



Lake Mackay SOP Project

Preliminary Acid Sulfate Soils Investigation

Prepared for:

Agrimin Limited

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● people ● planet ● professional

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Executive Summary

360 Environmental Pty Ltd (360 Environmental) was commissioned by Agrimin Limited (Agrimin) to undertake a Preliminary Acid Sulfate Soil Investigation for the Lake Mackay Sulfate of Potash (SOP) Project site. This investigation provides an evaluation of the potential for acid generation due to the disturbance of near surface sediments at the Lake Mackay SOP Project site.

The Mackay SOP Project comprises twelve tenements covering the majority of Lake Mackay for a combined area of approximately 3,013 km² (Figure 1). The nearest township is Kiwirrkurra, WA, located approximately 65 km south-west of the lake.

The Project covers the majority of the Western Australia portion of Lake Mackay, which is a hypersaline lake. While typically associated with coastal environments, acid sulfate soils (ASS) can also develop in hypersaline lakes where the degradation of organic material and abundant sulfate in groundwater becomes reduced in anoxic environments to form sulfide minerals, ranging from acidic monosulfide muds (black oozes) to pyrite.

In recognition that there is a potential for AASS and PASS to occur at the site, the following preliminary ASS investigation has been guided by the Department of Water and Environmental Regulation's (DWER) guideline *Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes* originally published in 2015 by the former Department of Environment Regulation (DER, 2015a). Given the Project area is considerably larger than 50 ha, strict adherence to the soil sampling requirements of the Acid Sulfate Soil Guideline Series (2015) has not been undertaken at this preliminary stage of the Project development. This preliminary investigation has been designed to opportunistically collect samples in association with other field programmes, however, the scope of work is considered to provide sufficient data to enable a preliminary evaluation of the potential for acid generation due to the disturbance of near surface sediments at the site.

Sediment samples were collected in conjunction with the installation of fourteen (14) x 100 m test trenches and 1 pilot pond [to depths up to 10 m below ground surface (mbgs)] that were installed by Agrimin between 13 August 2017 and 30 October 2017.

Objectives and Scope

The objectives of this preliminary acid sulfate soil investigation are as follows:

- To opportunistically collect samples as part of the lake trenching programme to characterise the acid generating and neutralising capacity of the near surface sediments that may be disturbed during development activities;
- To determine (to the extent possible) the areas where ASS exists in the proposed areas of intrusive ground disturbance;
- To obtain sufficient information so that an initial analysis of the risks and consequences associated with the disturbance and exposure of acid generating materials, including potential impacts on benthic habitats, water quality and local vegetation, and

- To enable a general understanding of the requirements for suitable management practices to be adopted during site development and operations and identify requirements for further investigations as part of the mining approvals process.

The following scope of work has been undertaken:

- Project management and organisation of logistics with Agrimin;
- Review of existing geologic, drilling, and hydrogeologic data from the project area;
- Preparation of a field work plan to be coordinated with the existing trenching programme for onsite use by Agrimin that defines the number of samples to be collected at each trench location including sample collection methods;
- Training of Agrimin personnel on the collection methods and field testing procedures;
- Collection of samples at 0.5 m intervals (where possible) for analysis of pH_F and pH_{FOX} through the profile of each trench (a total of 119 primary samples and 14 QA/QC have been collected) to a total depth of 10 mbgs;
- Submission of up to 10 samples from each encountered lithology for laboratory analysis by a NATA accredited laboratory (ALS) for chromium reducible sulfur (CRS) (67 primary samples and 4 QA/QC), for metals (aluminium, arsenic, chromium, cadmium, copper, iron, lead, mercury, nickel and zinc) (23 primary samples and 3 QA/QC) and for total uranium (17 primary samples and 1 QA/QC), and
- Data interpretation, review of existing hydrogeological data (including groundwater quality) and other support documents and preparation of a preliminary technical report including and assessment of potential ASS risks and recommendations for future site investigation and management requirements.

Results - ASS Occurrence

Based on soil field pH results (obtained from 119 samples), there were no pH_F values indicative of actual acid sulfate soil (AASS) and there were no pH_{FOX} values indicative of potential acid sulfate soil (PASS) from any of the soil samples tested. Based on the laboratory results, no occurrences of AASS were identified within the Project area. Within the majority of the project area there were no occurrences of PASS, with the exception of only two black ooze samples collected from sample locations along the southern edge of lake. The findings are summarised in the table below:

ASS Distribution

Soil Type	Number of samples	Description	Depth (mbgs)	CRS (%S)	Net Acidity (%S)	ASS Classification
Black Ooze	11	Dark brown to black thin layer approximately 5 mm thick.	0 – 0.05	<0.005 to 0.12	<0.02	Majority NASS, with only two samples in the very southern end of lake slightly exceeds assessment criteria for CRS (PASS)
SAND, light brown, brown or grey	20	Light brown, brown, cream or grey evaporitic sand. The sands contain variable gypsum and fine silt content. Typically a thin layer (approximately 8 mm thick) was observed. Sand was typically observed either above (on the ground surface) or below the black ooze layer and typically extended to depths of up to 1 mbgs. However, in three trenches (T11, T12 and T20) cream or grey evaporative sand was also encountered between 2.0 and 6 m, interbedded with orange/ red / brown clays and sandy clays.	0 – 6	<0.05 to 0.005	<0.02	NASS
SILTY to SANDY CLAY Red/ brown or light brown OR SILTY to CLAYEY SANDS, red/brown	17	Red brown or light brown clay with varying sand and silt content or red / brown silty to clayey sands was observed within the majority of trenches, typically underlying the black ooze and extending up to 5 m bgs.	0.05 – 5	<0.005 to 0.006	<0.02	NASS
CLAY, Red / brown	65	Thick layer of red/brown firm to hard clay. The clay extends to the maximum depth of 10 mbgs across the site. The clay may be interbedded at isolated locations with thin sand layers.	~ 0.3 - 10	<0.005 to 0.016	<0.02	NASS
CLAY, green and SILTY CLAY, green/brown	6	In one trench (T22) a green firm to hard clay was encountered at 4 mbgs and was underlain by a green/brown silty clay. A red/brown/ green firm to hard clay was also observed in Trench 9, PP and 12 (between 2 and 6 m bgl). A green clay (soft to firm) and plastic was also observed at 2 to 2.5 mbgs at trench (T20).	2.0 to 6	<0.005 to 0.006	<0.02	NASS

Conclusions and Recommendations

Based on the results presented in this report, 360 Environmental makes the following conclusions:

- Based on soil field pH results, there were no pH_F values indicative of actual acid sulfate soil (AASS) and there were no pH_{FOX} values indicative of potential acid sulfate soil (PASS) from any of the soil samples tested;
- For three black ooze samples, a laboratory pH decrease greater than 3 units (3.1 to 3.4) between pH_F and pH_{FOX} was reported. This indicates that some black ooze samples have acid generating potential (PASS). Sixty percent (60%) of black ooze samples reported a CRS %S above laboratory limits of reporting (LOR). Two of the black ooze samples (T20_0.03 and PP_0.02), located on the very southern edge of the lake, indicate that these two samples are PASS with CRS concentrations of 0.062%S and 0.12%S. Given that the majority of the remaining black ooze samples collected from the central sections of the lake recorded pH changes below the criteria, and no other criteria were exceeded, overall the black ooze lithology in the central sections of the lake is determined to be NASS. The western edge of the lake was not sampled during the investigation and it is possible that black ooze may also be PASS along the western fringe of the lake;
- All other soil types reported no laboratory pH changes greater than 3 units, indicative of NASS. The remainder of the samples from all other soil types had a concentration of CRS below the 0.03 %S action criteria, indicating the majority of the soil types were NASS. Further, most other lithologies had a CRS concentration less than LOR with only 23% of red/brown clays reporting a CRS above LOR;
- Net Acidity [minus acid neutralising capacity (ANC)] was <0.02 %S in the majority of analysed soil samples, confirming the majority of soils are non-acid sulfate soils (NASS). Only two black ooze samples in the very southern end of lake reported net acidity minus ANC above assessment criteria, ranging from 0.06 to 0.12 S%;
- In addition, acid neutralising capacity (ANC) across all soil types ranged from 0.04 %S to 3.9 S%. Based on these results, the majority of lithologies encountered are considered to have a low risk of acid generation due to the absence of sulphides and the inherently elevated ANC;
- All heavy metal concentrations for all lithologies were below their relevant Ecological Investigation Levels (EILs), indicating they pose a low risk to the receiving ecological environment;
- The majority of soils samples reported total uranium at less than the laboratory limit of reporting, the only exception was one soil sample from the pilot pond location. All soil samples reported concentrations below the soil standards for the protection of human health from Canada (Nova Scotia). In the absence for EILs for uranium, the soil standards for the protection of human health from Canada (Nova Scotia) have been adopted;

- Aluminium and iron were detected within all samples with the highest concentrations observed within the SANDY CLAY red/brown, CLAY red brown and CLAY, green lithologies suggesting that there is a potential for aluminium and iron mobilisation into the groundwater from these units under acidic conditions;
- Site specific groundwater information was collected as part of a separate hydrogeological study undertaken as part of the baseline assessment for the Project. High concentrations of chloride, sodium and TDS were observed in all of the groundwater samples which are indicative of a hypersaline lake, and
- The $\text{Cl}^-:\text{SO}_4^{2-}$ ratio of the groundwater was greater than 2 (ranged from 6.4 to 11.6) in all groundwater analysed indicating that there is not likely to be an extra source of sulfate from current or historic sulfate oxidation and leaching into the groundwater system. The concentrations within the groundwater are representative of natural background concentrations within an undisturbed environment.

The following recommendations are made based on the outcome of this preliminary ASS investigation:

- Further sampling and analysis should be undertaken of the black ooze material in the southern and western fringes of the lake where development is potentially going to occur;
- Based on the results of this preliminary investigation, a limited Acid Sulfate Soils Management Plan (ASSMP) may be required only to manage the black ooze material in the southern and western fringes of the lake. However, this will be determined following further sampling and analysis in these areas;
- To establish more detailed baseline conditions of the underlying groundwater, it is recommended that groundwater monitoring for pH, redox, dissolved oxygen, electrical conductivity (EC) is undertaken and future groundwater samples are analysed for:
 - Total acidity, total alkalinity, pH;
 - Dissolved metals (aluminium, arsenic, chromium, iron, manganese, nickel, selenium, zinc);
 - Total metals (aluminium, iron);
 - Ammonia, total nitrogen, total phosphorus, filterable reactive phosphorus (FRP), and
 - TDS (mg/L).

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1 Introduction

360 Environmental Pty Ltd (360 Environmental) was commissioned by the Agrimin Limited (Agrimin) to undertake a Preliminary Acid Sulfate Soil Investigation for the Lake Mackay Sulfate of Potash (SOP) Project site. This investigation provides an evaluation of the potential for acid generation due to the disturbance of near surface sediments at the Lake Mackay SOP Project site (Figure 1).

The Mackay SOP Project comprises twelve tenements covering the majority of Lake Mackay for a combined area of approximately 3,013 km². Lake Mackay (the lake, locally known as Wilkinkara) is a seasonally inundated salt lake located in the Great Sandy Desert on the Western Australian (WA) and Northern Territory (NT) border, with most of the lake located in WA. The nearest township is Kiwirrkurra, WA, located approximately 65 km south-west of the lake. The Project covers the majority of Lake Mackay which is hypersaline.

1.1 Background

The Project currently has an Indicated Mineral Resource of 4.4 million tonnes and an Inferred Mineral Resource of 18.9 million tonnes of SOP at a potassium concentration of 3,603mg/L of brine. These Mineral Resources have been defined to an average depth of 24.7 m, however, the initial study incorporates brine extraction from only the top 5.5 m of the deposit. This preliminary ASS investigation has examined lake sediments to a depth of 6 m below ground surface (mbgs).

Sediment samples were collected in conjunction with the proposed installation of fourteen (14) x 100 m test trenches and 1 pilot pond [to depths up to 10 m below ground surface (mbgs)] that were installed by Agrimin between 13 August 2017 and 30 October 2017.

1.1.1 Acid sulfate soils in hypersaline environments

Acid sulfate soils (ASS) are the common name given to soils containing iron sulfides or their oxidation products. Upon exposure to air, the iron sulfides (commonly pyrite) oxidise to produce sulfuric acid, iron precipitates and potentially elevated concentrations of elements such as aluminium, iron and arsenic that have the potential to adversely impact upon the environment.

While typically associated with coastal environments, ASS can also develop in hypersaline lakes where the degradation of organic material and abundant sulfate in groundwater becomes reduced in anoxic environments to form sulfide minerals, ranging from acidic monosulfide muds (black oozes) to pyrite. Although the hypersaline environment typically contains a considerable surplus of acid neutralising capacity, because the rates of acid generation and acid neutralisation may differ, development activities such as trenching, excavation and dredging, as well as loading that result in the compaction of saturated soils or sediments, may result in temporary or long-term acid generation. Fluxes in the natural balance between acid generation and neutralisation, may pose a risk to biota associated with the hypersaline lake system. Intermittent black oozes have previously been encountered within the lake sediments during the exploration activities.

1.2 Objectives

This ASS investigation has been undertaken in order to characterise ASS within the on-lake environment site in recognition that there is a potential for actual ASS (AASS), potential ASS (PASS) and non-ASS (NASS) to occur at the site.

The objectives of this preliminary acid sulfate soil investigation were as follows:

- Opportunistically collect samples as part of the lake trenching programme to characterise the acid generating and neutralising capacity of the near surface sediments that may be disturbed during development activities;
- To determine (to the extent possible) the areas where ASS exists in the proposed areas of intrusive ground disturbance;
- To obtain sufficient information so that an initial analysis of the risks and consequences associated with the disturbance and exposure of acid generating materials including potential impacts on benthic habitats, water quality and local vegetation, and
- To enable a general understanding of the requirements for suitable management practices to be adopted during site development and operations and identify requirements for further investigations as part of the mining approvals process.

1.3 Scope of Works

The following preliminary ASS investigation will be guided by the DWER guideline *Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes* originally published in 2015 by the former DER (DER, 2015a). Given the Project area is considerably larger than 50 ha, strict adherence to the soil sampling requirements of the Acid Sulfate Soil Guideline Series (2015) has not been undertaken at this preliminary stage of the Project development. This preliminary investigation has been designed to opportunistically collect samples in association with other field programmes, however, the scope of work is considered to provide sufficient data to enable a preliminary evaluation of the potential for acid generation due to the disturbance of near surface sediments at the site.

The following scope of work has been undertaken:

- Project management and organisation of logistics with Agrimin;
- Review of existing geologic, drilling, and hydrogeologic data from the project area;
- Preparation of a field work plan to be coordinated with the existing trenching programme for onsite use by Agrimin that defines the number of samples to be collected at each trench location including sample collection methods;
- Training of Agrimin personnel on the collection methods and field testing procedures;
- Collection of samples at 0.5 m intervals (where possible) for analysis of pH_F and pH_{FOX} through the profile of each trench (a total of 119 samples and 14 QA/QC have been collected to date) to a total depth of 10 mbgs;
- Submission of up to 10 samples from each encountered lithology for laboratory analysis by a NATA accredited laboratory (ALS) for chromium reducible sulfur (CRS)

(67 primary samples and 4 QA/QC), for metals (aluminium, arsenic, chromium, cadmium, copper, iron, lead, mercury, nickel and zinc) (23 primary samples and 3 QA/QC) and for total uranium (17 primary samples and 1 QA/QC), and

- Data interpretation, review of existing hydrogeological data (including groundwater quality) and other support documents and preparation of a preliminary technical report (this report) including and assessment of potential ASS risks and recommendations for future site investigation and management requirements.

1.4 Regulatory Guidance

Guidance on the assessment and management of ASS is provided in the following documents:

- DWER (former DER), 2015a. *Acid Sulfate Soils Guideline Series – Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes*.
- DWER (former DER), 2015b. *Acid Sulfate Soils Guideline Series – Treatment and Management of Soil and Water in Acid Sulfate Soils Landscapes*.

The *Acid Sulfate Soil Guideline Series* (2015) provides action criteria based on levels of oxidisable sulfur measured for broad categories of sediment types. Works undertaken in sediments or soils that exceed these action criteria may require the preparation of an acid sulfate soil management plan (ASSMP).

2 Proposed Activities

The information in this section has been obtained from the Agrimin Mackay SOP Project Scoping Study (Lycopodium, 2016) and represents a preliminary concept model of the Project that is subject to change based on the results of future findings during the pre-feasibility and feasibility stages of the Project. SOP production will involve the pumping of brine from extraction trenches into a series of solar evaporation ponds. Crystallised potassium salts will then be dry harvested and trucked to the process plant for processing into SOP. The SOP products will be transported in bulk by road trains to a rail load-out located in Alice Springs and then railed to a selected port for shipment. The proposed site layout is presented in Figure 2.

2.1 Sediment Disturbing Activities

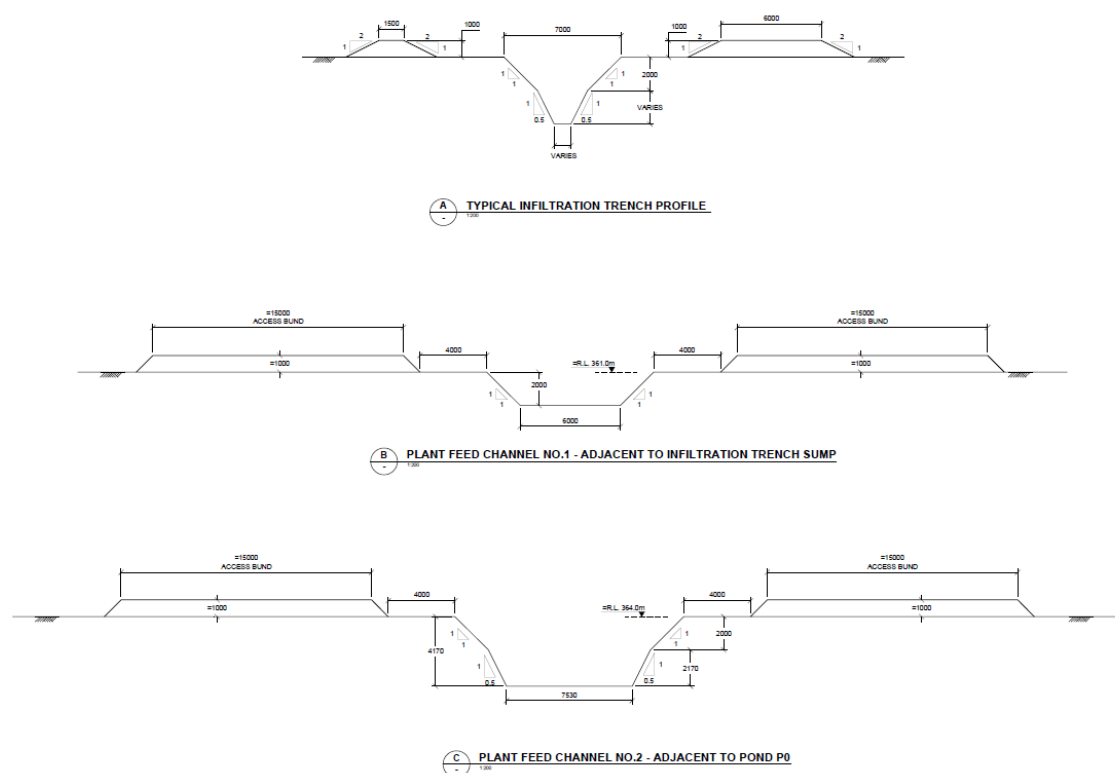
The SOP Project covers the majority of Lake Mackay for a combined area of approximately 3,013 km².

Based on current information (Knight Piesold 2018), the brine (66.5 GL per year) will be extracted via an approximately 550 km long trench network. The lake sediment will be excavated to construct the trench network and placed alongside the trenches. The trench design based on a depth of 5.5 m is shown in Plate 1. Some excavated sediment will be used for the road bases. The trenches will have an average width of 7 m on surface. However, the total trench disturbance will be between 40 m and 60 m on surface after allowing for the extracted material to be placed along the sides of each trench. This extracted material be formed and compacted to create a 1 m high bund along the sides of each trench.

The trench network will feed into a pond feed channel that will drain to the evaporation ponds. The lake sediments will also need to be excavated to construct the pond feed channels. It is expected that the sediment excavated will be placed alongside the pond feed channels.

The potassium concentration has been estimated at 3,600 mg/L of brine.

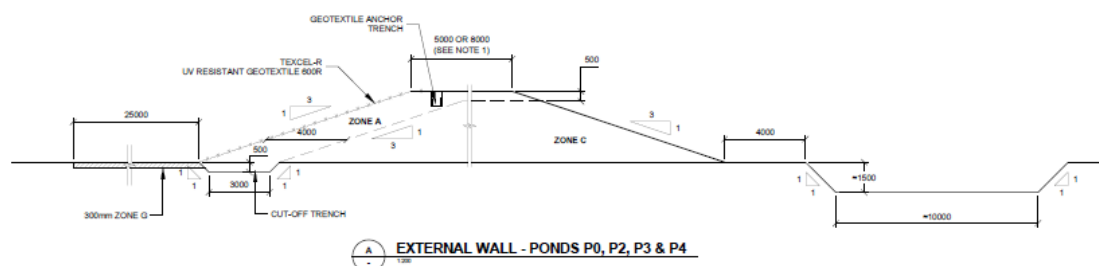
Plate 1: Proposed excavation trench (from Knight Piesold 2018)



The brine will be evaporated within a series of evaporation ponds to facilitate the crystallisation of targeted potassium salts. Solar evaporation ponds will be constructed on the western side of Lake Mackay (Figure 2). This will involve the cut-to-fill construction of pond walls on the surface of the lake using the lakebed clay sediments. Therefore, the lake sediments will be excavated to form the ponds. Due to the lake's favourable geotechnical characteristics these ponds can be unlined (Plate 2). The evaporation ponds will cover an initial area of 3,400 ha and will expand to 6,000 ha over a 20-year period (Knight Piesold 2018). This is easily accommodated by Lake Mackay which has a total area of approximately 350,000 ha.

A geotextile liner will be used on the external pond walls to protect against erosion.

Plate 2. External Evaporation Pond Wall (from Knight Piesold 2018)



The process plant will not be constructed on the lakebed. At this stage it is expected that lake sediments will not be disturbed during the construction of the plant. The process

plant components are planned to be prefabricated, pre-assembled, standard types of mechanical and electrical equipment, either mobile or fixed (Lycopodium, 2016).

Stockpiled potassium salts from the ponds will be coarsely crushed, screened and fed into a flotation process to separate the bulk of the potassium salts from halite and other minor materials (Lycopodium, 2016). Concentrated potassium salts will then be sent to the SOP crystallisers where process water is added to dissolve excess magnesium sulfate to produce SOP (Lycopodium, 2016). The SOP crystals will be dried, compacted and glazed to meet desired product specifications (Lycopodium, 2016).

In addition, proposed activities that result in the compaction of saturated soils or sediments are also a process that may result in the disturbance of acid sulfate sediments. These may include loading and stockpiling of potassium salts and granular SOP and disposal of process waste to a tailings stack.

Sediment disturbance may also be required for the construction of site infrastructure including a tailings stack and a site access road from the process plant to the evaporation ponds.

2.2 Groundwater Extraction

The brine (hypersaline groundwater) will be extracted via an approximately 540 km long trench network. It is expected that 66.5 GL of hypersaline groundwater will be extracted per year. The radius of drawdown from the proposed extraction has not yet been determined. However, possible acid sulfate sediments within the cone of depression from the proposed extraction could be disturbed from the lowering of the water table.

It is estimated that 2.3 GL of fresh water per year will be required to operate the process plant and other uses for the Project. This groundwater is proposed to be extracted from a borefield located approximately 15 km south of the proposed plant site (Lycopodium, 2016). The proposed borefield is approximately 14 km south of the lakebed. Based on this distance, the likely radius of drawn down of the groundwater table from the extraction of water will not impact on Lake Mackay sediments.

3 Environmental Setting

3.1 Geology

Based on the Regolith of Western Australia (500 m grid) (GeoView online map), regionally the surface geology of the site is described as Lacustrine deposits, including lake, playa (temporary lake) and fringing dunes. Lacustrine deposits typically comprise mud, silt, evaporate, limestone and minor sand (Quaternary in age). Based on the 1:250,000 Geological Series Sheet (1976) Sheet SF 52-10, other geological units that occur in association with Lake Mackay include:

- Halite, gypsum, sand, silt, clay - evaporitic and lacustrine, and
- Sand, halite, gypsum, calcrete - aeolian and minor evaporitic.

In the area adjacent to Lake Mackay, aeolian deposits, comprising sand and clayey sand are present as longitudinal dunes. Sand plain deposits (quaternary in age) also occur within the extent of Lake Mackay (Lycopodium, 2016). Extensive tracts of calcrete comprising massive, nodular and cavernous sandy limestone of tertiary age occur adjacent to Lake Mackay where they formed as paleodrainage valley infill deposits. Quaternary aeolian deposits often overlie the calcrete deposits (Lycopodium 2016).

The stratigraphy of Lake Mackay sediments comprises a coarse grained upper gypsum sand unit, predominately present in the eastern areas of the Lake to depths up to 1 mbgs. This unit has interbedded silt layers and grades downwards into sandy clay. Beneath this unit, red clay extends to underlying bedrock. The lake depth is approximately 16 m in the west of the lake and deepening to over 30 m on the northern territory border (Lycopodium, 2016).

