SALT ASH QUARRY

GEOTECHNICAL DESIGN ASSESSMENT
Holcim Australia (Pty Ltd)

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Executive Summary

Holcim Australia Pty Ltd (Holcim) has engaged Encompass Mining (Encompass) to undertake geotechnical studies to deliver recommendations for slope design parameters as part of the Environmental Impact Studies (EIS).

Stability assessments of the Salt Ash Sand Quarry project have been undertaken using material properties which were derived locally. The key findings from the analysis were as follows:

- 3D LEM design assessment returned Factors of Safety (FoS) higher than the required design acceptance criteria (DAC) for the proposed dredge pond design.
- All designs meet the required DAC when a seismic loading is applied.
- No further adjustment to the geotechnical slope design recommendations are required.

During the final or terminal phase, the lowest Factor of Safety (FoS) slope has also been identified as the west facing dredge pond slope with a FoS result of 2.1. The failure mode also indicates an overall circular/slumping type failure from the crest to the bottom of the dredge void which would not propagate further than the boundary marker.

Due to the unconsolidated/uncemented nature of the ground throughout the sand quarry, there is a potential for bench instability or collapse to occur from virtually any location on the dredge pond wall. The potential for dredging pond bench crest collapse is increased at the advancing pond face as a consequence of the dredging operation.

A key risk management measure is the implementation of appropriate exclusion zones at the unstable pond crest. The risk due to pond crest collapse is controlled by maintaining an exclusion zone (from the active dredge pond face). Appropriately trained personnel may only enter this zone to conduct inspections and occasional maintenance. Bund walls and cones demarcate the exclusion zone.

It is likely that minor local sloughs may occur, particularly during and shortly after heavy rain events and caution should be exercised when operating close to the batter faces after such. It is also recommended that regular and frequent monitoring of the slope performance be carried out during the asset life. Special attention should be paid to the external boundary areas above the active face. Visual inspection for tension cracks and local failures along with surveys of the pit wall should be conducted.

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1. Introduction

Encompass Mining Solutions (Encompass) understands that Holcim Australia Pty Ltd (Holcim), wish to expand sand resources from their existing quarry operation at 8 Oakvale Drive, Salt Ash, NSW (Lot 4 DP 774726) approximately 20 kilometres (km) northeast of Newcastle.

The quarry is located on the northern side of Stockton Bight, which extends north from Worimi on the north side of Fullerton Cove towards Anna Bay to the east. The operation is bounded by Worimi National Park to the south, cleared agricultural land to the north and historical sand quarries to the east and west. Within the mining tenement, the northern portion of the site comprises disturbed / mined areas, with the southern portion comprising vegetated sand dunes. Most of the site is between 5m Australian Height datum (AHD) and 10m AHD, with a large dune in the southeastern corner reaching around 30m AHD.

The site is currently an active quarry with excavation of the sand above the groundwater table (dry) which is then wet processed on site for glass and construction uses. It is understood that the remaining resources above 5m AHD within the current mining tenement are limited and Holcim is looking to extend the mining operations below 5m AHD.

Extracting sand below 5m AHD will intersect the groundwater table therefore a hydraulic suction dredge method is proposed. The total depth of extraction is expected to be approximately -28m AHD below current surface level, with working and rehabilitated profiles of 1V:3H (approx. 18°) above groundwater and 1V:5H (approx. 26°) below, with a beaching bench established at the water level. A plan of the dredge pond is presented in Figure 1.

To assist with this application, Encompass has been engaged by Mr. Rob Elliott of Holcim to undertake a geotechnical assessment of the site (this report) and to develop a management plan which identifies potential geotechnical risks and suitable risk treatment options.

1.1 Scope of works

The scope of work for the geotechnical assessment for project included the following tasks:

- Review existing geotechnical and geological data to collate relevant laboratory testing and geotechnical logging information,
- Construct a geotechnical model,
- Conduct analysis for the dredge pond pit shell,
- Assess stability of sand dune system, and
- Identify potential risks and propose mitigation strategies.

1.2 Information available

The information provided to or obtained by Encompass Mining, which was pertinent to this geotechnical study, comprised the following:

- Relevant formal and memorandum reports,
- Holcim geological, structural and pit design wireframes, and
- Data from historical and recent geotechnical drilling, sampling and testing program.

A full list of the reports and data used for the report can in found in the References. Other information is discussed in later sections of this report.

Figure 1 Salt Ash project overview

2. Proposed Pit Design

2.1 General

It is understood that a suction dredger will be used to excavate the pond to the proposed target depth (-28 m AHD).

Dredging using a suction dredger involves inserting the suction head to a specified depth (typically 3 m to 5 m) below the existing surface. As the material around the suction head is mined it results in oversteepening of the surrounding area, initiating slope instability, resulting in erosive sand-water mixture flows from the upper slopes. This slope failure initiation is often referred to as “breaching” and retreats up-slope with a velocity dependent on the permeability of the sand.

Based on the provided information, excavation of the pond will be undertaken using a staged approach (2022 EIS) from centre of the site and progressively move in a clockwise direction. The proposed dredge pond geometry is as follows:

- Total depth of extraction is expected to be approximately -28 m AHD below current surface level.
- Working and rehabilitated profiles of 1V:3H (approx. 18°) above the groundwater table and 1V:5H (approx. 26°) below the groundwater table.
- A 10 m wide perimeter haul road bench will be established around the dredge pond.

The project will progress in seven stages:

Stage 1 – Dry mining

Similar to existing operations, sand extraction will first involve clearing and grubbing of vegetation and stripping and where feasible, stockpiling of topsoil/organic layer for later reuse in rehabilitation. Topsoil/organics will be stockpiled in a previously disturbed area in the south-eastern portion of the quarry. The sand will be extracted by front-end loader to a nominated depth, followed by an excavator above and below the aquifer within its reach. The excavated sand will then be transferred by front-end loader and/or dump trucks to the existing processing plant for processing. As the groundwater table is encountered, a pond will be created and made large enough to float a dredge.

Stages 2 -7 – Dredge operations

The dredge will start in the centre of the site, immediately south of the processing area of the quarry and progressively extract sand in a staged process. The staging of extraction will proceed from the centre of the site in a clockwise direction. The dredge will move backwards and forwards across the dredge pond, vacuuming (dredging) away the underwater sand resource.

A slurry containing a mixture of sand and water will be pumped from the dredge via a floated pipeline to a processing plant to be established. The dredge will manoeuvre around the pond and will be secured to the pond banks via wires and guide ropes.

At the conclusion of Stage 7, a large pond covering approximately 35.4 hectares (ha) will be retained for post quarry closure and final land use purposes.

2.2 Historical drilling campaigns

Resource drilling has been undertaken across operations through a combination of air core, sonic, wash-bore and cone penetrometer drilling field activities. As part of the 2020 Holcim resource definition project, a geotechnical logging campaign was completed by Geos Mining Mineral Consultants (Geos 2020).

In 2021 Xstract (Xstract 2021) undertook a site investigation for the dredge pond extents. This investigation involved one solid flight auger / wash-bore hole and eight (8) cone penetration tests (CPT) tests. Standard penetration tests (SPT) were undertaken at regular intervals. In 2024 Geosyntec (Geosyntec 2025) also completed additional environmental field studies targeting acid sulphate soil (ASS) criteria.

Figure 2 illustrates presents an overview of the resource, geotechnical and ASS investigation locations across the Salt Ash Sand project area.

