ENV Solutions

Engineering the Future

ACID SULFATE SOIL MANAGEMENT PLAN

Australian Bay Lobster Producers Ltd (ABLP)
9484 Tweed Valley Way, Chinderah NSW
(Lot 1 DP1192506)

For:

Earthtrak Pty Ltd

October 2018

Environmental Engineering Solutions
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TABLES and FIGURES (IN TEXT)

1 Introduction

1.1 Overview

ENV Solutions have been engaged by Earthtrak Pty Ltd (Earthtrak) to prepare an Acid Sulfate Soils Management Plan (ASSMP) for the proposed treatment and beneficial reuse of acid sulfate soils (ASS) during landraising of a property occupied by Australia Bay Lobster Producers Ltd (ABLP). The property is located at 9484 Tweed Valley Way, Chinderah NSW (Lot 1 DP1192506) ('the site'). The relative location of the site is shown on Figure 1, **Attachment 1.**

The proposed activities will include receiving imported ASS excavated from various sites in the Tweed Heads District, which have been investigated and pre-determined as ASS. The imported material will be placed directly into the treatment area, limed at the pre-determined liming rate, validated and then beneficially used as fill on site.

An amendment to the Development Application (DA-282-11-2004-i) is currently being prepared be Planit Consulting Pty Ltd to enable the treatment of ASS at the site.

The site is approximately 45 ha in size, where the ABLP facility is located in the north-western portion and the remaining areas are vacant paddocks intended for landraising in the order of 4.0 m. A plan showing the layout of the current and proposed activities is included in Figure 2, **Attachment 1.**

This ASSMP sets out the methodology, treatment requirements and management procedures to be adopted during the proposed activities.

1.2 Acid Sulfate Soils (ASS)

Acid Sulfate Soil (ASS) is the common name given to soils containing iron sulfides (pyrite). When exposed to oxygen through lowering of surrounding groundwater or excavation, air drawn into the soils can cause oxidation of the iron sulfides, producing sulfuric acid.

ASS typically occurs in low-lying coastal areas. Runoff from exposed ASS areas may find its way to stormwater, groundwater and eventually into natural aquatic environments. The acidic runoff may lower the pH of receiving waters, increase the concentration of metals and reduce the natural buffering capacity of the receiving waters. Exposure to oxidised conditions can also cause acidic corrosion to steel and concrete structures.

There are two basic types of ASS: Actual Acid Sulfate Soils (AASS) and Potential Acid Sulfate Soils (PASS). AASS are soils in which some sulfides have already been oxidised. Hence AASS environments may be acidic, but have low potential for further acid generation. PASS are soils in which the sulfides have not yet been oxidized (i.e. they contain oxidisable sulfur). AASS and PASS can coexist.

In anaerobic conditions (such as below the watertable), PASS do not pose an environmental threat, however if conditions change (such as during dewatering, excavation or drought), the sulfides can oxidise and form sulfuric acid. Developments involving excavation or dewatering must establish the presence and extent of ASS down the soil profile, as works may intercept ASS horizons and pose risks to both human and ecological health.

1.3 Objectives

The objectives of this ASSMP report are to:

- Provide an ASSMP for treating and managing ASS imported to the site from various locations within the Tweed Valley District in accordance with the amended DA (prepared by Planit), Department of Agriculture and Water Resources (DAWR) National Acid Sulfate Soils Guidance: *National acid sulfate soils sampling and identification methods manual* (2018), NSW EPA's Waste Classification Guidelines, Part 4: Acid sulfate soils, (2014) and the Tweed Local Environmental Plan (TLEP, 2014)
- Provide investigation steps and requirements of materials prior to material is imported to site, in accordance with the Department of Agriculture and Water Resources' National Acid Sulfate Soils Guidance: *National acid sulfate soils sampling and identification methods manual* (2018).

- Provide management steps and operational methodology, including environmental controls and procedures, to reduce the potential risks to the environment during the importation, storage and treatment of ASS and subsequent reuse of treated ASS.

1.4 Legislative Requirements

This report was prepared in accordance with the following guidance documents:

- Agricultural and Resources Management Council of Australia and New Zealand (ARMCANZ) and Australian and New Zealand Environment and Conservation Council (ANZECC). January 2000. National Strategy for the Management of Coastal Acid Sulfate Soils (ANZECC / ARMCANZ 2000);
- Department of Agriculture and Water Resources (DAWR). National Acid Sulfate Soils Guidance: *National acid sulfate soils sampling and identification methods manual* (DAWR, 2018)
- Resource Recovery Order under Part 9, Clause 93 of the Protection of the Environment Operations (Waste) Regulation 2014 - The excavated natural material order and exemption 2014, NSW EPA.
- Waste Classification Guidelines - Part 1: Classifying Waste, NSW EPA, November 2014; and
- Waste Classification Guidelines - Part 4: Acid Sulfate Soils, NSW EPA, November 2014.

2 Existing Site Conditions and Surrounding Environment

2.1 Site Identification Details

The site identification details are summarised in Table 1 below.

Table 1: Summary of site identification details

Site address	9484 Tweed Valley Way, Chinderah NSW
Lot, Deposited Plan	Lot 1 DP1192506
Approximate site area (ha)	45
Local Government	Tweed Local Government
Property Owner	Australia Bay Lobster Producers (ABLP)
Current land use	Aquaculture facility on part of site and vacant
Proposed land use	Expansion of aquaculture facility, commercial/industrial storage facility
Land Zoning	RU1 – Primary Production (Tweed Local Environmental Plan 2014) (LEP, 2014)
Topography	1-3 m AHD (Australian Height Datum)

2.2 Site Conditions

The site is approximately 45 ha, where the proposed landraising will be completed in a three-stage process of 15 ha each. The site is rectangular in shape and flat, although has a very gentle slope towards the eastern part of the site. The site ranges between 5m and 4m Australian Height Datum (Google Earth, 2018).

The north-western portion of the site is currently being used by site owners (ABLP) as an aquaculture facility while the remainder of the site has been vacant.

Much of the surrounding area is used for agricultural proposes with the Pacific Motorway running north-south to the west of the site.

2.3 Surrounding Environment

The site is bordered by large agricultural properties on north, east and southern sides. The Pacific Motorway borders the site on the western side. The site is located approximately 4.3 km west of the town centre of Kingscliff.

The site lies within a flood planning area as indicated by the Tweed Shire Council flood risk mapping (LEP, 2014) – refer to Figure 3, **Attachment 1**.

3 ASS Investigation (Pre-importation Requirements)

Prior to the material being excavated and imported to the treatment site, the generating site must be investigated to gain an understanding of the soil properties. This investigation shall be undertaken in accordance with the Department of Agriculture and Water Resources (DAWR) National Acid Sulfate Soils Guidance: *National acid sulfate soils sampling and identification methods manual* (2018) and the NSW EPA Excavated Natural Material (ENM) Order and Exemption (2014).

3.1 Sampling Requirements

A detailed soil sampling investigation is required for every site **prior to excavation** to determine the individual soil characteristics. The investigation should incorporate both **ASS and ENM** sampling into the sampling regime in accordance with the previously mentioned technical guidance documents.

