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Engineering

Stormwater Management Plan

Proposed Industrial Subdivision

Property:
Lot 1 DP1260203
John Renshaw Drive, Black Hill

Applicant:
Broaden Management Pty Ltd

Date:
October 2021

Working Beyond Expectations

Project Management • Town Planning • Engineering • Surveying
Visualisation • Economic Analysis • Social Impact • Urban Planning

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Document Control Sheet

Issue No.	Amendment	Date	Prepared By	Checked By
A	Final	03/08/2018	MKN	LG
B	Revised drawings	14/08/2018	MKN	LG
C	Updated applicant name	17/08/2018	MKN	LG
D	Revised lot layout	05/08/2021	MKN	LG
E	Revised lot layout	14/10/2021	MKN	RK

Limitations Statement

This report has been prepared in accordance with and for the purposes outlined in the scope of services agreed between ADW Johnson Pty Ltd and the Client. It has been prepared based on the information supplied by the Client, as well as investigation undertaken by ADW Johnson and the sub-consultants engaged by the Client for the project.

Unless otherwise specified in this report, information and advice received from external parties during the course of this project was not independently verified. However, any such information was, in our opinion, deemed to be current and relevant prior to its use. Whilst all reasonable skill, diligence and care have been taken to provide accurate information and appropriate recommendations, it is not warranted or guaranteed and no responsibility or liability for any information, opinion or commentary contained herein or for any consequences of its use will be accepted by ADW Johnson or by any person involved in the preparation of this assessment and report.

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Executive Summary

ADW Johnson has been engaged by Broaden Management Pty Ltd to prepare a Stormwater Management Plan (SWMP) to address the stormwater management requirements of a proposed forty lot industrial development within the Black Hill Urban Release Area. This report accompanies a development application for the intended subdivision.

The Stormwater Management Plan specifically addresses both stormwater quantity and quality outcomes for the proposed development. Additionally, it presents a flood study undertaken for the watercourses which convey through the development site.

It is proposed that On-Site Detention (OSD) controls be provided on each developed lot to limit their peak discharge to less than or equal to their predeveloped magnitude. A stormwater routing model was created using the XPRAFTS software to calculate the peak discharge rates under pre-developed and post developed site conditions. Modelling indicates that the provision of OSD sufficiently retards peak flows discharging from the site.

Similarly, individual lots shall incorporate Water Sensitive Urban Design (WSUD) controls in accordance with Council's Development Control Plan. Stormwater treatment devices were modelled generically in MUSIC but may include a combination of rainwater tanks, open basins, and pit screens. Using MUSIC, a water quality treatment train comprising generic allotment controls and gross pollutant traps was shown to meet pollutant reduction targets for the site overall.

The specific configuration of OSD and WSUD controls should be the subject of future applications to appropriately reflect the nature of each lot's eventual use.

The river profiling software HEC-RAS was used to determine the flood extents of watercourses within the subject site. Modelling indicated that roads and lots created by the proposed development are above the 1% AEP flood extents. In conjunction with HEC-RAS simulations, two culvert road crossings and one channel within the development have been sized to convey the 1-in-100-year peak flow. The capacity of an existing twin-cell box culvert beneath John Renshaw Drive has also been verified.

An Erosion and Sediment Control Plan is provided which details controls and practices to manage and contain pollutant runoff during construction in accordance with Landcom's 'Blue Book' and Cessnock City Council's DCP.

The details and information presented in this Stormwater Management Plan confirm that the proposed subdivision can satisfy Council's requirements in relation to stormwater attenuation, runoff quality, flooding, and erosion and sediment control.

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1.0 Introduction

ADW Johnson has been engaged by Broaden Management Pty Ltd to prepare a Stormwater Management Report addressing the stormwater management and flooding requirements for a proposed industrial subdivision of Lot 1 DP1260203, Black Hill ('the site'). This report accompanies a development application for the intended subdivision which shall include:

- Thirty-eight new industrial lots ranging from 1.9 hectares to 6.4 hectares;
- One electrical substation lot; and
- Approximately 41 ha of E2 Environmental Conservation land.

The site is the subject of the Black Hill Urban Release Area (URA) established April 2017. It is bounded by the existing Beresfield industrial estate to the northeast, John Renshaw Drive to the north and Black Hill Road to the south. The eastern adjoining property, located within the Newcastle City Council LGA, holds an approval for an industrial development.

The location and extents of the subject site are shown in ***Figure 1***.

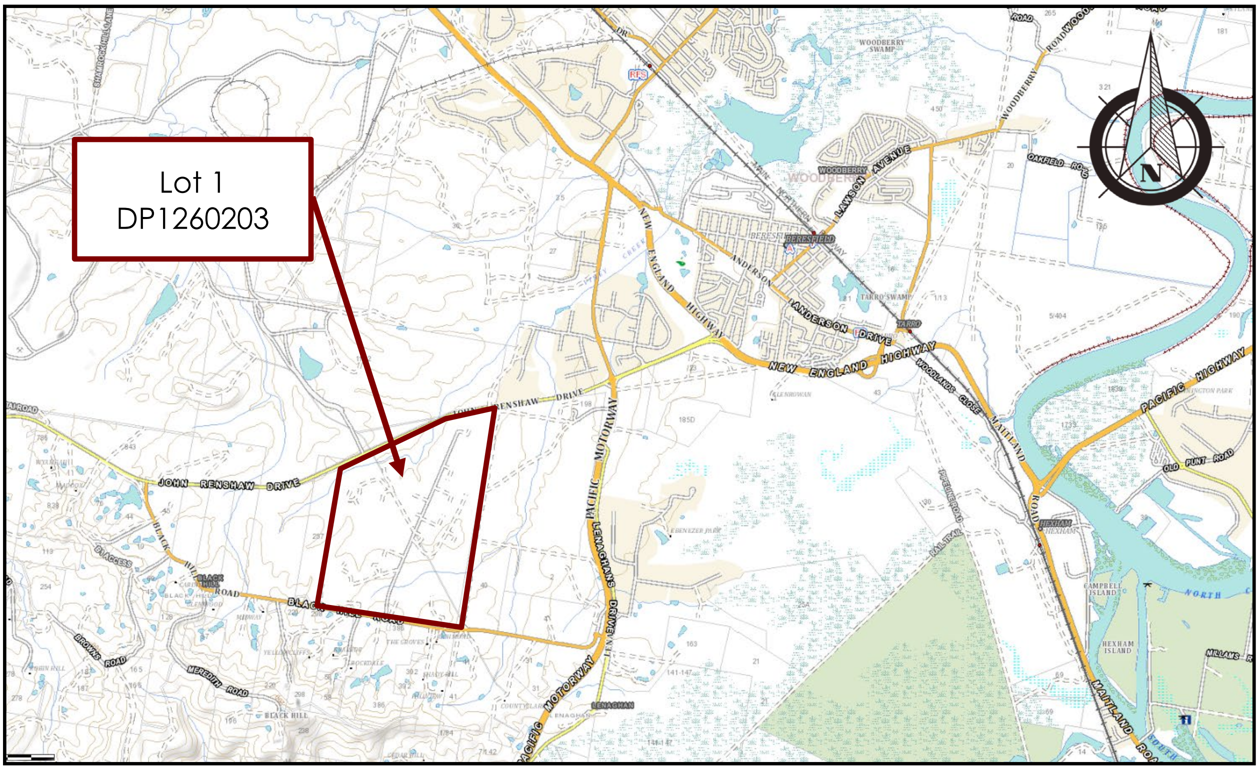

Figure 1 - Site Locality.
(Source: https://maps.six.nsw.gov.au/)

2.0 Site Description

2.1 EXISTING SITE

The site is located on John Renshaw Drive at Black Hill within the Cessnock LGA. Lot 1 DP1260203 has a total area of approximately 300 hectares, 175 of which is zoned for industrial development. The residual lot comprises E2 Environmental Conservation land to the north and E4 Environmental Living Land to the south.

The subject site was used by Steggles for intensive poultry farming until operations ceased in 2003. As a result of the lot's previous occupation, much of the site has been cleared and predominantly comprises grassland with denser vegetation present in copses and along corridors. Topography is generally undulating and slopes towards watercourses at approximately 2-5 percent, with regionalised flat areas where previous earthworks have been undertaken.

The site is presently used for cattle grazing and rural-residential occupation. It is subject to infrastructure easements, notably for electrical transmission lines and a water main.

Previous geotechnical investigations noted the prevalence of fill overlying residual clay and shale bedrock (Douglas Partners 2017). It is therefore expected that soils are moderately infiltrative.

2.2 EXISTING DRAINAGE

Three principal tributaries of Weakleys Flat Creek converge within the subject site and convey water flows to the north. Weakleys Flat Creek converges with Viney Creek approximately 1500m downstream of the site, which ultimately discharges to the Hunter River. At its point of discharge from the site, Weakleys Flat Creek receives a total catchment of approximately 290 hectares.

The eastern portion of the site drains eastwards to a channel within the adjoining property (Lot 30 DP870411). The channel receives a total catchment of approximately 42 hectares: 26 hectares from the subject site; 15 hectares from the adjoining property; and 1 hectare of John Renshaw Drive. Channel flows are conveyed beneath John Renshaw drive via a culvert and ultimately flows northward into Viney Creek.

Figure 2 presents the Strahler hierarchy of watercourses. From ***Figure 2*** it is seen that Weakleys Flat Creek is a 2nd order stream with 1st order tributaries within the site.

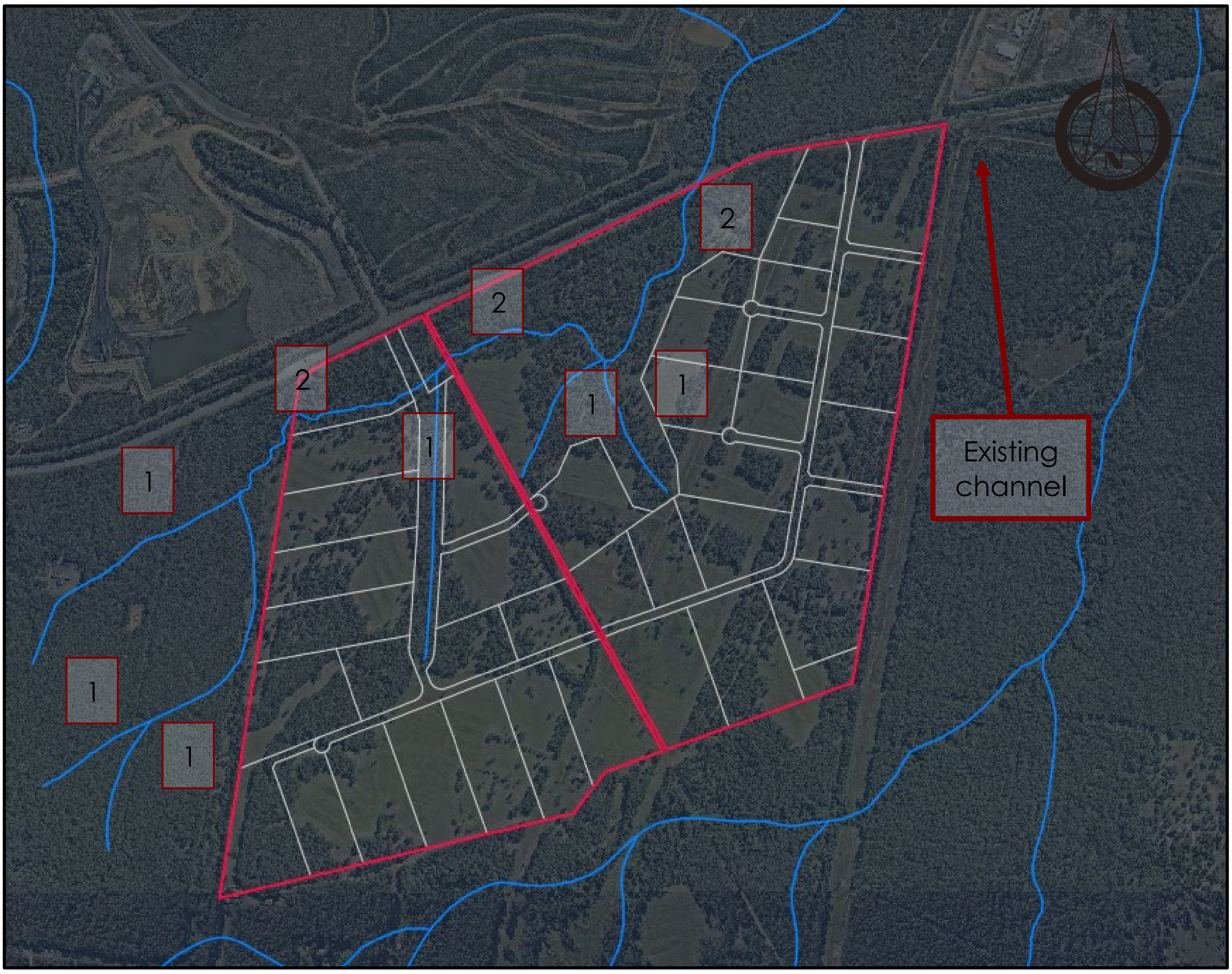

Figure 2 - Hierarchy of Watercourses.

The majority of the site drains freely to the watercourses shown in ***Figure 2***, noting the exception several small farm dams which would be decommissioned during the intended works. Riparian corridors are dense with highly disturbed vegetation and are dominated by exotic species, a likely result of farming practices and nutrient loading during its use as a poultry farm. Watercourses, though well-defined, are characterised by significant overgrowth and woody debris.

With reference to the topographic and geotechnical conditions described in ***Section 2.1***, it is evident that the site's hydrologic regime is dominated by surficial runoff into distinct watercourses. It is imperative that the adopted stormwater management strategy is sympathetic to these existing hydrologic conditions.

2.3 EXISTING DRAINAGE INFRASTRUCTURE

As described in ***Section 2.2***, there are two concentrated points of discharge from the north of the site. Weakleys Flat Creek is conveyed beneath John Renshaw Drive by a twin cell rectangular box culvert as shown in ***Figure 3***. A site investigation has confirmed each cell to be approximately 3.3m tall and 3.6m wide.

Figure 3 – Rectangular box culvert beneath John Renshaw Drive.

The box culvert receives stormwater flow from not only the Weakleys Flat catchment, but also road water from the westbound lane of John Renshaw Drive which is collected by a concrete dish drain.

The channel to the site's east discharges under John Renshaw Drive via a 1200 mm circular culvert as shown in ***Figure 4***.

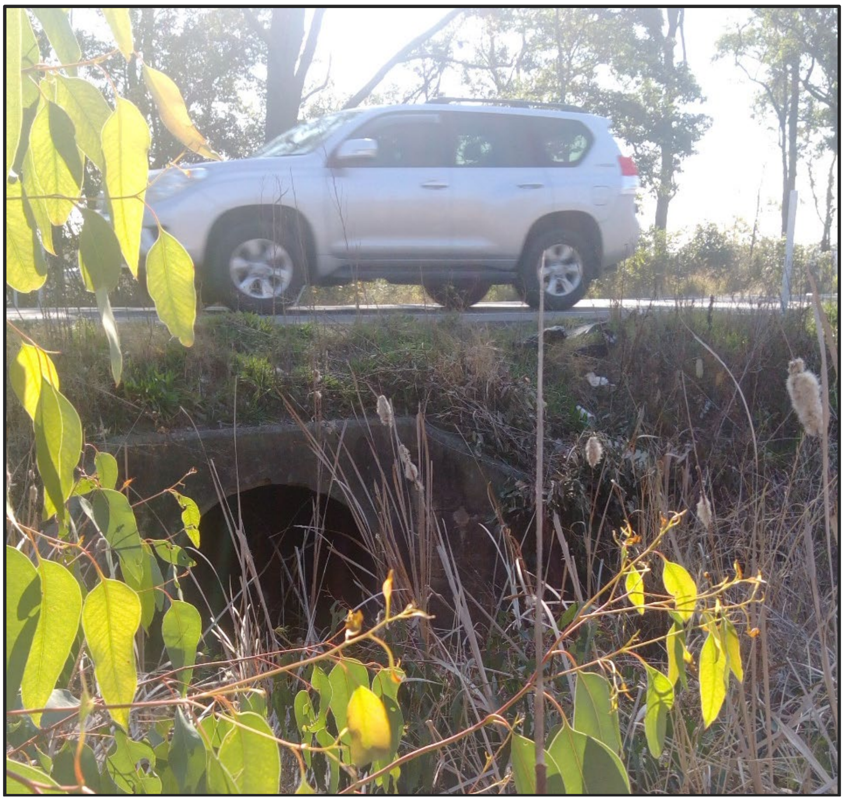

Figure 4 – Circular culvert beneath John Renshaw Drive.

A depression at the upstream end of the culvert receives flow from the channel via three 525mm stormwater pipes as shown in ***Figure 5***. The culvert also receives road water from John Renshaw Drive via an existing swale which terminates in a concrete dish drain as shown in ***Figure 6***.

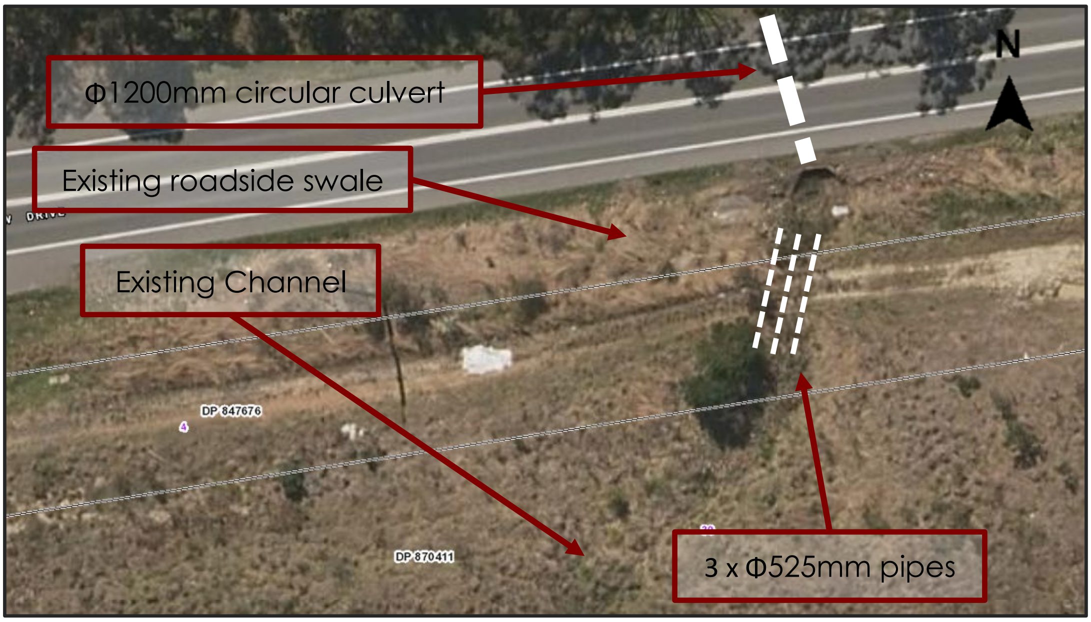

Figure 5 - Hydraulic infrastructure east of the site.
(Source: https://maps.six.nsw.gov.au/)

Figure 6 - Existing swale and concrete dish drain in John Renshaw Drive.

2.4 PROPOSED DEVELOPMENT

The Black Hill Urban Release Area (URA) includes the subject site exclusively as shown in ***Figure 7.***

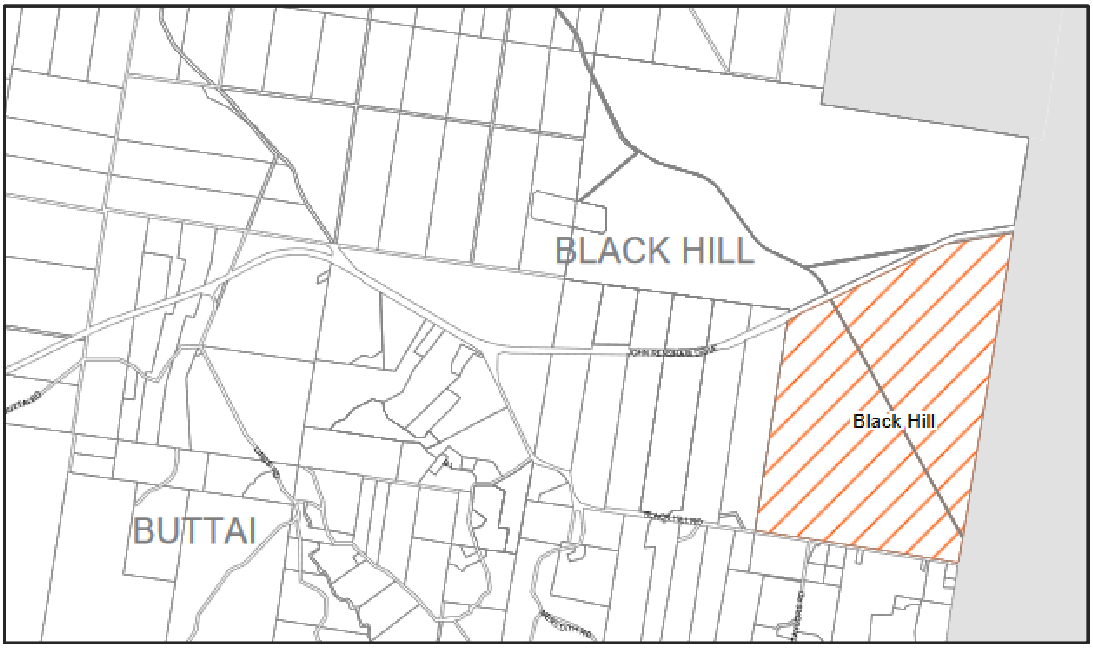

Figure 7 – Black Hill Urban Release Area.
(Source: CLEP 2011 (updated April 2017))

As described in ***Section 1***, the site is intended for subdivision creating thirty-eight industrial lots, one electrical substation lot and one E2 Environmental Conservation lot. Although the specific use of each industrial lot is not presently known, the Black Hill URA is well suited to typical industrial land uses such as warehousing, freight and engineering. Proposed industrial lots are located centrally within the subject site, with residual land to the north retained for environmental conservation. There is a separate and pending development application for subdivision of the E4 Environmental Living land which occupies the southern portion of the site.

The development will be supported by typical civil infrastructure including roads, water and sewer reticulation and other services. Stormwater management infrastructure associated with the development will incorporate a conventional pit-and-pipe drainage network discharging to watercourses described in ***Section 2.2***. A 1st order stream is intended for realignment parallel to the western access road and is described in detail in ***Section 6***. Finally, the development will require two culvert crossings.

The proposed development is shown conceptually in ***Figure 8*** below.

Figure 8 – Proposed Development.

3.0 Council Requirements

Cessnock City Council outlines the engineering requirements for stormwater management within their *'Stormwater Drainage Design'* (2010) and *'Cessnock Development Control Plan'* (2010). It is noted that the Black Hill URA does not impose an area-specific DCP.

3.1 STORMWATER DETENTION

A stormwater detention system must ensure that the limits of downstream (and upstream) flooding are not increased by the development for design storms ranging from the 63.2% AEP (1-year ARI) to the 1% AEP. Conformance with this requirement is evaluated by comparing peak discharges from the predeveloped and developed site using hydrologic routing.

3.2 STORMWATER QUALITY

Council's DCP requires that all subdivisions take account of the principles of environmental sustainability and encourages environmental buffers. With reference to stormwater management, the proposed development should incorporate water quality improvement devices to reduce pollutant loads entering receiving watercourses. Pollutant reduction targets have been adopted from Australian Runoff Quality (ARQ) 2006 guidelines and are presented in ***Table 1*** below.

Table 1 - Water Quality Targets

Pollutant	Targets
Total Suspended Solids (TSS)	80% of average annual load
Total Phosphorus (TP)	45% of average annual load
Total Nitrogen (TN)	45% of average annual load

3.3 FLOODING

Each allotment created by the subdivision must include flood-free land for building sites. The major drainage network, including watercourses and hydraulic structures (existing and proposed), should be designed to accommodate the 1% AEP peak flow.

Being a high-hazard area, the proposed channel (parallel to the entry road) must be designed with 0.2m freeboard above the peak 1% AEP stage and a velocity-depth product not exceeding 1m^2/s. Flow velocity within vegetated channels must also be limited to below 1.5m/s. These requirements are defined by Council's *Engineering Requirements for Development (Stormwater Drainage Design)*.

Assessment of proposed and existing culverts must account for entry blockages in accordance with Australian Rainfall & Runoff (ARR) 2016.

3.4 EROSION AND SEDIMENT CONTROL

Erosion and Sediment Control (ESC) is to be undertaken according to Landcom's *Blue Book* (2004) and Council's DCP. The intent of this requirement is to mitigate erosion and prevent sediment-laden run-off from leaving the site during site preparation and construction.

4.0 Stormwater Strategy

As discussed in ***Section 2.1***, the existing hydrology is characterised by surficial runoff into well-defined watercourses, with catchments clearly demarcated by ridgelines. Whilst noting that most of the site is already in a highly disturbed state, minimising impact on the natural hydrologic behaviour of catchments is a fundamental principle of Water Sensitive Urban Design (WSUD) (Landcom 2010). Moreover, ecological outcomes for the site's residual environmental land are highly dependent on effective stormwater management of the development itself.

Subsequently, concept road and earthworks design has been sympathetic to the existing catchment topography. Lots are graded to discharge to tributaries generally consistent with their predeveloped conditions to ensure that watercourses are not significantly over or underwhelmed by stormwater flows.

There are two points of legal discharge from the proposed development. The majority of the site drains to tributaries of Weakleys Flat Creek which conveys under John Renshaw Drive via a twin-cell box culvert. A smaller development catchment will report to and integrate with the stormwater drainage system of the approved adjoining industrial estate. As shown in ***Figure 9***, the approved adjoining development will formalise the existing channel described in ***Section 2.3***, and will be sized to accommodate its existing upstream catchment.

