Appendix K. Spoil management strategy

Shoalhaven Hydro Expansion Project - Main Works Environmental Impact Statement

SSI-10033

Origin Energy Eraring Pty Ltd

November 2022

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Shoalhaven Hydro Expansion Project - Main Works

Spoil management strategy

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1. Introduction

1.1 Project overview

Origin proposes to develop the Shoalhaven Pumped Hydro Expansion Project involving the construction and operation of a new underground pumped hydro power plant on and under the land between the Fitzroy Falls Reservoir and Lake Yarrunga (the Project). The indicative Project layout is provided in Figure 1-1. A full description of the Project is provided in Chapter 3 of the Environmental Impact Statement (EIS).

The Project involves excavation of approximately 8 kilometres (km) of underground tunnels, a power house and various surface excavations totalling approximately 300,000 cubic metres ($m^{3)}$ (approximately 420,000 m^3 bulked volume) of excavated spoil.

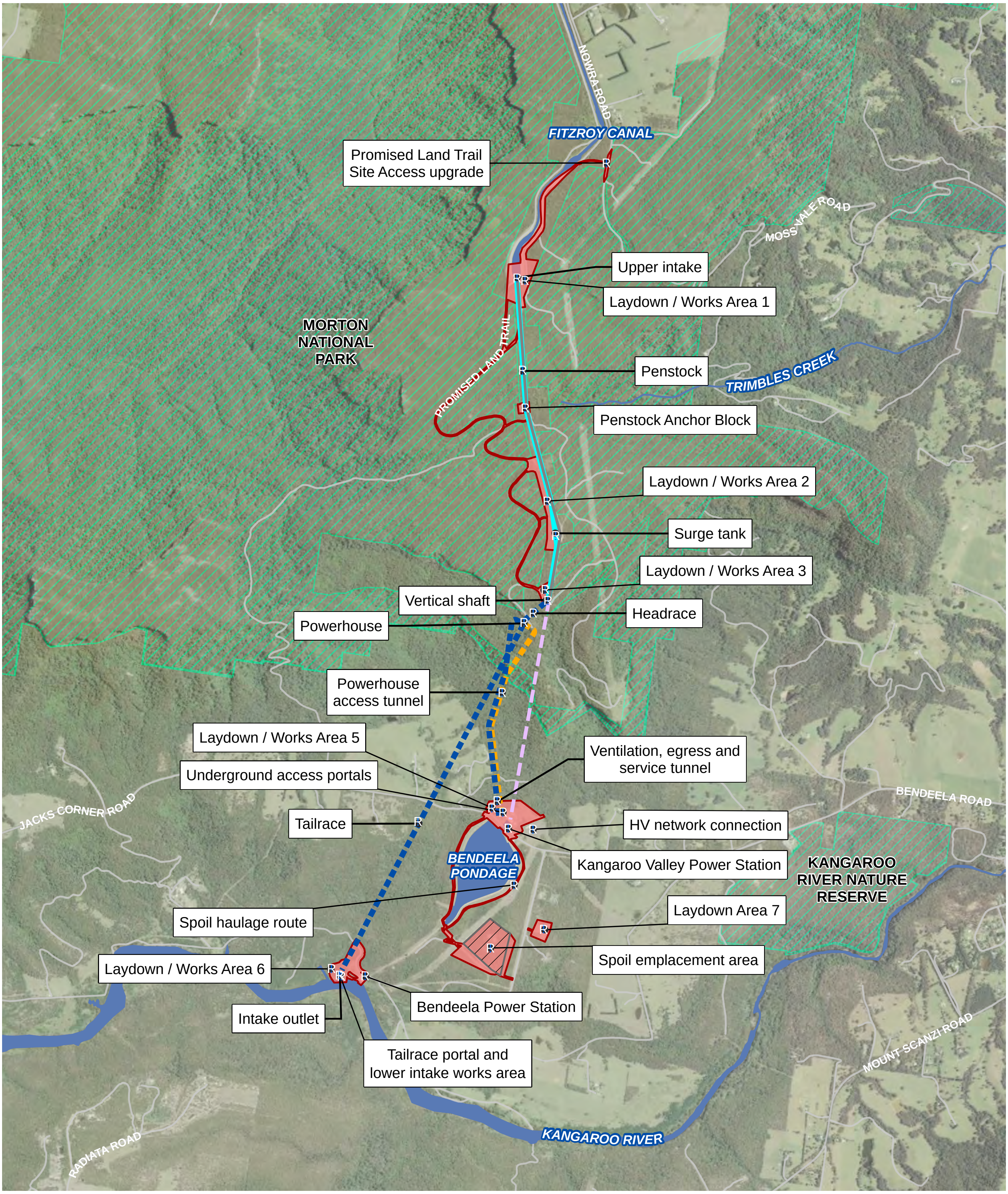
1.2 Secretaries Environmental Assessment Requirements

This spoil management strategy forms part of the EIS for the Project. The EIS has been prepared under Division 5.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

Table 1-1 outlines (in bold) the SEARs relevant to spoil management along with a reference to where these are addressed.

Table 1-1 SEARs relevant to Spoil Management

Secretary's requirement	Where addressed in this report
Land – including: - an assessment of impacts of the project on soils, land capability, including potential impacts associated with the use of hydrocarbons and chemicals, ***dealing with the spoil generated by the project***, and geotechnical stability of the site and surrounds, including completion of a Land Use Conflict Risk Assessment in accordance with DPI's Land Use Conflict Risk Assessment Guide;	This spoil management strategy outlines the approach to spoil management only but underpins assessment of impacts on land provided in the main body of the EIS.
- an assessment of the impacts of the project on landforms, including the short and long term geotechnical stability of any new landforms and any seismic or subsidence impacts; and	Refer to separate report
- ***an assessment of the risk of soil and water contamination based on the predicted geochemistry of the excavated rock and any disturbance of land associated with previous mining activities and naturally occurring asbestos in the vicinity of the site***; and	Addressed in Section 3 and 4 of this report.
- a strategy to manage the progressive rehabilitation of the land disturbed by the project and enhance any new landforms created.	Refer to main body of the EIS.
Water – including: - an assessment of the impacts of the project on groundwater aquifers and groundwater dependent ecosystems having regard to the NSW Aquifer Interference Policy and relevant Water Sharing Plans;	Refer to Appendix J for the Groundwater Technical Report
- a detailed site water balance for the project, including water supply and wastewater disposal arrangements; - an assessment of whether the project would have a neutral or beneficial effect on water quality;	Refer to Appendix I for the Surface Water Quality, Hydrology and Geomorphology Technical Report
- where the project involves works within 40 metres of the high bank of any river, lake or wetlands (collectively waterfront land), identify likely impacts to the waterfront land, and how the activities are to be designed and implemented in accordance with the DPI Guidelines for Controlled Activities on Waterfront Land (2018) and (if necessary) Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (DPI 2003); and Policy & Guidelines for Fish Habitat Conservation & Management (DPI, 2013); and	Refer to Appendix I for the Surface Water Quality, Hydrology and Geomorphology Technical Report
- a strategy to manage spoil;	This report.



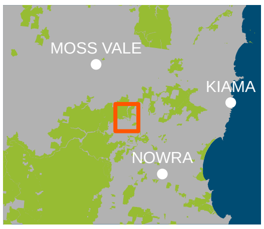
Legend

	Points of interest		Waterway
	Existing KV tunnel alignment		Road
	Existing scheme pipeline		NPWS Reserve
	Indicative above ground pipeline		Waterbody
	Indicative tunnel alignment		
	Indicative access tunnel		
	Project area		
	Spoil Emplacement		

0 1 2 km

1:40,000 at A4

GDA2020 MGA Zone 56



Data sources

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Department of Planning and Environment 2022
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Figure 1-1 Indicative Project layout

1.3 Report purpose

The purpose of this report is to address the SEARs requirements related to spoil management and describe the proposed strategy for the management of excavated rock (spoil) from both surface and underground works. Particular focus is provided on the key identified geochemical risk of geological units that have the potential to be acid generating and their long-term storage, management and treatment to achieve environmentally responsible and sustainable outcomes. The report would be progressed to a spoil management plan as part of the detailed design in response to greater design certainty and actual construction methodologies.

2. Spoil management strategy

Key sustainability elements considered during the development of the spoil management strategy are listed in Table 2-1. These elements form the foundation of a Spoil Management Plan that will be developed during the detailed engineering and design phase of the Project by the selected construction Contractor.

