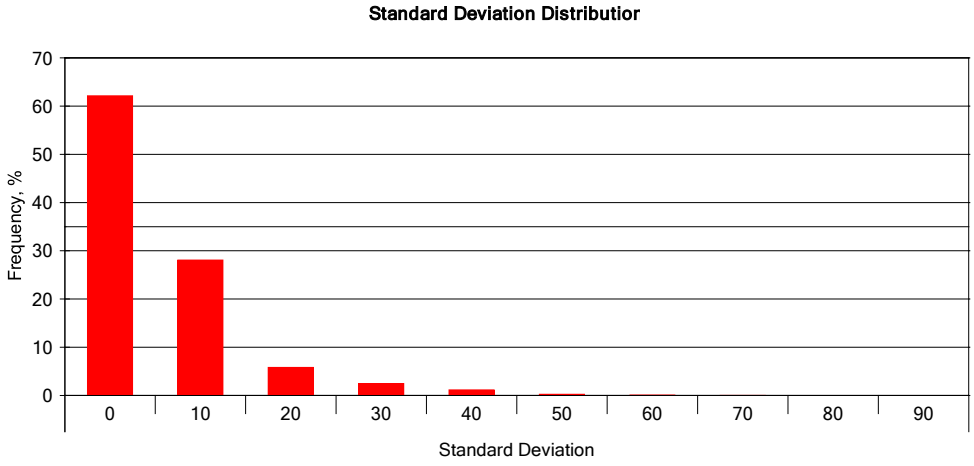


Figure 28 Sigma-Theta (wind direction standard deviation) distribution

Appendix 4. Ausplume configuration file (Existing)

1

Wills STP Existing

Concentration or deposition	Concentration
Emission rate units	OUV/second
Concentration units	Odour_Units
Units conversion factor	1.00E+00
Constant background concentration	0.00E+00
Terrain effects	None
Smooth stability class changes?	No
Other stability class adjustments ("urban modes")	None
Ignore building wake effects?	Yes
Decay coefficient (unless overridden by met. file)	0.000
Anemometer height	10 m
Roughness height at the wind vane site	0.300 m
Use the convective PDF algorithm?	No
Averaging time for sigma-theta values	60 min.

DISPERSION CURVES

Horizontal dispersion curves for sources <100m high	Sigma-theta
Vertical dispersion curves for sources <100m high	Pasquill-Gifford
Horizontal dispersion curves for sources >100m high	Briggs Rural
Vertical dispersion curves for sources >100m high	Briggs Rural
Enhance horizontal plume spreads for buoyancy?	Yes
Enhance vertical plume spreads for buoyancy?	Yes
Adjust horizontal P-G formulae for roughness height?	Yes
Adjust vertical P-G formulae for roughness height?	Yes
Roughness height	0.100m
Adjustment for wind directional shear	None

PLUME RISE OPTIONS

Gradual plume rise?	Yes
Stack-tip downwash included?	Yes
Building downwash algorithm:	PRIME method.
Entrainment coeff. for neutral & stable lapse rates	0.60,0.60
Partial penetration of elevated inversions?	No
Disregard temp. gradients in the hourly met. file?	No

and in the absence of boundary-layer potential temperature gradients
given by the hourly met. file, a value from the following table
(in K/m) is used:

Wind Speed Category	Stability Class A	B	C	D	E	F
1	0.000	0.000	0.000	0.000	0.020	0.035
2	0.000	0.000	0.000	0.000	0.020	0.035
3	0.000	0.000	0.000	0.000	0.020	0.035
4	0.000	0.000	0.000	0.000	0.020	0.035
5	0.000	0.000	0.000	0.000	0.020	0.035
6	0.000	0.000	0.000	0.000	0.020	0.035

WIND SPEED CATEGORIES
Boundaries between categories (in m/s) are: 1.54, 3.09, 5.14, 8.23, 10.80

WIND PROFILE EXPONENTS: "Irwin Urban" values (unless overridden by met. file)

AVERAGING TIMES
1 hour

1

Wills STP Existing

SOURCE CHARACTERISTICS

INTEGRATED AREA SOURCE: 21

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540713	6461908	0m	36m	68m	44deg	1m	4m

(Constant) emission rate = 1.25E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 22

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540702	6461895	0m	36m	20m	44deg	1m	4m

(Constant) emission rate = 1.25E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 31

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540717	6461980	0m	20m	12m	46deg	0m	1m

(Constant) emission rate = 2.50E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 41

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540509	6461910	0m	53m	53m	46deg	0m	0m

(Constant) emission rate = 1.00E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 42

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540560	6461948	0m	53m	53m	46deg	0m	0m

(Constant) emission rate = 1.00E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 43

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540547	6461859	0m	53m	53m	46deg	0m	0m

(Constant) emission rate = 1.00E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 51

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540476	6461834	0m	66m	15m	46deg	0m	0m

(Constant) emission rate = 1.50E-01 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 61

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540872	6461944	0m	60m	60m	15deg	0m	0m

(Constant) emission rate = 1.50E-01 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 71

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540924	6461994	0m	30m	45m	15deg	0m	0m

(Constant) emission rate = 1.50E-01 OUV/second per square metre
No gravitational settling or scavenging.

1

Wills STP Existing

RECEPTOR LOCATIONS

The Cartesian receptor grid has the following x-values (or eastings):
540200.m 540250.m 540300.m 540350.m 540400.m 540450.m 540500.m
540550.m 540600.m 540650.m 540700.m 540750.m 540800.m 540850.m
540900.m 540950.m 541000.m 541050.m 541100.m 541150.m 541200.m
541250.m 541300.m 541350.m 541400.m 541450.m 541500.m 541550.m
541600.m 541650.m 541700.m

and these y-values (or northings):
6461200.m 6461250.m 6461300.m 6461350.m 6461400.m 6461450.m 6461500.m
6461550.m 6461600.m 6461650.m 6461700.m 6461750.m 6461800.m 6461850.m
6461900.m 6461950.m 6462000.m 6462050.m 6462100.m 6462150.m 6462200.m
6462250.m 6462300.m 6462350.m 6462400.m

DISCRETE RECEPTOR LOCATIONS (in metres)

No.	X	Y	ELEVN	HEIGHT	No.	X	Y	ELEVN	HEIGHT
1	540712	6461907	0.0	0.0	6	540547	6461859	0.0	0.0
2	540702	6461895	0.0	0.0	7	540476	6461834	0.0	0.0
3	540717	6461980	0.0	0.0	8	540871	6461944	0.0	0.0
4	540509	6461910	0.0	0.0	9	540924	6461994	0.0	0.0
5	540560	6461948	0.0	0.0	10	541287	6462084	0.0	0.0

METEOROLOGICAL DATA : st,047048,47 ,BROKEN HILL AIRPORT AWS,01/1947,

Appendix 5. Ausplume configuration file (Scenario 1)

1

Wills STP Scenario 1

Concentration or deposition	Concentration
Emission rate units	OUV/second
Concentration units	Odour_Units
Units conversion factor	1.00E+00
Constant background concentration	0.00E+00
Terrain effects	None
Smooth stability class changes?	No
Other stability class adjustments ("urban modes")	None
Ignore building wake effects?	Yes
Decay coefficient (unless overridden by met. file)	0.000
Anemometer height	10 m
Roughness height at the wind vane site	0.300 m
Use the convective PDF algorithm?	No
Averaging time for sigma-theta values	60 min.

DISPERSION CURVES

Horizontal dispersion curves for sources <100m high	Sigma-theta
Vertical dispersion curves for sources <100m high	Pasquill-Gifford
Horizontal dispersion curves for sources >100m high	Briggs Rural
Vertical dispersion curves for sources >100m high	Briggs Rural
Enhance horizontal plume spreads for buoyancy?	Yes
Enhance vertical plume spreads for buoyancy?	Yes
Adjust horizontal P-G formulae for roughness height?	Yes
Adjust vertical P-G formulae for roughness height?	Yes
Roughness height	0.100m
Adjustment for wind directional shear	None

PLUME RISE OPTIONS

Gradual plume rise?	Yes
Stack-tip downwash included?	Yes
Building downwash algorithm:	PRIME method.
Entrainment coeff. for neutral & stable lapse rates	0.60,0.60
Partial penetration of elevated inversions?	No
Disregard temp. gradients in the hourly met. file?	No

and in the absence of boundary-layer potential temperature gradients
given by the hourly met. file, a value from the following table
(in K/m) is used:

Wind Speed Category	Stability Class A	B	C	D	E	F
1	0.000	0.000	0.000	0.000	0.020	0.035
2	0.000	0.000	0.000	0.000	0.020	0.035
3	0.000	0.000	0.000	0.000	0.020	0.035
4	0.000	0.000	0.000	0.000	0.020	0.035
5	0.000	0.000	0.000	0.000	0.020	0.035
6	0.000	0.000	0.000	0.000	0.020	0.035

WIND SPEED CATEGORIES
Boundaries between categories (in m/s) are: 1.54, 3.09, 5.14, 8.23, 10.80

WIND PROFILE EXPONENTS: "Irwin Urban" values (unless overridden by met. file)

AVERAGING TIMES
1 hour

1

Wills STP Scenario 1

SOURCE CHARACTERISTICS

INTEGRATED AREA SOURCE: 21

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540713	6461908	0m	36m	68m	44deg	1m	4m

(Constant) emission rate = 1.25E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 22

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540702	6461895	0m	36m	20m	44deg	1m	4m

(Constant) emission rate = 1.25E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 31

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540717	6461980	0m	20m	12m	46deg	0m	1m

(Constant) emission rate = 2.50E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 41

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540509	6461910	0m	53m	53m	46deg	0m	0m

(Constant) emission rate = 1.00E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 42

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540560	6461948	0m	53m	53m	46deg	0m	0m

(Constant) emission rate = 1.00E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 43

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540547	6461859	0m	53m	53m	46deg	0m	0m

(Constant) emission rate = 1.00E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 51

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540476	6461834	0m	66m	15m	46deg	0m	0m

(Constant) emission rate = 1.50E-01 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 61

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540872	6461944	0m	60m	60m	15deg	0m	0m

(Constant) emission rate = 1.50E-01 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 71

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540924	6461994	0m	30m	45m	15deg	0m	0m

(Constant) emission rate = 1.50E-01 OUV/second per square metre
No gravitational settling or scavenging.

1

Wills STP Scenario 1

RECEPTOR LOCATIONS

The Cartesian receptor grid has the following x-values (or eastings):
540200.m 540250.m 540300.m 540350.m 540400.m 540450.m 540500.m
540550.m 540600.m 540650.m 540700.m 540750.m 540800.m 540850.m
540900.m 540950.m 541000.m 541050.m 541100.m 541150.m 541200.m
541250.m 541300.m 541350.m 541400.m 541450.m 541500.m 541550.m
541600.m 541650.m 541700.m

and these y-values (or northings):
6461200.m 6461250.m 6461300.m 6461350.m 6461400.m 6461450.m 6461500.m
6461550.m 6461600.m 6461650.m 6461700.m 6461750.m 6461800.m 6461850.m
6461900.m 6461950.m 6462000.m 6462050.m 6462100.m 6462150.m 6462200.m
6462250.m 6462300.m 6462350.m 6462400.m

DISCRETE RECEPTOR LOCATIONS (in metres)

No.	X	Y	ELEVN	HEIGHT	No.	X	Y	ELEVN	HEIGHT
1	540712	6461907	0.0	0.0	6	540547	6461859	0.0	0.0
2	540702	6461895	0.0	0.0	7	540476	6461834	0.0	0.0
3	540717	6461980	0.0	0.0	8	540871	6461944	0.0	0.0
4	540509	6461910	0.0	0.0	9	540924	6461994	0.0	0.0
5	540560	6461948	0.0	0.0	10	541287	6462084	0.0	0.0

METEOROLOGICAL DATA : st,047048,47 ,BROKEN HILL AIRPORT AWS,01/1947,

Appendix 6. Ausplume configuration file (Scenario 2)

1

Wills STP Scenario 2

Concentration or deposition	Concentration
Emission rate units	OUV/second
Concentration units	Odour_Units
Units conversion factor	1.00E+00
Constant background concentration	0.00E+00
Terrain effects	None
Smooth stability class changes?	No
Other stability class adjustments ("urban modes")	None
Ignore building wake effects?	Yes
Decay coefficient (unless overridden by met. file)	0.000
Anemometer height	10 m
Roughness height at the wind vane site	0.300 m
Use the convective PDF algorithm?	No
Averaging time for sigma-theta values	60 min.

DISPERSION CURVES

Horizontal dispersion curves for sources <100m high	Sigma-theta
Vertical dispersion curves for sources <100m high	Pasquill-Gifford
Horizontal dispersion curves for sources >100m high	Briggs Rural
Vertical dispersion curves for sources >100m high	Briggs Rural
Enhance horizontal plume spreads for buoyancy?	Yes
Enhance vertical plume spreads for buoyancy?	Yes
Adjust horizontal P-G formulae for roughness height?	Yes
Adjust vertical P-G formulae for roughness height?	Yes
Roughness height	0.100m
Adjustment for wind directional shear	None

PLUME RISE OPTIONS

Gradual plume rise?	Yes
Stack-tip downwash included?	Yes
Building downwash algorithm:	PRIME method.
Entrainment coeff. for neutral & stable lapse rates	0.60,0.60
Partial penetration of elevated inversions?	No
Disregard temp. gradients in the hourly met. file?	No

and in the absence of boundary-layer potential temperature gradients
given by the hourly met. file, a value from the following table
(in K/m) is used:

Wind Speed Category	Stability Class A	B	C	D	E	F
1	0.000	0.000	0.000	0.000	0.020	0.035
2	0.000	0.000	0.000	0.000	0.020	0.035
3	0.000	0.000	0.000	0.000	0.020	0.035
4	0.000	0.000	0.000	0.000	0.020	0.035
5	0.000	0.000	0.000	0.000	0.020	0.035
6	0.000	0.000	0.000	0.000	0.020	0.035

WIND SPEED CATEGORIES
Boundaries between categories (in m/s) are: 1.54, 3.09, 5.14, 8.23, 10.80

WIND PROFILE EXPONENTS: "Irwin Urban" values (unless overridden by met. file)

AVERAGING TIMES
1 hour

1

Wills STP Scenario 2

SOURCE CHARACTERISTICS

INTEGRATED AREA SOURCE: 21

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540713	6461908	0m	36m	68m	44deg	1m	4m

(Constant) emission rate = 1.25E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 22

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540702	6461895	0m	36m	20m	44deg	1m	4m

(Constant) emission rate = 1.25E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 31

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540717	6461980	0m	20m	12m	46deg	0m	1m

(Constant) emission rate = 2.50E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 41

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540509	6461910	0m	53m	53m	46deg	0m	0m

(Constant) emission rate = 1.00E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 42

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540560	6461948	0m	53m	53m	46deg	0m	0m

(Constant) emission rate = 1.00E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 43

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540547	6461859	0m	53m	53m	46deg	0m	0m

(Constant) emission rate = 1.00E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 51

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540476	6461834	0m	66m	15m	46deg	0m	0m

(Constant) emission rate = 1.50E-01 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 61

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540447	6461988	0m	65m	100m	15deg	0m	0m

(Constant) emission rate = 1.50E-01 OUV/second per square metre
No gravitational settling or scavenging.

1

Wills STP Scenario 2

RECEPTOR LOCATIONS

The Cartesian receptor grid has the following x-values (or eastings):
540200.m 540250.m 540300.m 540350.m 540400.m 540450.m 540500.m
540550.m 540600.m 540650.m 540700.m 540750.m 540800.m 540850.m
540900.m 540950.m 541000.m 541050.m 541100.m 541150.m 541200.m
541250.m 541300.m 541350.m 541400.m 541450.m 541500.m 541550.m
541600.m 541650.m 541700.m

and these y-values (or northings):
6461200.m 6461250.m 6461300.m 6461350.m 6461400.m 6461450.m 6461500.m
6461550.m 6461600.m 6461650.m 6461700.m 6461750.m 6461800.m 6461850.m
6461900.m 6461950.m 6462000.m 6462050.m 6462100.m 6462150.m 6462200.m
6462250.m 6462300.m 6462350.m 6462400.m

DISCRETE RECEPTOR LOCATIONS (in metres)

No.	X	Y	ELEVN	HEIGHT	No.	X	Y	ELEVN	HEIGHT
1	540712	6461907	0.0	0.0	5	540560	6461948	0.0	0.0
2	540702	6461895	0.0	0.0	6	540547	6461859	0.0	0.0
3	540717	6461980	0.0	0.0	7	540476	6461834	0.0	0.0
4	540509	6461910	0.0	0.0	8	540447	6461988	0.0	0.0

METEOROLOGICAL DATA : st,047048,47 ,BROKEN HILL AIRPORT AWS,01/1947,

Appendix 7. Ausplume configuration file (Scenario 3)

1

Wills STP Scenario 3

Concentration or deposition	Concentration
Emission rate units	OUV/second
Concentration units	Odour_Units
Units conversion factor	1.00E+00
Constant background concentration	0.00E+00
Terrain effects	None
Smooth stability class changes?	No
Other stability class adjustments ("urban modes")	None
Ignore building wake effects?	Yes
Decay coefficient (unless overridden by met. file)	0.000
Anemometer height	10 m
Roughness height at the wind vane site	0.300 m
Use the convective PDF algorithm?	No
Averaging time for sigma-theta values	60 min.

DISPERSION CURVES

Horizontal dispersion curves for sources <100m high	Sigma-theta
Vertical dispersion curves for sources <100m high	Pasquill-Gifford
Horizontal dispersion curves for sources >100m high	Briggs Rural
Vertical dispersion curves for sources >100m high	Briggs Rural
Enhance horizontal plume spreads for buoyancy?	Yes
Enhance vertical plume spreads for buoyancy?	Yes
Adjust horizontal P-G formulae for roughness height?	Yes
Adjust vertical P-G formulae for roughness height?	Yes
Roughness height	0.100m
Adjustment for wind directional shear	None

PLUME RISE OPTIONS

Gradual plume rise?	Yes
Stack-tip downwash included?	Yes
Building downwash algorithm:	PRIME method.
Entrainment coeff. for neutral & stable lapse rates	0.60,0.60
Partial penetration of elevated inversions?	No
Disregard temp. gradients in the hourly met. file?	No

and in the absence of boundary-layer potential temperature gradients
given by the hourly met. file, a value from the following table
(in K/m) is used:

Wind Speed Category	Stability Class A	B	C	D	E	F
1	0.000	0.000	0.000	0.000	0.020	0.035
2	0.000	0.000	0.000	0.000	0.020	0.035
3	0.000	0.000	0.000	0.000	0.020	0.035
4	0.000	0.000	0.000	0.000	0.020	0.035
5	0.000	0.000	0.000	0.000	0.020	0.035
6	0.000	0.000	0.000	0.000	0.020	0.035

WIND SPEED CATEGORIES
Boundaries between categories (in m/s) are: 1.54, 3.09, 5.14, 8.23, 10.80

WIND PROFILE EXPONENTS: "Irwin Urban" values (unless overridden by met. file)

AVERAGING TIMES
1 hour

1

Wills STP Scenario 3

SOURCE CHARACTERISTICS

INTEGRATED AREA SOURCE: 21

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540713	6461908	0m	36m	68m	44deg	1m	4m

(Constant) emission rate = 1.25E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 22

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540702	6461895	0m	36m	20m	44deg	1m	4m

(Constant) emission rate = 1.25E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 31

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540717	6461980	0m	20m	12m	46deg	0m	1m

(Constant) emission rate = 2.50E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 51

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540476	6461834	0m	66m	15m	46deg	0m	0m

(Constant) emission rate = 1.50E-01 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED CIRCULAR AREA SOURCE: 41

X0(m)	Y0(m)	Ground El	Radius	No. Vertices	Ver. spread	Height
540659	6461929	0m	5m	20	0m	0m

(Constant) emission rate = 2.40E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED CIRCULAR AREA SOURCE: 61

X0(m)	Y0(m)	Ground El	Radius	No. Vertices	Ver. spread	Height
540657	6461951	0m	13m	20	0m	0m

(Constant) emission rate = 2.40E+00 OUV/second per square metre
No gravitational settling or scavenging.

VOLUME SOURCE: 71

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
540704	6461960	0m	5m	3m	1m

(Constant) emission rate = 7.67E+02 OUV/second
No gravitational settling or scavenging.

1

Wills STP Scenario 3

RECEPTOR LOCATIONS

The Cartesian receptor grid has the following x-values (or eastings):
540200.m 540250.m 540300.m 540350.m 540400.m 540450.m 540500.m
540550.m 540600.m 540650.m 540700.m 540750.m 540800.m 540850.m
540900.m 540950.m 541000.m 541050.m 541100.m 541150.m 541200.m
541250.m 541300.m 541350.m 541400.m 541450.m 541500.m 541550.m
541600.m 541650.m 541700.m

and these y-values (or northings):
6461200.m 6461250.m 6461300.m 6461350.m 6461400.m 6461450.m 6461500.m
6461550.m 6461600.m 6461650.m 6461700.m 6461750.m 6461800.m 6461850.m
6461900.m 6461950.m 6462000.m 6462050.m 6462100.m 6462150.m 6462200.m
6462250.m 6462300.m 6462350.m 6462400.m

DISCRETE RECEPTOR LOCATIONS (in metres)

No.	X	Y	ELEVN	HEIGHT	No.	X	Y	ELEVN	HEIGHT
1	540712	6461907	0.0	0.0	5	540659	6461929	0.0	0.0
2	540702	6461895	0.0	0.0	6	540657	6461951	0.0	0.0
3	540717	6461980	0.0	0.0	7	540649	6461881	0.0	0.0
4	540476	6461834	0.0	0.0					

METEOROLOGICAL DATA : st,047048,47 ,BROKEN HILL AIRPORT AWS,01/1947,

Appendix 8. Ausplume configuration file (Scenario 4)

1

Wills STP Scenario 4

Concentration or deposition	Concentration
Emission rate units	OUV/second
Concentration units	Odour_Units
Units conversion factor	1.00E+00
Constant background concentration	0.00E+00
Terrain effects	None
Smooth stability class changes?	No
Other stability class adjustments ("urban modes")	None
Ignore building wake effects?	Yes
Decay coefficient (unless overridden by met. file)	0.000
Anemometer height	10 m
Roughness height at the wind vane site	0.300 m
Use the convective PDF algorithm?	No
Averaging time for sigma-theta values	60 min.

DISPERSION CURVES

Horizontal dispersion curves for sources <100m high	Sigma-theta
Vertical dispersion curves for sources <100m high	Pasquill-Gifford
Horizontal dispersion curves for sources >100m high	Briggs Rural
Vertical dispersion curves for sources >100m high	Briggs Rural
Enhance horizontal plume spreads for buoyancy?	Yes
Enhance vertical plume spreads for buoyancy?	Yes
Adjust horizontal P-G formulae for roughness height?	Yes
Adjust vertical P-G formulae for roughness height?	Yes
Roughness height	0.100m
Adjustment for wind directional shear	None

PLUME RISE OPTIONS

Gradual plume rise?	Yes
Stack-tip downwash included?	Yes
Building downwash algorithm:	PRIME method.
Entrainment coeff. for neutral & stable lapse rates	0.60,0.60
Partial penetration of elevated inversions?	No
Disregard temp. gradients in the hourly met. file?	No

and in the absence of boundary-layer potential temperature gradients
given by the hourly met. file, a value from the following table
(in K/m) is used:

Wind Speed Category	Stability Class A	B	C	D	E	F
1	0.000	0.000	0.000	0.000	0.020	0.035
2	0.000	0.000	0.000	0.000	0.020	0.035
3	0.000	0.000	0.000	0.000	0.020	0.035
4	0.000	0.000	0.000	0.000	0.020	0.035
5	0.000	0.000	0.000	0.000	0.020	0.035
6	0.000	0.000	0.000	0.000	0.020	0.035

WIND SPEED CATEGORIES
Boundaries between categories (in m/s) are: 1.54, 3.09, 5.14, 8.23, 10.80

WIND PROFILE EXPONENTS: "Irwin Urban" values (unless overridden by met. file)

AVERAGING TIMES
1 hour

1

Wills STP Scenario 4

SOURCE CHARACTERISTICS

INTEGRATED AREA SOURCE: 21

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540713	6461908	0m	36m	68m	44deg	1m	4m

(Constant) emission rate = 1.25E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 22

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540702	6461895	0m	36m	20m	44deg	1m	4m

(Constant) emission rate = 1.25E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 31

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540717	6461980	0m	20m	12m	46deg	0m	1m

(Constant) emission rate = 2.50E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 51

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540476	6461834	0m	66m	15m	46deg	0m	0m

(Constant) emission rate = 1.50E-01 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 41

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540564	6461868	0m	40m	40m	50deg	0m	0m

(Constant) emission rate = 1.00E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 42

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540529	6461911	0m	40m	40m	50deg	0m	0m

(Constant) emission rate = 1.00E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 43

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540574	6461946	0m	40m	40m	50deg	0m	0m

(Constant) emission rate = 1.00E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 44

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540500	6461949	0m	40m	40m	50deg	0m	0m

(Constant) emission rate = 1.00E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 45

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540542	6461983	0m	40m	40m	50deg	0m	0m

(Constant) emission rate = 1.00E+00 OUV/second per square metre
No gravitational settling or scavenging.

1

Wills STP Scenario 4

RECEPTOR LOCATIONS

The Cartesian receptor grid has the following x-values (or eastings):
540200.m 540250.m 540300.m 540350.m 540400.m 540450.m 540500.m
540550.m 540600.m 540650.m 540700.m 540750.m 540800.m 540850.m
540900.m 540950.m 541000.m 541050.m 541100.m 541150.m 541200.m
541250.m 541300.m 541350.m 541400.m 541450.m 541500.m 541550.m
541600.m 541650.m 541700.m

and these y-values (or northings):
6461200.m 6461250.m 6461300.m 6461350.m 6461400.m 6461450.m 6461500.m
6461550.m 6461600.m 6461650.m 6461700.m 6461750.m 6461800.m 6461850.m
6461900.m 6461950.m 6462000.m 6462050.m 6462100.m 6462150.m 6462200.m
6462250.m 6462300.m 6462350.m 6462400.m

DISCRETE RECEPTOR LOCATIONS (in metres)

No.	X	Y	ELEVN	HEIGHT	No.	X	Y	ELEVN	HEIGHT
1	540712	6461907	0.0	0.0	6	540529	6461911	0.0	0.0
2	540702	6461895	0.0	0.0	7	540574	6461946	0.0	0.0
3	540717	6461980	0.0	0.0	8	540500	6461949	0.0	0.0
4	540476	6461834	0.0	0.0	9	540542	6461983	0.0	0.0
5	540564	6461868	0.0	0.0					

METEOROLOGICAL DATA : st,047048,47 ,BROKEN HILL AIRPORT AWS,01/1947,
No gravitational settling or scavenging.

Appendix 9. Ausplume configuration file (Scenario 5)

1

Wills STP Scenario 5

Concentration or deposition	Concentration
Emission rate units	OUV/second
Concentration units	Odour_Units
Units conversion factor	1.00E+00
Constant background concentration	0.00E+00
Terrain effects	None
Smooth stability class changes?	No
Other stability class adjustments ("urban modes")	None
Ignore building wake effects?	Yes
Decay coefficient (unless overridden by met. file)	0.000
Anemometer height	10 m
Roughness height at the wind vane site	0.300 m
Use the convective PDF algorithm?	No
Averaging time for sigma-theta values	60 min.

DISPERSION CURVES

Horizontal dispersion curves for sources <100m high	Sigma-theta
Vertical dispersion curves for sources <100m high	Pasquill-Gifford
Horizontal dispersion curves for sources >100m high	Briggs Rural
Vertical dispersion curves for sources >100m high	Briggs Rural
Enhance horizontal plume spreads for buoyancy?	Yes
Enhance vertical plume spreads for buoyancy?	Yes
Adjust horizontal P-G formulae for roughness height?	Yes
Adjust vertical P-G formulae for roughness height?	Yes
Roughness height	0.100m
Adjustment for wind directional shear	None

PLUME RISE OPTIONS

Gradual plume rise?	Yes
Stack-tip downwash included?	Yes
Building downwash algorithm:	PRIME method.
Entrainment coeff. for neutral & stable lapse rates	0.60,0.60
Partial penetration of elevated inversions?	No
Disregard temp. gradients in the hourly met. file?	No

and in the absence of boundary-layer potential temperature gradients
given by the hourly met. file, a value from the following table
(in K/m) is used:

Wind Speed Category	Stability Class A	B	C	D	E	F
1	0.000	0.000	0.000	0.000	0.020	0.035
2	0.000	0.000	0.000	0.000	0.020	0.035
3	0.000	0.000	0.000	0.000	0.020	0.035
4	0.000	0.000	0.000	0.000	0.020	0.035
5	0.000	0.000	0.000	0.000	0.020	0.035
6	0.000	0.000	0.000	0.000	0.020	0.035

WIND SPEED CATEGORIES
Boundaries between categories (in m/s) are: 1.54, 3.09, 5.14, 8.23, 10.80

WIND PROFILE EXPONENTS: "Irwin Urban" values (unless overridden by met. file)

AVERAGING TIMES
1 hour

1

Wills STP Scenario 5

SOURCE CHARACTERISTICS

STACK SOURCE: 1

X(m)	Y(m)	Ground Elev.	Stack Height	Diameter	Temperature	Speed
540826	6461932	0m	4m	0.35m	30C	10.0m/s

No building wake effects.
(Constant) emission rate = 8.33E+02 OUV/second
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 21

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540798	6461793	0m	60m	50m	-34deg	2m	4m

(Constant) emission rate = 1.25E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 31

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540786	6461784	0m	15m	65m	-34deg	2m	1m

(Constant) emission rate = 1.25E+00 OUV/second per square metre
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: 41

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
540769	6461835	0m	60m	15m	-34deg	2m	0m

(Constant) emission rate = 2.40E+00 OUV/second per square metre
No gravitational settling or scavenging.

VOLUME SOURCE: 71

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
540718	6461789	0m	5m	3m	1m

(Constant) emission rate = 4.86E+02 OUV/second
No gravitational settling or scavenging.

1

Wills STP Scenario 5

RECEPTOR LOCATIONS

The Cartesian receptor grid has the following x-values (or eastings):
540200.m 540250.m 540300.m 540350.m 540400.m 540450.m 540500.m
540550.m 540600.m 540650.m 540700.m 540750.m 540800.m 540850.m
540900.m 540950.m 541000.m 541050.m 541100.m 541150.m 541200.m
541250.m 541300.m 541350.m 541400.m 541450.m 541500.m 541550.m
541600.m 541650.m 541700.m

and these y-values (or northings):
6461200.m 6461250.m 6461300.m 6461350.m 6461400.m 6461450.m 6461500.m
6461550.m 6461600.m 6461650.m 6461700.m 6461750.m 6461800.m 6461850.m
6461900.m 6461950.m 6462000.m 6462050.m 6462100.m 6462150.m 6462200.m
6462250.m 6462300.m 6462350.m 6462400.m

DISCRETE RECEPTOR LOCATIONS (in metres)

No.	X	Y	ELEVN	HEIGHT	No.	X	Y	ELEVN	HEIGHT
1	540798	6461793	0.0	0.0					

METEOROLOGICAL DATA : st,047048,47 ,BROKEN HILL AIRPORT AWS,01/1947,

Appendix C: Noise Impact Assessment (Bridges Acoustics, 2025)

BRIDGES
ACOUSTICS
ABN: 73 254 053 305

78 Woodglen Close
PO Box 61
PATERSON NSW 2421

0407 385 866
bridgesacoustics@gmail.com

WILLS STREET SEWAGE TREATMENT PLANT REPLACEMENT

NOISE IMPACT ASSESSMENT

REPORT J0182-12-R1

13 JUNE 2025

Prepared for:
Essential Water
PO Box 5730
PORT MACQUARIE NSW 2444

Prepared by:
Mark Bridges BE Mech (Hons) MAAS
Principal Consultant

TABLE OF CONTENTS

GLOSSARY AND ABBREVIATIONS **2**
1 INTRODUCTION **3**
1.1 Environmental Noise Policies 3
2 RECEPTORS **4**
3 NOISE CRITERIA **4**
3.1 Operational Noise 4
3.1.1 Background Noise Levels 5
3.1.2 Project Noise Levels 5
3.1.3 Modifying Factors 6
3.2 Sleep Disturbance 6
3.3 Construction Noise 7
3.4 Traffic Noise 7
4 ASSESSMENT **8**
4.1 Calculation Procedure 8
4.2 Atmospheric Conditions 8
4.2.1 General Discussion 8
4.2.2 Temperature Gradients 8
4.2.3 Prevailing Winds 9
4.2.4 Modelled Weather Conditions 10
4.3 Operational Noise Sources 10
4.4 Operating Noise Levels – Wills STP 11
4.4.1 Low Frequency Noise Levels 12
4.4.2 Tonal Noise Assessment 12
4.4.3 Sleep Disturbance 13
4.5 Operating Noise Levels – SBHSPS 13
4.6 Construction Noise 14
4.6.1 Bulk Earthworks 14
4.6.2 Concrete Pouring 15
4.6.3 Mechanical and Electrical 16
4.6.4 Wills STP Road Construction 16
4.6.5 Rising Main from SBHSPS to Wills STP 17
4.6.6 Demolition of Existing Infrastructure 18
4.6.7 Overall Construction Noise Recommendation 18
4.7 Road Traffic Noise 19
4.7.1 Operational Traffic 19
4.7.2 Construction Traffic 19
5 CONCLUSION **20**
APPENDIX A – NOISE SOURCE DETAILS **21**
APPENDIX B – FIGURES **22**

GLOSSARY AND ABBREVIATIONS

The following acoustical terms and abbreviations are used in this report:

- Sound Pressure — Small air pressure variations above and below normal atmospheric pressure that are perceived by human ears as sound;
- Frequency — The rate of sound pressure fluctuations per second, expressed as cycles per second or hertz (Hz). Human ears in good condition can typically detect sound in the frequency range 20 Hz to 20,000 Hz (20 kHz), depending on sound level;
- Decibels, dB — A noise level unit based on a logarithmic scale of pascals of sound pressure above and below atmospheric pressure. Human ears in good condition can typically detect sound pressures from the threshold of perception at 0 dB (20 uPa) to the threshold of pain at 140 dB (200 Pa). An increase of 10 dB is perceived as an approximate doubling of sound level by an average human ear;
- dBL — Linear decibels, the same as dB but used to explicitly define a decibel scale in the absence of any frequency weighting such as dBA;
- dBA — A-weighted decibels, where the A weighting means frequencies below 500Hz and above 10kHz are artificially reduced to approximate the frequency response of an average human ear. Most sound monitoring instruments include an A-weighting option, enabling direct measurement of noise levels in dBA;
- LA1 — The A-weighted noise level exceeded 1% of the time (which can be thought of as the loudest 1% of the time) over a measurement or assessment period of typically 15 minutes and commonly used to assess sleep disturbance at night;
- LA90 — The A-weighted noise level exceeded 90% of the time (which can be thought of as the quietest 10% of the time) over a defined measurement period of 15 minutes excluding any noise from the project being considered, and widely accepted as the background noise level;
- LAeq — The A-weighted equivalent continuous, or logarithmic average, noise level over a defined time period of typically 15 minutes, either measured or predicted at a specific receptor location;
- Sound Power — Sound energy emitted by a source, measured in watts (W) or expressed on a decibel scale with 0 dB representing 1 picowatt (1 pW) of sound power. While both sound pressure and sound power can be expressed on a decibel scale, the two are not interchangeable or directly comparable. Sound power levels are most commonly expressed as unweighted decibels (dBL) in each frequency band but can be expressed as A-weighted decibels (dBA);
- EPA — NSW Environment Protection Authority;
- DPHI — NSW Department of Planning, Housing and Infrastructure;
- NPI — *NSW Noise Policy for Industry* (EPA, 2017);
- RNP — *NSW Road Noise Policy* (EPA, 2011);
- ICNG — *Interim Construction Noise Guideline* (EPA, 2009);
- DCNG — *Draft Construction Noise Guideline* (EPA, 2020);
- Day — As defined in the NPI for industrial noise, 7 am to 6 pm Monday to Saturday, 8 am to 6 pm Sunday and public holidays;

  As defined in the RNP for road traffic noise, 7 am to 10 pm;

  As defined in the ICNG for construction noise, 7 am to 6 pm Monday to Friday, 8 am to 1 pm Saturday;
- Evening — As defined in the NPI for industrial noise, 6 pm to 10 pm;

- Night — As defined in the NPI for industrial noise, 10 pm to 7 am Monday to Saturday, 10 pm to 8 am Sunday and public holidays;
  As defined in the RNP for road traffic noise, 10 pm to 7 am every day;
- Wills STP — The proposed Wills Street Sewage Treatment Plant;
- SBHSTP — The existing South Broken Hill Sewage Treatment Plant;
- SBHSPS — The proposed South Broken Hill Sewage Pumping Station, intended to replace the SBHSTP;
- ENM — Environmental Noise Model software, used to calculate noise from an industrial facility to receptors taking into account all relevant factors including terrain and weather conditions.

1 INTRODUCTION

Essential Water (Essential) operates the existing Wills Street Sewage Treatment Plant (Wills STP) located approximately 420 m south-west of the Broken Hill suburban area. Essential also operates the South Broken Hill STP (SBHSTP) located approximately 900 m south of Broken Hill. Essential has proposed a project to replace both of these existing facilities with:

- a new Wills STP on land adjacent to and south-west of the existing facility; and
- a new South Broken Hill Sewage Pumping Station (SBHSPS) and rising main to the new Wills STP to replace the SBHSTP.

Both of the new facilities would be constructed while the existing facilities continue to operate to ensure continuity of service, with a brief shutdown and change-over when each new facility is completed.

This noise impact assessment report was commissioned by Essential to assess and report on environmental noise levels during the construction and future operational phases of the project.

1.1 Environmental Noise Policies

The NSW government has developed or adopted policies and recommended procedures to assess environmental noise levels from various noise source categories. The following policy documents are relevant to this assessment:

- The *NSW Noise Policy for Industry* (NPI) (EPA, 2017) is intended to guide noise investigations for existing or proposed industrial developments, including vehicle movements within industrial developments. The NPI recommends procedures to determine:
  - background noise levels at receptor properties;
  - existing noise levels from an industrial site;
  - recommended, not mandatory, noise criteria for existing and proposed operations;
  - predicted noise levels from proposed developments; and
  - negotiation options if recommended noise criteria are not or may not be met.
- The *NSW Road Noise Policy* (RNP) (EPA, 2011) includes recommended traffic noise criteria for highways and other road categories, for various situations including additional traffic due to proposed developments or projects;
- The *Interim Construction Noise Guideline* (ICNG) (EPA, 2009) includes recommended construction hours, quantitative noise management levels and qualitative methods to assess construction noise impacts to receptors; and

- The *Draft Construction Noise Guideline* (DCNG) (EPA, 2020) contains draft amendments to the ICNG and was prepared for public review and comments.

Differences between the ICNG and the DCNG are relatively minor with similar recommended construction noise management levels. An assessment to the ICNG, covering the construction phase of the project, is therefore considered appropriate in the absence of a finalised guideline based on the DCNG.

2 RECEPTORS

This noise impact assessment considers noise from the project to the closest and potentially most affected privately owned properties, on the basis that compliance with relevant noise criteria at the closest properties will guarantee compliance with the noise criteria at more remote properties.

Assessed residential receptors, representing the closest residences to each project site, are listed below:

R1 46 Wills Street located approximately 360 m north-east of the existing Wills STP entrance and approximately 400 m north-east of the existing STP inlet works;

R2 4 Ryan Street located approximately 450 m south-east of the existing Wills STP entrance and 350 m east of the existing STP sludge drying beds;

R3 1 Queen Street located approximately 1000 m north-west of the existing SBHSTP entrance; and

R4 55 Knox Street located approximately 560 m north-east of the existing SBHSTP entrance;

Non-residential receptors closest to the project include:

R5 The Broken Hill Community Recycling Centre located at the western end of Wills Street approximately 760 m west of the Wills STP entrance. A used goods shop is attached to the Recycling Centre which would be considered a commercial development;

R6 Various light industrial properties on Kanandah Road, with the nearest of these properties located approximately 670 m south of the existing Wills STP entrance and 240 m from the existing tertiary pond; and

R7 The Royal Flying Doctor Service adjacent to the airport approximately 570 m south-east of the existing SBHSTP entrance.

3 NOISE CRITERIA

Noise from the project has been compared to the most appropriate criteria for each source type with operation of industrial facilities, construction work and road traffic noise assessed separately.

3.1 Operational Noise

The most relevant NSW Government noise policy for industrial facilities is the NPI. The EPA intended the NPI to apply to major industrial projects, generally those which are assessed and approved by the NSW Department of Planning, Housing & Infrastructure (DPHI). However, the NPI is also widely acknowledged as the most appropriate policy to assess noise from other industrial developments in NSW including sewage treatment plants, sewage pumping stations and other water infrastructure.

The NPI does not specify mandatory noise limits and has no legal force. Legally enforceable noise limits can only be set by a regulatory authority as part of a development consent or other formal project approval, or by the EPA in an Environment Protection Licence (EPL). The NPI instead recommends “project noise trigger levels” which are project-specific and, if exceeded, are intended to trigger investigations into noise mitigation or management measures to avoid potentially unacceptable

noise impacts to sensitive properties such as private residences. The project noise trigger levels are primarily intended to guide regulatory authorities and assist them in setting enforceable limits. Notwithstanding the above, regulatory authorities typically adopt the recommendations of the NPI as noise limits in development consents unless there are compelling reasons to adopt alternative limits for particular projects.

The NPI is not intended to result in all industrial noise sources being inaudible at all sensitive receivers. Rather, it recognises the value industrial activity provides to the community and the inherently noisy nature of most industries. It also recognises the community's need to be protected from excessive or unreasonable noise. While an appropriate balance between these competing desires may be debated, the NPI is widely recognised as an appropriate policy for the majority of situations.

3.1.1 Background Noise Levels

The NPI recommends minimum threshold background noise levels of:

- 35 LA90,15min during the day; and
- 30 LA90,15min during the evening and night.

Where the measured background noise level in any time period is lower than the recommended minimum threshold level for that period, the minimum threshold level is adopted rather than the measured levels for the purpose of setting the project intrusive levels.

Background noise levels at residential and other receptors closest to each facility have not been measured as part of this assessment. Sources of background noise typically include local and regional road traffic, insects, birds and wind, however these sources are considered unlikely to result in background levels above the minimum threshold levels during any time period. The minimum threshold levels have therefore been adopted for this assessment.

3.1.2 Project Noise Levels

The NPI recommends two main project noise levels:

- Project intrusive levels set 5 dBA above the background noise level in each of the day, evening and night periods in which the industrial development operates. The intrusive levels only apply to residential receptors and are intended to limit the relative audibility of the industrial source at each receptor; and
- Project amenity levels in each time period set according to the character of the receptor area. The project amenity levels apply to residential, commercial and other receptor categories and are intended to limit the cumulative noise level from all industrial sources in the area. In most cases the project amenity levels (that apply to noise from the project alone) are set 5 dBA lower than the amenity levels (that apply to noise from all sources of industrial noise in the area).

The adopted minimum threshold background levels lead to project intrusive levels of 40 LAeq,15min during the day and 35 LAeq,15min during the evening and night at all residential receptors near both the Wills STP and SBHSPS.

Project amenity levels for residential receptors differ for rural, suburban and urban residences. Residences near the project are best described as suburban residences and, according to Table 2.2 of the NPI, are assigned recommended amenity levels of 55 LAeq,11hr during the day, 45 LAeq,4hr for the evening and 40 LAeq,9hr for the night period. Project amenity levels are set 5 dBA lower.

Amenity levels for commercial and industrial developments recommended in Table 2.2 in the INP are 65 and 70 LAeq respectively. Project amenity levels are set 5 dBA lower.

Table 1 presents a summary of noise criteria at closest receptors.

Table 1: Project Noise Criteria at Closest Receptors

Receptor	Project Intrusive Level, Day/Evening/Night, LAeq,15min	Project Amenity Level, Day/Evening/Night, LAeq,period
R1, 46 Wills Street	40 / 35 / 35	50 / 40 / 35
R2, 4 Ryan Street	40 / 35 / 35	50 / 40 / 35
R3, 1 Queen Street	40 / 35 / 35	50 / 40 / 35
R4, 55 Knox Street	40 / 35 / 35	50 / 40 / 35
R5, Recycling Centre	N/A [1]	60 / 60 / 60
R6, Kanandah Road	N/A [1]	65 / 65 / 65
R7, Royal Flying Doctor Service	N/A [1]	60 / 60 / 60

1 Project intrusive levels only apply to residential receptors

The lowest of the intrusive or amenity levels are adopted as the limiting criteria at each receptor. The project intrusive levels are therefore adopted as the limiting criteria for residential receptors and the project amenity criteria apply at commercial and industrial receptors.

3.1.3 Modifying Factors

A modifying factor or annoying noise characteristic as defined in the NPI is a special noise character that makes it more noticeable to a human ear. Modifying factors include:

- Tonal noise, which means a noise source produces most of its sound energy in a narrow frequency range and is therefore more audible. Typical examples include vehicle reverse alarms and emergency vehicle sirens which are specifically designed to attract attention, however other sources including pumps and fans can also produce tonal noise. If tonal noise is present at one or more receptors, a +5 dBA correction is required to predicted noise levels before comparison with relevant criteria;
- Low frequency noise, defined in the NPI as the frequency range 10 to 160 Hz, which passes through the façade of buildings more efficiently than higher frequencies and can cause noticeable resonances within occupied rooms. If low frequency noise levels exceed a threshold spectrum defined in the NPI then one of the following corrections is required:
  - +2 dBA if the industrial source is up to and including 5 dBA above the low frequency threshold spectrum in any 1/3 octave band; or
  - +5 dBA if the industrial source is up to and including 5 dBA above the low frequency threshold spectrum in any 1/3 octave band.
- Intermittent noise, which is defined in the NPI as a regular change of more than 5 dBA at the receptor and the change is clearly audible. Vehicle reverse alarms and emergency vehicle sirens are typical examples of intermittent noise.

The project is unlikely to produce intermittent noise, however tonal and low frequency noise is considered in this report.

3.2 Sleep Disturbance

Sleep can be disturbed by noise, although the level and character of noise required to disturb sleep varies considerably from person to person. Section 2.5 of the NPI points to Section 5.4 of the RNP for

a summary of current research findings, concluding further research is required to definitively set noise limits to minimise sleep disturbance. The NPI further suggests any noise during the night that exceeds:

- an average level of 40 LAeq,15min or the intrusive level, whichever is greater; and/or
- a maximum level of 52 dBA or 15 dBA above the background noise level, whichever is greater;

may not necessarily cause sleep disturbance but should trigger a maximum noise level assessment. Such an assessment would consider the maximum level, the extent the maximum level exceeds the background level and the number of times this is expected to occur during the night period.

3.3 Construction Noise

The ICNG recommends a quantitative construction noise assessment for potentially significant projects. A less detailed qualitative assessment method is recommended for smaller projects, primarily involving temporary maintenance works rather than construction, that are not likely to produce significant noise at a receptor for more than 3 weeks. Based on this guidance, a quantitative construction noise assessment is appropriate for this project.

Table 2 of the ICNG recommends the following construction noise management levels to be applied at residential receptors during normal construction hours of 7 am to 6 pm Monday to Friday and 8 am to 1 pm Saturday:

- A Noise Affected level set 10 dBA above the Rating Background Level (RBL). The noise affected level represents the point above which there may be some community reaction to noise. Predicted construction noise over this level triggers a recommendation that all feasible and reasonable mitigation measures be applied during the construction period; and
- A Highly Noise Affected level set at 75 LAeq. The highly affected level represents the point above which there may be a strong community reaction to noise and requires consideration of respite periods considering community feedback regarding sensitive times in each day and other relevant factors.

Based on the minimum threshold background noise level of 35 LA90,15min for the day period, a noise affected level of 45 LAeq,15min has been adopted for this assessment.

Should construction work occur outside the normal construction hours, the ICNG recommends a noise affected level equal to the NPI recommended levels for operation of the project.

3.4 Traffic Noise

Section 2.3 of the NSW Road Noise Policy (RNP) specifies road traffic noise criteria from public roads to both residential and non-residential land uses. For existing residences affected by additional traffic on existing roads due to land-use developments, the RNP recommends:

- 55 LAeq,15hr during the day (7 am to 10 pm) and 50 LAeq,9hr during the night (10 pm to 7 am) from arterial and sub-arterial roads to 1 m from the external façade of residences; and
- 55 LAeq,1hr during the day and 50 LAeq,1hr during the night from local roads to 1 m from the external façade of residences.

Construction traffic is expected to access the Wills STP site via Kanandah Road which can be considered a sub-arterial road, while future operational traffic will access this site via Wills Street and the SBHSPS site via Picton Street which are both local roads. As the status of Kanandah Road is uncertain, the local road noise criteria will be applied to project-related traffic on all access routes.

4 ASSESSMENT

4.1 Calculation Procedure

Predicted environmental noise levels from future operation of the Wills STP have been calculated using RTA Technology's Environmental Noise Model (ENM) software. ENM is a general purpose noise modelling package that combines terrain and noise source information with other input parameters such as weather conditions to predict noise levels at specific receiver locations or as contours over a specified receiver area. It is recognised as one of the most appropriate choices of model software for situations involving complex topography and a large number of individual noise sources, and where a detailed assessment of the effects of atmospheric conditions on noise propagation is required.

The standard ENM package includes data input modules to allow terrain and noise source information to be entered and amended, plus an initial setup page containing terrain and source lists and modelled weather conditions for each scenario. All terrain and source files were prepared for this assessment using a combination of AutoCad and Excel based data then automatically converted to ENM format terrain and source files using custom software. All outputs were obtained using equivalents to ENM's standard sectioning and contouring algorithms. Figures in Appendix A indicate the terrain and noise source locations included in the model. Noise contour figures are presented in Appendix B for each set of operating sources and weather conditions.

Construction noise and traffic noise levels were calculated considering only distance, reflection off hard ground and atmospheric absorption to assessed receptors. As required by the RNP, traffic noise calculations also considered reflection from the exposed residential façade.

4.2 Atmospheric Conditions

4.2.1 General Discussion

A review of atmospheric conditions that occur in the vicinity of the project site was completed to determine the effect of such conditions on noise propagation from the project. Parameters such as air temperature, relative humidity, wind speed profile and vertical temperature gradient can significantly influence noise levels from a source, with wind and vertical temperature gradient being the dominant factors.

The NPI recommends the following weather conditions should be considered in any noise assessment:

- A 3°C/100m inversion during the night where inversions occur for at least 30% of the time during winter evenings and nights plus a 2m/s drainage flow from source to receiver where the source is on higher ground than the receiver with no intervening hills; and
- A gradient wind of up to 3 m/s from source to receiver where such a wind occurs for at least 30% of the time in any season or time period.

Weather data from the Bureau of Meteorology's Broken Hill Airport automatic weather station (Station 47048) were supplied by Essential for analysis. Supplied data included air temperature, wind speed and wind direction in 10 minute intervals from 1 July 2018 to 30 June 2023, a total period of five years.

4.2.2 Temperature Gradients

The Bureau of Meteorology does not directly measure temperature gradients as temperature sensors are only positioned at the standard height of 10 m above the ground. However, negative temperature gradients can be confidently predicted during the day and positive gradients can be confidently assumed during the majority of nights. Temperature inversions are therefore assumed to occur and the NPI default 3 °C/100m has been adopted for the evening and night periods.

4.2.3 Prevailing Winds

Analysis of supplied weather data to determine the occurrence and direction of prevailing winds was completed according to the procedure recommended in the INP:

- Sort the data by season and time period (day, evening and night);
- For each season and time period, separate the data into 16 compass directions; and
- For each compass direction, sum the occurrence of vector wind speeds in the range 0.5 to 3 m/s, considering winds up to 45° from the compass direction, and express the result as a percentage of the total time in that season and time period.

The result of this process is the percentage occurrence of potentially noise enhancing winds in each season, time period and direction, as presented in Table 2. Shaded values exceed 30% and are therefore considered significant enough to require consideration in this assessment according to the NPI.

Table 2: Percentage Occurrence of Prevailing Winds, BOM Broken Hill Airport 2018-2023.

Wind Direction	Occurrence of Noise Enhancing Winds, % of Season and Time Period											
	Day				Evening				Night			
	Sum	Aut	Win	Spr	Sum	Aut	Win	Spr	Sum	Aut	Win	Spr
N	6	11	14	9	8	19	28	18	12	22	26	17
NNE	7	11	13	9	10	21	27	17	11	19	22	15
NE	8	11	12	9	12	23	26	18	11	19	20	16
ENE	9	13	13	10	14	26	25	20	16	23	22	19
E	10	15	13	12	19	**30**	23	22	23	**30**	25	25
ESE	11	16	13	14	19	28	23	22	25	28	20	26
SE	12	16	12	14	15	25	21	20	22	25	14	22
SSE	10	15	12	12	15	24	18	19	18	23	14	20
S	9	14	12	11	16	25	20	19	16	24	17	19
SSW	9	16	12	11	17	26	20	19	17	24	20	18
SW	10	16	14	12	17	24	21	19	18	24	21	18
WSW	10	17	15	12	13	19	23	17	17	23	21	17
W	9	15	15	11	8	16	23	16	13	21	22	16
WNW	7	12	14	9	7	15	26	16	8	17	21	13
NW	6	12	14	9	7	15	27	15	10	18	26	17
NNW	6	12	14	9	7	17	26	16	13	23	**29**	20

Shaded values indicate gradient winds occur over, or close to, 30% of the time

Table 2 shows easterly gradient winds are significant during autumn evenings and nights. Winds from the north-north-west occur for 29% of the time during winter nights and, while they do not reach the 30% threshold recommended in the NPI, have been conservatively included in the assessment.

4.2.4 Modelled Weather Conditions

Table 3 presents modelled weather conditions based on the assumptions and wind analysis results described above.

Table 3: Modelled Weather Conditions

Time Period, Scenario	Temp, °C	Relative Humidity %	Wind Speed m/s	Wind Direction	Vert. Temp. Gradient, °C/100m
Day Calm	25	60	0	-	-2
Evening/Night Calm	20	70	0	-	0
Evening/Night Inversion	10	70	0	-	3
Evening/Night Wind	10	70	3	East	0
	10	70	3	NNW	0

As the evening and night periods include similar prevailing weather conditions, these two periods have been combined in the noise model. Calculated noise levels and noise contours have been presented for the following three scenarios:

- Day calm;
- Evening/night calm; and
- Evening/night prevailing weather (worst case of inversion, east wind and NNW wind scenarios).

4.3 Operational Noise Sources

The location of significant process equipment and noise levels produced by that equipment have been determined by the following data sources:

- Supplied plans showing the currently proposed location of significant process components;
- *Broken Hill STP Design Basis and Preliminary Concept Design Review Report* (Beca HunterH2O, December 2024); and
- Previous noise measurements around similar process equipment on other STP sites, primarily in the Hunter Valley region.

Significant components within the Wills STP are shown on the figures in Appendix A, using a source code from A to I for each component. The actual source location is the lower left corner of each text entity in the figures. The exact SBHSPS location has not yet been determined, however it has been assumed to be located closest to receptors which is adjacent to the SBHSTP's inlet works.

Table 4 presents a summary of significant noise sources including the component source code for correlation with the figures and total dBA sound power level of each source. One-third octave sound power data are presented in Appendix A.

Occasional septage and sludge truck movements have been modelled assuming each truck travels within the site at low speed and requires relatively low engine speed and power. As sludge trucks travel further within the site than a septage truck, noise from one sludge truck movement in a 15 minute period has been distributed over 8 representative locations between the STP entrance and the sludge outloading facility. Table 4 includes a sound power level for the entire truck movement and a sound power level for partial truck noise at each modelled location along the truck route.

Table 4: Significant Noise Source Summary, Wills STP

Source Code	Component (major sources)	Sound Power Level, dBA	Number of Sources
A	Inlet works (covered screens, screenings compactor, grit tank agitator and pump)	84	1
B	Bioreactor (surface aerators, pumps)	88	1
C	Recycled water system (pump)	73	1
D	Dewatering (pump, belt press)	73	1
E	Sludge outloading (pump)	73	1
F	Foul water (pump)	73	1
G	Odour control (fan)	81	1
H	Septage receival (pump)	73	1
I	Switchroom (fan)	79	1
J	Power transformers (fans)	79	1
T	Septage or sludge truck (25% of 15 min period, low speed)	86	0
t	Septage or sludge truck (per location along route)	77	8

The SBHSPS is located some distance from the Wills STP and has not been included in the noise model. The SBHSPS is anticipated to include the following noise sources:

- Submersible pumps operating below water level in a wet well. Noise data are not available for submersible pumps as they are much quieter than dry well pumps and are often inaudible or barely audible at ground level directly above the wet well; and
- A reflux (one-way) valve in the rising main, assumed to be located on or near the surface close to the SBHSPS. A reflux valve produces a brief impact noise as it closes each time the pump switches off, with this noise rarely audible beyond 5 to 10 m from the valve.

4.4 Operating Noise Levels – Wills STP

Noise contour figures B2 to B4 in Appendix B show calculated LAeq,15min noise levels from the Wills STP for the day and combined evening/night periods. A summary of calculated noise levels is shown in Table 5 for receptors near the Wills STP, along with the adopted noise criteria from Table 1.

Table 5: Predicted Noise Levels and Noise Criteria, Wills STP, LAeq,15min

Receptor	Day Calm		Evening/Night Calm		Evening/Night Prevailing	
	Predicted	Criteria	Predicted	Criteria	Predicted	Criteria
R1, 46 Wills St	15	40	16	35	19	35
R2, 4 Ryan St	16	40	17	35	21	35
R5, Recycling Centre	12	60	13	60	25	60
R6, Kanandah Rd	22	65	22	65	31	65
Noise Contour Figure	B2		B3		B4	

Table 5 shows calculated LAeq,15min levels, however project amenity levels for receptors R5 and R6 are noise levels averaged an entire day, evening or night rather than over a 15 minute period. Project amenity levels to R5 and R6 have not been calculated separately and are conservatively assumed to be equal to the LAeq,15min levels.

Predicted noise level are substantially lower than the noise criteria in all time periods, including the effect on noise propagation of temperature inversions and winds during the evening and night periods.

4.4.1 Low Frequency Noise Levels

Low frequency noise levels at residential receptors R1 and R2 have been calculated by:

- Taking the received noise levels for the frequency range 25 Hz to 160 Hz supplied by the noise model;
- Comparing source sound power levels with received noise levels to determine the total attenuation in each frequency band;
- Applying the same attenuation determined for the 25 Hz band to the component sound power levels in the lower frequency bands 10 to 20 Hz that the noise model does not include, to calculate received noise levels in those lower bands;
- Comparing received noise levels over the entire low frequency range to the NPI recommended low frequency threshold spectrum.

Results from this procedure, expressed as dBL rather than dBA levels for direct comparison with the NPI recommended low frequency threshold spectrum, are presented in Table 6.

Table 6: Low Frequency Noise Level from Wills STP to Residential Receptors, Leq,15min

Frequency Band, Hz	10	12	16	20	25	31	40	50	63	80	100	125	160
Receptor	Received Noise Level and Threshold Level, dBL												
R1, 46 Wills St	17	17	16	15	16	18	20	21	23	19	19	16	11
R2, 4 Ryan St	17	17	16	15	16	18	20	21	24	19	19	17	12
Low frequency threshold	92	89	86	77	69	61	54	50	50	48	48	46	44

Table 6 indicates low frequency noise levels are expected to remain at least 20 dBL below the recommended low frequency threshold spectrum. Low frequency noise impacts are therefore unlikely to occur at any receptor.

4.4.2 Tonal Noise Assessment

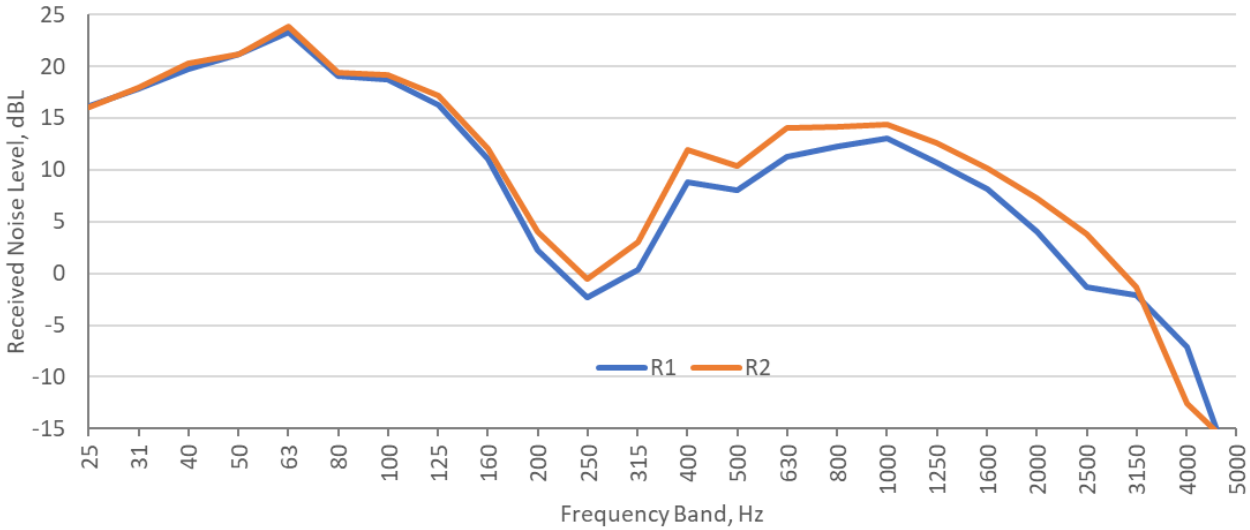
A tonal noise as defined in the NPI refers to a noise source that produces dominant noise in a relatively narrow frequency range such as a single 1/3 octave frequency band. Inspection of a source sound power spectrum indicates a tonal source, with a distinct peak in the spectrum compared to adjacent frequency bands, while inspection of a received noise spectrum indicates tonal noise at a receptor.

According to the NPI, tonal noise is assessed at the receptor and is identified by a noise level at least:

- 15 dBL above adjacent frequency bands in the range 25 – 125 Hz;
- 8 dBL above adjacent frequency bands in the range 160 – 400 Hz; and
- 5 dBL above adjacent frequency bands in the range 500 – 10000 Hz.

Inspection of sound power data for proposed sources indicates no sources produce noise that would be defined in the NPI as tonal. In addition, a review of the received noise level spectra at residential receptors R1 and R2 indicates calculated Wills STP noise levels are not tonal, as shown in Figure 1.

Figure 1: Received Noise Level Spectra to Receptors R1 and R2, LAeq,15min



4.4.3 Sleep Disturbance

Sleep disturbance can occur due to a short, sharp noise that intrudes above the background noise level during the period 10 pm to 7 am, or to 8 am on Sundays and public holidays.

An STP has little potential to disturb sleep during the night assuming no significant staff activity and heavy vehicle movements occur at night. A detailed sleep disturbance assessment for normal operation is therefore not justified.

Emergency maintenance staff callouts may occasionally be required at night due to critical equipment breakdown. Such callouts are assumed to involve a light vehicle, or at worst a medium truck, with staff primarily using hand tools to repair equipment. More extensive work, including work requiring a crane or other heavy equipment, would normally occur during the day.

A brief training program for maintenance staff is recommended to raise awareness of sleep disturbance issues and to determine and adopt practical methods of minimising noise during the occasional night callout.

Maintenance vehicles should be fitted with the quietest possible reverse alarms, ideally using a broadband sound rather than distinct frequencies. Alternatively an override switch may be fitted to maintenance vehicles to disable the audible reverse alarm and activate a visible reversing flasher for night operation.

4.5 Operating Noise Levels – SBHSPS

Sewage pumping stations are typically located within suburban areas adjacent to residences. Submersible pumps operate under the water level and are typically inaudible or barely audible at a distance of 5 m from the station, and reflux valves are similarly inaudible at a distance of 5 to 10 m from the station. The only other surface facilities associated with a pumping station are electrical controls and power supplies, which produce insignificant noise.

The SBHSPS will be located close to the existing SBHSTP at least 560 m from R4 which is the nearest residential receptor and 570 m from the nearest commercial receptor R7. There are no

reasonable circumstances that would result in audible noise from operation of the SBHSPS, apart from occasional visits by Essential's maintenance staff which would occur during the day.

Based on this review of the SBHSPS, detailed noise calculations are not required to demonstrate compliance with the operating noise criteria.