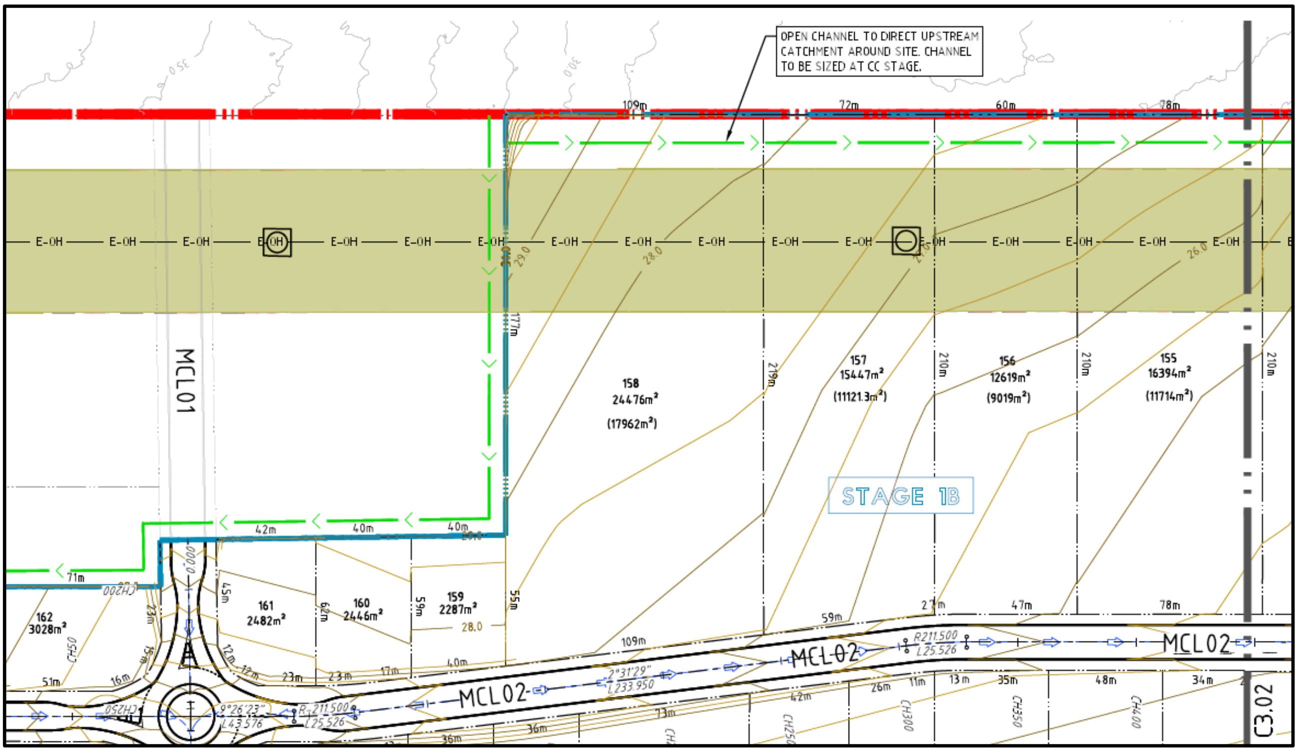

Figure 9 – Adjoining Development Stormwater Drainage.
(Source: Northrop 2020)

It is noted from ***Section 2.3*** that the specific use and intensification of individual allotments is presently unknown. The hydrologic behaviour of each lot will be a function of its impervious fraction, rainwater harvesting requirements and building envelopes; in turn, these are functions of each lot's industrial application. It follows that the best outcome for the development overall would be achieved by tailoring the stormwater management strategy for each created lot to its eventual configuration. This would be the subject of future applications.

This stormwater management strategy has therefore been developed assuming that On-Site Detention (OSD) and water quality controls will be provided for each lot in accordance with the objectives established in ***Section 3***. The focal point of this study is communal infrastructure including proposed and existing channels and culverts, as well as the flooding behaviour of Weakleys Flat Creek and its tributaries.

Importantly, this stormwater management plan does not propose stormwater detention for internal roads. The design philosophy, described in further detail in ***Section 5***, is to allow road water to drain freely into receiving tributaries, discharging from the site before the arrival of peak flows arising from developed lots and upstream catchments. Gross Pollutant Traps (GPTs) are proposed to ensure that water quality requirements are similarly satisfied prior to discharge from the site.

It is proposed that flow beneath the proposed entry road from John Renshaw Drive be conveyed by a multi-cell rectangular box culvert; however, provided similar clear area is achieved, a spanning or piered bridge should not be precluded as an alternative.

A vegetated trapezoidal open channel has been sized to convey road and lot runoff from the westernmost extent of the development. The channel shall include a low flow section and appropriate safety provisions.

Stormwater Management Plans for the proposed development may be found in ***Appendix A***.

5.0 Stormwater Detention

The proposed development will increase the catchment's impervious area and therefore contribute to additional stormwater runoff. Using the runoff routing model XPRAFTS, this section details how on-site stormwater detention controls will attenuate stormwater flows and from the site in accordance with Council's requirements.

5.1 MODELLING PARAMETERS

5.1.1 Rainfall Intensity

The Rainfall Intensity Frequency Duration (IFD) data adopted was sourced from the Bureau of Meteorology website. The catchment was modelled using ARR 2016 IFD data as it captures meteorological conditions more effectively than the superseded 1987 IFD data.

5.1.2 XPRAFTS Parameters

Values for Manning's n were selected for each catchment's specific surface type, noting the prevalence of grassland and brush within the subject site, and the heavy stand of timber existing upstream. Lag times for each catchment were initially computed assuming a catchment flow of one metre per second, then revised following flood simulation (refer to ***Section 6***).

Rainfall loss models for the catchments predeveloped and develops states are summarised in ***Table 2*** below.

Table 2 – Initial and Continuing Losses

Condition	Initial loss (mm)	Continuing loss (mm/h)
Pervious	5	2.5
Impervious	1	0

In accordance with Council's drainage design requirements, a β_x value of 1.1 was adopted to calibrate the predeveloped catchment model to an equivalent rational method calculation. The parameters utilised within the XPRAFTS model are provided in full detail in ***Appendix B.***

5.2 CATCHMENTS

Catchments and subcatchments were delineated by analysis of the topographical survey information (LiDAR) and concept engineering plans. Predeveloped and developed catchment plans are provided in ***Appendix A***.

5.2.1 Predeveloped Catchment

The predeveloped catchment was assumed to be wholly pervious which conservatively neglects the presence of remaining site structures as well as John Renshaw Drive to the north. Overall, it was found that a catchment of approximately 299 hectares drains to the box culvert over Weakleys Flat Creek, and 42 hectares drains to the existing channel to the east.

5.2.2 Developed Catchment

In accordance with Cessnock Council's '*Stormwater Drainage Design*', an impervious fraction 85% was assumed for all roadways and industrial land. The developed subcatchment areas were determined utilising the proposed site grading plan and concept stormwater layout presented in the concept engineering plans.

In total, it was found that a catchment of approximately 310 hectares drains to the box culvert in the developed state, representing a modest increase of less than four percent. As evident in the catchment plans presented in ***Appendix A***, the 11-hectare increase in total catchment area can be attributed to regrading of lots in the development's southwestern corner. The catchment area draining to the eastern adjoining channel remains unchanged at 42 hectares.

5.3 ON-SITE DETENTION

As discussed in ***Section 4***, it is proposed that OSD is provided on created allotments with the intention of attenuating peak flows to their equivalent predeveloped magnitudes. The individual configuration of OSD controls will vary according to eventual land use, rainwater reuse rates and spatial arrangement of each lot. Subsequently, dictation of how each lot meets stormwater attenuation targets shall be the subject of further reporting to support development applications for industrial land use. Notwithstanding, it is envisaged that developed lots will incorporate any or all of the following controls:

1. **Rainwater tanks** – the installation of rainwater tanks would facilitate the harvesting and reuse of rainwater for irrigation, toilets, bathrooms and fire tank replenishment, such that tanks are rarely at full capacity. It follows that rainwater tanks would rarely be full and therefore provide an important secondary function of detaining stormwater flows. Reuse rates are dependent on lot-specific factors such as roof areas, landscaping requirements and inhabiting staff, and tanks should be sized accordingly;

2. **Stormwater detention basins** – open basins will either occupy the lot frontage or be positioned at rear-of-lot. Outlets shall integrate with street drainage infrastructure or tail out to receiving watercourses; and

3. **Underground storage tanks** – Depending on lot configuration and use, there may be preference to implement underground storage tanks as well as (or instead of) open basins.

Detained lots have been modelled conceptually in XPRAFTS by adopting their respective predeveloped catchment parameters and a 0% impervious fraction.

5.4 ATTENUATION OF ROAD WATER FLOWS

It was noted by modelling the predeveloped catchment that peak flows at both points of discharge were generally observed during longer-duration design storms. Subsequently, road water from the development has been allowed to drain freely, allowing for passage of its discharge peak before the arrival of the catchment's peak flow overall. To illustrate this effect, ***Figure 10*** below compares the predeveloped and developed hydrographs at the discharge point to the site ('Outlet 2') for the critical (120 minute) 10% AEP storm.

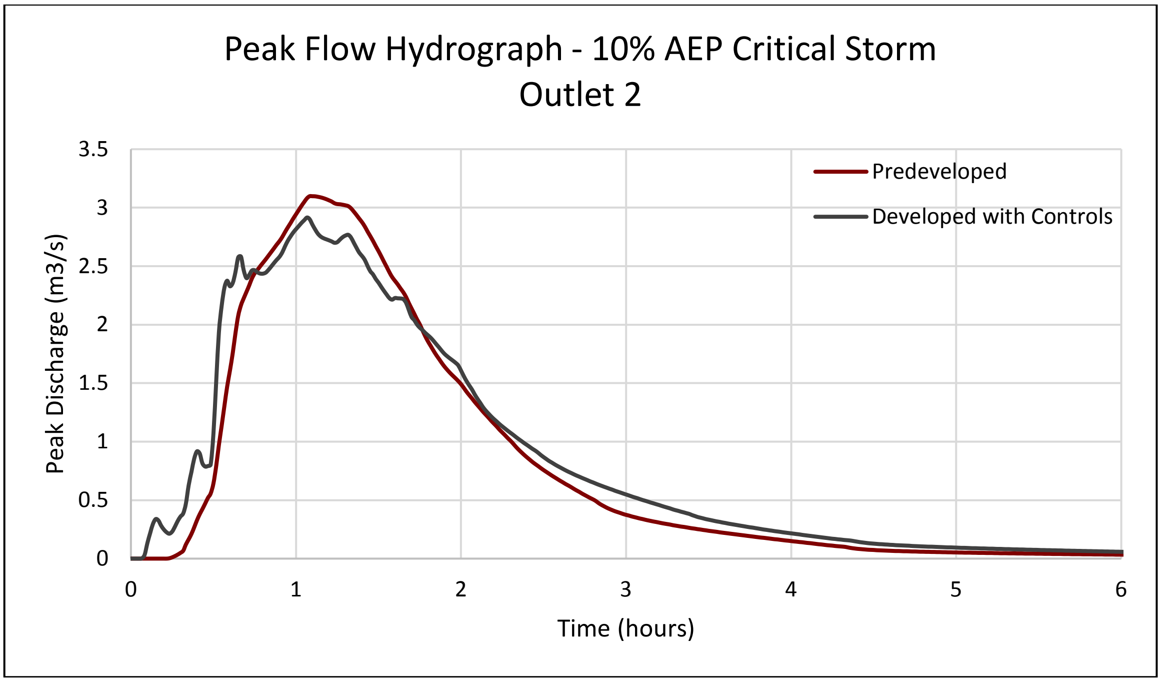

Figure 10 - 10% AEP Peak Flow Hydrograph at Outlet 2.

From ***Figure 10*** it is seen that high early discharge from the impervious pavement has disrupted the flood peak, resulting in a lower maximum flowrate overall. This was the principal motivation for not attenuating road water from the proposed development.

5.5 STORMWATER DETENTION RESULTS

The predeveloped, developed and detained peak flows were computed using XPRAFTS for AEPs ranging from 63.2% (1-year ARI) to 1%. The results of this exercise are summarised in ***Tables 3*** and ***4*** below.

Table 3 - Stormwater Detention Results at Outlet 1 (box culvert)

Storm Event (AEP)	Peak Discharges (m3/s)		
	Predeveloped	Developed (w/o OSD)	Developed (with OSD)
63.2% (1-year ARI)	8.3	12.3	8.3
39.3% (2-year ARI)	12.0	16.3	11.8
10%	18.8	24.1	18.3
5%	22.2	26.1	21.6
1%	28.9	33.5	28.0

Table 4 - Stormwater Detention Results at Outlet 2 (Adjoining drainage system)

Storm Event (AEP)	Peak Discharges (m3/s)		
	Predeveloped	Developed (w/o OSD)	Developed (with OSD)
63.2% (1-year ARI)	1.4	4.7	1.4
39.3% (2-year ARI)	2.1	6.1	2.0
10%	3.1	8.8	3.1
5%	3.7	10.2	3.6
1%	5.2	12.3	4.8

From ***Tables 3*** and ***4*** it can be seen that provision of OSD reduced peak flows at both outlets to less than their predeveloped magnitudes. It is noted that peak flows reported under developed conditions are modestly reduced from the previous version of this report, owing to minor redistribution of subcatchments.

6.0 Flood Study

The flood assessment was carried out utilising the U.S. Army Corps of Engineers' River Analysis System (HEC-RAS) software. This software is capable of simulating one-dimensional flows through a full network of open channels, dendritic systems and single river reaches.

HEC-RAS was used in conjunction with the 12d civil software package. Cross sections of watercourses were exported from 12d based on LiDAR survey. Water surface data was then exported from HEC-RAS back into 12d to create the flood extents plan provided in ***Appendix A***.

It is noted that 'Revision D' of this report reflects a minor alteration of the site layout and subsequent adjustment of subcatchments. Given that the peak flows reported in ***Section 5.5*** are generally consistent with (and modestly less than) the previous revision, it is demonstrated that the revised layout has negligible impacts with respect to flooding. Moreover, the proposed development's realigned water course and culvert crossings, being the focal points of the previous assessment, are unchanged.

6.1 FLOOD STUDY PARAMETERS

A screengrab of the HEC-RAS model and adopted parameters are provided in full detail in ***Appendix C***. Discussion on selected surface roughness's and boundary conditions is provided in ***Sections 6.1.1*** and ***6.1.2*** below.

6.1.1 Roughness

The HEC-RAS model requires the input of Manning's 'n' roughness for the channel and overbanks under consideration. Ground-truthing and previous reporting (Douglas Partners 2017) has confirmed the presence of well defined, incised watercourses with dense and exotic vegetation occupying riparian zones. Roughness values for each tributary were selected with reference to the described vegetative conditions and are summarised in ***Table 5*** below.

Table 5 - Adopted Surface Roughness Values

Location	Adopted roughness value (Manning's 'n')	
	Channel	Overbank
Weakleys Flat Creek & tributaries	0.06	0.07
Proposed channel	0.045	0.045

6.1.2 Boundary Conditions

Newcastle City Council's *Lower Hunter Flood Model at Hexham* is relevant to the subject site. In their 2008 revision of the model, DHI Water & Environment employed numerical techniques to ascertain the regional flood behaviour of the Lower Hunter River Flood. The extents of the 1% AEP regional flood level as modelled by DHI Water & Environment are presented in ***Figure 11*** below.

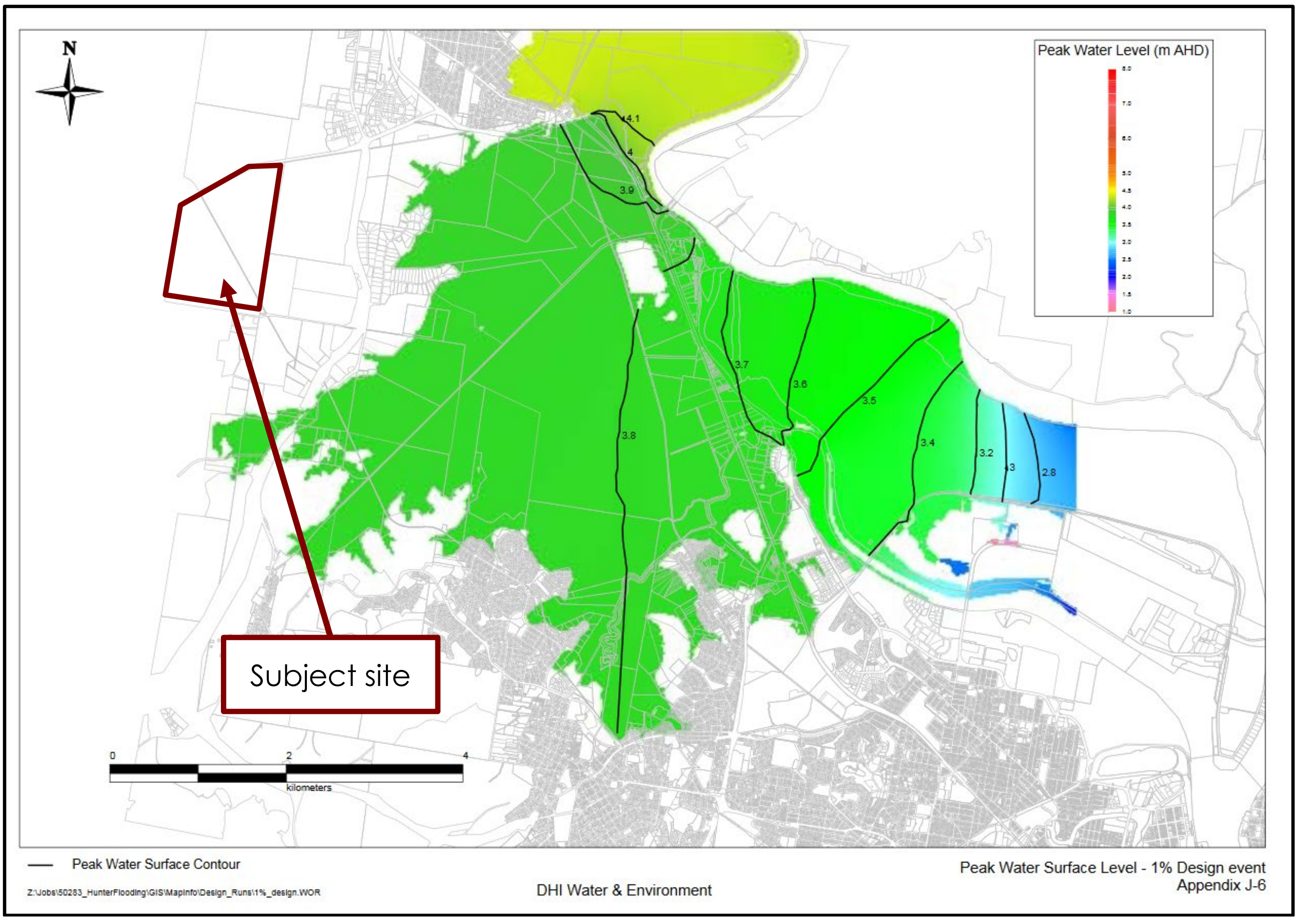

Figure 11 - 1% AEP Flood Extents for the Lower Hunter River Floodplain.
(Source: DHI Water & Environment 2008)

In addition, 1% AEP flood maps are readily available from Cessnock City Council's online mapping tool. Attention is drawn to ***Figure 12*** which presents the 1% AEP flood extents of Four Mile Creek which lies approximately 1 km west of the site.

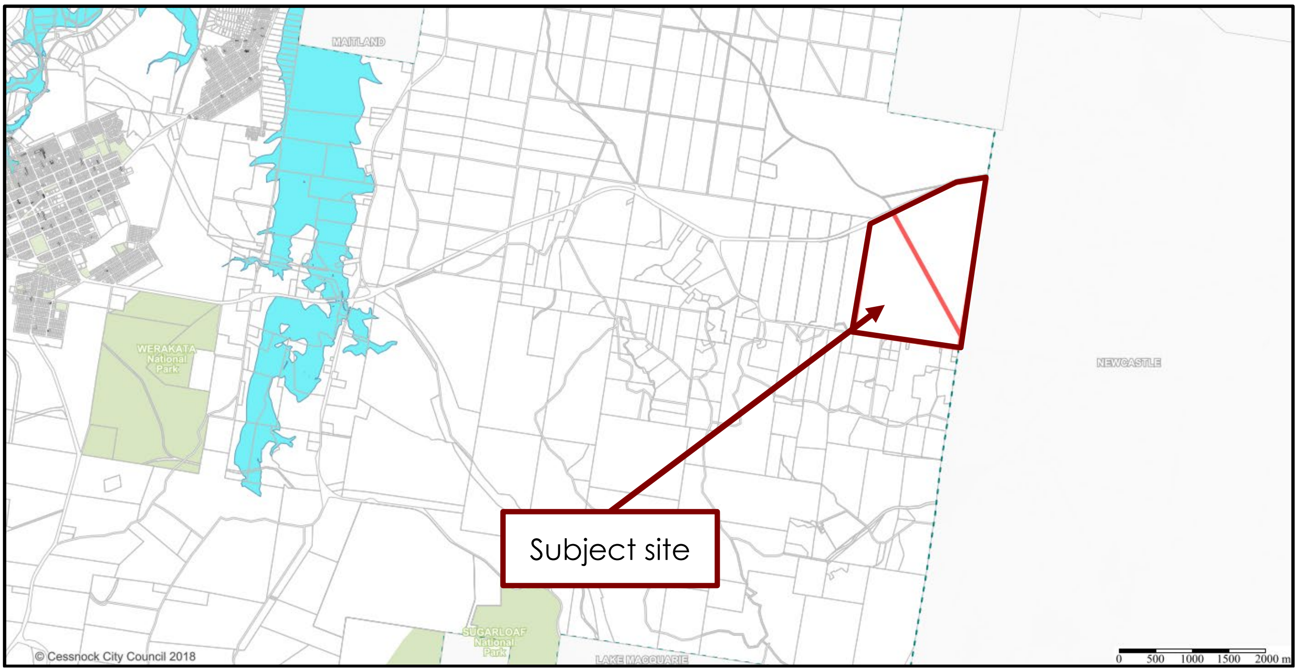

Figure 12 - 1% AEP Flood Extents for Four Mile Creek.
(Source: Cessnock City Council 2018)

From ***Figures 11*** and ***12*** it is evident that the proposed development is not prone to regional flooding of the Lower Hunter River. Given that backwater effects do not prevail, the downstream boundary condition applied within the HEC-RAS model was normal depth for a river slope of 1%.

6.2 DEVELOPED CATCHMENT FLOOD STUDY

HEC-RAS modelling was undertaken to determine the flood extents and flow profile of watercourses for the 1% AEP design storm event. Peak flows for each tributary were derived from the XPRAFTS simulation described in ***Section 5.*** Existing and proposed culverts were modelled within HEC-RAS to accurately reflect hydraulic conditions.

The computed 1% AEP flood extents for the subject site are shown within ***Appendix A***. It is evident from the plans that Council's objective to create flood-free land in each proposed lot is satisfied.

6.3 ASSESSMENT OF HYDRAULIC INFRASTRUCTURE

6.3.1 Proposed Culvert Crossing – Western Access Road

As shown in the concept stormwater layout plan, a road crossing is proposed to convey Weakleys Flat Creek beneath the western access road. Preference has been given to rectangular box culverts at this location; however, provided that equivalent open areas are achieved, there is no mandate which precludes a road bridge. The culvert has been modelled as 50m long (given the presence of wide batters at this location) with an ineffective flow area between the top of culverts and road level.

A hydraulic structure blockage assessment was conducted in accordance with Book 6, Chapter 6 of ARR 2016. ARR prescribes that a debris risk assessment is performed with respect to catchment conditions, the result of which is summarised in ***Table 6*** below.

Table 6 - Hydraulic Structure Blockage Risk Assessment – Western Access Road

Risk category	Risk Rating	Comment
Debris availability	Medium	• Thick vegetation and grazing lands with stands of trees in upstream catchment.
Debris mobility	Medium	• Main debris source (vegetation) close to watercourses.
Debris transportability	Medium	• Wide flow regime during the 1% AEP design event.
Overall rating	**Medium**	

As significant trees were present in the vicinity of the watercourse, the average length of the largest 10% of likely debris (L_{10}) was estimated as 2.0m. Subsequently, for a proposed cell width of 2.4m, a blockage factor of 25% was applied.

The proposed culvert's specifications are presented in ***Table 7*** below and have been selected to afford a 0.5m freeboard above the 1% AEP flood level in conjunction with the applied blockage factor. Although the specifications are conceptual and subject to detailed design, it is evident that the culvert crossing can be configured to meet Council's requirements.

Table 7 – Proposed Culvert Crossing Details – Western Access Road

Dimensions	Invert Level (m AHD)		1% AEP Freeboard (with blockage)	Gradient
	Upstream	Downstream		
3 x 50m (L) x 2.4m (W) x 1.8m (H)	23.50	23.34	0.54m	0.3%

6.3.2 Proposed Culvert Crossing – Cul-de-sac Road

A second culvert is proposed to convey the realigned channel beneath a cul-de-sac road in the western portion of the site. The debris blockage risk assessment for this structure, which conveys flows from the proposed development only, is presented in ***Table 8*** below.

Table 8 - Hydraulic Structure Blockage Risk Assessment – Cul-de-sac Road

Risk category	Risk Rating	Comment
Debris availability	Low	• Industrial catchment
Debris mobility	Low	• Roads and setbacks provide a buffer between channel and debris sources
Debris transportability	Medium	• Wide flow regime during the 1% AEP design event
Overall rating	**Low**	

Given that debris would likely take the form of building materials and road litter, the average length of the largest 10% of likely debris (L_{10}) was estimated as 1.5m. Subsequently, for a proposed cell width of 1.5m, a blockage factor of 0% was applied.

The proposed culvert has been sized preliminarily using manning's equation for a design grade of 0.5% and manning 'n' of 0.013 (concrete). A 1% AEP peak flow of 4.8m^3/s was obtained from XPRAFTS computations described in ***Section 5***. Conceptual culvert specifications are provided in ***Table 9*** below and are subject to detailed design.

Table 9 – Proposed Culvert Crossing Details – Cul-de-sac Road

# of cells	Cell width (m)	Cell height (m)	1% AEP freeboard	Gradient
2	1.5	0.75	0.54	0.5%

6.3.3 Existing Twin Cell Box Culvert

Weakleys Flat Creek discharges under John Renshaw Drive via a twin-cell rectangular box culvert beneath John Renshaw Drive. Whilst XPRAFTS routing has confirmed that the peak 1% AEP discharge is not increased by the intended development at the culvert, HEC-RAS has been used to assess its performance. With reference to the blockage assessment presented in ***Section 6.3.1*** a blockage factor of 25% was applied.

Modelling confirmed that the existing culvert achieved a freeboard of 0.39m above the 1% AEP flood level with design blockage. Importantly, the result indicates that John Renshaw Drive is not overtopped by the 1% AEP design event at this location.

6.3.4 Proposed Channel Realignment

It is proposed that a vegetated channel will be constructed to convey road and lot runoff northwards into an upper tributary of Weakleys Flat Creek. The channel is a realignment of a 1st order stream as shown in ***Figure 13*** below. It is noted that realignment of 1st order streams is permissible in accordance with the *Water Management Act 2000 (NSW)* administered by the NSW office of Water.

Figure 13 – Intended watercourse realignment.

The channel shall be trapezoidal, vegetated and generally parallel with the western access road as presented in the concept engineering plans. Manning's equation has been employed to preliminarily size the channel assuming an average slope of 1.3% and a manning's 'n' of 0.05 (thick brush). It has been designed in two sections – north and south of the proposed culvert – to account for the larger catchment received at the downstream end. Peak 1% AEP flows were adopted for both sections from XPRAFTS modelling described in ***Section 5***.