Table 2-1. Key sustainability elements spoil management plan

Key sustainability element	Strategy consideration
Reduce/Avoid	The alignment and dimensions of the underground structures is a function of the hydraulic conditions and the size of the equipment to be installed in the power plant. Reducing excavation volumes is of direct cost benefit to the Project and the hydraulic design is carefully considered to optimise the design and sizing of underground works. There is no scope to avoid the displacement of spoil during construction, and reducing volumes is a natural consequence of design optimisation. Modern construction techniques reduce the volume of over excavating material for both surface and underground works.
Lessons learned and good industry practices	Consider other project experiences in the region and be guided by recognised industry guidelines.
Prudent adaptable planning and experience informed solutions	Engineering solutions for uncertainty of spoil characteristics but pre-planning steps to respond if assumptions change.
Recovering, reuse and recycling of excavated material	Subject to the suitability of the material (neutral impact), a portion of the non-acid forming material (NAF) and acid consuming material (ACM) will be stockpiled and recovered and re-used where practical in the construction of the Project such as for construction of road pavements, embankments, engineering fill, aggregates for concrete, and other beneficial reuse purposes identified during construction. Where feasible, soil with organic material will be recovered and used for revegetation. Other options for off-site beneficial use may become apparent during the Project such as provision for use by the local council, National Parks and Wildlife Services and /or WaterNSW for infrastructure projects; however, this is not expected to be a large volume and will be assessed and permitted through appropriate means in accordance with the EPA guidelines.
On-site treatment, on-site disposal and containment	On-site disposal and treatment of spoil generated from the excavation of surface and underground structures is considered the most economic and able to be undertaken in an environmentally responsible and sustainable manner. Material containing acid sulphate that is potential acid forming (PAF) will be identified and managed to contain and neutralise unfavourable effects to meet relevant guidelines and all EPL limits. The Strategy broadly includes: ▪ Establish criteria and thresholds commonly used in NSW tunnelling projects to characterise acid forming characteristics of the spoil. as PAF, Potentially Acid Forming Low Capacity (PAF-LC), NAF and ACM ▪ Establish a dedicated containment areas for spoil and storage zones according to the material characteristics ▪ PAF material will be managed separately from "PAF-LC, NAF and ACM material and subject to adopted management methods prior to emplacement. The following method options are considered credible and achievable within the scope of the Spoil Management Plan for the Project to manage PAF: ▪ Encapsulation of PAF materials within the spoil emplacement area to minimise oxidation, separate the material from rainfall and overland flows and contain and control water runoff that comes in contact with the material ▪ Physical blending of PAF material with ACM prior to emplacement

Key sustainability element	Strategy consideration
	▪ Neutralisation treatment prior to emplacement.
Off-site disposal	In the unlikely event that offsite disposal of spoil is required it will be managed in accordance to the EPA guidelines and the Industrial Waste Management Policy under a purpose developed management plan. Certified disposal facilities will only be used.

In the absence of currently identified off-site beneficial use options, spoil excavated during construction of surface and underground structures will require permanent stockpiling within the Project site thereby avoiding unfavourable social and environmental impacts associated with hauling the material for offsite or disposal.

2.1 Identification of preferred permanent spoil stockpile area

The selection of the location of the permanent spoil stockpile has been optimise based on the following criteria:

- Be located above the maximum probable flood level
- Be located in an area where the groundwater table is well below the surface and away from natural waterways
- Be located in an area of low biodiversity and cultural values (i.e. previously disturbed site) and where visual, noise and dust impacts can be reasonably engineered and managed
- Be located close to the source of spoil to reduce haulage distance and the associated indirect sustainability footprint of the Project.

An area to the east of the Bendeela Pondage was selected as shown in Figure 1-1. Positioning of the spoil stockpiles and containment cells between the Bendeela Pondage and Lower Bendeela Road offers an aesthetically favourable location for a landform that is consistent with existing topography and is screened from the road by a retained vegetation buffer.

2.2 Indicative Spoil emplacement design concept

The design concept of the stockpile includes:

- 80,000m^2 area to stockpile nominally 420,000m^3 of excavated spoil (bulk volume)
- Earthworks to partially level and form swales and a small bund around the perimeter of the stockpile area to act as drainage lines for stockpile runoff
- Construction of a containment cell for PAF that cannot otherwise be effectively treated and neutralised.

Plant and equipment operating in or adjacent to the stockpile area may include a crushing plant to grade the material for use.

The indicative spoil emplacement design concept is illustrated in Figure 2-1 with further detail provided in Appendix A.

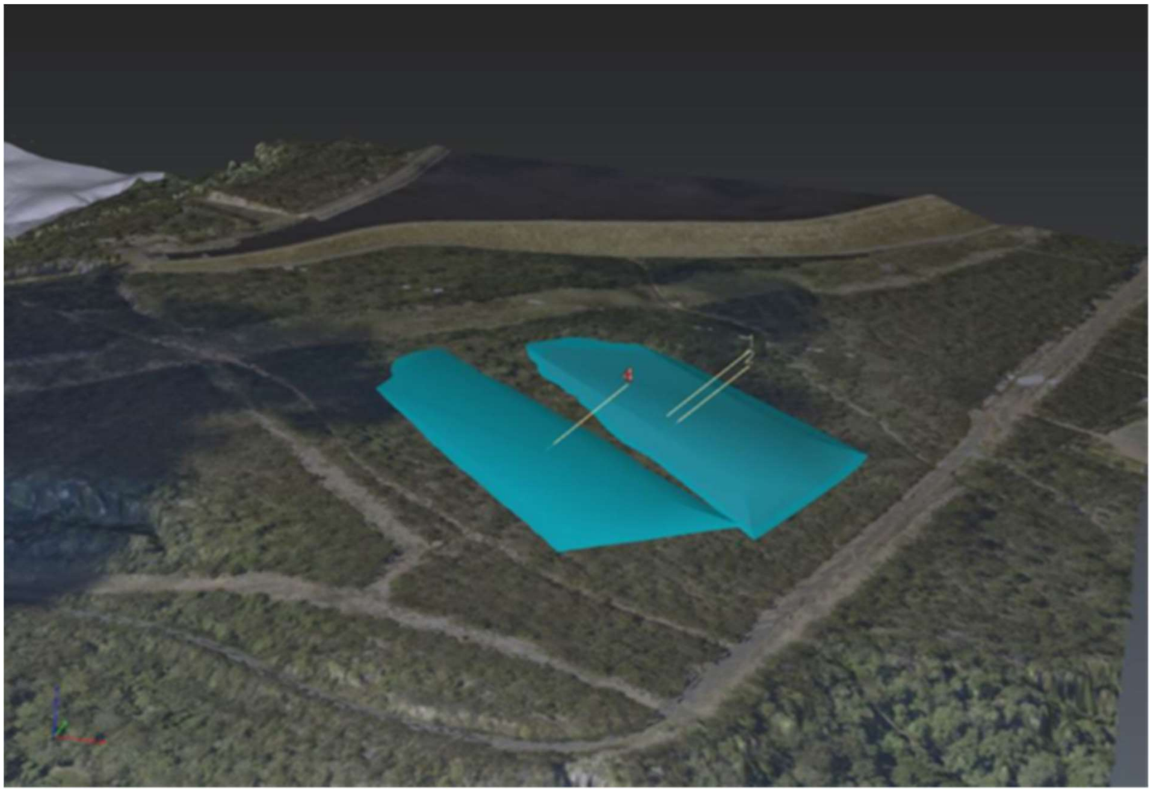

Figure 2-1 Indicative emplacement design visualisation

2.2.1 Site preparation and capping layer

Most of the area of the proposed spoil emplacement was disturbed during construction of the Shoalhaven Scheme in the late 1970s. The area has since revegetated and currently comprises of regrowth forest and a strip of remnant vegetation along the Lower Bendeela Road. Only minor localised earthworks are envisaged and will be required to prepare the site for spoil disposal as follows:

- The vegetation will be removed for reuse
- The topsoil, where present, will be stripped and stockpiled for reuse
- The base layer of emplacement areas will be prepared.

Excavation for the Project is proposed to begin with the main access tunnel, ventilation and egress tunnel and tailrace tunnel (concurrently), followed by adits and cavern. Excavation of these elements are anticipated to predominantly produce NAF and ACM spoil (refer to Section 3) that is expected to be suitable for use in preparation of the base layer and capping material if required. The excavation of the vertical shaft has a higher potential to intersect PAF but would occur later in the program allowing time for establishment of an encapsulation area if required.

In the event that PAF encapsulation is required, the base of the PAF area would be formed by a low permeability layer overlaid with a drainage system. A gentle gradient towards the retention pond would facilitate drainage.

NAF and ACM siltstone materials obtained from the Nowra Sandstone, Berry Siltstone and Snapper Point formations are expected to be suitable as a bed and capping material.

2.2.2 Collection and treatment of potential acid drainage

Potential inflows that infiltrates into PAF material will be collected via a drainage system to be constructed at the base of the cell and discharged into a retention and settling pond. The retention pond will be lined with a suitable impervious lining to reduce the risk of ground infiltration. The location and dimension of the pond will be confirmed during detail design. Based on an initial concept, it is envisioned that the pond will be located at the north-eastern side of the spoil area as shown in **Figure 2-2**.