Figure 2 Salt Ash Sand Quarry historical drilling

3. Engineering Geology Model

3.1 Geology

The Salt Ash Quarry is located within the Holocene Outer Barrier System. The sands extracted from the barrier system have been exploited for concrete, foundry, rendering, tiles, industrial fillers, grouts and glass manufacture. The sands of the Outer Barrier have been deposited largely by transgressive dunes and are typically well-sorted, rounded to sub-rounded grains.

A mineral resource assessment of the quarry was conducted by Geos Mining Mineral Consultants for Holcim in December 2020. The purpose of Geos' assessment was to evaluate the suitability of the sand deposit for glass and fine concrete aggregate. The Geos investigation identified three (3) sub-horizontal sand units: D1, D2, and D3, which are understood to be based on grain size, grain shape, staining of quartz and other geological features.

2021 drilling conducted by Xstract further expanded the engineering geology model to include a marine clay unit at the base of the D3 unit. More recently, geological work completed by Geosyntec further refined the sand resource model into four (4) units: D1, D1/D2, D2 and D3.

A summary of the characteristics of the different units is as follows:

- **D1 – Sand**: Fine to medium grained, grey. Silty Sand: Fine grained, grey; overlying
- **D1 / D2 – Clay to Sandy Clay**: Low to medium plasticity, dark grey, fine to medium grained sand, shell fragments. **Clayey Sand**: Fine to medium grained, dark grey with clay; overlying
- **D2 – Sand**: Fine to medium grained, grey. **Sand**: Medium grained, grey, trace fine gravel, dark grey; overlying
- **D3 – Silty Sand**: Fine grained, dark grey, trace gravel. **Sand**: Fine to medium grained, grey; overlying
- **CLAY** - Medium to high plasticity, green / grey mottled red / brown.

3.1 Hydrogeology

Regional groundwater flow is primarily horizontal, with some downward flow due to the relatively high recharge rate. Groundwater flow is influenced by topography, the dune system and regional recharge/discharge zones, with water draining either to Tilligerry Creek to the northwest of the site or Stockton Bight to the south-east. Therefore, there is a north-east to southwest orientated groundwater drainage axis along the length of the Stockton sand beds aquifer (Hydrominex, 2022), (ENV Solutions, 2025).

Recent standing water levels measured at the site average 1.3m AHD across the site. It is noted that the groundwater levels are typically highest during the July to September period, with lower evaporation and higher rainfall.

3.2 Hydrology

The majority of the property is 5 to 15 m Australian Height Datum (AHD). The southeastern corner of the site is topographically the highest, with an area of the dune within the property extending between 5 and 33m AHD. Areas of the property extend to 20m in the northeast and northwest of the site, with a topographically lower area in the middle of the site

Low-lying flat areas are located immediately to the north of the site and form the floodplain of Tilligerry Creek. The topographic elevation in this area is typically 0 to 2m AHD.

There is flood potential around Tilligerry Creek in this low-lying area (BMT Floodplain study and plan, 2017), however flood modelling indicates the site is not at risk of flooding except in events of extreme rainfall. Due to the high permeability of the sands, it is possible that flat lying areas of the site could flood in extreme rainfall events, leading to rise in the water table to surface

The quarry is a formed basin and has no direct surface flow connection to adjacent areas, apart from a small area along the northern perimeter of the quarry which drains to a drainage channel adjacent to the northern boundary of the site. The drainage channel runs north alongside the private access road to the quarry where it meets Tilligerry Creek, approximately 510m north of the site. It is likely that this drainage channel was previously constructed as part of a series of irrigation channels for agricultural land uses to the north of the site.

Other than two previously constructed process water ponds, there are no permanent streams or waterbodies in the site indicating that surface runoff is minimal, and infiltration occurs quickly through porous sands contributing to high groundwater recharge.

Some temporary ponding of water is evident in the site, particularly following significant and prolonged rain events. However, it is likely this ponding is associated with naturally low lying interdunal swales where there is interaction with shallow groundwater.

Water levels in the existing process water ponds is approximately 4.8m AHD. The ponds are inferred to not have a strong hydraulic connection to the aquifer below as they predominantly retain their water level when monitored groundwater levels fluctuate.

3.3 Seismicity

The influence of earthquake induced dynamic loading on slope performance has been assessed as part of slope design process for the project. The most recent value for Peak Ground Acceleration (PGA), as published by Geoscience Australia website, has been calculated to be 0.01g for a 10% chance of being exceeded in the next 50 years.

Read and Stacey (2009) also suggest a third to a half of the maximum credible earthquake as an input for analysis. Encompass Mining has used seismic loading of 0.005g as input.

4. Slope Design Considerations

4.1 Design acceptance criteria

The selection of suitable acceptance criteria is a key part of the design and development of stability management practices. The design acceptance criteria (DAC) adopted for this assessment was sourced from NSW Resources Regulator, Health and Safety at Quarries, November 2018 for the extractives industry.

In nominating the design acceptance criteria for the proposed dredge pond and in line with the guidelines set out by NSW Resources Regulator, consideration has also been given to the data uncertainty associated with the respective geological units as well as the risk associated with potential instability.

Table 1 Design acceptance criteria (DAC) – NSW Resources Regulator

CONSEQUENCE OF FAILURE	SLOPE FAILURE EXAMPLE	MINIMUM FACTOR OF SAFETY (FOS)	
		STATIC	PSEUDO-STATIC
Moderate	Minor failures of slopes not affecting Infrastructure / site personnel	1.2	1.0
Serious	Failures undercutting adjacent infrastructure (i.e. offices, fixed plant, haul roads, etc.)	1.5	1.1
Extreme	Failures undercutting public infrastructure / adjoining leases	2.0	1.2

Based on above outlined aspects and in light of the anticipated risk of instability within the confines of the project site, the following design acceptance criteria has been nominated:

- A Factor of Safety (FoS) of 2.0 is proposed for all design considerations (operational, terminal and rehabilitated slopes).
- A Factor of Safety of 1.2 for seismic conditions.

4.2 Potential failure modes

Based on the geological information presented and our understanding of the Stockton Sand Bight region and the dredging process, it is possible to interpret potential failure modes that need to be analysed as part of the slope design process. The scale and mode of anticipated instabilities form a crucial component of the geotechnical domaining process.

The primary instability mechanism identified for the proposed dredge pond is circular failure, which typically occurs in sand materials such as the overburden and/or sand resources. This instability mechanism can also result in stockpiled material. Circular failure is dependent upon the shear strength characteristics of the sand materials, the slope angle of the excavated face and the groundwater conditions within the sand materials.

Circular failure occurring as a potential failure mechanism has been identified primarily for the overburden and resource units at the site. This failure mechanism is not considered to pose any significant risk, providing adequate surface water management measures are coupled with a suitable dredge pond geometry.

Circular failure can also result, particularly where the standing groundwater level interfaces with the exposed sand batters above pond level. Undercutting of the base/foundation could potentially increase the likelihood of circular failure of the overlying batter slope. This instability mechanism can be managed with suitable batter design (including offset from base of slope) and surface water management.

The secondary mechanism of potential instability can occur from erosion of exposed batters, as the initiation of instabilities within exposed sand units are usually governed by buildup of pore water pressures as a result of uncontrolled / excessive surface water ingress. This can lead to a decrease in material strength and eventuate as slumping and / or sloughing of batters.

These potential instabilities can occur due to:

- The presence of highly disturbed material
- Weak planes encountered during excavation of sand resources
- Improper surface water and groundwater management
- Inappropriate construction geometry.