Channel details are provided in ***Table 10*** and should be read in conjunction with Council's requirements for major drainage channels articulated in ***Section 3.3***. These requirements relate to peak velocity, freeboard and velocity-depth product.

Table 10 – Realigned channel details

Channel section	North	South
1% AEP flowrate (m^3/s)	6.3	4.8
Channel base width (m)	7.0	5.5
Embankment slope	1V:4H	1V:4H
Channel depth (m)	0.8	0.8
Water depth (m)	0.6	0.6
Freeboard above 1% AEP peak flow	0.2	0.2
Peak velocity (m/s)	1.5	1.5
Velocity-depth (m^2/s)	0.9	0.9

The results shown in ***Table 10,*** though preliminary, confirm that the 1st order stream can be realigned to safely and effectively convey stormwater through the site.

6.4 PEAK STAGES AND VELOCITIES

The peak flood water velocity and depth was monitored at several key locations within the development shown in ***Figure 14***. The results of this exercise are summarised in ***Table 11***.

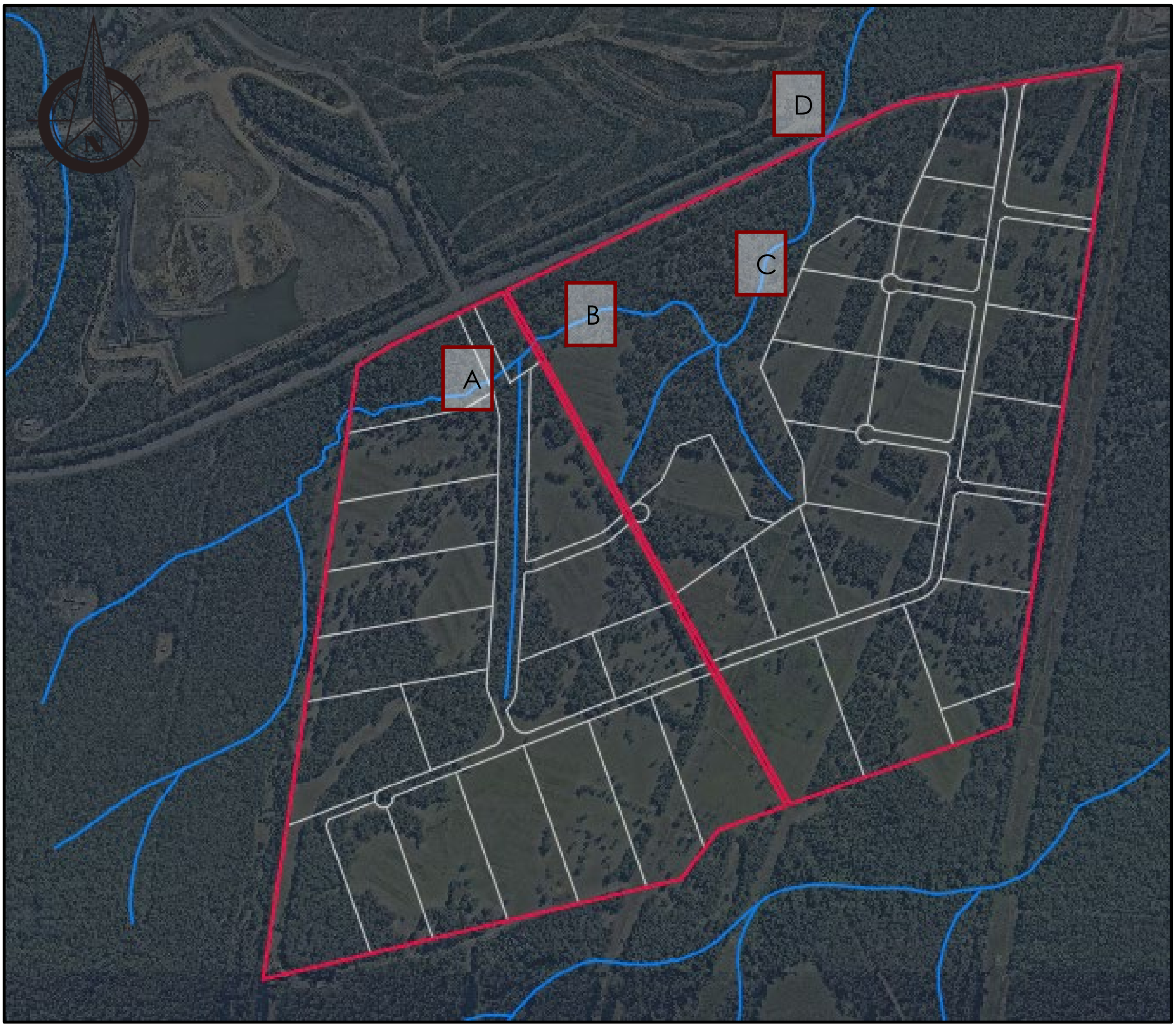

Figure 14 - Locations of Flood Results.

Table 11 – 1% AEP Peak Flows and Velocities

Location	1% AEP Peak magnitudes		
	Flow (m^3/s)	Depth (m)	Velocity (m/s)
A - Upstream of culvert crossing	9.43	1.51	0.18
B – Downstream of channel confluence	16.49	1.50	0.60
C – Downstream of tributaries confluence	26.59	1.20	1.26
D – Upstream of receiving culvert	27.98	2.83	0.72

The 1% AEP peak velocities and depths shown in ***Table 11*** are typical of a natural watercourse receiving a large catchment. Water profiles and flood extents are provided in full detail as an appendix to this report (***Appendix C***).

6.4.1 Flood Hazard Map

The hazard associated with floodwaters is a function of its depth and velocity. The NSW Floodplain Development Manual (2005) recognises two principal hazard levels as follows:

- High Hazard – floodwaters for which wading is unsafe, vehicles may become unstable and the potential for damage to structures is high; and
- Low hazard – floodwater from which adults could generally wade to safety.

The velocity-depth relationship used to define hazard level in the Floodplain Development Manual is replicated in ***Figure 15*** below. It is noted from ***Figure 15*** that floodwater with a velocity in excess of 2m/s or depth greater than 1m are automatically considered highly hazardous.

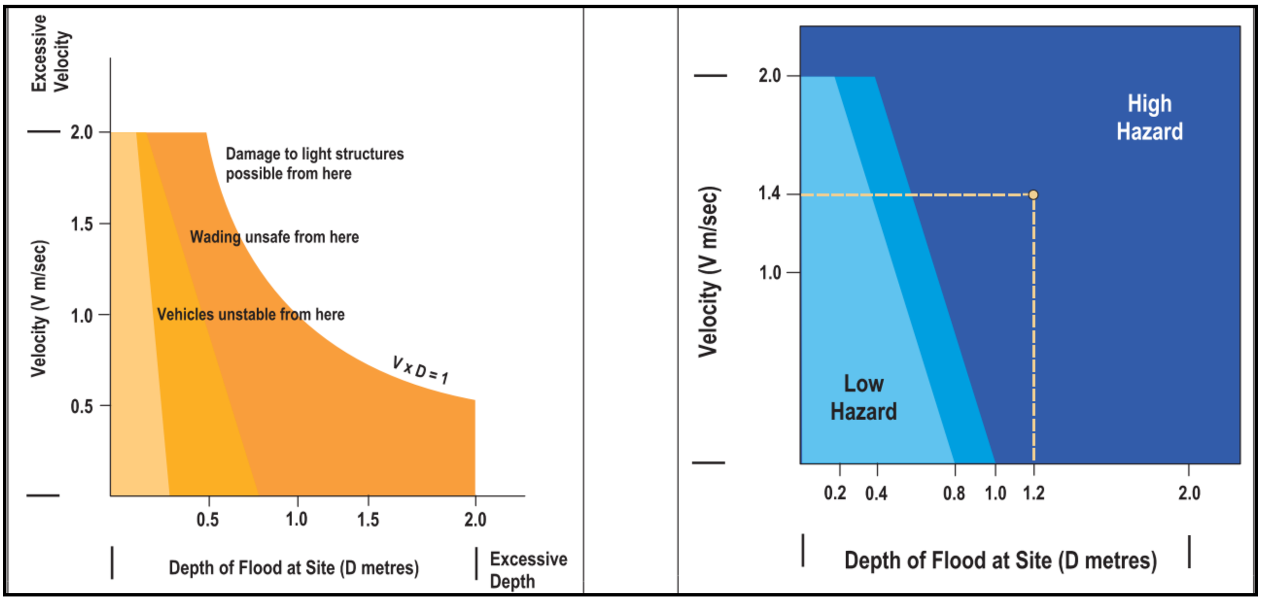

Figure 15 - Categorisation of Flood Hazard Levels.
(Source: Floodplain Development Manual 2005)

As the risk to life and property posed by a flood varies across a floodplain, it is prudent to assess the variability of flooding across the subject site. Subsequently, provisional flood hazard mapping for all channels and watercourses is provided within the stormwater management plans in ***Appendix A***. Mapping results indicate that all high hazard areas exist in E2 land outside of the intended development footprint. Risk within the vicinity of the realigned channel, which is regarded by Council's *Engineering Requirements* as a high-hazard major drainage channel, shall be managed through the provision of signposted warnings and vegetation to reduce the likelihood of accidental entry.

It is noted that the flood hazard mapping is an interpretation based on the velocity and depth outputs of the HEC-RAS model outlined in within this section. No allowance has been made for additional factors which affect hazard levels, such as the adoption of effective local flood plans.

7.0 Stormwater Quality

The quality of the stormwater discharging from the development was determined using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC). The MUSIC model was used to simulate pollutant source elements for the proposed development and the treatment of the pollutant loading using treatment devices.

7.1 MUSIC MODELLING PARAMETERS

7.1.1 Rainfall and Evapotranspiration

Rainfall data from Tocal, Paterson weather station was input into the MUSIC model. Paterson is situated 26km north of the subject site and suitably reflects local conditions. Six-minute rainfall information for the year of 1989 was analysed and deemed to be a reasonable representation of the average yearly rainfall and rainfall event distribution. A comparison of Paterson's 1989 rainfall with the long-term averages for Paterson is presented in ***Table 12*** below.

Table 12 - Comparison of Paterson Rainfall Data

Data suite	Paterson1989	Paterson Long-term Average
Annual rainfall (mm)	904.6	940.3
Annual days of rainfall	89	89.9

It can be seen from ***Table 12*** that the rainfall and number of rainfall days for Paterson in 1989 was comparable with the annual averages taken for the 50-year period from 1967 to 2018. The annual rainfall and evapotranspiration time series graph for Paterson in 1989 is shown in ***Figure 16.***

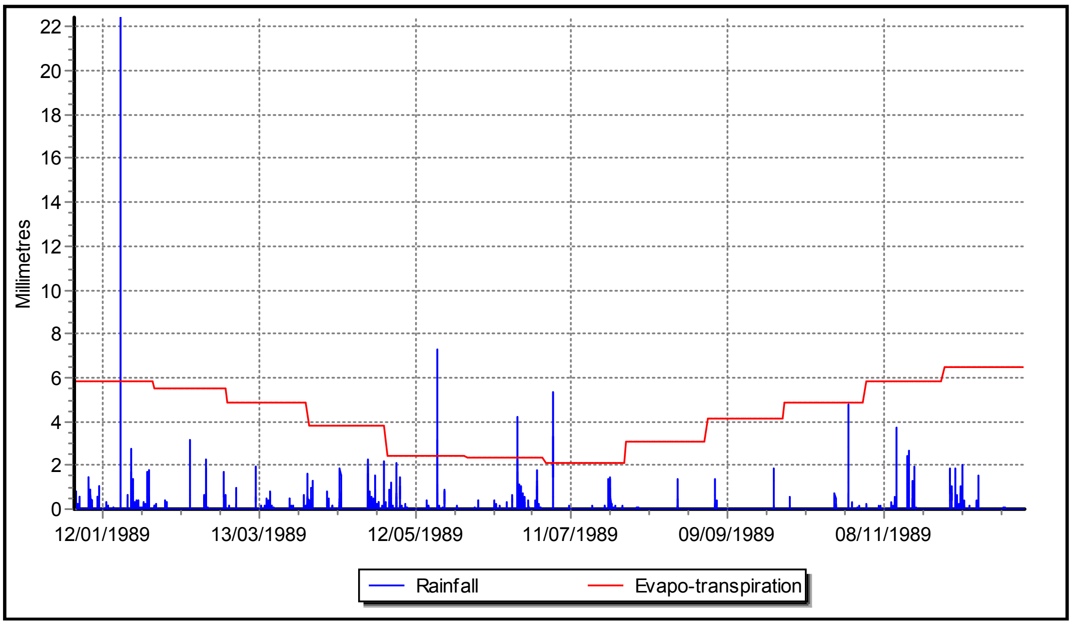

Figure 16 - Rainfall and Evapotranspiration Graph.

7.1.2 Catchment Plan

The development site was delineated into eight subcatchments, each corresponding to a point of discharge into receiving watercourses/channels. Undeveloped catchments, namely the residual E2 land and upstream catchment, were not modelled within MUSIC in order to avoid untoward dilution effects. ***Figure 17*** presents a breakdown of MUSIC catchments for the site.

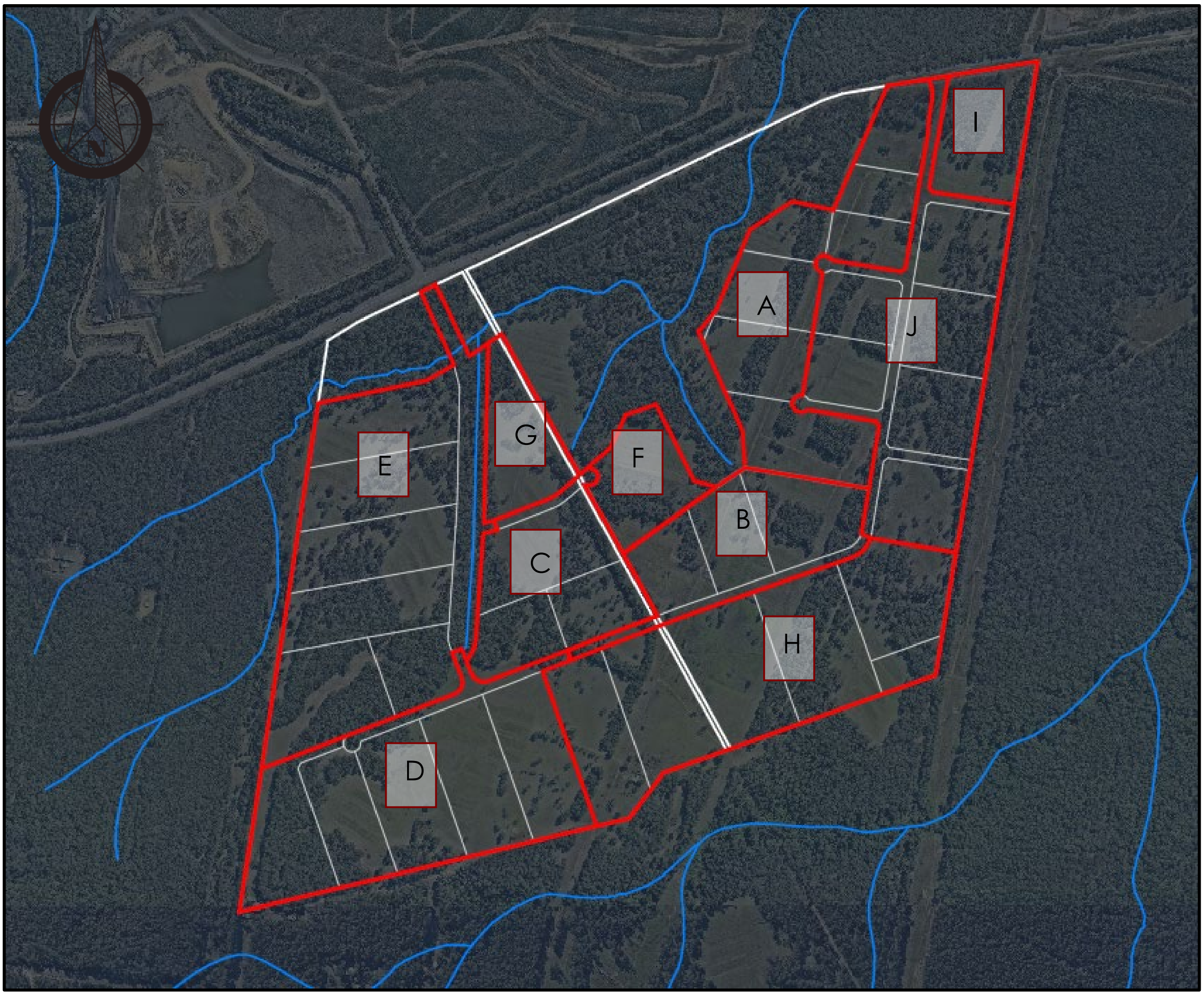

Figure 17 - MUSIC Catchments.

7.1.3 Subcatchment Composition

Subcatchments were separated within MUSIC according to their developed surface type. A total building area of 60% was adopted for each individual allotment. Noting the omission of undeveloped environmental land, the model defined the following surface types:

- **Roof** – This surface type defines the impervious roof area of each lot. It has been assumed 100% impervious and accounts for 60% of the total lot area;
- **Lots (Industrial)** – This surface type defines the lot area after the removal of the roof area. Typical utilisation of this area would include car parking, industrial hardstand, OSD controls and landscaping. It has been assumed 62.5% impervious and occupies the remaining 40% of each lot; and

- **Road (sealed)** – This surface type defines the road reserve area. It has been assumed to be 85% impervious accounting for pervious road verge.

Summation of roof and lot areas equates to an impervious fraction of 85%. Subsequently, Impervious fractions for each land use are consistent with Cessnock City Council's stormwater drainage design requirements. ***Table 13*** summarises the total area and surface composition of each subcatchment.

Table 13 - Subcatchment Land Use Areas

Subcatchment	Total lot area (ha)		Road area (ha)	Total (ha)
	Roof	Lot		
A	12.262	8.175	0.000	20.437
B	6.424	4.283	1.691	12.398
C	6.584	4.390	0.657	11.631
D	15.052	10.034	1.610	26.696
E	18.840	12.560	2.544	33.944
F	3.051	2.034	0.000	5.085
G	2.964	1.976	0.000	4.940
H	17.939	11.959	0.000	29.898
I	3.507	2.338	0.000	5.845
J	12.229	8.153	4.505	24.887
TOTAL	**98.852**	**65.902**	**11.007**	**175.761**

7.1.4 Rainfall-Runoff Parameters

Surface parameter inputs and pollutant concentrations were obtained from the '*Draft NSW MUSIC Modelling Guidelines*' (BMT WBM, 2010). These are summarised in ***Tables 14*** and ***15.***

Table 14 - MUSIC Rainfall-Runoff Parameters

Parameter	Roof	Lot	Road
Rainfall Threshold (mm/day)	0.3	1	1.5
Soil Storage Capacity (mm)	170	170	170
Initial Storage (% of Capacity)	30	30	30
Field Capacity (mm)	80	80	80
Infiltration - a	200	200	200
Infiltration - b	2.4	2.4	2.4
Initial Depth (mm)	10	10	10
Daily Recharge Rate (%)	50	50	50
Daily Baseflow Rate (%)	5	5	5
Daily Deep Seepage Rate (%)	0	0	0

Table 15 - MUSIC Model Baseflow and Stormflow Pollutant Concentrations

Land Use		Mean Concentration (mg/L-log$_{10}$)		
		TSS	TP	TN
Roof	Baseflow	N/A	N/A	N/A
	Stormflow	1.30	-0.89	0.30
Lot	Baseflow	1.20	-0.85	0.11
	Stormflow	2.15	-0.60	0.30
Road	Baseflow	1.20	-0.85	0.11
	Stormflow	2.43	-0.30	0.34

7.2 CONSTRAINTS TO WATER SENSITIVE URBAN DESIGN

Like all industrial development, the proposed subdivision is subject to site-specific Water Sensitive Urban Design (WSUD) constraints. These are articulated below.

- Geomorphology – as discussed in ***Section 2***, the site's hydrologic regime is dominated by surficial runoff into well-defined watercourses. Owing to the presence of residual clays and site fill, soil profiles are expected to be moderately infiltrative. The adopted WSUD strategy should respect existing conditions, with preference given to conveyance and source controls over infiltration-centric treatment devices;

- Ecology – the residual E2 environmental land through which the site watercourses convey are subject to ecological controls. There is a clear objective to avoid implementation of on-line water quality basins within E2-zoned land. Consideration must also be given to nutrient loading of downstream riparian corridors to prevent algal blooms and exotic overgrowth; and

- Industrial land use – the created lots shall be well-suited (but not limited to) warehousing, freight and engineering purposes. Given the unknown configuration of each developed lot, the adopted WSUD strategy must be accommodating of all potential applications and not impede the functionality and amenity of the site overall.

7.3 TREATMENT DEVICES

The adopted water quality treatment train included generic on-site WSUD controls and Gross Pollutant Traps (GPT's). These are described in detail in ***Section 7.3.1*** and ***7.3.2***.

7.3.1 On-site WSUD Controls

MUSIC modelling has been undertaken based on the fundamental assumption that each created lot shall individually satisfy the water quality targets summarised ***Section 3***. This was represented in MUSIC by applying a generic treatment node on all roof and lot areas.

The individual configuration of on-site WSUD controls will vary according to eventual land use, rainwater reuse rates and spatial arrangement. Subsequently, dictation of how each lot meets water quality improvement targets shall be the subject of further reporting at subsequent DA stages. Notwithstanding, it is envisaged that developed lots will incorporate any or all of the following:

1. **Rainwater tanks** – these are at-source controls which harvest roof water and store it for on-site reuse. Harvested rainwater could be reused for irrigation, toilets, bathrooms and fire tank replenishment. Reuse rates are dependent on lot-specific factors such as roof areas, landscaping requirements and occupying staff numbers;

2. **Stormwater detention basins** – these are end-of-line controls required for attenuating stormwater flows as described in ***Section 5***. Detention basins will either occupy the front or rear of lots, draining to either street drainage infrastructure or receiving watercourses respectively. Open detention basins allow suspended particles to settle and may be planted out for enhanced nutrient removal;

3. **Underground storage tanks** – these are end-of-line controls which similarly retard peak stormwater flows. Depending on lot configuration and use, there may be preference to use underground storage tanks as well as (or instead of) open basins; and

4. **Pit Screens and trash racks** – sites with significant hardstand or car parking areas will require internal stormwater drainage infrastructure. There is opportunity to provide debris-capturing screens on stormwater pits prior to discharging into OSD facilities.

7.3.2 Gross Pollutant Traps

GPTs are utilised as conveyance and end-of-line controls. It is proposed that GPTs are positioned prior to each piped drainage outlet in order to intercept a majority of stormwater discharging from the development. Attention is drawn to the stormwater management plans appended to this report (***Appendix A***) which show indicative device locations.

Modelling has adopted high-flow **Ecosol In-Line GPTs** which have been sized in accordance with their expected 3-month ARI design flow (taken as half of the 1-year ARI flow). The removal efficiency of the GPT is summarised in ***Table 16***.

Table 16 - GPT Removal Efficiencies

Pollutant	% Removal Efficiency *
Total Suspended Solids	55
Total Phosphorus	40
Total Nitrogen	40
Gross Pollutants	99

* (Ecosol Pty Ltd, 2015)

7.4 WATER QUALITY RESULTS

A screengrab of the constructed MUSIC model, showing catchment links and treatment devices, is provided as an appendix to this report (***Appendix D***). A monitoring node was established to represent the cumulative pollutant loading from both site discharge points, allowing pollutant reductions to be compared with the targets defined in ***Section 3***. The combined average annual pollutant loads from the site overall are summarised in ***Tables 17*** and ***18***.

Table 17 - Treatment Train Effectiveness – Outlet 1 (box culvert)

Pollutant	Developed Untreated Load	Developed Treated Load	Reduction (%)
TSS (kg/yr)	186000	33500	82.0
TP (kg/yr)	299	137	54.2
TN (kg/yr)	2140	960	55.2

Table 18 - Treatment Train Effectiveness – Outlet 2 (adjoining drainage system)

Pollutant	Developed Untreated Load	Developed Treated Load	Reduction (%)
TSS (kg/yr)	61000	12200	80.1
TP (kg/yr)	104	50.1	51.7
TN (kg/yr)	683	319	53.2

From ***Tables 17*** and ***18*** it can be seen that the treatment train successfully reduced the pollutant loading from the development with an efficiency surpassing Australian Runoff Quality (ARQ) objectives. It subsequently follows that Council's requirements in relation to water quality improvement are met.

8.0 Erosion and Sediment Control Plan

Council requires the use of erosion and sediment controls to manage and contain pollutant runoff during construction. All erosion and sediment controls and practices are to be in accordance with Council's *Engineering Requirements* and *Erosion and* Landcom's *Managing Urban Stormwater: Soils and Construction* (2004).

Treatment devices will be utilised to contain the generated pollutants from the site during construction. These include but are not limited to:

- Silt Fencing;
- Strawbale and Geotextile Fencing;
- Kerb Inlet Controls;
- Sandbag Kerb Inlet Sediment traps;
- Shaker Ramp; and
- Diversion Drains.

Any clean water entering the site from upstream catchments is to be diverted around the construction site where possible hence remaining clean. Runoff generated from within the site is to be treated and managed using a combination of the above stated treatment devices.

It is noted that development of the site will incur significant earthworks. Construction is proposed in stages to minimise the area of disturbed soil at any given time. The construction of temporary sediment basins is expected for each stage of the works and should be sized and configured during detailed design.

A preliminary Erosion and Sedimentation Control Plan is presented within ***Appendix A***. The attached Erosion and Sedimentation Control Plan is indicative only as another Erosion and Sedimentation Control Plan will be provided as part of the construction certificate drawings and a further plan will be provided by the contractor prior to construction.

9.0 Riparian Corridors

A riparian zone is land immediately alongside a watercourse and, when managed appropriately, often represents the most fertile and diverse portion of the surrounding landscape (NSW Office of Water 2012). Riparian lands contribute to streambank stability and ecological productivity, but may be vulnerable to deterioration induced by human activities.

The New South Wales Office of Water prescribes minimum Vegetated Riparian Zones (VRZs) on either side of a recognised watercourse. Works within VRZs are restricted to certain activities which cause limited disturbance to the riparian corridor in accordance with the *Water Management Act 2000 (NSW)*. VRZ widths are a function of streamflow category as follows:

Table 19 – Recommended Riparian Corridor Widths

Stream category	VRZ width (either side of channel) (m)
1st order	10
2nd order	20
3rd order	30
4th order	40

Where development encroaches onto a riparian corridor, the 'averaging rule' allows for development in the outer 50% of a VRZ provided offsets are created in the opposite corridor as shown in ***Figure 18*** below.

