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# Waikato region acid sulfate soils preliminary risk assessment

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# Waikato Region

## Acid Sulfate Soils Preliminary Risk Assessment

Waikato Regional Council

17 May 2024

→ **The Power of Commitment**

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# Executive Summary

Acid sulfate soils are naturally occurring sediments which contain reduced inorganic sulfur or sulfide minerals (Dear et al., 2014), formed in reducing redox conditions. These acidic soils are widespread, covering over 17 million hectares of land worldwide (Andriesse and van Mensvoort, 2006). When undisturbed and below the groundwater table these soils remain in their reduced state and typically do not cause adverse environmental impacts. However, when these soils are exposed to oxygen via uplift, drainage or excavation, the sulfides may oxidise resulting in the production of sulfuric acid.

While the presence of acid sulfate soils is well documented overseas, little research has been done into the extent and implications of these soils here in New Zealand. The lack of readily available information about the distribution of acid sulfate soils makes it challenging for New Zealand regulators, infrastructure owners and designers to take these potentially damaging conditions into account in a consistent and effective way.

The Waikato Regional Council (WRC) has noted several adverse environmental impacts, which have been attributed to the presence of acid sulfate soil. Impacts include infrastructure damage, localised fish kills, fluctuating pH in surface water systems and increased aluminium, zinc, and iron concentrations in surface water, as a result of (pH dependent) metals leaching. Notably, within the Waikato Region, there are large areas where acid sulfate soils could occur and persist such as the Waikato and Hauraki Basins.

This report presents the findings of a preliminary spatial assessment of the Waikato Region to inform WRC of the probability of occurrence of acid sulfate soils. The investigation included producing a draft probability map that combines an extensive range of datasets with correlation to acid sulfate soils occurrence. Examples of these datasets, also referred to herein as inputs, are geology, elevation, soil type. These datasets were divided into classes (such as geological units or soil types) and given a qualitative rating of high, medium, low, or negligible based on the assumed probability of acid sulfate soil occurrence. The selection of inputs and the division of classes was informed by a multicriteria analysis of local experience, available literature and existing GIS databases encompassing the Waikato. High and medium probability areas identified within the draft map were ground truthed in order to test the assumptions within the draft map and estimate risk associated with each sample location.

One hundred (100) sample locations were assessed during the ground truthing assessment with samples collected at target depths of 0.5 m, 1.0 m, and 2.0 m below the surface. Of the samples collected, 199 were analysed for field screening analysis (pH analysis) and 100 were analysed for Chromium reducible Sulfur (CrS) analysis.

For the samples tested for pH analysis it was identified that no samples had a pH less than 4.0. Numerous samples had a pH less than 5.0. The $pH_{KCl}$ results indicated that the majority of the samples analysed had a weak influence of natural environmental acidity or organic acidity, indicating the acidity was likely due to the presence of sulfuric acid within the samples. Furthermore, the CrS analysis showed that in 15% of the samples, the Peroxide Oxidisable Sulfur (POS) results were above the adopted action criterion of 18 mol $H^+$ / t, indicating that these samples have a high potential for in situ acid sulfate soil generation. Titratable Actual Acidity (TAA) was also found to be above the adopted action criterion in 72% of the samples.

The above results contributed to the risk scoring of individual sample locations which was used to validate the final map found within Appendix B. The map produced from this investigation will enable developers and regulators to consider and, where appropriate, test for acid sulfate soils so that they can be avoided or managed and thereby reduce the likelihood of damage to the community and environment.

The map produced from this investigation is intended to be referred to as a high-level guide. Where site specific characterisation of acid sulfate soils is recommended, a detailed site-specific investigation should be undertaken. This report is subject to, and must be read in conjunction with, the limitations set out in section 2.4 and the assumptions and qualifications contained throughout the report.

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# 1. Definitions

*Table 1 Definitions*

| Terminology | Definition |
|---|---|
| Acid sulfate soils terminology | |
| Acid Neutralising Capacity (ANC) | A measure of a soils inherent ability to buffer acidity and resist the lowering of the soil pH. Acid buffering in the soil may be provided by dissolution of calcium and/or magnesium carbonates (e.g. shells), cation exchange reactions, and by reaction with organic and clay fractions.<br>The presence of carbonates in excess of the soils potential acidity does not necessarily prevent soil acidification if the carbonates acid buffering is not readily or rapidly available (e.g. if it is in coarse fragments the reaction rate may be slower than the acid production rate).<br>Formation of insoluble or sparingly soluble surface coatings (e.g. of iron oxides, gypsum, etc.) on the carbonates can also limit the soils ability to neutralize acid. |
| Acid sulfate soil (ASS) | Soils that are rich in sulfides and/or their oxidation products. The oxidation reactions and associated reactions can cause changes to the water and soil chemistry, such as acidification. |
| Actual acid sulfate soils | Soil that is highly acidic due to the oxidation of soil materials that are rich in iron sulfides, primarily pyrite. This oxidation produces hydrogen ions in excess of the sediments capacity to neutralise the acidity, resulting in soils of pH 4 or less. These soils are often associated with the presence of jarosite. |
| Actual acidity | The soluble and exchangeable acidity already present in the soil that can be mobilised and discharged, such as following a rainfall event. This acidity may arise as a consequence of the previous oxidation of sulfides. Actual acidity is a component of existing acidity.<br>NOTE: It does not include the less soluble acidity (i.e. retained acidity) held in hydroxy-sulfate minerals such as jarosite. |
| Acidity Trail | Acidity trail involves direct titrimetric determination of the acidity produced by oxidation. |
| Existing acidity | The acidity already presents in acid sulfate soils, usually as a result of oxidation of sulfides, but which can also be from organic material or acidic cations. It can be further subdivided into actual and retained acidity, i.e. Existing Acidity = Actual Acidity + Retained Acidity. |
| Liming rate | Fine grained $CaCO_3$ (e.g. agricultural lime) can be mixed into soil as a source of neutralising capacity. The liming rate is a calculation of the quantity of 100% calcium carbonate required to neutralise all existing and potential acidity. The reported liming rates typically include a conservative correction factor such e.g. 1.5x. |
| Limit Of Reporting (LOR) | The detection limit for the specific analysis based on the laboratory determined Method Detection Limit (MDL), usually at 99% confidence. |
| Net Acidity | A calculation summing up the capacity of a given soil to generate acidity under favourable conditions. The Acid Base Accounting (ABA) approach is accepted by industry as the main method used to predict net acidity resulting from the oxidation of sulfidic material and is determined via:<br>Net Acidity = Potential Sulfidic Acidity + Existing Acidity – Acid Neutralising Capacity (ANC)<br>For our purposes, Acid Neutralising Capacity is defined as follows:<br>ANC = measured ANC/fineness factor<br>See Titratable Peroxide Acidity for information about the fineness factor. |
| Peroxide Oxidisable Sulfur (POS) | Sulfur oxidised by peroxide digestion and calculated as %S. As this method employs a strong chemical oxidant (30% w/w $H_2O_2$), it provides a measure of the maximum amount of potentially oxidisable sulfur in the soil sample and hence can be used to estimate the potential sulfidic acidity.<br>This method can overestimate the potential sulfidic acidity in soils where appreciable organic sulfur is present and is oxidised by peroxide (e.g. soil layers rich in organic matter). |
| $pH_{KCl}$ | Potassium chloride suspension pH. pH in a 1:40 (Weight/Volume) suspension of soil in a solution of 1 mol potassium chloride. Soils with a $pH_{KCl}$ between 5.5 and 6.5 and no sulfides are deemed to pose a lower risk and therefore do not have Titratable Actual Acidity (TAA) measured. Soils with a $pH_{KCl}$ in this range that do contain sulfides should have TAA measured. |
| $pH_{OX}$ | Peroxide oxidised suspension pH. pH in a suspension of soil after initial digestion by 30% hydrogen peroxide. Following oxidation, $pH_{OX}$ is measured. |

| Terminology | Definition |
|---|---|
| Potential acid sulfate soils (PASS) | Soil containing iron sulfides or sulfidic material that has not been exposed to oxygen and become oxidised. The field pH of these soils in their undisturbed state is pH 4 or more and may be neutral to slightly alkaline. |
| Potential sulfidic acidity | Unoxidised sulfides that have the potential to produce acid if oxidised. Potential sulfidic acidity is measured through chemically oxidising any sulfides present followed by titrating the acidity generated.<br>For unoxidised soil material (with negligible acid-buffering/acid-neutralising components) the Titratable Sulfidic Acidity is often comparable to the potential sulfidic acidity predicted from sulfur measurements (e.g. SPOS). |
| Retained acidity | The less available fraction of the existing acidity (not measured by the Titratable Actual Acidity) that may be released slowly into the environment by hydrolysis of relatively insoluble sulfate salts (such as jarosite, natrojarosite, and other iron and aluminium hydroxy-sulfate minerals). |
| Sulfur Trail | Sulfur trail involves the determination of sulfur and stoichiometric relationships to predict potential acidity. |
| $S_{RAS}$ | Peroxide residue acid soluble sulfur is a determination of residual acid soluble or jarositic sulfur |
| Suspension Peroxide Oxidation Combined Acidity and Sulfur analytical method (SPOCAS) | The suspension peroxide oxidation combined acidity and sulfur (SPOCAS) method is a peroxide based method of measuring the acid generating potential of an acid sulfate soils. The SPOCAS analytical suite measures both the acid trail and the sulfur trail and provide a set of analytical results and derived calculations that allow calculation of net acidity. It is an alternative to the Chromium suite.<br>The SPOCAS method involves the measurement of pH, titratable acidity, sulfur, and cations on two soil sub-samples. One soil sub-sample is oxidised with hydrogen peroxide and the other is not. The differences between the two values of the analytes from the two sub-samples are then calculated. |
| Titratable Actual Acidity (TAA) | Acidity titration with standardised sodium hydroxide to pH 6.5 on 1:40, suspension in 1 mol potassium chloride. TAA (the first component of the acidity trail) is a measure of the soluble and exchangeable acidity already present in the soil, often as a consequence of the previous oxidation of sulfides. |
| Titratable Peroxide Acidity (TPA) | Acidity titration with standardised sodium hydroxide to pH 6.5 on 1:40 suspension in 1 mol potassium chloride after 30% hydrogen peroxide digestion. TPA is measured in mol $H^+$/tonne.<br>The TPA method is a measure of net acidity, since the acid produced by oxidation of sulfides has the opportunity to react with any acid buffering components in the sample (e.g. carbonates). When the TPA is zero (by definition $pH_{OX}$ >6.5), it indicates that under laboratory conditions (using a finely-ground sample) the acid-neutralising components in the soil material exceed the acid-producing components. Often neutralising material (e.g. coarse shell) present in the field may have low reactivity because of particle size and/or insoluble coatings.<br>Thus, the TPA measured on finely-ground samples in the laboratory could underestimate the net acid risk likely to be experienced in the field. To allow for the above, all measurements of the neutralising material (ANC) are divided by a fineness factor (FF) during Acid Base Accounting. |
| Titratable Sulfidic Acidity (TSA) | Calculated as (TPA – TAA). (Unit: mol $H^+$ /tonne).<br>For unoxidised soil material (with negligible acid-buffering/acid-neutralising components) the TSA is often comparable to the potential sulfidic acidity predicted from sulfur measurements (e.g. SPOS, SCR). In the absence of any appreciable Acid Neutralising Capacity, where there is a difference between SPOS and TSA (when expressed in equivalent units), the general approach in Acid Base Accounting is to use sulfur measurements to estimate sulfidic acidity.<br>However, should the TSA substantially exceed the sulfidic acidity predicted from the sulfur trail (e.g. SPOS, CrS) a cautionary approach is advisable. Such differences can indicate release of complexed iron and aluminium from organic sources and/or formation of simple organic acids during peroxide oxidation. While this acidity is commonly not rapidly released in the environment in the short term, it should not be immediately dismissed as being of no consequence.<br>There may be some risk if soils are only managed according to the acidity from sulfides. As a precaution, it is sometimes appropriate to increase the application rate of neutralising materials to nearer to that indicated when TSA is substituted into the Acid Based Accounting (ABA) equation. |
| Spatial assessment terminology | |
| Cell | Individual pixels within a raster dataset containing a particular value. The largest cell size within a raster dataset will determine the granularity of the output. |
| Classes | Classes are homogeneous collections of common features, each having the same spatial representation. Within this investigation is the specific attribute or characterising feature that has |

| Terminology | Definition |
| --- | --- |
| | been selected due to its association with acid sulfate soils (e.g. Holocene swamp deposits, gleys or flaxland). |
| Inputs | General term for the geographic information system (GIS) data layers used within this investigation. Inputs are the overarching layer or a combined group of subclasses portraying a specific layer (e.g. geology, soil type or vegetation). |
| Raster Data | A matrix of cells (or pixels) organised into rows and columns (or a grid) where each cell contains a value representing information (e.g. thematic representations of different units) |
| Resolution | The dimensions represented by each cell within a set of raster data. This is the detail in which a map dictates the location and shape of geographic features. |
| Scale | The ratio of an area on a map and the corresponding distance on the ground. |
| Vector Data | Sequential points which represent data as points, lines, and polygons (e.g. topography and layer boundaries) |

# 2. Introduction

The Waikato Regional Council (WRC) have commissioned GHD Limited (GHD) to undertake an assessment of acid sulfate soils risk in the Waikato Region and to produce a first-generation map showing the probability of occurrence based on the findings of the assessment.

## 2.1 Background

Acid sulfate soils are naturally occurring sediments which contain reduced inorganic sulfur, formed in reducing redox conditions. These acidic soils are widespread, covering over 17 million hectares of land worldwide (Andriesse and van Mensvoort, 2006). When undisturbed and below the groundwater table these soils remain in their reduced state and typically do not cause adverse environmental impacts. However, when these soils are exposed to oxygen via uplift, drainage or excavation, the sulfides may oxidise resulting in the production of acid. This acid generation can cause harmful environmental impacts such as low pH in waterways, mobilised ammoniacal-nitrogen, fish disease and mortality, and leaching of metals such as aluminium, zinc and iron. Harm can also occur to public and private infrastructure due to the corrosion of metal and subsurface concrete structures (such as reticulated water networks / pipelines, building foundations etc).

The presence of acid sulfate soil in New Zealand has been known about since the 1970s with key pieces of research including the assessments of acid sulfate soils occurrence in Auckland and other northern parts of New Zealand in the 1970s and 1980s (Dent, 1980, 1986 and Metson et al., 1977). These findings have been reaffirmed in recent soil investigations relating to infrastructure projects, predominantly in the Auckland and Northland regions.

WRC has noted several adverse environmental impacts in the Waikato Region that have been attributed to the presence of acid sulfate soil. These have included localised fish kills, fluctuating pH in surface water systems and increased aluminium, zinc, and iron concentrations in surface water, as a result of metals leaching. Impacts to WRC owned infrastructure have also been observed (J. Caldwell, personal communication, February 7, 2023).

WRC requested GHD to prepare a map identifying the probability of occurrence of acid sulfate soil in the Waikato Region, segregated into areas of low, medium, and high probability of occurrence. This map and report is intended to support WRC in:

– Providing guidance for development and infrastructure projects being undertaken though the region
– Undertaking maintenance work on WRC controlled assets
– Providing input into the development of plans and advice to developers and WRC contractors so that appropriate design and mitigation measures can be implemented to minimise environmental impacts and harm to infrastructure.

It is understood that WRC has already undertaken small-scale acid sulfate soil investigations within Aka Aka, Hauraki, and Hampton Downs areas. Further areas of interest identified by WRC include the expansion of drainage infrastructure and pump stations which may be subject to damage from acid sulfate soils. These areas of interest are located primarily within the Hauraki Basin, Waikato Basin and along the northern margins of the Waikato River. The approach undertaken by WRC by commissioning this work is in line with the methodology outlined in the Acid Sulfate Soil Manual (Acid Sulfate Soil Management Advisory Committee, 1998), where it is recommended that for developmental projects, sampling for acid sulfate soils should be undertaken in:

– Areas of significant future soil disturbance
– Areas which are highly environmentally sensitive
– Areas containing potentially high sulfide concentrations or a known sulfide source.

It is acknowledged that characterising soils within areas of significant works or with sensitive receptors is the best approach for quantifying the risk associated with acid sulfate soils. The investigations which have been undertaken and provided to GHD have shown evidence of acid sulfate soils and potential acid sulfate soils being present within the region.

### 2.1.1 Waikato Region overview

The Waikato Region is located within the central North Island of New Zealand. The region contains a broad range of topographical, geological, and geomorphological variation with numerous notable mountain ranges and basins. It has areas which are susceptible to acid sulfate soil presence.

#### 2.1.1.1 Generalised landscape

Broadly speaking, the Waikato Region comprises two primary basins, the Hauraki Basin, and the Waikato Basin, separated by a greywacke hill range that extends northward through the Hapūakohe and Hūnua ranges (Selby and Lowe, 1992).

These basins originated from the historical deposition of coastal marine sediments, which have accumulated due to subsidence of the basins. The Waikato Basin has relatively subsided compared to the surrounding hill ranges due to the influence of faulting and differential uplift (Selby and Lowe, 1992). The Hauraki Basin has subsided due to the influence of the Hauraki Rift and crustal thinning (Hochstein and Ballance, 1993). The deposited sediments within the basins become exposed due to a Holocene-era reduction in sea levels.

In addition, the region features a second greywacke range that also runs north to south. This range lies west of the Waikato Basin, serving as a divide between the basin and the western coast until reaching the northern limit of the greywacke range (Selby and Lowe, 1992). These north-south oriented greywacke ranges adjacent to the basins are commonly known as the ’uplands'.

The Hauraki Basin's eastern extent does not reach the coastline. The Kaimai Range separates the coastline from the basin's eastern region and is predominantly composed of volcanic material (Houghton and Cuthbertson, 1989).

The southern part of the Waikato includes mountain ranges like the Rangitoto and Mamaku ranges, acting as a boundary between the central and lower Waikato. Proceeding southward from the Rangitoto and Mamaku ranges, a volcanic plateau is situated within the Taupo Volcanic Zone (Wilson et al., 1995).

#### 2.1.1.2 Potential controls on acid sulfate soil generation

The Waikato and Hauraki basins consist of Holocene and Pleistocene marine coastal deposits. These basins, combined with erosion and drainage channels from elevated volcanogenic zones and uplifted mountain ranges, (Manville and Wilson, 2004) create favourable conditions for acid sulfate soil formation. Volcanogenic material, such as ashfall, can contribute to the presence of sulfur in the receiving environment soils. This may either be directly through the presence of sulfides, such as pyrite, or indirectly via runoff containing sulfate that may foster acid sulfate soil generation elsewhere. Due to these factors, both basins are considered key locations of investigations in this investigation for their potential to foster acid sulfate soil generation.

## 2.2 Purpose of this report

The purpose of this report is to document the findings of the acid sulfate soils preliminary risk assessment undertaken by GHD in 2022-2023 and to provide a representation of the acid sulfate soil probability map of the Waikato Region for WRC.

## 2.3 Scope

A spatial analysis exercise was undertaken by GHD to provide WRC with a GIS package that spatially represents the occurrence of acid sulfate soils within the Waikato Region. The spatial analysis was based on a multi-criteria review of available spatial information, literature, and ground characteristics. The spatial analysis was validated by 100 soil sampling locations from across the Waikato Region, which were facilitated by WRC. As per National Acid Sulfate Soils Guidance: National acid sulfate soils sampling and identification methods manual (Sullivan et al., 2018), this investigation took a staged approach which included:

Development of a draft probability map of acid sulfate soils within the Waikato Region:

– Development of a methodology to assess the occurrence of acid sulfate soils based on local experience and literature review of published guidelines and documents
– Review and selection of data input layers including:

- Publicly available aerial photography for the Waikato Region
- Readily available maps and GIS databases from Landcare Research, Department of Conservation (DOC) and WRC
- Published geological and topographical maps

Development and implementation of a ground truthing exercise within the Waikato Region:

– Selection of sampling locations
– Collection of soil samples from three depths (0.5 m, 1.0 m, and 2.0 m below the surface) at 100 target locations within the Waikato Region
– Laboratory testing of samples for pH field, pH field oxidised at Analytica Laboratories, an International Accreditation New Zealand (IANZ) accredited laboratory in Hamilton
– Laboratory testing of samples Suspension Peroxide Oxidation Combined Acidity and Sulfur (SPOCAS) and Chromium Reducible Sulfur (CrS) at ALS Laboratory Services Ltd in Brisbane (ALS), a laboratory with National Association of Testing Authorities, Australia (NATA) accreditation
– Tabulation and interpretation of the laboratory results following recognised guidance on acid sulfate soils, such as:
  - Australian National Acid Sulfate Soils Guidance National Acid Sulfate Soils sampling and identification methods manual, dated 2018
  - The Government of Western Australia Department of Environment Regulation Guidelines, dated 2015
  - Queensland Government Acid Sulfate Soil Management Guidelines.
– Revision of the multi-criteria analysis probability rating for each input class unit assessed based on the interpretation of the analytical results via a weighted scoring system including influence of CrS suite analytical results, field pH results and field observations

Development of a final probability map and a report documenting the findings:

– Preparation of a high-level map presenting the probability of acid sulfate soils materials occurring within soil profiles and landscapes based on the Australian National Coastal acid sulfate soils risk classification scheme (NatCASS, 2005)
– Generation of this report documenting the results of the investigation, commentary on the map and analysis and documentation of case studies of acid sulfate soils risks, investigations, and management.

## 2.4 Limitations

*This report: has been prepared by GHD for Waikato Regional Council and may only be used and relied on by Waikato Regional Council for the purpose agreed between GHD and Waikato Regional Council as set out in section 2.2 of this report.*

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## 2.5 Assumptions

This report was produced based on the following assumptions:

– The datasets provided by Manaaki Whenua Landcare Research, Land Information New Zealand (LINZ) and WRC are accurate and relevant for the purpose of this investigation

- The third-party information used within this investigation, including literature reviewed and GIS information incorporated, is accurate
- The samples collected during this investigation are representative (vertically and horizontally) of the geological and geomorphological units this assessment intended to characterise. It is assumed that the secondary locations appropriately represent the area initially targeted
- The sample results reported within this investigation by Analytica/ALS Laboratories are accurate and representative of the samples provided by GHD
- Where deviations to the sampling and analysis plan occurred, the solution implemented by GHD is suitable to maintain the quality of the data reported within this investigation
- The approach undertaken in the revisions of the final probability map by GHD are appropriate
- This probability map deliverable provides an indication of potential acid sulfate soils within the region and is subject to the accuracy and assumptions made during the assessment. It is likely there will be a significant variance on a local scale which site-specific investigations will be required to improve localised accuracy
- The probability map is intended to be amended over time. If further iterations of this map are undertaken, the limitations and assumptions referred to in this report should be referred to and updated if necessary.

# 3. Introduction to acid sulfate soils

Acid sulfate soils are sediments containing sulfide minerals, predominantly pyrite ($FeS_2$) (Dear et al., 2014). Acid sulfate soils are stable when in an anoxic (oxygen limited) environment, however, when exposed to oxygen the sulfides become unstable and oxidise, producing sulfuric acid and resulting in the mobilisation of metal ions (Equation 1)[1].

$$FeS_2 + 3.75O_2 + 3.5H_2O \rightarrow Fe(OH)_3 + 4H^+ + 2SO_4^{2-} \quad \textbf{Equation 1}$$

Acid sulfate soils form and persist in anoxic conditions, such as may occur in waterlogged reducing environments. When the water table is lowered or the soil is disturbed by excavations, the sulfides can become exposed to oxygen causing it to oxidise to sulfate, with acid and iron hydroxide co-products of this reaction. Even when undisturbed, aeration of acid sulfate soils can be significantly enhanced through extensive artificial drainage (Dent, 1986). Increased aeration of soils accelerates the process of sulfide oxidation.

Potential acid sulfate soils are soils or sediments which contain iron sulfides or other sulfidic minerals that have not been oxidised. This term indicates the potential for acid production if the soils are oxidised. Potential acid sulfate soils may contain iron sulfides in excess of the soil natural buffering capacity to neutralise acid. Actual acid sulfate soils are soils or sediments containing iron sulfides that have oxidised or are oxidizing (Macdonald, et al., 2002).

## 3.1 Occurrence

The iron sulfides present in acid sulfate soils are formed by naturally occurring, sulfate-reducing bacteria. The bacteria reduce sulfate present within some waters to form sulfide. Specifically, the sulfate is used as a terminal electron receptor in the degradation of organic matter. The sulfate reducing bacteria degrade organic matter through anoxic respiration, which produces hydrogen sulfide ($H_2S$) as a waste. Once the $H_2S$ waste is available within the environment, it reacts with positively charged metals, with the most commonly available metal being iron to produce pyrite and bicarbonate. While bicarbonate is commonly flushed out via tidal movement or groundwater outflow, pyrite and other metal sulfides typically accumulate and persist within the sediments. When soils containing pyrite are exposed to oxygen, the pyrite oxidises to sulfuric acid, causing the acidification of soil and groundwater pH.

The sulfate present in the water can come from any source, however it commonly originates from seawater, which has an abundance of sulfate. Iron sulfides can also be present in soil and rock from other sources, such as in volcanogenic soils. These volcanogenic sources of sulfur, as well as other sources such as anthropogenic environmental contamination may also provide a source of sulfate in water that can facilitate the formation of acid sulfate soils elsewhere.

The typical environment of formation for acid sulfate soils is anoxic, aquatic environments. These environments also are typically warm, low energy (calm) marine environments rich in organic matter (Macdonald, et al., 2002). As a result, acid sulfate soils are mostly, but not exclusively, found within swampy ground or coastal areas which were inundated during the last interglacial period before the Holocene (~10,000 years ago).

The combination of tectonic uplift with lower sea level has resulted in the occurrence of acid sulfate soils in terrestrial environments in New Zealand. Additionally, these processes, alongside anthropogenic impacts on the hydrogeological conditions, can lead to the promotion of aeration and oxidising conditions.

Although potential acid sulfate soils are usually formed in coastal environments such as wave-protected mangroves, saltmarshes, outer barrier tidal lakes, and backswamps, natural processes and land reclamation can result in these soils occurring a significant distance from the current coastline.

In Australia, sulfidic sediments have been found in most estuarine lowlands and acid sulfate soils are found around the majority of the Australian coastline (Yang, 1997; White et al., 1996). The northern regions of New Zealand share many similarities with Australian landscapes that have acid sulfate soils. It is not surprising that recent investigations have found acid sulfate soils in New Zealand.

[1] This is a simplification of the more detailed processes, equations, and kinetics. It is not intended as a full explanation but to assist the reader in a general understanding of the process.

Acid sulfate soils have been identified in New Zealand in the vicinity of the Hokianga and Kaipara Harbours (Dent, 1986), and have also been noted to have occurred within, but not limited to, Auckland, Aka aka, Hauraki and at some landfills around the region. This builds a case to suggest the presence of acid sulfate soils in the Waikato Region.

The generation of acid sulfate soils could occur for a variety of reasons. The main drivers for the genesis of acid sulfate soils are low lying environments which are permanently waterlogged and thus anoxic, a source of sulfur from coastal interactions and a source of organic matter to allow for the sulfate to sulfide reaction to occur. In addition to the above, low energy environments are also favourable for the generation and persistence of acid sulfate soils, allowing for anoxic conditions, poor drainage and the build-up of sulfur, metals, and fine grain size sediments.

An example of an acid sulfate soil generating environment is a historic river, for example the Tweed River, located within the east coast of Australia. The river became an estuarine environment as result of the valley river system being submerged during the last marine transgression (<20 ka BP). Whilst submarine, the river mouth was infilled, creating a sand barrier at the end of the system. This formed a waterlogged, low energy sulfur rich environment allowing for the generation and persistence of acid sulfate soils (Roy, 1984). This is a common process for coastal environments within Australia and New Zealand.

External elements which are altered with time can affect acid sulfate soils. Regional scale alterations such as those outlined in the following table can have similar effects on an environment of formation.

*Table 2 Regional scale alterations and effects on acid sulfate soil forming environments*

| Change over time | Reasoning |
|---|---|
| Uplift and subsidence | Elevation changes in the form of tectonic uplift and subsidence can have significant impacts on the generation of acid sulfate soils within an environment:<br>Uplift of a localised area can:<br>– Oxygenate previously waterlogged, sulfidic soils, potentially causing oxidation of acid sulfate soils<br>– Uplift soils of sulfatic marine sediments deposited during the Holocene will allow drainage of sulfate into the receiving environment<br>– Increase erosion of volcanic areas, leading to downstream deposition of sulfide-containing material, which could elevate the presence of acid sulfate soils in the catchment environment.<br>Subsidence of a localised area can raise the groundwater table and potentially waterlog the soil. This may allow the accumulation of sulfide within the subsided area and exacerbate subsequent acidification if oxygenated. |
| Dewatering | Draining the soils introduces air into the pores, promoting oxygenation. This aeration can activate potential sulfides, such as pyrite, triggering oxidation and potentially leading to the generation of actual acid sulfate soils (Hicks et al., 1999; Water & River Commission, 2002). |
| Sea level | The reduction in sea levels since the last glacial maximum has led to the emergence and aeration of soils previously submerged under marine deposits. This process can also influence the exposure of acid sulfate soils, depending on coastline degradation or advancement. The newly exposed soils, containing sulfidic materials like pyrite, become susceptible to oxidation upon contact with air, potentially leading to the generation of actual acid sulfate soils and associated environmental challenges. |
| Climate | Climate change, particularly rising temperatures, amplifies the creation and mobilisation of acid sulfate soils. This occurs through the facilitation of drought conditions that enable alternating cycles of dewatering and rewatering in an area. Such conditions permit both the oxidation of actual acid sulfate soils due to air exposure and their movement through flooding and system flushing (Simpson et al., 2010).<br>Acid sulfate soils related to purely change in temperature (i.e. global warming) does not necessarily promote the proliferation of sulfate-reducing bacteria (Nyman et. al, 2023). There is potential for bacteria productivity to increase due to temperature increase, however, this requires more research prior to being a reliable indication of acid sulfate soil generation. |
| Geomorphology | Over time, changes in the landscape's geomorphology mainly involve the erosion of elevated topographic regions and the sediment deposition within depressions. These processes can influence acid sulfate soil formation. Erosion of sulfidic materials and sediment deposition contribute to sulfur enrichment in low-lying and coastal areas as a result of accumulated deposits. |

## 3.2 Potential implications

While acid sulfate soils have been identified in New Zealand, the significance of this in New Zealand soil profiles remains uncertain due to limited research in this area. It is clear from the known presence of acid sulfate soils there is potential for these soils to present risk, as discussed below. However, several factors may impact the significance of this problem compared to other locales with known acid sulfate soil risks. For example, the presence of younger soils in Waikato may imply a potentially higher neutralisation capacity, which could influence the soil's ability to mitigate any acidity generated. Furthermore, the Waikato Region experiences larger volumes of regular and consistent rainfall, which could influence the production and retention of acidity. Lastly, differences in hydrogeology and groundwater conditions may contribute to variations in the spatial distribution and persistence of acid sulfate soils in the region. Despite these uncertainties, insights from experiences with acid sulfate soils domestically and in other countries, particularly Australia, can provide valuable guidance on the potential significance of the issue in the Waikato.

Acid generation from the oxidation of iron sulfides in acid sulfate soils can result in soil pH dropping to less than 4, with the extremely low pH conditions leading to increased concentrations of toxic metals in water (Wilson, 1995). Such adverse conditions can have deleterious effects on flora and fauna (Sammut et al., 1993).

An example of this is in Perth, Western Australia, where reduced rainfall and increased extraction of groundwater due to the expanding population led to a decline in the groundwater table. This decline has facilitated the oxidation of acid sulfate soils causing concentrations of potentially toxic elements to exceed health guideline values for domestic groundwater bore water (Hinwood et al., 2006).

The Richmond River in New South Wales, Australia, has experienced numerous leaching events of acidified water with high metal concentrations, such as iron and aluminium, discharged from areas containing acid sulfate soils. These discharges have been associated with major fish kills and with sub-lethal effects, such as red spot disease in fish (Corfield, 2000).

Accumulation of iron minerals formed from pyrite oxidation products is a common occurrence in acid sulfate soil landscapes. These precipitates, such as iron (oxy)hydroxide, can adversely affect aquatic and terrestrial environments (Summut et al., 1996). They may smother flora and fauna, cause deoxygenation in water bodies, stain banks and infrastructure, and reduce the area's amenity. Moreover, the acidity released from acid sulfate soils can impact minerals in the soil, leading to the release of metals, including aluminium, which can result in further environmental impacts. The impacts from acid sulfate soils are vast and extend to people, affecting environmental values, amenity, and physical well-being due to factors such as odours, toxicity, carcinogenicity of mobilised metals and compounds in water. The natural resources, such as fisheries, groundwater, surface water, and the flora and fauna inhabiting the region, are also susceptible to adverse effects (Cook et al., 2000).

The oxidation of iron sulfides in acid sulfate soils can have implications beyond the localised area. The affected surface and groundwater may impact surrounding regions some distance away from the original site, or acid sulfate soils may be displaced or moved to another location. Undisturbed acid sulfate soils typically oxidize slowly over time due to gradual environmental changes. The acid and dissolved metals generated may accumulate then be released episodically in concentrated slugs due to high rainfall events. Water quality issues are common under these conditions or in environments where significant disturbances have occurred (White et al., 1993).

The generation of highly corrosive sulfuric acid from the oxidation of pyritic minerals poses risks to concrete structures, shortening their lifespan. Concrete exposed to acidic conditions can experience various forms of deterioration, including loss of cement paste and aggregate, rust staining, cracking, and spalling. This is particularly concerning for infrastructure designed with long life expectancies, such as structural foundations, bridge abutments, pipes, pavements, and other concrete elements in contact with acidic soil and/or groundwater. Metal infrastructure, such as iron and aluminium products, is also vulnerable to direct corrosion under strong acidic conditions, compromising their integrity and potentially affecting reinforced pipes and other utilities in direct contact with strong acid (Fitzpatrick et al., 1998, Medawela et al., 2019).

Activities that can expose actual acid sulfate soils and potential acid sulfate soils include land development, building roads and railways, drainage and flood mitigation, agricultural activities that alter drainage patterns and disturb soils, dredging or land reclamations, dewatering that aerates previously saturated soils, changes in groundwater conditions due to filling and displacement, and reuse of actual and potential acid sulfate soils (Naylor et al., 1998).

# 4. Investigation overview

As stated in Section 2.2, the purpose of this report is to document the findings of the acid sulfate soils preliminary risk assessment undertaken by GHD in 2022-2023 and to provide a representation of the acid sulfate soil probability map of the Waikato Region for WRC.

### 4.1.1 Adopted investigation methodology

To inform WRC of the potential occurrence of acid sulfate soils within the region GHD has formulated a probabilistic distribution map. The creation of the final probability map entailed multifaceted investigations and iterative map enhancements. These investigative processes and outcomes adhered to the delineation provided in the following documents "National Acid Sulfate Soils Guidance: National acid sulfate soils sampling and identification methods manual" (Sullivan et al., 2018) and “National Acid Sulfate Soils Guidance: National acid sulfate soils identification and laboratory methods manual” (Sullivan et al., 2018) both referred to hereafter as the Australian National Guidance.

– Stage 1: Section 5 of this report documents the generation of the draft probability map. The draft probability map was a desktop investigation into the presence of acid sulfate soils within the Waikato, produced using available GIS information, literature documentation and conservative assumptions. Refer to Appendix A for the draft probability map. The generation of this map influenced the locations of field investigations undertaken within Stage 2
– Stage 2: Section 6 documents the sampling methodology, analytical results, and revisions to adopted inputs within Stage 1. The results analysed within this stage of investigation were incorporated into the final probability map produced within Stage 3
– Stage 3: Section 7 documents the refinement of the draft probability map based on the ground truthing results and conclusions of this assessment. Refer to Appendix B for the final probability map.

The probability maps produced do not differentiate between the occurrence of potential acid sulfate soils and the presence of actual acid sulfate soils which may be found on a given site. Identification of actual acid sulfate soil presence may require a different methodology to the inputs and scoring used within this investigation.

In line with the above, the ratings allocated within both maps provide an indication of how likely a given area is to contain acid sulfate soil generating conditions. This section documents the methodology for allocating the ratings within each revision. To ensure consistency, the methodology was not altered over the multiple revisions of the probability map.

### 4.1.2 Spatial analysis methodology

The spatial analysis methodology documented within this section was used to produce both the draft and final probability maps, based on spatial representation of parameters associated with theoretical presence of acid sulfate soils. The following steps were adopted:

– The first step entailed identifying spatial datasets that would contain information that is associated with the potential presence of acid sulfate soils occurring naturally within the environment. Within each of these datasets the relevant information was identified, then broken down into unique values. It was to these unique values that the scores were assigned (details of which are found in Section 5)
– Because each vector dataset had variable coverage across the region, to make each dataset spatially comparable it was required to create equal cell size rasters from each of the datasets (cell size = 10 m)
– A cell size of 10m was chosen due to the size of the area of interest (Waikato Region) and because the national level datasets did not contain the granularity of information that warranted a smaller cell size.
– Each cell in the raster had appropriated the score that was assigned to the vector data in each dataset. Where a cell encompassed multiple vector areas, the largest or largest combined area and its equivalent score was assigned to the cell.

This process means that there is not always a 1:1 correspondence between the value assigned to an area in the vector dataset and the value assigned to the raster cell. Rather, this method will capture the score that is represented by the majority area encompassed by a cell.

– The individual rasters were then consolidated. The calculation rule was to assign each cell in the final raster the largest score that had been assigned to the underlying cells of the constituent rasters.
– For the purposes of visualisation and area estimates the summation raster was converted back into a vector dataset.
– The map represents four probabilities of acid sulfate soils occurrence (Table 4).

### 4.1.3 Scoring

The scoring of each attribute within a dataset was based on a literature review that describes the likelihood of acid sulfate soil occurrence within that particular class. The assigned rating was converted from a text-based property to a numerical value for ease of calculation (shown in Table 3).

*Table 3 Probability scoring amounts*

| Probability rating | Score |
|---|---|
| High probability of occurrence | 100 |
| Medium probability of occurrence | 10 |
| Low probability of occurrence | 1 |
| Negligible probability of occurrence | 0 |

The calculation of cells scores across datasets acknowledged that a single area may be affected by multiple variables (e.g., a location has the texture of peat and also has high pH). The methodology used forthis assessment adopted the maximum value across overlaid variables. This is the value that determines the likelihood of acid sulfate soil occurrence. The overall ratings are described in Table 4.

*Table 4 Probability rating descriptions*

| Probability rating* | Description |
|---|---|
| High probability of occurrence | High probability areas are areas in which pedogenic processes have been suitable for the formation of acid sulfate soils, such as wetlands and mangroves, marine sediments. These are areas which are waterlogged and have a combination of a surplus of organic matter, sulfate, and iron content. The distribution of acid sulfate soil within these areas may be widespread or sporadic. |
| Medium probability of occurrence | Medium probability areas are areas which show some correlation to environments likely to contain acid sulfate soils but are considered to be lower risk due to greater uncertainty in this correlation. This may occur when an adopted input is broken into classes that are too broad and could signify either the presence or absence of acid sulfate soils. Alluvial / colluvial geology, organic soils, flaxland or herbaceous freshwater vegetation area indictors of a medium probability of occurrence. |
| Low probability of occurrence | Low probability areas are areas where environments have not generally been suitable for acid sulfate soil formation. Acid sulfate soils may be close to the surface or buried by many metres of alluvial sediments or windblown sand and soil groups that have the potential to contain unoxidised sulfides. The majority of these landforms are not expected to contain acid sulfate soils. Soil materials are often Pleistocene in age. |
| Negligible probability of occurrence | Negligible probability areas are areas where acid sulfate soils are not known or expected to occur, more so than low probability areas. |

*****The probabilities described within the above table do not preclude the possibility of iron sulfide being present in the soils from other processes described herein or other sources such as contamination or from volcanogenic sulfur. The potential implications of volcanogenic sulfur are discussed within Section 5.1.

By assigning the largest constituent score as the overall score, the methodology adopts a conservative estimation of the risk of acid sulfate soil occurrence. The below sections note the inputs and classes adopted into this investigation, providing information on the source and rationale of each input chosen by the project team.

# 5. Stage 1: Desktop Assessment

The draft probability map provided the basis for ground truthing investigations into the occurrence of acid sulfate soils within the project area. The ground truthing investigation and further scrutinisation of the inputs was undertaken to calibrate the map and support or correct assumptions.

Utilising the project teams' experience, the inputs selected within this investigation have been identified as key contributing factors to the probability of acid sulfate soils occurring within the region. Documentation of the inputs adopted, classes scored and rationale is provided within the following subsections.

## 5.1 Geology

The geology of the region provided a reliable indication of soil type, geomorphology, and environmental conditions, and was therefore included within this assessment. The selected data source of geology for this investigation was Digital QMAP (Geology – GNS 1:250,000 map) as it is the most up to date map available that covers the Waikato Region.

The published geological units adopted were assessed based on their environment of formation. High probability units included:

– Units with a source of sulfur inferred by lithological composition
– Units which were formed within coastal conditions, due to the correlation to environmental conditions such as shallow groundwater and wetlands which are favourable to the formation of acid sulfate soils
– Units with high amounts of organic matter, as the organic matter provides an energy source for sulfate reducing bacteria
– Units within low energy environments, which support the production and preservation of acid sulfate soils.

High probability areas that were excluded from the spatial assessment included all marine sediments that are currently below the high tidal level and sediments influenced by volcanogenic sources.

Marine sediments were excluded as they were outside of the scope of this assessment and are considered of be of negligible concern while in situ and are unlikely to be disturbed. It is noted that marine and estuarine sediments in the Waikato Region may be acid sulfate soils and care should be taken if disturbing or removing these sediments during coastal or port development projects.

Volcanogenic sources of sulfur such as debris or ashfalls may either directly contain reduced inorganic sulfur (sulfide) or increase a soil's ability to generate acid sulfate soils by providing a source of sulfur. However, this class of soil has not been considered within this investigation as the extents of volcanogenic sulfur in the forms of ashfalls, debris and erosional drainage channels are not well defined. In order for this class to be included, more knowledge of ashfall significance, locations and depths would be required. Modelling volcanogenic sources of sulfur was outside of the scope of this assessment and would require further consideration of the correlation to acid sulfate soils before being incorporated into a spatial assessment. It is assumed that where sulfur has run off volcanic formations or leached from ashfall deposits, its probability of occurrence was captured within other layers such as river deposits and swamps.

*Table 5 Probability rating applied to geological units*

| Geological formation | Class | Probability Rating |
|---|---|---|
| Holocene Swamp Deposits | Soft, dark brown to black, organic mud, muddy peat, and woody peat with minor overbank sand, silt, and mud. | High |
| Holocene Swamp Deposits | Soft, dark brown to black, mud, muddy sand, muddy peat, and peat. Locally extensive peat bogs. | High |
| Holocene Swamp Deposits | Soft, dark brown to black, organic mud, muddy peat, and woody peat. | High |

| Geological formation | Class | Probability Rating |
|---|---|---|
| Holocene River Deposits | Alluvial and colluvial sand, silt, mud and clay with local gravel and peat beds. | Med |
| Holocene River Deposits | Alluvial gravel, sand, silt, mud, and clay with local peat, includes modern riverbeds. | Med |
| Holocene River Deposits | Sand, silt mud and clay with local gravel and peat beds. | Med |
| Late Pleistocene River Deposits | Predominantly pumiceous sand, silt, mud, and clay, with interbedded gravel and peat. | Low |
| Late Pleistocene River Deposits | Alluvial and colluvial fan deposits consisting of poorly sorted, poorly consolidated gravel, sand, and clay. | Low |
| Late Pleistocene River Deposits | Poorly consolidated alluvial gravel, sand, and mud. | Low |
| Late Pleistocene River Deposits | Weathered undifferentiated poorly sorted gravel, sand, clay, and loess. | Low |
| Late Pleistocene River Deposits | Locally derived lacustrine mud, silt, gravel, and peat. | Low |
| Holocene Shoreline Deposits | Unconsolidated, sandy to muddy, pebbly and shelly beach ridges. | Low |
| Holocene Shoreline Deposits | Unconsolidated marine gravel, sand, and mud on modern beaches. | Low |
| Holocene Shoreline Deposits | Rapanui (NT2) Terrace coverbeds comprising a range of shallow marine to paralic sediments. | Low |
| Holocene Lahar Deposits | Massive, poorly sorted, matrix supported gravel, sand, and silt. | Low |
| Holocene Lahar Deposits | Poorly sorted bouldery gravel, debris hyper concentrated flow deposits, sand, silt, paleosol and peat. | Low |
| Holocene Hill Sope Deposits | Earthflow deposits containing poorly sorted clasts up to boulder size in a clay matrix. | Low |
| Holocene Human-made Deposits | Compacted mine waste in backfilled opencast pits and overburden landfill areas. | Low |
| All other units | | Negligible |

## 5.2 Elevation

The elevation data sourced within this investigation was in the form of a digital elevation model (DEM). Elevation provides key information in relation to the potential presence of acid sulfate soils as it identifies low lying regions or basins which may have elevations at or near the water table.

The LINZ 8m DEM (2012) was the only elevation model available that covered the Waikato Region. This dataset was derived from 20 m contours and is noted as being suitable for cartographic visualisation only. It had a cell size of 8m. WRC had a higher resolution, partial coverage DEM that was noted as preliminary only (as the vendor was still processing the final dataset), this had a cell size of 1m (DEM_Lower_Waikato_Piako_NZVD2016, created 2021). Therefore, in order to take advantage of the higher resolution, more current DEM, GHD decided to create a mosaic raster that utilised the higher resolution information where available and the lower resolution DEM for the remainder of the coverage area. To merge the two DEMs together, each raster underwent bilinear resampling so they both had a cell size of 10 m. then the datasets were mosaiced to form a single elevation data source. Bilinear resampling uses the weighted distance average for the four nearest input cell centers and can result in smoothing of the data. Bilinear resampling was selected as it did not create values outside the range of the source data. The mosaic operation was set so that the DEM_Lower_Waikato_Piako_NZVD2016 DEM was given precedence in areas where both elevation models overlapped. This mosaiced raster was then reclassed, with the probability ratings in Table 6,  for use within this investigation.

Acid sulfate soils are commonly present in lowland coastal environments due to the presence of the requisite environmental conditions. However, due to historical changes in sea level, geomorphology, and tectonic uplift it is likely that there is a presence of acid sulfate soils in areas that would not appear to be conducive to the formation of acid sulfate soils under current conditions. Other data layers adopted within this assessment may not be at sufficiently high resolution or consider temporal effects sufficiently to capture these effects at the coastal margin. Overseas experience shows that there is a strong correlation between elevation and acid sulfate soils as it provides a strong indication of areas likely to contain marine and sulfur rich sediments, higher water tables, swamp environments and peat environments at low elevations which are all associated with acid sulfate soils.

Building on the above, elevation was categorised into two groups for the probability map based on Australian National Guidance and The Government of Western Australia Department of Environment Regulation Guidelines dated 2015 (Western Australian Guidance):

– Lower elevations within the Australian National Guidance document are considered to be elevations of less than 5 m above the Australian height datum. This elevation range is based on the sea level change from present day to the last interglacial maximum. As New Zealand has experienced significantly more uplift in comparison to Australia, low elevation areas are designated as elevations of less than 10 m above the New Zealand Vertical Datum
– High elevations are designated as at or above 10 m of New Zealand Vertical Datum. These elevations are considered to have negligible probability of occurrence of acid sulfate soils.

The adopted scoring above for the draft probability map was seen as a conservative approach as the Waikato Region has significant topographical variation across the extent of the region (refer Section 2.1.1).

*Table 6 Probability rating applied to elevation*

| Class | Probability rating |
|---|---|
| <10 m Elevation | High |
| >10 m Elevation | Negligible |

## 5.3 Wetlands

Wetlands were included in this assessment as they are commonly associated with acid sulfate soils.

A suitable wetland layer was not readily available when undertaking this assessment, therefore, GHD merged three different wetland data sources, which were sourced from Ministry for the Environment (MfE) under a creative commons licence. The methodology of the merge was as documented below.

The merged wetland layer is a combination of the “Current Wetland Extent 2013” (classed as Current), “Wetland extent 2001” (classed as Current) and the “Prediction of wetlands before humans arrived” (classed as Historic) layers source from MfE. These layers were merged with the current wetland areas taking precedence to the historic areas, to provide insight into current and historic wetland areas. Prior to utilising this data, the wetland layers were pre-processed to exclude wetlands of an extent less than 2 hectares to limit the potential noise associated with this layer. The scale of the combined layer was 1:50,000.

Wetlands are the most common freshwater environments for acid sulfate soils occurrence (Lamontagne et al., 2004) as they typically contain the requisite environmental conditions for formation. Wetlands are typically low energy, anoxic, organic rich environments which are either permanently or intermittently waterlogged. A common inland wetland environment containing sulfide minerals is freshwater, poorly drained peat swamps (Brinkman and Pons 1973; Sammut et al., 1996) and is likely found within the Waikato Plains and the Hauraki Basin. Furthermore, permanently flooded wetlands tend to have greater sulfide concentrations than those with more regular wetting–drying regimes (Lamontagne et al., 2004).

Due to topographical, geomorphological, and anthropogenic alterations, wetlands have been classed based on relative groupings noted as “Current Wetlands” and “Historic Wetlands”:

– Current Wetland environments are assumed to:
  - Contain an environment that supports the formation and persistence of acid sulfate soils
  - Be waterlogged and, therefore, be more likely to contain high amounts of sulfide

    - Be within low energy environments and, therefore, accumulate finer grain sized sediments, inhibiting drainage.
- Historic Wetland environments are assumed to:
    - Have potentially been altered over time, resulting in them being less likely to possess conditions that produce acid sulfate soils
    - Have lower water tables or intermittently waterlogged soils and increased drainage and, therefore, increased oxygenation of the soils and less build-up of sulfide.

As discussed above, Current Wetlands are considered a higher probability than Historic Wetlands, and have been scored accordingly.

*Table 7 Probability rating applied to wetlands*

| Class | Probability rating |
|---|---|
| Current Wetland | High |
| Historic Wetland | Medium |

# 5.4 Vegetation

The Vegetation cover map of New Zealand was adopted into this assessment as vegetation could potentially show a correlation to acid sulfate soil presence. The vegetation cover map was sourced from WRC under a creative commons licence and is at a scale of 1:1,000,000.

Vegetation indicates soil types and conditions due to species preferences, potentially signalling the presence of acid sulfate soils or environments suitable for their formation. Examples include mangroves, rushes, and coastal shrubs, which thrive in low-energy, anoxic, waterlogged sites, and acidic soils. The distribution of these species might overlap with wetland areas, enhancing wetland coverage by extending wetland boundaries.

The majority of the vegetation types have negligible correlation with acid sulfate soils. ‘Wetland Communities’ is the only relevant type of vegetation included within this input.

*Table 8 Probability rating applied to vegetation*

| Class | Probability rating |
|---|---|
| Wetland Communities | High |
| All other vegetation types | Negligible |

# 5.5 Land cover

The Land Cover Database (LCDB) is a comprehensive classification of New Zealand’s land cover across different time periods. This assessment adopted version 5.0 of the LCDB, produced in 2018. This map comprises 33 distinct land cover categories for the mainland and was available by LRIS under a creative commons license. The data within this map is at a scale of 1:50,000.

The LCDB provides spatial distribution of various land cover types, especially for data gaps such as lakes, ponds, and small vegetation areas not covered by the vegetation data. This includes wetland vegetation, which strongly relates to acid sulfate soils.

Saline vegetation classes have higher probability than freshwater ones as acid sulfate soil generation typically is prolonged within freshwater environments when compared to saline environments (Lamontagne et al., 2004). The classes within this input have been scored accordingly.

*Table 9 Probability rating applied to land cover*

| Class | Probability rating |
|---|---|
| Herbaceous Saline Vegetation | High |
| Mangrove | High |

| Class | Probability rating |
|---|---|
| Herbaceous Freshwater Vegetation | Medium |
| Flaxland | Medium |
| All other land cover types | Negligible |

# 5.6 Soil type

Soil type within the Hamilton region was included within this investigation as it provides an indicator soil types more likely to correspond to the formation and persistence of acid sulfate soils, such as peat and peat containing soils. This layer was publicly available from WRC under the creative commons licence and is at a scale of 1:20,000.

The decision to include the soil type data of Hamilton was to provide a detailed probabilistic output of Hamilton of the most significant area of population and development in the region. While it is of only limited spatial extent, this dataset has a higher spatial detail than regional datasets, allowing for a higher resolution output within Hamilton City. This is understood to provide added relevance for the final map and give further clarity for stakeholders and developers within the City.

The classes included within this input encompassed various subclasses of peats. Emphasis was placed on peats within this layer, given their role in influencing the presence of acid sulfate soils. Soils with partial peat influences, such as peaty loams or peaty sands are less prone to acid sulfate soils due to improved drainage, oxygenation, and limited energy for sulfate-to-sulfide transformation.

The following ratings noted within Table 10 were applied to the classes within the draft probability map.

*Table 10 Probability rating applied to soil type*

| Class | Weighting |
|---|---|
| Peat | High |
| Peaty Clay Loam | High |
| Peaty Loam | Medium |
| Peaty Loam and Loamy Peat (Loamy Peat) | Medium |
| Peaty Sand | Medium |
| Peaty Sandy Loam | Medium |
| All other soil types | Negligible |

# 5.7 Smap

The Soil Order map (Smap) from LRIS was adopted as it provided an indication of soil types of general characteristics such a colour, organic content, and potential origin, grouped into 12 soil types. The Smap was obtained from LRIS under a creative commons licence and is at a scale of 1:50,000.

Soil type has an influence in the generation acid sulfate soils. Higher probability soil types include Gleys, Organics and Recent soils:

– Gley soils are they are typically waterlogged, anoxic, low energy environments which correlate with the environment of formation of acid sulfate soils (Hewitt, A.E., Balks, M.R., Lowe, D.J., 2021).
– Organic soils are soils formed in the partly decomposed remains of wetland plants (peat) or forest litter. The organic content of a soil plays a key role in sulfate reduction as it is consumed by sulfate reducing bacteria (Pons, 1973).
– Recent soils are less associated with the presence of acid sulfate soils as they have variable texture and high spatial variability. They occur on young land surfaces, including alluvial floodplains, unstable steep slopes, and slopes mantled by young volcanic ash.

– Raw Soils are associated with rocky areas, active screes, braided rivers, beaches, and tidal estuaries and are therefore likely have a low probability of acid sulfate soils occurrence.

The NZSC properties informed the classification process and rating for the spatial assessment (Table 11).

*Table 11* ***Probability rating applied to soil units***

| Class | Probability rating |
|---|---|
| Gley | High |
| Organic | Medium |
| Recent | Medium |
| Raw | Low |
| All other soil units | Negligible |

## 5.8 Soil texture

The soil texture map was included in this investigation as it documents a broad peat soil profile to a depth of 1 m across the Waikato Region. The soil texture layer was provided by LRIS under a creative commons licence. The scale of this map is 1:50,000.

