HANCOCK PROSPECTING PTY LTD

Alpha Coal Project Supplementary Environmental Impact Statement

T | Coal Mine – Tailing Storage Facility Update

Alpha Coal Tailings Storage Facility - Concept Design Report

April 2011

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Glossary

AEP	Annual Exceedence Probability
ANC	Acid Neutralising Capacity
ARI	Average recurrence interval
BOM	Bureau of Meteorology
CHPP	Coal Handling and Preparation Plant
CPP	Coal Preparation Plant
DERM	Department of Environment and Resource Management (QLD)
DME	Department of Mining and Energy
DSA	Design storage allowance
EC	Electrical Conductivity
EM	Electromagnetics
EM	Environmental Management
FOS	Factor of Safety
ha	Hectares
K	Hydraulic conductivity
kg	Kilogram
km	Kilometre
LD	Large diameter
m^2	meters squared
m^3	meters cubed
mm	millimetre
m/s	metres per second
ML/yr	Million litres per year
mm/a	millimetres per annum
Mtpa	Million tonnes per annum
NAF	Non-acid forming

NRW	Department of Natural Resources and Water
PAF	Potentially acid forming
PAF-LC	Potentially acid forming – low capacity
ROM	run-of-mine
TDS	Total Dissolved Solids
tph	Tonnes per hour
TSF	Tailings storage facility
yr	Year

Executive summary

The purpose of this report is to outline the main features and characteristics of the proposed Alpha Coal Tailings Storage Facility (TSF) for discussion across the project team, with regulatory authorities and other interested parties. The report describes the design and operational features of the TSF and its associated influencing forces at a discrete point in the design progression. It is important to note that the Alpha Coal Project, including the tailings disposal methodology, is an evolving undertaking and will no doubt progress further as the Project matures.

After a best for Project analysis, a fully lined tailings dam arrangement has been chosen, accepting pumped tailings slurry from the CPP at approximately 30% solids by weight. Once the tailings have been placed progressively in the tailings dam cells, excess water will be decanted off the top of the beached tailings. This liberated water will then report to a dedicated decant water dam for pumping back to the CPP for reuse. The tailings storage dam is proposed to be staged into different cells with a carefully planned series of wall lifts in each cell to maximise the tailings drying potential and spread out the capital spend over the life of the facility.

Careful attention is paid to environmental issues from a regulatory and a project-specific viewpoint. Consideration is given to potential flood and stormwater impacts on the facility, seepage into the proximate aquifer and Lagoon Creek, and the TSF structural integrity. With the information available to the Project at the time of writing, the proposed methods to alleviate such potential environmental and Project impacts are put forward. Apart from the required and regulated features of such facilities, initiatives have been employed such as lining cell floors to mitigate seepage resulting in the slowing down of saturation of subsurface rock layers, proposing a potential underdrainage system to extract further trapped water leading to lowering seepage pressures and aiding in rehabilitation, providing monitoring bores to test for seepage and chemical content and providing a framework for action if there are deviations from plan.

A view on the progressive closure of the TSF cells incorporating capping, rehabilitation and monitoring is provided as a set of commitments and a framework for further design progression and environmental management.

In addition, a TSF alternative has been provided in Section 3.4 and Appendix C. The alternative proposes a far smaller footprint and describes the intention to move to in-pit storage at some stage of the Project when a suitable void to accommodate the tailings has been provided by the mining operation. An investigative mine planning exercise has been undertaken, outlining two pit voids within the initial box cut area that could feasibly be left open to act as the basis for an in-pit TSF. Potential technical details and operating strategies of the in-pit TSF are also investigated.

1. Introduction

1.1 Location

The proposed Tailings Storage Facility (TSF) for the Alpha Coal Project (the Project) is located approximately 3 km to the southeast of the Coal Preparation Plant (CPP) - refer to Appendix A for an overall site layout. The main site features relating to the TSF include:

- a low rising ridge along the eastern boundary of the proposed mining lease; and
- Lagoon Creek which runs parallel-to and west of the ridge.

The proposed TSF is located between the ridge and Lagoon Creek. Survey data available indicates that this area is generally of low relief with local drainage generally tending west towards Lagoon Creek.

1.2 Site geology/hydrogeology

The proposed TSF is located to the west of an outcrop area of Colinlea Sandstone, and to the east of the subcrop line of the D coal seam (see Figure 1-1). The base of D seam is taken for the purpose of this report to be the upper boundary of the main aquifer portion of the Colinlea Sandstone. Based on limited geological log data and measured coal seam dip, the proposed TSF is deemed to be located over the D-E sands. The sub-E sands outcrop to the east of the TSF footprint.

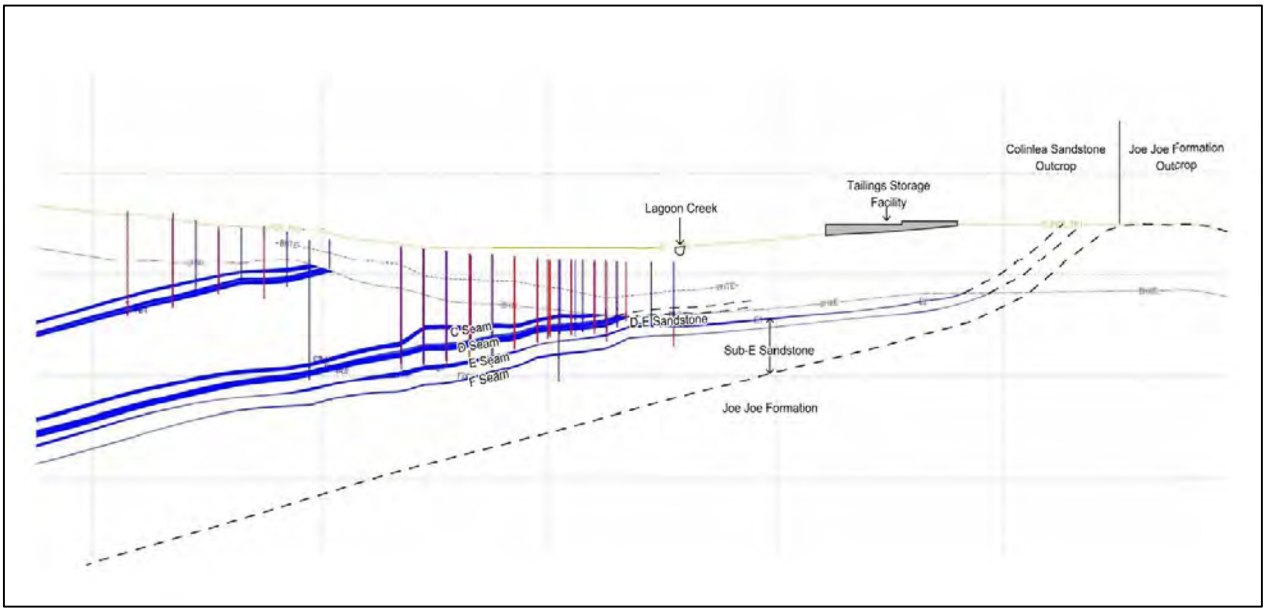


Figure 1-1: West-East cross-section through TSF footprint

Geotechnical drilling data (Douglas Partners 2010) indicates that the site is underlain by a low permeability (10^{-3} m/day) weathered parent sandstone and siltstone with a relatively thin veneer (several metres) of various compositions of sand, gravel, clay and silt. The majority of these sediments are derived from in-situ weathering of the Colinlea Sandstone sediments.

The northern half of the site generally comprises loose to medium silty sand/sandy gravel/gravely sand to a depth of up to 2.7 m over extremely low strength becoming very low to low strength sandstone. During the geotechnical investigations, stiff to very stiff sandy clay was encountered in places beneath the sandy gravel and above the sandstone.

The southern half of the site generally comprises loose to medium silty sand and clayey sand to 2.9 m depth overlying extremely low strength becoming very low to low strength sandstone/conglomerate.

The drilling log and test pit log details:

- test pits were dug to refusal at depths up to 2.5 m;
- auger holes were drilled to depths up to 5.5 m into weathered rock (no groundwater intersected);
- a number of test pits recorded the presence of weathered conglomerate at depths up to 2.5 m, and only one test pit recorded wet gravel (perched groundwater) from 1.2 to 1.6 m depth; and
- falling head permeability tests were undertaken on 6 boreholes within the TSF footprint. The bores were drilled to depths of between 2.5 and 5.5 m, and screened within weathered rock. Analysis of the slug tests returned hydraulic conductivity (K) values from 1.53 x 10^{-7} m/s to 2.31 x 10^{-8} m/s. These are low values for a rock described as a fine sandstone, and it is possible that the values represent the unsaturated K of the sandstone as it is 'wetting up' as the bores were dry when drilled. The horizontal K of the rock underlying the TSF may have a similar value to that returned from pumping tests in the Colinlea Sandstone (D-E sands), where K values ranged from 1.5 x 10^{-6} m/s to 2.7 x 10^{-5} m/s. The vertical K of sediments is often in the region of one order of magnitude lower than the horizontal K, so it may be reasonable to expect vertical K's in the order of 1 x 10^{-7} to 1 x 10^{-6} m/s. It is the vertical K of the rock that would control the downward leakage of leachate.

Groundwater levels beneath the TSF site are currently unknown, but in the closest groundwater monitoring bore (AMB-04, refer Figure 1-2) groundwater was struck at a depth of 38 m below surface, and rises to approximately 10 m from surface.

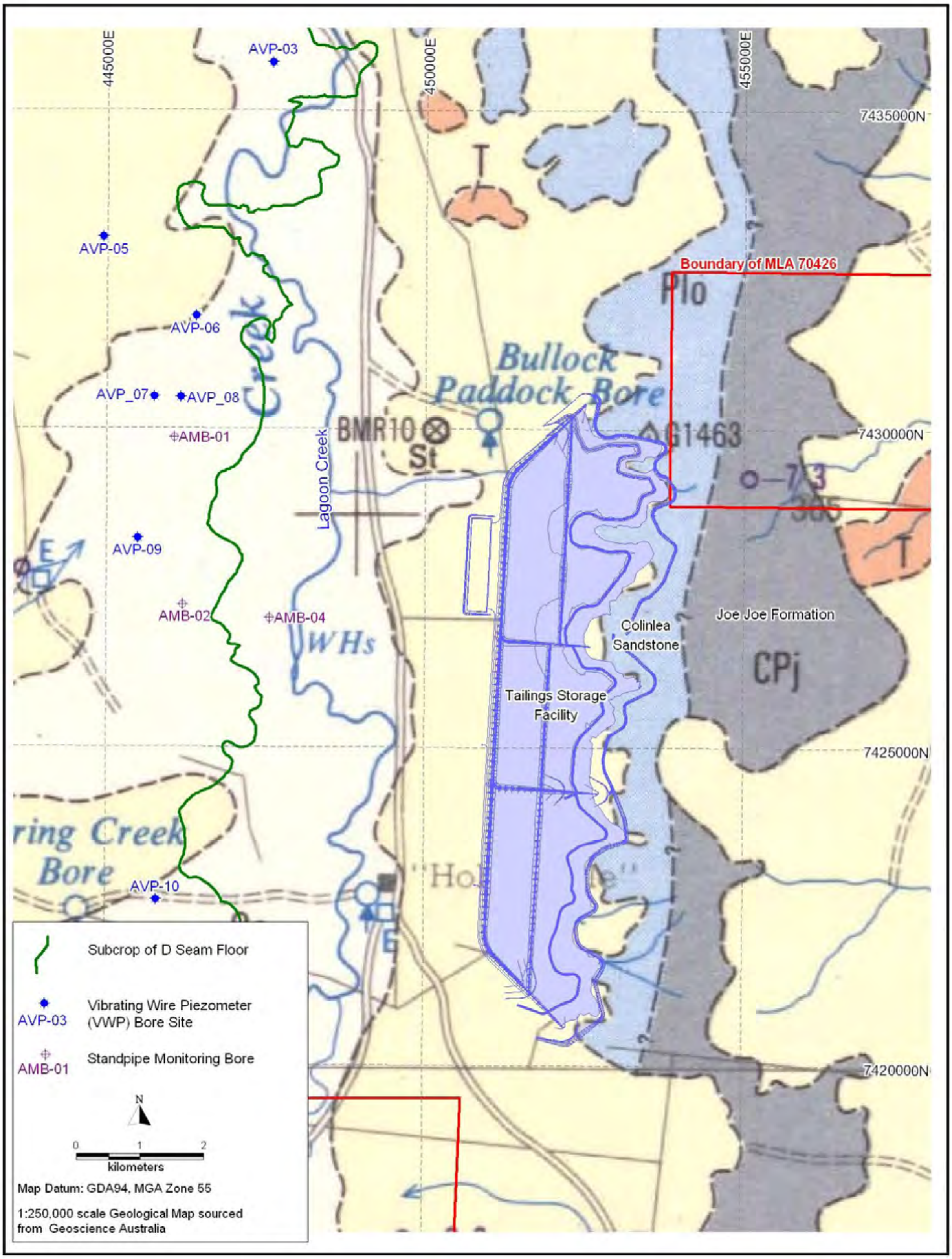


Figure 1-2: Location of TSF with respect to underlying geology

1.3 Hydrological information

1.3.1 Climate data

Climate data for the study area was obtained from the QLD Department of Environment and Resource Management (DERM) Data Drill. The Data Drill accesses grids of data derived by interpolating the Bureau of Meteorology's (BOM) station records.

Figure 1-2 shows the annual rainfall totals obtained for the Project site since 1900. The figure shows that annual site rainfall is highly variable, with a median of 501 mm. The median annual evaporation for the site is 1833 mm based on a pan factor of 0.8.

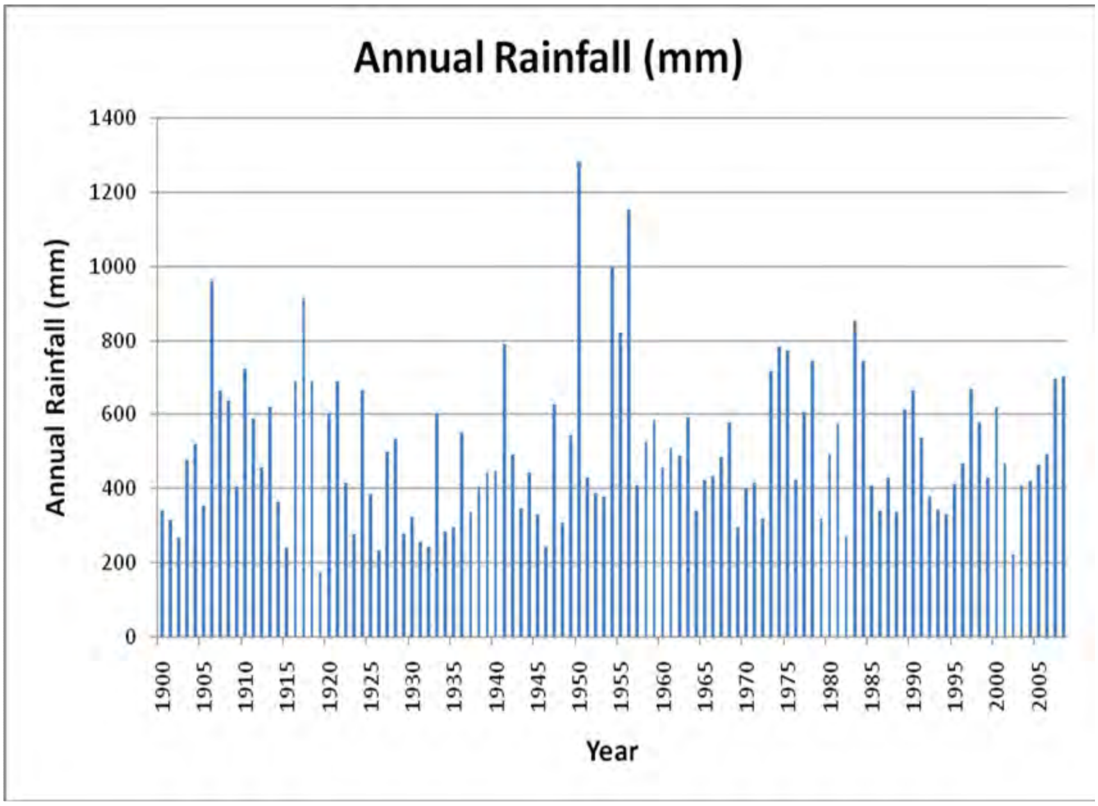


Figure 1-3: Annual rainfall at Alpha Mine site (source Data Drill)

Rainfall is seasonal with the bulk falling in the summer months between November and February, as shown in Figure 1-4.

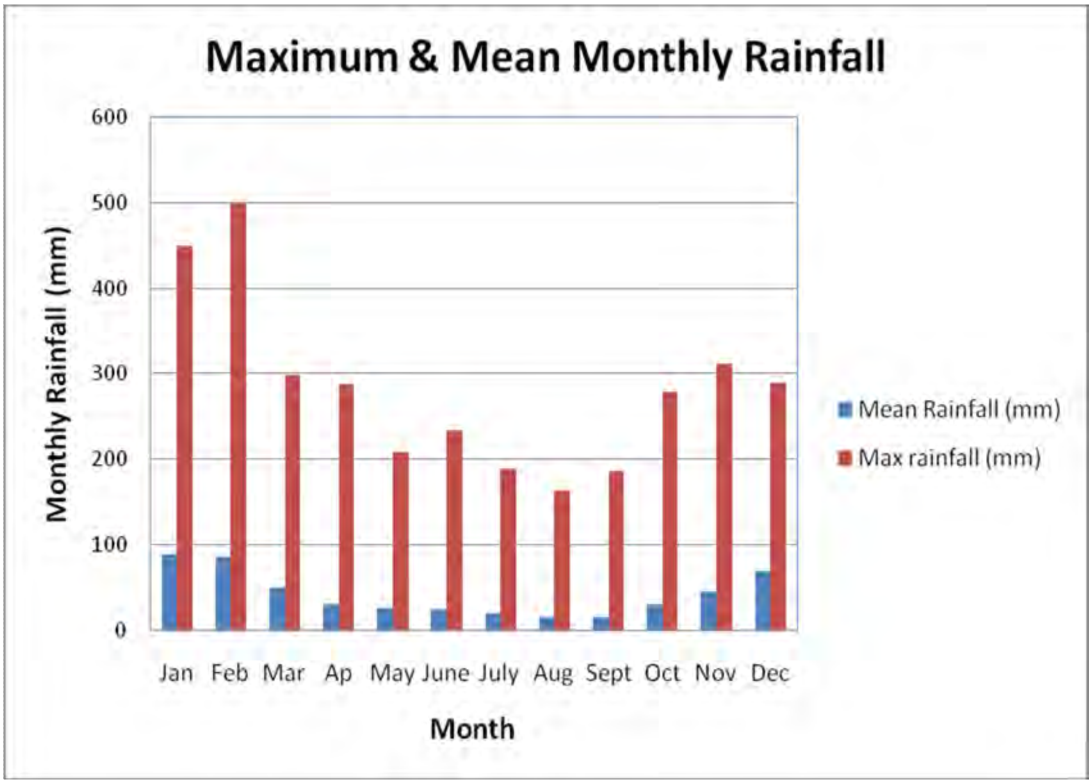


Figure 1-4: Monthly variation in rainfall at Alpha Mine site (source: Data Drill)

1.3.2 Annual exceedence probability of rainfall

Water storage facilities for contaminated water, including the TSF, will be designed in accordance with the DERM Manual for Assessing Hazard Categories and Hydraulic Performance of Dams Version 1.1, with sufficient reserve storage in dams and ponds to contain the design storage allowance (DSA). The DSA is calculated based on a critical wet period of 3 months as stipulated in the manual for the area in which the Alpha Mine is located. A graphical representation of the historic critical wet period rainfall data is indicated on Figure 1-4 below. High hazard category dams are designed to an Annual Exceedence Probability (AEP) of 1% (1 in 100 year event), while significant hazard category dams are designed for an AEP of 5% (1 in 20 year event).