3.2 Supporting Documentation

For each investigation a supporting report or letter style report should be produced outlining the investigation methods, results and conclusions. Laboratory results with calculated liming rates must be appended to the report.

Waste tracking documentation shall be compiled as outlined in Section 8 on the Management Plan.

In order to accept imported material the aforementioned supporting documentation must be completed.

4 Environmental Responsibilities and Roles

4.1 Overview

Earthtrak Pty Ltd is responsible for implementing the management requirements of this ASSMP, and will have responsibility for ensuring that all employees, subcontractors and persons involved with the proposed works are familiar with the requirements of the ASSMP.

Determining and implementing management for other environmental aspects associated with the works at the proposed development site, including but not limited to erosion and sediment control, and stormwater management, is also Earthtrak's responsibility and is to be addressed in their Environmental Management Plan. This ASSMP does not address environmental impact and mitigation measures associated with other environmental aspects of this project.

A copy of this ASSMP and the Environmental Management Plan must be kept by Earthtrak onsite, accessible to site personnel at all times. Successful implementation relies upon support from and compliance by all involved parties. Such responsibilities are detailed below.

4.2 Earthtrak Project Manager

- Review and monitor environmental performance at regular worksite meetings.
- Required to be notified of any major environmental incidents and review the management procedures in place to deal with such occurrences.
- Monitor non-compliance and review management procedures if problem persists.
- Ensure that appropriate and adequate resources are allocated to allow for effective implementation and maintenance of the ASSMP.

4.3 Earthtrak Supervisor/ Foreman

- Facilitate the reporting of incidents that may impact on the surrounding environment.
- Manage remediation actions to correct incidents of environmental non-compliance.
- Ensure that all staff are aware of and understand their responsibilities under the ASSMP.
- Identify any environmental training requirements.

4.4 ENV Environmental Consultant

- Provide guidance and advice to staff with regard to ASS management requirements.
- Monitor statutory requirements and ensure compliance.
- Where necessary, coordinate and/or assist in the response to environmental incidents.
- Maintain records of treatment, including verification testing of treated soils.
- Report all incidents with the potential to cause serious environmental harm to the Project Manager and where necessary, to the EPA.

Note that the above framework is specific to Acid Sulphate Soils Management only. Therefore, this framework should be implemented alongside other relevant environmental management plans (EMP's) including but not limited to;

- Environmental Management Plan; and,
- Sediment and Erosion Control Management Plan.

5 Management of ASS

5.1 Summary of Works

The activities identified that could potentially lead to exposure of acid sulfate soils onsite during the receival and treatment process are considered as the following:

- Importation of untreated acid sulfate soils;
- Storage of untreated acid sulfate soils;
- Treatment of acid sulfate soils; and,
- Leachate from imported soils.

It has been assumed from the preliminary design and the information detailed by Planit Consulting's Environmental Assessment (2018) that the total amount of acid sulfate soil material to be treated on site during the landraising activities will be approximately 500,000 m^3 over the 4 year lifespan.

In an effort to reduce the risk of exposure and subsequent oxidation of these materials, this ASSMP provides management guidelines and mitigation practices that are to be incorporated as a part of the proposed works.

5.2 Relevant Objectives

The objectives of this ASS Management Plan are to;

- Minimise the potential for inappropriate material handling through accurate identification of ASS;
- Manage ASS material so that the potential for environmental harm is minimised;
- Manage leachate capture and treatment to minimise environmental harm;
- Minimise the potential for adverse environmental impact due to handling, storage and application of hazardous materials related to the treatment of ASS; and
- Ensure awareness of all personnel involved in the works at the proposed development of the requirements of this ASSMP and its objectives and management, particularly those aspects relevant to the individual.

5.3 Targets & Performance Indicators

Key Performance Indicators (KPI's) and Targets of this ASS Management Plan are to ensure:

- All ASS containing material is **pre-identified** utilising best practice guidelines and methodologies;
- All material is **stockpiled and contained correctly** and kept separate during importation to the treatment area;
- Sulfide acidity is managed correctly onsite following full oxidation of disturbed ASS i.e**. appropriate treatment** of imported ASS confirmed by collection, analysis and interpretation of verification samples;
- Containment mitigation measures (i.e. bunds) are kept in 'working condition' where notes on any changes or augmentations are recorded and kept;
- Any collected **leachate** or surface water meets relevant criteria and/or existing characteristics prior to discharge to a receiving environment;
- Handling and storage of hazardous materials is undertaken in accordance with relevant legislation and that records are kept of said handling and storage; and
- All personnel involved onsite are aware of **ASSMP Objectives and Control Measures** prior to commencing work (i.e. via site Induction).

6 Neutralisation Treatment of Imported Soil

The following section refers to the treatment flowchart, available for viewing Figure 4, **Attachment 1**.

6.1 Excavation and Importation

All material excavated and imported during the landraising activities will be placed directly into the treatment area specified by Earthtrak Pty Ltd. At the time of preparing this ASSMP, the total estimated volume of soil to be imported is approximately 500,000 m^3 over the 4 years, however this volume will be received in batches of volumes up to 4,500 m^3 from various sites across the Tweed Valley District. Soils will require investigation prior to excavation and importation to determine the required liming rate. All material will be imported safely in a batch like process ensuring that each batch is kept separate to guarantee correct neutralisation is achieved.

6.2 Treatment Area

Once imported the material will be loaded directly into the treatment area. The treatment area will be made up of several sub-treatment areas in order to treat material for multiple sites concurrently. The treatment area must be appropriately constructed to intercept any material that may cause environmental harm to the surrounding environments (e.g. acid leachate collection systems and sediment traps around the treatment pad).

Material should be transported to the treatment area within 24 hours of exposure. As part of earthworks, soil requiring neutralisation will be placed in maximum 750 m^3 (bulked volume) stockpiles on each of the treatment pads.

6.2.1 Leachate Capture

The entire liming pad (treatment area) is to be constructed with a perimeter bund wall, no less than 400 mm high and no less than 500 mm wide. The bund wall should be constructed using fine-grained and non-dispersive material (clay) and should be compacted to be as impermeable as possible. The leachate collection point should be constructed as a sump that is of sufficient size to store a Q_{10} storm event (1:10 year ARI). See Section 6.2.3 for pond sizing calculations.

6.2.2 Leachate Treatment

Water and leachate collected in the sump should be monitored and recorded, in the project notes, using a calibrated pH meter. Testing should be conducted at the close of business each day until no further acid sulphate soils treatment is required.

Should water in the sump have a pH falling outside the ANZECC & ARMCANZ (2000) trigger value appropriate for the receiving watercourse, the water should be buffered using an accepted chemical neutralisation agent, (commonly superfine agricultural lime). Additional treatment may be required where other parameters such as turbidity (high iron “floc”) exceed the trigger value of 50 NTU. In this case the iron floc may be added in addition to the neutralising agent to ensure discharge water quality meet the ANZECC & ARMCANZ guidelines (2000).

Standard application rates for the treatment of water and leachate are presented in Table 2. The table indicates the amount of neutralising agent required to raise the pH of the water to neutral. For example, if the leachate has low salinity and a pH of 3.5, 16 kg of Aglime would be required to neutralise 1ML of water.

