REF: 6440WW

VERSION [1.0]

NOVEMBER 25, 2024

SOIL AND SITE ASSESSMENT FOR ONSITE WASTEWATER DISPOSAL

369 JACKS CORNER ROAD, KANGAROO VALLEY, NSW

LGA: Shoalhaven

Lot 27 DP 881838

Client: The Scots College – Glengarry Campus

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VERSION CONTROL

Title	Soil and Site Assessment for Onsite Wastewater Disposal			
Site address	369 Jacks Corner Road, Kangaroo Valley, NSW			
Description	Failed System Replacement			
Created By	Katherine Rose Kilpatrick B. Science (Geology) (UOW)			
Date Created	9/11/2023			
Version Number	**Modified By**	**Modifications Made**	**Date Modified**	**Status**
[0.1]	K.K.	Issue for client review - Draft	17/10/2024	Complete
[1.0]	K.K.	Issue for client review	25/11/2024	Complete

Limitations

The findings and recommendations in this report are based on the objectives and scope of work outlined above. Harris Environmental Consulting performed the services in a manner consistent with the normal level of care and expertise exercised by members of the environmental assessment profession. The report and conclusions are based on the information obtained at the time of the assessment. Changes to the site conditions may occur subsequent to the investigation described herein, through natural processes or through the intentional or accidental addition of contaminants, and these conditions may change with space and time. The results of this assessment are based upon site assessment conducted by HEC personnel and information provided by the client and site management. All conclusions regarding the property are the professional opinions of the HEC personnel involved with the project, subject to the qualifications made above. While normal assessments of data reliability have been made, HEC assumes no responsibility or liability for errors in any data obtained from regulatory agencies, information from sources outside of HEC, or developments resulting from situations outside the scope of this project.

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1. ASSESSMENT CRITERIA

This Soil and Site Assessment for On-site Wastewater Management was prepared by Harris Environmental Consulting Pty at the request of The Scots College – Glengarry Campus. It relates to the replacement of the failing reed bed and detention ponds with a new on-site wastewater disposal system on Lot 27 DP 881838 at 369 Jacks Corner Road, Kangaroo Valley, NSW.

Fieldwork was undertaken by Harris Environmental Consulting (HEC) on the 9th October 2023. This plan is based on the primary investigation of the soils, topography, and hydrology of the site observed on the day of inspection. Soil samples and photos of the site were taken for further analysis. This assessment was undertaken for a proposal to decommission the existing reed bed and detention ponds system and install a commercial Sewage Management Facility (SMF) for wastewater treatment, and a commercial irrigation scheme for treated wastewater disposal on site.

Harris Environmental Consulting was commissioned to undertake this Soil and Site Assessment for On Site Wastewater Management and System Design in accordance with:

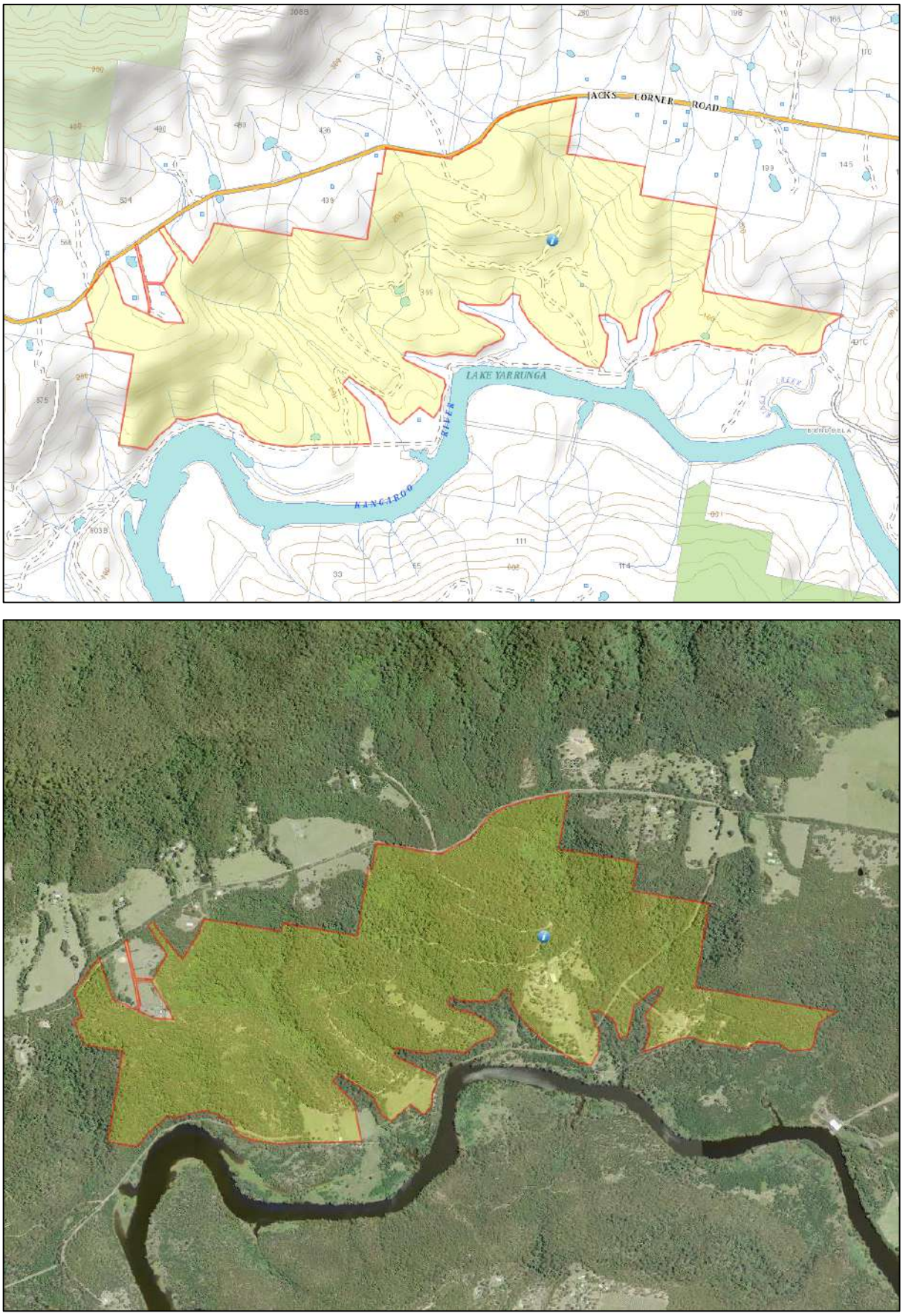
- Shoalhaven City Council's Development Control Plan
- Local Government Act 1993
- Australian Standard AS/NZS 3500 Plumbing and Drainage 2018
- Department of Environment and Conservation (NSW) (2004), Use of Effluent by Irrigation
- AS/NZ 1547:2012 On-site wastewater management (Standards Australia, 2012
- Sydney Catchment Authority (2011), Neutral or Beneficial Effect on Water Quality Assessment Guideline
- WaterNSW (2019), Designing and Installing On Site Wastewater Systems. A WaterNSW Current Recommended Practice

This report includes two key components.

- Firstly, the Soil and Site Assessment for On Site Wastewater Management is presented in Sections 3-9 of this report. This is a land capability assessment that follows the requirements of the DEC (2004) and WaterNSW (2019). This part of the assessment is specific to the type of treatment and disposal system proposed for the site.
- Secondly, the System Design is included in section 10 of the report. This provides specific details on how the proposed treatment and disposal system will be installed to meet the specific requirements of WaterNSW (2019).

The location of the property is shown in Figure 1.

FIGURE 1 SITE LOCATION FROM SIXMAPS



Source: NSW Six Maps

2. SITE INFORMATION

Our Ref:	6440ww	
Client:	The Scots College – Glengarry Campus	
Folio:	Lot 27 DP 881838	
Site address:	369 Jacks Corner Road, Kangaroo Valley, NSW	
Size of property:	~280 hectares	
Local Government Area:	Shoalhaven	
Water supply	Town equivalent – Kangaroo River	
Commercial wastewater load *@ 150L/day/person for each full-time occupant (Staff and Students), and 27L/day/person for each day-time visitor.*	Full-time occupants	170 people
	Day-time visitors	30
	Proposed wastewater class	Low Strength (secondary treated)
	Estimate load	26,370L/d
Proposed Irrigation scheme	Commercial Sewerage Management Facility (SMF) and fixed spray irrigation.	
Date site assessed:	9/10/2023	
Date report prepared:	25/11/2024	
Site assessor:	 Sean Harris	Msc Env Science (UOW), Grad dip Nat Res (UNE), BscAppSc, Agriculture (HAC)

3. SITE ASSESSMENT

Climate - rainfall	Barrengarry (The Old School House) Rainfall Station (Median annual 1183.6mm)
Climate - evaporation	Kangaroo Valley (Bendeela Pondage)
Flood potential	Proposed wastewater treatment system is above 1 in 100-year flood level; minor limitation. Proposed wastewater disposal area above 1 in 20-year flood level; minor limitation.
Frost potential	The site is not known to be subject to severe frosts, minor limitation.
Exposure	Southern aspect; minor limitation
Slope	8-14% slope; minor limitation
Landform	Uniform slope; minor limitation
Run-on	Minor potential for stormwater run-on; stormwater diversion bank is required.
Erosion potential	100% grass cover/minor erosion potential
Site drainage	Well drained, permeable soil profile; minor limitation
Evidence of fill	No evidence of fill; minor limitation
Domestic groundwater use	The Department of Primary Industries Office of Water search of groundwater bores found there are **no known groundwater bores** within 100m of the proposed effluent management area
Surface rock	Small portions of surface rock; minor limitation

4. DESIGN WASTEWATER LOAD

The proposed development will result in the final masterplan of the school campus to include:

1) 3x dormitories for students
2) 14x locations for staff accommodation (houses and units)
3) A Dining Hall
4) A Commercially Sized Kitchen
5) A Common Room
6) An Administration Building
7) A Multipurpose Room /Auditorium
8) 3x Classrooms buildings

The design wastewater flow for the proposed development is dependent on the number of occupants on site.

1) 170 full-time occupants
2) 30 day-time staff

These values of occupants have been provided by Scots College, through Baxter and Jacobson Architects.

The NSW Health Department (2001) "Septic Tank & Collection Well Accreditation Guidelines" provides estimates for daily flows based on types of premises and the available infrastructure. For the purpose of this assessment, the WaterNSW wastewater loading rate of 150L/person/day has been applied for all full-time occupants, and for each day-time visitors (staff), it assumed they would only generate 29L/day.

An estimate of the planned peak patronage in all aspects of the development and consequent design wastewater load is shown in Table 1 and is used to size the proposed irrigation area, treatment system and tanks.