Cumulative rainfall data corresponding to the tabulated AEP below have been calculated from a monthly decile analysis performed on Data Drill rainfall information from 1900 to 2009, obtained from the BOM. The results of this decile analysis are as shown in Figure 1-5.

Table 1-1: AEP for Critical wet period rainfall

AEP	Critical wet period rainfall (mm)
10 %	456
5 %	556
1 %	805
0.1 %	1218

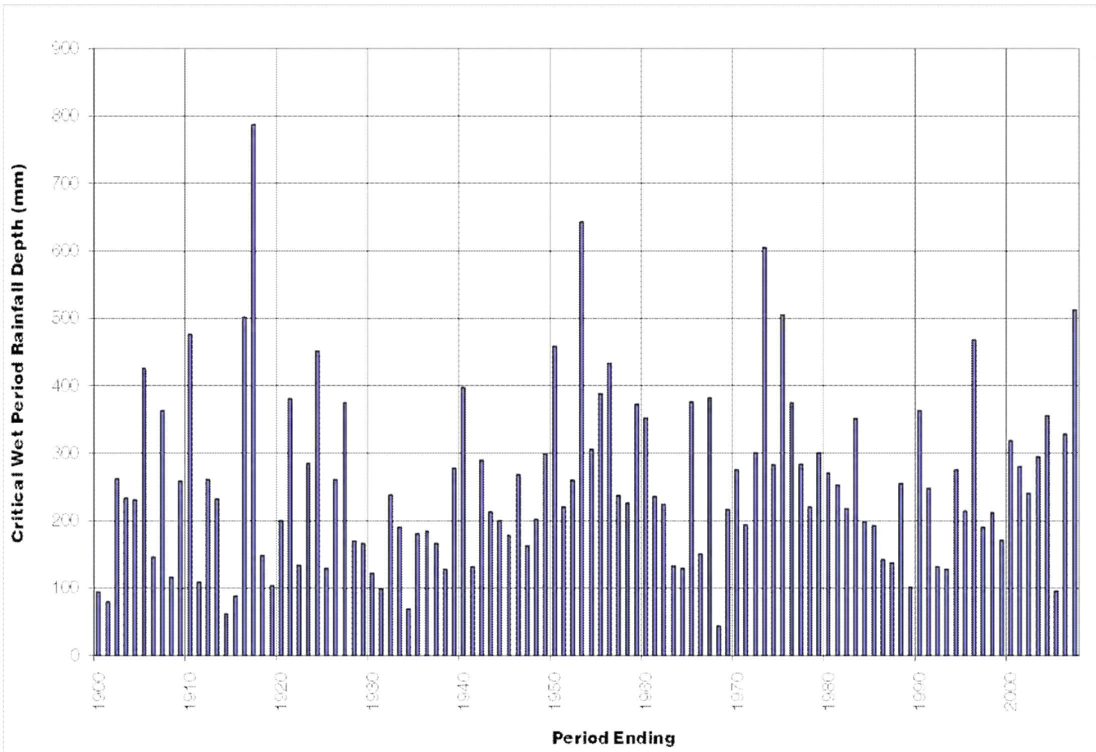


Figure 1-5: Historical three month critical wet period rainfall (source: Data Drill)

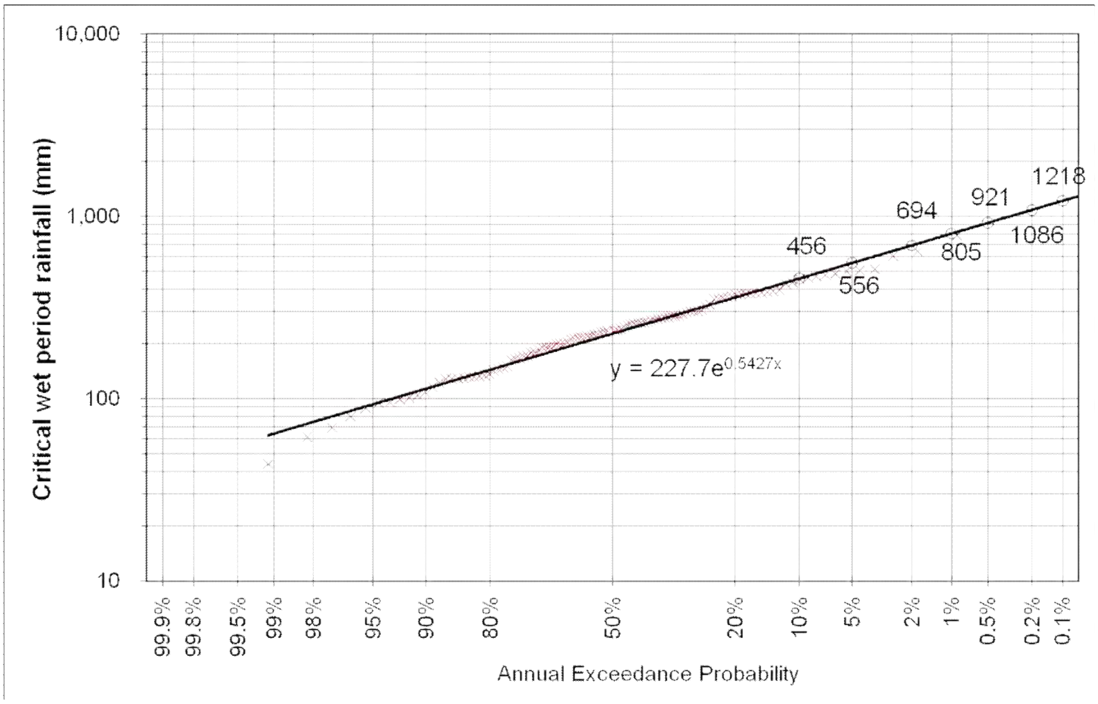


Figure 1-6: Decile analysis of three month critical wet period rainfall

1.3.3 Rainfall variation across the site

Two rainfall gauges are located across MLA 70426, labelled AVP-13 (in the west) and AVP-01 (adjacent to Sandy Creek in the west), and presented in Figure 1-7.

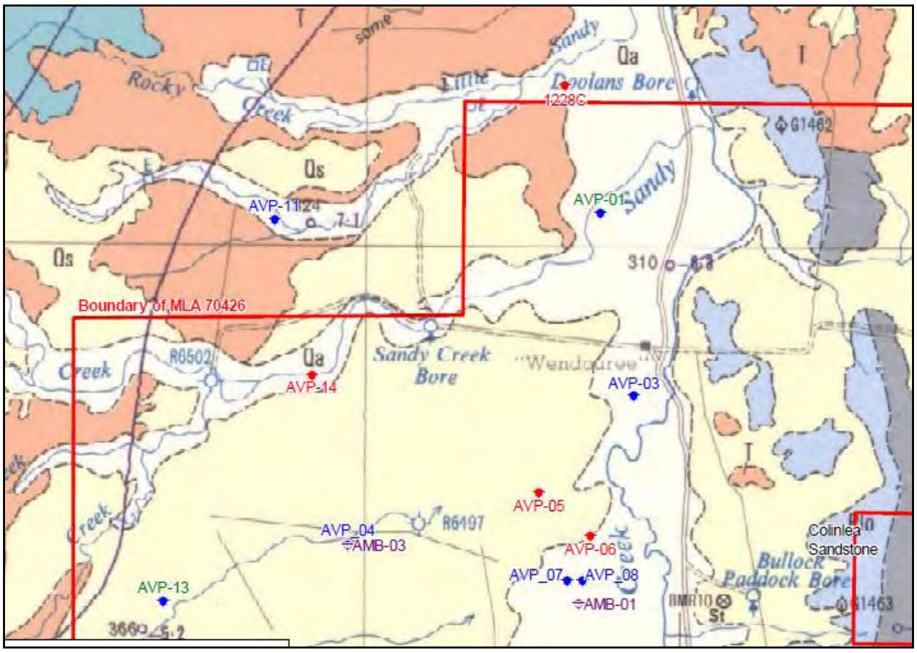


Figure 1-7: Rainfall measurement stations

The rainfall data collected during 2010 (wet year) indicates higher rainfall volumes to the west, adjacent to the Great Dividing Range. The rainfall records indicate significantly higher rainfall in the west of the site (1222.8 mm at AVP-13 compared to 810.6 mm at AVP-01, 25 km further east).

Table 1-2: Rainfall Data

Monthly Rainfall (mm)		
Month	**AVP-01**	**AVP-13**
Jan-10	220.6	205.6
Feb-10	166	183.6
Mar-10	50.8	32.2
Apr-10	26.6	29.8
May-10	27.6	16.2
Jun-10	2.8	1.6
Jul-10	10.4	7.8
Aug-10	67	59.6
Sep-10	173.4	270.8
Oct-10	7.6	37.8
Nov-10	44.8	189.2
Dec-10	13	188.6
Total	810.6	1222.8

2. Tailings process details

2.1 CPP tailings production and transport

The Alpha Coal Mine Coal Preparation Plant (CPP) will be designed to process 40 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal at a rate of 6000 tonnes per hour (tph). The CPP consists of four processing modules, namely two plants x two modules each, with each module producing rejects (coarse and fine) and tailings.

Rejects - The coarse reject material (the underflow from the dense medium cyclone) will be discharged directly onto a multi-slope reject drain screen for dewatering and then discharged on to a reject conveyor. The fine rejects including the overflow from the fine coal reject dewatering screen ex the Reflux Classifiers, are also directed to the reject conveyor. Both the coarse and fine rejects are delivered by conveyor to a reject bin where they are then disposed of by truck.

Tailings - In the fine circuits, the tailings from the sieve bend underflow and desliming cyclone overflow is pumped to the tailings thickener. Flocculent is added to the tailings entering the thickeners to assist in the solids thickening process. There are two tailings thickeners for the four CPP modules, one per pair of CPP modules. The thickened tailings is pumped via centrifugal pumps to the TSF at approximately 30% solids content where the pipelines discharge directly into the dam cells, approximately 3 km uphill from the CPP. Excess clarified water will overflow from the thickener into the clarified water sump and be recirculated through the plant as required. Each thickener has two sets of pumps and pipelines delivering the tailings to the TSF.

The tailings solids settle in the dam and the excess water is decanted into a separate dam where pumps return the water via pipelines as required to the processing plants for reuse in the process.

2.2 Tailings schedule

A preliminary quantification of tailings volumes per year of mine life has been undertaken and is included in Table 3-1. The table shows the estimated volume of tailings in the TSF for the ROM ramp-up plan and life of mine. These figures are indicative only and further refinement of these estimates are likely to take place once further testing on parameters such as solids specific gravity, tailings size distribution, rheology and emplacement methodology are undertaken.

2.3 Tailings characterisation

2.3.1 Geochemical & chemical

Representative samples of fine reject (tailings) materials have been generated for the Project from large diameter (LD) drill holes at the Project site. Based on the results of geochemical test work, the tailings materials are expected to be potentially acid forming – low capacity (PAF-LC). The tailings typically have a relatively low total sulphur content (0.5 – 0.6%) occurring in both the pyritic and organic forms. The tailings also have a very low Acid Neutralising Capacity (ANC) and overall the risk of acid generation is slightly elevated.

The salinity of the tailings is initially low to moderate, but has the potential to increase if the tailings are exposed to oxidising (unsaturated) conditions. Any increase in salinity would essentially be driven by the generation of sulphate salts from the oxidation of tailings materials.

There is currently no metal enrichment compared to background concentrations in the tailings solids and metals are sparingly soluble at neutral pH, with metal concentrations in water extracts within Australian drinking water quality standards and pH in the target range (pH 6 - 9).

Kinetic leach column tests are currently underway. The results of these tests will determine if any treatment of tailings is considered necessary.

2.3.2 Physical

The typical average properties expected are:

- Solids Content: 30% solids by weight;
- Sizing: D seam - 0.25mm + 0.00mm, C seam -0.125mm + 0.00mm;
- Solids Density: 1.61;
- Slurry Density: 1.27; and
- Size Distribution - See Table 2-1:

Table 2-1: Tailings Sizing (Wt%)

Sizing mm		Finest	Nominal
2.00	1.40	0.0	0.0
1.40	1.00	0.0	0.0
1.00	0.70	0.0	0.0
0.70	0.50	0.2	0.3
0.50	0.35	1.3	2.0
0.35	0.25	3.7	5.4
0.25	0.125	19.5	23.6
0.125	0.075	14.8	17.4
0.075	0.038	14.8	16.8
0.038	0.00	45.7	34.4
Total		**100.0**	**100.0**

2.4 Coal Preparation Plant water balance

As referred to earlier, the water management philosophy for the TSF creates opportunity for process water to be liberated from the tailings slurry and reclaimed for reuse back at the CPP. The following bullet points and table demonstrates details of the expected CPP water balance. Subsequent sections of this report detail the inputs and outputs of environmental influences such as rainfall and evaporation and refer to a water balance in a broader context for the TSF itself.

The CPP water balance diagram below is based on the following criteria:

- 40 Mtpa ROM feed;
- 75% wet yield;
- tailings pumped to the TSF at 30% solids; and
- 20% expected return water from tailings.

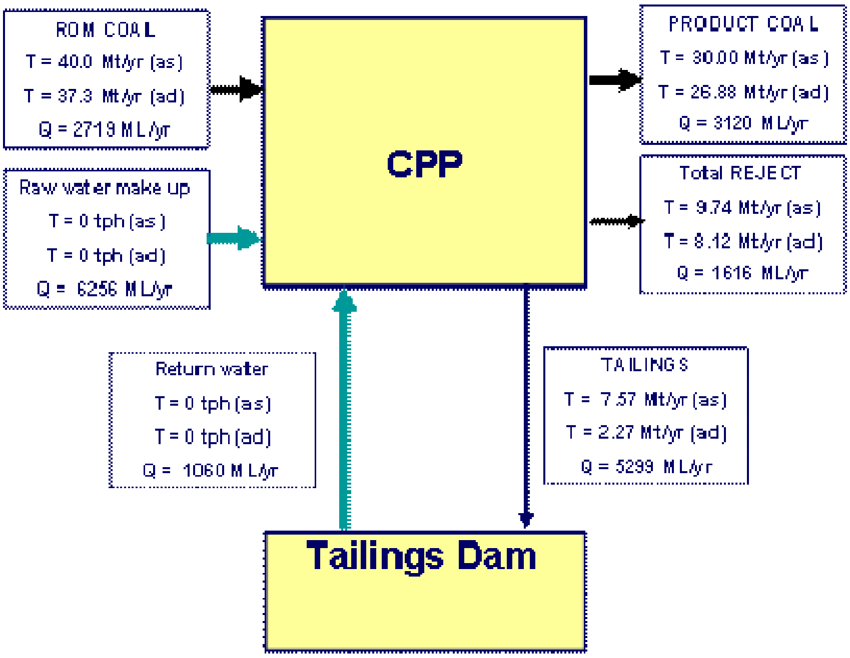


Figure 2-1: Water balance for CPP

The raw water make-up in the above diagram is for the CPP only. The total site raw water make-up for the Coal Handling and Preparation Plant (CHPP) is estimated as:

CPP raw water make-up:	6256ML/yr
Ancilliary demand (dust suppression, hose down)	227ML/yr
Total of above	**6483 ML/yr**
Add 10% contingency	648 ML/yr
Total raw water demand	**7131 ML/yr**

3. Tailings Storage Facility system design and operating strategy

3.1 Tailings Storage Facility location

The location of the Project TSF is based on factors such as existing site features, mine pit and dump locations, proximity to the CPP, mine tenement boundaries and other infrastructure locations. An explanation of the impacts of these various influencing factors is listed below.

- site features:
  - the north-south oriented ridge line to the east of the TSF effectively splits the runoff catchment into either heading towards the mine area, or away from it. The view is taken that the TSF is required to be under a catchment controlled and monitored by the mine; hence the western side of the ridge is the only choice; and
  - Lagoon Creek effectively provides another parallel north-south barrier to the location of the facility.
- mine and pit dump locations – The mining area immediately west of Lagoon Creek between the proposed Lagoon Creek levee and the pit low wall is entirely occupied by out of pit spoil dumps, haul roads and other infrastructure. Sufficient area here is not available for tailings disposal;
- proximity to the CPP – The current position of the TSF is a reasonable distance from the CPP, facilitating water recycling and the safe and efficient transfer of tailings;
- mine tenement boundaries – The current eastern boundary of EPC1210 further limits the TSF to a location on the western side of the said ridge; and
- other infrastructure – the MIA, rail loop and CPP are the main infrastructure facilities to affect the TSF location. This infrastructure is required in its current location, mainly as a result of the need to keep them central to the mining operation – necessary for an efficient and viable operation.

In summary, considering the current technology, site topography and storage philosophy adopted for the Project TSF, no genuine alternative location presents itself. Therefore it is noted that the various site features and required Project factors solely dictate the facility's current location. Sections 3.4 and 3.7 further expand on the realities of open cut mine planning and regional experience with regard to tailings storage philosophy and facility size and location.

3.2 Storage capacity

The Project TSF is proposed to receive and store the expected amount of tailings produced by the CPP for the nominal 30 year mine life. A discussion on the alternative to provide a short term TSF with a move to in-pit disposal is discussed in section 3.4 and Appendix C.

As stated previously, the tailings will be pumped to the TSF as a slurry with a consistency of 30% solids by mass, and that over time the tailings will settle and densify with approximately 20% of the water being collected in the decant system for ultimate return to the CPP for re-use. It has been assumed that an additional 10% of the initial water will be lost to evaporation. Due to the moisture content, a flat beaching slope has been incorporated into the facility design. On the above basis, the TSF requirements per year are included in Table 3-1.

Table 3-1: Tailings storage capacity quantities

		Solid Tailings	Water	Return water	Water loss	Stored	Cumulative
Year	Life of			20%	10%	tailings	Stored tailings
	mine	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML
2011	-3	0	0	0	0	0	0
2012	-2	0	0	0	0	0	0
2013	-1	0	0	0	0	0	0
2014	1	353	1330	266	133	1284	1284
2015	2	934	3515	703	351	3394	4678
2016	3	1204	4531	906	453	4375	9054
2017	4	1408	5299	1060	530	5117	14171
2018	5	1408	5299	1060	530	5117	19288
2019	6	1408	5299	1060	530	5117	24405
2020	7	1408	5299	1060	530	5117	29523
2021	8	1408	5299	1060	530	5117	34640
2022	9	1408	5299	1060	530	5117	39757
2023	10	1408	5299	1060	530	5117	44874
2024	11	1408	5299	1060	530	5117	49992
2025	12	1408	5299	1060	530	5117	55109
2026	13	1408	5299	1060	530	5117	60226
2027	14	1408	5299	1060	530	5117	65343
2028	15	1408	5299	1060	530	5117	70461
2029	16	1408	5299	1060	530	5117	75578
2030	17	1408	5299	1060	530	5117	80695
2031	18	1408	5299	1060	530	5117	85812
2032	19	1408	5299	1060	530	5117	90930
2033	20	1408	5299	1060	530	5117	96047
2034	21	1408	5299	1060	530	5117	101164
2035	22	1408	5299	1060	530	5117	106281
2036	23	1408	5299	1060	530	5117	111399
2037	24	1408	5299	1060	530	5117	116516
2038	25	1408	5299	1060	530	5117	121633
2039	26	1408	5299	1060	530	5117	126750
2040	27	1408	5299	1060	530	5117	131867
2041	28	1408	5299	1060	530	5117	136985
2042	29	1408	5299	1060	530	5117	142102
2043	30	1408	5299	1060	530	5117	147219

The anticipated progression and staging of the TSF is indicated schematically in Figure 3-1 below, and in tabular form in Table 3-2. Conceptual TSF drawings are included in Appendix B of this report for reference.

