APPENDIX C

Environmental Management Framework for Acid Sulfate Soils

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TECHNICAL MEMORANDUM

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ENVIRONMENTAL MANAGEMENT FRAMEWORK FOR ACID SULFATE SOILS

OVERVIEW

This Acid Sulfate Soil (ASS) Environmental Management Framework (EMF) has been prepared as part of the AEIS to provide further information and guidance to how acid sulfate soils present on the site will be managed including associated potential impacts on surface and groundwater quality. It supplements the ASS investigations and impact assessment presented in Chapter B3 of the EIS.

In accordance with the key findings of Chapter B3, the following is a summary of the potential risk of impact from the disturbance of ASS during the earthworks and construction phases of the project.

- Disturbance of actual and potential ASS during excavations for drain construction;
- Potential acidification of groundwater caused by ASS settling beneath the groundwater table during discharge; and
- Potential mobilisation of actual acidity in soils at the surface of the soil profile following placement of saturated fill materials;

The implementation of the strategies and procedures outlined in this EMF will mitigate and manage the potential ASS and groundwater impacts associated with the anticipated construction and earthworks activities.

In addition, this EMF outlines further sampling, testing and monitoring activities that will be undertaken prior to and during construction of the Sunshine Coast Airport (SCA) Expansion Project. Further investigations will be undertaken within the proposed development area in accordance with the sampling and analysis requirements indicated in the Queensland ASS Guide

The SCA Expansion Project development includes the following major earthworks components for the new runway and associated infrastructure (refer Figure 1);

- Bulk filling and construction of a new runway 13/31 and two end taxiway loops;
- Construction of new major drains (northern and western perimeter drains), the connecting minor runway drainage channel and maintenance and upgrade of the existing Southern perimeter drain;
- Extension of Airport Drive (two-lane extension) top service the new Air Traffic Control Tower (ATC), community viewing platform and the Aviation Rescue and Fire Fighting Service (ARFFS) facilities;
- Relocation of an existing water main transecting the proposed expansion area to be realigned within the Sunshine Coast Motorway Corridor; and
- Installation of associated underground services and infrastructure.

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Approximate Earthworks Quantities and Preliminary Liming Rates for Areas Containing ASS

Item of Development	Approx. Area Effected (m^2)	Existing Elevation (m AHD)	Finished Level (m AHD)	Cut (m^3)	Fill (m^3)	Disturbed Below 5 m AHD (m3)	Liming Rate Ranges (kg/m^3)
New Runway Platform	900,000	1 m AHD – 3.95 m AHD	4.65 m AHD	Nil	1.1 M	Nil	N/A
Northern Perimeter Drain	66,000	1 m AHD – 3.95 m AHD	TBC	74,000	Nil	74,000	2 kg/m^3 – 124 kg/m^{3*}
Western Perimeter Drain	26,400	1 m AHD – 3.95 m AHD	TBC	30,000	Nil	30,000	4 kg/m^3 – 124 kg/m^{3*}
Southern Perimeter Drain Maintenance	August 2014	1 m AHD – 3.95 m AHD	TBC	TBC	Nil	TBC	TBC
Runway Drain	2,000	1 m AHD – 3.95 m AHD	TBC	1,500	Nil	1,500	Nil – 9 kg/m^{3*}
Extension of Airport Drive	TBC	TBC	TBC	TBC	Nil	TBC	TBC
Relocation of Existing Water Main	TBC	TBC	TBC	TBC	Nil	TBC	TBC
Installation of underground services	TBC	TBC	TBC	TBC	Nil	TBC	TBC

* - To be revised based on findings from supplementary investigations
TBC – To be confirmed following supplementary investigations

BACKGROUND

Preliminary ASS investigations were undertaken by Golder in 2010 and 2012 to provide an acid sulfate soils (ASS) assessment for the Sunshine Coast Airport (SCA) expansion project as part of Schedule 6, Sunshine Coast Airport – Environmental Impact Statement – Geology, Soils and Groundwater Consultancy.

Twenty eight boreholes were distributed across the expansion site during the 2012 investigation. Thirteen boreholes were located along the proposed perimeter drain alignment at 350 m intervals (ASS 7 to ASS 16, ASS 18 to ASS 20) except between ASS 16 and ASS 18 where access could not be achieved. Boreholes were extended to 1m below the proposed depth of excavation (estimated at 1m), to satisfy the QLD SSP 2/02 guidelines.

Fifteen boreholes (BH1/12, BH3/12 to BH7/12, BH9/12 to BH17/12) drilled for the geotechnical investigation (Golder, 2012a), were sampled for ASS. These boreholes were distributed across the new runway corridor and

the future development area and extended to depths greater than 2m. However, samples for ASS analysis were collected to depth of 2.0 m only. Of these boreholes, 21 were located towards the northern end of the development and six in the southern end of the development. These boreholes supplemented the 12 boreholes completed during the 2010 investigation.

Borehole locations from the current and previous investigations are shown on Figure 1.

Based on stratigraphy encountered at the site and results of screening and quantitative analysis carried out, it is apparent that the Pleistocene age sands and muds on the majority of the site contain low to moderate levels of 'net acidity' (i.e. up to 50 and 50-300 moles H+/t, respectively); acidity is present as actual and potential acidity however the latter appears to be limited to depths of generally greater than 1 m. The acidity levels in the Pleistocene sands appear to be distributed uniformly laterally and vertically across the site.

On the north western end of the runway corridor, the results indicate that the unconsolidated grey clays from 0.5 m depth BGL contain organic matter and modern accretions of sulfides with resulting very high levels of net acidity (i.e. >600 moles H+/t) that is predominantly present as potential acidity. Elsewhere results indicate the indurated sands contain variable levels of net acidity (less than 300 moles H+/t) present as both actual and potential acidity.

The acidity regimes at each borehole sampled for ASS are indicated on Figure 1. The highest actual acidity (represented by TAA) and highest 'net acidity' detected at each location is indicated in moles H+/ tonne. The TAA and 'net acidity' values are similar at many locations as most samples contain negligible potential acidity. Significant levels of potential acidity are limited to locations towards the northern end of the site (i.e. within the Holocene deposits).