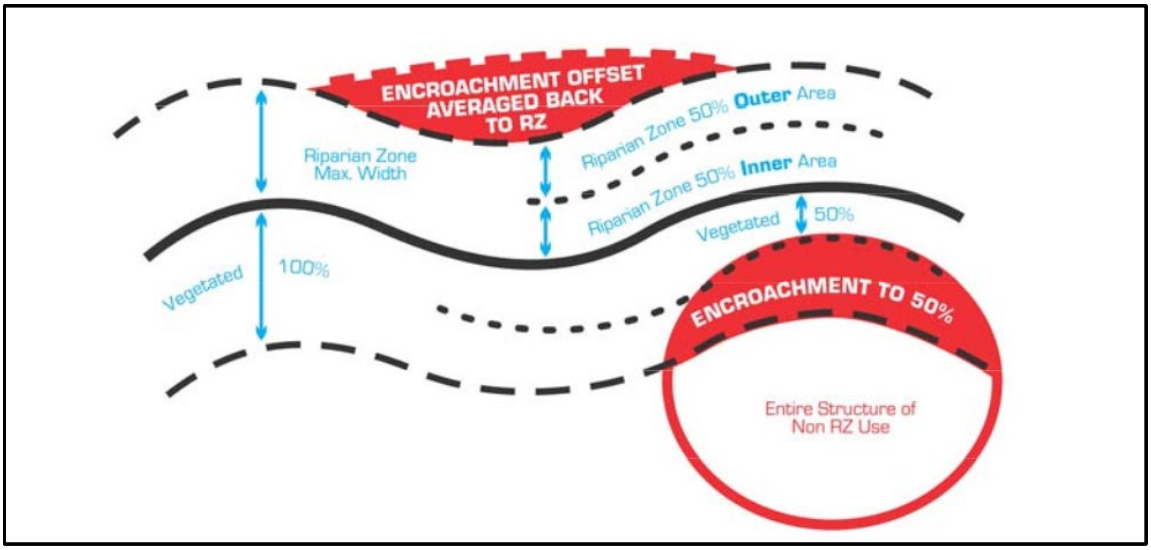

Figure 18 - Offset of Riparian Encroachment.
(Source: NSW Office of Water 2012)

Present watercourses have been categorised in ***Section 2*** of this report and confirm that the site is subject to the controls of 1st and 2nd order streams. With reference to ***Table 19***, the concept stormwater layout in ***Appendix A*** shows indicative riparian corridors associated with each watercourse. It is seen from the concept stormwater layout that minimum VRZs can be maintained outside of the proposed development area. The averaging rule has been applied where encroachment into the VRZ was likely.

In addition to minimum riparian setbacks, the *Water Management* Act defines permissible works undertaken on waterways. The Act allows for the realignment of 1st order streams as intended along the western access road of the subject site. The realigned channel must comply with the same controls as a 1st order stream and will therefore require 10m wide VRZs. A 40m wide allocation has been provided for the realigned channel's riparian corridor which satisfies minimum setback requirements.

Finally, it is noted that stormwater outlet structures are permissible into watercourses ranging from 1st order to 4th order (NSW Office of Water 2012).

10.0 Conclusion

This Stormwater Management Plan has been prepared to assess a proposed forty lot subdivision in relation to stormwater attenuation, runoff quality, flooding and Erosion & Sediment Control (ESC). A stormwater management strategy for the subdivision has been developed with specific reference to Council's requirements and best-practice guidelines. Noting site topography, incised watercourses and moderately infiltrative soils, preference has been given to a stormwater management strategy which promotes controlled discharge into watercourses consistent with their existing hydrologic regime.

The adopted stormwater strategy must accommodate a variety of potential industrial land uses for each developed lot. Subsequently, it is proposed that individual allotments incorporate On-Site Detention (OSD) and Water Sensitive Urban Design (WSUD) controls which will be optimised for each developed lot's roof area, impervious fraction and water reuse requirements. It is anticipated that such controls would include a combination of rainwater tanks, open basins, underground storage tanks and pit screens subject to future reporting.

The hydrologic routing package XPRAFTS was used to compare peak stormwater discharges from the site under predeveloped and developed conditions. Detained lots were modelled conceptually by adopting their respective predeveloped catchment parameters. Modelling indicates that the provision of OSD sufficiently retards peak flows discharging from the site overall, noting the exception of a negligible (1%) increase in the 1-year ARI critical design storm.

Desktop review has confirmed that the site is not subject to 1% AEP regional flooding. A flood study has been undertaken to assess the 1% AEP flood extents of Weakleys Flat Creek and its tributaries which convey stormwater flows from the intended development. The river profiling software HEC-RAS was used to confirm that created lots will occupy flood-free land. Additionally, results of this study indicate that the existing box culvert downstream of the site can accommodate the 1% AEP peak flow without overtopping John Renshaw Drive at this location.

HEC-RAS modelling was used to conceptually design hydraulic infrastructure associated with the development. A rectangular box culvert crossing has been sized to convey stormwater flows beneath the proposed entry road with appropriate freeboard and contingency for blockage. A realigned channel within the precinct has been configured in accordance with Council's requirements for high hazard areas.

The water quality treatment train recommended for the development includes on-lot WSUD controls and Gross Pollutant Traps (GPTs) at each piped outlet into receiving watercourses. Conceptual modelling indicates that the treatment train surpasses best-practice Australian Runoff Quality (ARQ) pollutant reduction targets.

To ensure downstream waters and adjacent properties are protected, appropriate erosion and sediment controls are to be undertaken during construction. Controls are to be implemented and monitored in accordance with Landcom's 'Blue Book' and Council's engineering guidelines. Temporary sediment basins will be required for each stage of construction and shall be the subject of future reporting. Additionally, all stormwater outlets into watercourses shall incorporate suitably-sized scour protection.

The details and information presented in this Stormwater Management Plan confirm that the proposed forty lot subdivision can satisfy Council's requirements in relation to stormwater attenuation, runoff quality, flooding, and erosion and sediment control.

11.0 References

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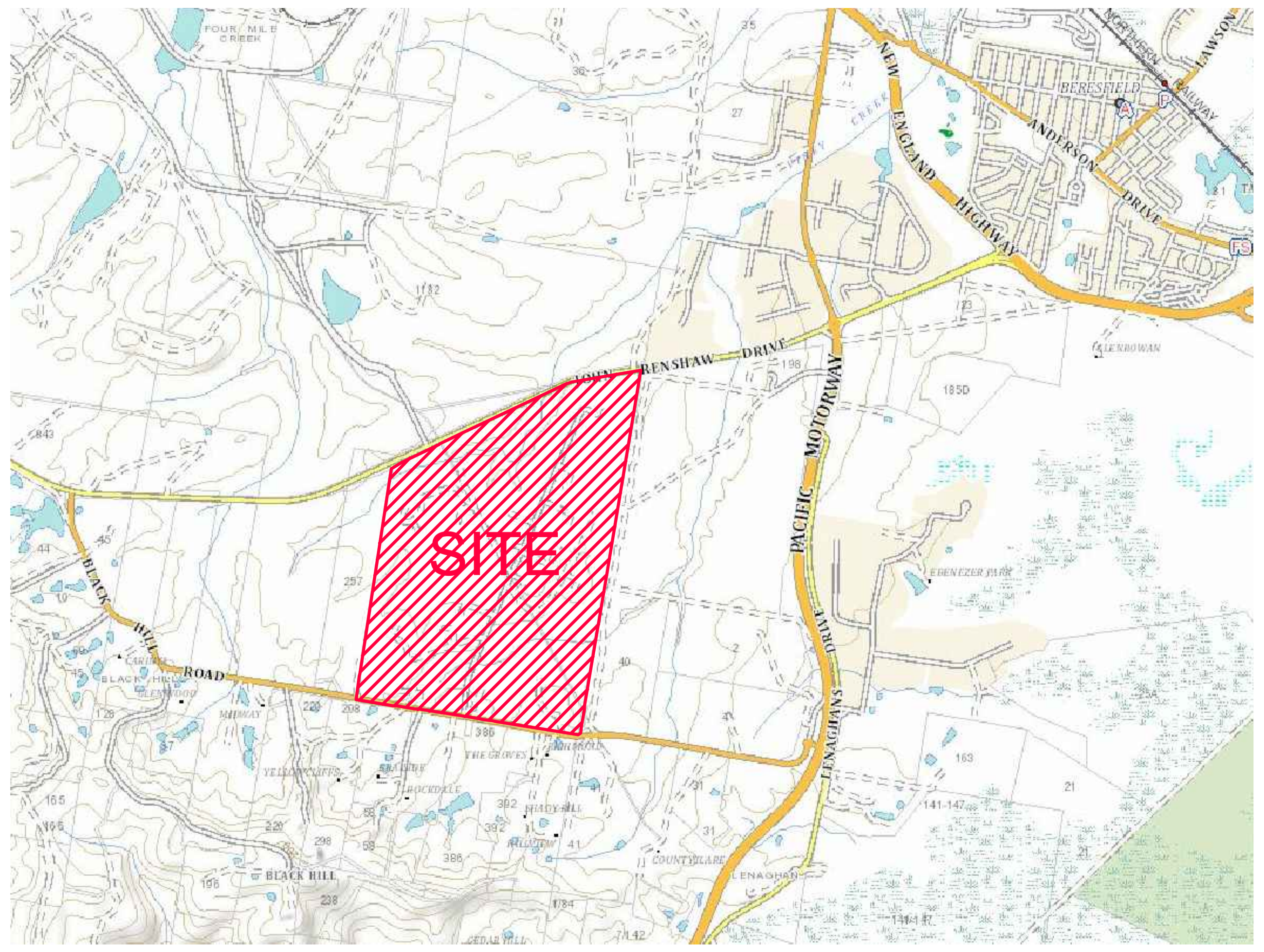
Appendix A – Stormwater Management Plans

239590-SWMP-001(H)

BLACK HILL INDUSTRIAL SUBDIVISION
STORMWATER MANAGEMENT PLAN
PROPOSED RESUBDIVISION OF LOT 1
IN THE BROADER SUBDIVISION OF LOT 1131 D.P.1057179
JOHN RENSHAW DRIVE, BLACK HILL



LOCALITY SKETCH
NOT TO SCALE

MGA

239590 SWMP

Sheet Title	Sheet Description
239590–SWMP–001(H)	TITLE SHEET, DRAWING INDEX, GENERAL NOTES & LOCALITY PLAN
239590–SWMP–002(H)	OVERALL SITE PLAN
239590–SWMP–101(H)	PRE–DEVELOPED CATCHMENT PLAN
239590–SWMP–102(H)	DEVELOPED CATHCMENT PLAN
239590–SWMP–103(H)	STORMWATER LAYOUT PLAN
239590–SWMP–104(H)	CHANNEL PROFILES
239590–SWMP–105(H)	1% AEP FLOOD EXTENTS
239590–SWMP–106(H)	100 YEAR FLOOD HAZARD PLAN
239590–SWMP–801(H)	EROSION & SEDIMENT CONTROL PLAN
239590–SWMP–802(H)	EROSION & SEDIMENT CONTROL DETAILS

100mm AT FULL SIZE

PRELIMINARY ISSUE

REV.	DATE	AMENDMENT	DRAWN	CHECK	DESIGN	VERIFY
A	03.08.2018	INITIAL ISSUE	E.G.	R.K.	M.K.	R.K.
B	14.08.2018	AMENDMENTS PER INSTRUCTION	E.G.	R.K.	M.K.	R.K.
C	17.08.2018	AMENDMENTS PER INSTRUCTION	E.G.	R.K.	M.K.	R.K.
D	29.01.2019	DA REFERENCE UPDATED	D.W.	R.K.	M.K.	R.K.
E	01.02.2019	PROPERTY REFERENCE UPDATED	D.W.	R.K.	M.K.	R.K.
F	06.08.2021	LAYOUT AMENDMENT	RJC	R.K.	M.K.	R.K.
G	16.08.2021	MINOR AMENDMENTS	RJC.	R.K.	M.K.	R.K.
H	15.10.2021	BOUNDARY AMENDMENTS	I.B.	R.K.	M.K.	R.K.

SCALES

DESIGN FILE N:\239590\Design\12D\

ALL DIMENSIONS ARE IN METRES. DO NOT SCALE

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CLIENT
BROADEN MANAGEMENT PTY LTD

PROPERTY DESCRIPTION
BLACK HILL INDUSTRIAL SUBDIVISION
STORMWATER MANAGEMENT PLAN
PROPOSED RESUBDIVISION OF LOT 1
IN THE BROADER SUBDIVISION OF LOT 1131
D.P.1057179, JOHN RENSHAW DRIVE, BLACK HILL

SURVEYED: ADW Johnson
DATUM: A.H.D.

PROJECT
BLACK HILL CONCEPT PLANS

PLAN TITLE
TITLE SHEET, DRAWING INDEX, GENERAL NOTES & LOCALITY PLAN

PROJECT No.		DISCIPLINE		NUMBER	REV.
239590	–	SWMP	–	001	H

Plotted By: iainb Plot Date: 15/10/21 – 09:26 Cad File: C:\Users\iainb\AppData\Local\Temp\AcPublish_12324\239590–SWMP–001(H).dwg

239590-SWMP-002(H)

PLAN
SCALE 1:4000

PRELIMINARY ISSUE

100mm AT FULL SIZE

REV.	DATE	AMENDMENT	DRAWN	CHECK	DESIGN	VERIFY
A	03.08.2018	INITIAL ISSUE	E.G.	R.K.	M.K.	R.K.
B	14.08.2018	AMENDMENTS PER INSTRUCTION	E.G.	R.K.	M.K.	R.K.
C	17.08.2018	AMENDMENTS PER INSTRUCTION	E.G.	R.K.	M.K.	R.K.
D	29.01.2019	DA REFERENCE UPDATED	D.W.	R.K.	M.K.	R.K.
E	01.02.2019	PROPERTY REFERENCE UPDATED	D.W.	R.K.	M.K.	R.K.
F	06.08.2021	LAYOUT AMENDMENT	RJC	R.K.	M.K.	R.K.
G	16.08.2021	MINOR AMENDMENTS	RJC.	R.K.	M.K.	R.K.
H	15.10.2021	BOUNDARY AMENDMENTS	I.B.	R.K.	M.K.	R.K.

DESIGN FILE N:\239590\Design\12D\

SCALES
0 100 200 A1 / A3 1:4000 / 1:8000

ALL DIMENSIONS ARE IN METRES. DO NOT SCALE

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CLIENT
BROADEN MANAGEMENT PTY LTD

PROPERTY DESCRIPTION
BLACK HILL INDUSTRIAL SUBDIVISION
STORMWATER MANAGEMENT PLAN
PROPOSED RESUBDIVISION OF LOT 1
IN THE BROADER SUBDIVISION OF LOT 1131
D.P.1057179, JOHN RENSHAW DRIVE, BLACK HILL

SURVEYED: ADW Johnson
DATUM: A.H.D.

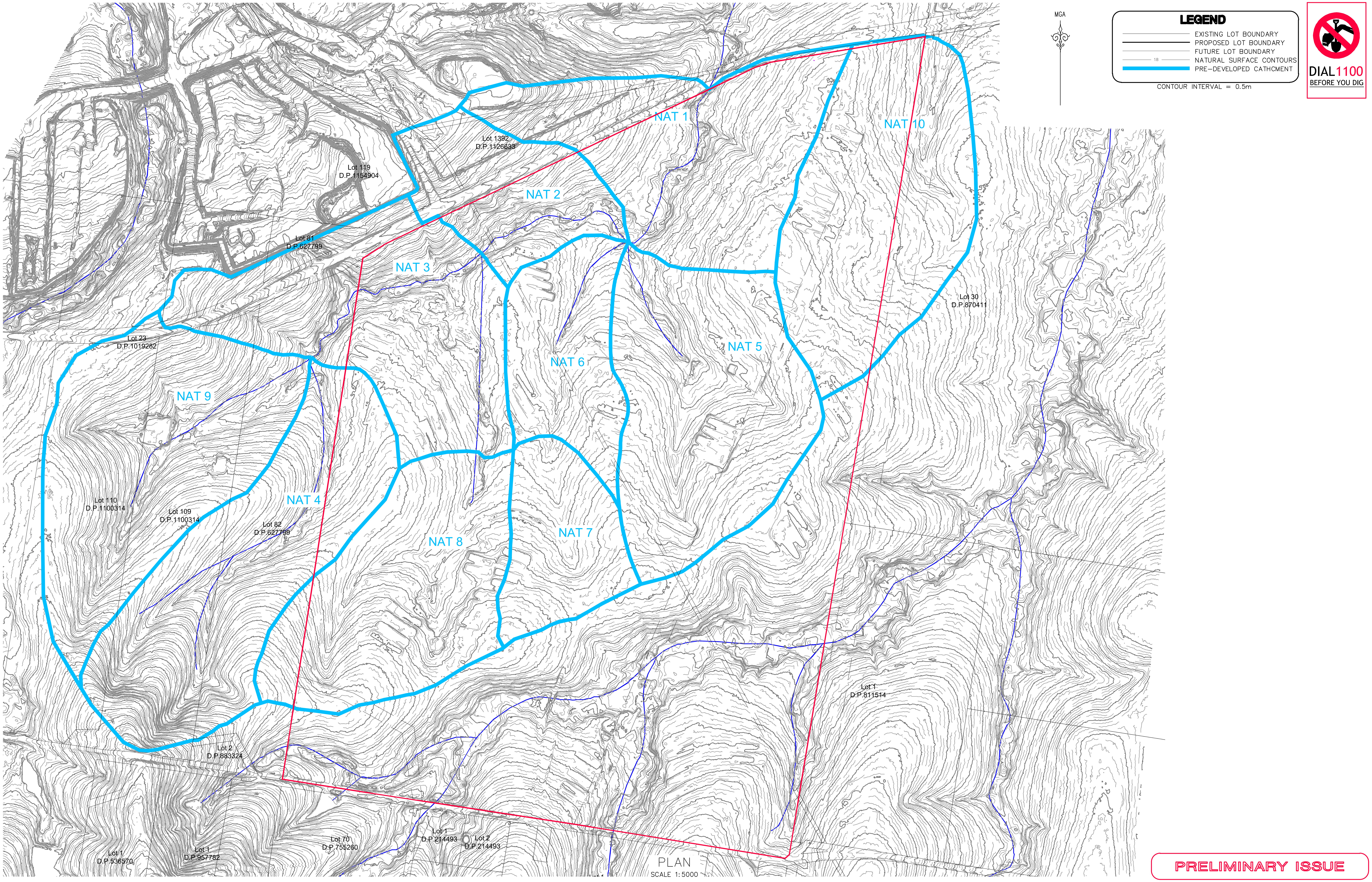
PROJECT
BLACK HILL CONCEPT PLANS

PLAN TITLE
OVERALL SITE PLAN

PROJECT No.	DISCIPLINE	NUMBER	REV.
239590	SWMP	002	H

Plotted By: iainb Plot Date: 15/10/21 – 09:27 Cad File: \\Jpserver10\adw-data\239590\Drawings\Engineering\Civil\SWMP\239590-SWMP-002(H).dwg

239590-SWMP-101(H)



PRELIMINARY ISSUE

100mm AT FULL SIZE

REV.	DATE	AMENDMENT	DRAWN	CHECK	DESIGN	VERIFY
A	03.08.2018	INITIAL ISSUE	E.G.	R.K.	M.K.	R.K.
B	14.08.2018	AMENDMENTS PER INSTRUCTION	E.G.	R.K.	M.K.	R.K.
C	17.08.2018	AMENDMENTS PER INSTRUCTION	E.G.	R.K.	M.K.	R.K.
D	29.01.2019	DA REFERENCE UPDATED	D.W.	R.K.	M.K.	R.K.
E	01.02.2019	PROPERTY REFERENCE UPDATED	D.W.	R.K.	M.K.	R.K.
F	06.08.2021	LAYOUT AMENDMENT	RJC	R.K.	M.K.	R.K.
G	16.08.2021	MINOR AMENDMENTS	RJC.	R.K.	M.K.	R.K.
H	15.10.2021	BOUNDARY AMENDMENTS	I.B.	R.K.	M.K.	R.K.

DESIGN FILE N:\239590\Design\12D\

SCALES
0 100 200 A1 / A3
1:5000 / 1:10000

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CLIENT
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PROPERTY DESCRIPTION
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STORMWATER MANAGEMENT PLAN
PROPOSED RESUBDIVISION OF LOT 1
IN THE BROADER SUBDIVISION OF LOT 1131
D.P.1057179, JOHN RENSHAW DRIVE, BLACK HILL

SURVEYED: ADW Johnson
DATUM: A.H.D.

PROJECT
BLACK HILL CONCEPT PLANS

PLAN TITLE
PRE-DEVELOPED CATCHMENT PLAN

PROJECT No.		DISCIPLINE		NUMBER	REV.
239590	–	SWMP	–	101	H

Plotted By: iainb Plot Date: 15/10/21 – 09:28 Cad File: \\Jpserver10\adw-data\239590\Drawings\Engineering\Civil\SWMP\239590-SWMP-101(H).dwg

239590-SWMP-102(H)

REV.	DATE	AMENDMENT	DRAWN	CHECK	DESIGN	VERIFY
A	03.08.2018	INITIAL ISSUE	E.G.	R.K.	M.K.	R.K.
B	14.08.2018	AMENDMENTS PER INSTRUCTION	E.G.	R.K.	M.K.	R.K.
C	17.08.2018	AMENDMENTS PER INSTRUCTION	E.G.	R.K.	M.K.	R.K.
D	29.01.2019	DA REFERENCE UPDATED	D.W.	R.K.	M.K.	R.K.
E	01.02.2019	PROPERTY REFERENCE UPDATED	D.W.	R.K.	M.K.	R.K.
F	06.08.2021	LAYOUT AMENDMENT	RJC	R.K.	M.K.	R.K.
G	16.08.2021	MINOR AMENDMENTS	RJC.	R.K.	M.K.	R.K.
H	15.10.2021	BOUNDARY AMENDMENTS	I.B.	R.K.	M.K.	R.K.

DESIGN FILE N:\239590\Design\12D\

SCALES
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1:5000 / 1:10000

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PROPERTY DESCRIPTION
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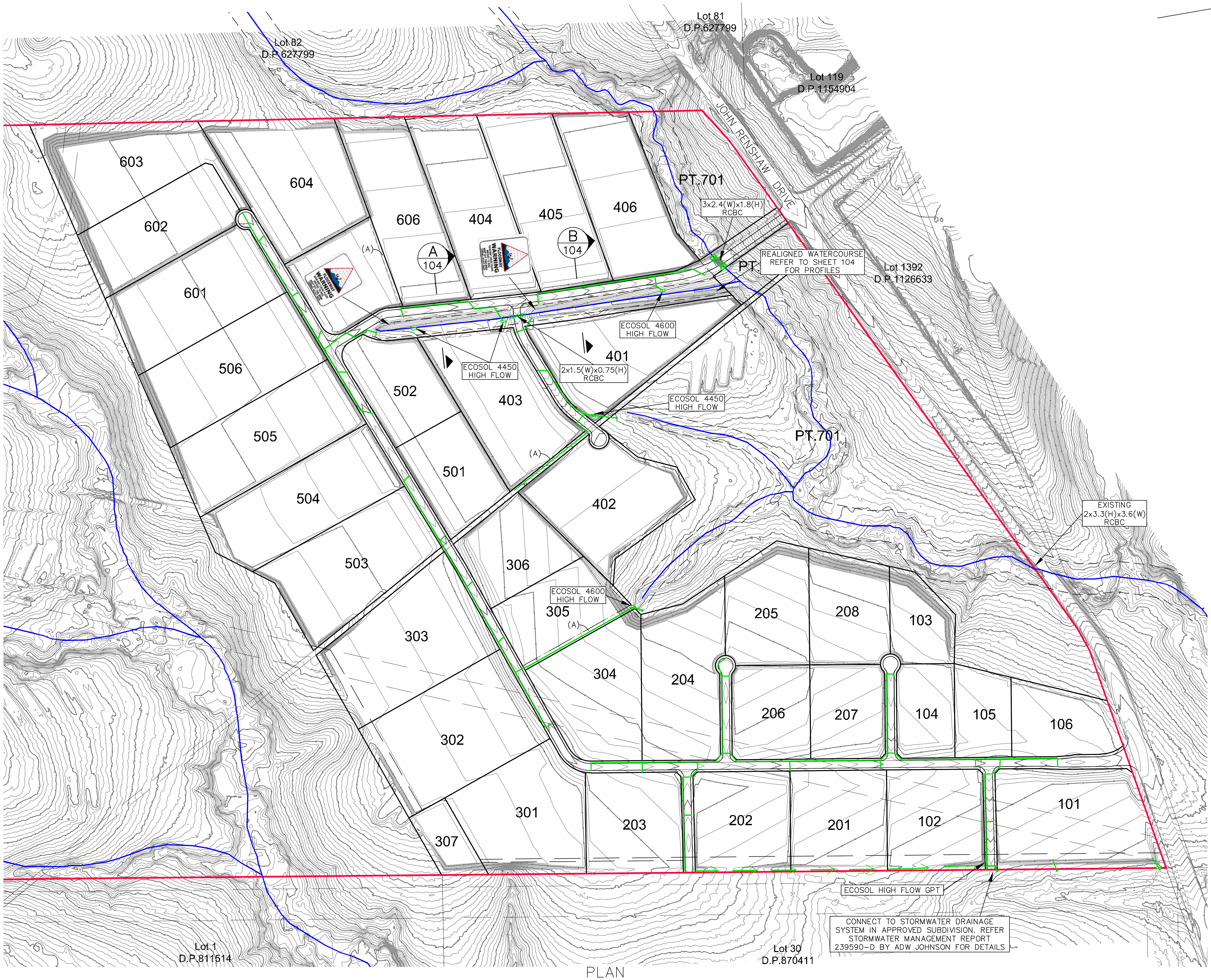
STORMWATER MANAGEMENT PLAN
PROPOSED RESUBDIVISION OF LOT 1
IN THE BROADER SUBDIVISION OF LOT 1131
D.P.1057179, JOHN RENSHAW DRIVE, BLACK HILL

PROJECT
BLACK HILL CONCEPT PLANS

PLAN TITLE
DEVELOPED CATHCMENT PLAN

SURVEYED	DATUM	PROJECT No.	DISCIPLINE	NUMBER	REV.
ADW Johnson	A.H.D.	239590	SWMP	102	H

Plotted By: iainb Plot Date: 15/10/21 - 09:29 Cad File: \\Jpserver10\adw-data\239590\Drawings\Engineering\Civil\SWMP\239590-SWMP-102(H).dwg



PLAN
SCALE 1:4000

LEGEND

- EXISTING LOT BOUNDARY
- PROPOSED LOT BOUNDARY
- FUTURE LOT BOUNDARY
- FINISHED SURFACE CONTOUR
- EXISTING WATERCOURSE
- PROPOSED STORMWATER
- PROPOSED INTERALLOTMENT SWALE DRAINAGE
- INDICATIVE RIPARIAN SETBACK
- (A) PROPOSED EASEMENT TO DRAIN STORMWATER

CONTOUR INTERVAL = 0.5m

DIAL 1100
BEFORE YOU DIG

PRELIMINARY ISSUE

100mm AT FULL SIZE

REV.	DATE	AMENDMENT	DRAWN	CHECK	DESIGN	VERIFY
A	03.08.2018	INITIAL ISSUE	E.G.	R.K.	M.K.	R.K.
B	14.08.2018	AMENDMENTS PER INSTRUCTION	E.G.	R.K.	M.K.	R.K.
C	17.08.2018	AMENDMENTS PER INSTRUCTION	E.G.	R.K.	M.K.	R.K.
D	29.01.2019	DA REFERENCE UPDATED	D.W.	R.K.	M.K.	R.K.
E	01.02.2019	PROPERTY REFERENCE UPDATED	D.W.	R.K.	M.K.	R.K.
F	06.08.2021	LAYOUT AMENDMENT	RJC	R.K.	M.K.	R.K.
G	16.08.2021	MINOR AMENDMENTS	RJC.	R.K.	M.K.	R.K.
H	15.10.2021	BOUNDARY AMENDMENTS	I.B.	R.K.	M.K.	R.K.