4.6 Construction Noise

Construction of the project would require a wide range of processes and equipment and would vary significantly from time to time depending on the tasks being completed. The entire construction period is expected to include the following major tasks, although many of these tasks will be completed in parallel in different areas of each site:

- Bulk earthworks to fill the existing ponds, level and grade the site;
- Detailed earthworks to construct trenches, pits and foundations, particularly for partly buried tanks and similar infrastructure;
- Concrete formwork and pouring;
- Mechanical installation including buried and above-ground pipelines;
- Electrical installation including buried cables and above ground equipment;
- Roads, turf and other surface finishes;
- A buried rising main from SBHSPS to Wills STP;
- Commissioning and testing followed by permanent diversion of sewage flow to the new facilities;
- Decommissioning and demolishing existing STP components; and
- Rehabilitation of disturbed areas.

Tasks with the greatest potential to produce significant noise at receptors include bulk earthworks and demolishing existing STP infrastructure, therefore these tasks have been assessed in more detail.

4.6.1 Bulk Earthworks

This construction task is assumed to include the following major equipment:

- Excavator x2 113 dBA sound power each;
- Truck x2 108 dBA sound power each;
- Dozer 114 dBA sound power;
- Roller x2 105 dBA sound power each;
- Grader 108 dBA sound power; and
- Skid steer x2 103 dBA sound power each.

The assumed equipment would produce a combined sound power level of 120 dBA. A more likely total sound power level in the range 117 to 119 dBA would occur with a subset of the assumed equipment operating at any one time.

A reasonable worst case sound power level of 120 dBA would result in a received noise level, considering distance attenuation over reflective ground and atmospheric absorption, of up to:

- 54 LAeq,15min at R1;
- 56 LAeq,15min at R2;
- 52 LAeq,15min at R3; and

- 53 LAeq,15min at R4.

This construction task is therefore likely to exceed the ICNG's recommended noise affected level of 45 LAeq,15min during busy times at the closest residential receptors. An assessment of noise mitigation and management measures is therefore appropriate.

The following noise mitigation options are considered likely to apply to this task:

- Minimise the number of machines operating simultaneously, particularly the louder machines such as excavators and the dozer;
- Use the quietest machines available, including limited reverse alarms or other audible warnings;
- Ensure all machines are maintained in good condition with a particular focus on the engine and exhaust system to minimise noise from these components;
- Operate each machine in a manner that avoids excessive noise, including switching a machine off rather than extended periods of unnecessary idling between periods of activity;
- Operate all machines at moderate engine power and speed where full power is not required;
- Avoid starting the task, or any heavy vehicles arriving or operating on the site, before 7 am; and
- Require the construction contractor and/or the bulk earthworks sub-contractor to prepare a Construction Noise Management Plan prior to starting work and complete the task according to the plan.

4.6.2 Concrete Pouring

This construction task is assumed to include the following major equipment:

- Concrete pump 111 dBA sound power;
- Concrete truck x2 108 dBA sound power each; and
- Air compressor 103 dBA sound power.

The assumed equipment would produce a combined sound power level of 114 dBA and a received noise level, considering distance attenuation over reflective ground and atmospheric absorption, of up to:

- 51 LAeq,15min at R1;
- 52 LAeq,15min at R2;
- 46 LAeq,15min at R3; and
- 47 LAeq,15min at R4.

This construction task is therefore likely to exceed the ICNG's recommended noise affected level of 45 LAeq,15min during each concrete pour. An assessment of noise mitigation and management measures is therefore appropriate.

The following noise mitigation options are considered likely to apply to this task:

- Carefully schedule the concrete truck times to minimise waiting time and extended periods of idling;
- Avoid full engine speed for each concrete truck where a lower speed is sufficient;
- Ensure all machines are maintained in good condition with a particular focus on the engine and exhaust system to minimise noise from these components;
- Avoid starting the concrete pour, or any heavy vehicles arriving or operating on the site, before 7 am; and

- Require the construction contractor and/or the concrete sub-contractor to prepare a Construction Noise Management Plan prior to starting work and complete the task according to the plan.

4.6.3 Mechanical and Electrical

This construction task includes installation of mechanical and electrical equipment, requiring the following major construction equipment:

- Delivery truck 105 dBA average sound power;
- Mobile crane 103 dBA average sound power;
- Impact wrenches 100 dBA sound power;

The assumed equipment would produce a combined sound power level of 109 dBA and a received noise level, considering distance attenuation over reflective ground and atmospheric absorption, of up to:

- 46 LAeq,15min at R1;
- 47 LAeq,15min at R2;
- 41 LAeq,15min at R3; and
- 42 LAeq,15min at R4.

This construction task is expected to slightly exceed the ICNG's recommended noise affected level of 45 LAeq,15min for short periods of time to unload heavy equipment off a delivery truck. Noise levels are likely to remain below the noise affected level for the majority of the time. An assessment of noise mitigation and management measures remains appropriate.

The following noise mitigation options are considered likely to apply to this task:

- Use the quietest available equipment, including limited reverse alarms or other audible warnings;
- Avoid full engine speed for each machine where a lower speed is sufficient;
- Ensure all machines are maintained in good condition with a particular focus on the engine and exhaust system to minimise noise from these components;
- Avoid unloading delivery trucks, or any heavy vehicles arriving or operating on the site, before 7 am; and
- Require the construction contractor and/or the mechanical and electrical sub-contractors to prepare a Construction Noise Management Plan prior to starting work and complete the task according to the plan.

4.6.4 Wills STP Road Construction

This construction task is assumed to include the following major equipment:

- Excavator 105 dBA sound power;
- Grader 108 dBA sound power;
- Roller x2 105 dBA sound power each;
- Aggregate truck 103 dBA average sound power;
- Bitumen truck 103 dBA average sound power; and
- Skid steer 103 dBA sound power.

The assumed equipment would produce a combined sound power level of 113 dBA and a received noise level, considering distance attenuation over reflective ground and atmospheric absorption, of up to:

- 50 LAeq,15min at R1; and
- 51 LAeq,15min at R2.

This construction task is therefore likely to exceed the ICNG's recommended noise affected level of 45 LAeq,15min during road pavement construction. An assessment of noise mitigation and management measures is therefore appropriate.

The following noise mitigation options are considered likely to apply to this task:

- Use the quietest available equipment, including limited reverse alarms or other audible warnings;
- Avoid full engine speed for each machine where a lower speed is sufficient;
- Ensure all machines are maintained in good condition with a particular focus on the engine and exhaust system to minimise noise from these components;
- Avoid starting the task, or any heavy vehicles arriving or operating on the site, before 7 am; and
- Require the construction contractor and/or the road sealing sub-contractor to prepare a Construction Noise Management Plan prior to starting work and complete the task according to the plan.

4.6.5 Rising Main from SBHSPS to Wills STP

This construction task will occur along the rising main route between the SBHSPS and the Wills STP. The proposed rising main route runs;

- from the SBHSPS to the intersection of the Silver City Highway and Kanandah Road;
- follows Kanandah Road to near the railway underpass; and
- runs under the railway then enters the Wills STP site near the western site boundary.

The rising main construction fleet would generally progress along the route, including;

- An excavator to construct and backfill a trench 108 dBA sound power;
- A truck to deliver pipe sections 103 dBA average sound power;
- A truck to deliver bedding sand 103 dBA average sound power;
- A backhoe to deposit a sand bed and install pipe sections 103 dBA sound power; and
- A skid steer for rehabilitation 103 dBA sound power.

The assumed equipment would produce a combined sound power level of 112 dBA and a received noise level, considering distance attenuation over reflective ground and atmospheric absorption, of up to:

- 45 LAeq,15min at R1 and R2; and
- 44 LAeq,15min at R3 and R4.

This construction task is expected to meet the ICNG's recommended noise affected level of 45 LAeq,15min at all residences.

Higher noise levels are expected at Kanandah Road light industrial properties adjacent to the route. As light industrial properties are not highly sensitive to noise and each property should expect to receive significant noise for only a few days as the construction fleet passes, no specific noise mitigation measures are recommended.

4.6.6 Demolition of Existing Infrastructure

This 'construction' task including removal of the existing Wills STP and SBHSTP is assumed to include the following major equipment:

- Excavator and concrete breaker 120 dBA sound power;
- Excavator and ripper 113 dBA sound power;
- Truck 108 dBA sound power;
- Skid steer 103 dBA sound power.

The assumed equipment would produce a combined sound power level of 121 dBA and a received noise level, considering distance attenuation over reflective ground and atmospheric absorption, of up to:

- 61 LAeq,15min at R1 and R2;
- 53 LAeq,15min at R3; and
- 54 LAeq,15min at R4.

This construction task is expected to be the loudest at receptors due to the excavator-mounted hydraulic hammer assumed to be required to remove existing concrete structures.

This task will exceed the ICNG's recommended noise affected level of 45 LAeq,15min. An assessment of noise mitigation and management measures is therefore appropriate.

The following noise mitigation options are considered likely to apply to this task:

- Use the quietest available equipment, including any available alternatives to an excavator-mounted hydraulic hammer to break and remove concrete structures;
- Advise the affected community of this task in advance, including the purpose of the task and expected duration. Solicit feedback from the community regarding any particularly sensitive times during the day and consider a later start time and respite times.
- Ensure all machines are maintained in good condition with a particular focus on the engine and exhaust system to minimise noise from these components;
- Avoid starting the task, or any heavy vehicles arriving or operating on the site, before 7 am; and
- Require the construction contractor and/or the demolition sub-contractor to prepare a Construction Noise Management Plan prior to starting work and complete the task according to the plan.

4.6.7 Overall Construction Noise Recommendation

A number of construction tasks are likely to result in noise levels over the noise affected level recommended in the ICNG. Noise mitigation and management measures have therefore been recommended for the majority of construction tasks, including prior preparation of a Construction Noise Management Plan (CNMP) and carefully following the recommendations in that Plan during the construction period.

A single CNMP prepared by the prime contractor is likely to be the most efficient solution rather than requiring each sub-contractor to prepare a separate CNMP. All sub-contractors would then be required to follow the main CNMP's recommendations. While selection of a construction contractor is a complex undertaking, some weighting should be applied in the decision matrix to each prospective contractor's prior experience with effective construction noise management.

4.7 Road Traffic Noise

4.7.1 Operational Traffic

The existing Wills STP and SBHSTP require regular staff visits, generating less than 10 vehicle movements per day on Wills Street, Picton Street and other feeder roads.

The replacement Wills STP is expected to require similar staffing levels and will therefore generate similar daily vehicle movements on Wills Street and other nearby roads. In contrast, the SBHSPS will generally operate without staff intervention, eliminating staff vehicle movements on Picton Street and nearby roads for the majority of days.

Given no significant change in vehicle movements to Wills STP and a reduction in vehicle movements to SBHSPS, a detailed operational traffic noise assessment is not required.

4.7.2 Construction Traffic

Construction of the project would require a number of additional vehicle movements to and from each site including light vehicles for personnel and heavy vehicles to deliver materials and equipment. Light vehicle movements would primarily occur in the morning and afternoon while heavy vehicle movements would be more evenly distributed throughout the day.

While vehicle movements would vary from day to day, reasonable worst case heavy vehicle movements may occur during the following two construction tasks:

- Bulk earthworks, assuming significant quantities of fill are imported or exported resulting in up to 20 trucks (40 movements) per day and up to 4 trucks (8 movements) per hour; and
- Concrete pouring, requiring up to 5 trucks (10 movements) per hour.

Noise from the assumed worst case heavy vehicle movements and an assumed maximum of 20 light vehicle movements per hour has been calculated to residences located 15 m and 20 m from the haul route to and from each site, resulting in:

- 55 LAeq,1hr from 20 car and 8 truck movements at 15 m from the road;
- 54 LAeq,1hr from 20 car and 8 truck movements at 20 m from the road;
- 56 LAeq,1hr from 20 car and 10 truck movements at 15 m from the road; and
- 55 LAeq,1hr from 20 car and 10 truck movements at 20 m from the road

Calculated noise levels indicate reasonable worst case construction traffic will most likely reach the traffic noise criterion for the day period.

The following traffic noise mitigation measures are recommended for the construction period:

- The construction contractor should actively discourage vehicles arriving at either construction site before 7 am, with a particular focus on heavy vehicles;
- In particular concrete pours are not recommended before 7.30 am to avoid vehicle movements, including the concrete pump, before 7 am;
- All drivers visiting the site should be encouraged to drive quietly within suburban areas, perhaps via a driver code of conduct implemented as part of each driver's site induction.

5 CONCLUSION

This assessment of the Wills Street STP project has indicated future operation of the project is very unlikely to exceed relevant noise criteria at any receptor. The project is not expected to produce tonal or significant low frequency noise and sleep disturbance caused by project operation at night is very unlikely. No operational noise mitigation or management measures are required.

The construction noise assessment has indicated noise levels at nearest residential receptors will be higher than the 'noise affected' level recommended in the current NSW construction noise policy. Therefore, a number of noise mitigation and management measures are recommended for the construction phase of the project, including development and implementation of a Construction Noise Management Plan before construction work commences.

Road traffic noise from operations and maintenance staff accessing the project site is expected to remain at a similar level or reduce as a result of the project. No exceedances of the operational traffic noise criteria are expected at any receptor.

Road traffic associated with the construction phase may slightly exceed traffic noise criteria at closest residences to the construction access route. Such exceedances are only expected on unusually busy days such as concrete pours, or if significant fill material must be imported to or exported from one or both sites. Given the occasional, minor and short term predicted exceedances of the traffic noise criteria, only minor traffic noise mitigation and management measures have been recommended.

Based on the results in this assessment, with the recommended or other equivalent noise mitigation measures in place, the project is expected to produce acceptable environmental noise levels.

APPENDIX A – NOISE SOURCE DETAILS

Third-octave sound power spectra, expressed as dBL in each frequency band, and the modelled height of each source above ground level are shown in the following table. The location of each source is shown in each of the figures in Appendix B.

Code	Height	25	31	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1k	1.2k	1.6k	2k	2.5k	3.1k	4k	5k	6.3k	8k	dBA	dBL
A	0.5	67	66	69	72	71	72	72	73	70	70	70	71	71	71	72	72	72	75	75	74	73	74	72	69	68	66	84	89
B	0.5	79	81	82	86	86	85	84	82	82	82	81	81	82	78	82	78	78	77	76	75	74	73	73	72	70	67	88	95
C	0.5	69	71	73	75	76	74	74	75	72	71	70	68	67	67	65	67	64	59	57	56	54	52	49	47	43	40	73	85
D	1	69	71	73	75	76	74	74	75	72	71	70	68	67	67	65	67	64	59	57	56	54	52	49	47	43	40	73	85
E	1	69	71	73	75	76	74	74	75	72	71	70	68	67	67	65	67	64	59	57	56	54	52	49	47	43	40	73	85
F	0.5	69	71	73	75	76	74	74	75	72	71	70	68	67	67	65	67	64	59	57	56	54	52	49	47	43	40	73	85
G	1.5	73	76	78	77	75	73	76	81	82	73	77	71	69	71	72	76	76	68	68	68	60	61	58	57	52	49	81	94
H	1	69	71	73	75	76	74	74	75	72	71	70	68	67	67	65	67	64	59	57	56	54	52	49	47	43	40	73	85
I	3	72	70	70	70	68	69	78	74	79	68	69	70	71	70	75	72	68	67	67	65	61	61	60	58	56	52	79	91
J	3	72	70	70	70	68	69	78	74	79	68	69	70	71	70	75	72	68	67	67	65	61	61	60	58	56	52	79	91
T	1	73	77	83	79	90	81	85	88	84	81	77	82	87	80	73	74	74	74	72	71	71	69	67	61	60	57	86	99
t	1	64	68	74	70	81	72	76	79	75	72	68	73	78	71	64	65	65	65	63	62	62	60	58	52	51	48	77	90

APPENDIX B – FIGURES

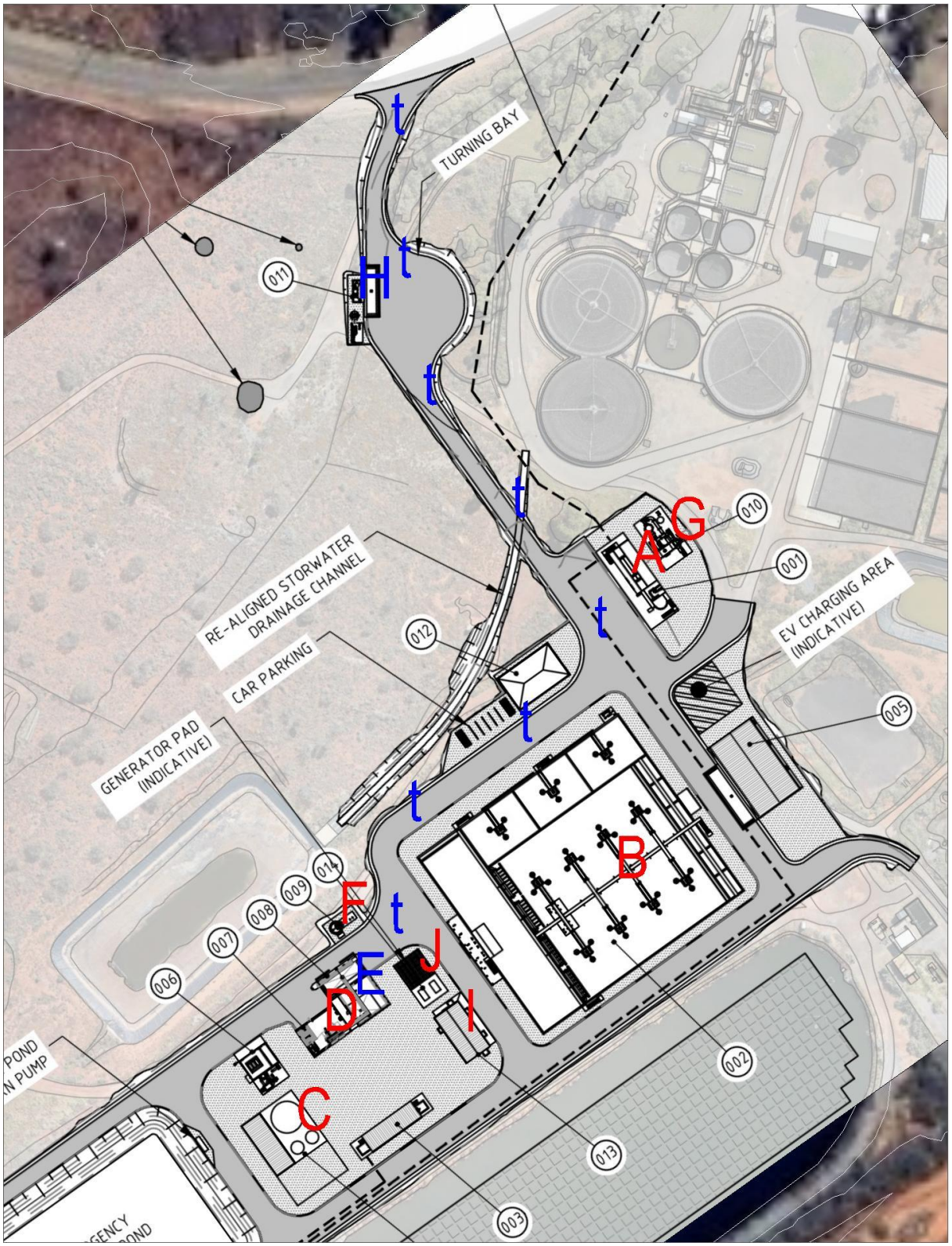


Figure B1 Modelled Noise Sources: source locations are the lower left corner of each text entity.

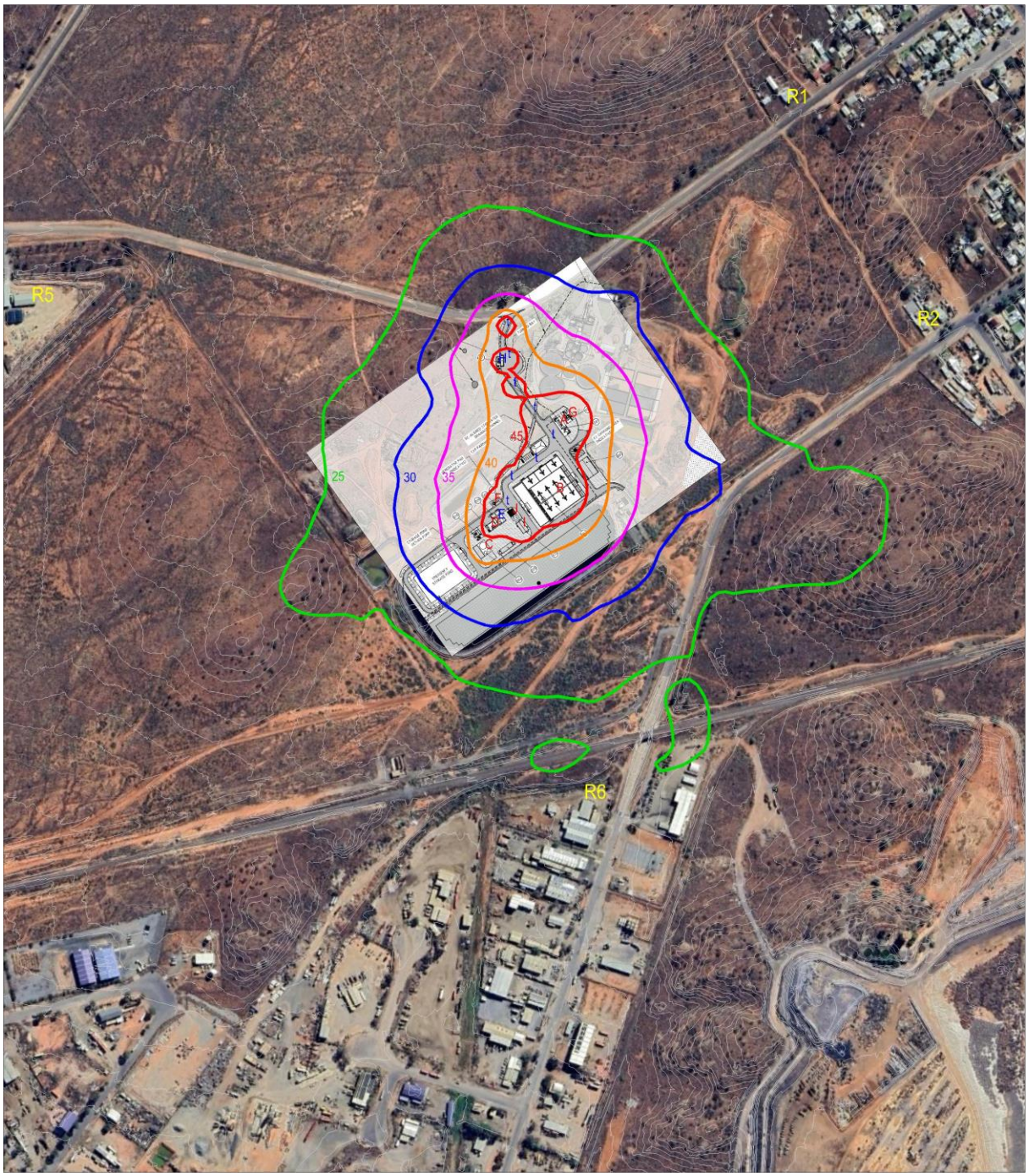


Figure B2 Noise Contours, Day Calm LAeq,15min

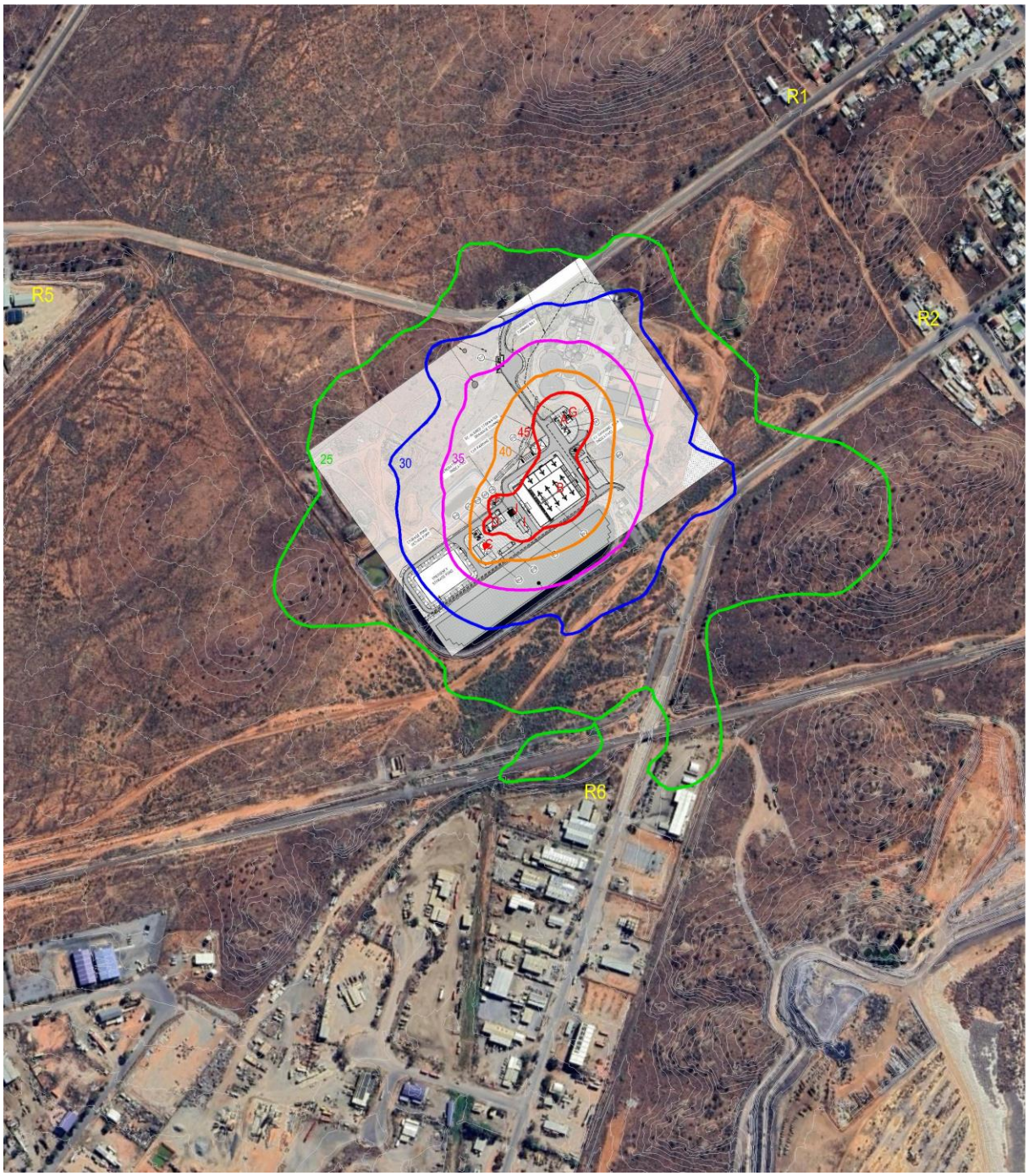


Figure B3 Noise Contours, Evening/Night Calm LAeq,15min

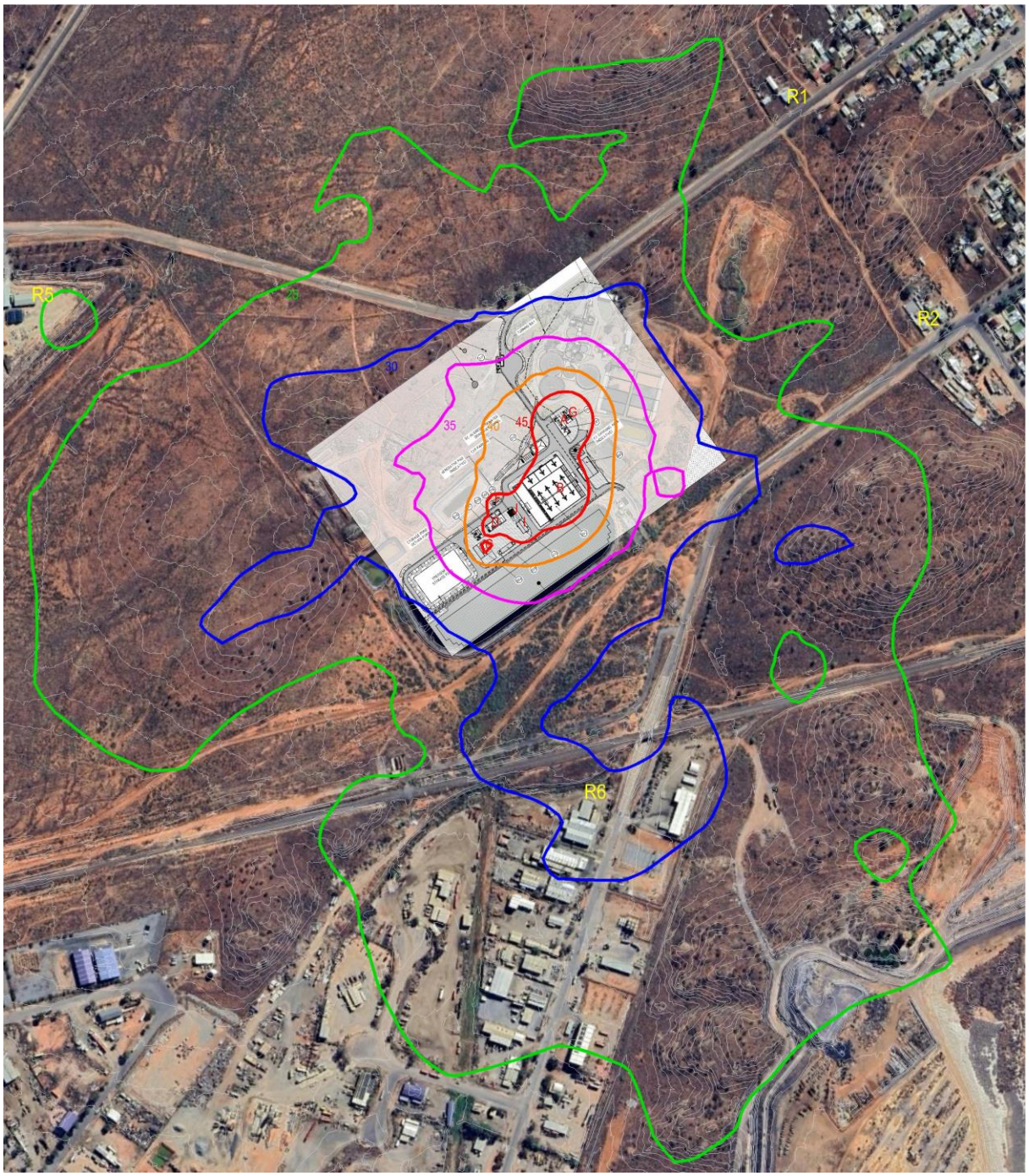


Figure B4 Noise Contours, Evening/Night Prevailing (Inversion and Wind), LAeq,15min

Appendix D: Ecological Impact Assessment

(AREA Environment and Heritage Consultants, 2025a)

AREA Environmental & Heritage Consultants ABN: 29 616 529 867

- ✓ Environmental impact assessments and approvals: REFs, MW REFs, PEAs
- ✓ Ecology, Aboriginal and historic heritage assessments
- ✓ Biodiversity assessment method (BAM) assessments (BDAR) and offsetting (BSAR)
- ✓ Plans of Management
- ✓ Aboriginal community engagement
- ✓ Stakeholder and community engagement
- ✓ Peer review / project briefs / budgeting assistance / expert witness
- ✓ Commercial external landscape designs for built or natural environments
- ✓ Vegetation Management Plans
- ✓ Stakeholder and community engagement

Ecological Impact Assessment

Wills Street Sewage Treatment Plant (STP) Upgrade Project

Essential Energy

Broken Hill Local Government Area

May 2025

AREA Environmental & Heritage Consultants acknowledges

Traditional Owners of the country on which we work

Document controls

Proponent	Essential Water
Client	Essential Energy
Quote number	QU-0845
Purchase Order	EW00002070
Document description	STP upgrade – Broken Hill. Ecological Impact Assessment Report
Client representative	Nathan Hegerty
AREA representative	Dave Sturman
Cover image	Section of the subject land

DOCUMENT STATUS		
DRAFT: Series V1.X AREA internal edits	**Date**	**Action**
V1.0	12.07.2024	For internal review
V1.1	15.07.2024	Internal edit
V1.2	15.07.2024	Internal edit
V1.3	22.07.2024	Internal edit
V1.4	25.07.2024	Internal edit
DRAFT Series V2.X Client / AREA internal edits	**Date**	**Action**
V2.0	29.07.2024	AREA to client
FINAL (Draft approved by client)	**Date**	**Action**
V3.0	21.08.2024	Final to client
V3.1	21/03/2025	Report revision
V3.2	24/03/2025	Final to client
V3.3	7/04/2025	Client edits
V3.4	15/05/2025	Client project design updates
V3.5	19/05/2025	Final edits

Prepared for Essential Energy	Nathan Hegerty Senior Environmental Engineer Essential Energy PO Box 5730 Port Macquarie NSW 2444 E: nathan.hegerty@essentialenergy.com.au
Prepared by AREA	Gabrielle Green Environmental Consultant AREA Environmental and Heritage Consultants Pty Ltd ABN:29 616 529 867 72 Brisbane Street Dubbo, NSW 2830 E: gabbi@areaenv.com.au

COPYRIGHT

This document and its contents are subject to copyright protection under the *Copyright Act 1968* (Cth) and all rights are reserved. The document is intended solely for the use of:

1. AREA Environmental & Heritage Consultants Pty Ltd, 2025 and
2. Essential Energy, 2025

and may not be reproduced, distributed, or transmitted in any form or by any means, including photocopying, recording, or other electronic or mechanical methods, without the prior written permission of the aforementioned in point 1. and 2.

Executive summary

Essential Water, a business unit of Essential Energy (the proponent) proposes to upgrade the existing Wills Street Sewage Treatment Plant (STP) in Broken Hill, to create the new Broken Hill STP (BHSTP). The proposal also includes:

- Construction of a new rising main to transfer sewage from the existing Broken Hill South STP to the new BHSTP, with a construction impact footprint of approximately 5.6 kilometres long by 10 metres wide.
- Construction of a new pump station at the current Broken Hill South STP, to facilitate transfer of the Broken Hill STP catchment sewage and transfer it to the new BHSTP via the new rising main.
- Decommissioning of redundant assets at the Broken Hill South STP.
- Replacement of approximately 1.2 kilometres of the existing treated effluent discharge pipe from the new BHSTP to the existing discharge point, with a construction impact footprint width of 10 metres (predominantly contained with the same impact footprint of the new rising main). An approximately 500m section of the existing treated effluent discharge pipe located within an existing easement on the land parcel immediately south of the existing Wills Street STP site will be decommissioned as a result of the replacement pipe.
- Upgrades to existing access roads, including construction access at the new BHSTP.

The proposal will be largely located within areas that have been previously cleared or heavily disturbed land including compacted dirt tracks, to minimise the clearing of native vegetation.

AREA Environmental & Heritage Consultants (AREA) has been engaged by Essential Energy (the client) to complete an ecological impact assessment for the proposal. The proposal will be assessed under Part 5, Division 5.1 of the *Environmental Planning and Assessment Act 1979*. This report takes into account the relevant requirements under the *Environment Protection Biodiversity Conservation Act 1999* (EPBC Act), *Biodiversity Conservation Act 2016* (BC Act) and NSW *Fisheries Management Act 1994* (FM Act).

The fieldwork component of this assessment was undertaken on 9 and 10 May 2023 by Lyndy Marshall of AREA. The purpose of the field assessment was to identify the range of ecological values present across the subject land, evaluate any residual ecological impacts, and determine if there would be a significant impact to matters of environmental significance.

The assessment determined the proposal will not result in a significant impact to matters protected under the EPBC Act, BC Act or FM Act.

The proposal would impact approximately 10.15-hectares which includes operational upgrades to Wills Street STP and an approximately 10-metre-wide disturbance corridor for the rising main. Replacement of the existing treated effluent discharge pipe would largely be within this 10-metre corridor. Up to 5.17 hectares of native vegetation, in four Plant Community Types would be impacted.

PCT ID	PCT name	Impact (ha)
0	Non-native vegetation	4.98
41	River Red Gum open woodland wetland of intermittent watercourses mainly of the arid climate zone	0.90
123	Mulga - Dead Finish on stony hills mainly of the Channel Country Bioregion and Broken Hill Complex Bioregion	0.58
155	Bluebush shrubland on stony rises and downs in the arid and semi-arid zones	2.61
158	Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)	1.08
	Total	**10.15**
	Total impact to native vegetation	**5.17**

Database searches and habitat assessment identified 79 listed species and two Threatened Ecological Communities, under the EPBC and or BC Act, as potentially occurring in or adjacent to the subject land.

One Threatened Ecological Community listed under the BC Act has the potential to be impacted by the proposal.

Threatened Ecological Community	BC Act listing	EPBC Act listing
Acacia loderi shrublands	EEC	Not Listed

EEC = Endangered Ecological Community

The impact of the proposal on listed threatened species, populations and ecological communities was assessed using the appropriate tests of significance, where applicable, under the EPBC Act, BC Act and/or FM Act, which concluded the proposal is unlikely to have a significant impact these entities.

Safeguards and mitigation measures have been provided to minimise harm to the environment.

No further ecological assessment is required.

Contents

Document controls i

Executive summary 1

Contents 3

Figures 5

Tables 6

1 Introduction 7

1.1 Objectives 7

1.2 Definitions 9

1.3 Project description 9

1.4 Subject land 14

2 Methods 3

2.1 Desktop review 4

2.1.1 Information sources 4

2.2 Field survey 5

2.2.1 Plant Community Types 5
2.2.2 Threatened Ecological Communities 5
2.2.3 Habitat assessment 6
2.2.4 Threatened fauna 6
2.2.5 Limitations 6

2.3 Significance of potential impact 6

2.3.1 NSW legislation – BC Act 7
2.3.2 Commonwealth legislation - EPBC Act 8

3 Desktop review results 10

3.1 Landscape context 10

3.1.1 IBRA bioregion and subregions 10
3.1.2 NSW Landscapes (Mitchell Landscapes) 10
3.1.3 Watercourses 12
3.1.4 Land use 16
3.1.5 Climate 16

3.2 Ecological context 18

3.2.1 EPBC Protected Matters 18
3.2.2 Predicted species 19
3.2.3 Plant Community Types 21
3.2.4 Threatened Ecological Communities 23
3.2.5 Biodiversity Values Map 23
3.2.6 Key Fish Habitat 23
3.2.7 Environmental conservation zones 23
3.2.8 Groundwater dependant ecosystems 24

3.2.9 Native Vegetation Regulatory (NVR) mapping 24

4 Field survey results 28

4.1 Search effort 28

4.2 Vegetation communities 32

4.2.1 Plant Community Types 32
4.2.2 Threatened Ecological Communities 44

4.3 Habitat 44

4.3.1 Wills Street STP Site 44
4.3.2 New incoming pipework 44
4.3.3 Treated effluent discharge pipe replacement route 46
4.3.4 Rising main route 46

4.4 Aquatic communities 48

4.5 Pests, weeds and disease 48

4.5.1 Wills Street STP Site 48
4.5.2 South Broken Hill STP Site 48

5 Impact analysis 49

5.1 Direct impact 49

5.1.1 Habitat, connectivity, and fragmentation 49
5.1.2 Native vegetation 49
5.1.3 Threatened Ecological Communities 50
5.1.4 Threatened species 50
5.1.5 Migratory species 50
5.1.6 Impact to groundwater dependent communities 51
5.1.7 Impact to hollow bearing trees 51
5.1.8 Soils and drainage 51
5.1.9 Weeds 52

5.2 Indirect impact 52

5.2.1 Injury to wildlife 52
5.2.2 Changes to hydrology and groundwater dependent ecosystems 53
5.2.3 Noise, light and vibration 53
5.2.4 Spread of pests, weeds and disease 53

5.3 Impact on Key Threatening Processes 53

5.4 Cumulative impact 57

6 Environmental safeguards and mitigation measures 58

6.1 Avoid impact 58

6.2 Minimise impact 58

6.3 Mitigate impact 58

7 Conclusion 60

8 References 61

Appendix A: Terms and abbreviations used in this report **62**

Appendix B: Database search results **65**

EPBC Protected Matters Search 65
IBRA predicted threatened species and communities' search 75
Field survey fauna species list 77

Groundwater dependant ecosystems – Terrestrial 78

Appendix C: Predicted threatened species assessment **79**

Appendix D: Tests and Assessments of significance **91**

EPBC Act Assessments of Significance 91

BC Act Tests of Significance 98

Figures

Figure 1-1: Location of the proposal 8
Figure 1-2: The proposal 1 of 3 11
Figure 1-3: The proposal 2 of 3 12
Figure 1-4: The proposal 3 of 3 13
Figure 1-5:Subject land 1
Figure 3-1: IBRA bioregions and subregions 13
Figure 3-2: NSW (Mitchell) Landscapes 14
Figure 3-3: Watercourses 15
Figure 3-4: Land use 17
Figure 3-5: BioNet records within the landscape assessment area 20
Figure 3-6: Plant Community Types from the State Vegetation Type Map 22
Figure 3-7: NSW Biodiversity Values Map 25
Figure 3-8: Land zone 26
Figure 3-9: Draft Native Vegetation Regulatory Map 27
Figure 4-1: Survey effort 1 of 3 29
Figure 4-2: Survey effort 2 of 3 30
Figure 4-3: Survey effort 3 of 3 31
Figure 4-4: Groundtruthed PCT overview map 34
Figure 4-5: Ground truthed PCTs within subject land 1 of 7 35
Figure 4-6: Ground truthed PCTs within subject land 2 of 7 36
Figure 4-7: Ground truthed PCTs within subject land 3 of 7 37

Figure 4-8: Ground truthed PCTs within subject land 4 of 7 38
Figure 4-9: Ground truthed PCTs within subject land 5 of 7 39
Figure 4-10: Ground truthed PCTs within subject land 6 of 7 40
Figure 4-11: Ground truthed PCTs within subject land 7 of 7 41
Figure 4-12: Site of New incoming pipework and trees to be removed (circled in red)..... 46

Tables

Table 1-1: Regional context of the subject land 14
Table 1-2: Proximity of environmentally sensitive areas to the subject land 14
Table 1-3: Pictures of the subject land 1
Table 2-1: AREA staff qualifications..... 3
Table 2-2: Resources used for this assessment..... 4
Table 3-1: NSW Landscapes descriptions 11
Table 3-2: Climate statistics for Broken Hill Airport AWS (BoM, 2024) 16
Table 3-3: EPBC Protected Matters Report summary 18
Table 3-4: BioNet results within landscape assessment buffer..... 19
Table 3-5: Plant Community Types mapped within 1500 metres..... 21
Table 3-6: Predicted Threatened Ecological Communities 23
Table 3-7: Additional TECs associated with PCTs identified in the landscape assessment area 23
Table 3-8: Land zones within subject land 24
Table 4-1: Plant Community Types recorded within the subject land 32
Table 4-2: Plant Community Types recorded in the subject land..... 42
Table 5-1: Native vegetation impacted by the proposal..... 50
Table 5-2: Assessment of Significance, Migratory birds 51
Table 5-3: Review of proposed impacts to Key Threatening Processes..... 54
Table 6-1: Environmental safeguards 58

1 Introduction

Essential Water, a business unit of Essential Energy (the proponent) propose to upgrade the current Wills Street Sewage Treatment Plant (STP) to create the new Broken Hill STP, as the current Wills Street STP has reached the end of its useful life span. The upgrade will add additional capacity and provide opportunity for the smaller South STP to later be retired from use. A new rising main is proposed to be installed to transport sewage from the current South STP catchment to the new BHSTP (the proposal). The proposal is located at the southwestern extent of Broken Hill NSW, approximately 3.5 kilometres from the town centre (Figure 1-1).

AREA Environmental & Heritage Consultants (AREA) was engaged by Essential Energy (the client) to complete an ecological assessment for the proposal.

1.1 Objectives

The objectives of this ecological assessment are to provide:

- accurate predictions and mapping of any vegetation clearing on site,
- detailed assessment of the potential impact to any threatened species, populations, endangered ecological communities or their habitats; groundwater dependent ecosystems predicted to occur; and any potential for offset requirements in accordance with relevant State or Commonwealth guidelines, and
- detailed descriptions of the measures to avoid, minimise, mitigate and offset impacts to biodiversity.

Essential Energy is the determining authority for this proposal under Part 5, Division 5.1, of the *Environmental Planning and Assessment Act 1979* (EP&A Act). This Ecological Impact Assessment addresses requirements under s.7.3 of the *Biodiversity Conservation Act 2016* (BC Act) and considers matters protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and NSW *Fisheries Management Act 1994* (FM Act).

This assessment addresses these primary requirements as well as the requirements of the following assessment frameworks.

International agreements:

- Japan-Australia Migratory Bird Agreement (JAMBA)
- China-Australia Migratory Bird Agreement (CAMBA)
- Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA)
- Ramsar Convention on Wetlands (Ramsar).

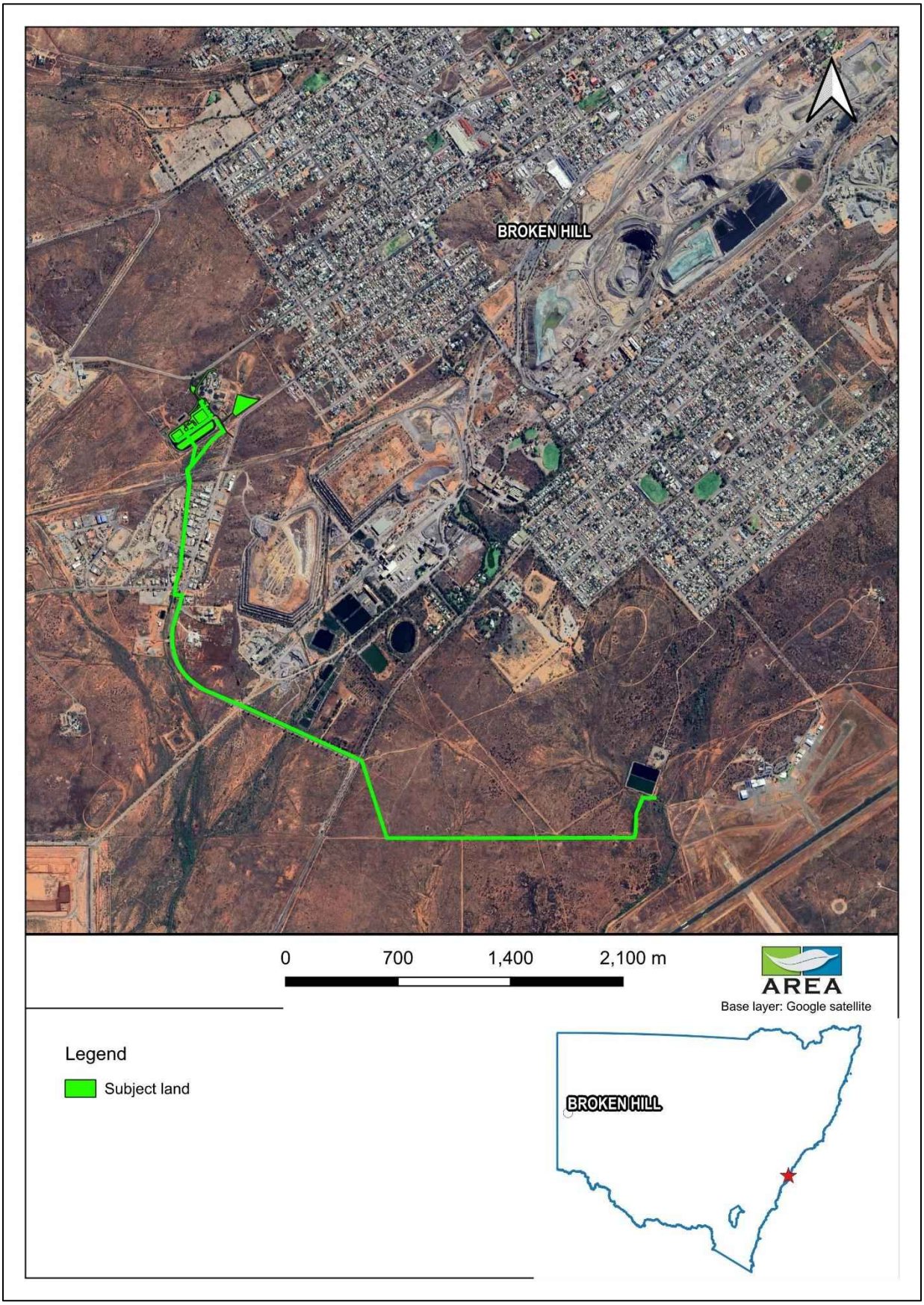
Commonwealth policies and guidelines:

- EPBC Act Environmental Offsets Policy
- Significant Impact Guidelines Version 1.1, 2013.

State guidelines:

- Threatened Species Test of Significance Guidelines (OEH, 2018),
- Guidelines for Division 5.1 assessments (DPE, 2022).

Figure 1-1: Location of the proposal



1.2 Definitions

Terms used in this report include:

- **Study Area** – the total area surveyed for this proposal
  - Including a 50-meter-wide corridor for potential disturbances along the proposed rising main route.
- **Subject land** – the land which may be directly impacted by the proposal located within the study area. These include:
  - A corridor which encompasses the rising main (5.6 kilometres), and, in part, the replacement of the existing treated effluent discharge pipe. This corridor varies in width between 10 and 12 metres.
  - Proposed construction of the new Broken Hill STP.
- **Landscape assessment area** – land directly or indirectly affected by the proposal and subject to assessment. For this assessment it includes the IBRA subregion, 1500 meters around the subject land for desktop review, and the subject land for the field assessment.

Additional terms and abbreviations are provided in Appendix A.

1.3 Project description

The Will Street Sewage Treatment Plant (STP) will be upgraded to become the new Broken Hill STP (BHSTP) located on previously disturbed land of which the current Will Street STP is located.

To connect the new BHSTP to the existing South Broken Hill STP, construction of a new rising main has been proposed. The disturbance corridor required for the construction of the rising main will be approximately 10 meters wide, located along a previously disturbed road corridor. The rising main will be used to transport current South STP catchment sewage and to the new BHSTP (Figure 1-2 to Figure 1-4). The project will also include the replacement of the existing treated effluent discharge pipe in its existing location (Figure 1-2 to Figure 1-4). This proposed disturbance is largely within the 10-metre-wide corridor for the rising main, however in some sections it deviates slightly, increasing the corridor width to up to 12 metres in total. The proposed impact footprint for the rising main and effluent discharge pipe is located within the 50-meter-wide assessed study area.

The rising main will predominately be constructed below ground, by a mixture of open trenching and underbores. Certain sections of the pipe may be constructed above ground where land forms, geology and gradients preclude its construction underground. A construction access road will be installed to connect the new Broken Hill STP and the construction laydown and office area to Kanandah Road approximately three meters wide. A 12-metre-wide

The proposed upgrades to transform the Wills Street STP into the new Broken Hill STP will include:

- South SPS-A sewer pump station is to be provided to collect the current South STP catchment sewage and transfer it to the BHSTP inlet receival chamber via a new rising main. The existing gravity main to Wills Street STP will be diverted to the new Preliminary Treatment inlet works.
- Preliminary Treatment – Screening and grit removal, including screening and grit washing and dewatering. The inlet works structure will contain an inlet receival chamber (receives flow from the rising mains, the foul water pump station, septage pump station and emergency return pumping), automatic and manual bypass screen channels, a vortex grit chamber, and a flow distribution chamber.
- Secondary Treatment – Two IDEAT bioreactors for organics oxidation, biological nitrogen removal and phosphorus removal (through microorganism growth and chemical precipitation by alum dosing). Sodium hydroxide dosing is provided for pH correction.
- Space onsite will also be allowed for an external carbon dosing system.
- An effluent balance tank for attenuation of high IDEA reactor decanted effluent flows with a lift pump system to feed the treated effluent UV disinfection system and deliver the treated effluent to White Leeds and/or existing open earthen discharge channel.
- Tertiary Treatment – A portion of the secondary treatment effluent will be further treated via a pre-validated UV system and a CCT chlorination system to provide recycled water quality suitable for site service water and the existing end users' applications.
- Excess sludge generated by the secondary process will be wasted to a 3-cell aerobic digester for stabilisation via the WAS pumps. A floating decanter is fitted in the first cell of the aerobic digester to achieve some level of sludge thickening. The digested sludge will be dewatered via a mechanical dewatering facility.
- Emergency Storage Pond-An emergency pond is provided for any unintended situations (Screens or grit removal maintenance, failure of effluent decanters, overflow of effluent balance tank, poor treated effluent water quality), an emergency flow return pump station shall be provided to return the emergency flow to the head of the plant for further treatment.
- Odour control- an odour control unit to be provided to treat foul air from the headspace of the inlet works (Beca HunterH20, 2024).

Figure 1-2: The proposal 1 of 3

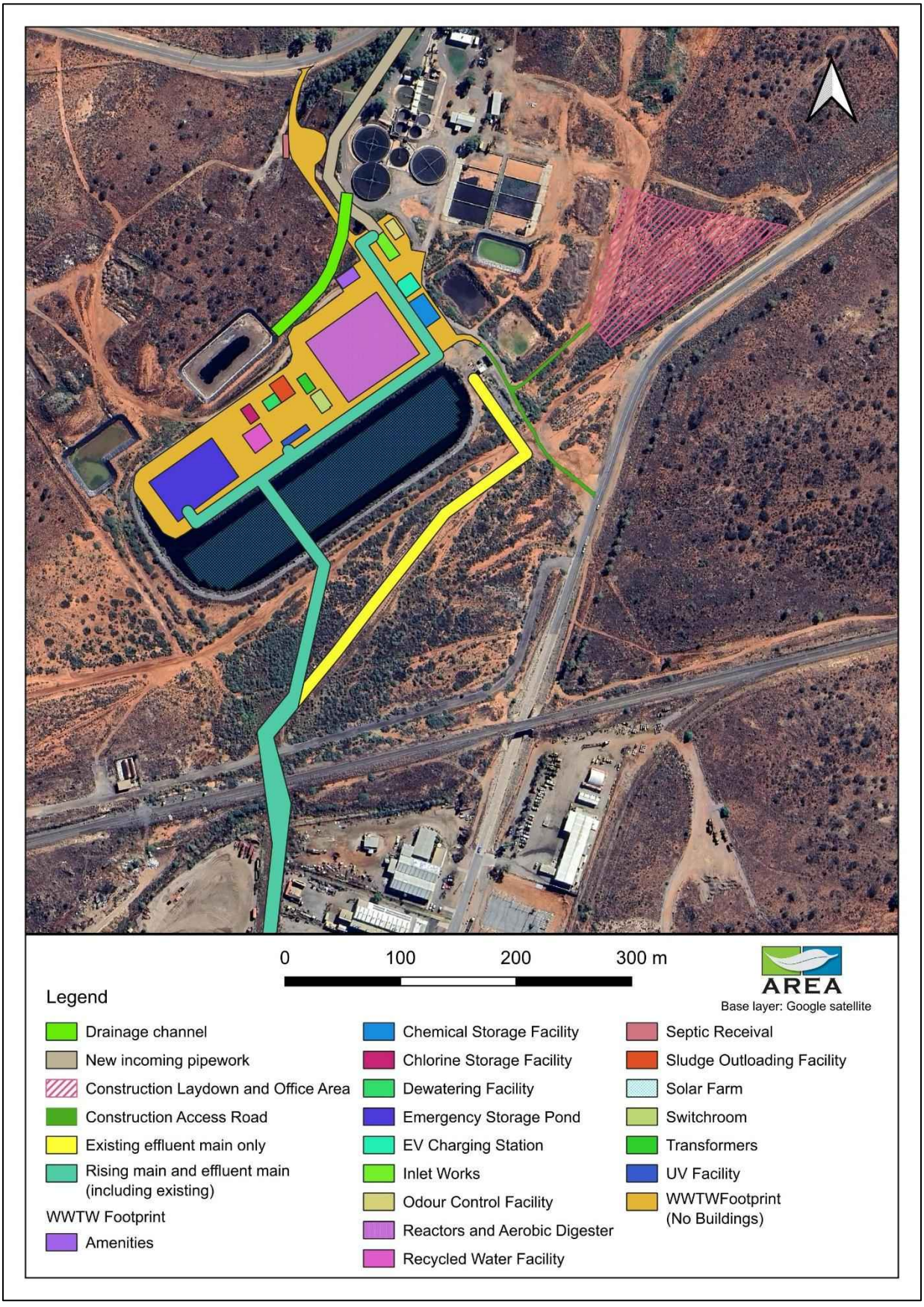


Figure 1-3: The proposal 2 of 3

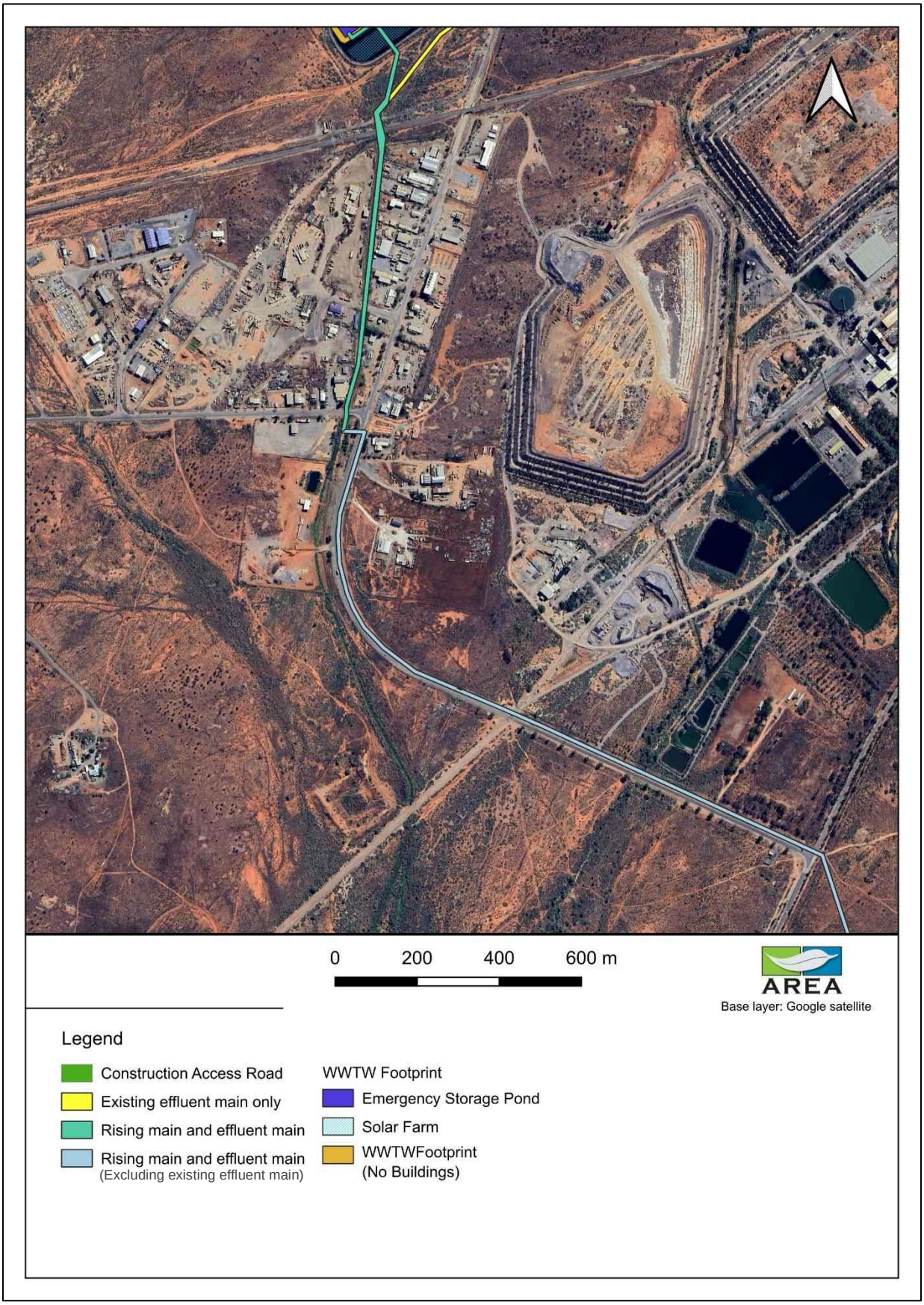
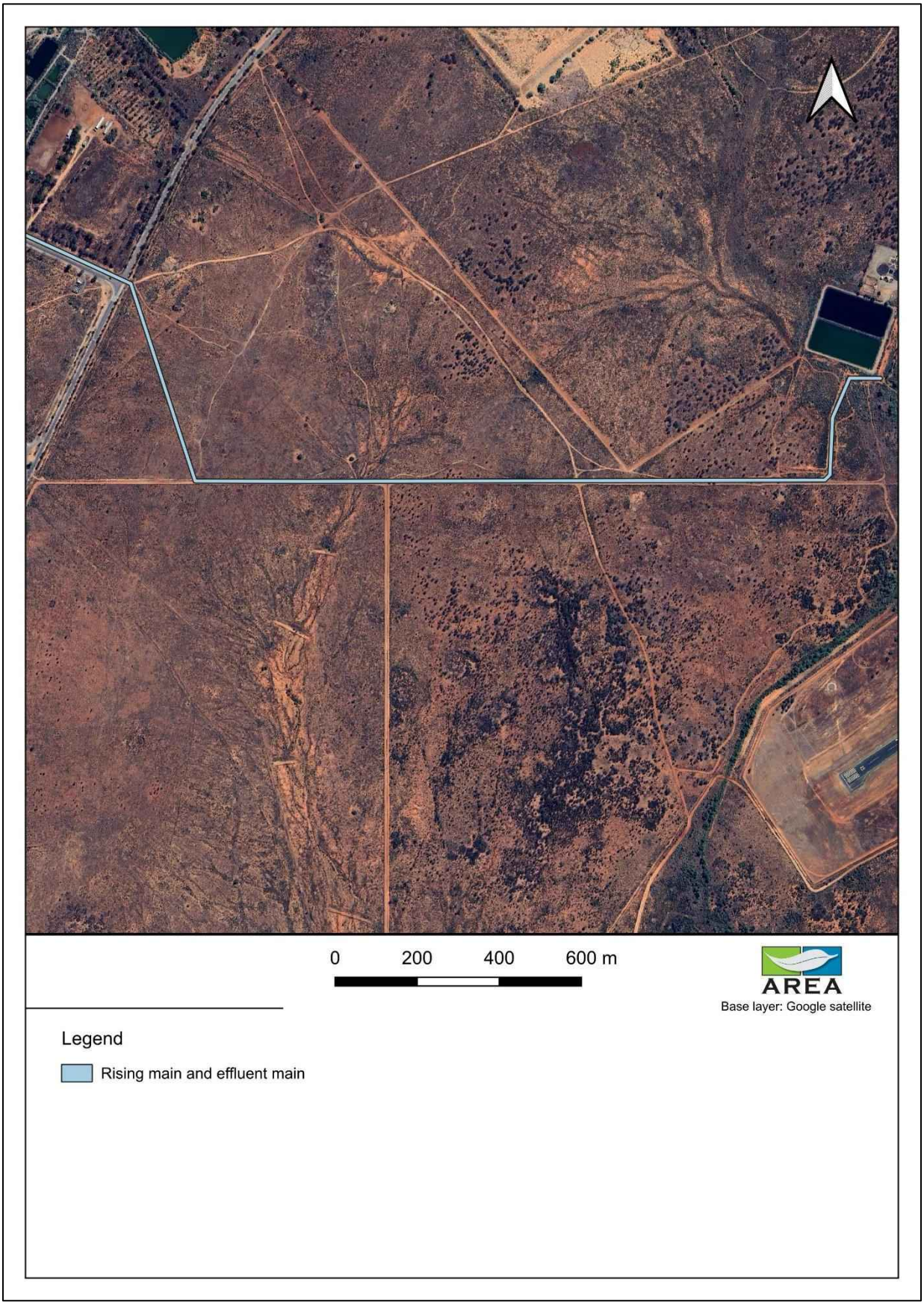


Figure 1-4: The proposal 3 of 3



1.4 Subject land

The regional and ecological context of the subject land is summarised in Table 1-1 and Table 1-2. Figure 1-3 shows the location of the proposal in relation to IBRA regions and sub-regions.

The local area has been historically cleared or disturbed for infrastructure, Table 1-3 provides photos and descriptions of the various points within the subject land.