Boreholes containing low levels of ASS (net acidity) are surrounded by a green halo, moderate level ASS by a yellow halo, high level ASS by an orange halo and very high level ASS by a red halo. The 'net acidity' values detected in the soil profile are also depicted on boreholes included in sections A-A' and B-B' included on Figures 2(A) and 2(B). The inferred extent, based on the preliminary investigations, of moderate to high level PASS is also shown on Figures 2(A) and 2(B).

Further investigations will be undertaken within the proposed development area in accordance with the sampling and analysis requirements indicated in the Queensland ASS Guidelines to better delineate the extent and severity of ASS across the site and develop and refine management and mitigation measures.

The management framework below outlines the scope, management objectives, actions and performance management information for the management of ASS as well as the following implementation and management procedures:

A - Stockpiling, Handling and Transport of ASS

B - Treatment and Validation of Excavated ASS

C - Monitoring of (Surface) Water Quality

D -Groundwater Quality Monitoring

Acid Sulfate Soil Management	
Issues	Acid Sulfate Soils (ASS) including: ■ Excavation of ASS/Potential ASS (PASS) from any areas of natural soils on the site; ■ Placement of dredged material for the new runway platform and taxi-way loops; ■ Stockpiling, handling and transport of ASS/PASS spoil; ■ On site treatment and validation of ASS/PASS spoil; and ■ Potential adverse impacts to groundwater or surface water quality on site or within the surrounding environment arising from the disturbance of ASS/PASS (if not managed correctly).

Acid Sulfate Soil Management	
Management Objectives	1. To avoid any potentially adverse impacts on the surrounding receiving environment (i.e. Maroochy River, sections of the Mt Coolum National Park and local vulnerable flora and fauna) that may result from the disturbance, treatment and transportation and placement of ASS/PASS material, through the effective management of all works involving ASS at the site. 2. To minimise any potentially adverse impacts resulting from: ▪ Disturbance of ASS/PASS soils via excavation or filling activities; ▪ Treatment and reuse of ASS/PASS spoil from excavations on site; and ▪ The construction and operation of the new drainage system. ▪ Over treatment of lime on disturbed ASS impacting the surrounding naturally acidic environments (i.e. acid frog habitat areas). 3. To comply with conditions of licences, permits or other approvals issued for the project.
Statutory Requirements	▪ The Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999*; ▪ *Queensland Environmental Protection Act*, 1994; ▪ Queensland Environmental Protection (Water) Policy, 2009; ▪ The ANZECC 'Australian and New Zealand Guidelines for Fresh and Marine Water Quality – 2000'; ▪ State Planning Policy – state interest guideline, Water quality, August 2014; ▪ Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines V4.0, 2014; ▪ Queensland (QASSIT) "Guidelines for Sampling and Testing Lowland Acid Sulfate Soils in Queensland – 1998" (and other current supplementary DEHP publications);
Performance Indicators for ASS Related Works	1. Supplementary detailed assessment and characterisation of the ASS conditions of the site in accordance with the sampling and analysis requirements indicated in the Queensland ASS Guidelines to be carried out. 2. Mapping of the extent, severity and distribution of ASS/PASS materials, in addition to the location of naturally acidic soils across the site. This will be refined as data from further ASS investigations becomes available. 3. ASS/PASS materials that have been neutralised by addition of agricultural lime shall have the following parameters determined by CRS test method: ▪ pH (post neutralisation) of 6.5 or greater ▪ Total Actual Acidity (TAA) = 0 ▪ Net Acidity is zero or negative 4. Limit the use of lime (where practicable) near to known naturally acidic environments (e.g. retained acid frog habitat areas). 5. Current groundwater 'baseline' parameters are yet to be established for the site and the surrounding receiving environment. Baseline groundwater parameters shall be established via a monthly groundwater monitoring program of a network of twelve (12) groundwater monitoring wells (5 existing and 7 yet to be installed) conducted over a period of no less than 6 months prior to the commencement of earthworks. It is anticipated that at least one groundwater monitoring well will be located within the boundary of the Mt Coolum National Park, adjacent to the existing Marcoola Drain to establish localised baseline conditions.

Acid Sulfate Soil Management	
	6. Groundwater quality shall not fall outside the established baseline range of values (upper or lower bounds) as outlines below: ▪ pH: 0.3 pH units below the lower bound of baseline range or above pH 8.5 ▪ Total Acidity: +/- 10% of baseline range ▪ Total Alkalinity : +/- 10% of baseline range ▪ Cl:SO_4 Ratio: +/- 10% of baseline range ▪ Dissolved Iron: +/- 10% of baseline range ▪ Dissolved Aluminium: +/- 10% of baseline range ▪ Landscape Aesthetic: no visual sign of vegetation stress or landscape degradation The groundwater quality objectives for the proposed monitoring location within the Mt Coolum National Park (given the high ecological value) would be established to maintain existing water quality (at 20th, 50th and 80th percentiles) and would further include: total dissolved solids (TDS), conductivity (EC), total anions and total cations. 7. The pH of all site run-off and groundwater seepage pumped from treatment areas and from excavations during construction, shall be monitored and if necessary treated on-site to achieve a pH of between 6.5 pH and 8.5 pH before release on-site or discharge off-site. 8. The pH of water contained in temporary sediment ponds/basins shall be monitored and treated if necessary to achieve pH levels of between pH 6.5 and pH 8.5 during operation. 9. Water Quality Objectives for receiving surface waters are established in the EPP Water 2009, Schedule 1 for the Maroochy River and tributaries for the following parameters: ▪ pH ▪ EC ▪ Turbidity ▪ Dissolved Oxygen ▪ Total Acidity ▪ Total Alkalinity ▪ Cl:SO_4 Ratio ▪ Total Iron ▪ Total Aluminium Water Quality Objectives not listed for the above parameters in the EPP Water 2009, will be established via a monthly monitoring program conducted over a period of no less than 6 months prior to the commencement of earthworks.
Proposed Earthworks and Construction Activities	Construction of elements of infrastructure involving the disturbance or treatment of ASS will occur in the following approximate sequence with some activities occurring concurrently (refer Figure 3), as follows. The following works are to be undertaken in accordance with the Implementation and Management Procedures outlined in this