Table 2 has been provided as a guide only. Depending on the chemistry of the water, additional neutralising agent may be required to obtain a pH of 7. Regular pH testing of the water should also be undertaken to monitor changes in pH following any dosing operations and recorded in the project notes.

Table 2: Neutralisation Rates for Leachate

Water pH	H+ (mol/L)	H+ (mol/ML)	Aglime to Neutralise 1 ML	Hydrated Lime to Neutralise 1 ML	Sodium Bicarbonate to Neutralise 1 ML
			Kilograms Required		
0.5	0.316	316228	15824	11716	26574
1.0	0.1	100000	5004	3705	8403
1.5	0.032	31623	1582	1172	2657
2.0	0.01	10000	500	371	840
2.5	0.0032	3162	158	117	266
3.0	0.001	1000	50	37	84
3.5	0.00032	316	16	12	27
4.0	0.0001	100	5	4	8.4
4.5	0.000032	32	1.6	1.17	2.66
5.0	0.00001	10	0.5	0.37	0.84
5.5	0.0000032	3.2	0.16	0.12	0.27
6.0	0.000001	1.0	0.05	0.037	0.08
6.5	0.00000032	0.3	0.016	0.012	0.027

Source: State Planning Policy 2/02 Guideline: Acid Sulfate Soils, Department of Natural Resources and Mines, Brisbane, 2004.

6.2.3 Leachate Pond Design

The capacity of the proposed leachate pond used to control sediment and leachate generated from the treatment area was determined using the guidelines provided in Managing urban stormwater: soils and construction (Landcom, 2004) also referred to as the 'Blue Book'. The calculations incorporate the area being a 'Type F' sediment type and a 'Group B' Hydrologic group:

Volume of leachate pond = Volume of settling zone (V1) + Settling storage volume (V2)

Settling zone (V1) = 10 x Cv x A x R where:
A = Treatment area 0.6118 ha
Cv is the volumetric runoff coefficient = 0.82 (Appendix F of Blue Book Table F3, page F-6)
R is the 5 day rainfall (90th percentile) = 82.5mm (as per Table 6.3a for Tweed Heads in Chapter 6 of the Blue Book)
10 is the unit correction constant
Settling zone (V1) = 10 x 0.82 x 0.6118 x 82.5 = 413.9 m^3 (413.9 kL)

Settling storage volume (V2) = 50% of settling zone (V1) = 206.9 m^3

Volume of leachate pond = (V1) + (V2) = 413.9 + 206.9 = **621 m^3**

Leachate pond dimensions = 161m x 3m x 1.3 m (refer to Figure 5, **Attachment 1**)

Comprehensive leachate pond calculations are available for viewing in **Attachment 3**.

6.2.4 Liming Pad Design

Prior to the commencement of importation of soils from sites pre-determined as ASS, the liming pad (treatment area) will be constructed in an area where it will not be disturbed during the landraising processes. A graphical

representation of a treatment pad is provided in Figure 5A and the treatment area layout including leachate capture and treatment pad design is provided in Figure 5, **Attachment 1**.

Basic Design

The liming pad should be constructed so the base of the pad is composed of compacted fine-grained material, so as to produce as impermeable foundation as possible (minimum 98% compaction). Ideally a clay liner, no less than 300 mm thick, should be placed on the base of the pad. The base of the pad should slope gently (2 – 5%) so as to allow water/leachate to drain to a designated collection point. A leachate collection system, as described above, should be constructed.

Guard Layer

The base of the liming pad should be dusted with AgLime at a rate determined using the following equation:

Guard layer (kg/m^2) = 0.2 x thickness of layer to be treated (m) x average liming rate (kg/tonne).

The guard-layer liming rate for the treatment area will be calculated prior to receiving the imported soils to ensure the correct guard layer thickness is applied for each 'batch'. The AgLime used for the guard layer should be spread using a lime/fertilizer spreader or excavator to ensure the base of the pad is evenly covered, prior to the placement of the material requiring treatment.

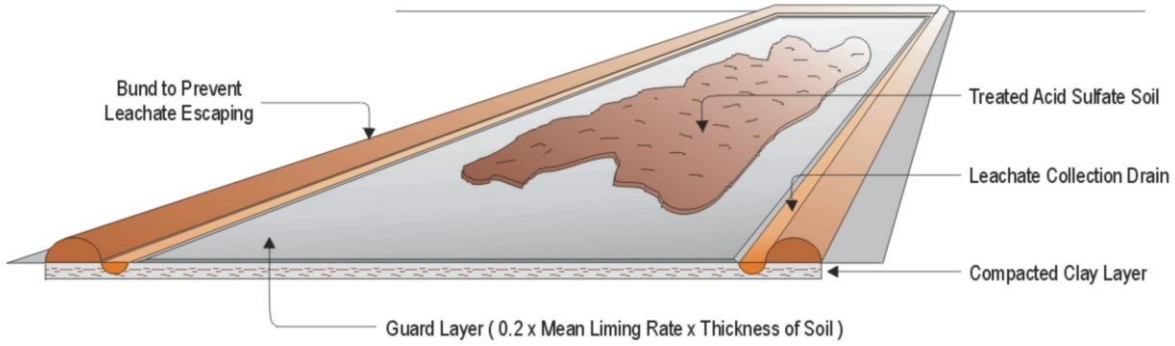

Figure 5A: Treatment Pad Design

6.3 Application Rates for Neutralising Agent

The application rates for the neutralising agent will be determined based on the laboratory analyses completed on samples collected during the preliminary ASS investigations prior to it being accepted on site.

All material excavated will be treated using the specified liming rates according to the site from which the soils derive. If sub-surface conditions vary significantly from those observed during the preliminary ASS investigation, including any indications of contamination, excavation should stop and qualified personnel should be engaged to assess the site conditions, including laboratory testing to confirm the concentrations of any contaminants observed.

6.4 Mixing of Neutralising Agent

The materials to be treated should be tipped onto the liming pad and spread by an excavator into a layer no greater than 900 mm in thickness. Ideally, the soils/sediments should be allowed to partially dry prior to attempting to mix the neutralising agent. If the soils are too moist, the neutralising agent will not be evenly distributed throughout the soils and pockets of AgLime and untreated sediment will form within the stockpile. If this occurs, the soils will not self-neutralise when acidic leachate develops.

There are several ways to mix the neutralising agent into the materials to be treated, all of which have positive and negative aspects. In this case, mixing will be undertaken with the use of an excavator in which stockpiles will be mixed with lime as they are transferred from one stockpile area to the next. The effectiveness of the

mixing process is contingent on the methodology of mixing. It is envisaged that the material shall be mixed a minimum of 3 times with an excavator or loader prior to being placed into the treated stockpile for validation testing.

Should particular soils (such as sticky cohesive clays) prove difficult to neutralise and validate, alternative mixing methodologies may need to be employed such as a Pug-mill setup with automatic lime dosing.

6.5 Waste Tracking

Waste tracking shall be undertaken by the Earthtrak Pty Ltd and provided in a final report to the receiving site, as per the requirements outlined in Section 8.