TABLE 1 ASSUMED WASTEWATER LOADS FOR DEVELOPMENT

	Number of Persons	Assumed Wastewater Load per Person	Total Wastewater Volumes
Fulltime Occupants	170	150L/day *From ASNS1547-2012 – Table H2 – Typical domestic wastewater design flow allowances*	25,500L/day
Day-time Staff	30	29L/day *From Septic Tank and Collection Well Accreditation Guidelines December 2001 – page 21 - School*	870L/day
26,370L/day			

4.1 MONITORED WATER USE

The current water usage is measured at 24,000L/day, measured at the freshwater pump station located near the southern edge of the land used for the main school yard. This volume is for 100 students, 37 on-site staff and family members and 27-day staff. It is assumed each day-time staff member would use 1/5 of the water a full-time occupant would. Therefore, the current water consumption is assumed to service 142.2 persons.

If 100% of the water consumed from the freshwater station becomes wastewater and is sent to the treatment system, then it could be assumed that the generated wastewater volume equals 168L/person/day (= 24,000L/142.2 persons). However, the occupants of the school use water for other activities, not just showering, washing and drinking. Therefore, it is assumed ~5-10% of the water pumped from the river does not enter the wastewater treatment system, but rather is absorbed locally on site after such events as vehicle washing or plant watering, where the water enters the ground below. This volume falls anywhere between 1,200-2,000L/day of wasted water that does not enter the system.

Therefore, the current wastewater load is probably closer to 22,000L/d. With the proposed increased number of people on site, this assessment adopts the peak rate of water use and patron numbers to calculate the design wastewater load of 26,370L/d.

The designed wastewater load has been calculated for 170 full-time occupants and 30 day-time visitors.

$$\left(170\ fulltime\ persons \times \frac{150L}{day}\right) + (30\ daytime\ persons \times \frac{29L}{day}) = 26{,}370L/day$$

5. SOIL ASSESSMENT

Method:	Five test pits to identify two representative soil profiles, using mechanical auger/crowbar/shovel
Depth to bedrock (m):	>500mm to restrictive layer; moderate limitation
Depth to water table:	No groundwater encountered at a depth of 500mm; minor limitation
Mottling	No subsoil mottling observed, indication of well drained subsoils
Coarse (%):	No coarse fragments in subsoil, minor limitation
pH (soil/water):	pH 5.1- 5.7; moderate limitation
Electrical conductivity:	<4, indicating salinity is not a constraint; minor limitation
EAT class	Class 7; indication of adequate soil structure
Salinity hazard:	No salinity information is available for this site. However, salinity is not expected to be a constraint. There is no acid sulfate risk.
Geological unit: *(From Geoscience Australia Portal)* Soil landscape: *(From eSPADE by NSW DPIE)* Australian Soil Classification: *(From Geoscience Australia Portal)*	Snapper Point Formation, Wandrawandian Siltstone - Fine- to medium-grained sandstone, siltstone, wave rippled conglomerate. Fine-grained quartz-lithic silty sandstone and siltstone Unmapped CSIRO classification: Rudosols*: Soils with little pedogenic development, typically loam and clay loam soils and are common on alluvial plains. Low to medium risk provided there is adequate depth to groundwater and not located on a flood plain* Kurosols*: Duplex soil with an acidic subsoil of greater clay content than the topsoil. Moderate capacity to adsorb phosphate. The lower hydraulic conductivity of the subsoil can lead to interflow, however if the design of the absorption field is on the basis of subsoil hydraulic properties (as is normally the case), this is a moderate risk soil.*
Surface rock:	No surface rock in proposed effluent management area
Bulk density:	Topsoil bulk density 1.16 – 1.36g/cm^3, minor limitation
CEC	0.9 – 1.6: minor to moderate limitation
PRI (Kg/ha to 1000mm)	968.6- 1998: moderate Limitation

5.1 HARRIS ENVIRONMENTAL PHYSICAL SOIL ASSESSMENT

Soil profile, BH1	Layer 1		DIR
	Texture Colour Depth Structure Coarse frag.	Loam Dark Brown 0-150mm Well structured N/A	N/A
	Layer 2		DIR
	Texture Colour Depth Structure Coarse frag.	Sandy loam Dark brown 150-300mm Moderately structured N/A	N/A
	Layer 3		DIR
	Texture Colour Depth Structure Coarse frag.	Clayey Sandy loam Dark brown 300-500mm Moderately structured N/A	**5mm/day**
Soil profile, BH2	Layer 1		DIR
	Texture Colour Depth Structure Coarse frag.	Loam Dark Brown 0-150mm Well structured N/A	N/A
	Layer 2		DIR
	Texture Colour Depth Structure Coarse frag.	Clayey Sandy Loam Brown 150-300mm Well structured N/A	**5mm/day**

6. SOIL TESTING

Two representative soil samples were sent to Australian Laboratory Services (ALS), a NATA accredited laboratory. Laboratory results are attached as Appendix II of this report and a summary of the results are as bellow. Soil samples were tested for:

- Electrical Conductivity
- pH
- Exchangeable Cation Exchange Capacity
- Emerson Aggregate Test
- Phosphorus Retention Index
- Bulk Density

The Department of Environment and Conservation (NSW) Environmental Guidelines, Use of Effluent (2004) and Sydney Catchment Authority (2006) *Neutral or Beneficial Effect on Water Quality Assessment Guidelines* provide criteria for evaluating a site for irrigation with effluent.

The DEC (2004) guidelines recommend a range of soil and site parameters that are also required to meet WaterNSW requirements. The parameters listed in Table 2 from DEC (2004).

TABLE 2 DEC (2004) TYPICAL SOIL CHARACTERISTICS

Property	Limitation			Restrictive feature
	None/minor	Moderate	Major	
Exchangeable sodium percentage (0-40cm)	0-5%	5-10	>10	Structural degradation and waterlogging
Exchangeable sodium percentage (40-100cm)	<10	>10	-	Structural degradation and waterlogging
Salinity measured as electrical conductivity (EC_e) (dS/m at 0-70cm)	<2	2-4	>4	Excess salt may restrict plant growth
Salinity measured as electrical conductivity (EC_e) (dS/m at 70-100cm)	<4	4-8	>8	Excess salt may restrict plant growth, potential seasonal groundwater rise
Depth to top of seasonal high water table (m)	>3	0.5-3	<0.5	Poor aeration, restricts plant growth, risk to groundwater
Depth to bedrock or hardpan (m)	>1	0.5-1	<0.5	Restrict plant growth, excess runoff, waterlogging
Saturated hydraulic conductivity (Ks, mm/h, (0-100cm)	20-80	5-20 or >80	<5	Excess runoff, waterlogging, poor infiltration
Available water capacity (AWC mm/m)	>100	<100	-	Little plant-available water in reserve, risk to groundwater
Soil pH_{CaCl} (Surface layer)	>6-7.5	3.5-6.0 or >7.5	<3.5	Reduces optimum plant growth
Effective Cation Exchange Capacity (ECE, cmol (+)/kg, Average 0-40cm)	>15	3-15	<3	Unable to hold plant nutrients
Emerson aggregate Class (0-100cm)	4, 5, 6, 7, 8	2, 3	1	Poor structure
Phosphorus (P) sorption (kg/ha at total 0-100cm)	High	Moderate	Low	Unable to immobilise any excess phosphorus

Further to this the Department of Local Government (1998) On-site Sewage Management for Single *Households*. The NSW Government provides additional criteria for evaluating a site for irrigation with effluent in relation to soil properties not covered by the DEC (2004).

TABLE 3 DLG (1998) TYPICAL SOIL CHARACTERISTICS

Property	Limitation			Restrictive feature
	None/minor	Moderate	Severe	
Bulk density (g/cm^3) sandy loam Loam & clay loam Clay	 <1.8 <1.6 <1.4	-	 >1.8 >1.6 >1.4	Restricts plant growth, indicator of permeability
Sodicity (Exchangeable sodium percentage)	<5	5-10	>10	Potential for structural degradation
Phosphorus sorption (kg/ha) (0-100cm for irrigation)	>6000	2000-6000	<2000	Unable to immobilise any excess phosphorus

a) Emerson Aggregate Class

The Emerson Aggregate Test is used as a general guide to soil sodicity, dispersibility and structural stability. Soils are separated into classes based on the behavior of the soil colloids when immersed in water. Hazelton and Murphy (1992) have defined aggregate classes and interpretations of these classes, as shown in Table 4.

TABLE 4 SOIL ANALYSIS RESULTS: EMERSON AGGREGATE TEST

BH/Layer	Emerson Stability class	Comments
Layer 1	Class 7	Minor limitation
Layer 2	Class 7	Minor limitation
Layer 3	Class 3	Moderate limitation

DEC (2004) provides a better assessment of EAT classes for effluent irrigation systems than DLG (1998). DEC (2004) ranks Class 4,5,6,7 & 8 as a minor limitation, Class 2 & 3 as a moderate limitation and Class 1 as a major limitation. The results in Table 4 indicate soils are not likely to be sodic, and a **minor limitation** in relation to the DEC (2004).

b) Electrical conductivity

Measurement of electrical conductivity (EC) in a 1 to 5 soil/water extract were used to determine salt content as a measure of salinity. DEC (2004) ranks a soil EC (dS/m) <2 as a minor limitation, 2 to 4 as moderate limitation and more than 4 as a major limitation. The results shown in Table 5 for all samples were less than 4 dS/m when converted to ECe by soil texture, and therefore salinity is **minor limitation**.

TABLE 5 SOIL ANALYSIS RESULTS: ELECTRICAL CONDUCTIVITY

BH/Layer	EC dS/m 1:5	Soil type	ECe dS/cm 1:5	Comments
Layer 1	0.025	Loam (x10)	0.25	Minor Limitation
Layer 2	0.012	Sandy loam (x12)	0.144	Minor Limitation
Layer 3	0.014	Clayey sandy loam (x12)	0.168	Minor Limitation

c) pH

DEC (2004) ranks soil pH ($CaCl_2$) >6-7.5 as a minor limitation, 3.5 - 6 as a moderate limitation and less than 3.5 as a major limitation. The results obtained in Table 6 indicate pH is a **moderate limitation** in relation to the DEC (2004).

TABLE 6 SOIL ANALYSIS RESULTS: PH

BH/Lot	pH in water 1:5	Comments
Layer 1	5.1	Moderate limitation
Layer 2	5.4	Moderate limitation
Layer 3	5.7	Moderate limitation

Acidity is not a major constraint, however problems associated with an acid soil include:

- Mineralisation of organic matter and release of other nutrients adversely affecting soils with a pH below 4.6 (slows microbial activity);

- Molybdenum, which is required by legumes to fix nitrogen and grasses for protein synthesis, is very insoluble and unavailable for plants in acid soils;
- Aluminium is elevated under acid conditions, which causes phosphorus to become immobilised within the plant and soil. For pH <5.5 Aluminium can be toxic to roots;
- Uptake of calcium and magnesium is restricted with very high levels of soluble aluminium.