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Acid Sulfate Soil Management	
	management framework to address the excavation, stockpiling, handling, treatment and validation of ASS and their associated by-products and potential environmental impacts. <u>Staging of Earthworks Involving ASS</u> 1. The excavation of the northern and western perimeter drains should result in the disturbance of approximately 104,000 m^3 of ASS/PASS material with 'net acidity' levels of up to 899 moles of acid / tonne requiring lime neutralisation treatment at liming rates ranging from 2 kg/m^3 to 124 kg/m^3 based on current investigation results. 2. Further investigations along the northern and western drainage alignments will need to be undertaken in line with the sampling and analysis requirements indicated in the Queensland ASS Guidelines to better delineate the extent and severity of ASS within the drainage alignment and develop and refine management and mitigation measures. 3. Potential groundwater drawdown from the northern perimeter drain (NPD) was identified as a potential concern due to the shallow groundwater levels across the site. Subsequently the drain design includes a low permeability cut-off wall on the northern side of the northern perimeter drain to minimise groundwater flow into the drain (refer Figure 4). 4. During construction of the NPD monitoring of the water table drawdown will be conducted utilising groundwater monitoring wells so that the effectiveness of the low permeability cut-off wall can be monitored and the extent of any groundwater draw down can be made. 5. Groundwater levels and quality will be monitored weekly during construction of the NPD and the zone of drawdown influence plotted where evident. In this way the volume of soil influenced by drawdown and hence potentially contributing to generation of additional acid can be calculated, though this should be limited with the inclusion of the low permeability cut-off wall to the drain design. 6. An ASS treatment area is to be prepared within a central area of the site to service the proposed northern and western perimeter drainage channels. The ASS treatment facility is to be located within the confines of the proposed perimeter drains to mitigate against the potential impact of neutral/alkaline leachate waters on the surrounding naturally acidic environment (refer Figure 3 for indicative location). The ASS treatment area (ASS Treatment Area 1) will be contained within a bunded area designed to retain a 100 year ARI 24 hour rainfall event, constructed from 'clean' fill material. The area is to be cleared and a lime guard layer applied at a rate of 15 kg/m^2 (which equates to 0.2 * 0.25%S * safety factor of 2). The lime is to be worked into the surface and compacted. The treatment area will be divided into 5 or 6 cells, each able to hold up to approximately one days excavation spoil from the northern and western perimeter drains. 7. At the commencement of earthworks for the new runway platform area, initial clearing of the site will be carried out, followed by the construction of a perimeter fence and access road. ▪ It has been assumed that the perimeter access road will be constructed from lime treated PASS spoil won from the northern and western perimeter drain excavation, supplemented by imported 'clean' gravel fill material where required; ▪ All limed treated spoil material will be verified prior to release from the treatment area and placement to form the bund; ▪ A lime 'guard layer' will be applied beneath the perimeter bund at a nominal rate of 10kg/m^2, for the width of the access road. ▪ The inside of the settlement pond perimeter bunds are assumed to be lined.

Acid Sulfate Soil Management	
	8. Following construction of the perimeter access road, vegetation is to be cleared off site or cut and stockpiled for mulching. The surface soils over much of the site contain low levels of actual ASS (up to 89 moles of acid/tonne, based on current investigation results) and will generally not be disturbed prior to placing fill. However, if for any reason, surface soils are disturbed, they will need to receive lime neutralisation treatment (e.g. application of a lime guard layer). 9. Final design and dimensions of the filling platform and the settlement pond are yet to be confirmed though are understood to sufficiently contain approximately 1.1 M m^3 of dredged sand fill material. While the tail water retention volume is in the order of 100,000 to 150,000 m^3 in the tailwater pond. 10. All fill for the project, including surcharge, will be delivered to the site in a single campaign. Placement of the sand fill by pumping from the dredge will begin in stages, and will be hydraulically placed within the fill area with the general filling sequence being from east to west, which is the general direction of the slope of the existing ground. Characterisation of the sand fill material is covered within the Dredge Management Plan and is not included in this ASS environmental management framework, noting as clean Holocene sand from Moreton Bay this material has little to no ASS potential. 11. The north-western portion of the runway platform is underlain by very soft to soft alluvial clay. To address the soft ground conditions within this location surcharge will be placed above the fill design level. The height of the surcharge above the final design level will be approximately 1 m for a period of 12 months. 12. Further assessment of the ASS conditions within the proposed runway platform and surrounding area will be required to be undertaken in line with the sampling and analysis requirements indicated in the Queensland ASS Guidelines to better delineate the extent and severity of ASS within the area and develop and refine management and mitigation measures. 13. The supplementary assessment will further allow for better delineation of the very soft to soft alluvial clays within the north-western portion of the runway platform. These soft sediments have the potential to “heave” under the sand fill placement allowing for the exposure of PASS materials and/or push actual acid sulfate soil back below the groundwater table allowing for the possible mobilisation of acidity. 14. Minor drainage for the runway and taxiways are to be constructed to direct stormwater into the Southern Perimeter Drain. The drains will have concrete lined inverts and be piped beneath the taxiways. Any natural material excavated during the construction of the runway drain and associated infrastructure will be transported to the ASS treatment area to undergo lime neutralisation treatment. 15. Maintenance works to the existing Southern Perimeter Drain is to be conducted and is understood to comprise clearing and reshaping of the existing drainage channel. All material excavated during the maintenance works of the Southern Perimeter Drain is to be transported to the ASS treatment facility and undergo validation sampling at a rate of 1 sample per 250 m^3 to determine if lime neutralisation treatment is required as in accordance with the procedures outlined in Implementation Procedure B. 16. A two-lane extension of Airport Drive is to be constructed to service the new Air Traffic Control Tower and Aviation Rescue and Fire Fighting Service. Earthworks for the proposed extension are anticipated to consist of shallow minor grading activities. The surface soils over much of the site contain low levels of actual ASS (up to 89 moles of acid/tonne, based on current investigation results) and as suchlime neutralisation treatment (e.g. application of a lime guard layer and treatment of excavated material) would be required.

Acid Sulfate Soil Management	
	17. The relocation of a Unity Water, water main is required to divert an existing main from within the proposed runway platform to a location within the Sunshine Motorway corridor. As this water main is a critical asset for Unity Water these works are to be undertaken as part of their network upgrade and is therefore outside the scope of this management framework. 18. Installation of underground services for water, sewer, power and communications is required to be undertaken. The new services will run from the existing terminal continue north within the road reserve, then run west (within the proposed service corridor) along the road reserve to supply the ATC/ARFFS facility. Earthworks activities for the installation of these services will intercept known ASS/PASS materials and lime neutralisation treatment and management will be required. 19. Further investigations within the proposed underground service corridor area will need to be undertaken in line with the sampling and analysis requirements indicated in the Queensland ASS Guidelines to delineate the extent and severity of ASS within the proposed service corridor and develop and refine management and mitigation measures.