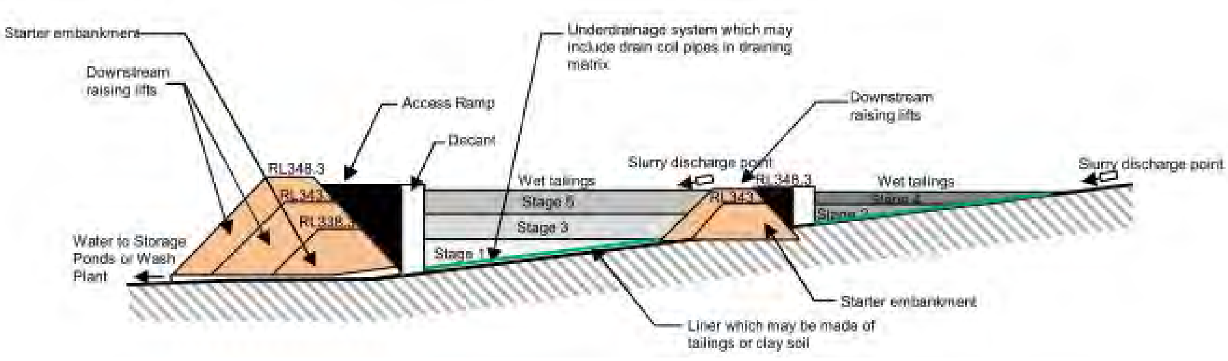


Figure 3-1: TSF development schematic sketch

Table 3-2: TSF cell / stage estimated volumes

Cells	Cell No.	Stage No.	Crest RL (m)	Estimated Storage Capacity (m^3)	Cumulative Storage Capacity (m^3)	Life of Mine (yrs)
1 & 2	1	1	338.3	12,922,715	12,922,715	1 - 3
	2	2	343.3	7,519,485	20,442,200	to 5
	1	3	343.3	14,160,216	34,602,416	to 8
	2	4	348.3	17,532,953	52,135,369	to 11
	1	5	348.3	14,279,302	66,414,671	to 14
3 & 4	3	1	338.3	10,378,788	76,793,459	to 16
	4	2	343.3	4,806,081	81,599,540	to 17
	3	3	343.3	8,814,532	90,414,072	to 19
	4	4	348.3	10,688,279	101,102,351	to 21
	3	5	348.3	8,873,750	109,976,101	to 23
5 & 6	5	1	338.3	12,862,162	122,838,263	to 25
	6	2	343.3	6,577,128	129,415,391	to 27
	5	3	343.3	10,698,311	140,113,702	to 28
	6	4	348.3	14,569,898	154,683,600	to 30

Ongoing testing and studies are being carried out during the current bulk sample test pit at Alpha to confirm the design basis.

The early stages of operation would allow confirmation of the tailings solids contents achieved in the cells in practice, and would also confirm beach angle slopes. Fine tuning of cell sizes and the lifting strategy would then be possible.

3.3 Tailings emplacement strategy

The tailings will be pumped to the TSF by a pipeline constructed along the TSF access road. Tailings will be discharged into the storage area via discharge points regularly spaced along the embankments or hillside. Discharge strategy of tailings would be developed to allow flexibility in operation and to force surface water to flow to the decant system.

The tailings will be discharged from the hillside of the facility with surface water to be collected through the decant structure located immediately upstream of the starter embankment.

The tailings will be disposed within six TSF cells in 5 stages (refer Figure 3-1). Given that the topography of the site, the deposition will occur as follows:

3.3.1 Stage 1

The following sequence is proposed for Stage 1:

- build the containment embankment at the low end (starter external embankment) using natural soil (clayey soils required);
- build a decant structure with an access ramp upstream of the starter embankment;
- discharge tailings from the hillside of the facility. Based on the solids/water content of the tailings slurry, it is predicted that once placed, the tailings will have a relatively flat surface, sloping downhill towards the embankment and decant structures;
- surface water to be drained through the decant structure to a water storage dam for re-use back at the CPP; and
- once the capacity of the storage area is reached in this Cell 1, the slurry should be discharged into Cell 2 located directly uphill.

3.3.2 Stage 2

The following sequence is proposed for Stage 2:

- Before Cell 1 is at capacity, build the dividing internal embankment between Cell 1 and Cell 2. Tailings and reject materials could be used for the construction of this embankment if found suitable for this purpose;
- build the decant structure with an access ramp immediately upstream of the internal embankment;
- discharge slurry from the hillside of the facility. As indicated above, the tailings surface is assumed flat;
- surface water to be drained through the decant structure to the decant storage water pond for re-use at the CPP; and
- once the capacity of the storage area is reached in Cell 2, the slurry should be discharged back into Cell 1 following the raising of the starter embankment.

3.3.3 Stage 3

The following sequence is proposed for Stage 3:

- downstream raising of the external starter embankment using natural soil material (clayey soils required);
- raise the access ramp and extend the height of the decant structure;
- discharge slurry from the hillside of the facility;
- surface water drainage will occur as before; and
- once the capacity of the storage area is again reached in the raised Cell 1, the slurry would be discharged back to the Cell 2 following the raising of the dividing internal embankment.

3.3.4 Stage 4

Repeat Stage 2.

3.3.5 Stage 5

Repeat Stage 3.

Once discharging tailings into Cells 3 and 4, rehabilitation of Cells 1 and 2 would be commenced.

The above five stages would be repeated for Cell 3 and Cell 4.

Once discharging tailings into Cells 5 and 6, rehabilitation of Cells 3 and 4 would be commenced.

The above five stages would be repeated for Cell 5 and Cell 6.

3.4 Tailings storage facility alternative (In-pit disposal)

3.4.1 General

Progression has been made since the last revision of this report to further explore this alternative. Further investigative mine planning and conceptual disposal cell design work has been undertaken to gain an appreciation of the likely requirements and characteristics of a facility as they would apply to the Project.

It is recognised that an out-of-pit TSF is required almost universally at all coal mine operations for at least the first period of mining operations. Due to the lack of a free mine pit void early in the mine life, disposal of tailings is often tasked to a purpose built impoundment, either of a co-disposal type or a conventional tailings impoundment. A move to in-pit disposal is often made once a suitable pit void is available.

This philosophy is generally accepted as standard practice for many Queensland coal mine developments and is the preference if proven viable for the Project. At the time of writing, uncertainties exist with a move to in-pit tailings disposal as there is no prior history with open cuts in the Galilee Basin. A trial mining operation currently in progress at the Project site will significantly enhance understanding of the characteristics of the Galilee stratigraphy. However, it is considered that the fully engineered and controlled out-of-pit arrangement currently proposed provides the lowest risk and most conservative solution on information currently available for the Project.

However, as stated previously, a shift to in-pit disposal sometime early in the mine life is the preferred philosophy. With regard to this philosophy, it is still assumed that an out-of-pit storage facility is to cater for the first 5 years of tailings production, with a move to in-pit disposal thereafter. HCPL will expedite this alternative if proven viable through further hands-on experience, ongoing testing and engineering investigation. As noted above, work is currently underway to progress this proposal, with the main input being the experience soon to be gained from the bulk sample test pit operation – underway at the time of writing. Further mine planning, testing on tailings rheology and tailings geochemistry is also in progress to further assess the viability of in-pit disposal. A more detailed and stand-alone in-pit tailings disposal study is planned during the middle of 2011, which is intended to form the basis for further discussions with regulators as the Project moves closer to execution.

3.4.2 In-pit disposal TSF general description

The figure in Appendix C provides a concept of the size and shape of the proposed 5 year out-of-pit TSF and the associated decant water dam. All engineering and operational characteristics proposed for the life-of-mine out of pit TSF are intended for this smaller facility. Such common items include:

<u>5 year out-of-pit TSF and decant dam:</u>

- a decant system reporting to the decant water dam;
- wall raising (using similar embankment design) and the ability to split the facility into cells, enabling alternate deposition promoting tailings consolidation and desiccation;
- a DSA for the required weather event for the 5 year out-of-pit TSF decant water dam, with upstream clean water diversion drains to limit the TSF's storm water catchment;

- groundwater monitoring;
- embankment stability monitoring; and
- emergency spillway.

Also included in Appendix C is a concept of the gross size and shape of a likely in-pit disposal facility. An investigative mine planning exercise was undertaken to identify the likely locations and extents of an in-pit facility, taking into account the following factors:

In-pit TSF:

- the operational and energy consumption benefits of a location close to the CPP, through relative efficiencies in slurry pumping;
- the need to provide an in-pit storage as early as possible to limit the extent of the out-of-pit facility; and
- the locations of pit access ramps and land bridges, so as to retain mining access and create safe and easy access to the in-pit TSF.

The in-pit tailings storage arrangement discussed in Section 3.4 consists of a facility with similar infrastructure requirements and operational characteristics to the out-of-pit solutions described in Section 3.2. The two in-pit tailings storage cells are proposed (refer Appendix C). These cells are to be located within voids left by the early mining operation during the box cut period. The two cells are located immediately west of the initial box cut low wall alignment. The cells are divided by an east-west aligned land bridge. The location of the cells, being as far east as possible, allows the voids to be opened up relatively early in the life-of-mine, helping minimise the time delay between the start of tailings production and the availability of the in-pit storage.

Most of the engineering and operational characteristics proposed for the life-of-mine out-of-pit TSF are intended for the in-pit facility. Such common items include:

In-pit TSF:

- an internal liner to mitigate seepage through the floor of the cells;
- a floating decant system reporting to the CPP for re-use;
- a multi-stage internal bund to mitigate seepage into the operating mine pits and to support the discharge pipeline;
- groundwater monitoring; and
- high and low wall stability monitoring.

For more information regarding the layout of the in-pit tailings storage facility in relation to the overall site layout, see Appendix C.

3.4.3 In-pit storage capacity

As discussed above for the TSF alternative general description, an out-of-pit storage facility is currently presumed to cater for the first 5 years of tailings production, with a move to in-pit disposal thereafter. This timing is in line with the outcomes of the initial investigative in-pit TSF mine planning exercise. The same tailings production rates, as given in Table 3-1, are assumed for this option.

Reference to Table 3-1, indicates that the total tailings quantity for a 30 year mine life is 147,219 ML (i.e. 147,219,000m^3). Reference to Appendix C, out-of-pit five year conceptual TSF drawing, indicates that the out-of-pit storage facility has a capacity of 22,197 ML (i.e. 22,197,000m^3, or 15% of the original). Based on Table 3-1 and the drawing provided in Appendix C, the 5 year out-of-pit TSF and in-pit storage facility needs to have a storage capacity of at least:

- 22,197 ML for a 5yr out-of-pit TSF; and
- 125,022 ML for an in-pit TSF

to be able to store the total 30 year mine life tailings quantity (i.e. 147,219ML).

Based on the stored tailings rate given in Table 3-1, it is assumed that tailings would be stored within the in-pit cells at a rate of 5117 ML/yr. It is anticipated that the tailings would be progressively placed in both pits in stages as indicated schematically in Figure 3-2.

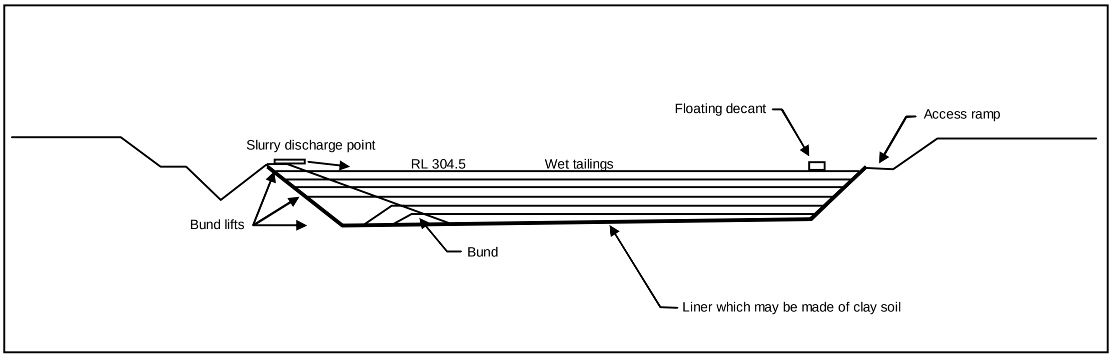


Figure 3-2: In-pit development schematic sketch

To minimise impact on the mining operation, a bund would be constructed prior to tailings placement to protect the western mine pit wall from seepage. Tailings would then be placed in the in-pit cells in stages. Provided in Table 3-3 is a summary of the in-pit cell/stage estimated storage capacities. The cumulative storage capacity is provided when the tailings is placed in lifts (up to 10 m in height), and the estimated mine life calculated assuming tailings is placed in the in-pit cells at a rate of 5117 ML/yr. It is also assumed in Table 3-3, that the in-pit storage cell 1 would be filled first after the 5 year out-of-pit TSF has reached capacity.

Table 3-3: In-pit cell / stage estimated volumes

In-pit storage cell	Stage No.	Lift height (m)	Lift RL (m)	Estimated cumulative storage capacity (m^3)	Life of Mine (yrs)
1	1	10	255	4,601,129	< 6
	2	20	265	13,776,727	to 8
	3	30	275	23,476,080	to 10
	4	40	285	33,699,379	to 12
	5	50	295	44,456,040	to 14
	6	59.5	304.5	55,177,472	to 16
2	1	10	250	5,696,689	to 17
	2	20	260	14,800,513	to 19
	3	30	270	24,372,526	to 21
	4	40	280	34,418,299	to 23
	5	50	290	44,948,972	to 25
	6	60	300	55,975,679	to 27
	7	64.5	304.5	61,102,494	to 28
			Total	**116,279,966**	**28**

Based on the current 5 year out-of-pit TSF and in-pit concept and tailings production rates, the mine life would only be about 28 years (not 30 years) and there would be an excess volume of tailings 8,742,034 m^3 (i.e. 125,022-116,280 = 8,742 ML) which cannot be stored. At this stage, this alternative tailings storage option is just conceptual. This remaining volume of tailings could be stored within the out-of-pit TSF by raising the containment embankment, however this would need to be confirmed through further studies.

Ongoing testing and studies are being carried out during the current Bulk Sample Test Pit operation at Alpha to confirm the design basis. The early stages of operation of the out-of-pit storage facility would allow confirmation of the tailings solids contents achieved in the cells in practice, and would also confirm beach angle slopes. Fine tuning of cell sizes and the lifting strategy would then be possible.

3.4.4 Geotechnical Conditions

The proposed in-pit tailings storage facility is located near to the area of the Bulk Sample Test Pit. Reference to the preliminary geotechnical investigation report for the proposed Alpha mine infrastructure (Project No. 74359) (Douglas Partners, 15 July 2010), indicates that in the area of the proposed in-pit tailings storage facility the subsurface conditions generally consist of sand/clay to shallow depths (i.e. 0 to 3m depth) overlying sandstone.

The in-pit tailings storage facility may be up to 50 m deep below natural ground level. Based on the encountered subsurface conditions, the majority of the pit would found in rock. During the in-pit design phase, a stability analysis of the low and high wall batter slopes would need to be completed to confirm that the design batter slope has an acceptable factor of safety (FOS).

3.4.5 Groundwater management

The disposal of tailings within the mine voids will require similar engineering considerations to the out-of-pit TSF. The disposal of wet tailings plus increased recharge within the backfill / rehabilitated area will create a groundwater mound within the mine pit. A lining on the floor and walls (to prevent seepage along strike) may be required to compartmentalise the tailings from the surrounding aquifers. Lining of the low wall may be required to prevent seepage from the in-pit tailings to the alluvium and Lagoon Creek.

Seepage, under gravity, to the west will report to the final void. The final void, based on the negative climate balance, will act as a sink, thus reducing the potential for seepage to migrate off site. Groundwater monitoring, and possible seepage management, will be required to the east of the in-pit tailings disposal.

For groundwater related detail concerning the five year out-of-pit storage, see Section 4.1.

3.4.6 Deposition strategy

Tailings would be pumped to the in-pit TSF by a pipeline constructed along the in-pit TSF access ramp. Tailings would be discharged into the in-pit via discharge points regularly spaced along the embankments constructed within the cells, along their western edge. Discharge strategy of tailings would be developed to allow flexibility in operation and to force surface water to flow eastwards toward the decant system. The discharge strategy would need to be developed in order to ensure:

- stability of the containment bunds and mine pit walls;
- safely maintain mining operations; and
- safety of mining personnel and TSF operators.

Tailings would be discharged from the embankment constructed within the mine pit. Surface water will be collected at the opposite end through a floating decant system. The tailings would be disposed within two in-pit cells in up to seven stages (refer Figure 3-1). The deposition will occur as follows:

3.4.6.1 Stage 1

The following sequence is proposed for Stage 1:

- Build bund at the low end (western end) of the mine pit void (cell) floor. Tailings and reject materials could be used for the construction of this bund if found suitable for this purpose (i.e. once placed and compacted this material should meet acceptable permeability targets and achieve the necessary strength and stability).
- Install a floating decant with an access ramp at the opposite end of the cell (eastern end). The floating decant could consist of a barge and pump house, with a pipeline sitting on pontoon supports. The floating barge/pump house would float on the in-pit surface water and be used to recover surface water and return it to the CPP for re-use.
- Discharge tailings from the bund. Based on the solids/water content of the tailings slurry, it is predicted that once placed, the tailings would have a relatively flat surface, sloping away from the embankment.

3.4.6.2 Stage 2

The following sequence is proposed for stage 2:

- raise the bund using tailings and reject materials if found suitable for this purpose;
- adjust access ramp and decant system; and
- discharge slurry from the bund. As indicated above, the tailings surface is assumed flat.

3.4.6.3 Stages 3 to 7

Repeat Stage 2.

Once discharging tailings into both in-pit cells has reached capacity, rehabilitation of the in-pit facility would commence.

3.4.7 Closure and rehabilitation of In-Pit Storage Facilities

Rehabilitation of the storage surface area would only be planned to begin once the surface of the disposed tailings reaches the original ground surface level. The strategy proposed for the in-pit TSF alternative includes:

- identifying topsoil resources for rehabilitation;
- excavating and stockpiling the topsoil for re-use during rehabilitation; and
- undertaking rehabilitation trials early in the development to determine optimum rehabilitation techniques for the site.

Specific areas would need to be established for conducting the trials under site specific conditions. The aims of the capping trials would be to optimise the rehabilitation design (capping thickness, type of materials and drainage measures). The purpose is also to investigate various growing methods and vegetation species. Design of the rehabilitation works for both the external batter slopes and over the surface area of the TSF, including capping, landforms and drainage will be evaluated further at the detailed design stage.

The rehabilitated surface would be designed to appropriate engineering and environment requirements. This includes landform design and surface water drainage to Lagoon Creek taking into account settlement that will result from the consolidation of the tailings.