Peaty soils serve as an indicator of acid sulfate soils, not always detected by other layers like Organic and Raw classes in Smap. Peaty soils are found in similar environments to acid sulfate soils, with high organic content and a sulfur source from organics. They often exist in low-energy, undisturbed areas that could sustain acid sulfate soils. Peats are linked to high water levels or waterlogged zones, promoting organic matter production. These areas likely align with high acid sulfate soil probability (Vile and Novak 2006).

Soils within the soil texture map aside from Peaty soils were considered unlikely to have a strong correlation with the occurrence of acid sulfate soils. The other soil textures were considered to likely be covered by soil type as opposed to texture.

The rating system applied soil textures is presented below (Table 12).

*Table 12* ***Probability rating applied to soil texture***

| Class | Probability rating |
|---|---|
| Peaty Soils | High |
| All other soil textures | Negligible |

## 5.9 pH

The Fundamental Soil Layers (FSL) pH data was included as it gives an indication of acidity and alkalinity and therefore may help inform where acid sulfate soils may occur. The FSL pH layer was sourced from LRIS under a creative commons licence and is at a scale of approximately 1:50,000.

Acid sulfate soils link to low pH values. The pH ranges used in this study, following Australian National Guidance, indicate that soils with pH ≤ 5 (acidic to strongly acidic) are associated with acid sulfate forming conditions whilst also promoting acid sulfate soil formation.

The rating system applied for different pH ranges and used to inform the acid sulfate soils map is presented below (Table 13). It was assumed that soils with an alkaline pH (pH >6.7) would neutralise acid sulfate soils generated, and therefore was considered negligible for this input. The pH 'MOD' value was adopted within this investigation rather than the pH 'MID' value as it is considered to approximate the most common pH value according to V3 of the LRIS data dictionary.

*Table 13* ***Probability rating applied to soil pH***

| Class | Probability rating |
|---|---|
| pH 4.5 – 5.1 | High |

| Class | Probability rating |
|---|---|
| pH 5.2 – 6.6 | Low |
| All other pH ranges | Negligible |

## 5.10 New Zealand soil classification

The FSL New Zealand Soil Classification layer (NZSC) was included in the spatial assessment due to the influence that certain soil types such as gley, organic and recent soil subgroups may have upon the potential for acid sulfate soils to occur. This layer was publicly available from LRIS under the creative commons licence and contains spatial information for 16 key attributes of soil which are then correlated using the NZSC (refer to Hewitt 2010 for classification). The FSL NZCS input layer is at a scale of 1:50,000.

This layer offered a detailed soil representation, surpassing Smap for marine sediment-related types. However, the limited number of sample points available for ground truthing combined with the relative specificity of units compared to the Smap, not all units were included.

Classes considered of high probability within this layer are those of which are associated with gleys, organics and recent soils as they commonly contain a source of available sulfur, are waterlogged, low energy environments and tend to have poor drainage and anoxic conditions[2].

The NZSC properties informed the classification process and rating for the spatial assessment (Table 14). Note, the list of soil subgroups included in Table 14 should not be considered as a complete or definitive list of soils that may be related to acid sulfate soils. The subgroups adopted in this investigation were those identified that may correlate to areas with acid sulfate soils and only includes those present in the Waikato Region.

*Table 14 Probability rating applied to NZSC*

| Class | Probability rating |
|---|---|
| GUF – Fluid Sulfuric Gley Soils | High |
| WGFU – Fluid Sulfidic Gley Raw Soils | High |
| GAO – Peaty Acid Gley Soils | High |
| GOA – Acidic Orthic Gley Soils | High |
| GAT – Typic Acid Gley Soils | High |
| GRA - Acidic Recent Gley Soils | High |
| GRO - Peaty Recent Gley Soils | High |
| GRT – Typic Recent Gley Soils | High |
| GUFQ - Fluid-Saline Sulfuric Gley Soils | High |
| GOO – Peaty Orthic Gley Soils | Medium |
| GOT – Typic Orthic Gley Soils | Medium |
| GSO - Peaty Sandy Gley Soils | Medium |
| WH - Hydrothermal Raw Soils | Medium |
| WS – Sandy Raw Soils | Medium |
| WHA - Active Hydrothermal Raw Soils | Medium |
| GOE - Melanic Orthic Gley Soils | Low |
| GOM – Melanic Orthic Gleys | Low |
| GOP – Peaty Orthic Gleys | Low |
| OHA – Acid Humic Organic Soils | Low |
| OFS - Sphagnic Fibric Organic Soils | Low |

[2] Refer to Section 5.7 for a more detailed description of the implications of gley, organic and recent soils associated with acid sulfate soils

| Class | Probability rating |
|---|---|
| OFA – Acidic Fibric Organic Soils | Low |
| OHA - Acid humic Organic Soils | Low |
| OHM – Mellow Humic Organic Soils | Low |
| OMA – Acid Mesic Organic Soils | Low |
| OMM - Mellow Mesic Organic Soils | Low |
| RFM – Mottled Fluvial Recent Soils | Low |
| RFT – Typic Fluvial Recent Soils | Low |
| RFW – Weathered Fluvial Recent Soils | Low |
| ROA – Acidic Orthic Recent Soils | Low |
| ROM - Mottled Orthic Recent Soils | Low |
| ROT - Typic Orthic Recent Soils | Low |
| ROW - Weathered Orthic Recent Soils | Low |
| RST – Typic Sandy Recent Soils | Low |
| All other soil units | Negligible |

# 5.11 Omitted data

## 5.11.1 Volcanic terrain

Volcanogenic soils encompassed within the Geology input (Section 5.1) theoretically offer favourable conditions for direct presence of reduced inorganic sulfur in the soils or the introduction of other sulfur species which may promote the generation of acid sulfate soils. This propensity stems from the sulfur-rich content within volcanic ash, which, when dispersed through ashfalls, supplements the soil with sulfur. However, this investigation has not focused on volcanogenic sources of sulfur due to the uncertainty related to extent and current depths of volcanogenic sulfur deposits. Further detailed information would be required to complete such an assessment.

This investigation has focused on the prediction of the presence of acid sulfate soils from the processes described in Section 3 and does not currently provide for other sources of sulfides, such as those of volcanic or contamination origin. This data may warrant further exploration in future investigations.

## 5.11.2 Readily available water

The LRIS map outlines the readily available water in the Waikato Region, which estimates the water accessible to plants within the soil profile to a depth of 0.9 meters below ground level (mbgl) or to the potential depth at which plants root. Although understanding the groundwater level would be valuable in identifying waterlogged areas, this layer does not differentiate between continuous saturation and intermittent saturation. This distinction has a significant impact on the use of this data as the continuity of saturation is crucial to both the formation and persistence of acid sulfate soils.

The acid sulfate soil guidelines of Western Australia highlight a heightened likelihood of acid sulfate soils in areas where the highest recorded water table level is within three meters of the surface (Government of Western Australia, Department of Environment Regulation, 2015). Understanding groundwater level and variability across the Waikato may provide useful further insight and may assist in the decision-making process for drainage and management of areas that contain the potential for the occurrence of acid sulfate soils.

## 5.11.3 Soil carbon

The LRIS FLS has a Soil Carbon layer which estimates the total carbon (organic matter content) as weighted averages for the upper part of the soil profile from 0-0.2 m depth. Organic carbon is decomposed by the anaerobic respiration of sulfate reducing bacteria and therefore the presence of abundant organic carbon is a useful indictor of environments where acid sulfate soils may have formed. However, the top 0-0.2 m of the soil profile is likely to be oxidised and is strongly influenced by active carbon exchange in the soil (e.g. via living plants), making this layer redundant for the purposes of this investigation. Furthermore, the value of this layer is assumed to be encompassed by the identification of the peat soil type within the FLS Soil Texture layer or the Recent soil type within the Smap.

### 5.11.4 Salinity

Salinity is an indicator of the presence of seawater, which is a source of sulfate and thus, may correspond to environments where acid sulfate soils generation is favourable. This layer has been omitted as elevation, soil type or geology were considered to be more reliable indicators of these environments.

## 5.12 Summary

The draft map produced is a spatial representation of the probability of occurrence of acid sulfate soils derived from the inputs described within Section 5 and execution documented within Section 4. The draft map is provided in Appendix A.

The draft map identified the following:

– Areas of high probability are typically located within the Waikato and Hauraki Basins and the drainage channels/valleys within the Kaimai Ranges and the uplands.

  High probability areas make up 22% of the total map area.

  A defect represented within the draft map is that the basins appear to extend too far south and to higher elevations where acid sulfate soils may not consistently be expected.

– Areas of medium probability are typically located:

  - Within the aforementioned uplands
  - Within the river channels of the southern portion of the region
  - Within the Hūnua Ranges and volcanic plateau.

  Medium probability areas make up 9% of the total area within this draft map.

– Low probability areas cover the majority of the southern Waikato volcanogenic plateau in addition to covering a high proportion of the upland and Kaimai ranges.

  Low probability areas make up 60% of the total draft map area

– Negligible probability areas are predominantly found within the southwestern portion of the Waikato.

  Negligible probability areas make up 8% of the total draft map area.

The following sections discuss the ground truthing exercise undertaken to test the assumptions and scoring of the draft spatial assessment, enabling evidence-based refinement of the inputs adopted. The refinements made as a result of the ground truthing exercise are noted within Section 6.6 and a comparison between the draft map and the refined, post-sampling final map is documented in Section 7.2 of this report.

# 6. Stage 2: Ground truthing

A ground truthing assessment was undertaken to test the assumptions made during the initial desktop spatial assessment and to further calibrate the probability rankings assigned to adopted classes. The ground truthing involved the quantitative analysis of samples collected from a variety of the adopted input classes, to inform the validation and calibration exercises.

The sample locations chosen for the intrusive investigation were selected from across the Waikato Region to target a range of the adopted classes. These locations were selected on a judgement basis to provide a range of different adopted classes and geographical distribution.

The following subsection provides a summary of the methodology adopted to ground truth the Waikato Region.

## 6.1 Field investigation

### 6.1.1 Sampling location selection

Sample sites were selected using targeted judgement, with a focus on high and medium probability areas identified during Stage 1 of the project. Some lower risk areas were also selected where the initial spatial assessment identified significant coverage of the Waikato Region or where areas of interest had been identified by WRC (refer to Section 2.1).

These locations were selected to test the assumptions made during the initial spatial assessment, such as the correlation between soil types and pedogenic environments likely to correspond to the formation of acid sulfate soil.

The sample location selection was biased to the central and northern areas of the Waikato Region. This was a consequence of the northern and central portions having a higher correlation to acid sulfate soil occurrence (refer to Section 2.1.1) compared to the southern portion. An implication of this bias is that the southern portion was characterised to a lesser extent than the northern and central Waikato, with the limited number of sample points allocated for this project restricting the areal extent of ground truthing to the areas of greatest interest.

The precise location of sampling was selected to facilitate site access and minimize the need to access private land. WRC were heavily involved in the site location confirmation, providing access and approval to all sites investigated.

All locations were approved for intrusive hand auguring and sampling under standard GHD ground penetration permit protocols. The ground penetration permit was approved by the GHD Project Director.

It is noted that due to health and safety and environmental damage concerns, the project team did not undertake any sampling in close proximity to water bodies, mangroves, or wetlands.

### 6.1.2 Sampling methodology

Sampling was undertaken in accordance with the Australian National Guidance and GHD standard operating procedures. The soil sampling methods adopted were confirmed by a suitably qualified and experienced practitioner (SQEP) with experience and knowledge in acid sulfate soil sampling.

#### 6.1.2.1 Sample locations and depths

Each of the selected locations was hand augured using a 50 mm manual hand auger to a target depth of 2 mbgl or termination depth. Termination depth was determined by refusal or inability to recover sufficient soil for sampling. In cases where man-made fill was encountered over the majority of the soil profile, the location was terminated, and a nearby alternative location was sought by the field team.

Sampling at different depths enabled GHD to provide a comment on the possible presence and condition of acid sulfate soils across the soil profile assessed. Default sampling collection depths were 0.5, 1, and 2 mbgl. Additional samples were collected at some sites where soil characteristics considered likely to correspond to the presence of acid sulfate soil were encountered at other depths. Characteristics included, but were not limited to, high organic content, $H_2S$ odour, proximity to the water table, or specific soil texture.

#### 6.1.2.2 Sampling procedures

The following sampling procedure was undertaken for each intrusive hand auger hole. Once the material was extracted, the recovered soil was laid out, visually assessed, and described in accordance with a modified New Zealand Geotechnical Society (NZGS) method, adjusted to emphasize characteristics of soils likely to contain acid sulfate soil. After logging the soil, the soil profile was photographed before sample collection took place. Once the sample was collected, the hand auger was cleaned using fresh water to reduce the risk of cross contamination of samples between sampling depths. Basic soil logs are provided in Appendix C of this report.

Samples were collected using new disposable gloves for each sample and double bagged in zip lock plastic bags. The samples were collected to minimize air in the bag, reducing the risk of sample oxidisation in transit to the laboratory. Following collection, the samples were placed directly into chilled ice chests for the duration of the day. When possible, samples were frozen and then delivered to Analytica Laboratories Limited as soon as possible.

All samples were collected following the above soil sampling procedures and transported to Analytica Laboratories in Hamilton for pH analysis. Once pH testing was completed, the samples were then forwarded onto ALS Brisbane for further analysis. All samples were transported under GHD chain of custody protocols. Detail on the analyses undertaken is provided within Section 6.2.

#### 6.1.2.3 Deviations in sampling methodology

Fourteen (14) sites located within private land were not able to be sampled due to access being declined by the landowners. These locations were relocated to publicly owned land with similar characteristics. These replacement locations are identifiable with a ‘B’ or ‘C’ added to the original Site number (i.e. if Site 1 was shifted, the naming convention of the shifted sample would read ‘Site 1B’).

#### 6.1.2.4 Duplicate samples

Duplicate samples were collected during the assessment at a rate of approximately 10 percent of the total samples collected. These samples were handled and submitted to the laboratory under the same conditions as the parent samples, but the laboratory was not notified which samples were parent samples. Duplicate samples ‘Dup A’ – ‘Dup T’ were submitted for pH testing.

Duplicate samples for Chromium reducible sulfur (CrS) analysis were not collected within this investigation. Instead, nine of the 100 samples collected for the analysis of CrS were also analysed using the Suspension Peroxide Oxidation Combined Acidity and Sulfur (SPOCAS) analytical method. This was undertaken to validate the CrS results via the over estimation of SPOCAS results. The reasoning as to why this validation was undertaken is further discussed within Section 6.3.1.2

The duplicate samples and comparison of analyses allowed GHD to understand the quality maintained by the field team and laboratory during this investigation. In addition, this enhances understanding of the relationship between different analytical methods used for acid sulfate soil identification and will allow for higher quality advice to be provided by WRC to stakeholders with interest in the assessment of acid sulfate soils.

## 6.2 Laboratory analysis

Analysis of the samples submitted was undertaken by Analytica Laboratories Ltd (an IANZ accredited laboratory) and ALS Brisbane, a National Association of Testing Authorities, Australia (NATA) approved laboratory with accreditation for CrS and SPOCAS analysis[3]:

– Approximately two parent samples per location were analysed for $pH_F$ and $pH_{FOX}$ (199 samples)
– Duplicate analysis of $pH_F$ and $pH_{FOX}$ was conducted on approximately 10% of the parent samples (20 samples)

[3] The testing was undertaken in accordance with the NATA acid sulfate soil: EA003 method and the Acid Sulfate Soils Laboratory Methods Guidelines (Ahern et al., 2004)

– Chromium reducible sulfur (CrS) analysis was carried out for one sample per location (100 samples)
– Suspension Peroxide Oxidation Combined Acidity and Sulfur (SPOCAS) analysis was performed on roughly 10% of the chromium reducible sample locations (9 samples).

To ensure preservation of the samples for future analysis, all samples were dried by the laboratory and stored in sealed containers.

The selected laboratory analysis undertaken during this investigation included two key deviations:

– Two (2) samples, namely sample numbers 44 1.3 m and 95 0.5 m, exceeded the holding time for CrS analysis due to a laboratory error in refreezing the samples after $pH_F$ and $pH_{FOX}$ analysis. These samples were still analysed upon GHD's request, however, were interpreted with caution. Refer to Section 6.4 for discussion of the exceedances
– Approximately two samples per location were analysed for $pH_F$ and $pH_{FOX}$ aside from the variations of the following sites which had either one or three samples analysed for:
  - Site 79 and Site 80 had three samples analysed for $pH_F$ and $pH_{FOX}$ analysis
  - Sites 18, 25, 62 and 73 all had one sample analysed for $pH_F$ and $pH_{FOX}$ analysis.

Results of this analysis are provided within Appendix D and laboratory issued reports are provided within Appendix F. The Quality Assurance and Quality Control (QA/QC) review of laboratory results and effects is discussed in Section 6.4.

# 6.3 Laboratory results

## 6.3.1 Adopted screening criteria

### 6.3.1.1 Field analysis criteria

$pH_F$ testing is a valuable method used to identify the presence of acid sulfate soils and is commonly employed to screen samples, determining which ones require further quantitative laboratory analysis. In this study, $pH_F$ was conducted in a laboratory under controlled conditions, following standard industry practice. $pH_F$ helps determine the existence of existing acidity (pH<7), such as that resulting from prior oxidation of sulfides (inorganic acid) and natural organic acids in the soils.

In conjunction with $pH_F$, $pH_{FOX}$ analysis was undertaken to provide insights into potential acid sulfate soils. A $pH_{FOX}$ value at least two pH units below the recorded $pH_F$ may indicate potential acid sulfate soil. The larger the difference between these two measurements (ΔpH), the more indicative the result is of potential acid sulfate soil. Furthermore, a lower final $pH_{FOX}$ value (e.g., less than pH 3) increases the likelihood of the material being potential acid sulfate soil. However, it is essential to note that slight pH changes are often due to the soils inability to buffer the pH of the peroxide solution, resulting in its adoption of the peroxide solutions pH (Ahern et al., 1998). The short duration of the test also can exclude some of the soils natural buffering capacity, which can occur at a slower rate.

The strength of the reaction with peroxide, known as the "Reaction Rate," is another indicator of potential acid sulfate soil, as higher concentrations of sulfides lead to a more robust reaction. This reaction rate is graded by visual observation from one (slight) to four (extreme). This indicator cannot be used in isolation, however, as organic matter and other soil constituents like manganese oxides can also cause a reaction. Caution must be exercised in interpreting reactions in surface soils and soils with high organic content, such as peat and certain marine or estuarine sediments.

***Table 15 Field pH testing cut-off criteria***

| | Highly Acidic Soils | Actual Acid Sulfate Soils | Potential Acid Sulfate Soils |
|---|---|---|---|
| $pH_F$ | ≤5 | ≤4 | |
| $pH_{FOX}$ | | | ≤3 |
| ΔpH | | | ≥2 |

It is worth noting that field techniques are useful exploratory tools but for the purpose of this investigation were only interpreted as a screening tool to identify the most appropriate sample to analyse from each sample location.

The best form of analysis of acid sulfate soil severity is the CrS method. Therefore, potential interpretations will be heavily weighted in terms of CrS data obtained as opposed to field techniques. The criteria associated with CrS are discussed within the following section.

#### 6.3.1.2 Laboratory analysis criteria

The CrS and SPOCAS methods are designed to standardise the set of analyses used to quantitatively assess the acid generation potential of soils suspected of containing pyrite and other iron sulfides.

In the absence of New Zealand based criteria, the Water Quality Australia, National Acid Sulfate Soils Guidance, June 2018 action levels have been adopted to define when acid sulfate soil disturbed at a site will need to be treated and managed. These action criteria are presented below. As clay content can influence a soils natural pH buffering capacity, the action levels are grouped by three broad texture categories: coarse, medium, and fine (Table 16).

The action criteria are based on the sum of existing plus potential acidity (TAA + a-SRAS [4] + a-SPOS (in mol $H^+$/tonne)). In the case where a sample was analysed for both CrS and SPOCAS Australian National Guidance recommends using CrS analysis in all instances, especially when organic content within soils is at 6% of total composition or above. For the purposes of this investigation, the SPOCAS results were heavily affected by organic matter within the soil, and therefore CrS was used. SPOCAS has been included as it demonstrates the difference, and potentially the reliability, of results when compared to CrS. This is further discussed in Section 6.4.

The criterion adopted within this investigation is the action criteria noted in the Australian National Guidance. This investigation has adopted the most conservative criterion as the 'trigger value'. The criteria of 18 mol H+/t indicates:

- If a sample had a net acidity of over 18 mol H+/t, the sample was considered to be potential acid sulfate soils
- If a sample had had a net acidity of lower than 18 mol H+/t, the sample will not be considered immediately as potential acid sulfate soils.

*Table 16 Texture-based acid sulfate soil action criteria*

<table>
<tr><th colspan="2">Type of material</th><th colspan="4">Sum of existing and potential acidity</th></tr>
<tr><th rowspan="2">Texture range (National committee on Soil and Terrain, 2009)</th><th rowspan="2">Approximate clay content (%)</th><th colspan="2">1 - 1000 t material disturbed</th><th colspan="2">> 1000 t material disturbed</th></tr>
<tr><th>%S-equiv. (oven-dried basis)</th><th>Mol H+/t (oven-dried basis)</th><th>%S-equiv. (oven-dried basis)</th><th>Mol H+/t (oven-dried basis)</th></tr>
<tr><td>Fine medium sands to heavy clays and silty clays</td><td>>40</td><td>0.1</td><td>62</td><td rowspan="3">0.03</td><td rowspan="3">18</td></tr>
<tr><td>Medium sandy loams to light clays</td><td>5 - 40</td><td>0.06</td><td>36</td></tr>
<tr><td>Coarse sands to loamy sands and peats</td><td>< 5</td><td>0.03</td><td>18</td></tr>
</table>

**Source**: Queensland Acid Sulfate Soil Technical Manual: Soil Management Guideline 2014 (Table 4-1).

CrS analysis is considered more reliable than SPOCAS analysis for assessing the presence of acid sulfate soils due to its specific focus on measuring the amount of reducible sulfur in the soil. CrS analysis targets the fraction of sulfur that is readily reducible by chromium in acidic conditions. This fraction primarily includes sulfide minerals, which are the key contributors to the formation of acid sulfate soils. By quantifying the reducible sulfur, CrS analysis directly provides information about the potential for sulfuric acid production upon oxidation of these sulfides. This targeted approach ensures that the analysis is focused on the critical components of acid sulfate soil formation, making it a more reliable indicator of the presence of acid sulfate soils.

SPOCAS analysis is a broader method that measures total sulfur content in the soil, including both organic and inorganic sulfur compounds. While SPOCAS analysis can offer valuable insights into overall sulfur content, it does not specifically distinguish between reducible sulfur from sulfides and sulfur in other forms, such as organic matter

[4] Peroxide residue acid soluble sulfur

or sulfates. As a result, SPOCAS analysis may overestimate the potential for sulfuric acid production from sulfides since it includes other sulfur compounds that do not contribute to acid sulfate soil formation. This lack of specificity makes SPOCAS analysis less is reliable for directly assessing the risk of acid sulfate soils and typically results in an over estimation of net acidity.

Furthermore, CrS analysis has been widely used and validated in scientific research and industry practice as a reliable method for quantifying sulfides in soils. The method follows standardised protocols, and the results are generally well-established and easily interpretable. In contrast, SPOCAS analysis may require additional interpretations and considerations, as the total sulfur content measured can be influenced by various factors, including soil types, organic matter content, and other sulfur compounds that may not be directly related to acid sulfate soil formation. Overall, the targeted and validated nature of CrS analysis makes it a more reliable tool for assessing the potential presence of acid sulfate soils.

The inclusion of SPOCAS in this investigation was limited to 10 percent of the total sites sampled as quality control, to demonstrate the above considerations and to aid in assessing the influence on results that may occur from the aforementioned factors.

#### 6.3.1.3 Field observations corroboration

The results reported by Analytica Laboratories were compiled and compared to the field observations noted during the ground truthing field investigations. This comparison is required as external factors such as vegetation, seepages, runoff and management history can alter soil acidity.

The review of field observations adhered to the Australian National Guidance and will consider specific factors that could influence the reasons for high acidity values. Observational data related to redox, $S0_4^{2-}$ : $Cl^-$ ratio and other groundwater indicators was not monitored during the field investigation.

Field observations are useful in the assessment process as they provide a visual indication of the soil’s characteristics and potential environmental influences. These observations may include the presence of effervescence upon exposure to air, the occurrence of pyrite in the soil, or distinct colour changes that suggest the presence of acid sulfate soils. Additionally, other visual signs, such as iron staining or mottling, can also indicate the likelihood of acid sulfate soils. By comparing these field observations with the laboratory results, the assessment gains a comprehensive understanding of the site's conditions and verifies the accuracy of the laboratory findings.

#### 6.3.1.4 Duplicate criteria

The QA/QC programme included the collection of duplicate samples. Field duplicate samples were taken at 20 of the 100 sites sampled and analysed at a rate of 10% of samples. In this study, duplicate and parent samples are assessed based on the relative percentage difference (RPD) between samples taken from each location using the following equation.

$$\text{RPD (\%)} = \frac{\langle Co - Cs \rangle}{\left\langle \frac{Co + Cs}{2} \right\rangle} \times 100$$

Where $Co$ = concentration obtained from the original sample

$Cs$ = concentration obtained from the duplicate sample

The standard acceptance criteria for RPDs are between 0 and 40% in soils. In some instances, a large percentage differential can occur with a small analytical differential between two samples due to the following:

– A small analytical differential between two samples based on the low levels of detection from the primary and duplicate soil sample
– Samples analysed in soil collected from non-homogenous (heterogeneous) soil profile.

## 6.3.2 Results

### 6.3.2.1 Field observations

Field observations are compiled within Appendix D. In summary:

- Approximately half the sites contained moderate to high oxidation and were either waterlogged or withholding moderate amounts of moisture
- Three of the sites visited had sulfurous odours within the samples collected
- The field notes identified that sample in-field indicators of acid sulfate soils often correlated with results that had a net acidity of over 18 mol $H^+$ / t.

Where field observations corroborate a specific analytical result they will be discussed in conjunction with the section of the analytical result they pertain to.

### 6.3.2.2 Field pH results

One hundred and ninety-nine (199) samples were sent to Analytica Laboratories Ltd for $pH_F$, $pH_{FOX}$, and reaction rate testing. The reported field $pH_F$ results indicate that the soils range from moderately alkaline to extremely acidic (8.29 to 4.16). The higher pH samples typically, but not always, are associated with marine sediments and the presence of carbonates[5]. The lower pH samples are often from swampy and peaty soils. The results from the pH analysis showed:

- The $pH_F$ results showed that 20 of the 199 samples (10%) were highly acidic soils (pH ≤5). Forty-two (42) samples had $pH_{FOX}$ of ≤3 indicating a high potential for the samples tested becoming strongly acidic
- Ninety-five (95) of the 199 samples (48%) show a decrease of ≥2 pH units compared to the samples $pH_F$ value
- Twenty-eight (28) of the 191 samples (15%) had a reaction rate to peroxide of 'very vigorous'. These reactions were commonly associated with soil profiles which included organics, apart from in three sandy samples.

The lower pH values of some of the soils may also be associated with organically bound sulfur within organic acids as well as sulfate, as organic matter was observed throughout the profile of some soils. The presence of carbonates within samples typically correlated with the samples that had higher pH values, as documented above.

### 6.3.2.3 Chromium reducible sulfur results

One hundred samples were analysed for a CrS suite, namely including results of net acidity, TAA, Peroxide Oxidisable Sulfur (POS), retained acidity and $pH_{KCl}$:

- In 15 of the 100 (15%) samples analysed, the POS results were above the action criterion of 18 mol $H^+$ / t, with the highest acidity reported in sample Site 27 1.0 m depth at 280 mol $H^+$ / t. The POS results indicate that these samples have a high potential for in situ acid sulfate soil generation
- The TAA results provide an indication of the existing acidity present within the soils. In 72 out of the 98 (72%) soil samples analysed, levels of actual acidity were reported above the adopted action criterion (18 mol $H^+$/t) with sample Site 80 1.65 m depth exhibiting the highest TAA result (641 mol $H^+$ / t)
- Of the 98 samples taken, 88 (90%) samples were reported to have a net acidity at or above the 18 mol $H^+$/t adopted criterion. The sample from Site 80 1.65 m depth had the highest net acidity with a net acidity of 691 mol $H^+$/t. As these sample results exceed the adopted acceptance criterion, these samples are consequently considered to represent acid sulfate soils for the purpose of this investigation
- Retained acidity results indicate that there is a low number of samples which will release acid into the environment over a long time. Of the 98 samples, 17 (17%) showed presence of retained acidity, however, six of these samples were below the detection limit. Eleven (11) of the samples (11%) samples had measurable concentrations of retained acidity, the highest being Site 90 2.0 m depth with a concentration of 47 mol $H^+$/t

[5] Carbonates are a base of carbonic acid, therefore can accept protons (in this case $H^+$ ions generated from acid sulfate soils, sulfuric acid), causing a decrease in the overall, freely availably acidity of the sample.

- $pH_{KCl}$ results indicates natural environmental acidity and the organic acids contribution to acidity of the sample. The $pH_{KCl}$ results ranged from 3.4 to 8.8, with the majority of the samples falling within a slightly acid pH of 5 to 6, indicating that the majority of the samples analysed had a weak influence of natural environmental acidity.

#### 6.3.2.4 Suspension peroxide oxidation combined acidity and sulfur results

Nine (9) samples were analysed for a SPOCAS analysis suite, which includes net acidity, TAA, POS, retained acidity and $pH_{KCl}$:

- POS results were reported to be above the 18 mol $H^+$ / t criterion in seven of the nine samples (78%) analysed. The highest POS reported 384 mol H+ / t of acid in sample Site 27 1.0 m depth. All samples above the POS criterion of 18 mol $H^+$ / t were higher than POS values seen within the CrS suite
- Three of the nine samples (33%) soil samples analysed, had a TAA reported above the adopted action criterion (18 mol $H^+$/t) with sample Site 68 0.65 m depth exhibiting the highest TAA result (454 mol $H^+$ / t)
- Of the nine samples analysed, four (44%) samples were reported to have a net acidity at or above the 18 mol $H^+$/t adopted criterion. The sample from Site 68 0.65 m depth had the highest net acidity with a net acidity of 463 mol $H^+$/t
- Retained acidity was only reported within two samples: Site 68 0.65 m and Site 4 1.00 m. Retained acidity within these samples was not high enough to report
- $pH_{KCl}$ results ranged from 3.4 to 7.8, with the majority of the samples falling within a slightly acid pH of 4.5 to 6 indicating that majority of the samples analysed had a stronger influence of natural/organic environmental acidity which is to be expected of SPOCAS.

#### 6.3.2.5 Peroxide Oxidisable Sulfur comparison

A small subset of samples was analysed (9 samples) for both CrS and SPOCAS within this assessment. The results of this analysis demonstrate that samples with concentrations of POS above the detection limit were consistently overestimated by the SPOCAS method of analysis when compared to CrS.

It is recommended that WRC specifies the use of the CrS method in future investigations to prevent over estimation of acid content and reduce the risk of over-investing in remedial works or management of acid sulfate soil risks.

## 6.4 Quality assurance and quality control discussion

Within this investigation there were instances where potential QA/QC breaches could have affected the quality or did affect the quantity of data received. The deviations, briefly discussed in previous sections, are summarised below:

- Where samples exceeded holding times and therefore could impact on the quality of the dataset, the results were interpreted with caution. The effects of the holding time exceedance may have caused the oxidisation of the reduced sulfur within the sample. Theoretically a sample in exceedance of holding time produces higher concentrations of TAA than CrS. This is likely the case as both samples with exceeded holding times reported CrS concentrations lower than detection limits. These results have been included within the investigation as they are understood to still provide insight into the investigation
- Reaction rate results were not provided in the initial submission of results issued by Analytica Laboratories, and the laboratory was not able to re-report them. This has left a gap in the dataset. However, reaction rates are not the key analytical parameter within this investigation, and therefore this data gap is considered negligible.
- The largest RPD for $pH_F$ was 17%, and 22% for $pH_{FOX}$ [6]. Based on these results, it is understood there is little variance between samples, indicating soils samples are consistent and homogeneous, and laboratory results are consistent.

[6] It is noted duplicate H had a pH difference of 1.86. Given pH is reported logarithmically, this difference is significant, however, this sample (70 1.0 m) contained carbonates, potentially causing the in high variance in the sample. This result has been assumed to be an acceptable variance in concentration given the site conditions.

– The SPOCAS results are understood to have corroborated the CrS results as, when above the detection limit, they were consistently overestimating the acidity content of the sample. This provides WRC further reassurance that CrS results are the most accurate form of laboratory method.

Given the above findings and the QA/QC procedures adopted, GHD considers that the data collected was suitable to proceed with the interpretation in support of the map revision.

# 6.5 Ground truthing interpretation

The ground truthing analysis and field observations were used to test the assumptions made about the initial inputs to aid in the refinement of the draft probability map. The ground truthing results provide quantitative data, which was used the test the correlation between of the adopted inputs and the presence of acid sulfate soils.

The revisions made as a result of ground truthing must be viewed with caution. This is due to the relatively low number of samples collected in comparison to the extent of the Waikato Region. The scope of the project did not allow for the collection of sufficient samples to complete a statistical analysis of the relationship between the adopted inputs and classes and probability of acid sulfate soils presence. It is recommended that further data is collected supplementary to this investigation to provide more insight into the interactions of acid sulfate soils and the environmental conditions within the Waikato Region. Once a sufficient dataset is compiled a statistical relationship analysis could be undertaken on the adopted inputs and classes.

To remove subjective bias where possible, an evidence-based scoring system was designed. The methodology of the scoring system adopted is outlined in Appendix E.

The scoring approach noted within Table 17 below was adopted for this investigation.

*Table 17 Sample scoring summary table*

| Category | Test | Criteria | Applied score |
|---|---|---|---|
| Acidity Scores | CrS | >100 mol $H^+$/t | 20 |
| | | >50 mol $H^+$/t | 15 |
| | | >18 mol $H^+$/t | 10 |
| | TAA | >300 mol $H^+$/t | 6 |
| | | >100 mol $H^+$/t | 4 |
| | | >18 mol $H^+$/t | 2 |
| pH | $pH_{ox}$ | <3 | 0.5 |
| | ΔpH | ≥2 | 0.2 |
| | Reaction rate | Extreme | 0.2 |
| Field observation | $H_2S$ | Noted | 0.5 |
| | Texture | Peat, peaty clay, or peaty silt | 0.5 |
| | Oxidation | High | 0.25 |
| | | Moderate | 0.1 |

Samples were individually scored on each of the characteristics, then summed. Total scores of samples were then given negligible, low, medium, and high-risk ratings[7]:

– Samples considered to be of negligible risk (19) were samples with scores between 0.0 and 1.9
– Samples considered to be of low risk (49) were samples with scores between 2.0 and 5.0
– Samples of medium risk (12) were samples with scores between 5.1 and 14.9
– Samples of high risk (18) were samples with scores greater than 15.

[7] Noted: only samples containing CrS results were included within the scoring as CrS analysis is the most accurate determinant of acid sulfate soils presence

As this dataset does not statistically categorise each class scored, any revisions were limited to shifting the probability rating of a unit by one class, unless there was sufficient data or faults identified within the inputs after scrutinisation. The revisions made within this section either:

– Update the probability rating based on sample risk or new insights, resulting in a probability shift up or down by one rating
– State that the probability rating should not change based on the sample spread or lack of samples within the class
– Escalate or nullify the probability rating of a given unit if substantial evidence is present.

### 6.5.1 Geology

Table 18 summarises the risks of the ground truthed samples intersecting the geology input. As the geology input was one of the most extensive inputs adopted within this investigation, it has been characterised to a high degree. For the purpose of interpreting this input, the geological formations have been referred to as opposed to the classes adopted. This is due to the lack of occurrence in other classes and a focus being applied to broader trends within this input.

Holocene Swamp Deposits had a large number of results showing the measured potential of acid sulfate soils. This class was originally rated as a high probability of occurrence due to the ideal conditions provided by swamps with an available amount of carbon, anoxic conditions, and a potential source of sulfur. There were a large number of positive results for acid sulfate soils within the classes of the Holocene Swamp Deposits geological formation with majority of the samples showing low and medium risk as opposed to negligible results. Given a sufficient amount of low-medium risk samples, as well as two high risk samples, the class retained a high probability rating.

Holocene River Deposits had a spread of samples, with six samples of high risk, five medium and 18 low risk samples. The hit rate for these samples indicates there may be a higher potential of acid sulfate soil occurrence than previously estimated. However, this result may be misleading as the investigation did not characterise the entire unit. River deposits are made of high and low energy areas from gravelly riverbeds to peaty, estuarine areas. No high energy riverbeds were sampled during the investigation as they have a very low probability of containing acid sulfate soil generating conditions. Therefore, the risk results displayed are likely biased towards the peat beds within the unit. Due to potential bias, it is unlikely that Holocene River Deposits should be considered high probability and therefore retained medium probability.

Late Pleistocene River Deposits (and, more specifically, the class of Cross-bedded pumice sand, silt, and gravel with interbedded peat) were considered of negligible probability prior to ground truthing. However, the field investigation showed numerous samples with acid sulfate soils risk when ground truthing. The original rating was set to negligible due to sandy and gravelly riverbed being reflective of high energy and oxygenation environments and consequently less favourable for the formation and persistence of acid sulfate soils. However, as the investigation targeted low energy areas, the majority of samples were found to be of low, medium, and high risk. The rate of occurrence of acid sulfate soils indicates this unit could potentially be of medium probability, but given the bias of the sampling to low energy sections, it has been revised by one unit to low risk.

All other classes within this input were not ground truthed or did not present a high enough number of results to be considered for reclassification. Those classes require further investigation to inform potential revision.

*Table 18 Ground truthing summary of the geology input*

| | | | Measured risk of acid sulfate soils | | | | |
|---|---|---|---|---|---|---|---|
| Geological formation | Class | Draft Probability Rating | High | Medium | Low | Negligible | Final Probability Rating |
| Holocene Swamp Deposits | Soft, dark brown to black, organic mud, muddy peat, and woody peat with minor overbank sand, silt, and mud. | High | 1 | | | | High |
| | Soft, dark brown to black, mud, muddy sand, muddy peat, and peat. Locally extensive peat bogs. | High | 1 | | 4 | 3 | High |
| | Soft, dark brown to black, organic mud, muddy peat, and woody peat. | High | | | 3 | 1 | High |
| Holocene River Deposits | Alluvial and colluvial sand, silt, mud and clay with local gravel and peat beds. | Med | | 1 | 4 | | Med |
| | Alluvial gravel, sand, silt, mud, and clay with local peat, includes modern riverbeds. | Med | 1 | 2 | 5 | 2 | Med |
| | Sand, silt mud and clay with local gravel and peat beds. | Med | | 2 | 9 | 2 | Med |
| Holocene Shoreline Deposits | Unconsolidated, sandy to muddy, pebbly and shelly beach ridges. | Low | 2 | | | | Low |
| Late Pleistocene River Deposits | Locally derived lacustrine mud, silt, gravel, and peat. | Low | | | 1 | 1 | Low |
| | Cross-bedded pumice sand, silt, and gravel with interbedded peat | Negligible | 3 | 5 | 13 | 3 | Low |

### 6.5.2 Elevation

Table 19 summarises the risks of the ground truthed samples intersecting the elevation input. Based on the sample risk identified within the elevation classes, both classes contain a similar sample distribution. As the sample range of <10 m shared similar outcomes to that of >10 m, elevations below 10 m are now categorised as having a low probability rating. It is recommended a higher resolution DEM is utilised within future investigations and lower elevation ranges are used. In addition to the sample risk and general occurrence, the <10 m elevation class identified improbable areas such as the beaches along the west coast of the Waikato as high-risk areas.

It is assumed that inlets or areas at sea level are influenced by factors present in higher-risk zones like river deposits, coastal sediments, or wetlands. Despite this, the elevation DEM has been incorporated into the final map revision to address potential gaps in coastal areas not covered by other input layers. Designating this class as low probability is unlikely to lead to an excessive representation of its influence.

*Table 19 Ground truthing summary of the elevation input*

| | | Measured potential for acid sulfate soil (number of test results) | | | | |
|---|---|---|---|---|---|---|
| Class | Draft Probability Rating | High | Medium | Low | Negligible | Final Probability Rating |
| <10 m Elevation | High | 10 | 6 | 25 | 8 | Low |
| >10 m Elevation | Negligible | 10 | 3 | 20 | 12 | Negligible |

### 6.5.3 Wetlands

Table 20 summarises the risks of the ground truthed samples intersecting the wetland input. The risk results for wetland extent samples showed a spread across the Historic Wetland category, with the majority being low risk. The sample locations within this class that indicated risk included mountainous areas and riverbanks, locations that are unlikely to foster acid sulfate soil occurrence. This led to the conclusion that the spatial distribution of this layer is potentially misleading. This class has therefore been reduced to a low probability. In addition to the above, the medium and high-risk samples intersecting the Historic Wetland class were often overlapped with Gley, Organic, or Peaty soils classes, and it is these other classes that are thought to be driving the occurrence of the higher risk samples that intersect the Historic Wetlands class, making this class of less importance to the final rating.

The Current Wetlands class had fewer ground truthing intersections than the Historic Wetland class samples due to smaller shapefile extent. Due to limited extent and intersected samples, Current Wetland class remained high probability as the original assumptions driving the probability still stand.

*Table 20 Ground truthing summary of the wetlands input*

| | | Measured potential for acid sulfate soil (number of test results) | | | | |
|---|---|---|---|---|---|---|
| Class | Draft Probability Rating | High | Medium | Low | Negligible | Final Probability Rating |
| Current Wetland | High | | | 1 | 2 | High |
| Historic Wetland | Medium | 7 | 8 | 26 | 9 | Low |

### 6.5.4 Vegetation

Table 21 summarises the risks of the ground truthed samples intersecting the vegetation input. The Wetland Communities class of the vegetation map from LRIS had five samples intersected, of either low or high risk. Considering the small shapefile extent and the relatively high rate of occurrence, the Wetland Communities class has retained a high probability of occurrence rating.

*Table 21 Ground truthing summary of the vegetation input*

| | | Measured potential for acid sulfate soil (number of test results) | | | | |
|---|---|---|---|---|---|---|
| Class | Draft Probability Rating | High | Medium | Low | Negligible | Final Probability Rating |
| Wetland Communities | High | 1 | | 4 | | High |

### 6.5.5 Land cover

Table 22 summarises the risks of the ground truthed samples intersecting the land cover input. Land cover classes were initially predicted to range from high to medium probability for the presence of acid sulfate soils. However, land cover types within this unit which correlated to the presence of acid sulfate soils were not commonly intersected within the field investigation.

Therefore, the classes have retained their probability ratings as the initial assumptions surrounding them are deemed appropriate until further truthed.

Mangrove and Flaxland classes within this input, and given a score in Section 5.5, were not intersected during this investigation

*Table 22 Ground truthing summary of the land cover input*

| | | Measured potential for acid sulfate soil (number of test results) | | | | |
|---|---|---|---|---|---|---|
| Class | Draft Probability Rating | High | Medium | Low | Negligible | Final Probability Rating |
| Herbaceous Saline Vegetation | High | | | 1 | | High |
| Herbaceous Freshwater Vegetation | Medium | | | 2 | | Medium |

### 6.5.6 Soil type

Table 23 summarises the risks of the ground truthed samples intersecting the soil type input. As the Hamilton region was sampled more intensively it was assumed that these classes would be well characterised. However, the majority of the classes were not characterised or not sufficiently sampled to prompt a change in probability rating. All classes, excluding the Peaty Loam and Loamy Peat (Loamy Peat), will remain as assumed within the draft probability map.

The Loamy Peat class presented the greatest number of results within the input. Three of the five results were of negligible risk. Due to the presence of potential acid sulfate soils risk within this class, it has retained a medium probability rating. The presence of loam within a sample does not usually correlate to the presence of acid sulfate soils, therefore, there is potential to reduce this probability to low when further truthed.

*Table 23 Ground truthing summary of the soil type input*

| | | Measured potential for acid sulfate soil (number of test results) | | | | |
|---|---|---|---|---|---|---|
| Class | Draft Probability Rating | High | Medium | Low | Negligible | Final Probability Rating |
| Peat | High | | | 1 | | High |
| Peaty Loam and Loamy Peat (Loamy Peat) | Medium | | | 2 | 3 | Medium |
| Peaty Loam | Medium | | | 1 | | Medium |
| Peaty Sand | Medium | 1 | | | | Medium |

### 6.5.7 Smap

Table 24 summarises the risks of the ground truthed samples intersecting the Smap input. Gley, Organic and Recent soils were intersected within this investigation. The Raw soil class was not intersected, and therefore retained a low probability.

Gley soils were initially rated high probability of acid sulfate soils occurrence due to gleys containing requisite conditions for acid sulfate soils generation. The gley soils were intersected on six of 18 'high risk' samples scored within this investigation and over 75% of the results showed acid sulfate risk of low or greater, affirming their high probability.

Organic soils were initially rated medium probability of acid sulfate soils. The results of the ground truthing were consistent with this. Seven out of 10 field sampling results were ranked low risk or higher. This class retained a medium probability rating given the occurrence of acid sulfate soil risk within the samples intersected.

Recent soils were initially ranked medium probability. Six of the samples truthed within this class were of low risk and one was high risk. Further investigation of this layer, however, showed that many of the Recent soils are in highly variable terrain, often elevated or in hilly topography. These areas do not meet the requisite acid sulfate soil forming conditions. The probability rating of this class has therefore been reduced to low.

*Table 24 Ground truthing summary of the soil units input*

| | | Measured potential for acid sulfate soil (number of test results) | | | | |
|---|---|---|---|---|---|---|
| Class | Draft Probability Rating | High | Medium | Low | Negligible | Final Probability Rating |
| Gley | High | 6 | 6 | 17 | 9 | High |
| Organic | Medium | 1 | 1 | 5 | 3 | Medium |
| Recent | Medium | 1 | | 6 | | Low |
| Raw | Low | | | | | Low |

### 6.5.8 Soil texture

Table 25 summarises the risks of the ground truthed samples intersecting the soil texture input. The soil texture map from LRIS had multiple occurrences of acid sulfate soil risk within the Peaty class. Low risk was the most common result. The Peaty class has, therefore, retained a high probability rating as it is commonly associated with the presence of acid sulfate soil when intersected during truthing.

*Table 25 Ground truthing summary of the soil texture input*

| | | Measured potential for acid sulfate soil (number of test results) | | | | |
|---|---|---|---|---|---|---|
| Class | Draft Probability Rating | High | Medium | Low | Negligible | Final Probability Rating |
| Peaty | High | 1 | 1 | 5 | 3 | High |

### 6.5.9 pH

Table 26 summarises the risks of the ground truthed samples intersecting the soil pH input. Soil pH 5.2 - 6.6 was initially considered to be of low probability of occurrence and pH ranges <5 were considered high probability of acid sulfate soil occurrence. The sample risk results varied across high, medium, low, and negligible risk for both pH ranges. The pH classes do not appear to show an increased correlation between lower pH and probability of acid sulfate soils.

The probabilities of both classes were reclassified to negligible probability as the inclusion of this layer would have added noise to the final map, diminishing its effectiveness. This is due to the spatial distribution of the pH classes indicating acid sulfate soil occurrence in areas which do not correlate with the environment of formation of acid sulfate soils.

*Table 26 Ground truthing summary of the pH input*

| | | Measured potential for acid sulfate soil (number of test results) | | | | |
|---|---|---|---|---|---|---|
| Class | Draft Probability Rating | High | Medium | Low | Negligible | Final Probability Rating |
| pH ≤ 5 | High | 1 | 2 | 9 | 5 | Negligible |
| pH 5.2 – 6.6 | Low | 12 | 8 | 29 | 10 | Negligible |

### 6.5.10 New Zealand soil classification

Table 27 summarises the risks of the ground truthed samples intersecting the NZSC input. The majority of the classes from the NZSC input were not intersected by sampling locations, and therefore were not revised within this assessment. Six classes had sufficient results to provide a basis for interpretation and the reclassification of the units.

Gley Acidic Typic (GAT) soils are found in poorly drained areas like waterlogged depressions or lowlands with restricted drainage and therefore were initially ranked high probability. GAT soils were not commonly intersected during this investigation. Therefore, this class has retained the high probability as the assumption made during the initial probability assessment still stands.

Typic Recent Gley (GRT) soils was initially rated high probability because the soil conditions inherent in this class of soil would support the formation of acid sulfate conditions. The GRT field results tend to be of low risk, however this class retained high probability as, when truthed, samples showed acid sulfate soil risk.

Typic Orthic Gley (GOT) soils were initially ranked medium probability of occurrence as they are common in low-lying areas and are poorly drained. GOT soils had numerous intersecting samples, mostly at low risk or higher. Upon cross-referencing with other inputs, high-risk samples often correlated with acid sulfate conditions in the same locations as Gley soils from the Smap input. As a result, GOT is reclassified as high probability.

Mellow Humic Organic (OHM), Acid Humic Organic (OHA), and Mellow Mesic Organic (OMM) soils are organic soils and have a number of samples of low risk or higher. These classes were re-rated as medium probability, given their tendency to contain acid sulfate soil risk and being of similar spatial distribution to the Smap organics class.

Sphagnic Fibric Organic (OFS), Acidic Fibric Organic (OFA), Mottled Fluvial Recent (RFM), Typic Fluvial Recent (RFW), Weathered Fluvial Recent (RFW) and Typic Sandy Recent (RST) soils were each initially ranked low probability. These classes have retained the low probability ranking, as the limited ground truthing provided no evidence to challenge the original assumptions.

Other classes within this input given a score in Section 5.10 were not intersected during this investigation.

*Table 27 Ground truthing summary of the NZSC input*

| | | Measured potential for acid sulfate soil (number of test results) | | | | |
|---|---|---|---|---|---|---|
| Class | Draft Probability Rating | High | Medium | Low | Negligible | Final Probability Rating |
| GAT – Typic Acid Gley Soils | High | | | 1 | 1 | High |
| GRT – Typic Recent Gley Soils | High | | | 7 | 1 | High |
| GOT – Typic Orthic Gley Soils | Medium | 3 | 3 | 6 | 2 | High |
| OFS - Sphagnic Fibric Organic Soils | Low | | | 1 | | Low |
| OFA – Acidic Fibric Organic Soils | Low | | | | 1 | Medium |
| OHA - Acid Humic Organic Soils | Low | | | 1 | 1 | Medium |
| OHM – Mellow Humic Organic Soils | Low | | | 2 | 1 | Medium |
| OMM - Mellow Mesic Organic Soils | Low | 1 | 1 | 1 | 1 | Medium |
| RFM – Mottled Fluvial Recent Soils | Low | | 1 | 1 | | Low |
| RFT – Typic Fluvial Recent Soils | Low | | | | 1 | Low |
| RFW – Weathered Fluvial Recent Soils | Low | | | 1 | | Low |
| RST – Typic Sandy Recent Soils | Low | | | 1 | | Low |

## 6.6 Ground truthing summary

Table 28 summarises all class revisions that were adopted based upon our field investigation. The ground truthing investigation confirmed the majority of class attributions within the draft probability map by analytical results, field characteristics and further scrutiny of the inputs adopted.

The class adjustments were primarily due to the inputs initially adopted within the draft map being inconsistent with theoretical spatial distribution or sample risk, and therefore indicating a lack of relationship between a given input and acid sulfate soil occurrence.

Some classes lacked sufficient sample coverage to draw any ground truthing conclusions, and so in these instances the draft input probabilities were retained.

*Table 28 Input probability revisions summary*

| Class of input | Draft probability | Final probability |
|---|---|---|
| Late Pleistocene River Deposits | Negligible | Low |
| <10 m Elevation | High | Low |
| Historic Wetlands | Medium | Low |
| Recent | Medium | Low |
| pH <5 | High | Negligible |
| pH >5 | Medium | Negligible |
| OFS, OHM, OHA and OMM | Low | Medium |
| GOT | Medium | High |

# 7. Stage 3: Probability of occurrence map

## 7.1 Samples and results geodatabase

The final post-sampling probability map (shown in Appendix B) will be supplied to WRC as a GIS package to publish on their online mapping software. This GIS package will include:

- The post-sampling vector polygon feature class (this will have only the final score that had been assigned to each 10m x 10m cell of the final raster, areas where the scores are the same will have been conglomerated during the process of converting the final raster into a vector layer)
- The source feature classes with the attribute used to determine the score and the assigned probability score.
- The raster layers created from these source layers showing only the post-sampling score.
- The sample locations (as a vector, point layer) showing ground truthing CrS results and the source layer attribute and probability score at that point.

This additional data (source layers and raster layers) will allow the user to interrogate the underlying scores that fed into the final post-sampling raster and associated vector polygon feature class.

The inputs provided will serve as the base map for a future repository of acid sulfate soil investigations within the region. This will allow WRC to update and revise this map through these future investigations and submissions of results. The visual format may also allow the public userbase to identify the potential occurrence of acidity within local or broader areas of the region.

The sample locations data will allow for further sample sites to be uploaded as further investigations are undertaken.

## 7.2 Map accuracy and limitations of this investigation

The final post-sampling probability map with the adjustments summarised within Section 6.6 was compared with the draft map produced in Stage 1 of this investigation. Overall the final probability map reduced the low, medium and high probability areas by 44%, 6%, and 8.2% of the total land cover area respectively. The reductions were rerated primarily as negligible probability, this resulted in an increase of 55.9% of the total land cover area of this rating. Refer to Table 29 for the percentage coverages of each probability ranking in the Waikato Region.

***Table 29 Probability comparison of acid sulfate soil occurrence between the draft and final probability maps***

| Acid sulfate soil probability | Draft map land cover (% total area) | Final map land cover (% total area) |
|---|---|---|
| High | 22.4 | 14.2 |
| Medium | 9.1 | 3.1 |
| Low | 60.0 | 15.3 |
| Negligible | 8.5 | 68.4 |

This comparison outlined that the ground truthing assessment generally improved the spatial representation of the probability of occurrence of acid sulfate soils derived from the spatial inputs alone by reducing factors which may over represent acid sulfate soil occurrence risk within the Region.

The following sections provide further commentary on the accuracy of the final probability map and limitations associated with this assessment.

### 7.2.1 Accuracy

The accuracy of the final probability map is subject to accuracy of the inputs adopted and areas ground truthed during this investigation. Therefore, the final map is expected to be interpreted as a high-level understanding of acid sulfate soil occurrence within the region.

The datasets utilised within this investigation were of scales ranging from 1:20,000 to 1:1,000,000. Compared to site-specific studies with high-resolution, the scales within this investigation were coarse. Nevertheless, they are considered adequate to provide an initial prediction of acid sulfate soil occurrence within the Waikato Region.

Site investigations of higher detail should be undertaken if there is a potential for disturbance of soils and or groundwater within areas broadly mapped as having a low, medium, or high potential for acid sulfate soils.

The layers that led to the production of this map were used as received and this assessment is, therefore, subject to the limitations inherent in those layers. This is likely because the original data sources were produced for different purposes to this assessment, such as for agricultural production purposes.

While ground truthing was undertaken on many of the classes selected within this assessment, results from this investigation are likely to have been influenced by other contributing factors, such as anthropogenic alteration and volcanic influence. While the influence of these contributing factors is difficult to isolate, every location ground truthed was qualitatively assessed using aerial photography and site notes to identify if external influence was present at the locations sampled.