7 Validation of Treated Soils

7.1 Environmental Testing of Treated Soils

Earthtrak Pty Ltd is responsible for ensuring that the validation sampling and analysis of lime treated soil is conducted by a suitably qualified person, and in a manner that will demonstrate, with acceptable confidence, that sufficient AgLime has been mixed into the ASS, to provide an adequate buffer, such that the material meets the criteria set out in Table 3.

Validation sampling locations will be selected, as approved by the Site Supervisor/Foreman, such that a representative distribution for sample locations is achieved for the treated soil.

Validation sampling and analysis will be undertaken at a frequency that will demonstrate that satisfactory neutralisation has taken place. The frequency of soil validation sampling and analysis will be:

- A minimum of 1 sample per 500 m^3 of remediated soil.

Note: If an unsatisfactory neutralisation is observed the material will be then be re-limed (at the liming rate indicated on the validation sampling results) and thoroughly mixed 3 times before being re-sampled for validation to ensure that neutralisation was successful, again at a minimum of 1 sample per 500m3. Material will not be removed from the treatment area prior to be validated and therefore approved to be used as general fill.

7.1.1 Sampling Technique

A suitably qualified Engineer/Scientist shall collect ten representative sub-samples to produce one (1) representative (composite) sample from each 500 m^3 of treated soil, in accordance with the following requirements:

- approximately 250 g of soil must be collected from 10 representative locations, evenly distributed through the 500 m^3 of treated spoil; and
- where the soil is cohesive, the sample must be homogenised in a large stainless bowl, or equivalent, and a representative sample taken from the homogenised composite material for analysis.

7.1.2 Laboratory Analysis

Suspension peroxide oxidation combined acidity and sulfur (SPOCAS) testing must be undertaken by a third party laboratory accredited by the National Association of Testing Authorities (NATA) for the required testing on all material that has been treated. Southern Cross University's Environmental Analysis Laboratory (EAL) and Envirolab in Sydney can perform the required testing. This testing generally takes 5 working days to complete, so the treated stockpile must have capacity to allow for testing results to be returned prior to moving from the liming treatment area.

7.2 Validation Reporting

Earthtrak Pty Ltd (PC) is responsible for ensuring that a suitably qualified Engineer/Scientist prepares two (2) copies of an ASS Neutralisation Certification Report ("ASSNCR") suitable for submission to Tweed Shire Council and/or the NSW EPA. The report will demonstrate that the excavated and treated soil has been sufficiently neutralised and meets the criteria presented in Table 3.

The ASSNCR will include, but not be limited to, the following information:

- Summary table of analytical results for each soil stockpile and the results of validation analysis;
- Plan of earthworks stockpile locations, showing:
  - Sample identification numbers

– Location of validation sampling.

By submitting the ASSNCR to the principal contractor for review, the contractor is deemed to be stating to the principal contractor that all information presented in the ASSNCR is true and accurate and that the remediation and validation of the ASS soils is of sufficient quality that the contractor is certifying that remediation, as defined under the contract, has been satisfactorily completed.

If the principal contractor considers that the ASSNCR does not provide sufficient evidence to demonstrate that satisfactory remediation has been achieved, or is of unsatisfactory quality, the principal contractor shall notify the contractor in writing, outlining the deficiencies in the ASSNCR and any corrective actions to be undertaken before approval by the principal contractor will be further considered. The contractor must immediately undertake such corrective action to the ASSNCR. The cost of such corrective action will be borne by the contractor.

All ASSNCR's and supporting documentation will be kept for 6 years and made available to Council or EPA if requested.

7.3 Neutralisation Criteria

The criteria presented in Table 6 will be used to ensure that the excavated material has been sufficiently neutralised. The criteria have been drawn from the (DAWR) National Acid Sulfate Soils Guidance: *National acid sulfate soils sampling and identification methods manual* (2018).

Table 3: Action Limits for Treatment of ASS

Soil Texture	Clay Content %	Sulfur Content % w/w	Acid Trail mol H^+ /tonne
Coarse (sand & gravel)	< 5	≥ 0.03	≥ 18
Medium (sandy loam - light clay)	5 – 40	≥ 0.06	≥ 36
Fine (medium to heavy clays, silty clays)	> 40	≥ 0.01	≥ 62

Where the laboratory results are less than or equal to the action criteria presented in Table 3 and / or have sufficient lime to neutralise all PASS/AASS present, the material will be considered to have been sufficiently neutralised.

Where the laboratory results do not meet the action criteria presented in Table 3, and additional liming is required for neutralisation additional lime at the rate required by the validation results shall be applied and the product then re-validated.

8 Waste Traceability

The total volume of ASS from a particular site shall be given an identification number and stockpiled and treated together. The Site Manager shall maintain a register of all volumes of material received from a particular site, liming rate applied and validation results.

Earthtrak shall ensure that traceability is maintained throughout all documented records under this project. All validation results, for a given site shall be recorded. Accountability for implementing a traceability program for neutralisation and on-site transport of the material lies with site management. The documentation will contain, but not be limited to, the following information:

- Truck registration
- Truck driver
- Date and time of departure from site
- Date and time of arrival at the disposal or beneficial re-use site
- Source of material (stockpile identification)
- Estimated volume of material transported.

Clear records of movements of excavated material to the treatment pads, treatment details (AgLime volumes and application times) and reuse destinations are to be kept. Table 4 provides an example of how the records could be tabulated.

Table 4: Example of a Record of Movement

Label	Date	Volume (m^3)	Location	Disposal Location A	Treatment Date	Volume of Aglime required	pH field testing	Testing Date	Result[1]	Disposal Location B	Disposal Location B
Vol A	5-6-06	150	Channel Ch 0-40	Treatment Pad	7-6-06	160 kg/tonne = 45,600 kg	pH_f = 6.5 pH_{fox} = 6.0	7-6-06	12-6-06 Acceptable (refer lab results)	12-6-04	Existing Drain Ch 0 to Ch 50, 3 m below surface level.
Vol B	6-6-06	330	Channel Ch 40-80	Treatment Pad	8-6-06	220 kg/tonne = 139,940 kg	pH_f = 5.5 pH_{fox} = 5.0	8-6-05	13-6-06 Failed	-	-
					14-6-06	120 kg/tonne = 45,240 kg	pH_f = 6.5 pH_{fox} = 6.0	14-6-06	19-6-06 Acceptable (refer lab results)	19-6-06	Existing Drain Ch 50 to Ch 120, 3 m below surface level.
Vol C	7-6-05	120	Table Drain	Lemura Quarry	NA	NA	NA	25-5-06	27-5-06 Sent to Lemura	NA	NA
Vol D	9-6-05	NA	Existing Drain Ch 20 - Ch 60	*In-situ* guard layer	9-6-06	80 kg/m^3 = 4,800 kg	NA	NA	NA	NA	NA

9 Management of Treated Excavated Materials

All management of treated ASS materials must be undertaken in accordance with the NSW EPA Waste Classification Guidelines, Part 4: Acid Sulfate Soils (refer Attachment 4), and other applicable EPA guidance documents.