Table 1-1: Regional context of the subject land

Criteria	Subject land
Interim Biogeographic Regionalisation for Australia (IBRA Region)	IBRA Region: Barrier Hill Complex IBRA Subregion: Barrier Range
Local Government Area	Broken Hill
Land use / disturbance	Grazing native vegetation, Services, Mining, Manufacturing and industrial, Other minimal use, Waste treatment and disposal, Reservoir/dam, Other minimum use.
Nearest watercourses	Watercourses intersected include: Three unnamed drainage lines (directly intersected along proposed route of rising main.
Elevation - Australian Height Datum	~306 m

Table 1-2: Proximity of environmentally sensitive areas to the subject land

Environmental Considerations	In the subject land?
Reserved or a dedicated National Park	No
National Heritage Places	Yes – City of Broken Hill
World Heritage Area	No
Mapped on Native Vegetation Regulatory (NVR) Map	Yes – section 3.2.9
Mapped on Biodiversity Values (BV) Map	No
Land identified in an Act as wilderness (Wilderness Act 1987)	No
Dedicated wetlands under the Ramsar Wetlands Convention?	No
Key Fish Habitat (KFH)	No
Regional Forest Agreement	No
Critical habitats	No

Figure 1-5:Subject land

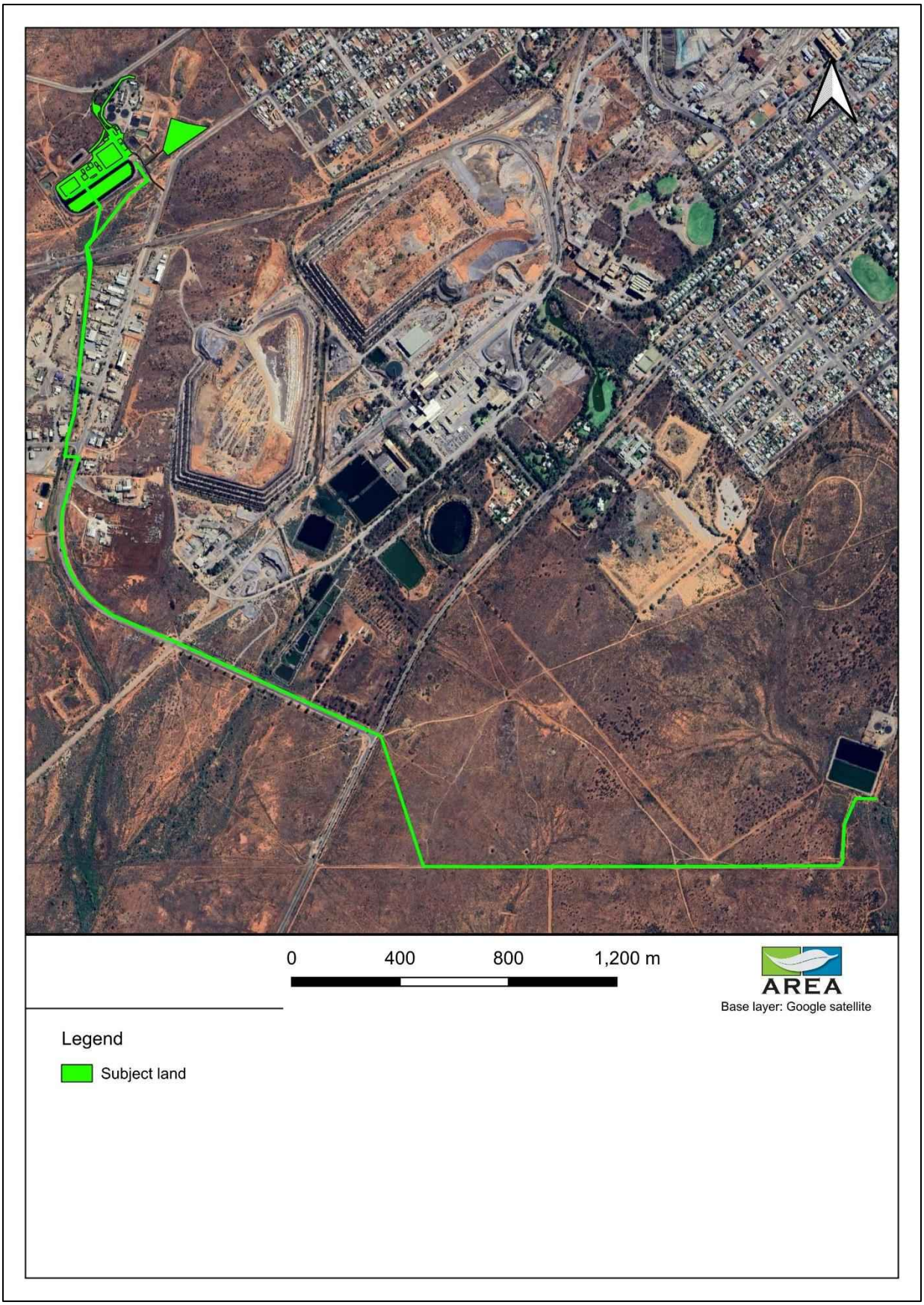


Table 1-3: Pictures of the subject land

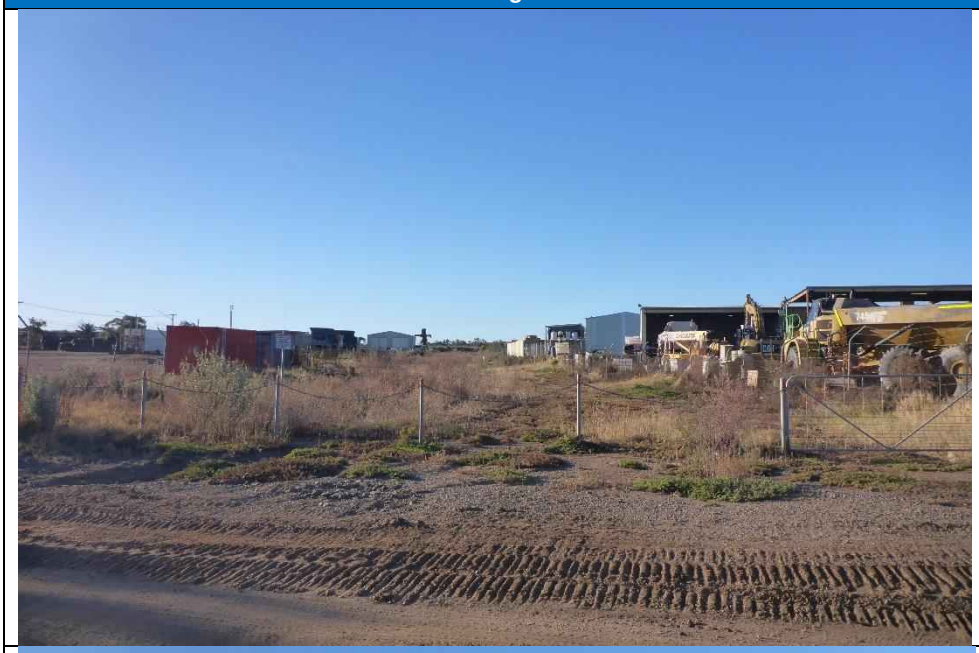
Image	Description
	Rising main route within a previously disturbed corridor
	Rising main northeastern end

Image	Description
	Rising main mid-way
	Rising main eastern end at South Broken Hill STP entry

2 Methods

The following methods were used for this assessment:

- desktop review of ecological databases and literature, and
- a field survey of the subject land using transect method by foot and vehicle.

The assessment rationale was to evaluate the type and quality of habitat to be impacted by the proposal, apply professional judgement, and then complete targeted assessment of potential habitat to detect the region's listed species, populations, or communities.

This assessment was completed by suitably qualified AREA staff (Table 2-1).

Table 2-1: AREA staff qualifications

Name	Position	CV Details	Role in this assessment
Lyndy Marshall	Senior ecologist, botanist / zoologist	• B. Sc. University of New England	Field survey
Gabrielle Green	Environmental Consultant	• B. Env. Sc. University of New England • AHCPCM201 – Recognising grasses • WHS White Card - general construction induction card (CGI1667253SEQ01) • RMS-worker on foot training • First Aid Certificate (Cert No. 6995717)	Report writing
Dave Sturman	Manager Senior consultant	• B. Env. Sc. Land and Water Specialisation Charles Sturt University • Cert III (Horticulture) • White card – general construction induction card. • RMS-worker on foot training. • Senior First Aid • Chainsaw operator ticket • Confined Space worker and atmospheric monitoring. • Risk assessment training. • AHCPM201-Recognising grasses • NSW OEH Biodiversity Assessment Method Assessor accreditation number BAAS #22015	Project management Report editor
Dylan Chew	Ecologist	• Bachelor of Environmental Science and Management Hons. (Conservation), University of Newcastle • Certificate III Information and Digital Technology • White card – general construction induction card	Report editor
Addy Watson	Manager Senior consultant	• Grad. Dip. Captive Vertebrate Management, Charles Sturt University • Grad. Cert. Social Impact, University of NSW • B. Env. Sc. University of New England. • NSW Biodiversity Assessment Method Accredited Assessor (BAAS19066) • Diploma Project Management • Lean Six Sigma Certificate (Sydney Uni) • WHS White Card • Apply First Aid. Certificate number: 07328	Client edits Report review

2.1 Desktop review

A desktop review was used to inform field surveys and assessment of potential impact to threatened flora and fauna (Section 4).

2.1.1 Information sources

Preliminary assessment drew on local experience, previous reporting and information held on government databases and archives (Table 2-2 and Appendix B).

Table 2-2: Resources used for this assessment

Title	Web address
Legislation	
Biodiversity Conservation Act 2016	https://www.legislation.nsw.gov.au/view/html/inforce/current/act-2016-063
Commonwealth Environment Protection & Biodiversity Conservation Act 1999	http://www.austlii.edu.au/au/legis/cth/consol_act/epabca1999588/
Environmental Planning and Assessment Act 1979	https://www.legislation.nsw.gov.au/view/html/inforce/current/act-1979-203
Fisheries Management Act 1994	https://www.legislation.nsw.gov.au/view/html/inforce/current/act-1994-038
National Parks and Wildlife Act 1974	https://www.legislation.nsw.gov.au/view/html/inforce/current/act-1974-080
Water Management Act 2000	https://www.legislation.nsw.gov.au/view/html/inforce/current/act-2000-092
Biodiversity	
DPE Threatened Species website	https://www.environment.nsw.gov.au/topics/animals-and-plants/threatened-species
Guide to Surveying Threatened Plants and their habitats (DPIE, 2020)	https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Biodiversity/surveying-threatened-plants-and-habitats-nsw-survey-guide-biodiversity-assessment-method-200146.pdf
NSW Biodiversity Values Map and Threshold Tool	https://www.lmbc.nsw.gov.au/Maps/index.html?viewer=BOSETMap
NSW Native Vegetation Regulatory Map	https://www.lmbc.nsw.gov.au/Maps/index.html?viewer=NVRMap
NSW Planning Portal	https://www.planningportal.nsw.gov.au/spatialviewer/#/find-a-property/address
PlantNET	http://plantnet.rbgsyd.nsw.gov.au/
Significant Impact Guidelines 1.1 - Matters of National Environmental Significance	http://www.environment.gov.au/epbc/publications/significant-impact-guidelines-11-matters-national-environmental-significance
Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities – Working Draft (DEC, 2004)	https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Threatened-species/draft-threatened-biodiversity-survey-guide.pdf
Threatened Species Assessment Guidelines - The Assessment of Significance (DPI, 2008)	Threatened-Species-Guidelines.pdf (nsw.gov.au)

2.2 Field survey

The fieldwork component of this assessment was undertaken from the 9 May to 10 May 2023 by Lindy Marshall, a subcontractor for AREA.

The objectives of the field assessment were to:

- describe the nature and extent of vegetation removal,
- determine if species, populations or communities listed in the EPBC, BC or FM Acts would be, or have potential to be, affected by the proposal,
- determine if groundwater dependent communities would be, or have potential to be, affected by the proposal; and,
- describe the quality and value of the habitat affected by the proposal.

Database searches were used to inform the field assessment and applied to determine the likelihood for a protected matter and Plant Community Type (PCT) to be recorded within the subject land and what targeted searches would be needed for detection.

Published information showing predicted threatened and non-native species were used during the field assessment. Where potentially threatened flora or fauna or ecological communities were identified, such resources were used to confirm occurrence.

The subject land was assessed using pedestrian and vehicular survey methods and consisted of sampling areas where impacts to native vegetation may occur, changes in vegetation type were evident and vegetation had a reasonable chance of supporting threatened flora or fauna species or communities.

Results of the field assessment are presented in Section 4.

2.2.1 Plant Community Types

Plant Community Types (PCT) were identified in the field using State Vegetation Map: Western Region Version 1.0. VIS_ID4492 (SVM4492) PCT map sourced from the NSW SEED website, as a baseline for the subject land and region.

The assessment aimed to confirm PCT and update those incorrectly mapped to the correct vegetation class, PCT and / or Threatened Ecological Community (TEC). PCT IDs and boundaries between the mapped PCT were adjusted after ground-truthing.

Areas of not native vegetation were also identified and included areas where the vegetation consisted of exotic species or where there was no vegetation such as along tracks and roads.

Formal vegetation plots were not used for this assessment.

2.2.2 Threatened Ecological Communities

Threatened Ecological Communities (TEC) were predicted using database searches, and the PCT associated with a TEC. Data collected during the field assessment and the NSW and Commonwealth descriptions of TEC was used to confirm presence or absence of TEC in the subject land.

2.2.3 Habitat assessment

Habitat in the subject land was assessed for its potential to provide resources for listed species predicted or known to occur. Database searches were used to inform the field assessment. Professional judgement was applied on site to determine a likelihood for a protected matter to be recorded and what targeted searches would be needed to detect and consider the magnitude of the potential impact.

In the field, any indirect evidence of fauna (i.e., scats, tracks, calls, fur, feathers, sloughed skins etc.) was investigated. Mature trees in the subject land, where present, were inspected for hollows and signs of use from listed fauna species and to determine if they were used as fauna breeding sites. Ground habitat such as rocks and logs which may be potential habitat for listed reptiles were inspected to determine if they were significant habitat.

2.2.4 Threatened fauna

Opportunistic sightings of mammals, birds, reptiles, and frogs were recorded during assessment of the subject land. Attention was given to identifying the presence of suitable habitat (e.g. tree hollows, nests, logs, watercourses) and signs of activity (e.g. feeding scars, scats).

2.2.5 Limitations

Not all animals and plants can be fully accounted for within any given subject land. The presence of threatened species is not static, and it changes over time, often in response to longer term natural forces which can at any time be dramatically influenced by man-made disturbance or weather. A 'precautionary approach' for species occurrence has been adopted where required. Database searches were used to identify threatened species known or predicted to occur in subject land. All of these are considered for their potential to occur in the subject land and likelihood of impact, therefore, the use of specific fauna survey methods such as trapping, ultrasonic call capture and nocturnal assessments was not considered necessary.

The assessment was conducted at a time where rare orchids may not be detectable.

The above-mentioned constraints are not considered to compromise the findings or results of the field assessment.

- To overcome limitations, database searches were conducted for threatened species, populations and ecological communities known to occur within the region before the fieldwork.
- The above-mentioned constraints are not considered to compromise the findings or results of the field assessment given the type of habitat affected by the Proposal.

2.3 Significance of potential impact

EPBC Act, BC Act and FM Act listed species, populations, communities, and migratory species, identified in the desktop review and field survey were assessed for likelihood of occurrence in the subject land, and likelihood of impact from the development.

The following three terms of likelihood were used in this process:

- "Unlikely" = There is a very low to low probability a species uses the subject land. Species unlikely to occur are also therefore, unlikely to be impacted. A test of significance under the EPBC or BC Act is not required for this species.
- "Potential" = There is a medium to high probability a species uses the subject land. If the development may impact this species a test of significance under the EPBC or BC Act is required for this species. If the development will not impact the species, a test of significance is not required.
- "Yes" = The species was or has been observed in or near the subject land and/or will be impacted by the development. A test of significance under the EPBC and / or BC Act is required for this species. If the development will not impact the species, a test of significance is not required.

Where a species scored 'Potential' or 'Yes' for likelihood of occurrence AND has potential to be impacted by the development, a test of significance has been completed as per the required BC Act test questions and EPBC Act significant impact criteria, see following sections.

Completed tests of significance required for this proposal, relative to the species conservation listing status and requirements, are included in Appendix D.

2.3.1 NSW legislation – BC Act

To determine whether a proposed development or activity is likely to significantly affect threatened species or ecological communities, or their habitats, within Section 7.3 of the BC ACT, the following questions are asked in a BC Act Threatened Species Test of Significance:

Adverse effects on the life cycle of a species:

1. in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Adverse effects on ecological communities:

2. in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:
    i. is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
    ii. is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Adverse effects on habitats:

3. in relation to the habitat of a threatened species or ecological community:
    i. the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and
    ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and

iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality.

Adverse effects on areas of outstanding biodiversity value:

4. whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly).

Key threatening processes:

5. whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

2.3.2 Commonwealth legislation - EPBC Act

Under the EPBC Act an action will require approval from the Australian Government Environment Minister (the minister) if the action has, or will have, or is likely to have, a significant impact on a matter of national environmental significance (MNES). The EPBC Act protects nationally and internationally important flora, fauna, ecological communities, and heritage places as defined in the EPBC Act as MNES.

The criteria applied to EPBC listed species, populations or communities when determining if a significant impact on any MNES is likely, are outlined below:

Critically endangered or endangered species:

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

(i) lead to a long-term decrease in the size of a population
(ii) reduce the area of occupancy of the species
(iii) fragment an existing population into two or more populations
(iv) adversely affect habitat critical to the survival of a species
(v) disrupt the breeding cycle of a population
(vi) modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
(vii) result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat
(viii) introduce disease that may cause the species to decline, or
(ix) interfere with the recovery of the species.

Vulnerable species:

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

(i) lead to a long-term decrease in the size of an important population of a species
(ii) reduce the area of occupancy of an important population
(iii) fragment an existing important population into two or more populations
(iv) adversely affect habitat critical to the survival of a species
(v) disrupt the breeding cycle of an important population

(vi) modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
(vii) result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
(viii) introduce disease that may cause the species to decline, or
(ix) interfere substantially with the recovery of the species.

Endangered or Critically Endangered Ecological Community:

An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

(i) reduce the extent of an ecological community
(ii) fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines
(iii) adversely affect habitat critical to the survival of an ecological community
(iv) modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns
(v) cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting
(vi) cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to assisting invasive species, that are harmful to the listed ecological community, to become established or causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological or
(vii) interfere with the recovery of an ecological community.

Definitions: A 'population of a species' as determined by the *Environment Protection and Biodiversity Conservation Act 1999* is an occurrence of the species in a particular area. In relation to critically endangered, endangered or vulnerable threatened species, occurrences include but are not limited to:

- a geographically distinct regional population, or collection of local populations, or
- a population, or collection of local populations, that occurs within a particular bioregion.

Important Population as determined by the *Environment Protection and Biodiversity Conservation Act 1999*, is one that for a vulnerable species:

- is likely to be key source populations either for breeding or dispersal
- is likely to be necessary for maintaining genetic diversity
- is at or near the limit of the species range.

3 Desktop review results

3.1 Landscape context

The landscape context of the subject land was considered when assessing potential impact of the proposal. The subject land is in the Broken Hill Complex IBRA bioregion Barrier Range IBRA subregion at approximately 302 metres Australian Height Datum (AHD).

The landscape in which the proposal occurs primarily contains a mixture of previously disturbed native and non-native and vegetation. The subject land supports Mulga and bluebush communities where native vegetation exists.

The subject land lies within the Darling River catchment.

3.1.1 IBRA bioregion and subregions

The proposal is in the Broken Hill Complex IBRA bioregion Barrier Range IBRA subregion (Figure 3-1). The Broken Hill Complex Bioregion lies in the far west of NSW, spanning the NSW-SA border. Across these two states the bioregion has an area of 5,691,042 hectares, with 3,811,697 hectares or 66.98 percent falling in NSW. The bioregion occupies about 4.8 percent of NSW. The Broken Hill Complex Bioregion generally has a hot, dry climate and lies within the NSW arid zone.

Mulga (*Acacia aneura*) communities coupled with chenopod shrubland composed of saltbush and bluebush communities (Benson, 2009) characterise the vegetation of the bioregion. Belah (*Casuarina cristata*), rosewood (*Alectryon oleifolius*), white cypress pine (*Callitris glaucophylla*) and mallee communities also occur throughout the bioregion (NSW National Parks and Wildlife, 2003)

Bioregions are relatively large land areas characterised by broad, landscape-scale natural features and environmental processes that influence the functions of entire ecosystems. They capture the large-scale geophysical patterns across Australia. These patterns in the landscape are linked to fauna and flora assemblages and processes at the ecosystem scale, thus providing a useful means for simplifying and reporting on more complex patterns of biodiversity. Subregions, as described by Morgan and Terrey (1992), are 'based on finer differences in geology, vegetation and other biophysical attributes and are the basis for determining the major regional ecosystems'.

The IBRA Interim Biogeographic Regionalisation of Australia (IBRA), and IBRA subregion inform the identification of PCT and habitat suitability for threatened species. Biodiversity does not recognise administrative boundaries, which is another reason to use a bioregional approach to assess all land across the region.

3.1.2 NSW Landscapes (Mitchell Landscapes)

The subject land traverses two different Michell Landscapes, the Barrier Downs and Barrier Ranges (Figure 3-2).These are summarised in Table 3-1.

NSW (Mitchell) Landscapes were developed for conservation planning and reserve establishment purposes and to provide consistent state-wide ecological units finer than the

existing bioregions and sub-regions. They have relatively homogeneous geomorphology, soils and broad vegetation types, and help to provide site context for the subject land.

Table 3-1: NSW Landscapes descriptions

Name	Description	Percent cleared
Barrier Downs	Barrier Downs ecosystem includes parts of nine land systems: *Bancannia, Cymbric, Floods Creek, Gap Hills, Katalpa, Nine Mile, Nundora, Nuntherungie* and *Oak Vale.* A complex landscape of the low strike ridges of rock outcrop, slopes and outwash areas of the Barrier Ranges. Steeply rolling lowlands on pre-Cambrian dolomite and calcareous shale and steeply dipping Devonian sandstone and conglomerate, with dense incised drainage, relief to 30m. Lithosols or shallow calcareous sandy loams on ridges, contour banded slopes of alternating stony red desert loams and stone-free red clays or solonized brown soils on long slopes. Dunes of deep clayey sand. Stony reddish-brown calcareous sandy loams, along drainage tracts, alluvial flats with brown self-mulching cracking clays. Ridges with scattered Mulga (*Acacia aneura),* prickly wattle (*Acacia victoriae),* low bluebush (*Maireana astrotricha),* scattered black bluebush (*Maireana pyramidata),* dead finish (*Acacia tetragonophylla),* some pearl bluebush (*Maireana sedifolia)* and isolated harlequin fuchsia (*Eremophila duttonii).* Slopes with isolated Mulga and needlewood (*Hakea leucoptera)* with scattered shrubs; local stands of dense low bluebush, contour banded bladder saltbush (*Atriplex vesicaria),* cabbage-tree wattle (*Acacia cana),* belah (*Casuarina cristata),* and pearl bluebush (*Maireana sedifolia),* with local clumps of moderately dense belah (*Casuarina cristata)* and Mulga, abundant bottlewashers (*Enneapogon* sp.) and copperburr (*Sclerolaena* sp.). Flats with copperburr, thorny saltbush (*Rhagodia* spinescens) and grasses and drainage lines with prickly wattle, western boobialla (*Myoporum montanum),* sandalwood (*Santalum lanceolatum),* rosewood (*Alectryon oleifolium),* belah (*Casuarina cristata),* white cypress pine (*Callitris glaucophylla)* and black box *(Eucalyptus largiflorens).* River red gum *(Eucalyptus camaldulensis)* along larger streams (Mitchell, 2008).	0%
Barrier Ranges	Barrier Ranges ecosystem includes parts of six land systems: *Barrier, Faraway, Mulga Dam, Nundooka, Umberumberka* and *Wonaminta.* Densely dissected ranges mainly of lower to middle Proterozoic metamorphic rocks including several varieties of gneiss, schist, amphibolite and pegmatites with north-east structural trends. Steep, partly bevelled, asymmetric strike ridges on associated dipping upper Proterozoic quartzite, sandstone and shales. Relief 30 to 200m. Trellised drainage patterns, narrow and incised in higher relief country. Rock outcrop and lithosols on upper slopes, red texture-contrast soils, locally calcareous, and contour banded steps on lower slopes. Shallow reddish-brown calcareous stony loamy sands on calcareous sandstone. Drainage tracts with reddish brown and yellowish-brown texture-contrast soils with coarse sands in channels. Rocky crests with little soil support scattered Mulga (*Acacia aneura),* dead finish (*Acacia tetragonophylla),* black bluebush (*Maireana pyramidata)* and bottlewashers (*Enneapogon* sp.). Upper slopes carry Mulga, black bluebush, pearl bluebush (*Maireana sedifolia),* bladder saltbush (*Atriplex vesicaria),* copperburr (*Sclerolaena* sp.) and grasses. Thorny saltbush (*Rhagodia* spinescens), prickly wattle (*Acacia victoriae),* belah (*Casuarina cristata)* and black bluebush on lower slopes. Alluvial flats support black bluebush, bladder saltbush (*Atriplex vesicaria),* belah, prickly wattle, copperburr, bottlewashers (*Enneapogon* sp.), *Sida* sp., and grasses. River red gum *(Eucalyptus camaldulensis)* along larger channels (Mitchell, 2008).	0%

3.1.3 Watercourses

Landscape features such as distance to water and land-use can greatly influence the ecology of an area and consequently the likelihood that protected matters are present.

No watercourses in the subject land were mapped in the Directory of Important Wetlands or as part of a Ramsar site.

Three unnamed ephemeral watercourses occur in the subject land (Figure 3-3). The proposal will intersect two second Strahler Order ephemeral drainage line and one first Strahler Order ephemeral drainage line. The non perennial ephemeral watercourses are unlikely to support fish species through lack of permanent water.

The proposed rising main intersects and runs adjacent to an unnamed drainage channel.

Figure 3-1: IBRA bioregions and subregions

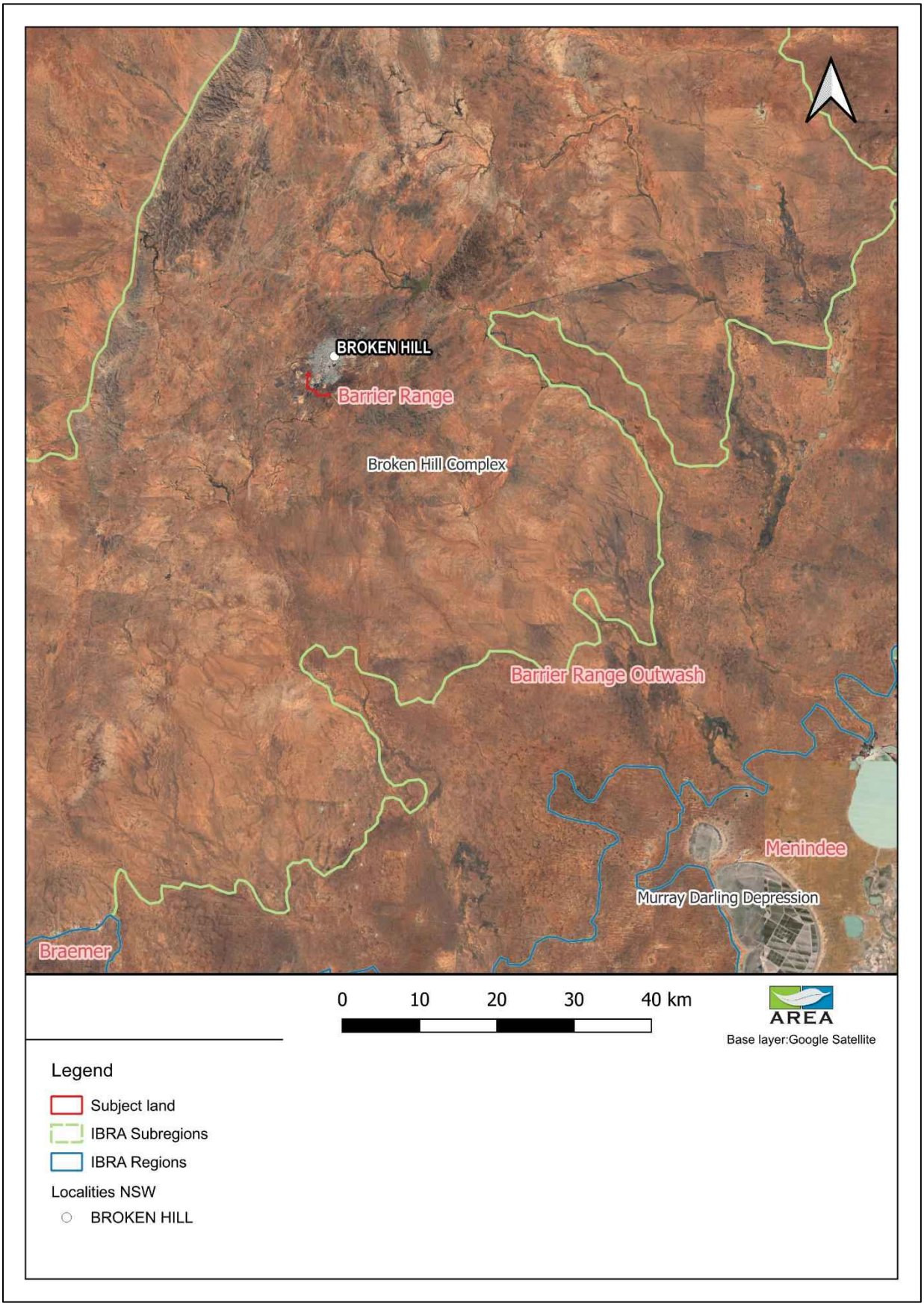


Figure 3-2: NSW (Mitchell) Landscapes

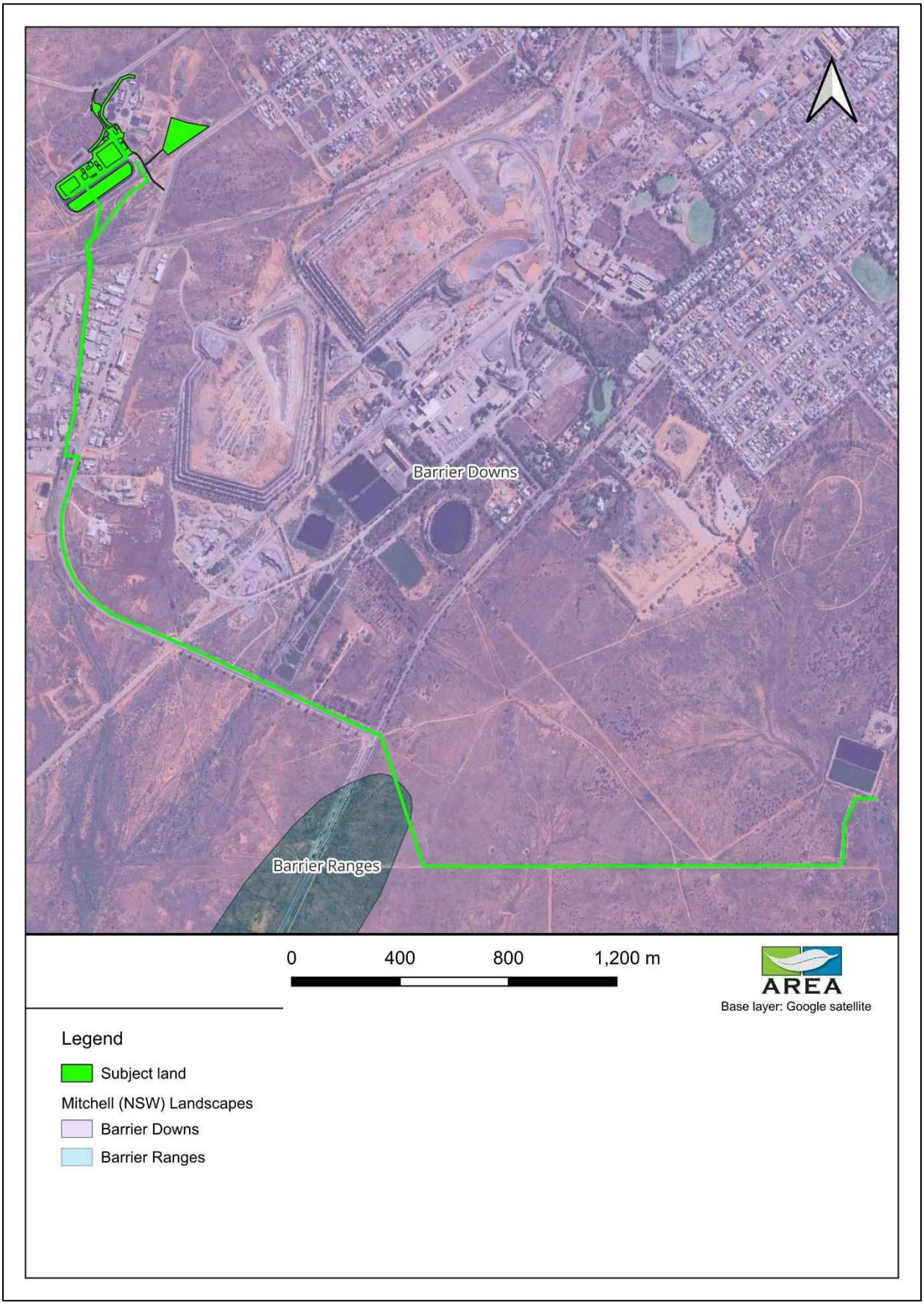
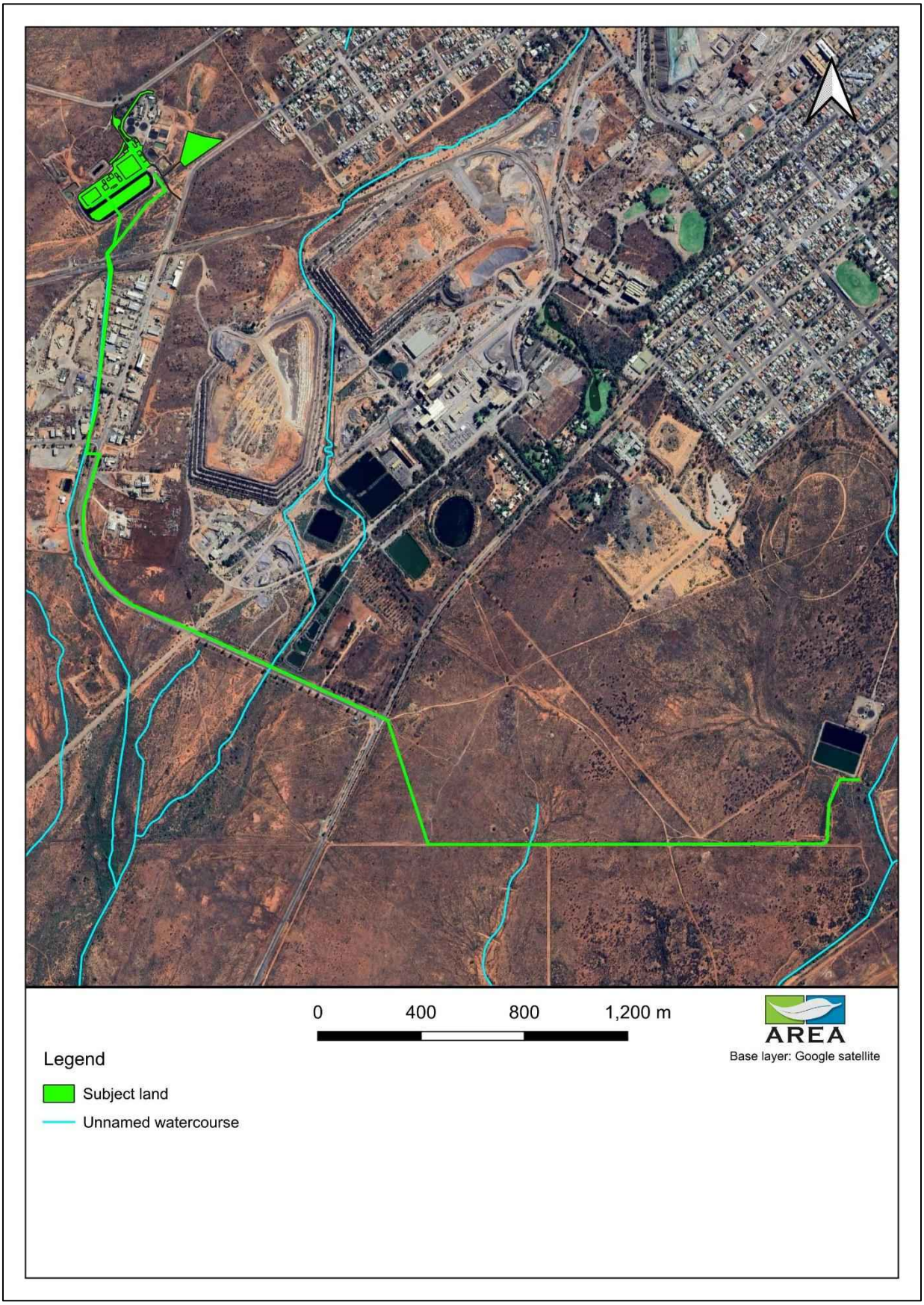


Figure 3-3: Watercourses



3.1.4 Land use

Land uses are mapped, representing a range of historic land use impacts, from cropping to nature conservation (Figure 3-4).

Land use mapping captures how the landscape in NSW is being used for food production, forestry, nature conservation, infrastructure, and urban development. It can be used to monitor changes in the landscape and identify impacts on biodiversity values and individual ecosystems.

Land Use mapped within the subject land include.

- 2.1.0 Grazing native vegetation
- 5.3.0 manufacturing and industrial
- 5.5.0 services
- 5.7.0 transport and communication
- 5.8.0 mining
- 5.9.0 waste treatment and disposal
- 1.3.0 other minimal use.

3.1.5 Climate

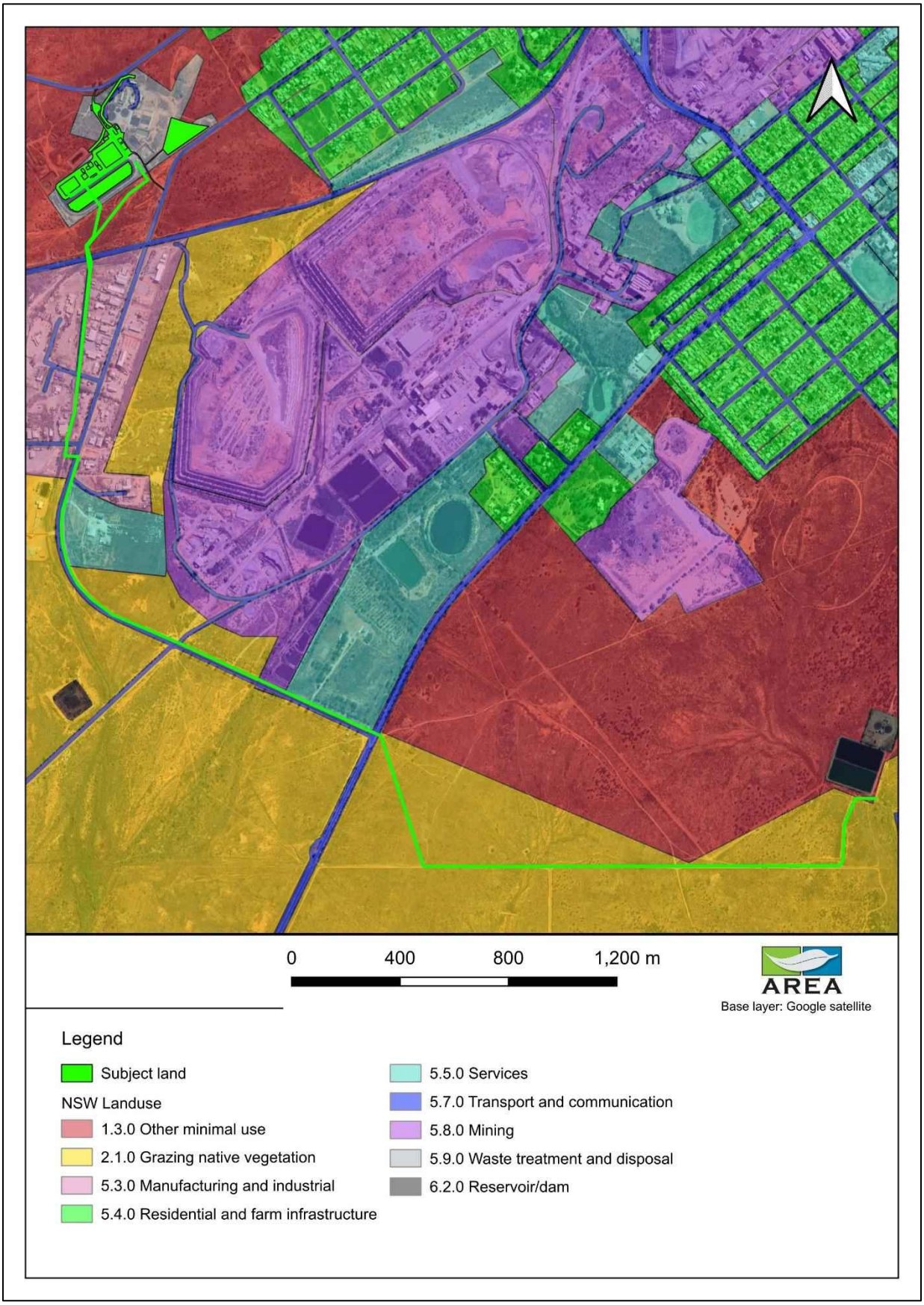
The long-term climate statistics were collected from the Broken Hill Airport AWS (47048) (Table 3-2). Weather conditions during the field survey were fine and sunny.

Table 3-2: Climate statistics for Broken Hill Airport AWS (BoM, 2024)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Max (°C)	33.8	32.5	29.1	24.4	19.1	16.0	15.6	17.9	21.9	25.6	28.8	31.7	24.7
Mean Min (°C)	19.4	18.5	15.4	11.4	7.7	5.7	4.9	5.6	8.4	11.6	14.8	17.4	11.7
Mean Rain (mm)	29.3	18.7	21.6	20.6	19.5	15.2	16.7	18.0	21.3	25.4	21.6	20.6	249.0

red = highest value blue = lowest value

Figure 3-4: Land use



3.2 Ecological context

3.2.1 EPBC Protected Matters

An EPBC Protected Matters Report generated for this proposal considered environmental matters within a 1500 metre buffer of the proposal. This report is provided in Appendix B and summarised in Table 3-3.

Potential impacts to species and communities highlighted are considered in the following sections of this report.

Table 3-3: EPBC Protected Matters Report summary

MNES	Result	Relevance to this assessment
World Heritage Properties	None	-
National Heritage Places	1	City of Broken Hill
Wetlands of International Importance	None	-
Great Barrier Reef Marine Park	None	-
Commonwealth Marine Area	None	-
Listed Threatened Ecological Communities	None	
Listed Threatened Species	17	Section 4.4 and Section 5.1.4
Listed Migratory Species	8	Section 5.1.5
Commonwealth Land	3	Defence housing Authority Transport and Regional Services – Airservices Australia Unknown - Commonwealth Land
Commonwealth Heritage Places	None	-
Listed Marine Species	13	All birds, considered as Migratory Species, Section 5.1.5
Whales and Other Cetaceans	None	-
Critical Habitats	None	-
Commonwealth Reserves Terrestrial	None	-
Australian Marine Parks	None	-
Habitat Critical to the survival of Marine Turtles	None	-
State and Territory Reserves	None	-
Regional Forest Agreements	None	-
Nationally Important Wetlands	None	-
EPBC Act Referrals	6	Not relevant - see Appendix B
Key Ecological Features (Marine)	None	-
Biologically Important Areas	None	-
Bioregional Assessments	None	-
Geological and Bioregional Assessments	None	-

3.2.2 Predicted species

Desktop results using the IBRA Barrier Range subregion threatened species search, identified a total of 69 EPBC and or BC listed species predicted to occur in the subregion where the proposal site is located (Appendix B) (Department of Climate Change, Energy, the Environment and Water, 2024).

Of these, eight species have previously been recorded within 1500 meters of the proposal (Table 3-4 and Figure 3-5) (Office of Environment and Heritage, 2017).

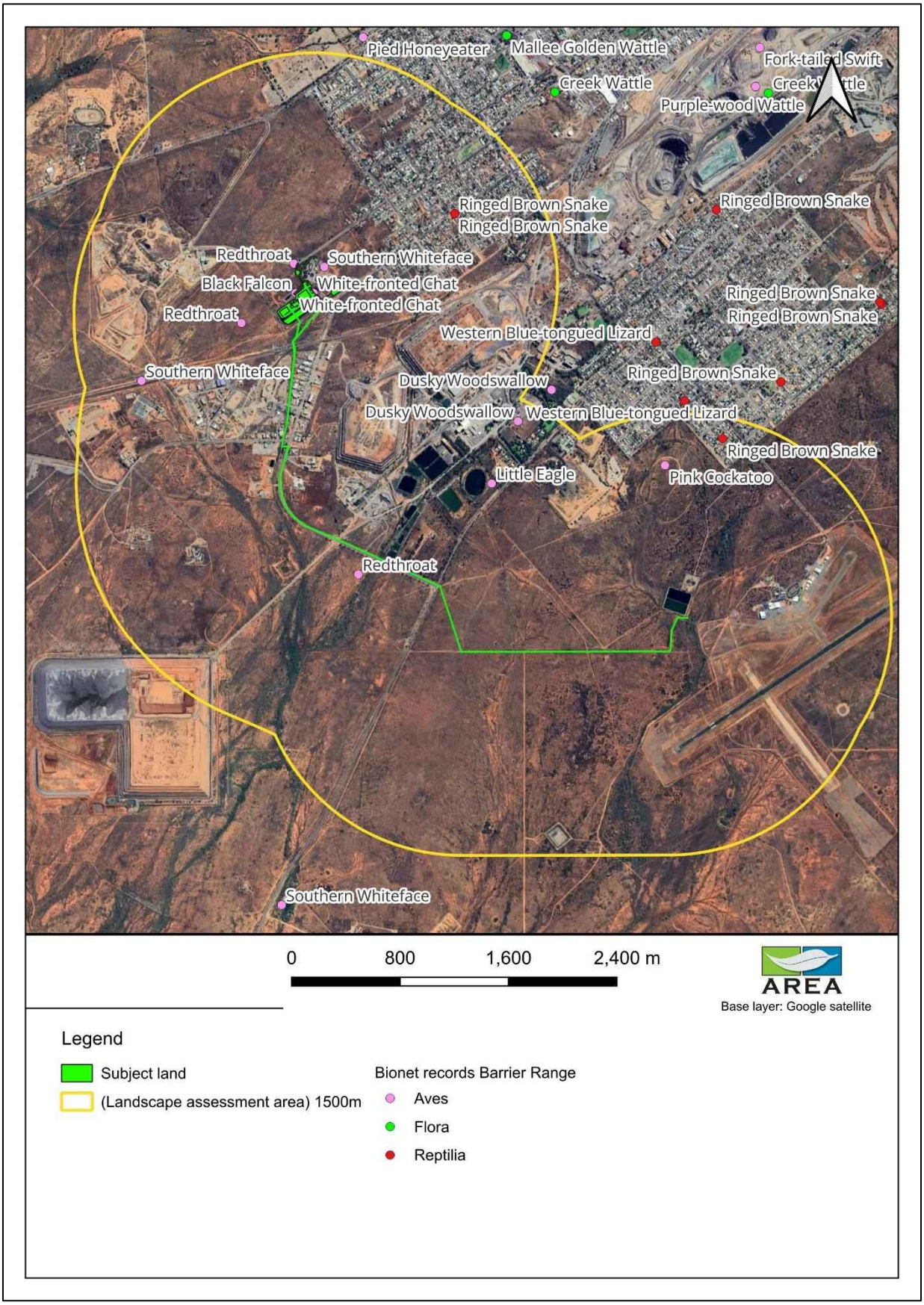
A full of list of threatened species with potential to occur in the subject land is provided in Appendix B.

Table 3-4: BioNet results within landscape assessment buffer

Scientific name	Common name	NSW status	Commonwealth status
Aves			
Aphelocephala leucopsis	Southern Whiteface	V	V
Artamus cyanopterus cyanopterus	Dusky Woodswallow	V	NL
Certhionyx variegatus	Pied Honeyeater	V	NL
Epthianura albifrons	White-fronted Chat	V	NL
Falco subniger	Black Falcon	V	NL
Hieraaetus morphnoides	Little Eagle	V	NL
Lophochroa leadbeateri	Pink Cockatoo	V	NL
Pyrrholaemus brunneus	Redthroat	V	NL
Rostratula australis	Australian Painted Snipe	E	E
Reptiles			
Pseudonaja modesta	Ringed Brown Snake	V	NL

V = Vulnerable E = Endangered CE = Critically Endangered M = Migratory NL = Not Listed

Figure 3-5: BioNet records within the landscape assessment area



3.2.3 Plant Community Types

State Vegetation Map (SVM) Western SVM 4492, was used to determine PCTs with potential to occur within the subject land.

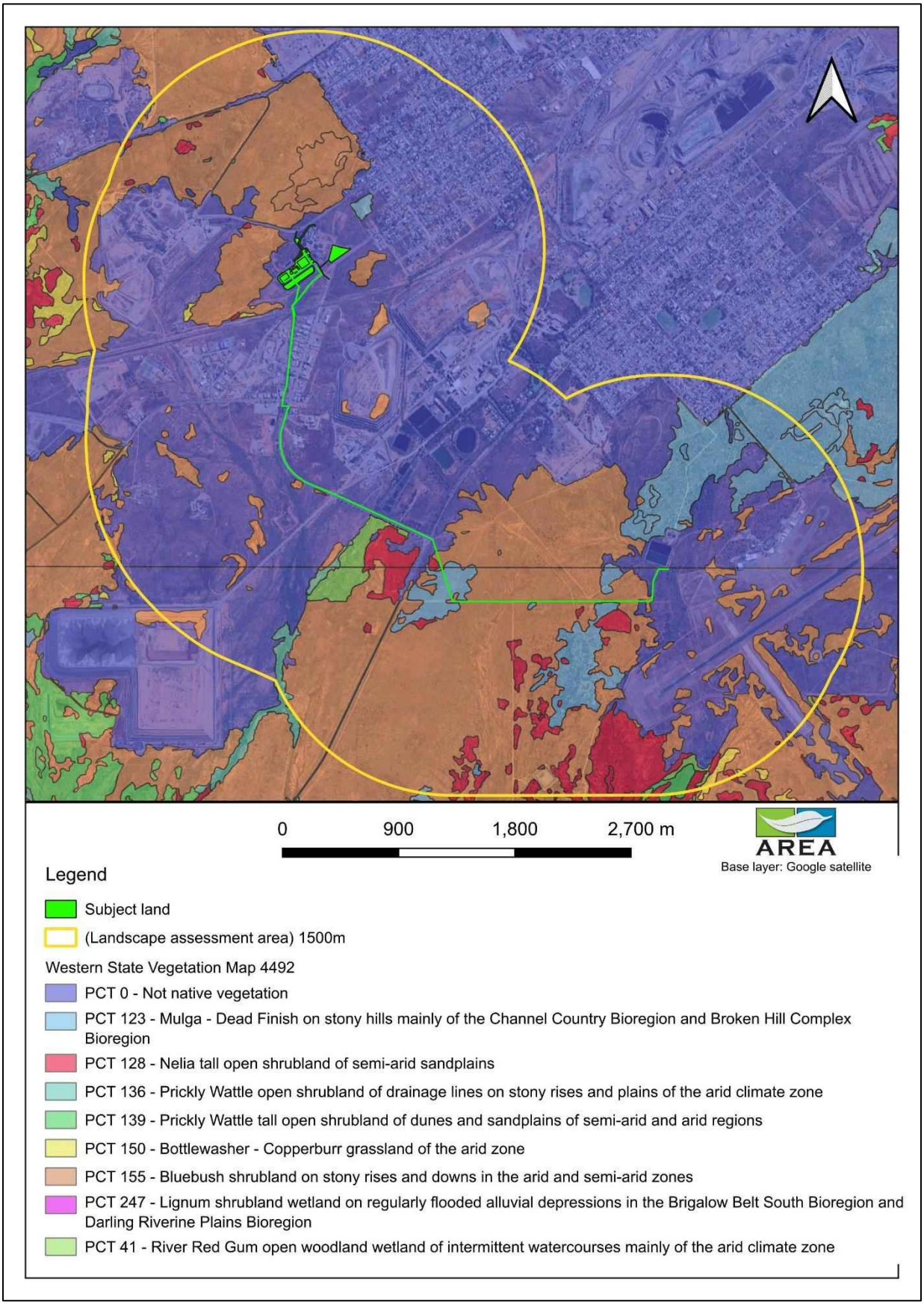
Nine PCTs including not native vegetation were mapped as potentially occurring within 1500 metres of the subject land described in Table 3-5 and (Figure 3-6).

Table 3-5: Plant Community Types mapped within 1500 metres

PCT ID	PCT Name	Formation	Class
0	Not Native	Not Native	Not Native
41	River Red Gum open woodland wetland of intermittent watercourses mainly of the arid climate zone	Semi-arid Woodlands (Grassy sub-formation)	North-west Floodplain Woodlands
123	Mulga - Dead Finish on stony hills mainly of the Channel Country Bioregion and Broken Hill Complex Bioregion	Arid Shrublands (Acacia sub-formation)	Stony Desert Mulga Shrublands
128	Nelia tall open shrubland of semi-arid sandplains	Arid Shrublands (Acacia sub-formation)	Sand Plain Mulga Shrublands
136	Prickly Wattle open shrubland of drainage lines on stony rises and plains of the arid climate zone	Arid Shrublands (Chenopod sub-formation)	Gibber Chenopod Shrublands
139	Prickly Wattle tall open shrubland of dunes and sandplains of semi-arid and arid regions	Arid Shrublands (Acacia sub-formation)	Sand Plain Mulga Shrublands
150	Bottlewasher - Copperburr grassland of the arid zone	Arid Shrublands (Chenopod sub-formation)	Gibber Chenopod Shrublands
155	Bluebush shrubland on stony rises and downs in the arid and semi-arid zones	Arid Shrublands (Chenopod sub-formation)	Gibber Chenopod Shrublands
247	Lignum shrubland wetland on regularly flooded alluvial depressions in the Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion	Freshwater Wetlands	Inland Floodplain Shrublands

Generally, the vegetation within the subject land reflects historic ground surface disturbance and is altered from prior clearing activities. Native and not native vegetation exists throughout the subject land.

Figure 3-6: Plant Community Types from the State Vegetation Type Map



3.2.4 Threatened Ecological Communities

IBRA and MNES database searches identified two TECs as potentially occurring in the subject land (Table 3-6).

Table 3-6: Predicted Threatened Ecological Communities

Threatened Ecological Community	NSW status	Commonwealth status
Porcupine Grass Red Mallee Gum Coolabah hummock grassland/low sparse woodland in the Broken Hill Complex Bioregion	Critically Endangered Ecological Community	Not Listed
Acacia loderi shrublands	Endangered Ecological Community	Not Listed

Two additional TECs associated with PCTs mapped within the landscape assessment area were highlighted during the desktop assessment (Table 3-7).

Table 3-7: Additional TECs associated with PCTs identified in the landscape assessment area

Threatened Ecological Community	NSW status	Commonwealth status	Associated PCT
Acacia melvillei Shrubland in the Riverina and Murray-Darling Depression bioregions	Endangered Ecological Community	Not Listed	128
Artesian Springs Ecological Community in the Great Artesian Basin	Endangered Ecological Community	Not Listed	247

Field survey combined with desktop assessment results determined if any TEC are present and likely to be impacted by the development (Section 5.1.3).

3.2.5 Biodiversity Values Map

The proposal does not intersect any land mapped as Biodiversity values on the NSW Biodiversity Values Map[1] (Figure 3-7).

3.2.6 Key Fish Habitat

The proposal does not intersect areas mapped as Key Fish Habitat.

3.2.7 Environmental conservation zones

The NSW Planning Portal maps the subject land as shown below in Table 3-7 and Figure 3-8.

[1] https://www.lmbc.nsw.gov.au/Maps/index.html?viewer=BOSETMap

Table 3-8: Land zones within subject land

Land Zone code	Land Zone Name	Land Zone Purpose
E2	Environmental Conservation	Environmental Conservation
IN1	General Industrial	General Industrial
R1	General Residential	General Residential
RU2	Rural Landscape	Rural Landscape
SP1	Special Activities	Mining
SP2	Infrastructure	Road

3.2.8 Groundwater dependant ecosystems

The Bureau of Meteorology (BoM 2019) Atlas of Groundwater Dependant Ecosystems map was checked for Groundwater Dependent Ecosystems (GDEs). Results are provided in Appendix B.

The terrestrial groundwater dependence map shows areas of both low and high potential for GDEs occurring within the Landscape Assessment Area. Given the nature of the proposal and level of existing ground surface disturbance from the existing Wills Street and South Sewage Treatment Plant, impacts to terrestrial groundwater dependent ecosystems are unlikely.

No aquatic groundwater dependent ecosystems are mapped as occurring in the Landscape Assessment Area.

No subterranean groundwater dependent ecosystems are mapped as occurring in the Landscape Assessment Area.

3.2.9 Native Vegetation Regulatory (NVR) mapping

The subject land lies within land mapped as Category 2 – Regulated Land, and Land Excluded from the *Local Land Services Act 2013* (Figure 3-9) (NSW Government, 2024).

Land mapped as Category 2 – Sensitive Regulated Land lies along the southern boundary of the subject land however this would not be impacted by the proposal.

Figure 3-7: NSW Biodiversity Values Map

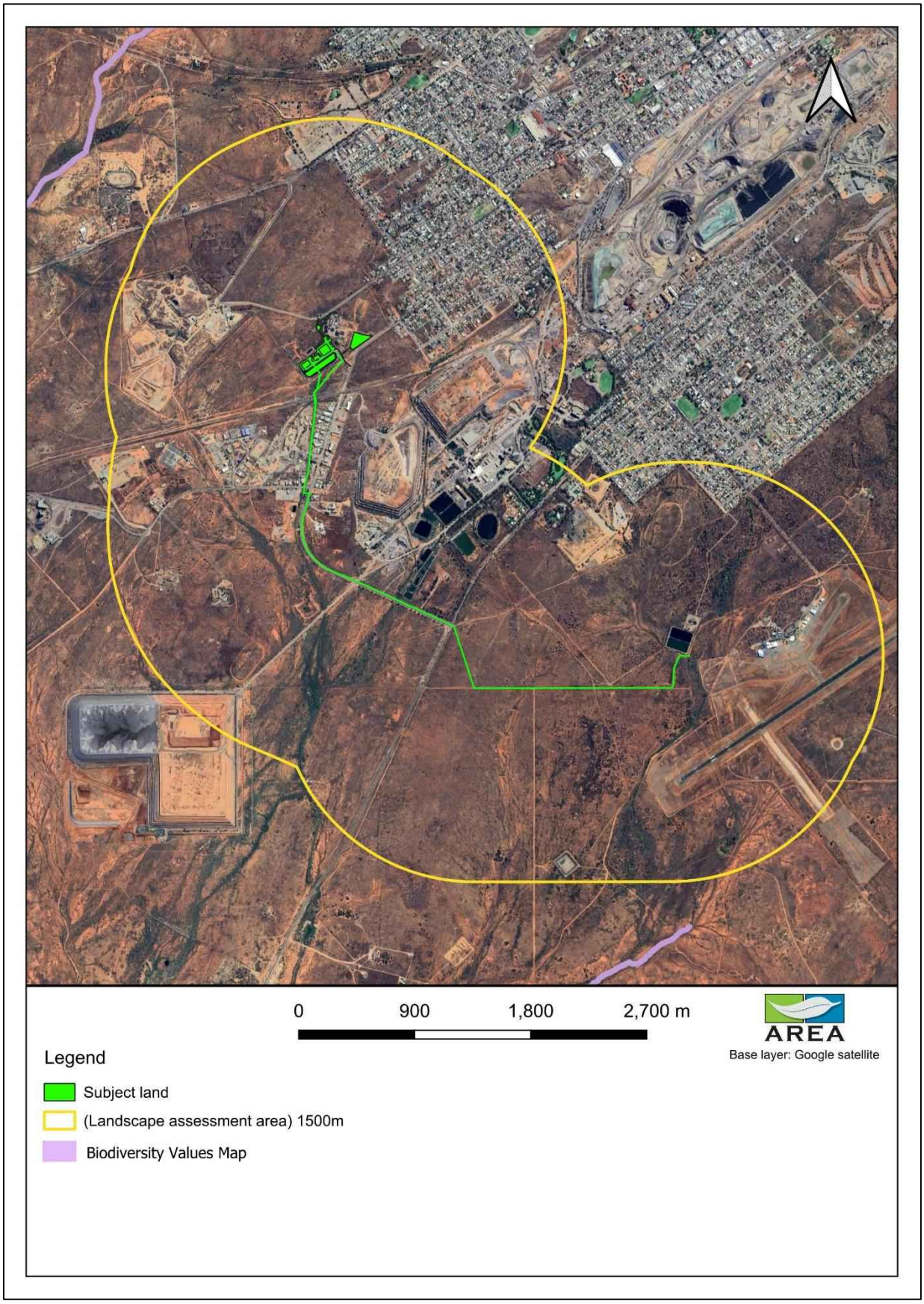


Figure 3-8: Land zone

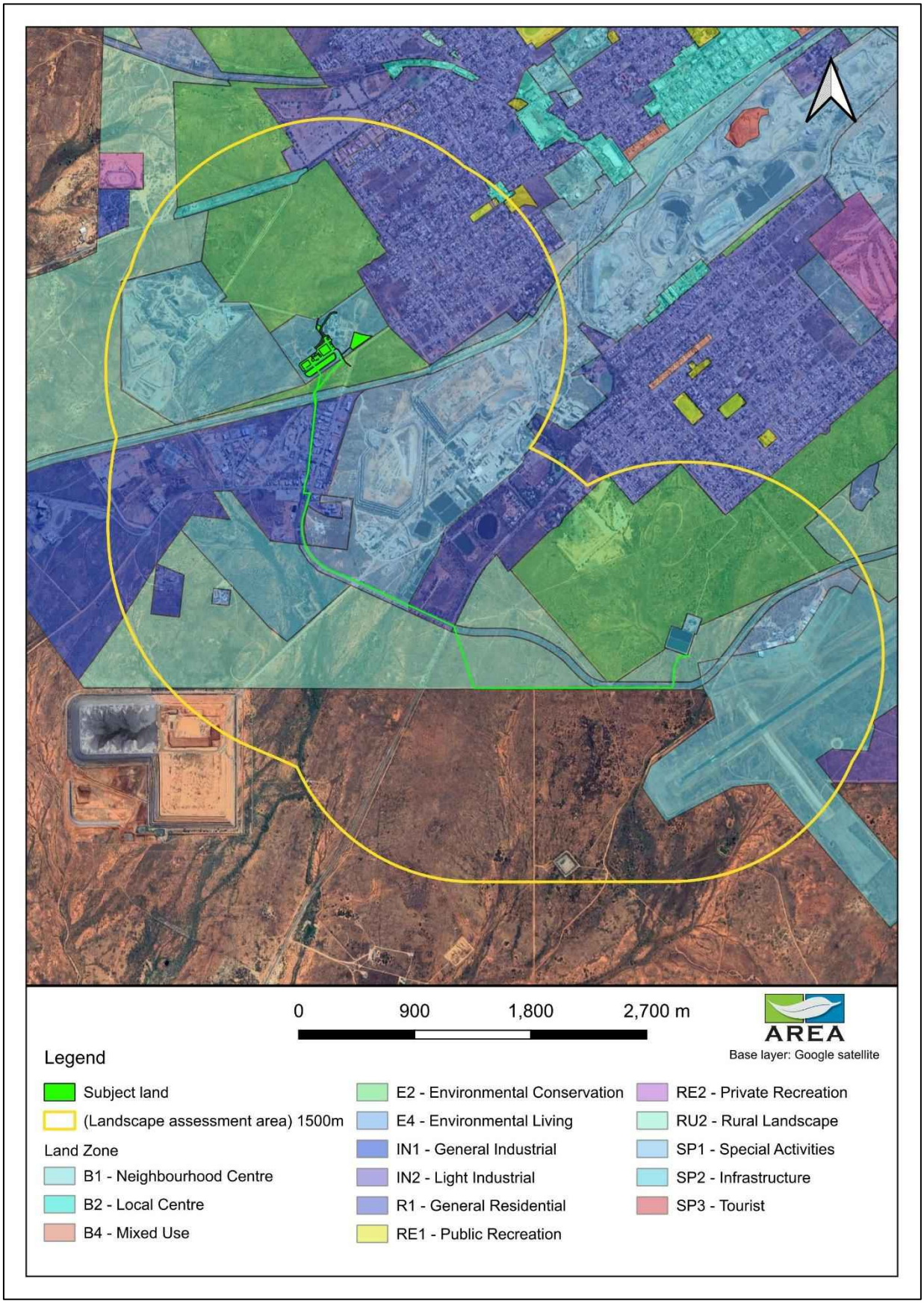
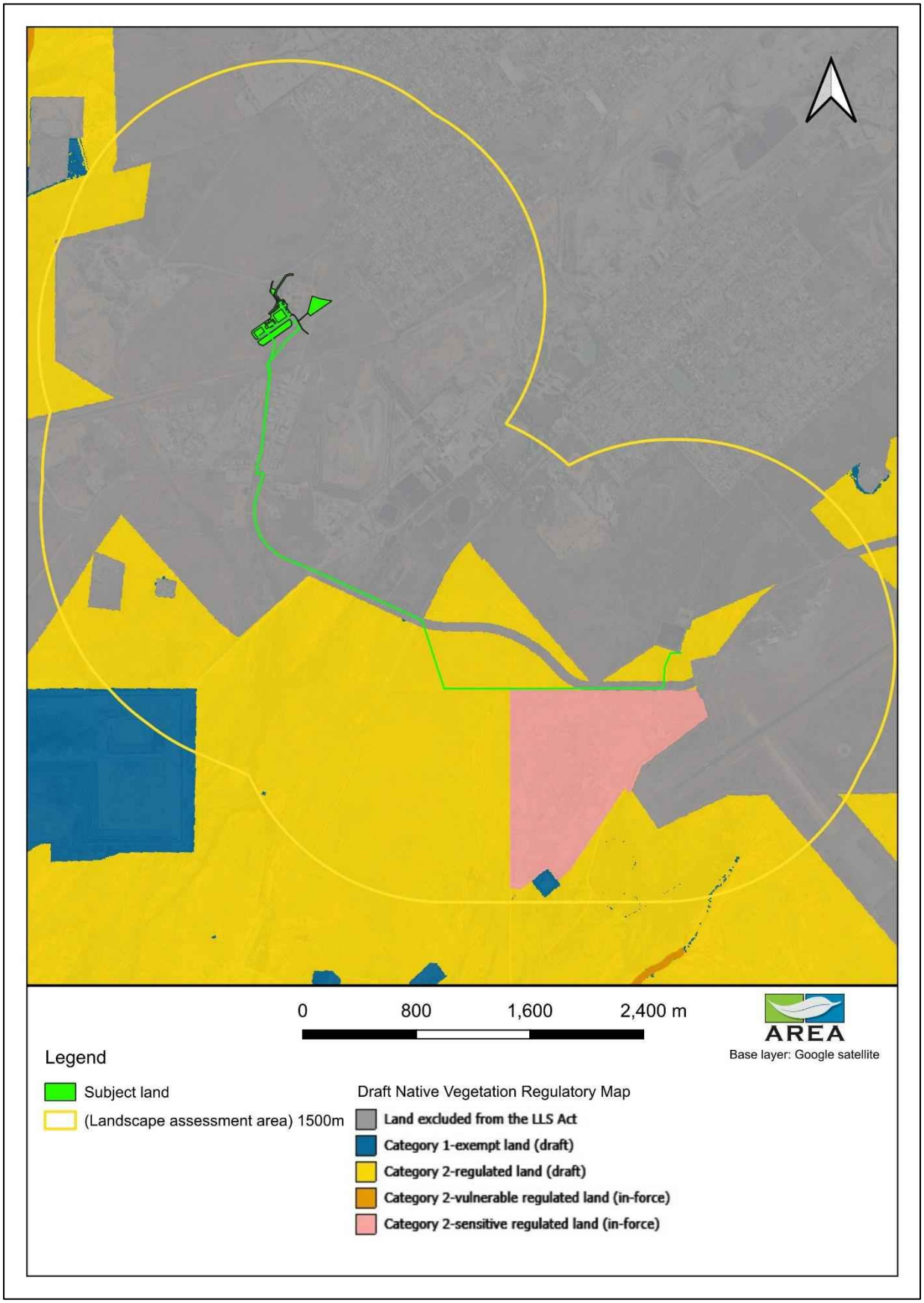


Figure 3-9: Draft Native Vegetation Regulatory Map



4 Field survey results

4.1 Search effort

The fieldwork component of this assessment was undertaken on 9 and 10 May 2023 using methods outlined in section 2.2 (Figure 4-1 to Figure 4-3).