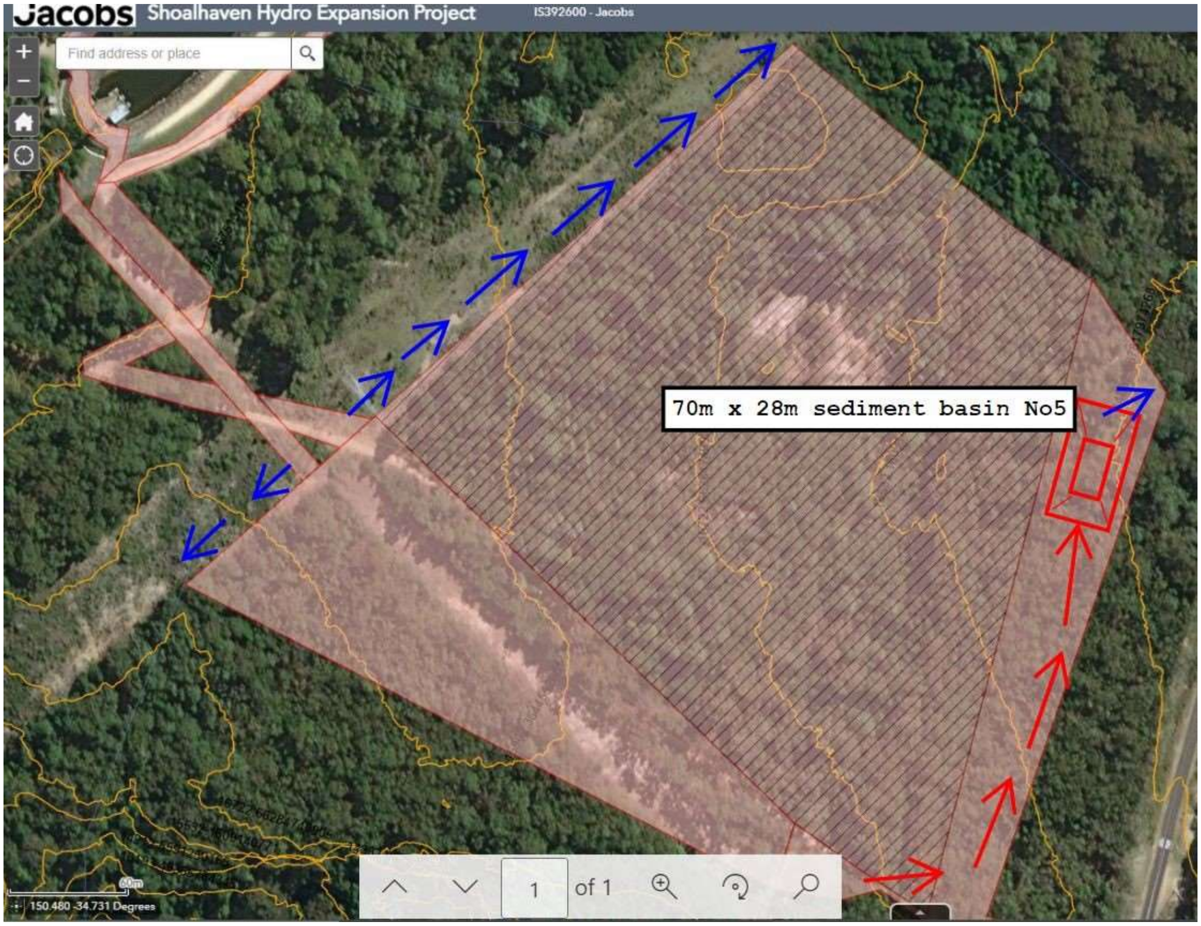

Figure 2-2. Drainage concept around permanent spoil area

A pH dosing system may be required to neutralise acidity and aeration for sludge precipitation in the pond until such time as collected water is confirmed as safe for direct discharge. The settling pond would provide for sufficient reserve capacity to buffer periods of elevated water infiltration and thus safeguard the discharge limit.

The collected water would be treated to the appropriate discharge criteria prior to discharge to the environment. Where feasible, the collected water will be re-used for use during construction as dust suppression.

2.3 Spoil transport

The main access tunnel and egress, services and ventilation tunnel will serve as the primary route for mucking spoil from the underground works. It will be necessary for some spoil from the tailrace tunnel to be removed through the tailrace entrance near Bendeela Power Station. A small amount of spoil from the blind boring of the headrace shaft will be removed from the upper scheme directly above the shaft. There will also be a minor amount of spoil from the surface excavation works for the surge tank, upper intake and penstock.

Spoil will be transported from the excavations to the spoil stockpile area located on the southeast side of the Bendeela Pondage. A combination of transport methods may be employed by the construction contractor including trucks and/or conveyor systems. The routes to the spoil stockpile area will include short transport distances along or across public access roads and private access roads; however, the criteria for design of the transport system is to minimise the use of public roads as reasonably practical. Where spoil haulage by local roads is required, it would be subject to a comprehensive traffic management plan to be prepared in consultation with the relevant roads authority, WaterNSW and landowners with affected access points.

As required, and based on space availability considerations, small temporary stockpiles at the main access tunnel portal and tailrace drive portal will be deployed. The temporary stockpiled spoil will be transported to the permanent stockpile area during the day. The temporary stockpile areas will be managed in an environmentally responsible way and management plans and engineering controls used to achieve EPL requirements.

The approximate capacity of the temporary stockpiles is shown in Table 2-2. The capacity of the temporary stockpiles will be confirmed by the Contractor during the detailed engineering and design phase.

Table 2-2. Local stockpile areas key features

Temporary Stockpile Area	Estimated capacity (ton)	Estimated area (m^2)
Main Access Portal	1,000	445
Tailrace area	200	225

3. Geochemical risk assessment

The geochemical risk associated with Project generated spoil is identified as the presence in PAF materials in some formations intersected by underground works. Acid generation occurs when sulphide and sulphate minerals in the rock are exposed to oxygen and water. Tunnelling and spoil management and emplacement have the potential to lead to such exposure and result in acid drainage if not appropriately managed.

The concept design for the spoil stockpile area has considered the following hazards:

- The uncontrolled release of acidic (low pH) water from the stockpile area to the environment (surface runoff or leachate to groundwater)
- Damage to infrastructure from the acidic characteristics of the spoil
- Long term integrity of embankments, lining material or encapsulation material.

3.1 Acid Rock Potential

Conventional tunnelling industry practice in the NSW region for classification of acid sulphate rock is the basis for establishing thresholds for characterisation of the spoil for Spoil Management Plans. In 2019 a geotechnical investigation program obtained approximately 50 samples from 4 boreholes along the alignment which were tested for acid forming properties.

Experience by Transport for NSW (TfNSW) on previous tunnelling projects has considered threshold values that include net acid producing potential (NAPP) and net acid generation (NAG). The thresholds are summarized in Table 3.1. The threshold values have been extended to specify a potentially PAF-LC category and are used in conjunction with the threshold classification recommended by AMIRA.

Table 3.1. Criteria for managing acid sulphate and metalliferous drainage

Primary geotechnical material type	NAPP (kg H_2SO_4/tonne)	NAG pH
Potentially Acid Forming (PAF)	>10	<4.5
Potentially Acid Forming Low Capacity (PAF-LC)	0 to 10	<4.5
Non-Acid Forming (NAF)	Negative	≥4.5
Acid Consuming (ACM)	<-100	≥4.5
Uncertain	Positive	≥4.5
	Negative	<4.5
	Positive	<4.5

The criteria as described in the table above is proposed to be the basis for categorisation of excavated material for the Project. Tests results from the 2019 Geotechnical Investigation Program at the Project site is shown graphically in Diagram 3.1 and Diagram 3.2 below showing the NAPP versus NAG distribution of the unit types.