3.2 Site specific lithology

A search of the DWER Water Information Reporting database in September 2017 identified 3 groundwater bores within the site that were drilled by Agrimin. Based on the drill logs that were available for these 3 groundwater bores, the site specific lithology can be summarised as follows:

- Brown clay or coarse gypsum sand 0 mbgs to 0.6 mbgs;
- Red brown to brown clay to sandy clay 0.6 mbgs to up to 2.7 mbgs;
- Fine cemented gypsum sand 1.8 mbgs to up to 3 mbgs;
- Red brown to brown clay with traces of gypsum 2.2 mbgs to 16 mbgs;
- Coarse crystalline gypsum 15 mbgs to 16.7 mbgs, and
- Red brown clay with traces of gypsum 16.5 mbgs to 30 mbgs.

Similar lithology was encountered during this ASS trench sampling investigation, namely:

- A surficial salt crust (in trenches T2, T6, T8, T14, T15, T16 and T21) and/or brown evaporative/gypsum sand (in trenches T6, T7, T8, T11 and PP), overlying a black ooze lithology in the majority of the trenches (T2, T5, T7, T12, T20, T21, T22 T14, T15, T16,

T2, T22 and PP) to a depth of up to 0.05 mbgs, underlain by light brown, brown or grey evaporative sand (T11, T12, T15, T16, T20 and T22) at some locations, up to a depth of 1 mbgs;

- This is further underlain by red brown or light brown silty to sandy clay with varying sand and silt content OR red / brown silty to clayey sands. In the majority of trenches this lithology was immediately below the black ooze lithology and extended up to 5 mbgs;
- This is further underlain by brown or red clays to a depth up to 10 mbgs. In some locations (T6, T9, PP), the brown, red clays were encountered directly beneath the surface sands or black ooze;
- In three trenches (T11, T12 and T20) cream or grey evaporative sand was also encountered between 2.0 mbgs and 6 mbgs, interbedded with orange/ red / brown clays and sandy clays, and
- In one trench (T22) a green firm to hard clay was encountered between 3.5 mbgs and 4.5 mbgs and was underlain by a green/brown silty clay to 6 mbgs. A red/brown/ green clay was also observed in Trench 9, PP and trench 12 (between 2 and 6 m bgl). A green clay (soft to firm) and plastic was also observed at 2 mbgs to 2.5 mbgs at trench (T20).

3.3 ASS Risk Mapping

The Australian National Acid Sulfate Soil Risk Map (ASRIS online map) indicates that Lake Mackay sediments have a high probability/low confidence of the presence of potential acid sulfate soils.

3.4 Topography and Hydrology

The site is located within the Mackay basin, specifically within Lake Mackay. Lake Mackay is an ephemeral hypersaline lake. The Lake Mackay lakebed covers an area of approximately 3,325 km² and measures approximately 100 km east to west and 100 km north to south. Lake McKay is the low point of the enormous groundwater and surface water catchment area that is approximately 87,000 km². The elevation of Lake Mackay ranges between 355 m and 370 m Australian Height Datum (AHD).

The catchment area extends mainly to the east of the lake through the valley between McDonnell Range and the range to the south (Lycopodium, 2016). This is the contributing catchment for the groundwater paleochannel system and for surface water runoff in times of abnormally heavy flows that generate significant surface flow. The catchment area excluding such abnormal rainfall periods is probably closer to approximately half this size (Lycopodium, 2016).

There is also an extensive system of paleovalleys and paleochannels. These originate in the Northern Territory and extend west to the valley between the ranges to Lake Mackay, which is the discharge point for water in the paleochannels (Lycopodium, 2016).

Lake Mackay undergoes some inundation during the wet season (December to March), with water entering the lake along a series of channels (Lycopodium, 2016).

3.5 Hydrogeology

A search of the DWER Water Information Reporting database in September 2017 identified 3 groundwater bores within the site (Appendix A) consisting of three groundwater bores drilled by Agrimin. The status and use of the bores were not specified.

There were no groundwater bores within a 1 km radius, surrounding the site. Based on this review, no current use of groundwater within a 1 km radius of the site can be identified.

The site is within the lakebed of Lake Mackay. Lake Mackay is the low point of the enormous groundwater and surface water catchment area. The water table underlying the lakebed is typically encountered at around 0.4 mbgs at most points around the lake. However, Lake Mackay undergoes some inundation during the wet season (December to March) (Lycopodium, 2016).

Regional groundwater flows predominantly from an easterly direction towards Lake McKay. Groundwater flows through the extensive system of palaeovalleys and palaeochannels originating in the Northern Territory and intersecting the lake in the east and along the southern boundary. Lake Mackay is the discharge point for groundwater and surface water in the paleochannels (Lycopodium, 2016). There is also possible upward groundwater migration from the basement beneath the salt lake (Lycopodium, 2016).

An investigation was undertaken by Geosciences Australia of the Wilkinkarra palaeovalley system, which is located east of Lake Mackay (Lycopodium, 2016). They concluded that the palaeovalley system ends in Lake Mackay. The investigation identified that the palaeovalley comprised an upper layer of calcrete and underlying units of sandy sediments with internal clay units all overlying weathered basement of the Arunta Region and Ngalia Basin. The groundwater flow within the channel is towards Lake Mackay (Lycopodium, 2016).

The groundwater underlying the site is considered to be hypersaline. No information is available on the quality (total dissolved solids) of the underlying groundwater.

3.6 Surrounding Land uses

The site is very remote. The closest town is Kiwirrkurra community located approximately 65 km south west of the Project.

3.7 Environmentally Sensitive Receptors

The nearest sensitive receptor is Lake Mackay and adjacent swamps and pans. The site is within the lakebed of Lake Mackay. Lake Mackay is an ephemeral hypersaline lake which can support significant populations of water birds and other salt lake fauna such as crustaceans during periods of inundation.

360 Environmental conducted a waterbird survey across the lake and local environs (flooded claypans and freshwater lakes) in April 2017 and a single phase Level 2 fauna survey (largely off-lake as well as targeting selected on-lake islands) in May 2017 for the Lake Mackay SOP Project for Agrimin. A total of 21 conservation significant species (including Priority species) were identified during the desktop review of database

searches. These comprised one reptile species, 16 bird species from 11 families, and three mammal species from two families (360 Environmental (a), 2017).

Five conservation significant species in total were recorded during the 10-day field survey – the Fork-tailed Swift (*Apus pacificus*), Australian Painted Snipe (*Rostratula australis*), Sharp-tailed Sandpiper (*Calidris acuminata*), Common Greenshank (*Tringa nebularia*) and Red-necked Stint (*Calidris ruficollis*). All species, except for the Fork-tailed Swift, were recorded during the waterbird survey (360 Environmental (b), 2017).

These migratory shorebirds (and other waterbirds) will likely utilise the Survey Area sporadically and are unlikely to depend exclusively on the foraging habitat present. This habitat is also widespread and common in the overall vicinity of the Survey Area and, importantly, is also more broadly represented around the lake and across the region. It should also be noted that these migratory birds are likely to only visit the lake and its claypans when episodically significant rainfall events occur and fill these waterbodies (360 Environmental (a), 2017).

360 Environmental also conducted a Detailed Flora and Vegetation Assessment for the Lake Mackay SOP Project for Agrimin in April 2017. No Threatened flora species pursuant to the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and/or gazetted as Threatened pursuant to the *Wildlife Conservation Act 1950* were recorded during the recent flora and vegetation survey (360 Environmental (c), 2017).

A review of the Department of Biodiversity Conservation and Attractions (DBCA), formerly Department of Parks and Wildlife (DPaW), threatened flora database and EPBC Protected Matters Search Tool (PMST) did not identify any Threatened/EPBC listed species, however, ten taxa listed as Priority flora were identified as potentially occurring in the survey area (360 Environmental, 2017). Of these ten conservation significant flora, four are considered Likely to occur – *Goodenia virgata* (P2) (recorded during the survey), *Thysanotus sp.* Desert East of Newman (P2), *Dampiera atriplicina* (P3) and *Goodenia modesta* (P3) (recorded during the survey).

Three Priority listed flora were recorded during the survey comprising one Priority 1 taxon (*Tecticornia globulifera*), one Priority 2 taxon (*Goodenia virgata*) and one Priority 3 taxon (*Goodenia modesta*) (360 environmental (c), 2017).

3.8 Potential Environmental Impacts

Disturbance of potential acid sulfate sediments (PASS) may potentially result in the oxidisation of sulfides and the generation of acidity. The major environmental impacts commonly associated with the acidification of acid sulfate sediments, either through dredging, excavation, dewatering or surcharging, include the release of acidity into water that in turn mobilises heavy metals such as aluminium, arsenic, manganese, iron, and zinc from within the sediment into the groundwater.

4 Sampling and Analysis Plan

4.1 Sediment Sampling Locations

Sediment samples were opportunistically collected as part of the lake trenching programme. Sediment samples have been collected during the excavation of 14 trenches of 100 m in length and 1 pilot pond (PP) to a depth of up to 10 m depth by Agrimin in August, September and October 2017.

In accordance with the *Acid Sulfate Soil Guideline Series* (2015) and given the Project area is considerably larger than 50 ha, the final sampling regime (if required) will need to be considered by the DWER on a project specific basis. The proposed methodology aims to provide a preliminary characterisation of the acid generating potential and neutralising capacity of near surface sediments that will be disturbed during development works.

The trench sample locations are shown in Figure 3 and further details are provided in Table A.

The general sampling requirement was the collection of field samples at 0.5 m intervals down the soil profile to a depth of 6 mbgs for the majority of trenches. In one trench (T12), samples were collected to a depth of 10 mbgs. In some trenches, water filled the trench at 0.33 mbgs to 1 mbgs and samples were unable to be collected from deeper depths.

Table A: Trench Location and Sediment Sample Details

Trench Number	Coordinates ¹ GDA94 Z 52		Sample Method	Max Depth of Sampling mbgs
	Easting	Northing		
2	460022	7512116	Trench sampling	0.5
5	479981	7508068	Trench sampling	0.33
6	482030	7494097	Trench sampling	4
7	484981	7511898	Trench sampling	5
8	490922	7507101	Trench sampling	4.5
9	491044	7519229	Trench sampling	6
11	495975	7518101	Trench sampling	6
12	499728	7513973	Trench sampling	10
14	452555	7515036	Trench sampling	1
15	485924	7491739	Trench sampling	0.5
16	452706	7505167	Trench sampling	1
20	485923	7491845	Trench sampling	6

Trench Number	Coordinates ¹ GDA94 Z 52		Sample Method	Max Depth of Sampling
	Easting	Northing		mbgs
21	474098	7504090	Trench sampling	5.5
22	495997	7513449	Trench sampling	6
PP	464400	7495221	Trench sampling	6

1. Coordinate estimated based on field GPS unless otherwise noted

4.2 Sediment Sampling Methodology

ASS sediment field investigations were undertaken over four sampling periods by Agrimin's Sustainability Manager and/or Hydrogeologist, namely:

- 13 August 2017 to 17 August 2017;
- 13 September to 14 September 2017;
- 27 September 2017, and
- 26 October to 30 October 2017.

A field work plan was provided by 360 Environmental to the Agrimin Sustainability Manager that defined the number of samples to be collected at each trench location including sample collection methods. Training of Agrimin personnel on the collection methods and field testing procedures was also undertaken by 360 Environmental.

Trenches were excavated at 15 locations (including the pilot pond) using an excavator. The general sampling requirement was the collection of 12 primary field samples and 1 duplicate sample per trench investigation down the soil profile to a depth of 6 mbgs (or as deep as the trench could be excavated). Sediment samples were collected at 0.5 m intervals, or at smaller intervals where variation in lithology or specific lithologies (such as black ooze, gypsum, yellow/ green clay) were observed.

Sediment sampling was undertaken partially in accordance with the Soil Characterisation Sampling and Analysis Plan (SAP) - Lake Mackay SOP (Appendix B). Any deviation from the SAP are described in the methodology outlined below:

- An excavator was used to dig the trenches and remove the sediment;
- Sediment was removed at regular 0.5 m intervals for sediment sample analysis (where possible);
- At each 0.5 m interval, a full bucket load of material was recovered from the trench (where possible);
- Each bucket load was placed on the lake surface alongside the trench in as compact a heap as possible;
- A compact heap was required to preserve the integrity of the material for sediment sampling. In some cases a sediment sample was unable to be taken straight away and it was a few days before the sample could be retrieved. By maintaining a

compact heap of material for sampling it was expected that the material towards the centre of the heap would be less compromised by oxygen ingress over a period of time and, therefore, still provided material of reasonable integrity for sampling when the opportunity arose;

- The material recovered for sampling was placed alongside the trench in order of depth, starting with the 0.5 m interval closest to the trench and placing subsequent material next to, but progressively further away from, the trench (i.e. 6.0 m sample was located furthest from the trench);
- Samples were collected using fresh, unused disposable gloves directly from alongside the trench, and
- Where a trench did not obtain its full (6.0 m) depth, or was abandoned, sample material was still recovered at 0.5 m intervals to the maximum trench depth that could be achieved.

Field samples were collected as per Table B. Laboratory sampling methods are detailed in Table C. Soil field testing (soil pH_F and pH_{FOX} testing) was undertaken in accordance with 360 Environmental Technical Standard Operating Procedures (TSOP) AS2 - *Acid Sulfate Soil Sampling* (Appendix B). Decontamination and Instrument Calibration was undertaken in accordance with 360 Environmental TSOP E2 –Decontamination and TSOP E-1 Instrument Calibration (Appendix B).

Table B: Field Sampling Requirements

SAMPLING COMPONENT	REQUIREMENT
Sample Logging	The lithology of the trenches was logged as per Agrimin's standards
Sample Volume	1x 400 ml bag (in laboratory supplied soil bags)
Sample Labelling	All samples bags were labelled with the following information: Sample ID : Sample Location_depth (e.g. T21_0.5) Sample Date and Time: DD/MM/YYYY HH:MM Sampler Name 360 Project Number: 2225
Sample Location	The geographic location of the sample was be recorded using handheld GPS or equivalent
Sample Storage	Samples were collected and stored in plastic bags and excess air removed prior to sealing.
Sample Preservation	Samples were preserved on ice in the field and in transit back to the site camp adjacent to Lake Mackay where they were then either analysed immediately or stored frozen for later analysis. If possible, all pH _F and pH _{FOX} field testing was carried out on samples stored at the camp within 24 hours of acquiring the samples. Frozen samples were transferred from the site camp to Alice Springs by plane in a sealed esky. In Alice Springs, the samples were immediately transferred to a freezer for storage. Frozen samples were then transported by plane from Alice Springs to Perth in a sealed esky where they were then transferred to a freezer prior to delivery to the laboratory. While every attempt was made to maintain the integrity of the samples, the remote location of the lake meant that transferring the samples over considerable distances prior to field and, particularly, laboratory analysis was unavoidable which, in turn, may have impacted sample results. The implications of the incorrect preservation are discussed in Section 5.
Field Documentation	F1 Project Field Log AS1 Soil pH _F and pH _{FOX} Testing
QA/QC	1:20 blind duplicate samples were collected

SAMPLING COMPONENT	REQUIREMENT
	Samples were sent to laboratory using the provided Chain of Custody (COC) form provided by 360 Environmental

Table C: Laboratory Sampling Requirements

SAMPLING COMPONENT	REQUIREMENT
Sample Volume	1x 400ml bag
Sample Preservation	Samples were chilled with ice in the field and then frozen on site back at camp. Samples were transferred frozen in a sealed esky to Alice Springs where they were once again stored in a freezer prior to transfer to Perth. Samples were transferred to Perth frozen in a sealed esky and stored in a freezer for delivery to the laboratory.
Laboratory	Samples were sent to the following Laboratory under appropriate COC. Eurofins/MGT Unit 2, 91 Leach Hwy, WA 6105, Kewdale

Agrimin personnel collected primary sediment samples at least every 0.5 m intervals through the profile of each trench and logged the sediment lithology noting any observations indicative of ASS, such as black organic matter, water level, moisture content any other diagnostic features.

Photographs showing the typical sediment profile at the site are provided in Appendix D.

Samples were chilled and sent under chain of custody to Nation Association of Testing Authorities (NATA) accredited laboratory Eurofins MGT for analysis.

4.3 Sediment pH_F and pH_{FOX}

Sediment field testing (soil pH_F and pH_{FOX} testing) was undertaken in accordance with 360 Environmental Technical Standard Operating Procedures (TSOP) AS2 - Acid Sulfate Soil Sampling (Appendix B) for trenches T2, T5, T7, T8, T14, T15, T16, T21 and T22. All primary and duplicate samples (total of 59 primary and 9 duplicates) were tested in the field for soil pH_F and pH_{FOX}. Samples were typically collected from at least 0.5 m intervals down the soil profile to a depth of up to 6 mbgs (or as deep as the trench could be excavated).

For these trenches (T2, T5, T7, T8, T14, T15, T16, T21 and T22), 36 select samples (also selected for Chromium Reducible Sulfur) were retested by the laboratory for pH_F and pH_{FOX} to assess the integrity of the handling and transport method.

For all remaining trenches and pilot pond, the sediment samples were analysed at NATA accredited laboratory (Eurofins MGT) for pH_F and pH_{FOX}. Samples were typically collected from at least 0.5 m intervals down the soil profile to a depth of up to 6 mbgs (or as deep as the trench could be excavated). A total of 95 primary and 5 duplicates (QA/QC) were analysed at NATA accredited laboratory (Eurofins MGT) for pH_F and pH_{FOX}.

In total, (both in the field and the lab), 119 primary samples and 14 QA/QC have been tested for sediment pH_F and pH_{FOX}.

4.4 Sediment Laboratory Analysis

A total of 67 primary and 4 duplicates (QA/QC) were analysed at NATA accredited laboratory (Eurofins MGT) for Chromium Reducible Sulfur (CRS). CRS analysis was undertaken from each lithology encountered to determine total sulfur concentration, net

acidity, and acid neutralising capacity (ANC). This was undertaken by Eurofins MGT. Samples were chosen for analysis in accordance with the DWER protocol based on field assessment criteria as detailed in Table E along with field observations. The laboratory soil samples were selected based on the highest risk sample (based on the field pH_F and pH_{FOX} tests) from each lithological unit in each sediment profile.

In addition, analysis for metals (aluminium, arsenic, chromium, cadmium, copper, iron, lead, mercury, nickel and zinc) was undertaken on 23 primary samples and 3 duplicate QA/QC from a range of identified lithologies encountered from the trenches. Analysis for total uranium was also undertaken on 17 primary samples and 1 duplicate QA/QC.

4.5 Temporary Groundwater Monitoring Wells

Thirty seven temporary groundwater monitoring wells were installed within the site between August and November 2017 under the supervision of Agrimin's Hydrogeologist as part of an associated hydrogeological study.

Monitoring piezometers were installed using a 150 mm wide auger attachment on the arm of the excavator. The resulting hole was filled with 50 mm OD PVC, slotted (1mm slot size) and blank 50 mm casing. The annulus is then filled with a 1,8 - 2.4 mm graded silica gravel pack to surface. All piezometers have bottom and top end caps.

Temporary monitoring well locations are presented in Figure 4 and summarised in Table D.

Table D: Temporary Monitoring Wells

ID	Coordinates GDA94 Z 52		Bore Hole Base mbgs	Screened Interval m below top of casing (TOC)	Top of Casing m (above ground)
	Easting	Northing			
T2 20mN	460022	7512136	4.08	Not provided	0.45
T2 50mN	460022	7512167	4.17	Not provided	0.35
T2 20mW	459997	7512072	4.31	Not provided	0.38
T2 50mW	459966	7512073	4.07	Not provided	0.28
T5 20mN	479984	7508098	4.5	Not provided	0.5
T5 50mN	479984	7508123	4.63	Not provided	0.57
T5 20mE	480009	7508031	4.8	Not provided	0.47
T5 50mE	480034	7508034	4.82	Not provided	0.44
T5 100mE	480084	7508035	4.67	Not provided	0.46
T6 20mN	482030	7494117	5.02	Not provided	0.5
T6 50mN	482033	7494146	5.08	Not provided	0.5
T6 20mE	482052	7494052	5.02	Not provided	0.5
T6 50mE	482086	7494053	5.02	Not provided	0.5
T6 100mE	482134	7494049	5.05	Not provided	0.5
T6 20mW	482005	7494051	4.82	Not provided	0.5
T8 20mN	490924	7507408	4.89	Not provided	0.5
T8 50mN	490925	7507438	4.89	Not provided	0.5
T8 20mE	490955	7507340	4.77	Not provided	0.5
T8 50mE	490986	7507346	4.58	Not provided	0.5
T8 100mE	491029	7507352	4.96	Not provided	0.5
T9 20mN	491048	7519251	-	Not provided	-
T9 50mN	491058	7519280	-	Not provided	-
T9 20mE	491058	7519181	-	Not provided	-
T9 50mE	491087	7519177	-	Not provided	-
T9 100mE	491134	7519167	-	Not provided	-
T11 20mN	495972	7518121	-	Not provided	-
T11 50mN	495967	7518149	-	Not provided	-
T11 20mE	496007	7518057	-	Not provided	-
T11 50mE	496036	7518062	-	Not provided	-
T11 100mE	496083	7518074	-	Not provided	-
T11 20mS	495995	7517978	-	Not provided	-
T11 50mS	495999	7517951	-	Not provided	-
T11 20mW	495962	7518042	-	Not provided	-
T11 50mW	495936	7518038	-	Not provided	-
T11 100mW	495896	7518027	-	Not provided	-
T12 20mW	499696	7514011	1.5	0.5-1.5	0.5
T12 30mW	499689	7514010	1.5	0.5-1.5	0.5
T14 20mN	452557	7515052	4.5	0.5-4.5	0.5
T14 50mN	452553	7515081	3.32	0.5-3.3	0.58
T14 20mE	452590	7514995	3.68	0.5-3.6	0.52
T14 50mE	452619	7515001	4.24	0.5-4.2	0.6
T14 100mE	452670	7515012	3.6	0.5-3.6	0.52
T14 20mS	452580	7514905	3.7	0.5-3.7	0.4
T14 50mS	452586	7514876	3.74	0.5-3.7	0.42
T14 20mW	452545	7514968	3.7	0.4-3.7	0.43
T14 50mW	452513	7514964	3.03	0.5-3	0.41
T16 20mN	452707	7505182	2.68	Not provided	0.4
T16 50mN	452706	7505215	2.4	Not provided	0.4
T16 20mE	452733	7505116	2.7	Not provided	0.39
T16 50mE	452762	7505115	3.18	Not provided	0.35
T16 100mE	452813	7505117	2.08	Not provided	0.55

ID	Coordinates GDA94 Z 52		Bore Hole Base mbgs	Screened Interval m below top of casing (TOC)	Top of Casing m (above ground)
	Easting	Northing			
T16 20mS	452709	7505043	3.5	Not provided	0.5
T16 50mS	452711	7505013	2.26	Not provided	0.45
T16 20mW	452682	7505118	2.39	Not provided	0.45
T16 50mW	452653	7505118	2.49	Not provided	0.37
T16 100mW	452604	7505119	2.66	Not provided	0.43
T20 20mN	485925	7491866	5.04	Not provided	0.5
T20 50mN	485922	7491898	5.05	Not provided	0.5
T20 20mE	485945	7491801	5.04	Not provided	0.5
T20 50mE	485974	7491800	4.96	Not provided	0.5
T20 100mE	486028	7491809	4.86	Not provided	0.5
T20 20mW	485898	7491813	4.96	Not provided	0.5
T20 50mW	485873	7491813	4.83	Not provided	0.5
T21 20mE	474048	7505047	-	Not provided	-
T21 50mE	474147	7505043	-	Not provided	-
T21 20mS	474098	7504965	-	Not provided	-
T21 50mS	474098	7504937	-	Not provided	-
T21 20mW	474071	7504965	-	Not provided	-
T21 50mW	474043	7504937	-	Not provided	-
T22 20mN	495958	7513457	1.5	0.5-1.5	0.5
T22 50mN	495952	7513489	1.5	0.5-1.5	0.5
T22 20mE	496018	7513455	4.3	0.5-4.3	0.5
T22 50mE	496048	7513455	3.8	0.5-3.8	0.5
T22 100mE	496098	7513455	4	0.5-4	0.5
PP1	464400	7495221	-	Not provided	-
PP2	464470	7495402	-	Not provided	-
PP3	464544	7495588	-	Not provided	-

4.6 Groundwater Laboratory Analysis

Groundwater analytical data was provided by Agrimin from associated hydrogeological studies undertaken by Agrimin. Groundwater samples were analysed at Intertek Genalysis for:

- Calcium (Ca), chlorine (Cl), potassium (K), magnesium (Mg), sodium (Na), sulfur (S), sulfate (SO₄);
- Specific gravity, and
- Total Dissolved Solids (TDS).

4.7 Quality Assurance and Quality Control (Sediment)

Field and laboratory quality assurance/quality control (QA/QC) measures are presented in Section 4.2 and evaluation of QA/QC data is presented in Section 5.

4.8 Assessment Criteria

ASS Assessment criteria are detailed in Table E.