In order to assess the feasibility and likelihood of these failure modes both 3D and 2D limit equilibrium (LEM) stability assessment of the dredge pond design was undertaken.

5. Slope Stability Assessment

5.1 Modelling process

The surfaces provided were imported into Deswik.CAD to develop 3D surfaces of the proposed design for input into Rocscience Slide3 a 3D limit equilibrium slope stability analysis software. Surfaces for Slide3 were expanded to include the proposed pit design and immediate surrounding area, which is the area of focus. A groundwater surface was established at approximately 1.3m AHD.

Analyses were undertaken to assess slope stability in terms of Factor of Safety for overall slope scale selected for any possible interactive slip surface. Slide (Rocscience) was used to undertake stability analyses; Slide2 and Slide3 are 2D/3D limit equilibrium slope stability program used for assessing circular or non-circular failure surfaces in terms of FoS using vertical slice methods. The objective of these analyses was to assess slope stability (in terms of FoS) in terms of rock mass strength and bedding strength considerations, and groundwater conditions for the design.

For 2D LEM modelling, a cuckoo search using the GLE/Morgenstern-Price methodology was utilised for computing the global minimum factor of safety. All search options were applied with failure surface optimisation with convex surfaces only. Similarly, for 3D LEM modelling, an intelligent search using the GLE/Morgenstern-Price methodology was run.

Stability analyses were also carried out on a series of 2D sections through the dredge pond. Several design sections were chosen as necessary for stability analyses within the identified design sectors. The design sections were chosen based on the following factors:

- Deepest portions of the dredge pond
- Specific instability mechanisms

5.2 Modelling parameters

The geotechnical unit material strengths assigned are presented in Table 2. Shear strengths have been interpretated though the combined site investigation drilling and empirical relationships for sands and gravels.

Table 2 Salt Ash Sand Quarry – Material Parameters

GEOTECHNICAL UNIT		UNIT WEIGHT (kN/m3)	FRICTION ANGLE (°)	COHESION (kPa)
Sand (>3.5m to 2m AHD) [D1}		17	36	5
Sandy clay / Clay (2m to 0m AHD) [D1 / D2]		18	30	5
Sand (0 to -12m AHD) [D2]		18	38	0
Sand (-12m to -28m AHD) [D2]		19	38	0
Gravel (-28m to -29m AHD) [D3]		20	40	0
Clay (-29m to -33m AHD)		20	28	200

5.3 Analysis results

In summary, the dredge pond design parameters for the Salt Ash Sand project are robust with Table 3 presenting the modelling results.

The findings from the analysis of the proposed designs are as follows:

- 3D LEM design assessment returned Factors of Safety (FoS) higher than the required design acceptance criteria (DAC) for the proposed dredge pond design.
- All designs meet the required DAC when a seismic loading of 0.005 is applied.
- No further adjustment to the geotechnical slope design recommendations are required to meet DAC.

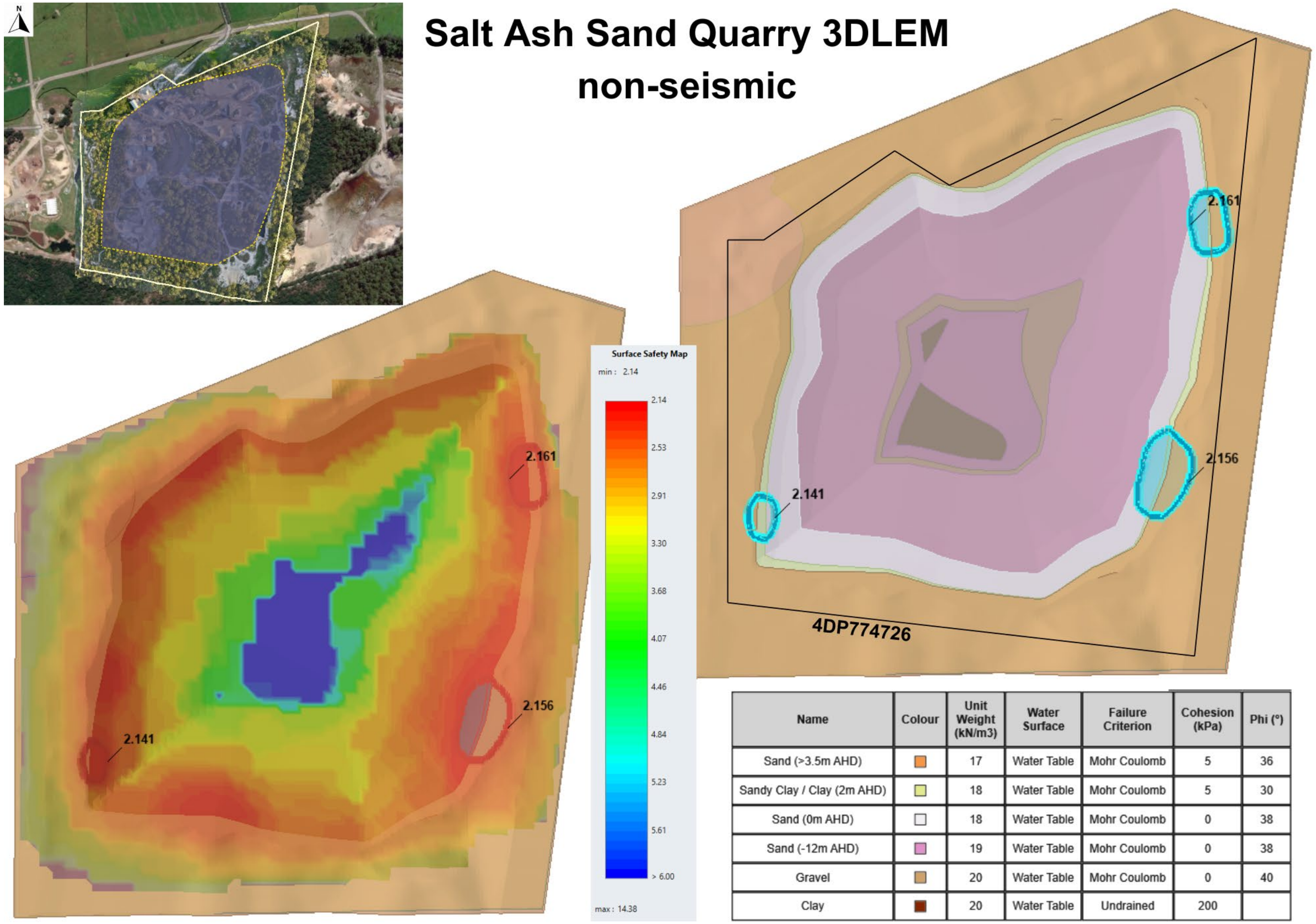
For any dredge operation, the principal geotechnical risk for the pond walls is rotational failures developing whilst personnel or machinery are working near the pond crest. Periodic collapse will occur as the dredge advances and is influenced by the variable sand material, the depth of the dredge pond and the rate of dredging.

During the final or terminal phase, the lowest Factor of Safety (FoS) slope has also been identified as the west facing dredge pond slope with a result of 2.1. The failure mode also indicates an overall circular/slumping type failure from the crest to the bottom of the dredge void which would not propagate further than the boundary marker.

Figure 3 to Figure 5 presents 3D/2DLEM overview for the design assessment, presentations of all slope stability results are also included in Appendix A.