Implementation and Management Procedures	
Implementation and Management Procedure A - Stockpiling, Handling and Transport of ASS	**<u>Stockpiling, Handling and Transport of ASS</u>** **A1. General** The procedures outlined below are provided for the management of the stockpiling, handling and transport of ASS (including both ASS, PASS and Acidic soils). It is proposed to transport excavated ASS materials to the ASS treatment area located on the project site as soon as practicable. The project Site Supervisor or their delegated representative will be responsible for the day to day operations and management of the treatment area and for ensuring that the excavated ASS is remediated and verified in accordance with the ASSMP and associated procedures. **A2. Objectives** ■ Appropriately manage the stockpiling, handling and transport of confirmed and suspected ASS materials ■ Comply with conditions of licences, permits or other approvals issued for the project. **A3. Management Measures – Excavations and Trenching** As a general practice in excavation and trenching operations, stockpiles of excavated material should be left exposed for the minimum practical time before being treated and/or replaced beneath the permanent groundwater table before oxidation can occur. The Queensland Soil Management Guidelines recommend reburial below the permanent water table within 18 hours (overnight). This can be effectively managed by staging excavation operations into short sections of work that are kept open for limited time periods (i.e. overnight or <18 hours). A guard layer of lime will be placed within sections of the proposed drains to intercept and neutralise any acidity mobilised from normally unsaturated actual ASS that settles beneath the water table. Liming rates will be established once further assessment has been completed. The lime neutralisation rates will also take into account the acid tolerant nature of some species in the immediate receiving environment. During earthworks any trenches left exposed at the end of shift must have a lime guard layer applied to prevent the oxidation of any pyritic sediment and mitigation of leachate. Specific rates for lime guard layers for different soil types and ASS regimes will be formulated following results of supplementary investigations in line with the sampling and analysis requirements indicated in the Queensland ASS Guidelines. For minor trenching excavations the following backfilling techniques will be adopted; ■ A guard layer shall be applied adjacent to and on the up-side gradient of the proposed trench excavation works prior to placement of excavated materials. ■ Excavated materials will be stockpiled for the shortest possible time prior to lime treatment and backfilling to limit exposure. Lime shall be applied to the base of the excavation prior to further works and backfilling with limed materials. ■ Excavated material shall be limed at the nominated rate during backfilling to achieve mixing. The highest liming rate as determined by laboratory analysis within location shall be adopted for backfilling of representative materials for a 50 m length. ■ Excess material that cannot be backfilled into the trench to below ground level shall be transported to the designated bunded stockpile/treatment area for lime treatment. ■ Where practicable, stockpiling and liming should not be conducted in areas directly adjacent to watercourses or drainage channels.

- As the surrounding environment is naturally acidic, measures should be undertaken to prevent over liming of ASS material and the potential release of neutral/alkaline leachate (e.g. establishing temporary bunds during in-situ neutralisation treatment)

Any excavated material retrieved from excavations extending below the depth of investigation and from a new soil horizon must be sampled and analysed at a rate of 1 test per 250m^3 (minimum 2 tests) for the verification and formulation of lime neutralisation rates (if required).

All waters collected from groundwater and surface water inflow into excavations via seepage and runoff must be retained, monitored and appropriately treated in accordance with Implementation Procedure C to comply with the appropriate discharge criteria prior to discharge off site or re-use on site.

Groundwater inflow from the area north of the NPD has been identified as a potential issue during construction of the NPD and as such, a low permeability cut-off wall has been incorporated into the drain design to mitigate the possible impacts of lowered groundwater levels and the potential oxidation of surrounding sediments.

The management and mitigation measures for excavation and trenching activities as outlined in these procedures will be revised and refined following further ASS investigations in accordance with the sampling and analysis requirements indicated in the Queensland ASS Guidelines and finalisation of the perimeter drain design and construction methodologies.

A4. Management Measures – Stockpiling, Handling and Transport of ASS

Wherever practical the earthworks handling should involve transport directly from cut to treatment/fill areas and stockpiling of untreated soils with existing or potential acidity should be avoided. The recommended maximum time period for which soils can be temporarily stockpiled without treatment is 18 hours (overnight) for coarse sandy material and 3 days, (e.g. a weekend, 66 hours) for fine textured silty clay material.

All confirmed and suspected ASS materials encountered during excavations will be transported by truck to the designated ASS treatment facility. Accurate details of material movements must be kept by the Site Supervisor or their delegated representative with respect to volumes, origin, material type and destination. Materials shall be transported in suitable trucks to prevent spillage of soil and leakage of water.

Due care is to be taken when transporting saturated /supersaturated soils and sediments (e.g. wet, silty/sandy material). Where practicable filling of trucks with wet materials shall be modified to avoid spillage, use of covers and lined trucks should be considered.

The Site Supervisor will be responsible for maintaining the site and the transport route free of spilled and sloughed ASS sediments. All such spilled sediments are to be regularly (daily) collected and transported to the designated treatment area for neutralisation.

Any ASS materials that cannot be transported in the time frame detailed above must be stockpiled on site on a suitably prepared storage area and the following additional management measures should be followed:

- Stockpiles are to be contained by bunds with stormwater runoff directed to a collection sump. Bunds are to be constructed from low permeability materials that are not ASS.
- A guard layer of neutralising agent should be spread across the soil surface prior to placement of the stockpile. The rate of neutralising agent applied should be based on 0.3 times the average total potential plus existing acidity for every 1 m height of soil in the stockpile.