Table E: ASS Assessment Criteria

Criteria	Source	Description, Use and Application
Field Assessment Criteria	DER (2015a)	<p>The presence of AASS or PASS are generally indicated as follows:</p> <ul style="list-style-type: none"> • $\text{pH}_F < 4$ is indicative of AASS; • pH_F of 4 to 5.5 is an acid soil and may be indicative of an AASS presence; • $\text{pH}_{\text{FOX}} < 3$ combined with a significant reaction is indicative of PASS, and • A large pH_F to pH_{FOX} drop (i.e. > 3) is indicative of PASS. <p>Other indicators such as presence/absence of organic matter, fill, jarosite, etc., are used to aid in the interpretation of field results.</p>
Action Criteria	DER (2015a)	For disturbances of > 1000 tonnes a net acidity action criterion of 0.03 %S is applicable.

Samples analysed for heavy metals are assessed against Ecological Investigation Levels (EILs) for Urban residential / Public Open Space (Table F). Under the NEPM land classification system, EILs for Public Open Spaces are the most relevant to an undisturbed remote location such as Lake MacKay. It is noted that these criteria were derived under neutral soil conditions and metals present in concentrations less than the EIL may pose a greater risk to the environment under highly acidic conditions.

Table F: Heavy Metals Assessment Criteria

Beneficial Use/ Environmental Value	Criteria	Description, Use, Application
Ecological (Urban residential/public open space) (NEPM 2013)	EIL	Values developed for a broad range of metals and organic substances. EILs depend on specific soil physiochemical properties and land use scenarios and generally apply to the top 2 m of soil.

5 Data Useability and Validity Assessment (Sediment Sampling)

Prior to data interpretation, the field and analytical results and QC data were evaluated for accuracy, precision and representativeness of the data and compiled into a QA/QC report (Table 3) to evaluate the suitability of the data for assessment purposes and identify any bias that may exist within the data set. Laboratory certificates are included in Appendix D.

5.1 Field QA/QC

Table G summarises the compliance with the field QA/QC procedures.

Table G: Soil Field QA/QC Compliance

Field QA/QC	Component	Compliant	Reference
Calibration	Field equipment requiring calibration was calibrated prior to sampling and complied with calibration checks.	Yes	Appendix E
Sample Collection	Soil samples were collected in accordance with required sampling procedures	Y	Appendix B
	Standardised field documentation (trench completion reports) used to record field activities. Trench completion reports were completed for each trench location.	Y	
	Laboratory prepared sample bags and bottles used for sample collection	Y	Appendix D
	Decontamination of sample equipment undertaken between samples	Y	Appendix B
Sample Handling and Transit	Samples were chilled with ice in the field and then frozen on site back at camp. Samples were transferred frozen in a sealed esky to Alice Springs where they were once again stored in a freezer prior to transfer to Perth. Samples were transferred to Perth frozen in a sealed esky and stored in a freezer for delivery to the laboratory. While every attempt was made to maintain the integrity of the samples, the remote location of the lake meant that transferring the samples over considerable distances prior to field and, particularly, laboratory analysis was unavoidable which, in turn, may have impacted sample results.	Y	Appendix D
	Samples appropriately handled between field and laboratory	Y	Appendix D
	Samples transported under chain of custody	Y	Appendix D
	Samples received in good condition at the laboratory	Y	Appendix D

Table H summarises the number and frequency of field QC samples and compliance with QC sample frequency and typical data quality indicator (DQI) assessment criteria. Where LORs differ between the primary and secondary laboratories, the RPD was only calculated where both results exceed the largest LOR.

Table H: Soil Field QA/QC Sample Compliance

QC Sample Type	Primary Sample	% of Primary Samples	No. of QC Samples Acceptable?	QC DQI	DQI Non-Compliances
Duplicate	T2_0 (lab test)	6%	Yes	RPD >30%	Aluminium 46%, Chromium 32%, Copper 32%, Iron 64%.
Duplicate	T5_0.05 (lab test)	6%	Yes	RPD >30%	Aluminium 76%, Iron 47%, 33% CRS and ANC 67%
Duplicate	T8_0.03 (lab test)	6%	Yes	RPD >30%	ANC 33%
Duplicate	T12_0.5 (lab test)	6%	Yes	RPD >30%	ANC 113%

5.2 Laboratory QA/QC

Outcomes of the laboratory QA/QC data validation assessment are summarised below in Table I. DQIs for the laboratory QA/QC components are defined within the laboratory certificate of analysis provided in Appendix D.

Table I: Laboratory QA/QC Summary

QA/QC	Compliant ? (Y/N)	QC Non-Compliances
Analytes Holding Times / Sample Preservation	N	<p>All the metals analyses were performed within holding times. However, pHF and pHFOX testing could not occur within 24 hours of collection.</p> <p>Samples were chilled with ice in the field and then frozen on site back at camp. Samples were transferred frozen in a sealed esky to Alice Springs where they were once again stored in a freezer prior to transfer to Perth. Samples were transferred to Perth frozen in a sealed esky and stored in a freezer for delivery to the laboratory. While every attempt was made to maintain the integrity of the samples, the remote location of the lake meant that transferring the samples over considerable distances prior to field and, particularly, laboratory analysis was unavoidable which, in turn, may have impacted sample results.</p> <p>Prior to analysis (for sediment samples from the final sampling round, 26 to 30 October 17), the previously dried samples used for CRS suite analysis still contained moisture and were not frozen. This meant the samples were inappropriately preserved for the Chromium Reducible Sulfur Suite analysis. Due to the inappropriate preservation of the samples, the Chromium Reducible Sulfur Suite results for report number 573748 are not NATA accredited.</p>
Limits of Reporting (LORs) acceptable	Y	LORs were acceptable.
Laboratory Duplicates	N	<p>Sufficient laboratory duplicate samples were analysed for all COPCs.</p> <p>All laboratory duplicate samples were within the specified range.</p>
Laboratory Surrogates	Y	All surrogate samples for soil were within the acceptable range as specified by the laboratory.
Laboratory Matrix Spikes	N	All matrix spike samples for soil were within the acceptable range as specified by the laboratory with the exception of one sample. Soil sample Q08 on report number 560004-S,
Laboratory Method Blanks	Y	All samples for soil and water were below acceptance limits (set at LOR).
Laboratory Control Samples	Y	All laboratory control samples for soil and water were within the acceptable range as specified by the laboratory.

5.3 Data Usability

In evaluating the data quality, it was identified that there were field and laboratory QA/QC DQI non-compliances associated with the analytical results for soils and groundwater as noted in Tables G, H and I. All soil vapour QC data were compliant with the nominated DQIs.

In consideration of the outcomes of the QA/QC evaluation for the non-compliances presented below, the reported non-compliances are not considered to materially impact on the interpretation and use of the data at this stage of the investigation. Where potential bias has been introduced as a result of the QA/QC evaluation, the higher concentration data has conservatively been adopted for use at this stage of the investigation.

5.3.1 Field QA/QC

5.3.1.1 RPDs

It was identified that there were three primary samples where the field QA/QC had non-compliances with the RPD of field duplicate:

- T2-0 and the duplicate (QC1) reported RPDs above the DQI for aluminium (46%), chromium (32%), copper (32%) and iron (64%). For chromium and copper the RPDs were only slightly above the acceptable criterion of 30%. Both the primary and duplicate samples had low level concentrations (less than 10 times the LOR), whereby small variations in concentration results in large RPD values, and are therefore considered to be insignificant. The exceedances for aluminium and iron are most likely due to the heterogeneous nature of sediments. The highest concentration (the primary sample) has been used in this investigation as a conservative approach;
- T5-0.05 and the duplicate (QC2) reported RPDs above the DQI for aluminium (76%), iron (47%), CRS (33%) and ANC (67%). For CRS and ANC both the primary and duplicate samples had low level concentrations (less than 10 times the LOR), whereby small variations in concentration results in large RPD values, and are therefore considered to be insignificant. The exceedances for aluminium and iron are most likely due to the heterogeneous nature of soil. The highest concentration (the duplicate sample) has been considered in this investigation as a conservative approach;
- T8-0.05 and the duplicate (QC1) reported RPD above the DQI for ANC (33%). For ANC the RPD was only slightly above the acceptable criterion of 30%. Both the primary and duplicate samples had low level concentrations (less than 10 times the LOR), whereby small variations in concentration results in large RPD values, and are therefore considered to be insignificant, and
- T12-0.5 and the duplicate (QC1) reported RPDs above the DQI for ANC (110%). The exceedances for ANC are most likely due to the heterogeneous nature of soil. The lowest concentration (the duplicate sample) has been considered in this investigation as a conservative approach.

5.3.1.2 Sample Preservation

Samples were chilled with ice in the field and then frozen on site back at camp. Samples were transferred frozen in a sealed esky to Alice Springs where they were once again stored in a freezer prior to transfer to Perth. Samples were transferred to Perth frozen in a sealed esky and stored in a freezer for delivery to the laboratory. While every attempt was made to maintain the integrity of the samples, the remote location of the lake meant that transferring the samples over considerable distances prior to field and, particularly, laboratory analysis was unavoidable which, in turn, may have impacted sample results.

Based on a review of the pH_F and pH_{FOX} testing and CRS suite analytical data, no actual acidity was reported in any of the samples (total actual acidity was $<0.02\%$ S in all samples). In addition, net acidity (S%) concentrations were all less than the laboratory limit of reporting (LOR) in all samples analysed, indicating that there are minimal sulfides available to react. Although, the sample preservation was not ideal, as there was no actual acidity reported in any of the samples analysed, it is considered unlikely that the analytical data has been affected by the preservation technique. Therefore, the analytical results are considered useable for assessment purposes.

5.3.2 Laboratory QA/QC

5.3.2.1 Matrix Spikes

In evaluating the data quality, it was identified that there was one laboratory QA/QC noncompliance with the matrix spike for zinc in lab sample Q08 being below the acceptance limits. The laboratory control sample for zinc was, however, within the acceptable range, as were all other matrix spikes for metals and, therefore, the non-compliant matrix spike is not considered to introduce bias to the data set.

5.3.2.2 Sample Preservation

Prior to analysis (for sediment samples from the final sampling round, 26 to 30 October 2017), the previously dried samples used for CRS suite analysis still contained moisture and were not frozen. This meant the samples were inappropriately preserved for the Chromium Reducible Sulfur Suite analysis. Due to the inappropriate preservation of the samples, the Chromium Reducible Sulfur Suite results for this report are not NATA accredited.

Based on a review of the pH_F and pH_{FOX} testing and CRS suite analytical data, no actual acidity was reported in any of the samples (total actual acidity was $<0.02\%$ S in all samples). In addition, net acidity (S%) concentrations were all less than the laboratory limit of reporting (LOR) in all samples analysed, indicating that there are minimal sulfides available to react. Although the sample preservation was not ideal, as there were no actual acidity reported in any of the samples analysed, it is considered unlikely that the analytical data has been affected by the preservation technique. Therefore, the analytical results are considered useable for assessment purposes.

6 Results

6.1 Sediments and soils

6.1.1 Lithology

Lithological descriptions from the August to October 2017 field investigation and photographs are provided in Appendix C. Encountered lithologies are summarised in Table J.

Table J: Lithologies

Soil Type	Description	Depth (mbgs)
Black Ooze	Dark brown to black thin layer approximately 5 mm thick.	0 – 0.05
SAND, light brown, brown or grey	Light brown, brown, cream or grey evaporitic sand. The sands contain variable gypsum and fine silt content. Typically a thin layer (approximately 8 mm thick) was observed. Sand was typically observed either above (on the ground surface) or below the black ooze layer and typically extended to depths of up to 1 mbgs. However, in three trenches (T11, T12 and T20) cream or grey evaporative sand was also encountered between 2.0 and 6 m, interbedded with orange/ red / brown clays and sandy clays.	0 – 6
SILTY to SANDY CLAY Red/ brown or light brown OR SILTY to CLAYEY SANDS, red/brown	Red brown or light brown clay with varying sand and silt content or red / brown silty to clayey sands was observed within the majority of trenches, typically underlying the black ooze and extending up to 5 m bgs.	0.05 – 5
CLAY, Red / brown	Thick layer of red/brown firm to hard clay. The clay extends to the maximum depth of 10 mbgs across the site. The clay may be interbedded at isolated locations with thin sand layers.	~ 0.3 - 10
CLAY, green and SILTY CLAY, green/brown	In one trench (T22) a green firm to hard clay was encountered at 4 mbgs and was underlain by a green/brown silty clay. A red/brown/ green firm to hard clay was also observed in Trench 9, PP and 12 (between 2 and 6 m bgl). A green clay (soft to firm) and plastic was also observed at 2 to 2.5 mbgs at trench (T20).	2.0 to 6

6.1.2 Field and Analytical ASS Results

Field and laboratory results are presented in Table 1 with reference to assessment criteria as outlined in Section 4.8. Laboratory analysis for CRS was carried out on the highest risk samples within each lithology from each trench to provide confirmation of the field results. The samples were also chosen to ensure that sediment types encountered across the site were sufficiently represented. Laboratory reports are provided in Appendix D.

Field and laboratory results for each soil type are summarised as follows:

Black Ooze (11 samples)

A thin layer of black ooze was observed in the majority of trenches (T2, T5, T7, T12, T14, T15 T16, T20, T21, T22 and PP) to a depth of up to 0.05 mbgs. It was often overlain by either a surficial salt crust or a thin layer of light brown sand. The following results of the black ooze were identified:

- Field analysis pH_F ranges from 7.4 to 8.3 and laboratory analysis pH_F ranges from 7.6 to 8.4, with no values indicative of AASS;
- Field analysis pH_{FOX} ranges from 5.6 to 6.3 and laboratory analysis pH_{FOX} ranges from 5.0 to 7.6, with no values indicative of PASS;
- Laboratory pH changes ranged from 0.5 to 3.4 in nine samples, with only 3 sample (T7_0.01, T20_0.03 and PP_0.02) values decreasing by more than 3. This indicates that the majority of samples are not PASS with only 3 potential PASS samples;
- Total actual acidity (TAA) was < 0.02 %S in the ten analysed samples;
- CRS ranged from < 0.005 %S to 0.12 %S in the ten analysed samples. Only two samples exceeded the 0.03 %S action criteria (T20_0.03, 0.12 S% and PP_0.02, 0.062 S%). These samples were collected from location along the southern edge of the lake. No samples exceeded the 0.03 %S action criteria. This indicates that the majority of samples are not PASS with only 2 potential PASS samples;
- Six samples (T2_0.05, T14_0.01, T14_0, T20_0.03, PP_0.02 and T21_0) out of a total of ten samples reported CRS %S above LOR;
- Net Acidity was < 0.02 %S in the all ten analysed samples, indicating that the majority of the soils are non-acid sulfate soils (NASS), and
- ANC was 0.04 to 0.47 S% in the 10 analysed samples.

Based on the results as summarised above, the majority of black ooze is determined to be NASS. The only exceptions were two samples, T20_0.03 and PP_0.02. These samples are considered PASS and were collected from locations along the southern edge of the lake suggesting that higher potential for PASS in the black ooze may be associated with the accumulation of sediments along the edges of Lake Mackay. Excess ANC was present in all samples, indicating a natural potential buffering capacity. On average, the concentration of ANC S % was a factor of 40 times the concentration of CRS S%.

SAND, light brown, cream, brown or grey (20 samples)

A light brown to brown sand was observed either above (on the ground surface) or below the black ooze layer and extended to depths of up to 0.5 mbgs. A grey sand was observed up to 1 mbgs. The sands contain variable gypsum and fine silt content. However, in three trenches (T11, T12 and T20) cream or grey evaporative sand was also encountered between 2.0 and 6 m, interbedded with orange/ red / brown clays and sandy clays. The following results for this material were identified:

- Field analysis pH_F ranges from 7.2 to 8.2 and laboratory analysis pH_F ranges from 7.3 to 8.3, with no values indicative of AASS;
- Field analysis pH_{FOX} ranges from 5.5 to 6.4 and laboratory analysis pH_F ranges from 6.1 to 8.7, with no values indicative of PASS;
- Laboratory pH changes range from 0.2 to 2.2. This indicates that the samples are not PASS;
- TAA was < 0.02 %S for all fifteen samples analysed;

- CRS ranges from < 0.005 to 0.005 %S. Only one sample (T22_0.5) reported a CRS S% above LOR. No samples exceeded the 0.03 %S action criteria;
- Net Acidity was < 0.02 %S for all fifteen samples, confirming the soils are non-acid sulfate soils (NASS), and
- ANC was 0.07 to 3.9 S% in the 15 analysed samples.

Based on the results as summarised above, the SAND is determined to be NASS. Excess ANC was present in all samples, indicating a natural potential buffering capacity. On average, the concentration of ANC S % was a factor of 105 times the concentration of CRS S%.

SILTY to SANDY CLAY Red/ brown or light brown or SILTY to CLAYEY SANDS, red/brown (17 samples)

Red brown or light brown clay with varying sand and silt content or red/brown silty to clayey sands was observed within the majority of trenches, typically underlying the black ooze and extending up to 5 mbgs. The following results for this material were identified:

- Field analysis pH_F ranges from 7.4 to 8.2 and laboratory analysis pH_F ranges from 7.2 to 8.1 , with no values indicative of AASS;
- Field analysis pH_{FOX} ranges from 5.8 to 6.5 and laboratory analysis pH_{FOX} ranges from 6.5 to 8 , with no values indicative of PASS;
- Laboratory pH changes range from 0 to 1.6 . This indicates that the samples are not PASS;
- TAA was < 0.02 %S for all eleven samples analysed;
- CRS ranges from < 0.005 to 0.006 %S. Only one sample (T8_1.5) reported a CRS S% above LOR. No samples exceeded the 0.03 %S action criteria;
- Net Acidity was < 0.02 %S for all eleven samples, confirming the soils are non-acid sulfate soils (NASS), and
- ANC was 0.04 to 0.8 S% in the 11 analysed samples.

Based on the results as summarised above, the SILTY to SANDY CLAY Red/ brown or light brown or SILTY to CLAYEY SANDS, red/brown is determined to be NASS. Excess ANC was present in all samples, indicating a natural potential buffering capacity. On average, the concentration of ANC S % was a factor of 74 times the concentration of CRS S%.

CLAY, red/brown (65 samples)

A thick layer of red/brown firm to hard clay was observed in the majority of trenches. The clay typically extends from approximately 0.3 mbgs to the maximum depth of 10 mbgs across the site. The following results for this material were identified:

- Field analysis pH_F ranges from 7.6 to 8.1 and laboratory analysis pH_F ranges from 5.7 to 8 with no values indicative of AASS;

- Field analysis pH_{FOX} ranges from 5.7 to 6.2 and laboratory analysis pH_{FOX} ranges from 6.3 to 8.4 with no values indicative of PASS;
- Laboratory pH changes range from 0 to 1.8. This indicates that the samples are not PASS.
- TAA was < 0.02 %S for all twenty six samples analysed;
- CRS ranges from < 0.005 to 0.016 %S. Six samples (T7_0.3, T7_5, T8_3, T8_4.5, T9_1.0 and T22_2.5) out of a total of twenty six samples reported CRS %S above LOR. No samples exceeded the 0.03 %S action criteria;
- Net Acidity was < 0.02 %S for all twenty six samples, confirming the soils are non-acid sulfate soils (NASS), and
- ANC was 0.16 to 1.2 S% in the 26 analysed samples.

Based on the results as summarised above, the red/brown CLAY is determined to be NASS. Excess ANC was present in all samples, indicating a natural potential buffering capacity. On average, the concentration of ANC S % was a factor of 96 times the concentration of CRS S%.

CLAY, green / SILTY CLAY, green/brown (6 samples)

In one trench (T22), a green firm to hard clay was encountered at 4 mbgs and was underlain by a green/brown silty clay. A red/brown/green firm to hard clay was also observed in Trench 9, Piot Pond (PP) and Trench 12 (between 2 and 6 m bgl). A green clay (soft to firm) and plastic was also observed at 2 mbgs to 2.5 mbgs at trench (T20). The following results for this material were identified:

- Field analysis pH_F was 8.0 for both samples and laboratory analysis pH_F was 6.7 to 8.0, with no values indicative of AASS;
- Field analysis pH_{FOX} ranges from 5.8 to 6.0 and laboratory analysis pH_{FOX} was 7.6 to 8.0, with no values indicative of PASS;
- TAA was < 0.02 %S for all the five samples analysed;
- CRS was < 0.005 %S to 0.006 % S for all the five samples analysed. The samples did not exceed the 0.03 %S action criteria. Only one sample out of five analysed was reported above LOR;
- Net Acidity was < 0.02 %S for all the five samples analysed, confirming the soil type is non-acid sulfate soils (NASS), and
- ANC was 0.36 to 0.74 S% for the five samples analysed.

Based on the results as summarised above, the green CLAY to SILTY CLAY is determined to be NASS. Excess ANC was present in all samples, indicating a natural potential buffering capacity. On average, the concentration of ANC S % was a factor of 112 times the concentration of CRS S%.

6.1.3 Review of integrity of the handling and transport method.

Thirty six selective samples from trenches (T2, T5, T7, T8, T14, T15, T16, T21 and T22), pH_F and pH_{FOX} were tested in the field and then retested by the laboratory to assess the integrity of the handling and transport method. A comparison of the field to laboratory data are summarised as follows:

- The average field analysis pH_F was 7.8, with a range of 7.4 to 8.3;
- The average laboratory analysis pH_F was 7.4, with a range of 6.3 to 8.3;
- The average field analysis pH_{FOX} was 6.0, with a range of 5.4 to 6.4, and
- The average laboratory analysis pH_{FOX} was 7.3, with a range of 5 to 8.6.

A comparison of the field and laboratory pH_F value, demonstrates that pH values are similar between the field and laboratory. However, the laboratory value is typically slightly more acidic than the value tested in the field. For the pH_{FOX} value, the field tested value is more acidic than the laboratory tested value. Based on a review of the pH_F and pH_{FOX} testing and CRS suite analytical data, no actual acidity was reported in any of the samples (total actual acidity was < 0.02 %S in all samples). In addition, net acidity (S%) concentrations were all less than the laboratory limit of reporting (LOR) in all samples analysed, indicating that there are minimal sulphides available to react. Although, there was slight variation between field and laboratory tested pH, as there were no actual acidity reported in any of the samples analysed, it is considered unlikely that the analytical data has been significantly affected by the handling and storage method.

6.1.1 Heavy Metals

Heavy metal laboratory results from the analysis of 23 primary samples are presented in Table 2 with reference to assessment criteria as outlined in Section 4.8 and summarised in Table K. Analysis for total uranium was also undertaken on 17 primary samples and presented in Table 2.

Table K: Metals Summary

Analyte	Concentration Range (mg/kg)	Samples exceeding EILs (Urban Residential/ Open Public Space)
Aluminium	760 – 46,000	None
Arsenic	<2 – 5.1	None
Cadmium	<0.4 – 0.5	None
Chromium	<5 – 54	None
Copper	<5– 23	None
Iron	1,300 – 47,000	None
Lead	<5 – 19	None
Mercury	<0.1	None
Nickel	<5 – 23	None
Uranium	<10 - 16	None
Zinc	<5 – 56	None

Based on the laboratory analysis, the following conclusions were drawn:

- All heavy metal concentrations for all lithologies were below their relevant EILs indicating they pose a low risk to the receiving ecological environment;
- Aluminium and iron were detected within all samples with the highest concentrations observed within the SANDY CLAY red/brown, CLAY red brown and CLAY, green lithologies suggesting that there is a potential for aluminium and iron mobilisation into the groundwater from these units under acidic conditions, and
- In the absence for EILs for uranium, the soil standards for the protection of human health from Canada (Nova Scotia) have been adopted. The majority of soils samples reported total uranium at less than the laboratory limit of reporting, the only exception was one sample from the pilot pond location (PP_2.0, 16 mg/kg). All samples reported concentration below the soil standards for the protection of human health from Canada (Nova Scotia).

6.2 Groundwater

The following section summarises the results of site specific groundwater information collected as part of a separate hydrogeological study undertaken as part of the baseline assessment for the project. Data discussed in this section were collected by Agrimin and are provided to support an understanding of the site-specific receiving environment.

6.2.1 Field Results

Static water levels (SWL) were measured in temporary piezometers between August and October 2017 and are presented in Table L. In addition, SWL were also measured in some of the trenches during this period. This is presented in Table M. The SWL data is summarised as follows:

- During the monitoring period, SWLs in the piezometers ranged from 0.15 mbgs (T20 100mE) to 0.97 mbgs (T14 20mS), and
- During the monitoring period, water levels in the trenches ranged from 0.5 mbgs (Trench 9) to 1.3 mbgs (Trench 22). The water levels measured in the trenches may not be static because the water levels were still recovering after excavation. The Agrimin hydrologist advised that the SWL across the lake is typically between 0.5-0.6 mbgs.

Site specific groundwater flow direction cannot be determined at this stage. However, regional groundwater flows predominantly from an easterly direction towards Lake Mackay. Groundwater flows through the extensive system of palaeovalleys and palaeochannels originating in the Northern Territory and intersecting the lake in the east and along the southern boundary. Lake Mackay is the discharge point for groundwater and surface water in the paleochannels (Lycopodium, 2016).