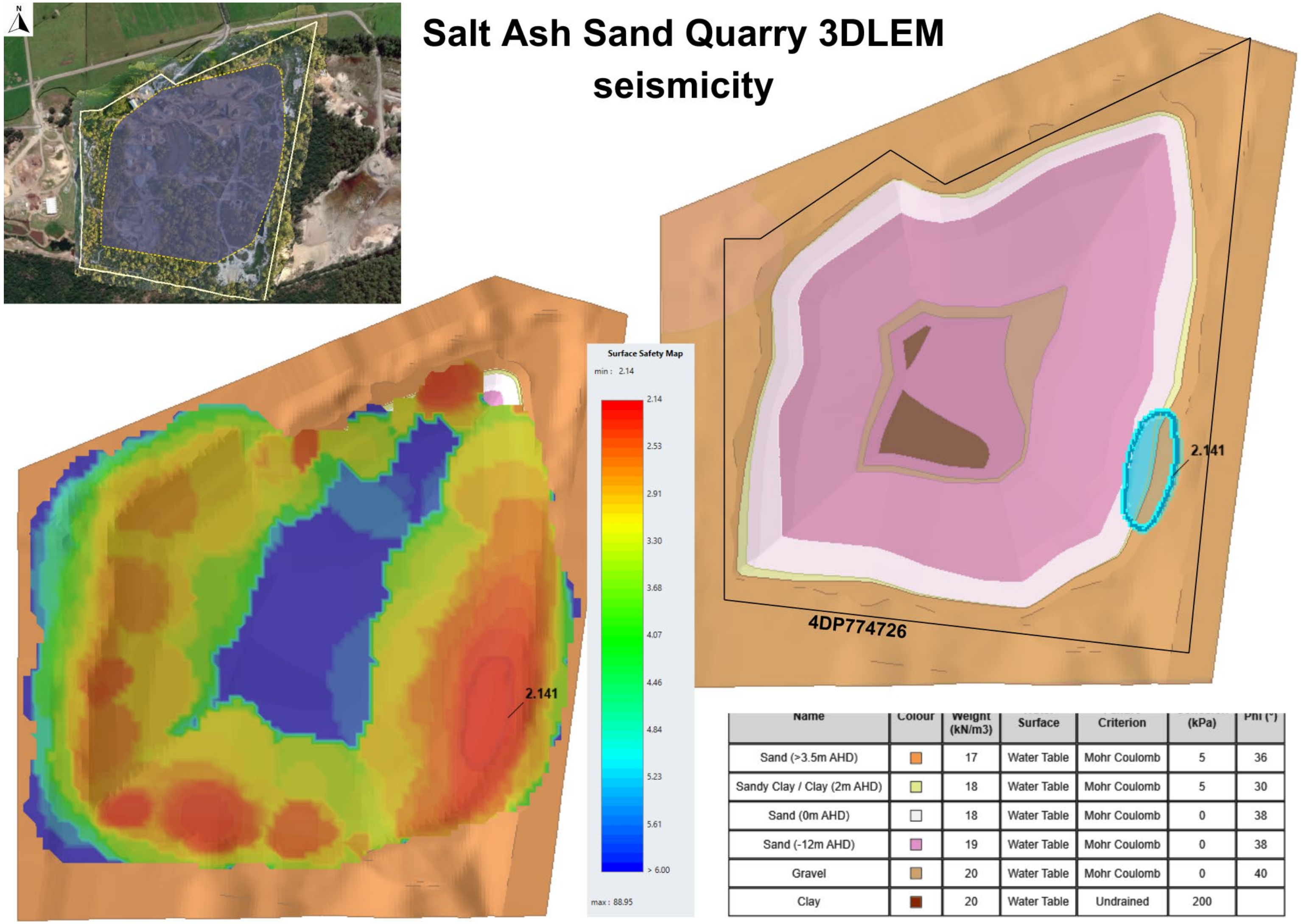
Table 3 Salt Ash Sand Quarry – Factor of Safety (FoS) results

3D FACTOR OF SAFETY		COMMENTS
1.3m AHD GWL	SEISMICITY	
2.1	2.1	2D cross sections FoS results (2.13-2.28)



Name	Colour	Unit Weight (kN/m3)	Water Surface	Failure Criterion	Cohesion (kPa)	Phi (°)
Sand (>3.5m AHD)		17	Water Table	Mohr Coulomb	5	36
Sandy Clay / Clay (2m AHD)		18	Water Table	Mohr Coulomb	5	30
Sand (0m AHD)		18	Water Table	Mohr Coulomb	0	38
Sand (-12m AHD)		19	Water Table	Mohr Coulomb	0	38
Gravel		20	Water Table	Mohr Coulomb	0	40
Clay		20	Water Table	Undrained	200	

Figure 3 Salt Ash Sand Quarry – non-seismic LEM



Name	Colour	Weight (kN/m3)	Surface	Criterion	(kPa)	Phi (°)
Sand (>3.5m AHD)		17	Water Table	Mohr Coulomb	5	36
Sandy Clay / Clay (2m AHD)		18	Water Table	Mohr Coulomb	5	30
Sand (0m AHD)		18	Water Table	Mohr Coulomb	0	38
Sand (-12m AHD)		19	Water Table	Mohr Coulomb	0	38
Gravel		20	Water Table	Mohr Coulomb	0	40
Clay		20	Water Table	Undrained	200	