Once the excavated material is treated, and the validation testing results are shown to meet the neutralisation criteria (Section 7.3), the treated material can be re-used on the receiving site. As detailed in Table 4 all material must be tracked and documented to reduce the risk of environmental harm. All waste material shall meet the requirements of the Excavated Natural Material Exemption (apart from ASS requirements) prior to being accepted on the site.

10 References

Agricultural and Resources Management Council of Australia and New Zealand (ARMCANZ) and Australian and New Zealand Environment and Conservation Council (ANZECC). January 2000, National Strategy for the Management of Coastal Acid Sulfate Soils.

Agricultural and Resources Management Council of Australia and New Zealand (ARMCANZ) and Australian and New Zealand Environment and Conservation Council (ANZECC), 2000, Australian and New Zealand Guidelines for Fresh and Marine Water Quality.

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NSW EPA (2014). Resource Recovery Order under Part 9, Clause 93 of the Protection of the Environment Operations (Waste) Regulation 2014 - The excavated natural material order and exemption 2014.

White, I. And Melville, M.D. (1993). Treatment and Containment of Potential Acid Sulfate Soils-Formation, Distribution, Properties and Management of Potential Acid Sulfate Soils. Consultants Report to the Roads and Traffic Authority.

11 Scope and Limitations of Acid Sulfate Soil (ASS) Assessment

This report includes the results of an Acid Sulfate Soil (ASS) assessment prepared for the purpose of this commission. The data and advice provided herein relate only to the project and structures described herein and must be reviewed by a competent engineer/scientist before being used for any other purpose. Earthtrak Pty Ltd accepts no responsibility for other use of the data.

Where drill hole or test pit logs, laboratory tests, geophysical test and similar work have been performed and recorded by subcontractors or others, the data are included and used in the form provided by others. The responsibility for the accuracy of such data remains with the issuing authority, not with Earthtrak Pty Ltd.

The advice tendered in this report is based on information obtained from the assessment locations, tests points and sample points and is not warranted in respect to the conditions that may be encountered across the site at other than these locations. It is emphasised that the actual characteristics of the subsurface materials may vary significantly between adjacent test points and sample intervals and at locations other than where observations, explorations and investigations have been made. Subsurface conditions, including groundwater levels and contaminant concentrations can change in a limited time. This should be borne in mind when assessing the data.

It should be noted that because of the inherent uncertainties in subsurface evaluations, changed or unanticipated subsurface conditions might occur that could affect total project cost and/or execution. Earthtrak Pty Ltd does not accept responsibility of the consequences of significant variances in the conditions and the requirements for execution of the work.

During remediation or subsequent investigations, the subsurface and surface earthworks and excavations should be examined by a suitably qualified and experienced Engineer/Scientist who will judge whether the revealed conditions accord with both the assumptions in this report and/or the design of the remediation works. If they do not accord, the Engineer/Scientist will modify the advice in this report and/or design of the works to accord with the circumstances that are revealed.

An understanding of the subsurface site conditions depends on the integration of many pieces of information; some regional, some site-specific, some structure-specific and some experience based. Therefore, this report should not be altered, amended or abbreviated, issued in part or issued incomplete in any way without prior checking and approval by Earthtrak Pty Ltd. Earthtrak Pty Ltd accepts no responsibility for any circumstances which arise from the issue of the report, which has been modified in any way as outlined above.

12 Attachments

Attachment 1	Figures
Attachment 2	NSW EPA Waste Classification Guidelines, Part 4: Acid Sulfate Soils
Attachment 3	Leachate Pond Calculations

ATTACHMENT 1

Figures

Figure 1: Site Location Plan
Figure 2: Site Layout
Figure 3: Flood Risk Mapping
Figure 4: Treatment Flowchart
Figure 5: Treatment Area Layout

Site area (approximate)

0 500 1 km

Figure 1 - Site Location
9484 Tweed Valley Way, Chinderah NSW

EarthTrak Pty Ltd
Acid Sulfate Soil Management Plan
Job No: 18313

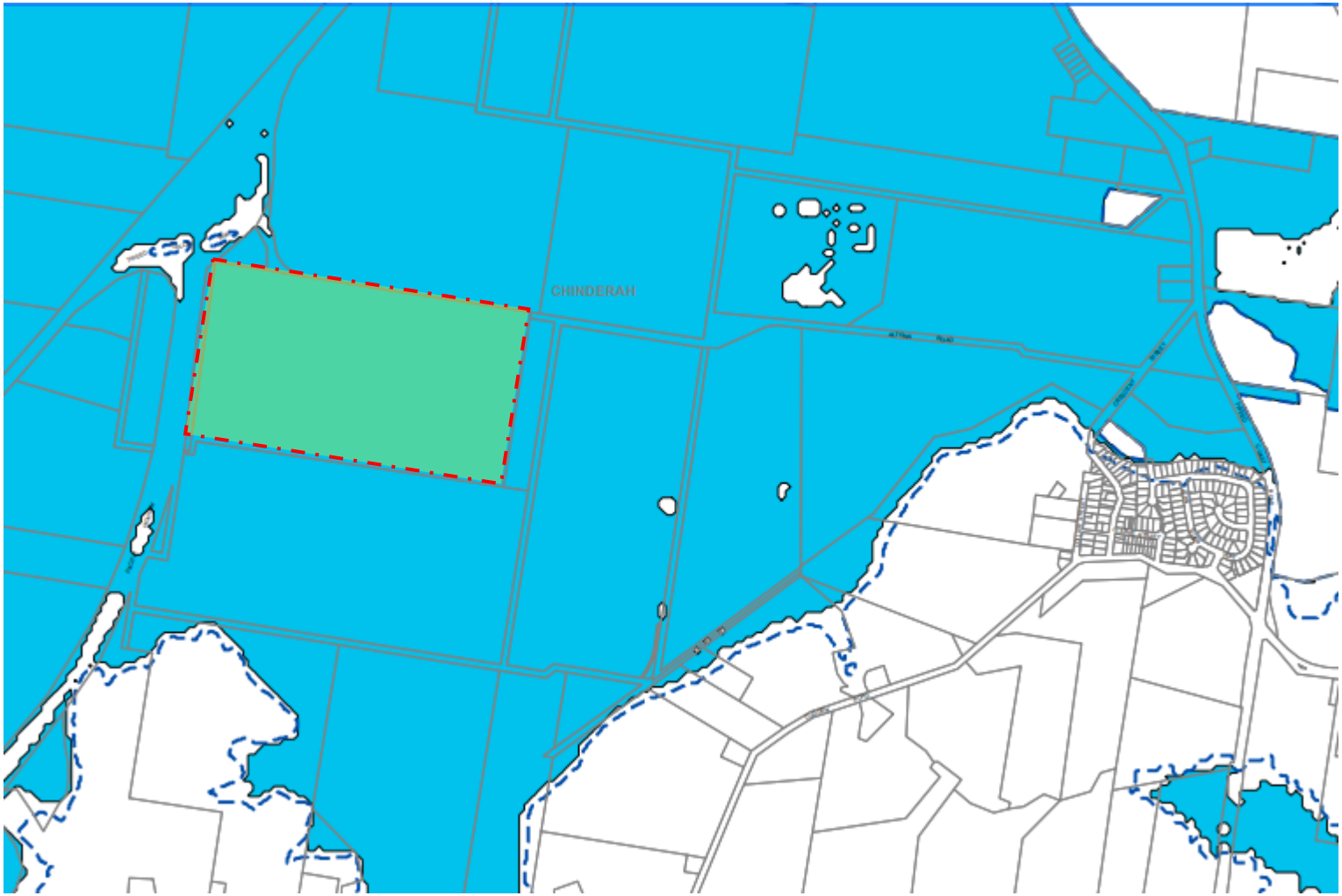
Image source: Six Maps (2009)