For acidic soils, it will be necessary to apply lime on a regular basis and grow pasture species that are tolerant of these conditions.

d) Cation Exchange Capacity (CEC)

The Cation Exchange Capacity (CEC) is the sum of the five most abundant exchangeable cations, which includes magnesium (Mg), sodium (Na), calcium (Ca), potassium (K) and in strongly acid soil, aluminum (Al).

The DEC (2004) ranks soil Cation Exchange Capacity >15% as a minor limitation, 3-15% as a moderate limitation and <3% as a major limitation. A low CEC means the soil has a low resistance to changes in soil chemistry that are caused by land use, limits the soils ability to hold plant nutrients. The results obtained in Table 7 indicate the CEC is a major limitation in relation to the DEC (2004).

Sodicity is measured by the Exchangeable Sodium Percentage (ESP), which is the portion of the CEC occupied by sodium (Na) cations. DLG (1998) ranks soil sodicity (ESP) <5% as a minor limitation, 5-10% as a moderate limitation and >10% as a major limitation. Sodic soils may impact plant growth and soil dispersion. Furthermore, Soils that are high in magnesium and sodium show more dispersion than soils that are high in sodium and calcium. Ca/Mg ratios <1 are Ca deficient, 1-4 are Ca Low, 6-4 are balanced, 6-10 are Mg low, and >10 are Mg high. Gypsum is needed to replace the sodium with calcium in sodic soils. The results of Table 7 indicate that sodicity is a moderate limitation in relation to the DLG (1998).

TABLE 7 SOIL ANALYSIS RESULTS: EXCHANGEABLE CATION EXCHANGE

Cation Exchange Capacity (CEC)						
Layer 1	**Calcium**	**Magnesium**	**Potassium**	**Sodium**	**CEC**	**Ca/Mg**
Meq/100g	0.5	0.4	0.3	0.2	1.6	1.3
% CEC	31.3	25.0	18.8	12.6 (ESP)	100	-
Level	Very Low	Low	Low	Major	Moderate	Ca low
Limitation	Minor	Minor	Minor	Moderate	Minor	Minor
Layer 2	**Calcium**	**Magnesium**	**Potassium**	**Sodium**	**CEC**	**Ca/Mg**
Meq/100g	0.2	0.4	0.2	<0.1	0.8	0.5
% CEC	25.0	50.0	25.0	3.8 (ESP)	100	-
Level	Very Low	Low	Low	Minor	Moderate	Ca deficient
Limitation	Minor	Minor	Minor	Moderate	Minor	Minor
Layer 3	**Calcium**	**Magnesium**	**Potassium**	**Sodium**	**CEC**	**Ca/Mg**
Meq/100g		0.2	0.2	0.2	0.9	1.5
% CEC	33.3	22.2	22.2	24.3 (ESP)	100	-
Level	Very Low	Very Low	Low	Major	Moderate	Ca low
Limitation	Minor	Minor	Minor	Moderate	Minor	Minor

e) Phosphorus Retention/Sorption

The phosphorus sorption capacity is used to predict the life of the site in terms of its ability to immobilise Phosphorus. The Phosphorus Retention Index (PRI) is a measure of the capacity of the soil to sorb phosphorus, in order to differentiate between soils exhibiting high and low Phosphorus retention. DLG (1998) ranks phosphorus sorption, in kg/ha over a depth of 1000mm, as: >6000 as a minor limitation, 2000-6000 as a moderate limitation; and less than 2000 as a major limitation. WaterNSW (2019) notes that phosphorus sorption values in the phosphorus loading example in the 'Silver Book are not typical of most locations.

Site-specific weighted phosphorus sorption values must be used to determine the size of the effluent irrigation area based on nutrient balances. Phosphorus sorption data in milligrams per kilogram (mg/kg) is converted to kilograms per hectare (kg/ha) using the following equation.

Psorp (kg/ha) = Psorp (mg/kg) x soil depth (m) x bulk density (kg/m3) x 0.01

The results in Table 8 indicate Phosphorus sorption is a **major limitation** in relation to DLG (1998). However, WaterNSW 2019 recommends the use of far more conservative values (see Figure 2). The phosphorus sorption values identified from ALS testing are between the recommend values of DLG (1998) and WaterNSW (2019), and therefore must be suitable for the site.

TABLE 8 SOIL ANALYSIS RESULTS: PHOSPHORUS RETENTION

BH	Bulk density (kg/m^3)	Bulk density (g/cm^3)	PRI (mgP/kg)	PRI (kg/ha) to 1000mm	Limitation
Layer 1	1160	1.16	835	968.6	Major
Layer 2	1330	1.33	1280	1702.4	Major
Layer 3	1350	1.35	1480	1998	Major

FIGURE 2 WATERNSW 2019 PHOSPHORUS SORPTION UPTAKE VALUES

Appendix 1
Phosphorus Sorption Uptake Values

Soil Category	Texture	Structure	Acceptable P_{sorp}* (mg/kg)
1	Gravels and sands	Structureless	50
2a	Sandy loams	Weak	100
2b	Sandy loams	Massive	100
3a	Loams	High / moderate	200
3b	Loams	Weak / massive	200
4a	Clay loams	High / moderate	400
4b	Clay loams	Weak	400
4c	Clay loams	Massive	400
5a	Light clays	Strong	500
5b	Light clays	Moderate	500
5c	Light clays	Weak / massive	500
6a	Med-heavy clays	Strong	600
6b	Med-heavy clays	Moderate	600
6c	Med-heavy clays	Weak / massive	600

* If soil parent material is basalt then increase Psorp by 100mg/kg

f) Bulk Density

Bulk density is the oven dry weight of the soil per unit volume. It affects porosity, soil strength and plant growth in the topsoil. Bulk density is a measure of the density of a porous material that considers the density of solid material and the level of porosity. The results in Table 9 indicate for a sandy loam soil, bulk density is a **minor limitation** in relation to the DLG (1998).

TABLE 9 BULK DENSITY

BH/Lot	Bulk density (g/cm^3)	Comments
Layer 1	1.16	Minor limitation
Layer 2	1.33	Minor limitation
Layer 3	1.35	Minor limitation

7. SUMMARY OF SOIL AND SITE CONSTRAINTS

The proposed effluent disposal area has a uniform side slope, with slopes ranging between 3-14 % falling to the south to southeast. Local relief across the proposed effluent disposal area is approximately 24m (vertical) over 200m (horizontal), altitude 40m-66m AHD. The site is fully grassed with no indications of sheet or gully erosion. This location is currently being used for spray irrigation, however, this assessment recommends installing a new and larger irrigation system to dispose of the larger volume of secondary treated wastewater associated with the new dormitories and increased student numbers.

As the proposed irrigation area is located on top of the ridge of the hill, any surface flows would run southwest and northeast towards drainage depressions. These drainage depressions are 137m and 127m away respectively. Furthermore, these drainage depressions connect to the Kangaroo River; at the closest extent of the irrigation field, there is 160m between Kangaroo River and the irrigation field.

Three soil samples were sent to a NATA registered laboratory to be tested for Electrical Conductivity, pH, Exchangeable Cation Exchange Capacity, Emerson Aggregate Test and Phosphorus Sorption Capacity.

The results found limitations included a standard top-soil bulk density, a moderate pH and a moderate CEC.

The characteristics of the effluent to be applied are of importance when considering the impact on soils that are sodic and potentially dispersible. Effluents with Sodium Absorption Ratio values less than 3 will lower the ESP of sodic soils (DLG et al 1998), with Graaff and Patterson (2001) strongly arguing that the interplay of effluent SAR and EC, together with the ESP of the soil should be considered in assessing dispersion risk. These sources indicate that the effluent composition needs to be monitored, assessed, and if necessary, adjusted by gypsum dosing.

pH is a moderate constraint in the subsoil which may restrict plant growth. Applying lime to the topsoil will neutralise the acidity, promote plant growth and alleviate potential toxic effects of acidity.

The shallow sandy loam profile has suitable phosphorus absorption properties and permeability for the application of secondary treated wastewater by spray irrigation.

Photo 1 Onsite soil assessment and soil profile for bore hole 1 – north end of irrigation field.

Photo 2 Onsite soil assessment and soil profile for bore hole 2 – south end of irrigation field.

Photo 5 Looking south down the existing irrigation field.

Photo 6 Existing failing detention disinfection ponds – significant algae growth.

8. PROPOSED METHOD OF WASTEWATER TREATMENT

8.1 COMMERCIAL SEWERAGE MANAGEMENT FACILITY

A commercial Sewerage Management Facility is proposed to treat wastewater from the proposed development. The owner will need to lodge with Council an application to install and operate a Sewage Management System under the Local government act 1993, Section 68. Council will require the owner to have selected a SMF manufacturer and provide Council with the necessary plans and specifications including tank dimensions and capacity, operation and maintenance details, plus the installers name, address, phone number and license number.

The SMF will be installed and maintained in accordance with Section 5 of the guidelines "Use of Effluent by Irrigation, DEC (2004). Upon approval from Shoalhaven Council, the owner is to enter into a servicing contract with an approved servicing agent for the life of the system and begin a thorough environmental monitoring program. Copies of the written service and monitoring reports should be lodged with Council following each quarterly service and following environmental monitoring. Shoalhaven council is the approving authority, with the Department of Water and Energy (DWE) and NSW Health acting in an advisory role (to council) for processing section 68 approvals. Division 4 of The Local Government (General) Regulation 2005 provides details for the approval to operate as well as the broad performance standards and other criteria for approvals relating to the management of waste.

The wastewater management system that has yet to be selected.

8.2 RISK ASSESSMENT

The treated wastewater will be applied via spray irrigation to the subsoil. Wastewater will not be re-used for any other purpose. The proposed SMF will provide secondary treatment. After wastewater is applied by spray irrigation, there is a low risk of human contact and it is consistent with the DWE definition of a **low level** of risk (DWE, 2008). A low exposure risk level is proposed as the end uses have a low level of human contact. This includes:

a) Urban irrigation with enhanced restricted access and application irrigation, which assumes:

- no access after irrigation (1-4 hours or until dry);
- minimum buffer zones to the nearest point of public access;
- spray drift controls; or

b) Agricultural irrigation.

The commercial SMF will be designed to meet and exceed the effluent compliance values for low level risk, which includes the compliance values listed in Table 10:

TABLE 10 EFFLUENT COMPLIANCE VALUES FOR LOW LEVEL RISK EXPOSURE (DWE, 2008)

E.coli	**<1000cfu/100ml
BOD	<20mg/L
SS	< 30mg/L
pH	6.5-8.5
Disinfection (if used) *	Cl:0.2-2.0 mg/L residual UV (TBA)

** E.Coli compliance values shown in Table 10 have been superseded by the NSW Health Advisory Note 4 January 2017, *Recommended Final Uses of Effluent based on the Type of Treatment.* This requires **E. coli to be treated to <30cfu/100ml.**

8.3 EFFLUENT QUALITY

Further to DWE (2008) compliance values for low-risk effluent, the DEC (2004) sets out the classification of effluent for environmental management based on strength. The commercial sewerage management facility will be designed to meet the DEC (2004) compliance values for Low-strength effluent. Where these values are in conflict with the DWE (2008) compliance values, the lesser value is to be used to assess the effluent. Exceedance of these values will require corrective action and further environmental management controls.