3.5 Tailings decant water dam

3.5.1 Background

The tailings decant water dam acts as one of the primary sources of water for the CPP, and will be equipped with a pump and return pipeline to the CPP. All decant water collected by way of the decant structures (described more fully below) and other recovery water, reports to this dam by way of a series of gravity fed pipelines.

Inflows to the dam include 1060 ML/yr of decant water from the tailings as well as rainfall falling in the catchment that reports to the dam.

Based on information published regarding water quality in similar TSF's in Queensland, it is possible that the water contained in the dam will reach elevated salinity levels. This is likely to result in a significant hazard dam categorisation in terms of Table 3 of DERM's Manual for Assessing Hazard Categories and Hydraulic Performance of Dams.

Outflows from the dam include process water supply to the CPP by way of a pump and a pipeline, evaporation and seepage.

3.5.2 Storage capacity

The decant water dam is conservatively sized for the storm water DSA, plus three months process water input (tailings decant and Class A effluent from the proximate waste water treatment works) during the 3 month DSA wet period with no allowance for evaporation.

The catchment area reporting to the decant water dam will include the decant dam catchment itself, plus the active TSF cell(s) catchment. The applicable dam hazard category has been assumed as 'High' for the purposes of obtaining a conservative DSA for the concept design.

Hence, the concept design level of the decant water dam embankments has been raised to incorporate a design storage allowance (DSA) for stormwater runoff, equivalent to a 3 month critical wet period for a 1 % AEP (1 in 100 year event). A freeboard of 0.5 m has been allowed between the top of the DSA and the embankment crest. A detailed hazard category assessment for the TSF will be undertaken at a later stage of the Project.

3.5.3 Water balance

During the TSF detailed design development, a water balance will be undertaken to confirm that the TSF, decant system, decant water dam and return pump and pipelines are sized sufficiently to prevent spillages into natural watercourses.

3.6 Decant system

Recovery of surface water from the tailings will be predominantly via a decant system. The decant system will include decant structures located at low points immediately upstream of the main embankment. The decant structure will consist of concrete rings supported on a reinforced concrete footing. The crest height of the decant structure will be adjusted by adding rings as the level of the tailings in the TSF rises. The decant structure is accessed for general maintenance and raising via the main embankment with an access ramp that would be raised with general fill at each raising stage. The concrete rings would be supported by rock fill to resist any lateral loading from the incremental construction of the access ramp.

Water collected by the decant system is proposed to be removed by an outfall system comprising flexible pipes that discharge into the decant water dam located downstream of the main embankment. The decant discharge pipe work will include flow measurement to monitor flow between the TSF and the decant dam. Design of the pipe work under the embankment and siltation issues will be evaluated at the detailed design stage.

3.7 TSF options considered

As discussed previously, the Project is currently proposing to employ a conventional tailings dam solution for the disposal of coal tailings over the life of the mine. This method of disposal was arrived at after consideration of several alternative options which are discussed below. A detailed evaluation matrix is given in Table 3-3. For completeness the chosen scenario is summarised in the first system description below.

3.7.1 Conventional thickener/tailings dam

In this option flocculated tailings will be pumped (two lines per thickener) to the TSF at approximately 30% solids. Solids will settle with clean water being decanted into a downstream clean water dam for subsequent recycle to the CPP. It is planned that on average 20% of the water pumped from the CPP will be recycled.

Dam construction will be staged with corresponding staged rehabilitation using revegetated coarse reject, mine spoil and original topsoil.

Coarse reject will be conveyed to a bin and subsequently trucked for disposal in the mining area.

Advantages and disadvantages of this methodology are given below:

- advantages:
  - proven outcome methodology;
  - ease of operation; and
  - comparatively lower capital and operating costs.

- disadvantages:
  - comparatively lower recycled water;
  - potential for dam seepage is greater than other options with higher % solids disposal;
  - possible delayed rehabilitation due to extended dewatering time. However, this is somewhat alleviated in the proposed Project TSF by way of employing methods to accelerate this process through methods such as underdrainage and efficient beaching and decanting; and
  - potential ground water interference.

3.7.2 Co-disposal

This method involves pumping a mixture of tailings and coarse reject to a co-disposal dam at about 40 to 45% solids. The solids are spigotted into the dam at variable locations with clean water being decanted into a downstream clean water dam for subsequent recycle to the CPP. Clean water recycle is at similar levels to that of conventional tailings dams.

- advantages:
  - potentially faster rehabilitation time as the dam dries out at a faster rate;
  - simpler coarse reject handling (no trucks); and
  - in theory a higher percentage of water recycle can be achieved. This is however difficult to validate from actual operational experience.
- disadvantages:
  - significantly larger dam size to cater for both coarse reject and tailings;
  - co-disposal emplacements need to be close to the CPP due to pumping limitations;
  - dust issues on the large impoundment areas;
  - high pumping and pipeline costs. High wear rates occur necessitating frequent maintenance, rotation/replacement of pipes etc;
  - high electrical power consumption;
  - pipe blockages causing operational issues such as spillage and reduced system availability; and
  - intensive dam management required involving dozer movement of the coarse material, periodic movement of spigots and associated pipelines.

3.7.3 Thickened tailings disposal

This involves the further thickening of tailings to up to about 45% to 60% solids. This can potentially be achieved by thickening cones and/or super flocculation.

3.7.3.1 Paste disposal

Typically, thickener underflow (30% solids) is pumped as per conventional tailings disposal to the tailings dam (or cell) site. The tailings are then further thickened (about 50% solids) before disposal into a dam or a series of elongated cells. Water is recycled from both thickeners and from the paste disposal site (minimal at high % solids).

- advantages:
  - theoretical higher water recovery than a conventional tailings dam; and
  - smaller disposal sites due to higher solids content disposal.
- disadvantages:
  - the paste is verging on thixotropic, requiring positive displacement pumps working at pressure;
  - rehabilitation is more difficult as the paste is difficult to further dewater; and
  - Paste thickening of coal tailings is difficult because of the comparatively low specific gravity of the tailings material. Applications are normally utilising higher SG tailings e.g. bauxite or iron ore. Paste thickening of coal tailings is therefore uncommon.

3.7.3.2 Super flocculation

Thickened tailings using super flocculation is also possible. Under this method, normally flocculated thickener underflow (at about 30% solids) is further flocculated just prior to discharge into the tailings dam. This flocculation effectively further increases the solids content to 40 to 50%. This method can be simply retrofitted to a conventional tailings dam. It should however be noted that this method is tailings specific. The effectiveness of super flocculation will vary with material type. Water is recycled as per normal from the tailings dam to the CPP.

- advantages:
  - theoretical higher water recovery than a conventional tailings dam;
  - smaller disposal sites due to higher solids content disposal; and
  - super flocculation at the point of discharge avoids the problems associated with paste pumping.
- disadvantages:
  - rehabilitation is more difficult as the thickened tailings is difficult to further dewater;
  - effectiveness is tailings specific and dependent on material type; and
  - very high flocculent consumption.

3.7.4 Dry tailings

This method involves the drying of the tailings (to about 35% moisture) ex the thickener underflow using filters (belt press, plate and frame or similar). The 'dry tailings' is then mixed (on a conveyor) with coarse reject and the resultant mixture conveyed to a pad outside the CPP. The reject is then conveyed or trucked to a disposal site.

- advantages:
  - theoretically high water recovery, if the filters work at design product moistures; and
  - disposal sites are available for rehabilitation earlier.
- disadvantages:
  - this technology is very capital intensive. Filter capacity is low in comparison to the tonnage to be dried resulting in large banks of filters;
  - filters have to date proven to have very low availability requiring significant operational labour;
  - loading and trucking of the combined 'dry' reject is often operationally difficult (with significant spillage) due to poor (high moisture) performance of the filters;
  - higher than planed moisture contents causes handling problems (including slumping) at the disposal site; and
  - dams have to be constructed to handle run off/seepage at the disposal site.

3.7.5 In-pit disposal

This commonly employed method uses a combination of a conventional out-of-pit TSF to cater for tailings produced early in the mine life, with a shift to disposal in exhausted mine pit voids once the mining schedule permits.

- advantages:
  - a smaller requirement for tailings to be stored above ground in dam structures, leading to possible capital expenditure savings;
  - due to the smaller dam size - less long term environmental legacy issues concerning the longevity of the rehabilitated storage structure;
  - less land taken and disturbed for the TSF footprint; and
  - all other advantages per the 'conventional thickener/tailings dam' point.
- disadvantages:
  - longer tailings pumping distances;
  - interfaces with haul road and mine traffic;
  - mine plan needs to accommodate accordingly; and
  - all other disadvantages per the 'conventional thickener/tailings dam' point.

The current mine plan progressed fully for the Project is not able to provide empty voids early in the mine life for tailings disposal. For this reason (and others described in section 3.4), it has not been taken forward into the evaluation procedure that follows. Further mine planning progression and testing may well prove that it is feasible to accommodate tailings in-pit, but for now, the life-of-mine storage facility presented in this report demonstrates a worst case scenario regarding the TSF footprint.

3.7.6 Experience at other Queensland coal mines

Recent Queensland coal mine site experience has favoured co-disposal, although some mines are now regretting this decision due to the large size (and number) of storage dams required (usually at an ever increasing distance from the CPP) as well as increasing operating costs (pumping, pipelines, dam material management).

Most established mines use conventional tailings dams (followed by in-pit disposal), sometimes supplemented by hauling (and mixing) of coarse reject at the dam site.

Two smaller mines have implemented dry tailings disposal over the past 18 months with mixed success (operational issues with filters, resultant high moisture product and disposal issues).

To date a form of thickened tailings (super flocculation) has been successfully retrofitted at one Queensland coal mine for tailings being discharged into an old mine void.

In recent years there have not been major issues with acid leaching or salinity from coal mine tailings dams in Queensland. Most Queensland coal mines have comparatively low sulphur content coals (< 0.7%) and the Project's coal quality characteristics are no exception. Note that the comparatively high proportion of organic sulphur (about 0.35%) in the Project's coal should further help this situation.

TSFs are not normally lined (apart from clay on occasions). There is usually not significant concentration of trace elements. This is also the case with the Project's tailings.

3.7.7 Selection of preferred option

The selection of the preferred tailings disposal option was undertaken using a weighted evaluation matrix process. Each option was judged against the others over a range of weighted criteria which included:

- overall environmental impact;
- dam rehabilitation issues (timing and difficulty);
- level of water recycle from dam;
- proven technology;
- operational difficulty;
- capital cost; and
- operating cost.

The criteria weightings are viewed as providing a reasonable balance between environmental, operating and financial issues. Scores are based on the assessment of advantages and disadvantages given earlier.

Results are given in Table 3-4.

Table 3-4: Tailings Disposal Methodology Evaluation Matrix

Criteria	**Wt %**	**Tailings Dam**		**Co-Disposal**		**Paste**		**Super Floc**		**Dry**	
		Score	**Wtd Score**	**Score**	**Wtd Score**	**Score**	**Wtd Score**	**Score**	**Wtd Score**	**Score**	**Wtd Score**
Env Impact	20	7	1.4	6	1.2	8	1.6	7	1.4	8	1.6
Rehab	15	6	0.9	7	1.05	7	1.05	7	1.05	8	1.20
Recycle	10	6	0.6	7	0.7	7	0.7	7	0.7	8	0.8
Tech Risk	10	8	0.8	8	0.8	5	0.5	7	0.7	5	0.5
Operations	15	7	1.05	7	1.05	6	0.9	7	1.05	5	0.75
Capex	10	8	0.8	5	0.5	6	0.6	7	0.7	4	0.4
Opex	20	7	1.4	5	1.0	5	1.0	6	1.2	4	0.8
Total	**100**		**6.95**		**6.30**		**6.35**		**6.80**		**6.05**
Ranking			**1**		**4**		**3**		**2**		**5**

Scoring: 10 = Low, 5 = Medium, 0 = High

Based on this evaluation, the preferred tailings disposal methodology is Conventional Disposal followed by Super Flocculation. As has been noted previously, super flocculation is a comparatively easy retrofit to conventional disposal.

If the matrix evaluation was proven to be in error, the second best option is then comparatively easy to install. It should be further noted that there is a significant gap in scores between super flocculation and the third and fourth options of paste disposal and co-disposal. Therefore in the event of evaluation error, there is little chance that the preferred option would change to either of those options.

It is also worth re-stating that the Conventional Disposal method presented here may well be augmented by a switch to in-pit storage after an initial mining period if progression of the mine plan reveals it as a possibility.

4. Impoundment civil design

The following report section describes the physical performance of the proposed TSF as it relates to the Project's performance needs, regulatory requirements, environmental concerns and the nature of the site. Some basic high-level design criteria derived from these parameters are as follows:

- an operational design life of 30 years;
- an indefinite long term life once closed and rehabilitated;
- negligible seepage of the contained water to the surrounding surface and subsurface environs;
- adequate flood storage to alleviate the risk of discharge from the tailings dam cells and the decant dam to the environment;
- an emergency spillway sized in accordance with the latest version of DERM's Manual for Assessing Hazard Categories and Hydraulic Performance of Dams - Table 4;
- efficient reuse of process water; and
- all embankments and slopes designed for stability and strength to commonly recognised and legislated guidelines/standards.

4.1 Groundwater implications

4.1.1 General

Refer to Section 1.2 for a description of the geology and hydrogeology of the Project area. If the TSF was unlined, it is postulated that, given the geology of the proposed TSF site, migration of leachate from the facility could potentially occur. The mechanisms by which seepage would occur are interpreted to include:

- downward leakage through surficial sediments (silty sands derived from weathering of the underlying Colinlea Sandstone) until reaching lower permeability weathered sandstones and siltstones;
- lateral migration through the surficial sediments, particularly weathered conglomerates and sands/gravels;
- movement of leachate down-gradient at shallow depth toward Lagoon Creek where it would discharge to the Lagoon Creek alluvium;
- over time, the weathered rock profile would become saturated, and the hydraulic conductivity of the rock underlying the TSF could be expected to become higher by several orders of magnitude (from low values in the range of 10^{-7} to 10^{-8} m/s observed from testing of unsaturated rock, to 10^{-6} or 10^{-5} m/s values (horizontal K) observed from pumping tests undertaken on the same formation under saturated conditions. Vertical K could be expected to be one order of magnitude lower than saturated horizontal K;
- therefore, movement of leachate away from the facility would be preferentially via shallow subsurface flow toward Lagoon Creek, in addition to deeper downward infiltration through the saturated rock underlying the TSF.

The location of the proposed TSF is interpreted to be on D-E sandstone outcrop. Groundwater extraction will occur as part of mine dewatering operations, and the subsequent cone of depression will ensure that any potential seepage from the TSF that reaches the watertable will report to the dewatering system, or the final void. Thus the potential for offsite seepage migration from the TSF via the groundwater system is limited.

Based on the current conceptualisation of the TSF area, there is potential for seepage from the TSF to migrate vertically downward until low permeability strata is encountered, at which point seepage could migrate horizontally toward Lagoon Creek. This horizontal migration can be identified through shallow groundwater monitoring and managed using infrastructure to intercept and/or contain seepage (such as scavenger wells or cut-off trenches).

Design of the TSF will ensure limited potential for leakage from the facility. The current proposed design of the TSF is for a fully lined impoundment as more specifically defined herein. Investigation and monitoring commitments are outlined in Section 5.2.

4.1.2 Impact on recharge

The rainfall patterns described in Section 1.3.3 and the recorded groundwater level data (groundwater flow from south-south west to north-north east) indicate increased recharge from the west of the site. Diffuse recharge along the Great Dividing Range is considered to be the dominant recharge mechanism over the study area, compared to the direct recharge on the low permeability Colinlea Sandstone outcrop areas to the east.

Mine operations and tailings disposal will not impact on recharge to the west, which is recognised to be regionally significant based on greater surface area and higher rainfall. As this recharge mechanism is dominant, based on groundwater flow patterns and surface area, recharge from the area of Colinlea Sandstone outcrop and subcrop is not as regionally significant as recharge that occurs to the west of the site. Thus the slight reduction in recharge over the Colinlea outcrop area, due to the proposed TSF footprint, is not considered to have a marked impact on groundwater resources within the study area.

As mentioned previously, the lined TSF proposed will result in a reduction in recharge to the underlying Colinlea Sandstone than if it were proposed as unlined.

4.1.3 Impact on discharge

It is interpreted that regional groundwater flow is from topographically elevated areas toward Lagoon Creek, and it is possible that groundwater discharges to Lagoon Creek as the potentiometric surface approaches ground level to the north.

The presence of the proposed open-cut mine will result in a cone of depression, the result of which groundwater flow will be altered towards the mine pit. This will reduce groundwater levels in the vicinity of Lagoon Creek, effectively removing the potential for groundwater discharge to Lagoon Creek in the vicinity of the mine operations. Further information about these impacts is contained in the groundwater technical report – Volume 5, Appendix G of the Project EIS.

The magnitude and extent of drawdown beneath Lagoon Creek, and potential for impact on groundwater dependant ecosystems, will be considered as part of the regional groundwater modelling that is currently underway for both this project and the adjacent Kevin’s Corner mining project.

4.1.4 Artificial recharge

The proposed TSF has potential to act as a continuous source of seepage if no steps are taken to mitigate the risk. Based on the site geology, this seepage could migrate horizontally along the weathered / fresh rock interface, and as saturation increases, migrate vertically resulting in deep drainage (to be captured within the cone of depression).

The shallow seepage, moving under gravity along the weathered / fresh rock interface, has potential to enter Lagoon Creek. As noted in this report, seepage and monitoring controls will be installed. This will include nested piezometers so that the effectiveness of seepage controls can be monitored. Should seepage be recorded, then additional controls, such as an interception trench will be considered.

Seepage risk will be reduced through the TSF liner and the potential underdrainage system. Seepage migration, should it occur, will move through preferential flow paths (possible clast supported conglomerate, fractures, etc) within the Colinlea Sandstone and enter the underlying groundwater resources. Migration would then occur to the mine pit as it is predicted that the TSF is located within the drawdown cone created by mine dewatering.

In the long term, seepage under gravity to the west will report to the final void. The final void, based on the negative climate balance, will act as a sink, thus reducing the potential for seepage to migrate off site.

Figure 4-1 provides a conceptual diagram of possible seepage flow patterns, controls and monitoring points in the vicinity of the proposed TSF.