0 75 150m

Figure 2 - Site Layout
9484 Tweed Valley Way, Chinderah NSW

EarthTrak Pty Ltd
Acid Sulfate Soil Management Plan
Job No: 18313

Image source: Six Maps (2009)



Flood Planning Land

Flood Planning Area

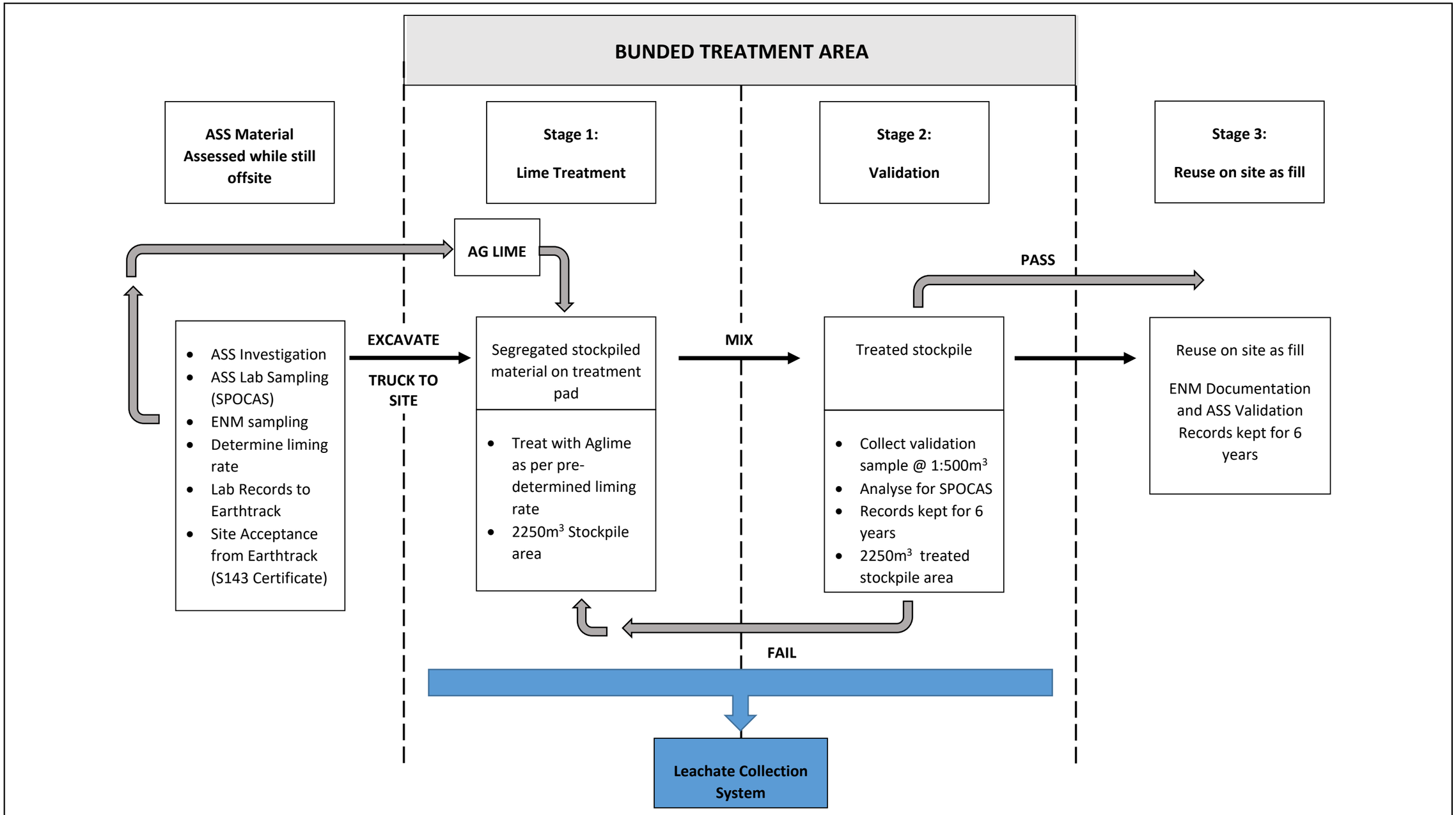
Level of Probable Maximum Flood

Site area (approximate)

Image source: Tweed Shire Council (LEP, 2014)

Figure 3 – Flood Risk Mapping
9484 Tweed Valley Way, Chinderah NSW

EarthTrak Pty Ltd
Acid Sulfate Soil Management Plan
Job No: 18313



ENV Solutions
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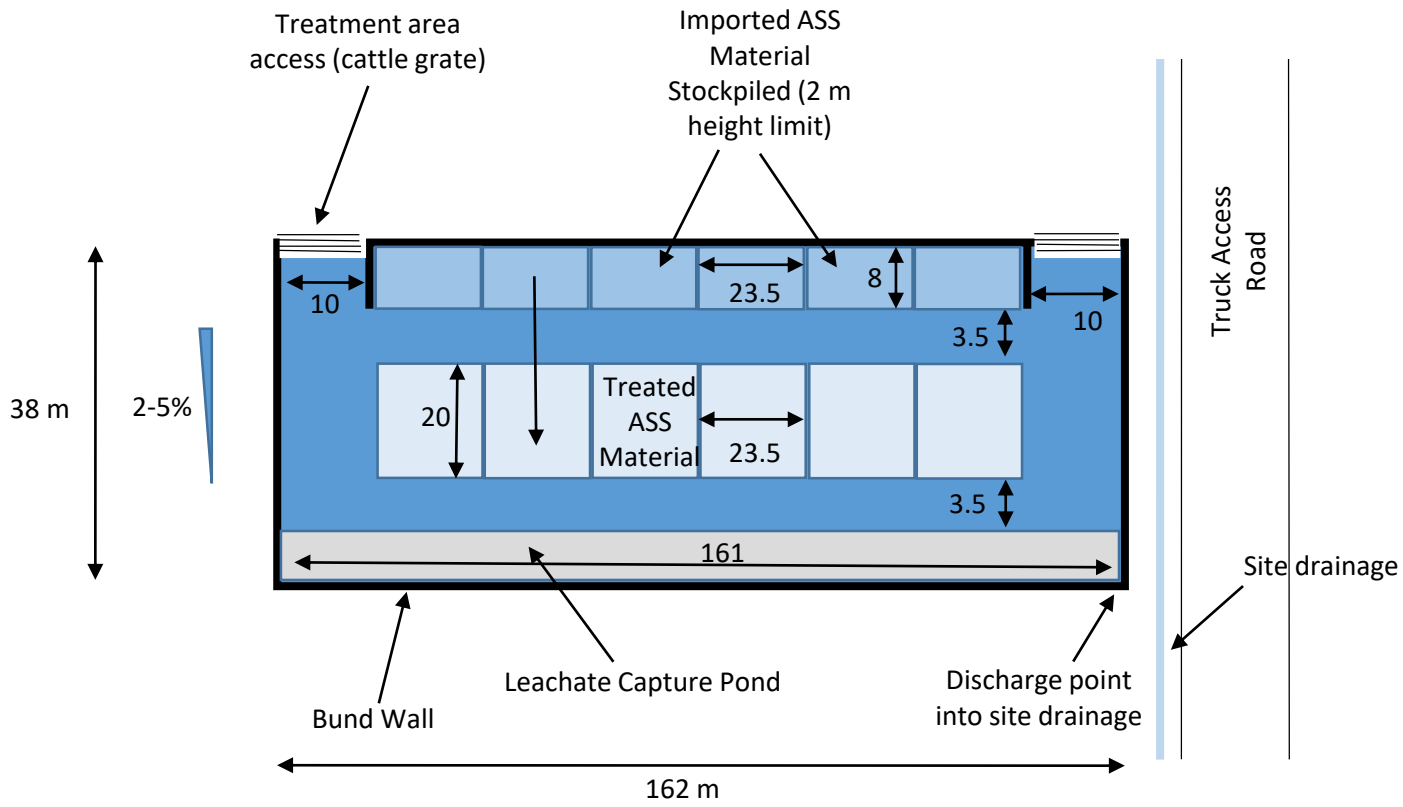
Job No.: 18313
Project: ASSMP