TABLE 11 CLASSIFICATION OF EFFLUENT FOR ENVIRONMENTAL MANAGEMENT. DEC (2004)

	Strength (Average concentration mg/L)[1]		
Constituent	**Low[2]**	**Medium**	**High**
Total Nitrogen	<50	50-100	>100
Total Phosphorus	<10	10-20	>20
BOD_5	<40	40-1,500	>1,500
TDS[3]	<600	600-1,000	>1,000-2,500
Other pollutants	Effluent with more than five time[4] the ANZECC and ARMCANZ (2000) long-term water quality trigger values for irrigation waters must be considered high strength for the purpose of establishing a strength class for runoff and discharge controls and will require close examination to ensure soil is not contaminated.		
Grease & Oil	Effluent with more than 1,500mg/L of grease and oil must be considered high strength and irrigation rates and practices must be managed to ensure soil and vegetation is not damaged.		

TABLE 12 CLASSIFICATION OF EFFLUENT FOR ENVIRONMENTAL MANAGEMENT. DEC (2004)

Metal	Total concentration (mg/L)	Comments
Aluminum	5.0	High toxicity in acid soils. Not a concern if pH of soils is above 6.5
Arsenic	0.1	
Beryllium	0.1	
Cadmium	0.01	Higher toxicity in acid soils
Chromium VI	0.1	
Cobalt	0.05	
Copper	0.2	
Iron	0.2	
Lead	2	
Lithium	2.5	Citrus: 0.075mg/L
Manganese	0.2	
Mercury	0.002	
Molybdenum	0.01	
Nickel	0.2	
Selenium	0.02	
Zinc	2.0	1 mg/L recommended for sandy soil pH 6
Source	ANZECC and ARMCANZ (2000) (refer to any current Australian Water Quality Guidelines as they are updated and endorsed for use in NSW)	
Note:	Trigger values should only be used in conjunction with information on each individual element and the potential for offsite transport of contaminants (See ANZECC & ARMCANZ (2000) Volume 3, section 9.2.5) See also short-term use trigger values (Up to 20 years) and cumulative contaminant loading limit triggers in ANZECC & ARMCANZ (2000), Volume 1, Table 4.2.10.	

8.4 LOCATION OF TREATMENT SYSTEM

The location of the treatment system should be decided in conjunction by the licensed plumber in consultation with the property owner. The treatment system must be positioned on a stable, level base and be downslope of the development so there is sufficient fall from drainage outlets in within the development. The location of treatment system must be

- Downslope of the buildings from where wastewater is generated;
- at least 2.5m away from the building
- at least 5m from the property boundary
- at least 6m downslope from any in ground water storage tanks.

Treatment systems installation must comply with the manufacturer's recommendations, AS/NZS 3500.2:2018 Plumbing and Drainage Part 2 Sanitary Plumbing and Drainage' and Council requirements.

8.5 INSTALLATION OF PIPES

The SMF installation must comply with the manufacturer's recommendations, AS/NZS 3500.2:2018 Plumbing and Drainage Part 2 Sanitary Plumbing and Drainage' and Council requirements. Minimum pipe diameter calculations are presented in Table 13.

The sewer pipes between the buildings, treatment system and irrigation area must be buried at a depth that provides protection against mechanical damage or deformation, in accordance with 'AS/NZS 3500(Set):20018 Plumbing and Drainage Set'. Table 16 shows the minimum pipe depth for trafficable areas.

In addition, where a sewer carrying untreated wastewater to a treatment system is longer than 60 metres, the minimum grade should be doubled, and inspection ports should be installed at least every 30 metres or at an angle or change of grade.

The sewer pipes between the plumbing amenities, SMF, and irrigation area must be buried at a depth that provides protection against mechanical damage or deformation, in accordance with 'AS/NZS 3500.2:2018 Plumbing and Drainage Set'. Table 14 shows the minimum pipe depth for trafficable areas.

TABLE 13 MINIMUM PIPE DIAMETER CALCULATIONS

Nominal pipe size (DN)	Minimum grade %	Minimum grade ratio
65	2.5	1:40
80	1.65	1:60
100	1.65	1:60
125	1.25	1:80
150	1.00	1:100
Source: 'AS/NZS 3500.2.:2003 Plumbing and Drainage Part 2 Sanitary Plumbing and Drainage' Table 3.2. NB: pipe grades are expressed as a percentage of vertical to horizontal distances.		

TABLE 14 MINIMUM PIPE DEPTH FOR TRAFFICABLE AREAS

Location	Minimum depth of cover (mm) for all materials other than cast iron
Where subject to vehicular traffic	500
Elsewhere	300
Source: 'AS/NZS 3500 (Parts 0-4):2018 Plumbing and drainage Set'. Table 3.7.2 Minimum Cover for Buried Pipes'	

9. LOCATION AND METHOD OF IRRIGATION

9.1 METHOD OF IRRIGATION

Effluent will be applied using a method of spray irrigation that generates a low plume and coarse droplet to minimise the risk of wind drift. The proposed required irrigation area is currently used for effluent disposal of the existing disposal system. The area shall continue to be kept clear of vegetation and be routinely mowed to keep the grass down.

Due to the slope of the proposed effluent disposal area, a travelling irrigator such as the Technipharm Advanced Irrigator is not suitable for this purpose. Instead, a fixed sprinkler system of buried distribution lines and galvanised steel sheathed poly risers topped with appropriate sprinkler heads is recommended. In this scenario, a commercially sized water rotor would distribute treated wastewater between zones created such that even distribution of the area would be achieved. The volume of water sprayed from each zone before the water rotor directs further water to the next zone can be controlled by high and low float settings in the pump well. Fixed sprinklers do not require routine daily human input, other than scheduled inspections. Figure 3 below shows examples of fixed sprinkler systems.

FIGURE 3 FIXED SPRINKLER SYSTEMS

9.2 LOCATION OF IRRIGATION AREA

The land proposed for spray irrigation is located in the existing irrigation field, which has previously been cleared of vegetation and maintained, to provide land for effluent disposal as the property is very heavily vegetated with native bushland. This cleared area provides approximately 1.2 hectares of land for irrigation.

The effluent disposal area is over 40m from the nearest drainage depression, 100m from any water course and at least 12m from the property boundary. If more land is required for irrigation, the upslope detention UV ponds can be decommissioned, and the site rehabilitated to allow for the installation of more sprinklers.

9.3 SIZING EFFLUENT DISPOSAL AREA

The irrigation area needed to manage the flow regulated volume of **26,370L /d** was calculated using a monthly water and nutrient balance, following the method described in DLG (1998). Soil texture classification for Design Irrigation Rate is from ASNZ1547(2012).

The ***water balance*** requires an **6,980m^2** irrigation area based on the following variables:

- Barrengarry (The Old School House) median monthly rainfall (1183.6mm);
- Kangaroo Valley (Bendeela Pondage) monthly average evaporation (1270mm); and
- Application rate of 35mm/week or 5mm/day for sandy loam subsoils.

The ***nitrogen balance*** requires a **10,026m^2** irrigation area based on the following variables:

- SMF will reduce Total Nitrogen to 25mg/L; and
- Vegetative uptake rate of 240kg.N/ha/year for managed lawn.

The ***phosphorus balance*** requires an area of **3896.8m^2** irrigation area based on the following variables:

- SMF will reduce Total Phosphorus to 12mg/L;
- P-sorption of 1480mg/kg for sandy loam subsoils (measured ALS testing rate);
- Soils will be effective to retain 0.3% of predicted sorption for a soil depth of 0.5m.
- Crop uptake is assumed to be 30kg/ha/year for unmanaged lawn. (Appendix III)
- 50 year design life of system.
- Bulk density of 1.8g/cm^3

The largest of the three methods (most limiting) is required, see Appendices IV & V. For this site, the largest of the three methods is **10,026 m^2.**

In accordance with WaterNSW (2019), the irrigation area should be sized using a hydraulic balance, with a dedicated nutrient uptake area downslope and/or around the irrigation field, determined by the difference in area between the nutrient load and hydraulic load area. Water NSW (2019) states that this approach will help ensure that the vegetation is maintained, at least on the area required to satisfy the hydraulic balance and reduce the likelihood of vegetation die-off over the whole area in extended dry periods.

An irrigation area of minimum **6,980m^2** is required to be installed for this Assessment, with **3,126m^2** of additional land allocated for nutrient uptake area is required. Due to the size of the required irrigation area, an irrigation/installing wastewater specialist should be consulted to ensure peak efficiency of the irrigation system.

Harris Environmental Consulting has created a site plan identifying the required area for effluent disposal, with 15 sprinklers, each with 12.5m throw/490m^2 to show the total required land for disposal. The land between sprinklers will be utilized as nutrient uptake zones. This design provides great hydraulic irrigation than the calculated area of 6,980m^2, with a total irrigation area of 7,350m^2. It is expected that this design will be modified to best suit the

landscape and efficiency of disposal. A gate valve or hydraulic sequencing device should be installed to divert treated wastewater between the sprinklers.

The proposed location and setback distances of the land application area relevant to the site are to be consistent with the requirements in the conditions of consent, the DEC (2004) and this report.

9.4 WET WEATHER STORAGE

Wet weather storage will be incorporated into the design of the wastewater treatment system. The manufacturer will be required to provide sealed storage tanks that can provide the capacity to store wastewater for 7 days. This will provide storage for wet weather but may also be needed if there is equipment failure that prevents the treatment of wastewater. The location of this tank is to be decided in conjunction with a licensed plumber and the owner. The stored wastewater would need to be irrigated during school holidays and any other periods when occupancy is not at full capacity.

TABLE 15 WET WEATHER STORAGE TANKS

Daily inflow	7-Day Accumulation	Collection Tank Volume
26,370 L/d	184,590 L	>190,000L Combined storage

9.5 STORMWATER RUN-OFF CONTROL

Stormwater runoff shall be managed in accordance with Section 5 DEC (2004). This includes:

- Runoff diversion measures to prevent uncontaminated runoff entering the irrigation area, and;
- An earth bank will be installed upslope of the proposed irrigation area to prevent overland flow from entering the irrigation area. The earth bank will discharge runoff to a stable outlet that is outside of the irrigation area.

9.6 BUFFER DISTANCES

Table 16 shows the buffer distances in accordance Section 4 of the DEC (2004), Section 2 of WaterNSW (2019) and Chapter G8 of the Shoalhaven City DCP (2014).

In the case of Table 16, the proposed wastewater disposal area is compliant with the relevant WaterNSW(2019) buffer distances and DEC (2004) specified buffers for low effluent strength. Effluent quality criteria for low risk treated sewage is described in section 8.3.