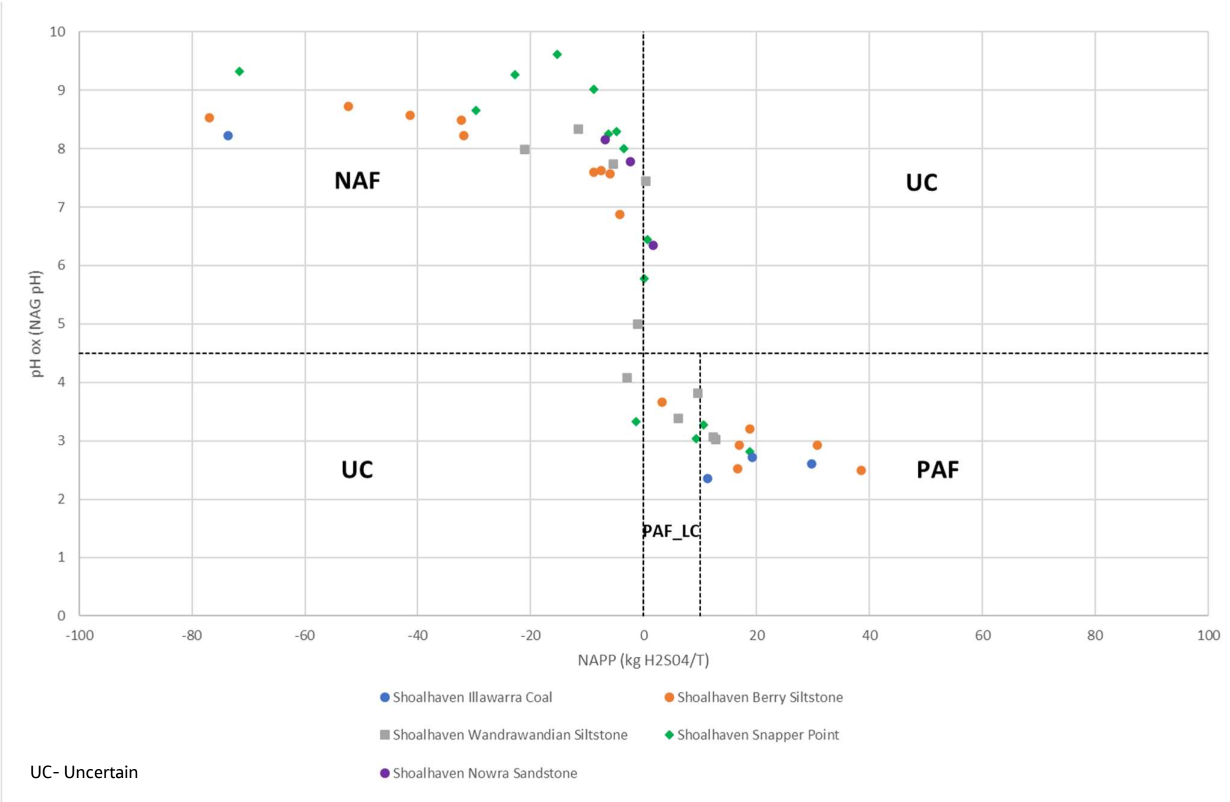

Diagram 3.1. Geochemical Plot of NAPP and NAG pH Data for Shoalhaven Project

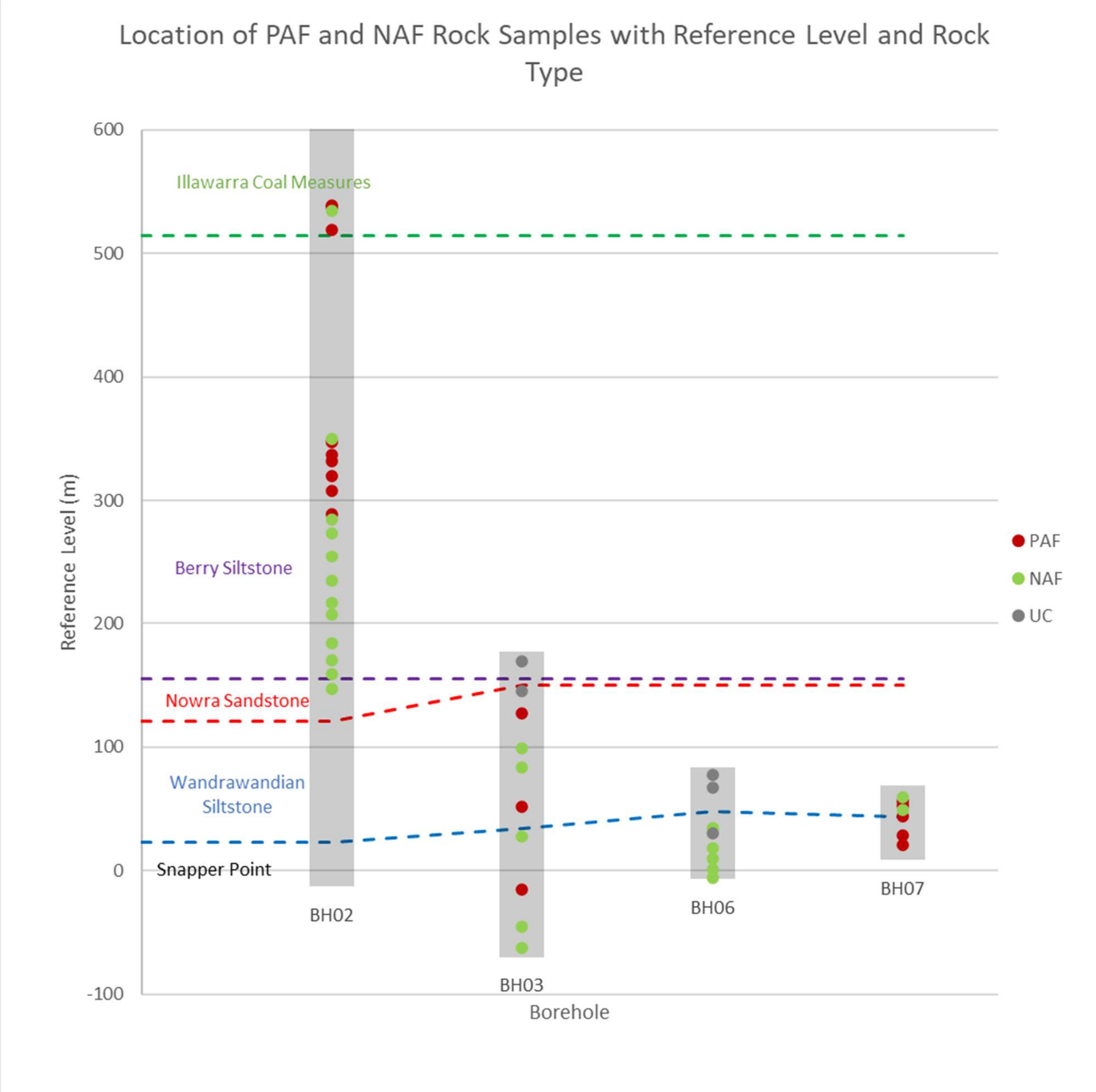

Diagram 3.2. Location of PAF and NAF Rock Samples with Reference Level and Rock Type

3.2 Characterisation of acid rock spoil

Indicative volumes of spoil produced per geological formation have been estimated from the geological model and are summarised on Table 3-2. Table 3-3 summarises the average and cumulative NAPP for all samples per geological unit.

The Wandrawandian and Berry formations show the highest PAF based on the limited test results, whereas the Nowra Sandstone results show that it is mainly NAF. The Illawarra Coal Measures, Berry Siltstone and Snapper Point Formation are indicated to be overall net acid consuming.

The overall NAPP of all samples tested (sum of all results as kg H2SO4/t) is strongly negative (-161 kg H2SO4/t), indicating the overall acid consuming potential of the combined samples.

Table 3-2 Spoil volumes per geological formation

Geological Unit	Volume excavated (m^3)	Percentage of total excavation volume
Hawkesbury Sandstone	17,222	5.8%
Narrabeen Group	180	0.1%
Illawarra Coal Measures	564	0.2%
Broughton Formation	1,916	0.6%
Budgong Sandstone	1,262	0.4%
Berry Siltstone	14,575	4.9%
Nowra Sandstone	27,900	9.4%
Wandrawandian Formation	55,105	18.6%
Snapper Point	177,326	59.9%

Table 3-3 Net acid forming potential

Geological Unit	Number of samples	Average Net Acid Producing Potential (kg H2SO4/t)	Cumulative Net Acid Producing Potential (kg H2SO4/t)	Classification
Illawarra Coal Measures	4	-3.3	-13.3	Net ACM
Berry Siltstone	16	-9.0	-143.3	Net ACM
Nowra Sandstone	2	-0.3	-0.6	NAF material
Wandrawandian Formation	13	9.2	119.2	PAF material
Snapper Point	12	-10.3	-123.2	Net ACM

Based on the volumes and classifications in Table 3-2 and Table 3-3, approximate volumes of NAF, ACM and PAF are estimated as shown in Table 3-4.

Table 3-4 Estimated material classification for the excavation works

Material Classification	Estimated Volume (m3)	Percentage of total excavated material (%)
Non-acid Forming Material (NAF)	48,481	16.4
Acid Consuming Material (ACM)	192,464	65
Potential Acid Forming Material (PAF)	55,105	18.6

The limited test samples obtained, and the extent of the underground construction, limits the representation and conclusions that can be drawn with regard to acids forming characteristics; however with this in mind the sampling and analysis of potentially acid forming materials undertaken to date indicates that the potential volume of acid forming materials could be in the order of 20% of the overall volume of material to be excavated.

Furthermore, material with net acid consuming potential is indicated to comprise the bulk of the excavated material and could plausibly be used for mixing with potential acid forming materials in the spoil emplacement to neutralise the acid forming potential.

It is evident that an adaptable management plan that includes progressive testing and assessment of the excavated material is necessary for development of a spoil stockpile that is constructed and managed in a long term sustainable way. This may include such things as a smaller containment area for material that cannot be easily treated and engineered to be easily expanded is a sensible engineering solution with flexibility to expand it as better information is obtained.

One additional borehole across the full stratigraphy in which the underground works will be constructed is planned and further acid rock laboratory testing will be undertaken to add to the current test dataset. This information will assist in the refinement of management strategies and plans during the detailed engineering and design phase of the Project.