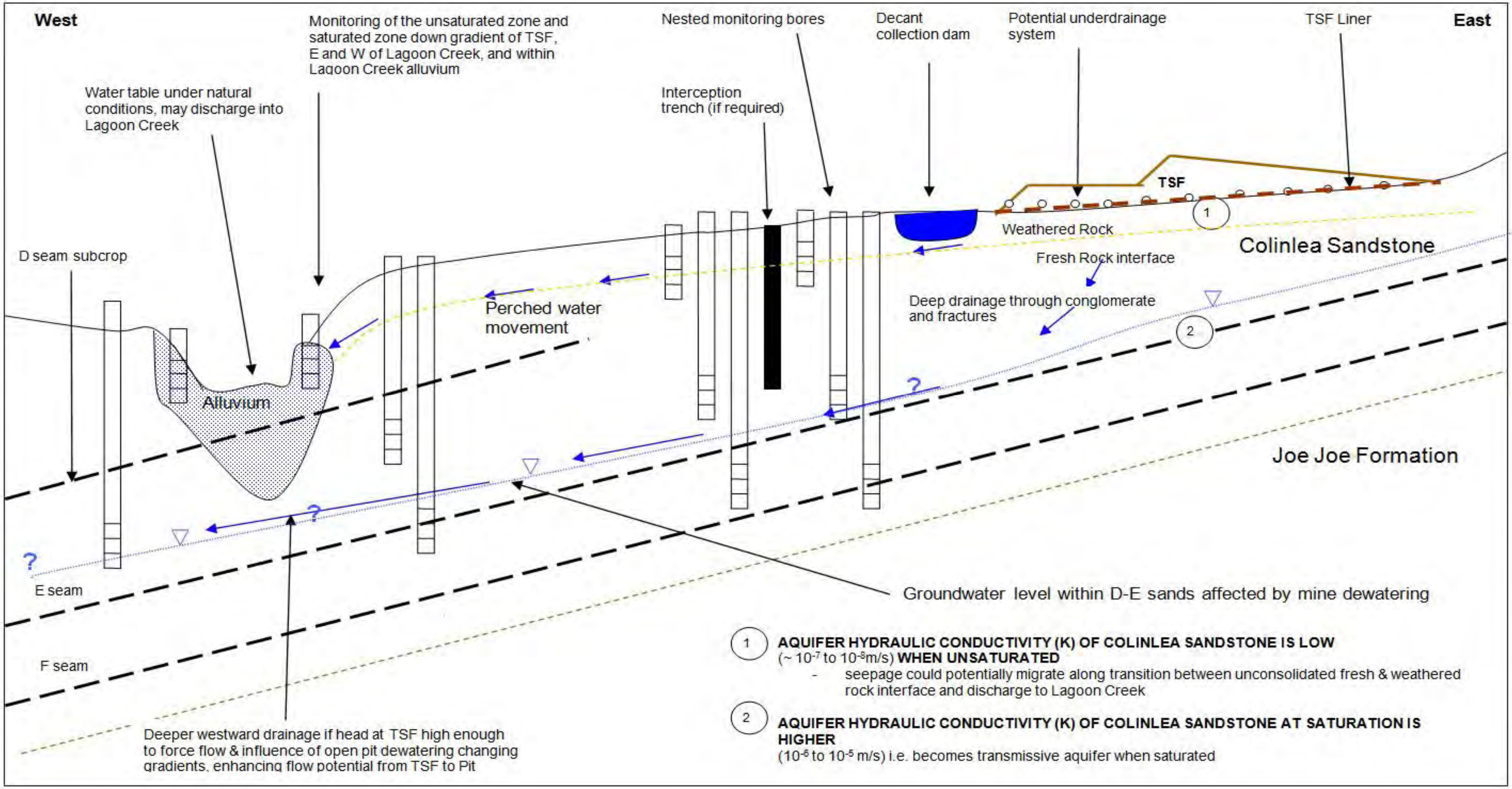


Figure 4-1: Seepage migration and migration measures associated with the TSF

4.2 Seepage control

4.2.1 General

The TSF will be designed to minimise any adverse environmental effects arising from seepage from the impoundments. Seepage from the TSF would be minimised by implementing some, or all, of the following measures as appropriately required after further more detailed engineering evaluation:

- design and construction of main embankments using fill materials placed to engineering specifications;
- providing a liner system to reduce seepage from the TSF to groundwater;
- providing an underdrainage system to collect seepage from the TSF;
- recovery of surface water from within the TSF using an engineered recovery system;
- management of tailings deposition via discharge points to ensure that tailings are deposited in a controlled manner maximising evaporation and decant;
- providing appropriate embankment drainage design to manage seepage through embankment; and
- compaction of existing soils within the storage area.

Further geotechnical investigation will be undertaken at the detailed design stage in order to determine subsurface conditions across the full extent of this site and further assess the hydrogeology of the area to finalise design measures for seepage control.

4.2.2 Liner system

The available geotechnical data indicates that seepage may occur through the foundation soils and underlying sandstones. Therefore a liner system may be required in areas where sandy soils are encountered to limit seepage of tailings water into the foundation soils/rock and reduce the impact to groundwater and the Lagoon Creek alluvial area. It is considered that the sandy clay layer encountered in places in the northern half of the TSF site could act as a liner system in these areas which would limit seepage into the foundation. The liner system could be established in a number of ways, including using either the clayey soils won from site or from tailings fines. Further investigation and studies are planned at the detailed design stage to finalise the design of the liner system to accord with accepted standards and a permeability target of around 10^{-9}m/s.

4.2.3 Underdrainage system

Given the low density of the slurry, the tailings will settle in the TSF with significant associated water content, generating a hydraulic head. Should an acceptable permeability target not be achieved, an underdrainage system will be employed. An underdrainage system or subsurface drainage is widely used to increase the rate of dewatering and consolidation of placed tailings. The underdrainage system could also provide the following:

- improve stability by lowering the phreatic surface;
- improve water return to the plant;
- promote early consolidation of the solids;
- subsurface drainage placed above a liner would reduce the hydraulic head on the liner thereby reducing the quantity of seepage through the liner;
- reducing the moisture content of the tailings during operation will also reduce long term seepage from TSF, improving effects on groundwater; and
- stabilisation of the TSF during operation through dewatering/drainage will reduce consolidation and differential settlement of the surface which is important for successful rehabilitation.

The underdrainage system would involve the installation above the liner system of slotted pipe and geotextile drains running across the floor of the TSF covered with granular free draining sand material (refer Figure 4-2 below). This would discharge via a pipe in the same trench as the decant outlet and flow to the tailings decant water dam. The design of this underdrainage system would be further evaluated in the detailed design stage.

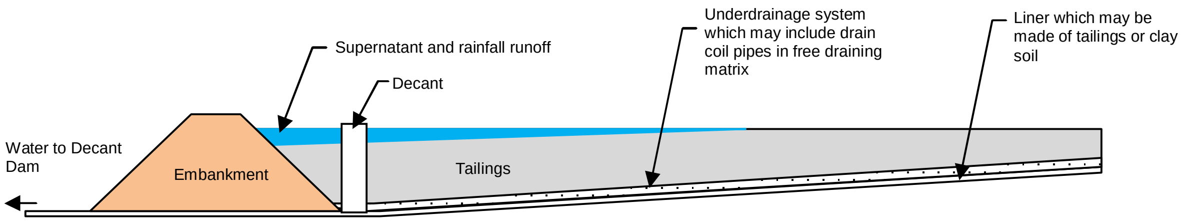


Figure 4-2: TSF underdrainage system schematic sketch

4.2.4 Piping concerns

Piping through the embankment, especially around through-embankment structures, is an important design consideration with any dam or TSF. The decant water pipelines, by nature, have to pass through or under the embankment in order to drain the decant water by gravity to the decant dam. While piping failure is a concern within the normal embankment structure, the risk is elevated around these pipes and will be dealt with accordingly in the detailed design stage.

Seepage collars around the penetrations at multiple points along the penetrating pipe will most likely form the main physical mitigation strategy. Appropriate detailing around the start of the penetration is also required, with attention being paid to the shape of headwalls and footings supporting the penetrating structures. Especially tight earthworks compaction standards and material specifications will also be written into the design documentation with regard to these areas.

4.2.5 Embankment toe drain

Around the perimeter of the TSF, a seepage drain is required. The drain will be installed along the external toe of the main embankment. The drain will catch water seeping through the containment embankment and drain it to the decant water dam. Seepage water will report to evaporation ponds located proximate to the TSF cells as their development progresses from north to south.

4.3 Embankment design

4.3.1 Design criteria

Generally, embankments containing tailings require appropriate design and operation techniques in order to perform satisfactorily as part of the TSF. While the tailings disposal system would be decommissioned at completion of tailings discharge in each cell, the embankments will need to be designed to perform indefinitely as they would ultimately contain the tailings indefinitely.

Embankments will be designed and constructed in accordance with ICOLD and ANCOLD guidelines and requirements for tailings dams. The TSF would be designed for a 30 year operating life and would include 6 cells that are constructed progressively. Dam raising and staging is described in Section 3. Embankments would be constructed using locally available materials where possible.

Operational management would ensure that embankment maintenance and capital development activities comply with ANCOLD and other relevant design and regulatory requirements. Monitoring of tailings characteristics, water balance, groundwater etc would be routinely reviewed.

The design of the TSF includes:

- external starter embankments and their subsequent raising which require soil materials for construction; and
- internal embankments and their subsequent raising which separate the various cells upslope, which could be constructed out of the tailings and reject material (depending on acceptable geochemical properties).

Engineering design parameters that have been used for the TSF concept design and which will be applicable to the detailed design include:

- a minimum acceptable factor of safety of 1.5 for long term embankment slope stability;
- a minimum factor of safety of 1.2 for short term stability during construction;
- a minimum factor of safety of 1.1 under seismic loading conditions;
- a freeboard of 0.5 m plus 0.8 m for DSA requirement; and
- a seismic coefficient of 0.04 g for horizontal force.

The above criteria are in accordance with internationally accepted guidelines including those of ANCOLD.

4.3.2 Stability analyses

The profile of the main starter embankment with the future downstream lifts is considered to be one of the most critical issues of the TSF stability. For the purpose of analyses, two downstream embankment lifts of 5 m height each have been assumed with crest levels shown in Figure 4-3.

The factor of safety of the embankment profile will be affected by the following parameters:

- water level through the embankment material;
- level of tailings behind the embankments;
- external slope of the embankments; and
- shear strength properties of the embankment materials and foundation.

At the current preliminary design stage, it has been assumed that the upstream face of the external embankment will be constructed with low permeability material to prevent any seepage of water from the disposal area to the embankment core.

Preliminary stability analyses were conducted in order to demonstrate the stability of the proposed embankments and to identify the following:

- critical slip surface;
- minimum overall factor of safety; and
- required downstream slope and material to meet above indicated criteria.

The analyses were carried out on a typical cross section of the external embankment with two downstream lifts using Slope/w computer program. The geotechnical model was based on the following soil parameters:

Table 4-1: Soil parameters

Material	Unit Weight γ (kN/m^3)	Friction Angle ϕ'(°)	Cohesion c' (kPa)
Embankment Fill	19	30	5
Tailings	17	25	0
Foundation	19	35	0

The preliminary stability analysis was completed for the following cases:

- no phreatic surface;
- phreatic surface within embankment dam and TSF; and
- phreatic surface within embankment dam and TSF, and seismic coefficient = 0.04 g.

The results of the stability analyses are summarised in Table 4-2:

Table 4-2: Stability analysis results

Phreatic surface	Condition	FOS
None	Static	1.77
Within embankment dam / TSF	Static	1.50
Within embankment dam / TSF	Pseudo Static	1.32

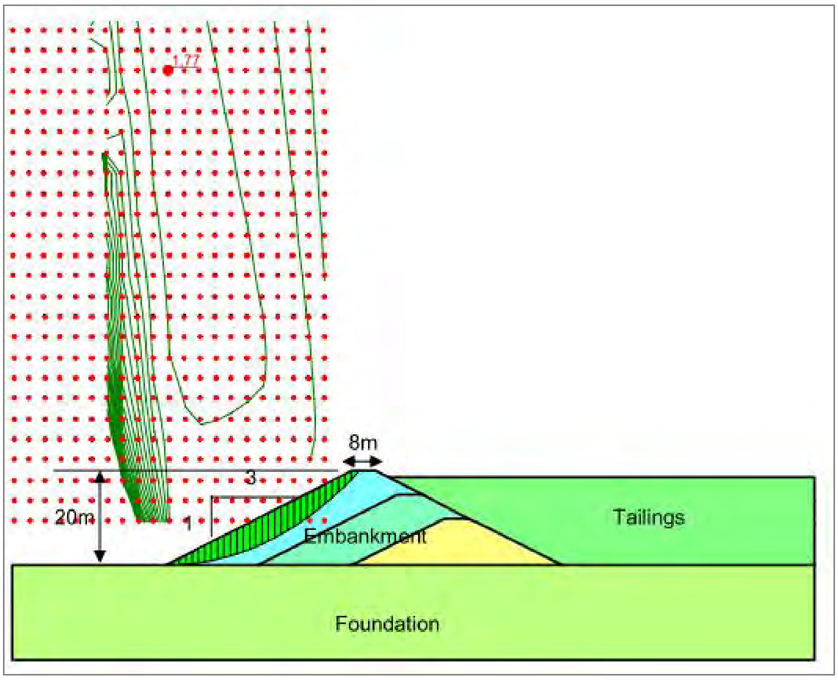


Figure 4-3: No phreatic surface (static)

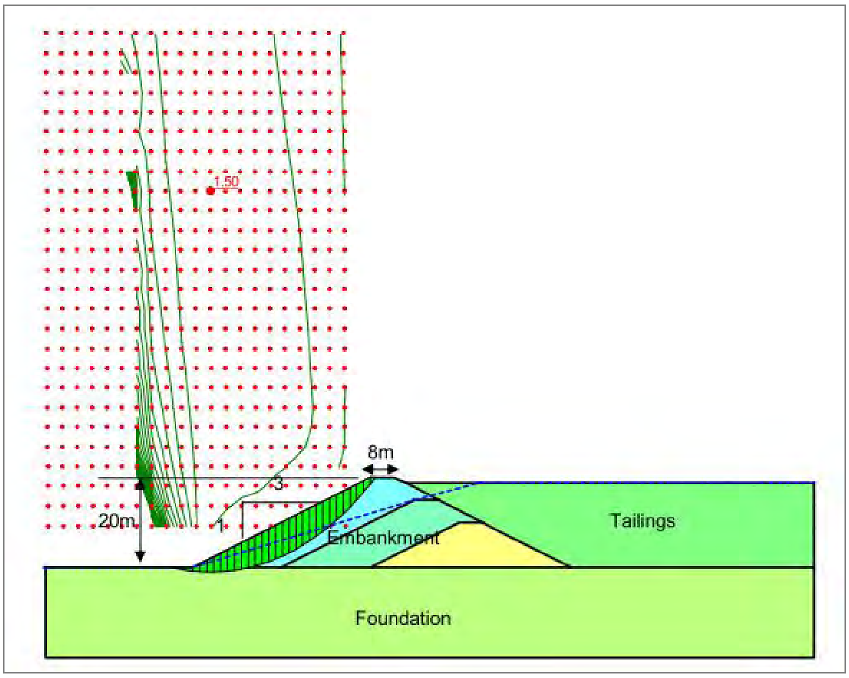


Figure 4-4: Phreatic surface within embankment dam and TSF (Static)

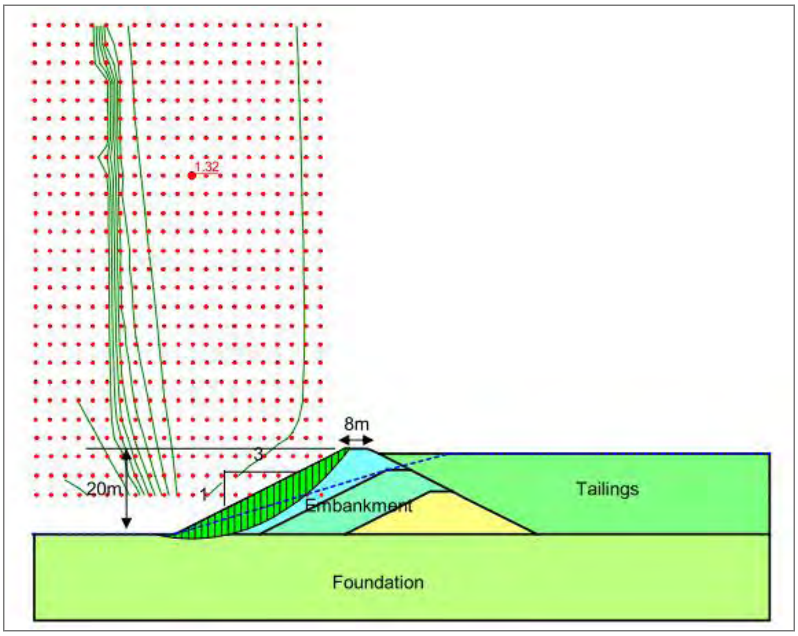


Figure 4-5: Phreatic surface within embankment dam and TSF (Pseudo Static)

Detailed stability analyses will be progressed at the detailed design.

4.4 Surface water management

In order to minimise the catchment areas reporting to the TSF, upstream clean water cut-off drains will be constructed to divert stormwater runoff around the proposed TSF structure into natural watercourses downstream of the embankments. These drains will be phased to tie in with the proposed staged development of the tailings cells.

All the cut off drains have been sized based on a 1% AEP time of concentration event (1 in 100 year) with an allowance for 0.5 m of freeboard.

The drains will be topsoiled and grass seeded with rock protection provided at significant bends. Additionally all outlets from the drains to the natural surface will contain rock protection to minimise scour and assist in dissipating the runoff into sheet flow.

4.5 Emergency spillway

The preliminary design provides spillways for each cell that have been designed to convey the peak runoff in accordance with DERM's Manual for Assessing Hazard Categories and Hydraulic Performance of Dams – Table 4.

The spillways will generally outlet to the natural surface from where the existing surface grading will direct the runoff away from the facility to existing watercourses.

All spillways outlets will be rock protected and flared to minimise scour and assist with dissipation of runoff to sheet flow.

4.6 Construction methodology

All construction works to do with the TSF will be performed by a reputable civil contractor with prior experience constructing similar structures. Strict control will be placed on the contractor by way of engaging the civil design engineer and the geotechnical design engineer throughout the construction period to ensure the works are constructed in accordance with the required design parameters. A third party geotechnician will be engaged to undertake confirmation testing including compaction/permeability/dispersion testing to further ensure the facility is constructed in accordance with requirements.

4.7 Regulatory category

A hazard assessment study will be carried out at the design stage to assess the hazard category of this tailings storage facility. This study will be based on the current ANCOLD guidelines and DERM recommendations for TSF design.

Given that this facility will most likely be of High/Significant hazard category, the risk of TSF failure will also be assessed using methods described in ANCOLD guidelines on risk assessment. These methods will include analysing the many different sources of risk as follows:

- embankment failures (overtopping, piping, instability, etc);
- decant structure blockage;
- leakage from TSF or water pond;
- groundwater seepage; and
- break/burst in tailings discharge pipeline.

5. Surveillance

5.1 Tailings chemical analysis

The tailings solids will be monitored for geochemical characteristics (pH, Electrical Conductivity (EC), acidity, alkalinity, sulphur species (total, organic, sulphide and sulphate) and Acid Neutralising Capacity (ANC)) on a monthly basis until such time as the variability of the geochemical characteristics of the tailings solids is well defined (estimated as approximately 12 months). Thereafter, a less frequent testing regime will be employed with testing frequencies at least annually, with discrete testing operations required if significant changes in feedstock and/or process parameters are realised.

The tailings decant water and TSF seepage water will also be monitored on a monthly basis and tested for pH, EC, total dissolved solids (TDS), acidity and alkalinity. Major anions (sulphate, chloride, fluoride), major cations (calcium, magnesium, sodium and potassium) and trace metals (aluminium, arsenic, antimony, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, selenium, silver, uranium, vanadium and zinc) will be included in the range of analytes tested in these water samples, initially on a quarterly basis (for 12 months) and then on an annual basis throughout the life of mine. Should the pH of the TSF seepage water decrease below pH 5.5 or the EC increase by more than 100%, the full range of analytes described above will be included in the test suite.

5.2 Groundwater monitoring

Groundwater level and quality will be monitored over the duration of the tailings discharge operations as well as after cessation, as part of an on-going closure plan. Groundwater monitoring bores will be installed not only on the main embankments but it may be necessary to install them to monitor specific areas of interest. Groundwater monitoring bores may consist of PVC slotted casings installed in gravel packed boreholes on the embankment crest.