TABLE 16 RECOMMENDED BUFFER DISTANCES

ASSESSMENT GUIDELINES	BUFFER DISTANCES
WaterNSW (2019)	• 100 metres to permanent surface waters (e.g. rivers, creeks, streams, lakes etc.) • 40 metres to other waters (e.g. dams, intermittent water courses, overland flow paths etc.)

<table>
<tr><td>Shoalhaven Chapter G8</td><td colspan="3">• 6 metres if area up-gradient and 3 metres if area down-gradient of swimming pools, property boundaries, driveways and buildings, including dwellings.</td></tr>
<tr><td rowspan="7">DEC (2004)</td><td></td><td>Low effluent strength</td><td>High effluent strength</td></tr>
<tr><td>Where spray irrigation gives rise to aerosols near houses, schools, playing fields, public open spaces and water bodies.</td><td>50*m</td><td>50m</td></tr>
<tr><td>Natural water bodies (e.g. rivers and lakes)</td><td>50m</td><td>50m</td></tr>
<tr><td>Other waters (e.g. artificial water with beneficial uses, small streams, intermittent streams, water distribution, drainage channels and dams)</td><td>Site-specific</td><td>Site-specific</td></tr>
<tr><td>Others sensitive areas (e.g. waters in drinking water catchments, aquatic ecosystems with high conservation value, wetlands, native stands for vegetation)</td><td>Site-specific</td><td>250m</td></tr>
<tr><td>Domestic well used for household water supply</td><td>Site-specific</td><td>250m</td></tr>
<tr><td>To town water supply bores</td><td>Site-specific</td><td>1000m</td></tr>
</table>

* Recommended in ARMCANZ, ANZECC and NHMRC (2000) for spray application of reclaimed water from sewerage systems.

9.7 SITE ACCESS AND SIGNAGE

Public access will be restricted from the proposed irrigation area to prevent direct contact with effluent. Due to the size of the proposed irrigation area and distance between the main school ground, fencing around the entire proposed irrigation area is severe endeavour. Additionally, this assessment is recommending installing a new irrigation system in the existing and active irrigation field. This area is not fenced and has not previously been required. This assessment recommends installing a gate across the access track, with fence work extending 10m either side into the bush. This fence work will be sign-posted and additional signs should be posted around the extent of the irrigation field. In all areas where the wastewater treatment or pipes run within areas of public access, all pipes and taps must be colour coded and/or signs marked, for example: 'EFFLUENT - NOT FOR DRINKING'. International diagram signs for non-English speakers will be necessary. Childproof taps should be used to prevent children from drinking non-potable water. Signs should be visible from the main point of access advising the type of reuse and any relevant restrictions to the public. Australian Standard, AS 1319–1994, Safety Signs in the Occupational Environment (Standards Australia 1994) should be referred to.

10. MONITORING REQUIREMENTS

Monitoring will be conducted in accordance Section 5 of DEC (2004). Monitoring results will assist in demonstrating due diligence and include:

- Validation and verification that the system design and equipment is adequate for the necessary treatment;
- Confirmation of the ongoing operational performance of the treatment system to protect human health and the environment; and
- Detection of any potential or actual failures on the treatment system and implement the appropriate corrective actions.

10.1 MONITORING PROGRAM

An effluent, soil & groundwater monitoring program will report on the performance of the effluent irrigation scheme for the life of the system. This will be prepared in consultation with Council and Water NSW.

The monitoring program will include soil and groundwater monitoring points located within the effluent disposal area and downslope of the tailwater dam. Effluent samples will be taken directly from the outlet of the sewerage management facility to ensure it meets the requirements for low strength and low risk effluent. A guide to the frequency and constituents to be tested are presented as follows within Tables 17 to 19. Monitoring points are to be installed across the site.

Monitoring will include baseline soil and groundwater conditions downslope of the irrigation area and from within the proposed effluent disposal area itself. Baseline groundwater samples will be obtained immediately downslope of the proposed irrigation area.

10.2 CONFIRM PERFORMANCE

Monitoring will occur monthly for the first year of operation to ensure the design of the SMF and surface water management procedures are effective in both wet and dry seasons. The results will be provided to Council and used to confirm performance and whether any adjustments are required. After this, monitoring will be conducted on an annual or event-only basis, the results will be provided to Council and used to confirm performance and whether any adjustments are required.

10.3 NON-CONFORMANCE AND COMPLAINTS

Any non-compliance, complaints or incidents will be handled in accordance non-compliance and complaints procedures. This includes recording the informants name, contact details, details of the event including cause, who received the complaint and follow up action taken.

TABLE 17 RECOMMENDED EFFLUENT SAMPLING STRATEGY

	Frequency of sampling		
Constituent	**Low Strength**	**Medium Strength**	**High Strength**
TSS	Quarterly	Quarterly	Monthly
Oil and grease	Biannually	Quarterly	Quarterly

Total P	Biannually	Quarterly	Quarterly
Total N	Biannually	Quarterly	Quarterly
BOD_5	Quarterly	Quarterly	Monthly
pH	Quarterly	Quarterly	Monthly
EC (dS/m); TDS	Quarterly	Quarterly	Monthly
Cations	Quarterly	Quarterly	Quarterly
SAR (√(meq/L))	Quarterly	Quarterly	Quarterly
Metals	yearly	Yearly[2]	Yearly[2]
Ocs	Yearly	Yearly[2]	Yearly[2]
Herbicides	Yearly	Yearly[2]	Yearly[2]
Thermotolerant coliforms (cfu/100ml)	Use specific[3]	Use specific[3]	Use specific[3]
Flow rate (L/d)	Monthly	Monthly	Monthly
Other	Advice should be sought from the Department of Environment and Conservation or local council[4]	Advice should be sought from the Department of Environment and Conservation or local council[4]	Advice should be sought from the Department of Environment and Conservation or local council[4]
Notes:	1. Units are in mg/L unless otherwise stated. 2. Higher frequencies will be required where these constituents are the constituents that determine the medium or high strength classification 3. Other effluents may not require monitoring for thermotolerant coliforms. Obtain advice from NSW-Health and/or NSW Department of Primary Industries. 4. Seek advice from the appropriate regulatory authority 5. BOD_5 may be replaced by tests such as chemical oxygen demand provided the relationship between the two measures is established.		

TABLE 18 RECOMMENDED SOIL MONITORING STRATEGY

	Frequency of sampling	
Constituents[1]	**Surface soil**	**Soil profile at four depth increments**
pH	Yearly	Yearly
EC (dS/m)	Yearly	Yearly
Nitrate-N	Yearly	Yearly
Total N	After 3 years	N/A
Available P	Yearly	N/A
Total P	After 3 years	After 3 years
Exchangeable sodium % (ESP)	Yearly	After 3 years
Heavy Metals and pesticides.	After 10 years[3]	N/A
P sorption capacity[2] (kg/ha)	After 3 years (site-specific)	After 3 years (site-specific)
Notes:	1. Units are in mg/L unless otherwise stated 2. As recommended by an accredited laboratory or soil specific 3. Or more frequently if any are identified/calculated as a risk factor.	

At least two groundwater monitoring dipwells will be installed at strategic locations to allow measurements of groundwater to be taken for testing in accordance with Table 19.

TABLE 19 RECOMMENDED GROUNDWATER MONITORING STRATEGY

Constituents[1]	**Frequency of sampling**[1,2]
Groundwater height	Quarterly
pH	Quarterly
EC (dS/m)	Quarterly
Cations (mg/L)	Yearly
Nitrate-N	Yearly
Total N	Yearly
Available P	Yearly
Total P	Yearly
Notes:	1. Groundwater need only be monitored if it is within 10m of ground surface and/or if existing groundwater quality at risk from the effluent irrigation scheme. 2. Groundwater sampling should occur on the established enterprises before crop planting, during the middle of the crop growth and quarterly/yearly thereafter (as above).

The owner shall arrange for the wastewater treatment system and effluent irrigation area to be inspected by an employee at least once a week to look for signs of failure, which could include ponding of effluent or odours. Appropriate action is to be taken.

11. SUMMARY

This report assesses the suitability of the soil and site more generally for on-site wastewater management. This assessment includes an estimate of the potential volume of wastewater that could be generated from the proposed development and sizes the required area for wastewater disposal at a suitable location that complies with the relevant assessment criteria. The specific outcomes of this report include:

- Installation of a Sewage Management Facility with the capacity to treat at least 26,370L of wastewater per day to a secondary standard;
- Installation of >190,000L (7-Days) of wet weather storage tanks;
- Commercial spray irrigation system to cover 6,980m^2, fenced and off-limits to the general public;
- Decommissioning of off-line dam (detention ponds) situated to the north of the irrigation area and rehabilitation of the site;
- Stormwater diversion measures to divert clean water away from the proposed irrigation area;
- Full management of the pasture grasses (mowing, then clipping removal)
- A monitoring program to include wastewater quality, soils and groundwater.

12. REFERENCES

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Designing and Installing On Site Wastewater Systems. A WaterNSW Current Recommended Practice (2019).

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NSW Agriculture (July 1999) Pastures and Acid Soils, pamphlet in a series on Acid Soil Management, prepared for the New South Wales Acid Soil Action Program by Mick Duncan, Acid Soils Specialist, Armidale, July 1999

FAO, (1978) Irrigation and Drainage Papers http://www.fao.org/docrep/X5560E/x5560e02.htm#1. effective rainfall and its significance

Robert van de Graaff and Robert A Patterson (2001): *Explaining the Mysteries of Salinity, Sodicity, SAR And ESP In On-Site Practice*

Department of Environment and Conservation (NSW) (2004) *Environmental Guidelines Use of Effluent by Irrigation*

Robert A Patterson (2001): Technical Note: T20-1 Emerson Aggregate Stability Test for Wastewater: An interpretation for consultants and regulators

APPENDIX I- ON SITE SOIL ASSESSMENT

ONSITE SOIL ASSESSMENT				
Site Location: 369 Jacks Corner Road, Kangaroo Valley				
Soil assessment method: Northcote textual			Date of assessment: 09/10/2023	
Method of excavation: Mechanical Auger/Shovel/crowbar			Assessor: Sean Harris	
Number of bore holes: Two (2)				
Bore Hole Location	Lower slope		**GPS Latitude**	-34.729499
Bore Hole Number	BH 2 (Purple)		**GPS Longitude**	150.446128
	Layer 1	**Layer 2**	**Layer 3**	**Layer 4**
Depth	0-300mm			
Texture	Sandy Loam			
Colour	Brown			
Structure	Well-Moderately			
Coarse fragments	No			
Water observation	No			
Mottling	No			
Fill material	No			
Site Features	**Flood potential**	Above 1 in 20 AEP	**Exposure**	South/west
	Frost Potential	Minor	**Slope**	~9%
	Erosion potential	Minor	**Landform**	Uniform side slope
	Comments	Lower slope. No surface or groundwater detected to full soil test depth. Site fully grassed. Auger had difficulty tearing through dense soil.		
Bore Hole Location	Top of hill		**GPS Latitude**	-34.467992744
Bore Hole Number	BH 1 (Pink)		**GPS Longitude**	150.357131826
	Layer 1	**Layer 2**	**Layer 3**	**Layer 4**
Depth	0-150mm	150-300mm	300-500mm	
Texture	Loam	Sandy Loam	Clayey Sandy Loam	
Colour	Brown	Brown – Red	Brown – Red – Orange	
Structure	Well	Moderately	Moderately	
Coarse fragments	No	No	Yes – Sandstone fragments	
Water observation	No	No	No	
Mottling	No	No	No	
Fill material	No	No	No	
Site Features	**Flood potential**	Above 1 in 20 AEP	**Exposure**	North/west
	Frost Potential	Minor	**Slope**	10-12%
	Erosion potential	Minor	**Landform**	Uniform side slope
	Comments	Top of hill. No surface or groundwater detected to full soil test depth. Site fully grassed. Auger had difficulty tearing through dense soil.		