The area surveyed during the field assessment is referred to as the study area. The study area is a 50-meter-wide corridor along the proposed rising main and the adjacent rising main access road. The proposed location of upgrades at the Wills Street STP were also assessed as the study area. The actual area of potential impact has been reduced through detailed design which has occurred between the field assessment and the preparation of this report. The area of potential impact is identified as the subject land.

Areas of the proposal comprising highly disturbed land such as existing tracks, where impacts to native vegetation and biodiversity values were determined unlikely, were not assessed in detail.

Figure 4-1: Survey effort 1 of 3

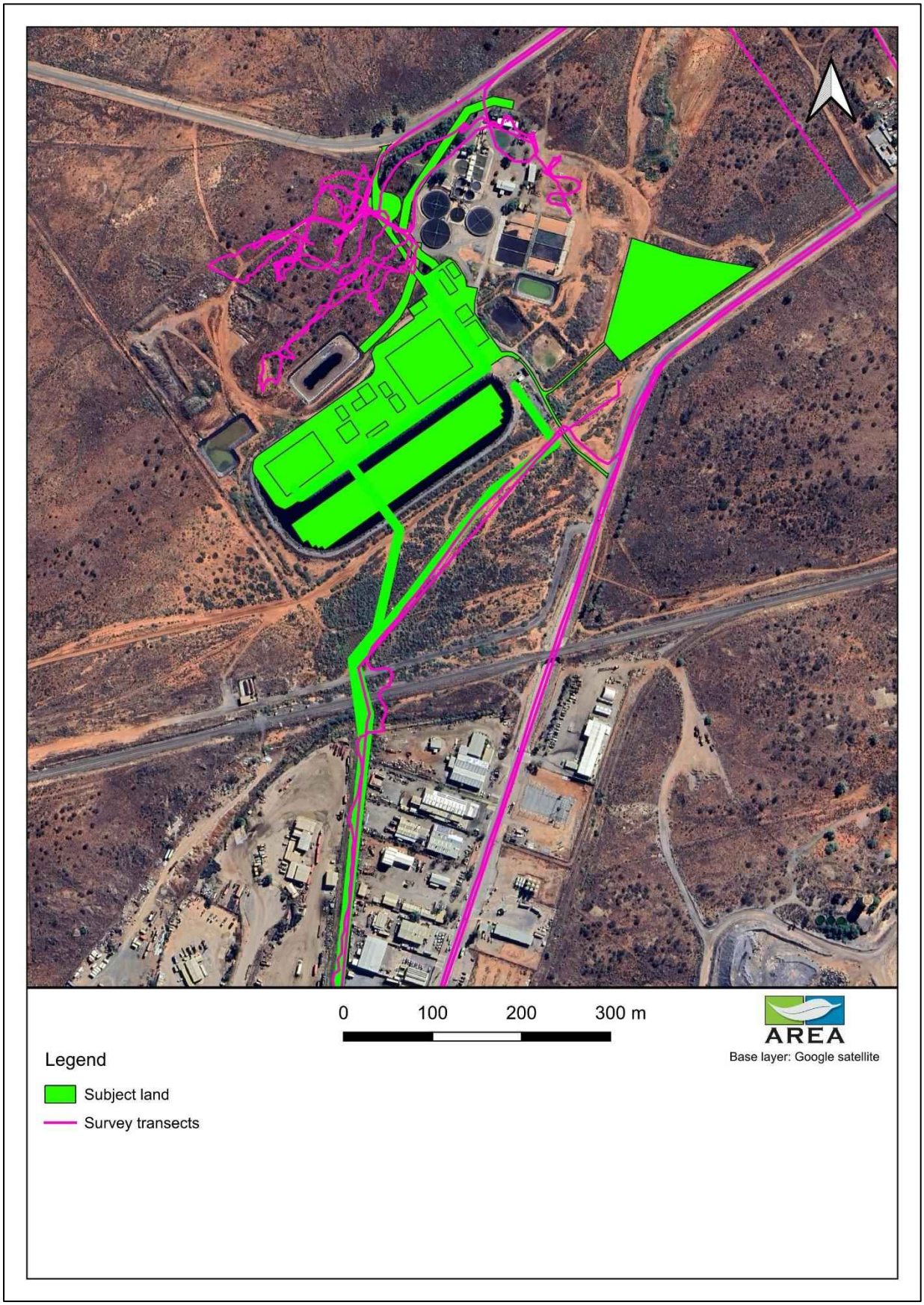


Figure 4-2: Survey effort 2 of 3

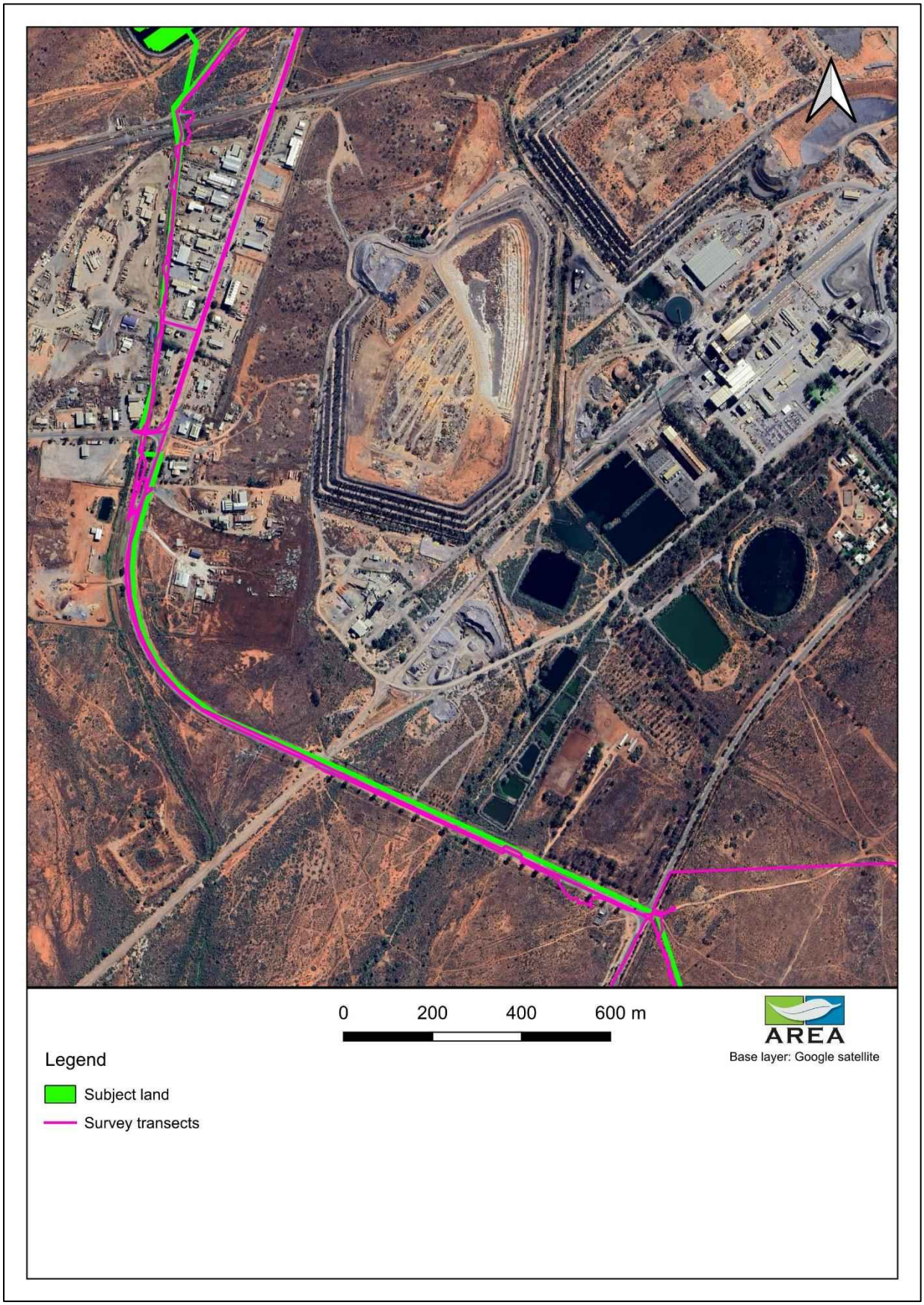
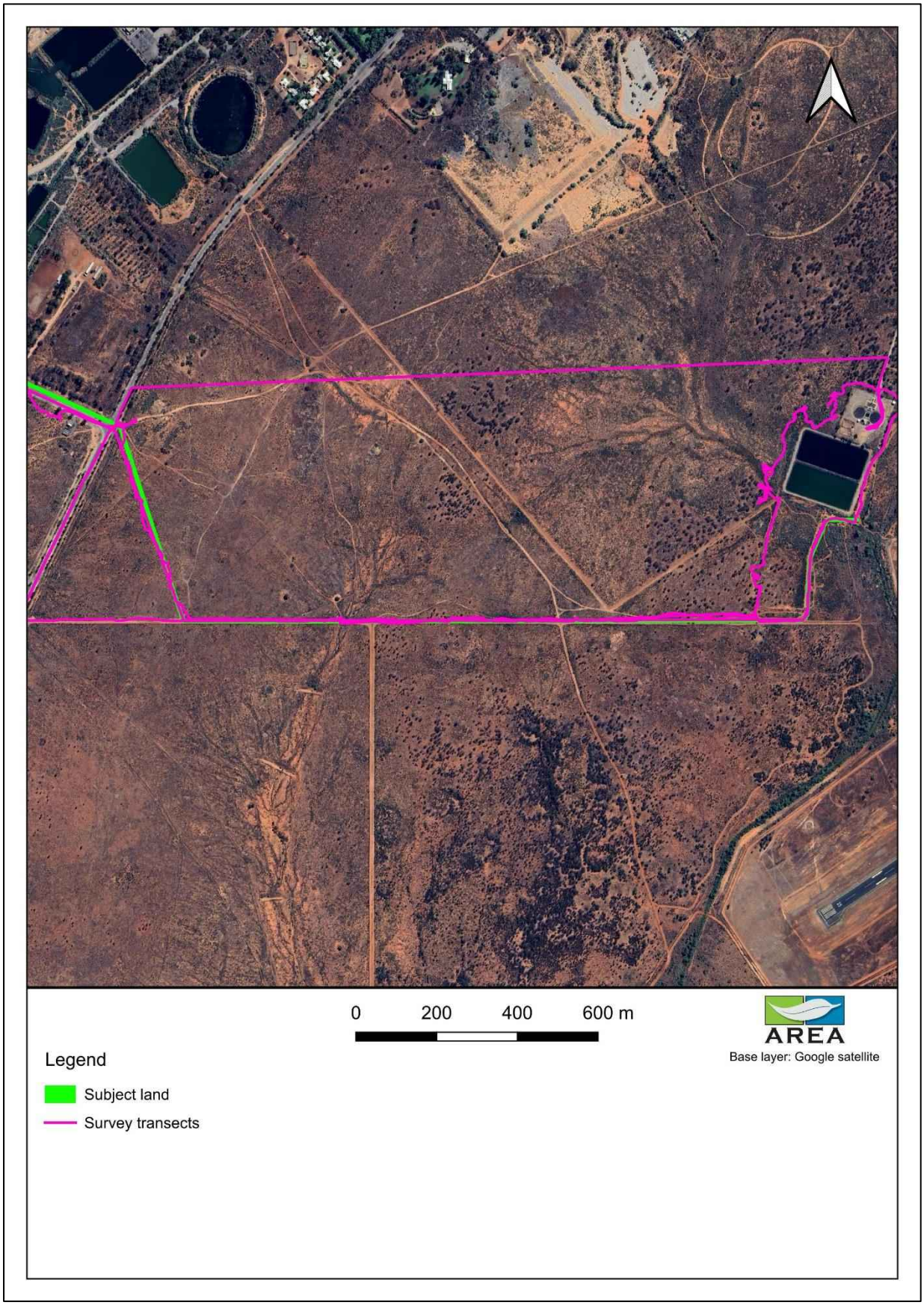


Figure 4-3: Survey effort 3 of 3



4.2 Vegetation communities

4.2.1 Plant Community Types

Plant Community Types mapped were corrected in the subject land based on field observations of mid, upper, ground stratum species and landform. PCTs confirmed as occurring within the subject land are outlined in Table 4-1. Figure 4-4 shows an overview of the ground truthed PCT map of the subject land with more detail shown inFigure 4-4: Groundtruthed PCT overview map

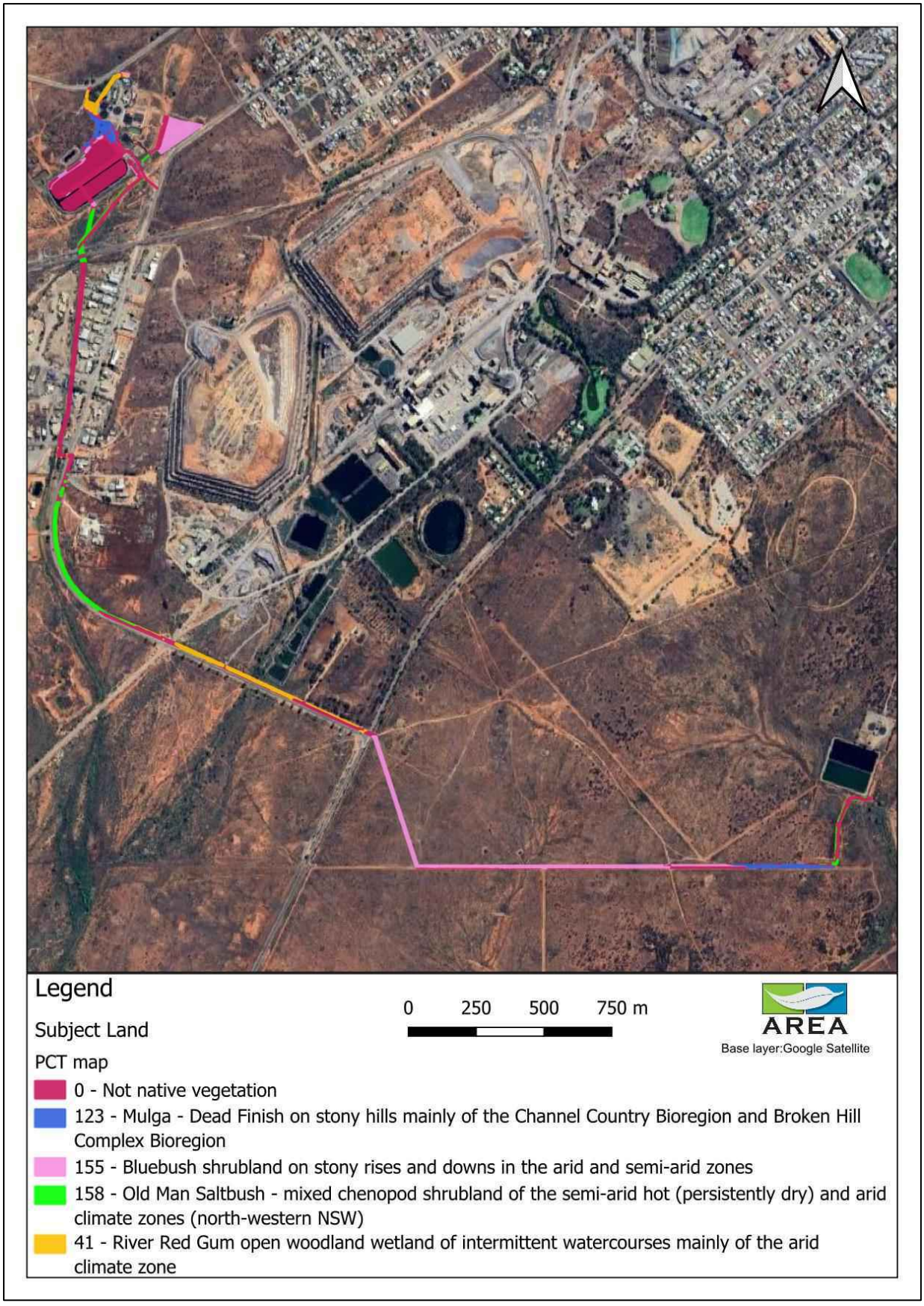


Figure 4-5 to Figure 4-11.

Two PCTs are associated with a TEC (section 4.2.2). Examples of each PCT are provided in Table 4-2.

Table 4-1: Plant Community Types recorded within the subject land

PCT ID	PCT Name	Class	Associated TEC
0	Not-Native – areas comprising largely exotic species/areas used for agriculture or unvegetated areas e.g., existing roads, tracks etc.	Non-Native	n/a
41	River Red Gum open woodland wetland of intermittent watercourses mainly of the arid climate zone	North-west Floodplain Woodlands	No associated TEC
123	Mulga - Dead Finish on stony hills mainly of the Channel Country Bioregion and Broken Hill Complex Bioregion	Stony Desert Mulga Shrublands	No associated TEC
155	Bluebush shrubland on stony rises and downs in the arid and semi-arid zones	Gibber Chenopod Shrublands	Listed BC Act, E: Acacia loderi shrublands
158	Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)	Riverine Chenopod Shrublands	Listed BC Act, CE: Artesian Springs Ecological Community in the Great Artesian Basin

The state vegetation map was used to determine which PCTs were present in the subject land during the field survey. Characteristics such as bluebush chenopod shrublands with no Mulga were used to determine the presence of PCT 155 *Bluebush shrubland on stony rises and downs in the arid and semi-arid zones.* The presence of PCT 123 *Mulga - Dead Finish on stony hills mainly of the Channel Country Bioregion and Broken Hill Complex Bioregion* was identified by the presence of Mulga *(Acacia aneura)*, Dead Finish *(Acacia tetragonophylla)* and chenopod ground stratum species.

The Northern section of the subject land at the proposed location of new incoming pipework is located within an area of PCT 41 *River Red Gum open woodland wetland of intermittent watercourses mainly of the arid climate zone.* Multiple River red Gum trees are likely to be impacted and removed within this 10-metre-wide disturbance footprint. A section of the alignment follows a drainage easement for approximately 720 meters from the southern side of the railway easement at the northern end of the alignment until the alignment intersects Kanandah Road. Vegetation within this area is predominantly Cooba *(Acacia salicina)* (some of which will require removal) with scattered River Red Gums (*Eucalyptus camaldulensis)* surrounding both remnant and revegetated since prior clearing. The ground stratum is generally weedy within this area, however, meets the characteristic of PCT 41 where upper and middle stratum species occur. The location of the drainage line in this area is also characteristic of PCT 41.

Multiple Planted (*Eucalyptus camaldulensis)* River Red Gum trees and native ground cover were also identified as occurring and potentially being impacted along Kanandah Road in the southern section of the alignment; therefore, these areas have also been classified as PCT 41.

The far southeastern section of the rising main connecting the alignment to the South Broken Hill STP was identified as PCT 158 *Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW).* This PCT was identified as best fit for this section of the subject land due to the Old Man Saltbush (*Atriplex*

nummularia) dominating the area and the presence of *Eucalyptus coolabah subs coolabah* scattered in the surrounding area with matching mid and ground stratum species.

The PCT descriptions were assessed in conjunction with site photos collected during the field survey for each PCT. Areas of the subject land which met the characteristics for each PCT were allocated as ground truthed vegetation.

Figure 4-4: Groundtruthed PCT overview map

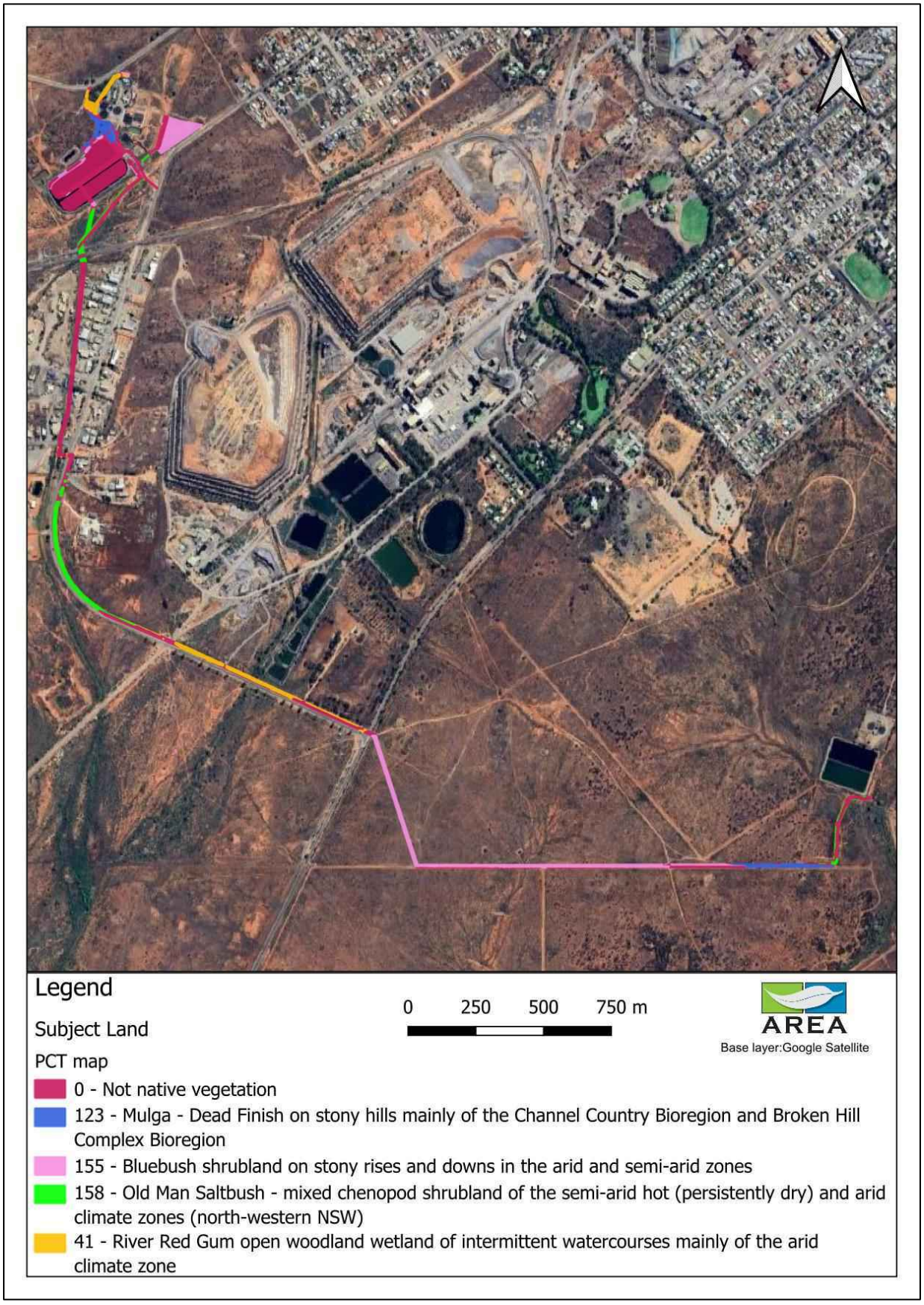


Figure 4-5: Ground truthed PCTs within subject land 1 of 7

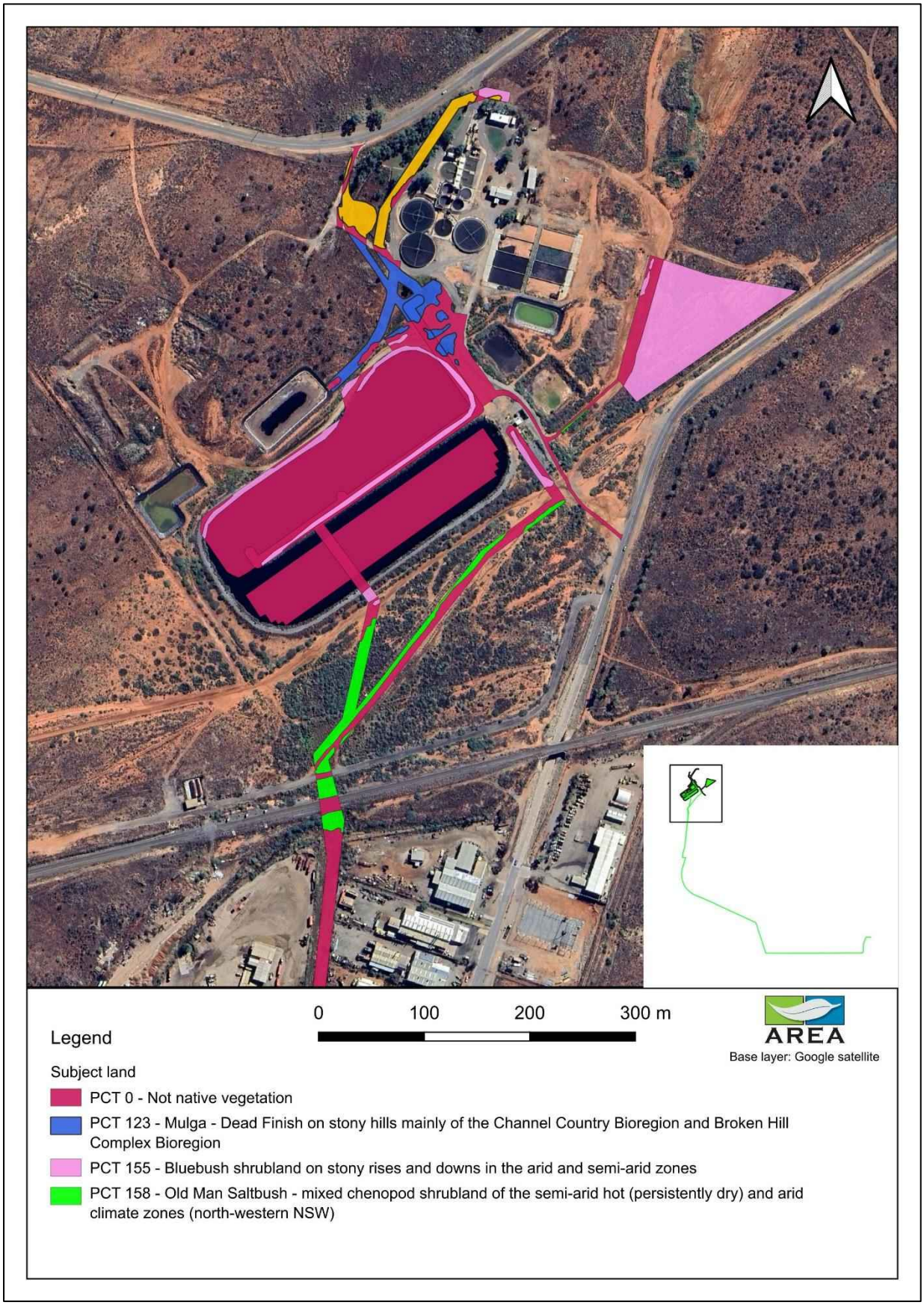


Figure 4-6: Ground truthed PCTs within subject land 2 of 7

Figure 4-7: Ground truthed PCTs within subject land 3 of 7

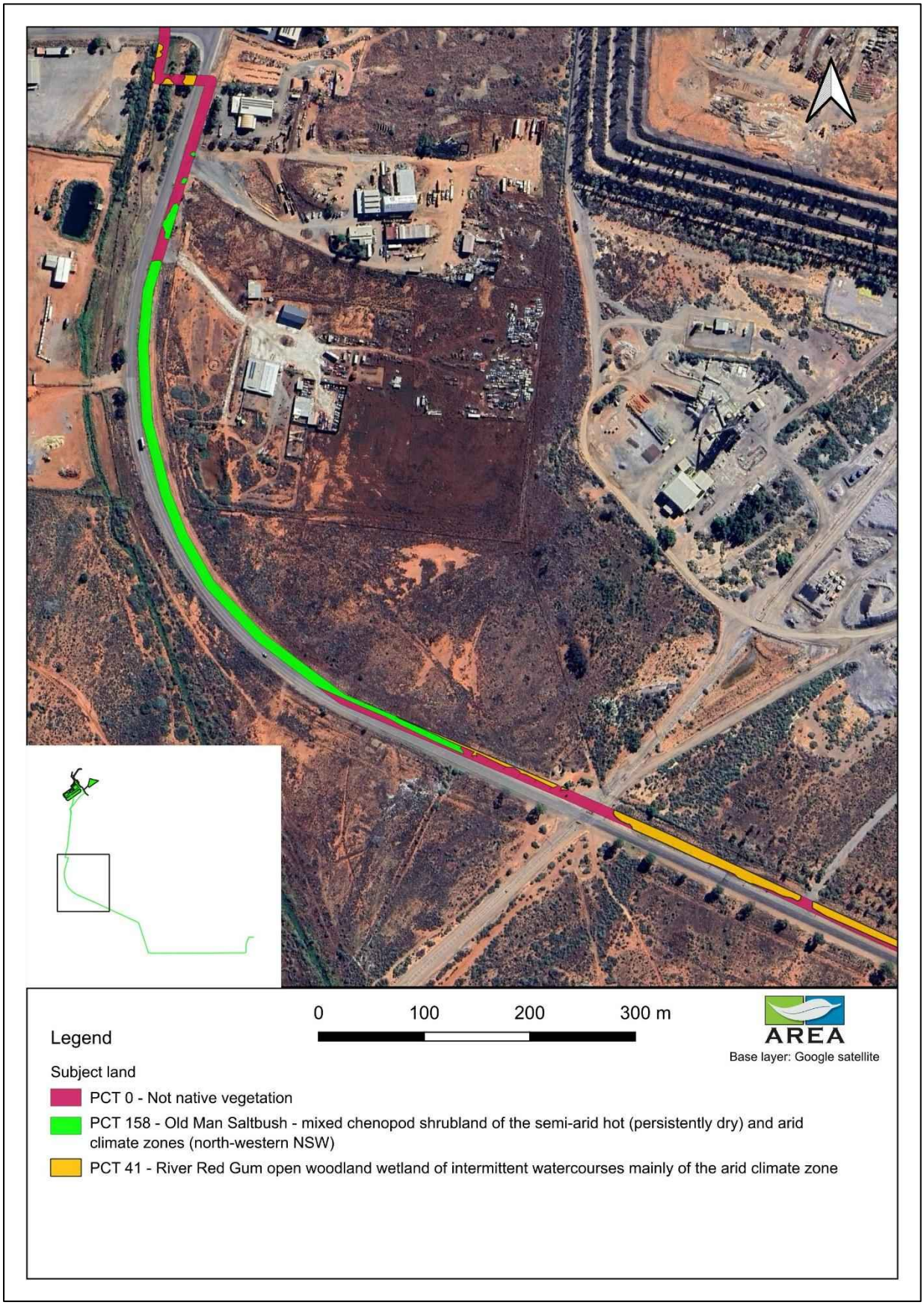


Figure 4-8: Ground truthed PCTs within subject land 4 of 7

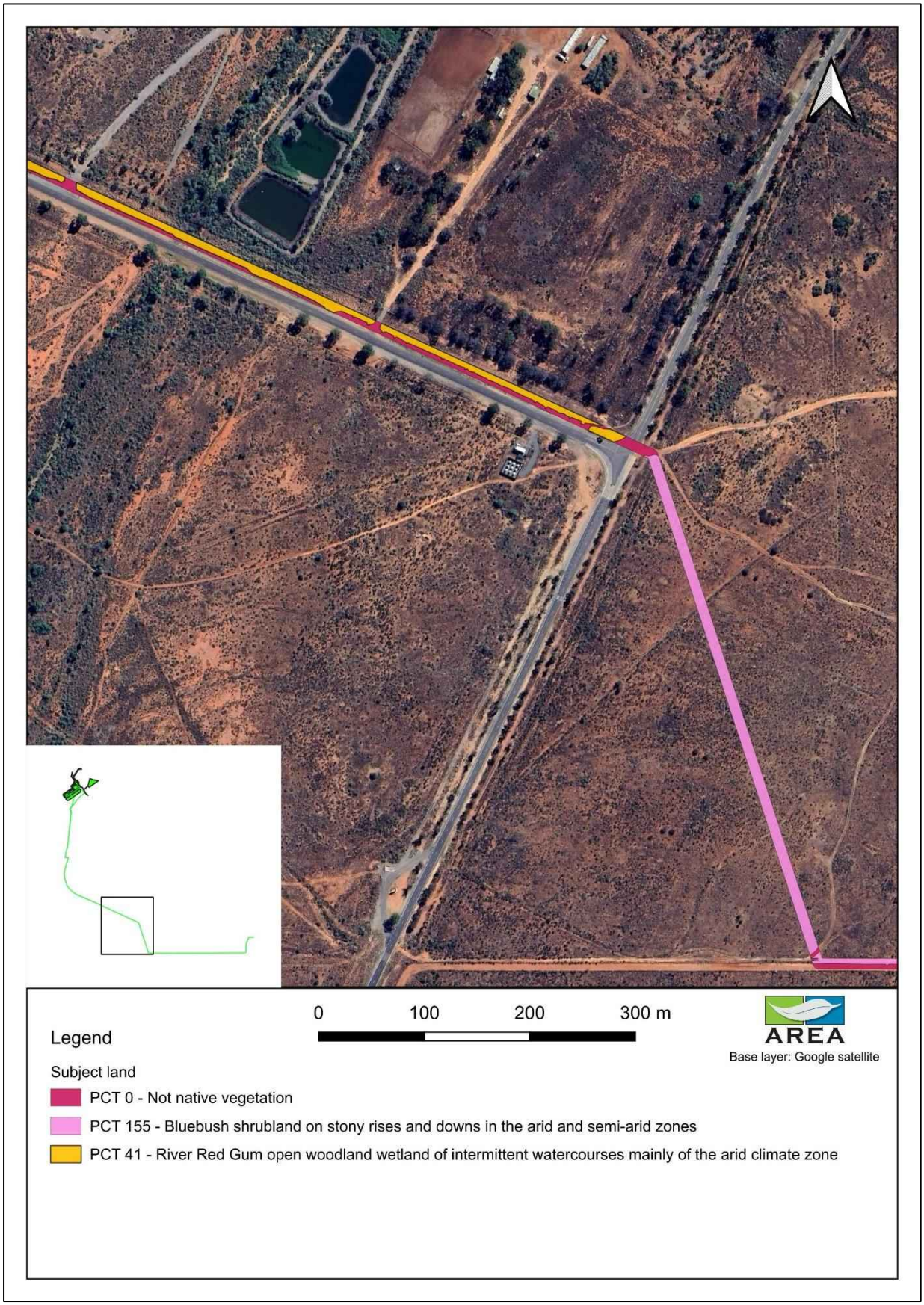


Figure 4-9: Ground truthed PCTs within subject land 5 of 7

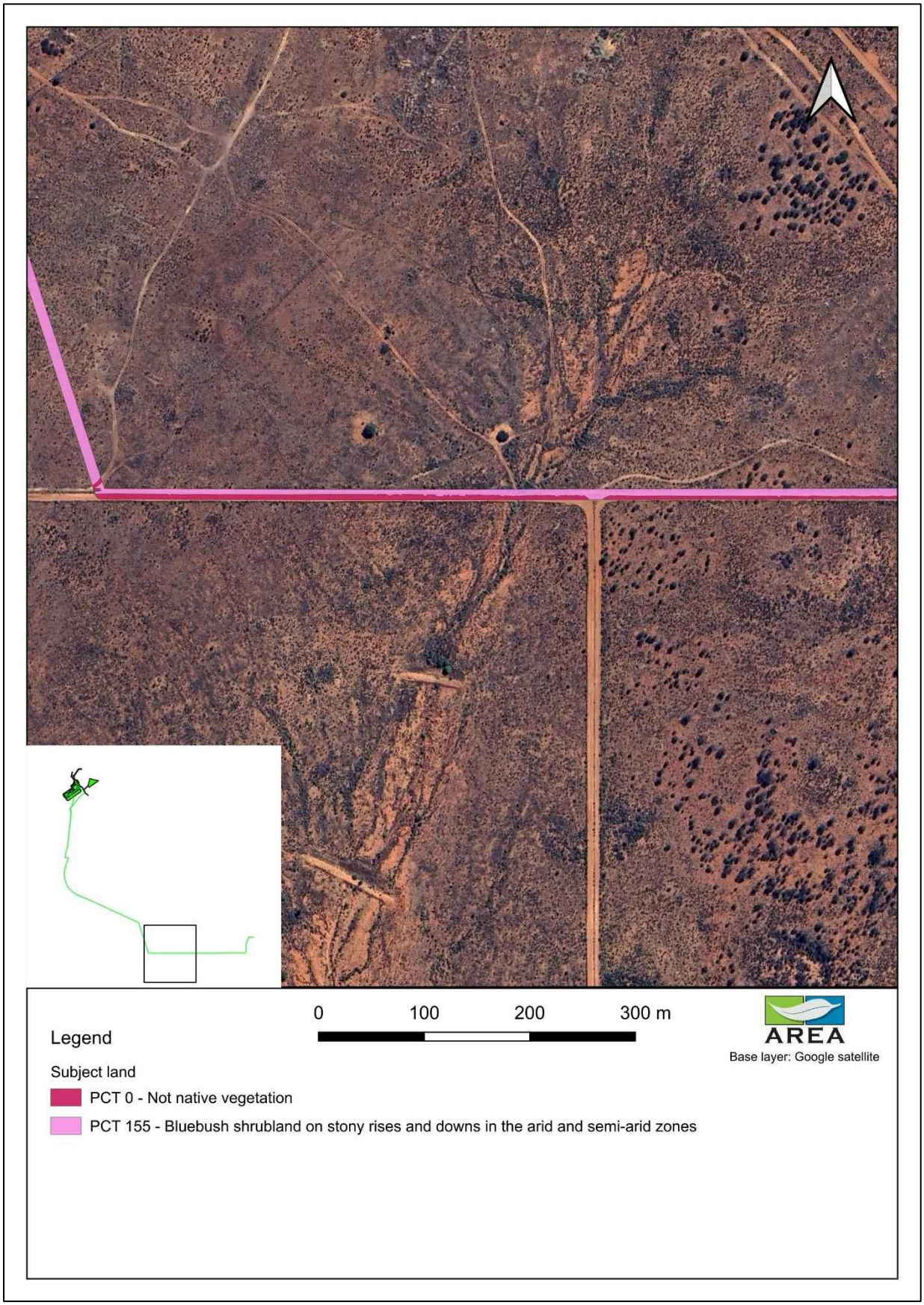


Figure 4-10: Ground truthed PCTs within subject land 6 of 7

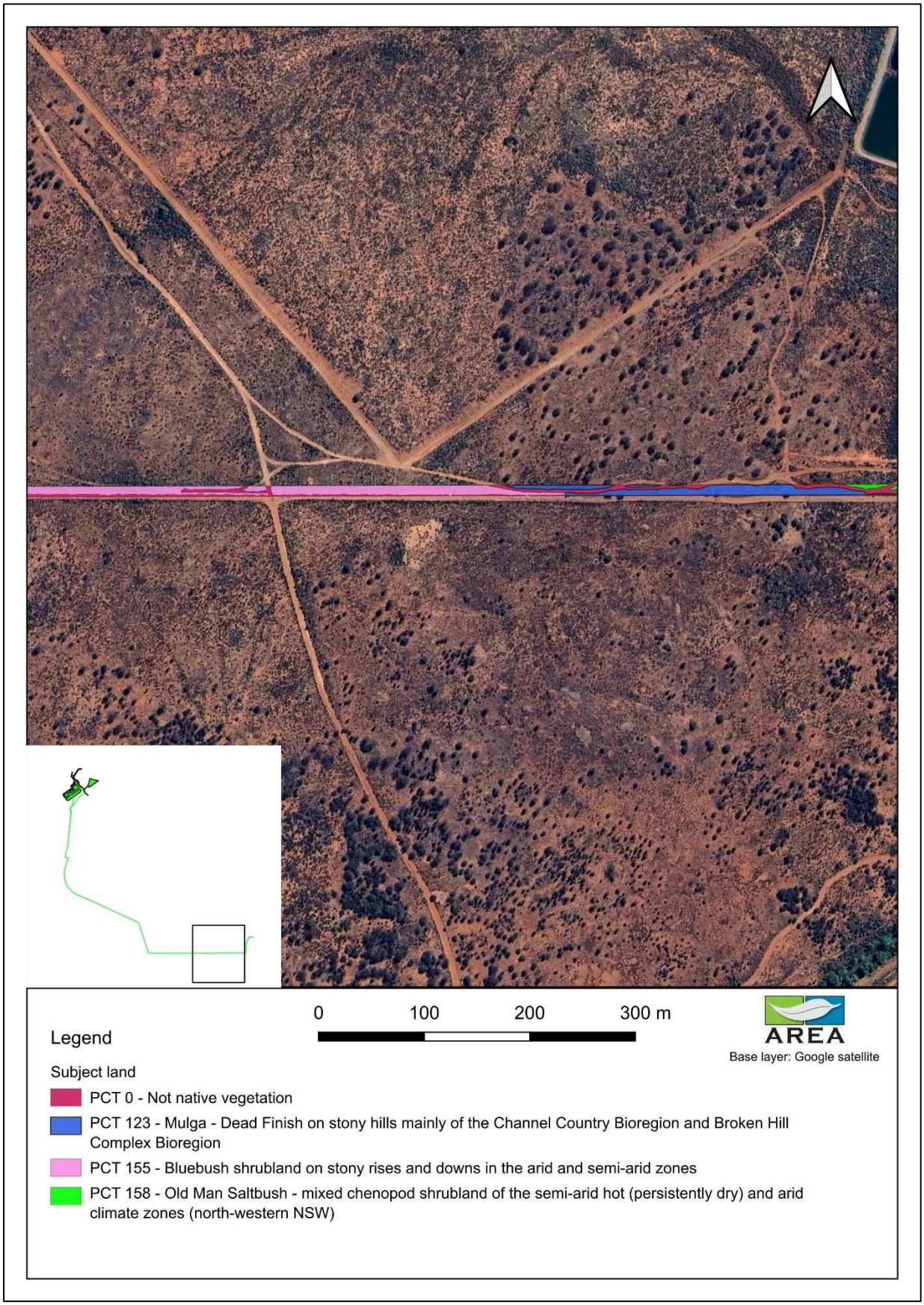


Figure 4-11: Ground truthed PCTs within subject land 7 of 7

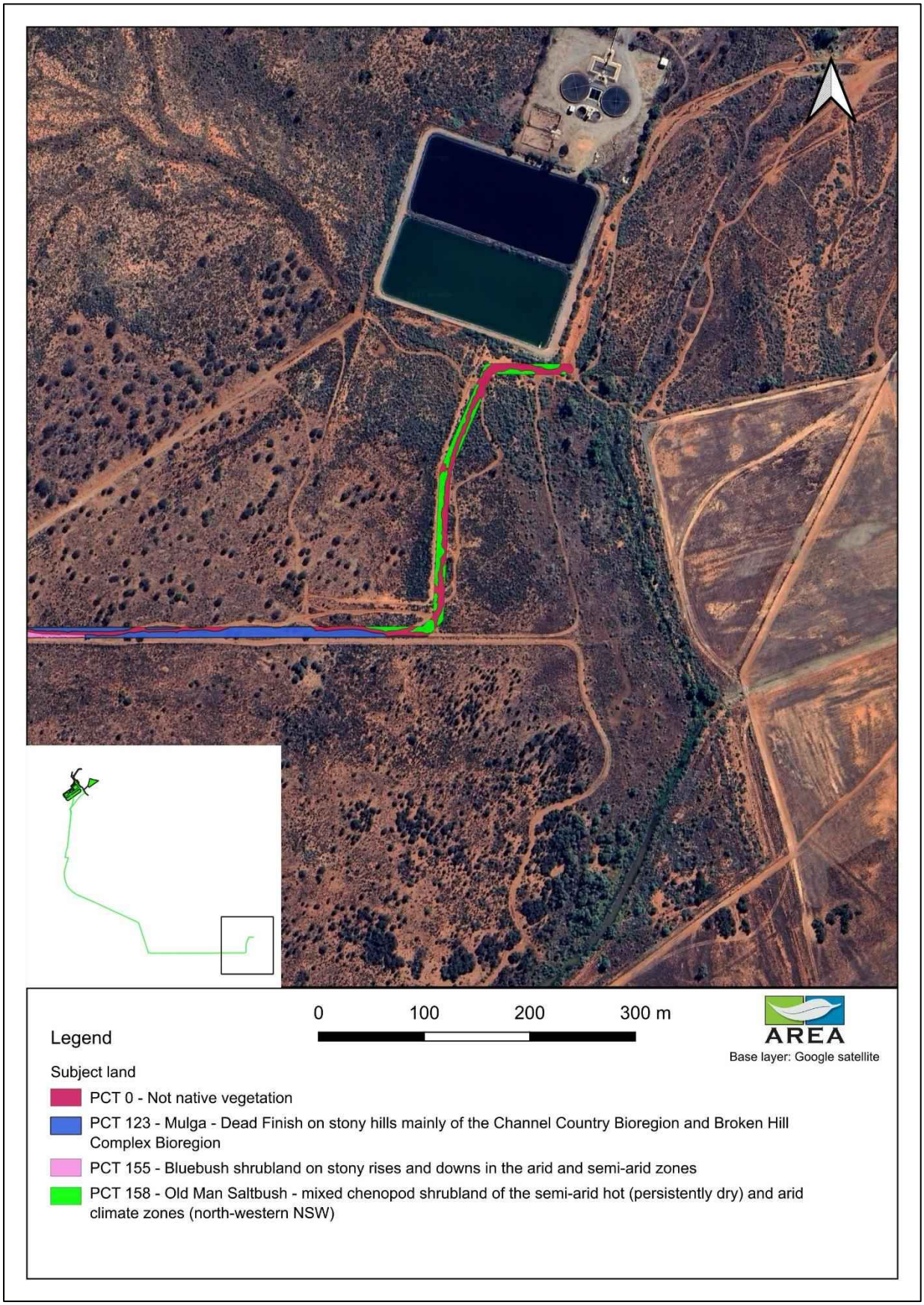


Table 4-2: Plant Community Types recorded in the subject land

PCT	Representative photo
PCT 41: River Red Gum open woodland wetland of intermittent watercourses mainly of the arid climate zone	
PCT 123 *Mulga - Dead Finish on stony hills mainly of the Channel Country Bioregion and Broken Hill Complex Bioregion*	

PCT	Representative photo
PCT 155 *Bluebush shrubland on stony rises and downs in the arid and semi-arid zones*	
PCT 158 Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)	

4.2.2 Threatened Ecological Communities

Of the four TECs identified on predictive database searches (section 3.2.4), one (*Acacia loderi shrublands*) is associated with PCT 155 *Bluebush shrubland on stony rises and downs in the arid and semi-arid* zones and was identified as potentially present within the subject land prior to historical clearing.

Porcupine Grass Red Mallee Gum Coolabah hummock grassland/low sparse woodland in the Broken Hill Complex Bioregion is not associated with any PCTs identified within the subject land. No Mallee species or porcupine grass consistent with this TEC were identified in the subject land during the field survey.

Acacia melvillei Shrubland in the Riverina and Murray-Darling Depression bioregions is not associated with any PCTs identified within the subject land, nor was there any evidence of *Acacia melvillei* detected during the field survey.

Artesian Springs Ecological Community in the Great Artesian Basin is not associated with any PCTs identified within the subject land. The subject land does not occur in the Great Artesian Basin. No Spring sediment mounds were recorded in the subject land during the field survey.

Presence of TECs with potential to occur has been assumed using the precautionary principle and assessed under Test of significance for BC and EBPC (Appendix D).

4.3 Habitat

4.3.1 Wills Street STP Site

Within the Wills St STP Site major works have previously been carried out over the lifetime of the plant leaving large areas of heavily disturbed ground with small areas of regrowth or contained planted revegetation.

A number of regrowth Mulga shrubs were identified as present and would require removal to construct the rising main for the new BHSTP site, (Plate 4-1) and a multiple mature Mulga shrubs were identified as potentially impacted by construction of the rising main (Plate 4-2) .

No hollow bearing trees were recorded within the assessed area of the Wills Street STP site.

4.3.2 New incoming pipework

New incoming pipework or construction of the New BHSTP will largely impact areas of Native vegetation, these include PCT 41, PCT 123 and a discrete area of PCT 155. The construction of this new incoming pipework will require the potential removal of several River Red Gum trees shown below in Figure 4-13.

Plate 4-1: Mulga regrowth potentially impacted by New BHSTP construction

Plate 4-2: Mature Mulga to be removed for construction of the rising main

Figure 4-12: Site of New incoming pipework and trees to be removed (circled in red)

4.3.3 Treated effluent discharge pipe replacement route

The replacement of the existing treated effluent discharge pipe will run from the new BHSTP for approximately 1.2 kilometres long and will end approximately 40 meters south of the Pinnacles Road and Kanandah Road intersection, at the existing discharge point. The treated effluent discharge pipe will largely transverse areas of Non-Native vegetation. Areas of potential native vegetation impacted include predominantly PCT 155, Pct 158 a small section of PCT 41 at the southern end of the route.

4.3.4 Rising main route

The rising main route connection to South Broken Hill STP is located along a fence line and is heavily disturbed and dominated with Old Man Saltbush *Atriplex nummularia* and sparse scattered Prickly Wattle (*Acacia victoriae*) shrubs (Plate 4-3). This section of the alignment has been identified as PCT 158 *Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW).* The rising main alignment is shown in Figure 1-2, Figure 1-3 and Figure 1-4.

No hollow bearing trees were recorded within the assessed area of the proposed rising main route.

Plate 4-3: Vegetation along the eastern fence line of the South Broken Hill STP entry site.

Threatened species

No listed flora or fauna species were recorded during the field assessment. Predicted listed species are assumed to occur in the subject land where suitable habitat exists and where the survey was not sufficient to confirm the species was not present.

No habitat of tree hollows, logs or watercourses was recorded in the subject land. Listed species that require these habitat features are unlikely to be present.

4.4 Aquatic communities

The proposal intersects three unnamed watercourses, two second Strahler Order drainage lines and one first Strahler Order drainage line. All drainage lines are ephemeral and likely form a part of the Darling River catchment.

4.5 Pests, weeds and disease

Two high threat exotic species were recorded in the subject land.

4.5.1 Wills Street STP Site

- Galenia (*Galenia pubescens*)
- Wards Weed (*Carrichtera annua*)

4.5.2 South Broken Hill STP Site

- Wards Weed (*Carrichtera annua*)

5 Impact analysis

5.1 Direct impact

Direct impacts are a direct result of construction activities. Direct impacts predicted to occur by the development are considered in the following sections. Safeguards and mitigation measures to reduce potential impacts are outlined in Section 6.

5.1.1 Habitat, connectivity, and fragmentation

All native vegetation mapped in the subject land has some role in habitat connectivity.

No habitat constraints or evidence of threatened species were recorded during the field survey. Vegetation within and surrounding the subject land is predominantly chenopod shrubland therefore fragmentation from surrounding habitat will unlikely be exacerbated.

The subject land occurs inside, and adjacent to, previously disturbed and fragmented landscape and is therefore unlikely to act as an important corridor for wildlife.

Some obstacles to wildlife movement may exist during the construction phase of the development as created by machinery and construction activities. These will be temporary and where an individual's movement may be disrupted this will not exclude the animal from habitat or its ability to more through the subject land during or post construction.

Vegetation in the surrounding landscape is already highly fragmented from previous disturbances and infrastructure such as existing tracks and the existing sewage treatment plants. The proposal will further contribute to fragmentation of a patch of native vegetation within the proposed rising main route, a 10-metre-wide corridor has been requested to accommodate the rising main and a rising main access road directly adjacent.

Given the location of the patch within the broader landscape, it is unlikely to act as an important corridor for the movement of fauna.

Connectivity will not be significantly reduced, nor will fragmentation be significantly increased by the proposal.

5.1.2 Native vegetation

Small areas of native vegetation will be impacted by the construction of the proposal. Impacts to native vegetation could result in the following outcomes:

- cause death or harm to fauna present in habitat during clearing
- remove ground layer foraging, nesting and feeding habitat for native species.

The area of impact to PCT recorded in the subject land is described in Table 5-1.

Table 5-1: Native vegetation impacted by the proposal

PCT ID	PCT name	Impact (ha)[1]
0	Non-native vegetation	4.98
41	River Red Gum open woodland wetland of intermittent watercourses mainly of the arid climate zone	0.90
123	Mulga - Dead Finish on stony hills mainly of the Channel Country Bioregion and Broken Hill Complex Bioregion	0.58
155	Bluebush shrubland on stony rises and downs in the arid and semi-arid zones	2.61
158	Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)	1.08
	Total	**10.15**
	Total impact to native vegetation	**5.17**

The impact areas were calculated based on disturbance areas at each STP, and assuming a direct 10-metre-wide disturbance corridor along the length of the rising main route. Replacement of the existing treated effluent discharge pipe would largely be within this 10-metre corridor. Up to 5.17 hectares of native vegetation, in four Plant Community Types would be impacted.

5.1.3 Threatened Ecological Communities

Tests / Assessments of significance under the BC Act and EPBC Act, for one TEC, *Acacia loderi Shrublands*, noted as having the potential to occur in the subject land, determined the proposal is unlikely to result in a significant impact to this TEC (Appendix D).

Mitigation measures outlined in Section 6 further aim to minimise any impacts to the TEC.

5.1.4 Threatened species

The likelihood of impact to threatened species identified by database searches (IBRA, MNES and BioNet) and field survey was considered in the predicted threatened species assessment (refer Appendix C). This assessment indicated a total of 30 threatened fauna and six threatened flora species have the potential to be impacted by the proposal.

Tests / Assessments of significance undertaken in in accordance with the BC Act and EPBC Act (Appendix D) show a significant impact to threatened species from the proposal is considered unlikely

No threatened species were identified as being significantly impacted by the proposal.

5.1.5 Migratory species

A significant impact to migratory bird species under the EPBC Act is considered unlikely.

Eight EPBC listed migratory birds' species were identified as potentially occurring in the subject land (Appendix B) and have been considered against the significance criteria in Table 5-2.

Table 5-2: Assessment of Significance, Migratory birds

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:	
Criteria	**Response**
substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species	There is little evidence to suggest that the subject land supports 'important habitat' for migratory species given the absence of permanent water and high disturbance levels within the landscape. The lack of proximity of wetlands of international importance reduces the likelihood that habitat in the subject land is 'important habitat'. The proposal is therefore unlikely to substantially modify, alter, destroy or isolate important habitat for migratory species.
result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or	The local area has a history of habitat modification for infrastructure. The proposal is unlikely to further contribute to establishment of invasive species beyond that which may already exist.
seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	The subject land is not an area of 'important habitat' for migratory birds, whether they are wetland or terrestrial species. It is unlikely that an ecological significant proportion of migratory birds would rely on habitat in the subject land.

5.1.6 Impact to groundwater dependent communities

No potential GDEs are mapped as present within the proposed subject land. A small area of high potential for groundwater interaction occurs outside of the subject land at the Wills Street STP site. However, the proposal is not expected to place any component of groundwater-dependent communities at risk of local extinction, given the level of disturbance already present at the existing Wills Street STP site and considering that the majority of the proposal will be constructed above ground.

No aquatic GDEs are mapped as occurring in the Subject land.

No subterranean GDEs are mapped as occurring in the Subject land.

5.1.7 Impact to hollow bearing trees

No hollow bearing trees were recorded in the proposed subject land (section 4.3).

5.1.8 Soils and drainage

Soils will be disturbed during construction and maintenance. Disturbed soils have the potential to move off the subject land and impact watercourses if not appropriately managed. Unnamed ephemeral drainage lines intersected along the proposal, have potential to be impacted by soil disturbance and runoff (section 3.1.3). Soil disturbance will be managed using standard processes to avoid long term impacts (Section 6).

Standard remediation processes applied to the area after construction will ensure no long-term impact to the biodiversity values. The development will not have long term or lasting impact on the hydrology at any scale.

5.1.9 Weeds

Inappropriate management of weed control can lead to the dissemination of weeds across the environment and may result in fines for both individuals and organisations engaged in the proposal. Processes such as clearing vegetation, removing and transporting topsoil, importing and exporting soil and mulch, as well as the movement of vehicles, are all activities that could contribute to the spread of weeds.

Under Schedule 4, Division 5 of the BC Act, the processes eligible for listing as Key Threatening Processes (KTP) include:

- A threatening process is eligible to be listed as a KTP if, in the opinion of the Scientific Committee –
    - It adversely affects threatened species or ecological communities, or
    - It could cause species or ecological communities that are not threatened to become threatened

Under the EPBC Act, a process can be listed as a KTP if it could:

- Cause a native species or ecological community to become eligible for inclusion in a threatened list (other than the conservation dependent category); or
- Cause an already listed threatened species or threatened ecological community to become more endangered; or
- Adversely affect two or more listed threatened species or threatened ecological communities.

Novel biota and their impact on biodiversity is listed as a KTP under the EPBC Act. 'Novel biota' refers to organisms that are new to an ecosystem whether by natural or human introduction (Australian Government, 2021).

Introduction or spread of weeds through the subject land is associated with these actions:

- removing native vegetation
- excavation, soil stripping and construction or demolition.

Direct impact from novel biota is unlikely if Environmental safeguards and mitigation measures in section 6 are implemented.

5.2 Indirect impact

Indirect impacts are those which are not a direct result of the proposal, often produced away from, or as a result of, a complex impact pathway. They can be hard to predict and difficult to manage. Indirect impacts are considered in the following sections and mitigation measures outlined in Section 6.

5.2.1 Injury to wildlife

Injury to wildlife is unlikely, but possible, during the construction phase of this proposal. Contact with wildlife and suitable habitat will be avoided wherever possible. Local wildlife rescue organisation should be contacted in the event wildlife requires rescue or removal.

5.2.2 Changes to hydrology and groundwater dependent ecosystems

Construction of the proposal has the potential to influence waterflow within the three ephemeral drainage lines intersecting the subject land (section 3.1.3 and section 5.1.9).

Given the small section of high potential for groundwater interaction occurs at the site of the existing Wills Street STP, changes to hydrology for GDEs within the subject land is unlikely. Surface hydrology may be impacted by this proposal due to the construction of a rising main access road and any new hard stand areas changing the course of water runoff. Given the arid nature of the area, it is unlikely that changes to hydrology will have a significant impact on threatened species, populations and communities.

5.2.3 Noise, light and vibration

Construction noise, light and vibration during construction may disturb fauna or prevent them using habitat in the subject land. This impact would be short term. The operation of the New Broken Hill STP will not have any noise, light and vibration impacts greater than what already exists at the Wills Street STP. The rising main pipeline which will be used to transport sewage catchment from the South Broken Hill STP will not produce and significant noise, or light emissions and no result in any vibration impacts.

5.2.4 Spread of pests, weeds and disease

Presence and control of weeds and pests have been considered in this assessment.

Removal of native vegetation, soil disturbance, and the movement of people, vehicles, and machinery, has the potential to result in the introduction or spread of weeds through the subject land. Essential Energy has a general biosecurity duty under the *Biosecurity Act 2015* to prevent, eliminate or minimise biosecurity risk so far as is reasonably practicable.

The safeguards in Table 6-1 will minimise the risk of weed colonisation in the subject land.