3.3 Naturally occurring asbestos

No evidence of naturally occurring asbestos has been recorded across the Project area. Figure 3-1 shows the location of the Project in relation to the mapped areas within NSW where naturally occurring asbestos has been found based on the Department of regional NSW data [1]. The Project is located more than 90 km away from the closest geological units with low potential of naturally occurring asbestos. Therefore, the likelihood of naturally occurring asbestos in the Project area has been assessed as extremely low resulting in a low risk.

Construction environmental and safety plans will consider the risk of naturally occurring asbestos and document measures to inspect the worksites for its presence. In the event of naturally occurring asbestos, the material will be managed in accordance with EPA and WorkSafe guidelines.

[1] https://datasets.seed.nsw.gov.au/dataset/naturally-occurring-asbestos

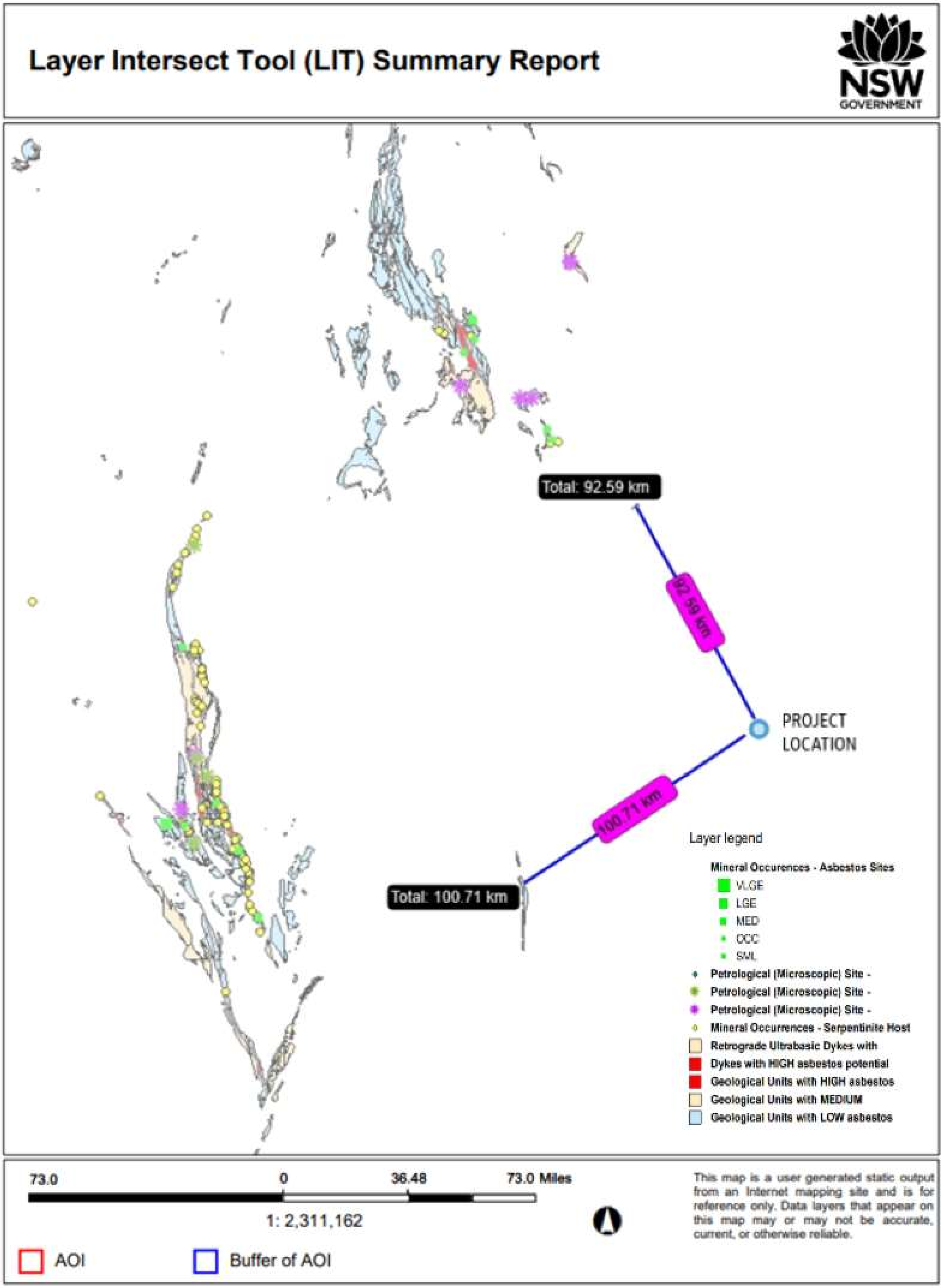

Figure 3-1. Closest naturally occurring asbestos areas to the Project

4. Management of acid rock spoil

Detailed management measures for the handling, stockpiling and long-term emplacement of potentially acid forming material will be documented in the Spoil Management Plan as part of the construction environmental management planning process which will be developed during detailed engineering and design phase of the Project.

The management plan key features are expected to cover:

- Characterisation and thresholds of spoil materials
- Blending, treatment (neutralisation), segregation and containment methods of reactive and non-reactive spoil materials
- Investigation, testing methods, procedures and decision-making criteria
- Development of long-term management and monitoring plans
- Collection and treatment of potential seepage and runoff.

4.1 Available management measures for PAF

Methods to manage PAF spoil material will be further investigated and selected by the Contractor during detail design based on an acid drainage risk assessment and may include:

- Separation
- Blending and co-disposal (on-site)
- Encapsulation / containment cell
- Off-site disposal.

Each method is described further in the following sections.

4.1.1 Separation

Separation of materials based on their properties to enable effective and sustainable management including:

- Re-use stockpiles of good quality material that is acceptable for re-use without treatment
- Blending stockpiles of ACM, NAF and PAF to facilitate a long term engineered placement and treatment solution.

4.1.2 Blending and co-disposal (on-site)

The available test results show some ACM potential of the excavated materials. Blending and co-disposal of PAF and ACM may be proven to be an effective treatment method . The following scenarios are considered credible management solutions that will be further assessed and developed as appropriate in the management plan:

- Blending and co-disposal ACM and PAF in separate regions within the main spoil area
- Blending and co-disposal ACM and PAF in a containment cell
- Blending ACM and PAF to re-use for construction or maintenance of roads, embankments or for underground filling of construction adits.

Blending and co-disposal will be informed by good industry practice investigation, testing and monitoring practices.

If blending with ACM is insufficient to manage PAF risks, PAF materials may be treated prior to placement in the containment cell. Standard treatment options include neutralising the material with lime or calcite-rich waste rock, or in the case that these neutralising materials are unavailable or provide insufficient reactivity over time, soda ash (sodium carbonate), caustic soda (sodium hydroxide) or magnesium oxide may be used.

Neutralisation of PAF spoil, if required, will be conducted in consultation with relevant authorities and geochemical/environmental specialists based on bench scale and pilot scale neutralisation studies.

An estimate of the quantity of calcite ($CaCO_3$) required to neutralise anticipated PAF materials was undertaken assuming:

- Potential acid formation (PAF) materials require treatment (i.e., all Wandrawandian Siltstone)
- Treatment of pyrite within PAF (only), and all rock has a pyrite content of 1% by volume
- The calcite will be well mixed with the PAF
- The PAF has negligible self-neutralising capacity
- A FOS of 2 is applied to account for the fact that acid neutralisation is significantly reduced at low pH.

Based on these conservative assumptions, 18,000 tonnes of calcite could be required. If required, calcite would be sourced and transported to site on an as needed basis such that large volumes are not required to be managed on-site prior to use.

4.1.3 Encapsulation / Containment cell

Where the developed management criteria determine it necessary, containment cells would be designed and constructed to:

- Limit contact between PAF spoil and percolating oxygenated (rainfall recharge) water
- Reduce the risk of acid drainage or seepage water interacting with groundwater and surface water
- Contain, and permit removal of, containment cell leachate
- Provide a relatively passive management system, reducing operational maintenance requirements.

The design and construction of the containment cell will consider:

- **Base lining barriers:** linings with long term resilience to the chemical characteristics of the contained material would be selected and installed; these could include a geomembrane, or other material such as clay. Drainage systems would direct any water that has been in contact with the material to a containment pond for treatment
- **Encapsulation to prevent water permeating into the stockpile and reacting with the stockpiled material:** Materials will be selected based on their long-term resilience and ability to meet the adopted criteria. Depending on the criteria and the level of permeability that containment and treatment facilities can manage, materials may include geomembrane or NAF and/or ACM material excavated from the site. Sloping and drainage away from the encapsulation material will also be a key strategy.

Typical cross sections of the containment cell are shown in Appendix A.

4.1.4 Re-use

NAF and ACM as determined by the criteria is expected to be suitable for re-use in construction. Examples of potential re-use include:

- Road construction and maintenance
- Embankment construction
- Aggregates for concrete
- Containment cell for PAF material
- Stockpile perimeter bunds
- Underground emplacement and filling of construction adits.