	■ The surface area of the stockpile is to be minimised by shaping and possibly capping or covering to prevent moisture loss and rainfall entry. **A5. Responsibilities** During stockpiling, handling and transport the following levels of responsibility shall exist: ■ The Site Supervisor or delegate is responsible for ensuring that the requirements of the ASSMP are communicated to site staff. ■ The Site Supervisor or delegate is responsible for ensuring the management strategies and procedures prescribed in the ASSMP are implemented at the site. ■ All other site personnel are responsible for implementing and undertaking the management strategies and procedures prescribed in the ASSMP, as applicable to their work activities. **A6. Monitoring and Reporting** Records shall be kept by the Site Supervisor or delegate to track soil movements around the site including diagrams, photographs, volumes and soil descriptions for stockpiles in temporary storage areas as well as final placement sites. Inspect the condition of stockpile batters, drains, open trenches and structure excavations. The Site Supervisor or delegate shall also maintain records to verify volumes of soils excavated and transported for treatment at the designated ASS treatment facility in conjunction with records of lime dosing and quantities of lime brought onsite. Should an additional or temporary ASS treatment facility be constructed, records regarding the construction, including photos should be maintained by the Site Supervisor or their delegated representative. In addition, specific details regarding volumes, origin, material type and destination should also be maintained by the Site Supervisor or delegate. Lime neutralisation rates and methodologies should also take into account the acid tolerant nature of some species in the immediate receiving environment. The Site Supervisor or delegate shall be responsible for ensuring that the ASS materials are managed in accordance with details provided above.

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Implementation and Management Procedures	
Implementation and Management Procedure B - Treatment and Validation of Excavated ASS	**<u>Treatment and Validation of Excavated ASS</u>** **B1. General** The procedures outlined below are provided for the on-site treatment and validation of acid sulfate soil (ASS) materials. **B2. Objectives** ■ Appropriately treat and manage ASS materials so as to minimise adverse effects on the natural and built environment (including infrastructure). ■ Comply with conditions of licences, permits or other approvals issued for the project. **B3. Implementation Measures** *B3 (A) Earthworks Strategy* An earthworks strategy shall be developed to plan and track movement, treatment and verification of ASS materials. *B3(B) ASS Treatment Facility* A treatment facility shall be constructed in general accordance with the requirements detailed in Soil Management Guidelines, 2014 and in conjunction with the following additional requirements: ■ The treatment area shall be prepared by stripping vegetation, topsoil and soil containing significant amounts of organic material and compacting the surface with a smooth drum roller. If sandy materials are exposed in the stripped surface, a layer of low permeability material shall be placed over the stripped surface. An area of at least 2m width shall be left between the treatment areas and bunds to allow collection of runoff and direction to sumps. Refer to surface water quality monitoring section for monitoring and treatment requirements applicable for collected waters. ■ The treatment area should be located within a central area of the site within the proposed northern and western perimeter drainage channels to avoid any potential adverse impacts from treated or untreated ASS leaching to the surrounding receiving environment. ■ Treatment pads shall to be contained within a bunded area. Bund walls shall be constructed with clean material (i.e. not ASS or acidic soils). The bunded area shall be designed to retain a 100 year ARI 24 hour rainfall event. ■ The treatment area will be divided into 5 or 6 cells, each able to hold up to approximately one days excavation spoil from the northern and western perimeter drains. ■ A guard layer of fine ground agricultural lime shall be applied to the treatment areas prior to placement of soils at a rate yet to be formulated based on data to be received from further investigations. The treatment facility and bund walls shall be inspected on a daily basis and maintained to prevent escape of soils or water from the facility.

B3 (C) ASS Treatment

Lime neutralisation treatment is to be undertaken in accordance with the following:

- ASS materials shall be placed into identified treatment lots (equivalent of one days excavation spoil) at the treatment facility where the material shall be spread in layers and allowed to dry (if required).
- Spread excavated soil in layers with a maximum thickness of approx. 300 mm.
- Mechanically turn the soil to promote thorough mixing through the full depth of the layer.
- Maintain soil moisture through; (i) controlled irrigation, (ii) covering with plastic to reduce evaporation of (iii) application of lime soon after excavation of moist soils. These measures will improve the dispersion of lime throughout the soil profile.
- Add lime at the required calculated treatment rate and thoroughly mix lime using appropriate mechanical means e.g. a disk plough or harrows.

Lime guard layers should be applied to the exposed surfaces during trenching activities as follows;

- Excavate proposed trenches to design, removing all material to treatment pads.
- Spread a lime guard layer over the base, batter and 5 m edge of excavation at a rate yet to be formulated (minimum rate of 5 kg/m^2).
- Mix the lime guard layer to a depth of 200 mm.
- The lime guard layer rates will also take into account the acid tolerant nature of some species in the immediate receiving environment.

B3 (D) Preliminary Liming Rates

Based on the results obtained to date, preliminary liming rates have been calculated in kg CaCO3/t and kg CaCO3/m^3 using a factor of safety (fineness factor) of 1.5 and an assumed bulk density of 1.8 tonne/m^3 for sands and 1.5 tonne/m^3 for clays. A summary of preliminary liming rates are presented in the Table B3-1 below.

Given that earthworks and construction activities will disturb known ASS and PASS materials through excavations (i.e. surface scraping and grading, services and drains) and fill placement , preliminary liming rates varying from 6 kg /m^3 to 124 kg /m^3 and will apply depending on the soil material excavated and further sampling in accordance with the guidelines.

Table B3-1, Liming Rates

Soil Type	**Preliminary Treatment Rate**
Surficial Sands	Up to 76 kg $CaCO_3$/m^3 (Average is 7 kg/m^3)
Indurated Sand “Coffee Rock”	Up to 25 kg CaCO3/m^3 (Average is 9 kg/m^3)
Silty Clays to 1 m depth Encountered at BH10, BH11, BH 11/12, BH7/12, BH6/12, ASS 7, ASS 8, ASS 9, ASS 10 (Generally of soft to firm consistency and grey in colour)	Up to 92 kg CaCO3/m^3 (Average is 17 kg/m^3)

Silty Clays below 1 m depth Encountered at BH10, BH11, ASS 10, ASS 15, BH5/12, BH7/12 (Generally of soft to firm consistency and grey in colour)	Up to 124 kg $CaCO_3/m^3$ (Average is 44 kg/m^3)

These liming rates would be refined following results of further ASS investigations undertaken in accordance with the sampling and analysis requirements indicated in the Queensland ASS Guidelines. Specific liming rates would be formulated for the effective management of ASS during the various proposed development activities providing more certainty in the liming rates and avoiding potential over treatment.