Ongoing monitoring and investigations will include:

- undertaking a repeat (electromagnetics) EM survey within 12 months of commencement of tailings emplacement, to test whether leakage of leachate from the TSF is occurring;
- monthly water level and quarterly water quality monitoring for the suite of parameters outlined above;
- Sample tailings water (and determine indicators compared to ambient groundwater);
- annual reporting of water level and water quality results; and
- notification to the regulating authority within one month of receiving water quality analysis results, should any parameters tested exceed agreed trigger levels.

Should trigger levels be exceeded, investigations will be undertaken to establish:

- whether actual environmental harm has occurred; and
- immediate measures that should be taken to reduce the potential for environmental harm.
- long-term mitigation measures required to address any existing contamination, and to prevent recurrence of contamination. This may include for example:
  - undertaking further EM surveys to establish the location of contaminant plumes;
  - installation of a low-permeability cut-off wall; and
  - installation of interception trenches to collect leachate and drain to a central sump for transfer of leachate to the process water stream.

Groundwater investigations that would be undertaken prior to final design of the TSF include:

- drilling and construction of nested groundwater monitoring bores up-gradient of the TSF, as well as down-gradient in the area of the downstream toe of the TSF, to establish the depth at which water is struck, and the depth to which water will rise in the bore. The nested sites would comprise a deep bore screened in saturated sediments, and a shallow bore that would be drilled dry initially, but would be monitored for appearance of water that could be indicative of leakage from the TSF;
- hydraulic testing on monitoring bores to test the saturated hydraulic conductivity of the material underlying the TSF;
- seepage modelling to make predictions of the potential for the TSF, as designed, to leak leachate to the shallow groundwater system and ultimately toward Lagoon Creek. Seepage modelling would be used to predict a hydraulic conductivity of material that would limit leakage from the TSF to levels deemed acceptable;
- daily water level monitoring (automatic dataloggers) reviewed monthly and monthly groundwater quality monitoring from bores to establish baseline levels prior to development of the facility. Based on available information from the waste management strategy the major potential contaminants are expected to include sulphate, elevated EC/TDS, decreased alkalinity and pH. If the seepage is acidic this may result in mobilisation of metals, most likely aluminium, iron and manganese, though other metals/metalloids to be monitored should include cadmium, copper, lead, nickel, selenium, and zinc;
- the suite of parameters to be tested will include:
  - field parameters – pH and EC;
  - major/minor ions, including TDS, calcium, magnesium, potassium, sodium, chloride, sulphate, alkalinity (hydroxide, carbonate, bicarbonate, total), fluoride;
  - metals/metalloids, including aluminium, arsenic, antimony, boron, cadmium, chromium, cobalt, copper, iron, lead, mercury, manganese, molybdenum, nickel, selenium, silver, uranium, vanadium, zinc; and
  - it is anticipated that the parameter list would be modified once the TSF is operational, and the nature of liquid generated by the TSF becomes apparent.
- an electromagnetics (EM) survey on the down-gradient side of the TSF to establish baseline conditions, prior to operation of the TSF.

5.3 Tailings Storage Facility structure

5.3.1 Embankment piezometers

Groundwater monitoring instrumentation would be installed within the TSF containment embankments to monitor its performance. This information is essential for on-going assessment of the stability of the embankments during tailings discharge and embankment raising. Piezometers may consist of Casagrande piezometers (direct monitoring of water level within tube) or pneumatic or vibrating wire piezometers (remote monitoring through a pressure device).

5.3.2 Survey monuments

Survey monuments would be installed on a nominal spacing (say 200 m) along each of the embankments. These monuments would be surveyed on a routine basis to detect any movements of the embankments. The results of survey monuments and piezometers will be used to assess overall stability of the embankments.

5.3.3 Meteorological station

A meteorological station would be installed near the TSF to monitor and record rainfall and evaporation data.

6. Rehabilitation and closure strategy

6.1 Rehabilitation of external embankment slopes

The proposed concept of rehabilitation of the external slopes of the TSF embankments is to establish naturally occurring vegetation without cultivation or irrigation. This could be achieved by developing a select fill layer on the outer face of the embankments and covering this with a layer of approximately 200 mm of topsoil. This topsoil is to be selected from areas where grasses, shrubs and trees have been established. Seeds of established plants are mixed into the topsoil which provides opportunity for natural germination when seasonal conditions are suitable. The external slopes will be designed to allow access for any future planting and maintenance and to comply with regulatory requirements.

6.2 Rehabilitation of Tailings Storage Facility surface - capping

Efficient management of the Project TSF will require progressive rehabilitation of the storage surface area. The surface profile of each of the TSF cells will continuously change. Thus the rehabilitation of a particular cell will only start once the tailings discharge operation is complete within that cell. Rehabilitation will be progressive with works to start in Cell 2 once tailings disposal ceases into this cell.

The strategy proposed for the Project includes:

- identifying topsoil resources for rehabilitation;
- excavating and stockpiling the topsoil for re-use during rehabilitation; and
- undertaking rehabilitation trials early in the development to determine optimum rehabilitation techniques for the site.

It is suggested that capping trials be undertaken in Cell 2 after the first 8 years of operations and after 12-13 years in Cell 1. Specific areas would need to be established for conducting the trials under site specific conditions. The aims of the capping trials would be to optimise the rehabilitation design (capping thickness, type of materials and drainage measures). The purpose is also to investigate various growing methods and vegetation species. Design of the rehabilitation works for both the external batter slopes and over the surface area of the TSF, including capping, landforms and drainage will be evaluated further at the detailed design stage.

6.3 Preliminary rehabilitation success criteria

The following preliminary success criteria (or closure criteria as they are often referred to) for the rehabilitation areas are included in Table 6-1. The success criteria are performance objectives or standards against which rehabilitation success in achieving a sustainable system for the proposed post-mine land use is demonstrated. Satisfaction and maintenance of the success criteria (as indicated by monitoring results) will demonstrate that the rehabilitated TSF is ready to be relinquished from the mine's financial assurance and could be handed back to stakeholders in a productive and sustainable condition.

The success criteria comprise indicators for vegetation, fauna, soil, stability, land use and safety on a landform-type basis that reflects the nominated post-mine land use of open grasslands with selective grazing opportunities.

For each element, standards that define rehabilitation success at mine closure are provided. Based on the generic indicators in Table 6-1, each criterion will be further developed to be specific, measurable, achievable, realistic and outcome based, and to reflect the principle of sustainable development. This will be based on results of further research and ongoing monitoring of the progressive rehabilitation areas. The success criteria will be reviewed every three to five years with stakeholder participation to ensure the nominated success criteria remain realistic and achievable.

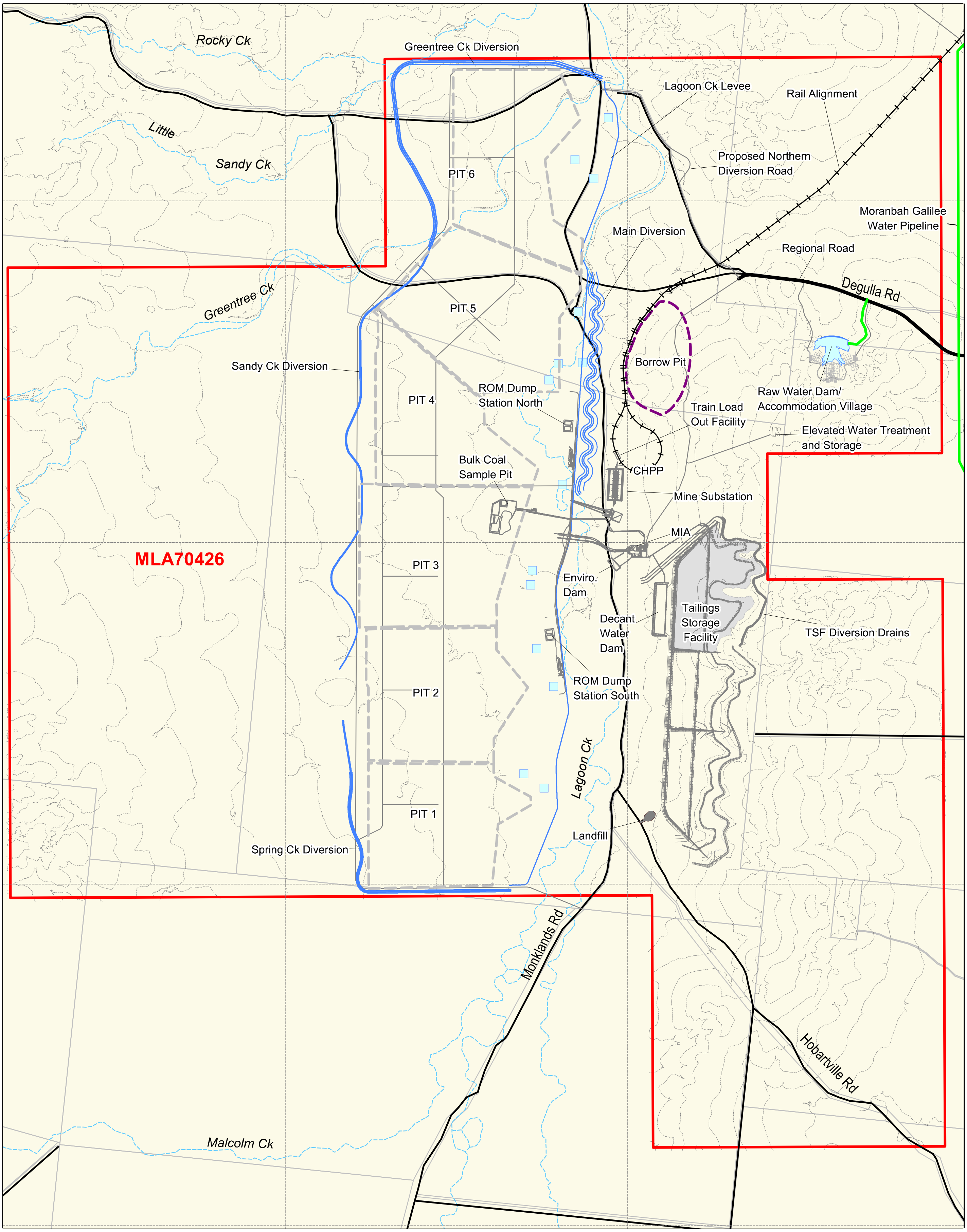
Decommissioning and rehabilitation strategies for all components of the Alpha Coal Project are detailed further in Volume 2, Section 25 of the EIS and in the Mine EM Plan.

Table 6-1: Preliminary Rehabilitation Success Criteria for TSF

Rehabilitation Element	Indicator	Criteria
Landform stability	*Erosion control*	Tailings are capped to a minimum depth of 1.5 m that includes a minimum topsoil depth of 200 mm on the cap. A minimum of 200 mm of topsoil on the outer face of the embankments. Erosion mitigation measures have been applied. Average soil loss per annum per domain unit is <40 tonnes/ha/yr (sheet erosion).
	Surface Water Drainage	Drainage control measures are installed. No water is observed leaching from the facility.
Water quality	*Salinity & pH*	Ensure receiving waters affected by surface water runoff have contaminant limits of electrical conductivity maximum of 2000 µS/cm and pH range of 5.5 to 8.5.
Topsoil	*Salinity*	Soil salinity content is <0.6 dS/m EC.
	pH	Soil pH is between 5.5 and 8.5.
	Sodium content	Soil Exchange Sodium Percentage (ESP) is <15 %.
	Nutrient cycling	Nutrient accumulation and recycling processes are occurring as evidenced by the presence of a litter layer, mycorrhizae and/or other microsymbionts. Adequate macro and micro-nutrients are present.
Vegetation	*Land use*	Area accomplishes and remains available for sustainable grazing.
	Surface cover	Minimum of 70 % vegetative cover is present (or 50 % if rocks, logs or other features of cover are present). No bare surfaces >20 m^2 in area or >10 m in length down slope.
	Species composition	Grasses representative of regionally occurring vegetation communities where possible or palatable, nutritious pasture grass and legume species are present.
	Resilience to disturbance	Established species survive and/or regenerate after disturbance. Weeds do not dominate native species after disturbance or after rain. Pests do not occur in substantial numbers or visibly affect the development of native plant species.
	Sustainability	Species are capable of setting viable seed, flowering or otherwise reproducing.
Fauna	*Vertebrate species*	Representation of a range of species characteristics from each faunal assemblage group (e.g. reptiles, birds, mammals), present in the ecosystem type, based on pre-mine fauna lists and sighted within the three-year period preceding mine closure. The number of vertebrate species does not show a decrease over a number of successive seasons prior to mine closure.
	Invertebrate species	Presence of representatives of a broad range of functional indicator groups involved in different ecological processes.
Safety	*General*	Risk assessment has been undertaken in accordance with relevant guidelines and Australian Standards and risks reduced to levels agreed with the stakeholders.

Appendix A

Overall Site Layout



Diversion
Contour (10m interval)
Water Pipeline
Mining Lease Application (MLA70426) Boundary
Water Dam
Borrow Pit
Pit Outline

Source: See Copyright Details below and for full disclosure Please Refer to the SEIS *Volume 2, Appendix B*

0 2 4Km
Scale 1:150,000 (A4)
Datum: GDA94, MGA Zone55

N W E S

PB PARSONS BRINCKERHOFF

ALPHA COAL PROJECT (MINE)
PROJECT LAYOUT

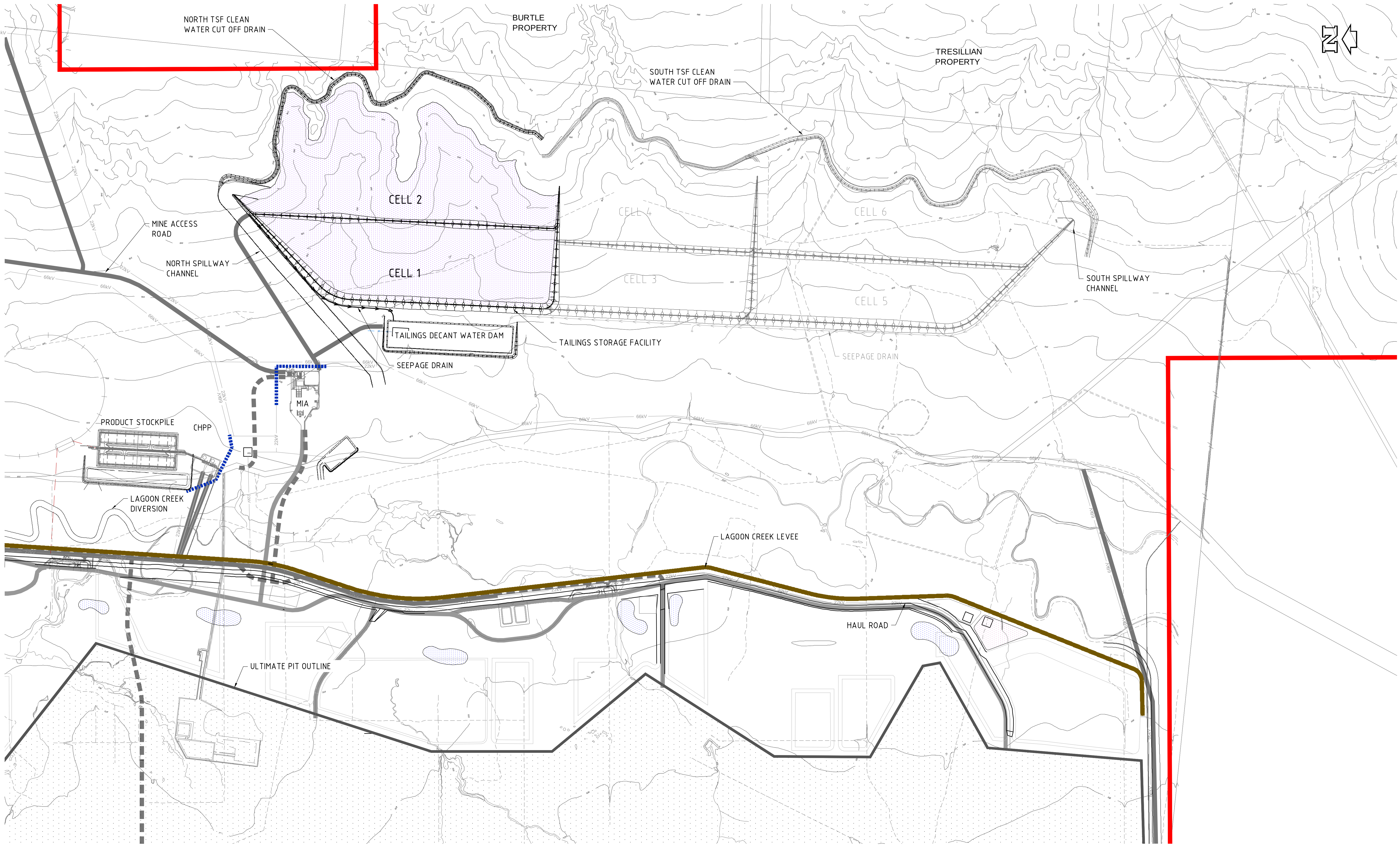
Job Number | 4262 6680
Revision | A
Date | 11-04-2011

Figure: A-1

File No: 42626680-g-2044.wor

Appendix B

TSF Concept Drawings



PLAN
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FOR CLIENT REVIEW
NOT FOR CONSTRUCTION

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REV	DESCRIPTION	BY	DRG CHK	ENG CHK	DATE	APPROVED
C	BFS ISSUE FOR CLIENT REVIEW	TLD			22.03.11	
B	ISSUED FOR CLIENT REVIEW AND BUDGET PRICING	MAH			14.09.10	
A	ISSUED FOR CLIENT REVIEW	TLD			01.09.10	

DRAWING REVISIONS

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REFERENCE DRAWINGS

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Full Size 1:20000 ; Half Reduction 1:40000
SCALE (m)

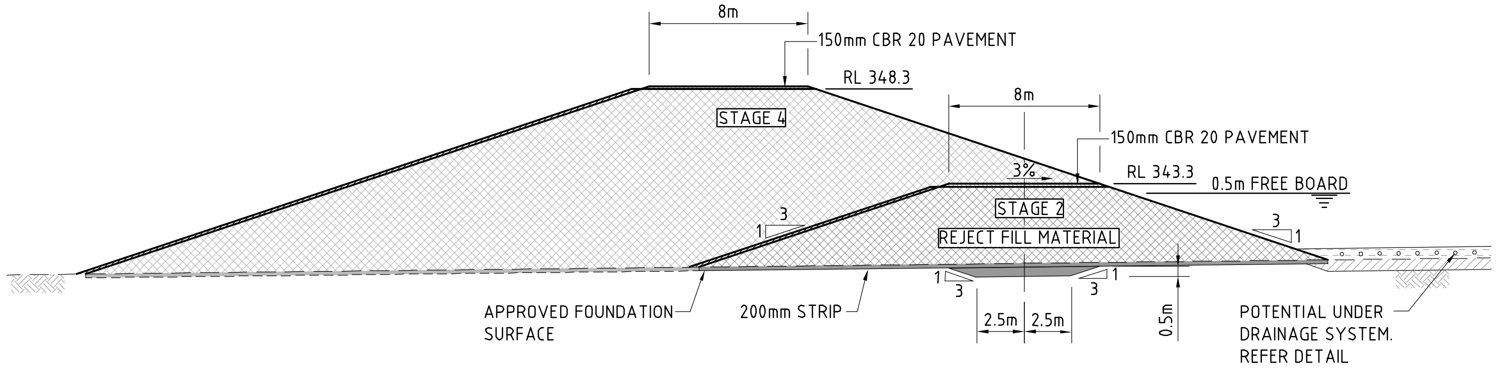
DRAWN	TLD	07.2010
CHECKED		
DESIGN ENGINEER		
LEAD ENGINEER		
SCALE		OR AS NOTED

DO NOT SCALE
IF IN DOUBT ....ASK !