The relationships and relative probabilities between different inputs are expected to be further clarified following more ground truthing sample collection or the collation of sample data from other sources.

The focus of the field investigation has primarily been on the northern and central portions of the Waikato Region. Therefore, there is potential for the southern region to be of lower accuracy when compared to the northern Waikato.

### 7.2.2 Limitations

The potential limitations noted within this assessment are discussed within the following sections pertaining to each stage of this investigation. The awareness of such limitations will allow for future improvements over further iterations of the probability map.

The noted input limitations are as follows:

- This investigation was constrained to the use of data that was spatially representable and publicly available and the age of the dataset, the quality of the data and the resolution of the datasets were as supplied. The adopted inputs are assumed to contain built-in limitations, and should not be viewed as completely accurate datasets
- The scale of this investigation covered the extent of the Waikato Region, which required national datasets. This meant using data of lower resolution compared to a study with a smaller extent. This also limited the investigation in terms of model complexity to reduce processing time and associated constraints
- A notable limitation was access to a digital elevation model that covered the entirety of the Waikato Region. Because the classification of the elevation values was broad, it was deemed adequate to use the LINZ 8 m national DEM for all areas outside of the WRC-supplied high resolution Lower Waikato Piako DEM. The resolution of the LINZ 8 m DEM was (in conjunction with the size of the study area) was influential in determining the raster cell size used in the analysis.
- The resampling and mosaicking of the elevation models results in values being generated that may not be present in the source data. Therefore, in particular areas, the elevation data, thus probability score, may differ slightly from those applied to the original dataset.
- This was a first-pass investigation into assessing the likelihood of acid sulfate soil occurrence. Hence the model was simplistic and designed to highlight areas most at risk, where more refined models can then be applied. This is thought to be acceptable considering the scale of the probability map produced.

The noted sampling limitations are as follows:

- The selected ground truthing locations were chosen in a judgement based rather than systematic sampling regime, with sampling biased toward the northern and central Waikato
- The ideal locations for characterising acid sulfate soils occurrence in some instances were not accessible due to health and safety protocols or accessibility issues. As a result, there is limited understanding of the association between acid sulfate soils occurrence and mangroves, current wetlands, and river channels within the Waikato
- There were 100 sites sampled during this investigation, which is a small sample size relative to the areal extent of the Waikato Region and the scale of the inputs included within this investigation. Therefore, this investigation was not of high resolution. This sample size limitation also drove the targeting of high-risk units, causing bias between high-risk inputs and other inputs
- The sample depths included within this investigation aimed to truth the ground to 2 mbgl. The desired intervals were not consistently sampled due to the refusal of the hand augers. This resulted in the relocation of some samples from originally targeted areas. It was assumed that this limitation had negligible impact on the data quality. Furthermore, the depths of samples were not critical to this investigation, as it targeted the horizontal characterisation of soils as opposed to vertical depth profiles. The targeted depth intervals should only be considered a desirable goal rather than a strict parameter.

The noted results and map revision limitations are as follows:

- A limitation of this investigation is that not all units for individual inputs were covered by the ground truthing analysis, and therefore the risk ratings these inputs could not be confirmed or reclassified. It is recommended more samples are collected within all input types and classes to further refine the final probability map.
- The results of this investigation are depth-limited, as data inputs and ground truthing results are generally not applicable to soils below 2 mbgl (e.g., the S-Map input only assesses the top 1 meter of soil and the ground truthing investigation did not investigate soils below 2 mbgl). Truthing of deeper sediments should be undertaken on a site-specific basis, not a regional scale
- This assessment focused on identifying the probability of acid sulfate soils generated within the Waikato Region and did not distinguish specifically between soil samples being potential acid sulfate soils or actual acid sulfate soils. This limits the level of specificity within the investigation outcomes
- This investigation aimed to remove bias and subjective interpretation where possible. The inclusion of field notes or observations within sample risk scores adds a small amount of subjectivity into the interpretation, more so than simply reviewing the CrS results and inferring relative probabilities from them. This introduction of additional bias within the results limits the replicability of this assessment. However, this is outweighed by the additional value that field observations provide indicating potential for acid sulfate soils
- Within the probability map revisions, the probabilities attributed to each unit are relative to one another within the layer and are not absolute probabilities across layers. Assignment of absolute probabilities would require a significant amount of ground truthing to have been undertaken within the region.

### 7.2.3 Improvements in spatial understanding and spatial methodology

This spatial assessment is an entry level investigation into the presence of acid sulfate soils within the Waikato Region. Based on the findings of this investigation, at a very high level of analysis, acid sulfate soils have been found to either be present or potentially present at a range of sites within the region. Due to this investigation being limited in terms of scale and input definition comparative to the sample size, it unlikely that this will be the final iteration of the GIS package. The understanding of acid sulfate soils within the Waikato is considered limited and will require investment into targeted ground truthing investigations in order to define and further understand the interactions between acid sulfate soils and the geology, geomorphology, and soil types within the Waikato. In addition, studies of the types and degrees of risk presented by acid sulfate soils would help to refine the assumptions made about the relationships between the data layers and the presence of acid sulfate soils.

It is recommended that soils within high probability environments (wetlands, low lying coastal areas or mangroves) are sampled at a high density to characterise the analytical characteristics of these areas within the Waikato and provide a basis for acid sulfate soils risk advice within these areas.

It is recommended that sampling equipment capable of extracting continuous cores (e.g., a window sampler instead of a manual hand auger) is used in future truthing investigations. This will allow soil logging to be undertaken with greater detail and provide improved confidence in the logs produced. The use of continuous core sampling would also limit the potential risk of sample mixing and cross-contamination. This is encouraged especially within waterlogged environments with low soil cohesion as this material is prone to collapse.It is recommended that there is a refinement in the methodology via the introduction of weightings (that describe the level of influence a data layer has over other data layers) or using an addition rule for scores to get more granularity of value categories and which therefore may provide a more nuanced interpretation of the input data. This improvement, however, relies heavily on the understanding of each individual input, something that significant ground truthing may be able to support.

The accessibility of a higher resolution DEM or higher resolution digitised geological data could mean that the scoring based on elevation or geological units could be more granular, resulting in a higher resolution probability map. This will improve most areas within the map, notably impacting the accuracy of acid sulfate soil probability within valleys and rivers and smaller scale features.

A larger population of CrS results will aid the future iterations of this spatial assessment as it will allow WRC to understand the interactions between acid sulfate soils and certain GIS inputs/data with more detail. This added data collection or truthing will aid the future accuracy and representation of acid sulfate soil probability throughout the region.

# 7.3 Recommendations

The following sections document our recommendations pertaining to potential future investigations and the management of acid sulfate soils within New Zealand.

## 7.3.1 Future investigations

### 7.3.1.1 Sampling and analysis

In light of the limitations noted within Section 7.2.2, it is recommended that more soil samples are collected to further the understanding of the relationship between the geology, geomorphology and hydrology of the Waikato Region and the occurrence of acid sulfate soils. Once a sufficient dataset is compiled it will allow for the statistical analysis of the inputs and thus allow the refinement of the probability map. In addition to this, a larger dataset may provide a basis for investigations into the temporal trends of occurrence of acid sulfate soils rather than solely the spatial distribution of acid sulfate soils.

It is recommended that an assessment into the risk presented by acid sulfate soils in a local context be undertaken. For example, acid sulfate soils can be strongly influenced by the texture and the form of the sulfides present in different soils. The real-world reaction kinetics could be assessed in trials or chip tray / incubation tests.

It is recommended that when undertaking further soil sampling WRC specifies the use of the CrS method to prevent over estimation of acid content and reduce the risk of over-investing in remedial works or management of acid sulfate soil risks.

### 7.3.1.2 Spatial methodology

The spatial assessment component of this investigation was an iterative process. It is recommended that further investigations automate the reclassification, rasterization, and raster calculation phases of processing to reduce processing time and minimise errors in manual inputs for calculations and changes in scoring. This automation is currently being investigated using FME (a tool used for data transformations), however, ESRI modelbuilder or Python scripting may also be potential options in the automation process.

There are many methodologies which could be used to resample and mosaic raster datasets, therefore, it would be advantageous for WRC to have a region-wide elevation model that can be supplied to contractors to ensure consistency in the data values that are being used in analysis. This will allow for more consistency across projects of a similar nature within the Waikato Region.

It is also recommended that higher resolution inputs are adopted within future investigations when they become available. This will allow more accurate illustration of potential of acid sulfate soil occurrence.

It is also recommended that a more refined methodology is introduced into future investigations via the introduction of weightings (that describe the level of influence a data layer has over other data layers) or using an addition rule for scores to get more granularity of value categories. These refinements may therefore provide a more nuanced interpretation of the input data. This improvement, however, relies on understanding each individual input, something that significant ground truthing may be able to support.

### 7.3.2 Management of acid sulfate soils

At the time of writing, New Zealand has yet to produce national or regional guidance for the management of acid sulfate soils. It is advisable to adopt management categories as a guide to determine the level of management that will be required to address risks associated with acid sulfate soils. These could be based on the amount of soil to be disturbed and its existing and potential acidity. Examples of this approach are documented within Australian national and state guidance such as Queensland Acid Sulfate Soils Technical Manual guidelines (Dear et al., 2014).

Over and above this approach, Australia has national guidance specifically on acid sulfate soil within inland and coastal settings which may be adopted depending on the area of disturbance:

– The National Strategy for the Management of Coastal Acid Sulfate Soils, produced by National Working Party on Acid Sulfate Soils, January 2000. The coastal documentation provides a holistic and comprehensive approach to identify acid sulfate soil presence, prevent it from increasing and encourage remedial actions to reduce existing acid water runoff.
– National Guidance for the Management of Acid Sulfate Soils in Inland Aquatic Ecosystems produced by Environment Protection and Heritage Council and the Natural Resource Management Ministerial Council, 2011. The inland documentation details the identification and management of inland acid sulfate soils, to reduce or eliminate the risks they pose to the Australian environment and its economy.

Careful consideration should be given to the development of New Zealand guidelines specific to the environment as some environments such as swamps and peat bogs may support a naturally low pH biosphere, fauna, and flora. The guidance should also allow for identification of risk and appropriate management of acid sulfate soils.

Based on the results from the limited sampling undertaken, the majority of high-risk sites assessed may require further investigations and management to limit drainage and oxidation of acid sulfate soils and the transportation of reaction products if activities such as the following are undertaken:

- Building roads and railways.
- Drainage and flood mitigation, shallow drainage and excavation or clearing of surface drains / swales.
- Agricultural use, which may alter drainage patterns and significantly disturb soils.
- Installing and laying utilities, excavations such as for pipelines, dams, and structure foundations.
- Dredging or land reclamation.
- Dewatering, including permanent or temporary drainage or pumping of groundwater, resulting in aeration of previously saturated soils or sediments.
- Filling resulting in changes to the groundwater conditions, displacement, and heave.
- Alteration of surface and groundwater drainage and flow patterns.
- Stockpiling, management, and reuse of actual or potential acid sulfate soils.
- Dewatering, including permanent or temporary drainage or pumping of groundwater, resulting in aeration of previously saturated soils or sediments.

# 8. References


Andriesse, W., & Van Mensvoort, M. E. F. (2006). Acid sulfate soils: distribution and extent. Encyclopedia of Soil Science, 1, 14-19.

Brinkman, R., & Pons, L. J. (1973). Recognition and prediction of acid sulfate soil conditions. Agricultural University.

Cook, F. J., Hicks, W., Gardner, E. A., Carlin, G. D., & Froggatt, D. W. (2000). Export of Acidity in Drainage Water from Acid Sulfate Soils. Marine Pollution Bulletin, 41(7–12).

Corfield, J. (2000). The effects of acid sulfate run-off on a subtidal estuarine macrobenthic community in the Richmond River, NSW, Australia. ICES Journal of Marine Science: Journal du Conseil, 57(5), 1517-1523.

Dear, S-E, Ahern, C. R., O'Brien, L. E., McElnea, A. E., Dobos, S. K., Moore, N. G., & Watling, K. M. (2014). Queensland Acid Sulfate Soil Technical Manual: Soil Management Guideline. Brisbane: Department of Science, Information Technology, Innovation, and the Arts, Queensland Government.

Dent, D. (1980). Acid sulfate soils: Morphology and prediction. Journal of Soil Science, 87-99.

Dent, D. (1986). Acid sulfate soils: A baseline for research and development, International Institute for Land Reclamation, and Improvement ILRI, Wageningen, The Netherlands.

Environment Protection and Heritage Council and the Natural Resource Management Ministerial Council. (2011). National Guidance for the Management of Acid Sulfate Soils in Inland Aquatic Ecosystems.

Fitzpatrick, R. W., Merry, R. H., Williams, J., White, I., Bowman, G., & Taylor, G. (1998). Acid Sulfate Soil Assessment: Coastal, Inland and Minespoil Conditions. National Land and Water Resources Audit Methods Paper, 18 pages.

Government of Western Australia; Department of Environment Regulation. (2015). Identification and investigation of acid sulfate soils and acidic landscapes. Perth: Department of Environment Regulation.

Hewitt, A. E (2010). New Zealand Soil Classification. Landcare Research Science Series No. 1.

Hewitt, A. E., Balks, M. R., & Lowe, D. J. (2021). The Soils of Aotearoa New Zealand. Springer International Publishing.

Hinwood, A. L., Horwitz, P., Appleyard, S., Barton, C., & Wajrak, M. (2006). Acid sulfate soil disturbance and metals in groundwater: Implications for human exposure through homegrown produce. Environmental Pollution, 143(1), 100-105.

Hochstein, M. P., & Ballance, P. F. (1993). Hauraki Rift: A young active intra-continental rift in a back-arc setting. In P. F. Ballance (Ed.), South Pacific Sedimentary Basins (pp. 295-308). Elsevier.

Houghton, B. F., & Cuthbertson, A. S. (1989). Sheet T14D-Kaimai. Geological Map of New Zealand 1:50 000. New Zealand Geological Survey, DSIR, Wellington.

Lamontagne, S., Hicks, W. S., Fitzpatrick, R. W., & Rogers, S. (2006). Sulfidic materials in dryland river wetlands. Marine and Freshwater Research, 57(8), 775-788.

Lamontagne S, Hicks WS, Fitzpatrick RW, Rogers S (2004). Survey and description of sulfidic materials in wetlands of the Lower River Murray floodplains: Implications for floodplain salinity management Technical Report 28/04. CSIRO Land and Water. Adelaide, Australia.

Macdonald, B. C. T., Quirk, R. G., Melville, M. D., Waite, T. D., White, I., Desmier, R., & Beattie, R. N. (2002). Sugar cane and acid sulfate soils: techniques for reduction of acid discharge. In Proceedings of the 2002 Conference of the Australian Society of Sugar Cane Technologists held at Cairns, Queensland, Australia, 29 April-2 May 2002 (pp. 311-315). PK Editorial Services Pty Ltd.

Macdonald, B. C. T., White, I., Åström, M. E., Keene, A. F., Melville, M. D., & Reynolds, J. K. (2007). Discharge of weathering products from acid sulfate soils after a rainfall event, Tweed River, eastern Australia. Applied Geochemistry, 22(12), 2695-2705.

Manville, V., & Wilson, C. J. N. (2004). The 26.5 ka Oruanui eruption, New Zealand: A review of the roles of volcanism and climate in the post-eruptive sedimentary response. New Zealand Journal of Geology and Geophysics, 47(3), 525-547.

Medawela, S., Indraratna, B., Pathirage, U., & Heitor, A. (2019). Controlling Soil and Water Acidity in Acid Sulfate Soil Terrains Using Permeable Reactive Barriers. In R. Sundaram, J. Shahu, & V. Havanagi (Eds.), Geotechnics for Transportation Infrastructure (Lecture Notes in Civil Engineering, vol. 28). Springer.

Metson, A. J., Janica, G. E., Cox, J. E., & Gibbs, D. B. (1977). The problem of acid sulfate soils with examples from north Auckland, New Zealand. New Zealand Journal of Science, 20, 371-394.

National Working Party on Acid Sulfate Soils. (2018). The National Strategy for the Management of Coastal Acid Sulfate Soils.

Naylor, S. D., Chapman, G. A., Atkinson, G., Murphy, C. L., Tulau, M. J., Flewin, T. C., ... & Morand, D. T. (1998). Guidelines for the use of acid sulfate soil risk maps, 2nd edn. NSW Department of Land and Water Conservation, Sydney.

Nyman, A., Johnson, A., Yu, C., Dopson, M., & Åström, M. (2023). Multi-element features of active acid sulfate soils across the Swedish coastal plains. Applied Geochemistry, 152.

Pons, L. J. (1973). Outline of the genesis, characteristics, classification, and improvement of acid sulfate soils. In Proceedings of the 1972 (Wageningen, Netherlands) International Acid Sulfate Soils Symposium (Vol. 1, pp. 3-27).

Roy P S (1984) New South Wales estuaries: their origin and evolution. ‘Coastal geomorphology in Australia’. (Ed. BG Thom) pp. 99–121. (Academic Press: Sydney)

Sammut, J., Melville, M. D., Callinan, R. B., & Fraser, G. C. (1995). Estuarine acidification: impacts on aquatic biota of draining acid sulfate soils. Australian Geographical Studies, 33(1), 89-100.

Sammut, J., White, I., & Melville, M. (1996). Acidification of an estuarine tributary in eastern Australia due to the drainage of acid sulfate soils. Marine Freshwater Research, 669-684.

Selby, M. J., & Lowe, D. J. (1992). The middle Waikato Basin and hills. In J. M. Soons & M. J. Selby (Eds.), Landforms of New Zealand: Second Edition. Auckland, New Zealand: Longman Paul.

Simpson, S. L., Fitzpatrick, R. W., Shand, P., Angel, B. M., Spadaro, D. A., & Mosley, L. (2010). Climate-driven mobilisation of acid and metals from acid sulfate soils. Marine and Freshwater Research, 61(1), 129-138.

Stone, Y, Ahern C R, and Blenden B (1998). Acid Sulfate Soils Manual 1998. Acid Sulfate Soil Management Advisory Committee, Wonllongbar, NSW, Australia.

Sullivan, L., Ward, N., Toppler, N., & Lancaster, G. (2018). National Acid Sulfate Soils guidance: National acid sulfate soils sampling and identification methods manual. Department of Agriculture and Water Resources, Canberra, ACT. CC BY 4.0.

Sullivan, L., Ward, N., Toppler, N., & Lancaster, G. (2018). National Acid Sulfate Soils Guidance: National acid sulfate soils identification and laboratory methods manual. Department of Agriculture and Water Resources, Canberra, ACT. CC BY 4.0.

Vile, M. A., & Novák, M. (2006). Sulfur cycling in boreal peatlands: From acid rain to global climate change. Boreal Peatland Ecosystems, 259-287.

Waters and Rivers Commission. (2002). Investigation of soil and groundwater acidity, Stirling. Department of Environmental Protection, Perth, Western Australia.

White, I., Melville, M., Wilson, B., Price, C., & Willett, I. (1993). The impact of acidified water on freshwater and estuarine fish populations in acid sulfate soil environments. Proceedings of the National Conference on Acid Sulfate Soils, (pp. 26-40). Coolangatta.

White, I., Wilson, B., Melville, M., Sammut, J., & Lin, C. (1996). Hydrology and drainage of acid sulfate soils. Proceedings of the 2nd National Conference of Acid Sulfate Soils, (pp. 103-107).

Wilson, C. J. N., Houghton, B. F., McWilliams, M. O., Lanphere, M. A., Weaver, S. D., & Briggs, R. M. (1995). Volcanic and structural evolution of Taupo Volcanic Zone, New Zealand: A review. Journal of Volcanology and Geothermal Research, 68(1–3), 1-28.

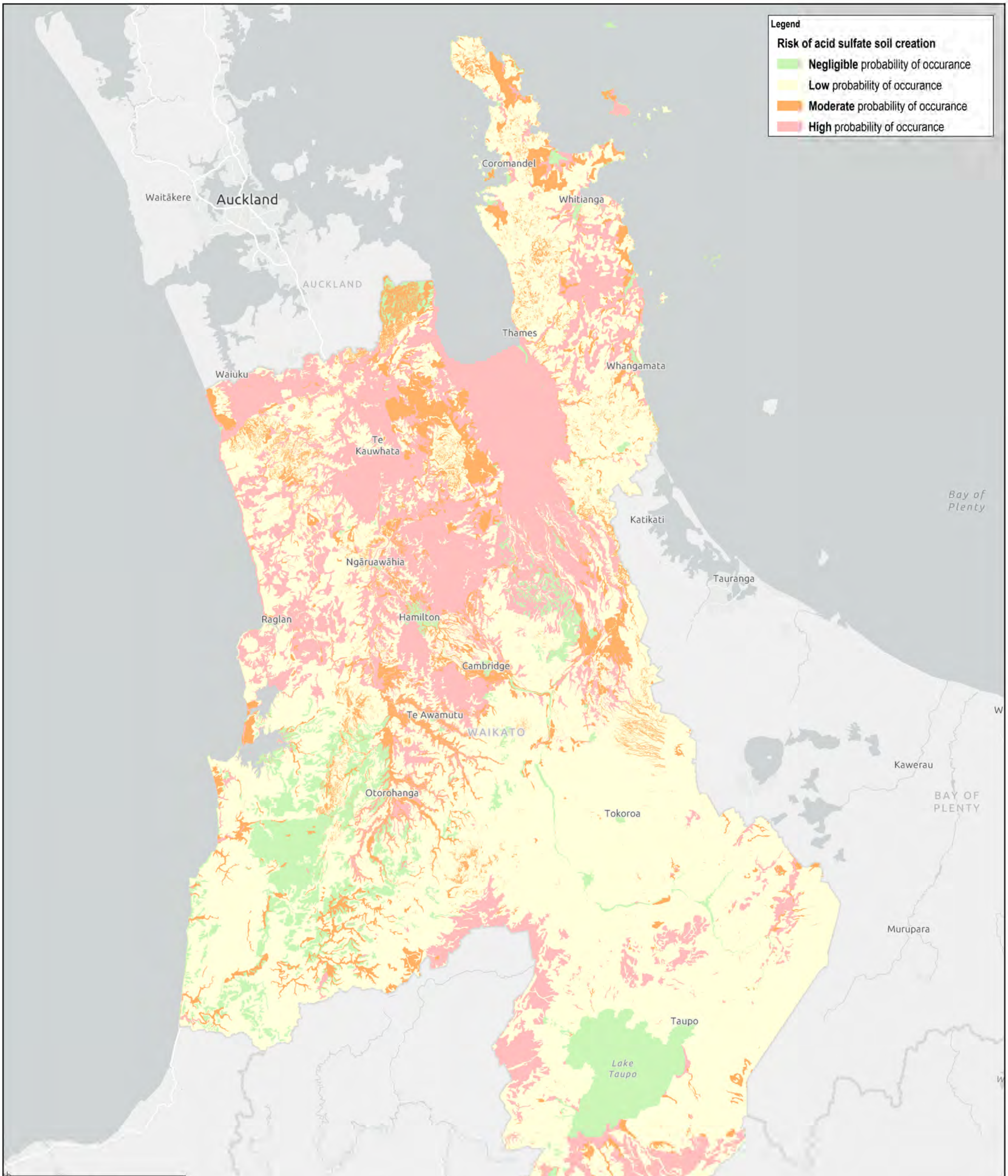
Wilson, B. P. (2005). Elevations of sulfurous layers in acid sulfate soils: What do they indicate about sea levels during the Holocene in eastern Australia?. Catena, 62(1), 45-56.

Yang, X. (1997). Applications of remote sensing and GIS to acid drainage management in an estuary floodplain agricultural environment. (Doctoral Dissertation, University of New South Wales).

# Appendices

# Appendix A

## Draft probability map




Data Disclaimer

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Paper Size ISO A3

0 10 20 30 40

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

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GHD

Waikato Regional Council
Waikato Region Acid Sulfate Soil Mapping

**Draft probability map of the potential for acid sulfate soils in the Waikato Region**

Project No. 12571919
Revision No. 0
Date 17/05/2024

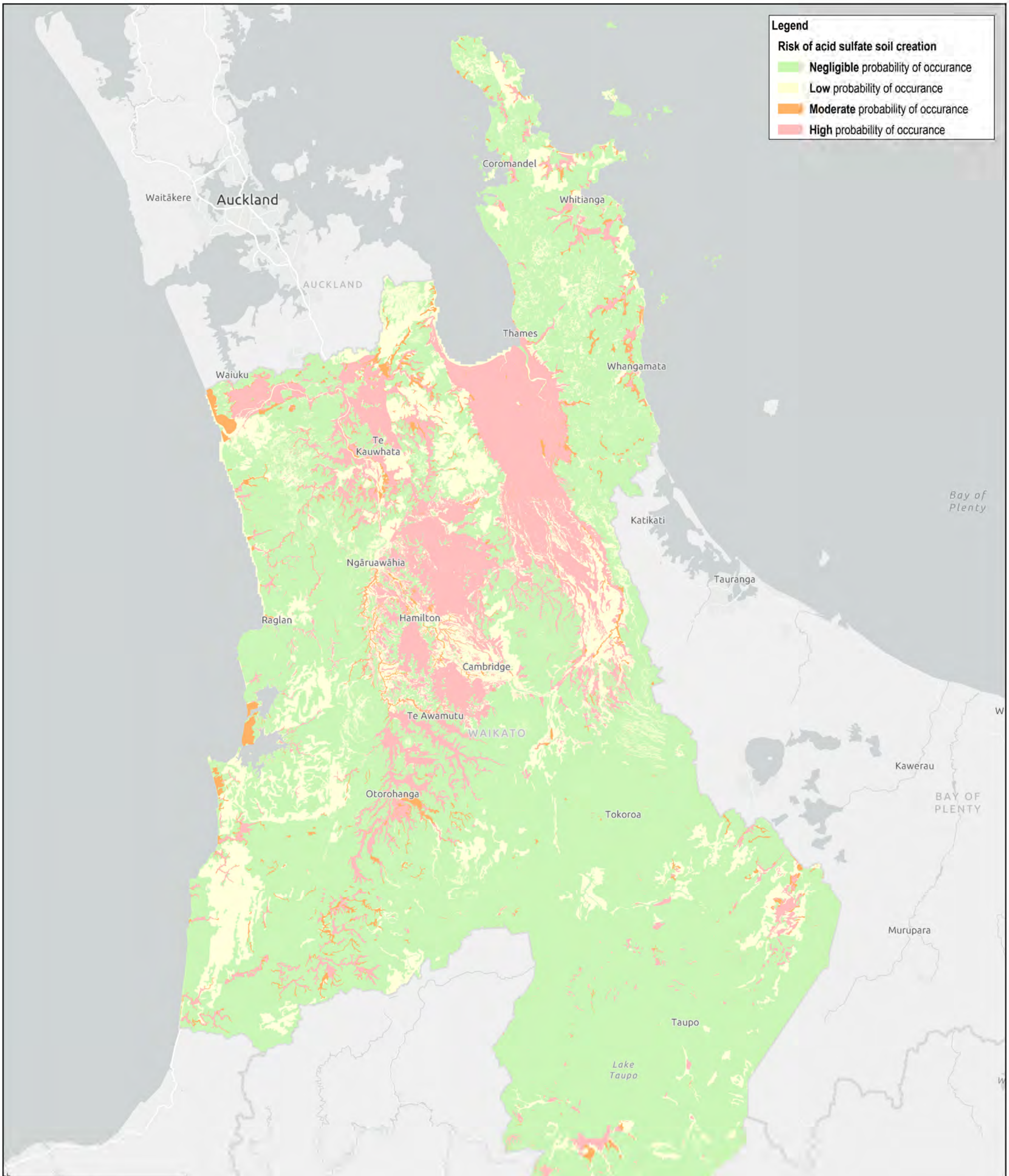
# APPENDIX A

N:\NZ\NZ GIS\Auckland\Projects\Projects\12571919_WaikatoASS_Survey\GIS\Maps\Working\12571919_Atlas\12571919_MCA_Atlas.aprx - 12571919_WaikatoASS_PreSampling_RiskMap_Rev0
Print date: 15 May 2024 - 11:45

Data source: LRIS (2023): Smap soil order, soil texture, Vegetative cover, FSL pH, FSL NZSC; WRC (2023): Soil map Hamilton, Lower Waikato DEM; LINZ (2023): 8m DEM; MfE (2023): Prediction of wetlands before humans arrived, Current wetland extent 2013. Light Gray Base: Stats NZ, Esri, TomTom, Garmin, Foursquare, FAO, METI/NASA, USGS

# Appendix B

## Final probability map




Data Disclaimer

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Paper Size ISO A3

0 10 20 30 40

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

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GHD

**Waikato Regional Council**
**Waikato Region Acid Sulfate Soil Mapping**

**Final probability map of the potential for acid sulfate soils in the Waikato Region**

Project No. **12571919**
Revision No. **0**
Date **17/05/2024**

**APPENDIX B**

N:\NZ\NZ GIS\Auckland\Projects\Projects\12571919_WaikatoASS_Survey\GIS\Maps\Working\12571919_Atlas\12571919_MCA_Atlas.aprx - 12571919_WaikatoASS_PostSampling_RiskMap_Rev0
Print date: 08 Jul 2024 - 23:23

Data source: LRIS (2023): Smap soil order, soil texture, Vegetation cover, FSL pH, FSL NZSC; WRC (2023): Soil map Hamilton, Lower Waikato DEM; LINZ (2023): 8m DEM; MfE (2023): Prediction of wetlands before humans arrived, Current wetland extent, 2013; Light Gray Base: Stats NZ, Esri, TomTom, Garmin, Foursquare, FAO, METI/NASA, USGS

# Appendix C

## Soil log data

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 80 |  | 0.15 | sandy topsoil loam with some medium gravel, trace clay, brown, granular and massive structure, very soft, dry, few roots | |
| Date | 9/03/2023 | | 0.55 | clay (likely marine), brown, moist, high plasticity, granular, soft, moist | * |
| Water Table (m bgl) | 0.85 | | 0.75 | sandy clay with trace gravels, brown, moist, high plasticity, massive structure | |
| Termination Depth (m) | 1.65 | | 0.95 | sandy clay, brown to brownish grey, moist, high plasticity, massive structure, firm | |
| | | | 1.25 | clay (organic?), grey, wet, high plasticity, soft, massive | * |
| | | | 1.4 | organic clay, brown to black, massive, soft, wet, few roots | |
| | | | 1.65 | clay with abundant organics, black to grey, massive, very soft, saturated, few roots | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 79 |  | 0.15 | sandy, silty topsoil, light brown, very soft, granular, moist | |
| | | | 0.3 | sandy topsoil, granular, soft, light brown to brown, moist, few roots | |
| Date | 9/03/2023 | | 0.45 | sandy topsoil, brown to grey, soft, moist, few roots | |
| Water Table (m bgl) | 1.89 | | 0.65 | clay, mottled gley, blocky massive, firm, moist, mottled, grey to red to brown | * |
| Termination Depth (m) | 2.0 | | 0.85 | clay, mottled gley, blocky massive, firm, moist, mottled, grey to red to brown | |
| | | | 1 | clay, mottled gley soil, brownish grey, blocky, moist, trace sand | * |
| | | | 1.25 | clay, mottled gley soil, brownish grey, blocky, moist, trace sand | |
| | | | 1.55 | clay, mottled gley soil, grey to brown with grey to redish mottles, blocky, moist, trace sand | |
| | | | 1.8 | clay, mottled gley soil, grey to brown with grey to redish mottles, blocky, moist, trace sand | |
| | | | 2 | clay, mottled gley soil, brown to dark brown, blocky, moist, trace sand | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 76 |  | 0.2 | sandy clay topsoil, light brown, soft, granular, dry, few roots | |
| Date | 9/03/2023 | | 0.5 | clay, dark brown to brown, granular, moist, firm | * |
| Water Table (m bgl) | NF | | 0.65 | Clay, light brown to grey, firm, blocky | |
| Termination Depth (m) | 1.0 | | 0.8 | sandy clay, light brown to grey massive, firm, moist | |
| | | | 1 | clay with trace gravels, brown, firm, massive, moist | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 78 |  | 0.15 | sandy silt, abundant roots, light brown, very soft, dry, low plasticity | |
| Date | 10/03/2023 | | 0.45 | silt sandy clay, brown, soft, moist, high plasticity | |
| Water Table (m bgl) | NF | | 0.6 | sandy clay, brown, soft, moist, high plasticity | * |
| Termination Depth (m) | 2.0 | | 0.75 | sandy clay,light brown to light grey, soft, moist, high plasticity | |
| | | | 1 | sandy clay, light grey, soft, moist, high plasticity | * |
| | | | 1.25 | sandy clay, brown to light grey, soft, moist, high plasticity | |
| | | | 1.65 | sandy clay, brown to light grey, soft, moist, high plasticity | |
| | | | 1.85 | sandy clay, brown to light grey, soft, moist, high plasticity | |
| | | | 2 | sandy clay, brown to light grey, soft, moist, high plasticity | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 10 |  | 0.2 | sandy silt, light brown to brown, soft, low plasticity, dry, trace roots | |
| Date | 10/03/2023 | | 0.6 | sandy clay, light brown to dark brown, streaky blackish mottles, dry, few roots, organic | * |
| Water Table (m bgl) | 0.95 | | 0.85 | organic sandy clay, dark brown, moist, low plasticity, very soft | |
| Termination Depth (m) | 2 | | 1.2 | organic sandy clay, dark brown to light brown, moist, high plasticity, soft | * |
| | | | 1.7 | organic sandy clay, dark brown, soft, wet, high plasticity, few roots | |
| | | | 2 | organic clay, dark grey, very soft, wet, high plasticity. | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 4 |  | 0.2 | sandy clay, light brown, soft, low plasticity, dry, few roots, some coarse gravels | |
| Date | 10/03/2023 | | 0.5 | sandy clay, light brown, firm, dry, high plasticity, trace roots | * |
| Water Table (m bgl) | NF | | 0.65 | sandy clay, brown, firm, moist, high plasticity, trace roots | |
| Termination Depth (m) | 1 | | 0.75 | sandy clay, brown, firm, moist, high plasticity, trace roots | |
| | | | 0.85 | sandy clay, light brown, firm, moist, high plasticity, trace roots | |
| | | | 1 | sandy clay, light brown, firm, moist, high plasticity, trace roots | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 26 |  | 0.2 | sandy clay, trace fine gravels and roots, tanish brown, soft, low plasticity, dry | |
| Date | 10/03/2023 | | 0.4 | sandy clay, brown to light brown with trace black mottles, firm, low plasticity, dry | |
| Water Table (m bgl) | NF | | 0.55 | sandy clay, brown to off black, firm, high plasticity, moist | * |
| Termination Depth (m) | 1.05 | | 0.75 | sandy clay, brown to dark brown with some black mottles, high plasticity, moist | |
| | | | 1 | clay with trace sand, light brown to brown, high plasticity, moist, firm | |
| | | | 1.05 | sandy clay, light to dark brown, soft, high plasticity, moist | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 39 |  | 0.2 | clay with trace sand, light brown to grey with some brown mottles, high plasticity, moist, some roots | |
| Date | 10/03/2023 | | 0.6 | sandy clay, light brown to light grey, some yellow brown and red mottles, firm, high plasticity, moist | * |
| Water Table (m bgl) | NF | | 0.75 | clay, light brown with black mottling, firm, moist | * |
| Termination Depth (m) | 0.75 | | | | |

| Site information | | Photoboard |
|---|---|---|
| Location | 51 |  |
| Date | 15/03/2023 | |
| Water Table (m bgl) | NF | |
| Termination Depth (m) | 1.55 | |

| Depth | Description (NZGS) | Sampled @ |
|---|---|---|
| 0.2 | silty clayey sand, tan to light brown, soft, low plasticity, moist | |
| 0.6 | silty clayey sand with trace fine gravels, light brown with trace black mottles, soft, low plasticity, moist | * |
| 0.85 | silty sand with a few fine gravels, light brown to grey, low plasticity, moist, soft | |
| 1.05 | silty sand, grey to light brown, soft, well graded, moist | * |
| 1.15 | silty sand, grey, soft, uniformly graded, wet | |
| 1.3 | silft fine to coarse sand, grey, soft, well graded, wet | |
| 1.5 | silft fine to coarse sand, grey to grey brown, soft, well graded, wet | |
| 1.55 | silft fine to coarse sand, grey to grey brown, soft, well graded, wet | * |

| Site information | | Photoboard |
|---|---|---|
| Location | 52 |  |
| Date | 15/03/2023 | |
| Water Table (m bgl) | NF | |
| Termination Depth (m) | 2 | |

| Depth | Description (NZGS) | Sampled @ |
|---|---|---|
| 0.2 | sandy clay, dark grey to greyish black, soft, low plasticity, moist, some roots | |
| 0.55 | clayey fine to medium, sand, grey to black, soft, low plasticity, dry, uniformly graded | * |
| 0.7 | clayey fine to medium, sand, grey to black, soft, low plasticity, dry, uniformly graded | |
| 0.85 | clayey fine to medium, sand, black to light brown, soft, low plasticity, dry, uniformly graded | |
| 1.05 | clayey fine to medium, sand, black to light brown, soft, low plasticity, dry, uniformly graded | * |
| 1.25 | clay-rich sand, light brown to dark grey, soft, low plasticity, well graded, wet. | |
| 1.55 | clayey sand, dark grey to light brown, soft, low plasticity, well graded, wet | |
| 1.7 | sandy clay, off white to black with some brown mottles, high plasticity, well graded, wet | |
| 2 | sandy clay, off white to black with some brown mottles, high plasticity, well graded, wet | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 53 |  | 0.2 | clayey fine sand, light brown with some tan mottles, soft, low plasticity, dry, uniformly graded | |
| Date | 15/03/2023 | | 0.6 | sandy clay, dark brown with some black mottles, firm, low plasticity, dry | * |
| Water Table (m bgl) | NF | | 0.95 | sandy organic clay, light brown to black, soft, low plasticity, moist | |
| Termination Depth (m) | 2 | | 1.3 | organic sandy clay, black to off white, soft, high plasticity, moist | * |
| | | | 1.7 | organic sandy clay, black, soft, high plasticity, moist | |
| | | | 2 | organic sandy clay, black, soft, high plasticity, moist, trace roots | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 11 |  | 0.15 | silty clay with trace sand, light brown with red-brown mottles, stiff, low plasticity, dry | |
| Date | 15/03/2023 | | 0.5 | sandy clay, light brown to cream coloured with red-brown mottles, stiff, low plasticity, moist | * |
| Water Table (m bgl) | NF | | 0.65 | sandy clay, light gey to brown with red-brown mottles, stiff, low plasticity, moist | |
| Termination Depth (m) | 0.75 | | 0.75 | clay with trace fine gravels, grey with some brown mottles, stiff, moist | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 37 |  | 0.2 | clay-rich sand, brown with black and red-brown mottles, soft, low plasticity, dry | |
| Date | 15/03/2023 | | 0.5 | sandy clay, brown, soft, low plasticity, dry | * |
| Water Table (m bgl) | NF | | 0.65 | sandy clay, brown, soft, low plasticity, dry | |
| Termination Depth (m) | 0.75 | | 0.75 | sandy clay, light brown with tan mottles, low plasticity, dry | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 9 |  | 0.15 | silty, gravelly sand, light grey, very soft, low plasticity, dry, trace roots, uniformly graded | |
| Date | 15/03/2023 | | 0.45 | clayey sand, brown to light grey, very soft, low plasticity, moist | |
| Water Table (m bgl) | NF | | 0.6 | sandy clay, light brown to light grey, soft, low plasticity, moist | * |
| Termination Depth (m) | 2 | | 0.75 | sandy clay, light brown to light grey with trace black mottles, soft, low plasticity, moist | |
| | | | 1 | sandy clay, dark brown, soft, low plasticity, moist | * |
| | | | 1.25 | silty fine sand, off white to grey, uniformly graged, low plasticity, moist | |
| | | | 1.5 | silty fine sand, grey to brown, uniformly graged, low plasticity, moist | |
| | | | 1.75 | clayey fine sand, grey to brown with some tan mottles, well graded, high plasticity, moist | |
| | | | 2 | sandy clay, grey to light brown with some redish brown mottles, soft, high plasticity, moist | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 7 |  | 0.2 | sandy silty organic topsoil, dark brown, very soft, low plasticity, dry | |
| Date | 22/03/2023 | | 0.75 | sandy clay, off white to tan, very soft, high plasticity, moist | |
| Water Table (m bgl) | NF | | 1 | sandy clay, off white to light brown, soft, low plsticity, moist | * |
| Termination Depth (m) | 2 | | 1.1 | sandy clay, off white to light brown, soft, low plsticity, moist | |
| | | | 1.3 | clayey sand, off white to light brown, very soft, low plasticity, moist | |
| | | | 1.5 | clayey sand, off white to light brown with some black and tan mottles, very soft, low plasticity, moist | |
| | | | 1.8 | clayey sand, off white to light brown with some black and tan mottles, very soft, low plasticity, wet | |
| | | | 2 | clayey sand, off white to light brown with some black and tan mottles, very soft, low plasticity, wet | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 65 |  | 0.3 | clay, light brown, very soft, high plasticity, moist, trace roots | |
| Date | 22/03/2023 | | 0.85 | sandy clay, grey to dark grey, moist, trace roots | |
| Water Table (m bgl) | 1.2 | | 1.3 | sandy clay, grey to dark grey, wet, trace roots | * |
| Termination Depth (m) | 2 | | 1.7 | sandy clay, dark brown, very soft, high plasticity, saturated, sulfurous odour | |
| | | | 2 | sandy clay, dark brown, very soft, high plasticity, saturated, sulfurous odour | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 1 |  | 0.25 | sandy clay, brown with rust coloured mottles, soft, low plasticity, dry | |
| Date | 22/03/2023 | | 0.55 | sandy clay, brown with tan and light brown layers, firm, high plasticity, moist, very stiff | * |
| Water Table (m bgl) | NF | | 0.75 | sandy clay, brown with tan and light brown layers, firm, high plasticity, moist, very stiff | |
| Termination Depth (m) | 1 | | 1 | sandy clay, brown with tan and light brown layers, firm, high plasticity, moist, very stiff | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 33 |  | 0.2 | silty sand, light brown, very soft, low plasticity, dry | |
| Date | 22/03/2023 | | 0.6 | silty clayey sand, brown to dark brown, soft, low plasticity, dry | * |
| Water Table (m bgl) | NF | | 0.75 | silty clayey sand, brown to dark brown, soft, low plasticity, dry | |
| Termination Depth (m) | 0.95 | | 0.9 | sandy clay, off white to dark brown, stiff, low plasticity, moist | |
| | | | 0.95 | sandy clay, off white to dark brown, stiff, low plasticity, moist | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 14 |  | 0.2 | clayey organic sand topsoil, dark grey, very soft, low plasticity, moist | |
| Date | 22/03/2023 | | 0.6 | clayey fine sand, lite brown, very soft, low plasticity, moist | * |
| Water Table (m bgl) | NF | | 0.8 | clayey fine sand, lite brown, very soft, low plasticity, moist | |
| Termination Depth (m) | 2 | | 1 | clayey fine sand, lite brown, very soft, low plasticity, moist | * |
| | | | 1.2 | silty fine sand, off white, very soft, low plasticity, moist | |
| | | | 1.5 | silty fine sand, off white to light brown with some brown mottles, very soft, low plasticity, moist | |
| | | | 1.75 | silty fine sand, off white to light brown, very soft, low plasticity, moist | |
| | | | 2 | sand, light grey, very soft, low plasticity, moist | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 3 |  | 0.2 | sandy silt organic topsoil, dark grey to black, soft, high plasticity, dry | |
| Date | 22/03/2023 | | 0.6 | sandy silt, black to tan, soft, low plasticity, moist | * |
| Water Table (m bgl) | 1.4 | | 0.85 | sandy silt, light greyish brown with black mottles, soft, low plasticity, moist | |
| Termination Depth (m) | 2 | | 1 | sandy silt, light greyish brown with black mottles, soft, low plasticity, moist | * |
| | | | 1.2 | sandy silt, light greyish brown with black mottles, soft, low plasticity, wet | |
| | | | 1.4 | sandy silt, light greyish brown with black mottles, soft, low plasticity, wet | |
| | | | 1.6 | sandy silt, light greyish brown with black mottles, soft, low plasticity, wet | |
| | | | 1.8 | sandy silt, light greyish brown with black mottles, soft, low plasticity, wet | |
| | | | 2 | sandy silt, light greyish brown with black mottles, soft, low plasticity, saturated | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 99 |  | 0.2 | sandy clay, dark brown to light black, soft, high plasticity, dry, trace roots | * |
| Date | 22/03/2023 | | 0.55 | sandy clay, brown with black mottles, stiff, high plasticity, moist | * |
| Water Table (m bgl) | NF | | 0.75 | sandy clay, light yellowish brown, low plasticity, moist, firm | |
| Termination Depth (m) | 0.82 | | 0.82 | sandy clay, light yellowish brown, low plasticity, moist, soft | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 2 |  | 0.2 | silty fine to medium sand, black to dark grey, very soft, low plasticity, dry, uniformly graded | * |
| Date | 22/03/2023 | | 0.6 | clayey silt with some medium gravel, dark grey to brown, firm, low plasticity, moist | * |
| Water Table (m bgl) | NF | | 0.8 | sandy clay, light brown to light black, low plasticity, moist | |
| Termination Depth (m) | 1.1 | | 1 | sandy clay, light brown to light black, high plasticity, moist | |
| | | | 1.1 | coarse sand to coarse gravel with trace clay, brown to tan, not cohesive, moist, well graded | * |

**Site information**

| | |
|---|---|
| Location | 87 |
| Date | 22/03/2023 |
| Water Table (m bgl) | NF |
| Termination Depth (m) | 1.25 |

**Photoboard**

| Depth | Description (NZGS) | Sampled @ |
|---|---|---|
| 0.2 | sandy silt, brown to dark brown, soft, low plasticity, moist | |
| 0.6 | sandy clay, light brown, soft, high plasticity, moist | * |
| 0.8 | sandy clay, tan to off white, firm, high plasticity, moist | |
| 1 | sandy clay, tan to off white with some brown mottles, firm, high plasticity, moist | * |
| 1.15 | clayey fine sand, off white to light brown, firm, high plasticity, wet | |
| 1.25 | clayey fine sand, off white to light brown, firm, high plasticity, wet | * |

**Site information**

| | |
|---|---|
| Location | 57 |
| Date | 29/03/2023 |
| Water Table (m bgl) | NF |
| Termination Depth (m) | 2 |

**Photoboard**

| Depth | Description (NZGS) | Sampled @ |
|---|---|---|
| 0.25 | clay, light brown to tan, high plasticity, soft, moist | |
| 0.65 | sandy clay, brown to tan, soft, high plasticity, moist | |
| 0.75 | sandy clay, brown to tan, soft, high plasticity, moist, trace fine gravels and trace roots | |
| 1 | sandy clay, brown to grey, soft, high plasticity, moist, trace roots | * |
| 1.3 | sandy clay, brown to grey, soft, high plasticity, moist, trace roots | |
| 1.7 | sandy clay, brown to grey, soft, high plasticity, wet, trace roots | |
| 2 | sandy clay, grey, soft, high plasticity, saturated, trace roots | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 75 |  | 0.2 | sandy clay, brown with grey layering, firm, high plasticity, moist | |
| Date | 29/03/2023 | | 0.6 | clay with trace sand, brown to grey, firm, high plasticity, moist | * |
| Water Table (m bgl) | NF | | 0.7 | clay with trace sand, grey to brown, stiff, high plasticity, moist | |
| Termination Depth (m) | 1.2 | | 0.9 | clay with trace sand, grey to brown with dark brown mottling, stiff, high plasticity, moist | |
| | | | 1.1 | clay with trace sand, grey to brown with dark brown mottling, firm, high plasticity, moist | * |
| | | | 1.2 | clay with trace sand, grey to brown with trace black mottling, firm, high plasticity, moist | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 60 |  | 0.2 | sandy clay, brown, firm, low plasticity, dry | |
| Date | 29/03/2023 | | 0.6 | sandy clay with trace fine gravels and organic materials (shells), brown, stiff, low plasticity, dry | * |
| Water Table (m bgl) | NF | | 0.75 | sandy clay with trace fine gravels and organic materials (shells), brown with tan mottles, stiff, low plasticity, dry | |
| Termination Depth (m) | 2 | | 1 | sandy clay, brown to light grey, firm, high plasticity, moist, contains shells | * |
| | | | 1.15 | sandy clay, brown to light grey, firm, high plasticity, moist | |
| | | | 1.35 | sandy clay, brown to light grey with trace black mottling, firm, high plasticity, moist | |
| | | | 1.55 | peaty clay, black to light grey, firm, moist | |
| | | | 1.8 | peaty clay, black to light grey, firm, moist | |
| | | | 2 | peaty clay, black to light grey, firm, moist, trace roots | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 63 |  | 0.2 | silty clay, brown, soft, wet, trace roots | |
| Date | 29/03/2023 | | 1 | sandy organic clay, blue-grey with brown mottles, soft, saturated, trace roots | * |
| Water Table (m bgl) | 0.5m | | 1.4 | sandy organic clay, blue-grey with brown mottles, soft, saturated, trace roots | |
| Termination Depth (m) | 2 | | 2 | sandy organic clay, blue-grey with brown mottles, soft, saturated, trace roots | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 88 |  | 0.2 | sandy clay, light brown to brown with redish brown mottles, firm, low plasticity, moist, trace roots | |
| Date | 29/03/2023 | | 0.6 | sandy silty clay, brown with dark brown streaks, firm, low plasticity, moist, trace roots | * |
| Water Table (m bgl) | NF | | 0.86 | sandy silty clay, brown with dark brown streaks, firm, low plasticity, moist, trace roots | * |
| Termination Depth (m) | 0.85 | | | | |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 74 |  | 0.2 | sandy clay, brown with tan mottles, soft, low plasticity, dry | |
| Date | 29/03/2023 | | 0.75 | sandy clay, light brown to brown, soft, high plasticity, moist | * |
| Water Table (m bgl) | NF | | | | |
| Termination Depth (m) | 0.75 | | | | |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 46 |  | 0.2 | sandy clay, dark brown with some black mottles, very soft, moist, low plasticity, trace roots | |
| Date | 29/03/2023 | | 0.6 | silty clay, brown to grey with rust coloured mottles, soft, moist, low plasticity | * |
| Water Table (m bgl) | 1 | | 0.9 | sandy clay, light brown, soft, high plasticity, moist | |
| Termination Depth (m) | 2 | | 1.1 | sandy clay, grey to brown, firm, high plasticity, wet | * |
| | | | 1.45 | sandy clay, grey to brown, firm, high plasticity, saturated | |
| | | | 2 | sandy clay, grey to black, soft, low plasticity, saturated | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 89 |  | 0.2 | sandy clay, brown to off white, soft, high plasticity, low plasticity | |
| Date | 29/03/2023 | | 0.5 | sandy clay, light grey to brown, stiff, high plasticity, dry | * |
| Water Table (m bgl) | NF | | 0.65 | sandy clay, light grey to brown with with trace black mottles, stiff, high plasticity, dry | |
| Termination Depth (m) | 1 | | 0.85 | sandy clay, light grey to brown with with trace black mottles, stiff, high plasticity, dry | |
| | | | 1 | sandy clay, light grey to brown with with trace black mottles, firm, high plasticity, dry | * |
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| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 38 |  | 0.2 | sandy silty clay, brown to light brown, soft, moist, high plasticity | |
| Date | 29/03/2023 | | 0.5 | sandy silty clay, brownish red to grey with black mottles, firm, moist, high plasticity | * |
| Water Table (m bgl) | NF | | 0.6 | sandy silty clay, brownish red to grey with black mottles, firm, moist, high plasticity | |
| Termination Depth (m) | 0.75 | | 0.75 | sandy silty clay, brownish red to grey with black mottles, firm, moist, high plasticity | * |
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| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 24 |  | 0.2 | sandy silty clay topsoil, brown, firm, low plasticity, moist | |
| Date | 31/03/2023 | | 0.5 | sandy clay topsoil, brown, stiff, low plasticity, moist | * |
| Water Table (m bgl) | NF | | 0.65 | sandy clay, grey to brown, soft, high plasticity, moist | |
| Termination Depth (m) | 1.55 | | 0.9 | sandy clay, grey to brown with some black mottles, stiff, high plasticity, moist | |
| | | | 1.1 | silty clay, light brown, soft, high plasticity, moist | * |
| | | | 1.25 | silty clay, light brown, soft, high plasticity, wet | |
| | | | 1.45 | silty clay, light brown to grey, soft, high plasticity, wet | |
| | | | 1.55 | silty clay, light brown to grey, soft, high plasticity, wet | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 48 |  | 0.2 | clayey medium sand, brown to light brown, very soft, dry, uniformly graded | |
| Date | 31/03/2023 | | 0.6 | clayey medium sand, brown to light brown, very soft, dry, uniformly graded | * |
| Water Table (m bgl) | NF | | 0.8 | sandy clay, brown, soft, moist, high plasticity | |
| Termination Depth (m) | 2 | | 1 | sandy clay, brown with redish brown mottles, soft, moist, high plasticity | * |
| | | | 1.25 | sandy clay, grey to brown, soft, high plasticity, moist | |
| | | | 1.55 | sandy clay, grey to brown with black and redish brown mottles, soft, high plasticity, moist | |
| | | | 1.75 | sandy clay, grey to brown with black and redish brown mottles, soft, high plasticity, moist | |
| | | | 2 | sandy clay, grey to brown with black and redish brown mottles, soft, high plasticity, moist | * |

| Site information | |
|---|---|
| Location | 73 |
| Date | 31/03/2023 |
| Water Table (m bgl) | NF |
| Termination Depth (m) | 0.9 |

Photoboard

| Depth | Description (NZGS) | Sampled @ |
|---|---|---|
| 0.2 | silty medium sand, redish brown, very soft, well graded, dry | |
| 0.55 | sandy clay, light brown, firm, high plasticity, moist | * |
| 0.75 | sandy clay, light brown, firm, high plasticity, moist | |
| 0.9 | sandy clay, light brown, firm, high plasticity, moist | * |

| Site information | |
|---|---|
| Location | 90 |
| Date | 31/03/2023 |
| Water Table (m bgl) | 0.5 |
| Termination Depth (m) | 2 |