B3 (E) Specific Liming Rates

To evaluate and determine specific lime neutralisation rates, collected samples shall be analysed for the Chromium Suite of tests - pHKCl, Chromium Reducible Sulfur (SCR), Total Actual Acidity (TAA) and Retained Acidity (SNAS, if pHKCl is below 4.5) and Acid Neutralising Capcity (ANC, if pHKCl is above 6.5). The liming rate required to neutralise the Net Acidity (Existing Acidity + Potential Acidity) shall be calculated by:

- Multiplying Net Acidity by a safety factor of 1.5 to allow for mixing deficiencies and poor reactivity of the lime;
- Multiplying the above result by the bulk density of the soil to arrive at the liming rate (kg/m3).
- Multiplying the above result by 1.03 (to account for an agricultural lime neutralising value of 97%).
- Calculating surface application rate (kg/m2) by multiplying the above result by the thickness of soil being treated.

B3 (F) Validation Testing

Validation samples shall be collected for each treated lot (1 per 250 m^3). The samples shall be formed by compositing materials from three randomly selected locations across the allotment. Samples shall be collected over the full thickness of the treated lot. The Chromium Suite shall be conducted on each sample to confirm net acidity by Acid Base Accounting.

B4. Performance Criteria

Both of the following conditions must be achieved to confirm neutralisation of Net Acidity in treated ASS materials:

- Potential Acidity + Existing Acidity - Acid Neutralisation Capacity ≤ 0
- pH ≥ 6.5

B5. Contingency Measures

Additional lime treatment and further validation testing shall be conducted where adequate neutralisation is not initially indicated.

B6. Monitoring and Reporting

Records shall be kept to verify volumes of soils transported to the treatment facility.

The Site Supervisor or delegate shall conduct an inspection of the transport route between the excavation sites and treatment facility on a daily basis.

The Site Supervisor or delegate shall maintain records tracking soil movements around the site including diagrams, photographs, volumes and soil descriptions for stockpiles in temporary storage areas as well as final fill placements.

	The Site Supervisor or delegate shall maintain records to verify volumes of lime used in ASS treatment and balanced against quantities of lime brought onsite. The Site Supervisor or delegate shall be responsible for ensuring verification tests are completed for each 250 m^3. The Site Supervisor or delegate shall conduct an inspection of the treatment areas including bunds and sumps on a weekly basis. The Site Supervisor or delegate shall maintain a register of testing results and a record of inspections. A summary report of all test results and inspections shall be complied by the Site Supervisor or delegate each week and submitted to the Environmental Manager.

Implementation and Management Procedures	
Implementation and Management Procedure C - Monitoring of Surface Water Quality	**Monitoring of Surface Water Quality** **C1. General** The procedures outlined below are provided to monitor and manage water quality in open excavations, sumps/check dams and run-off collection in treatment areas, in addition to the monitoring and management of dredge tailwater. Contingency measures are also provided for treatment and discharge of water. **C2. Objectives** ▪ Appropriately monitor waters entering open excavations. ▪ Appropriately manage waters to be discharged from open excavations. ▪ Appropriately monitor and treat (if required) run-off collected in treatment areas. ▪ Appropriately monitor waters within the Tailwater pond for ASS parameters. ▪ Appropriately manage, monitor and treat (if required) waters to be discharged from the ponds. ▪ Comply with conditions of licences, permits or other approvals issued for the project. **C3. Implementation Measures** *C3 (A) Dewatering Drawdown* Dewatering drawdown resulting from construction and dewatering activities shall be controlled to minimise the time and extent of draining ASS materials outside the extraction footprint. This has been identified as a potential issue in the construction of the NPD and as such, a low permeability cut-off wall has been incorporated into the drain design for mitigation purposes. For excavations where dewatering of ASS materials will occur over extended periods and/or extensive drawdown of the groundwater table is likely to be expected then additional procedures for managing groundwater drawdown shall be developed and the ASSMP revised. *C3(B) Monitoring of Water in Open Excavations* Where possible, excavations below the groundwater standing water level (SWL) should remain open for as minimal time as possible and pH monitoring on water accumulated in excavations will be undertaken. The following will occur: ▪ pH monitoring with a calibrated meter will be undertaken daily on each excavation where accumulated water is present. ▪ Where pH of less than 5 is detected, the water shall be treated by addition of hydrated lime and/or liquid caustic. Neutralising agents shall be stored in a covered bunded area to prevent accidental release to waters. *C3 (C) Discharge to Land* When water from open excavations, 'check dams' or the treatment area is being discharged to land, runoff cannot enter waterways or drains and the following procedures shall apply: ▪ The pH of seepage waters shall be monitored daily ▪ Where pH of less than 5 is detected, the water shall be directed to a holding pond or tank where treatment shall be conducted to meet the established performance criteria.

C3(D) Discharge to Surface Water Bodies

When water from open excavations or the treatment area is being discharged to surface water bodies the following procedures shall apply:

- The pH, DO, turbidity, ferrous iron and aluminium levels of waters within open excavations and the treatment area shall be monitored by field measurement prior to the commencement of discharge to a surface water body. Waters not meeting required performance indicators (see Table C4-1 below) shall be directed to a holding pond or tank where treatment shall be conducted until performance indicators are met. If ferrous iron is detected, then a water sample shall be collected and laboratory analysed for titrateable acidity to confirm total acidity risk and treatment requirements.
- Treatment shall not be permitted as part of direct discharge to an external surface water body. Treatment shall occur in a holding pond or tank.
- The pH, DO and turbidity of discharges to surface water bodies shall be monitored every two hours during discharge events.
- The pH, DO, turbidity, ferrous iron and aluminium levels within the accepting water body shall be monitored at a point at least 20m upstream of the discharge point on a daily basis to evaluate background water quality.
- The pH, DO, turbidity, ferrous iron and aluminium levels within accepting water body shall be monitored at a location 5m downstream of the discharge point every two hours during discharge events.
- Discharge to surface water bodies shall be ceased immediately on discovery of non-conformance with performance indicators.
- Water samples from surface water body monitoring points shall be collected on a monthly basis and submitted for laboratory analysis of total acidity, total alkalinity, chloride, sulfate, aluminium and iron.
- When discharge to surface water bodies is proposed, a supply of hydrated lime and/or liquid caustic shall be kept on site at all times for the treatment of acidic waters. The supply shall be at least 0.5 tonne of hydrated lime and/or 20L of liquid caustic. Neutralising agents shall be stored in a covered and bunded area to prevent accidental release to waters.
- All monitoring of water quality shall be carried out by a suitably qualified person, using calibrated equipment on samples that are representative of the discharge or background.