APPENDIX II- ALS LABORATORY SOIL TESTING RESULTS

CERTIFICATE OF ANALYSIS

Work Order	: **EW2304602**	Page	: 1 of 3
Client	: **HARRIS ENVIRONMENTAL CONSULTING**	Laboratory	: Environmental Division NSW South Coast
Contact	: SEAN HARRIS	Contact	: Aneta Prosaroski
Address	: 13 Macquarie Street PO Box 70 Jamberoo 2533	Address	: 1/19 Ralph Black Dr, North Wollongong 2500 NSW Australia
Telephone	: 02 4236 0954	Telephone	: 02 42253125
Project	: Glengary Scots College	Date Samples Received	: 17-Oct-2023 14:44
Order number	: 1	Date Analysis Commenced	: 19-Oct-2023
C-O-C number	: ----	Issue Date	: 01-Nov-2023 18:31
Sampler	: Client - Sean Harris		
Site	: ----		
Quote number	: SY/404/22		
No. of samples received	: 3		
No. of samples analysed	: 3		

Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Layla Hafner	Acid Sulphate Soils - Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Wisam Marassa	Inorganics Coordinator	Sydney Inorganics, Smithfield, NSW

right solutions. right partner.

Page	: 2 of 3
Work Order	: EW2304602
Client	: HARRIS ENVIRONMENTAL CONSULTING
Project	: Glengary Scots College

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- **Analytical work for this work order will be conducted at ALS Sydney.**
- EA058 Emerson: V. = Very, D. = Dark, L. = Light, VD. = Very Dark
- ED007 and ED008: When Exchangeable Al is reported from these methods, it should be noted that Rayment & Lyons (2011) suggests Exchange Acidity by 1M KCl - Method 15G1 (ED005) is a more suitable method for the determination of exchange acidity (H+ + Al3+).
- ALS is not NATA accredited for the analysis of bulk density in a soil matrix.

Page : 3 of 3
Work Order : EW2304602
Client : HARRIS ENVIRONMENTAL CONSULTING
Project : Glengary Scots College

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	Site 1 Layer 1	Site 1 layer 2	Site 1 Layer 3	----	----
			Sampling date / time	14-Oct-2023 00:00	14-Oct-2023 00:00	14-Oct-2023 00:00	----	----
Compound	CAS Number	LOR	Unit	EW2304602-001	EW2304602-002	EW2304602-003	--------	--------
				Result	Result	Result	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	5.1	5.4	5.7	----	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	25	12	14	----	----
EA051 : Bulk Density								
⊘ Bulk Density	BULK_DENSITY	1	kg/m3	1160	1330	1350	----	----
EA058: Emerson Aggregate Test								
Color (Munsell)	----	-	-	Very Dark Gray (7.5YR 3/1)	Brown (10YR 5/3)	Yellowish Brown (10YR 5/4)	----	----
Texture	----	-	-	Loam	Light Medium Clay	Light Medium Clay	----	----
Emerson Class Number	EC/TC	-	-	7	7	3	----	----
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	0.5	0.2	0.3	----	----
Exchangeable Magnesium	----	0.1	meq/100g	0.4	0.4	0.2	----	----
Exchangeable Potassium	----	0.1	meq/100g	0.3	0.2	0.2	----	----
Exchangeable Sodium	----	0.1	meq/100g	0.2	<0.1	0.2	----	----
Cation Exchange Capacity	----	0.1	meq/100g	1.6	0.8	0.9	----	----
Exchangeable Sodium Percent	----	0.1	%	12.6	3.8	24.3	----	----
EK072: Phosphate Sorption Capacity								
Phosphate Sorption Capacity	----	250	mg P sorbed/kg	835	1280	1480	----	----

Inter-Laboratory Testing

Analysis conducted by ALS Brisbane, NATA accreditation no. 825, site no. 818 (Chemistry) 18958 (Biology).
(SOIL) EA058: Emerson Aggregate Test
Analysis conducted by ALS Sydney, NATA accreditation no. 825, site no. 10911 (Chemistry) 14913 (Biology).
(SOIL) EA002: pH 1:5 (Soils)
(SOIL) EA010: Conductivity (1:5)
(SOIL) EA051 : Bulk Density
(SOIL) EK072: Phosphate Sorption Capacity
(SOIL) ED007: Exchangeable Cations

APPENDIX III- PHOSPHORUS AND NUTRIENT UPTAKE

Appendix 1
Phosphorus Sorption Uptake Values

Soil Category	Texture	Structure	Acceptable P_{sorp}* (mg/kg)
1	Gravels and sands	Structureless	50
2a	Sandy loams	Weak	100
2b	Sandy loams	Massive	100
3a	Loams	High / moderate	200
3b	Loams	Weak / massive	200
4a	Clay loams	High / moderate	400
4b	Clay loams	Weak	400
4c	Clay loams	Massive	400
5a	Light clays	Strong	500
5b	Light clays	Moderate	500
5c	Light clays	Weak / massive	500
6a	Med-heavy clays	Strong	600
6b	Med-heavy clays	Moderate	600
6c	Med-heavy clays	Weak / massive	600

* If soil parent material is basalt then increase Psorp by 100mg/kg

Nutrient Uptake Rates

Vegetation Type	Total Nitrogen (kg/ha/year)	Total Phosphorus (kg/ha/year)
Good quality woodland	90	25
Poor quality woodland	65	20
Lawn – fully managed (clippings removed)	240	30
Lawn – unmanaged	120	12
Improved pasture	280	24
Perennial pasture	99	11
Shrubs and some trees – fully managed	150	16
Shrubs and some trees – unmanaged	75	8

For **bulk density (g/cm³)**, apply the following values:

Sandy soil – 1.8g/cm³
Intermediate – 1.5g/cm³
Clayey soil – 1.3g/cm³

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APPENDIX IV- WATER BALANCE

Nominated Area Water Balance for Zero Storage

Site Address: **Scots College - 369 Jacks Corner Road, Kangaroo Valley**

INPUT DATA			
Design Wastewater Flow	Q	26370	L/day
Design DIR (from AS/NZ 1547:2012)	DIR	35	mm/week
Daily DIR		5.0	mm/day
Nominated Land Application Area	L	**6980**	m sq
Rainfall Data Station (Monthly Medians)	Barrengarry (The Old School House)		
Evaporation Data (Monthly Average)	Kangaroo Valley (Bendeela Pondage)		

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in month	D	\	days	31	28	31	30	31	30	31	31	30	31	30	31	**365.0**
Rainfall	P	\	mm/month	82.9	86.8	79.3	61.7	50.6	65.5	43.5	43.1	48	54.4	88.8	64.8	**704.6**
Evaporation	E	\	mm/month	136.3	116.3	94.8	73.6	44.7	35.8	46.1	76.4	89	122.9	131.7	155.7	**1123.3**
Crop Factor	C			0.80	0.75	0.70	0.65	0.60	0.60	0.60	0.60	0.65	0.70	0.75	0.80	
INPUTS																
Precipitation	(P)		mm/month	82.9	86.8	79.3	61.7	50.6	65.5	43.5	43.1	48	54.4	88.8	64.8	704.6
Effluent Irrigation	(W)	(Q x D) / L	mm/month	117.1	105.8	117.1	113.3	117.1	113.3	117.1	117.1	113.3	117.1	113.3	117.1	**1378.9**
Inputs		(P+W)	mm/month	200.0	188.7	203.9	192.6	178.8	163.9	182.6	160.6	156.4	165.1	167.7	205.9	2166.4
OUTPUTS																
Evapotranspiration	ET	ExC	mm/month	109	87	66	48	27	21	28	46	58	86	99	125	**799.5**
Percolation	B	(DIR/7)xD	mm/month	155.0	140	155.0	150.0	155.0	150.0	155.0	155.0	150.0	155.0	150.0	155.0	**1825.0**
Outputs		ET+B	mm/month	264.0	227.225	221.4	197.8	181.8	171.5	182.7	200.8	207.9	241.0	248.8	279.6	**2624.5**
Storage remaining from previous month			mm/month	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Storage	S	(P+I)-(ET+B)	mm/month	-64.0	-38.5	-17.4	-5.2	-3.0	-7.5	0.0	-40.2	-51.4	-75.9	-81.0	-73.6	
Cumulative Storage	M		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.00**
Largest M	**(V)**		mm	**0.00**												
		(V x L)/1000	m^3	**0.0**												

APPENDIX V- NITROGEN & PHOSPHORUS BALANCE

NITROGEN BALANCE				
SITE ADDRESS	**Scots College - 369 Jacks Corner Road, Kangaroo Valley**			
Daily volume	26370	L/day		
TN effluent conc	25.0	mg/L		
TN	0.65925	kg/d		
	240.62625	kg/yr		
Irrigation Area	**10,026**	**m2**	**1.002609375**	ha
TN annual application rate	0.024	kg/m2/yr		
	240.0	kg/ha/yr		
TN Uptake (managed land)	240	kg/ha/yr		
TN available for leaching	0	kg/ha/yr		
Or for site	**0.00**	kg/yr		

PHOSPHORUS BALANCE			
SITE ADDRESS	**Scots College - 369 Jacks Corner Road, Kangaroo Valley**		
Daily hydraulic load	26370	L/day	
TP effluent conc	12	mg/L	
TP effluent conc per day	316440	mg/day	
	115500.6	g/year	
P sorption rate of soil	1480	mg/kg	
Bulk density of soil	1.8	g/cm3	
	1800	kg/m3	
Land application area	**3896.8**	**m2**	
Soil depth	0.5	m	
Volume of soil	1948.391	m3	
Mass of soil	3507103.239	kg	
Total P sorption capacity	5190513	g	
Vegetation	Grass		
P annual uptake by vegetation	30	kg/ha/yr	
	11690.34413	g/yr	
Net annual P (in soil)	103810	g/yr	
Life of system	50.0	years	