Photoboard

| Depth | Description (NZGS) | Sampled @ |
|---|---|---|
| 0.2 | sandy clay, dark brown, very soft, high plasticity, moist | |
| 1 | sandy clay, black to grey, soft, high plasticity, wet, peaty texture | * |
| 1.4 | silty clay, grey to brown, very soft, high plasticity, saturated, abundant roots | |
| 1.7 | silty clay, grey to brown, very soft, high plasticity, saturated, abundant roots | |
| 2 | silty clay, grey to brown, very soft, high plasticity, saturated, abundant roots | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 25 |  | 0.2 | silty fine sand, dark brown, very soft, low plasticity, dry, uniformly graded | |
| Date | 31/03/2023 | | 0.5 | clayey fine sand, dark brown to light brown, soft, low plasticity, dry, uniformly graded | * |
| Water Table (m bgl) | 1.2 | | 0.7 | sandy clay, brown, soft, high plasticity, moist | |
| Termination Depth (m) | 2 | | 1 | sandy clay, brown, soft, high plasticity, moist | * |
| | | | 1.3 | sandy clay, brown to grey, very soft, high plasticity, wet | |
| | | | 1.45 | sandy clay, grey to tan with redish brown mottles, very soft, high plasticity, wet | |
| | | | 1.6 | clay with trace sand, blueish grey with brown mottles, stiff, wet | |
| | | | 1.8 | clay with trace sand, blueish grey with brown mottles, stiff, wet | |
| | | | 2 | sandy clay with trace sand, blueish grey with brown mottles, stiff, wet | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 18 |  | 0.2 | sandy clay, brown with light brown mottling, soft, low plasticity, moist | |
| Date | 31/03/2023 | | 0.5 | sandy clay, grey to yellowish brown, firm, high plasticity, moist | |
| Water Table (m bgl) | NF | | 0.75 | sandy clay, grey to yellowish brown, firm, high plasticity, moist | |
| Termination Depth (m) | 0.95 | | 0.85 | sandy clay, grey to yellowish brown, firm, high plasticity, moist | |
| | | | 0.95 | sandy clay, grey to light brown, firm, high plasticity, moist | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 62 |  | 0.2 | sandy clay, brown, stiff, low plasticity, dry | |
| Date | 31/03/2023 | | 0.55 | sandy clay, redish brown to brown, firm, high plasticity, moist | * |
| Water Table (m bgl) | NF | | 0.8 | sandy clay, redish brown to brown, firm, high plasticity, moist | |
| Termination Depth (m) | 1.15 | | 1 | sandy clay, light brown to grey, soft, high plasticity, moist | * |
| | | | 1.15 | sandy clay, light brown to grey, soft, high plasticity, moist | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 49 |  | 0.25 | clay with trace sand, brown to black, soft, high plasticity, moist, some roots | |
| Date | 5/04/2023 | | 0.75 | clay, black, soft, low plasticity, moist | |
| Water Table (m bgl) | 0.8 | | 1 | sandy clay, black to brown, very soft, high plasticity, saturated | * |
| Termination Depth (m) | 2 | | 1.3 | sandy clay, black to brown, very soft, high plasticity, saturated | |
| | | | 1.6 | sandy clay, black to brown, very soft, high plasticity, saturated | |
| | | | 2 | sandy clay, black to brown, very soft, high plasticity, saturated | * |

| Site information | |
|---|---|
| Location | 36 |
| Date | 5/04/2023 |
| Water Table (m bgl) | NF |
| Termination Depth (m) | 0.95 |

Photoboard

| Depth | Description (NZGS) | Sampled @ |
|---|---|---|
| 0.2 | sandy clay, light brown, soft, low plasticity, dry, some roots | |
| 0.7 | sandy clay, brown, soft, high plasticity, moist | * |
| 0.9 | sandy clay, brown to light brown, high plasticity, moist | |
| 0.95 | sandy clay, brown to light brown with some redish brown mottles, high plasticity, moist | * |

| Site information | |
|---|---|
| Location | 54 |
| Date | 5/04/2023 |
| Water Table (m bgl) | 1.3 |
| Termination Depth (m) | 2 |

Photoboard

| Depth | Description (NZGS) | Sampled @ |
|---|---|---|
| 0.25 | silty fine sand, brown, soft, low plasticity, uniformly graded, trace roots, dry | |
| 0.75 | sandy clay with trace medium gravels, brown with black mottles, soft, high plasticity, moist | |
| 1 | sandy clay, dark brown with black mottles, soft, high plasticity, moist, trace roots | * |
| 1.25 | organic sandy clay, black to brown, soft, high plasticity, wet, plastic and spongy peaty texture, trace roots | |
| 1.65 | organic sandy clay, black to brown, soft, high plasticity, wet, plastic and spongy peaty texture, trace roots | |
| 2 | organic sandy clay, black to brown, soft, high plasticity, wet, plastic and spongy peaty texture, trace roots | * |

| Site information | |
|---|---|
| Location | 55 |
| Date | 5/04/2023 |
| Water Table (m bgl) | 1.5 |
| Termination Depth (m) | 2 |

Photoboard

| Depth | Description (NZGS) | Sampled @ |
|---|---|---|
| 0.2 | sandy clay, light brown to grey with some tan mottles, low plasticity, soft, trace roots | |
| 0.6 | sandy clay, light brown to grey with some tan mottles, low plasticity, soft, trace roots | * |
| 0.9 | sandy clay, light brown to grey with some tan mottles, low plasticity, soft, trace roots | |
| 1.25 | sandy clay, brownish grey, soft, high plasticity, moist | * |
| 1.65 | sandy clay, brownish grey with brown mottles, soft, high plasticity, wet | |
| 2 | sandy clay, brownish grey with brown mottles, soft, high plasticity, saturated | * |

| Site information | |
|---|---|
| Location | 20 |
| Date | 5/04/2023 |
| Water Table (m bgl) | NF |
| Termination Depth (m) | 2 |

Photoboard

| Depth | Description (NZGS) | Sampled @ |
|---|---|---|
| 0.2 | sandy clay, brown, soft, low plasticity, moist, trace roots | |
| 0.6 | sandy clay, brown, soft, low plasticity, moist, trace roots | * |
| 0.8 | sandy clay, light brown to brown, soft, low plasticity, moist, trace roots | |
| 1 | sandy clay, light brown to brown, soft, low plasticity, moist, trace roots | * |
| 1.3 | sandy clay, light brown to brown, soft, low plasticity, moist, trace roots | |
| 1.5 | sandy clay, light brown to brown, soft, low plasticity, moist, trace roots | |
| 1.75 | sandy clay, light brown to brown, soft, low plasticity, moist, trace roots | |
| 2 | sandy clay, light brown to brown, soft, high plasticity, moist, trace roots | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 45 |  | 0.2 | sandy clay with trace fine gravels, dark brown with trace redish brown mottles, soft, low plasticity, moist | |
| Date | 5/04/2023 | | 0.55 | sandy clay with trace fine gravels, light brown with black mottles, firm, low plasticity, moist | * |
| Water Table (m bgl) | NF | | 0.75 | sandy clay with trace fine gravels, light brown with black mottles, firm, low plasticity, moist | |
| Termination Depth (m) | 0.95 | | 0.95 | sandy clay with trace fine gravels, light brown with black mottles, stiff, low plasticity, moist | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 56 |  | 0.2 | silty fine to medium sand, brown to grey, very soft, well graded, moist, abundant roots and shell material | |
| Date | 12/04/2023 | | 0.6 | sandy clay, blue-grey, soft, high plasticity, moist, shells present | * |
| Water Table (m bgl) | 1.1 | | 0.8 | sandy clay, blue-grey, soft, high plasticity, moist, shells present | |
| Termination Depth (m) | 2 | | 1 | sandy clay, blue-grey to blue-brown, soft, high plasticity, moist, shells present. Fine blue grey shells at bottom | * |
| | | | 1.3 | clayey fine to medium sand, blue-grey, very soft, uniformly graded, shells present | |
| | | | 1.55 | clayey fine to medium sand, blue-grey, very soft, uniformly graded, shells present | |
| | | | 1.8 | clayey fine to medium sand, blue-grey, very soft, uniformly graded, shells present | |
| | | | 2 | clayey fine to medium sand, blue-grey, very soft, uniformly graded, shells present | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 27 |  | 0.2 | sandy silt topsoil, dark brown, firm, dry, low plasticity, roots present | |
| Date | 12/04/2023 | | 0.65 | clay, brown with blackish brown streaks and mottles, stiff, high plasticity | |
| Water Table (m bgl) | NF | | 0.8 | clay, brown with blackish brown streaks and mottles, stiff, high plasticity | |
| Termination Depth (m) | 1 | | 1 | clay, brown to off white, stiff, high plasticity | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 44 |  | 0.2 | sandy clay topsoil then B horizon material, stiff, moist, tan to grey with brown mottles, high plasticity | |
| Date | 12/04/2023 | | 0.6 | sandy clay, tan to grey with brown mottles, stiff, high plasticity, moist | * |
| Water Table (m bgl) | NF | | 0.8 | sandy clay, tan to grey with brown mottles, stiff, high plasticity, moist | |
| Termination Depth (m) | 1.3 | | 1.05 | sandy clay, tan to grey with brown mottles, stiff, high plasticity, moist | |
| | | | 1.3 | sandy clay, tan to grey with brown mottles, stiff, high plasticity, moist | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 19 |  | 0.2 | sandy silty clay, firm, greyish brown with tanish brown mottles, low plasticity, moist | |
| Date | 12/04/2023 | | 0.55 | sandy clay, light brown to grey, soft, high plasticity, moist | * |
| Water Table (m bgl) | NF | | 0.8 | sandy clay, light brown to grey, soft, high plasticity, moist | |
| Termination Depth (m) | 1.2 | | 1 | sandy clay, light brown to grey, soft, high plasticity, moist | * |
| | | | 1.2 | sandy clay, light brown to grey, soft, high plasticity, moist | |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 81 |  | 0.25 | clay topsoil, dark brown with redish brown mottles, soft, low plasticity, moist, roots | |
| Date | 12/04/2023 | | 0.8 | sandy clay, greyish brown to dark grey, soft, low plasticity, moist | |
| Water Table (m bgl) | NF | | 1 | sandy clay, light brown to light grey, soft, high plasticity, moist | * |
| Termination Depth (m) | 1.35 | | 1.15 | sandy clay, light brown to light grey, soft, high plasticity, moist | |
| | | | 1.35 | sandy clay, light brown to light grey, soft, high plasticity, wet | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 22 |  | 0.2 | sandy clay, brown, soft, low plasticity, moist | |
| Date | 12/04/2023 | | 0.6 | clay, brown, firm, low plasticity, moist | * |
| Water Table (m bgl) | NF | | 0.8 | clay, brown, firm, low plasticity, moist | |
| Termination Depth (m) | 1.1 | | 1 | clay with trace sand, brown, very soft, wet, high plasticity | * |
| | | | 1.1 | clay with trace sand, brown, very soft, wet, high plasticity | |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 96 |  | 0.2 | sandy clay, light brown to brown with few grey streaks, firm, moist, low plasticity, trace roots | |
| Date | 12/04/2023 | | 0.55 | sandy clay, light brown to brown with redish brown mottles, firm, moist, low plasticity, trace roots | * |
| Water Table (m bgl) | NF | | 0.7 | sandy clay, light brown to brown with redish brown mottles, stiff, moist, low plasticity, trace roots | |
| Termination Depth (m) | 0.9 | | 0.9 | sandy clay, light brown to brown with redish brown mottles, stiff, moist, low plasticity, trace roots | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 95 |  | 0.35 | silty clay, brown, very soft, high plasticity, saturated, trace roots | |
| Date | 12/04/2023 | | 0.8 | organic clay with some peaty texture, dark brown, black and fibrous, soft, saturated, high plasticity | |
| Water Table (m bgl) | NF | | 1 | clay, brown to grey, stiff, high plasticity, saturated | |
| Termination Depth (m) | 1.15 | | 1.15 | clay, brown to grey, very stiff, high plasticity, saturated | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 85 |  | 0.2 | sandy silt topsoil, brown to light brown, soft, low plasticity, dry, abundant roots | |
| Date | 14/04/2023 | | 0.6 | medium sand with trace silt, light brown to off white, very soft, uniformly graded, dry | |
| Water Table (m bgl) | NF | | 0.8 | fine to coarse sand with some fine to medium gravels, light brown to off white, very soft, well graded, dry | |
| Termination Depth (m) | 2 | | 1 | fine to coarse sand with trace fine to medium gravels, light brown to off white with trace redish brown mottling, very soft, well graded, dry | * |
| | | | 1.2 | fine to coarse sand with trace fine to medium gravels, light brown to off white with trace redish brown mottling, very soft, well graded, dry | |
| | | | 1.4 | fine to coarse sand with trace fine to medium gravels, light brown to tan with trace redish brown mottling, very soft, well graded, dry | |
| | | | 1.6 | fine to coarse sand with trace fine to medium gravels, light brown to tan with trace redish brown mottling, soft, well graded, dry | |
| | | | 1.8 | fine to coarse sand with trace fine to medium gravels, light brown to tan with trace redish brown mottling, soft, well graded, dry | |
| | | | 2 | fine to coarse sand with trace fine to medium gravels, light brown to tan with trace redish brown mottling, soft, well graded, dry | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 32 |  | 0.2 | silty medium to fine sand topsoil, brown to dark brown, very soft, well graded, some roots, dry | |
| Date | 14/04/2023 | | 0.75 | sandy clay, brown, soft, high plasticity, moist, some roots | |
| Water Table (m bgl) | 1.1 | | 1 | sandy clay, brown to blue grey, soft, high plasticity, moist | * |
| Termination Depth (m) | 1.8 | | 1.35 | sandy clay, brown to blue grey, soft, high plasticity, wet | |
| | | | 1.6 | sandy clay, brown to blue grey, soft, high plasticity, wet | |
| | | | 1.8 | sandy clay, brown to blue grey, soft, high plasticity, saturated | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 23 |  | 0.3 | clayey fine to medium sand, brown to light brown, soft, well graded, some roots, dry | |
| Date | 14/04/2023 | | 0.75 | clayey fine sand, light brown to brown with some drk brown streaks, very soft, uniformly graded, dry | |
| Water Table (m bgl) | NF | | 1 | clayey fine sand, light brown to brown with some drk brown streaks, very soft, low plasticity, uniformly graded, dry | * |
| Termination Depth (m) | 2 | | 1.3 | sandy cay, light brown to dark brown, firm, high plasticity, moist | |
| | | | 1.6 | sandy cay, light brown to dark brown, firm, high plasticity, moist | |
| | | | 1.8 | clay, brown, firm, high plasticity, moist | |
| | | | 2 | clay, brown, firm, high plasticity, moist | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 5 |  | 0.2 | sandy clay, brown with dark brown streaks, firm, low plasticity, moist | |
| Date | 14/04/2023 | | 0.6 | sandy clay, dark brown to brown, soft, low plasticity, moist | * |
| Water Table (m bgl) | NF | | 0.8 | sandy clay, brown to dark brown, firm, low plasticity, moist | |
| Termination Depth (m) | 0.95 | | 0.95 | sandy clay, brown to dark brown, firm, low plasticity, moist | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 86 |  | 0.2 | sandy silt topsoil, brown to dark brown, soft, low plasticity, dry, some roots | |
| Date | 14/04/2023 | | 0.5 | silty fine sand, tanish brown, soft, low plasticity, uniformly graded, dry | * |
| Water Table (m bgl) | NF | | 0.7 | silty fine sand, tanish brown, soft, low plasticity, uniformly graded, dry | |
| Termination Depth (m) | 1.7 | | 1 | sandy clay, tanish brown, soft, low plasticity, dry | * |
| | | | 1.15 | silty sandy clay, tan, soft, low plasticity | |
| | | | 1.3 | sandy clay, brown to dark brown, firm, high plasticity, moist | |
| | | | 1.5 | sandy clay, brown to dark brown, firm, high plasticity, moist | |
| | | | 1.7 | sandy clay, brown to dark brown, firm, high plasticity, moist | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 6 |  | 0.2 | sandy clay topsoil, dark brown, soft, high plasticity, moist, some roots | |
| Date | 14/04/2023 | | 0.6 | sandy clay, brown to dark brown, firm, high plasticity, moist | * |
| Water Table (m bgl) | NF | | 0.8 | sandy clay, brown to dark brown, firm, high plasticity, moist | |
| Termination Depth (m) | 0.9 | | 0.9 | sandy clay, brown to dark brown, firm, high plasticity, moist | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 61 |  | 0.2 | clayey medium to coarse sand, light brown to tan, firm, low plasticity, dry, well graded | |
| Date | 14/04/2023 | | 0.6 | sandy clay, light brown with some red, pinkish red, and redish brown mottles, firm, low plasticity, dry, trace fine gravels | * |
| Water Table (m bgl) | NF | | 0.8 | sandy clay, light brown to brown with some black streaks, firm, low plasticity, dry | |
| Termination Depth (m) | 1.05 | | 1.05 | sandy clay, light brown with black mottles, soft, high plasticity, moist | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 17 |  | 0.2 | silty fine sand topsoil, dark brown to brown, very soft, low plasticity, abundant roots, dry | |
| Date | 14/04/2023 | | 0.6 | silty medium to coarse sand, light brown to light grey, very soft, well graded, dry | * |
| Water Table (m bgl) | NF | | 0.8 | silty medium to coarse sand, light brown to light grey with some greyish black streaks, very soft, well graded, dry | |
| Termination Depth (m) | 2 | | 1 | silty fine to coarse sand, light grey with some greyish black streaks, very soft, well graded, dry | * |
| | | | 1.2 | silty fine to coarse sand and trace fine gravels, light grey with some greyish black streaks, very soft, well graded, dry | |
| | | | 1.4 | silty fine to coarse sand and trace fine gravels, light grey with some greyish black streaks, very soft, well graded, dry | |
| | | | 2 | silty fine to coarse sand and trace fine gravels, light grey with some greyish black streaks, very soft, well graded, dry | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 92 |  | 0.2 | sandy silt topsoil, dark brown to grey, very soft, low plasticity, moist, roots present | |
| Date | 15/04/2023 | | 0.6 | silty fine to medium sand, grey to black, soft, low plasticity, moist, gap graded | * |
| Water Table (m bgl) | 1 | | 0.85 | silty fine to medium sand, grey to black, soft, low plasticity, wet, gap graded | |
| Termination Depth (m) | 2 | | 1.1 | fine to coarse sand, grey to off white, very soft, well graded, saturated | * |
| | | | 1.4 | sandy clay, brown to dark grey, soft, high plasticity, wet | |
| | | | 1.7 | sandy clay, brown to dark grey, soft, high plasticity, wet | |
| | | | 2 | sandy clay, brown to dark grey, soft, high plasticity, wet | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 35 |  | 0.2 | silty topsoil, dark grey to light black, very soft, high plasticity, dry, roots | |
| Date | 15/04/2023 | | 0.6 | sandy clay with some fine gravels, brown with black streaks, very soft, high plasticity, moist | * |
| Water Table (m bgl) | 1.5 | | 0.8 | sandy clay with some fine gravels, brown with black streaks, very soft, high plasticity, moist | |
| Termination Depth (m) | 2 | | 1 | sandy clay, brown with black streaks, very soft, high plasticity, moist | * |
| | | | 1.2 | clayey sand, light brown to dark grey with black streaks, soft, high plasticity, fine grained, uniformly graded, moist | |
| | | | 1.5 | clayey fine sand, grey to brownish grey, soft, low plasticity, uniformly graded, moist | |
| | | | 1.7 | clayey fine to coarse sand, grey to brown, soft, low plasticity, gap graded, saturated. | |
| | | | 2 | clayey fine to coarse sand, grey to brown, soft, low plasticity, gap graded, saturated. | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 71 |  | 0.2 | sandy silt topsoil, brown to light brown with some orange-brown areas, soft, high plasticity, moist, roots | |
| Date | 15/04/2023 | | 0.6 | silty medium to fine sand with some fine gravels, brownish grey, soft, low plasticity, well graded | * |
| Water Table (m bgl) | NF | | 0.8 | silty medium to fine sand with some fine gravels, brownish grey, soft, low plasticity, well graded | |
| Termination Depth (m) | 1.1 | | 1 | silty medium to fine sand with some fine gravels, brownish grey, soft, low plasticity, well graded | * |
| | | | 1.1 | silty medium to fine sand with some fine gravels, brownish grey, soft, low plasticity, well graded | |

| Site information | |
|---|---|
| Location | 42 |
| Date | 15/04/2023 |
| Water Table (m bgl) | NF |
| Termination Depth (m) | 1.1 |

Photoboard

| Depth | Description (NZGS) | Sampled @ |
|---|---|---|
| 0.2 | sandy silt topsoil, dark brown to dark grey, soft, low plasticity, moist, trace roots | |
| 0.6 | sandy clay and trace medium gravels, brown to dark brown with redish brown mottles, soft, low plasticity, moist | * |
| 0.8 | sandy clay and trace medium gravels, brown to dark brown with redish brown mottles, soft, low plasticity, moist | |
| 1 | clayey sand, medium to coarse grained, brown with redish brown and off white graines and mottles, soft, low plasticity, moist, well graded, some medium to coarse gravels | |
| 1.1 | clayey sand, medium to coarse grained, brown with redish brown and off white graines and mottles, soft, low plasticity, moist, well graded, some medium to coarse gravels | * |

| Site information | |
|---|---|
| Location | 13 |
| Date | 15/04/2023 |
| Water Table (m bgl) | NF |
| Termination Depth (m) | 2 |

Photoboard

| Depth | Description (NZGS) | Sampled @ |
|---|---|---|
| 0.2 | silty fine sand, dark brown to brown, soft, low plasticity, uniformly graded, moist | |
| 0.6 | sandy clay, tanish brown to dark brown, soft, high plasticity, moist | * |
| 0.8 | sandy clay, tanish brown to dark brown, soft, high plasticity, moist | |
| 1 | sandy clay, tanish brown to dark brown, soft, high plasticity, moist | * |
| 1.2 | sandy clay, tanish brown with dark brown streaks, soft, high plasticity, moist | |
| 1.4 | clayey sand, fine to medium grained, off white to light brown, soft, well graded, moist | |
| 2 | clayey sand, fine to medium grained, off white to light brown, soft, well graded, moist | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 72 |  | 0.2 | sandy silt topsoil, brown, soft, high plasticity, moist, roots | |
| Date | 15/04/2023 | | 0.6 | sandy silt, off white to brownish grey, soft, high plasticity, moist | * |
| Water Table (m bgl) | NF | | 0.8 | sandy silt, off white to brownish grey, soft, high plasticity, moist | |
| Termination Depth (m) | 2 | | 1 | sandy silt, off white with some grey and tan mottles, soft, high plasticity, moist | * |
| | | | 1.3 | sandy silt, off white with some grey and tan mottles, firm, high plasticity, moist | |
| | | | 1.6 | silty sand, fine to medium grained, greyish white, soft, low plasticity, uniformly graded, wet | |
| | | | 1.8 | silty sand, fine to medium grained, greyish white, soft, low plasticity, uniformly graded, wet | |
| | | | 2 | silty sand, fine to medium grained, greyish white, soft, low plasticity, uniformly graded, saturated | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 97 |  | 0.2 | sandy clay topsoil, brown to light brown, soft, high plasticity, moist | |
| Date | 18/04/2023 | | 0.6 | sandy clay, dark brown to light brown, soft, low plasticity, moist | * |
| Water Table (m bgl) | NF | | 0.8 | sandy clay with trace fine gravels, light brown to dark brown, firm, high plasticity, moist | |
| Termination Depth (m) | 1.55 | | 1 | sandy clay with trace fine gravels, light brown to dark brown, firm, high plasticity, moist | * |
| | | | 1.2 | sandy clay with trace fine gravels, light brown to dark brown, firm, high plasticity, moist | |
| | | | 1.4 | sandy clay, off white to dark brown, stiff, high plasticity, moist | |
| | | | 1.55 | sandy clay, off white to dark brown, stiff, high plasticity, moist | * |

| Site information | | Photoboard |
|---|---|---|
| Location | 66 |  |
| Date | 18/04/2023 | |
| Water Table (m bgl) | 0.4 | |
| Termination Depth (m) | 0.9 | |

| Depth | Description (NZGS) | Sampled @ |
|---|---|---|
| 0.2 | silty topsoil with trace sand, dark brown, very soft, high plasticity, moist, roots present | |
| 0.6 | fine to medium sand, brown with off white shells, well graded, moist, abundant shells, saturated | * |
| 0.8 | fine to medium sand, brown with off white shells, well graded, moist, abundant shells, saturated | |
| 0.9 | fine to medium sand, brown with off white shells, well graded, moist, abundant shells, saturated | * |

| Site information | | Photoboard |
|---|---|---|
| Location | 29 |  |
| Date | 18/04/2023 | |
| Water Table (m bgl) | 1.4 | |
| Termination Depth (m) | 1.7 | |

| Depth | Description (NZGS) | Sampled @ |
|---|---|---|
| 0.2 | silty fine sand, dark brown, uniformly graded, dry, very soft | |
| 0.6 | fine to medium marine sand, black, well graded, dry, off white shells | * |
| 0.8 | fine to medium sand, brown to black, well graded, moist, few shells | |
| 1 | fine to medium sand, light brown to brown, well graded, moist, few shells | * |
| 1.2 | fine to medium marine sand, light grey to off white to light brown, well graded, wet, abundant shells <5mm | |
| 1.4 | fine to medium marine sand, light grey to off white to light brown, well graded, wet, abundant shells <5mm | |
| 1.5 | fine to medium marine sand, light grey to off white to light brown, well graded, saturated, abundant shells <5mm | |
| 1.7 | fine to medium marine sand, light grey to off white to light brown, well graded, saturated, abundant shells <5mm | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 82 |  | 0.3 | claey fine to medium sand, light brown to grey with some red mottles, well graded, very soft, moist | |
| Date | 18/04/2023 | | 0.9 | sandy clay, brown to blue grey, very soft, high plasticity, moist | |
| Water Table (m bgl) | 1 | | 1.2 | sandy clay, blue grey to brown, soft, high plasticity, wet, some roots present | * |
| Termination Depth (m) | 2 | | 1.6 | silty sandy clay, blue grey, soft, high plasticity, saturated, roots present | |
| | | | 2 | clayey fine to coarse sand, likely marine, soft, low plasticity, well graded, saturated, sulfurous odour | * |

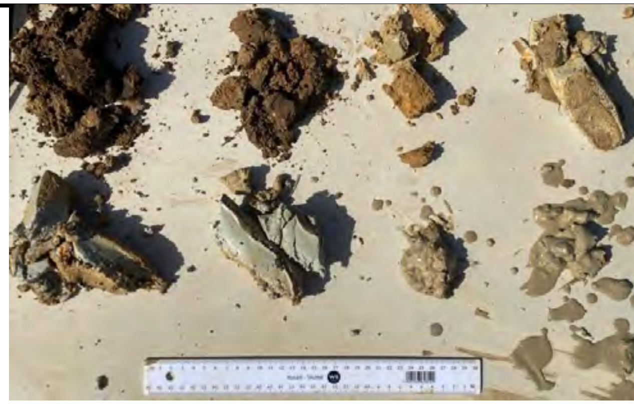
| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 94 |  | 0.2 | fine to medium sand, brown to blackish grey, well graded, moist, roots present | |
| Date | 18/04/2023 | | 0.6 | fine to coarse sand, blackish grey, well graded, moist, shells present | * |
| Water Table (m bgl) | 0.9 | | 0.8 | fine to coarse sand, blackish grey, well graded, moist, shells present | |
| Termination Depth (m) | 1.4 | | 1 | fine to coarse sand, blackish grey, well graded, wet, shells present | * |
| | | | 1.1 | fine to coarse sand, blackish grey, well graded, wet, soft, shells present | |
| | | | 1.3 | fine to coarse sand, blackish grey, well graded, wet, soft, shells present | * |
| | | | 1.4 | fine to coarse sand, blackish grey, well graded, wet, soft, shells present | |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 93 |  | 0.2 | sandy clay, light brown to brown, soft, high plasticity, moist | |
| Date | 18/04/2023 | | 0.6 | sandy clay, brown with light brown streaks, firm, high plasticity, moist | * |
| Water Table (m bgl) | NF | | 0.8 | sandy clay, light brown, firm, high plasticity, moist | |
| Termination Depth (m) | 0.9 | | 0.9 | sandy clay, light brown with dark brown mottles, firm, high plasticity, moist | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 30 |  | 0.25 | fine to medium sand, brown to dark brown, well graded, moist | |
| Date | 18/04/2023 | | 0.6 | sandy silt, light brown to brownish black, sift, low plasticity, moist | * |
| Water Table (m bgl) | NF | | 0.8 | sandy clay, dark brown to brown with black streaks, soft, high plasticity, moist | |
| Termination Depth (m) | 1.1 | | 1 | sandy clay with trace fine gravel, dark brown to brown with black streaks, soft, high plasticity, moist | * |
| | | | 1.1 | sandy clay, light brown to brown with some black mottles, soft, high plasticity, moist | |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 59B |  | 0.25 | clay with minor silt, dark greyish brown, soft, low plasticity, moist | |
| Date | 19/04/2023 | | 0.6 | sandy clay with trace fine gravels, light brown with some dark brown, firm, high plasticity, moist | * |
| Water Table (m bgl) | NF | | 0.8 | sandy clay with trace fine gravels, light brown with some dark brown with some yellow brown mottles, firm, high plasticity, moist | |
| Termination Depth (m) | 1 | | 1 | sandy clay with trace fine gravels, light brown with some dark brown with some yellow brown mottles, firm, high plasticity, moist, some coarse white sand at bottom | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 77B |  | 0.2 | silty fine to medium sand, dark brown, very soft, well graded, dry, some off white to grey medium gravels | |
| Date | 19/04/2023 | | 0.6 | sandy silt, greyish white with grey streaks and mottles, soft, low plasticity, moist | * |
| Water Table (m bgl) | NF | | 0.8 | sandy silt, greyish white to dark brown, soft, low plasticity, moist, some coarse gravels up to 30mm | * |
| Termination Depth (m) | 0.8 | | | | |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 98B |  | 0.2 | sandy clay topsoil, brown to light grey, very soft, high plasticity, dry | |
| Date | 19/04/2023 | | 0.6 | clayey fine sand, light grey to brown with redish brown layers/mottles, uniformly graded, dry | * |
| Water Table (m bgl) | 1.2 | | 0.8 | sandy clay, off white to light grey with redish brown mottles, soft, high plasticity, moist | |
| Termination Depth (m) | 1.6 | | 1 | sandy clay, blue grey to brown, firm, high plasticity, moist | * |
| | | | 1.2 | sandy clay, blue grey to brown, firm, high plasticity, moist | |
| | | | 1.4 | clayey fine sand, light grey, uniformly graded, saturated | |
| | | | 1.6 | clayey fine sand, light grey, uniformly graded, saturated | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 34B |  | 0.2 | silty fine sand, trace medium sand, grey with dark brown streaks, uniformly graded, dry | |
| Date | 19/04/2023 | | 0.6 | silty fine sand, trace medium sand, grey with yellow brown mottles, uniformly graded, dry | * |
| Water Table (m bgl) | NF | | 0.8 | clayey fine to medium sand, greyish brown to grey, low plasticity, well graded, dry | |
| Termination Depth (m) | 2 | | 1 | clayey medium sand, brown to dark brown, low plasticity, uniformly graded, dry | * |
| | | | 1.25 | clayey medium sand, dark grey to yellowish brown, low plasticity, uniformly graded, dry | |
| | | | 1.5 | fine to medium sand, grey, brown, and dark brown, well graded, moist | |
| | | | 1.75 | fine to medium sand, grey, brown, and dark brown, well graded, moist | |
| | | | 2 | fine to medium sand, grey, well graded, moist | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 50B |  | 0.2 | clay topsoil, dark brown, high plasticity, soft, moist, roots present | |
| Date | 19/04/2023 | | 0.6 | sandy clay, grey to brown with redish brown mottles, firm, high plasticity, moist | * |
| Water Table (m bgl) | NF | | 0.8 | clayey sand, fine grained, grey to off white with some brown mottles, soft, low plasticity, moist | |
| Termination Depth (m) | 1.35 | | 1 | clayey sand, fine grained, grey to off white with some brown mottles, soft, low plasticity, moist | * |
| | | | 1.25 | clayey fine to coarse sand, grey with tan stains, gap graded, moist | |
| | | | 1.35 | clayey fine to coarse sand, grey to brown, gap graded, moist | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 40B |  | 0.2 | clayey fine to medium sand with some medium to coarse gravels up to 25mm, dark brown with some white spots, soft, well graded, clay | |
| Date | 19/04/2023 | | 0.6 | clayey medium to coarse sand, brown to light brown with some off white and clear grains, well graded, dry, some fine gravels | * |
| Water Table (m bgl) | NF | | 0.8 | clayey medium to coarse sand, brown to light brown with some off white and clear grains, well graded, dry, some fine gravels | |
| Termination Depth (m) | 1.1 | | 1 | clayey medium to coarse sand, brown to light brown with some off white and clear grains, well graded, dry, some fine gravels | |
| | | | 1.1 | Medium to coarse sand, gap graded, dry, brown to dark brown | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 69 |  | 0.2 | sandy clay, dark brown, soft, high plasticity, moist | |
| Date | 19/04/2023 | | 0.6 | sandy clay, brown to dark brown, soft, high plasticity, moist | * |
| Water Table (m bgl) | NF | | 0.8 | sandy clay, grey brown with dark brown streaks, low plasticity, moist, soft | |
| Termination Depth (m) | 2 | | 1 | sandy clay, grey brown with yellow-brown mottles, low plasticity, moist, soft | * |
| | | | 1.2 | sandy clay, brownish grey with yellow-brown mottles, low plasticity, moist, soft | |
| | | | 1.4 | sandy clay, brownish grey with yellow-brown mottles, low plasticity, moist, soft | |
| | | | 1.6 | sandy clay, brownish grey with yellow-brown mottles, low plasticity, moist, soft | |
| | | | 1.8 | sandy clay, brownish grey with yellowish brown mottles, firm, high plasticity, moist | |
| | | | 2 | sandy clay, brownish grey with brown and black mottles, firm, high plasticity, moist | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 70 |  | 0.2 | sandy clay topsoil, dark brown, firm, low plasticity, dry | |
| Date | 19/04/2023 | | 0.6 | sandy clay, brown to dark brown, firm, low plasticity, dry | * |
| Water Table (m bgl) | NF | | 0.8 | silty fine sand, brown to grey, low plasticity, soft, uniformly graded, moist | |
| Termination Depth (m) | 1.1 | | 1 | sandy clay, grey with brown and dark brown mottles, firm, low plasticity, moist | * |
| | | | 1.1 | sandy clay, grey with brown and dark brown mottles, firm, low plasticity, moist | |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 83B |  | 0.25 | sandy clay with some medium gravel topsoil, dark greyish black to brown, soft, high plasticity, moist | |
| Date | 19/04/2023 | | 0.75 | sandy silty peat, black to brown, soft, low plasticity, wet, fibrous, roots present | |
| Water Table (m bgl) | 0.8 | | 1 | sandy peat, black, very soft, low plasticity, fibrous, saturated, roots present, no distinct smell | * |
| Termination Depth (m) | 2 | | 1.25 | sandy peat, black, very soft, low plasticity, fibrous, saturated, roots present, no distinct smell | |
| | | | 1.5 | sandy peat, black, very soft, low plasticity, fibrous, saturated, roots present, no distinct smell | |
| | | | 1.75 | sandy peat, black, very soft, low plasticity, fibrous, saturated, roots present, no distinct smell | |
| | | | 2 | sandy peat, black, very soft, low plasticity, fibrous, saturated, roots present, no distinct smell | |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 15 |  | 0.2 | sandy clay, light brown with dark brown mottles, firm, low plasticity, moist | |
| Date | 20/04/2023 | | 0.6 | sandy clay, light brown with dark brown mottles, firm, low plasticity, moist | * |
| Water Table (m bgl) | NF | | 0.8 | sandy clay, light brown with dark brown mottles, firm, low plasticity, moist | |
| Termination Depth (m) | 2 | | 1 | clayey fine to medium sand, brownish grey, well graded, soft, moist | * |
| | | | 1.2 | clayey fine to medium sand, grey to brown, well graded, soft, low plasticity, moist | |
| | | | 1.4 | clayey fine to medium sand, grey to brown, well graded, soft, low plasticity, moist | |
| | | | 1.6 | fine to coarse sand, grey with yellowish brown stains, well graded, moist | |
| | | | 1.8 | fine to coarse sand, grey with yellowish brown stains, well graded, moist | |
| | | | 2 | fine to coarse sand, grey with yellowish brown stains, well graded, moist | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 43B |  | 0.2 | sandy clay, blackish brown, soft, high plasticity, moist, roots present | |
| Date | 20/04/2023 | | 0.6 | sandy clay, brownish grey to dark grey, soft, high plasticity, moist | * |
| Water Table (m bgl) | 1.3 | | 0.8 | sandy clay, brownish grey to dark grey, soft, high plasticity, moist, some fibrous plant material | |
| Termination Depth (m) | 2 | | 1 | sandy clay, grey to yellowish brown, soft, high plasticity, moist, plant material present | * |
| | | | 1.2 | clay with minor sand, black to yellowish brown, soft, high plasticity, moist | |
| | | | 1.5 | clayey medium sand, grey with black and brown staining, soft, uniformly graded, moist | |
| | | | 1.75 | sandy peat, black with some brown stain, fibrous, soft, low plasticity, wet | |
| | | | 2 | sandy peat, black with some brown stain, fibrous, soft, low plasticity, wet | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 91 |  | 0.2 | clayey medium to coarse sand, dark brown, soft, low plasticity, well graded, surface roots, dry | |
| Date | 20/04/2023 | | 0.6 | silty clay, brown to grey with some dark grey streaks, soft, high plasticity, moist | * |
| Water Table (m bgl) | 1.6 | | 0.8 | sandy clay, grey to light brown, soft, high plasticity, moist | |
| Termination Depth (m) | 2 | | 1 | clayey fine to medium sand, grey with light brown layers, soft, high plasticity, moist, gap graded | * |
| | | | 1.2 | clayey fine to medium sand, grey with light brown layers, soft, high plasticity, moist, gap graded | |
| | | | 1.45 | clayey fine to medium sand, grey with light brown layers, soft, high plasticity, wet, gap graded | |
| | | | 1.75 | clayey fine to medium sand, grey with light brown layers, soft, high plasticity, wet, gap graded | |
| | | | 2 | clayey fine to medium sand, grey with light brown layers, soft, high plasticity, wet, gap graded, some blue clay | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 84B |  | 0.2 | sandy clay with trace fine gravels, black, soft, low plasticity, moist, plant material present | |
| Date | 20/04/2023 | | 0.6 | clayey fine to medium sand, black to brown, firm, low plasticity, well graded, moist | * |
| Water Table (m bgl) | NF | | 0.8 | sandy clay, blackish brown and brown layers, stiff, low plasticity, moist, plant material present | |
| Termination Depth (m) | 1 | | 1 | sandy clay, blackish brown and brown layers, stiff, low plasticity, moist, plant material present | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 58B |  | 0.2 | clayey medium to coarse sand, brown to dark brown to grey, soft, low plasticity, well graded, dry | |
| Date | 20/04/2023 | | 0.6 | clayey fine to medium sand, brown to grey with abundant yellow-brown mottles, well graded, dry | * |
| Water Table (m bgl) | 1 | | 0.8 | clayey fine to medium sand, grey to light brown, uniformly graded, wet | |
| Termination Depth (m) | 1.2 | | 1 | clayey fine to medium sand, grey to light brown, uniformly graded, wet | |
| | | | 1.2 | clayey fine to medium sand, grey to light brown, uniformly graded, wet | * |

| Site information | |
|---|---|
| Location | 47 |
| Date | 20/04/2023 |
| Water Table (m bgl) | 0.4 |
| Termination Depth (m) | 2 |

Photoboard

| Depth | Description (NZGS) | Sampled @ |
|---|---|---|
| 0.25 | sandy organic peaty silt topsoil, black, soft, high plasticity, moist, roots | |
| 0.75 | fibrous sandy peat, black, very soft, high plasticity, wet | |
| 1 | fibrous sandy peat, black, very soft, high plasticity, wet | * |
| 2 | fibrous sandy peat, black, very soft, high plasticity, wet | * |

| Site information | |
|---|---|
| Location | 12 |
| Date | 20/04/2023 |
| Water Table (m bgl) | 0.8 |
| Termination Depth (m) | 2 |

Photoboard

| Depth | Description (NZGS) | Sampled @ |
|---|---|---|
| 0.25 | sandy clay topsoil, brown, soft, low plasticity, moist | |
| 0.75 | sandy clay, brownish grey, soft, high plasticity, moist | |
| 1 | sandy peat, black, very soft, high plasticity, fibrous, saturated, sulfurous odour | * |
| 1.25 | sandy peat, black, very soft, high plasticity, fibrous, saturated, sulfurous odour | |
| 1.5 | sandy peat, black, very soft, high plasticity, fibrous, saturated, sulfurous odour, some coarse sand | |
| 1.75 | sandy peat, black, very soft, high plasticity, fibrous, saturated, sulfurous odour | |
| 2 | peat, black, soft, high plasticity, saturated, fibrous, abundant blue-grey clay | * |

| Site information | |
|---|---|
| Location | 31 |
| Date | 21/04/2023 |
| Water Table (m bgl) | 0.8 |
| Termination Depth (m) | 2 |

Photoboard

| Depth | Description (NZGS) | Sampled @ |
|---|---|---|
| 0.2 | sandy clay topsoil, brown, soft, low plasticity, moist | |
| 0.6 | sandy clay, brown, soft, low plasticity, moist, roots present | * |
| 0.8 | sandy clay, brown, soft, low plasticity, wet, roots present | |
| 1 | sandy clay, brown, soft, low plasticity, wet, roots present | * |
| 1.3 | silty clay with trace sand, greyish brown, very soft, low plasticity, saturated | |
| 1.65 | silty clay with trace sand, greyish brown, very soft, low plasticity, saturated, some fibrous plant material present | |
| 2 | clayey medium to coarse sand, blueish grey to brown, uniformly graded, saturated | * |

| Site information | |
|---|---|
| Location | 100 |
| Date | 21/04/2023 |
| Water Table (m bgl) | 0.7 |
| Termination Depth (m) | 1 |

Photoboard

| Depth | Description (NZGS) | Sampled @ |
|---|---|---|
| 0.2 | sandy clay topsoil, brown, soft, low plasticity, moist | |
| 0.6 | clay with minor sand and trace fine gravels, grey to dark brown with yellowish brown mottles, soft, high plasticity, moist | * |
| 0.8 | clay with minor sand and trace fine gravels, grey to dark brown with yellowish brown mottles, soft, high plasticity, moist | |
| 1 | sandy clay, light grey to brown, soft, high plasticity, saturated | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 21 |  | 0.2 | sandy clay, brown to dark brown, soft, low plasticity, moist, roots present | |
| Date | 21/04/2023 | | 0.6 | sandy clay, light brown, firm, high plasticity, moist | * |
| Water Table (m bgl) | NF | | 0.8 | sandy clay, brown to dark brown, firm, high plasticity, moist | * |
| Termination Depth (m) | 0.8 | | | | |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 16 |  | 0.2 | clayey sand topsoil, dark brown, soft, low plasticity, moist, roots present | |
| Date | 21/04/2023 | | 0.6 | sandy clay, grey with brown and yellowish brown mottles, stiff, low plasticity, moist | * |
| Water Table (m bgl) | NF | | 0.8 | sandy clay, grey with brown and yellowish brown mottles, stiff, low plasticity, moist | |
| Termination Depth (m) | 1.15 | | 1 | sandy clay, grey with brown and yellowish brown mottles, stiff, high plasticity, moist | |
| | | | 1.15 | sandy clay, grey with brown and yellowish brown mottles, stiff, high plasticity, moist | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 64B |  | 0.25 | sandy clay, dark brown to brown, firm, high plasticity, moist | |
| Date | 21/04/2023 | | 0.75 | peaty sandy clay, black, soft, high plasticity, moist, fibrous plant material present | |
| Water Table (m bgl) | 0.8 | | 1 | sandy peat, black soft, high plasticity, wet, fibrous plant material present | * |
| Termination Depth (m) | 2 | | 2 | sandy peat, black soft, high plasticity, saturated, fibrous plant material present | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 8B |  | 0.2 | silty fine to medium sand topsoil with minor fine to medium gravels, brown, very soft, uniformly graded, dry | |
| Date | 21/04/2023 | | 0.6 | silty fine to medium sand topsoil with minor fine to medium gravels, brown, very soft, uniformly graded, dry, roots present | * |
| Water Table (m bgl) | NF | | 0.8 | sandy clay, grey to brown, stiff, high plasticity, dry | |
| Termination Depth (m) | 1.1 | | 1 | silty medium sand, grey with some brown, very soft, uniformly graded, dry | |
| | | | 1.1 | silty medium sand, grey with some yellowish brown mottles, very soft, uniformly graded, dry | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 41C |  | 0.2 | clayey fine to medium sand topsoil, greyish brown, soft, uniformly graded, dry | |
| Date | 21/04/2023 | | 0.6 | clayey fine sand, brown to light brown, firm, low plasticity, uniformly graded | * |
| Water Table (m bgl) | NF | | 0.8 | clayey medium to coarse sand, light brown, firm, low plasticity, uniformly graded | |
| Termination Depth (m) | 2 | | 1 | sandy clay, grey to light brown with some yellowish brown mottling, soft, high plasticity, dry | * |
| | | | 1.2 | clayey fine to coarse sand, grey with some brown coloring, soft, low plasticity, well graded, moist | |
| | | | 1.4 | clayey fine to coarse sand, grey with some dark brown and yellowish brown coloring, soft, low plasticity, well graded, moist | |
| | | | 1.6 | coarse sand with some clay, brownish grey, soft, uniformly graded, moist | |
| | | | 1.8 | coarse sand with some clay, brownish grey, soft, uniformly graded, moist | |
| | | | 2 | coarse sand with some clay, brownish grey, soft, uniformly graded, moist | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 28B |  | 0.2 | clayey fine sand topsoil, dark brown, soft, uniformly graded, dry | |
| Date | 21/04/2023 | | 0.6 | clayey fine sand, brown to dark brown, soft, uniformly graded, dry | * |
| Water Table (m bgl) | NF | | 0.8 | fine to medium sand, grey to dark brown, uniformly graded, dry | |
| Termination Depth (m) | 2 | | 1 | fine to medium sand, grey to dark brown, uniformly graded, dry | * |
| | | | 1.2 | fine to medium sand, grey to dark brown, uniformly graded, dry | |
| | | | 1.4 | fine to medium sand, brown, uniformly graded, moist | |
| | | | 1.6 | fine to medium sand, brown, uniformly graded, moist | |
| | | | 1.8 | fine to medium sand, brown with yellowish brown mottles, well graded, moist | |
| | | | 2 | fine to medium sand, brown to grey with yellowish brown mottles, well graded, moist | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 68 |  | 0.25 | sandy silt topsoil, black, soft, low plasticity, dry | |
| Date | 21/04/2023 | | 0.75 | sandy clay, brownish grey to dark brown, soft, high plasticity, moist | |
| Water Table (m bgl) | NF | | 1 | clayey fine to medium sand with trace fine gravels, soft, low plasticity, uniformly graded, moist, grey with blackish brown streaks | |
| Termination Depth (m) | 1.15 | | 1.15 | clayey medium to coarse sand with trace fine gravels, soft, low plasticity, well graded, moist, grey with blackish brown streaks | * |

| Site information | | Photoboard | Depth | Description (NZGS) | Sampled @ |
|---|---|---|---|---|---|
| Location | 67 |  | 0.2 | sandy clay, black to dark brown, soft, low plasticity, dry | |
| Date | 21/04/2023 | | 0.6 | sandy clay, dark brown, soft, high plasticity, moist, some fibrous plant material | * |
| Water Table (m bgl) | NF | | 0.8 | sandy clay, grey to dark brown, firm, high plasticity, moist | |
| Termination Depth (m) | 0.9 | | 0.9 | sandy clay, grey to dark brown, firm, high plasticity, moist | * |