Table L: Static Water Levels (SWL) in Temporary Monitoring wells

ID	Coordinates GDA94 Z 52		SWL	
	Easting	Northing	m (*TOC)	m (bgs)
T2 20mN	460022	7512136	1.25	0.8
T2 50mN	460022	7512167	1.04	0.69
T2 20mW	459997	7512072	1.22	0.84
T2 50mW	459966	7512073	1.04	0.76
T5 20mN	479984	7508098	0.965	0.465
T5 50mN	479984	7508123	0.98	0.41
T5 20mE	480009	7508031	0.99	0.52
T5 50mE	480034	7508034	0.915	0.475
T5 100mE	480084	7508035	0.88	0.42
T6 20mN	482030	7494117	0.97	0.47
T6 50mN	482033	7494146	0.95	0.45
T6 20mE	482052	7494052	1.05	0.55
T6 50mE	482086	7494053	0.97	0.47
T6 100mE	482134	7494049	0.92	0.42
T6 20mW	482005	7494051	1.07	0.57
T8 20mN	490924	7507408	1.07	0.57
T8 50mN	490925	7507438	0.955	0.455
T8 20mE	490955	7507340	1.045	0.545
T8 50mE	490986	7507346	1.01	0.51
T8 100mE	491029	7507352	0.87	0.37
T9 20mN	491048	7519251	-	-
T9 50mN	491058	7519280	-	-
T9 20mE	491058	7519181	-	-
T9 50mE	491087	7519177	-	-
T9 100mE	491134	7519167	-	-
T11 20mN	495972	7518121	-	-
T11 50mN	495967	7518149	-	-
T11 20mE	496007	7518057	-	-
T11 50mE	496036	7518062	-	-
T11 100mE	496083	7518074	-	-
T11 20mS	495995	7517978	-	-
T11 50mS	495999	7517951	-	-
T11 20mW	495962	7518042	-	-
T11 50mW	495936	7518038	-	-
T11 100mW	495896	7518027	-	-
T12 20mW	499696	7514011	0.80	0.30
T12 30mW	499689	7514010	0.80	0.30
T14 20mN	452557	7515052	1.15	0.65
T14 50mN	452553	7515081	1.16	0.58
T14 20mE	452590	7514995	1.39	0.87
T14 50mE	452619	7515001	1.32	0.72
T14 100mE	452670	7515012	1.14	0.62
T14 20mS	452580	7514905	1.37	0.97
T14 50mS	452586	7514876	1.17	0.75
T14 20mW	452545	7514968	1.38	0.95
T14 50mW	452513	7514964	1.18	0.77
T 16 20mN	452707	7505182	1.07	0.67

ID	Coordinates GDA94 Z 52		SWL	
	Easting	Northing	m (*TOC)	m (bgs)
T16 50mN	452706	7505215	1.07	0.67
T16 20mE	452733	7505116	1.15	0.76
T16 50mE	452762	7505115	1.09	0.74
T16 100mE	452813	7505117	1.2	0.65
T16 20mS	452709	7505043	1.09	0.59
T16 50mS	452711	7505013	1.13	0.68
T16 20mW	452682	7505118	1.19	0.74
T16 50mW	452653	7505118	1.02	0.65
T16 100mW	452604	7505119	1.08	0.65
T20 20mN	485925	7491866	0.945	0.445
T20 50mN	485922	7491898	0.825	0.325
T20 20mE	485945	7491801	1.22	0.72
T20 50mE	485974	7491800	0.965	0.465
T20 100mE	486028	7491809	0.65	0.15
T20 20mW	485898	7491813	1.14	0.64
T20 50mW	485873	7491813	0.915	0.415
T21 20mE	474048	7505047	-	-
T21 50mE	474147	7505043	-	-
T21 20mS	474098	7504965	-	-
T21 50mS	474098	7504937	-	-
T21 20mW	474071	7504965	-	-
T21 50mW	474043	7504937	-	-
T22 20mN	495958	7513457	-	-
T22 50mN	495952	7513489	-	-
T22 20mE	496018	7513455	-	-
T22 50mE	496048	7513455	-	-
T22 100mE	496098	7513455	-	-
PP1	464400	7495221	-	-
PP2	464470	7495402	-	-
PP3	464544	7495588	-	-

*TOC – Top of Casing

Table M: Static Water Levels (SWL) in Trenches

Trench Number	SWL m(bgl)
Trench 2	0.76
Trench 5	0.75
Trench 6	No information
Trench 7	No information
Trench 8	No information
Trench 9	0.5
Trench 11	1.0
Trench 12	1
Trench 14	0.6
Trench 15	No information
Trench 16	No information
Trench 20	No information
Trench 21	No information
Trench 22	1.3

6.2.2 Analytical Results

Groundwater analytical reports are provided in Appendix D. Results of the baseline sampling are presented in Table 4 and summarised as follows:

- Calcium (Ca) concentrations range from 271 mg/L (Pilot Pond 2) to 693 mg/L (Trench 22);
- Chloride (Cl) concentrations were consistently high and ranged from 116,100 mg/L (Trench 22) to 174,800 mg/L (Trench 2);
- Potassium (K) concentrations ranged from 2,725 mg/L (Pilot Pond 2) to 3,998 mg/L (Trench 5);
- Magnesium (Mg) concentrations ranged from 1,884 mg/L (Trench 22) to 9,045 mg/L (Pilot Pond 2);
- Sodium (Na) concentrations were high and ranged from 76,592 mg/L (Trench 22) to 120,048 mg/L (Trench 2);
- Sulfur (S) concentrations ranged from 4,806 mg/L (Trench 16) to 8,028 mg/L (Trench 2);
- Sulfate concentrations ranged from 14,399 mg/L (Trench 16) to 23,772 mg/L (Trench 5), and
- Total dissolved Solids (TDS) (evaporation) ranged from 198 g/kg (Trench 22) to 266 g/kg (Trench 5) and were indicative of a hypersaline lake.

7 Discussion

7.1 ASS Occurrence

The findings of the investigation are summarised in Table N. The presence of AASS, PASS or NASS is identified based on soil type as presented in Table N.

Based on soil field pH results (obtained from 119 samples), there were no pH_F values indicative of AASS and there were no pH_{FOX} values indicative of (PASS from any of the soil samples tested.

Based on the laboratory results, there were no occurrences of AASS were identified within the Project area. Within the majority of the Project area, there were no occurrences of PASS, with the exception of only two black ooze samples collected from sample locations in the very southern edge of lake.

Table N: ASS Distribution

Soil Type	Number of samples	Description	Depth (mbgs)	CRS (%S)	Net Acidity (%S)	ASS Classification
Black Ooze	11	Dark brown to black thin layer approximately 5 mm thick.	0 – 0.05	<0.005 to 0.12	<0.02	Majority NASS, with only two samples in the very southern end of lake slightly exceeds assessment criteria for CRS (PASS)
SAND, light brown, brown or grey	20	Light brown, brown, cream or grey evaporitic sand. The sands contain variable gypsum and fine silt content. Typically a thin layer (approximately 8 mm thick) was observed. Sand was typically observed either above (on the ground surface) or below the black ooze layer and typically extended to depths of up to 1 mbgs. However, in three trenches (T11, T12 and T20) cream or grey evaporative sand was also encountered between 2.0 mbgs and 6 mbgs, interbedded with orange/ red / brown clays and sandy clays.	0 – 6	<0.05 to 0.005	<0.02	NASS
SILTY to SANDY CLAY Red/ brown or light brown OR SILTY to CLAYEY SANDS, red/brown	17	Red brown or light brown clay with varying sand and silt content or red/brown silty to clayey sands was observed within the majority of trenches, typically underlying the black ooze and extending up to 5 mbgs.	0.05 – 5	<0.005 to 0.006	<0.02	NASS

Soil Type	Number of samples	Description	Depth (mbgs)	CRS (%S)	Net Acidity (%S)	ASS Classification
CLAY, Red / brown	65	Thick layer of red/brown firm to hard clay. The clay extends to the maximum depth of 10 mbgs across the site. The clay may be interbedded at isolated locations with thin sand layers.	~ 0.3 - 10	<0.005 to 0.016	<0.02	NASS
CLAY, green and SILTY CLAY, green/brown	6	In one trench (T22) a green firm to hard clay was encountered at 4 mbgs and was underlain by a green/brown silty clay. A red/brown/ green firm to hard clay was also observed in Trench 9, PP and 12 (between 2 and 6 m bgl). A green clay (soft to firm) and plastic was also observed at 2 to 2.5 mbgs at trench (T20).	2.0 to 6	<0.005 to 0.006	<0.02	NASS

Based on the laboratory analysis, CRS ranged from <0.005 %S to 0.12 %S in the 67 analysed samples from all soil types.

The majority of the samples from all soil types had a concentration of CRS below the 0.03 %S action criteria, indicating the majority of the soil types were NASS. Only two samples of black ooze in the very southern end of lake slightly exceeded assessment criteria for CRS, indicating that the black ooze is possibly PASS along the southern edge of the lake.

Net Acidity was <0.02 %S in the all 67 analysed samples, confirming the soils are non-acid sulfate soils (NASS). Based on the results as summarised above, the majority of the encountered lithologies were determined to be NASS, with the exception of black ooze in the very southern end of the lake (possibly PASS).

7.2 Baseline Groundwater Conditions

The shallowest depth of 0.15 mbsl was recorded, with generally shallow groundwater levels recorded across the site.

High concentrations of chloride, sodium and TDS were observed in all of the groundwater samples which are indicative of a hypersaline lake. Groundwater concentrations of Ca and K were lowest in Pilot Pond 2 located in the southern end of the lake. Groundwater concentrations of Cl, Mg, TDS and Na were lowest in Trench 22 (31/10/17) located in the eastern end of the lake. Highest concentrations of chloride, sodium, potassium, sulfate, TDS and were reported in either Trench 2 or Trench 5, both located within the centre of the lake.

Groundwater flows through the extensive system of palaeovalleys and paleochannels originating in the Northern Territory and intersecting the lake in the east and along the southern boundary. Therefore, less saline groundwater (lower concentrations of Na, Cl, TDS) are likely to occur within the southern and eastern edges of the lake as they receive groundwater discharge.

The Cl:SO₄²⁻ ratio was greater than 2 (ranged from 6.4 to 11.6) in all groundwater analysed indicating that there is not likely to be an extra source of sulfate from current or historic

sulfate oxidation and leaching into the groundwater system. The concentrations within the groundwater are representative of natural background concentrations within an undisturbed environment.

8 Conclusions and Recommendations

Based on the results presented in this report, 360 Environmental makes the following conclusions:

- Based on soil field pH results, there were no pH_F values indicative of actual acid sulfate soil (AASS) and there were no pH_{FOX} values indicative of potential acid sulfate soil (PASS) from any of the soil samples tested;
- For three black ooze samples, a laboratory pH decrease greater than 3 units (3.1 to 3.4) between pH_F and pH_{FOX} was reported. This indicates that some black ooze samples have acid generating potential (PASS). Sixty percent (60%) of black ooze samples reported a CRS %S above laboratory limits of reporting (LOR). Two of the black ooze samples (T20_0.03 and PP_0.02), located on the very southern edge of the lake, indicate that these two samples are PASS with CRS concentrations of 0.062%S and 0.12%S. Given that the majority of the remaining black ooze samples collected from the central sections of the lake recorded pH changes below the criteria, and no other criteria was exceeded, overall the black ooze lithology in the central sections of the lake is determined to be NASS. The western edge of the lake was not sampled during the investigation and it is possible that black ooze may also be PASS along the western fringe of the lake. It should be noted that the black ooze lithology did not always appear form a continuous layer over the lake surface, instead forming a patchy distribution which could lead to some bias when considering its overall potential for acid generation;
- All other soil types reported no laboratory pH changes greater than 3 units, indicative of NASS. The remainder of the samples from all other soil types had a concentration of CRS below the 0.03 %S action criteria, indicating the majority of the soil types were NASS. Further, most other lithologies had a CRS concentration less than LOR with only 23% of red/brown clays reporting a CRS above LOR;
- Net Acidity [minus acid neutralising capacity (ANC)] was <0.02 %S in the majority of analysed soil samples, confirming the majority of soils are non-acid sulfate soils (NASS). Only two black ooze samples in the very southern end of lake reported net acidity minus ANC above assessment criteria, ranging from 0.06 to 0.12 S%;
- In addition, acid neutralising capacity (ANC) across all soil types ranged from 0.04 %S to 3.9 S%. Based on these results, the majority of lithologies encountered are considered to have a low risk of acid generation due to the absence of sulphides and the inherently elevated ANC;

- All heavy metal concentrations for all lithologies were below their relevant Ecological Investigation Levels (EILs), indicating they pose a low risk to the receiving ecological environment;
- The majority of soils samples reported total uranium at less than the laboratory limit of reporting, the only exception was one soil sample from the pilot pond location. All soil samples reported concentrations below the soil standards for the protection of human health from Canada (Nova Scotia). In the absence for EILs for uranium, the soil standards for the protection of human health from Canada (Nova Scotia) have been adopted;
- Aluminium and iron were detected within all samples with the highest concentrations observed within the SANDY CLAY red/brown, CLAY red brown and CLAY, green lithologies suggesting that there is a potential for aluminium and iron mobilisation into the groundwater from these units under acidic conditions;
- Site specific groundwater information was collected as part of a separate hydrogeological study undertaken as part of the baseline assessment for the Project. High concentrations of chloride, sodium and TDS were observed in all of the groundwater samples which are indicative of a hypersaline lake, and
- The $\text{Cl}:\text{SO}_4^{2-}$ ratio of the groundwater was greater than 2 (ranged from 6.4 to 11.6) in all groundwater analysed indicating that there is not likely to be an extra source of sulfate from current or historic sulfate oxidation and leaching into the groundwater system. The concentrations within the groundwater are representative of natural background concentrations within an undisturbed environment.

The following recommendations are made based on the outcome of this preliminary ASS investigation:

- Further sampling and analysis should be undertaken of the black ooze material in the southern and western fringes of the lake where development is potentially going to occur;
- Based on the results of this preliminary investigation, a limited Acid Sulfate Soils Management Plan (ASSMP) may be required only to manage the black ooze material in the southern and western fringes of the lake. However, this will be determined following further sampling and analysis in these areas;
- To establish more detailed baseline conditions of the underlying groundwater, it is recommended that groundwater monitoring for pH, redox, dissolved oxygen, electrical conductivity (EC) is undertaken and future groundwater samples are analysed for:
 - Total acidity, total alkalinity, pH;
 - Dissolved metals (aluminium, arsenic, chromium, iron, manganese, nickel, selenium, zinc);
 - Total metals (aluminium, iron);

- Ammonia, total nitrogen, total phosphorus, filterable reactive phosphorus (FRP), and
- TDS (mg/L).

9 Limitations

This report is produced strictly in accordance with the scope of services set out in the contract or otherwise agreed in accordance with the contract. 360 Environmental makes no representations or warranties in relation to the nature and quality of soil and water other than the visual observation and analytical data in this report.

In the preparation of this report, 360 Environmental has relied upon documents, information, data and analyses ("client's information") provided by the client and other individuals and entities. In most cases where client's information has been relied upon, such reliance has been indicated in this report. Unless expressly set out in this report, 360 Environmental has not verified that the client's information is accurate, exhaustive or current and the validity and accuracy of any aspect of the report including, or based upon, any part of the client's information is contingent upon the accuracy, exhaustiveness and currency of the client's information. 360 Environmental shall not be liable to the client or any other person in connection with any invalid or inaccurate aspect of this report where that invalidity or inaccuracy arose because the client's information was not accurate, exhaustive and current or arose because of any information or condition that was concealed, withheld, misrepresented, or otherwise not fully disclosed or available to 360 Environmental.

Aspects of this report, including the opinions, conclusions and recommendations it contains, are based on the results of the investigation, sampling and testing set out in the contract and otherwise in accordance with normal practices and standards. The investigation, sampling and testing are designed to produce results that represent a reasonable interpretation of the general conditions of the site that is the subject of this report. However, due to the characteristics of the site, including natural variations in site conditions, the results of the investigation, sampling and testing may not accurately represent the actual state of the whole site at all points.

It is important to recognise that site conditions, including the extent and concentration of contaminants, can change with time. This is particularly relevant if this report, including the data, opinions, conclusions and recommendations it contains, are to be used a considerable time after it was prepared. In these circumstances, further investigation of the site may be necessary.

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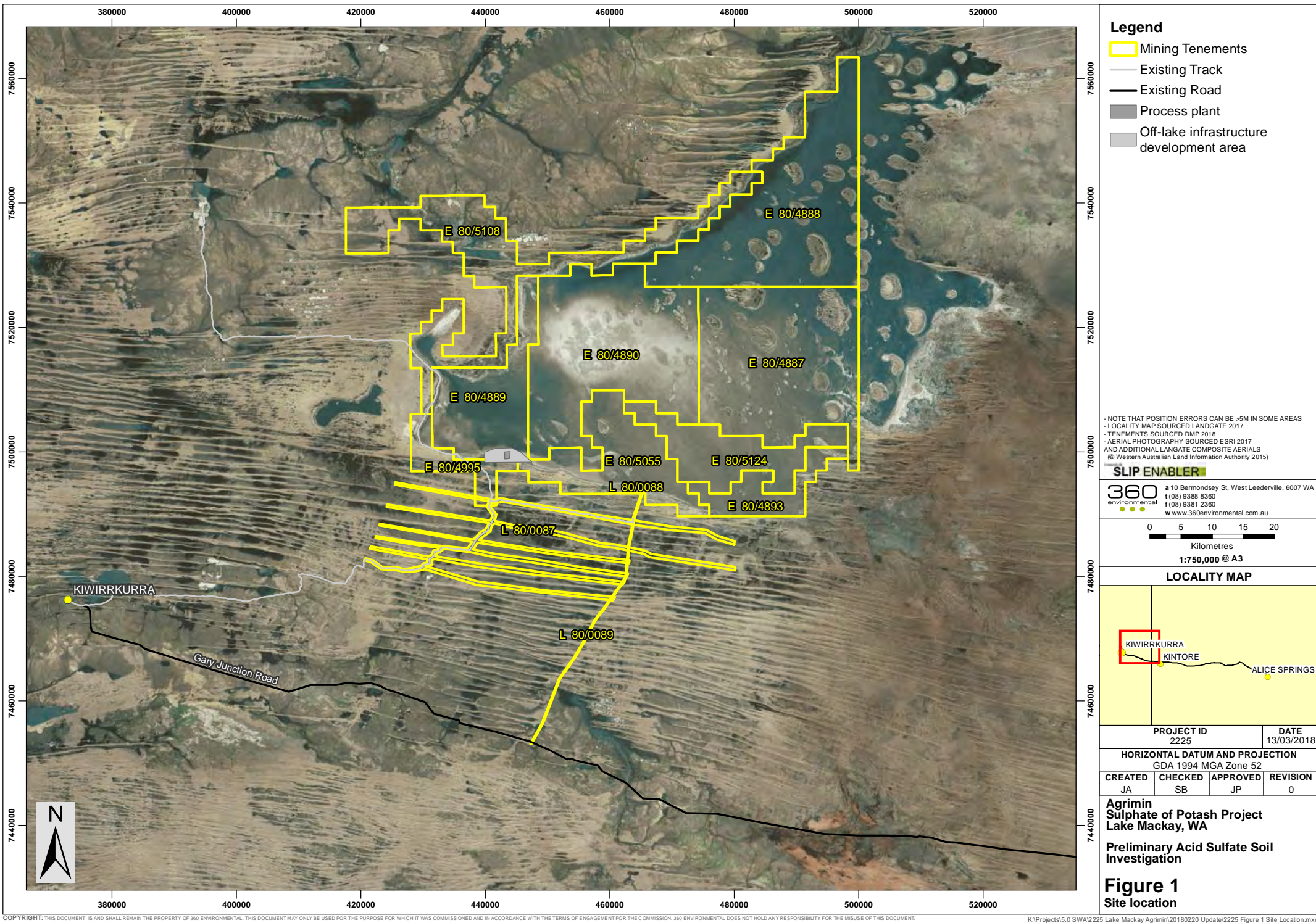
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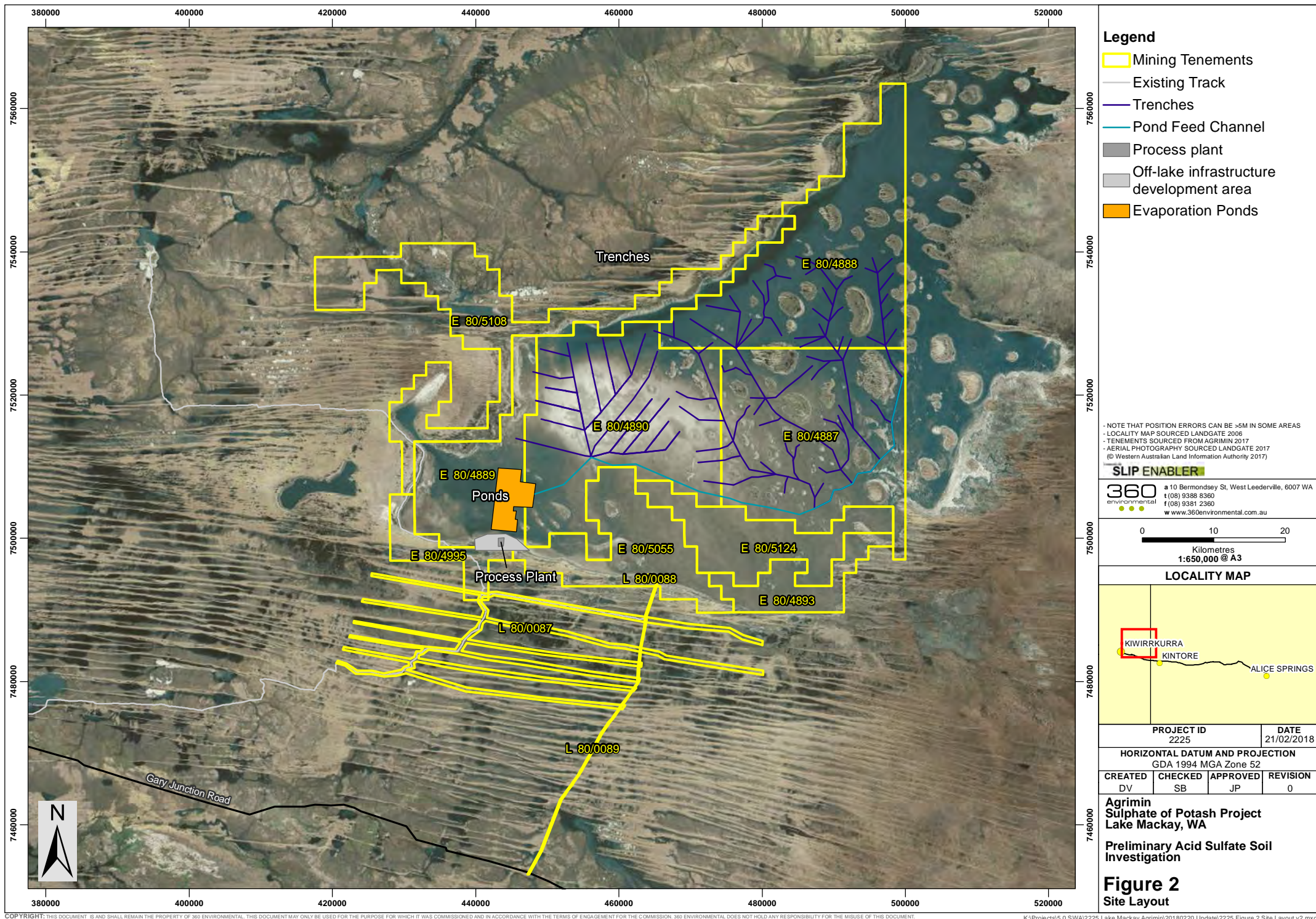
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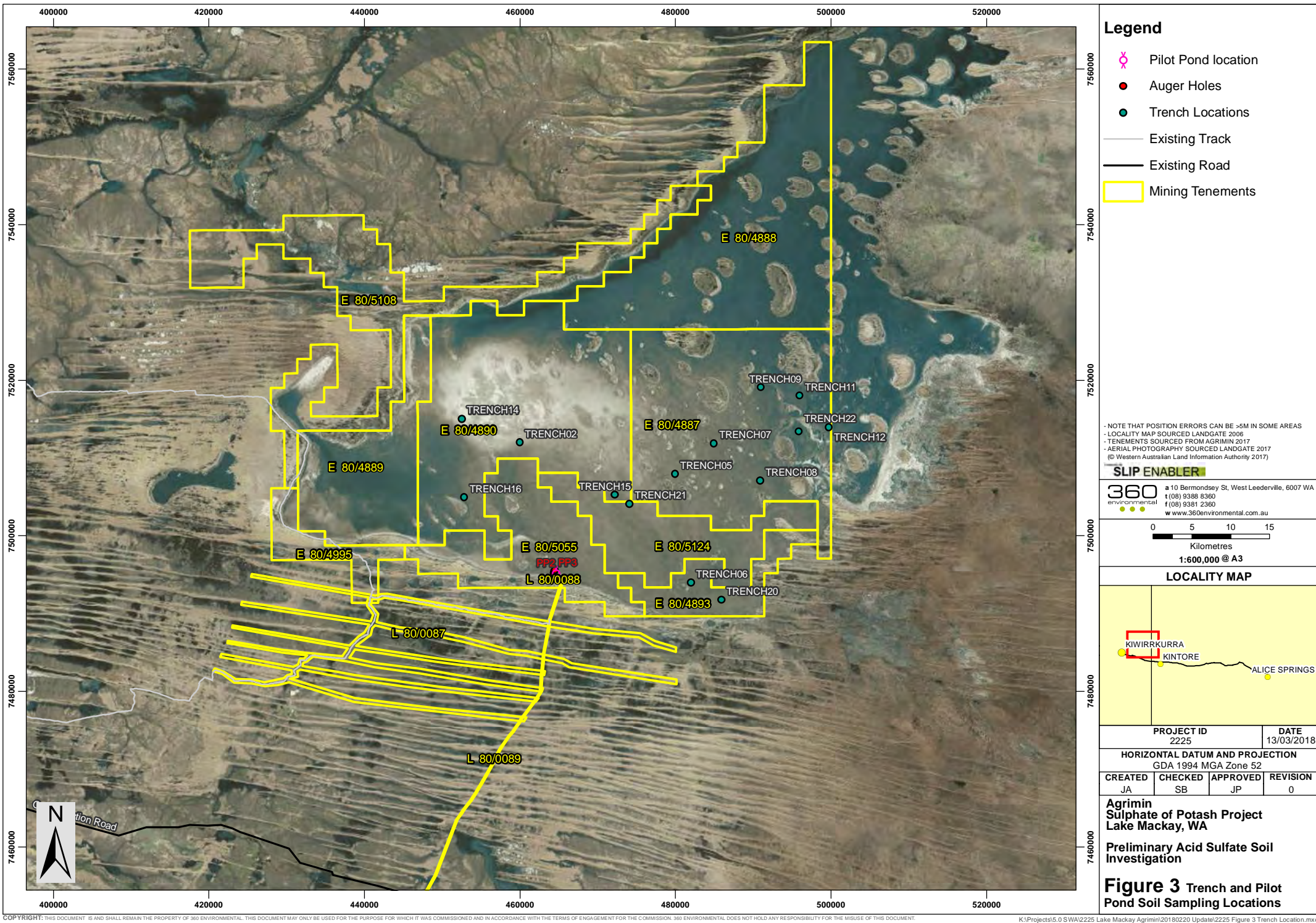
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FIGURES