5.3 Impact on Key Threatening Processes

Key Threatening Processes (KTPs) listed under the BC Act, EPBC Act and FM Act were reviewed in Table 5-3. Five will be negligibly exacerbated by the proposal:

- BC Act: Anthropogenic Climate Change
- BC Act: Clearing of native vegetation
- BC Act: Invasion of native plant communities by exotic perennial grasses
- EPBC Act: Land clearance
- EPBC Act: Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases

Table 5-3: Review of proposed impacts to Key Threatening Processes

KTP	Implication for proposal
BC Act KTPs	
Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands.	Neutral. The proposal would avoid impact to named watercourses and disturbance of unnamed ephemeral drainage lines would be managed to minimise this risk. Control measures would be followed to prevent alternation of watercourses.
Aggressive exclusion of birds from woodland and forest habitat by abundant Noisy Miners *Manorina melanocephala*	Neutral. The proposal is unlikely to influence Noisy Miner abundance
Alteration of habitat following subsidence due to longwall mining	Not applicable
Anthropogenic Climate Change	Negligibly. The proposal would result in the loss of a carbon sink consisting of native vegetation. The proposal would generate CO_2 emissions from construction machinery.
Bushrock Removal	Neutral. Bush rock would be left in the immediate vicinity of the proposal if disturbed.
Clearing of native vegetation	Increased. A small amount of native vegetation will be cleared (5.17ha)
Competition and grazing by the feral European Rabbit, *Oryctolagus cuniculus* (L.)	Neutral. The proposal is unlikely to influence feral rabbit numbers.
Competition and habitat degradation by Feral Goats, *Capra hircus* Linnaeus 1758	Neutral. The proposal is unlikely to influence feral goat numbers.
Competition from feral honeybees, *Apis mellifera* L.	Neutral. The proposal is unlikely to influence feral bee numbers.
Death or injury to marine species following capture in shark control programs on ocean beaches	Not applicable
Entanglement in, or injection of anthropogenic debris in marine and estuarine environments	Not applicable
Forest eucalypt dieback associated with over-abundant psyllids and Bell Miners	Not applicable
Habitat degradation and loss by Feral Horses (brumbies, wild horses), *Equus caballus* Linnaeus 1758	Neutral. The proposal is unlikely to influence feral horses.
Herbivory and environmental degradation caused by feral deer	Neutral. The proposal is unlikely to influence feral deer numbers.
High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition	Neutral. The proposal is low impact and is unlikely to result in accidental fire and associated disruption to native vegetation.
Importation of Red Imported Fire Ants *Solenopsis invicta* Buren 1972	Neutral. The proposal is unlikely to increase the abundance of Red Imported Fire Ants.
Infection by Psittacine circoviral (beak and feather) disease affecting endangered psittacine species	Neutral. The proposal is unlikely to influence any part of the beak and feather disease life cycle.
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	Neutral. The proposal does not have potential to result in transmission of this fungus. No named watercourses would be impacted by this proposal however two ephemeral drainage lines will be intersected by the proposal.

KTP	Implication for proposal
Infection of native plants by *Phytophthora cinnamomi*	Neutral. The proposal is unlikely to result in the introduction or spread of *Phytophthora cinnamomic*. It is not known to occur in the subject land.
Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family *Myrtaceae*	Neutral. The proposal is unlikely to result in the spread of Exotic Rust Fungi as the proposal footprint is outside the area of occupation for these fungi.
Introduction of the Large Earth Bumblebee *Bombus terrestris* (L.)	Neutral. The proposal is unlikely to result in the spread of *Bombus terrestris* as this species is not known to occur in NSW.
Invasion and establishment of exotic vines and scramblers	Neutral. The proposal is unlikely to result in the invasion and establishment of exotic vines and scramblers as the main species of this KTP are not present in the subject land and weed control measures would be followed to prevent invasion and establishment of exotic vines and scramblers.
Invasion and establishment of Scotch Broom (*Cytisus scoparius*)	Neutral. The proposal is unlikely to result in the invasion and establishment of Scotch Broom as it is not known to occur in the subject land. Standard weed control measures employed by Essential Water would be followed to prevent invasion and establishment of Scotch Broom.
Invasion and establishment of the Cane Toad (*Rhinella marina)*	Neutral. The proposal is unlikely to result in the invasion and establishment of the Cane Toad (*Rhinella marina)*.
Invasion of native plant communities by African Olive *Olea europaea subsp. cuspidata* (Wall. ex G. Don) Cif.	Neutral. The proposal is unlikely to result in the invasion and establishment of African Olive. Standard weed control measures would be followed to prevent invasion and establishment of African Olive.
Invasion of native plant communities by *Chrysanthemoides monilifera*	Neutral. The proposal is unlikely to result in the importation of Boneseed or Bitou Bush and these species are not known to occur in the subject land. Standard control measures would be followed to prevent importation.
Invasion of native plant communities by exotic perennial grasses	Negligibly. The proposal will possibly result in the introduction and establishment of exotic perennial grasses. Exotic grasses are already present in the proposal footprint however standard weed control measures employed by the proponent would be followed to exacerbation of invasion by exotic perennial grasses.
Invasion of the Yellow Crazy Ant, *Anoplolepis gracilipes* (Fr. Smith) into NSW	Neutral. The proposal is unlikely to result in the invasion the Yellow Crazy Ant is not known to occur in the subject land, they are more likely to occur in Northern Australia.
Invasion, establishment and spread of *Lantana camara*	Neutral. The proposal is unlikely to result in the invasion and establishment of *Lantana camara* as this species was not present in the subject land and weed control measures would be followed to prevent invasion and establishment of all exotic vines and scramblers.
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants	Neutral. The proposal is unlikely to result in the invasion and establishment of escaped garden plants. However, weed control measures would be followed to prevent establishment.
Loss and/or degradation of sites used for hill-topping by butterflies	Not relevant
Loss of Hollow-bearing Trees	Neutral. No hollow bearing trees will be impacted by the proposal. Mitigation measures will ensure impact is minimal and dead wood and trees disturbed by the proposal would not be removed from the immediate environment.
Predation and hybridisation by Feral Dogs, *Canis lupus familiaris*	Not relevant

KTP	Implication for proposal
Predation by the European Red Fox	Neutral. The proposal is unlikely to influence European red fox numbers.
Predation by the Plague Minnow (*Gambusia holbrooki*)	Neutral. The proposal is unlikely to influence Plague Minnow numbers, no key fish habitat occurs within the subject land.
Predation by the Ship Rat (*Rattus rattus*) on Lord Howe Island	Not relevant
Predation by feral cats	Neutral. The proposal is unlikely to influence feral cat numbers.
Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa* Linnaeus 1758	Neutral. The proposal is unlikely to influence feral pig numbers.
Removal of dead wood and dead trees	Neutral. Dead wood and trees disturbed by the proposal would not be removed from the immediate environment.
FM Act KTPs	
Alteration to the Natural Flow Regimes of Rivers and Streams	Neutral. The proposal is unlikely to influence flow regimes of rivers and streams provided control measures are followed to prevent alternation of watercourses.
Alteration to the Natural Temperature of Rivers and Streams	Neutral. The proposal is unlikely to influence the temperature of rivers and streams.
Increased Sediment Input to Rivers and Streams Due to Human Activities	Neutral. Soil disturbance as a result of the proposal would be managed to prevent movement of sediment, and the likelihood of active erosion establishing.
Introduction of Live Fish into Waters Outside their Natural Range after 1770	Neutral. The proposal is unlikely to influence introduction of Live Fish into Waters Outside their Natural Range after 1770.
Removal of Large Woody Debris from Rivers and Streams	Neutral. The proposal will not result in removal of large woody debris from rivers and streams.
The Prevention of Passage of Aquatic Biota as a Result of the Presence of Instream Structures	Neutral. The proposal is unlikely to prevent aquatic biota passage.
EPBC Act KTPs	
Aggressive exclusion of birds from potential woodland and forest habitat by over-abundant noisy miners (*Manorina melanocephala*)	Neutral. The proposal is unlikely to increase exclusion by Noisy Miners.
Competition and land degradation by rabbits	Neutral. The proposal is unlikely to influence feral rabbit numbers.
Competition and land degradation by unmanaged goats	Neutral. The proposal is unlikely to influence feral goat numbers.
Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*)	Neutral. The proposal is unlikely to result in the introduction or spread of *Phytophthora cinnamomic* due to elevation above area of occupation.
Incidental catch (bycatch) of Sea Turtle during coastal otter-trawling operations within Australian waters north of 28 degrees South	Not applicable
Incidental catch (or bycatch) of seabirds during oceanic longline fishing operations	Not applicable
Infection of amphibians with chytrid fungus resulting in chytridiomycosis	Neutral. The proposal does not have potential to result in transmission of this fungus. No named watercourses would be impacted by this proposal however three ephemeral drainage lines will be intersected by the proposal.

KTP	Implication for proposal
Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris	Not applicable
Invasion of northern Australia by Gamba Grass and other introduced grasses	Not applicable
Land clearance	Increased. A small amount of native vegetation will be cleared (5.17ha) which includes groundcover in historically cleared and disturbed areas or road corridors.
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants	Neutral. The proposal is unlikely to result in the invasion and establishment of escaped garden plants. Mitigation measures will minimise potential.
Loss of biodiversity and ecosystem integrity following invasion by the Yellow Crazy Ant (*Anoplolepis gracilipes*) on Christmas Island, Indian Ocean	Not applicable
Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases	Negligible. The proposal would result in minor, temporary loss of a carbon sink consisting of native vegetation. The proposal would generate CO_2 emissions.
Novel biota and their impact on biodiversity	Neutral. The proposal is unlikely to influence novel biota numbers. All relevant weeds, invasive species, pathogens etc have been discussed in their specific KTP.
Predation by European red fox	Neutral. The proposal is unlikely to influence European red fox numbers.
Predation by exotic rats on Australian offshore islands of less than 1000 km2 (100,000 ha)	Not applicable
Predation by feral cats	Neutral. The proposal is unlikely to influence feral cat numbers.
Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs	Neutral. The proposal is unlikely to influence feral pig numbers.
Psittacine Circoviral (beak and feather) Disease affecting endangered psittacine species	Neutral. The proposal is unlikely to influence any part of the beak and feather disease life cycle.
The biological effects, including lethal toxic ingestion, caused by Cane Toads (*Bufo marinus*)	Not relevant
The reduction in the biodiversity of Australian native fauna and flora due to the red imported fire ant, *Solenopsis invicta* (fire ant)	Neutral. Fire ants are not known to occur in the subject land and the proposal is unlikely to result in the importation of Fire Ants. Control measures would be followed to prevent importation.

5.4 Cumulative impact

Impacts from the proposal are considered unlikely to result in a permanent cumulative impact to native species, populations and communities given the activity will largely occur in an historically cleared and degraded landscape and a range of measures will be taken to avoid, minimise and mitigate potential impacts as set out in Section 6.

6 Environmental safeguards and mitigation measures

The proposal has followed the principles of 'avoid, minimise, mitigate' to reduce the impact on local biodiversity values.

6.1 Avoid impact

The following avoidance measures have been made:

- the subject land is largely located within previously cleared derived chenopod shrublands or land previously disturbed surrounding the Wills Street STP and adjacent previously cleared dirt tracks.
- removal of native vegetation will be avoided where practical.

6.2 Minimise impact

The following measures have been made to minimise impact to the environment:

- Soil excavated used to back fill the excavation areas, enabling and lower stratum species to quickly re-establish.
- High threat weeds should be responsibly disposed of when being removed from site While these exotic species are already present in the local landscape, spread of weed species should be limited wherever possible.

6.3 Mitigate impact

The environmental safeguards in Table 6-1 are recommended for minimising the impact of the proposal.

Table 6-1: Environmental safeguards

Impact	Environmental safeguards	Responsibility	Timing
General	Any change in design affecting land outside the subject land assessed in this report will require further ecological survey, notwithstanding minor changes to design and construction methodology, where the ecological values have been assessed.	Proponent	Pre-construction, construction, operation
Clearing and prevention of over-clearing	All personnel would be inducted to be aware any stand of native vegetation outside the subject site has legislative consequences if deliberately or accidentally impacted without approval. The extent of the clearing footprint is to be confined to the assessed areas. No clearing is permitted outside these areas without further assessment Ensure groundcover disturbance is kept to a minimum and within the assessed areas Where possible, vegetation to be removed would be mulched on-site and re-used to stabilise disturbed areas.	Contractor	Pre-construction

Impact	Environmental safeguards	Responsibility	Timing
Soil Management	Installation and maintenance of erosion and sediment controls In accordance with Landcom's Managing Urban Stormwater, Soils & Construction Guidelines (The Blue Book. Landcom 2004).	Contractor	Pre-construction and during construction
Damage to native vegetation outside of impact zone	Stockpile and compound sites would be located using the following criteria: At least 40 m away from the nearest waterway In areas of low ecological conservation significance (i.e. previously disturbed land) On relatively level ground Outside the one in 10-year Average Recurrence Interval (ARI) floodplain. Stockpiling materials and equipment and parking vehicles would be avoided within the dripline (extent of foliage cover) of any tree.	Contractor	Construction
Introduction and spread of noxious weeds and pathogens	Essential Energy has a general biosecurity duty under the Biosecurity Act 2015 to prevent, eliminate or minimise biosecurity risk so far as is reasonably practicable. Field crews shall follow procedures as outlined in Essential Energy's Operational Guideline: Biosecurity Risk Management (CERM1000.96) to prevent, eliminate or minimise biosecurity risk so far as is reasonably practicable, with particular reference to vehicle and equipment hygiene practises	Contractor	Construction
Disturbance to fallen timber, dead wood and bush rock	Any fallen timber, dead wood and bush rock (if present) encountered on site would be left in situ or relocated to a suitable place nearby.	Contractor	Construction
Disturbance to watercourses	Access the waterway in a way that minimises harm to banks or native vegetation. Keep machinery away from banks of the waterway (where possible). Do not refuel, store or decant chemicals within 50m of a waterway.	Proponent, contractor	Pre-construction and construction
Fauna management	Immediately prior to commencement of any vegetation removal involving machinery and/or tree-felling the area of clearing work is to be inspected for fauna. If fauna is detected, the animal is to be allowed to leave the site without any coercion, or a local wildlife rescue service is to be contacted to facilitate the safe removal of the animal from the worksite.	Contractor	Construction

7 Conclusion

The proposal will not result in a significant impact to the ecological values present in the subject land.

A total of 5.17 hectares of native vegetation will be impacted by the proposal.

One threatened ecological community, *Acacia loderi Shrublands*, was identified as present in the study area. Thirty threatened fauna and six threatened flora species have the potential to be impacted by the proposal.

Tests of significance prepared in accordance with section 7.3 of the BC Act and Assessments of Significant prepared in accordance with the EPBC Act Significant Impact Guidelines concluded that the proposed work could be undertaken without significantly impacting any threatened species, populations, ecological communities or areas of outstanding biodiversity value.

Notwithstanding, to ensure harm to the environment is further minimised, a number of safeguards and mitigation measures have been recommended. If implemented the proposal is unlikely to have a significant impact to species populations and communities listed under the EPBC Act, FM Act, or BC Act.

Based on the assessment, no referral or additional assessment is required.

8 References

Australian Government. (2021). *Department of Climate Change, Energy, the Environment and Water*. Retrieved from Novel biota and their impact on biodiversity: https://www.dcceew.gov.au/environment/biodiversity/threatened/key-threatening-processes/novel-biota-impact-on-biodiversity

Beca HunterH20. (2024). *Broken Hill STP Design Basis and Preliminary Concept Design Review Report.* Essential Water.

Benson, J. (2009). *New South Wales Vegetation Classification and Assessment, NSWVCA batabase.* Sydney: NSW DEC.

BoM. (2024). *Climate Data Online*. Retrieved from Bureau of Meteorology: http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=136&p_display_type=dailyDataFile&p_startYear=&p_c=&p_stn_num=047048

Bureau of Meteorology, Australian Government. (2024). *Groundwater Dependent Ecosystem Atlas*. Retrieved from http://www.bom.gov.au/water/groundwater/gde/map.shtml

DEC. (2004). *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities.* Sydney, NSW: NSW Government Department of Environment and Conservation.

Department of Climate Change, Energy, the Environment and Water. (2024). *Threatened biodiversity profile search*. Retrieved from https://threatenedspecies.bionet.nsw.gov.au/

DoE. (2013). *Matters of National Environmental Significance - Significant impact guidelines 1.1 - Environment Protection and Biodiversity Conservation Act 1999.* Department of the Environment. Canberra, ACT: Commonwealth of Australia . Retrieved April 2015, from http://www.environment.gov.au/system/files/resources/42f84df4-720b-4dcf-b262-48679a3aba58/files/nes-guidelines_1.pdf

Mitchell, P. (2008). *Descriptions for NSW (Mitchell) Landscapes.* Department of Environment and Climate Change.

NSW Government. (2024, June 17). *Transitional native vegetation regulatory map viewer*. Retrieved from https://www.lmbc.nsw.gov.au/Maps/index.html?viewer=NVRMap

NSW National Parks and Wildlife. (2003). Bioregions of NSW- Their biodiversity conservation and history. Hurstville, NSW, Australia: NSW National Parks and Wildlife.

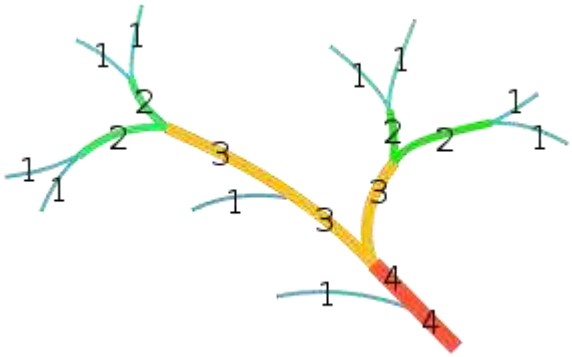
Office of Environment and Heritage. (2017). *Atlas of NSW Wildlife (online)*. Retrieved from Atlas of NSW Wildlife (online): http://www.environment.nsw.gov.au/asmslightprofileapp/account/login?ReturnUrl=%2fAtlasApp%2fDefault.aspx

Appendix A: Terms and abbreviations used in this report

Terms and abbreviations used in this report.

Abbreviation	Terminology	Description
	Assessment or test of significance	The Assessment of Significance refers to the factors that must be considered by decision makers to assess whether a Proposal is likely to have a significant effect on threatened biodiversity. These mechanisms are contained in s5A of the EP&A Act and s94 of the BC Act.
BoM	Australian Bureau of Meteorology	The Bureau of Meteorology is Australia's national weather, climate and water agency.
	Critical habitat	Critical habitat is defined as an area crucial to the survival of an endangered species, population or ecological community. The declaration of critical habitat provides greater protection and stricter controls over activities in the area.
	Cumulative impacts	Impacts, when considered together, lead to a stronger impact than any impact in isolation.
Study area		Total area assessed during the field survey.
Subject land		Encompasses all land which the Development Consent will apply to. This is the area to be impacted by the development and is the focus of this report.
	Direct impacts	Directly affect the habitat and individuals. They include, but are not limited to, death through predation, trampling, poisoning of the animal/plant itself and the removal of suitable habitat. When applying each factor, consideration must be given to all of the likely direct impacts of the proposed activity or development.
DCCEEW	Department of Climate Change, Energy, and the Environment	The DCCEEW protects Australia's natural environment and heritage sites as well as help Australia responds to climate change and carefully manage our water and energy resources.
EEC	Endangered Ecological Community	An ecological community identified by relevant legislation likely to become extinct or is in immediate danger of extinction.
TEC	Threatened Ecological Community	An ecological community identified by relevant legislation to be classed as threatened and or is in immediate danger of becoming endangered.
	Environment	The environment includes all aspects of the surroundings of humans, whether affecting any human as an individual or in his or her social groupings.
BC Act	*Biodiversity Conservation Act 2016*	Provides for the protection of the environment, especially matters of state environmental significance, and provides a state assessment and approvals process.
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth).	Provides for the protection of the environment, especially matters of national environmental significance, and provides a national assessment and approvals process.
GDA	Geocentric Datum of Australia	The Geocentric Datum of Australia (GDA) is the latest Australian coordinate system, replacing the Australian Geodetic Datum (AGD). The GDA is a part of a global coordinate reference frame and is directly compatible with the Global Navigation Satellite Systems.

Abbreviation	Terminology	Description
GDE	Groundwater Dependent Ecosystems	Six types of groundwater dependent ecosystems are conventionally recognised in Australia: Terrestrial vegetation relies on the availability of shallow groundwater. Wetlands such as paperbark swamp forests and mound springs ecosystems. River base flow systems where a groundwater discharge provides a base flow component to the river's discharge. Aquifer and cave ecosystems where life exists independent of sunlight Terrestrial fauna, both native and introduced, dependant on groundwater as a source of drinking water. Estuarine and near shore marine systems, such as some coastal mangroves, salt marshes and sea grass beds, which rely on the submarine discharge of groundwater.
	Habitat	The area occupied, or periodically or occasionally occupied, by any threatened species, population or ecological community and includes all the different aspects (both biotic and abiotic) used by species during the different stages of their life cycles.
IBRA	Interim Biogeographic Regionalisation of Australia	The Interim Biogeographic Regionalisation for Australia (IBRA) is a biogeographic regionalisation of Australia developed by the Australian Government's Department of the Environment. Each region is a land area made up of a group of interacting ecosystems repeated in similar form across the landscape.
	Indirect impacts	Occur when project-related activities affect species, populations or ecological communities in a manner other than direct loss. Indirect impacts can include loss of individuals through starvation, exposure, predation by domestic and/or feral animals, loss of breeding opportunities, loss of shade/shelter, deleterious hydrological changes, increased soil salinity, erosion, inhibition of nitrogen fixation, weed invasion, fertiliser drift, or increased human activity within or directly adjacent to sensitive habitat areas. As with direct impacts, consideration must be given, when applying each factor, to all of the likely indirect impacts of the proposed activity or development.
KTP	Key Threatening Process	A key threatening process is defined as a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities. A requirement of their listing on the Act is that the process adversely affects two or more threatened species, populations or ecological communities, or may cause species, populations or ecological communities not threatened to become threatened.
	Landscape Assessment Area	The landscape assessment area refers to a 1500-meter buffer placed on the subject land. The buffer is then used to conduct the desktop assessments for threatened fauna, flora or TECs previously recorded or predicted to occur within 1500 meters of the proposal.
LGA	Local Government Area	The relevant LGA is Governed by Council who are the determining authority for this development application.
	Local population	The population occurs in the subject land. The assessment of the local population may be extended to include individuals beyond the subject land if it can be clearly demonstrated contiguous or interconnecting parts of the population continue beyond the subject land. The local population of a threatened plant species comprises those individuals occurring in the subject land, or the cluster of individuals extend into habitat adjoining and contiguous with the subject land could reasonably be expected to be cross-pollinating with those in the subject land. The local population of resident fauna species comprises those individuals known or likely to occur in the subject land, as well as any

Abbreviation	Terminology	Description
		individuals occurring in adjoining areas (contiguous or otherwise) are known or likely to utilise habitats in the subject land. The local population of migratory or nomadic fauna species comprises those individuals likely to occur in the subject land from time to time.
	Local population (EEC)	The ecological community present within the subject land. However, the local occurrence may include adjacent areas if the ecological community on the subject landforms part of a larger contiguous area of the ecological community and the movement of individuals and exchange of genetic material across the boundary of the subject land can be clearly demonstrated.
MNES	Matters of national environmental significance.	Refers to the seven matters of national environmental significance outlined under the EPBC Act.
RAMSAR	Convention on Wetlands of International Importance	The Ramsar Convention's broad aims are to halt the worldwide loss of wetlands and to conserve, through wise use and management, those remaining. This requires international cooperation, policy making, capacity building and technology transfer.
Significant impact		A 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity.
Subject land		Subject land means the subject land and any additional areas which are likely to be affected by the Proposal, either directly or indirectly. The subject land should extend as far as is necessary to take all potential impacts into account.
Strahler stream order		Strahler stream order and are used to define stream size based on a hierarchy of tributaries. 

Appendix B: Database search results

EPBC Protected Matters Search

Australian Government
Department of Climate Change, Energy, the Environment and Water

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 13-Jun-2024

Summary
Details
- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

Caveat
Acknowledgements

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	1
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	17
Listed Migratory Species:	8

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	3
Commonwealth Heritage Places:	None
Listed Marine Species:	13
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	None
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	6
Key Ecological Features (Marine):	None
Biologically Important Areas:	None
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

National Heritage Places		[Resource Information]
Name	State	Legal Status
Historic		
City of Broken Hill	NSW	Listed place

Listed Threatened Species		[Resource Information]
Status of Conservation Dependent and Extinct are not MNES under the EPBC Act. Number is the current name ID.		
Scientific Name	Threatened Category	Presence Text
BIRD		
Amytornis modestus Thick-billed Grasswren [84121]	Vulnerable	Species or species habitat likely to occur within area
Aphelocephala leucopsis Southern Whiteface [529]	Vulnerable	Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat may occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Lophochroa leadbeateri leadbeateri		
Major Mitchell's Cockatoo (eastern), Eastern Major Mitchell's Cockatoo, Pink Cockatoo (eastern) [82926]	Endangered	Species or species habitat may occur within area
Melanodryas cucullata cucullata		
South-eastern Hooded Robin, Hooded Robin (south-eastern) [67093]	Endangered	Species or species habitat may occur within area
Neophema chrysostoma		
Blue-winged Parrot [726]	Vulnerable	Species or species habitat known to occur within area
Pedionomus torquatus		
Plains-wanderer [906]	Critically Endangered	Species or species habitat may occur within area
Rostratula australis		
Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
MAMMAL		
Notomys fuscus		
Dusky Hopping-mouse, Wilkiniti [125]	Vulnerable	Species or species habitat may occur within area
Nyctophilus corbeni		
Corben's Long-eared Bat, South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat may occur within area
PLANT		
Acacia carneorum		
Needle Wattle, Dead Finish, Purple-wood Wattle [66685]	Vulnerable	Species or species habitat known to occur within area
Solanum karsense		
Menindee Nightshade [7776]	Vulnerable	Species or species habitat may occur within area
Swainsona murrayana		
Slender Darling-pea, Slender Swainson, Murray Swainson-pea [6765]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		

Scientific Name	Threatened Category	Presence Text
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Motacilla cinerea		
Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava		
Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata		
Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Calidris melanotos		
Pectoral Sandpiper [858]		Species or species habitat may occur within area
Gallinago hardwickii		
Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Commonwealth Lands [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Commonwealth Land Name	State
Defence - Defence Housing Authority	
Commonwealth Land - Director of War Service Homes [15899]	NSW
Transport and Regional Services - Airservices Australia	

Commonwealth Land Name	State
Commonwealth Land - Airservices Australia [15194]	NSW

Unknown	
Commonwealth Land - [15196]	NSW

Listed Marine Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat known to occur within area overfly marine area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat may occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area overfly marine area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area overfly marine area
Neophema chrysostoma Blue-winged Parrot [726]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area overfly marine area

Extra Information

EPBC Act Referrals			[Resource Information]
Title of referral	Reference	Referral Outcome	Assessment Status
Broken Hill Battery Energy Storage System Project	2021/8918		Completed
Silver City Energy Storage Project	2022/09415		Completed
Not controlled action			
Blue Bush Project	2020/8821	Not Controlled Action	Completed
Broken Hill Solar Plant, NSW	2012/6621	Not Controlled Action	Completed
Development of Silverton Wind Farm	2009/4847	Not Controlled Action	Completed
Improving rabbit biocontrol: releasing another strain of RHDV.	2015/7522	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
sthrn two thirds of Australia			

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

© Commonwealth of Australia
Department of Climate Change, Energy, the Environment and Water
GPO Box 3090
Canberra ACT 2601 Australia
+61 2 6274 1111

IBRA predicted threatened species and communities' search

Threatened species and communities predicted to occur in the Barrier Range IBRA subregion (Department of Climate Change, Energy, the Environment and Water, 2024).

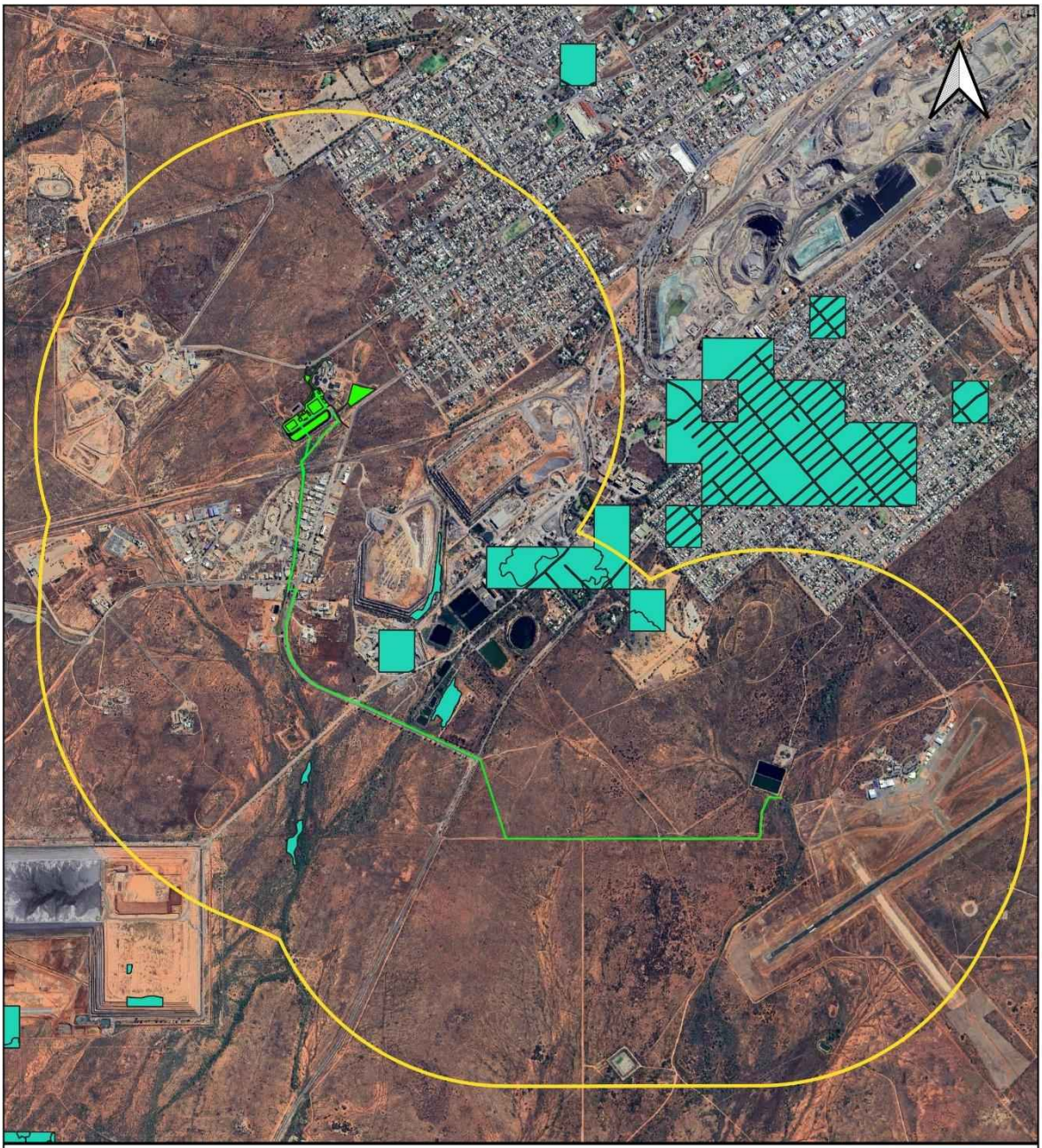
Scientific name	Common name	NSW status	Commonwealth status
Aves			
Amytornis modestus obscurior	Grey Range Thick-billed Grasswren	Critically Endangered	Critically Endangered
Aphelocephala leucopsis	Southern Whiteface	Vulnerable	Vulnerable
Ardeotis australis	Australian Bustard	Endangered	Not Listed
Artamus cyanopterus cyanopterus	Dusky Woodswallow	Vulnerable	Not Listed
Burhinus grallarius	Bush Stone-curlew	Endangered	Not Listed
Calamanthus campestris	Rufous Fieldwren	Vulnerable	Not Listed
Calidris ferruginea	Curlew Sandpiper	Endangered	Critically Endangered
Certhionyx variegatus	Pied Honeyeater	Vulnerable	Not Listed
Circus assimilis	Spotted Harrier	Vulnerable	Not Listed
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	Vulnerable	Not Listed
Daphoenositta chrysoptera	Varied Sittella	Vulnerable	Not Listed
Epthianura albifrons	White-fronted Chat	Vulnerable	Not Listed
Falco hypoleucos	Grey Falcon	Vulnerable	Vulnerable
Falco subniger	Black Falcon	Vulnerable	Vulnerable
Grantiella picta	Painted Honeyeater	Vulnerable	Vulnerable
Grus rubicunda	Brolga	Vulnerable	Vulnerable
Hamirostra melanosternon	Black-breasted Buzzard	Vulnerable	Not Listed
Hieraaetus morphnoides	Little Eagle	Vulnerable	Not Listed
Hirundapus caudacutus	White-throated Needletail	Vulnerable	Vulnerable
Lophochroa leadbeateri	Pink Cockatoo	Vulnerable	Endangered
Lophoictinia isura	Square-tailed Kite	Vulnerable	Not Listed
Melanodryas cucullata cucullata	South-eastern Hooded Robin	Endangered	Endangered
Neophema chrysostoma	Blue-winged Parrot	Vulnerable	Vulnerable
Neophema splendida	Scarlet-chested Parrot	Vulnerable	Not Listed
Oxyura australis	Blue-billed Duck	Vulnerable	Not Listed
Pedionomus torquatus	Plains-wanderer	Endangered	Critically Endangered
Phaps histrionica	Flock Bronzewing	Endangered	Not Listed
Pomatostomus halli	Hall's Babbler	Vulnerable	Not Listed
Pyrrholaemus brunneus	Redthroat	Vulnerable	Not Listed
Rostratula australis	Australian Painted Snipe	Endangered	Endangered
Stictonetta naevosa	Freckled Duck	Vulnerable	Not Listed
Tyto novaehollandiae	Masked Owl	Vulnerable	Not Listed
Mammals			
Chalinolobus picatus	Little Pied Bat	Vulnerable	Not Listed

Scientific name	Common name	NSW status	Commonwealth status
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	Vulnerable	Not Listed
Antechinomys laniger	Kultarr	Endangered	Not Listed
Sminthopsis macroura	Stripe-faced Dunnart	Vulnerable	Not Listed
Leggadina forresti	Forrest's Mouse	Vulnerable	Not Listed
Notomys fuscus	Dusky Hopping-mouse	Endangered	Vulnerable
Pseudomys australis	Plains Mouse	Vulnerable	Vulnerable
Pseudomys bolami	Bolam's Mouse	Endangered	Not Listed
Pseudomys hermannsburgensis	Sandy Inland Mouse	Vulnerable	Not Listed
Rattus villosissimus	Long-haired Rat	Vulnerable	Not Listed
Reptiles			
Antaresia stimsoni	Stimson's Python	Vulnerable	Not Listed
Antaresia childreni	Children's Python	Vulnerable	Not Listed
Aspidites ramsayi	Woma	Vulnerable	Not Listed
Ctenophorus mirrityana	Barrier Range Dragon	Endangered	Not Listed
Ctenotus brooksi	Wedgesnout Ctenotus	Vulnerable	Not Listed
Cyclodomorphus melanops elongatus	Mallee Slender Blue-tongue Lizard	Endangered	Not Listed
Delma australis	Marble-faced Delma	Endangered	Not Listed
Diplodactylus platyurus	Eastern Fat-tailed Gecko	Endangered	Not Listed
Lerista xanthura	Yellow-tailed Plain Slider	Vulnerable	Not Listed
Lucasium stenodactylum	Crowned Gecko	Vulnerable	Not Listed
Lucasium microplax	Southern Sandplain Gecko	Vulnerable	Not Listed
Pseudonaja modesta	Ringed Brown Snake	Endangered	Not Listed
Strophurus elderi	Jewelled Gecko	Vulnerable	Not Listed
Tiliqua occipitalis	Western Blue-tongued Lizard	Vulnerable	Not Listed
Tympanocryptis lineata	Canberra Grassland Earless Dragon	Critically Endangered	Critically Endangered
Flora			
Atriplex infrequens	A saltbush	Vulnerable	Vulnerable
Convolvulus tedmoorei	Bindweed	Endangered	Not Listed
Dysphania platycarpa	Dysphania platycarpa	Endangered	Not Listed
Eleocharis obicis	Spike-Rush	Vulnerable	Vulnerable
Erodiophyllum elderi	Koonamore Daisy	Endangered	Not Listed
Lepidium monoplocoides	Winged Peppercress	Endangered	Endangered
Swainsona flavicarinata	Yellow-Keeled Swainsona	Endangered	Not Listed
Swainsona murrayana	Slender Darling Pea	Vulnerable	Vulnerable
Swainsona viridis	Creeping Darling Pea	Endangered	Not Listed
Acacia carneorum	Purple-wood Wattle	Vulnerable	Vulnerable
Acacia notabilis	Mallee Golden Wattle	Endangered	Not Listed
Acacia rivalis	Creek Wattle	Endangered	Not Listed
Indigofera longibractea	Showy Indigo	Endangered	Not Listed

Field survey fauna species list

Location	Species
South BH STP Site	• Magpie *(Gymnorhina tibicen)* • Double-barred Finch *(Taeniopygia bichenovii)* • Black-faced Cuckoo shrike *(Coracina novaehollandiae)* • Crested Pigeon *(Ocyphaps lophotes)* • White-plumed Honeyeater *(Ptilotula penicillate)* • Pink-eared Duck *(Malacorhynchus membranaceus)* • Australasian Grebe *(Tachybaptus novaehollandiae)* • Tree Martin *(Petrochelidon nigricans)*
Wills St STP Site	• Black Kite *(Milvus migrans)* • Singing Honeyeater *(Lichenostomus virescens)* • White-wing Wren *(Malurus leucopterus)* • Magpie *(Gymnorhina tibicen)*

Groundwater dependant ecosystems – Terrestrial



Appendix C: Predicted threatened species assessment

Likelihood of impact to threatened species identified by database searches (IBRA, MNES and BioNet) and field survey is considered in the following table:

Scientific Name	Common Name	NSW Status	Commonwealth Status	Likelihood of Occurrence	Likelihood of impact	Test of Significance required
Birds						
Actitis hypoleucos	Common Sandpiper	Not Listed	Migratory	Unlikely, this species is a migratory species and utilises both salt water and freshwater ecosystems with varying levels of salinity. This species has been previously recorded in estuaries and deltas of streams. Generally, this species forages in shallow water and on bare soft mud at the edge of wetlands. Area surveyed. No suitable habitat present.	No	No
Amytornis modestus	Thick-billed Grasswren	Not Listed	Vulnerable	Potential, species inhabits chenopod shrublands, those especially dominated by saltbush *Atriplex* spp and bluebush *Maireana* spp. This species likely favours areas on drainage lines with taller and thicker densities of saltbush and bluebush.	Potential	Yes
Amytornis modestus obscurior	Grey Range Thick-billed Grasswren	Critically Endangered	Critically endangered	Potential, species inhabits dense, low saltbush, cottonbush, bluebush and nitre-bush areas on Sandy Plains or depressions in gibber. Also, occurs along watercourses amongst clumps of Cane grass.	Potential	No
Aphelocephala leucopsis	Southern Whiteface	Vulnerable	Vulnerable	Potential This species live in a wide range of open woodlands and shrublands where there is an understorey of grasses or shrubs, or both. These areas are usually in habitats dominated by acacias or eucalypts on ranges, foothills, lowlands, and plains. This species has been previously recorded within 500 meters of the subject land. Any known or likely habitat should be considered as habitat critical for this species.	Potential	Yes
Apus pacificus	Fork-tailed Swift	Not Listed	Migratory	Unlikely, this species is migratory and almost exclusively aerial. When in Australia this species mostly occurs over inland plains, above foothills or in coastal areas.	No	No
Ardeotis australis	Australian Bustard	Endangered	Not Listed	Potential, species prefers tussock and hummock grasslands, also occurs in low shrublands and low open grassy woodlands.	Potential	Yes
Arenaria interpres	Ruddy Turnstone	Not Listed	Vulnerable	Unlikely, this species does not breed in Australia. Foraging habitat for this species includes between supralittoral and lower littoral zones of foreshores. This species is often known to forage on exposed rocky platforms, coral reefs and mudflats. Area surveyed. No suitable habitat present.	No	No

Scientific Name	Common Name	NSW Status	Commonwealth Status	Likelihood of Occurrence	Likelihood of impact	Test of Significance required
Artamus cyanopterus cyanopterus	Dusky Woodswallow	Vulnerable	Not Listed	Potential. The species primarily occurs in open eucalypt forests and woodlands where it can be found foraging for insects above the canopy or over water. Area surveyed; No suitable habitat presents within the subject land; however, this species has been recorded within 500 meters of the proposal.	Potential	Yes
Burhinus grallarius	Bush Stone-curlew	Endangered	Not Listed	Unlikely. The species can be found in open woodlands with a sparse grassy ground layer and adequate fallen timber. Area surveyed; the habitat complexity required for this species is not present within the subject land.	No	No
Calamanthus campestris	Rufous Fieldwren	Vulnerable	Not Listed	Potential. Inhabits low shrublands, in particular saltbush and bluebush communities, and also areas around inland saline lakes.	Potential	Yes
Calidris acuminata	Sharp-tailed Sandpiper	Not Listed	Vulnerable	Unlikely. This species prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation including lagoons, swamps and lakes. Area surveyed and suitable habitat not present.	No	No
Calidris ferruginea	Curlew Sandpiper	Endangered	Critically Endangered	Unlikely. It occurs along the entire coast of NSW, particularly in the Hunter Estuary, and sometimes in freshwater wetlands in the Murray-Darling Basin. It generally occupies littoral and estuarine habitats, and in New South Wales is mainly found in intertidal mudflats of sheltered coasts. Area surveyed and suitable habitat not present.	No	No
Certhionyx variegatus	Pied Honeyeater	Vulnerable	Not Listed	Potential. Species prefers wattle shrub, primarily Mulga *(Acacia aneura)*, mallee, spinifex and eucalypt woodlands. Species is highly nomadic as it follows the erratic flowering of shrubs. This species also forages on saltbush fruit, berries, seed, flowers and insects. This species has been previously recorded on BioNet occurring within 1500 meters of the subject land.	Potential	Yes
Circus assimilis	Spotted Harrier	Vulnerable	Not Listed	Potential. Species is commonly found in native grassland, shrub steppe, agricultural land, and foraging over open habitat and the edges of inland wetlands.	Potential	Yes
Climacteris picumnus victoriae	Brown Treecreeper	Vulnerable	Not Listed	Unlikely. This species occurs in eucalypt forests and woodlands (particularly those dominated by stringing barks and rough bark	No	No

Scientific Name	Common Name	NSW Status	Commonwealth Status	Likelihood of Occurrence	Likelihood of impact	Test of Significance required
	(eastern subspecies)			eucalyptus) of inland plains and slopes of the Great Dividing Range. Area surveyed. No suitable habitat present.		
Daphoenositta chrysoptera	Varied Sittella	Vulnerable	Not Listed	Unlikely. The species inhabits woodlands containing rough-barked eucalyptus species where it nests in an upright tree fork, which is often reused for successive years. Area surveyed. No suitable habitat present.	No	No
Epthianura albifrons	White-fronted Chat	Vulnerable	Not Listed	Potential. Sociable species usually found foraging on bare or grassy ground in wetland areas, singly or in pairs. They are insectivorous, feeding mainly on flies and beetles caught from or close to the ground. In NSW, it occurs mostly in the southern half of the state, in damp open habitats along the coast, and near watercourses in the western part of the state. Along the coastline, it is found predominantly in saltmarsh vegetation but also in open grasslands and sometimes in low shrubs bordering wetland areas. Area surveyed, and no suitable native habitat is present within the subject land. However, this species has been previously recorded within approximately 10 meters of the subject land at the site of the current Wills Street STP.	Potential	Yes
Falco hypoleucos	Grey Falcon	Vulnerable	Vulnerable	Potential. Usually restricted to shrubland, grassland and wooded watercourses of arid-semi-arid regions. No aquatic habitat is present in the subject land. Suitable foraging habitat occurs within the subject land	Potential	Yes
Falco subniger	Black Falcon	Vulnerable	Not Listed	Potential The species have large home ranges and inhabits woodland, shrubland and grassland in the arid and semi-arid zones, especially wooded watercourses, and agricultural land with scattered remnant trees. No wooden watercourses occur in the subject land and the species have large home ranges allowing them to forage in other areas. This species has been previously recorded within 500 meters of the subject land.	Potential	Yes
Gallinago hardwickii	Latham's Snipe	Not Listed	Vulnerable	Unlikely. This species inhabits open, freshwater wetlands with low, dense vegetation including swamps, flooded grasslands or heathlands up to 2000m above sea-level. This species breeds outside of Australia and uses large bodies of water for roosting and foraging. Area surveyed. No suitable habitat present.	No	No
Grantiella picta	Painted Honeyeater	Vulnerable	Vulnerable	Unlikely.	Unlikely	No

Scientific Name	Common Name	NSW Status	Commonwealth Status	Likelihood of Occurrence	Likelihood of impact	Test of Significance required
				This species inhabits Weeping Myall *(Acacia pendula)*, Brigalow *(A. harpophylla)* and Box-Gum Woodlands where it commonly forages on the fruits of mistletoes. Area surveyed. No suitable habitat present.		
Grus rubicunda	Brolga	Vulnerable	Not Listed	Unlikely. The species is dependent on wetlands where they forage with their head entirely submerged. Area surveyed, and no suitable habitat is present within the subject land.	No	No
Hamirostra melanosternon	Black-breasted Buzzard	Vulnerable	Not Listed	Unlikely. The species is found sparsely in areas with less than 500mm of rainfall and occupies a large range of habitats especially along timbered watercourses which are the preferred breeding and foraging habitat. Area surveyed, and no suitable habitat is present within the subject land.	No	No
Hieraaetus morphnoides	Little Eagle	Vulnerable	Not Listed	Potential. The species occupies open eucalyptus woodlands rich in prey where it builds a large stick nest in a tall living tree. The species prey mainly consists of native prey including birds, reptiles, mammals and large insects. No large stick nests were recorded within the proposal. No permanent waterbodies or watercourses occur within the subject land. This species has been previously recorded on BioNet occurring within 500m of the subject land.	Potential	Yes
Hirundapus caudacutus	White-throated Needletail	Vulnerable	Vulnerable	Unlikely. The species is a migratory and primarily aerial species which occupies a wide range of habitats whilst feeding on insects. More commonly in coastal areas. Species does not breed in Australia, not common to be found inland therefore unlikely to occur in subject land.	No	No
Hydroprogne caspia	Caspian Tern	Not Listed	Migratory	Unlikely, this species is usually found in sheltered coastal embayment's, sandy, muddy margins are preferred. Foraging habitat includes open wetlands, lakes and rivers. Area surveyed. No suitable habitat present.	No	No
Lophochroa leadbeateri	Pink Cockatoo	Vulnerable	Endangered	Potential. The species is known to occupy a large range of habitats where it nests in hollows greater than 10cms in diameter and feeds especially on the seeds of native and exotic melons and on the seeds of species of saltbush, wattles and cypress pines. No hollows greater than >10cm will be impacted by the proposal. Area surveyed. Potential foraging habitat present however No suitable breeding habitat. This species has been previously recorded on BioNet occurring within 500m of the subject land.	Potential	Yes

Scientific Name	Common Name	NSW Status	Commonwealth Status	Likelihood of Occurrence	Likelihood of impact	Test of Significance required
Lophochroa leadbeateri leadbeateri	Major Mitchell's Cockatoo (eastern) Eastern Major Mitchell's Cockatoo, Pink Cockatoo (eastern)	Vulnerable	Endangered	Potential. The species is known to occupy a large range of habitats where it nests in hollows greater than 10cms in diameter and feeds especially on the seeds of native and exotic melons and on the seeds of species of saltbush, wattles and cypress pines. No hollows greater than >10cm will be impacted by the proposal. Area surveyed. Potential foraging habitat present however No suitable breeding habitat. The sub species *Lophochroa leadbeateri* has been previously recorded on BioNet within 500m of the subject land.	Potential	Yes
Lophoictinia isura	Square-tailed Kite	Vulnerable	Not Listed	Potential. The species has a large home range and is known to forage in eucalyptus dominated woodlands or forests in suburban trees and shrubs. The species is known to nest in trees located along or near watercourse, not consistent with habitat within the subject land. No large stick nests were identified as present during the field survey. Suitable foraging habitat occurs within the subject land.	Potential	Yes
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	Vulnerable	Not Listed	Unlikely, The species is known to occur in open areas adjacent woodland blocks in temperate eucalypt woodlands. These areas typically include mature eucalypts, saplings, small shrubs and moderately tall native grasses. Area surveyed. No suitable habitat present as this species requires structurally diverse habitats.	No	No
Neophema chrysostoma	Blue-winged Parrot	Not Listed	Vulnerable	Unlikely. This species form monogamous pairs and nests are made in hollows, preferably with a vertical opening, in live, dead trees or stumps. Foraging habitat includes Savannah woodland, grasslands, orchards, farmlands, marshes, heath, dunes, and other open habitats up to 1,200 m (3,937 ft) above sea level. Area surveyed. No suitable habitat present.	No	No
Neophema splendida	Scarlet-chested Parrot	Vulnerable	Not Listed	Potential. Species Inhabits semi-arid areas with mallee and Mulga scrublands/open woodlands with spinifex and saltbush ground covers. Suitable foraging habitat occurs within the subject land.	Potential	Yes
Oxyura australis	Blue-billed Duck	Vulnerable	Not Listed	Unlikely, Species preferred habitat includes deep water in large permanent wetlands and swamps with dense vegetation. Area surveyed. No suitable habitat present.	No	No

Scientific Name	Common Name	NSW Status	Commonwealth Status	Likelihood of Occurrence	Likelihood of impact	Test of Significance required
Pedionomus torquatus	Plains-wanderer	Endangered	Critically Endangered	Unlikely, Species preferred habitat typically comprises 50% bare ground, 10% fallen litter, and 40% herbs, forbs and grasses. They require grasslands with both open and denser vegetation for foraging and roosting, which is essential for their survival and recovery. The proposal does not intersect important habitat maps for this species.	No	No
Pezoporus occidentalis	Night Parrot	Endangered	Extinct	Unlikely, species is extinct within NSW. It is known to occur within spinifex grasslands in stony or sandy areas, with chenopod associations on floodplains, salt lakes, and clay plans. Area surveyed. No suitable habitat within the subject land.	No	No
Phaps histrionica	Flock Bronzewing	Endangered	Not Listed	Potential. Grassy plains, saltbush, spinifex and open Mulga. Species preferred habitat includes tussock grassland, in particular Mitchell grassland.	Potential	Yes
Pomatostomus halli	Hall's Babbler	Vulnerable	Not Listed	Unlikely, species habitat includes dry Acacia scrub, mainly Mulga, with a grassy understorey including spinifex located on ridges and plains with either sandy or stony soils.	Potential	Yes
Pyrrholaemus brunneus	Redthroat	Vulnerable	Not Listed	Potential. This species predominantly occurs in chenopod shrublands including Old Man Saltbush, Black Bluebush and Dillon Bush shrublands. This species has been previously recorded on BioNet occurring within 500m of the subject land.	Potential	Yes
Rostratula australis	Australian Painted Snipe	Endangered	Endangered	Potential This species prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. The species can be found foraging nocturnally on worms, molluscs and plant matter. Area surveyed, and no suitable habitat is present within the subject land however, this species was recorded within the Will street sewage treatment plant on BioNet in 1986.	Potential	Yes
Stictonetta naevosa	Freckled Duck	Vulnerable	Not Listed	Unlikely. Prefer permanent freshwater swamps and creeks with heavy growth of Cumbungi, Lignum or Tea-tree. During drier times they move from ephemeral breeding swamps to more permanent waters such as lakes, reservoirs, farm dams and sewage ponds. Area surveyed, and suitable habitat is not present within the subject land.	No	No
Tringa nebularia	Common Greenshank	Not Listed	Endangered	Unlikely, this species does not breed in Australia, outside of breeding season it occurs in all types of wetlands. Area surveyed. No suitable habitat present.	No	No

Scientific Name	Common Name	NSW Status	Commonwealth Status	Likelihood of Occurrence	Likelihood of impact	Test of Significance required
Tyto novaehollandiae	Masked Owl	Vulnerable	Not Listed	Unlikely, Species, roosts and breeds in moist eucalypt forested gullies and requires large tree hollows. This species sometimes also uses caves for nesting. Area surveyed. No suitable habitat present.	No	No
Mammals						
Nyctophilus corbeni	Corben's Long-eared Bat	Vulnerable	Vulnerable	Unlikely. Species roosts in tree hollows, crevices, and under loose bark, distinctly more common in box/ironbark/ cypress-pine vegetation. Area surveyed. This species preferred habitat does not occur within the subject land	No	No
Rattus villosissimus	Long-haired Rat	Vulnerable	Not Listed	Potential. Species eats roots stems, grass leaves and herbs, predominantly succulent species. Seeds, flowers and insects. Species survives in mesic, densely vegetated sites.	Potential	Yes
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	Vulnerable	Not Listed	Potential. Species roosts in tree hollows and can utilise mammal burrows in treeless areas. Species also forages for insects above the tree canopy and lower in open country	Potential	Yes
Antechinomys laniger	Kultarr	Endangered	Not Listed	Potential, species inhabits open country, especially claypans among Acacia woodlands. Potential habitat present.	Potential	Yes
Chalinolobus picatus	Little Pied Bat	Vulnerable	Not Listed	Potential. The species occurs in dry open forest, open woodland, Mulga woodlands, chenopod shrublands, cypress pine forest and mallee and Bimble box woodlands where the species roosts in caves, rock outcrops, mine shafts, tunnels and tree hollows. This species has been previously recorded within five kilometres of the proposal.	Potential	Yes
Leggadina forresti	Forrest's Mouse	Vulnerable	Not Listed	Potential. Species prefers semi-arid plains habitats, especially tussock grassland and chenopod shrubland, Mulga or savannah woodlands, claypans and sandy ridges. Species nests in shallow burrows and cracks in the soil.	Potential	Yes
Leporillus conditor	Greater Stick-nest Rat	Extinct	Vulnerable	Unlikely. This species has been identified as extinct within NSW. This species inhabits areas with succulent and semi-succulent plant species for foraging.	No	No
Notomys fuscus	Dusky Hopping-mouse	Endangered	Vulnerable	Potential. Species habitat includes sand dunes, hills and ridges, records have been collected in Bluebush (*Maireana pyramidata*) chenopod shrubland near a drainage line with River Red Gums.	Potential	Yes

Scientific Name	Common Name	NSW Status	Commonwealth Status	Likelihood of Occurrence	Likelihood of impact	Test of Significance required
				This species does not need to drink and forages in open sand areas, rarely venturing into surrounding habitats. This species has been previously recorded within four kilometres of the proposal.		
Pseudomys bolami	Bolam's Mouse	Endangered	Not Listed	Potential. Species requires a developed understorey of *Acacia, Dodonaea* or *Eremophila* species. Foraging habitat includes bluebush *(Maireana spp)* as well as seeds, fruit, blossoms, grasses, herbs and invertebrates like beetles and spiders. Potential bluebush foraging habitat is present within the subject land. This species has been previously recorded within 10 kilometres.	Potential	Yes
Pseudomys hermannsburgensis	Sandy Inland Mouse	Vulnerable	Not Listed	Potential. Occurs in habitat ranging from coolabah, *Acacia* woodlands, tall open shrublands, (commonly Mulga scrub) and hummock grasslands.	Potential	Yes
Pseudomys australis	Plains Mouse	Vulnerable	Vulnerable	Unlikely, This species is restricted to the gibber plains of Lake Eyre Basin in northern south Australia and is presumed extinct in Queensland and NSW. Within the gibber plains primary habitat for this species includes mid slopes with boulders, small stones and Gilgai's (water soaks and depressions). Core refuge areas during poor conditions may occur on low-lying Gilgai's and watercourses of gibber plains. The preferred habitat for this species does not occur within the subject land therefore, potential occurrence of and impact to this species is unlikely.	Unlikely	No
Sminthopsis macroura	Stripe-faced Dunnart	Vulnerable	Not Listed	Potential. This species habitat can consist of low shrublands containing saltbush *(Atriplex spp*) and Bluebush *(Maireana spp)* within arid regions. Potential habitat occurs within the subject land.	Potential	Yes
Reptiles						
Antaresia stimsoni	Stimson's Python	Vulnerable	Not Listed	Unlikely. Species inhabits rock outcrops, sandy plains and dune fields associated with larger trees and termite mounds. Area surveyed. No suitable habitat present.	No	No
Antaresia children	Children's Python	Vulnerable	Not Listed	Potential, This species is terrestrial and semi-arboreal, inhabiting variable habitats including woodlands, shrublands (including Acacia and chenopods) and hummock grasslands where rocky outcrops provide caves and deep crevices, as well as tree lined water courses which provide numerous low hollows and fallen trees.	Potential	Yes

Scientific Name	Common Name	NSW Status	Commonwealth Status	Likelihood of Occurrence	Likelihood of impact	Test of Significance required
				Requires semi-arid habitats including rock outcrops, sandy plains and dune fields associated with larger trees and termite moulds. Potential habitat for this species occurs within the subject land.		
Lucasium microplax	Southern Sandplain Gecko	Vulnerable	Not Listed	Unlikely, This species is not known to occur within the subject land. This species habitat includes red sand habitats and elsewhere from savannah woodland and stony areas with shrubs. This species is only known from four separate locations in NSW, including Sturt National Park, Mutawintji National Park, Loch Lilly, 125 south of Broken Hill and Thurloo downs located 145 kilometres east of Tibooburra. Therefore, this species or species habitat is unlikely to occur or be impacted by the proposal within the subject land	No	No
Aspidites ramsayi	Woma	Vulnerable	Not Listed	Unlikely, species habitat includes subtropical to temperate deserts and sandy plains, dune fields and deep cracking black soil plains in semi-arid areas. Occurs in hummock grasslands, shrublands or woodlands. Area surveyed. No suitable habitat present.	No	No
Ctenophorus mirrityana	Barrier Range Dragon	Endangered	Not Listed	Unlikely, species is restricted to rock outcrops in ranges and gorges. Area surveyed. No suitable habitat present.	No	No
Ctenotus brooksi	Wedgesnout Ctenotus	Vulnerable	Not Listed	Unlikely, species prefers areas of loose sand interspersed with vegetation on and near the crests of dunes. This species has only been recorded from unconsolidated sand dunes and not from low consolidated red sand ridges. Area surveyed. No suitable habitat present.	No	No
Cyclodomorphus melanops elongatus	Mallee Slender Blue-tongue Lizard	Endangered	Not Listed	Unlikely, species prefers mallee/spinifex communities on a sandy or mixed sand/gravel substrate (plains, ridges or hillslopes). Area surveyed. No suitable habitat present.	No	No
Delma australis	Marble-faced Delma	Endangered	Not Listed	Unlikely. Species is restricted to temperate mallee woodlands or spinifex grasslands. Area surveyed. No suitable habitat present.	No	No
Diplodactylus platyurus	Eastern Fat-tailed Gecko	Endangered	Not Listed	Potential. Species is highly specialised in its use of habitat. It is known to shelter in vertical spider burrows and cracks in the ground.	Potential	Yes
Lerista xanthura	Yellow-tailed Plain Slider	Vulnerable	Not Listed	Unlikely. Species occurs on grassed alluvial sands and sand dunes, including dry open woodlands and spinifex-dominated red sand plains. Area surveyed. No suitable habitat present.	No	No

Scientific Name	Common Name	NSW Status	Commonwealth Status	Likelihood of Occurrence	Likelihood of impact	Test of Significance required
Lucasium stenodactylum	Crowned Gecko	Vulnerable	Not Listed	Potential. Species habitat includes red sand habitats, savannah woodland and stony areas with shrubs. Species is only known to occur from four separate locations, the closest being 125kilometres south of broken hill.	Potential	Yes
Pseudonaja modesta	Ringed Brown Snake	Endangered	Not Listed	Potential. Species is terrestrial and preferred habitat includes drier areas including rocky outcrops and dry watercourses. This species has been previously recorded within approximately 1kilometres of the subject land.	Potential	Yes
Strophurus elderi	Jewelled Gecko	Vulnerable	Not Listed	Unlikely, species is restricted to habitats containing spinifex on red sandy plains, dunes, and to some degree stony hills. Area surveyed. No suitable habitat present.	No	No
Tiliqua occipitalis	Western Blue-tongued Lizard	Vulnerable	Not Listed	Potential. Species inhabits plains, swales, ranges and sometimes dunes of loamy, clayey/sandy soils vegetated by woodlands. Species preferred vegetation type appears to be mixed mallee/Triodia communities. This species has been previously recorded within 2kilometres of the subject land.	Potential	Yes
Tympanocryptis lineata	Canberra Grassland Earless Dragon	Critically Endangered	Not Listed	Unlikely, species occurs in and is restricted to a small number of natural Temperate Grassland sites dominated by wallaby grasses, spear grasses, Poa Tussock, Red Grass, and occasionally kangaroo grass. Species prefers habitat with an open structure with small patches of bare ground between the grasses and herbs. Area surveyed and sufficient habitat complexity to support a viable local population of this species is not present.	No	No
Flora						
Acacia carneorum	Purple-wood Wattle	Endangered	Endangered	Unlikely. This species was not observed during the field assessment conducted during the preferred survey period.	No	No
Acacia notabilis	Mallee Golden Wattle	Endangered	Not Listed	Unlikely. This species was not observed during the field assessment conducted during the preferred survey period.	No	No
Acacia rivalis	Creek Wattle	Endangered	Not Listed	Unlikely. This species was not observed during the field assessment conducted during the preferred survey period.	No	No

Scientific Name	Common Name	NSW Status	Commonwealth Status	Likelihood of Occurrence	Likelihood of impact	Test of Significance required
Atriplex infrequens	A saltbush	Vulnerable	Vulnerable	Potential. The field survey was completed outside of the preferred survey period and other Atriplex species were identified as present within the subject land at the time of the survey.	Potential	Yes
Convolvulus tedmoorei	Bindweed	Endangered	Not Listed	Potential, survey is required 1 month after good rain between June and September. species potential for occurrence could not be ruled out during the field survey as it was completed outside of the required survey period.	Potential	Yes
Dysphania platycarpa	Dysphania platycarpa	Endangered	Not Listed	Unlikely. This species preferred habitat to grow on is heavy soils near ephemeral water. Area surveyed. No suitable habitat present.	No	No
Eleocharis obicis	Spike-Rush	Vulnerable	Vulnerable	Potential- This species emerges in periodically waterlogged sites after good soaking rain primarily in spring. Species is best surveyed after soaking rains	Potential	Yes
Erodiophyllum elderi	Koonamore Daisy	Endangered	Not Listed	Potential. This species mainly grows on alluvial floodplains in central Australia. However, it is commonly recorded from Mulga shrubland with chenopods in SA and WA.	Potential	Yes
Indigofera longibractea	Showy Indigo	Endangered	Not Listed	Unlikely. This species was not observed during a field assessment conducted during preferred survey period. No suitable habitat of rocky creek beds and drainage lines were present.	No	No
Lepidium monoplocoides	Winged Peppercress	Endangered	Endangered	Unlikely This species is mostly restricted to seasonally moist sites not consistent with the subject land. Plants usually emerge 1 month after rain and only persist for a few months. Due to this plant occurring in ephemeral conditions it may not be detectable during the suggested survey times if they occur during dry periods.	No	No
Solanum karsense	Menindee Nightshade	Vulnerable	Vulnerable	Unlikely This species prefers habitats usually include lake beds, or floodplains of heavy grey clays with a high self-mulching surface. This species can also be found on sandy floodplains and ridges in calcareous soils. Area surveyed. Species preferred habitat was not recorded in the subject land.	No	No
Swainsona flavicarinata	Yellow-Keeled Swainsona	Endangered	Not Listed	Potential. This species grows in Mulga communities on red earths and on stony soils supporting Badder saltbush. This species has an outlier population in the Broken Hill-Menindee district and is not commonly found elsewhere in NSW.	Potential	Yes

Scientific Name	Common Name	NSW Status	Commonwealth Status	Likelihood of Occurrence	Likelihood of impact	Test of Significance required
Swainsona murrayana	Slender Darling Pea	Vulnerable	Vulnerable	Unlikely, this species is likely to be found within remnant native grasslands or grassy woodlands which have been intermittently grazed or cultivated. Area surveyed. No suitable habitat is present within the subject land.	No	No
Swainsona viridis	Creeping Darling Pea	Endangered	Not Listed	Potential. This species grows in dry, sandy or stony areas located within creek beds or on the banks. This species is also found on sandy soils near watercourses. This species has been previously known to occur along a roadside sandplain in sandy-loam soil. Species potential habitat occurs within the subject land.	Potential	Yes
TECs						
Acacia loderi shrublands		Endangered Ecological Community	Not Listed	Potential. Plant Community Type 155 associated with this Threatened Ecological Community was recorded within areas of the subject land during the field survey.	Potential	Yes
Porcupine Grass Red Mallee Gum Coolabah hummock grassland/low sparse woodland in the Broken Hill Complex Bioregion		Critically Endangered Ecological Community	Not Listed	Unlikely. Plant Community Types associated with this Threatened Ecological Community were not identified in the subject land. This threatened Ecological Community was therefore, not identified to be present during the field survey.	No	No
Artesian Springs Ecological Community in the Great Artesian Basin		Critically Endangered	Not listed	Unlikely. The subject land does not occur in the Great Artesian Basin. No Spring sediment mounds were recorded in the subject land during the field survey.	No	No
Acacia melvillei Shrubland in the Riverina and Murray-Darling Depression bioregions.		Endangered Ecological Community	Not Listed	Unlikely. Plant Community Types associated with this Threatened Ecological Community were not identified in the subject land. No *Acacia Melvillei* was determined to be present; therefore, this Threatened Ecological Community was not identified to be present during the field survey.	No	No

V = Vulnerable, E = Endangered, CE = Critically Endangered, M = Migratory

Appendix D: Tests and Assessments of significance

EPBC Act Assessments of Significance

MNES – Vulnerable flora species: • ***Atriplex infrequens* - A saltbush** • ***Eleocharis obicis* - Spike-Rush**	
Significant impact criteria	
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
Statement	Response
lead to a long-term decrease in the size of an important population of a species	A local viable population of these species were not recorded during the field survey. No records within 500 meters of the subject land have been previously recorded. The surrounding landscape is similar outside of the subject land, therefore if the species are impacted to any level, it will not reduce the area of occupancy for these species. The proposal is largely located within areas previously cleared or highly disturbed land and native vegetation affected is well represented outside of the subject land. The proposal is unlikely to lead to a long-term decrease in the size of an important population of these species.
reduce the area of occupancy of an important population	The proposal will not reduce the area of occupancy of an important population of these species as no important population has been recorded occurring previously or during the field survey. The proposal is largely located within areas previously cleared or highly disturbed land and native vegetation affected is well represented outside of the subject land.
fragment an existing important population into two or more populations	The proposal will not fragment an existing important population into two or more populations as the surrounding landscape is similar outside of the subject land. The proposal is largely located within areas previously cleared or highly disturbed land.
adversely affect habitat critical to the survival of a species	The proposal is largely located within areas previously cleared or highly disturbed land. Native vegetation to be cleared is well represented outside of the subject land. Therefore, if the species are impacted to any level, habitat critical to the survival of these species will not be adversely affected.
disrupt the breeding cycle of an important population	The proposal will not disrupt the breeding cycle of an important population of these species as the proposal is largely located within areas previously cleared or highly disturbed land. No important populations of these species have been previously identified as occurring within the subject land.
modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Potential habitat for these species is available in the surrounding landscape outside of the subject land. The proposal will not modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that these species are likely to decline.
result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	The proposal will not result in invasive species that are harmful to this vulnerable/endangered species becoming established in the vulnerable/endangered species' habitat to any greater extent than already exists.
introduce disease that may cause the species to decline, or	The proposal will not result in disease that may cause these species to decline becoming established to any greater extent than already exists.
interfere substantially with the recovery of the species.	The proposal will not substantially interfere with the recovery these species.
Summary statement:	

MNES – Vulnerable flora species:

- ***Atriplex infrequens* - A saltbush**
- ***Eleocharis obicis* - Spike-Rush**

Native vegetation to be cleared will be minimised and is well represented outside of the subject land. The proposal will not result in a significant impact to this species.