Figure 4 Salt Ash Sand Quarry -seismic LEM

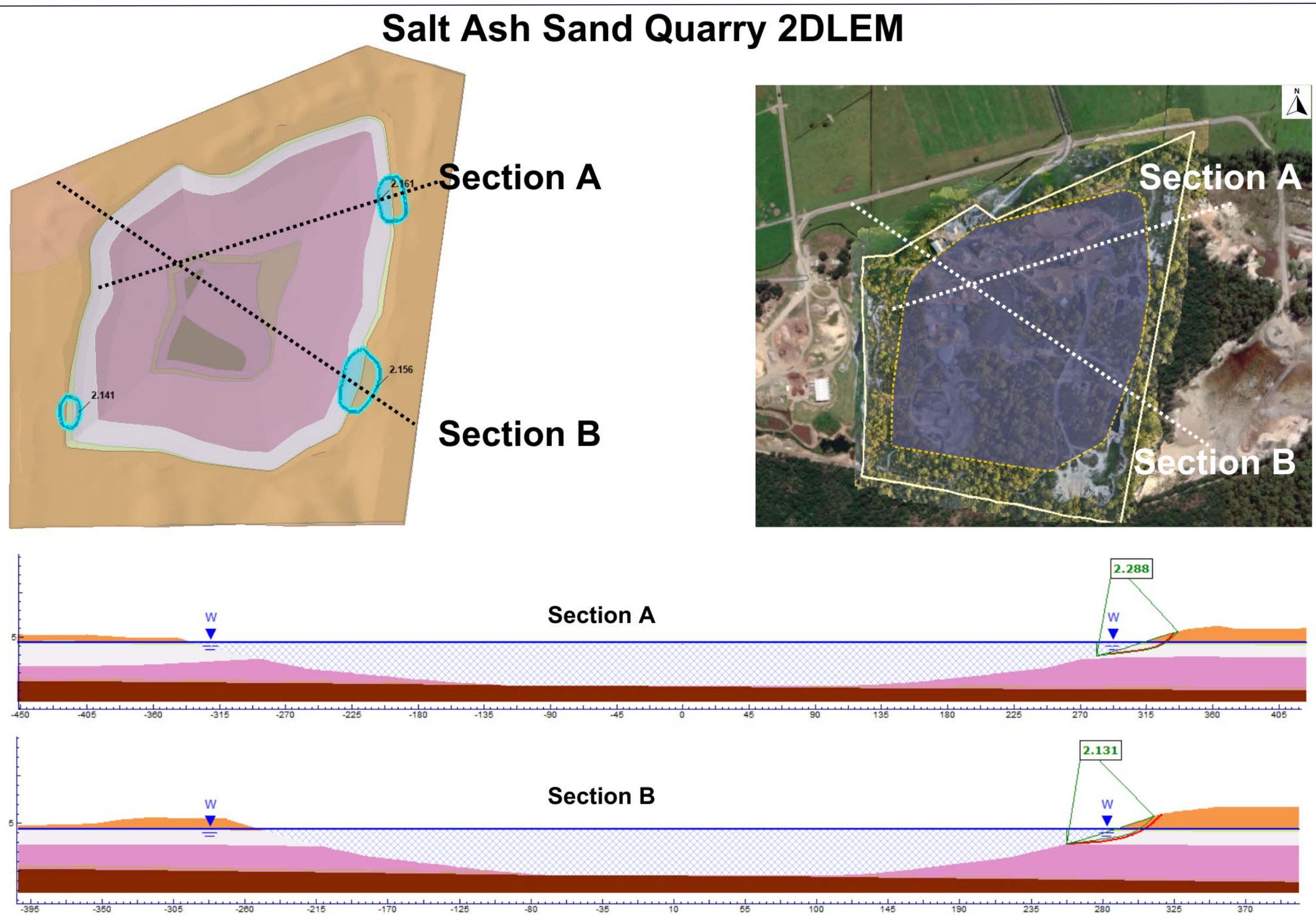


Figure 5 Salt Ash Sand Quarry – 2DLEM

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6. Risk Mitigation / Monitoring Plan

Typical of all geotechnical models for slope design, variability can be expected in the occurrence, distribution and condition of structure, geotechnical units and strengths. The fundamental premise of this design is that the data, interpretations and assumptions made are representative of the conditions.

However, some geotechnical risk exists due to variability and the chance of rogue, unknown features or conditions. The design assessment concludes that the Salt Ash Sand Quarry project designs are geotechnically safe and stable. It is recommended that a monitoring plan, with appropriate triggers, be put in place to assess both design conformance and performance. The purpose of the monitoring is to verify key design assumptions and to detect abnormal slope displacements which may indicate early onset of slope failure. The Salt Ash Sand monitoring plan should be split into multiple phases of installation and comprise of the following three main components:

- **Pore pressure monitoring to verify groundwater pressures;** Groundwater levels should be monitored by both borehole piezometers and visual observations of the standing groundwater levels within the dredge pond. Rain gauges are also an indication of the total rainfall over a selected period of time at a specific location. Rainfall can influence groundwater levels and can cause surface erosion, potentially affecting slope stability.

- **Displacement surface monitoring to identify the potential instability;** The performance of the dredge pond slopes during and after excavation should be monitored to identify any precursors to failure.

- **Ongoing surface visual inspections:** An independent geotechnical consultant should visually assess conditions as part of their six-monthly operational review. Observations should include visual observations for slope cracking, toe heave or displacement that may indicate potential slope movement.

Geotechnical slope monitoring devices have become increasingly accurate and as such are an important tool for locating any potential failures of ground conditions before they become hazardous. Data is used to interpret potential subsurface movements that may be the precursor for instabilities.

Based on general experience with dredge/water storage and process water facilities elsewhere, we are recommending the installation of either time domain reflectometers (TDR) or inclinometers coupled with vibrating wire piezometer (VWP) instrumentation. Both displacement and piezometer instrumentation are a Life of Asset (LOA) monitoring tool used throughout operational and post-closure life to provide history and continual data useable for stability analysis.

A fundamental part of instrumentation installation is also the formulation of trigger action levels for monitoring locations and linking with the other forms of geotechnical review, including the following:

- Regular survey monitoring of the slopes for indications design non-conformance.
- Periodic inspection of the pit slopes during development by an experienced geotechnical engineer.
- Documentation of groundwater inflows.
- Documentation of any slope failures.

7. Geotechnical Risk Assessment

Table 4 presents the geotechnical hazards relating to the proposed dredge pond design

Table 4 Geotechnical hazards – Salt Ash Sand Quarry

HAZARD	DESCRIPTION
Hazard 1 Slumping/erosion of sand batters, slumping of internal stockpiles	Potential for small scale circular instability, as a result of slumping and / or sloughing of the any operating, terminal or remediated sand batter faces and stockpiles, where applicable. Potential causes for slumping include, but are not limited to: • Highly disturbed materials and/or weak planes encountered during excavation of sand resources. • Improper surface and groundwater management during underwater extraction around the batter faces or periphery of stockpiles • Inappropriate construction geometry. • Could occur due to groundwater drawdown in the region surrounding the quarry.
Hazard 2 Deep seated circular instability	Larger scale slope volume movements that are governed by the sand shear strength characteristics. • Movement of this hazard occurs in a circular/rotational manner and is dependent upon the slope geometry, material strength and groundwater conditions. • Consequences of this type of hazard can include partial or full loss of pit crests and impacting working benches. • Could occur due to groundwater drawdown in the region surrounding the quarry. • In extreme cases the failure zone may migrate some distance from the pit crest which may exceed the project authority boundary.
Hazard 3 Slumping of sand batters above beaching zone	Potential for small scale circular instability to occur above the water line (or beaching point). • This mechanism may be exacerbated due to undercutting of the submerged slopes, highly disturbed (very loose) materials, weak planes encountered during excavation of sand resources. • This mechanism may also result due to improper surface and groundwater management during underwater extraction or inappropriate construction geometry.

The Holcim risk management system has been used to rate the geotechnical hazards/ risks according to their likelihood and consequence and is used to classify identified hazards in terms of risk.

Consequence and likelihood are defined in Table 5 and Table 6 . Risk is defined as the product of likelihood and consequence (in safety and/or financial terms):

Risk = Consequence x Likelihood

The risk is assessed in accordance with Table 7 is based on the categories of likelihood and consequence defined below.

Table 5 Consequence Categories & Definition

CONSEQUENCE CATEGORIES	INJURY	ENVIRONMENTAL	ASSET DAMAGE
Minor Category 1	First Aid Injury (FAI) - An injury requiring first aid treatment only	Environmental complaint, minor spill or discharge immediately contained/ cleaned up, minor non-compliance	Cost in the order of $1,000 to return property, plant or other assets to pre-incident condition
Significant Category 2	Medically Treated Injury (MTI) – An injury/ illness that requires treatment by a medical or para-medical professional	Uncontrolled release of dust, discharge or spill locally contained and short-term non-compliance, local media enquiry	Cost in the order of $10,000 to return property, plant or other assets to pre-incident condition
Serious Category 3	Restricted/ Modified Work Injury (RWI) - A person is unable to carry out their normal work activity	Uncontrolled discharge with minor effects on environment, state media coverage, multiple complaints, infringement notice or direction by regulator	Cost in the order of $100,000 to return property, plant or other assets to pre-incident condition
Severe Category 4	Lost Time Injury (LTI) – An injury/ Illness resulting in the worker not being able to return to work the day after the injury occurred	Uncontrolled discharge or event with significant effect on the environment, national media coverage, serious non-compliance, enforcement investigation/ prosecution likely, penalty $10,000-<$100,000	Cost up to $1 million to return property, plant or other assets to pre-incident condition
Disaster Category 5	Injuries or Illnesses that result in a fatality or multiple fatality	Permanent long-term effect on the environment, prosecution, penalty >$100,000, risk of international exposure.	Cost >$1 million to return property, plant or other assets to pre-incident condition

Table 6 Likelihood Categories

LIKELIHOOD CATEGORIES	DEFINITION
A - Certain	Expected to occur in most circumstances (this is the likelihood of the potential consequence occurring as a result of the event)
B - Likely	Will probably occur in most circumstances (this is the likelihood of the potential consequence occurring as a result of the event)
C - Possible	Should occur at some time (this is the likelihood of the potential consequence occurring as a result of the event)
D - Unlikely	Could occur at some time (this is the likelihood of the potential consequence occurring as a result of the event)
E - Rare	May occur in exceptional circumstances (this is the likelihood of the potential consequence occurring as a result of the event)

Table 7 Holcim Risk Matrix

Risk Score Matrix

Holcim
Strength. Performance. Passion.