C3 (E) Monitoring of Water in Tailwater Pond

Tailwater within the ponds shall be monitored at locations to be confirmed following detailed pond design as follows:

- Where pH is within the range of pH 6.5 and 8.5 measurements shall be conducted using a calibrated meter twice daily at each nominated monitoring location, when water is present.
- Where pH is detected below 6.5, continuous pH measurement shall be conducted using a calibrated meter and datalogger at each nominated monitoring location.
- Where pH of less than 5.5 is detected, the water shall be treated by addition of hydrated lime and/or liquid caustic to achieve a pH of between pH 6.5 and 8.5. Inline pH adjustment pumps are to be utilized for treatment of low pH waters (<pH 5.5) prior to discharge.
- Should the pH fall outside the adopted discharge range of pH 6.5 to pH 8.5, the water shall be treated with hydrated lime until performance criteria are met. If turbid after liming, the water shall also be treated with gypsum to promote flocculation of suspended solids, before discharging.

C3 (F) Tailwater Discharge

Prior to discharge tailwater must meet the performance criteria listed below and the following procedures adhere to;

- Waters not meeting required performance criteria shall be treated until these criteria are met.
- Treatment shall not be permitted as part of direct discharge to an external surface water body.
- The pH and turbidity (presence of iron floc) in the polishing pond shall be monitored every two hours during discharge events.
- Discharge to surface water bodies shall be ceased immediately on discovery of non-conformance with performance criteria.
- A supply of hydrated lime and/or liquid caustic shall be kept on site at all times for the treatment of acidic waters. The supply shall be at least 0.5 tonne of hydrated lime and/or 200L of liquid caustic. Neutralising agents shall be stored in a covered and bunded area to prevent accidental release to waters.
- All monitoring of water quality shall be carried out by a suitably qualified person, using calibrated equipment on samples that are representative of the discharge or background.
- The Project Environmental Management Plan should also be consulted for guidance on additional monitoring parameters and performance limits not directly related to ASS.

It should be noted that these performance indicators have been set specifically in relation to ASS risks and apply in addition to other water quality limits and indicators outlined as part of other management plans for the AEP. These include the Dredge Management Plan (Chapter E2 of the EIS) which deals with overall TSS and NTU discharges to receiving waters from the tailwater and the Water Quality Management Plan for Marcoola Drain (prepared as part of the AEIS) which is specifically focussed on the control of salinity from the tailwater discharge.

C4. Performance Indicators

C4 (A) Surface Water Quality – Performance Criteria

Table C4-1: Surface Water Quality Performance Criteria

Monitoring Point	Discharge Location	Parameter	Performance Indicator		Monitoring Frequency
			Minimum	Maximum	
Seepage into Excavation	Land Surface (with no overland flow discharging to waterway)	pH	5.0 (where pH<5 discharge must be directed to holding pond)	-	Daily
Seepage into Excavation / Treatment Area	Holding Tank/Pond	pH	6.5	8.5	Daily
		Turbidity	No visible Iron Floc	-	
		DO	2mg/L	-	

			Ferrous Iron	-	3mg/L	Daily
			Aluminium	-	TBC	
	Holding Tank/Pond (and 5m downstream of discharge point)	Waterway	pH	B-0.5 but not less than 6.5	B+0.5 but not greater than 8.5	Prior to commencement of each tank/pond discharge
			Turbidity	No visible Iron Floc	B+2NTU or 15NTU	
			DO	B	-	
			Ferrous Iron	-	TBC	
			Aluminium	-	TBC	
			Total acidity, total alkalinity, Cl, SO_4, Al As & Fe	-	ANZECC (2000) 95% protection level marine or B	Monthly
	Background (B) approximately 20 m from discharge point into Waterway	Waterway	pH, DO, Turbidity, Ferrous Iron, Aluminium			Daily Prior Discharge
			Total acidity, total alkalinity, Cl, SO_4, Al, As & Fe			Monthly**

**-Background 'baseline' data yet to be collected.
TBC- To be confirmed following supplementary investigations.

C4(B) Tailwater Discharge - Performance Criteria

The State Planning Policy lists the following as acceptable outcomes in relation to ASS and disposal of wastewater to waterways

- the pH of any wastewater discharged is maintained between 6.5 and 8.5 to avoid mobilisation of acid, iron, aluminium, and metals, and
- holding times of neutralised wastewaters ensures the flocculation and removal of any dissolved iron prior to release, and
- visible iron floc is not present in any discharge, and
- precipitated iron floc is contained and disposed of, and

	▪ wastewater and precipitates that cannot be contained and treated for discharge on site are removed and disposed of through trade waste or another lawful method. **C5. Contingency Measures** In addition to the above, if the pH of the dredge tailwater drops below pH 5 at any time then this Procedure will need to be reviewed and the monitoring parameters will be increased to include, total acidity, total alkalinity, ferrous iron and aluminium. **C6. Monitoring and Reporting** Additional procedures shall be developed and the ASSMP revised for site specific excavations requiring dewatering as required. The Site Supervisor or delegate shall be responsible for ensuring monitoring listed in *D4(A)* and *D4(B)* is conducted at the required frequency. The Site Supervisor or delegate shall maintain a register of testing results and a record of inspections. A summary report of all test results and inspections shall be compiled by the Site Supervisor or delegate each week and submitted to the Environmental Manager and/or the Superintendent. The Site Supervisor or delegate shall inform the Environmental Manager and/or the Superintendent of non-compliance with Table *D4(A)* and *D4(B)* in external surface water bodies upon detection. The Environmental Manager and/or the Superintendent shall inform DEHP of such non-compliances as soon as practicable and instigate an assessment of the impact.