4.1.5 Off-site disposal

Based on the investigations underpinning this strategy, Origin considers it reasonable that long term sustainable solutions for storage of spoil from underground excavations are available at the site and that offsite disposal is not a credible requirement for the spoil. However, if required, for part of the excavation materials for unforeseen circumstances, off-site disposal will be managed in accordance with the EPA guidelines and the Industrial Waste Management Policy. No investigation is being undertaken to consider large scale offsite disposal.

5. Mitigation measures

The main safety and environmental risks associated with spoil management are well understood and the measures to control and mitigate these risks will be further developed in the Spoil Management Plan and Construction Environmental Management Plan to be developed during detail design. The key risks and their available mitigation measures are summarised in Table 5-1

Table 5-1 geotechnical risk mitigation measures

	Hazard / Risk	Mitigation measure	Timing
L1	Geotechnical stability	▪ The strategy for managing the geotechnical stability of the Project landforms during construction and operation will continue to be refined through detailed design ▪ Detailed design of the Project will consider and address geotechnical stability risks in accordance with applicable design standards where feasible and reasonable ▪ The permanent landform changes based on the final land use and operational requirements will be considered in the rehabilitation management plan.	Detailed design
L2	Potential surface contamination	Potential surface contamination-related impacts associated with the Project will be managed by: ▪ An unexpected finds protocol, during the extent of the construction works. This will include guidance on identifying potential contaminated land characteristics (visual, odours, etc), steps to cease works in the affected area, further investigation to assess the extent, magnitude and type of contaminants and appropriate remedial actions ▪ Management of surface water when present to minimise the mobilisation of any potential residual soil impacts that could migrate to sensitive off-site ecological receptors.	Construction
L3	Spoil management	A spoil management plan will be prepared for the Project. The spoil management plan will outline appropriate management procedures for the generation, management of spoil. It will include, but not be limited to: ▪ Confirming spoil quantities ▪ Procedures for classification and testing of spoil, including classification of PAF and any other hazardous spoil materials based on site-specific data and testing currently available and additional data obtained during details design, to facilitate management of materials and ensure appropriate treatment and placement of materials ▪ Identification of spoil reuse measures, including segregation of soils as subsoils and topsoils ▪ Spoil stockpile management procedures, include the management of PAF spoil ▪ Spoil haulage routes ▪ Spoil disposal and reuse locations ▪ Measures for managing PAF spoil including methods to safely handle, segregate, transport and contain materials, including treatment of PAF ▪ Rehabilitation of the spoil emplacement facility with native vegetation similar to existing and to the extent it will not impact	Detailed design/ Construction/ Operation

	Hazard / Risk	Mitigation measure	Timing
		any encapsulation integrity. The plan will also include a monitoring program. The plan will follow recommendations from relevant guidelines.	
L4	Hydrocarbon and chemical spills	Chemicals will be stored in accordance with their safety data sheets, and where practical, will be stored within bunded areas.	Construction/ operation
L5		Refuelling of construction plant and equipment will occur only within controlled areas.	Construction/ operation
L6		Spill kits will be maintained on site during construction, and spill clean-up material will be placed in dedicated covered skip bin for collection for off-site disposal.	Construction
L7	Rehabilitation management	A rehabilitation management plan will be prepared to guide the long term rehabilitation of the Project. The rehabilitation plan will: ▪ Include a detailed plan for rehabilitation of the site including any permanent new landforms ▪ Characterise the soil types within the disturbance area ▪ Include details of soil management measures ▪ Include detailed performance and completion criteria for evaluating the performance of the rehabilitation of the sites, and triggering any remedial action (if necessary) ▪ Describe the measures that will be implemented to: – Comply with the rehabilitation objectives and associated performance and completion criteria – Progressively rehabilitate the site. Include a program to monitor and report the effectiveness of these measures.	Construction
L8	Landform stability	Where relevant, batter slopes will be designed by a geotechnical engineer and will consider the long-term stability of the landform, including appropriate drainage and erosion measures. Slope stability measures, including shotcrete and rock bolts, will be utilised if required. The option of backfilling excavated areas to pre-disturbed conditions will be investigated as part of the detailed design.	Detailed design
L9		Final landform design will be developed as part of the detail design where opportunities to reinstate local landform changes to complement the surrounding topography and reduce visual impacts will be investigated.	Detailed design
L10	Acid drainage If not properly managed, PAF material could generate acid drain that could represent a risk for the community and the environment	A spoil management plan covering the management of hazardous spoil materials will be prepared during detail design. The plan will set out the procedures for identifying, handling and managing hazardous spoil. The plan will also include a monitoring program and an emergency response plan in the event an incident occurs. The plan will follow recommendations from the EPA guidelines and be developed in consultation with WaterNSW . Options for treatment of PAF material will be further investigated in the detail design.	Detailed design/ Construction
L11	Pollution Inappropriate disposal of PAF material could generate pollution that	The spoil management plan will: ▪ Provide characterisation of spoil materials, including classification of PAF and NAF materials based on site-specific data and testing currently available and additional data obtained during details	Detailed design/ Construction

	Hazard / Risk	Mitigation measure	Timing
	could represent a risk for the community and environment	design, to facilitate management of materials and ensure appropriate treatment and placement of materials ▪ Nominate methods to characterise materials, and identify PAF risk, and the degree of treatment required. ▪ Designate methods to safely handle, segregate, transport and contain materials, including treatment of PAF ▪ Develop requirements for the treatment of PAF.	
L12	Workers Health Construction staff may be exposed to direct contact with contaminated acid soil or groundwater during construction of underground works and spoil handling	Safety plans including Safe Working Method (SWSM) Statements will be provide by the Contractor to identify risk and mitigation measures during constructions. The SWSM will be developed as per guidelines from Safe Work Australia.	Construction

Appendix A: Concept spoil emplacement designs and encapsulation cross sections

DATE: 13/09/2022 11:39:08 AM
NAME: GONZALEZ, ALEJANDRO ALBERT

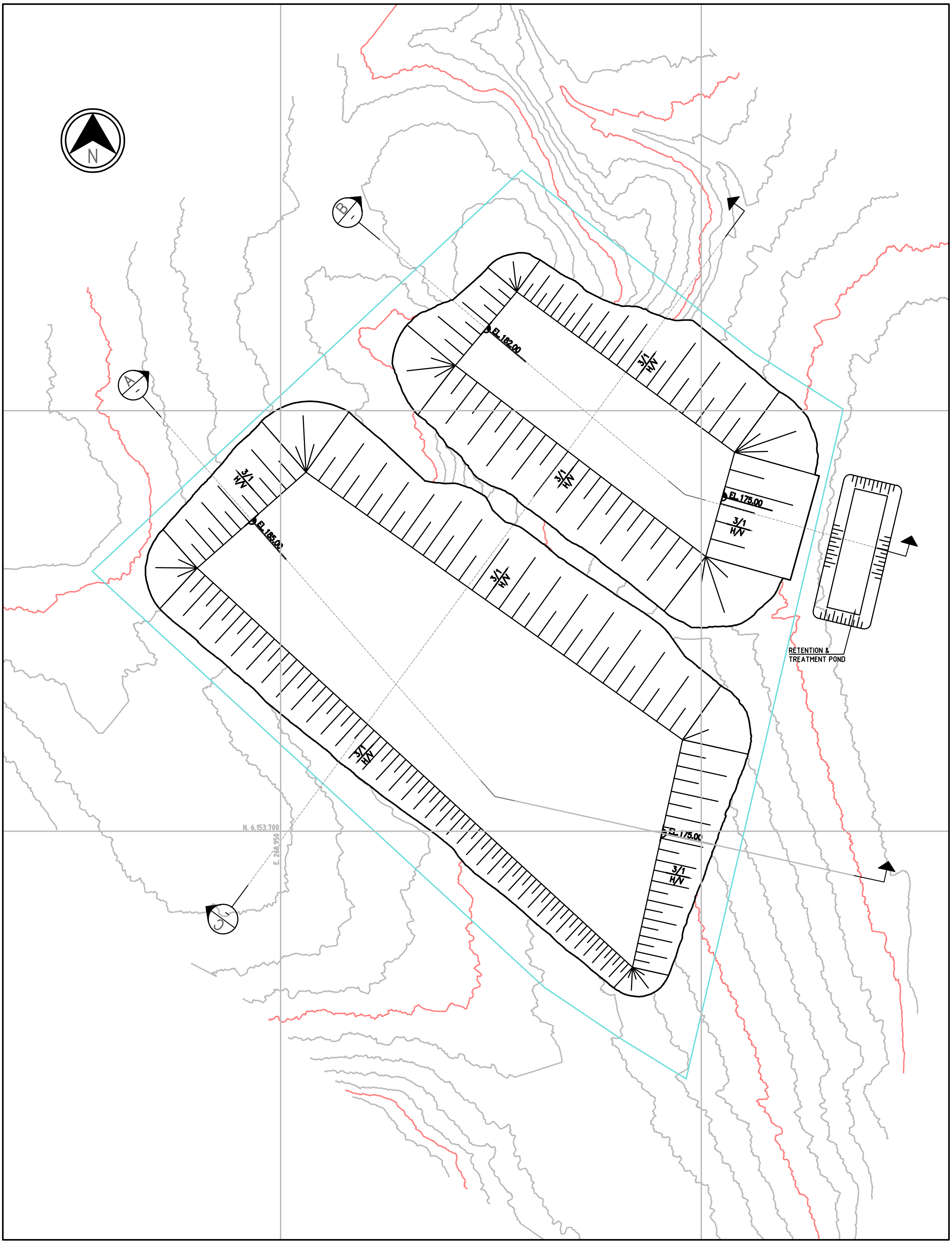

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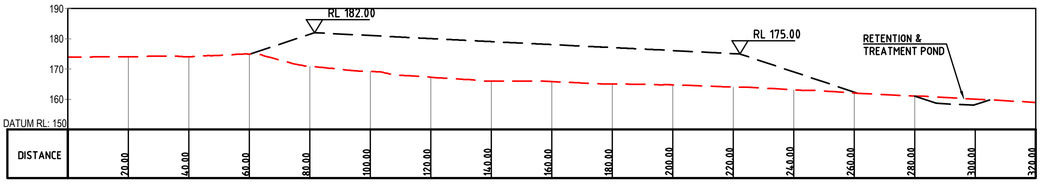
FIGURE 1.1