What is an important population of a species?

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:
• key source populations either for breeding or dispersal
• populations that are necessary for maintaining genetic diversity, and/or
• populations that are near the limit of the species range.

What is an invasive species?

An 'invasive species' is an introduced species, including an introduced (translocated) native species, which out-competes native species for space and resources, or which is a predator of native species. Introducing an invasive species into an area may result in that species becoming established. An invasive species may harm listed threatened species or ecological communities by direct competition, modification of habitat or predation.

What is habitat critical to the survival of a species or ecological community?

'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary:
• for activities such as foraging, breeding, roosting, or dispersal
• for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
• to maintain genetic diversity and long-term evolutionary development, or
• for the reintroduction of populations or recovery of the species or ecological community.
Such habitat may be but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the minister under the EPBC Act.

MNES - Endangered Aves species:

- ***Lophochroa leadbeateri leadbeateri* – Pink Cockatoo (eastern)**
- ***Lophochroa leadbeateri* – Pink Cockatoo**

Significant impact criteria

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

Statement	Response
lead to a long-term decrease in the size of a population	A local viable population of this species was not recorded during the field survey the Pink Cockatoo (*Lophochroa leadbeateri*) have previous records within 1500 meters of the subject land. The surrounding landscape is similar outside of the subject land, therefore if the species are impacted to any level, it will not reduce the area of occupancy for these species. The proposal is unlikely to lead to a long-term decrease in the size of an important population of a species.
reduce the area of occupancy of the species	The proposal will not affect the area of occupancy of this species. No individuals were identified to occur within the subject land at the time of the survey. Suitable foraging and breeding habitat is represented in the surrounding areas.
fragment an existing population into important population into two or more populations	No important populations were recorded within the subject land. Fragmentation would not be notably increased above that already afforded by the existing road and sewage treatment plants adjacent the subject land.
adversely affect habitat critical to the survival of a species	It is unlikely the habitat in the subject land represents habitat critical to the survival of this species.
disrupt the breeding cycle of a population	The proposal will not disrupt the breeding cycle as no breeding habitat for this species is present in the subject land.
modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The proposal will not modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that these species are likely to decline.
result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	The proposal is unlikely to result in invasive species becoming established in the threatened species' habitat, any more than is already occurring.

MNES - Endangered Aves species: • ***Lophochroa leadbeateri leadbeateri* – Pink Cockatoo (eastern)** • ***Lophochroa leadbeateri* – Pink Cockatoo**	
introduce disease that may cause the species to decline, or	The proposal will not result in disease that may cause this species to decline or becoming established to any greater extent than already exists.
interfere with the recovery of the species.	The proposal will not interfere substantially with the recovery of these species. This species was not observed within the subject land. Any impacts to foraging habitat will be minimal with more suitable habitat represented outside the subject land.
Summary statement:	
Native vegetation to be cleared will be minimised and is well represented outside of the subject land. The proposal will not result in a significant impact to this species.	
What is an important population of a species? An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are: • key source populations either for breeding or dispersal • populations that are necessary for maintaining genetic diversity, and/or • populations that are near the limit of the species range.	
What is an invasive species?	
An 'invasive species' is an introduced species, including an introduced (translocated) native species, which out-competes native species for space and resources, or which is a predator of native species. Introducing an invasive species into an area may result in that species becoming established. An invasive species may harm listed threatened species or ecological communities by direct competition, modification of habitat or predation.	
What is habitat critical to the survival of a species or ecological community?	
'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary: • for activities such as foraging, breeding, roosting, or dispersal • for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators) • to maintain genetic diversity and long-term evolutionary development, or • for the reintroduction of populations or recovery of the species or ecological community. Such habitat may be but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the minister under the EPBC Act.	

MNES - Endangered Aves species: • ***Rostratula australis* - Australian Painted Snipe**	
Significant impact criteria	
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
Statement	Response
lead to a long-term decrease in the size of a population	A local viable population of this species was not recorded during the field survey the Australian Painted Snipe (*Rostratula australis*) have previous records at the Will street sewage treatment plant within the subject land, therefore if the species are impacted to any level, it will not reduce the area of occupancy for these species. The proposal is unlikely to lead to a long-term decrease in the size of an important population of a species.
reduce the area of occupancy of the species	The proposal will not affect the area of occupancy of this species. No individuals were identified to occur within the subject land at the time of the survey.
fragment an existing population into important population into two or more populations	No important populations were recorded within the subject land. Fragmentation would not be notably increased above that already afforded by the existing road and sewage treatment plants adjacent the subject land.
adversely affect habitat critical to the survival of a species	It is unlikely the habitat in the subject land represents habitat critical to the survival of this species.
disrupt the breeding cycle of a population	The proposal will not disrupt the breeding cycle as no breeding habitat for this species is present in the subject land.
modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The proposal will not modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that these species are likely to decline.
result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	The proposal is unlikely to result in invasive species becoming established in the threatened species' habitat, any more than is already occurring.
introduce disease that may cause the species to decline, or	The proposal will not result in disease that may cause this species to decline or becoming established to any greater extent than already exists.
interfere with the recovery of the species.	The proposal will not interfere substantially with the recovery of these species. This species was not observed within the subject land during the field survey or recorded on BioNet as occurring within the last 30 years. Any impacts to foraging habitat will be minimal.
Summary statement:	
The proposal will not result in a significant impact to this species.	
What is an important population of a species? An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are: • key source populations either for breeding or dispersal • populations that are necessary for maintaining genetic diversity, and/or • populations that are near the limit of the species range.	
What is an invasive species?	
An 'invasive species' is an introduced species, including an introduced (translocated) native species, which out-competes native species for space and resources, or which is a predator of native species. Introducing an invasive species into an area may result in that species becoming established. An invasive species may harm listed threatened species or ecological communities by direct competition, modification of habitat or predation.	
What is habitat critical to the survival of a species or ecological community?	
'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary: • for activities such as foraging, breeding, roosting, or dispersal • for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators) • to maintain genetic diversity and long-term evolutionary development, or • for the reintroduction of populations or recovery of the species or ecological community. Such habitat may be but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the minister under the EPBC Act.	

MNES - Vulnerable Aves species: • ***Aphelocephala leucopsis* - Southern Whiteface** • ***Falco hypoleucos* - Grey Falcon**	
Significant impact criteria	
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
Statement	Response
lead to a long-term decrease in the size of an important population of a species	A local viable population of these species were not recorded during the field survey however the Southern Whiteface *(Aphelocephala leucopsis*) has previous records within 1500 meters of the subject land. The surrounding landscape is similar outside of the subject land, therefore if the species are impacted to any level, it will not reduce the area of occupancy for these species. The proposal is unlikely to lead to a long-term decrease in the size of an important population of a species.
reduce the area of occupancy of an important population	The proposal will not affect the area of occupancy for these species. No individuals were identified to occur within the subject land at the time of the survey. Suitable foraging and breeding habitat is represented in the surrounding areas.
fragment an existing important population into two or more populations	No important populations were recorded within the subject land. Fragmentation would not be notably increased above that already afforded by the existing road and sewage treatment plants adjacent the subject land.
adversely affect habitat critical to the survival of a species	It is unlikely the habitat in the subject land represents habitat critical to the survival of this species.
disrupt the breeding cycle of an important population	The proposal will not disrupt the breeding cycle as limited breeding habitat is present in the subject land.
modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The proposal will not modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that these species are likely to decline. A small area of potentially suitable habitat would be impacted.
result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	The proposal is unlikely to result in invasive species becoming established in the threatened species' habitat, any more than is already occurring.
introduce disease that may cause the species to decline, or	The proposal will not result in disease that may cause these species to decline or becoming established to any greater extent than already exists.
interfere substantially with the recovery of the species.	The proposal will not interfere substantially with the recovery of these species. These species were not observed within the subject land. Any impacts will be minimal with more suitable habitat represented outside the subject land.
Summary statement:	
Native vegetation to be cleared will be minimised and is well represented outside of the subject land. The proposal will not result in a significant impact to this species.	
What is an important population of a species? An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are: • key source populations either for breeding or dispersal • populations that are necessary for maintaining genetic diversity, and/or • populations that are near the limit of the species range.	
What is an invasive species?	
An 'invasive species' is an introduced species, including an introduced (translocated) native species, which out-competes native species for space and resources, or which is a predator of native species. Introducing an invasive species into an area may result in that species becoming established. An invasive species may harm listed threatened species or ecological communities by direct competition, modification of habitat or predation.	
What is habitat critical to the survival of a species or ecological community?	
'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary: • for activities such as foraging, breeding, roosting, or dispersal • for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators) • to maintain genetic diversity and long-term evolutionary development, or • for the reintroduction of populations or recovery of the species or ecological community. Such habitat may be but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the minister under the EPBC Act.	

MNES - Vulnerable Aves species: • ***Amytornis modestus* - Thick-billed Grasswren**	
Significant impact criteria	
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
Statement	Response
lead to a long-term decrease in the size of an important population of a species	A local viable population of this species was not recorded during the field survey. The surrounding landscape is similar outside of the subject land, therefore if the species are impacted to any level, it will not reduce the area of occupancy for these species. The proposal is unlikely to lead to a long-term decrease in the size of an important population of a species.
reduce the area of occupancy of an important population	The proposal will not affect the area of occupancy for this species. No individuals were identified to occur within the subject land at the time of the survey. Suitable foraging and breeding habitat is represented in the surrounding areas.
fragment an existing important population into two or more populations	No important populations were recorded within the subject land. Fragmentation would not be notably increased above that already afforded by the existing road and sewage treatment plants adjacent the subject land.
adversely affect habitat critical to the survival of a species	It is unlikely the habitat in the subject land represents habitat critical to the survival of this species.
disrupt the breeding cycle of an important population	The proposal will not disrupt the breeding cycle as limited breeding habitat is present in the subject land.
modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The proposal will not modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that these species are likely to decline. A small area of potentially suitable habitat would be impacted.
result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	The proposal is unlikely to result in invasive species becoming established in the threatened species' habitat, any more than is already occurring.
introduce disease that may cause the species to decline, or	The proposal will not result in disease that may cause these species to decline or becoming established to any greater extent than already exists.
interfere substantially with the recovery of the species.	The proposal will not interfere substantially with the recovery of these species. These species were not observed within the subject land. Any impacts will be minimal with more suitable habitat represented outside the subject land.
Summary statement:	
Native vegetation to be cleared will be minimised and is well represented outside of the subject land. The proposal will not result in a significant impact to this species.	
What is an important population of a species? An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are: • key source populations either for breeding or dispersal • populations that are necessary for maintaining genetic diversity, and/or • populations that are near the limit of the species range.	
What is an invasive species?	
An 'invasive species' is an introduced species, including an introduced (translocated) native species, which out-competes native species for space and resources, or which is a predator of native species. Introducing an invasive species into an area may result in that species becoming established. An invasive species may harm listed threatened species or ecological communities by direct competition, modification of habitat or predation.	
What is habitat critical to the survival of a species or ecological community?	
'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary: • for activities such as foraging, breeding, roosting, or dispersal • for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators) • to maintain genetic diversity and long-term evolutionary development, or • for the reintroduction of populations or recovery of the species or ecological community. Such habitat may be but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the minister under the EPBC Act.	

MNES – Vulnerable mammal species considered: • ***Notomys fuscus* - Dusky Hopping-mouse**	
Significant impact criteria An action is likely to have a significant impact on an endangered species if there is a real chance or possibility that it will:	
Statement	Response
lead to a long-term decrease in the size of an important population of a species	The proposal is unlikely to result in a long-term decrease in the population size of the Dusky Hopping-mouse (*Notomys fuscus*) given the subject land contains minimal suitable habitat, is historically cleared and disturbed land with compacted dirt tracks. The subject land is unlikely to support viable populations of this species. Suitable habitat is represented well outside of the subject land.
reduce the area of occupancy of an important population	The proposal is unlikely to reduce the area of occupancy of the Dusky Hopping-mouse (*Notomys fuscus*) given the limited extent of and change to available suitable habitat which would be impacted.
fragment an existing important population into two or more populations	The proposal is unlikely to fragment an existing Dusky Hopping-mouse (*Notomys fuscus*) population into two or more populations. The proposal would not increase the fragmentation already afforded by the existing roads and sewage treatment plant adjacent the proposal.
adversely affect habitat critical to the survival of a species	The proposal is unlikely to adversely affect habitat critical to the survival of the Dusky Hopping-mouse (*Notomys fuscus*). Habitat for this species is well represented outside the subject land. Vegetation to be cleared as part of this proposal is generally in poor to moderate condition. Impact to native vegetation will be reduced by the proposal as it predominantly occurs within historically cleared and disturbed land with compacted dirt tracks.
disrupt the breeding cycle of an important population	The proposal will not disrupt the breeding cycle of the Dusky Hopping-mouse (*Notomys fuscus*). No populations of these species have been previously recorded within 1500 meters of the subject land, more favourable habitat for this species is available outside the subject land.
modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The proposal will not modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that Dusky Hopping-mouse (*Notomys fuscus*) are likely to decline. Vegetation disturbance will be minimal as the proposal predominantly occurs within historically cleared and disturbed land with compacted dirt tracks. Habitat for this species is well represented outside the subject land.
result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Given the specifications of the development, the proposal is unlikely to result in invasive species becoming established in the threatened species' habitat, any more than is already occurring.
introduce disease that may cause the species to decline, or	The proposal will not result in disease that may cause these species to decline or becoming established to any greater extent than already exists.
interfere substantially with the recovery of the species.	The proposal will not interfere substantially with the recovery of these species in this location. This species has not previously been recorded within 1500 meters of the subject land and more suitable habitat for this species occurs outside of the subject land.
Summary statement: Native vegetation to be cleared will be minimised and is well represented outside of the subject land. The proposal will not result in a significant impact to this species.	
What is an important population of a species? An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are: • key source populations either for breeding or dispersal • populations that are necessary for maintaining genetic diversity, and/or • populations that are near the limit of the species range.	
What is an invasive species? An 'invasive species' is an introduced species, including an introduced (translocated) native species, which out-competes native species for space and resources, or which is a predator of native species. Introducing an invasive species into an area may result in that species becoming established. An invasive species may harm listed threatened species or ecological communities by direct competition, modification of habitat or predation.	
What is habitat critical to the survival of a species or ecological community? 'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary: • for activities such as foraging, breeding, roosting, or dispersal • for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators) • to maintain genetic diversity and long-term evolutionary development, or	

• for the reintroduction of populations or recovery of the species or ecological community. Such habitat may be but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the minister under the EPBC Act.

BC Act Tests of Significance

BC Act test of significance for threatened ecological communities: **Endangered Ecological Community - *Acacia loderi shrublands***	
Significant impact criteria - An action is likely to have a significant impact on a protected matter if there is a real chance or possibility that it will have:	
Statement	Response
Adverse effects on the life cycle of a species (a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction	N/A
Adverse effects on ecological communities (b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction	The vegetation type mapping for this community is no longer applicable. The mapped area has been long cleared and is now a derived Blue bush, copperburr shrubland grassland.
Adverse effects on habitats (c) in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality	N/A
Adverse effects on areas of outstanding biodiversity value (d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)	The proposal will not have an adverse effect on any declared area of outstanding biodiversity value.
Key threatening processes (e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process	The proposal will exacerbate removal of some native vegetation but will not impact vegetation this community is reliant on. Dead wood and trees will be locally relocated. The proposal would exacerbate the KTPs listed in Section 5.3. The exacerbations are unlikely to result in significant impacts to this Threatened Ecological Community.
Summary statement: The proposal will not result in a significant impact to this TEC.	

In determining the nature and magnitude of an impact, matters were considered such as:
- pre-construction, construction and occupation/maintenance phases
- all on-site and off-site impacts, including location, installation, operation and maintenance of auxiliary infrastructure and fire management zones
- all direct and indirect impacts
- the frequency and duration of each known or likely impact/action
- the total impact which can be attributed to that action over the entire geographic area affected, and over time
- the sensitivity of the receiving environment
- the degree of confidence with which the impacts of the action are known and understood.

All factors should be considered as well as any other information considered relevant to the test. Sources and currency of data and information are to be documented and referenced. Limitations, uncertainties and known gaps in information are also to be documented to inform the decision-maker

BC Act test of significance for fauna (bird) species:

- ***Rostratula australis* – Australia Painted Snipe**

Significant impact criteria - An action is likely to have a significant impact on a protected matter if there is a real chance or possibility that it will have:

Statement	Response
Adverse effects on the life cycle of a species (a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction	No breeding habitat for these species will be impacted by this proposal. Some foraging habitats for these species may be impacted. The proposal has mitigated potential impacts to foraging habitat by largely being located within areas that have been previously cleared or heavily disturbed land including compacted dirt tracks, to limit the clearing of native vegetation. No breeding habitat was recorded occurring within the subject land. The latest sighting of this species within the subject land occurred in 1986.
Adverse effects on ecological communities (b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction	N/A
Adverse effects on habitats (c) in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality	Adverse impacts on habitat to the extent the species would become locally extinct are unlikely. The proposal will not modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that these species are likely to decline. No individuals would be excluded form suitable habitat at any time. This species has not been recorded within the subject land for 30 years, nor does any preferred breeding habitat occur currently in the subject land. The proposal will be largely located with areas that have been previously cleared or heavily disturbed, to limit the clearing of native vegetation.
Adverse effects on areas of outstanding biodiversity value (d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)	The proposal will not have an adverse effect on any declared area of outstanding biodiversity value.
Key threatening processes (e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process	The proposal would exacerbate the KTPs listed in Section 5.3. The exacerbations are unlikely to result in significant impacts to the species.
Summary statement: The proposal will not result in a significant impact to these species. Any impacts will be minimal as the proposal is largely located within areas which have been previously cleared and heavily disturbed land.	

In determining the nature and magnitude of an impact, matters were considered such as:
- pre-construction, construction and occupation/maintenance phases
- all on-site and off-site impacts, including location, installation, operation and maintenance of auxiliary infrastructure and fire management zones
- all direct and indirect impacts
- the frequency and duration of each known or likely impact/action
- the total impact which can be attributed to that action over the entire geographic area affected, and over time

BC Act test of significance for fauna (bird) species: • ***Rostratula australis* – Australia Painted Snipe**
• the sensitivity of the receiving environment • the degree of confidence with which the impacts of the action are known and understood. All factors should be considered as well as any other information considered relevant to the test. Sources and currency of data and information are to be documented and referenced. Limitations, uncertainties and known gaps in information are also to be documented to inform the decision-maker

BC Act test of significance for fauna (bird) species: • ***Aphelocephala leucopsis* - Southern Whiteface** • ***Circus assimilis* - Spotted Harrier** • ***Falco hypoleucos* - Grey Falcon** • ***Falco subniger* - Black Falcon** • ***Hieraaetus morphnoides* - Little Eagle** • ***Lophochroa leadbeateri* - Pink Cockatoo** • ***Lophochroa leadbeateri leadbeateri* - Pink Cockatoo (eastern)** • ***Neophema splendida* - Scarlet-chested Parrot** • ***Lophoictinia isura* - Square-tailed Kite**	
Significant impact criteria - An action is likely to have a significant impact on a protected matter if there is a real chance or possibility that it will have:	
Statement	Response
Adverse effects on the life cycle of a species (a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction	No breeding habitat for these species will be impacted by this proposal. Some foraging habitats for these species may be impacted. The proposal has mitigated potential impacts to foraging habitat by largely being located within areas that have been previously cleared or heavily disturbed land including compacted dirt tracks, to limit the clearing of native vegetation. Suitable breeding or foraging habitat exists in abundance outside the subject land.
Adverse effects on ecological communities (b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction	N/A
Adverse effects on habitats (c) in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality	Adverse impacts on habitat to the extent the species would become locally extinct are unlikely. The proposal will not modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that these species are likely to decline. No individuals would be excluded form suitable habitat at any time. The proposal will be largely located with areas that have been previously cleared or heavily disturbed, to limit the clearing of native vegetation.
Adverse effects on areas of outstanding biodiversity value (d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)	The proposal will not have an adverse effect on any declared area of outstanding biodiversity value.
Key threatening processes (e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process	The proposal would exacerbate the KTPs listed in Section 5.3. The exacerbations are unlikely to result in significant impacts to the species.
Summary statement: The proposal will not result in a significant impact to these species. Any impacts will be minimal as the proposal is largely located within areas which have been previously cleared and heavily disturbed land.	

BC Act test of significance for fauna (bird) species:

- ***Aphelocephala leucopsis* - Southern Whiteface**
- ***Circus assimilis* - Spotted Harrier**
- ***Falco hypoleucos* - Grey Falcon**
- ***Falco subniger* - Black Falcon**
- ***Hieraaetus morphnoides* - Little Eagle**
- ***Lophochroa leadbeateri* - Pink Cockatoo**
- ***Lophochroa leadbeateri leadbeateri* - Pink Cockatoo (eastern)**
- ***Neophema splendida* - Scarlet-chested Parrot**
- ***Lophoictinia isura* - Square-tailed Kite**

In determining the nature and magnitude of an impact, matters were considered such as:

- pre-construction, construction and occupation/maintenance phases
- all on-site and off-site impacts, including location, installation, operation and maintenance of auxiliary infrastructure and fire management zones
- all direct and indirect impacts
- the frequency and duration of each known or likely impact/action
- the total impact which can be attributed to that action over the entire geographic area affected, and over time
- the sensitivity of the receiving environment
- the degree of confidence with which the impacts of the action are known and understood.

All factors should be considered as well as any other information considered relevant to the test. Sources and currency of data and information are to be documented and referenced. Limitations, uncertainties and known gaps in information are also to be documented to inform the decision-maker

BC Act test of significance for fauna (bird) species:

- ***Artamus cyanopterus cyanopterus* – Dusky Woodswallow**
- ***Ardeotis australis* – Australian Bustard**
- ***Calamanthus campestris* - Rufous Fieldwren**
- ***Certhionyx variegatus* - Pied Honeyeater**
- ***Epthianura albifrons* – White-fronted Chat**
- ***Grantiella picta* - Painted Honeyeater**
- ***Pomatostomus halli* - Hall's Babbler**
- ***Pyrrholaemus brunneus* – Redthroat**
- ***Phaps histrionica* - Flock Bronzewing**

Significant impact criteria - An action is likely to have a significant impact on a protected matter if there is a real chance or possibility that it will have:

Statement	Response
Adverse effects on the life cycle of a species (a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction	Potential breeding or foraging habitat for these species may be impacted by this proposal. However, the proposal has mitigated this impact by avoiding hollow bearing large trees and the proposal will be largely located within areas that have been previously cleared or heavily disturbed land including compacted dirt tracks, to limit the clearing of native vegetation. Suitable breeding and foraging habitat occur in abundance outside the subject land.
Adverse effects on ecological communities (b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction	N/A
Adverse effects on habitats (c) in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality	Adverse impacts on habitat to the extent the species would become locally extinct are unlikely. The proposal will not modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that these species are likely to decline. No individuals would be excluded form suitable habitat at any time. The proposal will be largely located with areas that have been previously cleared or disturbed, to limit the clearing of native vegetation.

BC Act test of significance for fauna (bird) species: • ***Artamus cyanopterus cyanopterus* – Dusky Woodswallow** • ***Ardeotis australis* – Australian Bustard** • ***Calamanthus campestris* - Rufous Fieldwren** • ***Certhionyx variegatus* - Pied Honeyeater** • ***Epthianura albifrons* – White-fronted Chat** • ***Grantiella picta* - Painted Honeyeater** • ***Pomatostomus halli* - Hall's Babbler** • ***Pyrrholaemus brunneus* – Redthroat** • ***Phaps histrionica* - Flock Bronzewing**	
Adverse effects on areas of outstanding biodiversity value (d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)	The proposal will not have an adverse effect on any declared area of outstanding biodiversity value.
Key threatening processes (e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process	The proposal would exacerbate the KTPs listed in Section 5.3. The exacerbations are unlikely to result in significant impacts to the species.
Summary statement: The proposal will not result in a significant impact to these species. Any impacts will be minimal as the proposal is largely located within areas which have been previously cleared and disturbed land.	
In determining the nature and magnitude of an impact, matters were considered such as: • pre-construction, construction and occupation/maintenance phases • all on-site and off-site impacts, including location, installation, operation and maintenance of auxiliary infrastructure and fire management zones • all direct and indirect impacts • the frequency and duration of each known or likely impact/action • the total impact which can be attributed to that action over the entire geographic area affected, and over time • the sensitivity of the receiving environment • the degree of confidence with which the impacts of the action are known and understood. All factors should be considered as well as any other information considered relevant to the test. Sources and currency of data and information are to be documented and referenced. Limitations, uncertainties and known gaps in information are also to be documented to inform the decision-maker	

BC Act test of significance for fauna (mammal) species: • ***Antechinomys laniger* – Kultarr** • ***Leggadina forresti* - Forrest's Mouse** • ***Rattus villosissimus* - Long-haired Rat** • ***Notomys fuscus* - Dusky Hopping-mouse** • ***Pseudomys bolami* - Bolam's Mouse** • ***Pseudomys hermannsburgensis* - Sandy Inland Mouse** • ***Sminthopsis macroura* - Stripe-faced Dunnart**	
Significant impact criteria - An action is likely to have a significant impact on a protected matter if there is a real chance or possibility that it will have:	
Statement	Response
Adverse effects on the life cycle of a species (a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction	The proposal will not disrupt the breeding cycle of these species as the proposal will be largely located within areas that have been previously cleared or heavily disturbed land including compacted dirt tracks to limit the clearing of native vegetation reducing potential impact to mammal burrows. The proposal is unlikely to have adverse effects on the lifecycle of these species, that would put local viable populations at risk of extinction.
Adverse effects on ecological communities (b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction	N/A
Adverse effects on habitats (c) in relation to the habitat of a threatened species or ecological community:	Adverse impacts on habitat to the extent the species would become locally extinct are unlikely. The proposal will not modify, destroy, remove, isolate, or

BC Act test of significance for fauna (mammal) species: • ***Antechinomys laniger* – Kultarr** • ***Leggadina forresti* - Forrest's Mouse** • ***Rattus villosissimus* - Long-haired Rat** • ***Notomys fuscus* - Dusky Hopping-mouse** • ***Pseudomys bolami* - Bolam's Mouse** • ***Pseudomys hermannsburgensis* - Sandy Inland Mouse** • ***Sminthopsis macroura* - Stripe-faced Dunnart**	
(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality	decrease the availability or quality of habitat to the extent that these species are likely to decline. No individuals would be excluded from suitable habitat at any time. Impact to native vegetation will be minimised by following previously cleared easements and compacted dirt tracks within previously cleared or disturbed land.
Adverse effects on areas of outstanding biodiversity value (d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)	The proposal will not have an adverse effect on any declared area of outstanding biodiversity value.
Key threatening processes (e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process	The proposal would exacerbate the KTPs listed in Section 5.3. The exacerbations are unlikely to result in significant impacts to the species.
Summary statement: The proposal will not result in a significant impact to these species. Any impacts will be minimal as the proposal is largely located within areas which have been previously cleared and disturbed land.	
In determining the nature and magnitude of an impact, matters were considered such as: • pre-construction, construction and occupation/maintenance phases • all on-site and off-site impacts, including location, installation, operation and maintenance of auxiliary infrastructure and fire management zones • all direct and indirect impacts • the frequency and duration of each known or likely impact/action • the total impact which can be attributed to that action over the entire geographic area affected, and over time • the sensitivity of the receiving environment • the degree of confidence with which the impacts of the action are known and understood. All factors should be considered as well as any other information considered relevant to the test. Sources and currency of data and information are to be documented and referenced. Limitations, uncertainties and known gaps in information are also to be documented to inform the decision-maker	

BC Act test of significance for fauna (mammal) species: • ***Chalinolobus picatus* - Little Pied Bat** • ***Saccolaimus flaviventris* - Yellow-bellied Sheathtail-bat**	
Significant impact criteria - An action is likely to have a significant impact on a protected matter if there is a real chance or possibility that it will have:	
Statement	Response
Adverse effects on the life cycle of a species (a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction	The proposal will not disrupt the breeding cycle of these species as the proposal will be largely located within areas that have been previously cleared or heavily disturbed land including compacted dirt tracks to limit the clearing of native vegetation and reducing potential impact to mammal burrows. Hollow bearing trees will be avoided by the proposal. The proposal is unlikely to have adverse effects on the lifecycle of these species, that would put local viable populations at risk of extinction.
Adverse effects on ecological communities (b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction	N/A

BC Act test of significance for fauna (mammal) species: • ***Chalinolobus picatus* - Little Pied Bat** • ***Saccolaimus flaviventris* - Yellow-bellied Sheathtail-bat**	
Adverse effects on habitats (c) in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality	Adverse impacts on habitat to the extent the species would become locally extinct are unlikely. The proposal will not modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that these species are likely to decline. No individuals would be excluded from suitable habitat at any time. Impact to native vegetation will be minimised by avoiding hollow bearing trees and the proposal largely occurring within previously cleared or disturbed land to avoid potential impact to mammal burrows.
Adverse effects on areas of outstanding biodiversity value (d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)	The proposal will not have an adverse effect on any declared area of outstanding biodiversity value.
Key threatening processes (e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process	The proposal would exacerbate the KTPs listed in Section 5.3. The exacerbations are unlikely to result in significant impacts to the species.
Summary statement: The proposal will not result in a significant impact to these species. Any impacts will be minimal as the proposal is largely located within areas which have been previously cleared and heavily disturbed land.	
In determining the nature and magnitude of an impact, matters were considered such as: • pre-construction, construction and occupation/maintenance phases • all on-site and off-site impacts, including location, installation, operation and maintenance of auxiliary infrastructure and fire management zones • all direct and indirect impacts • the frequency and duration of each known or likely impact/action • the total impact which can be attributed to that action over the entire geographic area affected, and over time • the sensitivity of the receiving environment • the degree of confidence with which the impacts of the action are known and understood. All factors should be considered as well as any other information considered relevant to the test. Sources and currency of data and information are to be documented and referenced. Limitations, uncertainties and known gaps in information are also to be documented to inform the decision-maker	

BC Act Test of Significance for fauna (reptile) species: • ***Diplodactylus platyurus* - Eastern Fat-tailed Gecko** • ***Lucasium stenodactylum* - Crowned Gecko** • ***Pseudonaja modesta* - Ringed Brown Snake** • ***Antaresia children* - Children's Python** • ***Tiliqua occipitalis* - Western Blue-tongued Lizard**	
Significant impact criteria - An action is likely to have a significant impact on a protected matter if there is a real chance or possibility that it will have:	
Statement	Response
Adverse effects on the life cycle of a species (a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction	The proposal will not disrupt the breeding cycle of these species as the proposal will be largely located within areas that have been previously cleared or heavily disturbed land including compacted dirt tracks to limit the clearing of native vegetation. The proposal is unlikely to have adverse effects on the lifecycle of these species, that would put local viable populations at risk of extinction.
Adverse effects on ecological communities (b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction	N/A
Adverse effects on habitats (c) in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality	Adverse impacts on habitat to the extent the species would become locally extinct are unlikely. The proposal will not modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that these species are likely to decline. No individuals would be excluded from suitable habitat at any time. Impacted vegetation would be minimised as the proposal will be largely located within areas that have been previously cleared or heavily disturbed land including compacted dirt tracks.
Adverse effects on areas of outstanding biodiversity value (d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)	The proposal will not have an adverse effect on any declared area of outstanding biodiversity value.
Key threatening processes (e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process	The proposal would exacerbate the KTPs listed in Section 5.3. The exacerbations are unlikely to result in significant impacts to the species.
Summary statement: The proposal will not result in a significant impact to these species. Any impacts will be minimal as the proposal is largely located within areas which have been previously cleared and heavily disturbed land.	
In determining the nature and magnitude of an impact, matters were considered such as: • pre-construction, construction and occupation/maintenance phases • all on-site and off-site impacts, including location, installation, operation and maintenance of auxiliary infrastructure and fire management zones • all direct and indirect impacts • the frequency and duration of each known or likely impact/action • the total impact which can be attributed to that action over the entire geographic area affected, and over time • the sensitivity of the receiving environment • the degree of confidence with which the impacts of the action are known and understood. All factors should be considered as well as any other information considered relevant to the test. Sources and currency of data and information are to be documented and referenced. Limitations, uncertainties and known gaps in information are also to be documented to inform the decision-maker	

BC Act Test of Significance for flora species: • ***Atriplex infrequens* A Saltbush** • ***Convolvulus tedmoorei* Bindweed** • ***Eleocharis obicis* Spike-Rush** • ***Erodiophyllum elderi* – Koonamore Daisy** • ***Swainsona flavicarinata* Yellow-Keeled Swainsona** • ***Swainsona viridis* – Creeping Darling Pea**	
Significant impact criteria - An action is likely to have a significant impact on a protected matter if there is a real chance or possibility that it will have:	
Statement	Response
Adverse effects on the life cycle of a species (a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction	The proposal is unlikely to have adverse effects on the lifecycle of this species. The proposal will be largely located within areas that have been previously cleared or heavily disturbed land including compacted dirt tracks. This will reduce the impact on native vegetation and its seedbank.
Adverse effects on ecological communities (b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction	N/A
Adverse effects on habitats (c) in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality	Adverse impacts on habitat are unlikely. The proposal will not modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that these species are likely to decline. Impact to native vegetation will be reduced by the proposal being located largely within areas previously cleared or heavily disturbed land including compacted dirt tracks.
Adverse effects on areas of outstanding biodiversity value (d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)	The proposal will not have an adverse effect on any declared area of outstanding biodiversity value.
Key threatening processes (e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process	The proposal would exacerbate the KTPs listed in Section 5.3. The exacerbations are unlikely to result in significant impacts to the species.
Summary statement: The proposal will not result in a significant impact to these species. Any impacts will be minimal as the proposal is largely located within areas which have been previously cleared and heavily disturbed land.	
In determining the nature and magnitude of an impact, matters were considered such as: • pre-construction, construction and occupation/maintenance phases • all on-site and off-site impacts, including location, installation, operation and maintenance of auxiliary infrastructure and fire management zones • all direct and indirect impacts • the frequency and duration of each known or likely impact/action • the total impact which can be attributed to that action over the entire geographic area affected, and over time • the sensitivity of the receiving environment • the degree of confidence with which the impacts of the action are known and understood. All factors should be considered as well as any other information considered relevant to the test. Sources and currency of data and information are to be documented and referenced. Limitations, uncertainties and known gaps in information are also to be documented to inform the decision-maker	

Appendix E: Aboriginal Heritage Due Diligence Assessment

(AREA Environment and Heritage Consultants, 2025b)

AREA Environmental & Heritage Consultants ABN: 29 616 529 867

- ✓ Environmental impact assessments and approvals: REFs, MW REFs, PEAs
- ✓ Ecology, Aboriginal and historic heritage assessments
- ✓ Biodiversity assessment method (BAM) assessments (BDAR) and offsetting (BSAR)
- ✓ Plans of Management
- ✓ Aboriginal community engagement
- ✓ Stakeholder and community engagement
- ✓ Peer review / project briefs / budgeting assistance / expert witness
- ✓ Commercial external landscape designs for built or natural environments
- ✓ Vegetation Management Plans
- ✓ Stakeholder and community engagement

Aboriginal Heritage Due Diligence Assessment Report

Wills Street Sewage Treatment Plant (STP) Upgrade Project

Broken Hill LGA NSW

Report to Essential Energy

May 2025

"The Old Macquarie Brewery" c1876, 72 Brisbane Street Dubbo NSW 2830
Ph 0409 852 098
phil@areaenv.com.au

AREA Environmental & Heritage Consultants ABN:29 616 529 867

- Environmental impact assessment, auditing, and approvals
- High level preliminary environmental assessment (PEA)
- Review of environmental factors (REF)
- Peer review
- Community engagement
- Biobanking and biodiversity offsetting assessments
- Aboriginal heritage assessments and community walkovers
- Landscape architecture and design

AREA Environmental & Heritage Consultants acknowledges the Traditional Owners of the Country on which we work.

Document Controls

Proponent	Essential Water	
Client	Essential Energy	
Project No / Purchase Order No	NA	
AREA Job No.	QU-0844	
Document Description	Wills Street STP Upgrade Aboriginal Due Diligence Assessment Report	
Clients Representative Managing this Document	Nathan Hegerty	
AREA Person(s) Managing this Document	Anna Darby (AD) Environmental Consultant	
Cover image	View of the Study Area	
DOCUMENT STATUS		
DRAFT: Series V1.X AREA internal edits	**Date**	**Action**
V1.0	14.08.2023	For internal review
V1.1	11.07.2024	SG to AD
V1.2	12.07.2024	AREA Internal edit
V1.3	16.07.2024	AREA Internal edit
V1.4	19.07.2024	AREA Internal Edit
DRAFT Series V2.X Client / AREA internal edits	**Date**	**Action**
V2.0	26.07.2024	AREA to Client
FINAL (draft approved by Client	**Date**	**Action**
V3.0	21.08.2024	Final to Client
V3.1	25.03.2025	AREA Update (AG)
V3.2	01.04.2025	Internal Review
V3.3	09.04.2025	AREA to Client
V3.4	15.05.2025	To client with project updates
Prepared For Essential Energy	Nathan Hegerty **Essential Energy** PO Box 5730 Port Macquarie NSW 2444 E: Nathan.hegerty@essentialenergy.com.au	
Prepared By AREA	Kim Newman Senior Heritage Consultant **AREA Environmental & Heritage Consultants Pty Ltd** "The Old Macquarie Brewery" c1876, 72 Brisbane St Dubbo NSW 2830 E kim@areaenv.com.au ABN: 29 616 529 867	

COPYRIGHT
© AREA Environmental & Heritage Consultants Pty Ltd, 2025
and
©Essential Energy, 2025
All intellectual property and copyright reserved.
Apart from any fair dealing for private Study, research, criticism or review, as permitted under the *Copyright Act 1968*, no part of this report may be reproduced, transmitted, stored in a retrieval system or adapted in any form or by any means (electronic, mechanical, photocopying, recording or otherwise) without written permission.
Enquiries would be addressed to AREA Environmental & Heritage Consultants Pty Ltd.

Executive summary

Background

Essential Water (the Proponent), a business unit of Essential Energy is proposing to upgrade the current Wills Street Sewage Treatment Plant to create the new Broken Hill STP, as the current Wills Street STP has reached the end of its useful life span. The upgrade will add additional capacity and provide an opportunity for the smaller South STP to later be retired from use. A new rising main has been proposed to be installed to transport sewage from the current South STP catchment to the new BHSTP (the Proposal). The Proposal is located at the southwestern extent of Broken Hill, approximately 3.5 kilometres from the town centre.

AREA Environmental & Heritage Consultants (AREA) has been engaged by the Proponent to complete an Aboriginal due diligence assessment in accordance with *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales* (DCCEEW 2010). In addition, the report will provide supporting recommendations if any further assessment and/or management or mitigation measures are required.

An archaeological survey of the Study Area was undertaken over two days on 9 and 10 May 2023, with Chris Quayle representing Barkandji Traditional Owners.

The disturbance corridor required for the construction of the rising main will be approximately 10 meters wide and largely located along previously disturbed road corridors. The rising main will be used to transport current South STP catchment sewage to the new BHSTP. The project will also include the replacement of the existing treated effluent discharge pipe, largely in its existing location.

The rising main will predominately be constructed below ground, by a mixture of open trenching and under bores. Certain sections of the pipe may be constructed above ground where landforms, geology and gradients preclude its construction underground.

The works that have been proposed for the new BHSTP includes:

- Construction of a new rising main to transfer sewage from the existing Broken Hill South STP to the new BHSTP, with a construction impact footprint of approximately 5.6 kilometres long by 10 metres wide.
- Construction of a new pump station at the current Broken Hill South STP, to facilitate transfer of the Broken Hill STP catchment sewage and transfer it to the new BHSTP via the new rising main.
- Decommissioning of redundant assets at the Broken Hill South STP
- Replacement of approximately 1.2 kilometres of the existing treated effluent discharge pipe form the new BHSTP to the existing discharge point, with a construction impact footprint width of 10 metres (predominantly contained with the same impact footprint of the new rising main). An approximately 500m section of the existing treated effluent discharge pipe located within an existing easement on the land parcel immediately south of the existing Wills Street STP site will be decommissioned as a result of the replacement pipe.
- Upgrades to existing access roads, including construction access at the new BHSTP.

Aboriginal Sites Recorded

Five previously unrecorded Aboriginal sites were recorded during the survey; four stone artefact scatters and one isolated find. All sites are located outside the proposed construction footprint. Three artefact scatters were situated in the south of the Study Area, to the west and northwest, just outside the rising main development footprint. The last artefact scatter and isolated find were identified outside the BHSTP construction footprint, near an unsealed track. All sites will be avoided, but the sites will require management to prevent inadvertent impact.

Recommendations

The following mitigation measures are required to reduce the potential for inadvertent impact to Aboriginal sites recorded within and outside the Study Area.

- Site supervisors, and construction work crews be made aware of the locations of Broken Hill STP AS04 and Broken Hill STP IF01 at the existing Wills Street STP. It is recommended that temporary fencing be erected around these sites.
- BHSTP AS01, BHSTP AS02, and BHSTP AS03 to the northwest and west of the existing South STP site, are located at an adequate distance away from the proposed construction activities and do not require temporary fencing. Site supervisors and construction work crews would be made aware of their location.
- All staff working must be made aware of the legislative protection offered for all cultural heritage sites under the NSW NPW Act.

In addition to these mitigation measures, the following general recommendations are made:

- If any objects, suspected to be Aboriginal heritage in origin, be encountered during the proposed works, all works must cease within 20 metres of the find and the unexpected finds protocols (Appendix B) should be implemented.
- If changes are made to the proposal outside of the current development footprint, further assessment will be required.
- If suspected human remains are located during any stage of the proposed works, all works relating to this project must stop immediately, and the NSW police be immediately notified.

Table of Contents

Document Controls i
Executive summary ii
Table of Contents iv
Figures v
Tables vi
Glossary vii
1 Introduction 1
1.1 Background 1
1.2 Locality 2
1.3 Project description 2
1.4 Project personnel 7
1.5 Aboriginal community involvement 7
2 Legislative context 8
2.1 National Parks and Wildlife Act 1974 8
2.2 Native Title Act 1994 8
2.3 Environmental Planning and Assessment Act 1979 8
3 Landscape features 9
3.1 Overview 9
3.2 Landforms and topography 9
3.3 Waterways 9
3.4 Geology and soils 10
3.5 Vegetation 12
3.6 Climate 12
3.7 Historical context and land use history 13
4 Archaeological Context 14
4.1 Regional ethnohistoric context 14
4.2 Local archaeological context 15
4.2.1 Database searches 15
4.2.2 Previous studies 18
4.2.3 Previous studies discussion 20
4.3 Predictive model 21
5 Archaeological survey 22
5.1 Methodology 22
5.2 Constraints 28
5.3 Survey Results 28
5.3.1 Newly Recorded Aboriginal sites 31
5.3.1.1 Broken Hill STP AS01 (AHIMS ID Pending) 31

5.3.1.2 Broken Hill STP AS02 (AHIMS ID Pending) 32
5.3.1.3 Broken Hill STP AS03 (AHIMS ID Pending) 34
5.3.1.4 Broken Hill STP AS04 (AHIMS ID Pending) 35
5.3.1.5 Broken Hill STP IF01 (AHIMS ID Pending) 36
5.3.1.6 Quartz boulders 38
5.3.2 Ground Surface Disturbance 42
5.3.3 Discussion 42
6 Assessment of significance 43
7 Impact and management 45
7.1 Overview 45
7.2 Impacts to Aboriginal Heritage 45
7.3 Management and mitigation options 45
8 References 46
Appendix A. AHIMS Extensive Search Results (Conducted 27.03.2025) 48
Appendix B Unanticipated Find Protocol 53

Figures

Figure 1-1: The Study Area. 5
Figure 1-2: Facilities at BHSTP. 6
Figure 3-1: Waterways surrounding the Study Area 11
Figure 4-1: Results of the extensive AHIMS search 16
Figure 4-2: Aboriginal sites within 600 meters of the Study Area 17
Figure 5-1: Survey effort overview 23
Figure 5-2: Survey effort where the facilities have been proposed. 24
Figure 5-3: Survey effort south of the proposed facilities. 25
Figure 5-4: Survey effort further south of the proposed facilities. 26
Figure 5-5: Survey effort in the south of the Study Area 27
Figure 5-6: Southern section of the rising main development footprint covered with salt bush and low GSV 29
Figure 5-7: View South Broken Hill STP highly disturb due to animal activities (rabbit burrows) 29
Figure 5-8: View proposed rising main route disturbance due to graded fence line 30
Figure 5-9: View proposed rising main route eroded tracks 30
Figure 5-10: View proposed rising main route disturbance due to power line easements and underground electric cabling 30
Figure 5-11: View disturbance due to dug out ponds 30
Figure 5-12: 50% GSV within the exposure, overview facing south 31
Figure 5-13: Broken Hill STP AS01 Quartz flakes closeup 31
Figure 5-14: Broken Hill STP AS01 Quartz core closeup 32
Figure 5-15: View south of Broken Hill STP AS02 showing exposures within the saltbush 33

Figure 5-16: Broken Hill STP AS02 overview to west 33
Figure 5-17: Example of opaque quartz within Broken Hill STP AS02 33
Figure 5-18: View north across Broken Hill AS02 33
Figure 5-19: View west across the site 34
Figure 5-20: View along the eastern side of the fence line 34
Figure 5-21: Sample view of artefacts at the Broken Hill STP AS03 35
Figure 5-22: View south showing general location of Broken Hill STP AS04 36
Figure 5-23: View north showing general location of Broken Hill STP AS04 36
Figure 5-24: View south across Broken Hill STP IF01 37
Figure 5-25: Sample view of vegetation and GSV 37
Figure 5-26: View conchoidal opaque quartz flake 37
Figure 5-27: View west across Broken Hill STP IF04 37
Figure 5-28: Location of the newly recorded Aboriginal sites 39
Figure 5-29: Close up of the newly recorded Aboriginal sites near Broken Hill STP 40
Figure 5-30: Close up of the sites recorded in the southern end of the Study Area 41

Tables

Table 1-1: Regional geographical context of the Study Area 2
Table 1-2: Summary of the project team's qualifications 7
Table 3-1: Summary climate data (red maximum, blue minimum values) 12
Table 4-1: Summary of database searches for Aboriginal Heritage 15
Table 6-1: Summary of significance for sites recorded 43

Glossary

Terms and acronyms used in this document.

Acronym	Definition
ACHMP	Aboriginal Cultural Heritage Management Plan
AHIP	Aboriginal heritage impact permit
AHMP	Aboriginal Heritage Management Plan
AREA	AREA Environmental & Heritage Consultants
BOM	Bureau of Meteorology
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DPE	Department of Planning and Environment
EIS	Environmental impact statement
EP&A Act	Environmental Planning and Assessment Act 1979
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
GPS	Global positioning system
GSV	Ground Surface Visibility
GSD	Ground Surface Disturbance
LALC	Local Aboriginal Land Council
LEP	Local Environmental Plan
LGA	Local Government Area
NPW Act	National Parks and Wildlife Act 1974
NPWS	National Parks and Wildlife Service
NSW	New South Wales
PAD	Potential Archaeological Deposit
PWA	Public Works Advisory
OEH	Office of Environment and Heritage
RAP	Registered Aboriginal Parties
REF	Review of Environmental Factors
Study Area	The area assessed
Development footprint	All disturbance areas affected by the proposal

1 Introduction

1.1 Background

AREA Environmental & Heritage Consultants (AREA) has been engaged by the Proponent to complete an Aboriginal due diligence assessment in accordance with *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales* (DCCEEW 2010). The aim of this report is to identify if any Aboriginal objects or areas of archaeological potential would be impacted by the proposal and if an Aboriginal Heritage Impact Permit (AHIP) would be required. In addition, the report will provide supporting recommendations if any further assessment and/or management or mitigation measures are required.

The city of Broken Hill[1] has a population of approximately 17,800 and is currently serviced by two sewage treatment plants (STPs), the Wills Street STP and the South Broken Hill STP. The STPs are owned and operated by Essential Water, a business unit of Essential Energy (the Proponent).

The Wills Street STP was commissioned in 1939, upgraded in 1956 and in the 1980's. This STP is at the end of its serviceable life and a replacement is required for ongoing compliance with the Environment Protection Licence (EPL) issued by NSW Environment Protection Authority (EPA).

The South STP was built in the 1960's and is in a relatively poor condition. This STP now requires significant remedial works to ensure its reliability and compliance with the EPL for its discharges.

In 2011, GHD completed a report on treatment plant upgrade options and recommended closing the South STP and transferring its sewage to a new plant at Wills Street, called the Broken Hill Sewage Treatment Plant (BHSTP).

In October 2018, Public Works Advisory (PWA) did another Study to find the best site for the new plant. They preferred building a new Intermittently Decanted Extended Aeration (IDEA) type activated sludge plant at the existing Wills Street site. Sewage from the South STP area will be pumped to the upgraded Wills Street plant.

In 2019, PWA developed a business case to support the design and construction of the new plant. Essential Water then hired Beca Hunter H2O, to create a revised concept design, detailed design, and the necessary tender documents to ensure cost-effective infrastructure through a primarily Construct Only Contract (Beca HunterH2O Holdings Pty Limited, 2024).

[1] It was proclaimed a city in 1907, making it one of the earliest regional cities in New South Wales. Despite its relatively small population, it has city status due to its historical significance, economic importance (especially in mining), and governance structure under Broken Hill City Council.

1.2 Locality

The Study Area is located in the south of Broken Hill within the city limits. The regional geographical context of the Study Area is provided in Table 1-1.

Table 1-1: Regional geographical context of the Study Area

Criteria	Study Area
Central coordinates (GDA94 z56)	541016 mE 6462244 mN
Interim Biogeographic Regionalisation for Australia (IBRA Region)	Broken Hill Complex Region and Barrier Range Subregion
State	NSW
Topographical map sheet	Broken Hill 1:100 000
Local Government Area	Broken Hill LGA
Local Aboriginal Land Council area (LALC)	Broken Hill LALC
Parish	Soudan
County	Picton
Native Title Determination	Barkandji Traditional Owners #8 (Part A) Determination
Nearest town / Locality	Broken Hill
Accessed from nearest town by	Wills Street
Land use / Disturbance	Farming and existing STP
Nearest waterway (Name, Strahler Order)	Stirling Vale Creek
Spot point Australian Height Datum (AHD)	294 – 300 m
Surrounding land use	Sewage treatment plant, farming, road corridor

1.3 Project description

A new rising main has been proposed to be installed to transport sewage from the current South STP catchment to the new BHSTP (the Proposal). The Proposal is located at the southwestern extent of Broken Hill, approximately 3.5 kilometres from the town centre (Figure 1-1).

The disturbance corridor required for the construction of the rising main will be approximately 10 meters wide and largely located along previously disturbed road corridors. The rising main will be used to transport current South STP catchment sewage and to the new BHSTP. The project will also include the replacement of the existing treated effluent discharge pipe in its existing location. The proposal would impact approximately 10.15-hectares which includes operational upgrades to Wills Street STP and an approximately 10-metre-wide disturbance corridor for the rising main. Replacement of the existing treated effluent discharge pipe would largely be within this 10-metre corridor.

The rising main will predominately be constructed below ground, by a mixture of open trenching and under bores. Certain sections of the pipe may be constructed above ground where landforms, geology and gradients preclude its construction underground.

Essential Water (the Proponent), a business unit of Essential Energy is proposing to upgrade the current Wills Street Sewage Treatment Plant (STP) to create the new Broken Hill STP (BHSTP), as the current Wills Street STP has reached the end of its useful life span. The upgrade will add additional capacity and provide an opportunity for the smaller South STP to later be retired from use.

The proposal for the new BHSTP (Figure 1-2) includes:

- Construction of a new rising main to transfer sewage from the existing Broken Hill South STP to the new BHSTP, with a construction impact footprint of approximately 5.6 kilometres long by 10 metres wide.
- Construction of a new pump station at the current Broken Hill South STP, to facilitate transfer of the Broken Hill STP catchment sewage and transfer it to the new BHSTP via the new rising main.
- Decommissioning of redundant assets at the Broken Hill South STP
- Replacement of approximately 1.2 kilometres of the existing treated effluent discharge pipe from the new BHSTP to the existing discharge point, with a construction impact footprint width of 10 metres (predominantly contained with the same impact footprint of the new rising main).
- Upgrades to existing access roads, including construction access at the new BHSTP.

The other proposed upgrades to transform the Wills Street STP into the new Broken Hill STP will include:

- The existing gravity main to Wills Street STP will be diverted to the new Preliminary Treatment inlet works.
- Preliminary Treatment – Screening and grit removal, including screening and grit washing and dewatering. The inlet works structure will contain an inlet receival chamber (receives flow from the rising mains, the foul water pump station, septage pump station and emergency return pumping), automatic and manual bypass screen channels, a vortex grit chamber, and a flow distribution chamber.
- Secondary Treatment – Two IDEAT bioreactors for organics oxidation, biological nitrogen removal and phosphorus removal (through microorganism growth and chemical precipitation by alum dosing). Sodium hydroxide dosing is provided for pH correction.
- Space onsite will also be allowed for an external carbon dosing system.
- An effluent balance tank for attenuation of high IDEA reactor decanted effluent flows with a lift pump system to feed the treated effluent UV disinfection system and deliver the treated effluent to White Leeds and/or existing open earthen discharge channel.
- Tertiary Treatment – A portion of the secondary treatment effluent will be further treated via a pre-validated UV system and a CCT chlorination system to provide recycled water quality suitable for site service water and the existing end users' applications.
- Excess sludge generated by the secondary process will be wasted to a 3-cell aerobic digester for stabilisation via the WAS pumps. A floating decanter is fitted in the first cell of the aerobic digester to achieve some level of sludge thickening. The digested sludge will be dewatered via a mechanical dewatering facility.
- Emergency Storage Pond-An emergency pond is provided for any unintended situations (Screens or grit removal maintenance, failure of effluent decanters, overflow of effluent balance tank, poor treated effluent water quality), an emergency flow return pump station shall be provided to return the emergency flow to the head of the plant for further treatment.

- Odour control- an odour control unit to be provided to treat foul air from the headspace of the inlet works" (Beca HunterH20, 2024).

Figure 1-1: The Study Area

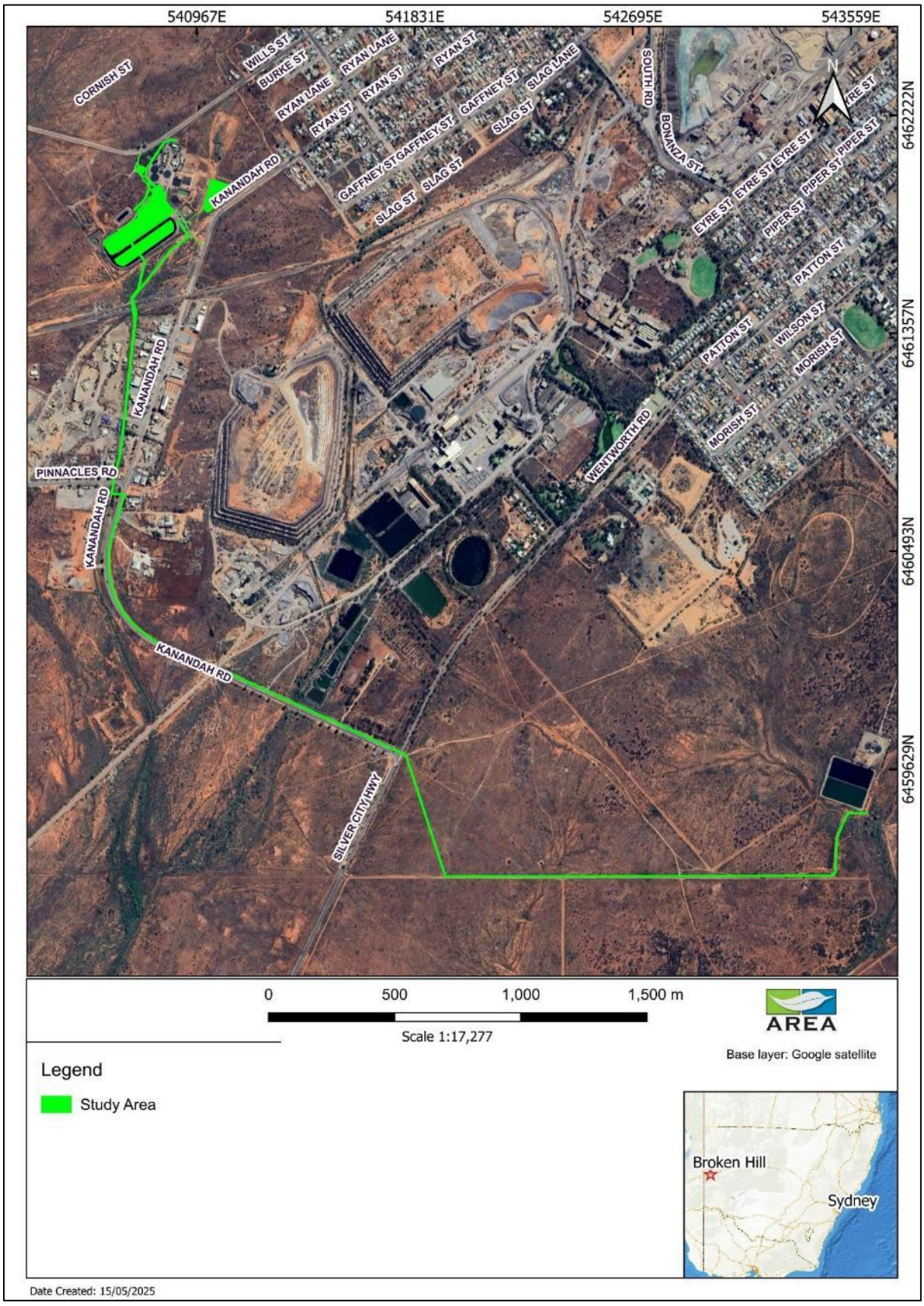
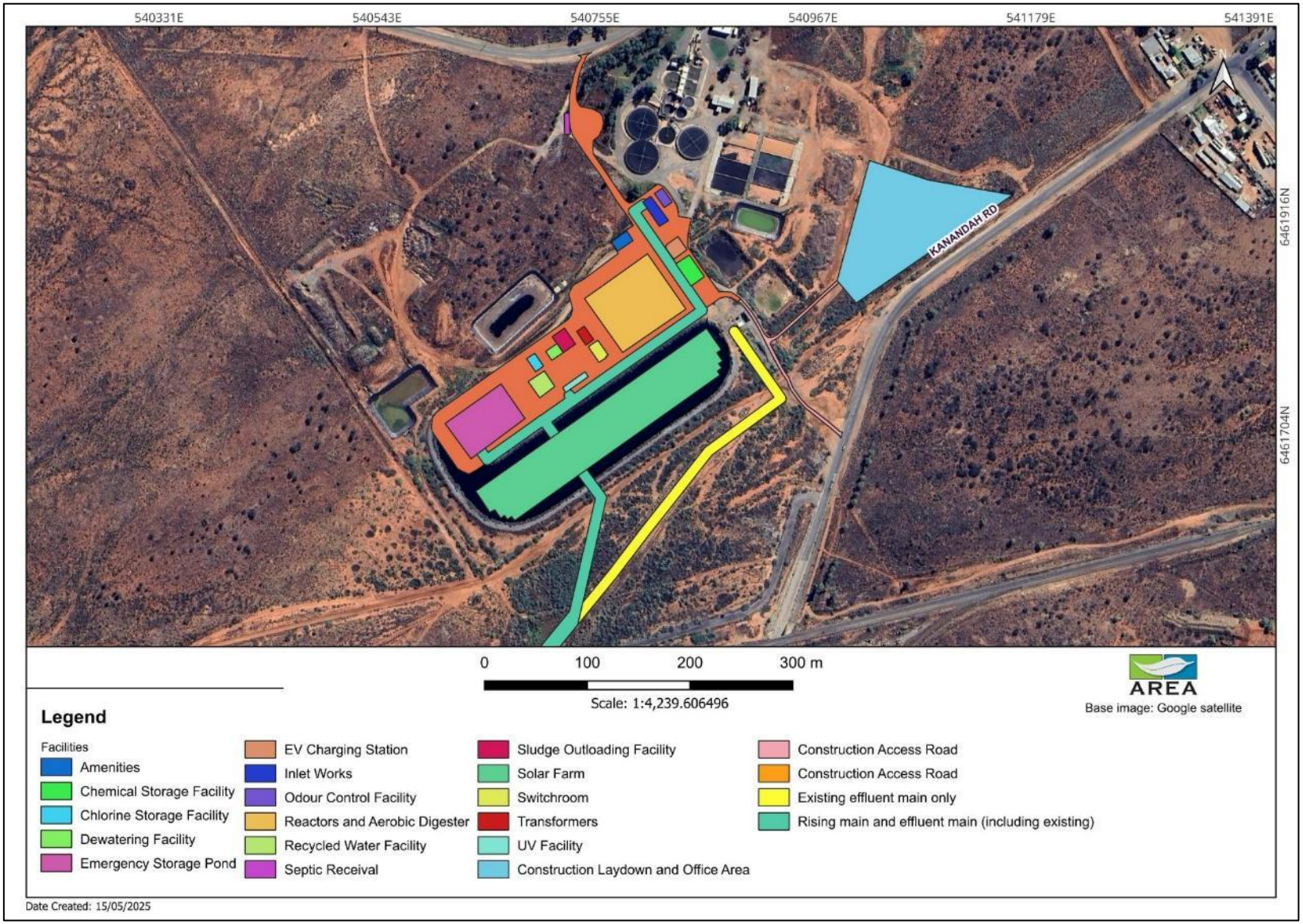


Figure 1-2: Facilities at BHSTP



1.4 Project personnel

This assessment was carried out by appropriately experienced or qualified staff (Table 1-2). Kim Newman of AREA conducted the survey, Anna Darby and Dr. Seema Gahlot of AREA prepared this report.