Legend

- Pilot Pond location
- Auger Holes
- Trench Locations
- Existing Track
- Existing Road
- Mining Tenements

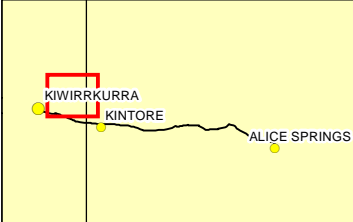
- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- LOCALITY MAP SOURCED LANDGATE 2006
- TENEMENTS SOURCED FROM AGRIMIN 2017
- AERIAL PHOTOGRAPHY SOURCED LANDGATE 2017
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LOCALITY MAP

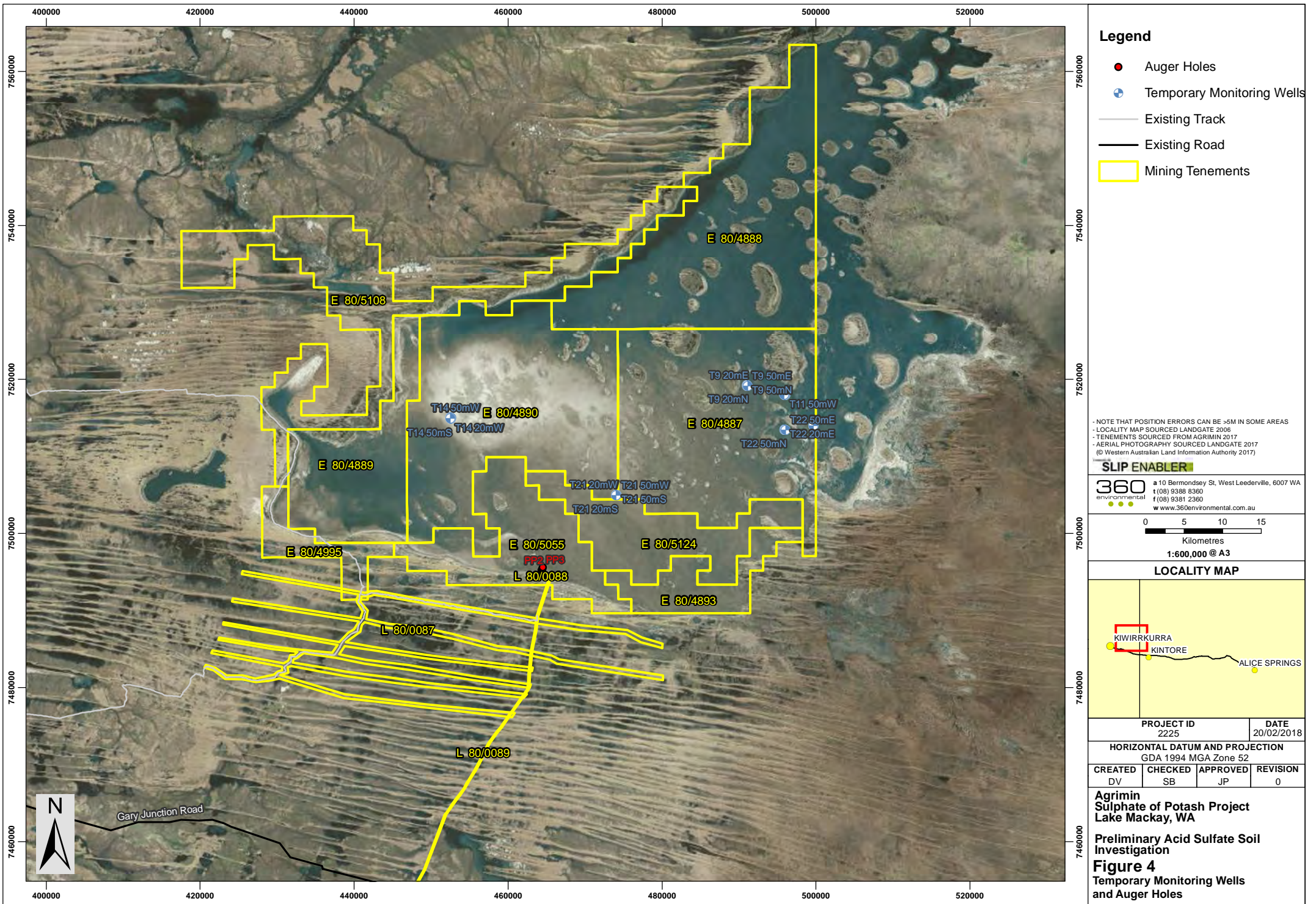


PROJECT ID 2225		DATE 13/03/2018	
HORIZONTAL DATUM AND PROJECTION GDA 1994 MGA Zone 52			
CREATED JA	CHECKED SB	APPROVED JP	REVISION 0

Agrimin
Sulphate of Potash Project
Lake Mackay, WA

Preliminary Acid Sulfate Soil
Investigation

Figure 3 Trench and Pilot
Pond Soil Sampling Locations



Legend

- Auger Holes
- Temporary Monitoring Wells
- Existing Track
- Existing Road
- Mining Tenements

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- LOCALITY MAP SOURCED LANDGATE 2006
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LOCALITY MAP

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**Preliminary Acid Sulfate Soil
Investigation**

**Figure 4
Temporary Monitoring Wells
and Auger Holes**

TABLES

Bore Hole ID	Sample Depth mblg	Simplified Lithology	Field Analysis				Laboratory Analysis				Chromium Reducible Sulfur Suite						ASS Interpretation
			pH _i	pH _{tox}	pH _{change}	Reaction	pH _i	pH _{tox}	pH _{change}	Reaction	pH-KCl	TAA equiv. 5% pyrite	CRS (%S)	Net Acidity (%S)	Net Acidity (%S) - ANC (%S)	ANC (%S)	
			Assessment Criteria: <5.5	<3.0	>3	>2	<5.5	<3.0	>3	>2	<5.5	0.03	0.03	0.03	0.03	-	
T2	0	Black Ooze	7.4	6.3	1.1	2	7.6	7.1	0.5	4	8.2	< 0.02	< 0.005	< 0.02	< 0.02	0.42	NASS
	0.5	sandy CLAY, red/brown	7.4	6.1	1.3	2	7.5	7.5	0	4	7.7	< 0.02	< 0.005	< 0.02	< 0.02	0.18	
T5	0	SAND, light brown	7.2	5.5	1.7	1	---	---	---	---	---	---	---	---	---	---	NASS
	0.05	Black Ooze	8.3	5.5	2.8	1	7.8	6.5	1.3	2	7	< 0.02	0.01	< 0.02	< 0.02	0.04	
	0.13	silty CLAY, dark brown	7.8	6.5	1.3	2	---	---	---	---	---	---	---	---	---	---	
	0.2	CLAY, red	7.8	6.3	1.5	2	6.5	8.4	1.9	4	7.9	< 0.02	< 0.005	< 0.02	< 0.02	0.21	
	0.3	silty SAND, light brown	8.2	6.5	1.7	2	---	---	---	---	---	---	---	---	---	---	
	0.33	Clay, red/brown	7.8	6.4	1.4	2	6.8	8.6	1.8	4	8	< 0.02	< 0.005	< 0.02	< 0.02	0.28	
T6	0.02	Evaporite SAND, grey/black	---	---	---	---	8.3	6.1	2.2	2	7.9	< 0.02	< 0.005	< 0.02	< 0.02	0.12	NASS
	0.5	CLAY, red	---	---	---	---	8	8.3	0.3	4	8.1	< 0.02	< 0.005	< 0.02	< 0.02	0.43	
	1	CLAY, red	---	---	---	---	7.9	8.2	0.3	4	8.3	< 0.02	< 0.005	< 0.02	< 0.02	0.48	
	1.5	CLAY, red	---	---	---	---	7.7	7.2	0.5	2	---	---	---	---	---	---	
	2	CLAY, red	---	---	---	---	7.7	7.1	0.6	2	---	---	---	---	---	---	
	2.5	CLAY, red	---	---	---	---	7.6	7	0.6	2	8.4	< 0.02	< 0.005	< 0.02	< 0.02	1.2	
	3	CLAY, red	---	---	---	---	7.7	7.1	0.6	2	---	---	---	---	---	---	
	3.5	CLAY, red	---	---	---	---	7.8	7.1	0.7	2	---	---	---	---	---	---	
T7	4	CLAY, red	---	---	---	---	7.8	7.2	0.6	2	---	---	---	---	---	---	NASS
	0.03	SAND, light brown	7.2	5.522	1.7	1	---	---	---	---	---	---	---	---	---	---	
	0.01*	Black Ooze	8	5.4	2.6	2	8.3	5.0	3.3	3	7.5	< 0.02	0.014	< 0.02	< 0.02	0.07	
	0.05	Clay, brown	7.7	6.1	1.6	2	6.9	8.2	1.3	4	8.1	< 0.02	< 0.005	< 0.02	< 0.02	0.38	
	0.2	Clay, red/brown	7.8	6.1	1.7	1	---	---	---	---	---	---	---	---	---	---	
	0.29	silty Clay, light brown	7.9	6.1	1.8	2	---	---	---	---	---	---	---	---	---	---	
	0.3	silty CLAY, red	7.9	6	1.9	2	8.1	6.5	1.6	3	7.7	< 0.02	0.006	< 0.02	< 0.02	0.04	
	0.5	CLAY, brown	7.9	6	1.9	2	---	---	---	---	---	---	---	---	---	---	
	2	CLAY, red/brown	7.8	6	1.8	2	6.3	6.9	0.6	1	8.3	< 0.02	< 0.005	< 0.02	< 0.02	0.44	
	5	CLAY, red/brown	8.1	6.2	1.9	1	7.9	7.3	0.6	2	8.5	< 0.02	0.006	< 0.02	< 0.02	0.71	
T8	0.03	SAND, light brown	8.2	5.8	2.4	1	8.2	6.8	1.4	2	7.5	< 0.02	< 0.005	< 0.02	< 0.02	0.07	NASS
	0.5	sandy CLAY, red/brown	7.8	5.8	2.0	1	7.4	7.1	0.3	2	8.1	< 0.02	< 0.005	< 0.02	< 0.02	0.42	
	1	CLAY, red/brown	7.9	5.9	2.0	1	---	---	---	---	---	---	---	---	---	---	
	1.5	CLAY, red/brown	7.9	5.8	2.1	1	6.6	6.9	0.3	2	8.3	< 0.02	0.005	< 0.02	< 0.02	0.47	
	2	CLAY, red/brown	8	5.9	2.1	1	---	---	---	---	---	---	---	---	---	---	
	2.5	CLAY, red/brown	8	5.9	2.1	1	---	---	---	---	---	---	---	---	---	---	
	3	CLAY, red/brown	7.7	5.9	1.8	1	7	7.4	0.4	2	8.4	< 0.02	0.008	< 0.02	< 0.02	0.54	
	3.5	CLAY, red/brown	8	5.9	2.1	1	---	---	---	---	---	---	---	---	---	---	
T9	4	CLAY, red/brown	7.6	5.9	1.7	1	---	---	---	---	---	---	---	---	---	---	NASS
	4.5	CLAY, red/brown	7.9	5.9	2.0	1	6.9	7.1	0.2	2	8.4	< 0.02	0.006	< 0.02	< 0.02	0.64	
	0.5	sandy CLAY, dark brown/red	---	---	---	---	7.7	6.9	0.8	4	8.1	< 0.02	< 0.005	< 0.02	< 0.02	0.83	
	1	CLAY, red	---	---	---	---	7.6	6.6	1	2	8.4	< 0.02	0.016	< 0.02	0.02	0.91	
	1.5	CLAY, red/grey	---	---	---	---	7.7	7.0	0.7	4	---	---	---	---	---	---	
	2	CLAY, red	---	---	---	---	7.9	7.4	0.5	4	---	---	---	---	---	---	
	2.5	CLAY, red	---	---	---	---	7.8	7.4	0.4	4	---	---	---	---	---	---	
	3	CLAY, red	---	---	---	---	7.9	7.6	0.3	4	---	---	---	---	---	---	
	3.5	CLAY, red	---	---	---	---	7.8	7.2	0.6	2	---	---	---	---	---	---	
	4	CLAY, red	---	---	---	---	7.9	7.7	0.2	4	---	---	---	---	---	---	
T11	4.5	CLAY, red	---	---	---	---	7.9	7.9	0	4	---	---	---	---	---	---	NASS
	5	CLAY, red	---	---	---	---	7.8	7.4	0.4	4	---	---	---	---	---	---	
	6	CLAY, red/brown/green	---	---	---	---	8.0	7.5	0.5	4	8.4	< 0.02	0.006	< 0.02	< 0.02	0.66	
	0.5	evaporite SAND, brown	---	---	---	---	8	7	1	2	8.3	< 0.02	< 0.005	< 0.02	< 0.02	0.6	
	1	evaporite SAND, dark grey/black	---	---	---	---	7.8	7	0.8	2	---	---	---	---	---	---	
	1.5	clayey SAND, brown/orange	---	---	---	---	7.5	6.6	0.9	3	7.2	< 0.02	< 0.005	< 0.02	< 0.02	0.12	
	2	evaporite CLAY, tan	---	---	---	---	7.3	6.9	0.4	4	---	---	---	---	---	---	
	3.5	evaporite SAND, mottled	---	---	---	---	7.3	6.5	0.8	4	7.4	< 0.02	< 0.005	< 0.02	< 0.02	0.16	
	4	CLAY, olive brown	---	---	---	---	7.5	7.6	0.1	4	---	---	---	---	---	---	
	4.5	evaporite sandy CLAY, mottled brown	---	---	---	---	7.5	7.1	0.4	4	7.4	< 0.02	< 0.005	< 0.02	< 0.02	0.21	
T12	5	sandy CLAY, orange/brown	---	---	---	---	7.4	7.6	0.2	4	---	---	---	---	---	---	NASS
	6	evaporite SAND, cream/orange	---	---	---	---	7.6	7.2	0.4	4	---	---	---	---	---	---	
	0.01	Black Ooze	---	---	---	---	7.8	6.8	1	4	8.2	< 0.02	< 0.005	< 0.02	< 0.02	0.4	
	0.45	gypsum SAND, brown	---	---	---	---	8.0	7.1	0.9	3	8.4	< 0.02	< 0.005	< 0.02	< 0.02	0.71	
	0.5	SAND, brown	---	---	---	---	7.9	6.9	1	3	8.3	< 0.02	< 0.005	< 0.02	< 0.02	0.53	
	0.6	SAND, brown	---	---	---	---	7.9	6.9	1	3	---	---	---	---	---	---	
	1	CLAY, red	---	---	---	---	7.3	7.3	0	3	---	---	---	---	---	---	
	1.5	CLAY, red	---	---	---	---	7	6.5	0.5	3	---	---	---	---	---	---	
	2	CLAY, brown	---	---	---	---	7	6.3	0.7	4	6.9	< 0.02	< 0.005	< 0.02	< 0.02	0.16	
	2.5	gypsum SAND, cream	---	---	---	---	7.4	6.6	0.8	3	7.3	< 0.02	< 0.005	< 0.02	< 0.02	0.1	
	3	sandy CLAY, brown	---	---	---	---	7.2	6.6	0.6	4	---	---	---	---	---	---	
	3.5	CLAY, brown	---	---	---	---	7.2	7.2	0	4	---	---	---	---	---	---	
	4	gypsum SAND, cream	---	---	---	---	7.3	6.4	0.9	3	7.5	< 0.02	< 0.005	< 0.02	< 0.02	0.19	
	4.5	CLAY, red/grey	---	---	---	---	7.5	7.9	0.4	4	---	---	---	---	---	---	
	5	CLAY, red/brown/green	---	---	---	---	7.6	7.4	0.2	3	7.7	< 0.02	< 0.005	< 0.02	< 0.02	0.36	
	6	CLAY, brown	---	---	---	---	7.6	7.0	0.6	3	---	---	---	---	---	---	
	10	CLAY, red	---	---	---	---	7.1	6.5	0.6	3	6.9	< 0.02	< 0.005	< 0.02	< 0.02	0.16	
T14	0	Black Ooze	7.4	5.9	1.5	2	7.8	6.6	1.2	4	8.3	< 0.02	0.016	< 0.02	0.02	0.5	NASS
	0.5	silty SAND, red/brown	7.8	6.2	1.6	2	7.4	7.9	0.5	4	7.9	< 0.02	< 0.005	< 0.02	< 0.02	0.46	
	1	CLAY, red/brown	7.7	6.2	1.5	2	7.6	7.8	0.2	4	8.2	< 0.02	< 0.005	< 0.02	< 0.02	0.67	
T15	0	Black Ooze	8	5.6	2.4	2	---	---	---	---	---	---	---	---	---	---	NASS
	0.05	SAND, brown	7.9	6.4	1.5	2	7.6	8.3	0.7	4	8	< 0.02	< 0.005	< 0.02	< 0.02	0.44	
	0.5	sandy CLAY, red/brown	7.8	6.1	1.7	1	7.5	8.1	0.6	4	8	< 0.02	< 0.005	< 0.02	< 0.02	0.22	
	0	Black Ooze	7.4	5.7	1.7	1	7.6	6.6	1	2	8	< 0.02	< 0.005	< 0.02	< 0.02	0.38	

			Field Analysis				Laboratory Analysis				Chromium Reducible Sulfur Suite						ASS Interpretation
Bore Hole ID	Sample Depth mbgl	Simplified Lithology	pH _f	pH _{tox}	pH _{change}	Reaction	pH _f	pH _{tox}	pH _{change}	Reaction	pH-KCl	TAA equiv. 5% pyrite	CRS (%S)	Net Acidity (%S)	Net Acidity (%S) - ANC (%S)	ANC (%S)	
Assessment Criteria:			<5.5	<3.0	>-3	>2	<5.5	<3.0	>3	>2	<5.5	0.03	0.03	0.03	0.03	-	
T16	0.03	silty SAND, red/brown	7.6	6.5	1.1	2	---	---	---	---	---	---	---	---	---	---	NASS
	1	clayey SAND, red/brown	7.7	6	1.7	2	7.5	7.9	0.4	4	8	< 0.02	< 0.005	< 0.02	< 0.02	0.36	
	1.0A	SAND, grey	7.5	5.8	1.7	1	7.6	8.2	0.6	4	7.5	< 0.02	< 0.005	< 0.02	< 0.02	0.12	
T20	0.03	Black ooze	---	---	---	---	8.2	5.1	3.1	4	7.7	< 0.02	0.12	< 0.02	0.12	0.47	PASS
	0.06	evaporite SAND, grey	---	---	---	---	7.6	7.4	0.2	4	7.7	< 0.02	< 0.005	< 0.02	< 0.02	0.09	NASS
	0.5	evaporite CLAY, brown	---	---	---	---	7.8	8.7	0.9	4	7.6	< 0.02	< 0.005	< 0.02	< 0.02	0.21	
	1	CLAY, brown	---	---	---	---	7.5	8	0.5	4	8.1	< 0.02	< 0.005	< 0.02	< 0.02	0.6	
	1.5	CLAY, brown	---	---	---	---	7.6	6.9	0.7	4	7.9	< 0.02	< 0.005	< 0.02	< 0.02	0.47	
	2	evaporite SAND, grey	---	---	---	---	7.9	8.3	0.4	4	8.6	< 0.02	< 0.005	< 0.02	< 0.02	3.9	
	2.5	CLAY, olive	---	---	---	---	7.8	7.3	0.5	2	8.5	< 0.02	< 0.005	< 0.02	< 0.02	0.74	
	3	CLAY, brown	---	---	---	---	7.7	6.9	0.8	2	---	---	---	---	---	---	
	3.5	CLAY, brown	---	---	---	---	7.8	6.9	0.9	2	---	---	---	---	---	---	
	6	CLAY, brown	---	---	---	---	7.6	6.8	0.8	2	8.2	< 0.02	< 0.005	< 0.02	< 0.02	0.81	
T21	0	Black Ooze	8.1	6.2	1.9	1	8.1	7.6	0.5	4	8.3	< 0.02	0.005	< 0.02	< 0.02	0.41	NASS
	0.05	sandy CLAY, brown	7.7	6.2	1.5	2	7.6	6.9	0.7	2	8.2	< 0.02	< 0.005	< 0.02	< 0.02	0.46	
	0.5	CLAY, red	7.6	5.8	1.8	1	7.5	7.8	0.3	4	8.1	< 0.02	< 0.005	< 0.02	< 0.02	0.33	
	1	CLAY, brown	7.5	6.1	1.4	2	7.5	8.1	0.6	4	8.1	< 0.02	< 0.005	< 0.02	< 0.02	0.62	
	1.5	CLAY, red	7.6	6	1.6	1	---	---	---	---	---	---	---	---	---	---	
	2	sandy CLAY, red	7.5	5.9	1.6	1	7.6	7	0.6	2	8.3	< 0.02	< 0.005	< 0.02	< 0.02	0.63	
	2.5	CLAY, red	7.7	5.8	1.9	1	---	---	---	---	---	---	---	---	---	---	
	3	CLAY, red	7.7	5.8	1.9	1	7.9	7.2	0.7	2	8.4	< 0.02	< 0.005	< 0.02	< 0.02	0.79	
	3.5	CLAY, red	7.8	6	1.8	1	---	---	---	---	---	---	---	---	---	---	
	4	CLAY, red	7.7	5.8	1.9	1	7.7	7.1	0.6	3	8.4	< 0.02	< 0.005	< 0.02	< 0.02	0.92	
	4.5	CLAY, red	7.7	5.9	1.8	1	---	---	---	---	---	---	---	---	---	---	
	5	CLAY, red	7.8	5.8	2.0	1	7.8	7.3	0.5	3	8.5	< 0.02	< 0.005	< 0.02	< 0.02	0.87	
T22	5.5	CLAY, red	7.7	5.7	2.0	1	---	---	---	---	---	---	---	---	---	---	
	0.03	Black Ooze	7.4	5.6	1.8	1	7.6	6.8	---	2	8.1	< 0.02	< 0.005	< 0.02	< 0.02	0.19	NASS
	0.5	SAND, light brown	7.6	5.8	1.8	1	7.8	6.9	---	2	8	< 0.02	0.005	< 0.02	< 0.02	0.18	
	1	CLAY, red/brown	7.8	5.9	1.9	1	6.8	7.2	---	3	7.7	< 0.02	< 0.005	< 0.02	< 0.02	0.14	
	1.5	CLAY, red/brown	7.8	5.9	1.9	1	---	---	---	---	---	---	---	---	---	---	
	2	CLAY, red/brown	7.7	6	1.7	1	---	---	---	---	---	---	---	---	---	---	
	2.5	CLAY, red/brown	7.9	6.1	1.8	2	6.3	7.5	---	3	8.8	< 0.02	0.014	< 0.02	< 0.02	0.99	
	3	CLAY, red/brown	7.9	5.9	2.0	1	---	---	---	---	---	---	---	---	---	---	
	3.5	CLAY, red/brown	7.9	5.8	2.1	1	---	---	---	---	---	---	---	---	---	---	
4	CLAY, green	8	6	2.0	2	6.7	7.7	---	3	8.7	< 0.02	< 0.005	< 0.02	< 0.02	0.58		
PP	6	silty CLAY, green/brown	8	5.8	2.2	1	---	---	---	---	---	---	---	---	---	---	
	0.02	evaporite SAND, grey/black organic material	---	---	---	---	7.5	6.5	1	2	7.8	< 0.02	< 0.005	< 0.02	< 0.02	0.45	NASS
	0.02b	Black ooze	---	---	---	---	8.4	5	3.4	2	8.2	< 0.02	0.062	< 0.02	0.06	0.41	PASS
	0.3	CLAY, red/brown	---	---	---	---	7.4	7.5	0.1	4	7.6	< 0.02	< 0.005	< 0.02	< 0.02	0.32	NASS
	2	CLAY, mottled red/ brown/ tan/olive	---	---	---	---	7.9	7.9	0	4	8.1	< 0.02	< 0.005	< 0.02	< 0.02	0.58	
6	CLAY, red/brown	---	---	---	---	7.8	7.6	0.2	4	---	---	---	---	---	---		

Notes

NASS: Non Acid Sulfate Soil

PASS: Potential Acid Sulfate Soil

AASS: Actual Acid Sulfate Soil

ANC: Acid Neutralising Capacity

*Mislabeled as T7_0.1 in lab report

Sample ID	Unit	LOR	Assessment Criteria	T2_0	T6_0.02	T11_1.0	T11_4.5	T12_0.01	T12_0.5	T12_2.5	T14_0.5	T15_0.5	T20_1.0
Laboratory ID			EIL	P17-Au28569	P17-No25779	P17-No02825	P17-No02823	P17-No02826	P17-No02832	P17-No02829	P17-Au28572	P17-Au28576	P17-No25785
Sample Date				13/08/2017	26/10/2017	27/09/2017	27/09/2017	27/09/2017	27/09/2017	27/09/2017	13/08/2017	15/08/2017	30/10/2017
Laboratory				Eurofins MGT	Eurofins MGT	Eurofins MGT	Eurofins MGT	Eurofins MGT	Eurofins MGT	Eurofins MGT	Eurofins MGT	Eurofins MGT	Eurofins MGT
Simplified Lithology				Black Ooze	Evaporite SAND, grey/black	Evaporite SAND, dark grey/black	Evaporite sandy CLAY, mottled brown	Black Ooze	SAND, brown	Gypsum SAND, cream	SILTY SAND, red/brown	SANDY CLAY red/brown	CLAY, brown
Heavy Metals													
Aluminium	mg/kg	10	---	9600	1100	4300	15000	2700	2600	7500	12000	9300	44000
Arsenic	mg/kg	2	100	< 2	< 2	< 2	2.1	< 2	< 2	< 2	2	< 2	3.9
Cadmium	mg/kg	0.4	---	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Chromium	mg/kg	5	190**	18	< 5	7.7	18	< 5	< 5	8.5	20	16	44
Copper	mg/kg	5	60**	7.8	< 5	< 5	11	< 5	< 5	8.9	9.6	7.7	25
Iron	mg/kg	20	---	16000	1500	6400	17000	3500	3300	8900	17000	14000	52000
Lead	mg/kg	5	1100	< 5	< 5	< 5	9.3	6.1	< 5	< 5	< 5	< 5	22
Mercury	mg/kg	0.1	---	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Nickel	mg/kg	5	30**	5.7	< 5	< 5	7.8	< 5	< 5	< 5	6.1	5.1	19
Uranium	mg/kg	10	23***	---	<10	<10	<10	<10	<10	<10	---	---	<10
Zinc	mg/kg	5	70**	28	< 5	14	21	10	5.2	10	25	15	48

Acronyms:

LOR = limits of reporting

mg/kg = milligrams per kilogram

"---" = criteria have not been derived for these chemical constituents/compounds.