SITE PLAN: KEY

- SUBJECT PROPERTY BOUNDARY
- 2m CONTOURS
- DRAINAGE CHANNELS
- 80mm EFFLUENT MAIN
- 80mm EFFLUENT IRRIGATION PIPE
- PROPOSED HOLDING TANK
- EXISTING DETENTION PONDS
- PROPOSED TOTAL IRRIGATION AND NUTRIENT UPTAKE ZONE - >10,026sqm
- PROPOSED PUMP STATION - to provide sufficient pressue to the system, & GATE VALVE
- PROPOSED 12.5m THROW SPRINKLER - 6,980sqm
- EXISTING 34,000L SEPTIC TANK
- EXISTING PUMP STATION
- EXISTING 3000L PUMP SUCTION TANK
- SOIL TEST PIT LOCATIONS

149.6m
48.6m
100.4m
211.0m
199.7m
137.2m
159.8m
200
HARRIS

Issue:	Description:	Date	Drawn	Approved
v0.1	Issue for client review	03.11.23	KK	SH
v0.2	Issue for client review	09.09.24	KK	SH
v1.0	Issue for client review	14.10.24	KK	SH

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Wastewater | Bushfire | Stormwater

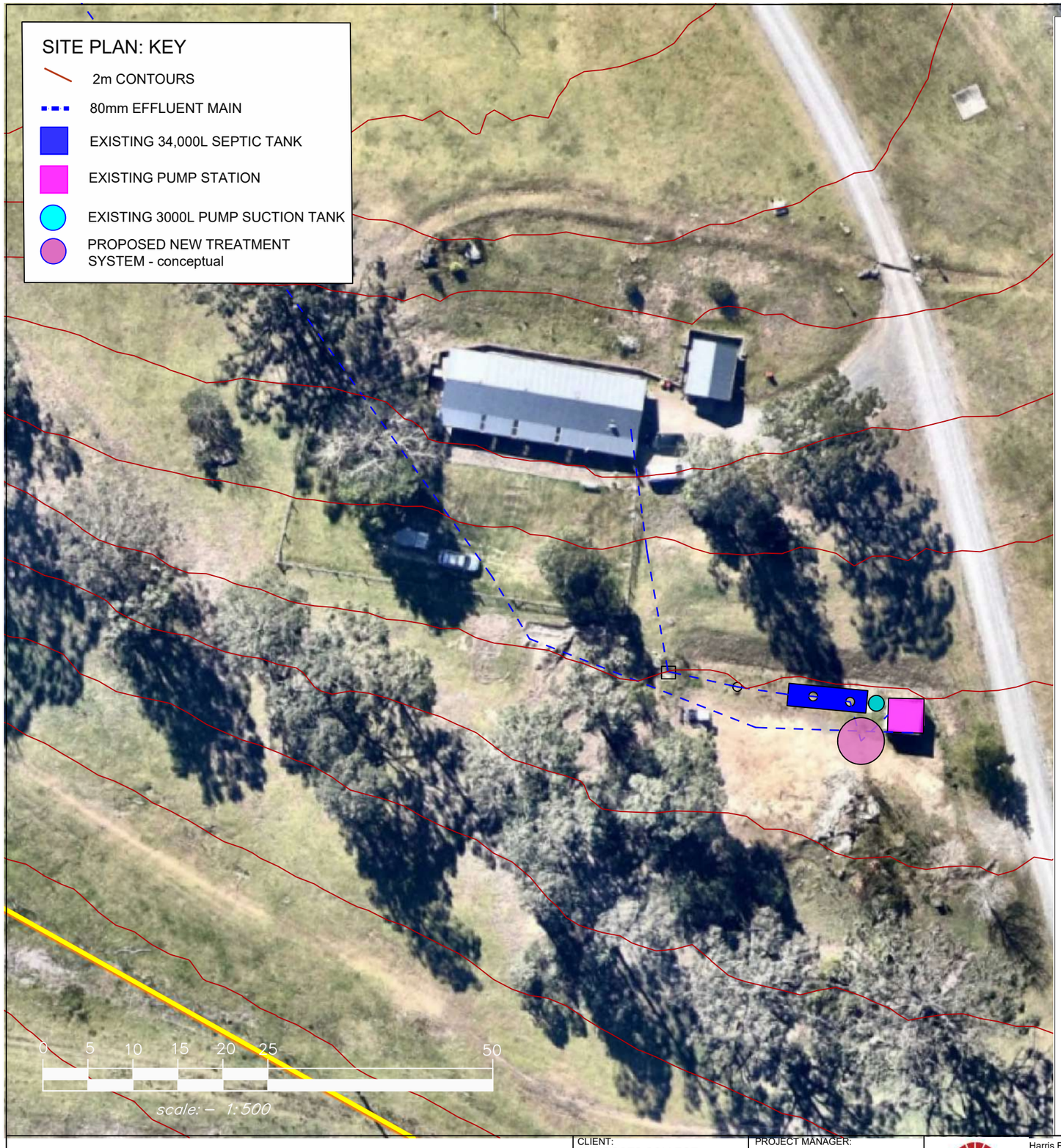
Project:
PROPOSED SCHOOL WASTEWATER SYSTEM UPGRADE
LOT 27 DP 881838
369 JACKS CORNER ROAD, KANGAROO VALLEY, NSW
LGA: SHOALHAVEN

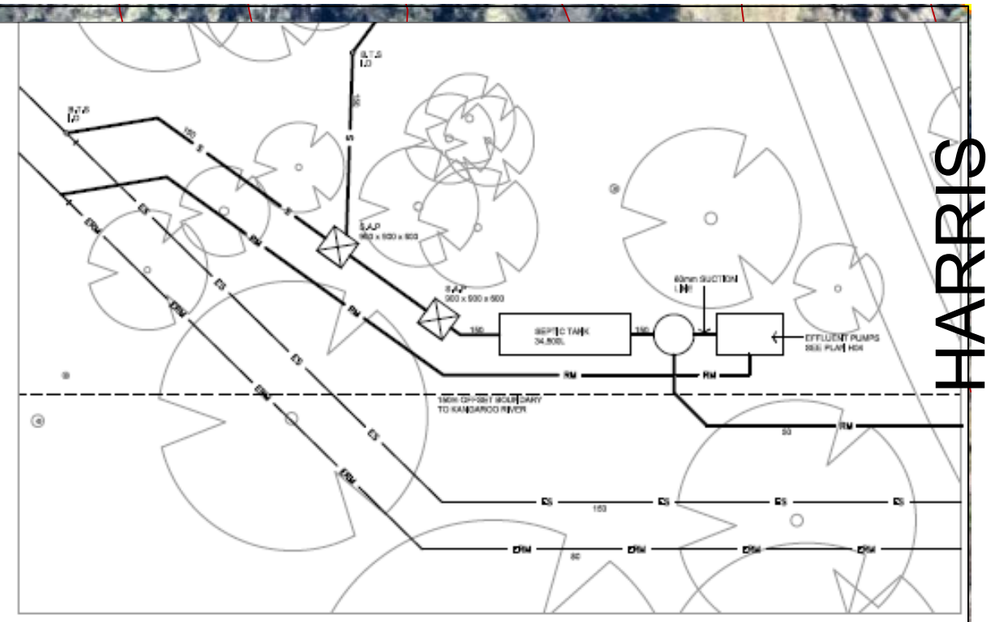
Drawing Title:
WASTEWATER MANAGEMENT PLAN DETAILS SHEET No.1

Drawn:	Date:	Paper Size:	Q.A. Check:	Date:
KK	14.10.2024	ISO Expand A3	Complete	14.10.2024
Designed:	Our reference:	Scale:	Issue:	
KK	6440WW	1:2500	v1.0	

SITE PLAN: KEY

- 2m CONTOURS
- 80mm EFFLUENT MAIN
- EXISTING 34,000L SEPTIC TANK
- EXISTING PUMP STATION
- EXISTING 3000L PUMP SUCTION TANK
- PROPOSED NEW TREATMENT SYSTEM - conceptual





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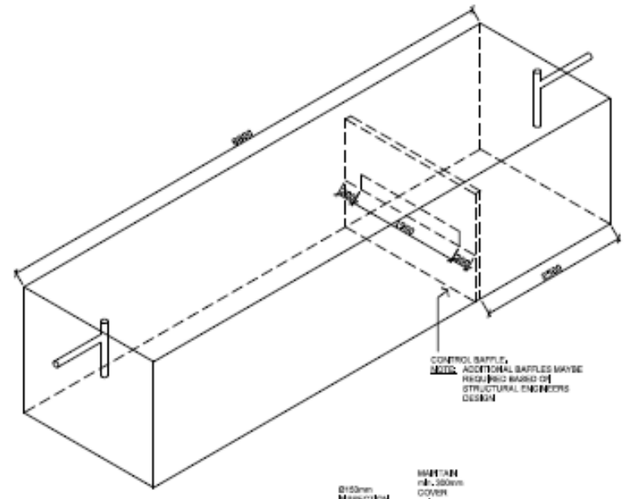

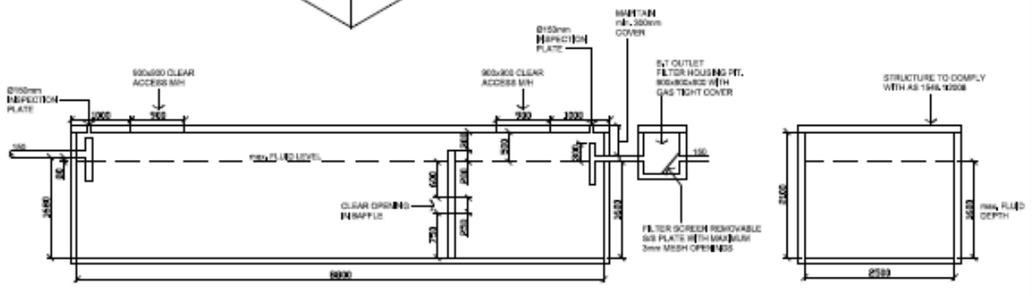

MAIN SEPTIC TANK MINIMUM CAPACITY 34,5kL

NOTE: ALL DIMENSIONS SHOWN ARE INTERNAL TANK REQUIREMENTS. ALL ENTRY TO SEPTIC TANK CHAMBER VIA APPROVED CONFINED SPACE ENTRY M/H.