Table 1-2: Summary of the project team's qualifications

Name	Position	CV Details	Task
Phillip Cameron	Principal consultant	• BSc. Macquarie University • Ass Dip App Sci. University of Queensland • Certified Environmental Practitioner (EIANZ) • Practicing member of the Environment Institute of Australia and New Zealand (EIANZ)	Project manager Reviewed the report
Kim Newman	Senior Heritage Consultant	• Bachelor of Archaeology (Honours) University of New England • Master of Science (Archaeology). University of New England • PhD Candidate in Archaeology (Griffith University Qld)	Led the field survey
Anna Darby	Senior Heritage Consultant	• Bachelor of Arts and Bachelor of Science (Archaeology, Palaeoanthropology and Forensic Science). University of New England • Bachelor of Science (Honours). University of New England	Reviewed the report Co - authored the report
Dr. Seema Gahlot	Heritage Consultant	• Bachelor of Arts (Hons) in History. • Master of Arts in Archaeology, Panjab University • PhD in Ancient Indian History and Archaeology • Diploma in Aboriginal studies for professional and community services, TAFE NSW	Co - authored the report
Adelia Gower	Senior Heritage Consultant	• Bachelor of Arts (Extended Major in Archaeology), University of Queensland.	Co - authored the report
Addy Watson	Manager Senior consultant	• Grad. Dip. Captive Vertebrate Management, Charles Sturt University • Grad. Cert. Social Impact, University of NSW • B. Env. Sc. University of New England. • NSW Biodiversity Assessment Method Accredited Assessor (BAAS19066) • Diploma Project Management • Lean Six Sigma Certificate (Sydney Uni) • WHS White Card • Apply First Aid. Certificate number: 07328	Client edits Report review

1.5 Aboriginal community involvement

Aboriginal community consultation in accordance with the *Aboriginal Cultural Heritage Consultation Requirements for Proponents* (ACHCRs; DCCEEW 2010) is not a formal requirement for Due Diligence assessments. Based on advice given to Essential Water by AREA, the Proponent has opted to engage with Barkandji Traditional Owners.

An archaeological survey of the Study Area was taken over two days on 9th and 10th May 2023, with Chris Quayle representing Barkandji Traditional Owners (accepted and registered claim: NC2015/001 - Barkandji Traditional Owners #8).

2 Legislative context

2.1 National Parks and Wildlife Act 1974

Under the *National Parks and Wildlife Act 1974* (NP&W Act 1974), the Director-General of the NPWS is responsible for the care and protection of Aboriginal objects and places in NSW. An *Aboriginal object* is defined as any deposit, object or material evidence (not being a handicraft made for sale) relating to the Aboriginal habitation of the area that comprises NSW, being habitation before or concurrent with (or both) the occupation of that area by persons of non-Aboriginal extraction and includes Aboriginal remains. An *Aboriginal place* is defined as any place of special significance with respect to Aboriginal culture as declared by the Minister.

Under Section 86 of the Act, a person must not harm an Aboriginal object or place. Penalties are in place for anyone who breaches these conditions or knowingly defaces or destroys an Aboriginal object or place without a permit.

In order to undertake a proposed activity which is likely to involve harm to an Aboriginal place or object, it is necessary to apply to Heritage NSW for an Aboriginal Heritage Impact Permit (AHIP). AHIPs are issued by NSW Heritage under Section 90 of the Act, and permit harm to certain Aboriginal objects or Aboriginal places.

2.2 Native Title Act 1994

The *Native Title (NSW) Act 1994* was introduced to work in conjunction with the *Native Title Act 1993* (Cth). Native Title claims, registers and Indigenous Land Use Agreements are administered under the NSW Act.

The Study Area is within the NC2015/001 - Barkandji Traditional Owners #8 (Part A) Native Title Determination. The proposal site is located on land where Native title has been extinguished, according to the outcome of the determination of this claim.

2.3 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act) establishes the framework for cultural heritage values to be formally assessed in the land use planning and development consent process. The EP&A Act consists of three main parts of direct relevance to Aboriginal cultural heritage:

- Part 3 which governs the preparation of planning instruments
- Part 4 which relates to development assessment processes
- Part 5 which relates to activity approvals by governing (determining) authorities.

The proposed work will be in accordance with Part 5, Division 5.1.

3 Landscape features

3.1 Overview

A review of the landscape of the Study Area and surrounds allows for comparison with other previously archaeologically investigated areas. It also assists in assessing existing and previous disturbances which may have affected the integrity of archaeological remains. Environmental features such as landforms, topography, water sources, geology, soils, and vegetation are also relevant in an archaeological assessment.

The Study Area is in the central area of the Broken Hill Complex Bioregion, Barrier Range subregion.

3.2 Landforms and topography

The Broken Hill Complex Bioregion is geologically unique, with the western half composed of ancient basement rocks of the Adelaide Fold Belt, and the eastern half, the edge of much younger rocks of the Tasman Fold Belt. Many of the rocks and minerals found in the region are of considerable interest and economic importance, and geology exerts strong controls on the landscape (Dunn & Shaukar, 2003).

Characteristics landforms within the Barrier Range subregion include steep, low rocky ranges oriented to bedrock structure, with prominent fault scarps. The Study Area is on a relatively flat elevation of 280 meters with small crests occurring throughout at elevations of 300 metres AHD.

These landforms did not present a barrier for pre-European human movement across this landscape. The Barrier Ranges, with their elevated ridges (up to 300 meters above the plains), would have offered extensive visibility across the landscape, making them ideal for navigation and wayfinding. There also would have been multiple places for sheltered campsites with lookout vantages and ceremonial sites in prominent, elevated locations. These are reflected in cultural knowledge provided by the Traditional Owners and the AHIMS database search results for the broader region.

3.3 Waterways

The Study Area is in the Upper Darling catchment area, with the Darling River being the closest major river, about 100 kilometres southeast of Broken Hill. The nearest non-perennial waterways to the Study Area are Stirling Vale Creek, three kilometres to the north, and Kellys Creek, three kilometres south of the rising main development footprint (Figure 3-1).

Despite the arid environment, certain areas within the bioregion contained semi-permanent waterholes, which were crucial for survival. These water sources provided essential resources for both humans and native wildlife, enabling subsistence practices like hunting and foraging.

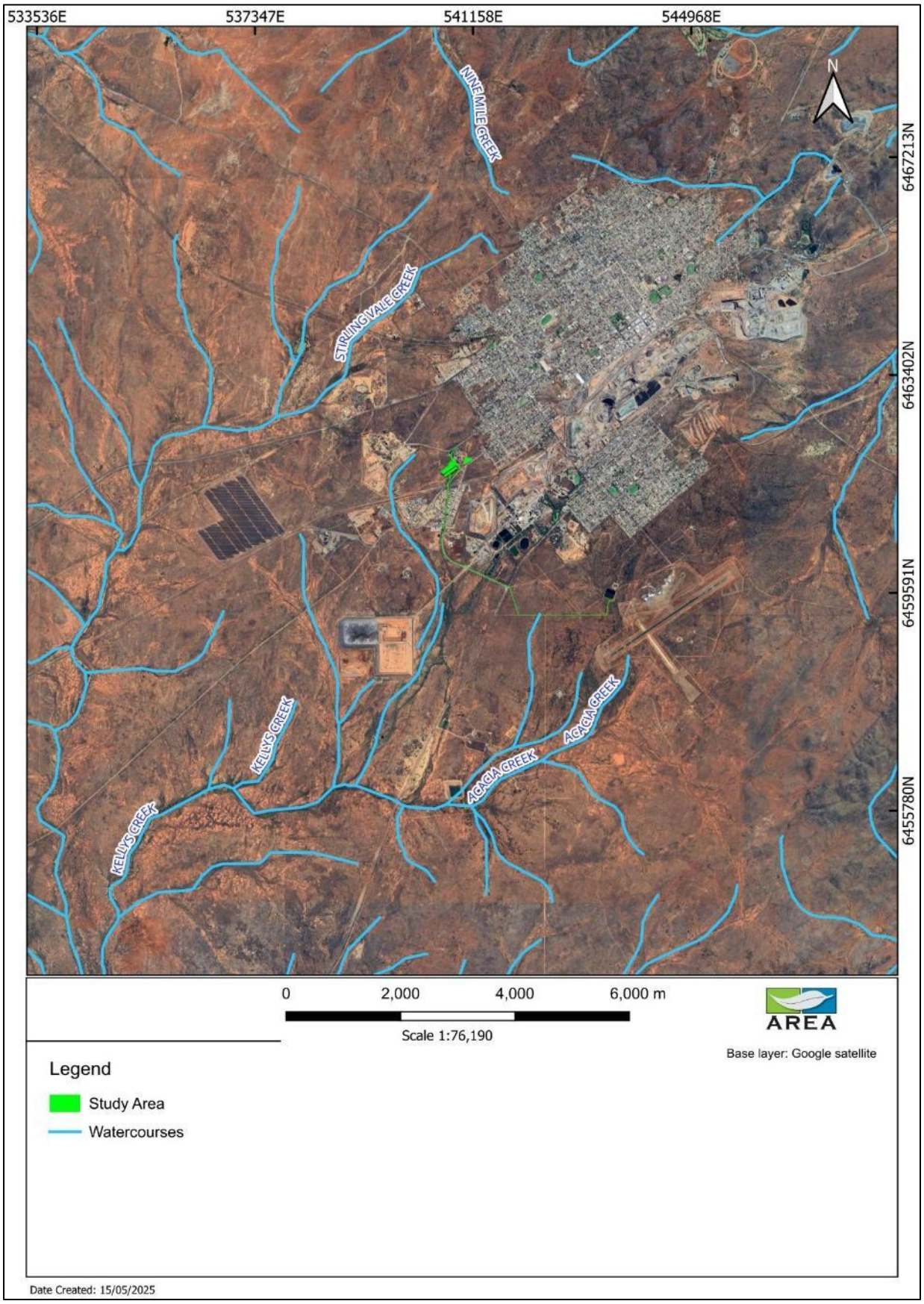
The Wiljakali people traditionally occupied the lands around Broken Hill. Their occupation of the land was thought to have been intermittent due to the scarcity of water. The same scarcity of water made the area unattractive for European occupiers, allowing traditional Aboriginal ways of life to continue longer there than in many other parts of New South Wales, into the 1870s.

3.4 Geology and soils

The Barrier Ranges are a prominent landscape feature within the subregion and is located 50 kilometres north of the Study Area. They are a triangular block of metamorphic and deformed sedimentary rocks forming a series of northeast and northwest trending ridges rising up to 300 metres above the surrounding plains (Dunn & Shaukar, 2003). The geology within the Barrier Range subregion is comprised of ancient gneiss, schists, amphibolite, granites and pegmatites with north-east structural trends. These are overlain by Cambrian sediments with northwest trends (Dunn & Shaukar, 2003). The geological makeup indicates a rich diversity of raw materials potentially suitable for stone tool manufacture (particularly from schist and amphibolite), ochre and pigment extraction, especially where iron-rich minerals or clay pockets occur and heat-retaining stones for cooking or ceremonial use.

Soils in the Study Area are typically rocky outcrops with shallow stony soil on the crests. Areas in the lower zones with better moisture retention support the potential for diverse plant communities. Texture contrast profiles are common, and quality differs according to rock type (Dunn & Shaukar, 2003).

Figure 3-1: Waterways surrounding the Study Area



3.5 Vegetation

The bioregion is comprised of limited mulga, dead finish and bluebush on the ridges. Denser shrubs including belah, whitewood, turpentine, prickly wattle, punty bush with bluebush, grasses and forbs on the lower slopes. River red gum line larger creeks, shrubs and grasses increase on the outwash fans. Curly mallee can also be found on limestone outcrops. The vegetation within the Study Area reflects historic ground surface disturbance and is altered from prior clearing activities. Native and non-native vegetation exists throughout the Study Area.

3.6 Climate

The Broken Hill Complex Bioregion generally has a hot, dry climate. It lies within the NSW arid zone, which is dominated by a hot, persistently dry desert climate (Stern & et al, 2000). Patches of semi-arid climate in the centre of the bioregion complement the arid climate prevalent in most of the bioregion.

Broken Hill experiences hot dry summers, cool winters and wet autumns (BoM, 2024). Broken Hill has an annual mean rainfall of 249.0 millimeters (Table 3-1).

Table 3-1: Summary climate data (red maximum, blue minimum values)

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual mean	Years
Mean maximum temperature (°C)	33.8	32.5	29.1	24.4	19.1	16.0	15.6	17.9	21.9	25.6	28.8	31.7	24.7	1957 2024
Mean minimum temperature (°C)	19.4	18.5	15.4	11.4	7.7	5.7	4.9	5.6	8.4	11.6	14.8	17.4	11.7	1957 2024
Mean rainfall (mm)	29.3	18.7	21.6	20.6	19.5	15.2	16.7	18.0	21.3	25.4	21.6	20.6	249.0	1947 2024
Decile 5 (median) rainfall (mm)	16.3	7.8	10.0	10.6	10.8	9.8	14.0	13.6	13.5	16.1	13.8	13.8	12.51	N/A
Mean number of days of rain ≥ 1 mm	2.4	1.7	1.9	1.8	2.5	2.4	2.8	2.8	2.5	2.8	2.6	2.1	28.3	1947 2024

The Broken Hill region, while characterised today by a semi-arid climate, was more climatically variable over the Holocene epoch (last ~11,700 years). This variation influenced the extent and nature of Aboriginal occupation in the region. During the early to mid-Holocene (c. 11,000–5,000 years BP), the climate in inland southeastern Australia, including the Barrier Ranges and Broken Hill, was warmer and wetter than it is today[2]. This period likely supported greater availability of surface water, more diverse vegetation, and expanded resource zones.

Archaeological and paleoenvironmental data suggests that this allowed for more sustained or regular Aboriginal occupation in areas that are currently marginal. The late Holocene (c. 5,000 years BP to present) saw a gradual shift to more arid and unpredictable conditions, aligning

[2] Dunn, P.R. & Shaukar, R.M. (2003). Broken Hill Complex Bioregion – Biodiversity Survey. NSW NPWS.
Smith, M.A. (2013). The Archaeology of Australia's Deserts. Cambridge University Press.
Williams, A.N. et al. (2015). "A Continental Narrative: Human Settlement Patterns and Climate Change during the Holocene in Australia", Quaternary Science Reviews 123: 91–112.
Bureau of Meteorology: www.bom.gov.au

more closely with modern climate patterns. Aboriginal groups adapted through increased mobility, environmental knowledge, and strategic use of water and food refugia.

3.7 Historical context and land use history

Land-use history refers to the past land use of the Study Area. The nature and frequency of different land-use activities is assessed to understand preservation levels of material traces of any Aboriginal sites (e.g. a single ploughing event may have much less impact on in-situ archaeological material than decades of annual ploughing; land clearing would have had an impact on subsurface deposits, which may have resulted in the removal of any culturally modified trees entirely).

Charles Sturt was recorded as the first European to explorer of the Broken Hill region. He first traversed the northern region of the Darling River in 1829, then ventured slightly west of the junction of the Bogan and Darling Rivers, some 500 kilometres east of Broken Hill. In 1835, Major Thomas Mitchell's expedition followed Sturt's route from Sydney but continued along the Darling River around Menindee Lakes, almost following the confluence of the Murray River. Sturt's 1844 expedition into Australia's interior followed the Murray River to its junction with the Darling River, then northwards to Stephens Creek and further north into the Barrier Ranges (Kearns, 1976). Once Sturt returned to Adelaide in 1846, the news of the lands along the Darling River inspired squatters to quickly take up various runs along the River within the same year (Kearns, 1976).

Broken Hill got its name from the rocky outcrop visible above the plains and was founded by boundary rider Charles Rasp in 1883. Charles Rasp along with David James and James Poole pegged the first mining lease, and were later joined by George McCulloch, Phillip Charley, George Urquart and George Lind. These men founded the Syndicate of Seven in 1885, the company would then develop into Australia's largest industrial organisation, the Broken Hill Proprietary (BHP) company limited (Kearns 1951). The first post office was opened in 1886, hospital in 1887 and theatre, church and police lockup in 1888. In 1990, the Municipality of Broken Hill had a population of 11,000, a railway was established that connected with the South Australian railway head at Cockburn. BHP ceased mining in Broken Hill in 1939, and since then, 14 different companies have mined in the area.

4 Archaeological Context

4.1 Regional ethnohistoric context

The archaeological record indicates that Aboriginal people have been present in Australia for approximately 60,000 years. It also provides evidence of a dynamic culture coupled with a long occupation of the land. The Study Area is within the traditional lands of the Barkindji[3] (Paakantyi, or Barkandji) people. The name is derived from the Barkindji word for Darling River, *paaka,* which means river people. The lands of the Barkindji extend along the Darling River, near Bourke down to Wentworth, and towards the lower end of the Paroo and Warrego rivers.

The Wilyakali[4] and Barkindji peoples are encompassed in NC2015/001 - Barkandji Traditional Owners #8 Determined Native Tite Claim. The Wilyakali are distinct but closely related Aboriginal groups whose traditional lands are located in western NSW, particularly around the Broken Hill, Menindee, and Darling River regions. Their relationship is based on shared boundaries, cultural exchange, kinship, and trade, rather than a unified identity. Wilyakali is considered a language group of the Western Desert language family, possibly a dialect of Wilyakali/Wilyagali. Barkindji (or Paakantji) is a distinct language, part of the Darling Riverine language groups.

The Barkindji today were derived from several dialects, all speaking variations of the same language. Historically these dialects were distinctive groups, but with colonisation, these groups are more singularly recognised as Barkindji today. The Barkindji spoke with the language (*Paakantyi palku*) and had intermarriage connections linking smaller dialect groups together as far as far western NSW (Hercus, 1982) and (Hercus, 1993).

According to Sarah Martin, author of the *Cobar Rock Art Management Study* (1991), the Study Area is within the Parindji (Barindji) dialect (Martin, 1991). The Parindji occupied the scrub country east of the Darling River. They adapted to the dry sandplains, dune fields and hills of the edge of the Darling Basin and were thought to have differed from the Barkindji for their lack of swimming skills (Martin, 1988).

Despite linguistic differences, both groups maintained intercultural communication and mutual recognition of boundaries and rights which is recognised in NC2015/001 - Barkandji Traditional Owners #8 Determined Native Tite Claim over Broken Hill. Their differences are evidenced on August 28, 2023, by the Federal Court of Australia who formally recognised the Wilyakali people's native title over approximately 9,200 square kilometres of land in eastern South Australia, extending from the New South Wales border near Mannahill. Additionally, in December 2018, the Wilyakali people were recognised as native title holders in a shared determination with the Adnyamathanha and Ngadjuri peoples over certain areas in South Australia.

[3] The spelling of 'Barkindji' is used in this report to be consistent with the Barkandji Malyangapa People Native Title Claim Determination

[4] The spelling of Wilyakali is used in this report to be consistent with the Barkandji Malyangapa People Native Title Claim Determination and their Registered Native Title Claim in SA. Other spellings include Wiljakali, Wilyakali, Wilyagali.

4.2 Local archaeological context

4.2.1 Database searches

Searches of the local and state heritage databases provides an archaeological context and identification of any previously recorded Aboriginal sites located within or near the Study Area. The results of these searches are summarised in Table 4-1 and presented in Appendix B.

Table 4-1: Summary of database searches for Aboriginal Heritage

Database	Date of Search	Parameters	Results
AHIMS Client ID: 778311	27/03/2025	GDA Zone 54 537723 – 545388 mE 6457231 – 6463737 mN	66 Aboriginal sites were recorded within the search area. No sites are recorded within the Study Area.
Broken Hill LEP	27/03/2025	Schedule 5: Environmental Heritage	No items relating to Aboriginal heritage are recorded on the local heritage register within the Study Area. One Aboriginal place, the Pinnacles is located 10 km southwest of the Study Area.
Native Title Vision	27/03/2025	NSW	The Study Area is within the NC2015/001 - Barkandji Traditional Owners #8 (Part A) Determination
State Heritage Register	27/03/2025	Broken Hill LGA	No items relating to Aboriginal heritage are recorded on the State heritage register within the Study Area

The location of all Aboriginal sites is culturally sensitive information. This information, including any AHIMS data presented as a map or otherwise, in this report needs to be removed if this report enters the public domain.

An extensive search of the NSW AHIMS database was conducted on 27 March 2025 (Client ID 989255). The search showed there were 66 sites in the vicinity of the Study Area. The distribution of recorded Aboriginal sites is shown in (Figure 4-1).

No sites were located within the Study Area, however, there are 15 sites within 600 metres of the Study Area (Figure 4-2). Majority of the sites recorded were stone artefacts or had stone artefacts with other site features (n=64), followed by stone quarries (n=8), and hearth (n=4), with one stone arrangement and one Aboriginal resource place. As suggested by the search results, the likelihood of finding a site (highest probability of a stone artefact) in the Study Area is high.

Figure 4-1: Results of the extensive AHIMS search

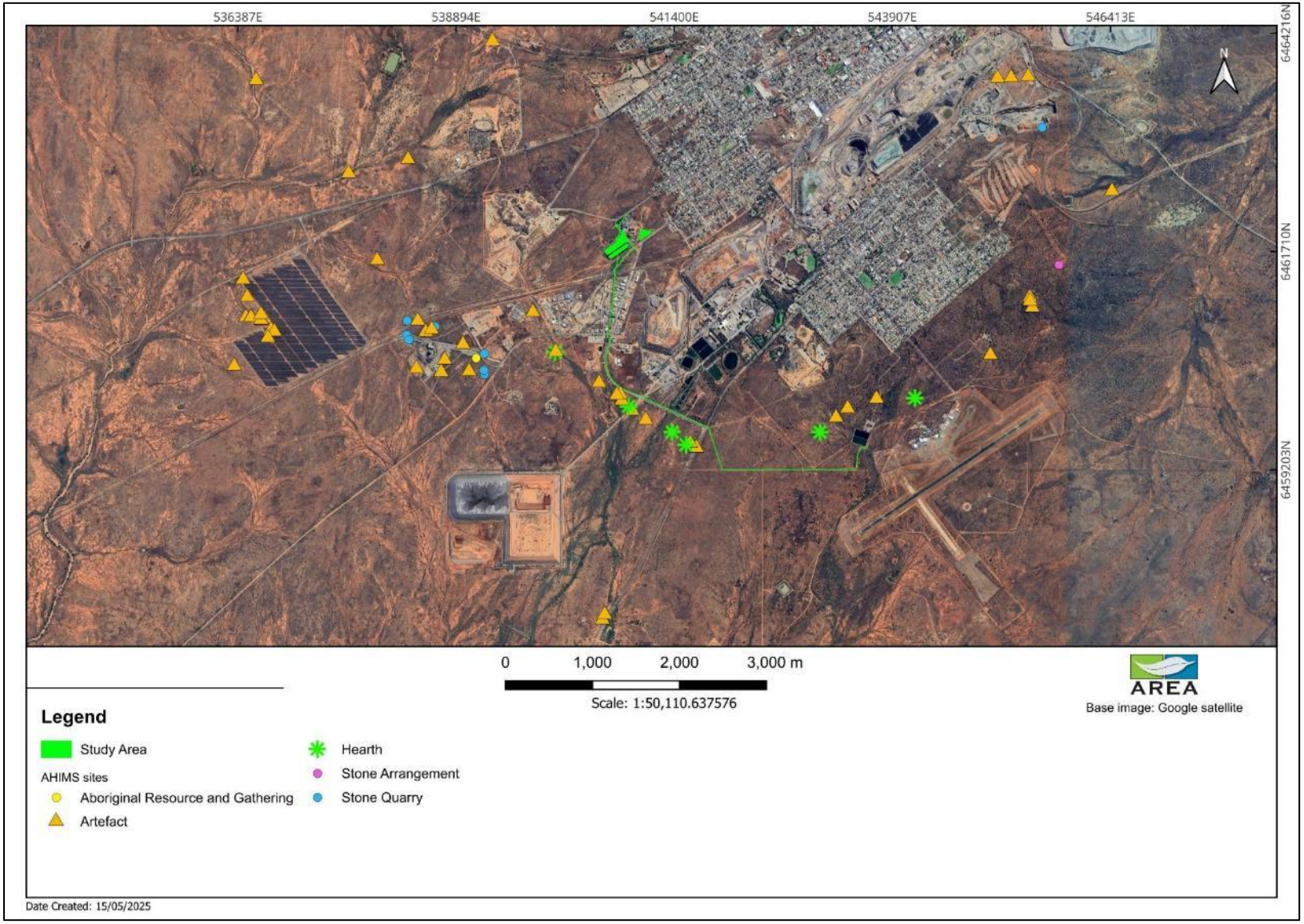
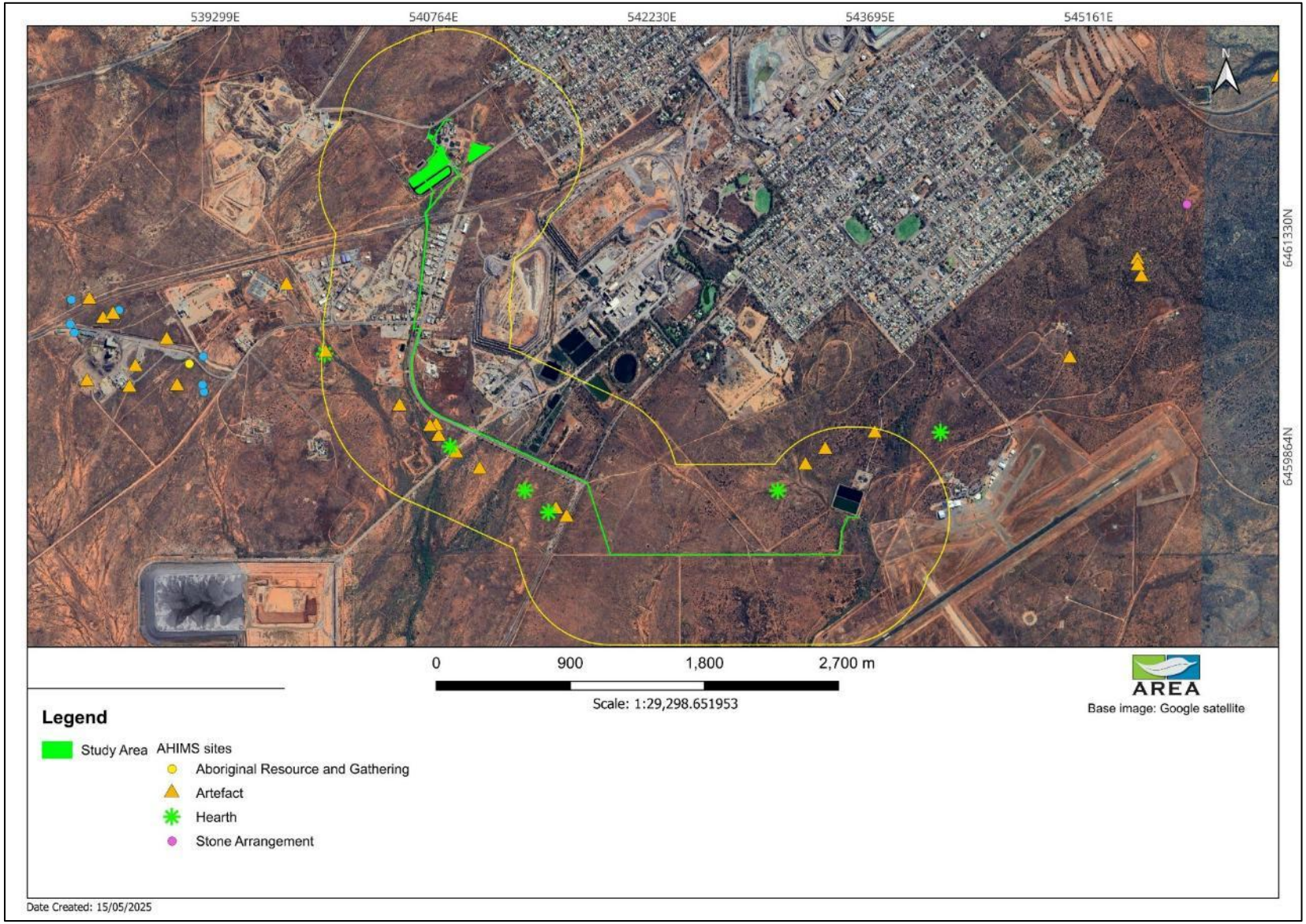


Figure 4-2: Aboriginal sites within 600 meters of the Study Area



4.2.2 Previous studies

Previous archaeological reports have been conducted in the Broken Hill region. Most of these reports were completed either as a result of compliance projects or due diligence assessments associated with infrastructure development applications. Below is a summary of some of these archaeological reports.

Blantyre Seismic Survey for BHP Petroleum (Thompson, 1986)

P. Thompson conducted a survey of the seismic line within the Teryawynia area as a due diligence assessment for petroleum exploration activities in PEL 246 (the Study Area). Teryawynia is located about 170 kilometres east of the current Study Area. During this survey, 56 Aboriginal sites along the seismic line traversed were identified and recorded. Site cards for the Aboriginal sites were provided, but no additional details were included in the report.

Mineral Separation Plant, Broken Hill, NSW: Aboriginal and Non Aboriginal Heritage Assessment (Heritage Search, 2001)

Heritage Search conducted a heritage assessment for BeMax Resources NL on a one square kilometre area where a new Mineral Separation Plant (MSP) was planned. This was the area surrounding the current Study Area. The survey recorded seven quartz quarries, eight open campsites, and one additional quartz quarry in the railway reserves, three meters north of the northern boundary of the MSP Study Area. The Aboriginal sites had limited archaeological value because they contained very few artefacts, and many had been displaced by erosion. The report suggested that these sites have low scientific importance and recommended that BeMax Resources NL obtain an AHIP to salvage any Aboriginal sites that would be affected by the MSP construction.

Silverton Wind Farm, NSW: Stages 2 and 3 and Powerline Route (Broken Hill to Red Cliffs) Aboriginal Heritage and Non Indigenous Heritage (New South Wales Archaeology PtyLtd, 2007)

New South Wales Archaeology Pty Ltd was commissioned by NGH Environmental on behalf of Silverton Wind Farm Devlopments to compile an archaeological and heritage review of the proposed overhead transmission line between Broken Hill and Red Cliffs.

Silverton Wind Farm Developments proposed to build a wind farm near Silverton, northwest of Broken Hill, over 682 squared meters of land. Silverton is located approximately 25 kilometres northwest of the current Study Area.

The Study Area was divided into four sections for the AHIMS search: Pine Creek (45 sites), Ana Branch (85 sites), Darling River (61 sites), and Buronga Gol Gol (72 sites).

Broken Hill Solar Plant Environmental Assessment Vol.7 Appendix F to Appendix H (Ozark Environmental and Heritage Management Pty Ltd, 2012)

Sinclair Knight Mertz, on behalf of AGL Energy and with help from OzArk Environmental and Heritage Pty Ltd, commissioned an archaeological survey of a 200-hectare site located between the Barrier Highway and the Broken Hill railway line. Silverton is located about 25 kilometres northwest of the current Study Area. The Broken Hill Solar Plant is located about four kilometres west of the current Study Area

The survey identified 14 Aboriginal sites. Thirteen were discovered within the Study Area, and one was within the transmission line easement east of the Study Area. Further consultation with Aboriginal community stakeholders through an Aboriginal Heritage Management Plan (AHMP) is needed to manage these sites.

A Review of Environmental Factors (REF) prepared for Essential Water for White Leeds Pipeline, Broken Hill, NSW (Envirokey Pty Ltd., 2013)

Envirokey engaged Onsite Cultural Heritage Management (OSCHM) Pty. Ltd. to undertake an Aboriginal heritage investigation for the proposed works. The proposed White Leeds pipeline area was located three kilometres south of the current Study Area.

The field survey revealed that a historic glass bottle fragment (from circa 1920s – 1930s) was located approximately 50 metres east of an ephemeral creek and 25 metres northeast of the proposed pipeline at its closest point and suggests historical activities associated with early mining.

A search of the AHIMS database identified a total of 27 Aboriginal sites within a 10 by 10 kilometres of the search area. None of these sites were located within the pipeline corridor. During the field survey, OSCHM (2013) identified an artefact scatter of 20 artefacts in a disturbed context due to traffic and extensive water erosion.

Aboriginal Cultural Heritage Assessment Report prepared for AGL Energy Limited under Broken Hill Battery Energy Storage System Project, Broken Hill, NSW (AECOM Australia Pty Ltd, 2021)

AECOM Australia Pty Ltd (AECOM) was commissioned by AGL Energy Limited (AGL) to undertake an Aboriginal cultural heritage assessment for the construction of a battery storage facility at Broken Hill. The proposed was located 700 meters west of the current Study Area.

The field survey was undertaken in conjunction with Broken Hill Local Aboriginal Land Council (Broken Hill LALC), the Wilyakali Aboriginal Corporation and Barkandji #8 Native Title Determinants.

No Aboriginal sites or areas of Potential Archaeological Deposit were identified during the survey. Overall, the survey identified a predominately disturbed landscape where topsoils had been graded and levelled. RAPs present during the survey also noted that land within the Study Area had been subjected to significant ground disturbances. As such, the potential for intact Aboriginal subsurface sites was assessed as low.

Broken Hill Battery Energy Storage System Project Modification Aboriginal Cultural Heritage Assessment Report (AECOM, 2022)

During a site survey in November 2021, one artefact scatter comprising of at least 20 artefacts was identified. No artefacts were recovered during the subsequent subsurface excavation program. The artefact scatter was assessed as having low scientific significance due to its disturbed context. The site was later salvaged before the proposed works could be constructed.

Two Proposed Trenches for New Underground 22Kv Electricity Communication and Earth Bond Cables Aboriginal Heritage Due Diligence Assessment Report (AREA Environmental and Heritage Consultants, 2024)

AREA was commissioned by Essential Energy to carry out an Aboriginal Heritage Due Diligence Assessment for a project to install new underground 22kV electricity, communication, and earth bond cables. These would link the Pinnacles Place Zone Substation to the TransGrid Broken Hill Substation. No Aboriginal objects or sites with archaeological potential were found as a result of this assessment.

Aboriginal Cultural Heritage Test Excavation Report, Pinnacles Place (OzArk Environment and Heritage, 2025)

OzArk was commission by Essential Energy to carry out an archaeological test excavation program for the above-mentioned underground cable project. The archaeological test excavation program was agreed to as part of easement negotiations with Broken Hill LALC to enable construction of the cables across a section of Crown Land subject to an Aboriginal Land Claim. The archaeological test excavation demonstrated that there was no surface or subsurface Aboriginal objects or subsurface archaeological deposits in the study area. Test excavation results indicate that Aboriginal objects in the study area were unlikely. No further archaeological investigation or site monitoring was recommended.

4.2.3 Previous studies discussion

56 Aboriginal sites were located in Teryawynia, which comprises of a mainly flat and dry landform. The Mineral Separation Plant project identified quartz quarries, and open campsites, suggesting an association of sites and resource rich areas. These sites were also affected by erosion, indicating they were found in areas prone to surface water movement or wind erosion. Stone artefacts were located near to an ephemeral creek during a due diligence survey for the White Leeds Pipeline area. Artefact scatters were also identified during the surveys for the Battery Energy Storage System and transmission line corridor. This indicates that even in altered or developed landscapes can still contain remnants of Aboriginal heritage. These previous assessments suggests that Aboriginal sites are often associated with resource availability (e.g. quartz deposits), proximity to water sources (creeks or rivers) and even in disturbed or modified landscapes. However, erosion and human activities have significantly impacted the preservation of the sites.

4.3 Predictive model

A predictive model combines the archaeological context of the Study Area, with landscape data to suggest probable Aboriginal site types, their distributions, and their levels of preservation that might occur in the region.

Areas of archaeological potential are regarded as any high-risk landforms that have remained reasonably intact and undisturbed. The definition of disturbance follows Part 5, Division 2, Section 58 of the N*ational Parks and Wildlife Regulation 2019* (NPWR, 2019). Sensitive landforms follow the definitions supplied in the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW* (DECCW, 2010):

- within 200 metres of waters[5], or
- located within a sand dune system[6], or
- located on a ridge top, ridge line or headland, or
- located within 200 metres below or above a cliff face or
- within 20 metres of, or in a cave, rock shelter, or a cave mouth.

The nearest named waterway (Acacia Creek) is located 800 metres south of the Study Area. One unnamed ephemeral waterway intersects the Study Area.

The Study Area located within a highly disturbed road corridor and within the existing Wills Street WTP footprint, therefore there is a low likelihood of intact Aboriginal sites occurring in the Study Area.

[5] 'Waters' means the whole or any part of: any river, stream, lake, lagoon, swamp, wetlands, natural watercourse, tidal waters (including the sea). Note: the boundary or tidal waters is defined as the high-water mark (NPWR, 2019).

[6] Refers to sand ridges and sand hills formed by the wind, usually found in desert regions, near a lake or in costal areas. In areas of western NSW, windblown dunes can occur along the eastern edges of ephemeral lakes (called lunette dunes). The can also occur along the banks of rivers.

5 Archaeological survey

5.1 Methodology

The due diligence survey was conducted in accordance with the *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (DECCW 2010). A pedestrian survey was led by Kim Newman of AREA over two days: 9 and 10 May 2023, together with Chris Quayle representing Barkandji Traditional Owners.

The aim of the survey was to ground truth any previously recorded sites, identify any new Aboriginal sites, and assess the Study Area for the potential of subsurface deposits. The ground surfaces were examined for any Aboriginal objects (stone artefacts, imported shell, or other traces of Aboriginal occupation) and all mature trees were examined for signs of cultural scarring or marking.

A handheld GPS was used to ensure the entirety of the Study Area was surveyed. Pedestrian tracks were recorded, location of any new sites was photographed and detailed written records of landscape features relevant to archaeological potential were taken. It is important to note the tracks for the survey represent only one person from the survey team (AREA staff) (Figure 5-1). Features recorded include disturbance levels, GSV and landforms of high archaeological potential (see Section 4.3).

Figure 5-1: Survey effort overview

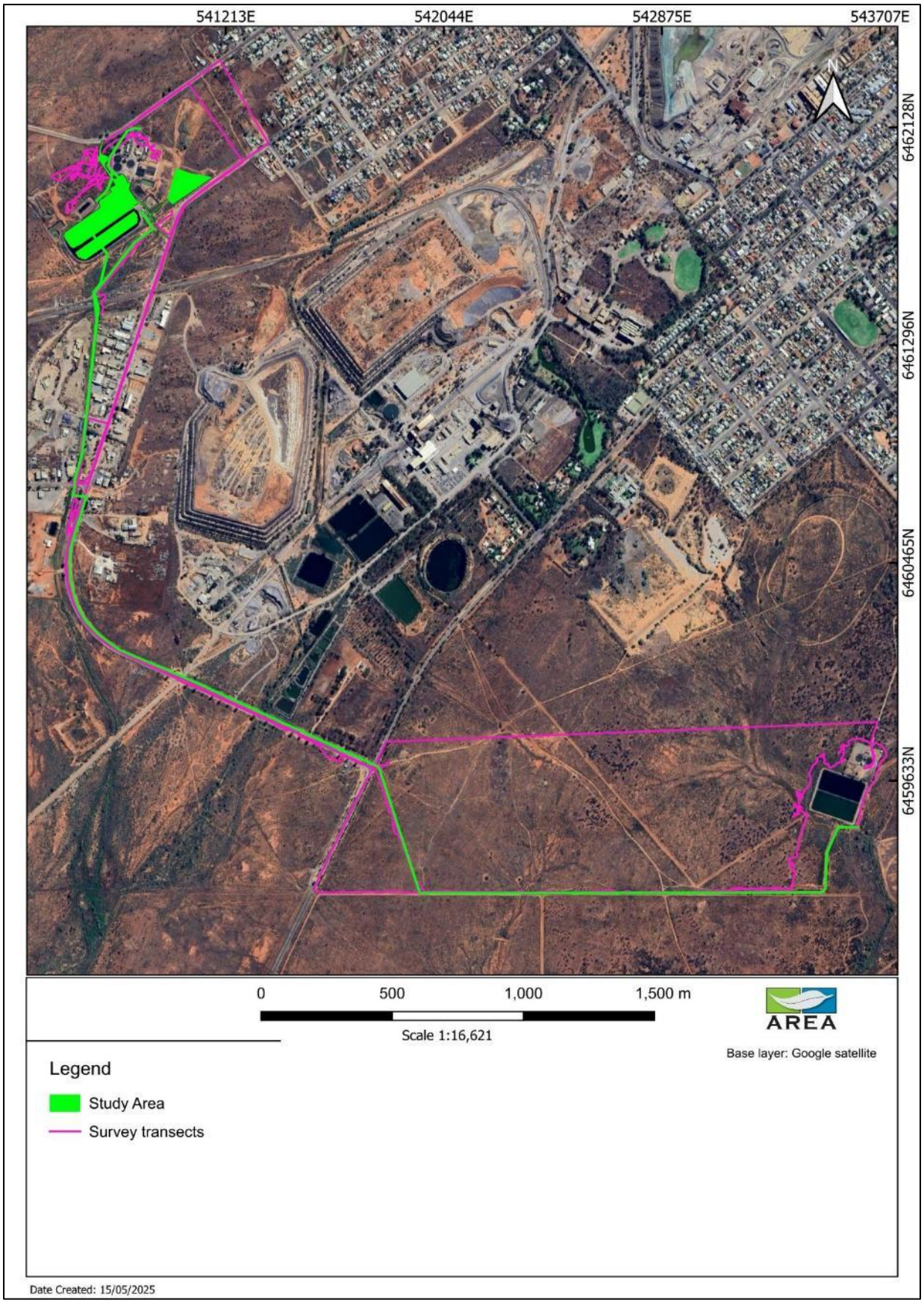


Figure 5-2: Survey effort where the facilities have been proposed

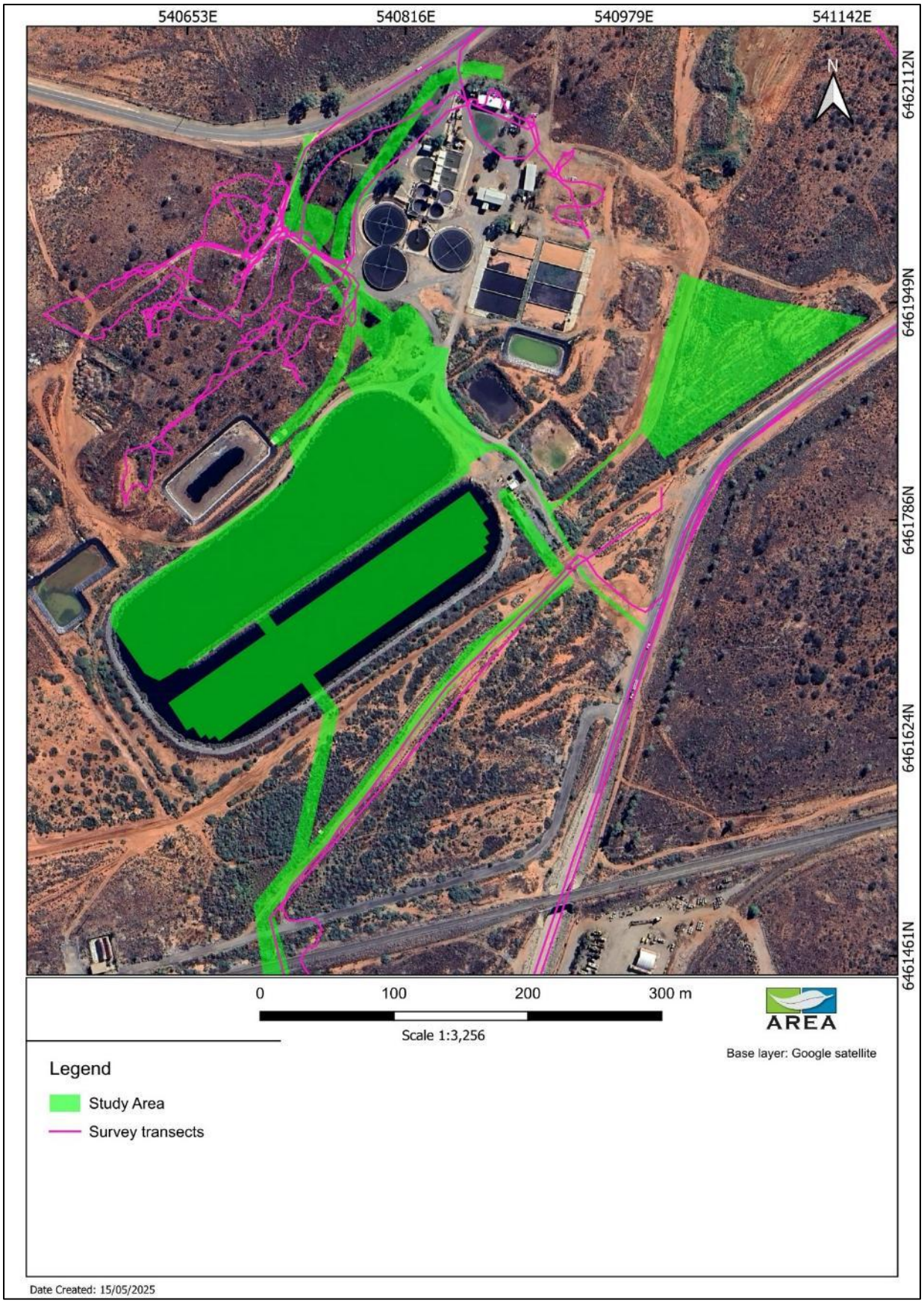


Figure 5-3: Survey effort south of the proposed facilities

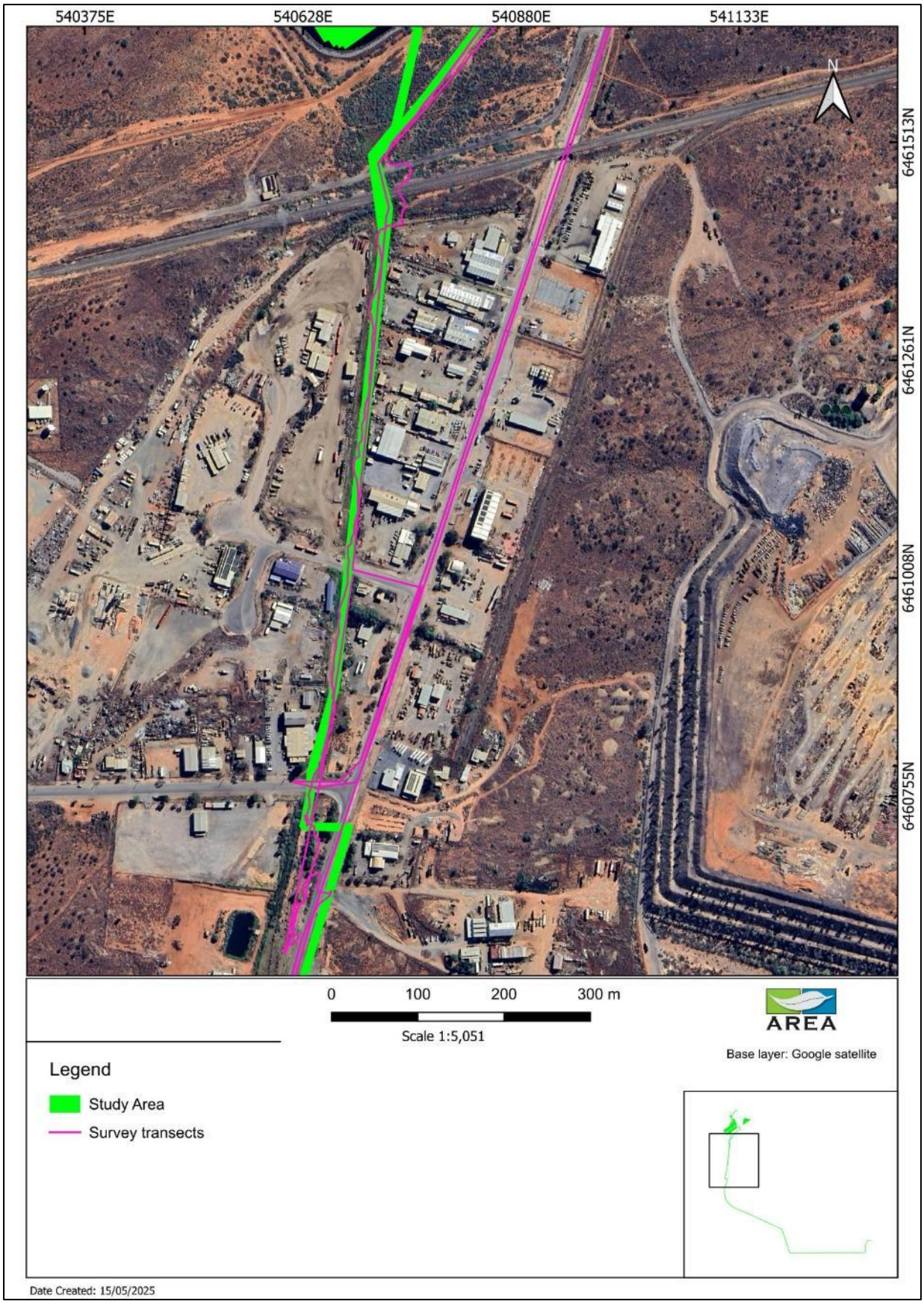


Figure 5-4: Survey effort further south of the proposed facilities.

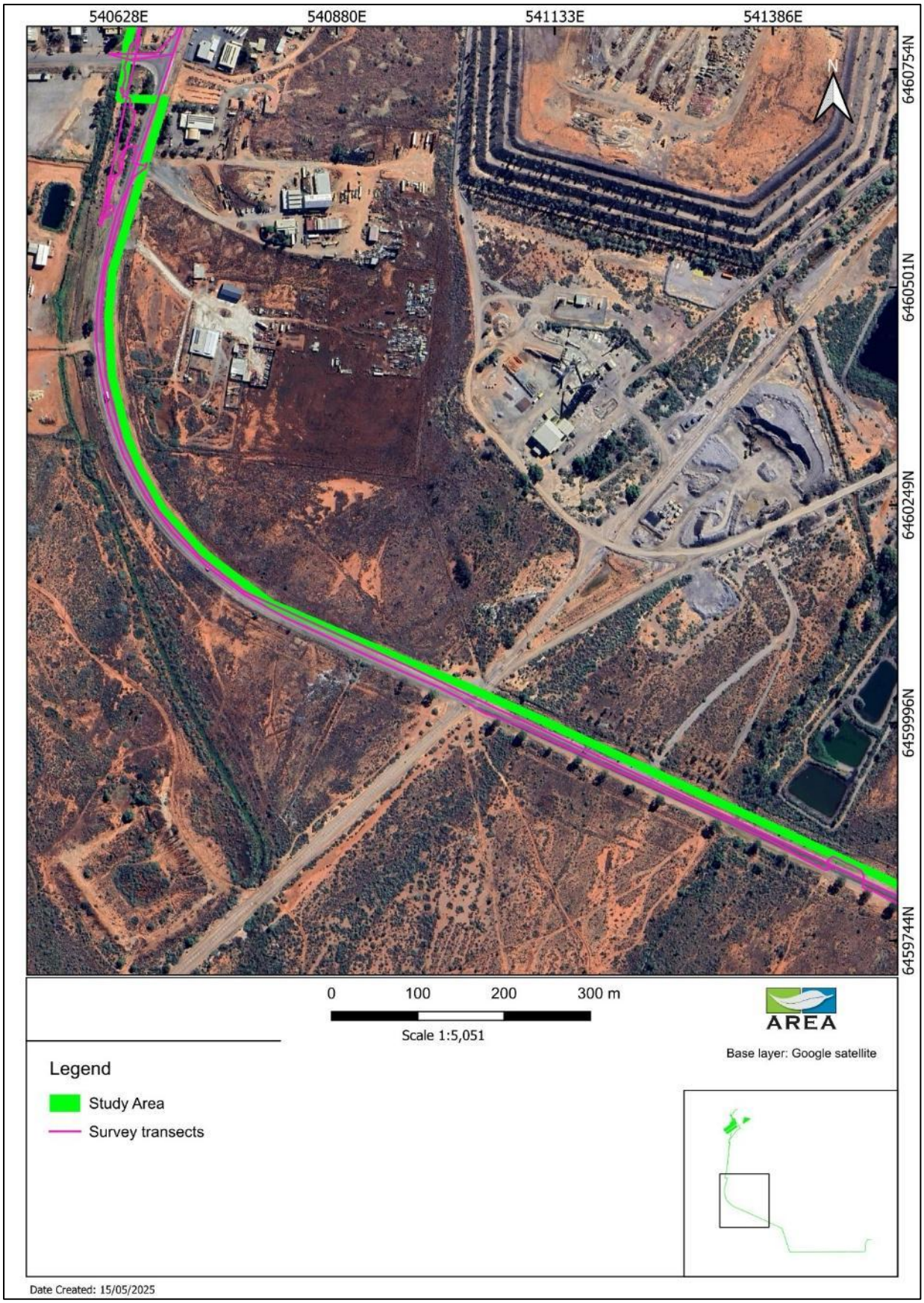
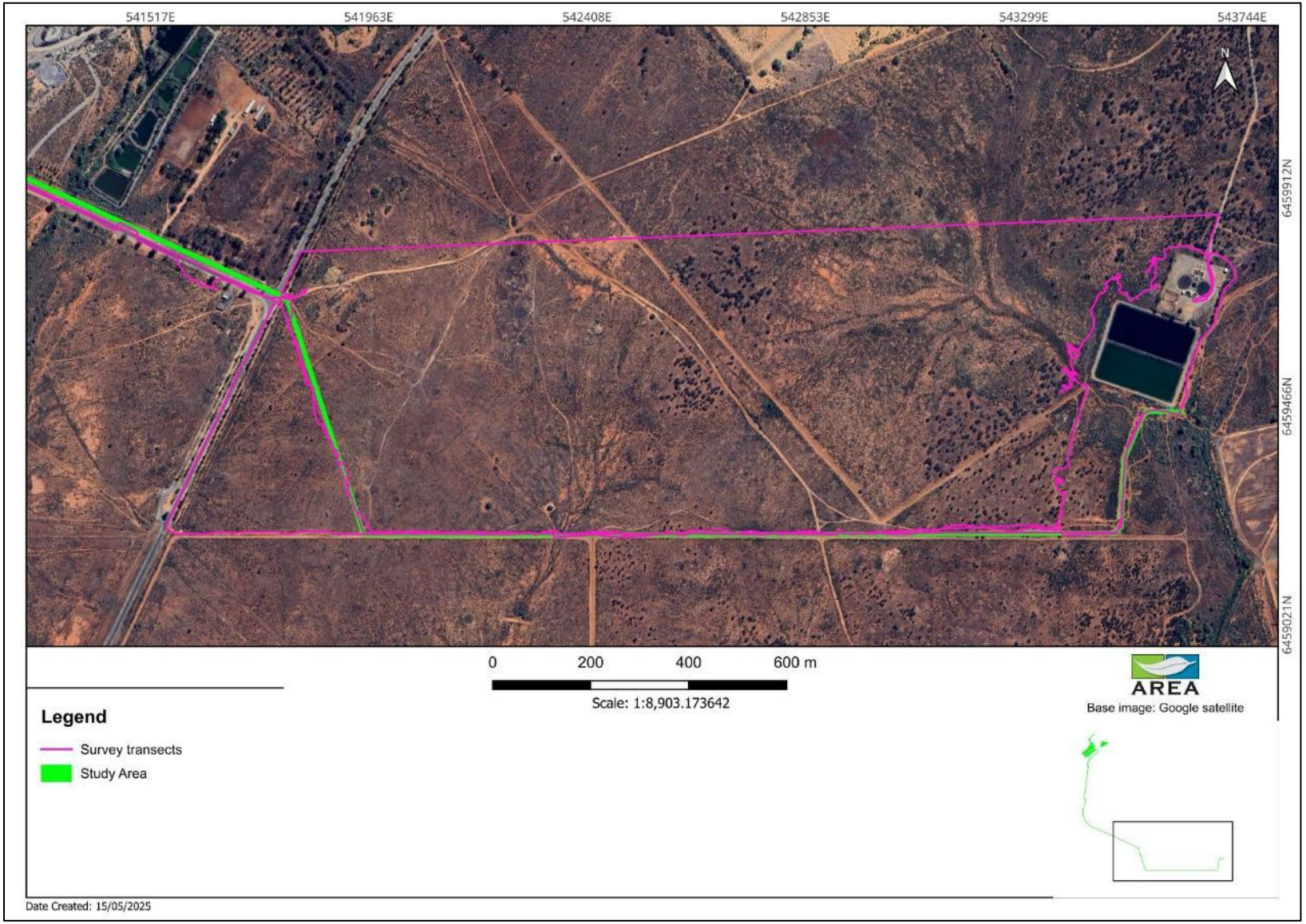


Figure 5-5: Survey effort in the south of the Study Area



5.2 Constraints

During the survey, a fragment of clear crystal quartz was identified. Quartz of this nature is culturally significant to the Barkandji People and was used for men's business. Women were not allowed to touch clear crystal quartz, and the AREA site officer conducting the survey is female. Out of respect for the traditions of the Barkandji People, the site officer did not touch, record, or photograph any artefacts made from clear crystal quartz. The general location and extent of the artefact scatter was recorded as a requirement for registering the site with AHIMS.

5.3 Survey Results

The Broken Hill South STP site is heavily disturbed and modified due to the construction and operation of the existing STP infrastructure. The landscape to the northwest and west of the Broken Hill South STP site, shows less signs of disturbance. The proposed new pump station would be installed within the disturbed footprint of the existing Broken Hill STP site.

The southeastern section, where the rising main development footprint turns north to the southern STP was comprised of a flat landform covered in red sandy soils, granite fragments and was thickly covered with saltbush. GSV was very low in areas that were densely covered in saltbush, with other exposed areas at 50%. The section towards South Broken Hill STP, was noted as heavily disturbed. Disturbances noted were rabbit warrens, spoil heaps, earth mounds, access tracks, and gravelled surfaces (Figure 5-6 and Figure 5-7).

From the Silver City Highway east to where the rising main development footprint turns north to the southern STP, the landscape was covered with regenerated chenopod shrubland, consisting primarily of Bluebush (*Maireana sp.*), and naturally fractured ironstone. This section was highly disturbed due to the grading in relation to the fence line and an access track extending to Silver City Highway and Wentworth Road. GSV on the track was 80% and 20% off the track (Figure 5-8 and Figure 5-9).

The eastern end of Kanandah Road (west of the Silver City Highway) was covered with dense saltbush vegetation GSV was between 0% and 5%. The ground in this area had been impacted by activities relating to the construction of power line easements, underground electric cabling, and Telstra cable installations along the road (Figure 5-10). Additionally, the installation of a larger drainage pipeline at the road culverts had caused further surface disturbance within the road corridor and the rising main development area.

The drainage easement in which route of the proposed rising main extends in a northerly direction from approximately the Pinnacles Road to the railway corridor is a highly modified and disturbed ephemeral drainage line. It serves both as a modified stormwater drain and utility corridor, containing the existing treated effluent discharge pipe from the existing Wills Street STP and other underground utilities.

After crossing the railway line, the rising main development footprint follows an existing pipeline easement for a former rising main with a nearby heavily disturbed graded track, before entering the Wills Street STP site. It was assessed as unlikely to contain any intact Aboriginal sites.

The BHSTP construction footprint area was in in a highly disturbed landform due to the existing Wills Street STP. The central section of the facilities was disturbed due to dug-out ponds near the existing water treatment plant (Figure 5-11). The new BHSTP infrastructure will be constructed at the site of the existing large tertiary treatment pond, a heavily disturbed and modified portion of the existing Wills Street STP site.

Five additional Aboriginal sites were recorded during the survey, four artefact scatters and one isolated find. Three artefact scatters were situated at the southeastern extent of the Study Area, to the west and northwest of the Broken Hill South STP site, and outside the rising main development footprint (Figure 5-30). The last artefact scatter and isolated find were identified within the existing Wills Street STP Site, but outside the BHSTP construction footprint, near an unsealed track (Figure 5-29.

Figure 5-6: Southern section of the rising main development footprint covered with salt bush and low GSV

Figure 5-7: View South Broken Hill STP highly disturb due to animal activities (rabbit burrows)

Figure 5-8: View proposed rising main route disturbance due to graded fence line

Figure 5-9: View proposed rising main route eroded tracks

Figure 5-10: View proposed rising main route disturbance due to power line easements and underground electric cabling

Figure 5-11: View disturbance due to dug out ponds

5.3.1 Newly Recorded Aboriginal sites

5.3.1.1 Broken Hill STP AS01 (AHIMS ID Pending)

Site type: Stone artefact scatter

Centroid: GDA 2020 Zone 54 543527 mE, 6459745 mN
Site length: 100 metres
Site 75width: 35 metres

Broken Hill STP AS01 is a low-density artefact scatter containing four opaque quartz flakes (Figure 5-13) and two opaque quartz cores (Figure 5-14). The cores were bipolar and showed no visible signs of early flaking. The artefacts were found in exposures between the dense saltbush vegetation.

Broken Hill STP AS01 was located on a flat landform characterised by red sandy soil and granite fragments. The nearest unnamed non-perennial waterway was approximately 280 meters east of Broken Hill STP AS01. The site was located 40 metres west of the current Broken Hill South STP.

The extent of the scatter measured approximately 100 metres east to west and 35 metres north to south. GSV was limited due to the salt bush vegetation in the surrounding area. The site was found in an exposed area with 50% GSV (Figure 5-12).

The site is located outside the Study Area and will be **avoided**.

Figure 5-12: 50% GSV within the exposure, overview facing south

Figure 5-13: Broken Hill STP AS01 Quartz flakes closeup

Figure 5-14: Broken Hill STP AS01 Quartz core closeup

5.3.1.2 Broken Hill STP AS02 (AHIMS ID Pending)

Site type: Stone artefact scatter
Centroid: GDA 2020 Zone 54 543389 mE, 6459539 mN
Site length: 118 metres
Site width: 53 metres

Broken Hill STP AS02 is an artefact scatter consisting of approximately 50 to 100 artefacts manufactured by a mix of opaque and clear crystal quartz. The clear crystal quartz is culturally significant to the Barkandji people, used for men's business. Out of respect for the traditions of the community, photographs were not taken of any clear crystal quartz artefacts.

Broken Hill STP AS02 is located on flat landform with red sandy soil. The nearest unnamed non-perennial waterway is approximately 300 meters east of the site. The artefact scatter is located 140 metres east from the rising main development footprint. The site extent measures 118 meters from north to south and 53 meters from east to west (Figure 5-15 and Figure 5-16). GSV at the time of recording the site was limited due to salt bush vegetation in the surrounding area. GSV in the exposed areas where the artefacts were found had 50% GSV.

Broken Hill STP AS02 is partially exposed due to a small drainage depression that divides it into two sections. Artefacts were visible among the native grass and saltbush. The site had been highly disturbed by an earth bund to the east (two meters high and eight meters wide) near the fence line and South STP ponds, an unsealed track to the south, and an artificial ridge with a planted boundary. The eastern boundary of the site is marked by a fence line along the western edge of South STP ponds, while the southern boundary is defined by an unsealed track (Figure 5-17 and Figure 5-18).

Broken Hill STP AS02 is located outside the Study Area and will be **avoided**.