**In the absence of site specific soil parameters, the most conservative EILs have been adopted

***In the absence of EIL values for Uranium, the soil standards for the protection of human health from Canada (Nova Scotia) have been adopted.

Font and Cell :

- Coloured cells indicate exceedence of relevant assessment criteria

- Bolded analytical data indicates detection above LOR

Ecological Investigation Level - Urban Residential/ Open Public Space

Sample ID	Unit	LOR	Assessment Criteria	T20_2.5	T21_0	T21_1.0	T21_2.0	T5_0.05	T7_0.05	T8_0.5	T22_0.03	T22_2.5	T22_4.0
Laboratory ID			EIL	P17-No25788	P17-Au28581	P17-Au28584	P17-Au28586	P17-Se27802	P17-Se27807	P17-Se27813	P17-Se27817	P17-Se27820	P17-Se27821
Sample Date				30/10/2017	15/08/2017	17/08/2017	17/08/2017	14/09/2017	14/09/2017	13/09/2017	13/09/2017	13/09/2017	13/09/2017
Laboratory				Eurofins MGT	Eurofins MGT	Eurofins MGT	Eurofins MGT	Eurofins MGT	Eurofins MGT	Eurofins MGT	Eurofins MGT	Eurofins MGT	Eurofins MGT
Simplified Lithology				CLAY, olive	Black Ooze	Clay, brown	SANDY CLAY, red	Black Ooze	CLAY, brown	SANDY CLAY, red/brown	Black Ooze	CLAY, red/brown	CLAY, green
Heavy Metals													
Aluminium	mg/kg	10	---	32000	5600	9500	38000	760	14000	46000	1800	38000	43000
Arsenic	mg/kg	2	100	4.2	< 2	< 2	4	< 2	2.6	5.1	< 2	4.2	4.6
Cadmium	mg/kg	0.4	---	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	0.5
Chromium	mg/kg	5	190**	35	12	16	47	< 5	22	54	< 5	33	48
Copper	mg/kg	5	60**	35	7.5	11	19	< 5	11	20	< 5	23	22
Iron	mg/kg	20	---	43000	7900	12000	39000	1300	18000	47000	2100	34000	45000
Lead	mg/kg	5	1100	11	< 5	< 5	12	< 5	5.4	15	< 5	19	12
Mercury	mg/kg	0.1	---	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Nickel	mg/kg	5	30**	13	< 5	5.4	17	< 5	6.7	20	< 5	23	21
Uranium	mg/kg	10	23***	<10	---	---	---	<10	<10	<10	<10	<10	<10
Zinc	mg/kg	5	70**	45	17	30	44	< 5	26	54	< 5	54	56

Acronyms:

LOR = limits of reporting

mg/kg = milligrams per kilogram

"---" = criteria have not been derived for these chemical constituents/compounds.

**In the absence of site specific soil parameters, the most conservative EILs have been adopted

***In the absence of EIL values for Uranium, the soil standards for the protection of human health from Canada (Nova Scotia) have been adopted.

Font and Cell :

- Coloured cells indicate exceedence of relevant assessment criteria

- Bolded analytical data indicates detection above LOR

 Ecological Investigation Level - Urban Residential/ Open Public Space

Sample ID	Unit	LOR	Assessment Criteria	PP_0.02	PP_0.02B	PP_2.0
Laboratory ID			EIL	P17-No25775	P17-No25776	P17-No25778
Sample Date				Not Provided	Not Provided	Not Provided
Laboratory				Eurofins MGT	Eurofins MGT	Eurofins MGT
Simplified Lithology				evaporatite SAND, grey/black organic material	Black Ooze	CLAY, mottled red/ brown/ tan/olive
Heavy Metals						
Aluminium	mg/kg	10	---	7500	6400	38000
Arsenic	mg/kg	2	100	< 2	< 2	5.7
Cadmium	mg/kg	0.4	---	< 0.4	< 0.4	< 0.4
Chromium	mg/kg	5	190**	15	13	66
Copper	mg/kg	5	60**	5.9	5.4	24
Iron	mg/kg	20	---	11000	10000	49000
Lead	mg/kg	5	1100	< 5	< 5	21
Mercury	mg/kg	0.1	---	< 0.1	< 0.1	< 0.1
Nickel	mg/kg	5	30**	< 5	< 5	19
Uranium	mg/kg	10	23***	<10	<10	16
Zinc	mg/kg	5	70**	22	19	67

Acronyms:

LOR = limits of reporting

mg/kg = milligrams per kilogram

"---" = criteria have not been derived for these chemical constituents/compounds.

**In the absence of site specific soil parameters, the most conservative EILs have been adopted

***In the absence of EIL values for Uranium, the soil standards for the protection of human health from Canada (Nova Scotia) have been adopted.

Font and Cell :

- Coloured cells indicate exceedence of relevant assessment criteria

- Bolded analytical data indicates detection above LOR

 Ecological Investigation Level - Urban Residential/ Open Public Space

Sample Type	Unit	LOR	Primary	Duplicate	RPD	Primary	Duplicate	RPD	Primary	Duplicate	RPD	Primary	Duplicate	RPD	Primary	Duplicate	RPD
Sample ID			T2_0	QC1		T2_0	QC1		T2_0.05	QC2		T14_0	QC3		T15_0	QC4	
Laboratory Sample ID			-	-		P17-Au28569	P17-Au28562		-	-		-	-		-	-	
Sample Date			13/08/2017	17/08/2017		13/08/2017	17/08/2017		13/08/2017	13/08/2017		13/08/2017	13/08/2017		15/08/2017	15/08/2017	
Laboratory			Field Result	Field Result		Eurofins MGT	Eurofins MGT		Field Result	Field Result		Field Result	Field Result		Field Result	Field Result	
Laboratory pHf and pHox																	
pHfield	pH Units	0.1	7.4	7.4	0%	7.6	7.4	3%	7.4	7.5	1%	7.4	7.4	0%	8.0	8.0	0%
pHfox	pH Units	0.1	6.3	6	5%	7.1	6.7	6%	6.1	5.8	5%	5.9	6.0	2%	5.6	5.5	2%
Heavy Metals																	
Aluminium	mg/kg	10	---	---	---	9600	6000	46%	---	---	---	---	---	---	---	---	---
Arsenic	mg/kg	2	---	---	---	< 2	< 2	NA	---	---	---	---	---	---	---	---	---
Cadmium	mg/kg	0.4	---	---	---	< 0.4	< 0.4	NA	---	---	---	---	---	---	---	---	---
Chromium	mg/kg	5	---	---	---	18	13	32%	---	---	---	---	---	---	---	---	---
Copper	mg/kg	5	---	---	---	7.8	5.6	33%	---	---	---	---	---	---	---	---	---
Iron	mg/kg	20	---	---	---	16000	8200	64%	---	---	---	---	---	---	---	---	---
Lead	mg/kg	5	---	---	---	< 5	< 5	NA	---	---	---	---	---	---	---	---	---
Uranium	mg/kg	10	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Mercury	mg/kg	0.1	---	---	---	< 0.1	< 0.1	NA	---	---	---	---	---	---	---	---	---
Nickel	mg/kg	5	---	---	---	5.7	< 5	NA	---	---	---	---	---	---	---	---	---
Zinc	mg/kg	5	---	---	---	28	21	29%	---	---	---	---	---	---	---	---	---
pH-KCL																	
pH-KCL	pH Units	0.1	---	---	---	8.2	8.3	1%	---	---	---	---	---	---	---	---	---
TAA equiv. S% pyrite	% pyrite S	0.02	---	---	---	< 0.02	< 0.02	NA	---	---	---	---	---	---	---	---	---
CRS	%S	0.005	---	---	---	< 0.005	0.005	NA	---	---	---	---	---	---	---	---	---
Net Acidity	%S	0.02	---	---	---	< 0.02	< 0.02	NA	---	---	---	---	---	---	---	---	---
Net Acidity (%S) - ANC (%S)	% S	0.02	---	---	---	< 0.02	< 0.02	NA	---	---	---	---	---	---	---	---	---
ANC	%S	0.02	---	---	---	0.42	0.36	15%	---	---	---	---	---	---	---	---	---

*RPDs have only been considered where a concentration is greater than 1 times the EQL.

**High RPDs are in bold (Acceptable RPDs is 30%)

***Interlab Duplicates are matched on a per compound basis as methods vary between laboratories. Any methods in the row header relate to those used in the primary laboratory

Sample Type	Unit	LOR	Primary	Duplicate	RPD	Primary	Duplicate	RPD	Primary	Duplicate	RPD	Primary	Duplicate	RPD
Sample ID			T16_0	QC5		T21_0	QC7		T16_0.03	QC6		T5_0.05	QC1	
Laboratory Sample ID			-	-		-	-		-	-		-	-	
Sample Date			13/08/2017	17/08/2017		15/08/2017	15/08/2017		13/08/2017	13/08/2017		14/09/2017	14/09/2017	
Laboratory			Field Result	Field Result		Field Result	Field Result		Field Result	Field Result		Field Result	Field Result	
Laboratory pHf and pHox														
pHfield	pH Units	0.1	7.4	8.0	8%	8.1	8.4	6%	7.6	7.5	1%	7.9	8.3	6%
pHfox	pH Units	0.1	5.7	6.9	19%	6.2	6.2	0%	6.5	6.4	2%	5.7	5.5	4%
Heavy Metals														
Aluminium	mg/kg	10	---	---	---	---	---	---	---	---	---	---	---	---
Arsenic	mg/kg	2	---	---	---	---	---	---	---	---	---	---	---	---
Cadmium	mg/kg	0.4	---	---	---	---	---	---	---	---	---	---	---	---
Chromium	mg/kg	5	---	---	---	---	---	---	---	---	---	---	---	---
Copper	mg/kg	5	---	---	---	---	---	---	---	---	---	---	---	---
Iron	mg/kg	20	---	---	---	---	---	---	---	---	---	---	---	---
Lead	mg/kg	5	---	---	---	---	---	---	---	---	---	---	---	---
Uranium	mg/kg	10	---	---	---	---	---	---	---	---	---	---	---	---
Mercury	mg/kg	0.1	---	---	---	---	---	---	---	---	---	---	---	---
Nickel	mg/kg	5	---	---	---	---	---	---	---	---	---	---	---	---
Zinc	mg/kg	5	---	---	---	---	---	---	---	---	---	---	---	---
pH-KCL	pH Units	0.1	---	---	---	---	---	---	---	---	---	---	---	---
TAA equiv. S% pyrite	% pyrite S	0.02	---	---	---	---	---	---	---	---	---	---	---	---
CRS	%S	0.005	---	---	---	---	---	---	---	---	---	---	---	---
Net Acidity	%S	0.02	---	---	---	---	---	---	---	---	---	---	---	---
Net Acidity (%S) - ANC (%S)	% S	0.02	---	---	---	---	---	---	---	---	---	---	---	---
ANC	%S	0.02	---	---	---	---	---	---	---	---	---	---	---	---

*RPDs have only been considered where a concentration is greater than 1 times the EQL.

**High RPDs are in bold (Acceptable RPDs is 30%)

***Interlab Duplicates are matched on a per compound basis as methods vary between laboratories. Any methods in the row header relate to those used in the primary laboratory

Sample Type	Unit	LOR	Primary	Duplicate	RPD	Primary	Duplicate	RPD	Primary	Duplicate	RPD	Primary	Duplicate	RPD	Primary	Duplicate	RPD
Sample ID			T5_0.05	QC1		T8_0.03	QC2		T8_0.03	QC2		T12_0.5	QC1		T12_2.5	QC2	
Laboratory Sample ID			P17-Se27802	P17-Se27805		-	-		P17-Se27811	P17-Se27812		P17-Oc21182	P17-Oc21188		P17-Oc21178	P17-Oc21189	
Sample Date			14/09/2017	14/09/2017		13/09/2017	13/09/2017		13/09/2017	13/09/2017		27/09/2017	27/09/2017		27/09/2017	27/09/2017	
Laboratory			Eurofins MGT	Eurofins MGT		Field Result	Field Result		Eurofins MGT	Eurofins MGT		Eurofins MGT	Eurofins MGT		Eurofins MGT	Eurofins MGT	
Laboratory pHf and pHox																	
pHfield	pH Units	0.1	7.8	8.2	5%	8.2	7.9	6%	8.2	7.9	4%	7.9	7.9	0%	7.4	7.4	0%
pHfox	pH Units	0.1	6.5	5.2	22%	5.8	5.6	4%	6.8	6.7	1%	6.9	6.6	4%	6.6	6	10%
Heavy Metals																	
Aluminium	mg/kg	10	760	1700	76%	---	---	---	---	---	---	2600	3000	14%	7500	---	---
Arsenic	mg/kg	2	< 2	< 2	NA	---	---	---	---	---	---	< 2	< 2	NA	< 2	---	---
Cadmium	mg/kg	0.4	< 0.4	< 0.4	NA	---	---	---	---	---	---	< 0.4	< 0.4	NA	< 0.4	---	---
Chromium	mg/kg	5	< 5	5.3	NA	---	---	---	---	---	---	< 5	5.1	NA	8.5	---	---
Copper	mg/kg	5	< 5	< 5	NA	---	---	---	---	---	---	< 5	< 5	NA	8.9	---	---
Iron	mg/kg	20	1300	2100	47%	---	---	---	---	---	---	3300	3700	11%	8900	---	---
Lead	mg/kg	5	< 5	< 5	NA	---	---	---	---	---	---	< 5	< 5	NA	< 5	---	---
Uranium	mg/kg	10	<10	<10	NA	---	---	---	---	---	---	---	---	---	---	---	---
Mercury	mg/kg	0.1	< 0.1	< 0.1	NA	---	---	---	---	---	---	< 0.1	< 0.1	NA	< 0.1	---	---
Nickel	mg/kg	5	< 5	< 5	NA	---	---	---	---	---	---	< 5	< 5	NA	< 5	---	---
Zinc	mg/kg	5	< 5	5.9	NA	---	---	---	---	---	---	5.2	5.8	11%	10	---	---
pH-KCL	pH Units	0.1	7	7.4	6%	---	---	---	7.5	7.4	1%	8.3	9	8%	---	---	---
TAA equiv. S% pyrite	% pyrite S	0.02	<0.02	< 0.02	NA	---	---	---	< 0.02	< 0.02	NA	< 0.02	< 0.02	NA	---	---	---
CRS	%S	0.005	0.01	0.014	33%	---	---	---	< 0.005	0.007	NA	< 0.005	0.008	NA	---	---	---
Net Acidity	%S	0.02	<0.02	<0.02	NA	---	---	---	< 0.02	< 0.02	NA	< 0.02	< 0.02	NA	---	---	---
Net Acidity (%S) - ANC (%S)	% S	0.02	< 0.02	<0.02	NA	---	---	---	< 0.02	< 0.02	NA	< 0.02	< 0.02	NA	---	---	---
ANC	%S	0.02	0.04	0.08	67%	---	---	---	0.07	0.05	33%	0.53	1.9	113%	---	---	---

*RPDs have only been considered where a concentration is greater than 1 times the EQL.

**High RPDs are in bold (Acceptable RPDs is 30%)

***Interlab Duplicates are matched on a per compound basis as methods vary between laboratories. Any methods in the row header relate to those used in the primary laboratory

Agrimin
Lake Mackay SOP Project
Table 4: Groundwater Analytical Results

Sample ID			TRENCH 16	TRENCH T16	TRENCH T14	TRENCH T14	PILOT POND PP#1	PILOT POND PP#2	PILOT POND PP#3	TRENCH14	TRENCH16	TRENCH2	TRENCH5	TRENCH14	TRENCH14	TRENCH16	TRENCH16	TRENCH 22	TRENCH 22	TRENCH 22	TRENCH 5	TRENCH 5
Date			5/9/17	30/9/17	30/9/17	7/10/17	2/10/17	2/10/17	2/10/17	Not Provided	Not provided	4/9/17	4/9/17	16/8/17	2/9/17	16/8/17	2/9/17	23/11/17	31/10/17	6/11/17	31/10/17	6/11/17
Laboratory			Intertek	Intertek	Intertek	Intertek	Intertek	Intertek	Intertek	Intertek	Intertek	Intertek	Intertek	Intertek	Intertek	Intertek	Intertek	Intertek	Intertek	Intertek	Intertek	Intertek
Analyte	Unit	LOR																				
Ca	mg/L	1	467	458	465	466	413	271	281	447	445	358	444	462	463	455	412	661	693	686	403	395
CL	mg/L	10	166510	169190	165610	168300	150390	141440	143230	164400	161100	174800	164900	162300	164100	163200	169400	120530	116100	120530	171930	166620
Cl:SO4 ratio	g/L	0.01	11.56	9.54	7.54	8.14	6.90	7.72	7.97	7.44	7.31	---	---	---	---	---	---	6.49	6.37	6.43	7.33	7.01
Ion Bal	%	---	---	---	---	---	---	---	---	-1	0	---	---	---	---	---	---	---	---	---	---	---
K	mg/L	2	3631	3624	3646	3635	3434	2725	2808	3410	3342	3920	3998	3809	3815	3763	3793	2907	2970	3103	3922	3805
Mg	mg/L	1	2848	2883	3688	3678	5411	9045	7594	3874	2892	3496	3408	3358	3408	2578	2618	1884	1932	2008	3570	3469
Na	mg/L	2	109802	111226	110859	111131	97631	84169	87700	106133	106071	120048	114494	113246	113415	113354	116455	76592	78947	82167	113511	110441
S	mg/L	5	4806	5922	7333	6906	7275	6114	6000	7380	7359	8028	7612	7218	7345	7433	7646	6197	6088	6259	7825	7935
SO4	mg/L	15	14399	17742	21967	20688	21793	18316	17973	22108	22046	---	---	---	---	---	---	18564	18237	18750	23441	23772
Specific Gravity	N/A	0.001	1.20	1.20	1.20	1.20	1.19	1.17	1.18	1.20	1.19	---	---	---	---	---	---	1.15	1.16	1.15	1.20	1.20
TDS	g/Kg	0.02	251.18	257.19	256.47	257.05	235.15	229.02	228.54	257.85	252.37	---	---	---	---	---	---	198.25	199.17	202.46	265.62	262.39
EC	ms/CM	0.01	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	>200.00	>200.00	>200.00	>200.00	>200.00

APPENDIX A

DoW Water Information Reporting Data



Site reference 120670009 - Gibson Desert North - Company - Company

Alternative Site References

Numbering System	Reference Code	Site Name	Short Name
AWRC	120670009	Gibson Desert North - Company	Company
TEXT_HIST	2670009	GIBSON DESERT NORTH - COMPANY	Company
WIN_ID	23087686		Company

General Details

Site Type	Groundwater	Sub Type	Bore or Well	Site Geofeature	Ground
Northing	7504992	Easting	450003	Zone	52
Latitude	-22.561024061	Longitude	128.513698918	Spheroid	GDA94
Thou250 Map Index	SF5210	Geographic Precision (+/- m)	+/-10m		
Local Govt Authority	SHIRE OF EAST PILBARA	Locality	GIBSON DESERT NORTH	DWER Region	North West
Catchment	Basin Mackay	Estuary		BOM Rainfall District	13 - Northeast
River Basin	1206 - Mackay Basin	Groundwater Area	Canning-Kimberley	Groundwater Province	Combined Fractured Rock
Surface Water Area	Mackay Basin	Surface Water SubArea	Mackay Basin	GgStn Catchment Area(km2)	N/A
Site Comment	Bore MA02				

Depth Measurement Points *(Site reference: 120670009)*

Measurement Point Type	Elevation (m as per Datum Plane)	Datum	Measurement Method	Date	Comments
Ground level	0	GL	Unknown	09/08/2015	

Drilling - No Data Available



Site Details Report

Date: 27/09/2017

Borehole Information (Site reference: 120670009)

Completed Date	9/08/2015	Drill Method Name	See Comment		
Owner Name	Agrimin Ltd	Drill Rig Name	Unknown		
Drill Company Name	Colling Exploration	Total Construction Depth (mbGL)	15.35	Depth Drilled (mbGL)	16.7
Comments	Method: Aircore				

Casing (Site reference: 120670009)

From (mbGL)	To (mbGL)	Element	Material	Inlet Type	Inside Dia. (mm)	Outside Dia. (mm)	Aperture (mm)	Comments
-0.350	15.350	Inlet (screen)	Unknown	Unknown		114	0.800	
0.000	15.350	Casing	PVC - Class 9	Not applicable		114		

Fill (Site reference: 120670009)

From (mbGL)	To (mbGL)	Fill Type	Material Type	Fill Volume (m3)	Grain Size (mm)
0.000	15.350	Annular Fill	Unknown		

Aquifers - No Data Available

Lithology Log (Site reference: 120670009)

From (mbGL)	To (mbGL)	Interpreted By	Substance	Lithological Description
0.000	0.600	Driller		Brown clay
0.600	1.800	Driller		Red brown clay
1.800	2.200	Driller		Fine cemented gypsum sand
2.200	16.000	Driller		Red brown clay with traces of gypsum
16.000	16.700	Driller		Weathered rock hard white siliceous unit



Stratigraphy Log - No Data Available

Advanced Data Summary - No Data Available



Site reference 120670010 - Gibson Desert North - Company - Company

Alternative Site References

Numbering System	Reference Code	Site Name	Short Name
AWRC	120670010	Gibson Desert North - Company	Company
TEXT_HIST	2670010	GIBSON DESERT NORTH - COMPANY	Company
WIN_ID	23087900		Company

General Details

Site Type	Groundwater	Sub Type	Bore or Well	Site Geofeature	Ground
Northing	7515003	Easting	499801	Zone	52
Latitude	-22.471320158	Longitude	128.998065638	Spheroid	GDA94
Thou250 Map Index	SF5210	Geographic Precision (+/- m)	+/-10m		
Local Govt Authority	SHIRE OF EAST PILBARA	Locality	GIBSON DESERT NORTH	DWER Region	North West
Catchment	Basin Mackay	Estuary		BOM Rainfall District	13 - Northeast
River Basin	1206 - Mackay Basin	Groundwater Area	Canning-Kimberley	Groundwater Province	Combined Fractured Rock
Surface Water Area	Mackay Basin	Surface Water SubArea	Mackay Basin	GgStn Catchment Area(km2)	N/A
Site Comment					

Depth Measurement Points (Site reference: 120670010)

Measurement Point Type	Elevation (m as per Datum Plane)	Datum	Measurement Method	Date	Comments
Ground level	0	GL	Unknown	16/08/2015	

Drilling - No Data Available



Site Details Report

Date: 27/09/2017

Borehole Information (Site reference: 120670010)