SCALES
0 100 200 A1 / A3
1:4000 / 1:8000
ALL DIMENSIONS ARE IN METRES. DO NOT SCALE

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ABN 62 129 445 398

CLIENT
BROADEN MANAGEMENT PTY LTD

PROPERTY DESCRIPTION
BLACK HILL INDUSTRIAL SUBDIVISION
STORMWATER MANAGEMENT PLAN
PROPOSED RESUBDIVISION OF LOT 1
IN THE BROADER SUBDIVISION OF LOT 1131
D.P.1057179, JOHN RENSHAW DRIVE, BLACK HILL

PROJECT
BLACK HILL CONCEPT PLANS

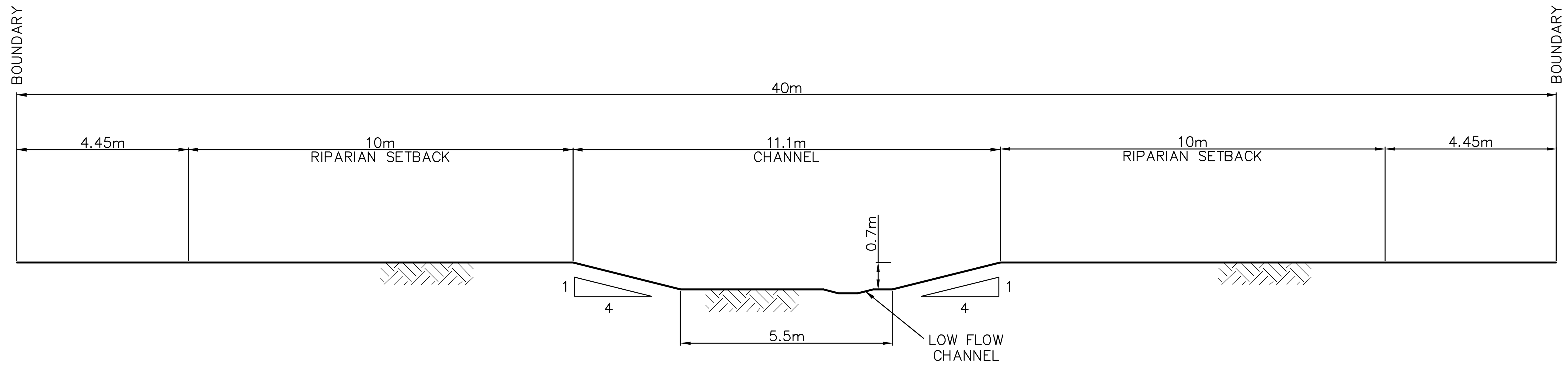
PLAN TITLE
STORMWATER LAYOUT PLAN

SURVEYED	DATUM	PROJECT No.	DISCIPLINE	NUMBER	REV.
ADW Johnson	A.H.D.	239590	SWMP	103	H

DESIGN FILE N:\239590\Design\12D\

Plotted By: iainb Plot Date: 15/10/21 – 09:30 Cad File: \\Jpserver10\adw-data\239590\Drawings\Engineering\Civil\SWMP\239590-SWMP-103(H).dwg

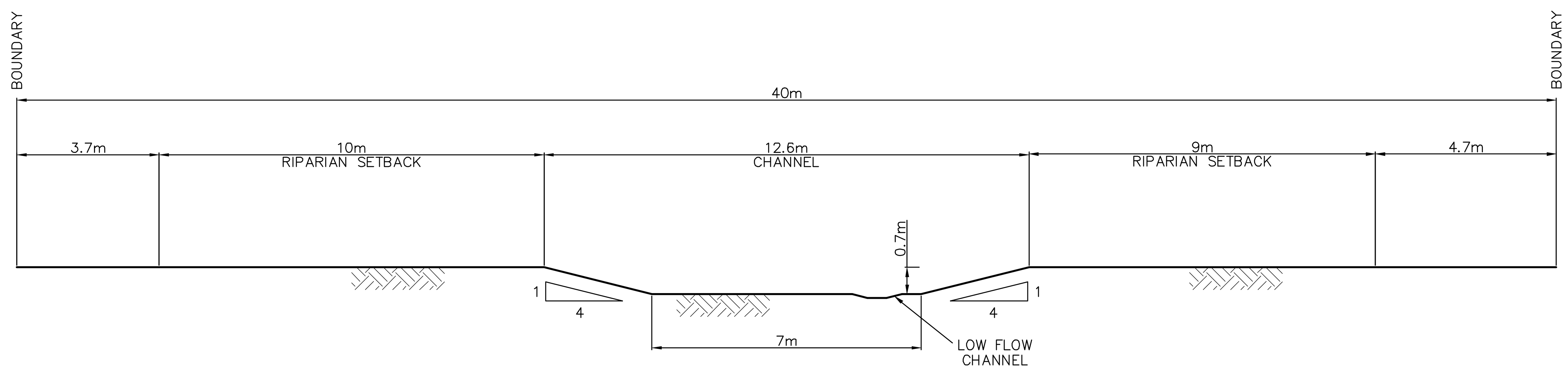
239590-SWMP-104(H)



CHANNEL PROFILE 1

SECTION A 103

SCALE 1:100



CHANNEL PROFILE 2

SECTION B 103

SCALE 1:100

100mm AT FULL SIZE

PRELIMINARY ISSUE

REV.	DATE	AMENDMENT	DRAWN	CHECK	DESIGN	VERIFY
A	03.08.2018	INITIAL ISSUE	E.G.	R.K.	M.K.	R.K.
B	14.08.2018	AMENDMENTS PER INSTRUCTION	E.G.	R.K.	M.K.	R.K.
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D	29.01.2019	DA REFERENCE UPDATED	D.W.	R.K.	M.K.	R.K.
E	01.02.2019	PROPERTY REFERENCE UPDATED	D.W.	R.K.	M.K.	R.K.
F	06.08.2021	LAYOUT AMENDMENT	RJC	R.K.	M.K.	R.K.
G	16.08.2021	MINOR AMENDMENTS	RJC.	R.K.	M.K.	R.K.
H	15.10.2021	BOUNDARY AMENDMENTS	I.B.	R.K.	M.K.	R.K.

DESIGN FILE N:\239590\Design\12D\

SCALES 0 1 2 3 4 A1 / A3 1:100 / 1:200

ALL DIMENSIONS ARE IN METRES. DO NOT SCALE

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CLIENT
BROADEN MANAGEMENT PTY LTD

PROPERTY DESCRIPTION
BLACK HILL INDUSTRIAL SUBDIVISION
STORMWATER MANAGEMENT PLAN
PROPOSED RESUBDIVISION OF LOT 1
IN THE BROADER SUBDIVISION OF LOT 1131
D.P.1057179, JOHN RENSHAW DRIVE, BLACK HILL

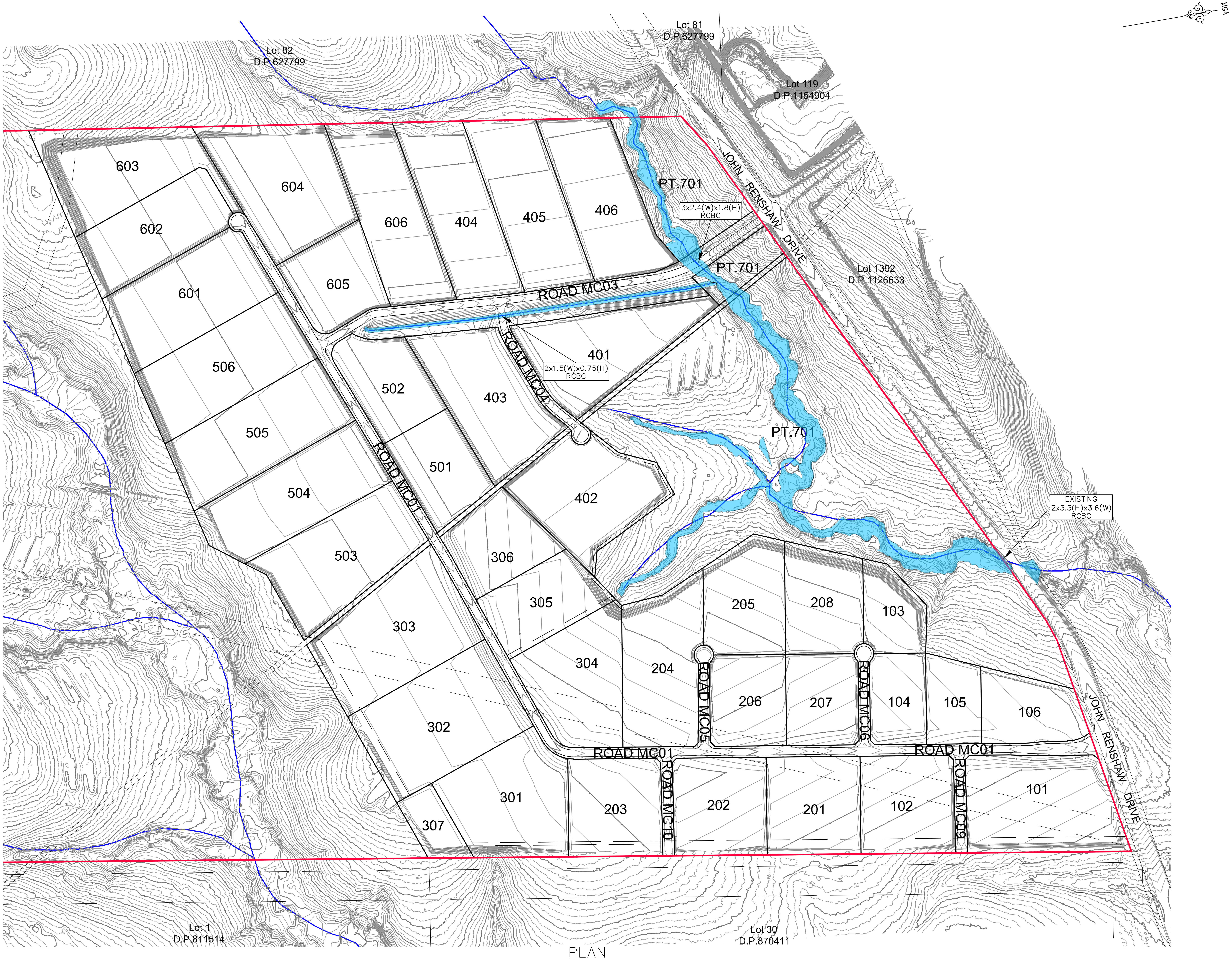
PROJECT
BLACK HILL CONCEPT PLANS

PLAN TITLE
CHANNEL PROFILES

SURVEYED	DATUM	PROJECT No.	DISCIPLINE	NUMBER	REV.
ADW Johnson	A.H.D.	239590	SWMP	104	H

Plotted By: iainb Plot Date: 15/10/21 – 09:30 Cad File: \\Jpserver10\adw-data\239590\Drawings\Engineering\Civil\SWMP\239590-SWMP-104(H).dwg

239590-SWMP-105(H)



PLAN
SCALE 1:4000

LEGEND

- EXISTING LOT BOUNDARY
- PROPOSED LOT BOUNDARY
- FUTURE LOT BOUNDARY
- FINISHED SURFACE CONTOUR
- EXISTING WATERCOURSE
- 1% AEP FLOOD EXTENT

CONTOUR INTERVAL = 0.5m

DIAL 1100 BEFORE YOU DIG

PRELIMINARY ISSUE

100mm AT FULL SIZE

REV.	DATE	AMENDMENT	DRAWN	CHECK	DESIGN	VERIFY
A	03.08.2018	INITIAL ISSUE	E.G.	R.K.	M.K.	R.K.
B	14.08.2018	AMENDMENTS PER INSTRUCTION	E.G.	R.K.	M.K.	R.K.
C	17.08.2018	AMENDMENTS PER INSTRUCTION	E.G.	R.K.	M.K.	R.K.
D	29.01.2019	DA REFERENCE UPDATED	D.W.	R.K.	M.K.	R.K.
E	01.02.2019	PROPERTY REFERENCE UPDATED	D.W.	R.K.	M.K.	R.K.
F	06.08.2021	LAYOUT AMENDMENT	RJC	R.K.	M.K.	R.K.
G	16.08.2021	MINOR AMENDMENTS	RJC	R.K.	M.K.	R.K.
H	15.10.2021	BOUNDARY AMENDMENTS	I.B.	R.K.	M.K.	R.K.

SCALES: 0 100 200 A1 / A3 1:4000 / 1:8000

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www.adwjohnson.com.au
ABN 62 129 445 398

CLIENT: BROADEN MANAGEMENT PTY LTD

PROPERTY DESCRIPTION:
BLACK HILL INDUSTRIAL SUBDIVISION
STORMWATER MANAGEMENT PLAN
PROPOSED RESUBDIVISION OF LOT 1
IN THE BROADER SUBDIVISION OF LOT 1131
D.P.1057179, JOHN RENSHAW DRIVE, BLACK HILL

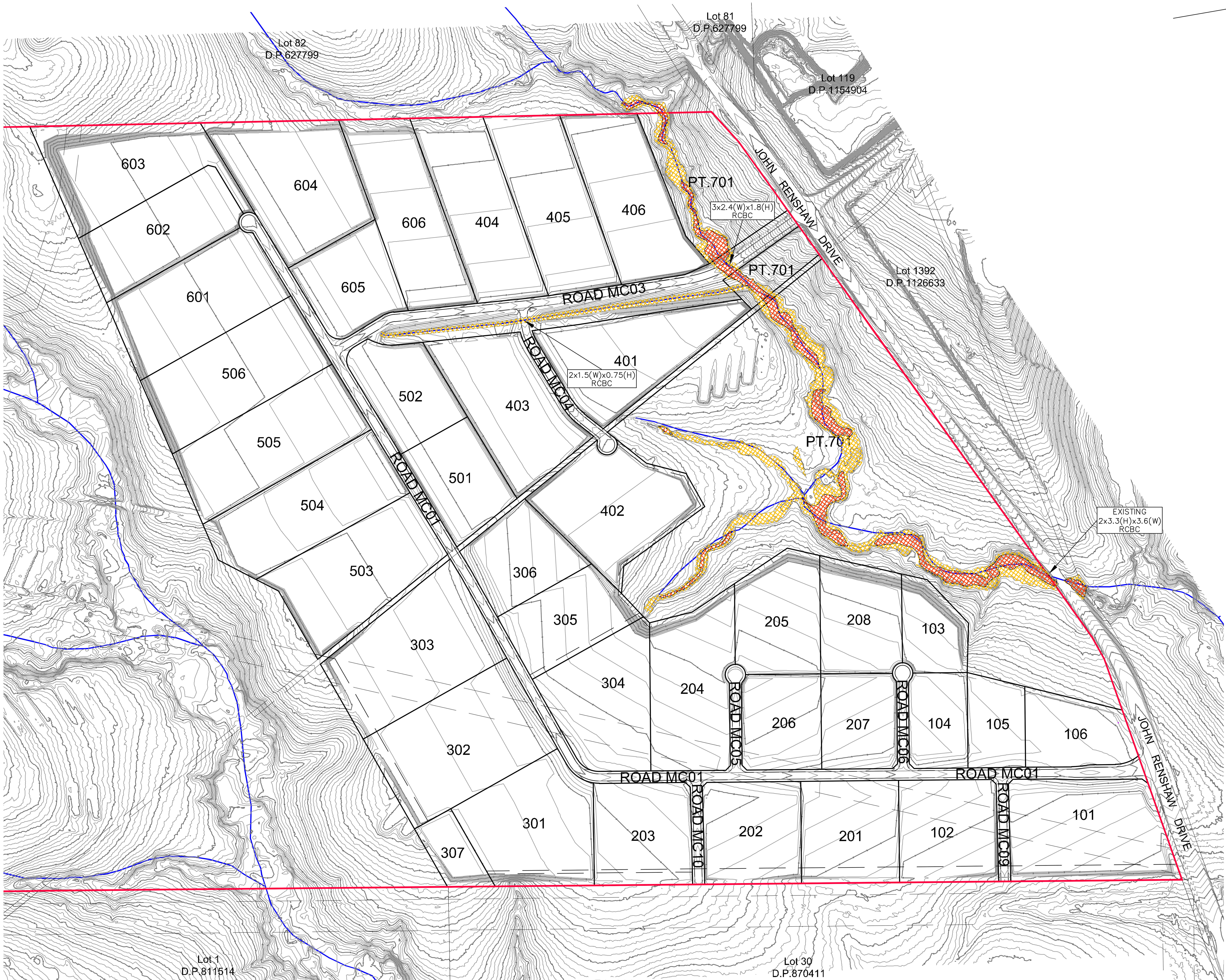
PROJECT: BLACK HILL CONCEPT PLANS

PLAN TITLE: 1% AEP FLOOD EXTENTS

SURVEYED	DATUM	PROJECT No.	DISCIPLINE	NUMBER	REV.
ADW Johnson	A.H.D.	239590	SWMP	105	H

Plotted By: iainb Plot Date: 15/10/21 - 09:31 Cad File: \\Jpserver10\adw-data\239590\Drawings\Engineering\Civil\SWMP\239590-SWMP-105(H).dwg

239590-SWMP-106(H)



PLAN

SCALE 1:4000

LEGEND

	EXISTING LOT BOUNDARY
	PROPOSED LOT BOUNDARY
	FUTURE LOT BOUNDARY
18	FINISHED SURFACE CONTOUR
	EXISTING WATERCOURSE
	1% AEP FLOOD EXTENT
	HIGH HAZARD
	LOW HAZARD

CONTOUR INTERVAL = 0.5m

DIAL 1100 BEFORE YOU DIG

PRELIMINARY ISSUE

100mm AT FULL SIZE

REV.	DATE	AMENDMENT	DRAWN	CHECK	DESIGN	VERIFY
A	03.08.2018	INITIAL ISSUE	E.G.	R.K.	M.K.	R.K.
B	14.08.2018	AMENDMENTS PER INSTRUCTION	E.G.	R.K.	M.K.	R.K.
C	17.08.2018	AMENDMENTS PER INSTRUCTION	E.G.	R.K.	M.K.	R.K.
D	29.01.2019	DA REFERENCE UPDATED	D.W.	R.K.	M.K.	R.K.
E	01.02.2019	PROPERTY REFERENCE UPDATED	D.W.	R.K.	M.K.	R.K.
F	06.08.2021	LAYOUT AMENDMENT	RJC	R.K.	M.K.	R.K.
G	16.08.2021	MINOR AMENDMENTS	RJC.	R.K.	M.K.	R.K.
H	15.10.2021	BOUNDARY AMENDMENTS	I.B.	R.K.	M.K.	R.K.

DESIGN FILE N:\239590\Design\12D\

SCALES
0 100 200 A1 / A3 1:4000 / 1:8000

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CLIENT
BROADEN MANAGEMENT PTY LTD

PROPERTY DESCRIPTION
BLACK HILL INDUSTRIAL SUBDIVISION
STORMWATER MANAGEMENT PLAN
PROPOSED RESUBDIVISION OF LOT 1
IN THE BROADER SUBDIVISION OF LOT 1131
D.P.1057179, JOHN RENSHAW DRIVE, BLACK HILL

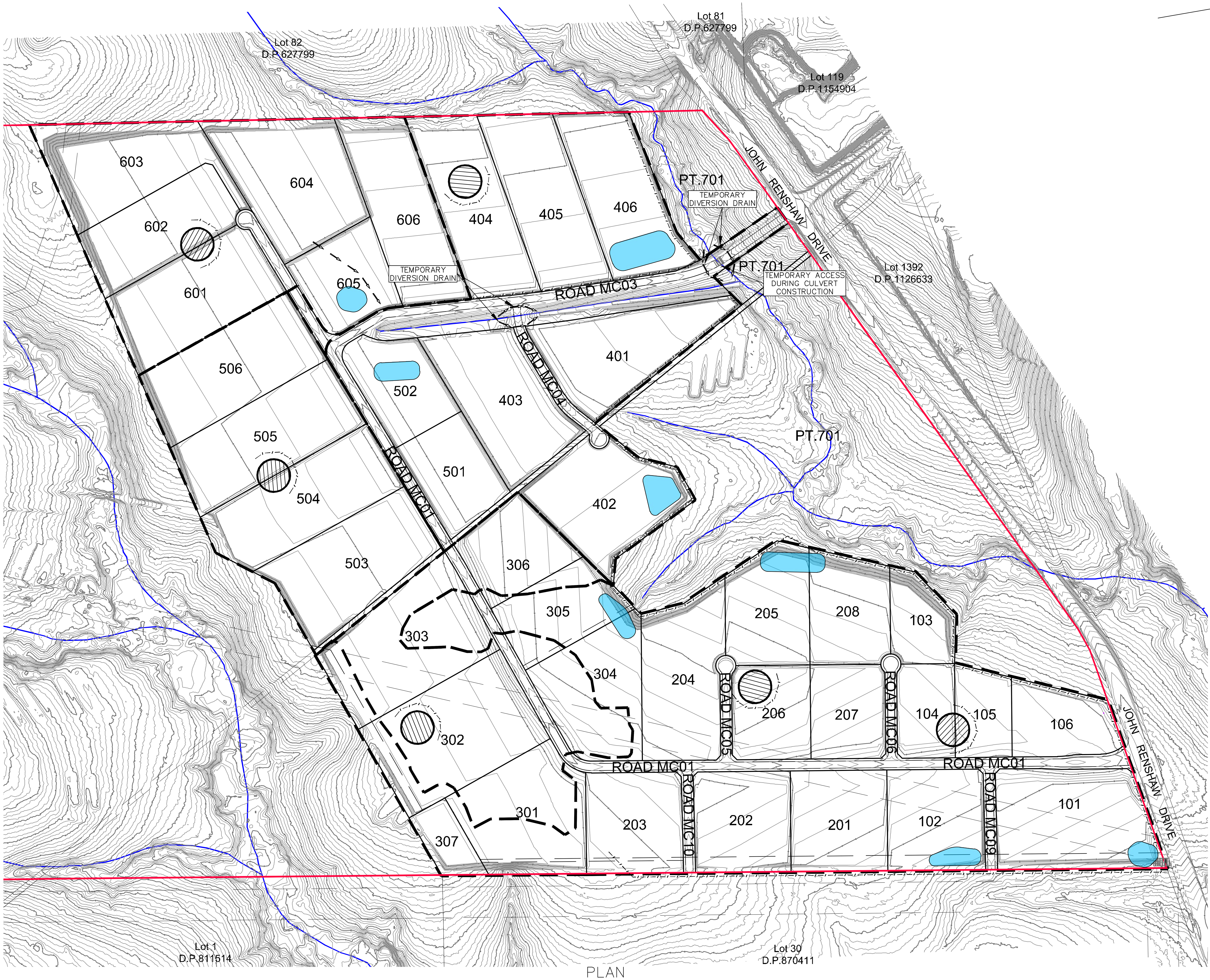
PROJECT
BLACK HILL CONCEPT PLANS

PLAN TITLE
100 YEAR FLOOD HAZARD PLAN

SURVEYED	DATUM	PROJECT No.	DISCIPLINE	NUMBER	REV.
ADW Johnson	A.H.D.	239590	SWMP	106	H

Plotted By: iainb Plot Date: 15/10/21 – 09:32 Cad File: \\Jpserver10\adw-data\239590\Drawings\Engineering\Civil\SWMP\239590-SWMP-106(H).dwg

239590-SWMP-801(H)



PLAN

SCALE 1:4000

LEGEND

- EXISTING LOT BOUNDARY
- PROPOSED LOT BOUNDARY
- LIMIT OF CONSTRUCTION
- PROPOSED KERB
- EXISTING KERB
- DESIGN SURFACE CONTOURS
- EXTENT OF BATTER
- EXISTING STORMWATER
- PROPOSED STORMWATER
- SILT FENCE
- CONSTRUCTION ACCESS
- HAYBALE BARRIERS
- GEOTEXTILE INLET FILTER
- GRAVEL BAGS
- PROPOSED STOCKPILE LOCATION
- MESH & GRAVEL INLET FILTER
- DIVERSION DRAIN
- TEMPORARY SEDIMENT BASIN

CONTOUR INTERVAL = 0.5m

DIAL 1100 BEFORE YOU DIG

STRAW BALE BARRIERS DOWN SLOPE OF KERB INLET PITS AND OUTLETS NOT SHOWN FOR CLARITY

100mm AT FULL SIZE

PRELIMINARY ISSUE

REV.	DATE	AMENDMENT	DRAWN	CHECK	DESIGN	VERIFY
A	03.08.2018	INITIAL ISSUE	E.G.	R.K.	M.K.	R.K.
B	14.08.2018	AMENDMENTS PER INSTRUCTION	E.G.	R.K.	M.K.	R.K.
C	17.08.2018	AMENDMENTS PER INSTRUCTION	E.G.	R.K.	M.K.	R.K.
D	29.01.2019	DA REFERENCE UPDATED	D.W.	R.K.	M.K.	R.K.
E	01.02.2019	PROPERTY REFERENCE UPDATED	D.W.	R.K.	M.K.	R.K.
F	06.08.2021	LAYOUT AMENDMENT	RJC	R.K.	M.K.	R.K.
G	16.08.2021	MINOR AMENDMENTS	RJC.	R.K.	M.K.	R.K.
H	15.10.2021	BOUNDARY AMENDMENTS	I.B.	R.K.	M.K.	R.K.

DESIGN FILE N:\239590\Design\12D\

SCALES
0 100 200 A1 / A3 1:4000 / 1:8000

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STORMWATER MANAGEMENT PLAN
PROPOSED RESUBDIVISION OF LOT 1
IN THE BROADER SUBDIVISION OF LOT 1131
D.P.1057179, JOHN RENSHAW DRIVE, BLACK HILL

SURVEYED: ADW Johnson
DATUM: A.H.D.