Figure 4 – ASS Treatment Flow Chart

Client: Earthtrak Pty Ltd

Date: 09/10/2018
By: Ollie Fick

Legend



Imported Stockpile Capacity:
6 x (23.5 x 8 x 2) = 2,256 m3

Treated Stockpile Capacity:
6 x (23.5 x 20 x 0.9) = 2,256 m3

Figure 5 – Treatment Area Layout
9484 Tweed Valley Way, Chinderah NSW

EarthTrak Pty Ltd
Acid Sulfate Soil Management Plan
Job No: 18313

ATTACHMENT 2

NSW EPA Waste Classification Guidelines (Part 4: Acid Sulfate Soils)

Waste classification guidelines

Part 4: Acid sulfate soils

www.epa.nsw.gov.au

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Contents

Classifying wastes into groups that pose similar risks to the environment and human health facilitates their management and appropriate disposal. It is the responsibility of those who generate waste to classify that waste. To assist waste generators classify the wastes they produce, the EPA has developed the *Waste Classification Guidelines* ('the Guidelines') which are a step-by-step process for classifying waste.

Generators and waste facilities must carefully follow the procedures in these Guidelines to ensure they comply with applicable laws in classifying their waste and safeguard protection of the environment and human health.

The Guidelines are comprised of the following sections, of which this document is Part 4:

Overview of the Guidelines

Part 1: Classifying waste

Part 2: Immobilisation of waste

Part 3: Waste containing radioactive material

Part 4: Acid sulfate soils

All sections of the Guidelines are available for download from the EPA website at www.epa.nsw.gov.au/waste/classification.htm.

Introduction

Acid sulfate soils (ASS) are those naturally occurring sediments and soils which contain sulfides, mainly iron sulfide and iron disulfide or their precursors. Exposure of these sulfides in the soil to oxygen – often as a result of drainage or excavation – can produce sulfuric acid, which may have a significant impact on the environment. Leaching of sulfuric acid into waterways can cause serious water quality problems, resulting in fish kills and damage to infrastructure, such as floodgates and bridges.

ASS are most commonly found in NSW along the coast and they need to be managed appropriately to avoid major environmental damage.

The NSW *Acid Sulfate Soils Manual*[1] (the ASS Manual) provides 'best practice' guidance for planning, assessing and managing activities in areas prone to developing ASS. The manual is available from the NSW Department of Planning: phone 1300 305 695.

Using this part of the Guidelines

This part of the EPA Waste Classification Guidelines (the Guidelines) applies to acid sulfate soils which are unable to be managed on-site. In these cases, off-site disposal to landfill is often the most appropriate management option.

Waste generators need to assess the status of ASS at their point of generation, using the techniques outlined in the ASS Manual. The ASS Manual also provides guidance for on-site management, while this part of the Waste Classification Guidelines details disposal requirements for ASS that need to be transported and managed off-site.

This document has advice on dealing with both 'potential' ASS and 'actual' ASS. The two types are often found together in the same soil profile, with actual ASS generally overlying potential ASS horizons.

Potential acid sulfate soils

Potential ASS are soils that contain iron sulfides or sulfidic materials that have not been exposed to air and thus are not oxidised. The pH of these soils in their undisturbed state is 5.5 or more, making them neutral or slightly alkaline. If not managed appropriately, potential ASS pose a considerable environmental risk: disturbance and exposure to air may render them severely acidic.

Handling potential acid sulfate soils prior to disposal

Potential ASS must be kept wet at all times during excavation and subsequent handling, transport and storage, until they can be disposed of safely. They must be received at the proposed disposal point within 16 hours of being dug up.

[1] Stone Y, Ahem, CR and Blunden, B 1998. *Acid Sulphate Soils Manual 1998*. Acid Sulphate Soils Management Advisory Committee (ASSMAC), Wollongbar, NSW.

Disposal of potential acid sulfate soils *below* the water table

Potential ASS may be disposed of in water below the permanent water table, provided:

- this occurs before they have had a chance to oxidise, i.e. within 24 hours of excavation

and

- they meet the definition of 'virgin excavated natural material' (VENM) under the *Protection of the Environment Operations Act 1997*, even though they contain sulfidic ores or soils.

Landfills must be licensed by the EPA to dispose of potential ASS below the water table. EPA's Environment Line has details on facilities able to accept this waste: phone 131 555.

Potential ASS must be disposed of within 8 hours of their receipt at a landfill and kept wet at all times until their burial at least two metres below the lowest historical level of the water table at the disposal site.

Documentation must be provided to the occupier of the landfill for each truckload of potential ASS received, indicating that the soil's excavation, transport and handling have been in accordance with the ASS Manual, thus preventing the generation of acid.

The occupier of the disposal site must also test the pH of each load of soil received immediately prior to its placement under water using the test method(s) in the ASS Manual (Methods 21A and/or 21Af). These details, together with the pH of the soil recorded at the time of its extraction, must be retained by the occupier of the landfill site.

The disposal site's licence will outline what documentation needs to be kept and for how long.

Soil that has dried out, undergone any oxidation of its sulfidic minerals, or which has a pH of less than 5.5 must be treated by neutralisation and disposed of at a landfill that can lawfully accept it (see **Disposal of actual acid sulfate soils** below).

The pH of the water at the landfill into which the potential ASS is placed must not be less than 6.0 at any time. Landfill licence conditions require the occupiers of potential ASS disposal sites to regularly monitor the pH of ground and surface waters at their premises.