Implementation and Management Procedures	
Implementation and Management Procedure D - Groundwater Quality Monitoring	**Groundwater Quality Monitoring** **D1. General** The procedures outlined below are provided to monitor, manage and mitigate potential transport and export of acidic groundwater and associated heavy metal contaminants due to groundwater drawdown from excavation activities and dredge sand fill settlement 'pushing' AASS below the groundwater table. Contingency measures are also provided for the mitigation and management of acidic groundwater exportation (if required). **D2. Objectives** ■ Appropriately monitor down gradient groundwater quality and compare against pre-construction baseline levels (to be established prior to construction). ■ Appropriately monitor and treat (if required) acidic groundwater via contingency measures such as the installation of lime trenches or lime slots in appropriate down gradient locations and within identified groundwater flow paths. ■ Appropriately monitor any changes to groundwater salinity in National Park or other retained conservation habitats during tailwater operations. ■ Comply with conditions of licences, permits or other approvals issued for the project. **D3. Implementation Measures** *D3(A) Baseline Groundwater Assessment* Current 'baseline' groundwater parameters are yet to be established for the site and the surrounding receiving environment. Baseline groundwater parameters shall be established via a monthly groundwater monitoring program of a network of twelve (12) groundwater monitoring wells (5 existing and 7 yet to be installed monitoring locations) conducted over a period of no less than 6 months prior to the commencement of earthworks. It is anticipated that at least one groundwater monitoring well will be located within the boundary of the Mt Coolum National Park adjacent to the existing Marcoola Drain, to establish baseline conditions and continued monitoring. It should be noted, that the installation of a groundwater monitoring well within the boundary of the Mt Coolum National Park will require the prior approval of the Department of National Parks, Sport and Racing. Baseline groundwater quality parameters will be established for the following; ■ Groundwater levels, pH, Conductivity (EC), chloride, sulfate, total alkalinity, total acidity, dissolved iron and dissolved aluminium. ■ The groundwater quality objectives for the proposed monitoring location within the Mt Coolum National Park (given the high ecological value) would further include: total dissolved solids, total anions and total cations as in accordance with the Water EPP 2009. *D3(B) Monitoring Groundwater Quality – During Construction* During construction of the northern and western perimeter drains groundwater quality will be conducted on a weekly basis for the following parameters and compared against the performance criteria (refer Table D4-1) ; ■ Groundwater levels, pH, Conductivity (EC), chloride, sulfate, total alkalinity, total acidity, dissolved iron and dissolved aluminium.

D3(C) Monitoring Groundwater Quality – During Pond Construction, Sand Fill Placement and Tailwater Discharge

- During pond construction, the placement of sand fill and tailwater discharge, groundwater monitoring will be conducted weekly for the following parameters and compared against the performance criteria (see Table D4-1).
- Groundwater levels, pH, Conductivity (EC), chloride, sulfate, total alkalinity, total acidity, dissolved iron and dissolved aluminium.
- The groundwater quality objectives for the proposed monitoring location within the Mt Coolum National Park (given the high ecological value) would further include: total dissolved solids, total anions and total cations as in accordance with the Water EPP 2009.

D3(D) Monitoring Groundwater Quality – Post Construction

Post construction, groundwater monitoring will be conducted on a monthly basis for a period of eighteen months (then on-going as required by SCA) for the following parameters and compared against the performance criteria (see Table D4-1).

- Groundwater levels, pH, Conductivity (EC), chloride, sulfate, total alkalinity, total acidity, dissolved iron and dissolved aluminium.

During the above groundwater monitoring period should any groundwater monitoring wells be damaged or destroyed they are to be re-instated before the next monitoring round or as soon as practicable.

D4. Groundwater Performance Criteria

Table D4-1: Groundwater Quality Performance Criteria

Parameter	Performance Indicator
pH	0.3 pH units below lower bound of baseline range or above 8.5 pH
Total Acidity	+/- 10% of baseline range
Total Alkalinity	+/- 10% of baseline range
Cl:SO_4 Ratio	+/- 10% of baseline range
Dissolved Iron	+/- 10% of baseline range
Dissolved Aluminium	+/- 10% of baseline range
Landscape Aesthetic	No visual signs of vegetation stress or landscape degradation

It should be noted that the groundwater quality objectives for the proposed groundwater monitoring location within the Mt Coolum National Park (given the high ecological value) would be established to maintain existing water quality (at 20^{th}, 50^{th} and 80^{th} percentiles) and would further include: TDS, EC, total anions and total cations as in accordance with the Water EPP 2009, for the Maroochy River.

D5. Contingency Measures

Should groundwater quality fall below established baseline conditions or other nominated performance indicator for any down gradient groundwater monitoring locations over three (3) consecutive monitoring events other management measures such as, localised lime slots or lime trenches shall be installed in appropriate locations.

For the groundwater well adjacent to Marcoola Drain in the Mount Coolum National Park area, where an exceedance of performance limits (based on baseline data collection) is

	detected as part of weekly monitoring over two (2) consecutive monitoring events, an investigation will be carried out to the likely cause of the exceedance and if the effects of the exceedance are likely to have any measurable impact on the environmental values present. These findings including corrective actions will be presented and discussed with the Department of National Parks, Sport and Racing and the Department of Environment and Heritage Protection. **D6. Monitoring and Reporting** The Site Supervisor or delegate shall be responsible for ensuring the above groundwater monitoring is conducted at the required frequency. The Site Supervisor shall maintain a register of testing results and a record of inspections. A summary report of all test results and inspection shall be compiled by the Site Supervisor or delegate each week and submitted to the Environmental Manager and/or Superintendent. The Site Supervisor or delegate shall inform the Environmental Manager and/or Superintendent of non-compliance with the performance indicators in down gradient groundwater monitoring locations upon detection. The Environmental Manager and/or Superintendent shall inform DEHP of such non-compliances as soon as practicable and instigate an assessment of impact.
Auditing and Reporting	**Auditing** The Environmental Manager will be responsible for ensuring that an auditing program is implemented for construction and treatment works. The audit program shall aim to ensure compliance with the ASSMP and relevant statutory requirements. The Environmental Manager shall appoint an experienced ASS practitioner to conduct regular auditing of activities and ASS management measures. Given the expected construction period a weekly, auditing schedule is recommended. The frequency of these audits may gradually decrease if a high level of compliance with the ASSMP is evident. The audit shall take the form of a visual inspection of the works and treatment sites and associated control measures and a review of monitoring data. A written record of auditing undertaken shall be maintained, including details on the date of the audit, activities undertaken, observations made and any non-conformances identified. A copy of the audit report shall be forwarded to the Environmental Manager within 2 days of the audit.
Training	**Training** All equipment operators, supervisors and subcontractors engaged in excavation works shall participate in induction training for ASS. This training will include basic recognition and identification of ASS, plus an outline of the requirements of the ASSMP. The Site Foreman shall verify attendance at induction training prior to commencement of site works.