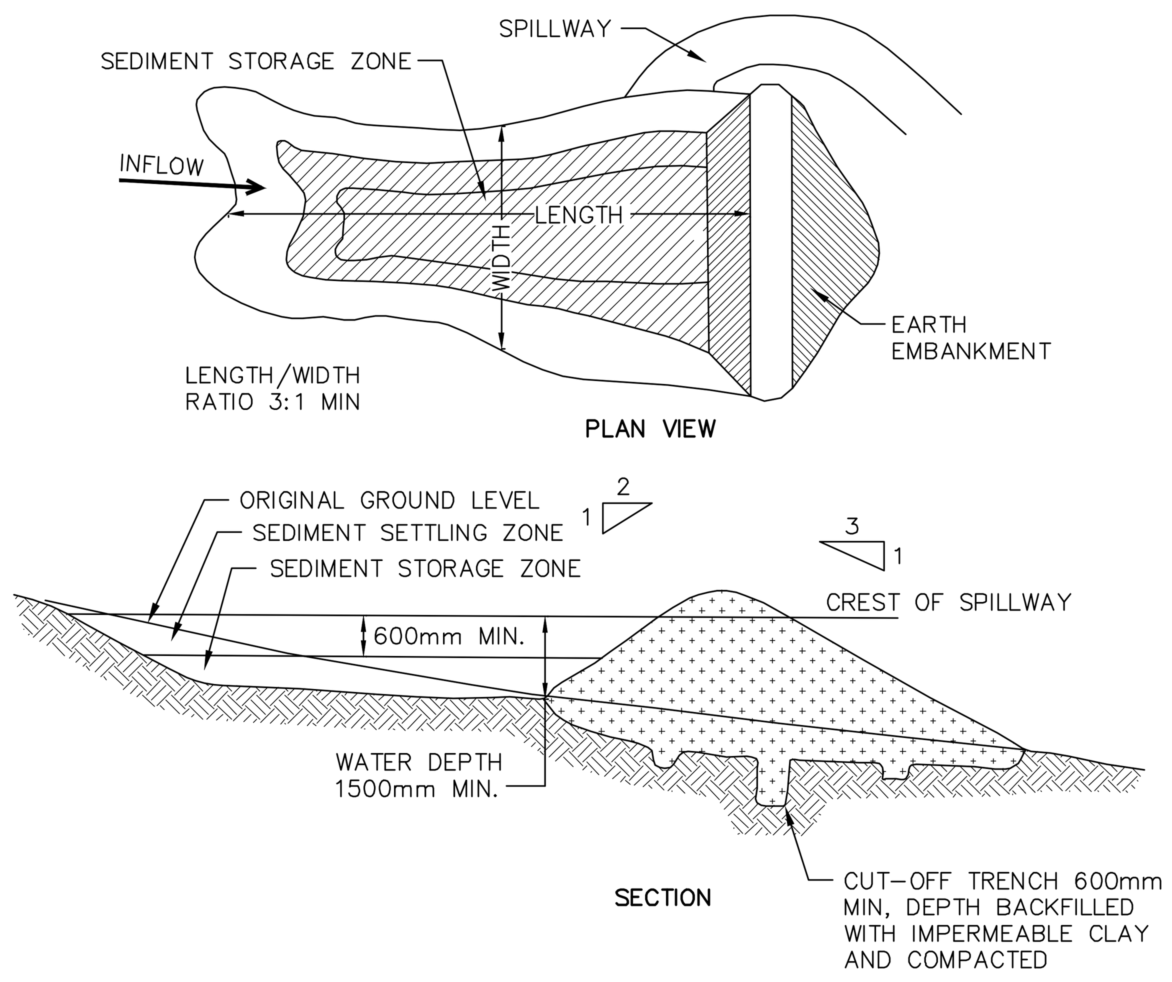
PROJECT
BLACK HILL CONCEPT PLANS

PLAN TITLE
EROSION & SEDIMENT CONTROL PLAN

PROJECT No.		DISCIPLINE		NUMBER	REV.
239590	-	SWMP	-	801	H

Plotted By: iainb Plot Date: 15/10/21 - 09:32 Cad File: \\Jpserver10\adw-data\239590\Drawings\Engineering\Civil\SWMP\239590-SWMP-801(H).dwg

239590-SWMP-802(H)



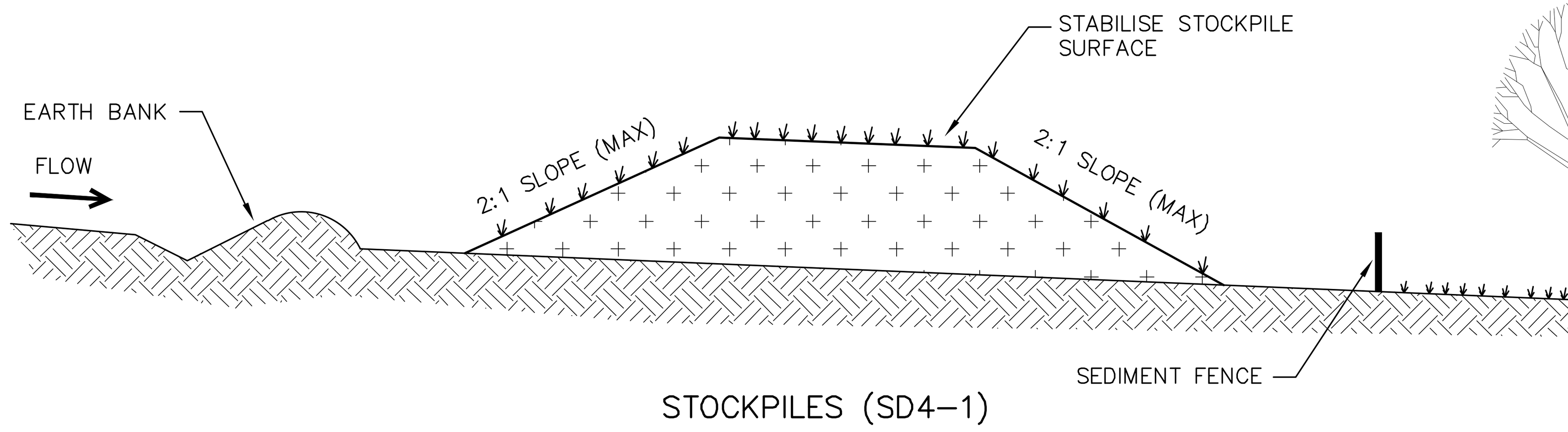
WET EARTH BASIN (SD6-4)

(APPLIES TO 'TYPE D' AND 'TYPE F' SOILS ONLY)

N.T.S.

CONSTRUCTION NOTES:

1. REMOVE ALL VEGETATION AND TOPSOIL FROM UNDER THE DAM WALL AND FROM WITHIN THE STORAGE AREA.
2. CONSTRUCT A CUT-OFF TRENCH 500mm DEEP AND 1200mm WIDE ALONG THE CENTRELINE OF THE EMBANKMENT EXTENDING TO A POINT ON THE GULLY WALL LEVEL WITH THE RISER CREST.
3. MAINTAIN THE TRENCH FREE OF WATER AND RECOMPACT THE MATERIALS WITH EQUIPMENT AS SPECIFIED IN THE SWMP TO 95 PERCENT STANDARD PROCTOR DENSITY.
4. SELECT FILL ACCORDING TO THE SWMP THAT IS FREE FROM ROOTS, WOOD, ROCK, LARGE STONE OR FOREIGN MATERIAL.
5. PREPARE THE SITE UNDER THE EMBANKMENT BY RIPPING TO AT LEAST 100mm TO HELP BOND THE COMPACTED FILL TO THE EXISTING SUBSTRATE.
6. SPREAD THE FILL IN 100mm TO 150mm LAYERS AND COMPACT IT AT OPTIMUM MOISTURE CONTENT FOLLOWING THE SWMP.
7. CONSTRUCT THE EMERGENCY SPILLWAY.
8. REHABILITATE THE STRUCTURE FOLLOWING THE SWMP.

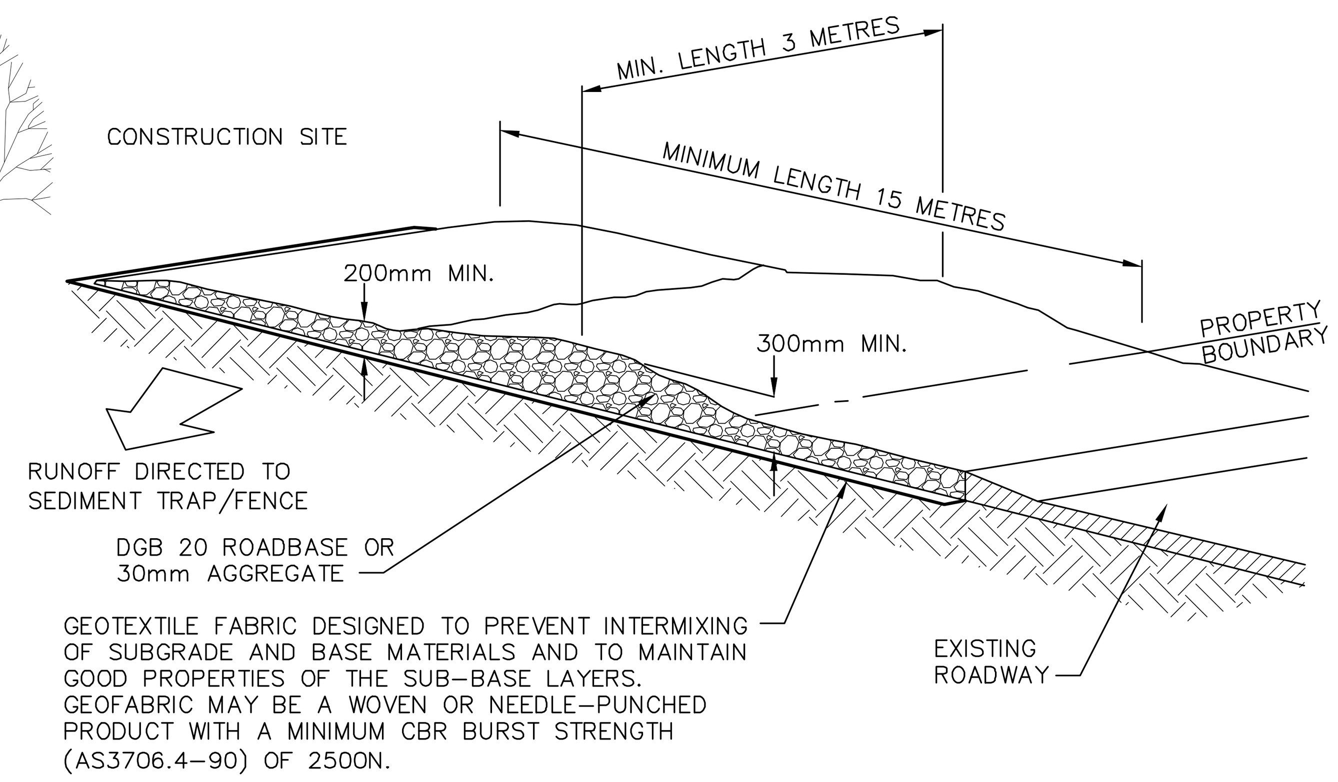


STOCKPILES (SD4-1)

N.T.S.

CONSTRUCTION NOTES:

1. PLACE STOCKPILES MORE THAN 2 (PREFERABLY 5) METRES FROM EXISTING VEGETATION, CONCENTRATED WATER FLOW, ROADS AND HAZARD AREAS.
2. CONSTRUCT ON THE CONTOUR AS LOW, FLAT, ELONGATED MOUNDS.
3. WHERE THERE IS SUFFICIENT AREA, TOPSOIL STOCKPILES SHALL BE LESS THAN 2 METRES IN HEIGHT.
4. WHERE THEY ARE TO BE IN PLACE FOR MORE THAN 10 DAYS, STABILISE FOLLOWING THE APPROVED ESCP OR SWMP TO REDUCE THE C-FACTOR TO LESS THAN 0.10.
5. CONSTRUCT EARTH BANKS (STANDARD DRAWING 5-5) ON THE UPSLOP SIDE TO DIVERT WATER AROUND STOCKPILES AND SEDIMENT FENCES (STANDARD DRAWING 6-8) 1 TO 2 METRES DOWNSLOPE.

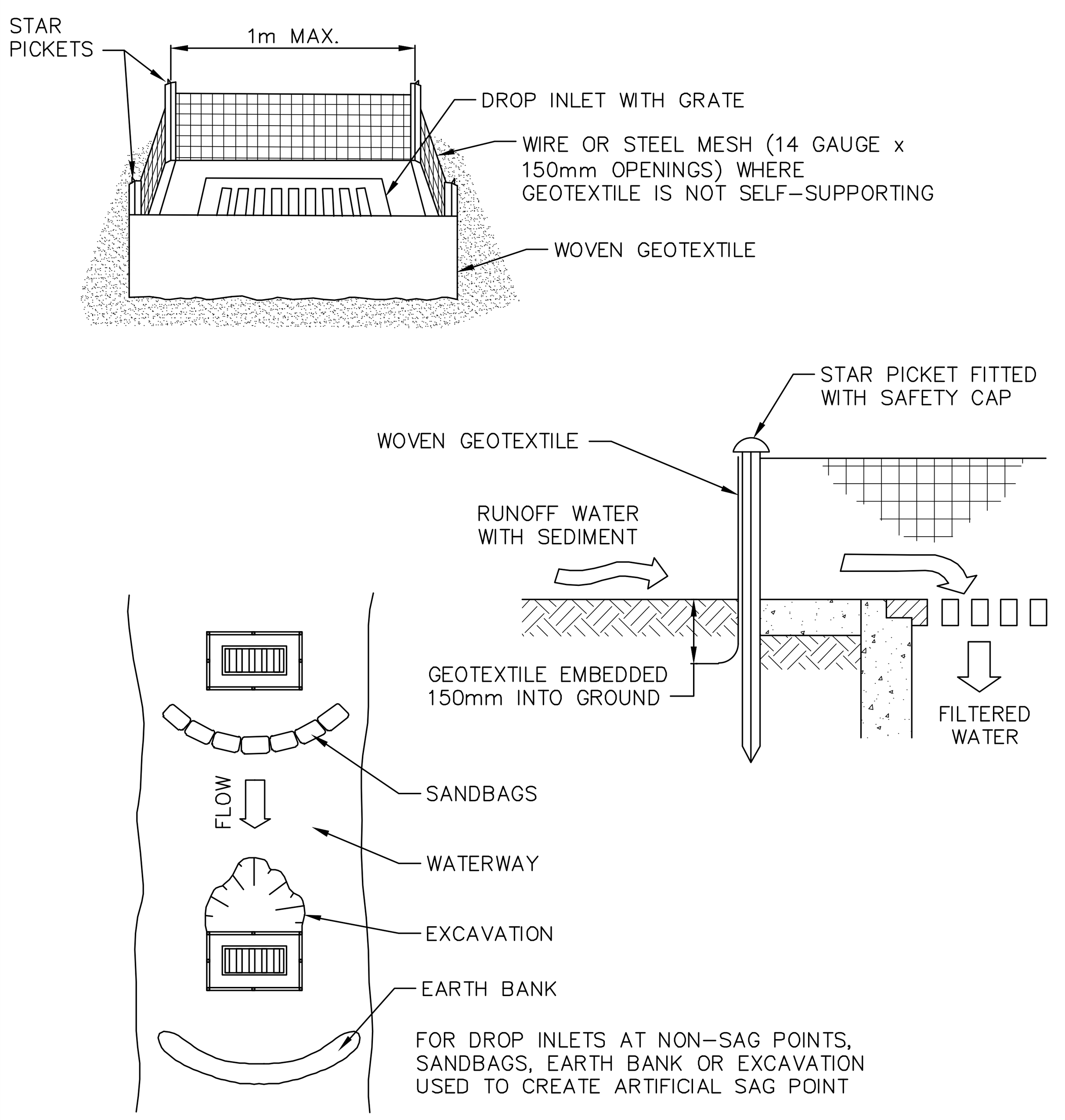


STABILISED SITE ACCESS (SD6-14)

N.T.S.

CONSTRUCTION NOTES:

1. STRIP THE TOPSOIL, LEVEL THE SITE AND COMPACT THE SUBGRADE.
2. COVER THE AREA WITH NEEDLE-PUNCHED GEOTEXTILE.
3. CONSTRUCT A 200mm THICK PAD OVER THE GEOTEXTILE USING ROAD BASE OR 30mm AGGREGATE.
4. ENSURE THE STRUCTURE IS AT LEAST 15 METRES LONG OR TO BUILDING ALIGNMENT AND AT LEAST 3 METRES WIDE.
5. WHERE A SEDIMENT FENCE JOINS ONTO THE STABILISED ACCESS, CONSTRUCT A HUMP IN THE STABILISED ACCESS TO DIVERT WATER TO THE SEDIMENT FENCE.

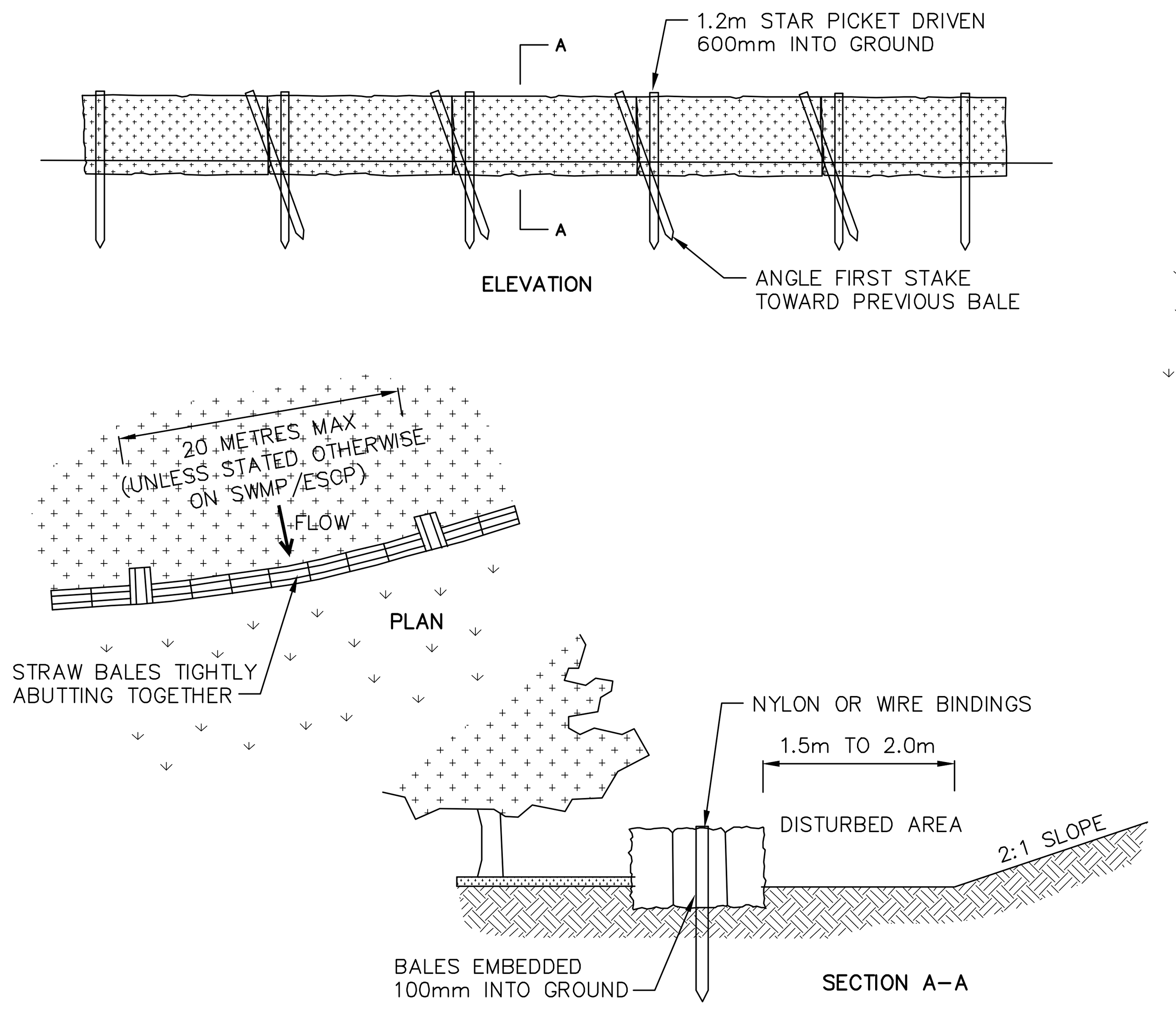


GEOTEXTILE INLET FILTER (SD6-12)

N.T.S.

CONSTRUCTION NOTES:

1. FABRICATE A SEDIMENT BARRIER MADE FROM GEOTEXTILE OR STRAW BALES.
2. REFER STANDARD DRAWINGS 6-7 & 6-8 FOR INSTALLATION PROCEDURES FOR THE STRAW BALES OR GEOFABRIC. REDUCE THE PICKET SPACING TO 1 METRE CENTRES.
3. IN WATERWAYS, ARTIFICIAL SAG POINTS CAN BE CREATED WITH SANDBAGS OR EARTH BANKS AS SHOWN IN THE DRAWING.
4. DO NOT COVER THE INLET WITH GEOTEXTILE UNLESS THE DESIGN IS ADEQUATE TO ALLOW FOR ALL WATERS TO BYPASS IT.

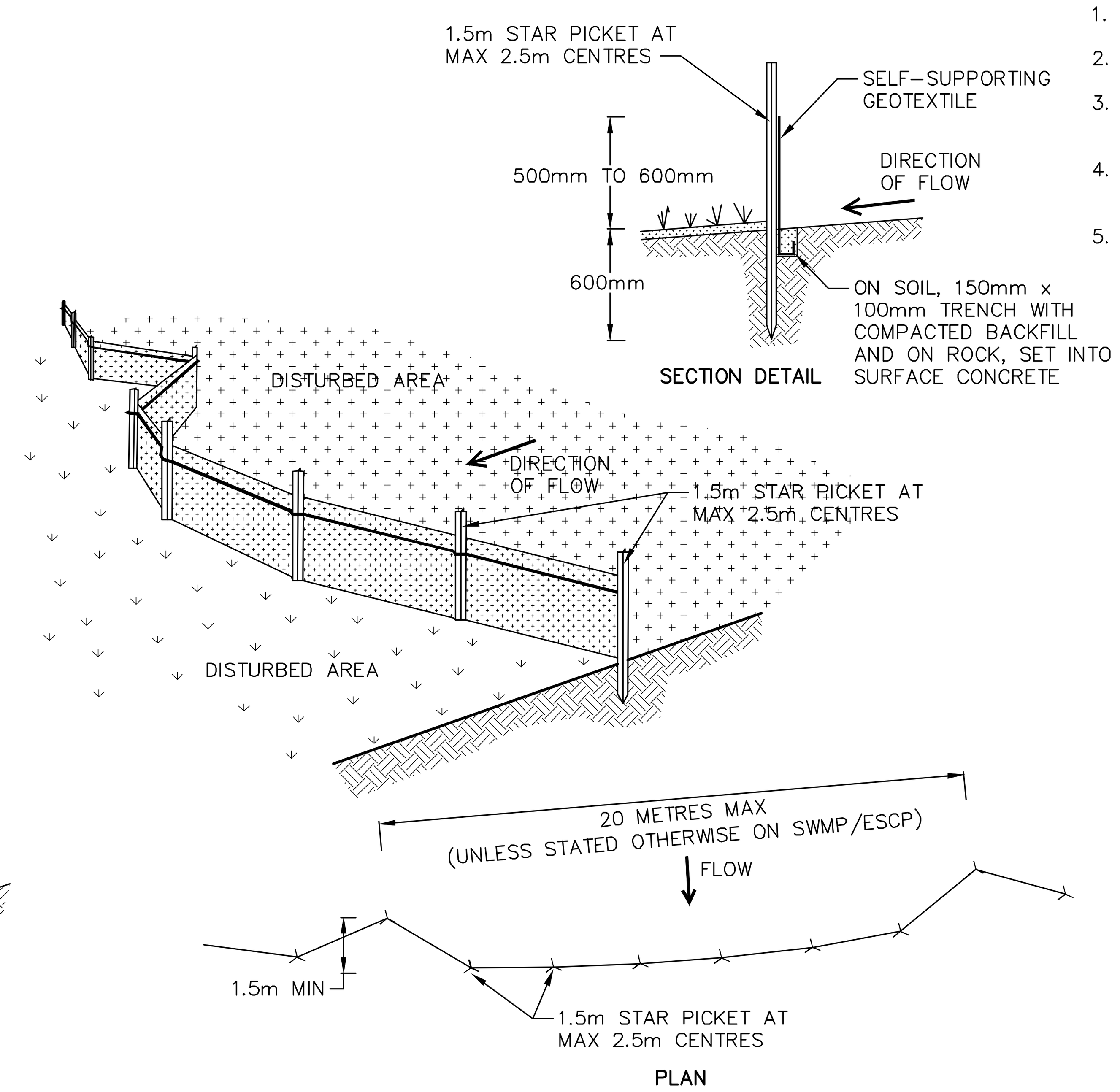


STRAW BALE FILTER (SD6-7)

N.T.S.

CONSTRUCTION NOTES:

1. CONSTRUCT THE STRAW BALE FILTER AS CLOSE AS POSSIBLE TO BEING PARALLEL TO THE CONTOURS OF THE SITE.
2. PLACE BALES LENGTHWISE IN A ROW WITH ENDS TIGHTLY ABUTTING. USE STRAW TO FILL ANY GAPS BETWEEN BALES. STRAWS ARE TO BE PLACED PARALLEL TO GROUND.
3. ENSURE THAT THE MAXIMUM HEIGHT OF THE FILTER IS ONE BALE.
4. EMBED EACH BALE IN THE GROUND 75mm TO 100mm AND ANCHOR WITH TWO 1.2m STAR PICKETS OR STAKES. ANGLE THE FIRST STAR PICKET OR STAKE IN EACH BALE TOWARDS THE PREVIOUSLY LAID BALE. DRIVE THEM 600mm IN THE GROUND AND, IF POSSIBLE, FLUSH WITH THE TOP OF THE BALES. WHERE STAR PICKETS ARE USED AND THEY PROTRUDE ABOVE THE BALES, ENSURE THEY ARE FITTED WITH SAFETY CAPS.
5. WHERE A STRAW BALE FILTER IS CONSTRUCTED DOWNSLOPE FROM A DISTURBED BATTER, ENSURE THE BALES ARE PLACES 1 TO 2 METRES DOWNSLOPE FROM THE TOE.
6. ESTABLISH A MAINTENANCE PROGRAM THAT ENSURES THE INTEGRITY OF THE BALES IS RETAINED – THEY COULD REQUIRE REPLACEMENT EACH TWO TO FOUR MONTHS.