HANCOCK COAL PTY LTD
PARSONS BRINCKERHOFF

CLIENT HANCOCK COAL PTY LTD
PB JOB No: 2123204A
PROJECT ALPHA COAL PROJECT – BFS
TITLE
WATER MANAGEMENT EARTHWORKS
TAILINGS STORAGE FACILITY (TSF)
OVERALL LAYOUT PLAN

DRG. NO. HC-PBA-67510-DRG-1201
A1 REVISION C



TYPICAL SECTION OF DIVIDING INTERNAL DAM WALL EMBANKMENT WITH REJECT FILL MATERIAL

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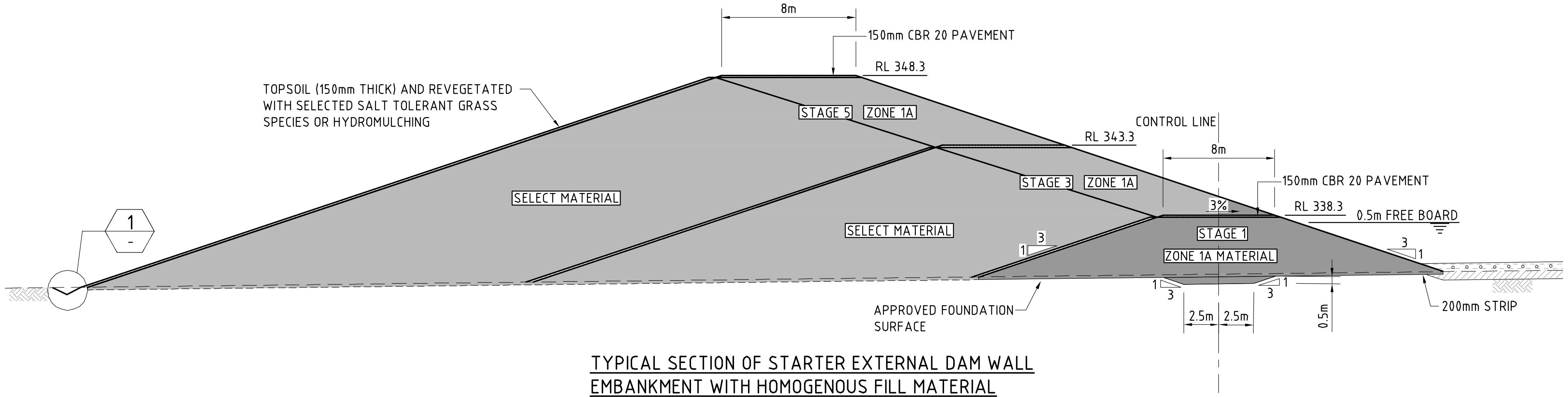

TYPICAL SECTION OF STARTER EXTERNAL DAM WALL EMBANKMENT WITH HOMOGENOUS FILL MATERIAL

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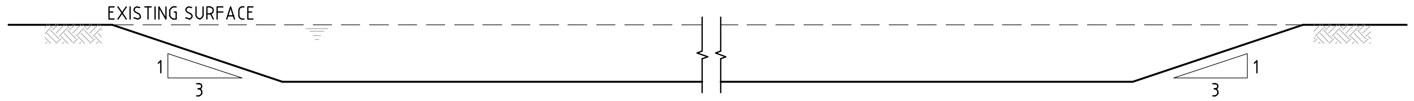
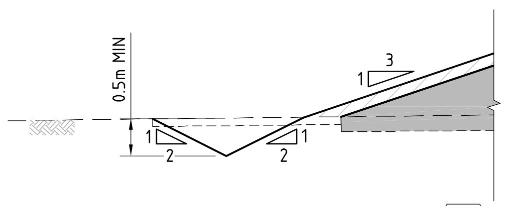


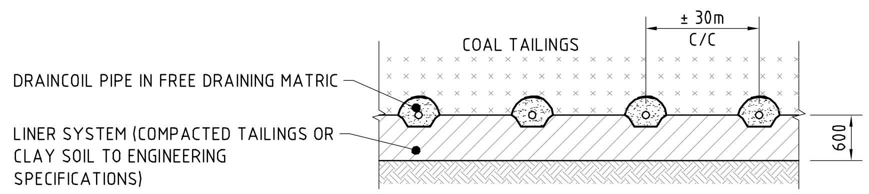
TYPICAL SECTION THROUGH SPILLWAY

SCALE 1:200



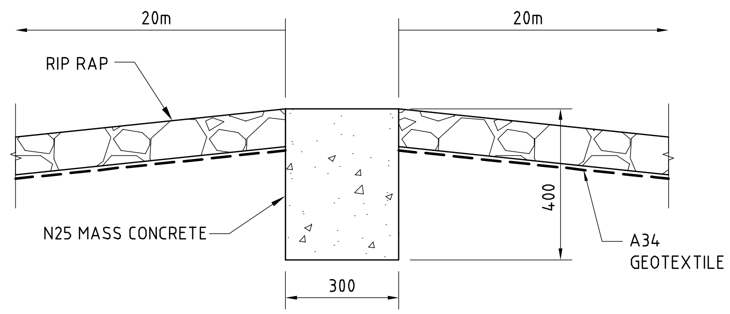
TYPICAL SECTION-SEEPAGE DRAIN (1 / -)

SCALE 1:50



POTENTIAL UNDER DRAINAGE SYSTEM DESIGN

NOT TO SCALE



TYPICAL SECTION THROUGH SPILLWAY CREST

SCALE 1:10

NOTES

1. AFTER STRIPPING OF TOPSOIL, THE EXPOSED SURFACES ARE TO BE RIPPED AND RE-COMPACTED WITH THE FIRST LAYER OF FILL PLACED THEREON TO NOT LESS THAN 98% MDD (STANDARD COMPACTION) AT ±2% OF OMC TO A MINIMUM DEPTH OF 0.6m FROM THE ORIGINAL SURFACE LEVEL.
2. A GEOTECHNICAL ASSESSMENT FOR APPROVED FOUNDATION SURFACE, AND SUITABILITY OF MATERIALS IN THE DAM EMBANKMENT SHOULD BE CARRIED OUT BY A COMPETENT PERSON. THIS SHOULD BE COMPLETED PRIOR TO PROCEEDING WITH CONSTRUCTION OF THE EMBANKMENT WALLS.
3. THE EMBANKMENT MATERIAL SHALL BE COMPACTED TO 98% STANDARD MAXIMUM DRY DENSITY (MDD) AT THEIR OPTIMUM MOISTURE CONTENT (OMC) OR JUST ABOVE IT (I.E. WITHIN RANGE OF -1% OMC AND +3%).
4. MEDIUM TO HIGH PLASTICITY SANDY CLAY SOILS ENCOUNTERED IN THE AREA ARE CONSIDERED SUITABLE ZONE 1A MATERIALS PROVIDED THEY MEET SOIL PARAMETERS :

MATERIAL PROPERTY	RECOMMENDED LIMITS
% PASSING 0.075mm	> 30%
LIQUID LIMIT	30% TO 70%
PLASTIC INDEX	> 15%
EMERSON NUMBER	≥ 4

5. EXISTING SURFACE LEVELS ARE DETERMINED FROM AERIAL SURVEY. CONTROL LINE LEVEL MAY BE ADJUSTED ACCORDINGLY TO ALLOW FOR ANY DISCREPANCY BETWEEN AERIAL AND ACTUAL LEVELS.

SPILLWAY DESIGN

OPERATIONAL LIFE OF DAM (YRS)	DESIGN EVENT BY HAZARD CATEGORY		
	HIGH PROBABILITY	SIGNIFICANT PROBABILITY	LOW PROBABILITY
1	1:10000	1:1000	1:100
2-5	1:50000	1:5000	1:100
6-10	1:100000	1:10000	1:100
11-30	1:250000	1:25000	1:100
> 30	1:1000000	1:100000	1:100

SOURCE: DERM DRAFT MANUAL FOR ASSESSING HAZARD CATEGORIES AND HYDRAULIC PERFORMANCE OF DAMS 15-11-2007.

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Plotted By: duffyt Plot Date: 24/03/11 - 09:23 Cad File: \\Aubnef\PROJ\H\Hancock_Coal\2123204A_HANCOCK_COAL_FEASIBILITY_STUD\09_CADD\Drawings\67500_WATER MANAGEMENT-EARTHWKS\HC-PBA-67510-DRG-1202.dwg

DRAWING NO.	TITLE
REFERENCE DRAWINGS	

REV	DESCRIPTION	BY	DRG CHK	ENG CHK	DATE	APPROVED
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C	REISSUED FOR CLIENT REVIEW	TLD			20.09.10	
B	ISSUED FOR CLIENT REVIEW AND BUDGET PRICING	MAH			14.09.10	
A	ISSUED FOR CLIENT REVIEW	TLD			01.09.10	

DRAWING REVISIONS

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DRAWN	TLD	07.2010
CHECKED		
DESIGN ENGINEER		
LEAD ENGINEER		
SCALE		OR AS NOTED

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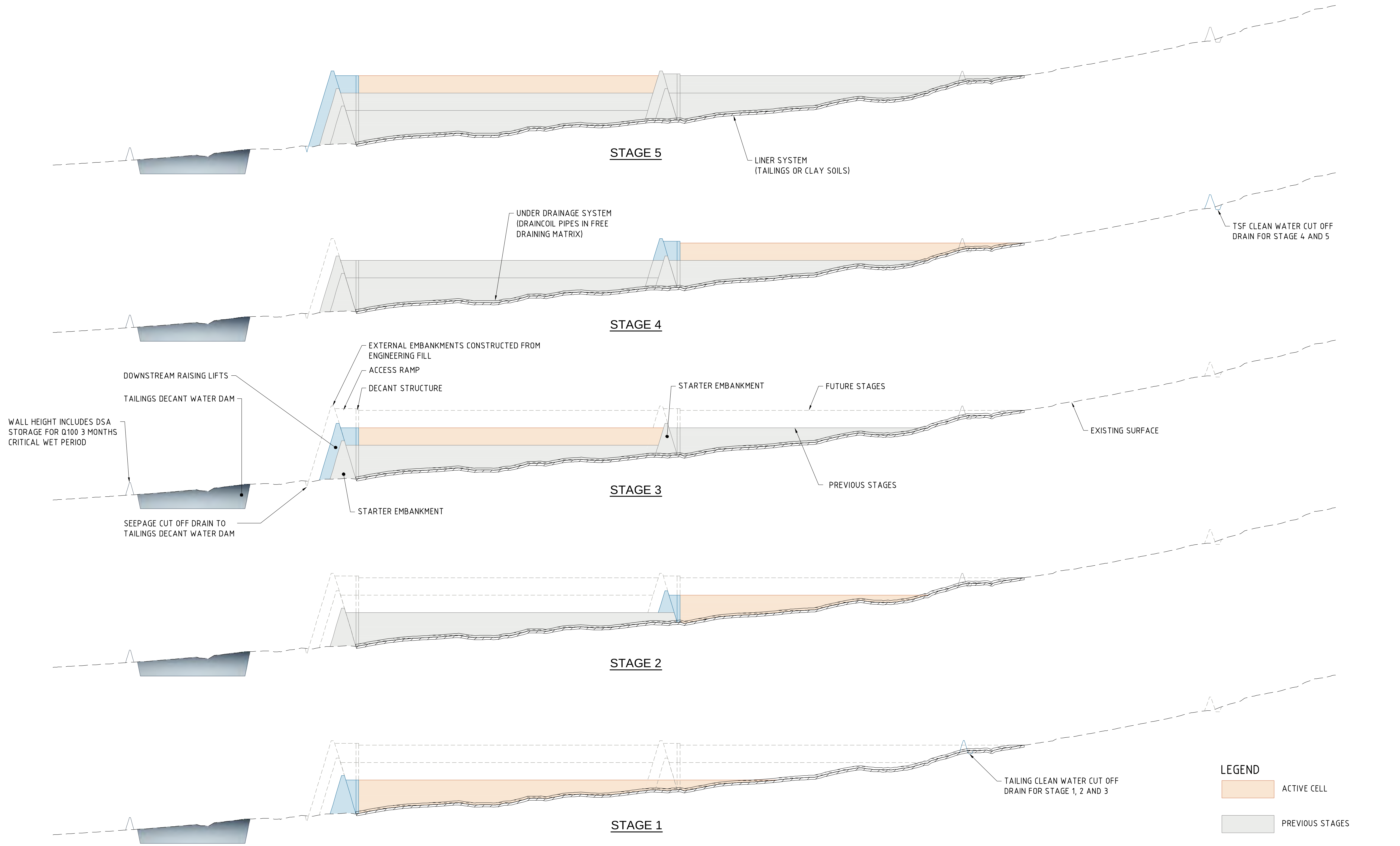
CLIENT HANCOCK COAL PTY LTD
PB JOB No: 2123204A
PROJECT ALPHA COAL PROJECT – BFS
TITLE
WATER MANAGEMENT EARTHWORKS
TAILINGS STORAGE FACILITY (TSF)
TYPICAL DAM WALL SECTIONS

DRG. NO. HC-PBA-67510-DRG-1202
A1 REVISION D



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		B	ISSUED FOR CLIENT REVIEW AND BUDGET PRICING	MAH			14.09.10	
		A	ISSUED FOR CLIENT REVIEW	TLD			01.09.10	

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VERTICAL
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SCALE		OR AS NOTED

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PROJECT ALPHA COAL PROJECT – BFS
TITLE
WATER MANAGEMENT EARTHWORKS
TAILINGS STORAGE FACILITY (TSF)
CROSS SECTION STAGING PLANS

DRG. NO. HC-PBA-67510-DRG-1203
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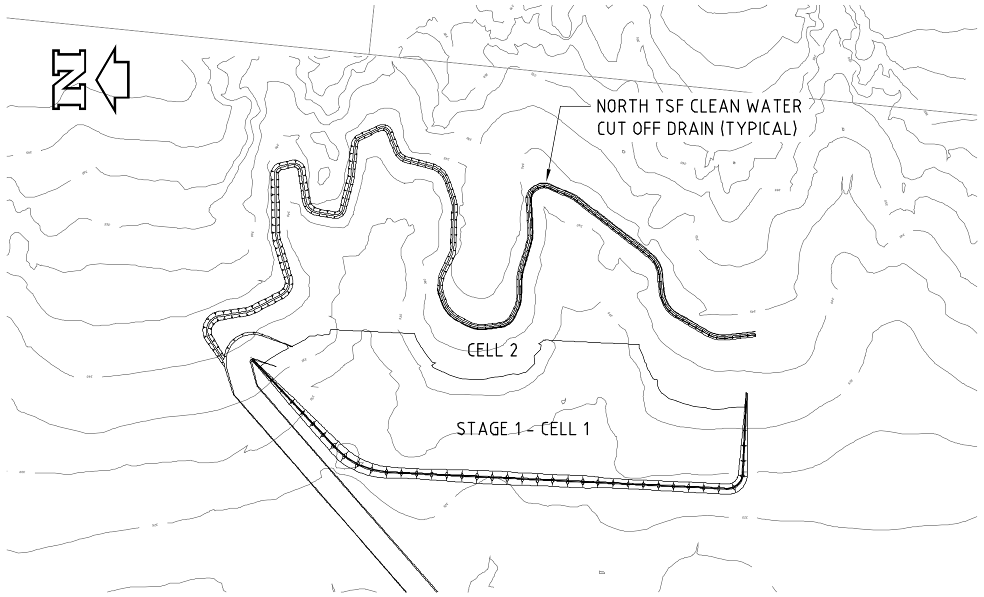
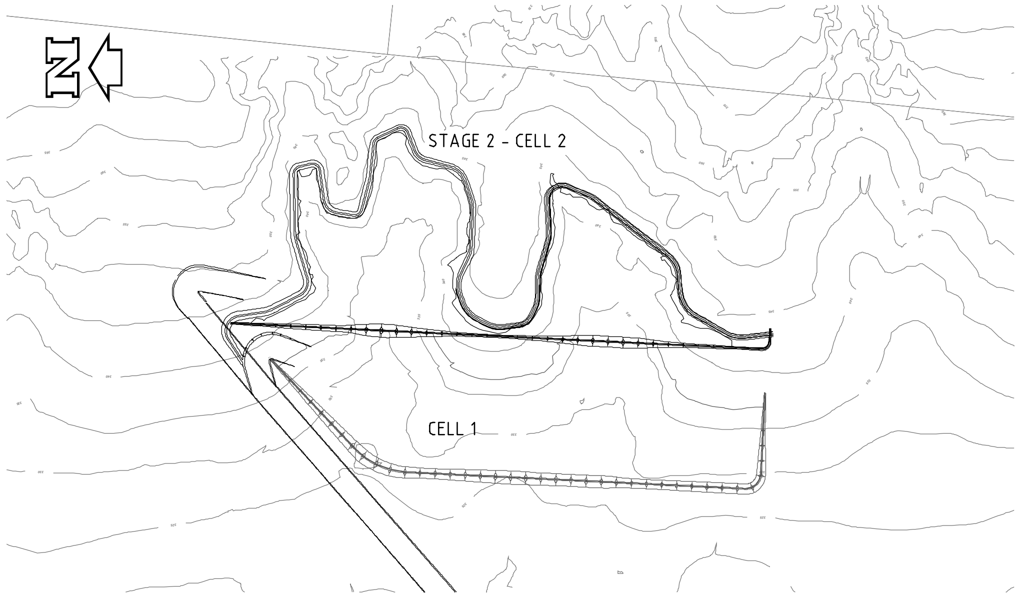
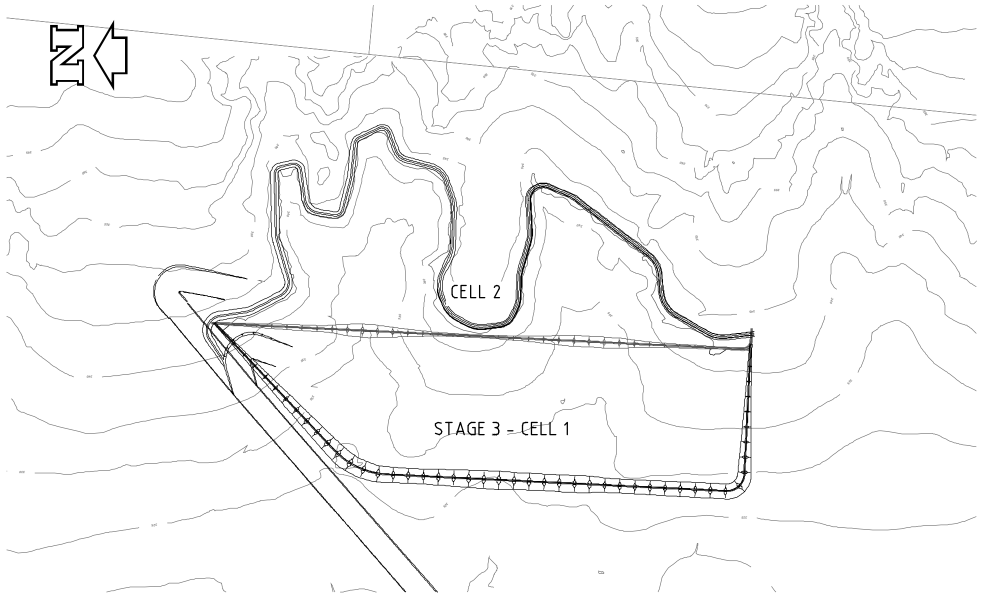