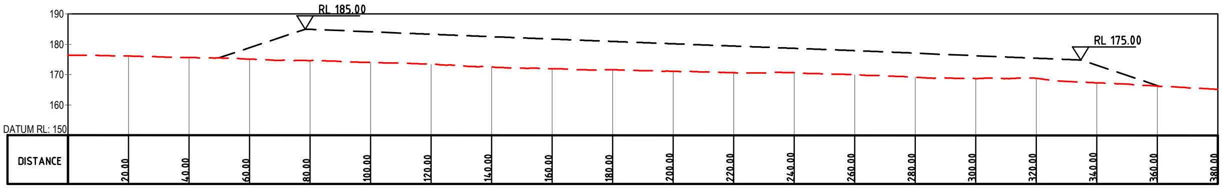
PERMANENT SPOIL AREA CONCEPT

PLAN VIEW

DATE: 13/09/2022 11:40:36 AM
NAME: GONZALEZ, ALEJANDRO ALBERT



SECTION B



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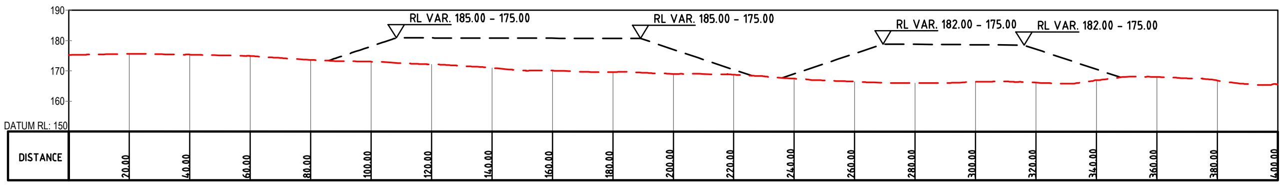

SECTION C

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PERMANENT SPOIL AREA CONCEPT

SECTIONS

FIGURE 1.2

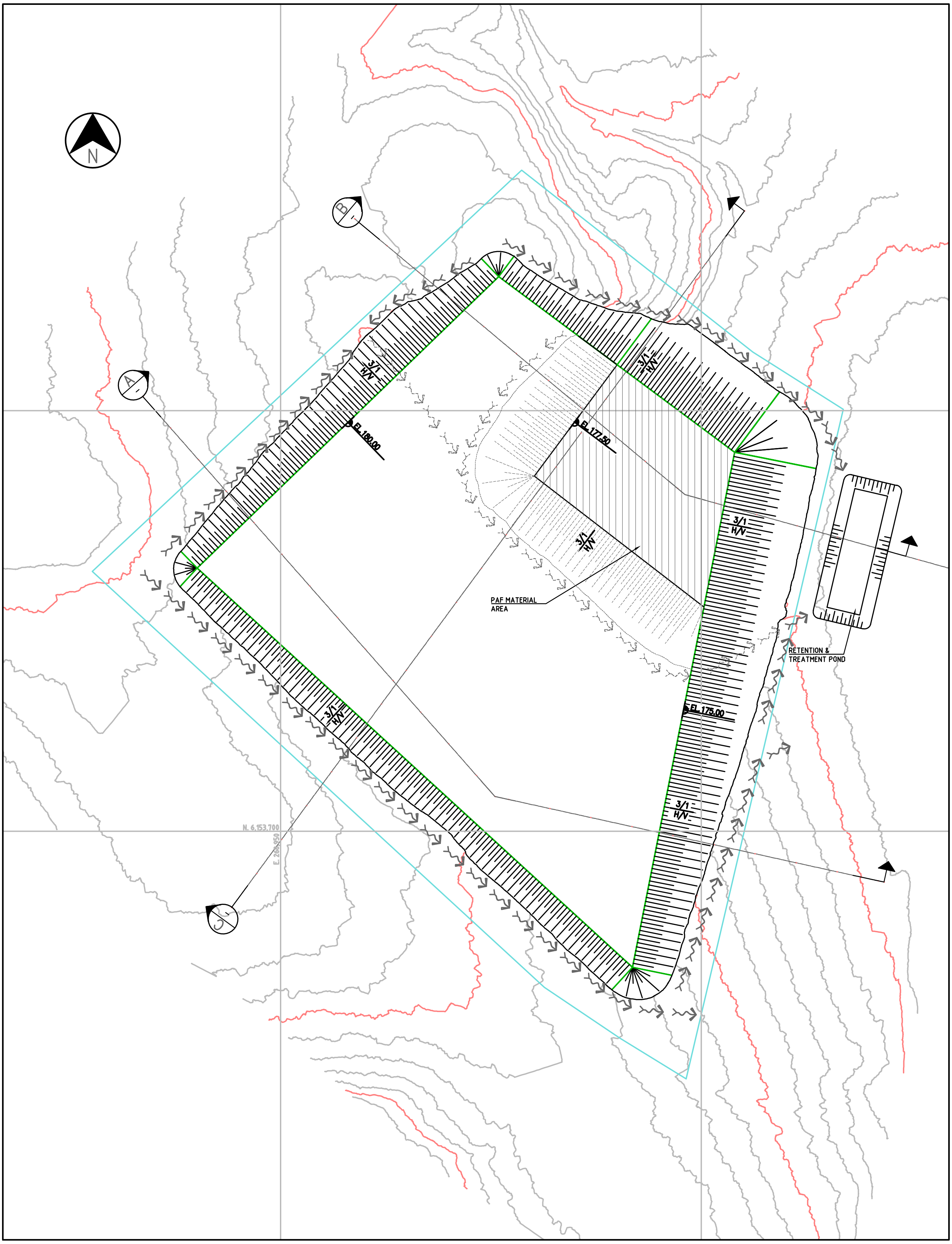

FIGURE 1.3

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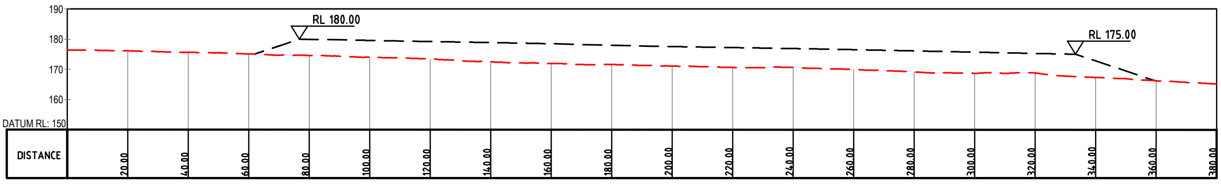
PERMANENT SPOIL AREA CONCEPT - OPTION 2

PLAN VIEW



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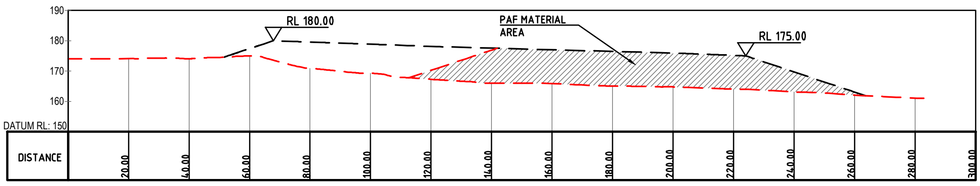

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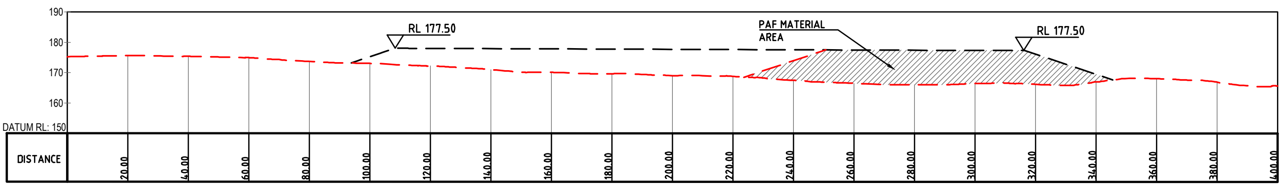