CONSEQUENCE

LIKELIHOOD / RISK RATING	5 Disaster	4 Severe	3 Serious	2 Significant	1 Minor
A Certain	HIGH	HIGH	HIGH	MED	MED
B Likely	HIGH	HIGH	MED	MED	LOW
C Possible	HIGH	MED	MED	LOW	LOW
D Unlikely	MED	MED	LOW	LOW	LOW
E Rare	MED	LOW	LOW	LOW	LOW

Table 8 Salt Ash Sand Quarry – Risk Assessment

HAZARD	CONSEQUENCE RATING	LIKELIHOOD RATING	RISK RATING	CORRECTIVE / MANAGEMENT ACTIONS CONTROLS	RESIDUAL CONSEQUENCE RATING	RESIDUAL LIKELIHOOD RATING	RESIDUAL RISK RATING
Hazard 1 Slumping/erosion of sand batters, slumping of internal stockpiles	Serious	Possible	MED	• Regular visual observations/monitoring undertaken • Establish exclusion zone(s) for pedestrian i.e., on-site personnel • Avoid quarry activities that would knowingly decrease the stability of batters and stockpiles • Ensure surface water drainage systems are adequately maintained to reduce water ingress into slope material • Pond water levels should be maintained to minimise the potential for instability of submerged batters, as lowering of the pond may result in instabilities occurring in previously submerged batters • Suitable stand-off distances for haul trucks and vehicles will be maintained from the dredge pond crest	Significant	Unlikely	LOW
Hazard 2 Deep seated circular instability	Severe	Unlikely	MED	• Regular visual observations/monitoring undertaken • Ensure surface water drainage systems are adequately maintained to reduce water ingress into slope material • Pond water levels should be maintained to minimise the potential for instability of submerged batters, as lowering of the pond may result in instabilities occurring in previously submerged batters • Groundwater monitoring data will be collected regularly to identify any adverse trends (if any)	Serious	Unlikely	LOW
Hazard 3 Slumping of sand batters above beaching zone	Serious	Possible	MED	• Regular visual observations/monitoring undertaken • Ensure surface water drainage systems are adequately maintained • Where 'soft' ground conditions are encountered at the waterline interface, a geotechnical engineer should inspect the area to ensure stability related risks are minimised • Any plant (fixed or mobile) should be located at a safe standoff distance from the crest of the interface	Significant	Unlikely	LOW

8. Conclusions and Recommendations

Modelling results indicate that the Salt Ash Sand Quarry project is currently stable with assessment results indicating a greater than typical industry standard design acceptance criteria (DAC) for a global or whole slope instability event.

As the dredge moves backwards and forwards across the dredge pond it essentially vacuums (dredges) away the underwater sand resource. The developed dredge pond lake forces then provide a reinforcing effect and suitable 'counterweight' to the submerged batters. Any instability below the waterline would manifest as a surficial shear / slump at the water line interface, it will therefore be important to carefully manage this interface to ensure that it does not inadvertently undercut the 'dry' slopes above.

Where 'soft' ground conditions are encountered at the waterline interface, a suitably qualified person should inspect the area to ensure geotechnical stability related risks are minimised. Any plant (fixed or mobile) should be located at a safe standoff distance from the crest of the interface. A field bearing capacity assessment, using dynamic cone penetrometers should be undertaken within these locations, prior to undertaking any underwater excavation.

Measures should also be undertaken to operate and maintain suitably robust ground conditions at the water line interface, to ensure that the material beneath dry slopes is not undermined. Any proposed extraction stockpiles, pads or fixed / mobile equipment should also be designed to meet these requirements. Exceeding these requirements may lead to circular failure of the underlying sand and subsequently affect the stability of the dry batters above.

Additionally, any stockpiling of the excavated / washed material should be undertaken at a safe standoff distance from the crest of the underwater excavation to ensure it is not adversely affected by the stockpile or from leached water. Ongoing assessments should be undertaken to determine the safe offset requirement for stockpiling operations.

A suitably designed surface drainage system should be implemented and maintained to prevent water from ponding in and around the toe of the dry batter above the waterline. Saturation of the toe of the dry batters may lead to a loss of strength of the site access road and any associated stability risks. Regular inspections and engineering control should be undertaken and implemented to minimise the risk of instability of the site access road, prior to and during excavation.

8.1 State Significant Development (SSD-9099356)

The following section was developed to provide commentary / technical responses to the agency Environmental Impact Statement (EIS) submissions.

8.1.1 NPWS Advice on EIS

EIS submission

- NPWS requests there be an effective buffer between sand extraction activities and the park's boundary to prevent impacts extending into the park. The proposal must not risk any change or impact to Worimi National Park. Obvious risks include erosion and slumping in the highly erodible sandy soils, changes to groundwater, and subsequent associated impacts. It is recommended the EIS confirms the size of a permanent buffer between sand extraction operations and the park's boundary and identify appropriate measures to ensure this buffer is protected from extraction operations.

- NPWS is concerned regarding the vagueness of the final state of the land at the end of Holcim's quarrying operations. The Rehabilitation Strategy Report provides 3 potential final stages of site rehabilitation. It is understood that fully backfilling the pit is dependent on sourcing suitable material, and that seems unlikely. As such, there are concerns regarding the stability of the final landform in what is a combined mobile and forested sand dune system. It is recommended the EIS consider the potential for long-term impacts to the park's ecosystems, including the long-term stability of the forested dunes in the park, if backfilling of the quarry does not occur as proposed.

Comments / response

Limited risk of excessive erosion and slumping impacting Worimi National Park. The dredge pond crest is set-back at considerable distance from the boundary and sand dune system.

The final dredge pond lake design presents a design acceptance criteria (DAC) well in exceedance of geotechnical best practices. The dredge pond has not been backfilled, with the current conceptual post closure landform to left as a waterbody.

Ongoing monitoring and inspections of the site will be linked to the Ground Control Management Plan (GCMP) and Principal Hazard Management Plans (PHMP).

8.1.2 Hunter Water Corp – Advice on EIS

EIS submission

- Inadequate information is provided in the EIS in relation to the long-term geotechnical stability and design requirements for batters up to 30 metres below the groundwater level in the proposed dredge pond, in the likely event that insufficient material is available for the proposed backfilling (i.e. rehabilitation option 1 – open pond). The EIS states that any failure of slopes is expected to occur progressively over a relatively slow timeframe (over several minutes to hours) rather than suddenly although sudden failures of the slope may result, and it is therefore critical that regular monitoring is undertaken throughout construction and operation of the project. It is unclear whether this risk may extend beyond the operating life of the proposed quarry. It is recommended that a much greater level of confidence around this issue is needed for adequate consideration of the proposal prior to its determination.