Disposal of potential acid sulfate soils *above* the water table

Where potential ASS cannot be classified as VENM or a suitable underwater disposal site at a landfill is not available, the soil must be treated in accordance with the neutralising techniques in the ASS Manual. After treatment the soil should be chemically assessed in accordance with Step 5 in Part 1 of the Waste Classification Guidelines, available at www.epa.nsw.gov.au/waste/classification.htm. This will determine whether any other contaminants are present in the material. When the classification has been established, the soil should be disposed of to a landfill that can lawfully accept that class of waste.

Actual acid sulfate soils

Actual ASS contain highly acidic soil horizons or layers resulting from the aeration of soil materials that are rich in sulfides, primarily iron sulfide. This oxidation produces more hydrogen ions than the sediment is able to neutralise, resulting in soils with a pH of 5.5 or less when measured in dry season conditions. These soils can usually be identified by the presence of pale yellow mottles and coatings of jarosite.

Treatment of actual acid sulfate soils prior to disposal

Actual ASS must be treated by the generator of the waste before they can be considered for disposal. Treatment should be in accordance with the neutralising techniques outlined in the ASS Manual.

Disposal of actual acid sulfate soils

Following neutralisation, the generator of the waste must chemically assess the soil in accordance with Step 5 of Part 1 of the Waste Classification Guidelines. This will determine whether there are any other contaminants that may affect how the waste is classified for disposal.

Once classified, the waste must be taken to a landfill licensed to accept that class of waste.

Prior arrangements should be made with the occupier of the landfill to ensure that it is licensed to accept the waste. The landfill should be informed that the actual ASS has been treated in accordance with the neutralising techniques outlined in the ASS Manual and that the waste has also been classified in accordance with Part 1 of the Waste Classification Guidelines.

ATTACHMENT 3

Leachate Pond Calculations

SWMP Commentary, Standard Calculation

Note: These "Standard Calculation" spreadsheets relate only to low erosion hazard lands as identified in figure 4.6 where the designer chooses to not use the RUSLE to size sediment basins. The more "Detailed Calculation" spreadsheets should be used on high erosion hazard lands as identified by figure 4.6 or where the designer chooses to run the RUSLE in calculations.

1. Site Data Sheet

Site name: ABLP ASS Treatment

Site location: 9484 Tweed Valley Way, Chinderah NSW

Precinct:

Description of site: ASS Treatment Area

Site area	Site						Remarks
	1	2					
Total catchment area (ha)	0.6118						
Disturbed catchment area (ha)	0.6118						

Soil analysis

Soil landscape							DIPNR mapping (if relevant)
Soil Texture Group	B						Sections 6.3.3(c), (d) and (e)

Rainfall data

Design rainfall depth (days)	5						See Sections 6.3.4 (d) and (e)
Design rainfall depth (percentile)	90						See Sections 6.3.4 (f) and (g)
x-day, y-percentile rainfall event	82.5						See Section 6.3.4 (h)
Rainfall intensity: 2-year, 6-hour storm	16						See IFD chart for the site
Rainfall erosivity (R-factor)	5840						Automatic calculation from above data

Comments:

2. Storm Flow Calculations

Peak flow is given by the Rational Formula:

$$Qy = 0.00278 \times C_{10} \times F_Y \times I_{y,\,tc} \times A$$

where:

- Q_y is peak flow rate (m^3/sec) of average recurrence interval (ARI) of "Y" years
- C_{10} is the runoff coefficient (dimensionless) for ARI of 10 years. Rural runoff coefficients are given in Volume 2, figure 5 of Pilgrim (1998), while urban runoff coefficients are given in Volume 1, Book VIII, figure 1.13 of Pilgrim (1998) and construction runoff coefficients are given in Appendix F
- F_y is a frequency factor for "Y" years. Rural values are given in Volume 1, Book IV, Table 1.1 of Pilgrim (1998) while urban coefficients are given in Volume 1, Book VIII, Table 1.6 of Pilgrim (1998)
- A is the catchment area in hectares (ha)
- $I_{y,\,tc}$ is the average rainfall intensity (mm/hr) for an ARI of "Y" years and a design duration of "tc" (minutes or hours)

Time of concentration (t_c) = $0.76 \times (A/100)^{0.38}$ hrs (Volume 1, Book IV of Pilgrim, 1998)

Note: For urban catchments the time of concentration should be determined by more precise calculations or reduced by a factor of 50 per cent.

Peak flow calculations, 1

Site	A (ha)	tc (mins)	Rainfall intensity, I, mm/hr						C_{10}
			$1_{yr,tc}$	$5_{yr,tc}$	$10_{yr,tc}$	$20_{yr,tc}$	$50_{yr,tc}$	$100_{yr,tc}$	
1	0.6118	7	122	186	204	229	261	234	0.82
2									

Peak flow calculations, 2

ARI yrs	Frequency factor (F_y)	Peak flows						Comment
		1	2					
		(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m3/s)	
$1_{yr,\,tc}$	0.67	0.114						
$5_{yr,\,tc}$	0.92	0.239						
$10_{yr,\,tc}$	1	0.285						
$20_{yr,\,tc}$	1.07	0.342						
$50_{yr,\,tc}$	1.17	0.426						
$100_{yr,\,tc}$	1.28	0.418						

4. Volume of Sediment Basins, *Type D* and *Type F* Soils

Basin volume = settling zone volume + sediment storage zone volume

Settling Zone Volume

The settling zone volume for *Type F* and *Type D* soils is calculated to provide capacity to contain all runoff expected from up to the y-percentile rainfall event. The volume of the basin's settling zone (V) can be determined as a function of the basin's surface area and depth to allow for particles to settle and can be determined by the following equation:

$$V = 10 \times C_v \times A \times R_{y\text{-}\%ile,\ x\text{-}day} \ (m^3)$$

where:

10 = a unit conversion factor

C_v = the volumetric runoff coefficient defined as that portion of rainfall that runs off as stormwater over the x-day period

R = is the x-day total rainfall depth (mm) that is not exceeded in y percent of rainfall events. (See Sections 6.3.4(d), (e), (f), (g) and (h)).

A = total catchment area (ha)

Sediment Storage Zone Volume

In the standard calculation, the sediment storage zone is 50 percent of the setting zone. However, designers can work to capture the 2-month soil loss as calculated by the RUSLE (Section 6.3.4(i)(ii)), in which case the "Detailed Calculation" spreadsheets should be used.

Total Basin Volume

Site	C_v	R x-day y-%ile	Total catchment area (ha)	Settling zone volume (m^3)	Sediment storage volume (m^3)	Total basin volume (m^3)
1	0.82	82.5	0.6118	413.8827	207	620.82405
2						

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		Name	Signed
FINAL	18/10/2018	James Foster	

Scope of Engagement / Statement of Limitations

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The conclusions presented in this report are based on a limited investigation of conditions with specific sampling locations chosen to be as representative as possible under the circumstances.

ENV's professional opinions contained in this report are subject to modification if additional information is obtained through further investigation, observation or validation testing and analysis during remedial activities. In some cases, further testing and analysis may be required, which may result in a further report with different conclusions.