Completed Date	16/08/2015	Drill Method Name	See Comment		
Owner Name	Agrimin Ltd	Drill Rig Name	Unknown		
Drill Company Name	Colling Exploration	Total Construction Depth (mbGL)	30	Depth Drilled (mbGL)	30
Comments	Method: Aircore				

Casing (Site reference: 120670010)

From (mbGL)	To (mbGL)	Element	Material	Inlet Type	Inside Dia. (mm)	Outside Dia. (mm)	Aperture (mm)	Comments
0.000	30.000	Casing	PVC - Class 9	Not applicable		114		
3.000	30.000	Inlet (screen)	PVC - Class 9	Unknown		114	0.800	

Fill (Site reference: 120670010)

From (mbGL)	To (mbGL)	Fill Type	Material Type	Fill Volume (m3)	Grain Size (mm)
0.000	30.000	Annular Fill	Unknown		

Aquifers - No Data Available



Lithology Log (Site reference: 120670010)

From (mbGL)	To (mbGL)	Interpreted By	Substance	Lithological Description
0.000	0.600	Driller		COARSE GYPSUM SAND
0.600	2.700	Driller		RED BROWN CLAY TO SANDY CLAY
2.700	3.000	Driller		CRYSTALLINE GYPSUM
3.000	15.000	Driller		RED BROWN CLAY WITH TRACES OF GYPSUM
15.000	16.500	Driller		COARSE CRYSTALLINE GYPSUM
16.500	30.000	Driller		RED BROWN CLAY WITH TRACES OF GYPSUM

Stratigraphy Log - No Data Available

Advanced Data Summary - No Data Available



Site reference 120670011 - Gibson Desert North - Company - Company

Alternative Site References

Numbering System	Reference Code	Site Name	Short Name
AWRC	120670011	Gibson Desert North - Company	Company
TEXT_HIST	2670011	GIBSON DESERT NORTH - COMPANY	Company
WIN_ID	23087901		Company

General Details

Site Type	Groundwater	Sub Type	Bore or Well	Site Geofeature	Ground
Northing	7535004	Easting	490003	Zone	52
Latitude	-22.290599214	Longitude	128.902950470	Spheroid	GDA94
Thou250 Map Index	SF5210	Geographic Precision (+/- m)	+/-10m		
Local Govt Authority	SHIRE OF EAST PILBARA	Locality	GIBSON DESERT NORTH	DWER Region	North West
Catchment	Basin Mackay	Estuary		BOM Rainfall District	13 - Northeast
River Basin	1206 - Mackay Basin	Groundwater Area	Canning-Kimberley	Groundwater Province	Combined Fractured Rock
Surface Water Area	Mackay Basin	Surface Water SubArea	Mackay Basin	GgStn Catchment Area(km2)	N/A
Site Comment					

Depth Measurement Points *(Site reference: 120670011)*

Measurement Point Type	Elevation (m as per Datum Plane)	Datum	Measurement Method	Date	Comments
Ground level	0	GL	Unknown	19/08/2015	

Drilling - No Data Available



Site Details Report

Date: 27/09/2017

Borehole Information (Site reference: 120670011)

Completed Date	19/08/2015	Drill Method Name	See Comment		
Owner Name	Agrimin Ltd	Drill Rig Name	Unknown		
Drill Company Name	Colling Exploration	Total Construction Depth (mbGL)	25.5	Depth Drilled (mbGL)	26
Comments	Method: Aircore				

Casing (Site reference: 120670011)

From (mbGL)	To (mbGL)	Element	Material	Inlet Type	Inside Dia. (mm)	Outside Dia. (mm)	Aperture (mm)	Comments
0.000	25.500	Casing	PVC - Class 9	Not applicable		114		
7.500	25.500	Inlet (screen)	PVC - Class 9	Unknown		114	0.800	

Fill (Site reference: 120670011)

From (mbGL)	To (mbGL)	Fill Type	Material Type	Fill Volume (m3)	Grain Size (mm)
0.000	26.000	Annular Fill	Unknown		

Aquifers - No Data Available

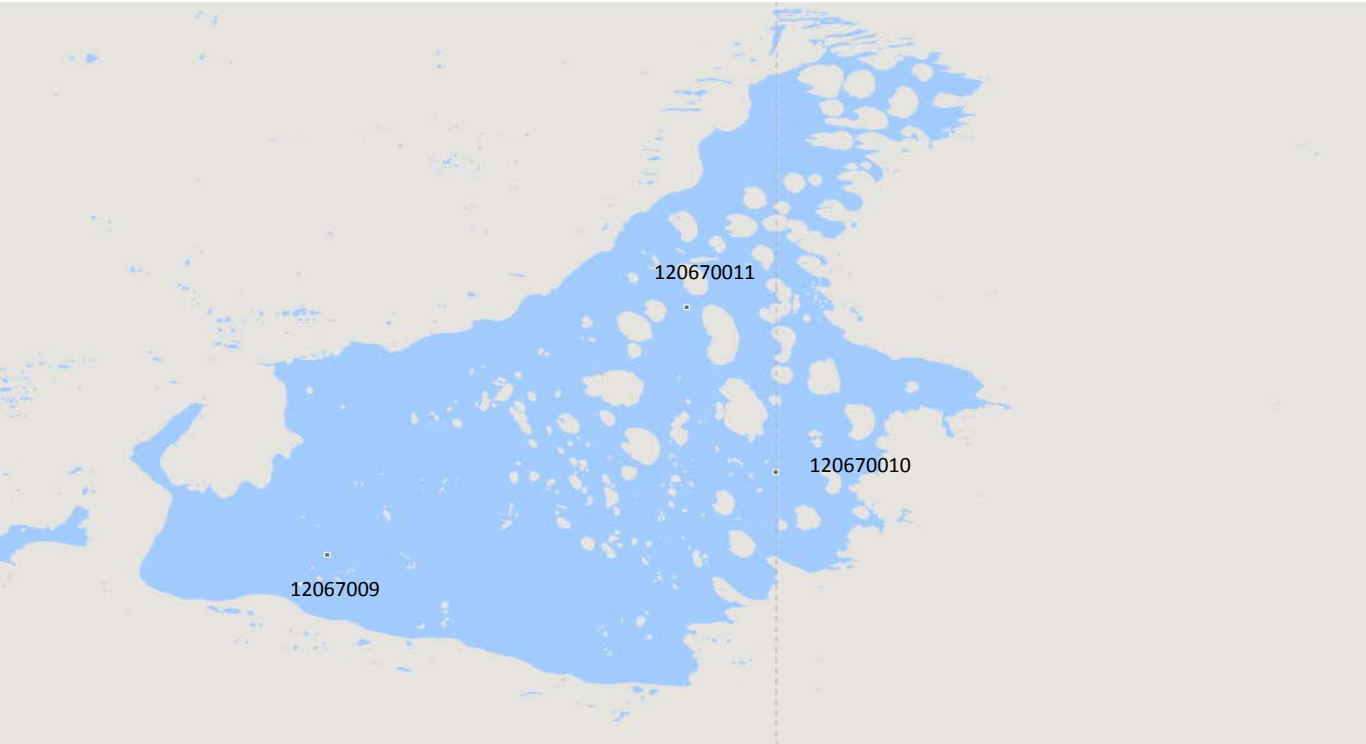
Lithology Log (Site reference: 120670011)

From (mbGL)	To (mbGL)	Interpreted By	Substance	Lithological Description
0.000	0.600	Driller		GYPSUM SAND
0.600	25.500	Driller		BROWN CLAY
25.500	26.000	Driller		IRONSTONE: Probably ferruginous sandstone

Stratigraphy Log - No Data Available

Advanced Data Summary - No Data Available





ID	Bore Name	Zone	Easting	Northing	Location	Asset Owner	Use	Start Date	Status
120670009	BORE	52	450003	7504992	within site area	Agirim Ltd	Unknown	Unknown	Unknown
120670010	BORE	52	499801	7515003	within site area	Agirim Ltd	Unknown	Unknown	Unknown
120670011	BORE	52	490003	7535004	within site area	Agirim Ltd	Unknown	Unknown	Unknown

APPENDIX B

Technical Standard Operating Procedures and Sampling and Analysis Plan

Our Ref: 2225 BA

30 June 2017

Michael Hartley
Hydrogeologist
Agrimin Limited
2C Loch Street
Nedlands WA 6009
Via Email: mhartley@agrimin.com.au



Dear Michael

Acid Sulfate Soil Characterisation Sampling and Analysis Plan – Lake Mackay SOP

360 Environmental is pleased to present the following sampling and analysis plan to assist Agrimin Potash Pty Ltd (Agrimin) in undertaking the field portion of the acid sulfate soil (ASS) investigation to ensure that sample collection meets the project objectives and is undertaken in accordance with the required regulatory standards.

It is understood that Agrimin shall undertake the acid sulfate soil (ASS) sampling during trenching works at the Lake Mackay SOP Project in July/August 2017.

This sampling and analysis plan (SAP) will:

- Define the sample collection strategy to allow for a preliminary assessment of the acid generating potential of sediments/soils (on a regional scale) that may be disturbed in association with the Lake Mackay SOP Project
- Provide information on the methods of sampling to be employed to achieve outcomes acceptable to the regulatory authority

1. Sample Locations

It is understood that Agrimin will be excavating 20 trenches of 100 m in length and up to 6 m depth. Following trench excavation, 8 temporary groundwater piezometers will be positioned around each trench. The ASS samples shall be collected from the temporary groundwater piezometers and sample lithologies will be chosen based on the lithologies encountered in the trench.

The general sampling requirements for the characterisation of the ASS potential at the Lake Mackay SOP project are as follows:

- Collection of 12 primary field samples and 1 duplicate sample per trench investigation area) at 0.5 m down the soil profile for pH_F and pH_{FOX} . In total there will be 240 field samples and 24 QAQC samples (duplicates)
- Laboratory analysis of samples from each identified lithology from across the site for:
 - Chromium reducible sulfur (CRS) (equal split of samples between the identified lithologies giving 80 samples and 4 duplicate QAQC)
 - Eight priority metals (As, Cd, Cr, Cu, Ni, Pb, Zn, Hg), Al and Fe (equal split of samples between the identified lithologies giving 20 samples including 1 duplicate QAQC)

The laboratory soil samples shall be collected based on the highest risk sample (based on the field pH_F and pH_{FOX} tests) from each lithological unit in each soil profile

The field samples shall be collected from the temporary piezometers with one sample collected the equivalent of 0.5 m vertical intervals down the lithological profile in the piezometers. The samples need not be collected from a single piezometer so long as the collective samples cover the entire lithological profile at 0.5 m intervals from one or a combination of temporary piezometers around a trench. For example:

- If the trench indicates consistent lateral lithology across its 100 m length, soil samples could be collected at half metre intervals from a single piezometer (PZ1):
 - PZ1_0 , PZ1_0.5 , PZ1_1.0 , PZ1_1.5, PZ1_2.0, PZ1_2.5, PZ1_3.0, PZ1_3.5, PZ1_4.0, PZ1_4.5, PZ1_5.0, PZ1_5.5
- If the trench indicates variable lateral lithology across its 100 m length, soil samples could be collected at half metre intervals from multiple piezometers (e.g PZ1, PZ3, PZ5, PZ7) in order to ensure all lithologies are targeted:
 - For example - PZ1_0 , PZ1_0.5 , PZ3_1.0 , PZ5_1.5, PZ7_2.0, PZ1_2.5, PZ5_3.0, PZ1_3.5, PZ1_4.0, PZ7_4.5, PZ5_5.0, PZ5_5.5

Time permitting, Agrimin should send the trench lithology logs to 360 Environmental for review and assistance in determining the best locations for sample collection from the piezometers, prior to piezometer installation.

2. Inferred Lithology

Based on the geological logs of provided by Agrimin there are several distinct geological units that are expected to be encountered on site.

- **Dark Grey or Red Brown SAND:** The majority of the project areas has thin light to dark grey to brown/red surface sands up to 0.8 m thick. The surface sands contain variable gypsum and fine silt content.
- **Dark Brown/Black OOZE:** The northwestern portion of the lake around trenches 1, 2, 3, 14 and 18 have dark brown to black with localised possible sulphide containing surface sands up to 0.25 m thick.
- **Red/Brown SILTY SAND and CLAYEY SAND:** The surficial sands are generally underlain by red/brown silty sands or clayey sands extending to a maximum depth of approximately 1.5 m below ground level (bgl).
- **Red/Brown CLAY:** Underlying the silt sands and clayey sands is a generally consistent and thick layer of variable mottled red/brown firm to hard clay. The clay extends to the maximum drilled depth of 11.25 mbgl across the site. The clay is interbedded at isolated locations with thin sand layers up to 0.25 m thick and with thin gypsum (**GYP SUM**) layers. The clay is generally consistent however, areas of yellow and green clay (**Yellow/Green CLAY**) were reported in the eastern and central southern portions of the site respectively.

Sampling should target these key lithologies. Table 1 provides an indicative distribution on how these materials should be sampled and analysed relative to their anticipated relative abundance. Actual sample numbers will be dependent upon field conditions and pH_F and pH_{FOX} results. Duplicate samples should be variably

Table 1: Indicative Primary Sample Collection Distribution

LITHOLOGY	# FIELD SAMPLES	# LABORATORY SAMPLES (SCR)	# LABORATORY SAMPLES (METALS)	SAMPLING RATIONALE
Dark Grey or Red Brown SAND	40	15	3	0.5 m sampling intervals
Dark Brown/Black OOZE	30	30	5	Priority sampling of this material when encountered. All samples should go to laboratory.
Red/Brown SILTY SAND and CLAYEY SAND	40	15	3	0.5 m sampling intervals
Red Brown CLAY	120	16	5	0.5 m sampling intervals
GYP SUM	5	2	1	Opportunistic sampling if encountered
Yellow/Green CLAY	5	2	1	Opportunistic sampling if encountered
QA/QC samples	24	4	1	1 - 2 duplicate samples should be collected from each trench area. At least 1 duplicate sample should be collected from the OOZE material.
TOTAL	264	84	19	

3. Sampling Procedure

The sampling procedure for the Agrimin field staff has been split into field sample collection and laboratory sample collection process.

3.1. Field Samples

Field samples shall be collected as per Table 2 below. Laboratory requirements are detailed in Table 3. Detailed sampling procedures, including field pH_F and pH_{FOX} testing methodology are provided in Attachment A.

Table 2: Field Sampling Requirements

SAMPLING COMPONENT	REQUIREMENT
Sample logging	The lithology of the trenches and piezometers should be logged as per Agrimin's standards
Sample volume	1x 400 ml bag (in laboratory supplied soil bags)
Sample labelling	All samples bags should be labelled with the following information: Sample ID : Sample Location_depth (e.g. PZ1_0.5) Sample Date and Time : DD/MM/YYYY HH:MM Sampler Name 360 Project Number : 2225
Sample Location	The geographic location of the sample should be recorded using handheld GPS or equivalent
Sample storage	Samples must be collected and stored in plastic bags and excess air removed prior to sealing.
Sample preservation	Samples should be stored on ice in the field and in transit to the laboratory. If pH _F and pH _{FOX} testing cannot occur within 24 hours of collection, samples should be frozen. Samples should be frozen after pH _F and pH _{FOX} testing until such time as they can be transported to the lab.
Field Documentation	F1 Project Field Log AS1 Soil pH _F and pH _{FOX} testing
QA/QC	1:20 blind duplicate samples to be collected Samples sent to laboratory using the provided Chain of Custody (COC) form to be provided by 360 Environmental

Table 3: Laboratory Sampling Requirements

SAMPLING COMPONENT	REQUIREMENT
Sample volume	1x 400ml bag
Sample Preservation	Samples are to be chilled with ice in the field and then frozen and stored in a freezer for delivery to the laboratory
Laboratory	Samples will be sent to the following Laboratory under appropriate COC. Eurofins/MGT Unit 2, 91 Leach Hwy Kewdale, WA 6105 Tel: 08 9251 9600

360 Environmental hopes this sampling and analysis plan sufficiently addresses Agrimin's requirements to facilitate commencement of its acid sulfate soil assessment at the Lake

Mackay SOP project. If you have any queries regarding the content of this plan, please feel free to contact me on 08 9388 8360.

Yours sincerely



Julie Palich
Principal Environmental Geoscientist

CC:
Gerry Bradley - gbradley@agrimin.com.au

Enclosures:
Attachment A: Field Procedures and Forms

ATTACHMENT A: FIELD PROCEDURES AND FORMS



Acid Sulfate Soils
Technical Standard
Operating Procedure

AS1: Soil and Water Testing

Rev. 1 (12 August 2016)

● people ● planet ● professional

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1 SCOPE AND APPLICATION

This TSOP addresses acid sulfate soil, dewatering effluent and groundwater field testing techniques and is applicable to:

- ASS Investigations
- Monitoring during earthworks and dewatering by 360 Environmental
- Monitoring during earthworks and dewatering by the Contractor

2 METHOD SUMMARY

- Soil pH_F and pH_F testing
- Water (i.e. groundwater, surface water of dewatering effluent) quality testing

3 REFERENCES

This TSOP references the following literature:

- Identification and investigation of acid sulfate soils and acidic landscapes, Department of Environment Regulations, Government of Australia, June 2015
- Treatment and management of soil and water in acid sulfate soil landscapes, Department of Environment Regulations, Government of Australia, June 2015

4 EQUIPMENT AND SUPPLIES

The following equipment is to be used:

- Acidity Test Kit (i.e. HI3820)
- Alkalinity Test Kit(i.e. HI3811)
- Water quality Meter (i.e. YSI Pro Plus Multiparameter Instrument)
- Calibration Solutions: pH4, pH7, pH10 ,EC 1413 $\mu\text{s}/\text{cm}$
- Test tubes (heat resistant)
- Test tube rack
- Wooden stirrers
- 30% hydrogen peroxide (pH adjusted to 4.5–5.5)
- sodium hydroxide (pH adjusted to 4.5–5.5)
- deionised (DI) water
- squirt bottle for DI water
- Nitrile gloves, safety glasses, protective clothing

- Buckets and brush
- Field form AS1
- First aid kit (especially eye wash solutions)
- Disposal paper towels

5 PROCEDURES

5.1 Soil

5.1.1 Field pH Test

- 1 Calibrate field pH meter as per TSOP E1.
- 2 Prepare the test tubes in the test tube rack. Mark each beaker with sample location, depth, stockpile ID etc.
- 3 Remove approximately one teaspoon of soil from the sampling location. Place approximately $\frac{1}{2}$ teaspoon of the soil into the pH_F test tube and place $\frac{1}{2}$ teaspoon of the soil into the pH_{FOX} test tube.
- 4 Place enough deionised water (pH 5.5) in the pH_F test tube to make a paste similar to 'grout mix' or 'white sauce', stirring with a skewer or similar to ensure all soil 'lumps' are removed. Do not leave the soil samples in the test tubes without water for more than 10 minutes.
- 5 Immediately place the pH meter probe into the test tube, ensuring that the probe is totally submerged in the soil:water paste. Never stir the paste with the electrode.
- 6 Wait for the reading to stabilise and record the pH measurement. All measurements and pH calibration should be recorded on Field Form AS1.

5.1.2 Field Oxidised pH Test

- 1 Adjust the pH of the 30% hydrogen peroxide to 5.0–5.5 before going into the field. This can be done by adding a few drops of sodium hydroxide at a time, checking the pH with the pH meter regularly. Sodium hydroxide is highly caustic so safety precautions must be exercised. Buffer only the amount to be used in the field at any one time.
- 2 Hydrogen peroxide should be well labelled and only small quantities should be taken into the field at any one time. This will ensure the longevity of the peroxide. Further, over time, the pH of the peroxide that has already been buffered may change. It is important to check the pH of the peroxide in the morning before departing to the field. Having a small quantity of sodium hydroxide in the field kit is recommended so the pH of the peroxide can be adjusted if required.
- 3 Calibrate the pH meter as per TSOP E1.
- 4 Prepare the test tubes in the test tube rack. Mark each beaker with sample location, depth, stockpile ID etc.

- 5 Remove approximately one teaspoon of soil from the sampling location. Place approximately ½ teaspoon of the soil into the pH_F test tube and place ½ teaspoon of the soil into the pH_{FOX} test tube.
- 6 Add a few drops of hydrogen peroxide to the soil in a heat-resistant test tube and stir the mixture. DO NOT add the peroxide to the test tube in which the pH_F test was conducted. The pH_{FOX} test tube should not have any deionised water in it. Beakers can be used however when multiple tests are being conducted it is difficult to handle the large beaker size efficiently. DO NOT add more than a few drops of peroxide at a time. This will prevent overflow and wastage of peroxide. A day's supply of peroxide should be allowed to reach room temperature prior to use.
- 7 Allow approximately 20 minutes for any reactions to occur. If substantial sulfides are present, the reaction will be vigorous and may occur almost instantly. In this case, it may not be necessary to stir the mixture. Careful watch will be needed in the early stages to ensure that there is no cross contamination of samples in the test tube rack. If the reaction is violent and the soil/peroxide mix is escaping from the test tube, a small amount of de-ionised water can be added to calm the reaction and control overflow.
- 8 Steps 6 and 7 may be repeated until the soil/peroxide mixture reaction has slowed. This will ensure that most of the sulfides have reacted.
- 9 If there is no initial reaction, individual test tubes containing the soil/peroxide mixture can be placed into a cup of hot water (especially in cooler weather) or in direct sunlight. This will encourage the initial reaction to occur. When the sample starts to 'bubble', remove the test tube immediately from the cup and replace into the test tube rack.
- 10 Rate each sample's reaction using the LMHX (low, medium, high, extreme) scale and record on Field Form AS1.
- 11 Wait for the soil/peroxide mixture to cool (may take up to 10 minutes).
- 12 Placing the pH meter into the test tube, ensuring that the probe is totally submerged in the soil/peroxide mixture. Never stir the mixture with the electrode. Wait for the reading to stabilise and record the pH_{FOX} measurement on Field Form AS1.

5.2 Water Sample Collection

- 1) Collect samples:
 - a) Undertake groundwater sample collection as per TSOP G3 - Groundwater Monitoring: Low Flow Purging and Sampling.
 - b) Collect samples surface water and dewatering effluent (pre-treatment and post-treatment) samples directly into sample containers.
- 2) Immediately test using multi-parameter meter and record of field sheet: temperature, dissolved oxygen, SPC, EC, pH, redox and TDS.
- 3) Undertake TTA and TALK testing as per Sections 5.3 and 5.4.

5.3 Total Titratable Acidity (TTA) Testing

Using the TTA test kit (i.e. Hanna Instruments HI3820):

5.3.1 Methyl Orange

- 1 Remove the cap from the small plastic cup. Rinse with sample, then fill to 5 ml mark and replace cap.
- 2 Add 1 drop dechlorinating reagent through cap port and mix by swirling cup in tight circles.
- 3 Add 1 drop bromophenol blue indicator through cap port and mix. If the solution is green or blue record methyl orange acidity as zero and skip to Phenolphthalein Acidity test (see Section 5.3.2). If solution is yellow continue to next step.
- 4 Take syringe and push the plunger completely into the syringe. Insert tip into HI 3820-0 solution and pull the plunger out until the lower edge of the plunger seal is on 0ml mark.
- 5 Place syringe into the cap port and slowly add the titration solution one drop at a time, swirling between drops. Continue adding titration solution until the solution in the cup changes from yellow to green.
- 6 Read the millilitres of titration solution from the syringe scale and multiply by 500 to obtain mg/L TTA. Record on Field Form AS2.

5.3.2 Phenolphthalein

- 1 Remove the cap from the small plastic cup. Rinse with sample, then fill to 5ml mark and replace cap.
- 2 Add 1 drop Phenolphthalein indicator through cap port and mix. If the solution turns red or pink, than solution is alkaline and proceed to Alkalinity Test 1.2. If the solution remains colourless continue to the next step.
- 3 Take syringe and push the plunger completely into the syringe. Insert tip into HI 3820-0 solution and pull the plunger out until the lower edge of the plunger seal is on 0ml mark.
- 4 Place syringe into the cap port and slowly add the titration solution one drop at a time, swirling between drops. Continue adding titration solution until the solution in the cup turns pink.
- 5 Read the millilitres of titration solution from the syringe scale and multiply by 500 to obtain mg/L TTA. Record on Field Form AS2.

5.3.3 Low Range Detections

If the TTA result is lower than 100mg/L the precision of the test can be improved follow steps below.

- 1 Remove the cap from the small plastic cup. Rinse with sample, then fill to 25ml mark and replace cap.

- 2 Continue with the test as explained for high range measurements.
- 3 Read the millilitres of titration solution from the syringe scale and multiply by 100 to obtain mg/L TTA. Record on Field Form AS2.

5.4 Total Alkalinity (TAlk) Testing

Using the TAlk test kit (i.e. Hanna Instruments HI3811):

5.4.1 Phenolphthalein

- 1 Remove the cap from the small plastic cup. Rinse with sample, then fill to 5ml mark and replace cap.
- 2 Add 1 drop Phenolphthalein indicator through cap port and mix. If the solution remains colourless, record the Phenolphthalein alkalinity as zero and proceed to Section 5.4.2. If the solution turns red or pink continue with the next step.
- 3 Take syringe and push the plunger completely into the syringe. Insert tip into HI 3811-0 solution and pull the plunger out until the lower edge of the plunger seal is on 0ml mark.
- 4 Place syringe into the cap port and slowly add the titration solution one drop at a time, swirling between drops. Continue adding titration solution until the solution in the cup turns colourless.
- 5 Read the millilitres of titration solution from the syringe scale and multiply by 300 to obtain mg/L TAlk. Record on Field Form AS2.