# Appendix D

## Results

# Appendix D
# Table 1
# Results Overview Table

| Site ID | Depth | Location | LAB ID | Descriptor | Titratable Peroxide Acidity | $pH_{KCl}$ | $pH_{OX}$ | Titratable Actual Acidity | Titratable Sulfidic Acidity | Chromium Reducible Sulphur | Peroxide Oxidisable Sulfur | Acid Reacted Calcium | Acid Reacted Magnesium | Net Acid Soluble Sulfur | Acid Neutralising Capacity | Net Acidity | Net Acidity excluding ANC | ANC Fineness Factor | Liming Rate | Liming Rate excluding ANC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | moles $H^+$/t | pH units | pH units | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | - | kg $CaCO_3$/t | kg $CaCO_3$/t |
| EQL | | | | | 2 | 0.1 | 0.1 | 2 | 2 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 0.5 | 1 | 1 |
| 1 | 1 | 175.23375, -37.73923 | 23-13954-17 | Holocene swamp deposits | - | 5.6 | - | 7 | - | <10 | - | - | - | - | - | 11.00 | 11.00 | 1.50 | <1 | <1 |
| 2 | 0.5 | 175.30754, -37.67114 | 23-13954-22 | Holocene swamp deposits | - | 4.7 | - | 62 | - | 12 | - | - | - | - | - | 74.00 | 74.00 | 1.50 | 6.00 | 6.00 |
| 3 | 2 | 175.14846, -37.66146 | 23-13954-20 | Holocene swamp deposits | - | - | - | - | - | - | - | - | - | 11 | - | 437.00 | 437.00 | - | 33.00 | 33.00 |
| 3 | 2 | 175.14846, -37.66146 | 23-13954-20 | Holocene swamp deposits | - | 5.2 | - | 16 | - | <10 | - | - | - | - | - | 19.00 | 19.00 | 1.50 | 1.00 | 1.00 |
| 4 | 1 | 174.95064, -37.26623 | 23-13954-6 | Holocene swamp deposits | 891 | 4.3 | 3 | 226 | 664 | 74 | 202 | 12 | 10 | <10 | - | 311.00 | 311.00 | 1.50 | 23.00 | 23.00 |
| 5 | 0.5 | 175.28117, -38.09486 | 23-13954-98 | Holocene swamp deposits | - | 4.8 | - | 73 | - | <10 | - | - | - | - | - | 73.00 | 73.00 | 1.50 | 5.00 | 5.00 |
| 6 | 0.9 | 175.30668, -37.91622 | 23-13954-89 | Holocene swamp deposits | - | 5.9 | - | 7 | - | 12 | - | - | - | - | - | 19.00 | 19.00 | 1.50 | 1.00 | 1.00 |
| 7 | 1 | 175.27246, -37.82038 | 23-13954-15 | Holocene swamp deposits | - | 4.6 | - | 69 | - | <10 | - | - | - | - | - | 72.00 | 72.00 | 1.50 | 5.00 | 5.00 |
| 9 | 1 | 175.14538, -37.47825 | 23-13954-14 | Holocene swamp deposits | - | 6 | - | <2 | - | <10 | - | - | - | - | - | <10 | <10 | 1.50 | <1 | <1 |
| 10 | 0.95 | 175.05823, -37.25535 | 23-13954-5 | Holocene swamp deposits | - | 4.9 | - | 86 | - | 14 | - | - | - | - | - | 100.00 | 100.00 | 1.50 | 8.00 | 8.00 |
| 10 | 2 | 175.05823, -37.25535 | 23-13954-5 | Holocene swamp deposits | - | 5.9 | - | 4 | - | <10 | - | - | - | - | - | 11.00 | 11.00 | 1.50 | <1 | <1 |
| 11 | 0.5 | 175.12955, -37.38958 | 23-13954-12 | Current wetland | - | 4.7 | - | 56 | - | 15 | - | - | - | - | - | 72.00 | 72.00 | 1.50 | 5.00 | 5.00 |
| 12 | 2 | 175.672, -37.37434 | 23-13954-55 | Holocene river deposits | - | 4.8 | - | 88 | - | <10 | - | - | - | - | - | 92.00 | 92.00 | 1.50 | 7.00 | 7.00 |
| 12 | 2 | 175.672, -37.37434 | 23-13954-55 | Holocene river deposits | - | 6.9 | - | <2 | - | <10 | - | - | - | - | 185 | <10 | <10 | 1.50 | <1 | <1 |
| 13 | 1 | 175.75866, -37.87975 | 23-13954-96 | Holocene river deposits | - | 4.4 | - | 160 | - | <10 | - | - | - | <10 | - | 160.00 | 160.00 | 1.50 | 12.00 | 12.00 |
| 14 | 1 | 175.20545, -37.69786 | 23-13954-19 | Holocene river deposits | - | 4.7 | - | 116 | - | 39 | - | - | - | - | - | 155.00 | 155.00 | 1.50 | 12.00 | 12.00 |
| 15 | 1 | 175.80547, -37.69603 | 23-13954-49 | Holocene river deposits | - | 4.9 | - | 42 | - | <10 | - | - | - | - | - | 42.00 | 42.00 | 1.50 | 3.00 | 3.00 |
| 16 | 1.15 | 175.46878, -37.77881 | 23-13954-59 | Holocene river deposits | - | 4.8 | - | 66 | - | 10 | - | - | - | - | - | 76.00 | 76.00 | 1.50 | 6.00 | 6.00 |
| 17 | 1 | 175.30043, -37.80948 | 23-13954-91 | Holocene river deposits | - | 5.2 | - | 17 | - | <10 | - | - | - | - | - | 21.00 | 21.00 | 1.50 | 2.00 | 2.00 |
| 18 | 0.95 | 175.51501, -37.6529 | 23-13954-71 | Holocene river deposits | 12 | 5.5 | 5.2 | 7 | 5 | <10 | <10 | <10 | <10 | - | - | <10 | <10 | 1.50 | 1.00 | 1.00 |
| 19 | 0.5 | 175.29931, -37.37999 | 23-13954-81 | Holocene river deposits | - | - | - | - | - | - | - | - | - | - | - | 14.00 | 14.00 | - | - | - |
| 20 | 2 | 175.37209, -37.2917 | 23-13954-77 | Holocene river deposits | - | 5.1 | - | 48 | - | <10 | - | - | - | - | - | 48.00 | 48.00 | 1.50 | 4.00 | 4.00 |
| 21 | 0.8 | 175.58386, -37.73936 | 23-13954-58 | High pH | - | 5.1 | - | 27 | - | <10 | - | - | - | - | - | 32.00 | 32.00 | 1.50 | 2.00 | 2.00 |
| 22 | 0.5 | 174.90288, -37.82146 | 23-13954-83 | High pH | - | 4.9 | - | 43 | - | <10 | - | - | - | - | - | 43.00 | 43.00 | 1.50 | 3.00 | 3.00 |
| 23 | 1 | 175.28181, -38.09497 | 23-13954-87 | high pH | - | 5.9 | - | 9 | - | 75 | - | - | - | - | - | 85.00 | 85.00 | 1.50 | 6.00 | 6.00 |
| 24 | 1.55 | 175.49476, -37.50425 | 23-13954-66 | High pH | - | 5.9 | - | 7 | - | 146 | - | - | - | - | - | 153.00 | 153.00 | 1.50 | 12.00 | 12.00 |
| 25 | 2 | 175.62836, -37.60093 | 23-13954-70 | High pH | 43 | 6.4 | 4.6 | <2 | 43 | <10 | 48 | 18 | <10 | - | - | <10 | <10 | 1.50 | <1 | <1 |
| 26 | 1 | 174.95255, -37.26015 | 23-13954-7 | Low pH | - | - | - | - | - | - | - | - | - | - | - | 48.00 | 48.00 | - | 4.00 | 4.00 |
| 27 | 1 | 175.20612, -37.19981 | 23-13954-80 | Low pH | 142 | 7.8 | 3.9 | <2 | 142 | 280 | 334 | <10 | 36 | - | 462 | <10 | 280.00 | 1.50 | <1 | 21.00 |
| 29 | 1 | 175.70686, -36.83448 | 23-13954-35 | Low pH | - | - | - | - | - | - | - | - | - | - | - | 206.00 | 334.00 | - | 15.00 | 25.00 |
| 30 | 0.5 | 175.85591, -37.19329 | 23-13954-39 | low pH | - | 4.3 | - | 77 | - | <10 | - | - | - | 27 | - | 109.00 | 109.00 | 1.50 | 8.00 | 8.00 |
| 31 | 2 | 175.67812, -37.74856 | 23-13954-56 | low pH | - | 4.5 | - | 54 | - | <10 | - | - | - | - | - | 64.00 | 64.00 | 1.50 | 5.00 | 5.00 |
| 32 | 1.8 | 175.21261, -38.18906 | 23-13954-86 | Low pH | - | 4.4 | - | 83 | - | 53 | - | - | - | 14 | - | 150.00 | 150.00 | 1.50 | 11.00 | 11.00 |
| 33 | 0.95 | 175.23583, -37.74153 | 23-13954-18 | Low pH | - | 3.9 | - | 182 | - | <10 | - | - | - | 19 | - | 211.00 | 211.00 | 1.50 | 16.00 | 16.00 |
| 35 | 0.5 | 175.85122, -38.22545 | 23-13954-93 | Low pH | - | 4.4 | - | 62 | - | <10 | - | - | - | <10 | - | 72.00 | 72.00 | 1.50 | 5.00 | 5.00 |
| 36 | 0.5 | 175.24143, -37.47588 | 23-13954-74 | Current wetland | - | 4.4 | - | 107 | - | <10 | - | - | - | <10 | - | 111.00 | 111.00 | 1.50 | 8.00 | 8.00 |
| 37 | 0.5 | 175.13095, -37.39122 | 23-13954-13 | Current wetland | - | 8.8 | - | <2 | - | <10 | - | - | - | - | 2,270 | <10 | <10 | 1.50 | <1 | <1 |
| 38 | 0.75 | 175.48331, -37.34075 | 23-13954-32 | Current wetland | - | 8.6 | - | <2 | - | <10 | - | - | - | - | 1,170 | <10 | <10 | 1.50 | <1 | <1 |
| 39 | 0.75 | 175.09692, -37.30237 | 23-13954-8 | Current wetland | - | - | - | - | - | - | - | - | - | - | - | 73.00 | 73.00 | - | 5.00 | 5.00 |
| 42 | 0.5 | 175.66898, -37.94247 | 23-13954-95 | Historic wetland | 62 | 5.9 | 4.5 | 11 | 51 | 34 | 62 | <10 | <10 | - | - | 44.00 | 44.00 | 1.50 | 3.00 | 3.00 |
| 44 | 1.3 | 175.27644, -37.35435 | 23-11477-29 | Historic wetland | - | 4.8 | - | 32.00 | - | <10 | - | - | | - | - | 32.00 | 32.00 | 1.50 | 2.00 | 2.00 |
| 45 | 0.95 | 175.4102, -37.33922 | 23-13954-78 | Historic wetland | 203 | 6.7 | 3.2 | <2 | 203 | 26 | 86 | <10 | <10 | - | 74 | <10 | 26.00 | 1.50 | <1 | 2.00 |
| 46 | 2 | 175.60794, -37.39554 | 23-13954-30 | Historic wetland | - | - | - | - | - | - | - | - | - | - | - | 164.00 | 86.00 | - | 12.00 | 6.00 |
| 47 | 1 | 175.57329, -37.48989 | 23-13954-54 | Wetland vegetation | - | 4.8 | - | 50 | - | <10 | - | - | - | - | - | 50.00 | 50.00 | 1.50 | 4.00 | 4.00 |
| 47 | 1 | 175.57329, -37.48989 | 23-13954-54 | Wetland vegetation | - | 5.4 | - | 35 | - | <10 | - | - | - | - | - | 44.00 | 44.00 | 1.50 | 3.00 | 3.00 |
| 48 | 2 | 175.51268, -37.46353 | 23-13954-67 | Wetland vegetation | - | 4.6 | - | 39 | - | <10 | - | - | - | - | - | 43.00 | 43.00 | 1.50 | 3.00 | 3.00 |
| 49 | 0.5 | 175.19516, -37.4887 | 23-13954-73 | Wetland vegetation | 12 | 5.4 | 4.6 | 8 | 4 | <10 | <10 | <10 | <10 | - | - | <10 | <10 | 1.50 | <1 | <1 |
| 51 | 1.55 | 175.14216, -37.43556 | 23-13954-9 | Wetland vegetation | - | - | - | - | - | - | - | - | - | - | - | 13.00 | 13.00 | - | - | - |
| 52 | 1 | 175.13684, -37.43094 | 23-13954-10 | Wetland vegetation | - | 5 | - | 65 | - | <10 | - | - | - | - | - | 71.00 | 71.00 | 1.50 | 5.00 | 5.00 |
| 53 | 2 | 175.2027, -37.39224 | 23-13954-11 | Wetland vegetation | - | 5.50 | - | 33.00 | - | <10 | - | - | - | - | - | 33.00 | 33.00 | 1.50 | 2.00 | 2.00 |
| 54 | 2 | 175.1866, -37.38038 | 23-13954-75 | Wetland vegetation | - | 5.6 | - | 32 | - | <10 | - | - | - | - | - | 36.00 | 36.00 | 1.50 | 3.00 | 3.00 |
| 55 | 2 | 175.1827, -37.346 | 23-13954-76 | Wetland vegetation | - | 5.5 | - | 4 | - | <10 | - | - | - | - | - | 13.00 | 13.00 | 1.50 | <1 | <1 |

| Site ID | Depth | Location | LAB ID | Descriptor | Titratable Peroxide Acidity | $pH_{KCl}$ | $pH_{OX}$ | Titratable Actual Acidity | Titratable Sulfidic Acidity | Chromium Reducible Sulphur | Peroxide Oxidisable Sulfur | Acid Reacted Calcium | Acid Reacted Magnesium | Net Acid Soluble Sulfur | Acid Neutralising Capacity | Net Acidity | Net Acidity excluding ANC | ANC Fineness Factor | Liming Rate | Liming Rate excluding ANC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | moles $H^+$/t | pH units | pH units | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | - | kg $CaCO_3$/t | kg $CaCO_3$/t |
| EQL | | | | | 2 | 0.1 | 0.1 | 2 | 2 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 0.5 | 1 | 1 |
| 56 | 2 | 175.31961, -37.18456 | 23-13954-79 | <10m elevation | - | 5 | - | 55 | - | <10 | - | - | - | - | - | 59.00 | 59.00 | 1.50 | 4.00 | 4.00 |
| 57 | 2 | 175.54561, -37.14794 | 23-13954-24 | <10m elevation | - | 4.6 | - | 71 | - | <10 | - | - | - | - | - | 71.00 | 71.00 | 1.50 | 5.00 | 5.00 |
| 60 | 2 | 175.4872, -37.21668 | 23-13954-26 | <10m elevation | - | 3.7 | - | 384 | - | 33 | - | - | - | 36 | - | 453.00 | 453.00 | 1.50 | 34.00 | 34.00 |
| 60 | 2 | 175.4872, -37.21668 | 23-13954-26 | <10m elevation | - | 5.1 | - | 44 | - | <10 | - | - | - | - | - | 44.00 | 44.00 | 1.50 | 3.00 | 3.00 |
| 61 | 0.5 | 175.21788, -37.83295 | 23-13954-90 | Peaty texture | - | 5.6 | - | 41 | - | <10 | - | - | - | - | - | 41.00 | 41.00 | 1.50 | 3.00 | 3.00 |
| 62 | 0.5 | 175.3432, -37.55061 | 23-13954-72 | Peaty texture | - | 5.1 | - | 12 | - | <10 | - | - | - | - | - | 12.00 | 12.00 | 1.50 | <1 | <1 |
| 63 | 2 | 175.42015, -37.2788 | 23-13954-27 | Peaty texture | - | 4.2 | - | 358 | - | 15 | - | - | - | 38 | - | 412.00 | 412.00 | 1.50 | 31.00 | 31.00 |
| 63 | 2 | 175.42015, -37.2788 | 23-13954-27 | Peaty texture | - | 4.6 | - | 38 | - | <10 | - | - | - | - | - | 38.00 | 38.00 | 1.50 | 3.00 | 3.00 |
| 65 | 1 | 175.19787, -37.76475 | 23-13954-16 | Peaty texture | - | 5 | - | 27 | - | <10 | - | - | - | - | - | 27.00 | 27.00 | 1.50 | 2.00 | 2.00 |
| 66 | 0.5 | 175.69609, -36.82363 | 23-13954-34 | Late Pleistocene river deposits | - | - | - | - | - | - | - | - | - | - | - | 579.00 | 579.00 | - | 43.00 | 43.00 |
| 67 | 0.9 | 175.32416, -37.7739 | 23-13954-65 | Historic wetland | - | 5 | - | 66 | - | 117 | - | - | - | - | - | 182.00 | 182.00 | 1.50 | 14.00 | 14.00 |
| 68 | 0.5 | 175.32061, -37.7703 | 23-13954-64 | Holocene swamp deposits | 4,210 | 3.4 | 2.1 | 454 | 3,750 | <10 | 125 | 21 | <10 | <10 | - | 463.00 | 463.00 | 1.50 | 35.00 | 35.00 |
| 69 | 2 | 175.30799, -37.82517 | 23-13954-46 | Low pH | - | - | - | - | - | - | - | - | - | - | - | 267.00 | 267.00 | - | 20.00 | 20.00 |
| 70 | 0.5 | 175.32077, -37.81916 | 23-13954-47 | Gley Soils | 662 | 4.8 | 3.9 | 150 | 512 | 34 | 117 | <10 | <10 | - | - | 184.00 | 184.00 | 1.50 | 14.00 | 14.00 |
| 71 | 0.5 | 175.68926, -37.96588 | 23-13954-94 | Historic wetland | - | 5 | - | 95 | - | 16 | - | - | - | - | - | 111.00 | 111.00 | 1.50 | 8.00 | 8.00 |
| 72 | 1 | 175.57082, -37.92687 | 23-13954-97 | Historic wetland | - | 4.8 | - | 61 | - | <10 | - | - | - | - | - | 61.00 | 61.00 | 1.50 | 4.00 | 4.00 |
| 73 | 0.9 | 175.68363, -37.37283 | 23-13954-68 | Holocene river deposits | - | 5.3 | - | 56 | - | <10 | - | - | - | - | - | 56.00 | 56.00 | 1.50 | 4.00 | 4.00 |
| 74 | 0.5 | 175.65717, -37.36427 | 23-13954-29 | Gley Soils | - | 5.1 | - | 15 | - | <10 | - | - | - | - | - | 15.00 | 15.00 | 1.50 | 1.00 | 1.00 |
| 75 | 1 | 175.5056, -37.2003 | 23-13954-25 | Gley Soils | - | 4.2 | - | 435 | - | <10 | - | - | - | 37 | - | 481.00 | 481.00 | 1.50 | 36.00 | 36.00 |
| 76 | 0.5 | 174.92985, -37.27729 | 23-13954-3 | Holocene river deposits | - | 4.2 | - | 416 | - | 14 | - | - | - | 44 | - | 474.00 | 474.00 | 1.50 | 36.00 | 36.00 |
| 78 | 2 | 174.74318, -37.3017 | 23-13954-4 | Gley Soils | - | 5 | - | 39 | - | <10 | - | - | - | - | - | 46.00 | 46.00 | 1.50 | 3.00 | 3.00 |
| 79 | 2 | 174.80117, -37.26241 | 23-13954-2 | Gley Soils | - | 5.4 | - | 14 | - | <10 | - | - | - | - | - | 20.00 | 20.00 | 1.50 | 2.00 | 2.00 |
| 80 | 1.65 | 174.75198, -37.32765 | 23-13954-1 | Holocene swamp deposits | - | 4 | - | 641 | - | 13 | - | - | - | 37 | - | 691.00 | 691.00 | 1.50 | 52.00 | 52.00 |
| 81 | 1 | 174.87794, -37.79996 | 23-13954-82 | Historic wetland | - | 4.6 | - | 76 | - | <10 | - | - | - | - | - | 76.00 | 76.00 | 1.50 | 6.00 | 6.00 |
| 82 | 1 | 175.85014, -36.99026 | 23-13954-36 | Historic wetland | - | 4.9 | - | 24 | - | <10 | - | - | - | - | - | 32.00 | 32.00 | 1.50 | 2.00 | 2.00 |
| 82 | 1 | 175.85014, -36.99026 | 23-13954-36 | Historic wetland | - | 4.8 | - | 22 | - | <10 | - | - | - | - | - | 28.00 | 28.00 | 1.50 | 2.00 | 2.00 |
| 85 | 0.4 | 175.20285, -37.9891 | 23-13954-85 | Late Pleistocene river deposits | - | 5 | - | 19 | - | <10 | - | - | - | - | - | 24.00 | 24.00 | 1.50 | 2.00 | 2.00 |
| 86 | 1.7 | 175.32934, -38.01117 | 23-13954-88 | Gley Soils | - | 4.6 | - | 247 | - | 66 | - | - | - | - | - | 313.00 | 313.00 | 1.50 | 23.00 | 23.00 |
| 87 | 0.5 | 175.24697, -37.73968 | 23-13954-23 | Gley Soils | - | 4.8 | - | 27 | - | <10 | - | - | - | - | - | 31.00 | 31.00 | 1.50 | 2.00 | 2.00 |
| 88 | 0.5 | 175.49858, -37.27567 | 23-13954-28 | Gley Soils | - | 5 | - | 18 | - | <10 | - | - | - | - | - | 24.00 | 24.00 | 1.50 | 2.00 | 2.00 |
| 89 | 1 | 175.60916, -37.32102 | 23-13954-31 | Gley Soils | - | 5 | - | 26 | - | <10 | - | - | - | - | - | 29.00 | 29.00 | 1.50 | 2.00 | 2.00 |
| 90 | 2 | 175.70485, -37.54856 | 23-13954-69 | Gley Soils | - | 3.9 | - | 261 | - | 16 | - | - | - | 4 | - | 323.00 | 323.00 | 1.50 | 24.00 | 24.00 |
| 91 | 1 | 175.53371, -37.66457 | 23-13954-51 | Late Pleistocene river deposits | - | 4.7 | - | 45 | - | <10 | - | - | - | - | - | 50.00 | 50.00 | 1.50 | 4.00 | 4.00 |
| 92 | 1 | 175.78426, -38.3706 | 23-13954-92 | Late Pleistocene river deposits | - | 4.1 | - | 381 | - | 46 | - | - | - | 26 | - | 453.00 | 453.00 | 1.50 | 34.00 | 34.00 |
| 93 | 0.5 | 175.78267, -37.07529 | 23-13954-38 | Gley Soils | - | 4.5 | - | 74 | - | 11 | - | - | - | - | - | 86.00 | 86.00 | 1.50 | 6.00 | 6.00 |
| 94 | 1 | 175.85618, -37.02313 | 23-13954-37 | Gley Soils | - | 4.6 | - | 40 | - | <10 | - | - | - | - | - | 49.00 | 49.00 | 1.50 | 4.00 | 4.00 |
| 94 | 1 | 175.85618, -37.02313 | 23-13954-37 | Holocene river deposits | - | 5.2 | - | 19 | - | <10 | - | - | - | - | - | 26.00 | 26.00 | 1.50 | 2.00 | 2.00 |
| 95 | 0.5 | 175.08683, -37.89756 | 23-11477-39 | Gley Soils | - | 5.6 | - | 12.00 | - | <10 | - | - | | - | - | 20.00 | 20.00 | 1.50 | 2.00 | 2.00 |
| 96 | 0.5 | 175.03304, -37.84773 | 23-13954-84 | Gley Soils | - | 8.5 | - | <2 | - | 48 | - | - | - | - | 2,820 | <10 | 48.00 | 1.50 | <1 | 4.00 |
| 97 | 1.55 | 175.60053, -36.75651 | 23-13954-33 | Historic wetland | - | 4.6 | - | 132 | - | 10 | - | - | - | - | - | 142.00 | 142.00 | 1.50 | 11.00 | 11.00 |
| 99 | 0.2 | 175.05703, -37.57277 | 23-13954-21 | Low pH | - | 6.2 | - | 2 | - | <10 | - | - | - | - | - | 10.00 | 10.00 | 1.50 | <1 | <1 |
| 100 | 0.5 | 175.63577, -37.77213 | 23-13954-57 | Gley Soils | - | 5 | - | 25 | - | <10 | - | - | - | - | - | 25.00 | 25.00 | 1.50 | 2.00 | 2.00 |
| 28B | 1 | 175.23977, -37.73404 | 23-13954-63 | Low pH | - | 4.4 | - | 124 | - | <10 | - | - | - | <10 | - | 135.00 | 135.00 | 1.50 | 10.00 | 10.00 |
| 34B | 1 | 175.23366, -37.73193 | 23-13954-43 | Low pH | - | 4.7 | - | 83 | - | <10 | - | - | - | - | - | 83.00 | 83.00 | 1.50 | 6.00 | 6.00 |
| 40B | 0.5 | 175.26065, -37.75497 | 23-13954-45 | Volcanics | - | 5.5 | - | 23 | - | <10 | - | - | - | - | - | 27.00 | 27.00 | 1.50 | 2.00 | 2.00 |
| 41C | 1 | 175.28961, -37.75067 | 23-13954-62 | Historic wetland | - | 5.3 | - | 34 | - | 30 | - | - | - | - | - | 65.00 | 65.00 | 1.50 | 5.00 | 5.00 |
| 43B | 2 | 175.55662, -37.64463 | 23-13954-50 | Historic wetland | - | 6.4 | - | <2 | - | <10 | - | - | - | - | - | <10 | <10 | 1.50 | <1 | <1 |
| 50B | 1.35 | 175.25428, -37.7647 | 23-13954-44 | Volcanics | - | 5 | - | 64 | - | <10 | - | - | - | - | - | 71.00 | 71.00 | 1.50 | 5.00 | 5.00 |
| 58B | 0.5 | 175.56213, -37.50023 | 23-13954-53 | <10m elevation | - | 5 | - | 23 | - | <10 | - | - | - | - | - | 23.00 | 23.00 | 1.50 | 2.00 | 2.00 |
| 59B | 1 | 175.13342, -37.56914 | 23-13954-40 | <10m elevation | - | 4.9 | - | 65 | - | <10 | - | - | - | - | - | 65.00 | 65.00 | 1.50 | 5.00 | 5.00 |
| 64B | 2 | 175.2728, -37.80065 | 23-13954-60 | Peaty texture | - | 5.8 | - | 4 | - | <10 | - | - | - | - | - | <10 | <10 | 1.50 | <1 | <1 |
| 77B | 0.8 | 175.19324, -37.61181 | 23-13954-41 | Volcanics | - | 5.3 | - | 92 | - | <10 | - | - | - | - | - | 92.00 | 92.00 | 1.50 | 7.00 | 7.00 |
| 77B | 0.8 | 175.19324, -37.61181 | 23-13954-41 | Volcanics | - | 5.7 | - | 6 | - | <10 | - | - | - | - | - | 11.00 | 11.00 | 1.50 | <1 | <1 |
| 83B | 1 | 175.24977, -37.77454 | 23-13954-48 | Late Pleistocene river deposits | - | 5.9 | - | 11 | - | <10 | - | - | - | - | - | 16.00 | 16.00 | 1.50 | 1.00 | 1.00 |
| 84B | 1 | 175.53845, -37.65498 | 23-13954-52 | Late Pleistocene river deposits | - | 5.4 | - | 18 | - | <10 | - | - | - | - | - | 18.00 | 18.00 | 1.50 | 1.00 | 1.00 |
| 8B | 0.5 | 175.24892, -37.75508 | 23-13954-61 | Holocene swamp deposits | - | 5.3 | - | 28 | - | <10 | - | - | - | - | - | 32.00 | 32.00 | 1.50 | 2.00 | 2.00 |
| 98B | 1.6 | 175.25706, -37.64269 | 23-13954-42 | Volcanics | - | 5 | - | 46 | - | <10 | - | - | - | - | - | 50.00 | 50.00 | 1.50 | 4.00 | 4.00 |

| Site ID | Depth | Location | LAB ID | Descriptor | Titratable Peroxide Acidity | $pH_{KCl}$ | $pH_{OX}$ | Titratable Actual Acidity | Titratable Sulfidic Acidity | Chromium Reducible Sulphur | Net Acid Soluble Sulfur | Acid Neutralising Capacity | Net Acidity | Net Acidity excluding ANC | ANC Fineness Factor | Liming Rate | Liming Rate excluding ANC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | moles $H^+$/t | pH units | pH units | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | - | kg $CaCO_3$/t | kg $CaCO_3$/t |
| EQL | | | | | 2 | 0.1 | 0.1 | 2 | 2 | 10 | 10 | 10 | 10 | 10 | 0.5 | 1 | 1 |
| 84B | 1 | 175.53845, -37.65498 | 23-13954-52 | Late Pleistocene river deposits | - | 5.4 | - | 18 | - | <10 | - | - | 18.00 | 18.00 | 1.50 | 1.00 | 1.00 |
| 2 | 0.5 | 175.30754, -37.67114 | 23-13954-22 | Holocene swamp deposits | - | 4.7 | - | 62 | - | 12 | - | - | 74.00 | 74.00 | 1.50 | 6.00 | 6.00 |
| 3 | 2 | 175.14846, -37.66146 | 23-13954-20 | Holocene swamp deposits | - | 5.2 | - | 16 | - | <10 | - | - | 19.00 | 19.00 | 1.50 | 1.00 | 1.00 |
| 4 | 1 | 174.95064, -37.26623 | 23-13954-6 | Holocene swamp deposits | 891 | 4.3 | 3 | 226 | 664 | 74 | <10 | - | 311.00 | 311.00 | 1.50 | 23.00 | 23.00 |
| 5 | 0.5 | 175.28117, -38.09486 | 23-13954-98 | Holocene swamp deposits | - | 4.8 | - | 73 | - | <10 | - | - | 73.00 | 73.00 | 1.50 | 5.00 | 5.00 |
| 6 | 0.9 | 175.30668, -37.91622 | 23-13954-89 | Holocene swamp deposits | - | 5.9 | - | 7 | - | 12 | - | - | 19.00 | 19.00 | 1.50 | 1.00 | 1.00 |
| 7 | 1 | 175.27246, -37.82038 | 23-13954-15 | Holocene swamp deposits | - | 4.6 | - | 69 | - | <10 | - | - | 72.00 | 72.00 | 1.50 | 5.00 | 5.00 |
| 10 | 2 | 175.05823, -37.25535 | 23-13954-5 | Holocene swamp deposits | - | 4.9 | - | 86 | - | 14 | - | - | 100.00 | 100.00 | 1.50 | 8.00 | 8.00 |
| 11 | 0.5 | 175.12955, -37.38958 | 23-13954-12 | Current wetland | - | 4.7 | - | 56 | - | 15 | - | - | 72.00 | 72.00 | 1.50 | 5.00 | 5.00 |
| 12 | 2 | 175.672, -37.37434 | 23-13954-55 | Holocene river deposits | - | 4.8 | - | 88 | - | <10 | - | - | 92.00 | 92.00 | 1.50 | 7.00 | 7.00 |
| 13 | 1 | 175.75866, -37.87975 | 23-13954-96 | Holocene river deposits | - | 4.4 | - | 160 | - | <10 | <10 | - | 160.00 | 160.00 | 1.50 | 12.00 | 12.00 |
| 14 | 1 | 175.20545, -37.69786 | 23-13954-19 | Holocene river deposits | - | 4.7 | - | 116 | - | 39 | - | - | 155.00 | 155.00 | 1.50 | 12.00 | 12.00 |
| 15 | 1 | 175.80547, -37.69603 | 23-13954-49 | Holocene river deposits | - | 4.9 | - | 42 | - | <10 | - | - | 42.00 | 42.00 | 1.50 | 3.00 | 3.00 |
| 16 | 1.15 | 175.46878, -37.77881 | 23-13954-59 | Holocene river deposits | - | 4.8 | - | 66 | - | 10 | - | - | 76.00 | 76.00 | 1.50 | 6.00 | 6.00 |
| 17 | 1 | 175.30043, -37.80948 | 23-13954-91 | Holocene river deposits | - | 5.2 | - | 17 | - | <10 | - | - | 21.00 | 21.00 | 1.50 | 2.00 | 2.00 |
| 18 | 0.95 | 175.51501, -37.6529 | 23-13954-71 | Holocene river deposits | 12 | 5.5 | 5.2 | 7 | 5 | <10 | - | - | <10 | <10 | 1.50 | 1.00 | 1.00 |
| 20 | 2 | 175.37209, -37.2917 | 23-13954-77 | Holocene river deposits | - | 5.1 | - | 48 | - | <10 | - | - | 48.00 | 48.00 | 1.50 | 4.00 | 4.00 |
| 21 | 0.8 | 175.58386, -37.73936 | 23-13954-58 | High pH | - | 5.1 | - | 27 | - | <10 | - | - | 32.00 | 32.00 | 1.50 | 2.00 | 2.00 |
| 22 | 0.5 | 174.90288, -37.82146 | 23-13954-83 | High pH | - | 4.9 | - | 43 | - | <10 | - | - | 43.00 | 43.00 | 1.50 | 3.00 | 3.00 |
| 23 | 1 | 175.28181, -38.09497 | 23-13954-87 | high pH | - | 5.9 | - | 9 | - | 75 | - | - | 85.00 | 85.00 | 1.50 | 6.00 | 6.00 |
| 24 | 1.55 | 175.49476, -37.50425 | 23-13954-66 | High pH | - | 5.9 | - | 7 | - | 146 | - | - | 153.00 | 153.00 | 1.50 | 12.00 | 12.00 |
| 25 | 2 | 175.62836, -37.60093 | 23-13954-70 | High pH | 43 | 6.4 | 4.6 | <2 | 43 | <10 | - | - | <10 | <10 | 1.50 | <1 | <1 |
| 27 | 1 | 175.20612, -37.19981 | 23-13954-80 | Low pH | 142 | 7.8 | 3.9 | <2 | 142 | 280 | - | 462 | <10 | 280.00 | 1.50 | <1 | 21.00 |
| 30 | 0.5 | 175.85591, -37.19329 | 23-13954-39 | low pH | - | 4.3 | - | 77 | - | <10 | 27 | - | 109.00 | 109.00 | 1.50 | 8.00 | 8.00 |
| 31 | 2 | 175.67812, -37.74856 | 23-13954-56 | low pH | - | 4.5 | - | 54 | - | <10 | - | - | 64.00 | 64.00 | 1.50 | 5.00 | 5.00 |
| 32 | 1.8 | 175.21261, -38.18906 | 23-13954-86 | Low pH | - | 4.4 | - | 83 | - | 53 | 14 | - | 150.00 | 150.00 | 1.50 | 11.00 | 11.00 |
| 33 | 0.95 | 175.23583, -37.74153 | 23-13954-18 | Low pH | - | 3.9 | - | 182 | - | <10 | 19 | - | 211.00 | 211.00 | 1.50 | 16.00 | 16.00 |
| 35 | 0.5 | 175.85122, -38.22545 | 23-13954-93 | Low pH | - | 4.4 | - | 62 | - | <10 | <10 | - | 72.00 | 72.00 | 1.50 | 5.00 | 5.00 |
| 36 | 0.5 | 175.24143, -37.47588 | 23-13954-74 | Current wetland | - | 4.4 | - | 107 | - | <10 | <10 | - | 111.00 | 111.00 | 1.50 | 8.00 | 8.00 |
| 42 | 0.5 | 175.66898, -37.94247 | 23-13954-95 | Historic wetland | 62 | 5.9 | 4.5 | 11 | 51 | 34 | - | - | 44.00 | 44.00 | 1.50 | 3.00 | 3.00 |
| 44 | 1.3 | 175.27644, -37.35435 | 23-11477-29 | Historic wetland | - | 4.8 | - | 32.00 | - | <10 | - | - | 32.00 | 32.00 | 1.50 | 2.00 | 2.00 |
| 45 | 0.95 | 175.4102, -37.33922 | 23-13954-78 | Historic wetland | 203 | 6.7 | 3.2 | <2 | 203 | 26 | - | 74 | <10 | 26.00 | 1.50 | <1 | 2.00 |
| 47 | 1 | 175.57329, -37.48989 | 23-13954-54 | Wetland vegetation | - | 4.8 | - | 50 | - | <10 | - | - | 50.00 | 50.00 | 1.50 | 4.00 | 4.00 |
| 48 | 2 | 175.51268, -37.46353 | 23-13954-67 | Wetland vegetation | - | 4.6 | - | 39 | - | <10 | - | - | 43.00 | 43.00 | 1.50 | 3.00 | 3.00 |
| 49 | 0.5 | 175.19516, -37.4887 | 23-13954-73 | Wetland vegetation | 12 | 5.4 | 4.6 | 8 | 4 | <10 | - | - | <10 | <10 | 1.50 | <1 | <1 |
| 52 | 1 | 175.13684, -37.43094 | 23-13954-10 | Wetland vegetation | - | 5 | - | 65 | - | <10 | - | - | 71.00 | 71.00 | 1.50 | 5.00 | 5.00 |

| Site ID | Depth | Location | LAB ID | Descriptor | Titratable Peroxide Acidity | $pH_{KCl}$ | $pH_{OX}$ | Titratable Actual Acidity | Titratable Sulfidic Acidity | Chromium Reducible Sulphur | Net Acid Soluble Sulfur | Acid Neutralising Capacity | Net Acidity | Net Acidity excluding ANC | ANC Fineness Factor | Liming Rate | Liming Rate excluding ANC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | moles $H^+$/t | pH units | pH units | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | - | kg $CaCO_3$/t | kg $CaCO_3$/t |
| EQL | | | | | 2 | 0.1 | 0.1 | 2 | 2 | 10 | 10 | 10 | 10 | 10 | 0.5 | 1 | 1 |
| 53 | 2 | 175.2027, -37.39224 | 23-13954-11 | Wetland vegetation | - | 5.50 | - | 33 | - | <10 | - | - | 33.00 | 33.00 | 1.50 | 2.00 | 2.00 |
| 54 | 2 | 175.1866, -37.38038 | 23-13954-75 | Wetland vegetation | - | 5.6 | - | 32 | - | <10 | - | - | 36.00 | 36.00 | 1.50 | 3.00 | 3.00 |
| 56 | 2 | 175.31961, -37.18456 | 23-13954-79 | <10m elevation | - | 5 | - | 55 | - | <10 | - | - | 59.00 | 59.00 | 1.50 | 4.00 | 4.00 |
| 57 | 2 | 175.54561, -37.14794 | 23-13954-24 | <10m elevation | - | 4.6 | - | 71 | - | <10 | - | - | 71.00 | 71.00 | 1.50 | 5.00 | 5.00 |
| 60 | 2 | 175.4872, -37.21668 | 23-13954-26 | <10m elevation | - | 3.7 | - | 384 | - | 33 | 36 | - | 453.00 | 453.00 | 1.50 | 34.00 | 34.00 |
| 61 | 0.5 | 175.21788, -37.83295 | 23-13954-90 | Peaty texture | - | 5.6 | - | 41 | - | <10 | - | - | 41.00 | 41.00 | 1.50 | 3.00 | 3.00 |
| 63 | 2 | 175.42015, -37.2788 | 23-13954-27 | Peaty texture | - | 4.2 | - | 358 | - | 15 | 38 | - | 412.00 | 412.00 | 1.50 | 31.00 | 31.00 |
| 65 | 1 | 175.19787, -37.76475 | 23-13954-16 | Peaty texture | - | 5 | - | 27 | - | <10 | - | - | 27.00 | 27.00 | 1.50 | 2.00 | 2.00 |
| 67 | 0.9 | 175.32416, -37.7739 | 23-13954-65 | Historic wetland | - | 5 | - | 66 | - | 117 | - | - | 182.00 | 182.00 | 1.50 | 14.00 | 14.00 |
| 68 | 0.5 | 175.32061, -37.7703 | 23-13954-64 | Holocene swamp deposits | 4,210 | 3.4 | 2.1 | 454 | 3,750 | <10 | <10 | - | 463.00 | 463.00 | 1.50 | 35.00 | 35.00 |
| 70 | 0.5 | 175.32077, -37.81916 | 23-13954-47 | Gley Soils | 662 | 4.8 | 3.9 | 150 | 512 | 34 | - | - | 184.00 | 184.00 | 1.50 | 14.00 | 14.00 |
| 71 | 0.5 | 175.68926, -37.96588 | 23-13954-94 | Historic wetland | - | 5 | - | 95 | - | 16 | - | - | 111.00 | 111.00 | 1.50 | 8.00 | 8.00 |
| 72 | 1 | 175.57082, -37.92687 | 23-13954-97 | Historic wetland | - | 4.8 | - | 61 | - | <10 | - | - | 61.00 | 61.00 | 1.50 | 4.00 | 4.00 |
| 73 | 0.9 | 175.68363, -37.37283 | 23-13954-68 | Holocene river deposits | - | 5.3 | - | 56 | - | <10 | - | - | 56.00 | 56.00 | 1.50 | 4.00 | 4.00 |
| 75 | 1 | 175.5056, -37.2003 | 23-13954-25 | Gley Soils | - | 4.2 | - | 435 | - | <10 | 37 | - | 481.00 | 481.00 | 1.50 | 36.00 | 36.00 |
| 76 | 0.5 | 174.92985, -37.27729 | 23-13954-3 | Holocene river deposits | - | 4.2 | - | 416 | - | 14 | 44 | - | 474.00 | 474.00 | 1.50 | 36.00 | 36.00 |
| 78 | 2 | 174.74318, -37.3017 | 23-13954-4 | Gley Soils | - | 5 | - | 39 | - | <10 | - | - | 46.00 | 46.00 | 1.50 | 3.00 | 3.00 |
| 79 | 2 | 174.80117, -37.26241 | 23-13954-2 | Gley Soils | - | 5.4 | - | 14 | - | <10 | - | - | 20.00 | 20.00 | 1.50 | 2.00 | 2.00 |
| 80 | 1.65 | 174.75198, -37.32765 | 23-13954-1 | Holocene swamp deposits | - | 4 | - | 641 | - | 13 | 37 | - | 691.00 | 691.00 | 1.50 | 52.00 | 52.00 |
| 81 | 1 | 174.87794, -37.79996 | 23-13954-82 | Historic wetland | - | 4.6 | - | 76 | - | <10 | - | - | 76.00 | 76.00 | 1.50 | 6.00 | 6.00 |
| 82 | 1 | 175.85014, -36.99026 | 23-13954-36 | Historic wetland | - | 4.8 | - | 22 | - | <10 | - | - | 28.00 | 28.00 | 1.50 | 2.00 | 2.00 |
| 85 | 0.4 | 175.20285, -37.9891 | 23-13954-85 | Late Pleistocene river deposits | - | 5 | - | 19 | - | <10 | - | - | 24.00 | 24.00 | 1.50 | 2.00 | 2.00 |
| 86 | 1.7 | 175.32934, -38.01117 | 23-13954-88 | Gley Soils | - | 4.6 | - | 247 | - | 66 | - | - | 313.00 | 313.00 | 1.50 | 23.00 | 23.00 |
| 87 | 0.5 | 175.24697, -37.73968 | 23-13954-23 | Gley Soils | - | 4.8 | - | 27 | - | <10 | - | - | 31.00 | 31.00 | 1.50 | 2.00 | 2.00 |
| 88 | 0.5 | 175.49858, -37.27567 | 23-13954-28 | Gley Soils | - | 5 | - | 18 | - | <10 | - | - | 24.00 | 24.00 | 1.50 | 2.00 | 2.00 |
| 89 | 1 | 175.60916, -37.32102 | 23-13954-31 | Gley Soils | - | 5 | - | 26 | - | <10 | - | - | 29.00 | 29.00 | 1.50 | 2.00 | 2.00 |
| 90 | 2 | 175.70485, -37.54856 | 23-13954-69 | Gley Soils | - | 3.9 | - | 261 | - | 16 | 4 | - | 323.00 | 323.00 | 1.50 | 24.00 | 24.00 |
| 91 | 1 | 175.53371, -37.66457 | 23-13954-51 | Late Pleistocene river deposits | - | 4.7 | - | 45 | - | <10 | - | - | 50.00 | 50.00 | 1.50 | 4.00 | 4.00 |
| 92 | 1 | 175.78426, -38.3706 | 23-13954-92 | Late Pleistocene river deposits | - | 4.1 | - | 381 | - | 46 | 26 | - | 453.00 | 453.00 | 1.50 | 34.00 | 34.00 |
| 93 | 0.5 | 175.78267, -37.07529 | 23-13954-38 | Gley Soils | - | 4.5 | - | 74 | - | 11 | - | - | 86.00 | 86.00 | 1.50 | 6.00 | 6.00 |
| 94 | 1 | 175.85618, -37.02313 | 23-13954-37 | Gley Soils | - | 4.6 | - | 40 | - | <10 | - | - | 49.00 | 49.00 | 1.50 | 4.00 | 4.00 |
| 95 | 0.5 | 175.08683, -37.89756 | 23-11477-39 | Gley Soils | - | 5.6 | - | 12.00 | - | <10 | - | - | 20.00 | 20.00 | 1.50 | 2.00 | 2.00 |
| 96 | 0.5 | 175.03304, -37.84773 | 23-13954-84 | Gley Soils | - | 8.5 | - | <2 | - | 48 | - | 2,820 | <10 | 48.00 | 1.50 | <1 | 4.00 |
| 97 | 1.55 | 175.60053, -36.75651 | 23-13954-33 | Historic wetland | - | 4.6 | - | 132 | - | 10 | - | - | 142.00 | 142.00 | 1.50 | 11.00 | 11.00 |
| 100 | 0.5 | 175.63577, -37.77213 | 23-13954-57 | Gley Soils | - | 5 | - | 25 | - | <10 | - | - | 25.00 | 25.00 | 1.50 | 2.00 | 2.00 |
| 28B | 1 | 175.23977, -37.73404 | 23-13954-63 | Low pH | - | 4.4 | - | 124 | - | <10 | <10 | - | 135.00 | 135.00 | 1.50 | 10.00 | 10.00 |
| 34B | 1 | 175.23366, -37.73193 | 23-13954-43 | Low pH | - | 4.7 | - | 83 | - | <10 | - | - | 83.00 | 83.00 | 1.50 | 6.00 | 6.00 |
| 40B | 0.5 | 175.26065, -37.75497 | 23-13954-45 | Volcanics | - | 5.5 | - | 23 | - | <10 | - | - | 27.00 | 27.00 | 1.50 | 2.00 | 2.00 |
| 41C | 1 | 175.28961, -37.75067 | 23-13954-62 | Historic wetland | - | 5.3 | - | 34 | - | 30 | - | - | 65.00 | 65.00 | 1.50 | 5.00 | 5.00 |
| 50B | 1.35 | 175.25428, -37.7647 | 23-13954-44 | Volcanics | - | 5 | - | 64 | - | <10 | - | - | 71.00 | 71.00 | 1.50 | 5.00 | 5.00 |
| 58B | 0.5 | 175.56213, -37.50023 | 23-13954-53 | <10m elevation | - | 5 | - | 23 | - | <10 | - | - | 23.00 | 23.00 | 1.50 | 2.00 | 2.00 |
| 59B | 1 | 175.13342, -37.56914 | 23-13954-40 | <10m elevation | - | 4.9 | - | 65 | - | <10 | - | - | 65.00 | 65.00 | 1.50 | 5.00 | 5.00 |
| 77B | 0.8 | 175.19324, -37.61181 | 23-13954-41 | Volcanics | - | 5.3 | - | 92 | - | <10 | - | - | 92.00 | 92.00 | 1.50 | 7.00 | 7.00 |
| 8B | 0.5 | 175.24892, -37.75508 | 23-13954-61 | Holocene swamp deposits | - | 5.3 | - | 28 | - | <10 | - | - | 32.00 | 32.00 | 1.50 | 2.00 | 2.00 |
| 98B | 0.95 | 175.25706, -37.64269 | 23-13954-42 | Volcanics | - | 5 | - | 46 | - | <10 | - | - | 50.00 | 50.00 | 1.50 | 4.00 | 4.00 |

# Appendix D
# Table 3
# SPOCAS Results Table

| Site ID | Depth | Location | LAB ID | Descriptor | Titratable Peroxide Acidity | $pH_{KCl}$ | $pH_{OX}$ | Titratable Actual Acidity | Titratable Sulfidic Acidity | Peroxide Oxidisable Sulfur | Acid Reacted Calcium | Acid Reacted Magnesium | Net Acid Soluble Sulfur | Acid Neutralising Capacity | Net Acidity | Net Acidity excluding ANC | ANC Fineness Factor | Liming Rate | Liming Rate excluding ANC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | moles $H^+$/t | pH units | pH units | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | moles $H^+$/t | - | kg $CaCO_3$/t | kg $CaCO_3$/t |
| EQL | | | | | 2 | 0.1 | 0.1 | 2 | 2 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 0.5 | 1 | 1 |
| 4 | 1.00 | 174.95064, -37.26623 | 23-13954-6 | Holocene swamp deposits | 891 | 4.3 | 3 | 226 | 664 | 202 | 12 | 10 | <10 | - | 311.00 | 311.00 | 1.50 | 23.00 | 23.00 |
| 18 | 0.95 | 175.51501, -37.6529 | 23-13954-71 | Holocene river deposits | 12 | 5.5 | 5.2 | 7 | 5 | <10 | <10 | <10 | - | - | <10 | <10 | 1.50 | 1.00 | 1.00 |
| 25 | 2.00 | 175.62836, -37.60093 | 23-13954-70 | High pH | 43 | 6.4 | 4.6 | <2 | 43 | 48 | 18 | <10 | - | - | <10 | <10 | 1.50 | <1 | <1 |
| 27 | 1.00 | 175.20612, -37.19981 | 23-13954-80 | Low pH | 142 | 7.8 | 3.9 | <2 | 142 | 334 | <10 | 36 | - | 462 | <10 | 280.00 | 1.50 | <1 | 21.00 |
| 42 | 0.50 | 175.66898, -37.94247 | 23-13954-95 | Historic wetland | 62 | 5.9 | 4.5 | 11 | 51 | 62 | <10 | <10 | - | - | 44.00 | 44.00 | 1.50 | 3.00 | 3.00 |
| 45 | 0.95 | 175.4102, -37.33922 | 23-13954-78 | Historic wetland | 203 | 6.7 | 3.2 | <2 | 203 | 86 | <10 | <10 | - | 74 | <10 | 26.00 | 1.50 | <1 | 2.00 |
| 49 | 0.50 | 175.19516, -37.4887 | 23-13954-73 | Wetland vegetation | 12 | 5.4 | 4.6 | 8 | 4 | <10 | <10 | <10 | - | - | <10 | <10 | 1.50 | <1 | <1 |
| 70 | 0.50 | 175.32077, -37.81916 | 23-13954-47 | Gley Soils | 662 | 4.8 | 3.9 | 150 | 512 | 117 | <10 | <10 | - | - | 184.00 | 184.00 | 1.50 | 14.00 | 14.00 |
| 68 | 0.50 | 175.32061, -37.7703 | 23-13954-64 | Holocene swamp deposits | 4,210 | 3.4 | 2.1 | 454 | 3,750 | 125 | 21 | <10 | <10 | - | 463.00 | 463.00 | 1.50 | 35.00 | 35.00 |

# Appendix D
# Table 4
# pH and Field Descriptions Table

| Site ID | Depth | Location | Field pH Test ($pH_f$) | Field pH (oxidised, $pH_{ox}$) | $pH_{ox}$ - $pH_f$ ($\Delta pH$) | Reaction to peroxide | Descriptor | Sample location | Oxidation and secondary mineralisation (e.g. Jarosite) | Texture | Organic matter content | Carbonates | Water level and moisture | Sulfureous odour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.5m | 175.23375, -37.73923 | 6.29 | 4.43 | -1.86 | X - Slight Reaction | Holocene swamp deposits | Ashurst Park | Moderate oxidation, no jarosite | Sandy Silt | Low | None | Moderate Moisture | - |
| 1 | 1.0m | 175.23375, -37.73923 | 6.21 | 4.25 | -1.96 | X - Slight Reaction | Holocene swamp deposits | Ashurst Park | Moderate oxidation, no jarosite | Sandy Silt | Low | None | Moderate Moisture | - |
| 2 | 1.0m | 175.30754, -37.67114 | 5.79 | 4.1 | -1.69 | X - Slight Reaction | Holocene swamp deposits | Gordonton | Low oxidation, no jarosite | Silt/sand | Low | None | None | - |
| 2 | 0.5m | 175.30754, -37.67114 | 5.18 | 3.55 | -1.63 | X - Slight Reaction | Holocene swamp deposits | Gordonton | Low oxidation, no jarosite | Silt/sand | Low | None | None | - |
| 3 | 2.0m | 175.14846, -37.66146 | 6.34 | 3.81 | -2.53 | X - Slight Reaction | Holocene swamp deposits | Ngaruawahia | No oxidation, no jarosite | Peat | High | None | Moderate Moisture | - |
| 3 | 1.0m | 175.14846, -37.66146 | 6.18 | 3.77 | -2.41 | X - Slight Reaction | Holocene swamp deposits | Ngaruawahia | No oxidation, no jarosite | Peat | High | None | Moderate Moisture | - |
| 4 | 0.5m | 174.95064, -37.26623 | 4.9 | 3.35 | -1.55 | XX - Moderate Reaction | Holocene swamp deposits | Te Kauwhata | Low oxidation, no jarosite | Sand | Low | None | None | - |
| 4 | 1.0m | 174.95064, -37.26623 | 4.69 | 3.21 | -1.48 | X - Slight Reaction | Holocene swamp deposits | Te Kauwhata | Low oxidation, no jarosite | Sand | Low | None | None | - |
| 5 | .95m | 175.28117, -38.09486 | 6.05 | 4.57 | -1.48 | X - Slight Reaction | Holocene swamp deposits | Te Kawa | No oxidation, no jarosite | Sandy Silt | Low | None | None | - |
| 5 | 0.5m | 175.28117, -38.09486 | 5.73 | 4.14 | -1.59 | XXXX - Very Vigorous Reaction | Holocene swamp deposits | Te Kawa | No oxidation, no jarosite | Sandy Silt | Low | None | None | - |
| 6 | 0.5m | 175.30668, -37.91622 | 6.68 | 4.51 | -2.17 | X - Slight Reaction | Holocene swamp deposits | Ohaupo | No oxidation, no jarosite | Silt | Moderate | None | Low Moisture | - |
| 6 | 0.9m | 175.30668, -37.91622 | 6.3 | 4.46 | -1.84 | X - Slight Reaction | Holocene swamp deposits | Ohaupo | No oxidation, no jarosite | Silt | Moderate | None | Low Moisture | - |
| 7 | 2.0m | 175.27246, -37.82038 | 5.61 | 3.76 | -1.85 | X - Slight Reaction | Holocene swamp deposits | Deanswell Park | No oxidation, no jarosite | Silt | High | None | Low Moisture | - |
| 7 | 1.0m | 175.27246, -37.82038 | 5.04 | 3.56 | -1.48 | X - Slight Reaction | Holocene swamp deposits | Deanswell Park | No oxidation, no jarosite | Silt | High | None | Low Moisture | - |
| 9 | 1.0m | 175.14538, -37.47825 | 7.41 | 4.36 | -3.05 | XX - Moderate Reaction | Holocene swamp deposits | Lake Rotongaro | Low oxidation, no jarosite | Sand | Low | None | None | - |
| 9 | 2.0m | 175.14538, -37.47825 | 6.72 | 4.39 | -2.33 | X - Slight Reaction | Holocene swamp deposits | Lake Rotongaro | Low oxidation, no jarosite | Sand | Low | None | None | - |
| 10 | 2.0m | 175.05823, -37.25535 | 5.19 | 1.09 | -4.1 | XXXX - Very Vigorous Reaction | Holocene swamp deposits | McIntyre Rd, Pokeno | No oxidation, no jarosite | Peat | High | Low | Moderate Moisture | - |
| 10 | 1.0m | 175.05823, -37.25535 | 4.87 | 1.6 | -3.27 | XX - Moderate Reaction | Holocene swamp deposits | McIntyre Rd, Pokeno | No oxidation, no jarosite | Peat | High | Low | Moderate Moisture | - |
| 11 | 0.75m | 175.12955, -37.38958 | 5.14 | 2.46 | -2.68 | X - Slight Reaction | Current wetland | Te Kauwhata at Orchard Rd pump station | No oxidation, no jarosite | Silt | Moderate | None | None | - |
| 11 | 0.5m | 175.12955, -37.38958 | 4.87 | 1.95 | -2.92 | X - Slight Reaction | Current wetland | Te Kauwhata at Orchard Rd pump station | No oxidation, no jarosite | Silt | Moderate | None | None | - |
| 12 | 2.0m | 175.672, -37.37434 | 6.31 | 1.71 | -4.6 | XX - Moderate Reaction | Holocene river deposits | Paeroa | No oxidation, no jarosite | Peat | High | None | Waterlogged | Yes |
| 12 | 1.0m | 175.672, -37.37434 | 5.93 | 2.22 | -3.71 | XXX - High Reaction | Holocene river deposits | Paeroa | No oxidation, no jarosite | Peat | High | None | Waterlogged | Yes |
| 13 | 2.0m | 175.75866, -37.87975 | 6.39 | 5.04 | -1.35 | X - Slight Reaction | Holocene river deposits | Hinuera | No oxidation, no jarosite | Sand | Low | None | None | - |
| 13 | 1.0m | 175.75866, -37.87975 | 5.91 | 4.73 | -1.18 | X - Slight Reaction | Holocene river deposits | Hinuera | No oxidation, no jarosite | Sand | Low | None | None | - |
| 14 | 2.0m | 175.20545, -37.69786 | 6.78 | 4.55 | -2.23 | X - Slight Reaction | Holocene river deposits | Horotiu Bridge | No oxidation, no jarosite | Silt | Low | None | None | - |
| 14 | 1.0m | 175.20545, -37.69786 | 5.8 | 3.67 | -2.13 | X - Slight Reaction | Holocene river deposits | Horotiu Bridge | No oxidation, no jarosite | Silt | Low | None | None | - |
| 15 | 2.0m | 175.80547, -37.69603 | 6.39 | 5.11 | -1.28 | X - Slight Reaction | Holocene river deposits | Armdale Rd @ Wardville | No oxidation, no jarosite | Sand | None | None | None | - |
| 15 | 1.0m | 175.80547, -37.69603 | 6.1 | 4.71 | -1.39 | X - Slight Reaction | Holocene river deposits | Armdale Rd @ Wardville | No oxidation, no jarosite | Sand | None | None | None | - |
| 16 | 1.15m | 175.46878, -37.77881 | 6.29 | 4.28 | -2.01 | XX - Moderate Reaction | Holocene river deposits | Tauwhare @ scotsman Valley Rd | Moderate oxidation, no jarosite | Silt | Low | None | None | - |
| 16 | 0.5m | 175.46878, -37.77881 | 5.64 | 4.94 | -0.7 | XXXX - Very Vigorous Reaction | Holocene river deposits | Tauwhare @ scotsman Valley Rd | Moderate oxidation, no jarosite | Silt | Low | None | None | - |
| 17 | 1.0m | 175.30043, -37.80948 | 6.9 | 5.15 | -1.75 | X - Slight Reaction | Holocene river deposits | Peacocke esplanade | No oxidation, no jarosite | Sand | None | None | None | - |
| 17 | 2.0m | 175.30043, -37.80948 | 6.76 | 5.45 | -1.31 | X - Slight Reaction | Holocene river deposits | Peacocke esplanade | No oxidation, no jarosite | Sand | None | None | None | - |
| 18 | 0.95m | 175.51501, -37.6529 | 5.84 | 4.65 | -1.19 | X - Slight Reaction | Holocene river deposits | Morrinsville @ Wisely reserve | High oxidation, no jarosite | Silt | Low | None | Moderate Moisture | - |
| 19 | 0.5m | 175.29931, -37.37999 | 5.8 | 3.72 | -2.08 | XX - Moderate Reaction | Holocene river deposits | Waeranga @ Taniwha Rd | Low oxidation, no jarosite | Silt | Low | None | None | - |
| 19 | 1.0m | 175.29931, -37.37999 | 5.6 | 3.99 | -1.61 | X - Slight Reaction | Holocene river deposits | Waeranga @ Taniwha Rd | Low oxidation, no jarosite | Silt | Low | None | None | - |
| 20 | 2.0m | 175.37209, -37.2917 | 5.93 | 3.33 | -2.6 | XX - Moderate Reaction | Holocene river deposits | Hauraki golf course | No oxidation, no jarosite | Sand | None | None | None | - |
| 20 | 1.0m | 175.37209, -37.2917 | 5.55 | 3.26 | -2.29 | XX - Moderate Reaction | Holocene river deposits | Hauraki golf course | No oxidation, no jarosite | Sand | None | None | None | - |
| 21 | 0.8m | 175.58386, -37.73936 | 6.54 | 5.22 | -1.32 | XXXX - Very Vigorous Reaction | High pH | Kiwitahi school | No oxidation, no jarosite | Silt | Low | None | Low Moisture | - |
| 21 | 0.5m | 175.58386, -37.73936 | 6.34 | 5.22 | -1.12 | XXXX - Very Vigorous Reaction | High pH | Kiwitahi school | No oxidation, no jarosite | Silt | Low | None | Low Moisture | - |
| 22 | 0.5m | 174.90288, -37.82146 | 5.55 | 3.41 | -2.14 | X - Slight Reaction | High pH | Three rivers | No oxidation, no jarosite | Silt | Low | None | Low Moisture | - |
| 22 | 1.0m | 174.90288, -37.82146 | 4.81 | 3.43 | -1.38 | X - Slight Reaction | High pH | Three rivers | No oxidation, no jarosite | Silt | Low | None | Low Moisture | - |
| 23 | 1.0m | 175.28181, -38.09497 | 6.93 | 5.08 | -1.85 | X - Slight Reaction | high pH | Te Kawa | Low oxidation, no jarosite | Silt | Low | None | None | - |
| 23 | 2.0m | 175.28181, -38.09497 | 6.84 | 6.5 | -0.34 | X - Slight Reaction | High pH | Te Kawa | Low oxidation, no jarosite | Silt | Low | None | None | - |
| 24 | 1.0m | 175.49476, -37.50425 | 5.33 | 4.15 | -1.18 | X - Slight Reaction | High pH | Tahuna golf course | Moderate oxidation, no jarosite | Silt/Clay | Moderate | None | Moderate Moisture | - |
| 24 | 1.55m | 175.49476, -37.50425 | 5.32 | 3.84 | -1.48 | X - Slight Reaction | High pH | Tahuna golf course | Moderate oxidation, no jarosite | Silt/Clay | Moderate | None | Moderate Moisture | - |
| 25 | 2.0m | 175.62836, -37.60093 | 6.32 | 4.19 | -2.13 | XX - Moderate Reaction | High pH | Waitoa | Low oxidation, no jarosite | Peaty Clay | Moderate | None | Moderate Moistures | - |
| 26 | 0.5m | 174.95255, -37.26015 | 6.23 | 5.18 | -1.05 | XXXX - Very Vigorous Reaction | Low pH | Tuakau @ Centennial Park | Moderate oxidation, no jarosite | Peat | Moderate | None | None | - |
| 26 | 1.0m | 174.95255, -37.26015 | 5.78 | 3.64 | -2.14 | XXXX - Very Vigorous Reaction | Low pH | Tuakau @ Centennial Park | Moderate oxidation, no jarosite | Peat | Moderate | None | None | - |