Figure 5-15: View south of Broken Hill STP AS02 showing exposures within the saltbush

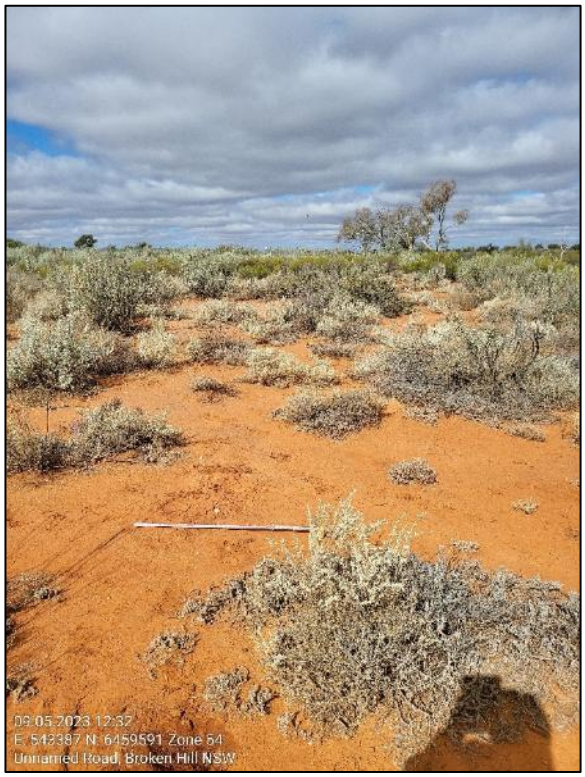


Figure 5-16: Broken Hill STP AS02 overview to west

Figure 5-17: Example of opaque quartz within Broken Hill STP AS02

Figure 5-18: View north across Broken Hill AS02

5.3.1.3 Broken Hill STP AS03 (AHIMS ID Pending)

Site type: Stone artefact scatter
Centroid: GDA 2020 Zone 54 543372 mE, 6459305 mN
Site length: 50 metres
Site width: 23 metres

Broken Hill STP AS03 is an artefact scatter that contains at least 20 opaque quartz cores and flakes found near the fence line (Figure 5-21). Most of the artefacts were found to the west of the fence line, except for three flakes that were located on the eastern side.

Broken Hill STP AS03 is located on a flat landform with red sandy soils. The nearest unnamed non-perennial waterway is located 300 metre east of the site. Disturbances at the included a graded fence line and animal burrows.

The site extends 50 meters from north to south and 23 meters from west to east and runs parallel to an unsealed track aligned north to south. Vegetation comprised of native grasses and small clusters of saltbushes (Figure 5-19 and Figure 5-20).

The artefacts on the eastern side of the fence line may have been displaced due to animal activities.

Broken Hill STP AS03 is located outside the Study Area and will be **avoided**.

Figure 5-19: View west across the site

Figure 5-20: View along the eastern side of the fence line

Figure 5-21: Sample view of artefacts at the Broken Hill STP AS03

5.3.1.4 Broken Hill STP AS04 (AHIMS ID Pending)

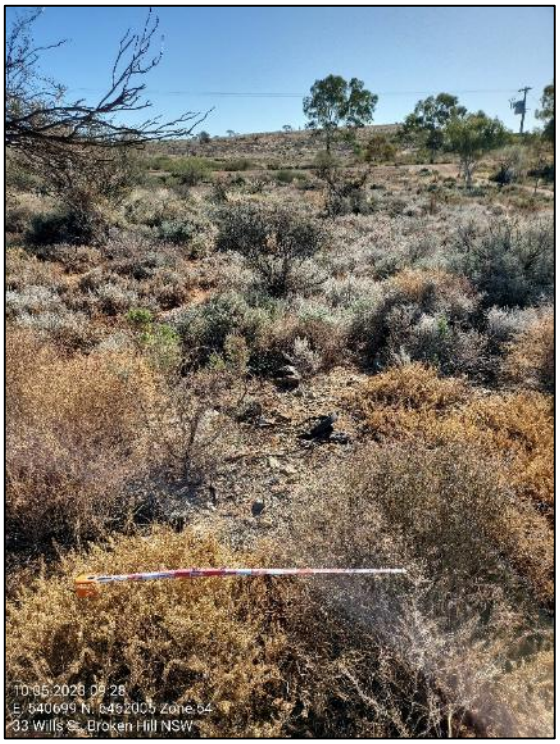
Site type: Stone artefact scatter
Centroid: GDA 2020 Zone 54 540697 mE, 6461977 mN
Site length: 6 metres
Site width: 5 metres

Broken Hill STP AS04 is located 90 metres south of Wills Street and along the southern edge of an unsealed access track within the existing Wills Street STP site. The site is a small artefact scatter consisting of five crystal quartz fragments. These are avoided by the proposal. The surrounding area is highly disturbed due to the construction of the STP and the access track. Stockpiles of broken concrete and granite fragments were observed in the general area (Figure 5-22 and Figure 5-23).

Broken Hill AS04 located outside the Study Area and will be **avoided.**

Figure 5-22: View south showing general location of Broken Hill STP AS04

Figure 5-23: View north showing general location of Broken Hill STP AS04



5.3.1.5 Broken Hill STP IF01 (AHIMS ID Pending)

Site type: Isolated find
Centroid: GDA 2020 Zone 54 540682 mE, 6462024 mN
Site length: 2 metres
Site width: 2 metres

Broken Hill STP IF01 (Figure 5-26) is an isolated find, situated on a flat landscape with red silty sand and a deflated siting. Broken Hill STP IF01 is located about 70 meters north of the Broken Hill STP construction footprint. The site is located 50 meters north of BHSTP AS 04, 50 meters south of Wills Street and 40 meters west of the proposed septage receival area within the BHSTP construction footprint. Vegetation within Broken Hill STP IF01 comprised of saltbush and tuffs of grasses. GSV was moderate with the artefact found within an exposure (Figure 5-25 and Figure 5-27).

The ground surface near Broken Hill STP IF01 was heavily disturbed, with the surrounding area serving as a dumping zone for large boulders of crystal quartz and granite, piled together approximately 30 meters east of the site (Figure 5-24).

The site is located outside Study Area and will be **avoided.**

Figure 5-24: View south across Broken Hill STP IF01

Figure 5-25: Sample view of vegetation and GSV

Figure 5-26: View conchoidal opaque quartz flake

Figure 5-27: View west across Broken Hill STP IF04

5.3.1.6 Quartz boulders

During the survey, a pile of clear crystal quartz boulders and granite boulders were observed approximately five metres east of an access track to the BHSTP, and 45 metres south of Wills Street. The pile appears to be a stockpile or dumping ground from when the access track and STP was constructed. Discussions with the RAPs during the survey concluded that these quartz boulders were likely not artefacts, but the material itself is culturally sensitive. The Barkandji community considers these boulders sacred due to their transcendental qualities and are requesting that no harm will be done to them. To avoid indirect impacts, management is prepared to relocate these boulders to an undisturbed area.

The boulders have subsequently been relocated to an area of the STP site, which will not be disturbed by current operations of the existing Wills Street STP, or future operation of the new BHSTP.

Figure 5-28: Location of the newly recorded Aboriginal sites

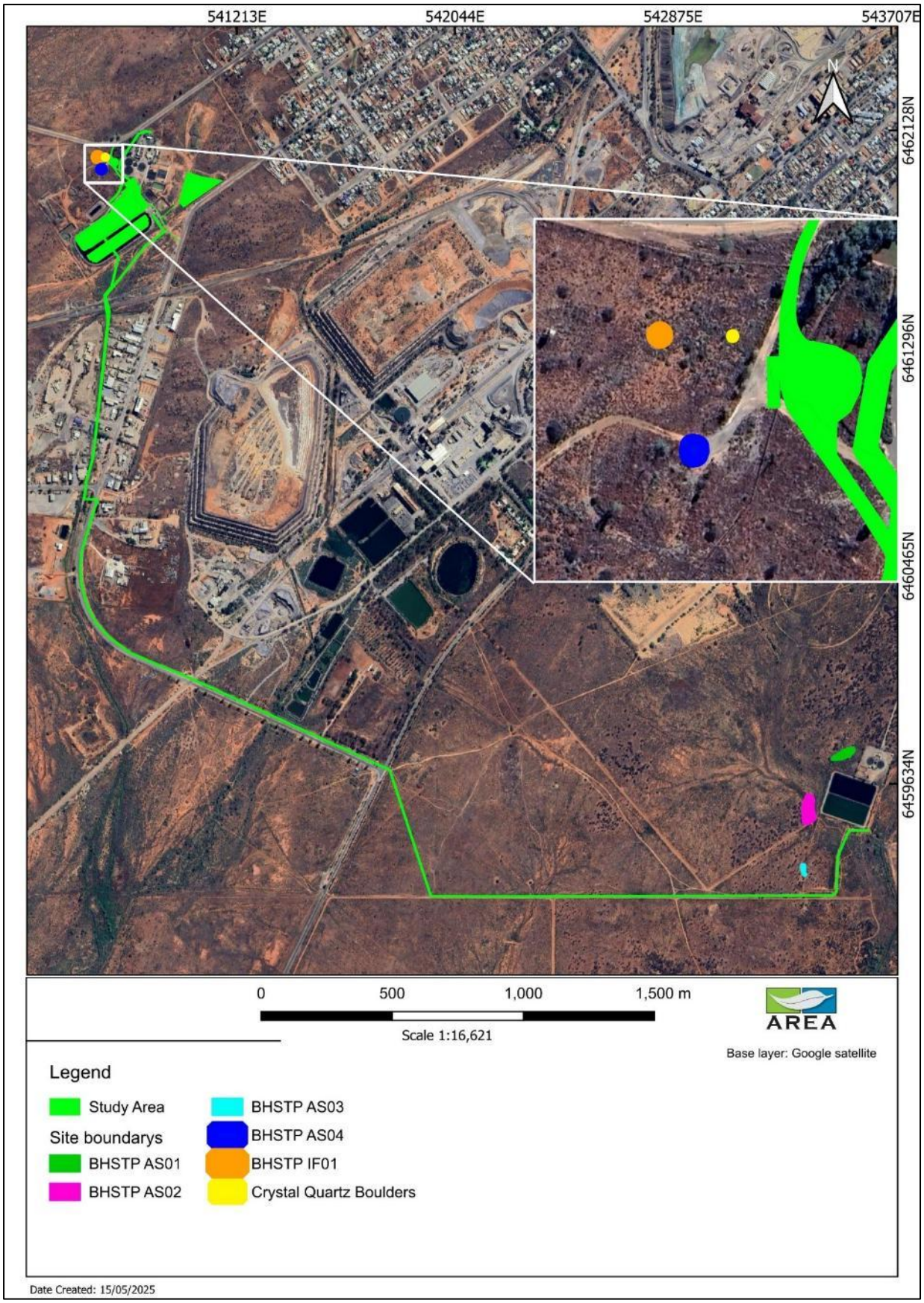
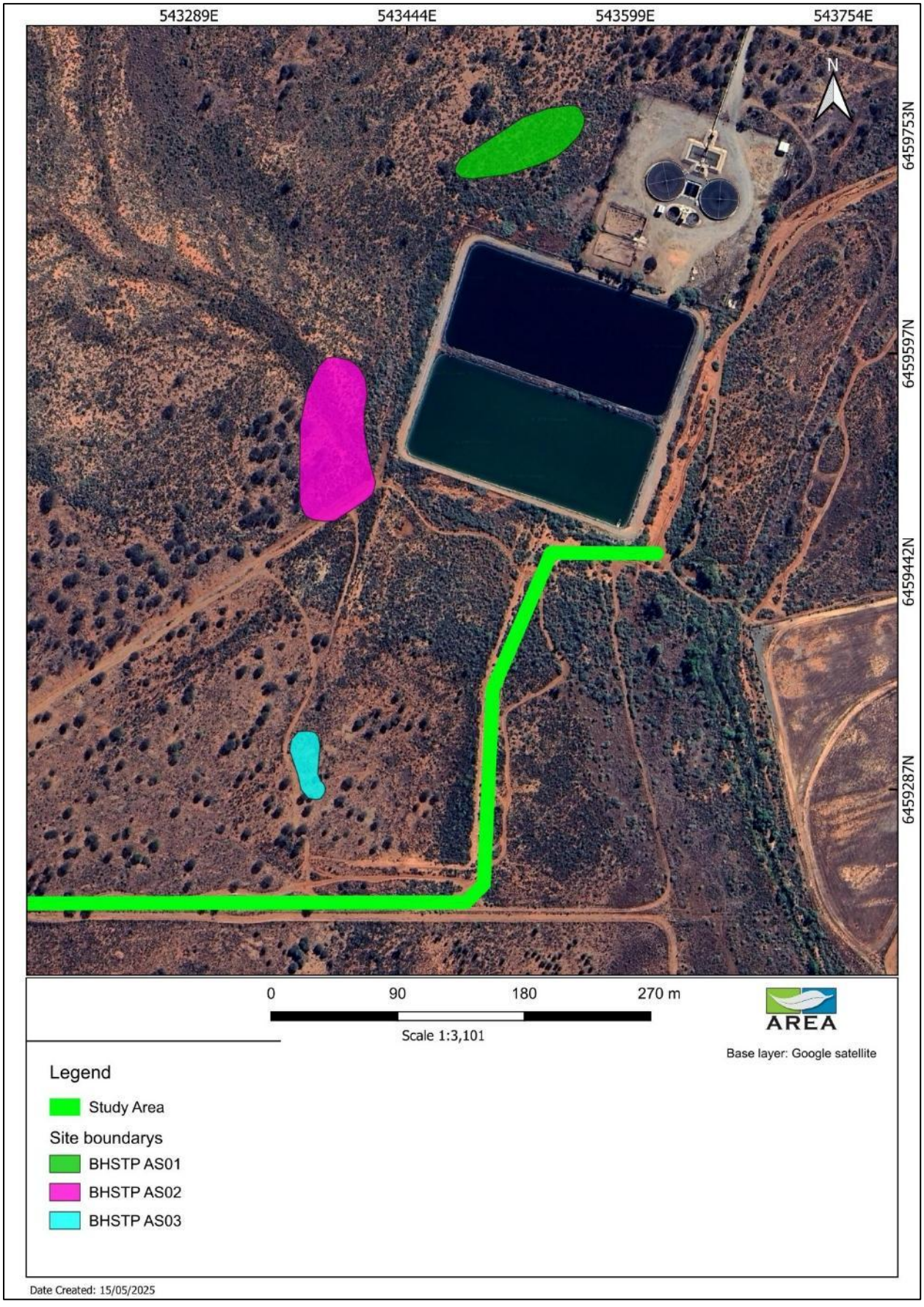


Figure 5-29: Close up of the newly recorded Aboriginal sites near Broken Hill STP

Figure 5-30: Close up of the sites recorded in the southern end of the Study Area



5.3.2 Ground Surface Disturbance

The entire Study Area was assessed as being previously subjected to significant ground disturbances. In the southeastern part of the rising main development footprint towards South STP, evidence of ground disturbance from animal activities (such as rabbit burrows and animal paths) and human activities, including earth mounds, dirt tracks, and gravel surfaces (Figure 5-7) was noted. This section of the Study Area has a low GSV due to dense native vegetation, such as salt bush (Figure 5-6).

The central and northern sections of the rising main development footprint, running parallel to Kanandah Road, are subject to significant ground disturbance due to existing pipeline installations, a graded fence line, eroded tracks, power line easements, and the installation of underground electric and Telstra cables (Figure 5-8, Figure 5-9, and Figure 5-10). Additionally, a road project that was underway at the time of the survey, near the Pinnacles Road and Kanandah Road intersections, involved replacing a culvert in the drainage easement which the proposed new rising main route and existing treated effluent pipeline traverse, which has further disturbed the surface at this location.

The Broken Hill STP construction footprint area is similarly disturbed from the construction and operation of the existing STP infrastructure (Figure 5-11).

5.3.3 Discussion

The Study Area is located on land subjected to significant ground disturbances from works associated with the construction and operation of the existing STP facilities, graded fence lines, vehicle tracks, overhead powerline corridors, underground electricity and Telstra cables, sewer and water pipeline installations, and road construction, including the replacement of the culvert beneath Pinnacles Road near the intersection with Kanandah Road. No intact Aboriginal objects or sites were uncovered in these disturbed areas and given the level of existing disturbance it is considered unlikely that any objects or sites would be encountered during construction works.

The sites BHSTP AS01, BHSTP AS02, and BHSTP AS03 are located on less disturbed land to the west and north of the existing South STP site and outside the rising main development footprint in the southeastern section of the Study Area. This section is thickly covered by saltbush, and the sites were recorded in exposed areas with 50% GSV. BHSTP AS04 and BHSTP IF01 are located on a less disturbed land within the Wills Street STP, but outside the proposed construction footprint of the new BHSTP.

6 Assessment of significance

Significance forms the basis for the management of Aboriginal cultural heritage. There are four main criteria for assessing the significance of Aboriginal cultural heritage sites listed in the OEH document *Guide to investigating, assessing, and reporting on Aboriginal cultural heritage in NSW* (OEH 2011). These are Social or Cultural significance, Aesthetic significance, Historic significance, and Scientific significance.

Each criterion of significance are rated low, moderate, or high. The following questions can be asked to help guide this rating (OEH 2011; 10):

- **Research potential:** does the evidence suggest any potential to contribute to an understanding of the area and/or region and/or state's natural and cultural history?
- **Representativeness:** how much variability (outside and/or inside the subject area) exists, what is already conserved, how much connectivity is there?
- **Rarity:** is the subject area important in demonstrating a distinctive way of life, custom, process, land-use, function or design no longer practised? Is it in danger of being lost or of exceptional interest?
- **Education potential:** does the subject area contain teaching sites or sites that might have teaching potential?

The level of significance of each site is summarised in Table 6-1.

Table 6-1: Summary of significance for sites recorded

Site ID	Social Significance	Aesthetic Significance	Historic Significance	Scientific Significance	Overall archaeological significance
BHSTP AS01 (AHIMS ID Pending)	Low	Moderate	Nil	Low	Low
BHSTP AS02 (AHIMS ID Pending)	Low	Moderate	Nil	Low	Low
BHSTP AS03(AHIMS ID Pending)	Low	Moderate	Nil	Low	Low
BHSTP AS04(AHIMS ID Pending)	Low	Moderate	Nil	Low	Low
BHSTP IF01(AHIMS ID Pending)	Low	Moderate	Nil	Low	Low

Social or cultural significance

Social or cultural value refers to the spiritual, traditional, historical, or contemporary associations and attachments the place or area has for Aboriginal people (OEH 2011). It relates to contemporary connections that Aboriginal people have with events that have taken place in that location or in the general area. In general, presence of Aboriginal sites provides evidence of connection to country and therefore is likely to be considered as important and significant regardless of its condition or representativeness.

Clear crystal quartz has significant cultural values associated with men's business irrespective of being an Aboriginal object (a stone tool) or not.

All Aboriginal sites located near waterways are significant to Aboriginal people which has an elevated potential.

Aesthetic significance

This refers to the sensory, scenic, architectural, and creative aspects of the place. It is often closely linked with the social values. It may consider form, scale, colour, texture and material of the fabric or landscape, and the smell and sounds associated with the place and its use (Australian ICOMOS1988, as cited in OEH 2011).

The stone artefact scatters contain a variety of artefact types including flakes and cores, with the raw materials including mix of opaque, clear crystal quartz and milky quartz. These sites have **moderate** aesthetic significance.

Culturally modified trees inherently have some aesthetic value. Mature trees have some level of aesthetic appeal, and the cultural scars provide a clear link to the Aboriginal use of the area. The culturally modified trees vary in size and shape which may indicate different functions. These sites have **moderate** aesthetic significance.

Historic significance

Historic value refers to the associations of a place with a historically important person, event, phase, or activity in an Aboriginal community. Historic places do not always have physical evidence of their historical importance (OEH 2011; 9).

There are no known historical associations between the Study Area and the local Aboriginal community. Therefore, there is **nil** historic significance of the development footprint and sites within them.

Scientific significance

This refers to the importance of a landscape, area, place or object because of its rarity, representativeness, and the extent to which it may contribute to further understanding and information (Australian ICOMOS 1988, as cited in OEH 2011; 9).

The distribution of the sites conformed to the predictive model set out in Section 4.3. On this level, the recorded sites are considered to be representative of these site types but are not rare. The scientific significance of the sites within the Study Area is rated as **low**.

7 Impact and management

7.1 Overview

Cultural heritage values identified for the proposal require management. Whether an impact is direct, indirect, or possible, Aboriginal sites will require some level of intervention to avoid harm in the first instance and where harm cannot be avoided the residual impact will be mitigated.

7.2 Impacts to Aboriginal Heritage

Five Aboriginal sites were recorded during this survey (Figure 5-28, Figure 5-29 and Figure 5-30), all sites are located outside the proposed construction footprint. As such direct impact to these sites will be avoided, but the sites will require management to prevent inadvertent impact.

7.3 Management and mitigation options

The following recommendations are required to reduce the potential for inadvertent impact to Aboriginal sites recorded within and outside the Study Area.

- Site supervisors, and construction work crews be made aware of the locations of Broken Hill STP AS04 and Broken Hill STP IF01 at the existing Wills Street STP. It is recommended that temporary fencing be erected around these sites.
- BHSTP AS01, BHSTP AS02, and BHSTP AS03 to the northwest and west of the existing South STP site, are located at an adequate distance away from the proposed construction activities and do not require temporary fencing. Site supervisors and construction work crews would be made aware of their location.
- All staff working must be made aware of the legislative protection offered for all cultural heritage sites under the NSW NPW Act.

In addition to these mitigation measures, the following general recommendations are made:

- If any objects, suspected to be Aboriginal heritage in origin, be encountered during the proposed works, all works must cease within 20 metres of the find and the unexpected finds protocols (Appendix B) should be implemented.
- If changes are made to the proposal outside of the current development footprint, another due diligence assessment will be required.
- If suspected human remains are located during any stage of the proposed works, all works relating to this project must stop immediately, and the NSW police be immediately notified

8 References

National Parks and Wildlife Act 1974 *(NSW)*

Native Title Act 1994 (NSW)

Environmental Planning and Assessment Act 1979 (NSW)

(n.d.).

AECOM. (2022). *Broken Hill Battery Energy Storage System Project Modification Aboriginal Cultural Heritage Assessment Report.* Sydney: AECOM Australia Pty Ltd.

AECOM Australia Pty Ltd. (2021). *Broken Hill Battery Energy Storage System Project Aboriginal Cultural Heritage Assessment Report.* Sydney: AECOM Australia Pty Ltd.

AREA Environmental and Heritage Consultants. (2024). *Two Proposed Trenches for New Underground 22Kv Electircity Communication and Earth Bond Cables Aboriginal Heritage Due Diligence Assessment Report.* Dubbo: AREA Environmental and Heritage Consultants.

AREA Environmental and Hertage Consultancy. (2024). *Two Proposed Trenches for New Underground 22Kv Electircity Communication and Earth Bond Cables Aboriginal Heritage Due Diligence Assessment Report.* Dubbo: AREA Environmental and Hertage Consultancy,.

Beca HunterH20. (2024). *Broken Hill STP Design Basis and Preliminary Concept Design Review Report.* Essential Water.

Beca HunterH2O Holdings Pty Limited. (2024). *Broken Hill STP Design Basis and Preliminary Concept Design Review Report* . Beca HunterH2O .

BoM. (2024). *Climate Statistics for Australian Locations: Broken Hill Airport AWS*. Retrieved from http://www.bom.gov.au/climate/averages/tables/cw_047048.shtml

Cupper, M. (2015). *Aboriginal Cultural Heritage Due Dilligence Assessment: Broken Hill Water Treatment Plant.* Merbein: LandSkape Natural and Cultural Heritage Management.

DECCW. (2010, September 13). *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW.* Retrieved from NSW Government Department of Environment, Climate Change, and Water: https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Aboriginal-cultural-heritage/due-diligence-code-of-practice-aboriginal-objects-protection-100798.pdf

DECCW (2010) *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (DECCW 2010).

Dunn, I., & Shaukar, R. (2003). *The Bioregions of New South Wales, their Bioediversity, conservation and history.* Hurstville: NSW National Parks and Wildlife Services.

Eco Logical Australia. (2022). *Broken Hill BESS: High Voltage Power Easement (Stage 2) Heritage.* Eco Logical Australia.

Envirokey Pty Ltd. (2013). *Review of Environmental Factors White Leeds Pipeline, Broken Hill, NSW.* Tathra: Envirokey Pty Ltd.

Hercus, L. A. (1982). *The Bagandji Language Pacific Linguistic Series B - No 67.*

Hercus, L. A. (1993). *Barkandji Dictionary.* Canberra: AIATSIS.

Heritage Search. (2001). *Mineral Seperation Plant, Broken Hill, NSW: Aboriginal and Non Aboriginal Heritage Assessment.* Bulli: Resuorce Strategies.

Kearns, R. H. (1951). *Book Collectors' Society of Australia. (1947). Biblionews Vol. 4 No. 8*. Retrieved from National Library of Australia: http://nla.gov.au/nla.obj-2987602660

Kearns, R. H. (1976). *Broken Hill Volume 4 1940-1973 Towards the Century.* Broken: The Broken Hill Historical Society.

Martin, S. (1988). *Archaeological Survey of Proposed Telecom Tower Sites near Ivanhoe Central Western NSW. A Report to Telecom Australia.*

Martin, S. (1991). *Cobar Rock Art Managemnt Study. A Report to the NSW NPWS.* Sydney.

New South Wales Archaeology PtyLtd. (2007). *Silverton Wind Farm, NSW: Stages 2 and 3 and Powerline Route (Broken Hill to Red Cliffs) Aboriginal Heritage and Non Indigenous Heritage.* Central Tilba: Silverton Wind Farm Devlopment.

NPWR. (2019). *National Parks and Wildlife Regulation, Division 2, Section 58.* Retrieved from NSW Legislation: https://legislation.nsw.gov.au/view/html/inforce/current/sl-2019-0408#sec.58

Office of Environment and Heritage (OEH) (2011) *Guide to investigating, assessing, and reporting on Aboriginal cultural heritage in NSW*.

Ozark Environmental and Heritage Management Pty Ltd. (2012). *Broken Hill Solar Plant Environmental Assessment.* Dubbo: Ozark Environmental and Heritage Management Pty Ltd.

Stern, H., & et al. (2000). *Objective Classification of Australian Climates, Australian Meteorological Magazine 49.*

Thompson, P. (1986). *Blantyre seismic survey.* Sydney: BHP Petroleum.

Appendix A. AHIMS Extensive Search Results (Conducted 27.03.2025)

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : Wills St B Hill

Client Service ID : 989255

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status **	SiteFeatures	SiteTypes	Reports
23-4-0091	AS16	AGD	54	538220	6460730	Open site	Valid	Stone Quarry : -, Artefact : -		98177,102768, 102793
	Contact	Recorders	Ms.Louise Gay					Permits		
23-4-0092	AS15	AGD	54	538325	6460180	Open site	Destroyed	Artefact : -		98177,99660,101767,102768, 102793
	Contact	Recorders	Ms.Louise Gay					Permits	1782,1783	
23-4-0093	AS14	AGD	54	538213	6460566	Open site	Destroyed	Stone Quarry : -, Artefact : -		98177,99660,101767,102768, 102793
	Contact	Recorders	Ms.Louise Gay					Permits	1782,1783	
23-4-0081	AS1	AGD	54	539110	6460112	Open site	Valid	Stone Quarry : -, Artefact : -		98177,102768, 102793
	Contact	Recorders	Ms.Louise Gay					Permits		
23-4-0082	AS3	AGD	54	539012	6460300	Open site	Valid	Aboriginal Resource and Gathering : -		98177,102768, 102793
	Contact	Recorders	Ms.Louise Gay					Permits		
23-4-0083	AS4	AGD	54	539106	6460350	Open site	Valid	Stone Quarry : -, Artefact : -		98177,102768, 102793
	Contact	Recorders	Ms.Louise Gay					Permits		
23-4-0084	AS5	AGD	54	538860	6460460	Open site	Destroyed	Artefact : -		98177,99660,101767,102768, 102793
	Contact	Recorders	Ms.Louise Gay					Permits	1782,1783	
23-4-0085	AS6	AGD	54	538930	6460150	Open site	Valid	Artefact : -		98177,102768, 102793
	Contact	Recorders	Ms.Louise Gay					Permits		
23-4-0086	AS7	AGD	54	538650	6460280	Open site	Destroyed	Artefact : -		98177,99660,101767,102768, 102793
	Contact	Recorders	Ms.Louise Gay					Permits	1782,1783	
23-4-0087	AS8	AGD	54	538610	6460140	Open site	Destroyed	Artefact : -		98177,99660,101767,102768, 102793
	Contact	Recorders	Ms.Louise Gay					Permits	1782,1783	
23-4-0088	AS9	AGD	54	538341	6460729	Open site	Destroyed	Artefact : -		98177,99659,102768,102793
	Contact	Recorders	Ms.Louise Gay					Permits	1782,1783	
23-4-0089	AS10	AGD	54	538433	6460600	Open site	Destroyed	Artefact : -		98177,99660,101767,102768, 102793
	Contact	Recorders	Ms.Louise Gay					Permits	1782,1783	

Report generated by AHIMS Web Service on 27/03/2025 for Phillip Cameron for the following area at Lat, Long From : -32.0298, 141.3717 - Lat, Long To : -31.957, 141.4955. Number of Aboriginal sites and Aboriginal objects found is 66

This information is not guaranteed to be free from error omission. Heritage NSW and its employees disclaim liability for any act done or omission made on the information and consequences of such acts or omission.

Page 1 of 5

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : Wills St B Hill

Client Service ID : 989255

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status **	SiteFeatures	SiteTypes	Reports
23-4-0090	AS12	AGD	54	538540	6460660	Open site	Destroyed	Stone Quarry : -, Artefact : -		98177,99660,101767,102768,102793
	Contact	Recorders	Ms.Louise Gay					Permits	1782,1783	
23-4-0111	AS11	AGD	54	538500	6460630	Open site	Destroyed	Artefact : -		98177,99660,101767,102768,102793
	Contact	Recorders	Ms.Louise Gay					Permits	1782,1783	
23-4-0112	AS2	AGD	54	539100	6460160	Open site	Valid	Stone Quarry : -		98177,102768,102793
	Contact	Recorders	Ms.Louise Gay					Permits		
23-4-0107	AS13	AGD	54	538240	6460510	Open site	Destroyed	Stone Quarry : -		98177,99660,101767,102768,102793
	Contact	Recorders	Ms.Louise Gay					Permits	1782,1783	
23-4-0132	South Broken Hill	AGD	54	546320	6462220	Open site	Valid	Artefact : 2		
	Contact	Recorders	Mr.John Appleton					Permits		
23-4-0608	SU27B/L2	GDA	54	536594	6463675	Open site	Valid	Artefact : 1		
	Contact	Recorders	Doctor.Julie Dibden					Permits		
23-4-0615	SU27B/L9	GDA	54	537658	6462606	Open site	Valid	Artefact : 1		102768,102793
	Contact	Recorders	Doctor.Julie Dibden					Permits		
23-4-0616	Broken Hill Solar - Site #1	GDA	54	536478	6460952	Open site	Valid	Artefact : 1		102961
	Contact	Recorders	OzArk Environmental and Heritage Management - Dubbo					Permits		
23-4-0617	Broken Hill Solar - Site #2	GDA	54	536536	6460959	Open site	Valid	Artefact : 1		102961
	Contact	Recorders	OzArk Environmental and Heritage Management - Dubbo					Permits		
23-4-0618	Broken Hill Solar - Site #3	GDA	54	536536	6460950	Open site	Valid	Artefact : 1		102961
	Contact	Recorders	OzArk Environmental and Heritage Management - Dubbo					Permits		
23-4-0619	Broken Hill Solar - Site #4	GDA	54	536692	6460937	Open site	Valid	Artefact : 1		102961
	Contact	Recorders	OzArk Environmental and Heritage Management - Dubbo					Permits		
23-4-0620	Broken Hill Solar - Site #5	GDA	54	536667	6460912	Open site	Valid	Artefact : 1		102961
	Contact	Recorders	OzArk Environmental and Heritage Management - Dubbo					Permits		
23-4-0621	Broken Hill Solar - Site #6	GDA	54	536767	6460809	Open site	Valid	Artefact : 1		102961
	Contact	Recorders	OzArk Environmental and Heritage Management - Dubbo					Permits		
23-4-0622	Broken Hill Solar - Site #7	GDA	54	536805	6460788	Open site	Valid	Artefact : 1		102961
	Contact	Recorders	OzArk Environmental and Heritage Management - Dubbo					Permits		
23-4-0623	Broken Hill Solarr - Site #8	GDA	54	536649	6460922	Open site	Valid	Artefact : 1		102961
	Contact	Recorders	OzArk Environmental and Heritage Management - Dubbo					Permits		
23-4-0624	Broken Hill Solar - Site #9	GDA	54	536730	6460717	Open site	Valid	Artefact : 1		102961

Report generated by AHIMS Web Service on 27/03/2025 for Phillip Cameron for the following area at Lat, Long From : -32.0298, 141.3717 - Lat, Long To : -31.957, 141.4955. Number of Aboriginal sites and Aboriginal objects found is 66

This information is not guaranteed to be free from error omission. Heritage NSW and its employees disclaim liability for any act done or omission made on the information and consequences of such acts or omission.

Page 2 of 5

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : Wills St B Hill

Client Service ID : 989255

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status **	SiteFeatures	SiteTypes	Reports
	Contact	Recorders	OzArk Environmental and Heritage Management - Dubbo					Permits		
23-4-0625	Broken Hill Solar - Site #10	GDA	54	536343	6460392	Open site	Valid	Artefact : 1		102961
	Contact	Recorders	OzArk Environmental and Heritage Management - Dubbo					Permits		
23-4-0626	Broken Hill Solar - Site #11	GDA	54	537986	6461608	Open site	Valid	Artefact : 1		102961
	Contact	Recorders	OzArk Environmental and Heritage Management - Dubbo					Permits		
23-4-0627	Broken Hill Solar - Site #12	GDA	54	536445	6461385	Open site	Valid	Artefact : 1		102961
	Contact	Recorders	OzArk Environmental and Heritage Management - Dubbo					Permits		
23-4-0628	Broken Hill Solar - Site #13	GDA	54	536493	6461184	Open site	Valid	Artefact : 1		102961
	Contact	Recorders	Doctor.Jodie Benton,OzArk Environmental and Heritage Management - Dubbo					Permits		
23-4-0629	Broken Hill Solar - Site #14	GDA	54	536652	6460984	Open site	Valid	Artefact : 1		102961
	Contact	Recorders	OzArk Environmental and Heritage Management - Dubbo					Permits		
23-4-0635	SWF SU280/L3	GDA	54	539311	6464126	Open site	Valid	Artefact : 5		
	Contact	Recorders	Doctor.Julie Dibden					Permits		
23-4-0636	Mawsons Quarry Ab. Quarry 1	GDA	54	545632	6463133	Open site	Valid	Artefact : 1, Stone Quarry : 1		102982
	Contact	Recorders	Doctor.Jodie Benton					Permits		
23-4-0637	Mawsons Quarry Isolated Find 1	GDA	54	545117	6463700	Open site	Valid	Artefact : 1		102982
	Contact	Recorders	Doctor.Jodie Benton					Permits		
23-4-0638	Mawsons Quarry Open Site 2	GDA	54	545468	6463718	Open site	Valid	Artefact : 1		102982
	Contact	Recorders	Doctor.Jodie Benton					Permits		
23-4-0639	Mawsons Quarry Open Site 1	GDA	54	545273	6463704	Open site	Valid	Artefact : 1		102982
	Contact	Recorders	Doctor.Jodie Benton					Permits		
23-4-0640	Broken Hill (A-CAES) Kanandah 1 (BH Site 33) & AHIMS #23-4-0641	GDA	54	540033	6460551	Open site	Valid	Artefact : -, Hearth : -		
	Contact	Recorders	Doctor.Matt Cupper,Doctor.Rebecca Parkes,LandSkape - Natural & Cultural Heritag					Permits		
23-4-0641	Kanandah 2	GDA	54	540039	6460557	Open site	Valid	Artefact : -		
	Contact	Recorders	Doctor.Matt Cupper,LandSkape - Natural & Cultural Heritage Management					Permits		
31-1-0104	Acacia Creek 1	GDA	54	540104	6456221	Open site	Valid	Artefact : -		
	Contact	Recorders	Niche Environment and Heritage,Doctor.Matt Cupper,LandSkape - Natural & Cultur					Permits		
31-1-0563	Murray to Broken Hill Pipeline AFT1	GDA	54	540604	6457538	Open site	Destroyed	Artefact : -		
	Contact	Recorders	Niche Environment and Heritage,Niche Environment and Heritage,Ms.Clare Anders					Permits	4173	
31-1-0564	Murray to Broken Hill Pipeline AFT2	GDA	54	540577	6457480	Open site	Valid	Artefact : -		
	Contact	Recorders	Niche Environment and Heritage,Ms.Clare Anderson					Permits	4173	
23-4-0682	Broken Hill (A-CAES) South airports regency area isolated artefact (BH Site 21)	GDA	54	544167	6460023	Open site	Valid	Hearth : -, Artefact : -		
	Contact	Recorders	Doctor.Rebecca Parkes,Miss.Lucy Blackam,Lantern Heritage Pty Ltd - Tathra					Permits		
23-4-0691	BESS-AS1-21	GDA	54	539776	6461011	Open site	Valid	Artefact : -		
	Contact	Recorders	Mr.Geordie Oakes,AECOM Australia Pty Ltd - Sydney					Permits		

Report generated by AHIMS Web Service on 27/03/2025 for Phillip Cameron for the following area at Lat, Long From : -32.0298, 141.3717 - Lat, Long To : -31.957, 141.4955. Number of Aboriginal sites and Aboriginal objects found is 66

This information is not guaranteed to be free from error omission. Heritage NSW and its employees disclaim liability for any act done or omission made on the information and consequences of such acts or omission.

Page 3 of 5

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : Wills St B Hill

Client Service ID : 989255

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status **	SiteFeatures	SiteTypes	Reports
23-4-0697	(BH AFT 20) Zone 6 excavation	GDA	54	545822	6461553	Open site	Valid	Artefact : -, Stone Arrangement : -		
	Contact	Recorders	Doctor.Rebecca Parkes,Lantern Heritage Pty Ltd - Tathra,Lantern Heritage Pty Ltd					Permits		
23-4-0698	Broken Hill (A-CAES) AFT 22 (BH Site 22)	GDA	54	543725	6460017	Open site	Valid	Artefact : -		
	Contact	Recorders	Doctor.Rebecca Parkes,Lantern Heritage Pty Ltd - Tathra					Permits		
23-4-0699	Broken Hill (A-CAES) AFT 23 (BH Site 23)	GDA	54	543393	6459907	Open site	Valid	Artefact : -		
	Contact	Recorders	Doctor.Rebecca Parkes,Lantern Heritage Pty Ltd - Tathra					Permits		
23-4-0700	Broken Hill (A-CAES) AFT 25 (BH Site 25)	GDA	54	543260	6459802	Open site	Valid	Artefact : -		
	Contact	Recorders	Doctor.Rebecca Parkes,Lantern Heritage Pty Ltd - Tathra					Permits		
31-1-0723	Broken Hill (A-CAES) AFT/HTH 26 (BH Site 26)	GDA	54	543075	6459632	Open site	Valid	Artefact : -, Hearth : -		
	Contact	Recorders	Doctor.Rebecca Parkes,Lantern Heritage Pty Ltd - Tathra					Permits		
31-1-0724	Broken Hill (A-CAES) AFT/HTH 27 (BH Site 27)	GDA	54	541376	6459634	Open site	Valid	Artefact : -, Hearth : -		
	Contact	Recorders	Doctor.Rebecca Parkes,Lantern Heritage Pty Ltd - Tathra					Permits		
23-4-0701	(BH AFT 28) Zone 11 excavation	GDA	54	541073	6459774	Open site	Valid	Artefact : -		
	Contact	Recorders	Doctor.Rebecca Parkes,Lantern Heritage Pty Ltd - Tathra,Lantern Heritage Pty Ltd					Permits		
23-4-0702	Broken Hill (A-CAES) AFT 29 (BH Site 29)	GDA	54	540536	6460198	Open site	Valid	Artefact : -		
	Contact	Recorders	Doctor.Rebecca Parkes,Lantern Heritage Pty Ltd - Tathra					Permits		
23-4-0703	Broken Hill (A-CAES) AFT 30 (BH Site 30)	GDA	54	545035	6460519	Open site	Valid	Artefact : -		
	Contact	Recorders	Doctor.Rebecca Parkes,Lantern Heritage Pty Ltd - Tathra					Permits		
23-4-0704	Broken Hill (A-CAES) AFT 31(BH Site 31)	GDA	54	545516	6461065	Open site	Valid	Artefact : -		
	Contact	Recorders	Doctor.Rebecca Parkes,Lantern Heritage Pty Ltd - Tathra					Permits		
23-4-0705	Broken Hill (A-CAES) AFT 43 (BH Site 43)	GDA	54	545488	6461181	Open site	Valid	Artefact : -		
	Contact	Recorders	Doctor.Rebecca Parkes,Lantern Heritage Pty Ltd - Tathra					Permits		
23-4-0706	Broken Hill (A-CAES) AFT 42 (BH Site 42)	GDA	54	545491	6461139	Open site	Valid	Artefact : -		
	Contact	Recorders	Doctor.Rebecca Parkes,Lantern Heritage Pty Ltd - Tathra					Permits		
31-1-0725	Broken Hill (A-CAES) AFT 41 (BH Site 41)	GDA	54	541656	6459453	Open site	Valid	Artefact : -		
	Contact	Recorders	Doctor.Rebecca Parkes,Lantern Heritage Pty Ltd - Tathra					Permits		
31-1-0726	Broken Hill (A-CAES) AFT 40 (BH Site 40)	GDA	54	541585	6459507	Open site	Valid	Artefact : -		
	Contact	Recorders	Doctor.Rebecca Parkes,Lantern Heritage Pty Ltd - Tathra					Permits		
31-1-0727	Broken Hill (A-CAES) HTH 39 (BH Site 39)	GDA	54	541536	6459487	Open site	Valid	Hearth : -		
	Contact	Recorders	Doctor.Rebecca Parkes,Lantern Heritage Pty Ltd - Tathra					Permits		
23-4-0707	Broken Hill (A-CAES) AFT 38 (BH Site 38)	GDA	54	540916	6459882	Open site	Valid	Artefact : -		
	Contact	Recorders	Doctor.Rebecca Parkes,Lantern Heritage Pty Ltd - Tathra					Permits		
23-4-0708	Broken Hill (A-CAES) AFT/HTH 37 (BH Site 37)	GDA	54	540875	6459929	Open site	Valid	Artefact : -, Hearth : -		
	Contact	Recorders	Doctor.Rebecca Parkes,Lantern Heritage Pty Ltd - Tathra					Permits		
23-4-0709	Broken Hill (A-CAES) AFT 36 (BH Site 36)	GDA	54	540798	6459995	Open site	Valid	Artefact : -		
	Contact	Recorders	Doctor.Rebecca Parkes,Lantern Heritage Pty Ltd - Tathra					Permits		

Report generated by AHIMS Web Service on 27/03/2025 for Phillip Cameron for the following area at Lat, Long From : -32.0298, 141.3717 - Lat, Long To : -31.957, 141.4955. Number of Aboriginal sites and Aboriginal objects found is 66

This information is not guaranteed to be free from error omission. Heritage NSW and its employees disclaim liability for any act done or omission made on the information and consequences of such acts or omission.

Page 4 of 5

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : Wills St B Hill

Client Service ID : 989255

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status **	SiteFeatures	SiteTypes	Reports
23-4-0710	Broken Hill (A-CAES) AFT 35 (BH Site 35)	GDA	54	540781	6460067	Open site	Valid	Artefact : -		
	Contact	Recorders	Doctor.Rebecca Parkes,Lantern Heritage Pty Ltd - Tathra					Permits		
23-4-0711	Broken Hill (A-CAES) AFT 34 (BH Site 34)	GDA	54	540740	6460059	Open site	Valid	Artefact : -		
	Contact	Recorders	Doctor.Rebecca Parkes,Lantern Heritage Pty Ltd - Tathra					Permits		
23-4-0723	BHTW_AS1	GDA	54	538341	6462766	Open site	Valid	Artefact : -		
	Contact	Recorders	OzArk Environmental and Heritage Management - Dubbo,Mr.William Marris					Permits		

**** Site Status**

Valid - The site has been recorded and accepted onto the system as valid

Destroyed - The site has been completely impacted or harmed usually as consequence of permit activity but sometimes also after natural events. There is nothing left of the site on the ground but proponents should proceed with caution.

Partially Destroyed - The site has been only partially impacted or harmed usually as consequence of permit activity but sometimes also after natural events. There might be parts or sections of the original site still present on the ground

Not a site - The site has been originally entered and accepted onto AHIMS as a valid site but after further investigations it was decided it is NOT an aboriginal site. Impact of this type of site does not require permit but Heritage NSW should be notified

Report generated by AHIMS Web Service on 27/03/2025 for Phillip Cameron for the following area at Lat, Long From : -32.0298, 141.3717 - Lat, Long To : -31.957, 141.4955. Number of Aboriginal sites and Aboriginal objects found is 66

This information is not guaranteed to be free from error omission. Heritage NSW and its employees disclaim liability for any act done or omission made on the information and consequences of such acts or omission.

Page 5 of 5

Appendix B Unanticipated Find Protocol

The protocol to be followed in the event previously unrecorded or unanticipated Aboriginal object(s) are encountered during the proposed works is as follows:

- All ground surface disturbance in the area of the finds should cease immediately the finds are uncovered. With an appropriate buffer zone of at least 20 meters to allow for the assessment and management of the find. All site personal will be informed about the buffer zone with no further works to occur within the buffer zone.
- If the finds are of human remains, the environmental manager or other nominated senior staff member will contact the NSW Police on the non-emergency line (02) 131 444.
- A Heritage specialist will be engaged to assess the Aboriginal place or object encountered, representative(s) from the registered the Aboriginal Stakeholders for the Project may also be engaged to assess the cultural significance of the place or object.
- If the Aboriginal heritage places or objects are found to be covered under the existing approvals to impact Aboriginal heritage within the Study Area, works may continue to be conducted in accordance with mitigation measures and approval requirements.
- If the Aboriginal heritage places or objects are found to not be covered under the existing approvals to impact Aboriginal heritage within the Study Area, works will not recommence at the heritage place or object until advised to do so by Heritage NSW.
- If the heritage place or object can be managed in situ, works at the heritage location will not recommence until appropriate heritage management controls have been implemented, such as protective fencing.
- For historic relics, work must cease in the affected area and the Heritage Council must be notified in writing (heritagemailbox@environment.nsw.gov.au). This is in accordance with section 146 of the Heritage Act 1977.
- Depending on the nature of the discovery, additional assessment may be required prior to the recommencement of work in the area. At a minimum, any find should be recorded by an archaeologist.

Appendix F: EPBC Act National Heritage Place Significant Impact Assessment

F.1 Introduction

Under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), an action that has, will have, or is likely to have, a "significant impact" upon a matter of national environmental significance (MNES) must be referred to the Australian Government Minister for the Environment and Energy for approval.

The MNES include:

- world heritage properties
- national heritage places
- wetlands of international importance (listed under the Ramsar Convention)
- nationally threatened species and ecological communities
- migratory species (protected under international agreements)
- Commonwealth marine areas
- The Great Barrier Reef Marine Park
- Nuclear actions (including uranium mining)
- A water resource, in relation to coal seam gas development and large coal mining development.

F.2 Proposed Action

The proposed action involves the replacement of STP infrastructure at the Wills Street STP, installation of a new sewer pump station at South STP, the construction of a new rising main between the South STP and Wills Street, and the replacement of the existing discharge pipe from the Wills Street STP. Decommissioning of redundant STP assets at both Wills Street and South STP sites would follow.

F.3 MNES Relevant to This Proposal

Search of Australia's National Heritage List indicated the proposed action will take place within the City of Broken Hill, which has been listed as a National Heritage place under the EPBC Act. Details of the listed place are provided in **Table F1**.

Table F1: Matters of National Environmental Significance

Place Name	City of Broken Hill, Silver City Hwy, Broken Hill, NSW, Australia
List	National Heritage List
Class	Historic
Legal Status	Listed place (20/01/2015)
Place ID	105861
Place File No	1/04/370/0044

F.4 EPBC Assessments of Significance

The *Matters of National Environmental Significance Significant impact guidelines 1.1* (significant impact guidelines) specify that approval under the EPBC Act is required for any action occurring within, or outside, a National Heritage place that has, will have, or is likely to have a significant impact on the National Heritage values of the National Heritage place. An action is likely to have a significant impact on the National Heritage values of a National Heritage place if there is a real chance or possibility that it will cause:

- One or more of the National Heritage values to be lost, or
- One or more of the National Heritage values to be degraded or damaged, or
- One or more of the National Heritage values to be notably altered, modified, obscured or diminished.

An assessment of the proposed action against the National Heritage values of the City of Broken Hill is provided in **Table F2**.

F.5 Conclusion

The proposed action involves the replacement of STP infrastructure at the Wills Street STP, installation of a new pump station at the South STP, construction of a new rising main between the two STPs, and decommissioning of the old plant and equipment at each STP site. Amongst other things, the primary objectives of the proposal are to replace an asset at the end of its useful life with a modern facility with additional capacity, which will facilitate the retirement of the smaller South STP, and provide sufficient treatment to meet the NSW EPA effluent discharge and effluent reuse criteria. Based on the impact assessment presented in **Table F2**, it is unlikely that the proposal will result in the National Heritage Values of the City of Broken Hill being lost, degraded, damaged, notably altered, modified, obscured or diminished. Therefore, the proposal is not considered to have a significant impact upon a National Heritage place (i.e. relevant MNES) and there is no requirement for the proposal to be referred to the Australian Government Minister for the Environment and Energy for approval.

Table F2: Significant Impact Assessment

Approval under the EPBC Act is required for any action occurring within, or outside, a National Heritage place that has, will have, or is likely to have a significant impact on the National Heritage values of the National Heritage place.

The National Heritage List contains places or groups of places with outstanding heritage value to Australia – whether natural, Indigenous or historic, or a combination of these.

Significant impact criteria:

An action is likely to have a significant impact on the National Heritage values of a National Heritage place if there is a real chance or possibility that it will cause:

- one or more of the National Heritage values to be lost; or
- one or more of the National Heritage values to be degraded or damaged; or
- one or more of the National Heritage values to be notably altered, modified, obscured or diminished.

Criterion	Values Statement (summary)	Response
A **Events, Processes**	The City of Broken Hill contains one of the world's largest deposits of silver/lead/zinc ore bodies. The City of Broken Hill is an exciting geological area of national and international renown. It provides a window into 2,300 million years of Earth's history and has recorded the landscapes and geological environments which have evolved in response to eons of geo-chronologic changes. In the field of mineralogy, the Broken Hill deposit has achieved its widest international recognition as one of the world's great "mineralogical rainforests" with approximately 300 mineral species reliably confirmed from the ore body. The Broken Hill mines have played a decisive role in Australia's mining history and Australia's national development. The wealth and expertise generated by mining at Broken Hill over such a long period has contributed markedly to Australia becoming well known as one of the world's major providers of raw materials. Broken Hill has contributed several world ranking innovative mining and metallurgical practices which were to benefit later lead and zinc mines.	The proposed action will not take place within an area of identified ore body or impact on the operation of existing mines. The proposed action will not impact on the Broken Hill mines' role in Australia's mining history, or the wealth and knowledge they have generated. It is unlikely that the events and processes values of Broken Hill will be lost, degraded, damaged, notably altered, modified, obscured or diminished, as a result of the proposal.
B **Rarity**	Broken Hill is unique amongst Australian geological deposits for its mineralogical diversity. The secondary zone of the Broken Hill ore body contains an extensive array of extremely rare well-crystallised minerals, and unrecorded species continue to be found. The rarity of	The proposed action will not take place within an area of identified ore body or impact on the operation of existing mines. Construction, operation and

	Broken Hill's mineralogy is demonstrated by its mineral deposits and the records of the mining companies. Broken Hill is a rare example of a long established, almost continuously operated mining town, with a long industrial history and strong union representation. The industrial actions of unions focussed on protecting jobs, improving community amenity and achieving safe and healthy conditions for workers within the mining industry and for workers generally is at a level of intensity unmatched elsewhere in Australia. The architecture of Broken Hill buildings varies, with official buildings having recognisable NSW Government Architect characteristics, the residential buildings exhibiting design and construction characteristics derived from South Australia, and commercial buildings, such as hotels, show characteristics from Melbourne's late Victorian architectural period. Broken Hill is a rare example of a mining town where 'green belt' regeneration measures were researched, tested and implemented. From the 1930s onwards with the assistance of mining companies, the revegetation of denuded areas adjacent to its urban areas was trialled and shown effective in reducing the adverse effect of dust storms. Albert Morris tested native and exotic species for their capacity to survive arid and semi-arid conditions.	maintenance of the Wills Street STP replacement project will ensure the local sewage treatment infrastructure meets the current and future needs for City of Broken Hill. The modern plant will thereby support existing and future residential and commercial/industrial development of the city The proposal site is considered a disturbed and highly modified environment, encompassing two existing STP sites, and the proposed rising main route, which follows road reserves, as it traverses through industrial and commercial areas of the Kanandah Road and Pinnacles Place industrial areas and existing tracks as it passes through areas identified as grazing native vegetation and mining rehabilitation areas. Part of the rising main route passes through the Willyama common, making up part of the 'green belt'. However, the proposed route will predominately follow existing disturbed tracks, with vegetation disturbance minimised to the greatest extent possible. It is unlikely that the rarity values of Broken Hill will be lost, degraded, damaged, notably altered, modified, obscured or diminished, as a result of the proposal.
C **Research**	Broken Hill has important research potential for further investigation into its innovative mining practices, its mineralogy and geology, its history of unionism and development of safe mining practices, and its social characteristics.	The proposed action will not take place within an area of identified ore body or impact on the operation of existing mines.

	A large collection of mining records and associated material is available to provide information on the methods of construction and the economic reasons for developing and mining along the Line of Lode. This collection has the potential to contribute further to the technical advancement of mining. Mining and research on the Broken Hill ore body spans an exceptional 120 years, and previously unrecorded mineral species continue to be discovered. Scientific research continues to generate important outcomes including new concepts in ore genesis.	The proposed action will not impact on research or innovative mining practices in the area. It is unlikely that the research values of Broken Hill will be lost, degraded, damaged, notably altered, modified, obscured or diminished, as a result of the proposal.
D **Principal characteristics of a class of places**	Broken Hill demonstrates the principal characteristics of an evolving mining town. With populations ranging from its early beginning to approximately 35,000 in 1915, to its current population of approximately 20,000 it represents a typical example of mining town growth and contraction, depending on economic circumstances, metal prices, supply and demand, and competition. The principal characteristics also include changes to the geo-chronological environment; relict mining infrastructure and the ever-changing nature of the results of mining activity as mining processes change; the patterns of mining leases aligned to the Line of Lode ore body; an administrative and commercial service centre historically based on the mining industry but diversified to service extensive pastoral interests; provision of residential accommodation in proximity to work locations; and despite its remoteness, extensive road, rail and air transportation links to Sydney, Adelaide and Melbourne. The grid pattern town layout has shown itself to be robust and flexible, standing the test of time and responding to social and technological change over 124 years. The characteristics that represent a mining town are also represented by continuing mining operations and their ever-changing nature, the remaining gossan outcrops of the Line of Lode, its relict mining infrastructure, all modes of road and rail transport infrastructure and its role as a centre for the Royal Flying Doctor Service.	The proposed action will not take place within an area of identified ore body or impact on the operation of existing mines. The proposed action involves the replacement of STP plant and equipment at the Wills Street STP, a new pump station at the South STP, construction of a new rising main between the two STPs, and decommissioning of the old plant and equipment at each STP site. The proposed action will not impact on extensive road, rail and air transportation links and will not impact on the grid pattern layout of the town. It is unlikely that the values associated with the principal characteristics of a class of places of Broken Hill will be lost, degraded, damaged, notably altered, modified, obscured or diminished, as a result of the proposal.
E **Aesthetic characteristics**	The distinctive aesthetic qualities of the Broken Hill include the mining landscape and the remaining bulk and scale of the Line of Lode with its relict mining infrastructure dominating and in such close proximity to the surrounding townscape, all set in a vast, arid landscape. This visual representation of mining activity on the surface and the barren character of the	The proposed action will not take place within an area of identified ore body or impact on the operation of existing mines.

	remaining mullock dumps identifies the physical location of the Line of Lode and the below surface mining of the layered mineral deposits. Broken Hill is a visually cohesive town with late Victorian and Federation era administrative and commercial buildings reflecting the mining wealth, and an unusually uniform and singular scale of residential housing with pockets of 'tin' architecture. The aesthetic urban qualities contrast with the surrounding belts of revegetated countryside, all set in an arid desert landscape in which the vivid colours, brilliant light and vast horizons stretch well beyond the city. The contrast between the built up area and the dominating arid desert landscape is heightened by the sharp, orthogonally distinctive abrupt urban edge. Broken Hill is a popular centre for artists, poets, film-makers and TV producers and is recognised as a major focus for artistic endeavour. The aesthetic significance of Broken Hill is demonstrated by: the dramatic and spectacular but ever-changing landscape form and the still massive scale of the barren mullock dumps along the Line of Lode so close to the central business area of the city; the design qualities of the streetscapes; the distinctive character of existing and relict mining infrastructure; and the unusual visual qualities of 'tin' residential and mining architecture.	The proposed action will not impact upon any of the Victorian and Federation era administrative and commercial buildings of the City of Broken Hill, or areas of residential housing of the City of Broken Hill, and will not impact upon the contrast between the built up area and surrounding desert landscape and belts of revegetated countryside. The proposed action involves the replacement of STP plant and equipment at the Wills Street STP, a new pump station at the South STP, construction of a new rising main between the two STPs, and decommissioning of the old plant and equipment at each STP site. It is unlikely that the proposal will significantly alter the landscape characteristics or aesthetic significance of Broken Hill. Similarly, it will not impact Broken Hill's ability to be a major focus for artistic endeavour. It is unlikely that the aesthetic characteristic values of Broken Hill will be lost, degraded, damaged, notably altered, modified, obscured or diminished, as a result of the proposal.
F **Creative or technical achievement**	Over many years Broken Hill has been the source of much of the world's knowledge on the extraction of minerals and the application of scientific method to separate minerals from the base ore. Broken Hill research and development expertise spread into major metalliferous and coal mining, engineering, chemical and manufacturing industries, notably the steel industry, lead smelting and the electrolytic zinc smelting process. These technological advances also had application for refractories, and for other industrial processes such as timber milling, the	The proposed action will not impact on knowledge on the extraction of minerals and the application of scientific method to separate minerals from the base ore, nor the ability for the development expertise to spread into major metalliferous and coal mining,

	production of paper, the manufacture of fertilisers, and cement, as well as for shipping and aircraft. The work of Albert Morris, eventually supported by mine management, in researching, validating and subsequently implementing regeneration measures to protect both the residential and mining areas from devastating dust storms is a major technical achievement. His work, recognised nationally and internationally, is evident in the 'green belt' surrounding Broken Hill.	engineering, chemical and manufacturing industries. The proposal site can be considered a disturbed and highly modified environment. The proposed action will not have a long-term negative impact on any identified areas of 'green belt' that surround Broken Hill. It is unlikely that the creative or technical achievement values of Broken Hill will be lost, degraded, damaged, notably altered, modified, obscured or diminished, as a result of the proposal.
G **Social value**	The City of Broken Hill is valued for its strong community spirit, self-reliance, and for exhibiting the resilience of a remote inland community. For the Australian community, Broken Hill symbolises the importance of the Broken Hill mines to the wealth of Australia. Broken Hill also symbolises the challenges and remoteness of the outback, which is a defining element for the community. The steep, barren and dominating mullock heaps, tailings, skimps and slagheap along the Line of Lode and the remnant outcrops of the Line of Lode gossan are highly valued by the community as the industrial and economic heart of the city, and as the reason for Broken Hill's existence. There is a deep, enduring and shared link between the existing community, past residents and the 'city in the desert'. This strength, depth and long-held connection between the community and the place Broken Hill and its outback landscape is made tangible by: its remoteness; the design and landscaping of the town with its 'oasis' like character and regeneration areas; an appreciation of the distinctive residential 'tin' architecture recalling the harsh living conditions; and the murals, public art and memorials located throughout the urban area. The social value of Broken Hill is represented by pride in being a Broken Hill resident; the continuous and ongoing mining operations; the adaptation of mining facilities for re-activated or new mining operations; and the resilience of the community to adapt to change and deal with its remoteness in times of adversity.	The proposed action will not negatively impact upon the sense of community and self-reliance of a remote inland community. The proposal will ensure the local sewage treatment infrastructure meets the current and future needs for the City of Broken Hill. The modern plant will thereby support existing and future residential and commercial/industrial development of the city It is unlikely that the proposed action will significantly alter the landscape characteristics or aesthetic significance of Broken Hill. The proposed action will not impact upon any of the Victorian and Federation era administrative and commercial buildings of the City of Broken Hill. It is unlikely that the social values of Broken Hill will be lost, degraded,

		damaged, notably altered, modified, obscured or diminished, as a result of the proposal.
H **Significant people**	The City of Broken Hill is important for its associations with many individuals who have played a prominent role in the Australian mining industry. Significant people include the lode's discoverer, Charles Rasp; engineer and metallurgist GD Delprat; the American mining engineer Herbert Hoover; Australian industrialists WL Baillieu, WS Robinson and MAE Mawby, union organisers Percy Brookfield and Eugene O'Neill and environmentalist Albert Morris. As a group, the Barrier Industrial Council is also important for its association with Broken Hill. The significance of important people and groups is represented by their association with mining the Line of Lode, ongoing mining operations, relict mining infrastructure, mining leases, local government and mining records, Barrier Industrial Council records, regeneration areas and BHCC records.	The proposed action will not impact upon the associations with many individuals who have played a prominent role in the Australian mining industry. The proposed action will not take place within an area of identified ore body or impact on the operation of existing mining operations. It is unlikely that the values associated with significant people of Broken Hill will be lost, degraded, damaged, notably altered, modified, obscured or diminished, as a result of the proposal.

Appendix G: Compliance with the Principles of the Crown Land Management Act

This Appendix documents the proposal's compliance with the six 'principles of Crown land management' as set out in section 1.4 of the *Crown Land Management Act 2016*.

PRINCIPLES OF CROWN LAND MANAGEMENT	COMPLIES?	COMMENTS
a) that environmental protection principles be observed in relation to the management and administration of Crown land	Yes	Essential Water (through Energy Energy) utilises the services of an environmental senior specialist and all environmental protection principles are observed and considered during management and administration of Crown land, as is reflected in the proposal's REF.
b) that the natural resources of Crown land (including water, soil, flora, fauna and scenic quality) be conserved wherever possible	Yes	The route of the proposed rising main, passes through two portions of Crown Land. In both cases the land is considered a highly disturbed and modified environment due to the construction of existing tracks, and/or installation of existing pipelines and other underground services. The proposed works will involve site disturbance through civil works, primarily by trenching for the installation of the new rising main. Disturbed areas will be managed in accordance with the requirements of the Blue Book to minimise potential impacts to waterways. Trenching work will temporarily disturb ground cover and low growing vegetation, which will be allowed to reestablish post construction. No threatened species, EECs or waterways are likely to be significantly impacted. It is unlikely the proposed, predominately underground pipeline, will have any long-term visual impacts. The impact of the proposal on the natural resources of Crown land will be minimal.
c) that public use and enjoyment of appropriate Crown land be encouraged	Yes	The infrastructure itself is a benefit to the public as it will enable the upgrade of the local sewage treatment and sewage reticulation network, which will ensure the local infrastructure meets the current and future needs, whilst minimising adverse environmental impacts and maximising positive social and economic benefits. The proposed rising will be installed below ground on already disturbed land, which will be reinstated once works are complete. The area around the easement is available for public use and is not utilised by Essential Water.
d) that, where appropriate, multiple use of Crown land be encouraged	Yes	All areas of trenching will be reinstated once work is complete, with disturbed areas allowed to re-establish post construction.
e) That, where appropriate, Crown land should be used and managed in such a way that both the land and its resources are sustained in perpetuity	Yes	The principles of Ecologically Sustainable Development (ESD) are incorporated into Essential Energy's policies and designs. The proposed works are located on already disturbed and modified land, which avoids potential impacts associated with development of a greenfield site. The impact of the proposal on the land and its resources will be minimal.

f)	that Crown land be occupied, used, sold, leased, licensed or otherwise dealt with in the best interests of the State consistent with the above principles	Yes	The proposal is vital to the safe and reliable operation of Essential Water's sewage treatment and sewerage reticulation networks, which is an outcome that is in the best interests of the State.

essential-energy
EssentialEnergyAU
essential_au
essentialenergytv

essentialenergy.com.au

Essential Energy