5.4.2 Bromophenol Blue

- 1 Remove the cap from the small plastic cup. Rinse with sample, then fill to 5ml mark and replace cap.
- 2 Add 1 drop Bromophenol Blue indicator through cap port and mix. If the solution is green or blue continue to next step.
- 3 Take syringe and push the plunger completely into the syringe. Insert tip into HI 3811-0 solution and pull the plunger out until the lower edge of the plunger seal is on 0ml mark.
- 4 Place syringe into the cap port and slowly add the titration solution one drop at a time, swirling between drops. Continue adding titration solution until the solution in the cup turns yellow.
- 5 Read the millilitres of titration solution from the syringe scale and multiply by 300 to obtain mg/L TAlk. Record on Field Form AS2.

5.4.3 Low Range Detections

If the result is lower than 100mg/L the precision of the test can be improved follow steps below.

- 1 Remove the cap from the small plastic cup. Rinse with sample, then fill to 25ml mark and replace cap.

- 2 Continue with the test as explained for high range measurements.
- 3 Read the millilitres of titration solution from the syringe scale and multiply by 100 to obtain mg/L TAlk. Record on Field Form AS2.

6 DOCUMENTATION

Field documentation needs to be undertaken as defined in 360 Environmental TSOP1. The following forms are required:

- 360 Environmental Form: ASS Field Form AS1 Soil pHF and FOX
- 360 Environmental Form: ASS Field Form AS2

7 DECONTAMINATION

Decontamination of field testing equipment is to be undertaken as per TSOP E2.

8 WASTE MANAGEMENT

Investigation derived waste is to be managed in accordance with TSOP W1.



Contaminated Sites
TECHNICAL
STANDARD
OPERATING
PROCEDURE
Instrument Calibration

TSOP E-1

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1 SCOPE AND APPLICATION

Calibration of field instruments forms part of the data quality initiative to ensure that data collected in the field can be reliably used. Field equipment used for on-site measurements will be calibrated in accordance with the manufacturer's specification before and after field use each day, or at a frequency recommended by the equipment manufacturer or industry practice. **All manufacturer calibration records must accompany the equipment for each rental.**

This TSOP applies to all instruments used at the site.

2 PID

The PID will be calibrated to manufacturer specifications by the rental operator and accompanied with a Calibration Certificate. The PID will be calibrated prior to the sampling event.

3 YSI Pro Plus Multiparameter Meter

- YSI Pro Plus Multiparameter Instrument calibration is needed for Electrical Conductivity (EC), pH 4 and pH 7.
- YSI multi parameter meter is to be calibrated prior to use (daily) and in line with the Manufacturers Calibration Manual.
- Daily calibration must be documented.



Contaminated Sites
TECHNICAL
STANDARD
OPERATING
PROCEDURE
Decontamination

TSOP E-2

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1 SCOPE

Decontamination is a critical QA/QC element to site investigations and must be applied appropriately. This TSOP provides the method to be employed as part of site characterisation activities.

2 PROCEDURES

Step 1: Decon Set Up

1. Set up decontamination equipment in dedicated area on site, away from impacted area/s.
2. Place clean used large plastic bag/tarp on the ground
3. Place two clean unused buckets on top of the tarp. Fill one bucket with deionised water for rinsate. Fill the second bucket with Decon 90 and deionised water.
4. Pour deionised water in decontaminated clean spray bottle.

Step 2: Decontamination

The following procedures are to be undertaken in order to minimise the risk of cross contamination of samples:

1. All samples are to be handled using disposal nitrile gloves, which are to be replaced between each sampling event.
2. Decontamination of manual sampling equipment includes:
 - o Remove soil (if viable) adhering to the sampling equipment by brushing
 - o Wash equipment with phosphate free detergent and rinsate water (laboratory supplied).
 - o Rinse equipment in bucket with deionised water
 - o Complete second rinsing by pouring deionised water over equipment

Specific decontamination procedures are as follows:

- Always decontaminate the water level meter/interface probe before starting investigations and at the end of investigations (daily), and between each use
- All reusable equipment used for each monitoring well installation will be decontaminated between each well location
- Thoroughly clean the tape measure and any stainless steel sample collection equipment (if warranted) before initiation of the sampling event and between sample collection endeavours
- All drill rods will be decontaminated with Decon 90 and rinsate water between each use.
- Decon the hand-auger barrel between each soil sample collection endeavour
- The riser, well screen and annual seal installation equipment should be cleaned immediately prior to well installation or certified clean from the manufactured and delivered to the site in a protective wrapping.

PROJECT FIELD LOG (DAILY)

Date: _____ **Project Number:** _____ **Project Name:** _____

Arrived: _____ **Departed:** _____ **Weather:** _____

PM: _____

Field Personnel: _____

Contractors: _____

Client Contact: _____ **Site Contact:** _____

Purpose of Visit (Tick Appropriate Box):

☐ Site Inspection ☐ Well Integrity Assessment

☐ Soil Bore Advancement (Drill Rig) ☐ Hand Augering ☐ Test Pits ☐ Soil Sampling

☐ Monitoring Well Installation (Drill Rig) ☐ Groundwater Monitoring ☐ Sediment Sampling

☐ Other (Specify): _____

Equipment Used:

☐ Calibration Certificate Received : _____ ☐ Calibration Undertaken: _____

Sampling:

Sampling Conducted: ☐ Y ☐ N Matrix: ☐ Soil ☐ Water ☐ Air

CoC Completed: ☐ Y ☐ N

Primary Lab: _____ Secondary Lab: _____

360
environmental

Quality Control Details:

QC	Type	Date and time	Primary	Media
QC				
QC				
QC				
QC				
QC				
QC				
QC				
QC				
QC				
QC				
QC				
QC				
QC				
QC				
QC				
QC				
QC				
QC				

QC	Collection Point	Collection Location	Date and time	Rinsate water batch #
RS				
RS				
RS				
RS				
RS				

QC	Date and time	Trip blank batch #
TB		
TB		
TB		
TB		
TB		

QC	Date and time	Collection Location	Blank water batch #
FB			
FB			
FB			
FB			
FB			

Description of Activities:

This image shows a single sheet of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There are approximately 20 lines visible. The paper has a slight shadow on the right side, suggesting it's resting on a surface. There is no handwriting or other markings on the paper.

Procedure - Soil Sampling from Lake Mackay Sediments

Introduction

The Acid Sulphate Soil (ASS) study at Lake Mackay requires soil samples to be taken of the various sediment lithologies identified by Agrimin at the Lake.

An opportunity to gain access to these lithologies across a large area of the Lake and through a deep profile of the Lake is presented as a result of the trenching work currently taking place.

Ideally, at each trench, soil samples are to be taken at 0.5 m intervals from surface to the full 6 m depth of the trench (or as deep as the trench can be excavated to). This would result in 12 soil samples being obtained from each trench. It is proposed to take the soil samples from material recovered by the Excavator and placed alongside the trench for safe and easy access.

Methodology

- Excavator arrives at location of next trench on Lake and commences excavation work;
- As the Excavator progresses the depth of the trench, material is to be removed at regular 0.5 m intervals for soil sample analysis;
- The 12 intervals required are – 0.5 m, 1.0 m, 1.5 m, 2.0m, 2.5m, 3.0 m, 3.5 m, 4.0 m, 4.5 m, 5.0 m, 5.5 m and 6.0 m.
- At each 0.5 m interval, a full bucket load of material should be recovered from the trench;
- Each bucket load is to be placed on the Lake surface alongside the trench in as compact a heap as possible.
- A compact heap is required to preserve the integrity of the material for soil sampling. If a soil sample cannot be taken straight away then it may be a number of days before the sample can be retrieved. By maintaining a compact heap of material for sampling it is hoped that the material towards the centre of the heap will be less compromised by oxygen ingress over a period of time and, therefore, still provide material of reasonable integrity for sampling when the opportunity arises;
- Place the material recovered for sampling alongside the trench in order of depth, starting with the 0.5 m interval closest to the trench and placing subsequent material next to, but progressively further away from, the trench (ie 6.0 m sample to be located furthest from the trench).
- Care should be taken when relocating the Excavator that the heaps recovered for soil analysis are not disturbed.
- The procedure outlined above is to be repeated at each new trench.

- Where a trench does not obtain its full (6.0 m) depth, or is abandoned, sample material should still be recovered at 0.5 m intervals to whatever trench depth is achieved.

Queries regarding this Soil Sampling Procedure should be directed to Gerry Bradley (Sustainability Manager, Agrimin), phone 0429 777 267 or email gbradley@agrimin.com.au or assistance sought from Michael Hartley or Andy Fulton, Agrimin representatives at Lake Mackay.

Gerry Bradley

Sustainability Manager

Agrimin Limited

20th August 2017



Acid Sulfate Soils
Technical Standard
Operating Procedure

AS1: Soil and Water Testing

Rev. 1 (12 August 2016)

Authorised by: JP

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1 SCOPE AND APPLICATION

This TSOP addresses acid sulfate soil, dewatering effluent and groundwater field testing techniques and is applicable to:

- ASS Investigations
- Monitoring during earthworks and dewatering by 360 Environmental
- Monitoring during earthworks and dewatering by the Contractor

2 METHOD SUMMARY

- Soil pH_F and pH_F testing
- Water (i.e. groundwater, surface water of dewatering effluent) quality testing

3 REFERENCES

This TSOP references the following literature:

- Identification and investigation of acid sulfate soils and acidic landscapes, Department of Environment Regulations, Government of Australia, June 2015
- Treatment and management of soil and water in acid sulfate soil landscapes, Department of Environment Regulations, Government of Australia, June 2015

4 EQUIPMENT AND SUPPLIES

The following equipment is to be used:

- Acidity Test Kit (i.e. HI3820)
- Alkalinity Test Kit(i.e. HI3811)
- Water quality Meter (i.e. YSI Pro Plus Multiparameter Instrument)
- Calibration Solutions: pH4, pH7, pH10 ,EC 1413 $\mu\text{s}/\text{cm}$
- Test tubes (heat resistant)
- Test tube rack
- Wooden stirrers
- 30% hydrogen peroxide (pH adjusted to 4.5–5.5)
- sodium hydroxide (pH adjusted to 4.5–5.5)
- deionised (DI) water
- squirt bottle for DI water
- Nitrile gloves, safety glasses, protective clothing

- Buckets and brush
- Field form AS1
- First aid kit (especially eye wash solutions)
- Disposal paper towels

5 PROCEDURES

5.1 Soil

5.1.1 Field pH Test

- 1 Calibrate field pH meter as per TSOP E1.
- 2 Prepare the test tubes in the test tube rack. Mark each beaker with sample location, depth, stockpile ID etc.
- 3 Remove approximately one teaspoon of soil from the sampling location. Place approximately ½ teaspoon of the soil into the pH_F test tube and place ½ teaspoon of the soil into the pH_{FOX} test tube.
- 4 Place enough deionised water (pH 5.5) in the pH_F test tube to make a paste similar to 'grout mix' or 'white sauce', stirring with a skewer or similar to ensure all soil 'lumps' are removed. Do not leave the soil samples in the test tubes without water for more than 10 minutes.
- 5 Immediately place the pH meter probe into the test tube, ensuring that the probe is totally submerged in the soil:water paste. Never stir the paste with the electrode.
- 6 Wait for the reading to stabilise and record the pH measurement. All measurements and pH calibration should be recorded on Field Form AS1.

5.1.2 Field Oxidised pH Test

- 1 Adjust the pH of the 30% hydrogen peroxide to 5.0–5.5 before going into the field. This can be done by adding a few drops of sodium hydroxide at a time, checking the pH with the pH meter regularly. Sodium hydroxide is highly caustic so safety precautions must be exercised. Buffer only the amount to be used in the field at any one time.
- 2 Hydrogen peroxide should be well labelled and only small quantities should be taken into the field at any one time. This will ensure the longevity of the peroxide. Further, over time, the pH of the peroxide that has already been buffered may change. It is important to check the pH of the peroxide in the morning before departing to the field. Having a small quantity of sodium hydroxide in the field kit is recommended so the pH of the peroxide can be adjusted if required.
- 3 Calibrate the pH meter as per TSOP E1.
- 4 Prepare the test tubes in the test tube rack. Mark each beaker with sample location, depth, stockpile ID etc.

- 5 Remove approximately one teaspoon of soil from the sampling location. Place approximately ½ teaspoon of the soil into the pH_F test tube and place ½ teaspoon of the soil into the pH_{FOX} test tube.
- 6 Add a few drops of hydrogen peroxide to the soil in a heat-resistant test tube and stir the mixture. DO NOT add the peroxide to the test tube in which the pH_F test was conducted. The pH_{FOX} test tube should not have any deionised water in it. Beakers can be used however when multiple tests are being conducted it is difficult to handle the large beaker size efficiently. DO NOT add more than a few drops of peroxide at a time. This will prevent overflow and wastage of peroxide. A day's supply of peroxide should be allowed to reach room temperature prior to use.
- 7 Allow approximately 20 minutes for any reactions to occur. If substantial sulfides are present, the reaction will be vigorous and may occur almost instantly. In this case, it may not be necessary to stir the mixture. Careful watch will be needed in the early stages to ensure that there is no cross contamination of samples in the test tube rack. If the reaction is violent and the soil/peroxide mix is escaping from the test tube, a small amount of de-ionised water can be added to calm the reaction and control overflow.
- 8 Steps 6 and 7 may be repeated until the soil/peroxide mixture reaction has slowed. This will ensure that most of the sulfides have reacted.
- 9 If there is no initial reaction, individual test tubes containing the soil/peroxide mixture can be placed into a cup of hot water (especially in cooler weather) or in direct sunlight. This will encourage the initial reaction to occur. When the sample starts to 'bubble', remove the test tube immediately from the cup and replace into the test tube rack.
- 10 Rate each sample's reaction using the LMHX (low, medium, high, extreme) scale and record on Field Form AS1.
- 11 Wait for the soil/peroxide mixture to cool (may take up to 10 minutes).
- 12 Placing the pH meter into the test tube, ensuring that the probe is totally submerged in the soil/peroxide mixture. Never stir the mixture with the electrode. Wait for the reading to stabilise and record the pH_{FOX} measurement on Field Form AS1.

5.2 Water Sample Collection

- 1) Collect samples:
 - a) Undertake groundwater sample collection as per TSOP G3 - Groundwater Monitoring: Low Flow Purging and Sampling.
 - b) Collect samples surface water and dewatering effluent (pre-treatment and post-treatment) samples directly into sample containers.
- 2) Immediately test using multi-parameter meter and record of field sheet: temperature, dissolved oxygen, SPC, EC, pH, redox and TDS.
- 3) Undertake TTA and TALK testing as per Sections 5.3 and 5.4.

5.3 Total Titratable Acidity (TTA) Testing

Using the TTA test kit (i.e. Hanna Instruments HI3820):

5.3.1 Methyl Orange

- 1 Remove the cap from the small plastic cup. Rinse with sample, then fill to 5 ml mark and replace cap.
- 2 Add 1 drop dechlorinating reagent through cap port and mix by swirling cup in tight circles.
- 3 Add 1 drop bromophenol blue indicator through cap port and mix. If the solution is green or blue record methyl orange acidity as zero and skip to Phenolphthalein Acidity test (see Section 5.3.2). If solution is yellow continue to next step.
- 4 Take syringe and push the plunger completely into the syringe. Insert tip into HI 3820-0 solution and pull the plunger out until the lower edge of the plunger seal is on 0ml mark.
- 5 Place syringe into the cap port and slowly add the titration solution one drop at a time, swirling between drops. Continue adding titration solution until the solution in the cup changes from yellow to green.
- 6 Read the millilitres of titration solution from the syringe scale and multiply by 500 to obtain mg/L TTA. Record on Field Form AS2.

5.3.2 Phenolphthalein

- 1 Remove the cap from the small plastic cup. Rinse with sample, then fill to 5ml mark and replace cap.
- 2 Add 1 drop Phenolphthalein indicator through cap port and mix. If the solution turns red or pink, than solution is alkaline and proceed to Alkalinity Test 1.2. If the solution remains colourless continue to the next step.
- 3 Take syringe and push the plunger completely into the syringe. Insert tip into HI 3820-0 solution and pull the plunger out until the lower edge of the plunger seal is on 0ml mark.
- 4 Place syringe into the cap port and slowly add the titration solution one drop at a time, swirling between drops. Continue adding titration solution until the solution in the cup turns pink.
- 5 Read the millilitres of titration solution from the syringe scale and multiply by 500 to obtain mg/L TTA. Record on Field Form AS2.

5.3.3 Low Range Detections

If the TTA result is lower than 100mg/L the precision of the test can be improved follow steps below.

- 1 Remove the cap from the small plastic cup. Rinse with sample, then fill to 25ml mark and replace cap.

- 2 Continue with the test as explained for high range measurements.
- 3 Read the millilitres of titration solution from the syringe scale and multiply by 100 to obtain mg/L TTA. Record on Field Form AS2.

5.4 Total Alkalinity (TAlk) Testing

Using the TAlk test kit (i.e. Hanna Instruments HI3811):

5.4.1 Phenolphthalein

- 1 Remove the cap from the small plastic cup. Rinse with sample, then fill to 5ml mark and replace cap.
- 2 Add 1 drop Phenolphthalein indicator through cap port and mix. If the solution remains colourless, record the Phenolphthalein alkalinity as zero and proceed to Section 5.4.2. If the solution turns red or pink continue with the next step.
- 3 Take syringe and push the plunger completely into the syringe. Insert tip into HI 3811-0 solution and pull the plunger out until the lower edge of the plunger seal is on 0ml mark.
- 4 Place syringe into the cap port and slowly add the titration solution one drop at a time, swirling between drops. Continue adding titration solution until the solution in the cup turns colourless.
- 5 Read the millilitres of titration solution from the syringe scale and multiply by 300 to obtain mg/L TAlk. Record on Field Form AS2.

5.4.2 Bromophenol Blue

- 1 Remove the cap from the small plastic cup. Rinse with sample, then fill to 5ml mark and replace cap.
- 2 Add 1 drop Bromophenol Blue indicator through cap port and mix. If the solution is green or blue continue to next step.
- 3 Take syringe and push the plunger completely into the syringe. Insert tip into HI 3811-0 solution and pull the plunger out until the lower edge of the plunger seal is on 0ml mark.
- 4 Place syringe into the cap port and slowly add the titration solution one drop at a time, swirling between drops. Continue adding titration solution until the solution in the cup turns yellow.
- 5 Read the millilitres of titration solution from the syringe scale and multiply by 300 to obtain mg/L TAlk. Record on Field Form AS2.

5.4.3 Low Range Detections

If the result is lower than 100mg/L the precision of the test can be improved follow steps below.

- 1 Remove the cap from the small plastic cup. Rinse with sample, then fill to 25ml mark and replace cap.

- 2 Continue with the test as explained for high range measurements.
- 3 Read the millilitres of titration solution from the syringe scale and multiply by 100 to obtain mg/L TAlk. Record on Field Form AS2.

6 DOCUMENTATION

Field documentation needs to be undertaken as defined in 360 Environmental TSOP1. The following forms are required:

- 360 Environmental Form: ASS Field Form AS1 Soil pHF and FOX
- 360 Environmental Form: ASS Field Form AS2

7 DECONTAMINATION

Decontamination of field testing equipment is to be undertaken as per TSOP E2.

8 WASTE MANAGEMENT

Investigation derived waste is to be managed in accordance with TSOP W1.



Contaminated Sites
TECHNICAL
STANDARD
OPERATING
PROCEDURE
Instrument Calibration

TSOP E-1

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1 SCOPE AND APPLICATION

Calibration of field instruments forms part of the data quality initiative to ensure that data collected in the field can be reliably used. Field equipment used for on-site measurements will be calibrated in accordance with the manufacturer's specification before and after field use each day, or at a frequency recommended by the equipment manufacturer or industry practice. **All manufacturer calibration records must accompany the equipment for each rental.**

This TSOP applies to all instruments used at the site.

2 PID

The PID will be calibrated to manufacturer specifications by the rental operator and accompanied with a Calibration Certificate. The PID will be calibrated prior to the sampling event.

3 YSI Pro Plus Multiparameter Meter

- YSI Pro Plus Multiparameter Instrument calibration is needed for Electrical Conductivity (EC), pH 4 and pH 7.
- YSI multi parameter meter is to be calibrated prior to use (daily) and in line with the Manufacturers Calibration Manual.
- Daily calibration must be documented.



Contaminated Sites
TECHNICAL
STANDARD
OPERATING
PROCEDURE
Decontamination

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1 SCOPE

Decontamination is a critical QA/QC element to site investigations and must be applied appropriately. This TSOP provides the method to be employed as part of site characterisation activities.

2 PROCEDURES

Step 1: Decon Set Up

1. Set up decontamination equipment in dedicated area on site, away from impacted area/s.
2. Place clean used large plastic bag/tarp on the ground
3. Place two clean unused buckets on top of the tarp. Fill one bucket with deionised water for rinsate. Fill the second bucket with Decon 90 and deionised water.
4. Pour deionised water in decontaminated clean spray bottle.

Step 2: Decontamination

The following procedures are to be undertaken in order to minimise the risk of cross contamination of samples:

1. All samples are to be handled using disposal nitrile gloves, which are to be replaced between each sampling event.
2. Decontamination of manual sampling equipment includes:
 - o Remove soil (if viable) adhering to the sampling equipment by brushing
 - o Wash equipment with phosphate free detergent and rinsate water (laboratory supplied).
 - o Rinse equipment in bucket with deionised water
 - o Complete second rinsing by pouring deionised water over equipment

Specific decontamination procedures are as follows:

- Always decontaminate the water level meter/interface probe before starting investigations and at the end of investigations (daily), and between each use
- All reusable equipment used for each monitoring well installation will be decontaminated between each well location
- Thoroughly clean the tape measure and any stainless steel sample collection equipment (if warranted) before initiation of the sampling event and between sample collection endeavours
- All drill rods will be decontaminated with Decon 90 and rinsate water between each use.
- Decon the hand-auger barrel between each soil sample collection endeavour
- The riser, well screen and annual seal installation equipment should be cleaned immediately prior to well installation or certified clean from the manufactured and delivered to the site in a protective wrapping.

APPENDIX C

Site Photographs



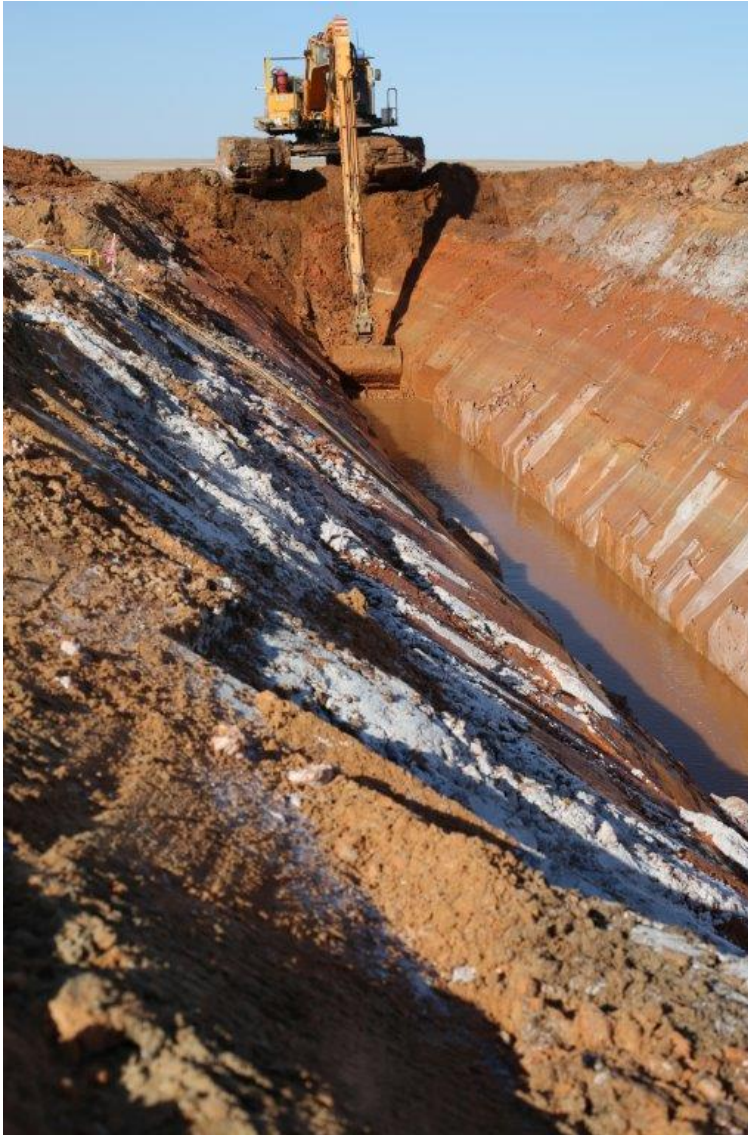
Photograph 1: Black ooze overlaying brown sandy layer



Photograph 1: Black ooze overlaying brown sandy layer



Photograph 3: Groundwater extraction for hydrogeological studies



Photograph 4: Excavation of a trench



Photograph 5: Exposed trench wall



Photograph 6: Exposed trench wall



Photograph 7:Excavation of a trench



Photograph 8: Exposed trench wall



Photograph 9: Profile from surface to 0.5 mbgl



Photograph 10: Trench wall with excavated material piled on top



Photograph 11: Trench wall