| Site ID | Depth | Location | Field pH Test ($pH_f$) | Field pH (oxidised, $pH_{ox}$) | $pH_{ox}$ - $pH_f$ ($\Delta pH$) | Reaction to peroxide | Descriptor | Sample location | Oxidation and secondary mineralisation (e.g. Jarosite) | Texture | Organic matter content | Carbonates | Water level and moisture | Sulfureous odour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 27 | 0.4m | 175.20612, -37.19981 | 5.86 | 4.21 | -1.65 | XXXX - Very Vigorous Reaction | Low pH | Mangatangi School | Low oxidation, no jarosite | Peaty Silt | High | None | Moderate Moisture | - |
| 27 | 1.0m | 175.20612, -37.19981 | 4.97 | 3.87 | -1.1 | X - Slight Reaction | Low pH | Mangatangi School | Low oxidation, no jarosite | Peaty Silt | High | None | Moderate Moisture | - |
| 29 | 1.0m | 175.70686, -36.83448 | 8.14 | 6.43 | -1.71 | X - Slight Reaction | Low pH | Whitianga low-lying | Low oxidation, no jarosite | Peat | Moderate | High | Moderate Moisture | - |
| 29 | 1.7m | 175.70686, -36.83448 | 8.07 | 6.46 | -1.61 | X - Slight Reaction | Low pH | Whitianga low-lying | Low oxidation, no jarosite | Peat | Moderate | High | Moderate Moisture | - |
| 30 | 0.5m | 175.85591, -37.19329 | 6.05 | 3.56 | -2.49 | XX - Moderate Reaction | Low pH | Whangamata | Low oxidation, no jarosite | Peat | High | None | Moderate Moisture | - |
| 30 | 1.0m | 175.85591, -37.19329 | 5.99 | 3.53 | -2.46 | XXX - High Reaction | Low pH | Whangamata | Low oxidation, no jarosite | Peat | High | None | Moderate Moisture | - |
| 31 | 2.0m | 175.67812, -37.74856 | 6.17 | 1.55 | -4.62 | XXX - High Reaction | Low pH | Piakoiti Rd | No oxidation, no jarosite | Silt | Moderate | None | Waterlogged | - |
| 31 | 1.0m | 175.67812, -37.74856 | 5.94 | 4.21 | -1.73 | XXXX - Very Vigorous Reaction | Low pH | Piakoiti Rd | No oxidation, no jarosite | Silt | Moderate | None | Waterlogged | - |
| 32 | 1.8m | 175.21261, -38.18906 | 6.55 | 2.38 | -4.17 | XX - Moderate Reaction | Low pH | Otorohanga @ Huiputea pump station | No oxidation, no jarosite | Silt | Moderate | None | Waterlogged | - |
| 32 | 1.0m | 175.21261, -38.18906 | 6.28 | 2.54 | -3.74 | XX - Moderate Reaction | Low pH | Otorohanga @ Huiputea pump station | No oxidation, no jarosite | Silt | Moderate | None | Waterlogged | - |
| 33 | 0.95m | 175.23583, -37.74153 | 5.39 | 3.8 | -1.59 | X - Slight Reaction | Low pH | Ashurst Park | Low oxidation, no jarosite | Silt | Low | None | None | - |
| 33 | 0.5m | 175.23583, -37.74153 | 5.16 | 3.76 | -1.4 | X - Slight Reaction | Low pH | Ashurst Park | Low oxidation, no jarosite | Silt | Low | None | None | - |
| 35 | 2.0m | 175.85122, -38.22545 | 6.09 | 4.9 | -1.19 | X - Slight Reaction | Low pH | Tokoroa @ James Higgins Park | Low oxidation, no jarosite | Silt | Low | Low | Waterlogged | - |
| 35 | 0.5m | 175.85122, -38.22545 | 5.81 | 4.72 | -1.09 | X - Slight Reaction | Low pH | Tokoroa @ James Higgins Park | Low oxidation, no jarosite | Silt | Low | Low | Waterlogged | - |
| 36 | 0.95m | 175.24143, -37.47588 | 5.67 | 3.69 | -1.98 | XX - Moderate Reaction | Current wetland | Lake Waikare @ Waikare Rd | Low oxidation, no jarosite | Sand | None | None | None | - |
| 36 | 0.5m | 175.24143, -37.47588 | 5.37 | 3.01 | -2.36 | XX - Moderate Reaction | Current wetland | Lake Waikare @ Waikare Rd | Low oxidation, no jarosite | Sand | None | None | None | - |
| 37 | 0.5m | 175.13095, -37.39122 | 5.52 | 3.62 | -1.9 | X - Slight Reaction | Current wetland | Te Kauwhata | Moderate oxidation, no jarosite | Sand | Low | None | None | - |
| 37 | 0.75m | 175.13095, -37.39122 | 5.33 | 3.9 | -1.43 | X - Slight Reaction | Current wetland | Te Kauwhata | Moderate oxidation, no jarosite | Sand | Low | None | None | - |
| 38 | 0.75m | 175.48331, -37.34075 | 5.08 | 2.98 | -2.1 | X - Slight Reaction | Current wetland | Kaihare Rd | High oxidation, no jarosite | Sand | None | None | None | - |
| 38 | 0.5m | 175.48331, -37.34075 | 4.91 | 3.26 | -1.65 | X - Slight Reaction | Current wetland | Kaihare Rd | High oxidation, no jarosite | Sand | None | None | None | - |
| 39 | 0.75m | 175.09692, -37.30237 | 5.67 | 2.88 | -2.79 | XX - Moderate Reaction | Current wetland | Island Block rd | No oxidation, no jarosite | Silt | Low | None | None | - |
| 39 | 0.5m | 175.09692, -37.30237 | 5.12 | 2.91 | -2.21 | X - Slight Reaction | Current wetland | Island Block rd | No oxidation, no jarosite | Silt | Low | None | None | - |
| 42 | 1.1m | 175.66898, -37.94247 | 6.4 | 4.39 | -2.01 | X - Slight Reaction | Historic wetland | SH 1 and 29 | Low oxidation, no jarosite | Sand | Low | None | None | - |
| 42 | 0.5m | 175.66898, -37.94247 | 6.16 | 3.61 | -2.55 | XX - Moderate Reaction | Historic wetland | SH 1 and 29 | Low oxidation, no jarosite | Sand | Low | None | None | - |
| 44 | 0.5m | 175.27644, -37.35435 | 6.27 | 3.67 | -2.6 | X - Slight Reaction | Historic wetland | Waeranga @ Reed Rd | No oxidation, no jarosite | Silty Clay | Low | None | None | - |
| 44 | 1.3m | 175.27644, -37.35435 | 5.26 | 3.18 | -2.08 | X - Slight Reaction | Historic wetland | Waeranga @ Reed Rd | No oxidation, no jarosite | Silty Clay | Low | None | None | - |
| 45 | 0.5m | 175.4102, -37.33922 | 5.37 | 4.23 | -1.14 | XXXX - Very Vigorous Reaction | Historic wetland | Torehape | Low oxidation, no jarosite | Silt | None | None | None | - |
| 45 | 0.95m | 175.4102, -37.33922 | 5.29 | 3.77 | -1.52 | XX - Moderate Reaction | Historic wetland | Torehape | Low oxidation, no jarosite | Silt | None | None | None | - |
| 46 | 2.0m | 175.60794, -37.39554 | 5.83 | 1.72 | -4.11 | X - Slight Reaction | Wetland vegetation | Tee head pump station | No oxidation, no jarosite | Clay | High | None | Low Moisture | - |
| 46 | 1.0m | 175.60794, -37.39554 | 5.05 | 1.93 | -3.12 | X - Slight Reaction | Wetland vegetation | Tee head pump station | No oxidation, no jarosite | Clay | High | None | Low Moisture | - |
| 47 | 2.0m | 175.57329, -37.48989 | 4.74 | 2.73 | -2.01 | X - Slight Reaction | Wetland vegetation | Paeroa-Tahuna Rd | Low oxidation, no jarosite | Peaty Silt | very High | None | Waterlogged | - |
| 47 | 1.0m | 175.57329, -37.48989 | 4.53 | 2.52 | -2.01 | X - Slight Reaction | Wetland vegetation | Paeroa-Tahuna Rd | Low oxidation, no jarosite | Peaty Silt | very High | None | Waterlogged | - |
| 48 | 2.0m | 175.51268, -37.46353 | 5.86 | 3.15 | -2.71 | XX - Moderate Reaction | Wetland vegetation | SH27 West Piako floodgate | Low oxidation, no jarosite | Clayey Silt | Low | None | Moderate Moisture | - |
| 48 | 1.0m | 175.51268, -37.46353 | 5.43 | 4.39 | -1.04 | XXXX - Very Vigorous Reaction | Wetland vegetation | SH27 West Piako floodgate | Low oxidation, no jarosite | Clayey Silt | Low | None | Moderate Moisture | - |
| 49 | 2.0m | 175.19516, -37.4887 | 4.89 | 2.78 | -2.11 | X - Slight Reaction | Wetland vegetation | Tahuna Rd | No oxidation, no jarosite | Peaty Silt | Very High | None | Waterlogged | - |
| 49 | 0.5m | 175.19516, -37.4887 | 4.5 | 2.05 | -2.45 | XXXX - Very Vigorous Reaction | Wetland vegetation | Tahuna Rd | No oxidation, no jarosite | Peaty Silt | Very High | None | Waterlogged | - |
| 51 | 1.55m | 175.14216, -37.43556 | 6.16 | 3.33 | -2.83 | X - Slight Reaction | Wetland vegetation | Rangiriri | No oxidation, no jarosite | Sand | Moderate | None | None | - |
| 51 | 1.0m | 175.14216, -37.43556 | 6.09 | 3.67 | -2.42 | X - Slight Reaction | Wetland vegetation | Rangiriri | No oxidation, no jarosite | Sand | Moderate | None | None | - |
| 52 | 1.0m | 175.13684, -37.43094 | 7.18 | 4.41 | -2.77 | X - Slight Reaction | Wetland vegetation | Austen St Rangiriri township north floodgate | Moderate oxidation, no jarosite | Peaty | very High | None | Moderate Moisture | - |
| 52 | 2.0m | 175.13684, -37.43094 | 6.92 | 4.93 | -1.99 | X - Slight Reaction | Wetland vegetation | Austen St Rangiriri township north floodgate | Moderate oxidation, no jarosite | Peaty | very High | None | Moderate Moisture | - |
| 53 | 2.0m | 175.2027, -37.39224 | 5.69 | 2.67 | -3.02 | X - Slight Reaction | Wetland vegetation | Waeranga Rd, left bank floodgate | Low oxidation, no jarosite | Peaty | very High | None | Moderate Moisture | - |
| 53 | 1.0m | 175.2027, -37.39224 | 5.43 | 3.05 | -2.38 | X - Slight Reaction | Wetland vegetation | Waeranga Rd, left bank floodgate | Low oxidation, no jarosite | Peaty | very High | None | Moderate Moisture | - |
| 54 | 2.0m | 175.1866, -37.38038 | 5.08 | 1.53 | -3.55 | XXX - High Reaction | Wetland vegetation | Belcher Rd | Low oxidation, no jarosite | Peaty | very High | None | Moderate Moisture | - |
| 54 | 1.0m | 175.1866, -37.38038 | 4.16 | 2.35 | -1.81 | XX - Moderate Reaction | Wetland vegetation | Belcher Rd | Low oxidation, no jarosite | Peaty | very High | None | Moderate Moisture | - |
| 55 | 2.0m | 175.1827, -37.346 | 5.07 | 2.61 | -2.46 | XX - Moderate Reaction | Wetland vegetation | Falls Rd | Moderate oxidation, no jarosite | Silt | Low | None | Moderate Moisture | - |
| 55 | 0.5m | 175.1827, -37.346 | 4.82 | 2.58 | -2.24 | X - Slight Reaction | Wetland vegetation | Falls Rd | Moderate oxidation, no jarosite | Silt | Low | None | Moderate Moisture | - |
| 56 | 1.0m | 175.31961, -37.18456 | 8.05 | 7.58 | -0.47 | XXXX - Very Vigorous Reaction | <10m elevation | E Coast Rd, Miranda | No oxidation, no jarosite | Clay | Low | Low | Waterlogged | - |
| 56 | 2.0m | 175.31961, -37.18456 | 7.95 | 6.46 | -1.49 | XX - Moderate Reaction | <10m elevation | E Coast Rd, Miranda | No oxidation, no jarosite | Clay | Low | Low | Waterlogged | - |
| 57 | 2.0m | 175.54561, -37.14794 | 6.82 | 2.77 | -4.05 | XXX - High Reaction | <10m elevation | Thames, Toyota floodgate | Moderate oxidation, no jarosite | Clay | Low | None | Waterlogged | - |
| 57 | 1.0m | 175.54561, -37.14794 | 6.58 | 3.29 | -3.29 | XXXX - Very Vigorous Reaction | <10m elevation | Thames, Toyota floodgate | Moderate oxidation, no jarosite | Clay | Low | None | Waterlogged | - |

# Appendix D
# Table 4
# pH and Field Descriptions Table

| Site ID | Depth | Location | Field pH Test ($pH_f$) | Field pH (oxidised, $pH_{ox}$) | $pH_{ox}$ - $pH_f$ ($\Delta pH$) | Reaction to peroxide | Descriptor | Sample location | Oxidation and secondary mineralisation (e.g. Jarosite) | Texture | Organic matter content | Carbonates | Water level and moisture | Sulfureous odour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 60 | 1.0m | 175.4872, -37.21668 | 8.12 | 5.53 | -2.59 | XX - Moderate Reaction | <10m elevation | Pipiroa West floodgate | No oxidation, no jarosite | Clay | Low | None | Waterlogged | - |
| 60 | 2.0m | 175.4872, -37.21668 | 7.22 | 4.23 | -2.99 | XX - Moderate Reaction | <10m elevation | Pipiroa West floodgate | No oxidation, no jarosite | Clay | Low | None | Waterlogged | - |
| 61 | 1.05m | 175.21788, -37.83295 | 5.42 | 4.33 | -1.09 | X - Slight Reaction | Peaty texture | Collins and Tuhikaramea rd | Moderate oxidation, no jarosite | Silt | Low | None | None | - |
| 61 | 0.5m | 175.21788, -37.83295 | 5.27 | 3.96 | -1.31 | X - Slight Reaction | Peaty texture | Collins and Tuhikaramea rd | Moderate oxidation, no jarosite | Silt | Low | None | None | - |
| 62 | 0.5m | 175.3432, -37.55061 | 5.87 | 3.23 | -2.64 | XXXX - Very Vigorous Reaction | Peaty texture | Proctor Rd and Flaxmill | Moderate oxidation, no jarosite | Sand | None | None | None | - |
| 63 | 0.5m | 175.42015, -37.2788 | 8.29 | 6.53 | -1.76 | XXXX - Very Vigorous Reaction | Peaty texture | Ngatea @ Canal E floodgate | No oxidation, no jarosite | Silt | High | Low | Moderate Moisture | - |
| 63 | 2.0m | 175.42015, -37.2788 | 8.14 | 4 | -4.14 | XXX - High Reaction | Peaty texture | Ngatea @ Canal E floodgate | No oxidation, no jarosite | Silt | High | Low | Moderate Moisture | - |
| 65 | 2.0m | 175.19787, -37.76475 | 6.01 | 2.55 | -3.46 | XXXX - Very Vigorous Reaction | Peaty texture | Take Rotokauri @ Dromara Dr. | Low oxidation, no jarosite | Peat | High | None | Waterlogged | Yes |
| 65 | 1.0m | 175.19787, -37.76475 | 5.93 | 1.86 | -4.07 | XX - Moderate Reaction | Peaty texture | Take Rotokauri @ Dromara Dr. | Low oxidation, no jarosite | Peat | High | None | Waterlogged | Yes |
| 66 | 0.9m | 175.69609, -36.82363 | 8.14 | 8.34 | 0.2 | XXXX - Very Vigorous Reaction | Late Pleistocene river deposits | Whitianga | Moderate oxidation, no jarosite | Sandy Silt | Low | High | Waterlogged | - |
| 66 | 0.5m | 175.69609, -36.82363 | 7.92 | 8.08 | 0.16 | XXXX - Very Vigorous Reaction | Late Pleistocene river deposits | Whitianga | Moderate oxidation, no jarosite | Sandy Silt | Low | High | Waterlogged | - |
| 67 | 0.9m | 175.32416, -37.7739 | 5.15 | 3.42 | -1.73 | X - Slight Reaction | Historic wetland | Ruakura inland port | Low oxidation, no jarosite | Silt | High | Moderate | None | - |
| 67 | 0.5m | 175.32416, -37.7739 | 5.05 | 3.75 | -1.3 | X - Slight Reaction | Historic wetland | Ruakura inland port | Low oxidation, no jarosite | Silt | High | Moderate | None | - |
| 68 | 1.15m | 175.32061, -37.7703 | 5.29 | 3.88 | -1.41 | X - Slight Reaction | Holocene swamp deposits | Ruakura inland port | Low oxidation, no jarosite | Silt | High | Moderate | None | - |
| 68 | 0.5m | 175.32061, -37.7703 | 4.73 | 3.24 | -1.49 | X - Slight Reaction | Holocene swamp deposits | Ruakura inland port | Low oxidation, no jarosite | Silt | High | Moderate | None | - |
| 69 | 1.0m | 175.30799, -37.82517 | 5.82 | 4.07 | -1.75 | X - Slight Reaction | Low pH | Peacockes @ Hall Rd | High oxidation, no jarosite | Silt | Low | Low | None | - |
| 69 | 2.0m | 175.30799, -37.82517 | 5.38 | 3.9 | -1.48 | XX - Moderate Reaction | Low pH | Peacockes @ Hall Rd | High oxidation, no jarosite | Silt | Low | Low | None | - |
| 70 | 1.0m | 175.32077, -37.81916 | 6.43 | 4.84 | -1.59 | X - Slight Reaction | Gley Soils | Peacockes Rd | Low oxidation, no jarosite | Silt | None | Low | None | - |
| 70 | 0.5m | 175.32077, -37.81916 | 5.62 | 3.85 | -1.77 | XX - Moderate Reaction | Gley Soils | Peacockes Rd | Low oxidation, no jarosite | Silt | None | Low | None | - |
| 71 | 1.0m | 175.68926, -37.96588 | 6.64 | 5.81 | -0.83 | XXXX - Very Vigorous Reaction | Historic wetland | Piarere expressway | No oxidation, no jarosite | Sand | Moderate | Low | None | - |
| 71 | 0.5m | 175.68926, -37.96588 | 6.27 | 4.43 | -1.84 | XX - Moderate Reaction | Historic wetland | Piarere expressway | No oxidation, no jarosite | Sand | Moderate | Low | None | - |
| 72 | 2.0m | 175.57082, -37.92687 | 5.66 | 4.46 | -1.2 | X - Slight Reaction | Historic wetland | Piarere expressway @ Tunakawa Rd | No oxidation, no jarosite | Silt | None | potentially | None | - |
| 72 | 1.0m | 175.57082, -37.92687 | 5.53 | 4.31 | -1.22 | X - Slight Reaction | Historic wetland | Piarere expressway @ Tunakawa Rd | No oxidation, no jarosite | Silt | None | potentially | None | - |
| 73 | 0.9m | 175.68363, -37.37283 | 6.09 | 4.32 | -1.77 | X - Slight Reaction | Holocene river deposits | Paeroa Racecourse | Moderate oxidation, no jarosite | Sand | None | None | None | - |
| 74 | 0.5m | 175.65717, -37.36427 | 5.59 | 2.9 | -2.69 | X - Slight Reaction | Gley Soils | Paeroa @ Opukeko floodgate | No oxidation, no jarosite | Sand | Moderate | None | None | - |
| 74 | 0.75m | 175.65717, -37.36427 | 5.55 | 3.33 | -2.22 | XXXX - Very Vigorous Reaction | Gley Soils | Paeroa @ Opukeko floodgate | No oxidation, no jarosite | Sand | Moderate | None | None | - |
| 75 | 1.2m | 175.5056, -37.2003 | 6.88 | 3.52 | -3.36 | XXX - High Reaction | Gley Soils | Shelly Beach Rd drain | No oxidation, no jarosite | Clay | Low | None | Moderate Moisture | - |
| 75 | 1.0m | 175.5056, -37.2003 | 6.8 | 2.46 | -4.34 | XXX - High Reaction | Gley Soils | Shelly Beach Rd drain | No oxidation, no jarosite | Clay | Low | None | Moderate Moisture | - |
| 76 | 1.0m | 174.92985, -37.27729 | 5.58 | 3.64 | -1.94 | Information not provided within laboratory report 23-07358 | Holocene river deposits | Tuakau development @ Tuakau pump station | Low oxidation, no jarosite | Silt | High | Moderate | None | - |
| 76 | 0.5m | 174.92985, -37.27729 | 5.16 | 3.29 | -1.87 | Information not provided within laboratory report 23-07358 | Holocene river deposits | Tuakau development @ Tuakau pump station | Low oxidation, no jarosite | Silt | High | Moderate | None | - |
| 78 | 1.0m | 174.74318, -37.3017 | 6.02 | 3.91 | -2.11 | X - Slight Reaction | Gley Soils | Otaua floodgate | Moderate oxidation, no jarosite | Silt | Low | None | None | - |
| 78 | 2.0m | 174.74318, -37.3017 | 5.68 | 2.64 | -3.04 | X - Slight Reaction | Gley Soils | Otaua floodgate | Moderate oxidation, no jarosite | Silt | Low | None | None | - |
| 79 | 2.0m | 174.80117, -37.26241 | 6.55 | 3.26 | -3.29 | Information not provided within laboratory report 23-07358 | Gley Soils | Masters Rd floodgate | Moderate oxidation, no jarosite | Silt | Low | None | None | - |
| 79 | 1.0m | 174.80117, -37.26241 | 6.02 | 3.23 | -2.79 | Information not provided within laboratory report 23-07358 | Gley Soils | Masters Rd floodgate | Moderate oxidation, no jarosite | Silt | Low | None | None | - |
| 79 | 0.5m | 174.80117, -37.26241 | 5.43 | 3.24 | -2.19 | Information not provided within laboratory report 23-07358 | Gley Soils | Masters Rd floodgate | Moderate oxidation, no jarosite | Silt | Low | None | None | - |
| 80 | 1.65m | 174.75198, -37.32765 | 6.31 | 2 | -4.31 | Information not provided within laboratory report 23-07358 | Holocene swamp deposits | Hoods landing boat ramp | No oxidation, no jarosite | Clay | High | None | Waterlogged | - |
| 80 | 1.0m | 174.75198, -37.32765 | 6.29 | 3.44 | -2.85 | Information not provided within laboratory report 23-07358 | Holocene swamp deposits | Hoods landing boat ramp | No oxidation, no jarosite | Clay | High | None | Waterlogged | - |
| 80 | 0.5m | 174.75198, -37.32765 | 6.04 | 4.13 | -1.91 | Information not provided within laboratory report 23-07358 | Holocene swamp deposits | Hoods landing boat ramp | No oxidation, no jarosite | Clay | High | None | Waterlogged | - |
| 81 | 1.35m | 174.87794, -37.79996 | 6.46 | 4.73 | -1.73 | X - Slight Reaction | Historic wetland | Raglan Rugby Club | Moderate oxidation, no jarosite | Sandy Silt | Low | None | Moderate Moisture | - |
| 81 | 1.0m | 174.87794, -37.79996 | 5.97 | 3.45 | -2.52 | X - Slight Reaction | Historic wetland | Raglan Rugby Club | Moderate oxidation, no jarosite | Sandy Silt | Low | None | Moderate Moisture | - |
| 82 | 1.0m | 175.85014, -36.99026 | 6.69 | 3.35 | -3.34 | XXXX - Very Vigorous Reaction | Historic wetland | Tairua pump station @ Ocean Beach rd | Low oxidation, no jarosite | Sandy Silt | High | None | Waterlogged | Yes |
| 82 | 2.0m | 175.85014, -36.99026 | 6.68 | 3.47 | -3.21 | XXX - High Reaction | Historic wetland | Tairua pump station @ Ocean Beach rd | Low oxidation, no jarosite | Sandy Silt | High | None | Waterlogged | Yes |
| 85 | 1.0m | 175.20285, -37.9891 | 6.04 | 4.74 | -1.3 | X - Slight Reaction | Late Pleistocene river deposits | Pirongia | Low oxidation, no jarosite | Sand | Low | Low | None | - |
| 85 | 0.4m | 175.20285, -37.9891 | 5.87 | 4.37 | -1.5 | XX - Moderate Reaction | Late Pleistocene river deposits | Pirongia | Low oxidation, no jarosite | Sand | Low | Low | None | - |
| 86 | 1.0m | 175.32934, -38.01117 | 6.61 | 5.84 | -0.77 | XXXX - Very Vigorous Reaction | Gley Soils | Te Awamutu@ albert park | Moderate oxidation, no jarosite | Sand | None | None | None | - |
| 86 | 1.7m | 175.32934, -38.01117 | 5.61 | 5.05 | -0.56 | XXXX - Very Vigorous Reaction | Gley Soils | Te Awamutu@ albert park | Moderate oxidation, no jarosite | Sand | None | None | None | - |
| 87 | 1.25m | 175.24697, -37.73968 | 6.05 | 4.23 | -1.82 | X - Slight Reaction | Gley Soils | Braithwaite park | Moderate oxidation, no jarosite | Silt | None | None | Moderate Moisture | - |
| 87 | 0.5m | 175.24697, -37.73968 | 5.99 | 4.13 | -1.86 | X - Slight Reaction | Gley Soils | Braithwaite park | Moderate oxidation, no jarosite | Silt | None | None | Moderate Moisture | - |
| 88 | 0.85m | 175.49858, -37.27567 | 5.98 | 3.09 | -2.89 | X - Slight Reaction | Gley Soils | Ngatea pump station | Low oxidation, no jarosite | Silty Sand | Low | None | Moderate Moisture | - |
| 88 | 0.5m | 175.49858, -37.27567 | 5.76 | 2.82 | -2.94 | X - Slight Reaction | Gley Soils | Ngatea pump station | Low oxidation, no jarosite | Silty Sand | Low | None | Moderate Moisture | - |

| Site ID | Depth | Location | Field pH Test ($pH_f$) | Field pH (oxidised, $pH_{ox}$) | $pH_{ox}$ - $pH_f$ ($\Delta pH$) | Reaction to peroxide | Descriptor | Sample location | Oxidation and secondary mineralisation (e.g. Jarosite) | Texture | Organic matter content | Carbonates | Water level and moisture | Sulfureous odour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 89 | 0.5m | 175.60916, -37.32102 | 4.91 | 2.75 | -2.16 | X - Slight Reaction | Gley Soils | Fisher Rd pump station | Low oxidation, no jarosite | Silty Sand | Low | None | Moderate Moisture | - |
| 89 | 1.0m | 175.60916, -37.32102 | 4.53 | 2.48 | -2.05 | X - Slight Reaction | Gley Soils | Fisher Rd pump station | Low oxidation, no jarosite | Silty Sand | Low | None | Moderate Moisture | - |
| 90 | 2.0m | 175.70485, -37.54856 | 6.19 | 1.82 | -4.37 | XX - Moderate Reaction | Gley Soils | Te Aroha | Moderate oxidation, no jarosite | Peat | High | None | Moderate Moisture | - |
| 90 | 1.0m | 175.70485, -37.54856 | 6.05 | 2.26 | -3.79 | XX - Moderate Reaction | Gley Soils | Te Aroha | Moderate oxidation, no jarosite | Peat | High | None | Moderate Moisture | - |
| 91 | 2.0m | 175.53371, -37.66457 | 6.37 | 4.85 | -1.52 | X - Slight Reaction | Late Pleistocene river deposits | Morrinsville @ Morrinsville-walton and Kuranui Rd | Low oxidation, no jarosite | Silt | High | Moderate | None | - |
| 91 | 1.0m | 175.53371, -37.66457 | 6.09 | 4.74 | -1.35 | X - Slight Reaction | Late Pleistocene river deposits | Morrinsville @ Morrinsville-walton and Kuranui Rd | Low oxidation, no jarosite | Silt | High | Moderate | None | - |
| 92 | 2.0m | 175.78426, -38.3706 | 6.51 | 4.93 | -1.58 | X - Slight Reaction | Late Pleistocene river deposits | Mangakino | Moderate oxidation, no jarosite | Sandy Silt | Moderate | High | Waterlogged | - |
| 92 | 1.0m | 175.78426, -38.3706 | 6.4 | 4.31 | -2.09 | X - Slight Reaction | Late Pleistocene river deposits | Mangakino | Moderate oxidation, no jarosite | Sandy Silt | Moderate | High | Waterlogged | - |
| 93 | 0.5m | 175.78267, -37.07529 | 6.02 | 3.15 | -2.87 | XX - Moderate Reaction | Gley Soils | Hikuai | Moderate oxidation, no jarosite | Sand | High | None | None | - |
| 93 | 0.9m | 175.78267, -37.07529 | 5.92 | 3.53 | -2.39 | XX - Moderate Reaction | Gley Soils | Hikuai | Moderate oxidation, no jarosite | Sand | High | None | None | - |
| 94 | 1.4m | 175.85618, -37.02313 | 6.78 | 1.73 | -5.05 | XX - Moderate Reaction | Holocene river deposits | Pauanui Beach | No oxidation, no jarosite | Peat | High | None | Moderate Moisture | - |
| 94 | 1.0m | 175.85618, -37.02313 | 6.62 | 1.69 | -4.93 | XX - Moderate Reaction | Holocene river deposits | Pauanui Beach | No oxidation, no jarosite | Peat | High | None | Moderate Moisture | - |
| 95 | 0.5m | 175.08683, -37.89756 | 6.55 | 2.7 | -3.85 | XX - Moderate Reaction | Gley Soils | Fillery Rd | Low oxidation, no jarosite | Silt | Moderate | None | Waterlogged | - |
| 95 | 1.15m | 175.08683, -37.89756 | 6.28 | 3.9 | -2.38 | X - Slight Reaction | Gley Soils | Fillery Rd | Low oxidation, no jarosite | Silt | Moderate | None | Waterlogged | - |
| 96 | 0.5m | 175.03304, -37.84773 | 5.67 | 3.57 | -2.1 | XX - Moderate Reaction | Gley Soils | Waitetuna | Low oxidation, no jarosite | Sand | None | None | None | - |
| 96 | 0.9m | 175.03304, -37.84773 | 5.62 | 3.86 | -1.76 | X - Slight Reaction | Gley Soils | Waitetuna | Low oxidation, no jarosite | Sand | None | None | None | - |
| 97 | 1.0m | 175.60053, -36.75651 | 5.38 | 4.28 | -1.1 | XX - Moderate Reaction | Historic wetland | Te Reranga | High oxidation, no jarosite | Sandy Silt | None | None | None | - |
| 97 | 1.55m | 175.60053, -36.75651 | 5.14 | 3.44 | -1.7 | X - Slight Reaction | Historic wetland | Te Reranga | High oxidation, no jarosite | Sandy Silt | None | None | None | - |
| 99 | 0.2m | 175.05703, -37.57277 | 6.34 | 2.98 | -3.36 | XXXX - Very Vigorous Reaction | Low pH | Waikokawai andMcDonald Mine Rds | High oxidation, no jarosite | Silt | Low | None | Moderate Moisture | - |
| 99 | 0.82m | 175.05703, -37.57277 | 5.12 | 3.42 | -1.7 | X - Slight Reaction | Low pH | Waikokawai andMcDonald Mine Rds | High oxidation, no jarosite | Silt | Low | None | Moderate Moisture | - |
| 100 | 0.5m | 175.63577, -37.77213 | 5.7 | 1.52 | -4.18 | X - Slight Reaction | Gley Soils | Paratu Rd | Moderate oxidation, no jarosite | Sandy Silt | Low | None | Moderate Moisture | - |
| 100 | 1.0m | 175.63577, -37.77213 | 5.62 | 3.58 | -2.04 | X - Slight Reaction | Gley Soils | Paratu Rd | Moderate oxidation, no jarosite | Sandy Silt | Low | None | Moderate Moisture | - |
| 28B | 0.25m | 175.23977, -37.73404 | 8.22 | 6.29 | -1.93 | XXXX - Very Vigorous Reaction | Low pH | Featherstone Park | No oxidation, no jarosite | Peaty Silt | High | Moderate | None | - |
| 28B | 2.0m | 175.23977, -37.73404 | 6.29 | 5.07 | -1.22 | X - Slight Reaction | Low pH | Featherstone Park | No oxidation, no jarosite | Peaty Silt | High | Moderate | None | - |
| 28B | 1.0m | 175.23977, -37.73404 | 5.83 | 4.26 | -1.57 | X - Slight Reaction | Low pH | Featherstone Park | No oxidation, no jarosite | Peaty Silt | High | yes | None | - |
| 34B | 2.0m | 175.23366, -37.73193 | 7.14 | 5.26 | -1.88 | X - Slight Reaction | Low pH | Pukete Farm park | Moderate oxidation, no jarosite | Sand | Low | Low | None | - |
| 34B | 1.0m | 175.23366, -37.73193 | 5.82 | 4.49 | -1.33 | X - Slight Reaction | Low pH | Pukete Farm park | Moderate oxidation, no jarosite | Sand | Low | Low | None | - |
| 40B | 1.1m | 175.26065, -37.75497 | 6.18 | 4.09 | -2.09 | X - Slight Reaction | Volcanics | Pukete Park | Moderate oxidation, no jarosite | Sand | Low | Low | None | - |
| 40B | 0.5m | 175.26065, -37.75497 | 5.2 | 3.45 | -1.75 | X - Slight Reaction | Volcanics | Pukete Park | Moderate oxidation, no jarosite | Sand | Low | Low | None | - |
| 41C | 2.0m | 175.28961, -37.75067 | 6.39 | 4.71 | -1.68 | X - Slight Reaction | Historic wetland | Hillary Park | Low oxidation, no jarosite | Sand | Low | None | None | - |
| 41C | 1.0m | 175.28961, -37.75067 | 6.18 | 4.13 | -2.05 | X - Slight Reaction | Historic wetland | Hillary Park | Low oxidation, no jarosite | Sand | Low | None | None | - |
| 43B | 1.0m | 175.55662, -37.64463 | 5.2 | 4.15 | -1.05 | X - Slight Reaction | Historic wetland | Murray Oaks Reserve | Moderate oxidation, no jarosite | Silty Clay | High | Low | Moderate Moisture | - |
| 43B | 2.0m | 175.55662, -37.64463 | 4.8 | 3.54 | -1.26 | X - Slight Reaction | Historic wetland | Murray Oaks Reserve | Moderate oxidation, no jarosite | Silty Clay | High | Low | Moderate Moisture | - |
| 50B | 1.35m | 175.25428, -37.7647 | 6.22 | 4.34 | -1.88 | X - Slight Reaction | Volcanics | Vardon Park | No oxidation, no jarosite | Silt | Low | None | None | - |
| 50B | 1.0m | 175.25428, -37.7647 | 5.8 | 4.43 | -1.37 | X - Slight Reaction | Volcanics | Vardon Park | No oxidation, no jarosite | Silt | Low | None | None | - |
| 58B | 1.2m | 175.56213, -37.50023 | 5.92 | 3.89 | -2.03 | X - Slight Reaction | <10m elevation | Paeroa-Tahuna and Awa Rd | Low oxidation, no jarosite | Silt | Low | None | None | - |
| 58B | 0.5m | 175.56213, -37.50023 | 5.53 | 3.65 | -1.88 | X - Slight Reaction | <10m elevation | Paeroa-Tahuna and Awa Rd | Low oxidation, no jarosite | Silt | Low | None | None | - |
| 59B | 0.5m | 175.13342, -37.56914 | 5.48 | 3.77 | -1.71 | X - Slight Reaction | <10m elevation | Lake Waahi boat ramp | Moderate oxidation, no jarosite | Silty Clay | Moderate | None | None | - |
| 59B | 1.0m | 175.13342, -37.56914 | 5.25 | 3.56 | -1.69 | X - Slight Reaction | <10m elevation | Lake Waahi boat ramp | Moderate oxidation, no jarosite | Silty Clay | Moderate | None | None | - |
| 64B | 0.5m | 175.2728, -37.80065 | 6.09 | 3.29 | -2.8 | X - Slight Reaction | Peaty texture | Innes Common | Low oxidation, no jarosite | Peat | very High | None | Moderate Moisture | - |
| 64B | 2.0m | 175.2728, -37.80065 | 5.67 | 3.2 | -2.47 | X - Slight Reaction | Peaty texture | Innes Common | Low oxidation, no jarosite | Peat | very High | None | Moderate Moisture | - |
| 77B | 0.5m | 175.19324, -37.61181 | 6.47 | 3.59 | -2.88 | XX - Moderate Reaction | Volcanics | Taupiri | Low oxidation, no jarosite | Silt | Low | None | None | - |
| 77B | 0.8m | 175.19324, -37.61181 | 6.19 | 3.49 | -2.7 | XX - Moderate Reaction | Volcanics | Taupiri | Low oxidation, no jarosite | Silt | Low | None | None | - |
| 83B | 2.0m | 175.24977, -37.77454 | 4.77 | 2.91 | -1.86 | X - Slight Reaction | Late Pleistocene river deposits | Lake Rotokaeo recreation reserve | Moderate oxidation, no jarosite | Sandy Silt | High | None | Waterlogged | - |
| 83B | 1.0m | 175.24977, -37.77454 | 4.59 | 2.86 | -1.73 | XX - Moderate Reaction | Late Pleistocene river deposits | Lake Rotokaeo recreation reserve | Moderate oxidation, no jarosite | Sandy Silt | High | None | Waterlogged | - |
| 84B | 0.5m | 175.53845, -37.65498 | 6.18 | 6.52 | 0.34 | XXXX - Very Vigorous Reaction | Late Pleistocene river deposits | Howie Park, Morrinsville | Moderate oxidation, no jarosite | Sandy Silt | High | None | Moderate Moisture | - |
| 84B | 1.0m | 175.53845, -37.65498 | 5.79 | 4.9 | -0.89 | XXXX - Very Vigorous Reaction | Late Pleistocene river deposits | Howie Park, Morrinsville | Moderate oxidation, no jarosite | Sandy Silt | High | None | Moderate Moisture | - |
| 8B | 1.1m | 175.24892, -37.75508 | 4.85 | 3.63 | -1.22 | X - Slight Reaction | Holocene swamp deposits | Vickery Park | Moderate oxidation, no jarosite | Silt | Low | Low | None | - |
| 8B | 0.5m | 175.24892, -37.75508 | 4.82 | 3.38 | -1.44 | X - Slight Reaction | Holocene swamp deposits | Vickery Park | Moderate oxidation, no jarosite | Silt | Low | Low | None | - |
| 98B | 1.6m | 175.25706, -37.64269 | 5.86 | 3.61 | -2.25 | X - Slight Reaction | Volcanics | SH1B and Lake Rd | Moderate oxidation, no jarosite | Clay | Moderate | None | Waterlogged | - |
| 98B | 1.0m | 175.25706, -37.64269 | 5.67 | 3.68 | -1.99 | X - Slight Reaction | Volcanics | SH1B and Lake Rd | Moderate oxidation, no jarosite | Clay | Moderate | None | Waterlogged | - |

**Appendix D**
**Table 5**
**Duplicate Results Table**

| Site ID | Depth | Field pH Test (pHf) | Field pH (oxidised, pHox) | pHox - pHf (ΔpH) | Duplicate ID | Field pH Test (pHf) | Field pH (oxidised, pHox) | pHox - pHf (ΔpH) | RPD pHf | RPD pHox |
|---|---|---|---|---|---|---|---|---|---|---|
| 13 | 2.0m | 6.39 | 5.04 | -1.35 | N | 6.14 | 5.3 | -0.84 | 2.00 | 2.51 |
| 17 | 2.0m | 6.76 | 5.45 | -1.31 | L | 6.18 | 4.62 | -1.56 | 4.48 | 8.24 |
| 22 | 1.0m | 4.81 | 3.43 | -1.38 | F | 4.73 | 3.36 | -1.37 | 0.84 | 1.03 |
| 24 | 1.55m | 5.32 | 3.84 | -1.48 | C | 5.23 | 3.96 | -1.27 | 0.85 | 1.54 |
| 32 | 1.0m | 6.28 | 2.54 | -3.74 | I | 5.79 | 2.76 | -3.03 | 4.06 | 4.15 |
| 35 | 0.5m | 5.81 | 4.72 | -1.09 | M | 5.38 | 3.69 | -1.69 | 3.84 | 12.25 |
| 45 | 0.95m | 5.29 | 3.77 | -1.52 | E | 5.37 | 3.62 | -1.75 | 0.75 | 2.03 |
| 46 | 2.0m | 5.83 | 1.72 | -4.11 | B | 6.32 | 2.67 | -3.65 | 4.03 | 21.64 |
| 61 | 0.5m | 5.27 | 3.96 | -1.31 | K | 5.09 | 3.96 | -1.13 | 1.74 | 0.00 |
| 62 | 0.5m | 5.87 | 3.23 | -2.64 | D | 4.48 | 3.62 | -0.86 | 13.43 | 5.69 |
| 68 | 0.5m | 4.73 | 3.24 | -1.49 | T | 4.81 | 3.25 | -1.56 | 0.84 | 0.15 |
| 69 | 2.0m | 5.38 | 3.9 | -1.48 | Q | 5.62 | 3.81 | -1.81 | 2.18 | 1.17 |
| 70 | 1.0m | 6.43 | 4.84 | -1.59 | H | 4.57 | 4.94 | 0.37 | 16.91 | 1.02 |
| 75 | 1.0m | 6.8 | 2.46 | -4.34 | A | 6.16 | 3.62 | -2.54 | 4.94 | 19.08 |
| 82 | 2.0m | 6.68 | 3.47 | -3.21 | O | 6.33 | 3.12 | -3.21 | 2.69 | 5.31 |
| 86 | 1.7m | 5.61 | 5.05 | -0.56 | J | 5.37 | 4.83 | -0.54 | 2.19 | 2.23 |
| 95 | 1.15m | 6.28 | 3.9 | -2.38 | G | 6.18 | 4.3 | -1.88 | 0.80 | 4.88 |
| 100 | 1.0m | 5.62 | 3.58 | -2.04 | S | 5.61 | 3.83 | -1.78 | 0.09 | 3.37 |
| 43B | 2.0m | 4.8 | 3.54 | -1.26 | R | 5.12 | 3.3 | -1.82 | 3.23 | 3.51 |
| 98B | 1.0m | 5.67 | 3.68 | -1.99 | P | 6.02 | 3.49 | -2.53 | 2.99 | 2.65 |

# Appendix E

## Sample scoring

# Sample scoring

To increase the replicability and allow refinement of this form of assessment in future investigations the samples taken within this investigation were individually scored to identify the amount of risk a particular sample poses. The samples represent low, medium, high, or negligible risk which will potentially aid in the identification of the probability of occurrence. A samples risk does not correlate directly to the probability of occurrence. The risk of a sample provides an indication of the severity of the sample rather than probability of occurrence. Theoretically, a group of samples intersecting a given class could all present low risk, however, depending on the consistency of low-risk samples intersecting that unit, the class may be attributed a high probability of occurrence due to the high presence of low-risk samples.

The scored approach was introduced to the investigation as it limits subjective biases to a certain extent, however, the decisions made within the revised scoring, documented within the following sections, are a combination of qualitative risk derived from the sample scoring, in conjunction with the project team's knowledge of geology, geomorphology and geography of the Waikato Region. It is understood that there is subjective bias present within this methodology, however, the approach has aimed to minimise it where possible.

## Methodology overview

The samples taken within this investigation were scored at the amounts documented within the following sections. Once scored, each input and class were compared to the individually scored sample which overlap the polygons on the GIS map.

This provided a method of individually evaluating the classes of each input at a greater detail and allowed the project team to identify where the strongest trends are and if a particular unit is being affected by one input over another. For example, a sample taken within the field investigations was taken in an area which was both a peaty bog and covered in flaxland. The analysis of all inputs allowed the project team to understand the main driver of acidity within the hypothetical sample location on comparison to the wider dataset of peaty bogs and flaxland units.

The following scoring was applied to the following lab and field results of each sample taken. Scoring was skewed to the qualitative data (net acidity) of the samples as it is the determining factor of acid sulfate soil risk covered within this investigation. The pH analysis and field observations were scored lower due to the reliability of this information and the information being indicative only in most cases.

Total scores of samples were added together then sorted into negligible, low, medium, and high-risk categories:

– Samples considered to be of negligible risk (19) were samples with scores of 0.0 < and > 1.9
– Samples considered to be of low risk (49) were samples with scores of 2.0< and > 5
– Samples of medium risk (12) were samples with scores of 5.1 < and >14.9
– Samples of high risk (18) were samples with scores of >15.

Note, only samples containing CrS results were included within the scoring as CrS analysis is the most accurate determinant of acid sulfate soils presence.

## Acidity score

Acidity scores included within this assessment are in relation to the CrS acidity and the TAA of a sample. The acidity scores will be applied different rating weightings due to their relevance to the purpose of this investigation.

CrS acidity indicates the amount of sulfur within a sample which is readily reducible into acid, and therefore is an indicator of potential acid sulfate soils.

TAA indicates existing acidity within a sample, and therefore is a representation of actual acidity of a sample. The presence of actual acidity may not be necessarily due to acid sulfate soils, and therefore has been scored lower.

The following scoring was applied to the different net acidity ranges:



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– For CrS scoring:

- Where a sample had a CrS acidity of >100 mol $H^+$/t, a score of 20 was allocated to a sample
- Where a sample had a CrS acidity of >50 mol $H^+$/t, a score of 15 was allocated to a sample
- Where a sample had a CrS acidity of >18 mol $H^+$/t, a score of 10 was allocated to a sample.

– For TAA scoring:

- Where a sample had a TAA of >300 mol $H^+$/t, a score of 6 was allocated to a sample
- Where a sample had a TAA of >100 mol $H^+$/t, a score of 4 was allocated to a sample
- Where a sample had a TAA of >18 mol $H^+$/t, a score of 2 was allocated to a sample.

Where samples have high CrS acidity and TAA, it is likely that this is the best indication of acid sulfate soil occurrence.

# pH analysis scoring

As documented in this report, field pH testing is a method of indicating the potential presence of acid sulfate soils (refer Section 6.3.1.1). A $pH_{ox}$ value of <3 is the most reliable field technique for identifying a potential presence of an acid sulfate soil. Change in $pH_{ox}$ and reaction rate are less reliable indicators of acid sulfate soils as they are both affected by the rate of reaction and overall time of reaction in which the test is undertaken on as this can vary heavily depending on the amount of carbonate, other metals, and organics within a sample.

Due to varying reliability of the testing undertaken, where a sample exceeded criteria of a potential acid sulfate soil (outlined within Section 6.3.1.1), a score of was applied to a sample in each criteria. pH laboratory results are indicative only of acid sulfate soils; therefore, the following scores were applied:

– Where $pH_{ox}$ was analysed for and over the criteria of <3 within the analysis, a score of 0.5 was attributed to a sample

– Where $pH_{ox}$ was analysed for with a change in pH of <-2 within the results, a score of 0.2 was attributed to a sample

– Where peroxide reaction rate was analysed for with a reaction to peroxide classed as ‘extreme,’ a score of 0.2 was attributed to a sample.

This method of scoring allowed a sample to potentially be eligible to be of elevated risk levels if it had all pH indicators above potential acid sulfate soil criteria, provided the sample has some field observations associated with acid sulfate soils.

# Field observations scoring

Potential acid sulfate soils are most reliably distinguished by their CrS results. However, the corroboration of the results with the field notes and observations provides further evidence and insight into whether the environment characterised by the sample may be an acid sulfate soil or have a source of acidity from external sources. Field notes and observations which were deemed most representative of a potential acid sulfate forming environment are oxidation and moisture content, texture type and if a sulfurous odour was noted within the sample or surrounding environment.

Visual indicators such as oxidation and moisture were noted to be the ‘less indicatory’ of acid sulfate soils compared to the texture of the soil being peat or having a sulfurous odour and have therefore been scored accordingly.

A sulfurous or rotten egg odour is an indicator of acid sulfate soils by the potential presence of sulfur within the soil in the form of hydrogen sulfide ($H_2S$) within the sample or hand auger hole. This indicates that acid sulfate soils have previously formed within the in-situ environment. Hydrogen sulfide gas can be detected at very low concentrations (Water Quality Australia, 2018), therefore, if noted it is likely the location sampled has a sulfur source in situ. The field notes do not document a differentiation of intensity of the odours, therefore, where a sample had a sulfurous odour, 0.5 was allocated to a sample as it is an indicator of hydrogen sulfate gas and potentially acid sulfate soils.



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Soil texture is an indication of environment of formation for acid sulfate soils. Textures such as peats have a high correlation to potential acid sulfate soil occurrence as they are commonly located within areas which produce a high amount of organic matter and are low energy and poorly drained, for example peat bogs or swamps. Peaty environments are an indicator of acidic environments and allow acid sulfate soils to generate and persist within the environment, therefore, where a sample had a texture of “peat”, “peaty clay” or “peaty silt” a score of 0.5 was allocated to a sample.

Oxidation of samples is an indication of potential acid sulfate soils as it is the result of metal, most commonly iron, oxides being exposed to air. Iron oxide presence can be an indicator of acid sulfate soils with jarosite or mottling presence being the best indicator. During this investigation, no jarosite or mottling was noted, therefore, scoring was weighted towards the amount of oxidation present within the sample as opposed to type of oxidation. Where a sample had a texture oxidisation of “high”, a score of 0.25 was allocated to a sample. Where a sample had an oxidisation of “moderate” 0.1 was allocated to a sample.

Moisture content is an indicator of the potential occurrence of acid sulfate soils as the naturally occurring sulfate within the water table is turned into sulfides by sulfate-reducing bacteria (Macdonald, et al., 2002). However, this field observation was not factored into the scoring as the soils could be anoxic, coincidentally wet, or intermittently waterlogged. Due to the variance in this field observation, it has been omitted from scoring.

## Scoring summary

The risk scoring allocated to each location sampled within this investigation was weighted heavily towards the CrS results. This was due to CrS results being the best method of identifying acid sulfate soil presence as it informs the concentration of freely reducible sulfur within a soil sample. Field pH investigation techniques and field notes are indicators of acid sulfate soil conditions, however, are far less reliable. This is due to:

– Field pH techniques having a high amount of variance within the testing as factors such as composition or duration can affect the result
– Field notes being highly subjective and not representative of the complex environment of formation which is required for the generation of acid sulfate soils.

Once sample locations had been scored on their CrS, TAA, pH results and field observations, the scores were summed. The sums of the scores were then compared to the score ranges adopted within Section 6.5 . The category a given sample or group of samples fall into does not necessarily correlate directly to their probability of occurrence. The risk associated within each sample more so represents the severity of the acid sulfate soils generated, given the soils were disturbed.


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# Appendix F

## Laboratory reports

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# Certificate of Analysis

GHD Ltd
Level 1, 586 Victoria Street,
Hamilton 3420

Attention: Jude Addenbrooke
Phone: +64 7 834 7912
Email: james.owers@ghd.com

Sampling Site: Multiple

Lab Reference: 23-07358
Submitted by: James Owers
Date Received: 13/03/2023
Testing Initiated: 24/03/2023
Date Completed: 24/03/2023
Order Number:
Reference: 12571919

## Report Comments

Samples were collected by yourselves (or your agent) and analysed as received at Analytica Laboratories. Samples were in acceptable condition unless otherwise noted on this report.
Specific testing dates are available on request.

### Field pH (ox) in Soil

| | | Client Sample ID | Site 80, 0.5m 0.5m | Site 80, 1.0m 1.0m | Site 80, 1.65m 1.65m | Site 79, 0.5m 0.5m | Site 79, 1.0m 1.0m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 10/03/2023 | 11/03/2023 | 12/03/2023 | 13/03/2023 | 14/03/2023 |
| Analyte | Unit | *Reporting Limit* | 23-07358-1 | 23-07358-2 | 23-07358-3 | 23-07358-4 | 23-07358-5 |
| $pH_F$* | pH | *1* | 6.04 | 6.29 | 6.31 | 5.43 | 6.02 |
| $pH_{ox}$* | pH | *1* | 4.13 | 3.44 | 2.00 | 3.24 | 3.23 |

### Field pH (ox) in Soil

| | | Client Sample ID | Site 79, 2.0m 2.0m | Site 76, 0.5m 0.5m | Site 76, 1.0m 1.0m |
|---|---|---|---|---|---|
| | | Date Sampled | 15/03/2023 | 16/03/2023 | 17/03/2023 |
| Analyte | Unit | *Reporting Limit* | 23-07358-6 | 23-07358-7 | 23-07358-8 |
| $pH_F$* | pH | *1* | 6.55 | 5.16 | 5.58 |
| $pH_{ox}$* | pH | *1* | 3.26 | 3.29 | 3.64 |

## Method Summary

**Field pH Test (pHf)** Acid Sulfate Soils Laboratory Method Guidelines.

**Field pH (oxidised) pHox** Acid Sulfate Soils Laboratory Method Guidelines.

Sharelle Frank, B.Sc. (Tech)
Technologist

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation with the exception of tests marked *, which are not accredited.
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# Certificate of Analysis

GHD Ltd
Level 1, 586 Victoria Street
Hamilton 3420

Attention: Jude Addenbrooke
Phone: 027 834 7912
Email: james.owers@ghd.com

Lab Reference: 23-09994
Submitted by: James Owers
Date Received: 4/04/2023
Testing Initiated: 14/04/2023
Date Completed: 3/05/2023
Order Number:
Reference: 12571919

Sampling Site: Multiple

## Report Comments

Samples were collected by yourselves (or your agent) and analysed as received at Analytica Laboratories. Samples were in acceptable condition unless otherwise noted on this report.
Specific testing dates are available on request.