SECTION C

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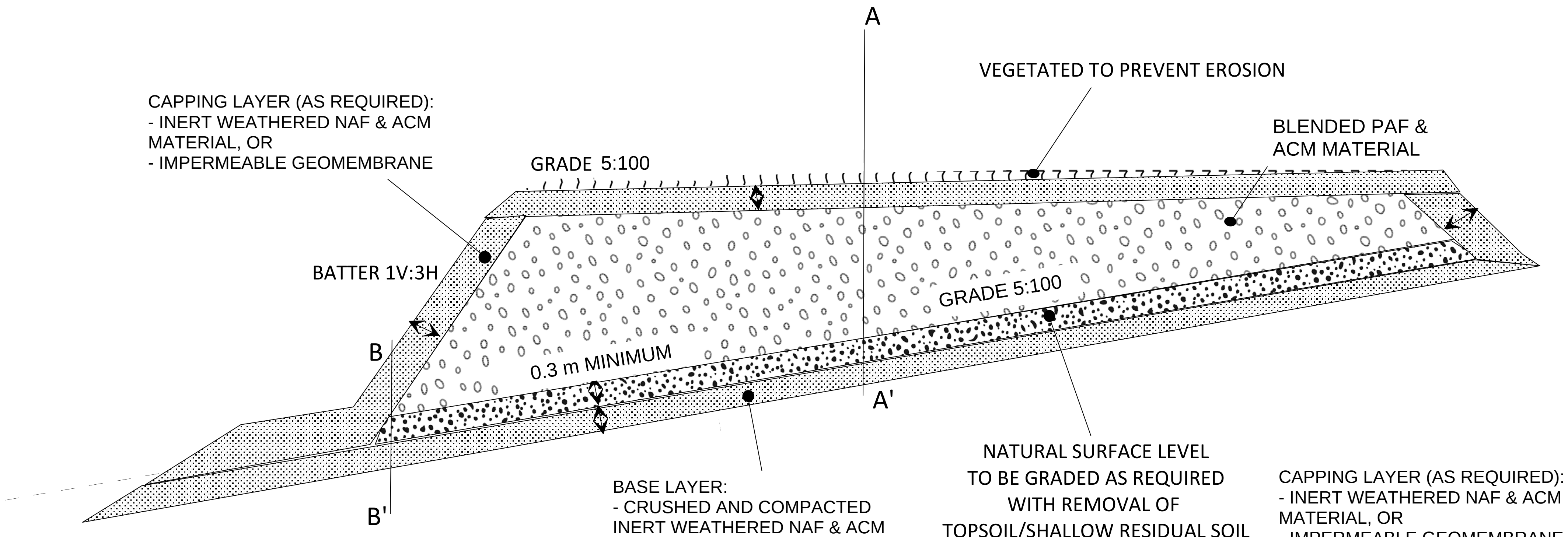
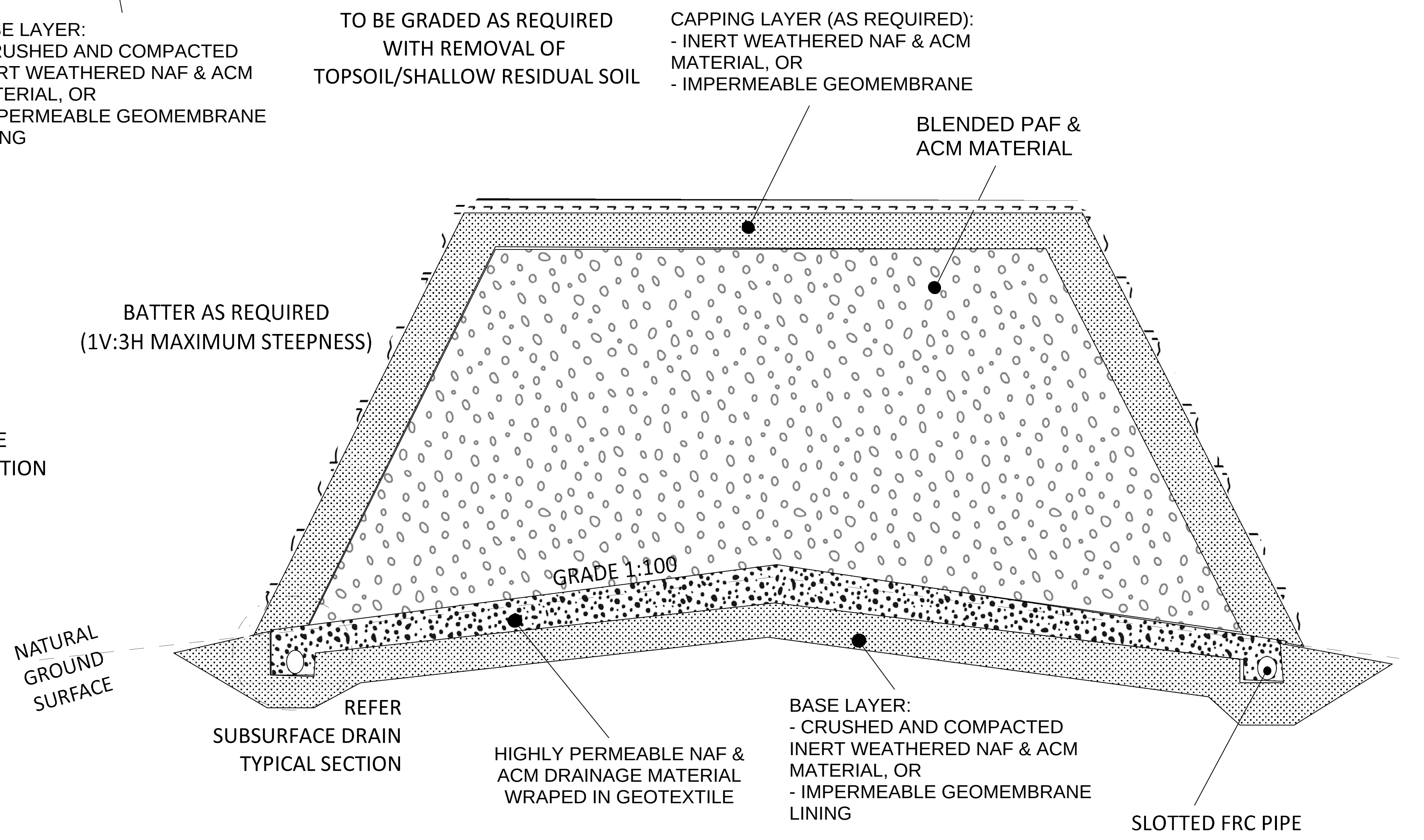
PERMANENT SPOIL AREA CONCEPT OPTION 2

SECTIONS

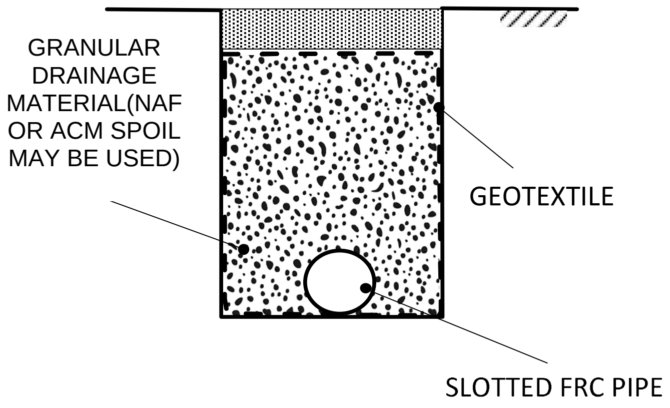
FIGURE 1.4



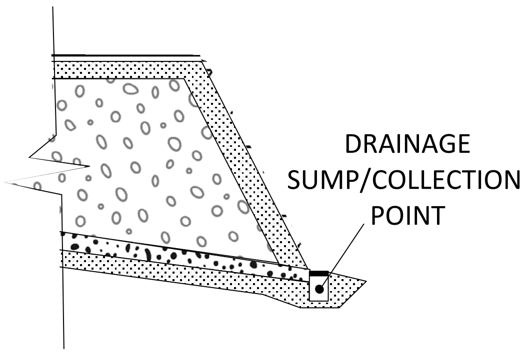
PAF STOCKPILE
TYPICAL SECTION



TYPICAL SECTION A-A'



SUBSURFACE DRAIN
TYPICAL SECTION



TYPICAL SECTION B-B'

DRAWING NOTES

1. INDICATIVE REFERENCE DESIGN FOR INFORMATION ONLY.
2. DESIGN GEOMETRY, MATERIALS, SPECIFICATIONS AND DETAILS TO BE REVIEWED FOLLOWING MATERIALS TESTING AND CONFIRMED AT DETAILED DESIGN STAGE.
3. BATTERS AND GRADIENTS SUBJECT TO GEOTECHNICAL ASSESSMENT

NOT TO SCALE