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- Despite the best of intentions and the implementation of strict management protocols, the introduction of fill materials to a site presents a contamination risk that cannot be eliminated. The use of fill materials to assist batter stability below the water level, where the materials cannot be inspected or feasibly recovered once they are placed, presents an even higher risk. The recommended approach to avoid such risks is to design the activity to be undertaken in a manner that does not require imported fill materials to be used. It would be useful to have more information on why it is necessary to import fill materials to assist with batter stability and an analysis of potentially available fill materials, sources and volumes to assist consideration of the proposal. It would also be useful to understand the design considerations for the proposed dredging activities without importing fill materials to assist batter stability, and associated resource recovery implications (both the reduction in the recoverable resource at the site and the redirection of approved materials from beneficial reuse elsewhere), which has not been considered in the EIS as an alternative approach.

Comments / response

The final dredge pond lake design presents a design acceptance criteria (DAC) well in exceedance of geotechnical best practices. The dredge pond has not been backfilled, with the current conceptual post closure landform to left as a waterbody.

Ongoing monitoring and inspections of the site will be linked to the Ground Control Management Plan (GCMP) and Principal Hazard Management Plans (PHMP).

8.1.3 Worimi Conservation Lands

EIS submission

- In 2015 the statutory Plan of Management (PoM) for the WCL was prepared by the Board and adopted by the Minister for Environment and the Minister for Lands and Water. Section 18.8 of the plan seeks to minimise impacts of mining and mineral exploration activities on the natural and Cultural values through appropriate environmental assessments and all necessary approvals being sought. The PoM also highlights the Board's concerns that the effects of these operations on sand movement and erosion are not adequately understood. These operations on the dune system require investigation and subsequent action required to minimise these impacts. We feel the EIS fails to do this and that the proposal presents a real risk to the WCL which is Aboriginal owned land under the Boards care and control.

Comments / response

Limited risk of excessive erosion and slumping impacting the wider area. The dredge pond crest is set-back at a considerable distance from the boundary and sand dune system.

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References

Geological database (Holcim)

- Drill Collars_Final 20181112

Geological/stratigraphic wireframes (Holcim)

- AU1221868_Salt_Ash_Strat_Model_20240502.omf
- Interpreted Stratigraphy_D1_D2_younger_20240506.dxf
- Interpreted Stratigraphy_D1_younger_groundsurface_20240506.dxf
- Interpreted Stratigraphy_D2_younger_20240506.dxf
- Interpreted Stratigraphy_D3_younger_20240506.dxf
- SaltAsh_LF_GeoModel.lfview

Pit design (Holcim)

- PitOpen.dxf / PitSolid.dxf

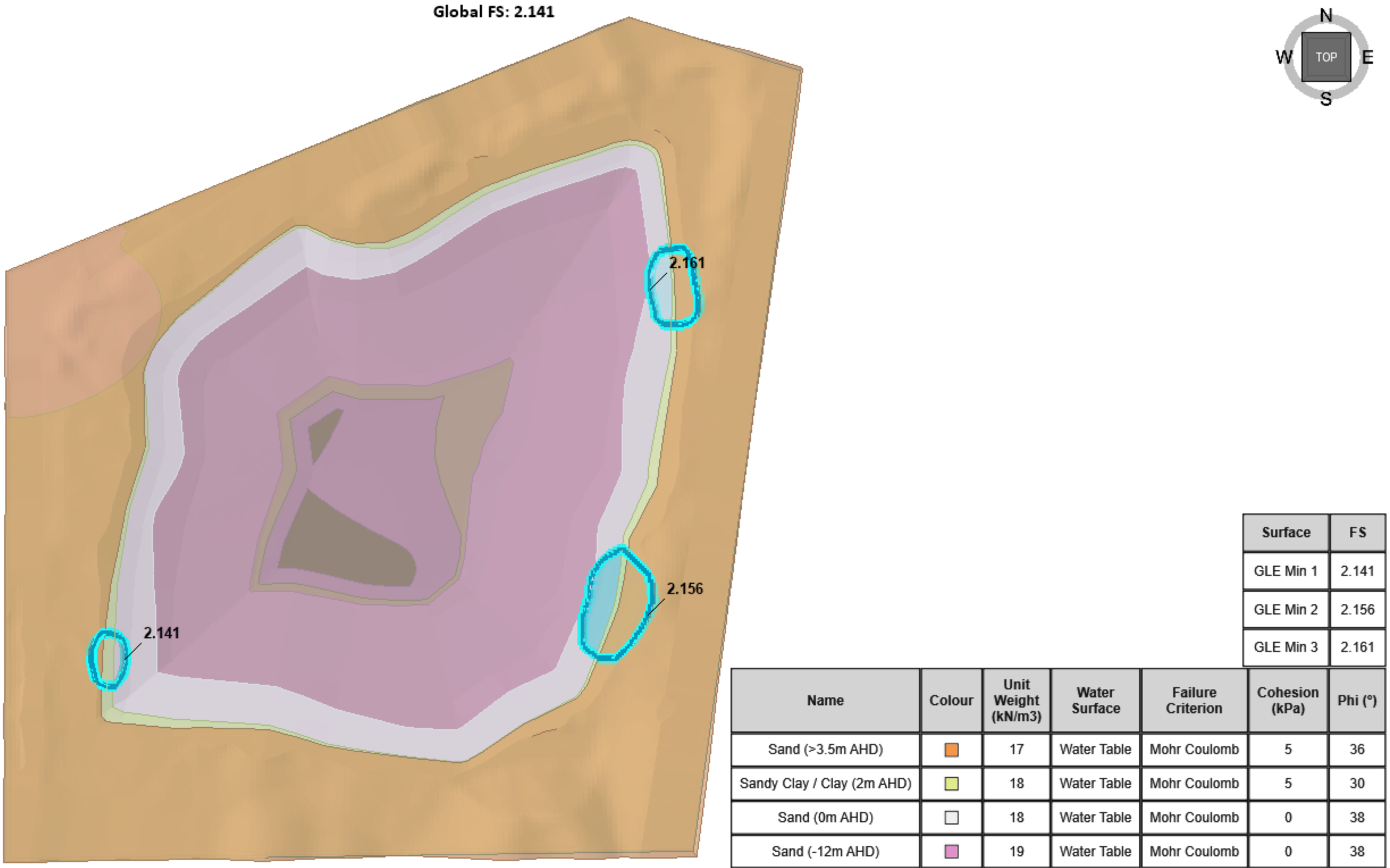
Reports

- 2025: Geosyntec – Acid Sulfate Soils Characterisation Investigation
- 2025: ENV Services – Groundwater Management Plan
- 2022: Hydrominex - Holcim Salt Ash Sand Operations - Groundwater Impact Assessment, NSW
- 2021: Xstract Mining – Geotechnical Report, Salt Ash Quarry XSTP21011-REP-001-REVC
- 2021: Xstract Mining – Geotechnical Report, Salt Ash Quarry XSTP21011-REP-001-REVB
- 2020: Geos Mining Consultants - Mineral Resource Assessment, Salt Ash Operation, Ref: 2791-06
- 2017: BMT WBM - Salt Ash Floodplain Risk management Study and Plan, Final report.