AMENDED REPORT. This report replaces in full a previous version R00 sent on 17/4/23. Report amended with Descriptor results

### Field pH (ox) in Soil

| | | Client Sample ID | Site 78, 2.0m 2.0m | Site 78, 1.0m 1.0m | Site 10, 2.0m 2.0m | Site 10, 1.0m 1.0m | Site 4, 1.0m 1.0m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 14/03/2023 | 14/03/2023 | 14/03/2023 | 14/03/2023 | 14/03/2023 |
| Analyte | Unit | *Reporting Limit* | 23-09994-1 | 23-09994-2 | 23-09994-3 | 23-09994-4 | 23-09994-5 |
| $pH_F$* | pH | *1* | 5.68 | 6.02 | 5.19 | 4.87 | 4.69 |
| $pH_{ox}$* | pH | *1* | 2.64 | 3.91 | 1.09 | 1.60 | 3.21 |
| Descriptor* | Descriptor | | X - Slight Reaction | X - Slight Reaction | XXXX - Very Vigorous Reaction | XX - Moderate Reaction | X - Slight Reaction |

### Field pH (ox) in Soil

| | | Client Sample ID | Site 4, 0.5m 0.5m | Site 26, 1.0m 1.0m | Site 26, 0.5m 0.5m | Site 39, 0.75m 0.75m | Site 39, 0.5m 0.5m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 14/03/2023 | 14/03/2023 | 14/03/2023 | 14/03/2023 | 14/03/2023 |
| Analyte | Unit | *Reporting Limit* | 23-09994-6 | 23-09994-7 | 23-09994-8 | 23-09994-9 | 23-09994-10 |
| $pH_F$* | pH | *1* | 4.90 | 5.78 | 6.23 | 5.67 | 5.12 |
| $pH_{ox}$* | pH | *1* | 3.35 | 3.64 | 5.18 | 2.88 | 2.91 |
| Descriptor* | Descriptor | | XX - Moderate Reaction | XXXX - Very Vigorous Reaction | XXXX - Very Vigorous Reaction | XX - Moderate Reaction | X - Slight Reaction |

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation with the exception of tests marked *, which are not accredited.
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## Field pH (ox) in Soil

| | | Client Sample ID | Site 51, 1.55m 0.55m | Site 51, 1.0m 1.0m | Site 52, 2.0m 2.0m | Site 52, 1.0m 1.0m | Site 53, 2.0m 2.0m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 15/03/2023 | 15/03/2023 | 15/03/2023 | 15/03/2023 | 15/03/2023 |
| Analyte | Unit | *Reporting Limit* | 23-09994-11 | 23-09994-12 | 23-09994-13 | 23-09994-14 | 23-09994-15 |
| $pH_F$* | pH | *1* | 6.16 | 6.09 | 6.92 | 7.18 | 5.69 |
| $pH_{ox}$* | pH | *1* | 3.33 | 3.67 | 4.93 | 4.41 | 2.67 |
| Descriptor* | Descriptor | | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction |

## Field pH (ox) in Soil

| | | Client Sample ID | Site 53, 1.0m 1.0m | Site 11, 0.75m 0.75m | Site 11, 0.5m 0.5m | Site 37, 0.75m 0.75m | Site 37, 0.5m 0.5m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 15/03/2023 | 15/03/2023 | 15/03/2023 | 15/03/2023 | 15/03/2023 |
| Analyte | Unit | *Reporting Limit* | 23-09994-16 | 23-09994-17 | 23-09994-18 | 23-09994-19 | 23-09994-20 |
| $pH_F$* | pH | *1* | 5.43 | 5.14 | 4.87 | 5.33 | 5.52 |
| $pH_{ox}$* | pH | *1* | 3.05 | 2.46 | 1.95 | 3.90 | 3.62 |
| Descriptor* | Descriptor | | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction |

## Field pH (ox) in Soil

| | | Client Sample ID | Site 9, 2.0m 2.0m | Site 9, 1.0m 1.0m | Site 7, 2.0m 2.0m | Site 7, 1.0m 1.0m | Site 65, 2.0m 2.0m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 15/03/2023 | 15/03/2023 | 22/03/2023 | 22/03/2023 | 22/03/2023 |
| Analyte | Unit | *Reporting Limit* | 23-09994-21 | 23-09994-22 | 23-09994-23 | 23-09994-24 | 23-09994-25 |
| $pH_F$* | pH | *1* | 6.72 | 7.41 | 5.61 | 5.04 | 6.01 |
| $pH_{ox}$* | pH | *1* | 4.39 | 4.36 | 3.76 | 3.56 | 2.55 |
| Descriptor* | Descriptor | | X - Slight Reaction | XX - Moderate Reaction | X - Slight Reaction | X - Slight Reaction | XXXX - Very Vigorous Reaction |

## Field pH (ox) in Soil

| | | Client Sample ID | Site 65, 1.0m 1.0m | Site 1, 1.0m 1.0m | Site 1, 0.5m 0.5m | Site 33, 0.95m 0.95m | Site 33, 0.5m 0.5m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 22/03/2023 | 22/03/2023 | 22/03/2023 | 22/03/2023 | 22/03/2023 |
| Analyte | Unit | *Reporting Limit* | 23-09994-26 | 23-09994-27 | 23-09994-28 | 23-09994-29 | 23-09994-30 |
| $pH_F$* | pH | *1* | 5.93 | 6.21 | 6.29 | 5.39 | 5.16 |
| $pH_{ox}$* | pH | *1* | 1.86 | 4.25 | 4.43 | 3.80 | 3.76 |
| Descriptor* | Descriptor | | XX - Moderate Reaction | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction |

## Field pH (ox) in Soil

| | | Client Sample ID | Site 14, 2.0m 2.0m | Site 14, 1.0m 1.0m | Site 3, 2.0m 2.0m | Site 3, 1.0m 1.0m | Site 99, 0.2m 0.2m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 22/03/2023 | 22/03/2023 | 22/03/2023 | 22/03/2023 | 22/03/2023 |
| Analyte | Unit | *Reporting Limit* | 23-09994-31 | 23-09994-32 | 23-09994-33 | 23-09994-34 | 23-09994-35 |
| $pH_F$* | pH | *1* | 6.78 | 5.80 | 6.34 | 6.18 | 6.34 |
| $pH_{ox}$* | pH | *1* | 4.55 | 3.67 | 3.81 | 3.77 | 2.98 |
| Descriptor* | Descriptor | | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction | XXXX - Very Vigorous Reaction |


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## Field pH (ox) in Soil

| | | Client Sample ID | Site 99, 0.82m 0.82m | Site 2, 1.0m 1.0m | Site 2, 0.5m 0.5m | Site 87, 1.25m 1.25m | Site 87, 0.5m 0.5m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 22/03/2023 | 22/03/2023 | 22/03/2023 | 22/03/2023 | 22/03/2023 |
| Analyte | Unit | *Reporting Limit* | 23-09994-36 | 23-09994-37 | 23-09994-38 | 23-09994-39 | 23-09994-40 |
| $pH_F$* | pH | *1* | 5.12 | 5.79 | 5.18 | 6.05 | 5.99 |
| $pH_{ox}$* | pH | *1* | 3.42 | 4.10 | 3.55 | 4.23 | 4.13 |
| Descriptor* | Descriptor | | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction |

## Field pH (ox) in Soil

| | | Client Sample ID | Site 28, 0.25m 0.25m | Site 57, 1.0m 1.0m | Site 57, 2.0m 2.0m | Site 75, 1.0m 1.0m | Site 75, 1.2m 1.2m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 29/03/2023 | 29/03/2023 | 29/03/2023 | 29/03/2023 | 29/03/2023 |
| Analyte | Unit | *Reporting Limit* | 23-09994-41 | 23-09994-42 | 23-09994-43 | 23-09994-44 | 23-09994-45 |
| $pH_F$* | pH | *1* | 8.22 | 6.58 | 6.82 | 6.80 | 6.88 |
| $pH_{ox}$* | pH | *1* | 6.29 | 3.29 | 2.77 | 2.46 | 3.52 |
| Descriptor* | Descriptor | | XXXX - Very Vigorous Reaction | XXXX - Very Vigorous Reaction | XXX - High Reaction | XXX - High Reaction | XXX - High Reaction |

## Field pH (ox) in Soil

| | | Client Sample ID | Site 60, 2.0m 2.0m | Site 60, 1.0m 1.0m | Site 63, 2.0m 2.0m | Site 63, 0.5m 0.5m | Site 88, 0.85m 0.85m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 29/03/2023 | 29/03/2023 | 29/03/2023 | 29/03/2023 | 29/03/2023 |
| Analyte | Unit | *Reporting Limit* | 23-09994-46 | 23-09994-47 | 23-09994-48 | 23-09994-49 | 23-09994-50 |
| $pH_F$* | pH | *1* | 7.22 | 8.12 | 8.14 | 8.29 | 5.98 |
| $pH_{ox}$* | pH | *1* | 4.23 | 5.53 | 4.00 | 6.53 | 3.09 |
| Descriptor* | Descriptor | | XX - Moderate Reaction | XX - Moderate Reaction | XXX - High Reaction | XXXX - Very Vigorous Reaction | X - Slight Reaction |

## Field pH (ox) in Soil

| | | Client Sample ID | Site 88, 0.5m 0.5m | Site 74, 0.75m 0.75m | Site 74, 0.5m 0.5m | Site 46, 2.0m 2.0m | Site 46, 1.0m 1.0m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 29/03/2023 | 29/03/2023 | 29/03/2023 | 29/03/2023 | 29/03/2023 |
| Analyte | Unit | *Reporting Limit* | 23-09994-51 | 23-09994-52 | 23-09994-53 | 23-09994-54 | 23-09994-55 |
| $pH_F$* | pH | *1* | 5.76 | 5.55 | 5.59 | 5.83 | 5.05 |
| $pH_{ox}$* | pH | *1* | 2.82 | 3.33 | 2.90 | 1.72 | 1.93 |
| Descriptor* | Descriptor | | X - Slight Reaction | XXXX - Very Vigorous Reaction | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction |

## Field pH (ox) in Soil

| | | Client Sample ID | Site 89, 1.0m 1m | Site 89, 0.5m 0.5m | Site 38, 0.75m 0.75m | Site 38, 0.5m 0.5m | Duplicate A |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 29/03/2023 | 29/03/2023 | 29/03/2023 | 29/03/2023 | |
| Analyte | Unit | *Reporting Limit* | 23-09994-56 | 23-09994-57 | 23-09994-58 | 23-09994-59 | 23-09994-60 |
| $pH_F$* | pH | *1* | 4.53 | 4.91 | 5.08 | 4.91 | 6.16 |
| $pH_{ox}$* | pH | *1* | 2.48 | 2.75 | 2.98 | 3.26 | 3.62 |
| Descriptor* | Descriptor | | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction | XXX - High Reaction |


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### Field pH (ox) in Soil

| | | Client Sample ID | Duplicate B |
|---|---|---|---|
| | | Date Sampled | |
| Analyte | Unit | *Reporting Limit* | 23-09994-61 |
| $pH_F$* | pH | *1* | 6.32 |
| $pH_{ox}$* | pH | *1* | 2.67 |
| Descriptor* | Descriptor | | XXXX - Very Vigorous Reaction |

## Method Summary

**Field pH Test (pHf)** Acid Sulfate Soils Laboratory Method Guidelines.

**Field pH (oxidised) pHox** Acid Sulfate Soils Laboratory Method Guidelines.

Sharelle Frank, B.Sc. (Tech)
Technologist


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# Certificate of Analysis

GHD Ltd
Level 1, 586 Victoria Street
Hamilton 3420

Attention: Jude Addenbrooke
Phone: +64 7 834 7912
Email: james.owens@ghd.com

Sampling Site: Multiple

Lab Reference: 23-11477
Submitted by: James Owers
Date Received: 18/04/2023
Testing Initiated: 2/05/2023
Date Completed: 6/05/2023
Order Number:
Reference: 12571919

## Report Comments

Samples were collected by yourselves (or your agent) and analysed as received at Analytica Laboratories. Samples were in acceptable condition unless otherwise noted on this report.
Specific testing dates are available on request.

### Field pH (ox) in Soil

| | | Client Sample ID | Site 24, 1.55m 1.55m | Site 24, 1.0m 1.0m | Site 48, 2.0m 2.0m | Site 48, 1.0m 1.0m | Site 73, 0.9m 0.9m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 31/03/2023 | 31/03/2023 | 31/03/2023 | 31/03/2023 | 31/03/2023 |
| Analyte | Unit | *Reporting Limit* | 23-11477-1 | 23-11477-2 | 23-11477-3 | 23-11477-4 | 23-11477-5 |
| $pH_F$* | pH | *1* | 5.32 | 5.33 | 5.86 | 5.43 | 6.09 |
| $pH_{ox}$* | pH | *1* | 3.84 | 4.15 | 3.15 | 4.39 | 4.32 |
| Descriptor* | Descriptor | | X - Slight Reaction | X - Slight Reaction | XX - Moderate Reaction | XXXX - Very Vigorous Reaction | X - Slight Reaction |

### Field pH (ox) in Soil

| | | Client Sample ID | Site 90, 2.0m 2.0m | Site 90, 1.0m 1.0m | Site 25, 2.0m 2.0m | Site 18, 0.95 0.95 | Site 62, 0.5m 0.5m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 31/03/2023 | 31/03/2023 | 31/03/2023 | 31/03/2023 | 31/03/2023 |
| Analyte | Unit | *Reporting Limit* | 23-11477-6 | 23-11477-7 | 23-11477-8 | 23-11477-10 | 23-11477-12 |
| $pH_F$* | pH | *1* | 6.19 | 6.05 | 6.32 | 5.84 | 5.87 |
| $pH_{ox}$* | pH | *1* | 1.82 | 2.26 | 4.19 | 4.65 | 3.23 |
| Descriptor* | Descriptor | | XX - Moderate Reaction | XX - Moderate Reaction | XX - Moderate Reaction | X - Slight Reaction | XXXX - Very Vigorous Reaction |

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## Field pH (ox) in Soil

| | | Client Sample ID | Site 49, 2.0m 2.0m | Site 49, 0.5m 0.5m | Site 36, 0.95m 0.95m | Site 36, 0.5m 0.5m | Site 54, 2.0m 2.0m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 5/04/2023 | 5/04/2023 | 5/04/2023 | 5/04/2023 | 5/04/2023 |
| Analyte | Unit | *Reporting Limit* | 23-11477-13 | 23-11477-14 | 23-11477-15 | 23-11477-16 | 23-11477-17 |
| $pH_F$* | pH | *1* | 4.89 | 4.50 | 5.67 | 5.37 | 5.08 |
| $pH_{ox}$* | pH | *1* | 2.78 | 2.05 | 3.69 | 3.01 | 1.53 |
| Descriptor* | Descriptor | | X - Slight Reaction | XXXX - Very Vigorous Reaction | XX - Moderate Reaction | XX - Moderate Reaction | XXX - High Reaction |

## Field pH (ox) in Soil

| | | Client Sample ID | Site 54, 1.0m 1.0m | Site 55, 2.0m 2.0m | Site 55, 0.5m 0.5m | Site 20, 2.0m 2.0m | Site 20, 1.0m 1.0m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 5/04/2023 | 5/04/2023 | 5/04/2023 | 5/04/2023 | 5/04/2023 |
| Analyte | Unit | *Reporting Limit* | 23-11477-18 | 23-11477-19 | 23-11477-20 | 23-11477-21 | 23-11477-22 |
| $pH_F$* | pH | *1* | 4.16 | 5.07 | 4.82 | 5.93 | 5.55 |
| $pH_{ox}$* | pH | *1* | 2.35 | 2.61 | 2.58 | 3.33 | 3.26 |
| Descriptor* | Descriptor | | XX - Moderate Reaction | XX - Moderate Reaction | X - Slight Reaction | XX - Moderate Reaction | XX - Moderate Reaction |

## Field pH (ox) in Soil

| | | Client Sample ID | Site 45, 0.95m 0.95m | Site 45, 0.5m 0.5m | Site 56, 2.0m 2.0m | Site 56, 1.0m 1.0m | Site 27, 1.0m 1.0m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 5/04/2023 | 5/04/2023 | 5/04/2023 | 12/04/2023 | 12/04/2023 |
| Analyte | Unit | *Reporting Limit* | 23-11477-23 | 23-11477-24 | 23-11477-25 | 23-11477-26 | 23-11477-27 |
| $pH_F$* | pH | *1* | 5.29 | 5.37 | 7.95 | 8.05 | 4.97 |
| $pH_{ox}$* | pH | *1* | 3.77 | 4.23 | 6.46 | 7.58 | 3.87 |
| Descriptor* | Descriptor | | XX - Moderate Reaction | XXXX - Very Vigorous Reaction | XX - Moderate Reaction | XXXX - Very Vigorous Reaction | X - Slight Reaction |

## Field pH (ox) in Soil

| | | Client Sample ID | Site 27, 0.4m 0.4m | Site 44, 1.3m 1.3m | Site 44, 0.5m 0.5m | Site 19, 1.0m 1.0m | Site 19, 0.5m 0.5m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 12/04/2023 | 12/04/2023 | 12/04/2023 | 12/04/2023 | 12/04/2023 |
| Analyte | Unit | *Reporting Limit* | 23-11477-28 | 23-11477-29 | 23-11477-30 | 23-11477-31 | 23-11477-32 |
| $pH_F$* | pH | *1* | 5.86 | 5.26 | 6.27 | 5.60 | 5.80 |
| $pH_{ox}$* | pH | *1* | 4.21 | 3.18 | 3.67 | 3.99 | 3.72 |
| Descriptor* | Descriptor | | XXXX - Very Vigorous Reaction | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction | XX - Moderate Reaction |

## Field pH (ox) in Soil

| | | Client Sample ID | Site 81, 1.35m 1.35m | Site 81, 1.0m 1.0m | Site 22, 1.0m 1.0m | Site 22, 0.5m 0.5m | Site 96, 0.9m 0.9m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 12/04/2023 | 12/04/2023 | 12/04/2023 | 12/04/2023 | 12/04/2023 |
| Analyte | Unit | *Reporting Limit* | 23-11477-33 | 23-11477-34 | 23-11477-35 | 23-11477-36 | 23-11477-37 |
| $pH_F$* | pH | *1* | 6.46 | 5.97 | 4.81 | 5.55 | 5.62 |
| $pH_{ox}$* | pH | *1* | 4.73 | 3.45 | 3.43 | 3.41 | 3.86 |
| Descriptor* | Descriptor | | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction |


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## Field pH (ox) in Soil

| | | Client Sample ID | Site 96, 0.5m 0.5m | Site 95, 1.15m 1.15m | Site 95, 0.5m 0.5m | Site 85, 1.0m 1.0m | Site 85, 0.4m 0.4m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 12/04/2023 | 12/04/2023 | 12/04/2023 | 14/04/2023 | 14/04/2023 |
| Analyte | Unit | *Reporting Limit* | 23-11477-38 | 23-11477-39 | 23-11477-40 | 23-11477-41 | 23-11477-42 |
| $pH_F$* | pH | *1* | 5.67 | 6.28 | 6.55 | 6.04 | 5.87 |
| $pH_{ox}$* | pH | *1* | 3.57 | 3.90 | 2.70 | 4.74 | 4.37 |
| Descriptor* | Descriptor | | XX - Moderate Reaction | X - Slight Reaction | XX - Moderate Reaction | X - Slight Reaction | XX - Moderate Reaction |

## Field pH (ox) in Soil

| | | Client Sample ID | Site 32, 1.8m 1.8m | Site 32, 1.0m 1.0m | Site 23, 2.0m 2.0m | Site 23, 1.0m 1.0m | Site 5, .95m .95m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 14/04/2023 | 14/04/2023 | 14/04/2023 | 14/04/2023 | 14/04/2023 |
| Analyte | Unit | *Reporting Limit* | 23-11477-43 | 23-11477-44 | 23-11477-45 | 23-11477-46 | 23-11477-47 |
| $pH_F$* | pH | *1* | 6.55 | 6.28 | 6.84 | 6.93 | 6.05 |
| $pH_{ox}$* | pH | *1* | 2.38 | 2.54 | 6.50 | 5.08 | 4.57 |
| Descriptor* | Descriptor | | XX - Moderate Reaction | XX - Moderate Reaction | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction |

## Field pH (ox) in Soil

| | | Client Sample ID | Site 86, 1.7m 1.7m | Site 86, 1.0m 1.0m | Site 6, 0.9m 0.9m | Site 6, 0.5m 0.5m | Site 61, 1.05m 1.05m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 14/04/2023 | 14/04/2023 | 14/04/2023 | 14/04/2023 | 14/04/2023 |
| Analyte | Unit | *Reporting Limit* | 23-11477-48 | 23-11477-49 | 23-11477-50 | 23-11477-51 | 23-11477-52 |
| $pH_F$* | pH | *1* | 5.61 | 6.61 | 6.30 | 6.68 | 5.42 |
| $pH_{ox}$* | pH | *1* | 5.05 | 5.84 | 4.46 | 4.51 | 4.33 |
| Descriptor* | Descriptor | | XXXX - Very Vigorous Reaction | XXXX - Very Vigorous Reaction | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction |

## Field pH (ox) in Soil

| | | Client Sample ID | Site 61, 0.5m 0.5m | Site 17, 2.0m 2.0m | Site 17, 1.0m 1.0m | Site 92, 2.0m 2.0m | Site 92, 1.0m 1.0m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 14/04/2023 | 14/04/2023 | 14/04/2023 | 15/04/2023 | 15/04/2023 |
| Analyte | Unit | *Reporting Limit* | 23-11477-53 | 23-11477-54 | 23-11477-55 | 23-11477-56 | 23-11477-57 |
| $pH_F$* | pH | *1* | 5.27 | 6.76 | 6.90 | 6.51 | 6.40 |
| $pH_{ox}$* | pH | *1* | 3.96 | 5.45 | 5.15 | 4.93 | 4.31 |
| Descriptor* | Descriptor | | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction |

## Field pH (ox) in Soil

| | | Client Sample ID | Site 35, 2.0m 2.0m | Site 35, 0.5m 0.5m | Site 71, 1.0m 1.0m | Site 71, 0.5m 0.5m | Site 42, 1.1m 1.0m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 15/04/2023 | 15/04/2023 | 15/04/2023 | 15/04/2023 | 15/04/2023 |
| Analyte | Unit | *Reporting Limit* | 23-11477-58 | 23-11477-59 | 23-11477-60 | 23-11477-61 | 23-11477-62 |
| $pH_F$* | pH | *1* | 6.09 | 5.81 | 6.64 | 6.27 | 6.40 |
| $pH_{ox}$* | pH | *1* | 4.90 | 4.72 | 5.81 | 4.43 | 4.39 |
| Descriptor* | Descriptor | | X - Slight Reaction | X - Slight Reaction | XXXX - Very Vigorous Reaction | XX - Moderate Reaction | X - Slight Reaction |


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## Field pH (ox) in Soil

| | | Client Sample ID | Site 42, 0.5m 0.5m | Site 13, 2.0m 2.0m | Site 13, 1.0m 1.0m | Site 72, 2.0m 2.0m | Site 72, 1.0m 2.0m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 15/04/2023 | 15/04/2023 | 15/04/2023 | 15/04/2023 | 15/04/2023 |
| Analyte | Unit | *Reporting Limit* | 23-11477-63 | 23-11477-64 | 23-11477-65 | 23-11477-66 | 23-11477-67 |
| $pH_F$* | pH | *1* | 6.16 | 6.39 | 5.91 | 5.66 | 5.53 |
| $pH_{ox}$* | pH | *1* | 3.61 | 5.04 | 4.73 | 4.46 | 4.31 |
| Descriptor* | Descriptor | | XX - Moderate Reaction | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction |

## Field pH (ox) in Soil

| | | Client Sample ID | Duplicate C | Duplicate D | Duplicate E | Duplicate F | Duplicate G |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | | | | | |
| Analyte | Unit | *Reporting Limit* | 23-11477-68 | 23-11477-69 | 23-11477-70 | 23-11477-71 | 23-11477-72 |
| $pH_F$* | pH | *1* | 5.23 | 4.48 | 5.37 | 4.73 | 6.18 |
| $pH_{ox}$* | pH | *1* | 3.96 | 3.62 | 3.62 | 3.36 | 4.30 |
| Descriptor* | Descriptor | | X - Slight Reaction | X - Slight Reaction | XX - Moderate Reaction | X - Slight Reaction | XX - Moderate Reaction |

## Field pH (ox) in Soil

| | | Client Sample ID | Duplicate H | Duplicate I | Duplicate J | Duplicate K | Duplicate L |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | | | | | |
| Analyte | Unit | *Reporting Limit* | 23-11477-73 | 23-11477-74 | 23-11477-75 | 23-11477-76 | 23-11477-77 |
| $pH_F$* | pH | *1* | 4.57 | 5.79 | 5.37 | 5.09 | 6.18 |
| $pH_{ox}$* | pH | *1* | 4.94 | 2.76 | 4.83 | 3.96 | 4.62 |
| Descriptor* | Descriptor | | X - Slight Reaction | XXX - High Reaction | XXX - High Reaction | X - Slight Reaction | X - Slight Reaction |

## Field pH (ox) in Soil

| | | Client Sample ID | Duplicate M | Duplicate N | Site 5, 0.5m |
|---|---|---|---|---|---|
| | | Date Sampled | | | |
| Analyte | Unit | *Reporting Limit* | 23-11477-78 | 23-11477-79 | 23-11477-104 |
| $pH_F$* | pH | *1* | 5.38 | 6.14 | 5.73 |
| $pH_{ox}$* | pH | *1* | 3.69 | 5.30 | 4.14 |
| Descriptor* | Descriptor | | XXX - High Reaction | X - Slight Reaction | XXXX - Very Vigorous Reaction |

## Method Summary

**Field pH Test (pHf)** Acid Sulfate Soils Laboratory Method Guidelines.

**Field pH (oxidised) pHox** Acid Sulfate Soils Laboratory Method Guidelines.

Sharelle Frank, B.Sc. (Tech)
Technologist


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# Certificate of Analysis

GHD Ltd
Level 1, 586 Victoria Street,
Hamilton 3420

Attention: James Owers
Phone: +64 78347912
Email: james.owers@ghd.com

Lab Reference: 23-12330
Submitted by: James Owers
Date Received: 24/04/2023
Testing Initiated: 4/05/2023
Date Completed: 6/05/2023
Order Number:
Reference: 12571919

Sampling Site: Multiple

## Report Comments

Samples were collected by yourselves (or your agent) and analysed as received at Analytica Laboratories. Samples were in acceptable condition unless otherwise noted on this report.
Specific testing dates are available on request.

### Field pH (ox) in Soil

| | | Client Sample ID | Site 97, 1.55m 1.55m | Site 97, 1.0m 1.0m | Site 66, 0.5m 0.5m | Site 66, 0.9m 0.9m | Site 29, 1.0m 1.0m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 18/04/2023 | 18/04/2023 | 18/04/2023 | 18/04/2023 | 18/04/2023 |
| Analyte | Unit | *Reporting Limit* | 23-12330-1 | 23-12330-2 | 23-12330-3 | 23-12330-4 | 23-12330-5 |
| $pH_F$* | pH | *1* | 5.14 | 5.38 | 7.92 | 8.14 | 8.14 |
| $pH_{ox}$* | pH | *1* | 3.44 | 4.28 | 8.08 | 8.34 | 6.43 |
| Descriptor* | Descriptor | | X - Slight Reaction | XX - Moderate Reaction | XXXX - Very Vigorous Reaction | XXXX - Very Vigorous Reaction | X - Slight Reaction |

### Field pH (ox) in Soil

| | | Client Sample ID | Site 29, 1.7m 1.7m | Site 82, 1.0m 1.0m | Site 82, 2.0m 2.0m | Site 94, 1.0m 1.0m | Site 94, 1.4m 1.4m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 18/04/2023 | 18/04/2023 | 18/04/2023 | 18/04/2023 | 18/04/2023 |
| Analyte | Unit | *Reporting Limit* | 23-12330-6 | 23-12330-7 | 23-12330-8 | 23-12330-9 | 23-12330-10 |
| $pH_F$* | pH | *1* | 8.07 | 6.69 | 6.68 | 6.62 | 6.78 |
| $pH_{ox}$* | pH | *1* | 6.46 | 3.35 | 3.47 | 1.69 | 1.73 |
| Descriptor* | Descriptor | | X - Slight Reaction | XXXX - Very Vigorous Reaction | XXX - High Reaction | XX - Moderate Reaction | XX - Moderate Reaction |

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation with the exception of tests marked *, which are not accredited.
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## Field pH (ox) in Soil

| | | Client Sample ID | Site 93, 0.5m 0.5m | Site 93, 0.9m 0.9m | Site 30, 0.5m 0.5m | Site 30, 1.0m 1.0m | Site 59B, 0.5m 0.5m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 18/04/2023 | 18/04/2023 | 18/04/2023 | 18/04/2023 | 19/04/2023 |
| Analyte | Unit | *Reporting Limit* | 23-12330-11 | 23-12330-12 | 23-12330-13 | 23-12330-14 | 23-12330-15 |
| $pH_F$* | pH | *1* | 6.02 | 5.92 | 6.05 | 5.99 | 5.48 |
| $pH_{ox}$* | pH | *1* | 3.15 | 3.53 | 3.56 | 3.53 | 3.77 |
| Descriptor* | Descriptor | | XX - Moderate Reaction | XX - Moderate Reaction | XX - Moderate Reaction | XXX - High Reaction | X - Slight Reaction |

## Field pH (ox) in Soil

| | | Client Sample ID | Site 59B, 1.0m 1.0m | Site 77B, 0.5m 0.5m | Site 77B, 0.8m 0.8m | Site 98B, 1.0m 1.0m | Site 98B, 1.6m 1.6m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 19/04/2023 | 19/04/2023 | 19/04/2023 | 19/04/2023 | 19/04/2023 |
| Analyte | Unit | *Reporting Limit* | 23-12330-16 | 23-12330-17 | 23-12330-18 | 23-12330-19 | 23-12330-20 |
| $pH_F$* | pH | *1* | 5.25 | 6.47 | 6.19 | 5.67 | 5.86 |
| $pH_{ox}$* | pH | *1* | 3.56 | 3.59 | 3.49 | 3.68 | 3.61 |
| Descriptor* | Descriptor | | X - Slight Reaction | XX - Moderate Reaction | XX - Moderate Reaction | X - Slight Reaction | X - Slight Reaction |

## Field pH (ox) in Soil

| | | Client Sample ID | Site 34B, 1.0m 1.0m | Site 34B, 2.0m 2.0m | Site 50B, 1.0m 1.0m | Site 50B, 1.35m 1.35m | Site 40B, 0.5m 0.5m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 19/04/2023 | 19/04/2023 | 19/04/2023 | 19/04/2023 | 19/04/2023 |
| Analyte | Unit | *Reporting Limit* | 23-12330-21 | 23-12330-22 | 23-12330-23 | 23-12330-24 | 23-12330-25 |
| $pH_F$* | pH | *1* | 5.82 | 7.14 | 5.80 | 6.22 | 5.20 |
| $pH_{ox}$* | pH | *1* | 4.49 | 5.26 | 4.43 | 4.34 | 3.45 |
| Descriptor* | Descriptor | | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction |

## Field pH (ox) in Soil

| | | Client Sample ID | Site 40B, 1.1m 1.1m | Site 69, 1.0m 1.0m | Site 69, 2.0m 2.0m | Site 70, 0.5m 0.5m | Site 70, 1.0m 1.0m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 19/04/2023 | 19/04/2023 | 19/04/2023 | 19/04/2023 | 19/04/2023 |
| Analyte | Unit | *Reporting Limit* | 23-12330-26 | 23-12330-27 | 23-12330-28 | 23-12330-29 | 23-12330-30 |
| $pH_F$* | pH | *1* | 6.18 | 5.82 | 5.38 | 5.62 | 6.43 |
| $pH_{ox}$* | pH | *1* | 4.09 | 4.07 | 3.90 | 3.85 | 4.84 |
| Descriptor* | Descriptor | | X - Slight Reaction | X - Slight Reaction | XX - Moderate Reaction | XX - Moderate Reaction | X - Slight Reaction |

## Field pH (ox) in Soil

| | | Client Sample ID | Site 83B, 1.0m 1.0m | Site 83B, 2.0m 2.0m | Site 15, 1.0m 1.0m | Site 15, 2.0m 2.0m | Site 43B, 1.0m 1.0m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 19/04/2023 | 19/04/2023 | 20/04/2023 | 20/04/2023 | 20/04/2023 |
| Analyte | Unit | *Reporting Limit* | 23-12330-31 | 23-12330-32 | 23-12330-33 | 23-12330-34 | 23-12330-35 |
| $pH_F$* | pH | *1* | 4.59 | 4.77 | 6.10 | 6.39 | 5.20 |
| $pH_{ox}$* | pH | *1* | 2.86 | 2.91 | 4.71 | 5.11 | 4.15 |
| Descriptor* | Descriptor | | XX - Moderate Reaction | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction |


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## Field pH (ox) in Soil

| Client Sample ID | | | Site 43B, 2.0m 2.0m | Site 91,1.0m 1.0m | Site 91, 2.0m 2.0m | Site 84B, 0.5m 0.5m | Site 84B, 1.0m 1.0m |
|---|---|---|---|---|---|---|---|
| Date Sampled | | | 20/04/2023 | 20/04/2023 | 20/04/2023 | 20/04/2023 | 20/04/2023 |
| Analyte | Unit | *Reporting Limit* | 23-12330-36 | 23-12330-37 | 23-12330-38 | 23-12330-39 | 23-12330-40 |
| $pH_F$* | pH | *1* | 4.80 | 6.09 | 6.37 | 6.18 | 5.79 |
| $pH_{ox}$* | pH | *1* | 3.54 | 4.74 | 4.85 | 6.52 | 4.90 |
| Descriptor* | Descriptor | | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction | XXXX - Very Vigorous Reaction | XXXX - Very Vigorous Reaction |

## Field pH (ox) in Soil

| Client Sample ID | | | Site 58B, 0.5m 0.5m | Site 58B, 1.2m 1.2m | Site 47, 1.0m 1.0m | Site 47, 2.0m 2.0m | Site 12, 1.0m 1.0m |
|---|---|---|---|---|---|---|---|
| Date Sampled | | | 20/04/2023 | 20/04/2023 | 20/04/2023 | 20/04/2023 | 20/04/2023 |
| Analyte | Unit | *Reporting Limit* | 23-12330-41 | 23-12330-42 | 23-12330-43 | 23-12330-44 | 23-12330-45 |
| $pH_F$* | pH | *1* | 5.53 | 5.92 | 4.53 | 4.74 | 5.93 |
| $pH_{ox}$* | pH | *1* | 3.65 | 3.89 | 2.52 | 2.73 | 2.22 |
| Descriptor* | Descriptor | | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction | XXX - High Reaction |

## Field pH (ox) in Soil

| Client Sample ID | | | Site 12, 2.0m 2.0m | Site 31, 1.0m 1.0m | Site 31, 2.0m 2.0m | Site 100, 0.5m 0.5m | Site 100, 1.0m 1.0m |
|---|---|---|---|---|---|---|---|
| Date Sampled | | | 20/04/2023 | 21/04/2023 | 21/04/2023 | 21/04/2023 | 21/04/2023 |
| Analyte | Unit | *Reporting Limit* | 23-12330-46 | 23-12330-47 | 23-12330-48 | 23-12330-49 | 23-12330-50 |
| $pH_F$* | pH | *1* | 6.31 | 5.94 | 6.17 | 5.70 | 5.62 |
| $pH_{ox}$* | pH | *1* | 1.71 | 4.21 | 1.55 | 1.52 | 3.58 |
| Descriptor* | Descriptor | | XX - Moderate Reaction | XXXX - Very Vigorous Reaction | XXX - High Reaction | X - Slight Reaction | X - Slight Reaction |

## Field pH (ox) in Soil

| Client Sample ID | | | Site 21, 0.5m 0.5m | Site 21, 0.8m 0.8m | Site 16, 0.5m 0.5m | Site 16, 1.15m 1.15m | Site 64B, 0.5m 0.5m |
|---|---|---|---|---|---|---|---|
| Date Sampled | | | 21/04/2023 | 21/04/2023 | 21/04/2023 | 21/04/2023 | 21/04/2023 |
| Analyte | Unit | *Reporting Limit* | 23-12330-51 | 23-12330-52 | 23-12330-53 | 23-12330-54 | 23-12330-55 |
| $pH_F$* | pH | *1* | 6.34 | 6.54 | 5.64 | 6.29 | 6.09 |
| $pH_{ox}$* | pH | *1* | 5.22 | 5.22 | 4.94 | 4.28 | 3.29 |
| Descriptor* | Descriptor | | XXXX - Very Vigorous Reaction | XXXX - Very Vigorous Reaction | XXXX - Very Vigorous Reaction | XX - Moderate Reaction | X - Slight Reaction |

## Field pH (ox) in Soil

| Client Sample ID | | | Site 64B, 2.0m 2.0m | Site 8B, 0.5m 0.5m | Site 8B, 1.1m 1.1m | Site 41C, 1.0m 1.0m | Site 41C, 2.0m 2.0m |
|---|---|---|---|---|---|---|---|
| Date Sampled | | | 21/04/2023 | 21/04/2023 | 21/04/2023 | 21/04/2023 | 21/04/2023 |
| Analyte | Unit | *Reporting Limit* | 23-12330-56 | 23-12330-57 | 23-12330-58 | 23-12330-59 | 23-12330-60 |
| $pH_F$* | pH | *1* | 5.67 | 4.82 | 4.85 | 6.18 | 6.39 |
| $pH_{ox}$* | pH | *1* | 3.20 | 3.38 | 3.63 | 4.13 | 4.71 |
| Descriptor* | Descriptor | | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction |


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## Field pH (ox) in Soil

| | | Client Sample ID | Site 28B, 1.0m<br>1.0m | Site 28B, 2.0m<br>2.0m | Site 68, 0.5m<br>0.5m | Site 68, 1.15m<br>1.15m | Site 67, 0.5m<br>0.5m |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 21/04/2023 | 21/04/2023 | 21/04/2023 | 21/04/2023 | 21/04/2023 |
| Analyte | Unit | *Reporting Limit* | 23-12330-61 | 23-12330-62 | 23-12330-63 | 23-12330-64 | 23-12330-65 |
| $pH_F$* | pH | *1* | 5.83 | 6.29 | 4.73 | 5.29 | 5.05 |
| $pH_{ox}$* | pH | *1* | 4.26 | 5.07 | 3.24 | 3.88 | 3.75 |
| Descriptor* | Descriptor | | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction |

## Field pH (ox) in Soil

| | | Client Sample ID | Site 67, 0.9m<br>0.9m | Duplicate O | Duplicate P | Duplicate Q | Duplicate R |
|---|---|---|---|---|---|---|---|
| | | Date Sampled | 21/04/2023 | | | | |
| Analyte | Unit | *Reporting Limit* | 23-12330-66 | 23-12330-67 | 23-12330-68 | 23-12330-69 | 23-12330-70 |
| $pH_F$* | pH | *1* | 5.15 | 6.33 | 6.02 | 5.62 | 5.12 |
| $pH_{ox}$* | pH | *1* | 3.42 | 3.12 | 3.49 | 3.81 | 3.30 |
| Descriptor* | Descriptor | | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction | X - Slight Reaction |

## Field pH (ox) in Soil

| | | Client Sample ID | Duplicate S | Duplicate T |
|---|---|---|---|---|
| | | Date Sampled | | |
| Analyte | Unit | *Reporting Limit* | 23-12330-71 | 23-12330-72 |
| $pH_F$* | pH | *1* | 5.61 | 4.81 |
| $pH_{ox}$* | pH | *1* | 3.83 | 3.25 |
| Descriptor* | Descriptor | | X - Slight Reaction | X - Slight Reaction |

## Method Summary

| | |
|---|---|
| **Field pH Test (pHf)** | Acid Sulfate Soils Laboratory Method Guidelines. |
| **Field pH (oxidised) pHox** | Acid Sulfate Soils Laboratory Method Guidelines. |

Sharelle Frank, B.Sc. (Tech)
Technologist


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# CERTIFICATE OF ANALYSIS

| | | | |
|---|---|---|---|
| **Work Order** | : **ES2316060** | Page | : 1 of 28 |
| Client | : **ANALYTICA LABORATORIES LIMITED** | Laboratory | : Environmental Division Sydney |
| Contact | : Default reports | Contact | : Customer Services ES |
| Address | : RUAKURA RESEARCH CENTRE 10 Bisley Road HAMILTON WAIKATO NZ 3240 | Address | : 277-289 Woodpark Road Smithfield NSW Australia 2164 |
| Telephone | : ---- | Telephone | : +61-2-8784 8555 |
| Project | : 23-13954 | Date Samples Received | : 15-May-2023 12:00 |
| Order number | : ---- | Date Analysis Commenced | : 12-Jun-2023 |
| C-O-C number | : ---- | Issue Date | : 14-Jun-2023 17:20 |
| Sampler | : ---- | | |
| Site | : ---- | | |
| Quote number | : EN/222 | | |
| No. of samples received | : 98 | | |
| No. of samples analysed | : 98 | | |

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

**Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.**

## *Signatories*

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

| *Signatories* | *Position* | *Accreditation Category* |
|---|---|---|
| Ben Felgendrejeris | Senior Acid Sulfate Soil Chemist | Brisbane Acid Sulphate Soils, Stafford, QLD |

## General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ASS: EA029 (SPOCAS): Excess ANC not required because pH OX less than 6.5.
- EA029 (SPOCAS): Unable to perform SPOCAS analysis on 23-13954-11 (ES2316060-011) due to insufficient sample volume.
- ASS: EA033 (CRS Suite): Laboratory determinations of ANC needs to be corroborated by effectiveness of the measured ANC in relation to incubation ANC. Unless corroborated, the results of ANC testing should be discounted when determining Net Acidity for comparison with action criteria, or for the determination of the acidity hazard and required liming amounts.
- ASS: EA033 (CRS Suite): Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime ($CaCO_3$) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from 'kg/t dry weight' to 'kg/m3 in-situ soil', multiply 'reported results' x 'wet bulk density of soil in t/m3'.
- ASS: EA029 (SPOCAS): Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime ($CaCO_3$) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from kg/t dry weight to kg/m3 in-situ soil, multiply reported results x wet bulk density of soil in t/m3.

## Analytical Results

| Sub-Matrix: SOIL (Matrix: SOIL) | | | Sample ID | 23-13954-1 Site 80, 1.65m | 23-13954-2 Site 79, 2.0m | 23-13954-3 Site 76, 0.5m | 23-13954-4 Site 78, 2.0m | 23-13954-5 Site 10, 2.0m |
|---|---|---|---|---|---|---|---|---|
| | | | Sampling date / time | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 |
| Compound | CAS Number | LOR | Unit | ES2316060-001 | ES2316060-002 | ES2316060-003 | ES2316060-004 | ES2316060-005 |
| | | | | Result | Result | Result | Result | Result |
| **EA029-A: pH Measurements** | | | | | | | | |
| pH KCl (23A) | ---- | 0.1 | pH Unit | ---- | ---- | ---- | ---- | **4.3** |
| pH OX (23B) | ---- | 0.1 | pH Unit | ---- | ---- | ---- | ---- | **3.0** |
| **EA029-B: Acidity Trail** | | | | | | | | |
| Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | ---- | ---- | ---- | ---- | **226** |
| Titratable Peroxide Acidity (23G) | ---- | 2 | mole H+ / t | ---- | ---- | ---- | ---- | **891** |
| Titratable Sulfidic Acidity (23H) | ---- | 2 | mole H+ / t | ---- | ---- | ---- | ---- | **664** |
| sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.020 | % pyrite S | ---- | ---- | ---- | ---- | **0.362** |
| sulfidic - Titratable Peroxide Acidity (s-23G) | ---- | 0.020 | % pyrite S | ---- | ---- | ---- | ---- | **1.43** |
| sulfidic - Titratable Sulfidic Acidity (s-23H) | ---- | 0.020 | % pyrite S | ---- | ---- | ---- | ---- | **1.06** |
| **EA029-C: Sulfur Trail** | | | | | | | | |
| KCl Extractable Sulfur (23Ce) | ---- | 0.020 | % S | ---- | ---- | ---- | ---- | **0.047** |
| Peroxide Sulfur (23De) | ---- | 0.020 | % S | ---- | ---- | ---- | ---- | **0.370** |
| Peroxide Oxidisable Sulfur (23E) | ---- | 0.020 | % S | ---- | ---- | ---- | ---- | **0.323** |
| acidity - Peroxide Oxidisable Sulfur (a-23E) | ---- | 10 | mole H+ / t | ---- | ---- | ---- | ---- | **202** |
| **EA029-D: Calcium Values** | | | | | | | | |
| KCl Extractable Calcium (23Vh) | ---- | 0.020 | % Ca | ---- | ---- | ---- | ---- | **0.152** |
| Peroxide Calcium (23Wh) | ---- | 0.020 | % Ca | ---- | ---- | ---- | ---- | **0.176** |
| Acid Reacted Calcium (23X) | ---- | 0.020 | % Ca | ---- | ---- | ---- | ---- | **0.024** |
| acidity - Acid Reacted Calcium (a-23X) | ---- | 10 | mole H+ / t | ---- | ---- | ---- | ---- | **12** |
| sulfidic - Acid Reacted Calcium (s-23X) | ---- | 0.020 | % S | ---- | ---- | ---- | ---- | <0.020 |
| **EA029-E: Magnesium Values** | | | | | | | | |
| KCl Extractable Magnesium (23Sm) | ---- | 0.020 | % Mg | ---- | ---- | ---- | ---- | **0.059** |
| Peroxide Magnesium (23Tm) | ---- | 0.020 | % Mg | ---- | ---- | ---- | ---- | **0.072** |
| Acid Reacted Magnesium (23U) | ---- | 0.020 | % Mg | ---- | ---- | ---- | ---- | <0.020 |
| Acidity - Acid Reacted Magnesium (a-23U) | ---- | 10 | mole H+ / t | ---- | ---- | ---- | ---- | **10** |
| sulfidic - Acid Reacted Magnesium (s-23U) | ---- | 0.020 | % S | ---- | ---- | ---- | ---- | <0.020 |
| **EA029-G: Retained Acidity** | | | | | | | | |
| HCl Extractable Sulfur (20Be) | ---- | 0.020 | % S | ---- | ---- | ---- | ---- | **0.057** |
| Net Acid Soluble Sulfur (20Je) | ---- | 0.020 | % S | ---- | ---- | ---- | ---- | <0.020 |
| acidity - Net Acid Soluble Sulfur (a-20J) | ---- | 10 | mole H+ / t | ---- | ---- | ---- | ---- | <10 |
| sulfidic - Net Acid Soluble Sulfur (s-20J) | ---- | 0.020 | % pyrite S | ---- | ---- | ---- | ---- | <0.020 |

## *Analytical Results*

| Sub-Matrix: SOIL (Matrix: SOIL) | | | Sample ID | 23-13954-1 Site 80, 1.65m | 23-13954-2 Site 79, 2.0m | 23-13954-3 Site 76, 0.5m | 23-13954-4 Site 78, 2.0m | 23-13954-5 Site 10, 2.0m |
|---|---|---|---|---|---|---|---|---|
| | | | Sampling date / time | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 |
| Compound | CAS Number | LOR | Unit | ES2316060-001 | ES2316060-002 | ES2316060-003 | ES2316060-004 | ES2316060-005 |
| | | | | Result | Result | Result | Result | Result |
| **EA029-H: Acid Base Accounting** | | | | | | | | |
| ANC Fineness Factor | ---- | 0.5 | - | ---- | ---- | ---- | ---- | 1.5 |
| Net Acidity (sulfur units) | ---- | 0.02 | % S | ---- | ---- | ---- | ---- | 0.70 |
| Net Acidity (acidity units) | ---- | 10 | mole H+ / t | ---- | ---- | ---- | ---- | 437 |
| Liming Rate | ---- | 1 | kg CaCO3/t | ---- | ---- | ---- | ---- | 33 |
| Net Acidity excluding ANC (sulfur units) | ---- | 0.02 | % S | ---- | ---- | ---- | ---- | 0.70 |
| Net Acidity excluding ANC (acidity units) | ---- | 10 | mole H+ / t | ---- | ---- | ---- | ---- | 437 |
| Liming Rate excluding ANC | ---- | 1 | kg CaCO3/t | ---- | ---- | ---- | ---- | 33 |
| **EA033-A: Actual Acidity** | | | | | | | | |
| pH KCl (23A) | ---- | 0.1 | pH Unit | 5.0 | 5.6 | 4.7 | 5.2 | 4.3 |
| Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | 66 | 7 | 62 | 16 | 226 |
| sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | 0.10 | <0.02 | 0.10 | 0.02 | 0.36 |
| **EA033-B: Potential Acidity** | | | | | | | | |
| Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | 0.187 | 0.006 | 0.020 | 0.006 | 0.119 |
| acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | 117 | <10 | 12 | <10 | 74 |
| **EA033-D: Retained Acidity** | | | | | | | | |
| KCl Extractable Sulfur (23Ce) | ---- | 0.02 | % S | ---- | ---- | ---- | ---- | 0.04 |
| HCl Extractable Sulfur (20Be) | ---- | 0.02 | % S | ---- | ---- | ---- | ---- | 0.06 |
| Net Acid Soluble Sulfur (20Je) | ---- | 0.02 | % S | ---- | ---- | ---- | ---- | 0.02 |
| acidity - Net Acid Soluble Sulfur (a-20J) | ---- | 10 | mole H+ / t | ---- | ---- | ---- | ---- | 11 |
| sulfidic - Net Acid Soluble Sulfur (s-20J) | ---- | 0.02 | % pyrite S | ---- | ---- | ---- | ---- | <0.02 |
| **EA033-E: Acid Base Accounting** | | | | | | | | |
| ANC Fineness Factor | ---- | 0.5 | - | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| Net Acidity (sulfur units) | ---- | 0.02 | % S | 0.29 | <0.02 | 0.12 | 0.03 | 0.50 |
| Net Acidity (acidity units) | ---- | 10 | mole H+ / t | 182 | 11 | 74 | 19 | 311 |
| Liming Rate | ---- | 1 | kg CaCO3/t | 14 | <1 | 6 | 1 | 23 |
| Net Acidity excluding ANC (sulfur units) | ---- | 0.02 | % S | 0.29 | <0.02 | 0.12 | 0.03 | 0.50 |
| Net Acidity excluding ANC (acidity units) | ---- | 10 | mole H+ / t | 182 | 11 | 74 | 19 | 311 |
| Liming Rate excluding ANC | ---- | 1 | kg CaCO3/t | 14 | <1 | 6 | 1 | 23 |

## Analytical Results

Sub-Matrix: SOIL
(Matrix: SOIL)

| Compound | CAS Number | LOR | Unit | 23-13954-6 Site 4, 1.0m | 23-13954-7 Site 26, 1.0m | 23-13954-8 Site 39, 0.75m | 23-13954-9 Site 51, 1.55m | 23-13954-10 Site 52, 1.0m |
|---|---|---|---|---|---|---|---|---|
| Sampling date / time | | | | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 |
| | | | | ES2316060-006 | ES2316060-007 | ES2316060-008 | ES2316060-009 | ES2316060-010 |
| | | | | Result | Result | Result | Result | Result |
| **EA033-A: Actual Acidity** | | | | | | | | |
| pH KCl (23A) | ---- | 0.1 | pH Unit | **4.8** | **5.9** | **4.6** | **6.0** | **5.9** |
| Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | **73** | **7** | **69** | <2 | **4** |
| sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | **0.12** | <0.02 | **0.11** | <0.02 | <0.02 |
| **EA033-B: Potential Acidity** | | | | | | | | |
| Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | <0.005 | **0.019** | **0.006** | <0.005 | **0.012** |
| acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | <10 | **12** | <10 | <10 | <10 |
| **EA033-E: Acid Base Accounting** | | | | | | | | |
| ANC Fineness Factor | ---- | 0.5 | - | **1.5** | **1.5** | **1.5** | **1.5** | **1.5** |
| Net Acidity (sulfur units) | ---- | 0.02 | % S | **0.12** | **0.03** | **0.12** | <0.02 | <0.02 |
| Net Acidity (acidity units) | ---- | 10 | mole H+ / t | **73** | **19** | **72** | <10 | **11** |
| Liming Rate | ---- | 1 | kg CaCO3/t | **5** | **1** | **5** | <1 | <1 |
| Net Acidity excluding ANC (sulfur units) | ---- | 0.02 | % S | **0.12** | **0.03** | **0.12** | <0.02 | <0.02 |
| Net Acidity excluding ANC (acidity units) | ---- | 10 | mole H+ / t | **73** | **19** | **72** | <10 | **11** |
| Liming Rate excluding ANC | ---- | 1 | kg CaCO3/t | **5** | **1** | **5** | <1 | <1 |

## Analytical Results

Sub-Matrix: SOIL
(Matrix: SOIL)

| Compound | CAS Number | LOR | Unit | 23-13954-11 Site 53, 2.0m | 23-13954-12 Site 11, 0.5m | 23-13954-13 Site 37, 0.5m | 23-13954-14 Site 9, 1.0m | 23-13954-15 Site 7, 1.0m |
|---|---|---|---|---|---|---|---|---|
| Sampling date / time | | | | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 |
| | | | | ES2316060-011 | ES2316060-012 | ES2316060-013 | ES2316060-014 | ES2316060-015 |
| | | | | Result | Result | Result | Result | Result |
| **EA033-A: Actual Acidity** | | | | | | | | |
| pH KCl (23A) | ---- | 0.1 | pH Unit | **4.9** | **4.7** | **4.8** | **6.9** | **4.4** |
| Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | **86** | **56** | **88** | <2 | **160** |
| sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | **0.14** | **0.09** | **0.14** | <0.02 | **0.26** |
| **EA033-B: Potential Acidity** | | | | | | | | |
| Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | **0.022** | **0.025** | **0.006** | **0.009** | <0.005 |
| acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | **14** | **15** | <10 | <10 | <10 |
| **EA033-C: Acid Neutralising Capacity** | | | | | | | | |
| Acid Neutralising Capacity (19A2) | ---- | 0.01 | % CaCO3 | ---- | ---- | ---- | **0.93** | ---- |
| acidity - Acid Neutralising Capacity (a-19A2) | ---- | 10 | mole H+ / t | ---- | ---- | ---- | **185** | ---- |
| sulfidic - Acid Neutralising Capacity (s-19A2) | ---- | 0.01 | % pyrite S | ---- | ---- | ---- | **0.30** | ---- |
| **EA033-D: Retained Acidity** | | | | | | | | |
| KCl Extractable Sulfur (23Ce) | ---- | 0.02 | % S | ---- | ---- | ---- | ---- | <0.02 |
| HCl Extractable Sulfur (20Be) | ---- | 0.02 | % S | ---- | ---- | ---- | ---- | <0.02 |
| Net Acid Soluble Sulfur (20Je) | ---- | 0.02 | % S | ---- | ---- | ---- | ---- | <0.02 |
| acidity - Net Acid Soluble Sulfur (a-20J) | ---- | 10 | mole H+ / t | ---- | ---- | ---- | ---- | <10 |
| sulfidic - Net Acid Soluble Sulfur (s-20J) | ---- | 0.02 | % pyrite S | ---- | ---- | ---- | ---- | <0.02 |
| **EA033-E: Acid Base Accounting** | | | | | | | | |
| ANC Fineness Factor | ---- | 0.5 | - | **1.5** | **1.5** | **1.5** | **1.5** | **1.5** |
| Net Acidity (sulfur units) | ---- | 0.02 | % S | **0.16** | **0.11** | **0.15** | <0.02 | **0.26** |
| Net Acidity (acidity units) | ---- | 10 | mole H+ / t | **100** | **72** | **92** | <10 | **160** |
| Liming Rate | ---- | 1 | kg CaCO3/t | **8** | **5** | **7** | <1 | **12** |
| Net Acidity excluding ANC (sulfur units) | ---- | 0.02 | % S | **0.16** | **0.11** | **0.15** | <0.02 | **0.26** |
| Net Acidity excluding ANC (acidity units) | ---- | 10 | mole H+ / t | **100** | **72** | **92** | <10 | **160** |
| Liming Rate excluding ANC | ---- | 1 | kg CaCO3/t | **8** | **5** | **7** | <1 | **12** |