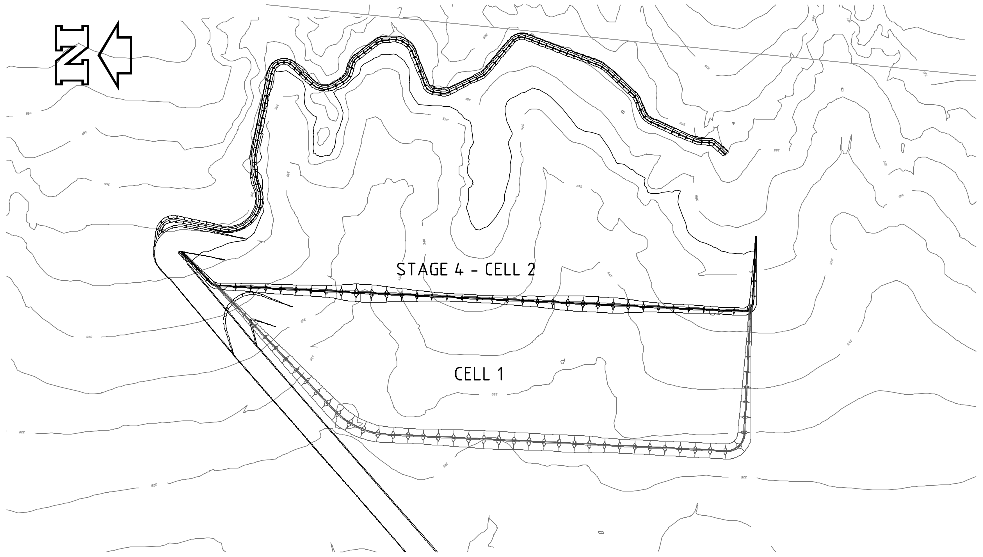
TAILINGS STORAGE FACILITY STAGE 1



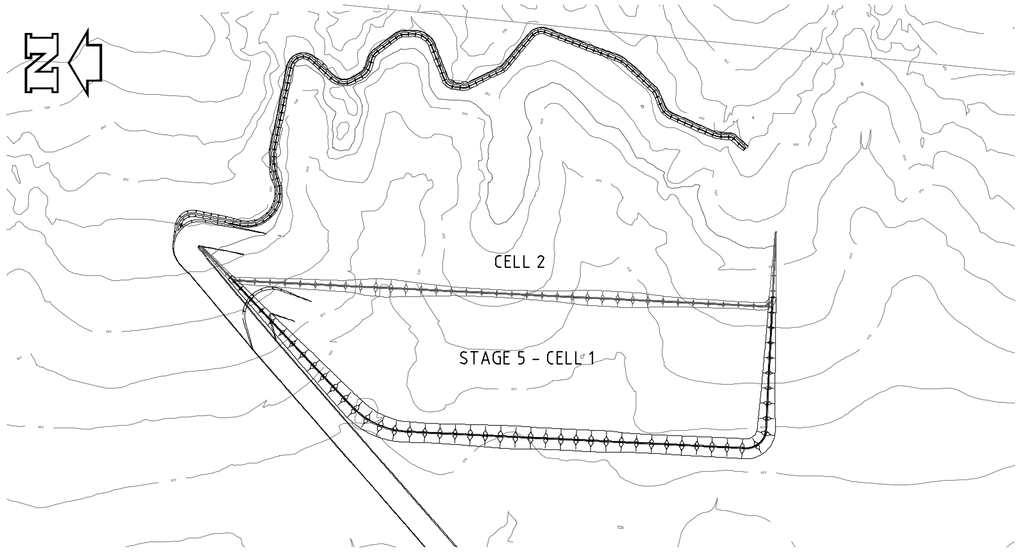
TAILINGS STORAGE FACILITY STAGE 2



TAILINGS STORAGE FACILITY STAGE 3



TAILINGS STORAGE FACILITY STAGE 4



TAILINGS STORAGE FACILITY STAGE 5

TAILINGS STORAGE FACILITY OPTION 2 - STORAGE TABLE

Cell No.	Stage Dam No.	Crest RL	Estimated Storage Capacity (m3)	Cumulative Storage Capacity (m3)	Life of Cell (Yrs)	Dam Embankment Fill (m3)	Life of Mine
1	1	338.3	12,922,715	66,414,671	2 to 3	1,575,818	1 to 3
2	2	343.3	7,519,485		3 to 4	624,399	3 to 5
1	3	343.3	14,160,216		1 to 2	1,765,491	5 to 8
2	4	348.3	17,532,953		2 to 3	1,092,600	8 to 11
1	5	348.3	14,279,302		2 to 3	2,564,194	11 to 14
3	1	338.3	10,378,788	109,976,101	2	1,491,107	14 to 16
4	2	343.3	4,806,081		2	611,914	16 to 17
3	3	343.3	8,814,532		0 to 1	1,481,995	17 to 19
4	4	348.3	10,688,279		1 to 2	972,770	19 to 21
3	5	348.3	8,873,750		1 to 2	2,016,083	21 to 23
5	1	338.3	12,862,162	165,537,054	2 to 3	1,350,433	23 to 25
6	2	343.3	6,577,128		2 to 3	922,088	25 to 27
5	3	343.3	10,698,311		1 to 2	1,440,870	27 to 28
6	4	348.3	14,569,898		2	1,326,031	28 to 30

LEGEND

ACTIVE CELL

PREVIOUS STAGES

NOTE: CELLS 3 TO 5 STAGES SIMILAR

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B	ISSUED FOR CLIENT REVIEW AND BUDGET PRICING	MAH			14.09.10	
A	ISSUED FOR CLIENT REVIEW	TLD			01.09.10	

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DESIGN ENGINEER		
LEAD ENGINEER		
SCALE		OR AS NOTED

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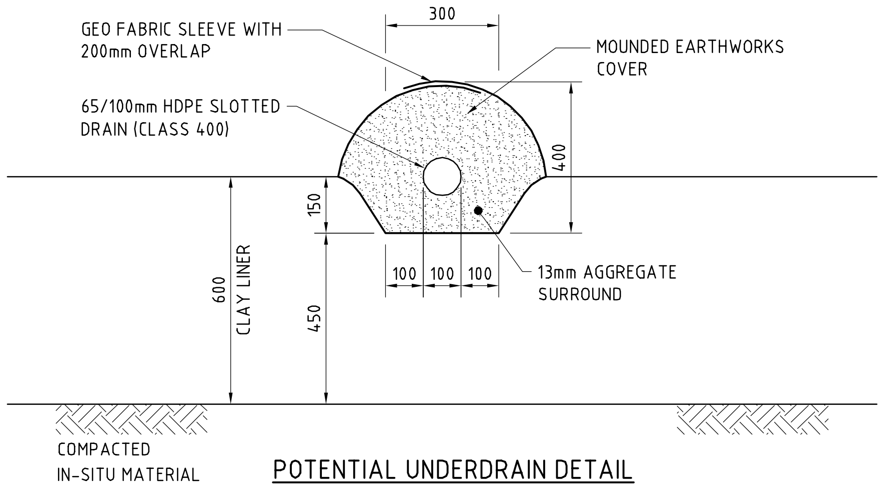
PROJECT ALPHA COAL PROJECT – BFS

TITLE
WATER MANAGEMENT EARTHWORKS
TAILINGS STORAGE FACILITY (TSF)
STAGING PLANS FOR CELL 1 AND CELL 2

DRG. NO.
HC-PBA-67510-DRG-1204

A1 REVISION C



POTENTIAL UNDERDRAIN DETAIL

SCALE 1:10

QUANTITIES	
13mm AGGREGATE 100mm⌀ DRAIN	$0.14m^3/m$
13mm AGGREGATE 65mm⌀ DRAIN	$0.13m^3/m$
GEOFABRIC	$1.80m^3/m$
EXCAVATION (NET)	$0.075m^3/m$

LEGEND

→——→	UNDER DRAINAGE SYSTEM (100mm⌀)
↣↣↣↣↣	UNDER DRAINAGE SYSTEM (65mm⌀)

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C	ISSUED FOR CLIENT REVIEW AND BUDGET PRICING	MAH			14.09.10	
B	ISSUED FOR CLIENT REVIEW	TLD			01.09.10	
A	ADDITIONAL THREE GROUNDWATER MONITOR BORES ADDED	MAH			30.08.10	

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DRAWN TLD 07.2010
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SCALE OR AS NOTED

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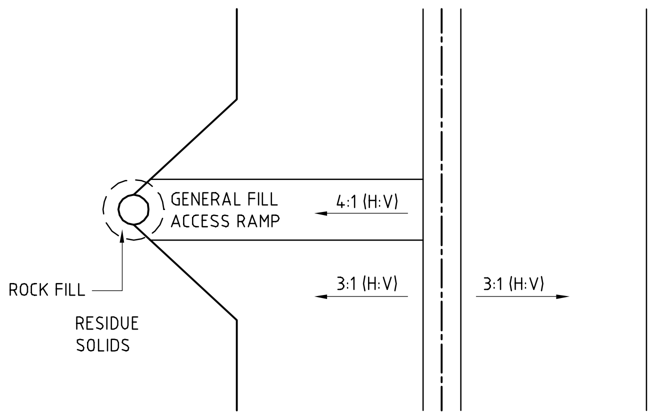
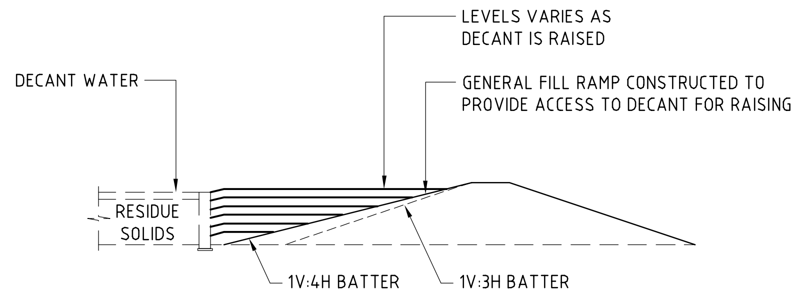
PROJECT ALPHA COAL PROJECT – BFS
PB JOB No: 2123204A
TITLE
WATER MANAGEMENT EARTHWORKS
TAILINGS STORAGE FACILITY (TSF)
DECANT ARRANGEMENT AND TYPICAL UNDERDRAIN DESIGN

DRG. NO. HC-PBA-67510-DRG-1205
A1 REVISION E



PLAN - DECANT ACCESS RAMP

NTS



SECTION - DECANT ACCESS RAMP

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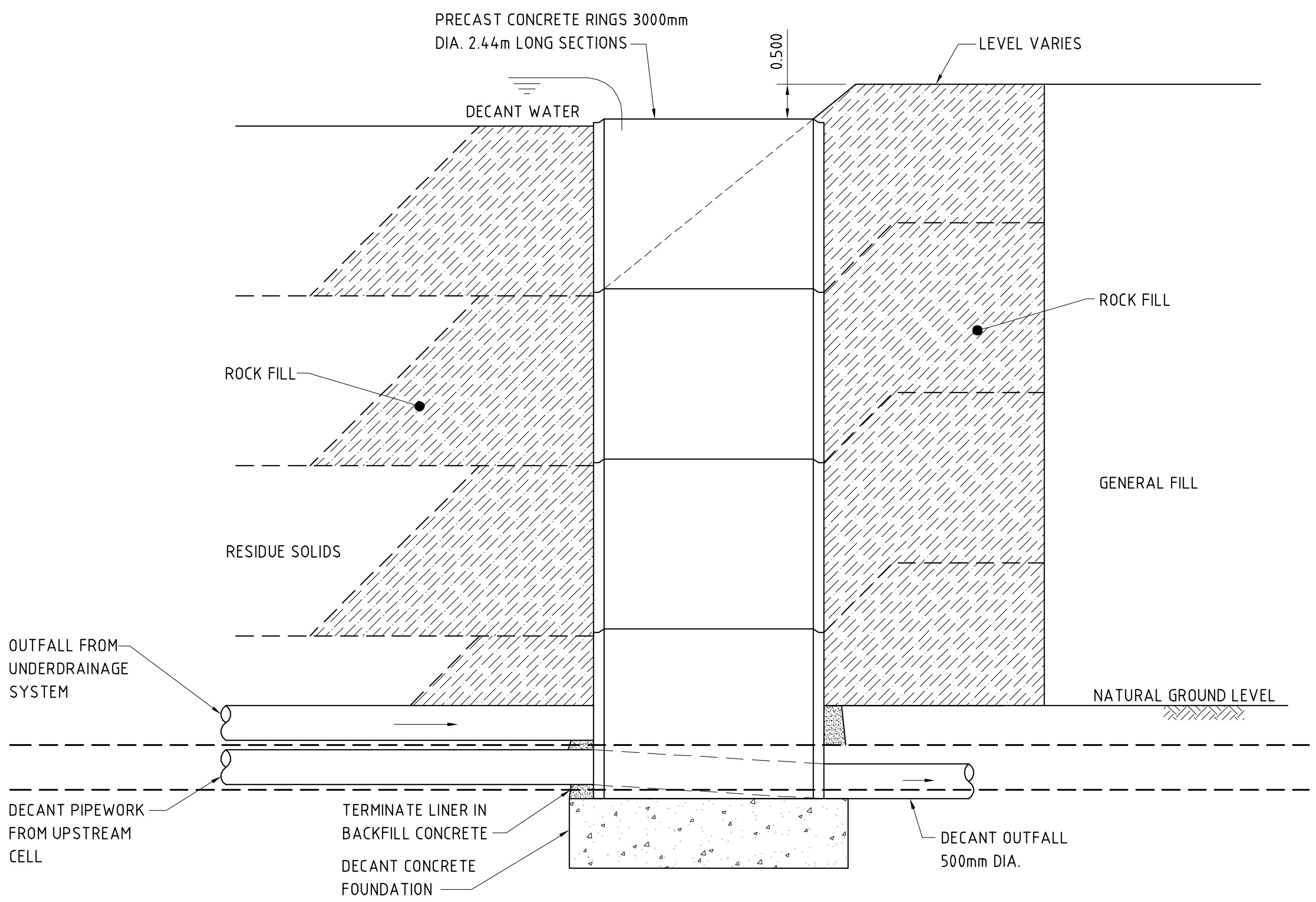

TYPICAL DECANT SUMP DETAIL

NTS

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		A	ISSUED FOR CLIENT REVIEW	TLD			01.09.10	
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SCALE		OR AS NOTED

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CLIENT HANCOCK COAL PTY LTD

PB JOB No: 2123204A

PROJECT ALPHA COAL PROJECT – BFS

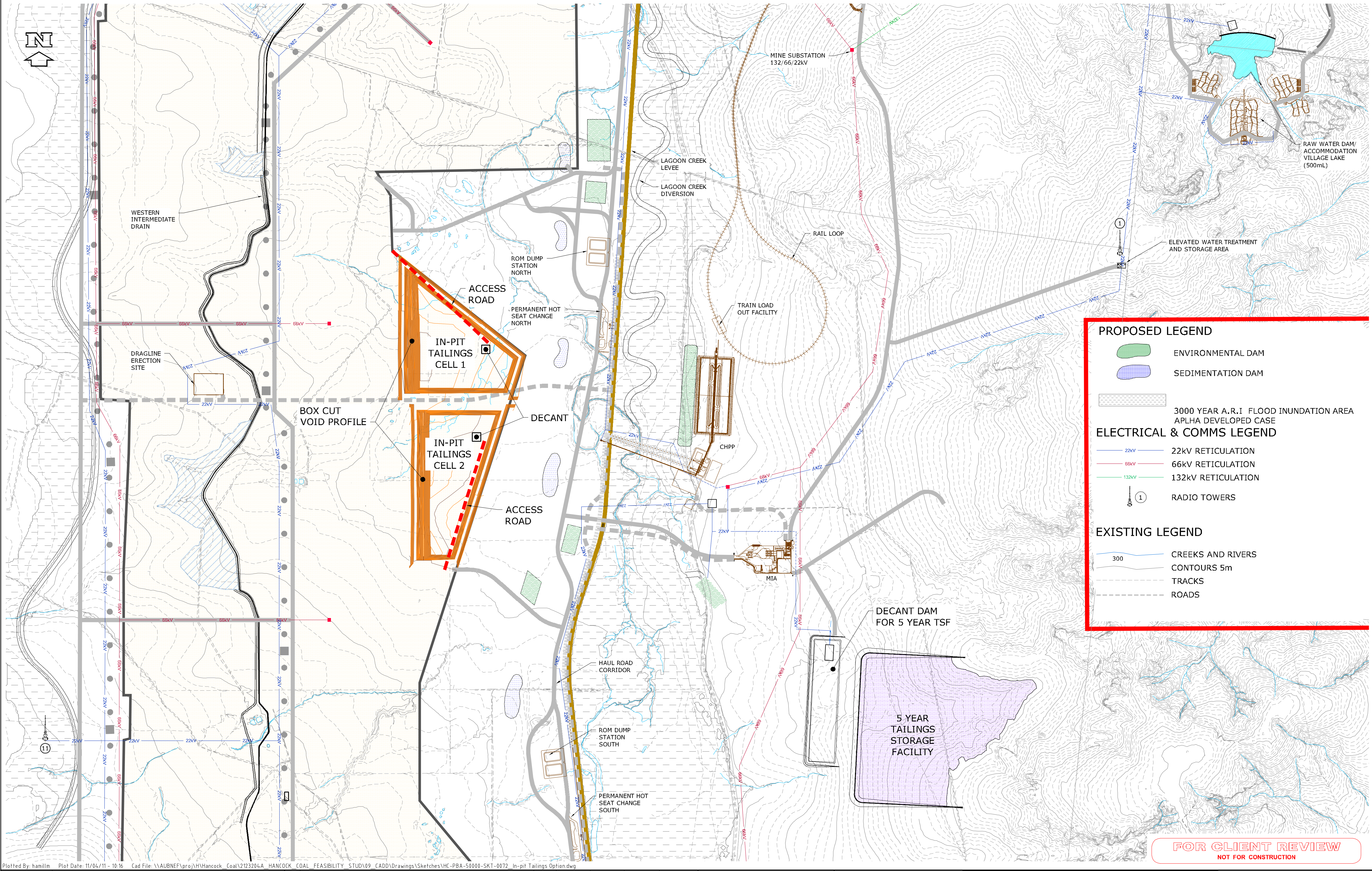
TITLE
WATER MANAGEMENT EARTHWORKS
TAILINGS STORAGE FACILITY (TSF)
DECANT STRUCTURE DETAILS

DRG. NO. HC-PBA-67510-DRG-1206

A1 REVISION D

Appendix C

TSF Alternative



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CHECKED
DESIGN ENGINEER
LEAD ENGINEER
SCALE — OR AS NOTED

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CLIENT HANCOCK COAL PTY LTD — PB JOB No: 2123204A
PROJECT ALPHA COAL PROJECT – BFS
TITLE
WATER MANAGMENT EARTHWORKS
IN-PIT TAILINGS OPTION

DRG. NO. HC-PBA-67510-SKT-0072
A1 — REVISION A