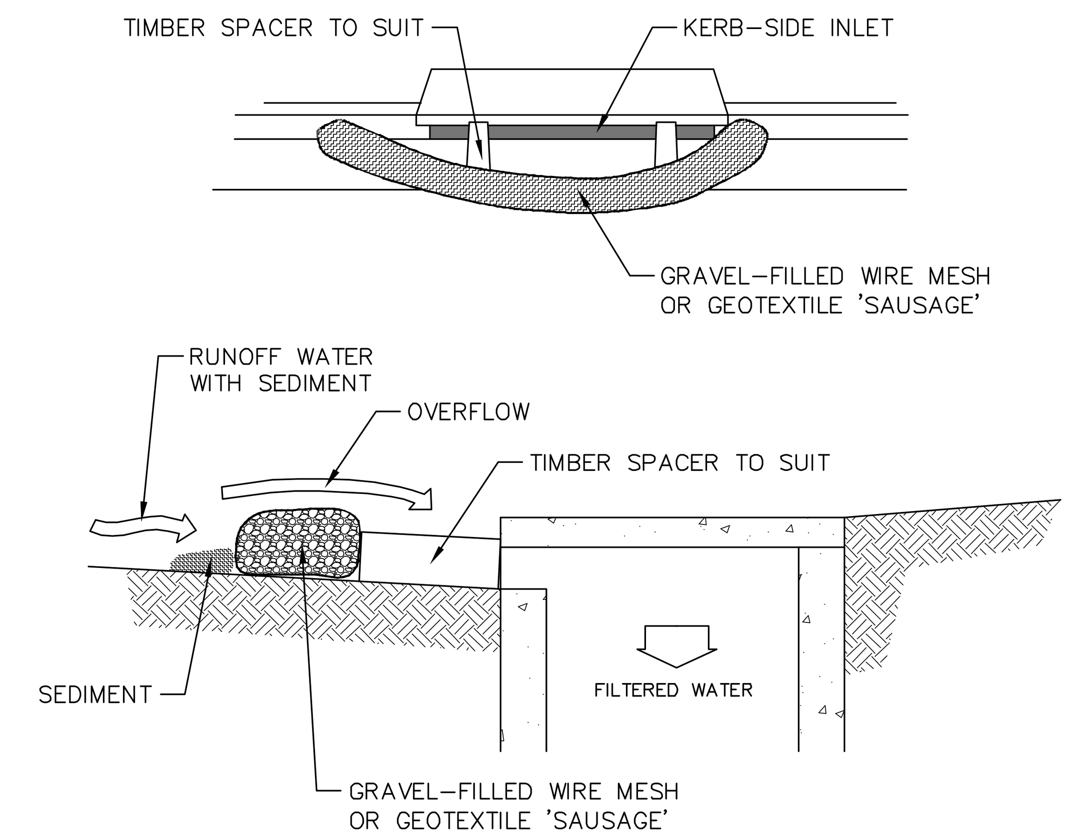


SEDIMENT FENCE (SD6-8)

N.T.S.

CONSTRUCTION NOTES:

1. CONSTRUCT SEDIMENT FENCES AS CLOSE AS POSSIBLE TO BEING PARALLEL TO THE CONTOURS OF THE SITE, BUT WITH SMALL RETURNS AS SHOWN IN THE DRAWING TO LIMIT THE CATCHMENT AREA OF ANY ONE SECTION. THE CATCHMENT AREA SHOULD BE SMALL ENOUGH TO LIMIT WATER FLOW IF CONCENTRATED AT ONE POINT TO 50 LITRES PER SECOND IN THE DESIGN STORM EVENT, USUALLY THE 10-YEAR EVENT.
2. CUT A 150mm DEEP TRENCH ALONG THE UPSLOPE LINE OF THE FENCE FOR THE BOTTOM OF THE FABRIC TO BE ENTRENCHED.
3. DRIVE 1.5m LONG STAR PICKETS INTO GROUND AT 2.5 METRE INTERVALS (MAX) AT DOWNSLOPE EDGE OF THE TRENCH. ENSURE ANY STAR PICKETS ARE FITTED WITH SAFETY CAPS.
4. FIX SELF-SUPPORTING GEOTEXTILE TO THE UPSLOPE SIDE OF THE POSTS ENSURING IT GOES TO THE BASE OF THE TRENCH. FIX THE GEOTEXTILE WITH WIRE TIES OR AS RECOMMENDED BY THE MANUFACTURER. ONLY USE GEOTEXTILE SPECIFICALLY PRODUCED FOR SEDIMENT FENCING. THE USE OF SHADE CLOTH FOR THIS PURPOSE IS NOT SATISFACTORY.
5. JOIN SECTIONS OF FABRIC AT A SUPPORT POST WITH A 150mm OVERLAP.
6. BACKFILL THE TRENCH OVER THE BASE OF THE FABRIC AND COMPACT IT THOROUGHLY OVER THE GEOTEXTILE.



NOTE: THIS PRACTICE ONLY TO BE USED WHERE SPECIFIED IN AN APPROVED SWMP/ESCP.

MESH AND GRAVEL INLET FILTER (SD6-11)

N.T.S.

CONSTRUCTION NOTES:

1. INSTALL FILTERS TO KERB INLETS ONLY ONLY AT SAG POINTS.
2. FABRICATE A SLEEVE MADE FROM GEOTEXTILE OR WIRE MESH LONGER THAN THE LENGTH OF THE INLET PIT AND FILL IT WITH 25mm TO 50mm GRAVEL.
3. FORM AN ELLIPTICAL CROSS SECTION ABOUT 150mm HIGH x 400mm WIDE.
4. PLACE THE FILTER AT THE OPENING LEAVING AT LEAST A 100mm SPACE BETWEEN IT AND THE KERB INLET. MAINTAIN THE OPENING WITH SPACER BLOCKS.
5. FORM A SEAL WITH THE KERB TO PREVENT SEDIMENT BYPASSING THE FILTER.
6. SANDBAGS FILLED WITH GRAVEL CAN SUBSTITUTE FOR THE MESH OR GEOTEXTILE PROVIDING THEY ARE PLACED SO THAT THEY FIRMLY ABUT EACH OTHER AND SEDIMENT-LADEN WATERS CANNOT PASS BETWEEN.

PRELIMINARY ISSUE

100mm AT FULL SIZE

REV.	DATE	AMENDMENT	DRAWN	CHECK	DESIGN	VERIFY
A	03.08.2018	INITIAL ISSUE	E.G.	R.K.	M.K.	R.K.
B	14.08.2018	AMENDMENTS PER INSTRUCTION	E.G.	R.K.	M.K.	R.K.
C	17.08.2018	AMENDMENTS PER INSTRUCTION	E.G.	R.K.	M.K.	R.K.
D	29.01.2019	DA REFERENCE UPDATED	D.W.	R.K.	M.K.	R.K.
E	01.02.2019	PROPERTY REFERENCE UPDATED	D.W.	R.K.	M.K.	R.K.
F	06.08.2021	LAYOUT AMENDMENT	RJC	R.K.	M.K.	R.K.
G	16.08.2021	MINOR AMENDMENTS	RJC	R.K.	M.K.	R.K.
H	15.10.2021	BOUNDARY AMENDMENTS	I.B.	R.K.	M.K.	R.K.

SCALES

ALL DIMENSIONS ARE IN METRES. DO NOT SCALE

DESIGN FILE N:\239590\Design\12D\

adw johnson

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ABN 62 129 445 398

CLIENT

BROADEN MANAGEMENT PTY LTD

PROPERTY DESCRIPTION

BLACK HILL INDUSTRIAL SUBDIVISION
STORMWATER MANAGEMENT PLAN
PROPOSED RESUBDIVISION OF LOT 1
IN THE BROADER SUBDIVISION OF LOT 1131
D.P.1057179, JOHN RENSHAW DRIVE, BLACK HILL

SURVEYED	DATUM
ADW Johnson	A.H.D.

PROJECT: BLACK HILL CONCEPT PLANS

PLAN TITLE: EROSION & SEDIMENT CONTROL DETAILS

PROJECT No.	DISCIPLINE	NUMBER	REV.
239590	SWMP	802	H

Plotted By: iainb Plot Date: 15/10/21 - 09:33 Cad File: \\Jpserver10\adw-data\239590\Drawings\Engineering\Civil\SWMP\239590-SWMP-802(H).dwg

Appendix B – Stormwater Detention

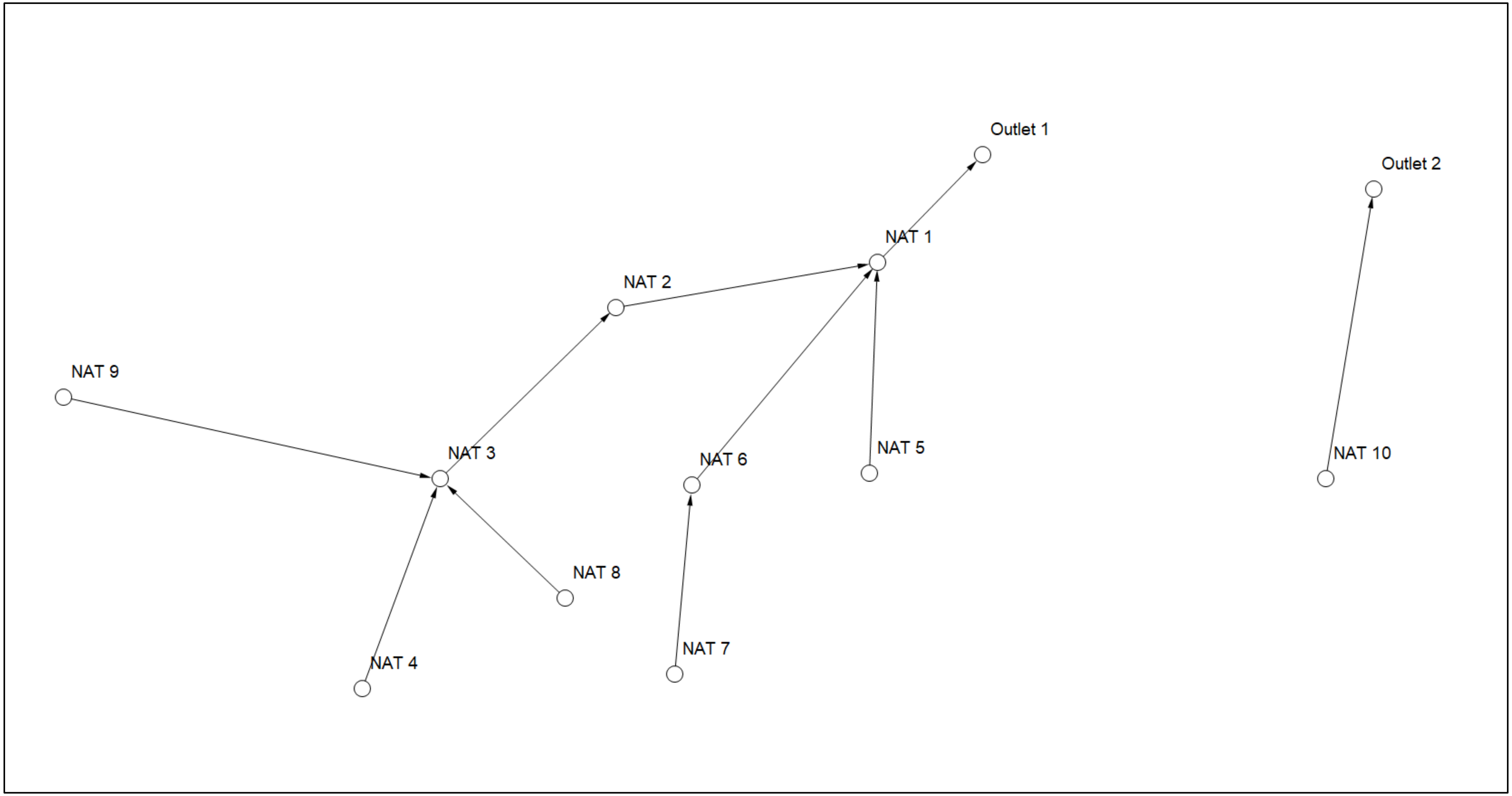


Figure B-1 – Predeveloped XPRAFTS Catchment Model

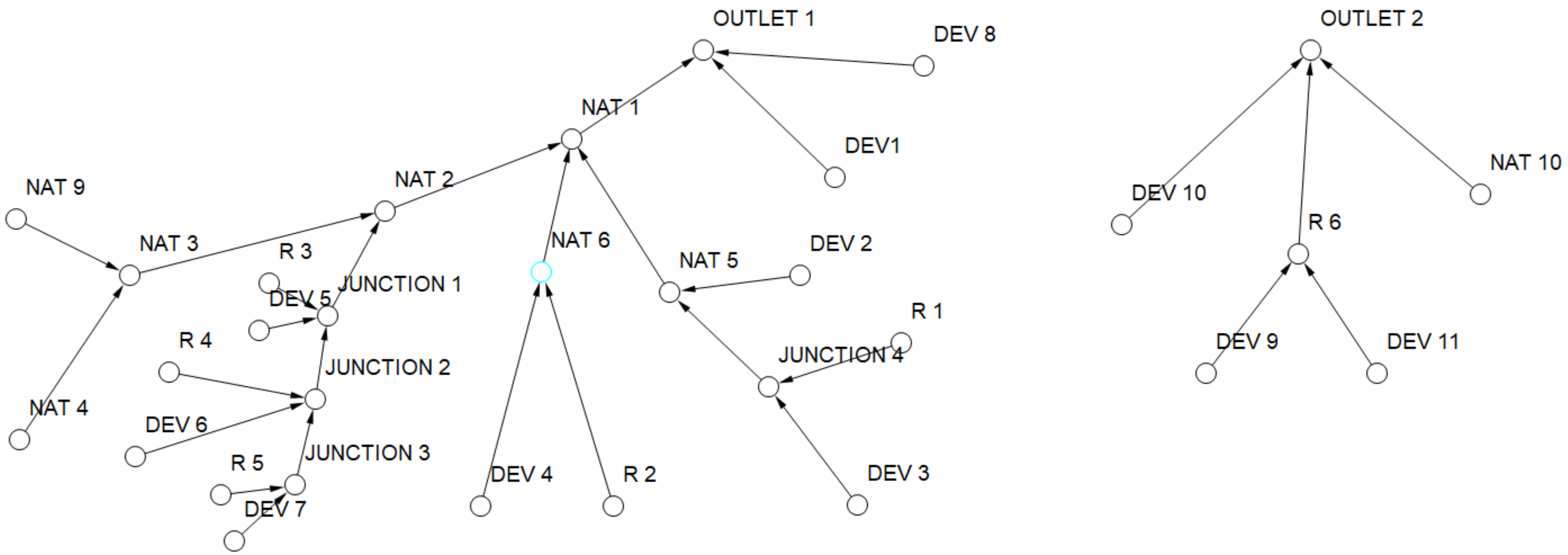


Figure B-2 – Developed XPRAFTS Catchment Model

Table B-1 – Predeveloped Catchment XPRAFTS Parameters

Subcatchment ID	Subcatchment Number	Total Area [ha]	Catchment Mannings 'n' [n value]	Percentage Impervious [%]	Init/Cont Rainfall Loss (mm mm/h)	Catchment Slope [%]
NAT 1	1	38.153	0.045	0	5/2.5	3.9
NAT 2	1	18.868	0.045	0	5/2.5	5.1
NAT 3	1	40.839	0.045	0	5/2.5	2.6
NAT 4	1	44	0.06	0	5/2.5	2.1
NAT 5	1	41.621	0.045	0	5/2.5	2.8
NAT 6	1	18.826	0.045	0	5/2.5	1.8
NAT 7	1	16.064	0.045	0	5/2.5	2.3
NAT 8	1	36.25	0.045	0	5/2.5	3
NAT 9	1	44.744	0.06	0	5/2.5	3.4
NAT 10	1	41.84	0.045	0	5/2.5	3.4

Table B-2 – Developed Catchment XPRAFTS Parameters

Subcatchment ID	Subcatchment Number	Total Area [ha]	Catchment Mannings 'n' [n value]	Percentage Impervious [%]	Init/Cont Rainfall Loss [mm/mm per h]	Catchment Slope [%]
NAT 1	1	24.12	0.045	0	10/5	3.9
NAT 2	1	18.453	0.045	0	10/5	5.1
NAT 3	1	20.808	0.045	0	10/5	2.6
NAT 4	1	39.616	0.06	0	10/5	2.1
NAT 5	1	5.17	0.06	0	10/5	3
NAT 6	1	6.837	0.06	0	10/5	4
NAT 10	1	15.195	0.045	0	10/5	2
DEV 10	1	17.205	0.045	0	10/5	1
NAT 9	1	44.699	0.06	0	10/5	3.4
R 3	1	0.325	0.03	0	10/5	2
	2	1.842	0.018	100	1/0	2
DEV 5	1	15.032	0.045	0	10/5	4
R 4	1	0.094	0.03	0	10/5	2
	2	0.475	0.018	100	1/0	2
R 5	1	0.219	0.03	0	10/5	2
	2	1.243	0.018	100	1/0	2
DEV 4	1	17.312	0.045	0	10/5	2.6
R 2	1	0.084	0.03	0	10/5	2
	2	0.475	0.018	100	1/0	2
DEV 3	1	29.851	0.045	0	10/5	3
R 1	1	0.264	0.03	0	10/5	2
	2	1.497	0.018	100	1/0	2
R 6	1	0.674	0.03	0	10/5	1
	2	3.818	0.018	100	1/0	1
DEV1	1	13.85	0.06	0	10/5	3
DEV 6	1	13.739	0.045	0	10/5	2.6
DEV 7	1	25.08	0.045	0	10/5	2.6
DEV 2	1	10.853	0.045	0	10/5	3.1

DEV 11	1	3.716	0.045	0	10/5	2
DEV 8	1	6.587	0.045	0	10/5	2.1
DEV 9	1	4.491	0.045	0	10/5	2

Table B-3 – Predeveloped XPRAFTS Lag Parameters

Link	Subcatchment Number	Hydrograph Lag [mins]
NAT 10 - Outlet 2 (link1)	1	0
NAT 4 - NAT 3 (link2)	1	15
NAT 3 - NAT 2 (link3)	1	12
NAT 2 - NAT 1 (link4)	1	9
NAT 1 - Outlet 1 (link5)	1	0
NAT 5 - NAT 1 (link6)	1	18
NAT 6 - NAT 1 (link7)	1	17
NAT 9 - NAT 3 (link8)	1	15
NAT 7 - NAT 6 (link9)	1	7
NAT 8 - NAT 3 (link10)	1	8

Table B-4 – Developed XPRAFTS Lag Parameters

Link	Subcatchment Number	Hydrograph Lag [mins]
NAT 4 - NAT 3 (link1)	1	15
NAT 3 - NAT 2 (link2)	1	15
NAT 2 - NAT 1 (link3)	1	9
NAT 1 - OUTLET 1 (link4)	1	9
NAT 5 - NAT 1 (link5)	1	0
NAT 10 - OUTLET 2 (link12)	1	0
NAT 9 - NAT 3 (link14)	1	15
DEV 4 - NAT 6 (link16)	1	6
DEV 3 - JUNCTION 4 (link18)	1	5
R 1 - JUNCTION 4 (link20)	1	0
	2	0
DEV1 - OUTLET 1 (link25)	1	0
R 2 - NAT 6 (link11)	1	0
	2	0
DEV 10 - OUTLET 2 (link8)	1	0
R 6 - OUTLET 2 (link10)	1	0
	2	0
JUNCTION 4 - NAT 5 (link15)	1	8
JUNCTION 1 - NAT 2 (link17)	1	0
DEV 5 - JUNCTION 1 (link6)	1	0
R 3 - JUNCTION 1 (link7)	1	0
	2	0
R 4 - JUNCTION 2 (link9)	1	6
	2	0
DEV 6 - JUNCTION 2 (link13)	1	9
R 5 - JUNCTION 3 (link19)	1	0
	2	0
DEV 7 - JUNCTION 3 (link21)	1	12
JUNCTION 3 - JUNCTION 2 (link22)	1	9
JUNCTION 2 - JUNCTION 1 (link23)	1	12
DEV 2 - NAT 5 (link24)	1	0
NAT 6 - NAT 1 (link27)	1	0
DEV 8 - OUTLET 1 (link29)	1	0
DEV 11 - R 6 (link26)	1	0
DEV 9 - R 6 (link30)	1	0

Appendix C - Flood Assessment

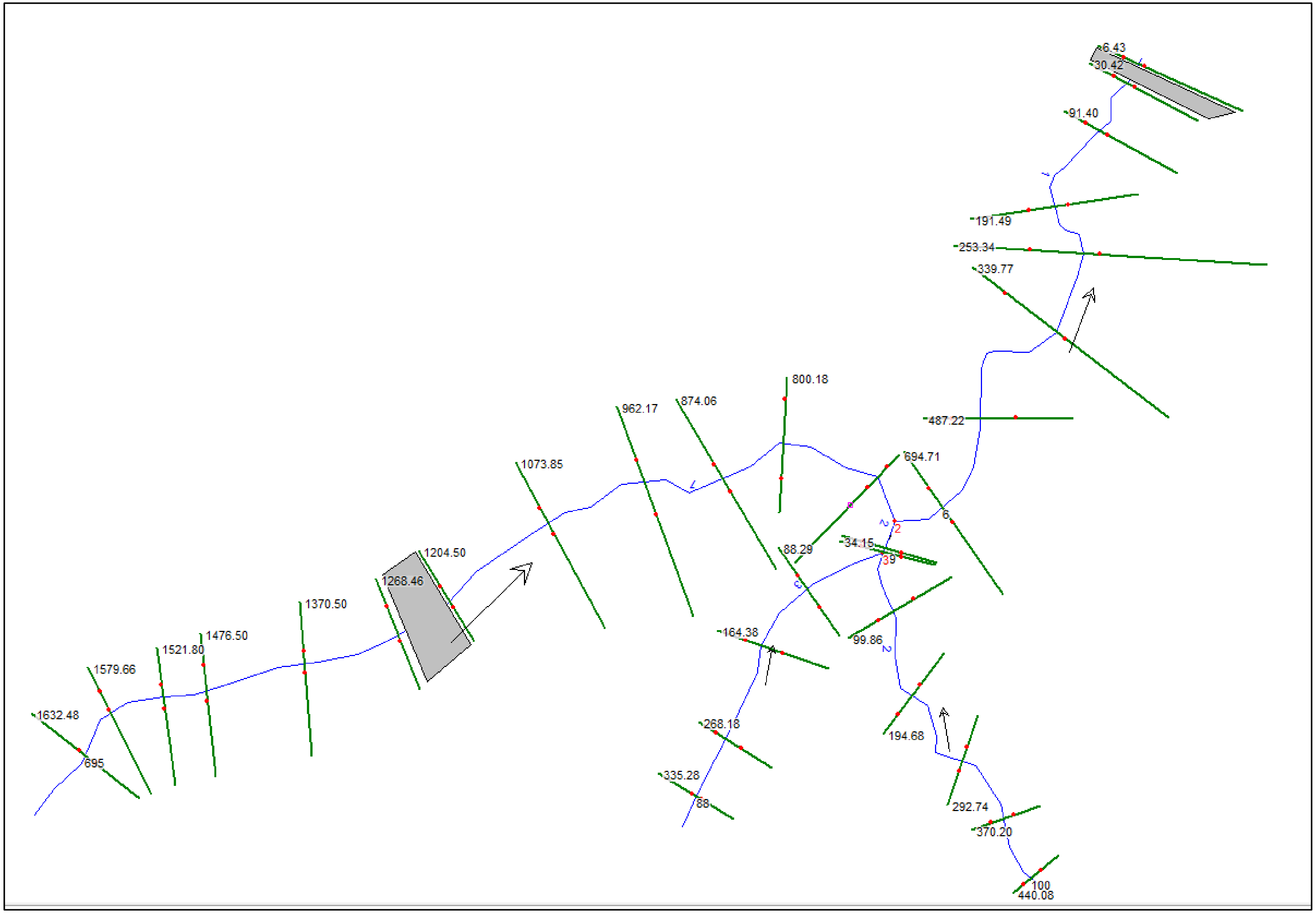
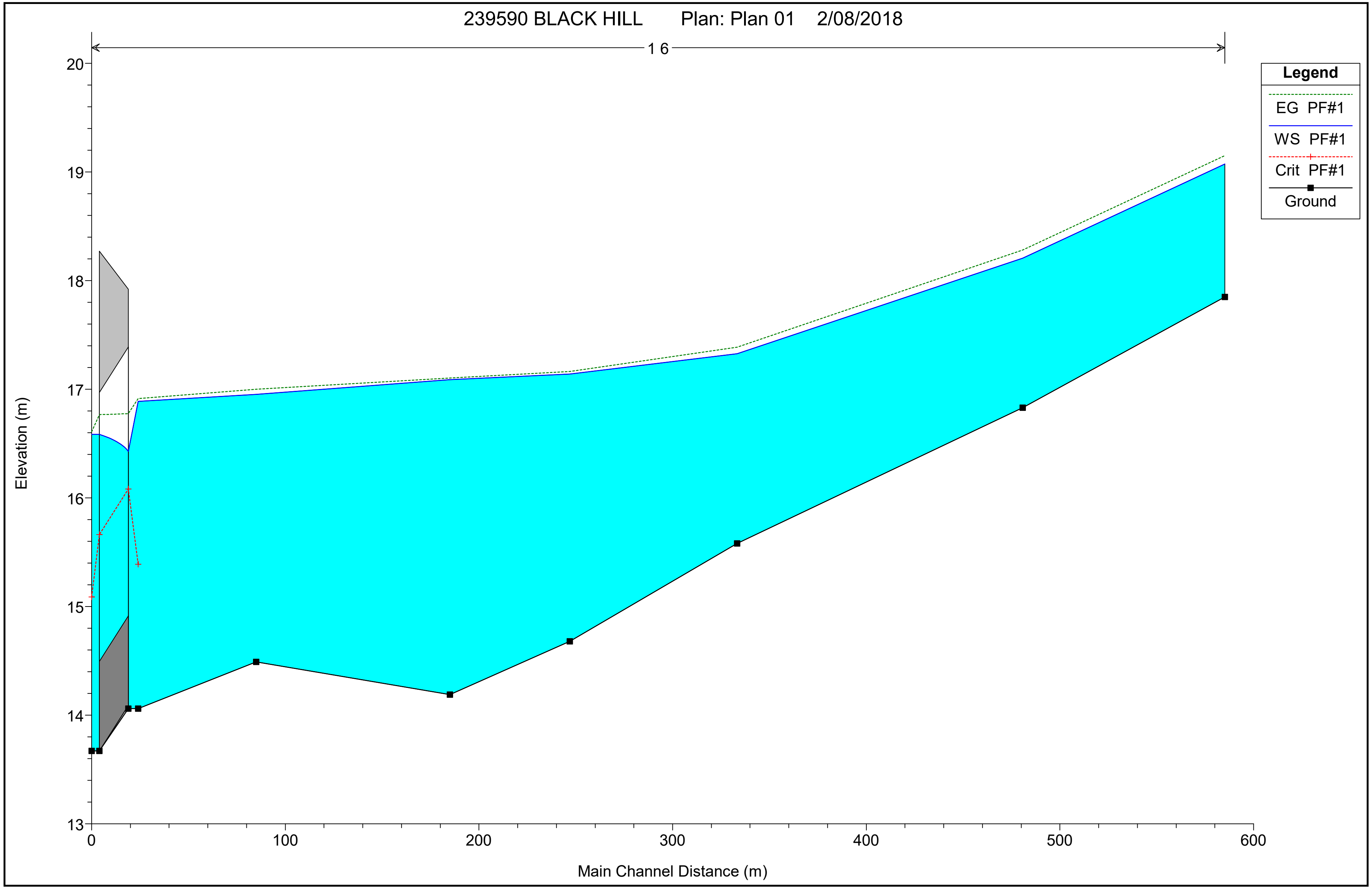