References

- Hawley, M and Cunning, J (Eds), 2017. Guidelines for mine waste dump and stockpile design. 370p. CSIRO Publishing: Collingwood.
- NSW Department of Planning and Environment, NSW Resources Regulator, August 2018, CM9 Reference: PUB18/184
- Read, J and Stacey, P, 2009. Guidelines for Open Pit Slope Design, 496p. CSIRO Publishing: Collingwood.
- Swiss Standard SN 670 010b, Characteristics Coefficients of soils, Association of Swiss Road and Traffic Engineers

APPENDIX A. LEM RESULTS



Surface	FS
GLE Min 1	2.141
GLE Min 2	2.156
GLE Min 3	2.161

Name	Colour	Unit Weight (kN/m3)	Water Surface	Failure Criterion	Cohesion (kPa)	Phi (°)
Sand (>3.5m AHD)		17	Water Table	Mohr Coulomb	5	36
Sandy Clay / Clay (2m AHD)		18	Water Table	Mohr Coulomb	5	30
Sand (0m AHD)		18	Water Table	Mohr Coulomb	0	38
Sand (-12m AHD)		19	Water Table	Mohr Coulomb	0	38
Gravel		20	Water Table	Mohr Coulomb	0	40
Clay		20	Water Table	Undrained	200	

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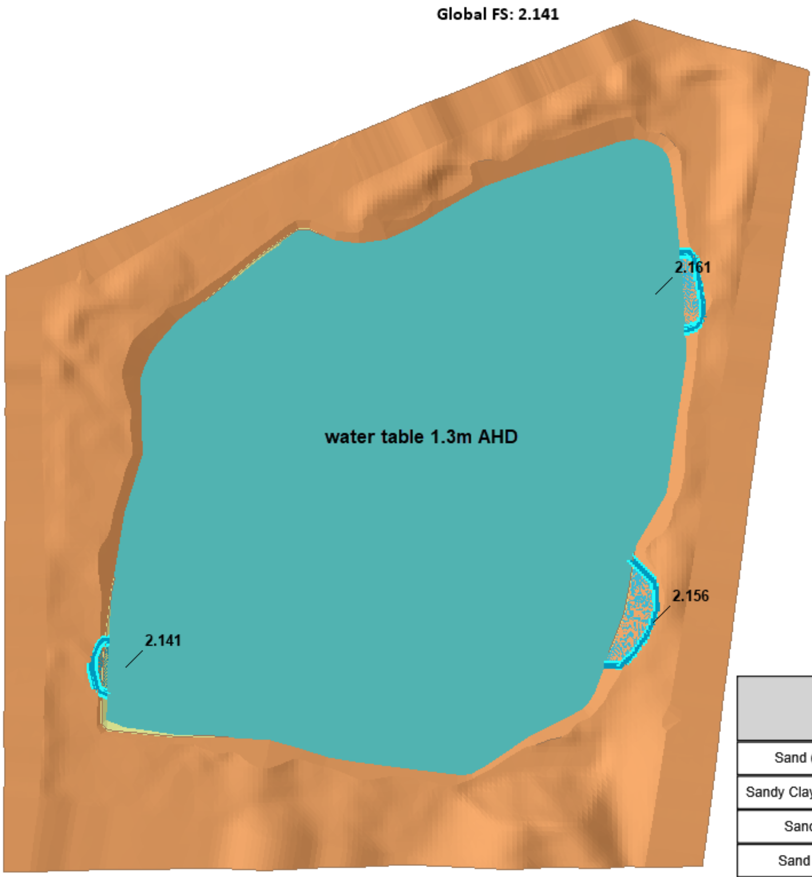

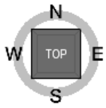

Surface	FS
GLE Min 1	2.141
GLE Min 2	2.156
GLE Min 3	2.161

Name	Colour	Unit Weight (kN/m3)	Water Surface	Failure Criterion	Cohesion (kPa)	Phi (°)
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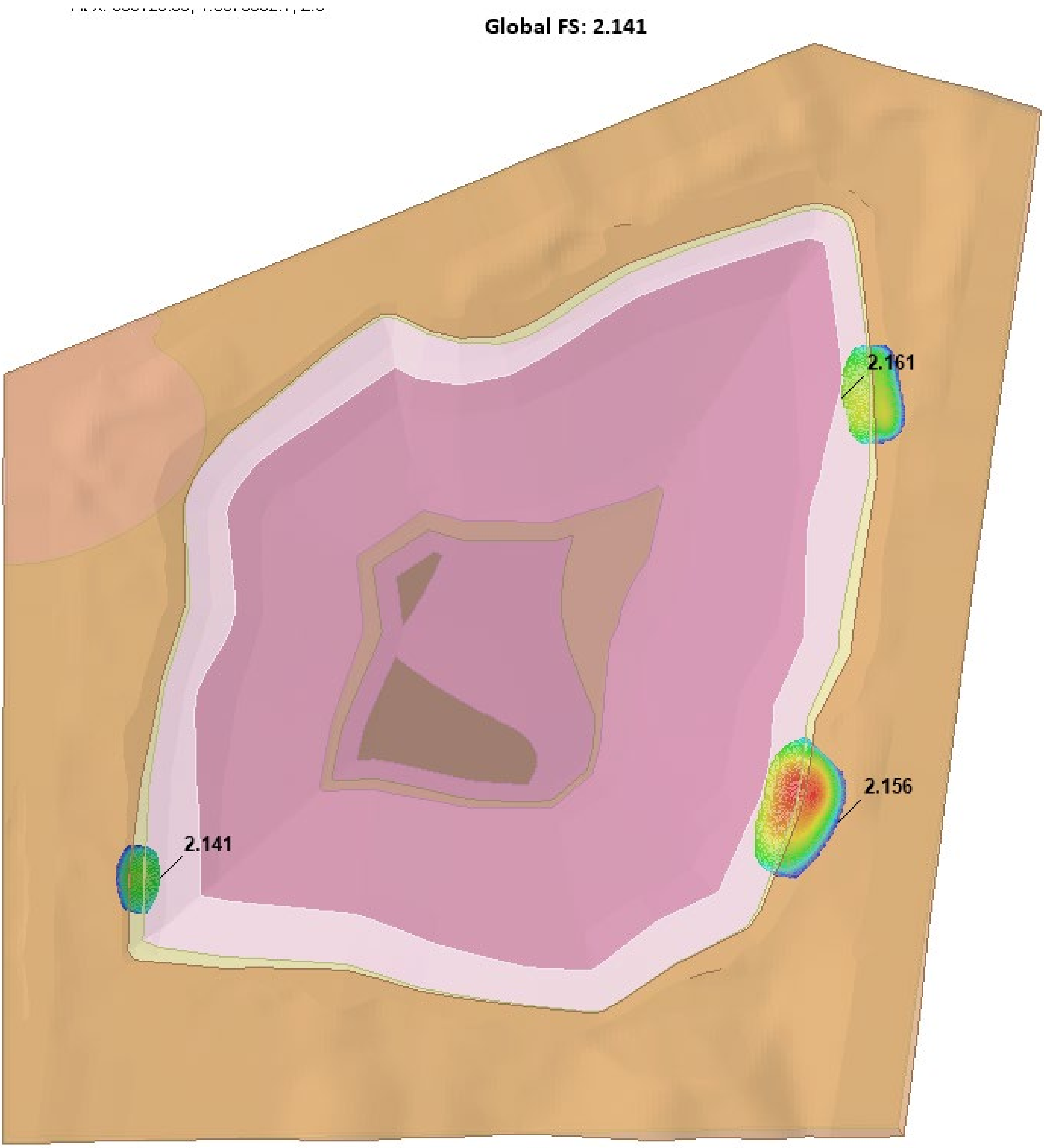
Gravel		20	Water Table	Mohr Coulomb	0	40
Clay		20	Water Table	Undrained	200	



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