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Drawing Title:
WASTEWATER MANAGEMENT PLAN DETAILS SHEET No.2

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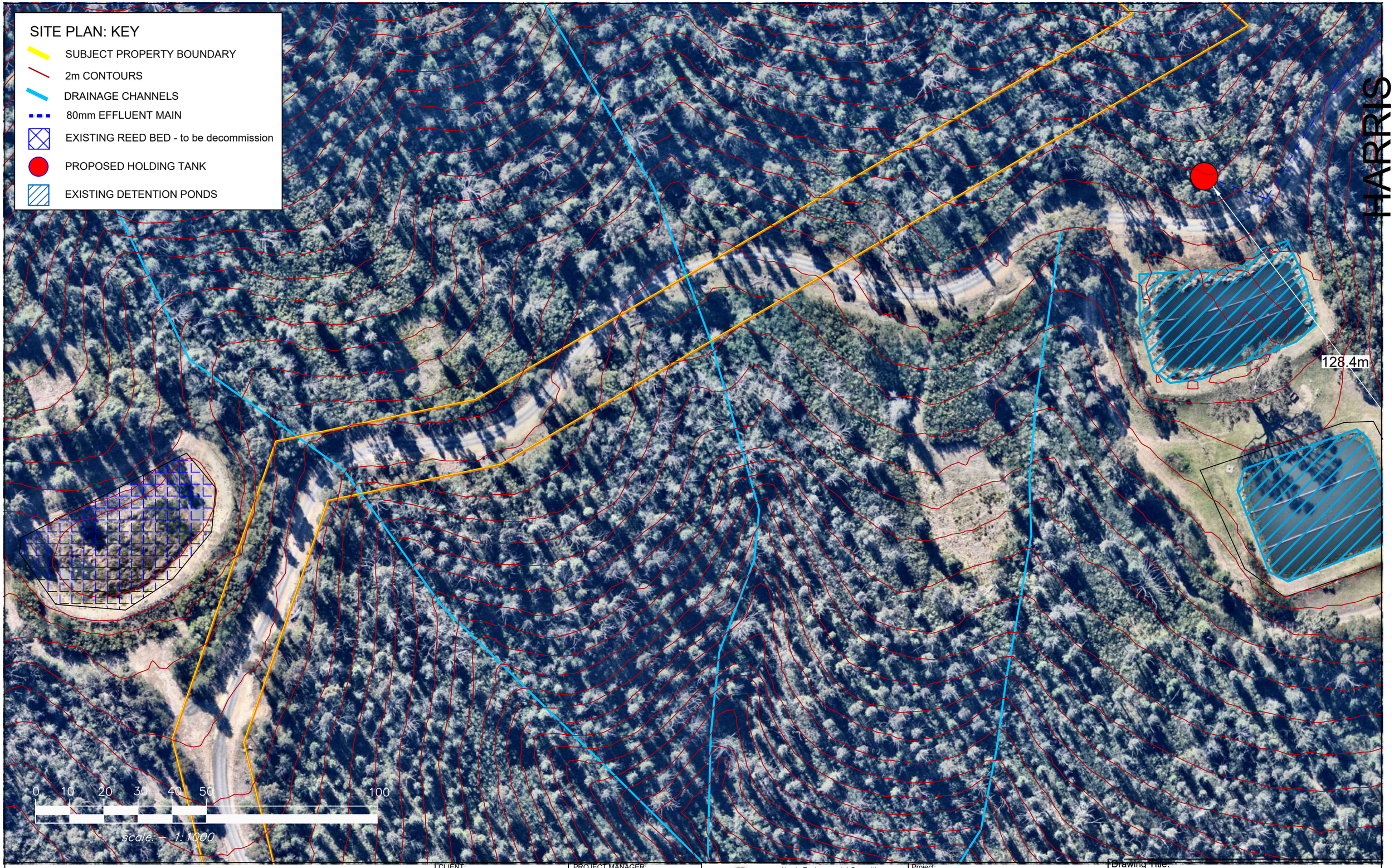

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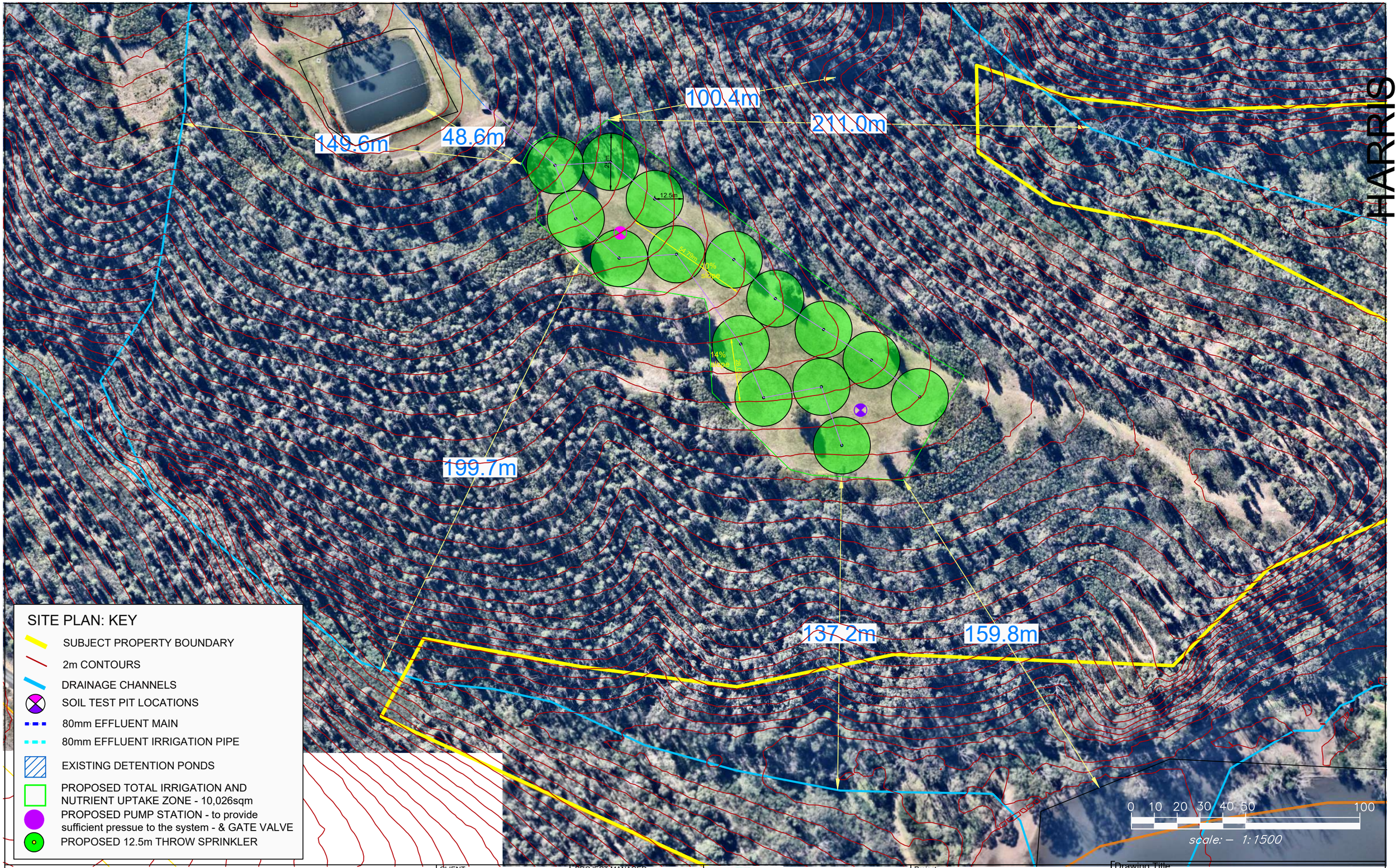

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Drawing Title:
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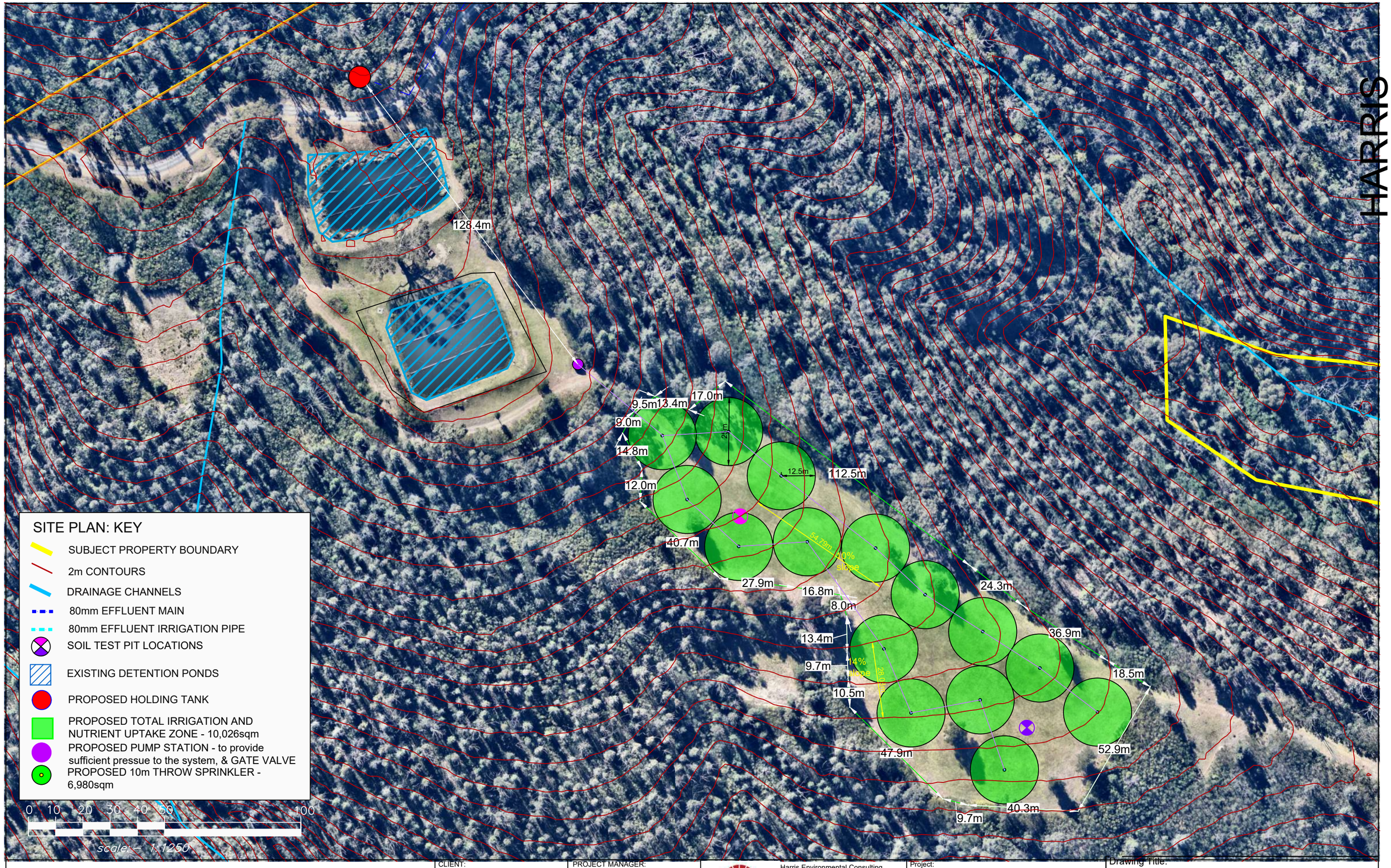

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