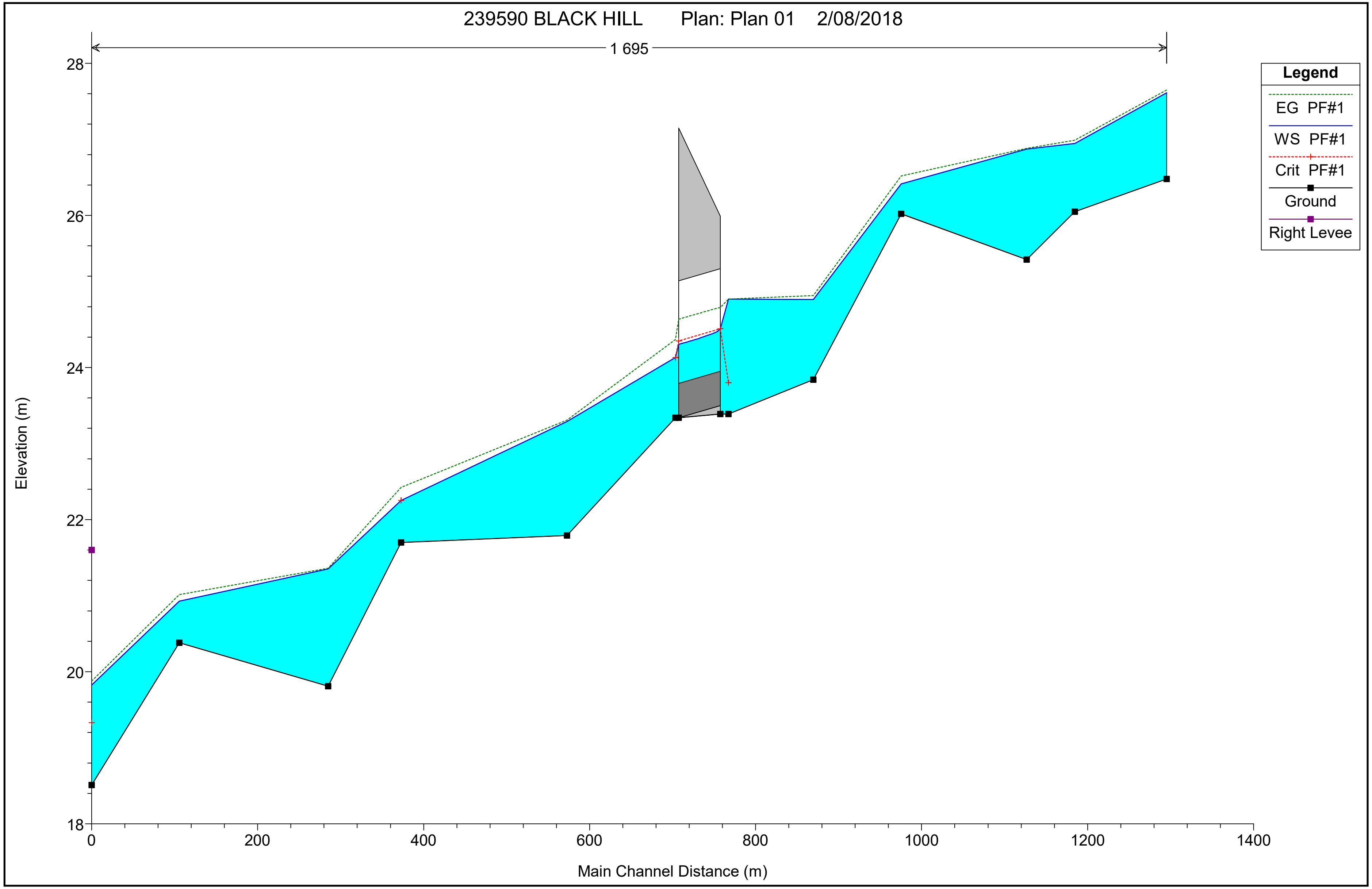
Figure C-1 – HEC-RAS Model and River Reaches.

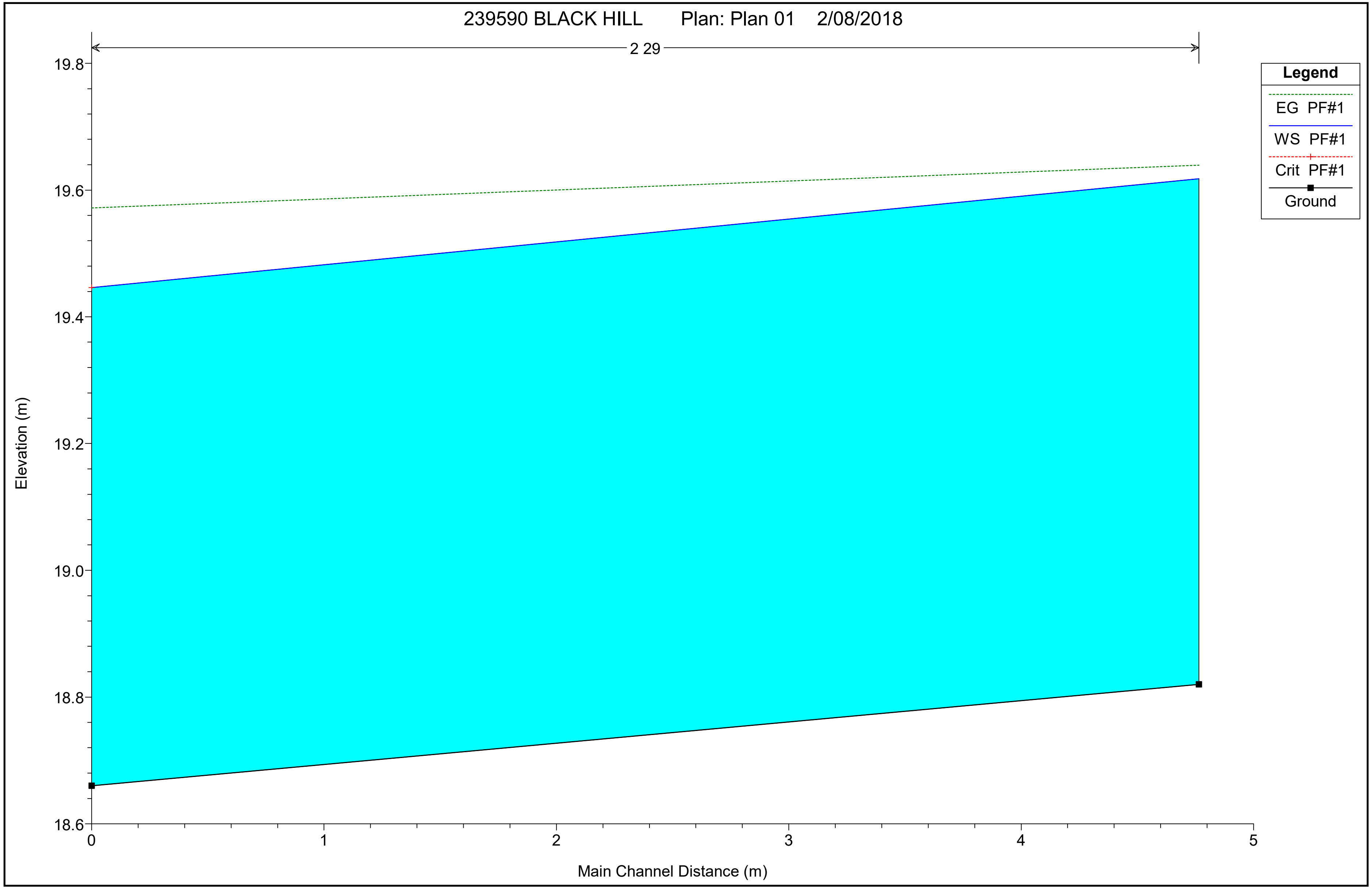
Table C-1 – 1% AEP HEC-RAS data

River	Reach	River Sta	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
3	88	335.28	3.23	23.75	24.45	24.34	24.52	0.022625	1.18	2.73	8.39	0.66
3	88	268.18	3.23	22.56	23.01		23.07	0.020515	1.04	3.09	10.63	0.62
3	88	164.38	3.23	21.67	22.08	21.93	22.1	0.005266	0.5	6.4	23.73	0.31
3	88	88.29	3.23	20.82	21.03	21.03	21.1	0.06918	1.18	2.73	19.4	1.01
2	100	440.08	6.26	23.11	23.94	23.68	23.99	0.008482	0.94	6.67	13.83	0.43
2	100	370.2	6.26	22.03	22.6	22.6	22.78	0.049723	1.91	3.28	8.81	1
2	100	292.74	6.26	21.14	22.17		22.18	0.001782	0.49	12.67	21.44	0.21
2	100	194.68	6.26	21.04	21.88		21.91	0.00463	0.7	8.93	18.32	0.32
2	100	99.86	6.26	20.34	20.72	20.72	20.83	0.058509	1.46	4.28	19.57	1
2	29	34.15	9.48	18.82	19.62		19.64	0.005045	0.65	14.58	36.47	0.33
2	29	29.39	9.48	18.66	19.45	19.45	19.57	0.055476	1.6	6.15	25.09	1
1	695	1632.48	9.43	26.48	27.61		27.65	0.005448	0.84	11.2	21.59	0.36
1	695	1579.66	9.43	26.05	26.95		26.99	0.00672	0.94	10.02	17.39	0.4
1	695	1521.8	9.43	25.42	26.87		26.88	0.000769	0.43	22.1	25.11	0.14
1	695	1476.5	9.43	26.02	26.41		26.52	0.036554	1.44	6.55	21.52	0.83
1	695	1370.5	9.43	23.84	24.89		24.95	0.007936	1.03	9.17	15.7	0.43
1	695	1268.46	9.43	23.39	24.9	23.8	24.9	0.00009	0.18	59.22	58.86	0.05
1	695	1210	Culvert									
1	695	1204.5	16.49	23.34	24.13	24.13	24.37	0.048	2.16	7.64	16.64	1.02
1	695	1073.85	16.49	21.79	23.29		23.31	0.001488	0.6	27.67	31.96	0.2
1	695	962.17	16.49	21.7	22.26	22.26	22.43	0.050738	1.82	9.05	26.73	1
1	695	874.06	16.49	19.81	21.35		21.36	0.000664	0.41	42.65	46.13	0.14
1	695	800.18	16.49	20.38	20.93		21.01	0.022059	1.29	12.78	33.96	0.67
1	695	694.71	16.49	18.51	19.82	19.33	19.87	0.006284	1.03	15.95	22.85	0.39
1	6	591.61	27.98	17.85	19.06		19.14	0.007601	1.26	23.15	30.25	0.45
1	6	487.22	27.98	16.83	18.2		18.27	0.008947	1.2	23.31	34.95	0.47
1	6	339.77	27.98	15.58	17.31		17.37	0.004408	1.07	26.14	27.09	0.35
1	6	253.34	27.98	14.68	17.12		17.14	0.001617	0.66	42.25	42.84	0.21

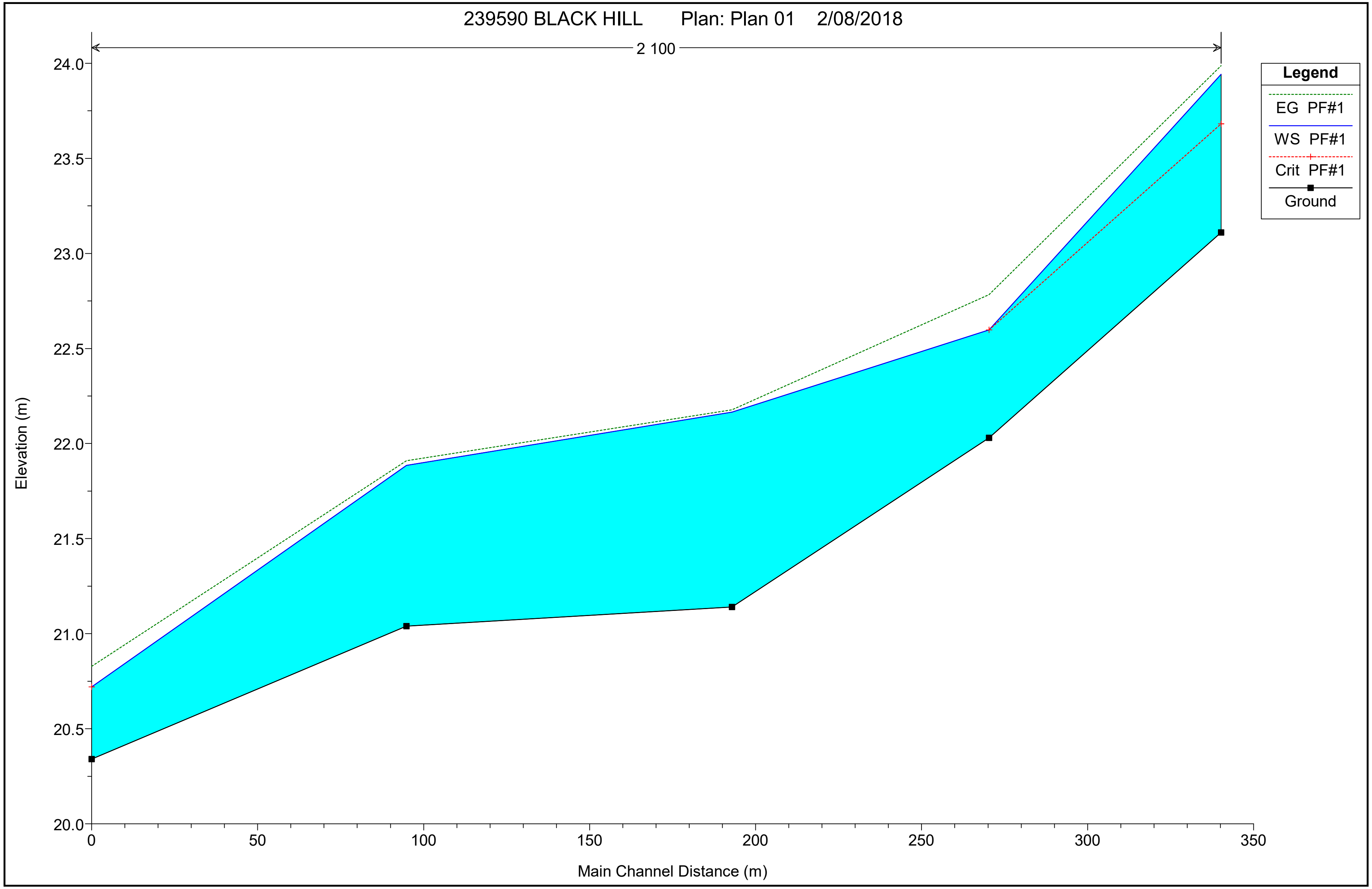
River	Reach	River Sta	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
1	6	191.49	27.98	14.19	17.07		17.08	0.000587	0.56	55.43	47.71	0.14
1	6	91.4	27.98	14.49	16.93		16.98	0.002154	1.01	30.94	29.97	0.26
1	6	30.42	27.98	14.06	16.87	15.38	16.89	0.000888	0.72	41.65	30.55	0.17
1	6	25	Culvert									
1	6	6.43	27.98	13.67	16.57	15.07	16.59	0.001001	0.74	42.41	31.08	0.18

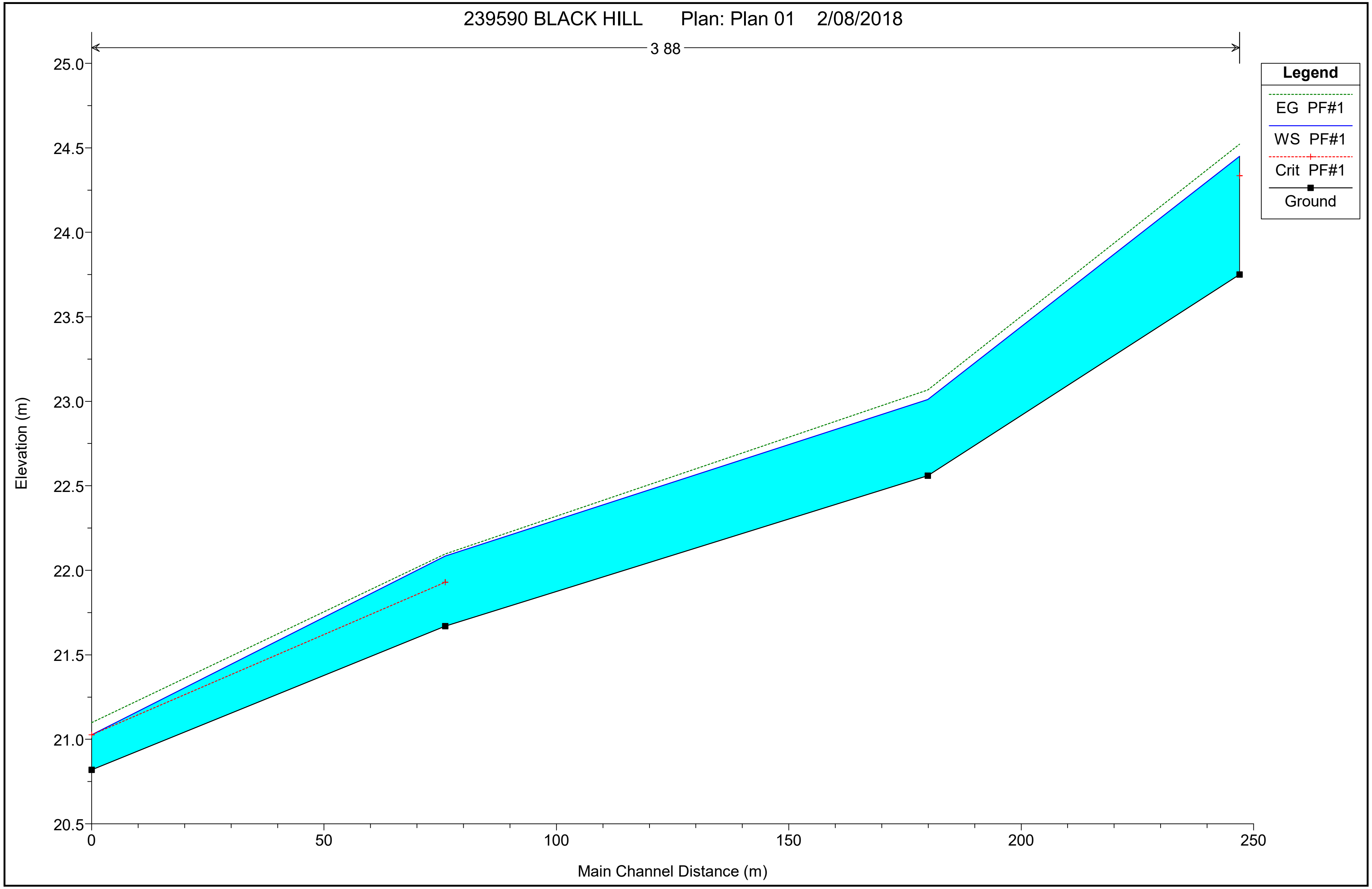

239590 BLACK HILL Plan: Plan 01 2/08/2018
1 6
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Elevation (m)
20
19
18
17
16
15
14
13
0
100
200
300
400
500
600
Main Channel Distance (m)


239590 BLACK HILL Plan: Plan 01 2/08/2018
1 695
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Right Levee
Elevation (m)
Main Channel Distance (m)
18
20
22
24
26
28
0
200
400
600
800
1000
1200
1400



239590 BLACK HILL Plan: Plan 01 2/08/2018
2 29
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Elevation (m)
19.8
19.6
19.4
19.2
19.0
18.8
18.6
0
1
2
3
4
5
Main Channel Distance (m)


239590 BLACK HILL Plan: Plan 01 2/08/2018
2 100
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Elevation (m)
24.0
23.5
23.0
22.5
22.0
21.5
21.0
20.5
20.0
0
50
100
150
200
250
300
350
Main Channel Distance (m)



239590 BLACK HILL Plan: Plan 01 2/08/2018
3 88
Legend
EG PF#1
WS PF#1
Crit PF#1
Ground
Elevation (m)
25.0
24.5
24.0
23.5
23.0
22.5
22.0
21.5
21.0
20.5
0
50
100
150
200
250
Main Channel Distance (m)

Appendix D - Stormwater Quality

TABLE D-1 – MUSIC CATCHMENT PLAN
FIGURE D-1 – MUSIC MODEL NETWORK

Table D-1 – Treatment Train Effectiveness for Subcatchments

Catchment	Pollutant	Source Load	Residual Load	% Reduction
A	Total Suspended Solids (kg/yr)	186000	33500	82.0
	Total Phosphorus (kg/yr)	299	137	54.2
	Total Nitrogen (kg/yr)	2140	960	55.2
B	Total Suspended Solids (kg/yr)	53200	9480	82.2
	Total Phosphorus (kg/yr)	86.4	39.1	54.7
	Total Nitrogen (kg/yr)	622	275	55.8
C	Total Suspended Solids (kg/yr)	14900	2140	85.7
	Total Phosphorus (kg/yr)	24	9.13	62.0
	Total Nitrogen (kg/yr)	175	64.8	62.9
D	Total Suspended Solids (kg/yr)	33200	5960	82.1
	Total Phosphorus (kg/yr)	55.5	24.3	56.2
	Total Nitrogen (kg/yr)	395	167	57.8
E	Total Suspended Solids (kg/yr)	43600	7780	82.2
	Total Phosphorus (kg/yr)	71.1	30.2	57.5
	Total Nitrogen (kg/yr)	494	201	59.3
F	Total Suspended Solids (kg/yr)	6230	1250	80.0
	Total Phosphorus (kg/yr)	9.99	5.49	45.0
	Total Nitrogen (kg/yr)	76.2	41.9	45.0
G	Total Suspended Solids (kg/yr)	5890	1180	80.0
	Total Phosphorus (kg/yr)	10	5.52	45.0
	Total Nitrogen (kg/yr)	74.8	41.1	45.0
H	Total Suspended Solids (kg/yr)	36500	7300	80.0
	Total Phosphorus (kg/yr)	57.9	31.9	45.0
	Total Nitrogen (kg/yr)	437	240	45.0
I	Total Suspended Solids (kg/yr)	25200	5040	80.0
	Total Phosphorus (kg/yr)	43.4	23.9	45.0
	Total Nitrogen (kg/yr)	308	169	45.0
J	Total Suspended Solids (kg/yr)	35800	7130	80.1
	Total Phosphorus (kg/yr)	60.2	26.2	56.5
	Total Nitrogen (kg/yr)	375	150	60.0

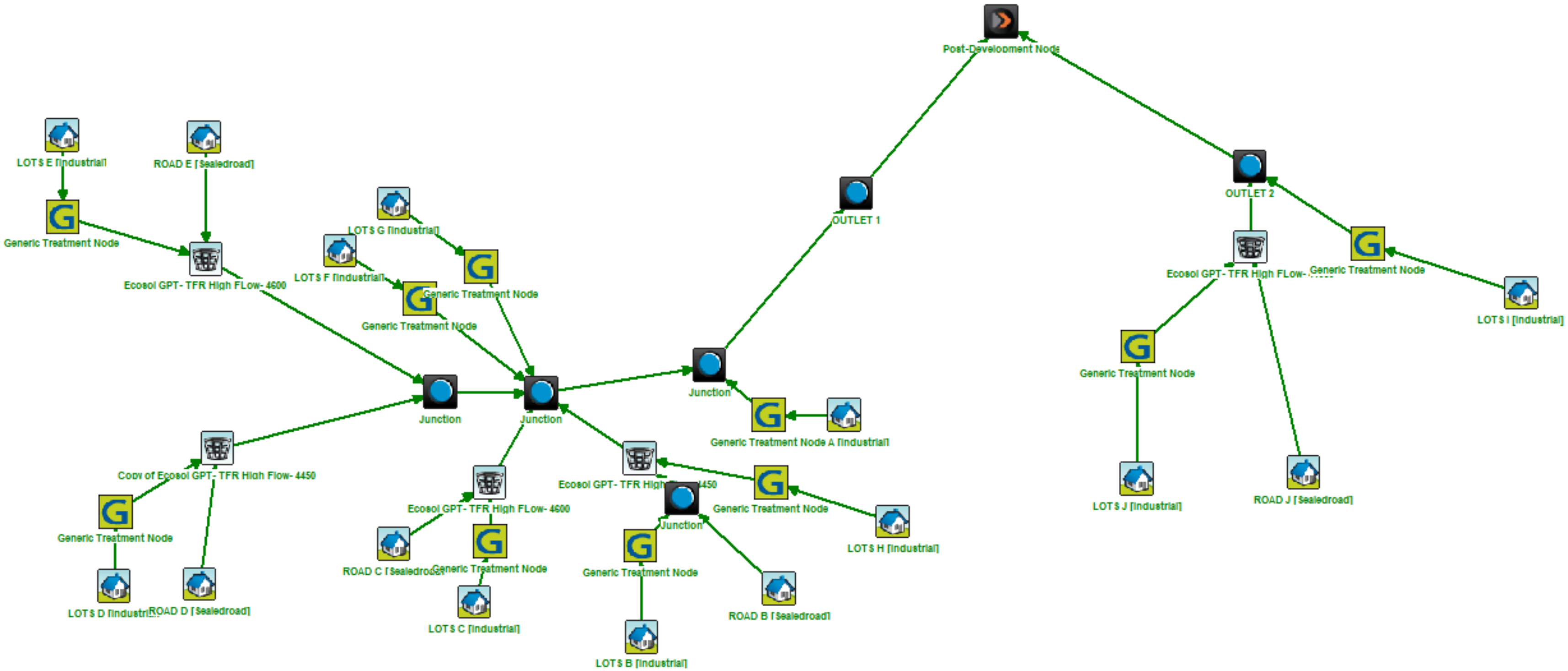


Figure D-1 – Music Model for Development Subcatchments.