## Analytical Results

| Sub-Matrix: SOIL (Matrix: SOIL) | | | Sample ID | 23-13954-16 Site 65, 1.0m | 23-13954-17 Site 1, 1.0m | 23-13954-18 Site 33, 0.95m | 23-13954-19 Site 14, 1.0m | 23-13954-20 Site 3, 2.0m |
|---|---|---|---|---|---|---|---|---|
| | | | Sampling date / time | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 |
| Compound | CAS Number | LOR | Unit | ES2316060-016 | ES2316060-017 | ES2316060-018 | ES2316060-019 | ES2316060-020 |
| | | | | Result | Result | Result | Result | Result |
| **EA029-A: pH Measurements** | | | | | | | | |
| pH KCl (23A) | ---- | 0.1 | pH Unit | ---- | ---- | ---- | ---- | **5.5** |
| pH OX (23B) | ---- | 0.1 | pH Unit | ---- | ---- | ---- | ---- | **5.2** |
| **EA029-B: Acidity Trail** | | | | | | | | |
| Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | ---- | ---- | ---- | ---- | **7** |
| Titratable Peroxide Acidity (23G) | ---- | 2 | mole H+ / t | ---- | ---- | ---- | ---- | **12** |
| Titratable Sulfidic Acidity (23H) | ---- | 2 | mole H+ / t | ---- | ---- | ---- | ---- | **5** |
| sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.020 | % pyrite S | ---- | ---- | ---- | ---- | <0.020 |
| sulfidic - Titratable Peroxide Acidity (s-23G) | ---- | 0.020 | % pyrite S | ---- | ---- | ---- | ---- | <0.020 |
| sulfidic - Titratable Sulfidic Acidity (s-23H) | ---- | 0.020 | % pyrite S | ---- | ---- | ---- | ---- | <0.020 |
| **EA029-C: Sulfur Trail** | | | | | | | | |
| KCl Extractable Sulfur (23Ce) | ---- | 0.020 | % S | ---- | ---- | ---- | ---- | <0.020 |
| Peroxide Sulfur (23De) | ---- | 0.020 | % S | ---- | ---- | ---- | ---- | <0.020 |
| Peroxide Oxidisable Sulfur (23E) | ---- | 0.020 | % S | ---- | ---- | ---- | ---- | <0.020 |
| acidity - Peroxide Oxidisable Sulfur (a-23E) | ---- | 10 | mole H+ / t | ---- | ---- | ---- | ---- | <10 |
| **EA029-D: Calcium Values** | | | | | | | | |
| KCl Extractable Calcium (23Vh) | ---- | 0.020 | % Ca | ---- | ---- | ---- | ---- | **0.042** |
| Peroxide Calcium (23Wh) | ---- | 0.020 | % Ca | ---- | ---- | ---- | ---- | **0.042** |
| Acid Reacted Calcium (23X) | ---- | 0.020 | % Ca | ---- | ---- | ---- | ---- | <0.020 |
| acidity - Acid Reacted Calcium (a-23X) | ---- | 10 | mole H+ / t | ---- | ---- | ---- | ---- | <10 |
| sulfidic - Acid Reacted Calcium (s-23X) | ---- | 0.020 | % S | ---- | ---- | ---- | ---- | <0.020 |
| **EA029-E: Magnesium Values** | | | | | | | | |
| KCl Extractable Magnesium (23Sm) | ---- | 0.020 | % Mg | ---- | ---- | ---- | ---- | <0.020 |
| Peroxide Magnesium (23Tm) | ---- | 0.020 | % Mg | ---- | ---- | ---- | ---- | <0.020 |
| Acid Reacted Magnesium (23U) | ---- | 0.020 | % Mg | ---- | ---- | ---- | ---- | <0.020 |
| Acidity - Acid Reacted Magnesium (a-23U) | ---- | 10 | mole H+ / t | ---- | ---- | ---- | ---- | <10 |
| sulfidic - Acid Reacted Magnesium (s-23U) | ---- | 0.020 | % S | ---- | ---- | ---- | ---- | <0.020 |
| **EA029-H: Acid Base Accounting** | | | | | | | | |
| ANC Fineness Factor | ---- | 0.5 | - | ---- | ---- | ---- | ---- | **1.5** |
| Net Acidity (sulfur units) | ---- | 0.02 | % S | ---- | ---- | ---- | ---- | <0.02 |
| Net Acidity (acidity units) | ---- | 10 | mole H+ / t | ---- | ---- | ---- | ---- | <10 |
| Liming Rate | ---- | 1 | kg CaCO3/t | ---- | ---- | ---- | ---- | <1 |

## Analytical Results

| Sub-Matrix: SOIL (Matrix: SOIL) | | | Sample ID | 23-13954-16 Site 65, 1.0m | 23-13954-17 Site 1, 1.0m | 23-13954-18 Site 33, 0.95m | 23-13954-19 Site 14, 1.0m | 23-13954-20 Site 3, 2.0m |
|---|---|---|---|---|---|---|---|---|
| | | | Sampling date / time | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 |
| Compound | CAS Number | LOR | Unit | ES2316060-016 | ES2316060-017 | ES2316060-018 | ES2316060-019 | ES2316060-020 |
| | | | | Result | Result | Result | Result | Result |
| **EA029-H: Acid Base Accounting - Continued** | | | | | | | | |
| Net Acidity excluding ANC (sulfur units) | ---- | 0.02 | % S | ---- | ---- | ---- | ---- | <0.02 |
| Net Acidity excluding ANC (acidity units) | ---- | 10 | mole H+ / t | ---- | ---- | ---- | ---- | <10 |
| Liming Rate excluding ANC | ---- | 1 | kg CaCO3/t | ---- | ---- | ---- | ---- | <1 |
| **EA033-A: Actual Acidity** | | | | | | | | |
| pH KCl (23A) | ---- | 0.1 | pH Unit | 4.7 | 4.9 | 4.8 | 5.2 | 5.5 |
| Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | 116 | 42 | 66 | 17 | 7 |
| sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | 0.19 | 0.07 | 0.11 | 0.03 | <0.02 |
| **EA033-B: Potential Acidity** | | | | | | | | |
| Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | 0.062 | <0.005 | 0.016 | 0.005 | 0.012 |
| acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | 39 | <10 | 10 | <10 | <10 |
| **EA033-E: Acid Base Accounting** | | | | | | | | |
| ANC Fineness Factor | ---- | 0.5 | - | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| Net Acidity (sulfur units) | ---- | 0.02 | % S | 0.25 | 0.07 | 0.12 | 0.03 | 0.02 |
| Net Acidity (acidity units) | ---- | 10 | mole H+ / t | 155 | 42 | 76 | 21 | 14 |
| Liming Rate | ---- | 1 | kg CaCO3/t | 12 | 3 | 6 | 2 | 1 |
| Net Acidity excluding ANC (sulfur units) | ---- | 0.02 | % S | 0.25 | 0.07 | 0.12 | 0.03 | 0.02 |
| Net Acidity excluding ANC (acidity units) | ---- | 10 | mole H+ / t | 155 | 42 | 76 | 21 | 14 |
| Liming Rate excluding ANC | ---- | 1 | kg CaCO3/t | 12 | 3 | 6 | 2 | 1 |

## Analytical Results

| Sub-Matrix: SOIL (Matrix: SOIL) | | | Sample ID | 23-13954-21 Site 99, 0.2m | 23-13954-22 Site 2, 0.5m | 23-13954-23 Site 87, 0.5m | 23-13954-24 Site 57, 2.0m | 23-13954-25 Site 75, 1.0m |
|---|---|---|---|---|---|---|---|---|
| | | | Sampling date / time | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 |
| Compound | CAS Number | LOR | Unit | ES2316060-021 | ES2316060-022 | ES2316060-023 | ES2316060-024 | ES2316060-025 |
| | | | | Result | Result | Result | Result | Result |
| **EA033-A: Actual Acidity** | | | | | | | | |
| pH KCl (23A) | ---- | 0.1 | pH Unit | **5.1** | **5.1** | **4.9** | **5.9** | **5.9** |
| Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | **48** | **27** | **43** | **9** | **7** |
| sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | **0.08** | **0.04** | **0.07** | <0.02 | <0.02 |
| **EA033-B: Potential Acidity** | | | | | | | | |
| Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | <0.005 | **0.008** | <0.005 | **0.121** | **0.234** |
| acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | <10 | <10 | <10 | **75** | **146** |
| **EA033-E: Acid Base Accounting** | | | | | | | | |
| ANC Fineness Factor | ---- | 0.5 | - | **1.5** | **1.5** | **1.5** | **1.5** | **1.5** |
| Net Acidity (sulfur units) | ---- | 0.02 | % S | **0.08** | **0.05** | **0.07** | **0.14** | **0.24** |
| Net Acidity (acidity units) | ---- | 10 | mole H+ / t | **48** | **32** | **43** | **85** | **153** |
| Liming Rate | ---- | 1 | kg CaCO3/t | **4** | **2** | **3** | **6** | **12** |
| Net Acidity excluding ANC (sulfur units) | ---- | 0.02 | % S | **0.08** | **0.05** | **0.07** | **0.14** | **0.24** |
| Net Acidity excluding ANC (acidity units) | ---- | 10 | mole H+ / t | **48** | **32** | **43** | **85** | **153** |
| Liming Rate excluding ANC | ---- | 1 | kg CaCO3/t | **4** | **2** | **3** | **6** | **12** |

## Analytical Results

Sub-Matrix: SOIL
(Matrix: SOIL)

| Compound | CAS Number | LOR | Unit | 23-13954-26 Site 60, 2.0m | 23-13954-27 Site 63, 2.0m | 23-13954-28 Site 88, 0.5m | 23-13954-29 Site 74, 0.5m | 23-13954-30 Site 46, 2.0m |
|---|---|---|---|---|---|---|---|---|
| Sampling date / time | | | | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 |
| | | | | ES2316060-026 | ES2316060-027 | ES2316060-028 | ES2316060-029 | ES2316060-030 |
| | | | | Result | Result | Result | Result | Result |
| **EA029-A: pH Measurements** | | | | | | | | |
| pH KCl (23A) | ---- | 0.1 | pH Unit | **6.4** | **7.8** | ---- | ---- | ---- |
| pH OX (23B) | ---- | 0.1 | pH Unit | **4.6** | **3.9** | ---- | ---- | ---- |
| **EA029-B: Acidity Trail** | | | | | | | | |
| Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | <2 | <2 | ---- | ---- | ---- |
| Titratable Peroxide Acidity (23G) | ---- | 2 | mole H+ / t | **43** | **142** | ---- | ---- | ---- |
| Titratable Sulfidic Acidity (23H) | ---- | 2 | mole H+ / t | **43** | **142** | ---- | ---- | ---- |
| sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.020 | % pyrite S | <0.020 | <0.020 | ---- | ---- | ---- |
| sulfidic - Titratable Peroxide Acidity (s-23G) | ---- | 0.020 | % pyrite S | **0.069** | **0.228** | ---- | ---- | ---- |
| sulfidic - Titratable Sulfidic Acidity (s-23H) | ---- | 0.020 | % pyrite S | **0.069** | **0.228** | ---- | ---- | ---- |
| **EA029-C: Sulfur Trail** | | | | | | | | |
| KCl Extractable Sulfur (23Ce) | ---- | 0.020 | % S | **0.052** | **0.088** | ---- | ---- | ---- |
| Peroxide Sulfur (23De) | ---- | 0.020 | % S | **0.130** | **0.624** | ---- | ---- | ---- |
| Peroxide Oxidisable Sulfur (23E) | ---- | 0.020 | % S | **0.077** | **0.535** | ---- | ---- | ---- |
| acidity - Peroxide Oxidisable Sulfur (a-23E) | ---- | 10 | mole H+ / t | **48** | **334** | ---- | ---- | ---- |
| **EA029-D: Calcium Values** | | | | | | | | |
| KCl Extractable Calcium (23Vh) | ---- | 0.020 | % Ca | **0.649** | **0.341** | ---- | ---- | ---- |
| Peroxide Calcium (23Wh) | ---- | 0.020 | % Ca | **0.686** | **0.350** | ---- | ---- | ---- |
| Acid Reacted Calcium (23X) | ---- | 0.020 | % Ca | **0.037** | <0.020 | ---- | ---- | ---- |
| acidity - Acid Reacted Calcium (a-23X) | ---- | 10 | mole H+ / t | **18** | <10 | ---- | ---- | ---- |
| sulfidic - Acid Reacted Calcium (s-23X) | ---- | 0.020 | % S | **0.029** | <0.020 | ---- | ---- | ---- |
| **EA029-E: Magnesium Values** | | | | | | | | |
| KCl Extractable Magnesium (23Sm) | ---- | 0.020 | % Mg | **0.117** | **0.181** | ---- | ---- | ---- |
| Peroxide Magnesium (23Tm) | ---- | 0.020 | % Mg | **0.123** | **0.224** | ---- | ---- | ---- |
| Acid Reacted Magnesium (23U) | ---- | 0.020 | % Mg | <0.020 | **0.044** | ---- | ---- | ---- |
| Acidity - Acid Reacted Magnesium (a-23U) | ---- | 10 | mole H+ / t | <10 | **36** | ---- | ---- | ---- |
| sulfidic - Acid Reacted Magnesium (s-23U) | ---- | 0.020 | % S | <0.020 | **0.058** | ---- | ---- | ---- |
| **EA029-H: Acid Base Accounting** | | | | | | | | |
| ANC Fineness Factor | ---- | 0.5 | - | **1.5** | **1.5** | ---- | ---- | ---- |
| Net Acidity (sulfur units) | ---- | 0.02 | % S | **0.08** | **0.33** | ---- | ---- | ---- |
| Net Acidity (acidity units) | ---- | 10 | mole H+ / t | **48** | **206** | ---- | ---- | ---- |
| Liming Rate | ---- | 1 | kg CaCO3/t | **4** | **15** | ---- | ---- | ---- |

## Analytical Results

Sub-Matrix: SOIL
(Matrix: SOIL)

| | | | Sample ID | 23-13954-26 Site 60, 2.0m | 23-13954-27 Site 63, 2.0m | 23-13954-28 Site 88, 0.5m | 23-13954-29 Site 74, 0.5m | 23-13954-30 Site 46, 2.0m |
|---|---|---|---|---|---|---|---|---|
| | | | Sampling date / time | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 |
| Compound | CAS Number | LOR | Unit | ES2316060-026 | ES2316060-027 | ES2316060-028 | ES2316060-029 | ES2316060-030 |
| | | | | Result | Result | Result | Result | Result |
| **EA029-H: Acid Base Accounting - Continued** | | | | | | | | |
| Net Acidity excluding ANC (sulfur units) | ---- | 0.02 | % S | 0.08 | 0.54 | ---- | ---- | ---- |
| Net Acidity excluding ANC (acidity units) | ---- | 10 | mole H+ / t | 48 | 334 | ---- | ---- | ---- |
| Liming Rate excluding ANC | ---- | 1 | kg CaCO3/t | 4 | 25 | ---- | ---- | ---- |
| **EA033-A: Actual Acidity** | | | | | | | | |
| pH KCl (23A) | ---- | 0.1 | pH Unit | 6.4 | 7.8 | 4.3 | 4.5 | 4.4 |
| Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | <2 | <2 | 77 | 54 | 83 |
| sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | <0.02 | <0.02 | 0.12 | 0.09 | 0.13 |
| **EA033-B: Potential Acidity** | | | | | | | | |
| Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | 0.009 | 0.448 | 0.008 | 0.016 | 0.085 |
| acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | <10 | 280 | <10 | <10 | 53 |
| **EA033-C: Acid Neutralising Capacity** | | | | | | | | |
| Acid Neutralising Capacity (19A2) | ---- | 0.01 | % CaCO3 | ---- | 2.31 | ---- | ---- | ---- |
| acidity - Acid Neutralising Capacity (a-19A2) | ---- | 10 | mole H+ / t | ---- | 462 | ---- | ---- | ---- |
| sulfidic - Acid Neutralising Capacity (s-19A2) | ---- | 0.01 | % pyrite S | ---- | 0.74 | ---- | ---- | ---- |
| **EA033-D: Retained Acidity** | | | | | | | | |
| KCl Extractable Sulfur (23Ce) | ---- | 0.02 | % S | ---- | ---- | <0.02 | ---- | 0.03 |
| HCl Extractable Sulfur (20Be) | ---- | 0.02 | % S | ---- | ---- | 0.03 | ---- | 0.04 |
| Net Acid Soluble Sulfur (20Je) | ---- | 0.02 | % S | ---- | ---- | 0.06 | ---- | 0.03 |
| acidity - Net Acid Soluble Sulfur (a-20J) | ---- | 10 | mole H+ / t | ---- | ---- | 27 | ---- | 14 |
| sulfidic - Net Acid Soluble Sulfur (s-20J) | ---- | 0.02 | % pyrite S | ---- | ---- | 0.04 | ---- | 0.02 |
| **EA033-E: Acid Base Accounting** | | | | | | | | |
| ANC Fineness Factor | ---- | 0.5 | - | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| Net Acidity (sulfur units) | ---- | 0.02 | % S | <0.02 | <0.02 | 0.18 | 0.10 | 0.24 |
| Net Acidity (acidity units) | ---- | 10 | mole H+ / t | <10 | <10 | 109 | 64 | 150 |
| Liming Rate | ---- | 1 | kg CaCO3/t | <1 | <1 | 8 | 5 | 11 |
| Net Acidity excluding ANC (sulfur units) | ---- | 0.02 | % S | <0.02 | 0.45 | 0.18 | 0.10 | 0.24 |
| Net Acidity excluding ANC (acidity units) | ---- | 10 | mole H+ / t | <10 | 280 | 109 | 64 | 150 |
| Liming Rate excluding ANC | ---- | 1 | kg CaCO3/t | <1 | 21 | 8 | 5 | 11 |

## Analytical Results

| Sub-Matrix: SOIL (Matrix: SOIL) | | | Sample ID | 23-13954-31 Site 89, 1.0m | 23-13954-32 Site 38, 0.75m | 23-13954-33 Site 97, 1.55m | 23-13954-34 Site 66, 0.5m | 23-13954-35 Site 29, 1.0m |
|---|---|---|---|---|---|---|---|---|
| | | | Sampling date / time | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 |
| Compound | CAS Number | LOR | Unit | ES2316060-031 | ES2316060-032 | ES2316060-033 | ES2316060-034 | ES2316060-035 |
| | | | | Result | Result | Result | Result | Result |
| **EA033-A: Actual Acidity** | | | | | | | | |
| pH KCl (23A) | ---- | 0.1 | pH Unit | **3.9** | **4.4** | **4.4** | **8.8** | **8.6** |
| Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | **182** | **62** | **107** | <2 | <2 |
| sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | **0.29** | **0.10** | **0.17** | <0.02 | <0.02 |
| **EA033-B: Potential Acidity** | | | | | | | | |
| Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | **0.016** | **0.013** | **0.007** | **0.015** | <0.005 |
| acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | <10 | <10 | <10 | <10 | <10 |
| **EA033-C: Acid Neutralising Capacity** | | | | | | | | |
| Acid Neutralising Capacity (19A2) | ---- | 0.01 | % CaCO3 | ---- | ---- | ---- | **11.4** | **5.85** |
| acidity - Acid Neutralising Capacity (a-19A2) | ---- | 10 | mole H+ / t | ---- | ---- | ---- | **2270** | **1170** |
| sulfidic - Acid Neutralising Capacity (s-19A2) | ---- | 0.01 | % pyrite S | ---- | ---- | ---- | **3.64** | **1.88** |
| **EA033-D: Retained Acidity** | | | | | | | | |
| KCl Extractable Sulfur (23Ce) | ---- | 0.02 | % S | <0.02 | **0.03** | <0.02 | ---- | ---- |
| HCl Extractable Sulfur (20Be) | ---- | 0.02 | % S | **0.02** | **0.03** | <0.02 | ---- | ---- |
| Net Acid Soluble Sulfur (20Je) | ---- | 0.02 | % S | **0.04** | <0.02 | <0.02 | ---- | ---- |
| acidity - Net Acid Soluble Sulfur (a-20J) | ---- | 10 | mole H+ / t | **19** | <10 | <10 | ---- | ---- |
| sulfidic - Net Acid Soluble Sulfur (s-20J) | ---- | 0.02 | % pyrite S | **0.03** | <0.02 | <0.02 | ---- | ---- |
| **EA033-E: Acid Base Accounting** | | | | | | | | |
| ANC Fineness Factor | ---- | 0.5 | - | **1.5** | **1.5** | **1.5** | **1.5** | **1.5** |
| Net Acidity (sulfur units) | ---- | 0.02 | % S | **0.34** | **0.11** | **0.18** | <0.02 | <0.02 |
| Net Acidity (acidity units) | ---- | 10 | mole H+ / t | **211** | **72** | **111** | <10 | <10 |
| Liming Rate | ---- | 1 | kg CaCO3/t | **16** | **5** | **8** | <1 | <1 |
| Net Acidity excluding ANC (sulfur units) | ---- | 0.02 | % S | **0.34** | **0.11** | **0.18** | <0.02 | <0.02 |
| Net Acidity excluding ANC (acidity units) | ---- | 10 | mole H+ / t | **211** | **72** | **111** | <10 | <10 |
| Liming Rate excluding ANC | ---- | 1 | kg CaCO3/t | **16** | **5** | **8** | <1 | <1 |

## Analytical Results

Sub-Matrix: SOIL
(Matrix: SOIL)

| | | | Sample ID | 23-13954-36 Site 82, 1.0m | 23-13954-37 Site 94, 1.0m | 23-13954-38 Site 93, 0.5m | 23-13954-39 Site 30, 0.5m | 23-13954-40 Site 59B, 1.0m |
|---|---|---|---|---|---|---|---|---|
| | | | Sampling date / time | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 |
| Compound | CAS Number | LOR | Unit | ES2316060-036 | ES2316060-037 | ES2316060-038 | ES2316060-039 | ES2316060-040 |
| | | | | Result | Result | Result | Result | Result |
| **EA029-A: pH Measurements** | | | | | | | | |
| pH KCl (23A) | ---- | 0.1 | pH Unit | **5.9** | **6.7** | ---- | ---- | ---- |
| pH OX (23B) | ---- | 0.1 | pH Unit | **4.5** | **3.2** | ---- | ---- | ---- |
| **EA029-B: Acidity Trail** | | | | | | | | |
| Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | **11** | <2 | ---- | ---- | ---- |
| Titratable Peroxide Acidity (23G) | ---- | 2 | mole H+ / t | **62** | **203** | ---- | ---- | ---- |
| Titratable Sulfidic Acidity (23H) | ---- | 2 | mole H+ / t | **51** | **203** | ---- | ---- | ---- |
| sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.020 | % pyrite S | <0.020 | <0.020 | ---- | ---- | ---- |
| sulfidic - Titratable Peroxide Acidity (s-23G) | ---- | 0.020 | % pyrite S | **0.099** | **0.326** | ---- | ---- | ---- |
| sulfidic - Titratable Sulfidic Acidity (s-23H) | ---- | 0.020 | % pyrite S | **0.081** | **0.326** | ---- | ---- | ---- |
| **EA029-C: Sulfur Trail** | | | | | | | | |
| KCl Extractable Sulfur (23Ce) | ---- | 0.020 | % S | <0.020 | <0.020 | ---- | ---- | ---- |
| Peroxide Sulfur (23De) | ---- | 0.020 | % S | **0.099** | **0.138** | ---- | ---- | ---- |
| Peroxide Oxidisable Sulfur (23E) | ---- | 0.020 | % S | **0.099** | **0.138** | ---- | ---- | ---- |
| acidity - Peroxide Oxidisable Sulfur (a-23E) | ---- | 10 | mole H+ / t | **62** | **86** | ---- | ---- | ---- |
| **EA029-D: Calcium Values** | | | | | | | | |
| KCl Extractable Calcium (23Vh) | ---- | 0.020 | % Ca | **0.242** | **0.101** | ---- | ---- | ---- |
| Peroxide Calcium (23Wh) | ---- | 0.020 | % Ca | **0.248** | **0.104** | ---- | ---- | ---- |
| Acid Reacted Calcium (23X) | ---- | 0.020 | % Ca | <0.020 | <0.020 | ---- | ---- | ---- |
| acidity - Acid Reacted Calcium (a-23X) | ---- | 10 | mole H+ / t | <10 | <10 | ---- | ---- | ---- |
| sulfidic - Acid Reacted Calcium (s-23X) | ---- | 0.020 | % S | <0.020 | <0.020 | ---- | ---- | ---- |
| **EA029-E: Magnesium Values** | | | | | | | | |
| KCl Extractable Magnesium (23Sm) | ---- | 0.020 | % Mg | **0.079** | <0.020 | ---- | ---- | ---- |
| Peroxide Magnesium (23Tm) | ---- | 0.020 | % Mg | **0.081** | <0.020 | ---- | ---- | ---- |
| Acid Reacted Magnesium (23U) | ---- | 0.020 | % Mg | <0.020 | <0.020 | ---- | ---- | ---- |
| Acidity - Acid Reacted Magnesium (a-23U) | ---- | 10 | mole H+ / t | <10 | <10 | ---- | ---- | ---- |
| sulfidic - Acid Reacted Magnesium (s-23U) | ---- | 0.020 | % S | <0.020 | <0.020 | ---- | ---- | ---- |
| **EA029-H: Acid Base Accounting** | | | | | | | | |
| ANC Fineness Factor | ---- | 0.5 | - | **1.5** | **1.5** | ---- | ---- | ---- |
| Net Acidity (sulfur units) | ---- | 0.02 | % S | **0.12** | **0.26** | ---- | ---- | ---- |
| Net Acidity (acidity units) | ---- | 10 | mole H+ / t | **73** | **164** | ---- | ---- | ---- |
| Liming Rate | ---- | 1 | kg CaCO3/t | **5** | **12** | ---- | ---- | ---- |

## Analytical Results

| Sub-Matrix: SOIL (Matrix: SOIL) | | | Sample ID | 23-13954-36 Site 82, 1.0m | 23-13954-37 Site 94, 1.0m | 23-13954-38 Site 93, 0.5m | 23-13954-39 Site 30, 0.5m | 23-13954-40 Site 59B, 1.0m |
|---|---|---|---|---|---|---|---|---|
| | | | Sampling date / time | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 |
| Compound | CAS Number | LOR | Unit | ES2316060-036 | ES2316060-037 | ES2316060-038 | ES2316060-039 | ES2316060-040 |
| | | | | Result | Result | Result | Result | Result |
| **EA029-H: Acid Base Accounting - Continued** | | | | | | | | |
| Net Acidity excluding ANC (sulfur units) | ---- | 0.02 | % S | 0.12 | 0.14 | ---- | ---- | ---- |
| Net Acidity excluding ANC (acidity units) | ---- | 10 | mole H+ / t | 73 | 86 | ---- | ---- | ---- |
| Liming Rate excluding ANC | ---- | 1 | kg CaCO3/t | 5 | 6 | ---- | ---- | ---- |
| **EA033-A: Actual Acidity** | | | | | | | | |
| pH KCl (23A) | ---- | 0.1 | pH Unit | 5.9 | 6.7 | 4.8 | 5.4 | 4.6 |
| Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | 11 | <2 | 50 | 35 | 39 |
| sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | <0.02 | <0.02 | 0.08 | 0.06 | 0.06 |
| **EA033-B: Potential Acidity** | | | | | | | | |
| Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | 0.054 | 0.041 | <0.005 | 0.013 | 0.006 |
| acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | 34 | 26 | <10 | <10 | <10 |
| **EA033-C: Acid Neutralising Capacity** | | | | | | | | |
| Acid Neutralising Capacity (19A2) | ---- | 0.01 | % CaCO3 | ---- | 0.37 | ---- | ---- | ---- |
| acidity - Acid Neutralising Capacity (a-19A2) | ---- | 10 | mole H+ / t | ---- | 74 | ---- | ---- | ---- |
| sulfidic - Acid Neutralising Capacity (s-19A2) | ---- | 0.01 | % pyrite S | ---- | 0.12 | ---- | ---- | ---- |
| **EA033-E: Acid Base Accounting** | | | | | | | | |
| ANC Fineness Factor | ---- | 0.5 | - | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| Net Acidity (sulfur units) | ---- | 0.02 | % S | 0.07 | <0.02 | 0.08 | 0.07 | 0.07 |
| Net Acidity (acidity units) | ---- | 10 | mole H+ / t | 44 | <10 | 50 | 44 | 43 |
| Liming Rate | ---- | 1 | kg CaCO3/t | 3 | <1 | 4 | 3 | 3 |
| Net Acidity excluding ANC (sulfur units) | ---- | 0.02 | % S | 0.07 | 0.04 | 0.08 | 0.07 | 0.07 |
| Net Acidity excluding ANC (acidity units) | ---- | 10 | mole H+ / t | 44 | 26 | 50 | 44 | 43 |
| Liming Rate excluding ANC | ---- | 1 | kg CaCO3/t | 3 | 2 | 4 | 3 | 3 |

## Analytical Results

Sub-Matrix: SOIL
(Matrix: SOIL)

| Compound | CAS Number | LOR | Unit | 23-13954-41 Site 77B, 0.8m | 23-13954-42 Site 98B, 1.6m | 23-13954-43 Site 34B, 1.0m | 23-13954-44 Site 50B, 1.35m | 23-13954-45 Site 40B, 0.5m |
|---|---|---|---|---|---|---|---|---|
| Sampling date / time | | | | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 |
| | | | | ES2316060-041 | ES2316060-042 | ES2316060-043 | ES2316060-044 | ES2316060-045 |
| | | | | Result | Result | Result | Result | Result |
| **EA029-A: pH Measurements** | | | | | | | | |
| pH KCl (23A) | ---- | 0.1 | pH Unit | **5.4** | ---- | ---- | ---- | ---- |
| pH OX (23B) | ---- | 0.1 | pH Unit | **4.6** | ---- | ---- | ---- | ---- |
| **EA029-B: Acidity Trail** | | | | | | | | |
| Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | **8** | ---- | ---- | ---- | ---- |
| Titratable Peroxide Acidity (23G) | ---- | 2 | mole H+ / t | **12** | ---- | ---- | ---- | ---- |
| Titratable Sulfidic Acidity (23H) | ---- | 2 | mole H+ / t | **4** | ---- | ---- | ---- | ---- |
| sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.020 | % pyrite S | <0.020 | ---- | ---- | ---- | ---- |
| sulfidic - Titratable Peroxide Acidity (s-23G) | ---- | 0.020 | % pyrite S | <0.020 | ---- | ---- | ---- | ---- |
| sulfidic - Titratable Sulfidic Acidity (s-23H) | ---- | 0.020 | % pyrite S | <0.020 | ---- | ---- | ---- | ---- |
| **EA029-C: Sulfur Trail** | | | | | | | | |
| KCl Extractable Sulfur (23Ce) | ---- | 0.020 | % S | <0.020 | ---- | ---- | ---- | ---- |
| Peroxide Sulfur (23De) | ---- | 0.020 | % S | <0.020 | ---- | ---- | ---- | ---- |
| Peroxide Oxidisable Sulfur (23E) | ---- | 0.020 | % S | <0.020 | ---- | ---- | ---- | ---- |
| acidity - Peroxide Oxidisable Sulfur (a-23E) | ---- | 10 | mole H+ / t | <10 | ---- | ---- | ---- | ---- |
| **EA029-D: Calcium Values** | | | | | | | | |
| KCl Extractable Calcium (23Vh) | ---- | 0.020 | % Ca | **0.076** | ---- | ---- | ---- | ---- |
| Peroxide Calcium (23Wh) | ---- | 0.020 | % Ca | **0.076** | ---- | ---- | ---- | ---- |
| Acid Reacted Calcium (23X) | ---- | 0.020 | % Ca | <0.020 | ---- | ---- | ---- | ---- |
| acidity - Acid Reacted Calcium (a-23X) | ---- | 10 | mole H+ / t | <10 | ---- | ---- | ---- | ---- |
| sulfidic - Acid Reacted Calcium (s-23X) | ---- | 0.020 | % S | <0.020 | ---- | ---- | ---- | ---- |
| **EA029-E: Magnesium Values** | | | | | | | | |
| KCl Extractable Magnesium (23Sm) | ---- | 0.020 | % Mg | **0.023** | ---- | ---- | ---- | ---- |
| Peroxide Magnesium (23Tm) | ---- | 0.020 | % Mg | **0.023** | ---- | ---- | ---- | ---- |
| Acid Reacted Magnesium (23U) | ---- | 0.020 | % Mg | <0.020 | ---- | ---- | ---- | ---- |
| Acidity - Acid Reacted Magnesium (a-23U) | ---- | 10 | mole H+ / t | <10 | ---- | ---- | ---- | ---- |
| sulfidic - Acid Reacted Magnesium (s-23U) | ---- | 0.020 | % S | <0.020 | ---- | ---- | ---- | ---- |
| **EA029-H: Acid Base Accounting** | | | | | | | | |
| ANC Fineness Factor | ---- | 0.5 | - | **1.5** | ---- | ---- | ---- | ---- |
| Net Acidity (sulfur units) | ---- | 0.02 | % S | <0.02 | ---- | ---- | ---- | ---- |
| Net Acidity (acidity units) | ---- | 10 | mole H+ / t | <10 | ---- | ---- | ---- | ---- |
| Liming Rate | ---- | 1 | kg CaCO3/t | <1 | ---- | ---- | ---- | ---- |

## Analytical Results

Sub-Matrix: SOIL
(Matrix: SOIL)

| Compound | CAS Number | LOR | Unit | 23-13954-41 Site 77B, 0.8m | 23-13954-42 Site 98B, 1.6m | 23-13954-43 Site 34B, 1.0m | 23-13954-44 Site 50B, 1.35m | 23-13954-45 Site 40B, 0.5m |
|---|---|---|---|---|---|---|---|---|
| Sampling date / time | | | | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 |
| | | | | ES2316060-041 | ES2316060-042 | ES2316060-043 | ES2316060-044 | ES2316060-045 |
| | | | | Result | Result | Result | Result | Result |
| **EA029-H: Acid Base Accounting - Continued** | | | | | | | | |
| **Net Acidity excluding ANC (sulfur units)** | ---- | 0.02 | % S | <0.02 | ---- | ---- | ---- | ---- |
| **Net Acidity excluding ANC (acidity units)** | ---- | 10 | mole H+ / t | <10 | ---- | ---- | ---- | ---- |
| **Liming Rate excluding ANC** | ---- | 1 | kg CaCO3/t | <1 | ---- | ---- | ---- | ---- |
| **EA033-A: Actual Acidity** | | | | | | | | |
| **pH KCl (23A)** | ---- | 0.1 | pH Unit | **5.4** | **5.0** | **5.6** | **5.5** | **5.0** |
| **Titratable Actual Acidity (23F)** | ---- | 2 | mole H+ / t | **8** | **65** | **32** | **4** | **55** |
| **sulfidic - Titratable Actual Acidity (s-23F)** | ---- | 0.02 | % pyrite S | <0.02 | **0.10** | **0.05** | <0.02 | **0.09** |
| **EA033-B: Potential Acidity** | | | | | | | | |
| **Chromium Reducible Sulfur (22B)** | ---- | 0.005 | % S | **0.008** | **0.009** | **0.006** | **0.015** | **0.006** |
| **acidity - Chromium Reducible Sulfur (a-22B)** | ---- | 10 | mole H+ / t | <10 | <10 | <10 | <10 | <10 |
| **EA033-E: Acid Base Accounting** | | | | | | | | |
| **ANC Fineness Factor** | ---- | 0.5 | - | **1.5** | **1.5** | **1.5** | **1.5** | **1.5** |
| **Net Acidity (sulfur units)** | ---- | 0.02 | % S | **0.02** | **0.11** | **0.06** | **0.02** | **0.10** |
| **Net Acidity (acidity units)** | ---- | 10 | mole H+ / t | **13** | **71** | **36** | **13** | **59** |
| **Liming Rate** | ---- | 1 | kg CaCO3/t | <1 | **5** | **3** | <1 | **4** |
| **Net Acidity excluding ANC (sulfur units)** | ---- | 0.02 | % S | **0.02** | **0.11** | **0.06** | **0.02** | **0.10** |
| **Net Acidity excluding ANC (acidity units)** | ---- | 10 | mole H+ / t | **13** | **71** | **36** | **13** | **59** |
| **Liming Rate excluding ANC** | ---- | 1 | kg CaCO3/t | <1 | **5** | **3** | <1 | **4** |

## Analytical Results

| Sub-Matrix: SOIL (Matrix: SOIL) | | | Sample ID | 23-13954-46 Site 69, 2.0m | 23-13954-47 Site 70, 0.5m | 23-13954-48 Site 83B, 1.0m | 23-13954-49 Site 15, 1.0m | 23-13954-50 Site 43B, 2.0m |
|---|---|---|---|---|---|---|---|---|
| | | | Sampling date / time | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 |
| Compound | CAS Number | LOR | Unit | ES2316060-046 | ES2316060-047 | ES2316060-048 | ES2316060-049 | ES2316060-050 |
| | | | | Result | Result | Result | Result | Result |
| **EA033-A: Actual Acidity** | | | | | | | | |
| pH KCl (23A) | ---- | 0.1 | pH Unit | **4.6** | **5.1** | **3.7** | **5.6** | **5.1** |
| Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | **71** | **44** | **384** | **41** | **12** |
| sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | **0.11** | **0.07** | **0.62** | **0.06** | <0.02 |
| **EA033-B: Potential Acidity** | | | | | | | | |
| Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | <0.005 | <0.005 | **0.053** | <0.005 | <0.005 |
| acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | <10 | <10 | **33** | <10 | <10 |
| **EA033-D: Retained Acidity** | | | | | | | | |
| KCl Extractable Sulfur (23Ce) | ---- | 0.02 | % S | ---- | ---- | <0.02 | ---- | ---- |
| HCl Extractable Sulfur (20Be) | ---- | 0.02 | % S | ---- | ---- | **0.04** | ---- | ---- |
| Net Acid Soluble Sulfur (20Je) | ---- | 0.02 | % S | ---- | ---- | **0.08** | ---- | ---- |
| acidity - Net Acid Soluble Sulfur (a-20J) | ---- | 10 | mole H+ / t | ---- | ---- | **36** | ---- | ---- |
| sulfidic - Net Acid Soluble Sulfur (s-20J) | ---- | 0.02 | % pyrite S | ---- | ---- | **0.06** | ---- | ---- |
| **EA033-E: Acid Base Accounting** | | | | | | | | |
| ANC Fineness Factor | ---- | 0.5 | - | **1.5** | **1.5** | **1.5** | **1.5** | **1.5** |
| Net Acidity (sulfur units) | ---- | 0.02 | % S | **0.11** | **0.07** | **0.72** | **0.06** | <0.02 |
| Net Acidity (acidity units) | ---- | 10 | mole H+ / t | **71** | **44** | **453** | **41** | **12** |
| Liming Rate | ---- | 1 | kg CaCO3/t | **5** | **3** | **34** | **3** | <1 |
| Net Acidity excluding ANC (sulfur units) | ---- | 0.02 | % S | **0.11** | **0.07** | **0.72** | **0.06** | <0.02 |
| Net Acidity excluding ANC (acidity units) | ---- | 10 | mole H+ / t | **71** | **44** | **453** | **41** | **12** |
| Liming Rate excluding ANC | ---- | 1 | kg CaCO3/t | **5** | **3** | **34** | **3** | <1 |

## Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

| Compound | CAS Number | LOR | Unit | 23-13954-51 Site 91, 1.0m | 23-13954-52 Site 84B, 1.0m | 23-13954-53 Site 58B, 0.5m | 23-13954-54 Site 47, 1.0m | 23-13954-55 Site 12, 2.0m |
|---|---|---|---|---|---|---|---|---|
| Sampling date / time | | | | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 |
| | | | | ES2316060-051 | ES2316060-052 | ES2316060-053 | ES2316060-054 | ES2316060-055 |
| | | | | Result | Result | Result | Result | Result |
| **EA029-A: pH Measurements** | | | | | | | | |
| pH KCl (23A) | ---- | 0.1 | pH Unit | ---- | ---- | ---- | 3.4 | 4.8 |
| pH OX (23B) | ---- | 0.1 | pH Unit | ---- | ---- | ---- | 2.1 | 3.9 |
| **EA029-B: Acidity Trail** | | | | | | | | |
| Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | ---- | ---- | ---- | 454 | 150 |
| Titratable Peroxide Acidity (23G) | ---- | 2 | mole H+ / t | ---- | ---- | ---- | 4210 | 662 |
| Titratable Sulfidic Acidity (23H) | ---- | 2 | mole H+ / t | ---- | ---- | ---- | 3750 | 512 |
| sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.020 | % pyrite S | ---- | ---- | ---- | 0.728 | 0.240 |
| sulfidic - Titratable Peroxide Acidity (s-23G) | ---- | 0.020 | % pyrite S | ---- | ---- | ---- | 6.74 | 1.06 |
| sulfidic - Titratable Sulfidic Acidity (s-23H) | ---- | 0.020 | % pyrite S | ---- | ---- | ---- | 6.02 | 0.821 |
| **EA029-C: Sulfur Trail** | | | | | | | | |
| KCl Extractable Sulfur (23Ce) | ---- | 0.020 | % S | ---- | ---- | ---- | <0.020 | 0.022 |
| Peroxide Sulfur (23De) | ---- | 0.020 | % S | ---- | ---- | ---- | 0.200 | 0.210 |
| Peroxide Oxidisable Sulfur (23E) | ---- | 0.020 | % S | ---- | ---- | ---- | 0.200 | 0.188 |
| acidity - Peroxide Oxidisable Sulfur (a-23E) | ---- | 10 | mole H+ / t | ---- | ---- | ---- | 125 | 117 |
| **EA029-D: Calcium Values** | | | | | | | | |
| KCl Extractable Calcium (23Vh) | ---- | 0.020 | % Ca | ---- | ---- | ---- | 0.108 | 0.140 |
| Peroxide Calcium (23Wh) | ---- | 0.020 | % Ca | ---- | ---- | ---- | 0.150 | 0.140 |
| Acid Reacted Calcium (23X) | ---- | 0.020 | % Ca | ---- | ---- | ---- | 0.042 | <0.020 |
| acidity - Acid Reacted Calcium (a-23X) | ---- | 10 | mole H+ / t | ---- | ---- | ---- | 21 | <10 |
| sulfidic - Acid Reacted Calcium (s-23X) | ---- | 0.020 | % S | ---- | ---- | ---- | 0.033 | <0.020 |
| **EA029-E: Magnesium Values** | | | | | | | | |
| KCl Extractable Magnesium (23Sm) | ---- | 0.020 | % Mg | ---- | ---- | ---- | 0.020 | 0.071 |
| Peroxide Magnesium (23Tm) | ---- | 0.020 | % Mg | ---- | ---- | ---- | 0.032 | 0.071 |
| Acid Reacted Magnesium (23U) | ---- | 0.020 | % Mg | ---- | ---- | ---- | <0.020 | <0.020 |
| Acidity - Acid Reacted Magnesium (a-23U) | ---- | 10 | mole H+ / t | ---- | ---- | ---- | <10 | <10 |
| sulfidic - Acid Reacted Magnesium (s-23U) | ---- | 0.020 | % S | ---- | ---- | ---- | <0.020 | <0.020 |
| **EA029-G: Retained Acidity** | | | | | | | | |
| HCl Extractable Sulfur (20Be) | ---- | 0.020 | % S | ---- | ---- | ---- | <0.020 | ---- |
| Net Acid Soluble Sulfur (20Je) | ---- | 0.020 | % S | ---- | ---- | ---- | <0.020 | ---- |
| acidity - Net Acid Soluble Sulfur (a-20J) | ---- | 10 | mole H+ / t | ---- | ---- | ---- | <10 | ---- |
| sulfidic - Net Acid Soluble Sulfur (s-20J) | ---- | 0.020 | % pyrite S | ---- | ---- | ---- | <0.020 | ---- |

## Analytical Results

| Sub-Matrix: SOIL (Matrix: SOIL) | | | Sample ID | 23-13954-51 Site 91, 1.0m | 23-13954-52 Site 84B, 1.0m | 23-13954-53 Site 58B, 0.5m | 23-13954-54 Site 47, 1.0m | 23-13954-55 Site 12, 2.0m |
|---|---|---|---|---|---|---|---|---|
| | | | Sampling date / time | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 |
| Compound | CAS Number | LOR | Unit | ES2316060-051 | ES2316060-052 | ES2316060-053 | ES2316060-054 | ES2316060-055 |
| | | | | Result | Result | Result | Result | Result |
| **EA029-H: Acid Base Accounting** | | | | | | | | |
| ANC Fineness Factor | ---- | 0.5 | - | ---- | ---- | ---- | 1.5 | 1.5 |
| Net Acidity (sulfur units) | ---- | 0.02 | % S | ---- | ---- | ---- | 0.93 | 0.43 |
| Net Acidity (acidity units) | ---- | 10 | mole H+ / t | ---- | ---- | ---- | 579 | 267 |
| Liming Rate | ---- | 1 | kg CaCO3/t | ---- | ---- | ---- | 43 | 20 |
| Net Acidity excluding ANC (sulfur units) | ---- | 0.02 | % S | ---- | ---- | ---- | 0.93 | 0.43 |
| Net Acidity excluding ANC (acidity units) | ---- | 10 | mole H+ / t | ---- | ---- | ---- | 579 | 267 |
| Liming Rate excluding ANC | ---- | 1 | kg CaCO3/t | ---- | ---- | ---- | 43 | 20 |
| **EA033-A: Actual Acidity** | | | | | | | | |
| pH KCl (23A) | ---- | 0.1 | pH Unit | 4.2 | 4.6 | 5.0 | 3.4 | 4.8 |
| Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | 358 | 38 | 27 | 454 | 150 |
| sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | 0.57 | 0.06 | 0.04 | 0.73 | 0.24 |
| **EA033-B: Potential Acidity** | | | | | | | | |
| Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | 0.025 | <0.005 | <0.005 | 0.014 | 0.055 |
| acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | 15 | <10 | <10 | <10 | 34 |
| **EA033-D: Retained Acidity** | | | | | | | | |
| KCl Extractable Sulfur (23Ce) | ---- | 0.02 | % S | <0.02 | ---- | ---- | <0.02 | ---- |
| HCl Extractable Sulfur (20Be) | ---- | 0.02 | % S | 0.04 | ---- | ---- | <0.02 | ---- |
| Net Acid Soluble Sulfur (20Je) | ---- | 0.02 | % S | 0.08 | ---- | ---- | <0.02 | ---- |
| acidity - Net Acid Soluble Sulfur (a-20J) | ---- | 10 | mole H+ / t | 38 | ---- | ---- | <10 | ---- |
| sulfidic - Net Acid Soluble Sulfur (s-20J) | ---- | 0.02 | % pyrite S | 0.06 | ---- | ---- | <0.02 | ---- |
| **EA033-E: Acid Base Accounting** | | | | | | | | |
| ANC Fineness Factor | ---- | 0.5 | - | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| Net Acidity (sulfur units) | ---- | 0.02 | % S | 0.66 | 0.06 | 0.04 | 0.74 | 0.29 |
| Net Acidity (acidity units) | ---- | 10 | mole H+ / t | 412 | 38 | 27 | 463 | 184 |
| Liming Rate | ---- | 1 | kg CaCO3/t | 31 | 3 | 2 | 35 | 14 |
| Net Acidity excluding ANC (sulfur units) | ---- | 0.02 | % S | 0.66 | 0.06 | 0.04 | 0.74 | 0.29 |
| Net Acidity excluding ANC (acidity units) | ---- | 10 | mole H+ / t | 412 | 38 | 27 | 463 | 184 |
| Liming Rate excluding ANC | ---- | 1 | kg CaCO3/t | 31 | 3 | 2 | 35 | 14 |

## *Analytical Results*

| Sub-Matrix: SOIL (Matrix: SOIL) | | | Sample ID | 23-13954-56 Site 31, 2.0m | 23-13954-57 Site 100, 0.5m | 23-13954-58 Site 21, 0.8m | 23-13954-59 Site 16, 1.15m | 23-13954-60 Site 64B, 2.0m |
|---|---|---|---|---|---|---|---|---|
| | | | Sampling date / time | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 |
| Compound | CAS Number | LOR | Unit | ES2316060-056 | ES2316060-057 | ES2316060-058 | ES2316060-059 | ES2316060-060 |
| | | | | Result | Result | Result | Result | Result |
| **EA033-A: Actual Acidity** | | | | | | | | |
| pH KCl (23A) | ---- | 0.1 | pH Unit | **5.0** | **4.8** | **5.3** | **5.1** | **4.2** |
| Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | **95** | **61** | **56** | **15** | **435** |
| sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | **0.15** | **0.10** | **0.09** | **0.02** | **0.70** |
| **EA033-B: Potential Acidity** | | | | | | | | |
| Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | **0.025** | <0.005 | <0.005 | <0.005 | **0.014** |
| acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | **16** | <10 | <10 | <10 | <10 |
| **EA033-D: Retained Acidity** | | | | | | | | |
| KCl Extractable Sulfur (23Ce) | ---- | 0.02 | % S | ---- | ---- | ---- | ---- | <0.02 |
| HCl Extractable Sulfur (20Be) | ---- | 0.02 | % S | ---- | ---- | ---- | ---- | **0.04** |
| Net Acid Soluble Sulfur (20Je) | ---- | 0.02 | % S | ---- | ---- | ---- | ---- | **0.08** |
| acidity - Net Acid Soluble Sulfur (a-20J) | ---- | 10 | mole H+ / t | ---- | ---- | ---- | ---- | **37** |
| sulfidic - Net Acid Soluble Sulfur (s-20J) | ---- | 0.02 | % pyrite S | ---- | ---- | ---- | ---- | **0.06** |
| **EA033-E: Acid Base Accounting** | | | | | | | | |
| ANC Fineness Factor | ---- | 0.5 | - | **1.5** | **1.5** | **1.5** | **1.5** | **1.5** |
| Net Acidity (sulfur units) | ---- | 0.02 | % S | **0.18** | **0.10** | **0.09** | **0.02** | **0.77** |
| Net Acidity (acidity units) | ---- | 10 | mole H+ / t | **111** | **61** | **56** | **15** | **481** |
| Liming Rate | ---- | 1 | kg CaCO3/t | **8** | **4** | **4** | **1** | **36** |
| Net Acidity excluding ANC (sulfur units) | ---- | 0.02 | % S | **0.18** | **0.10** | **0.09** | **0.02** | **0.77** |
| Net Acidity excluding ANC (acidity units) | ---- | 10 | mole H+ / t | **111** | **61** | **56** | **15** | **481** |
| Liming Rate excluding ANC | ---- | 1 | kg CaCO3/t | **8** | **4** | **4** | **1** | **36** |

## Analytical Results

Sub-Matrix: SOIL
(Matrix: SOIL)

| Compound | CAS Number | LOR | Unit | 23-13954-61 Site 8B, 0.5m | 23-13954-62 Site 41C, 1.0m | 23-13954-63 Site 28B, 1.0m | 23-13954-64 Site 68, 0.5m | 23-13954-65 Site 67, 0.9m |
|---|---|---|---|---|---|---|---|---|
| Sampling date / time | | | | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 |
| | | | | ES2316060-061 | ES2316060-062 | ES2316060-063 | ES2316060-064 | ES2316060-065 |
| | | | | Result | Result | Result | Result | Result |
| **EA033-A: Actual Acidity** | | | | | | | | |
| pH KCl (23A) | ---- | 0.1 | pH Unit | **4.2** | **5.0** | **5.4** | **4.0** | **4.6** |
| Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | **416** | **39** | **14** | **641** | **76** |
| sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | **0.67** | **0.06** | **0.02** | **1.03** | **0.12** |
| **EA033-B: Potential Acidity** | | | | | | | | |
| Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | **0.022** | **0.012** | **0.010** | **0.021** | <0.005 |
| acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | **14** | <10 | <10 | **13** | <10 |
| **EA033-D: Retained Acidity** | | | | | | | | |
| KCl Extractable Sulfur (23Ce) | ---- | 0.02 | % S | <0.02 | ---- | ---- | <0.02 | ---- |
| HCl Extractable Sulfur (20Be) | ---- | 0.02 | % S | **0.05** | ---- | ---- | **0.04** | ---- |
| Net Acid Soluble Sulfur (20Je) | ---- | 0.02 | % S | **0.09** | ---- | ---- | **0.08** | ---- |
| acidity - Net Acid Soluble Sulfur (a-20J) | ---- | 10 | mole H+ / t | **44** | ---- | ---- | **37** | ---- |
| sulfidic - Net Acid Soluble Sulfur (s-20J) | ---- | 0.02 | % pyrite S | **0.07** | ---- | ---- | **0.06** | ---- |
| **EA033-E: Acid Base Accounting** | | | | | | | | |
| ANC Fineness Factor | ---- | 0.5 | - | **1.5** | **1.5** | **1.5** | **1.5** | **1.5** |
| Net Acidity (sulfur units) | ---- | 0.02 | % S | **0.76** | **0.07** | **0.03** | **1.11** | **0.12** |
| Net Acidity (acidity units) | ---- | 10 | mole H+ / t | **474** | **46** | **20** | **691** | **76** |
| Liming Rate | ---- | 1 | kg CaCO3/t | **36** | **3** | **2** | **52** | **6** |
| Net Acidity excluding ANC (sulfur units) | ---- | 0.02 | % S | **0.76** | **0.07** | **0.03** | **1.11** | **0.12** |
| Net Acidity excluding ANC (acidity units) | ---- | 10 | mole H+ / t | **474** | **46** | **20** | **691** | **76** |
| Liming Rate excluding ANC | ---- | 1 | kg CaCO3/t | **36** | **3** | **2** | **52** | **6** |

## Analytical Results

| Sub-Matrix: SOIL (Matrix: SOIL) | | | Sample ID | 23-13954-66 Site 24, 1.55m | 23-13954-67 Site 48, 2.0m | 23-13954-68 Site 73, 0.8m | 23-13954-69 Site 90, 2.0m | 23-13954-70 Site 25, 2.0m |
|---|---|---|---|---|---|---|---|---|
| | | | Sampling date / time | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 |
| Compound | CAS Number | LOR | Unit | ES2316060-066 | ES2316060-067 | ES2316060-068 | ES2316060-069 | ES2316060-070 |
| | | | | Result | Result | Result | Result | Result |
| **EA033-A: Actual Acidity** | | | | | | | | |
| pH KCl (23A) | ---- | 0.1 | pH Unit | **4.8** | **4.9** | **5.0** | **4.6** | **4.8** |
| Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | **22** | **24** | **19** | **247** | **27** |
| sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | **0.04** | **0.04** | **0.03** | **0.40** | **0.04** |
| **EA033-B: Potential Acidity** | | | | | | | | |
| Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | **0.008** | **0.011** | **0.009** | **0.105** | **0.007** |
| acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | <10 | <10 | <10 | **66** | <10 |
| **EA033-E: Acid Base Accounting** | | | | | | | | |
| ANC Fineness Factor | ---- | 0.5 | - | **1.5** | **1.5** | **1.5** | **1.5** | **1.5** |
| Net Acidity (sulfur units) | ---- | 0.02 | % S | **0.04** | **0.05** | **0.04** | **0.50** | **0.05** |
| Net Acidity (acidity units) | ---- | 10 | mole H+ / t | **28** | **32** | **24** | **313** | **31** |
| Liming Rate | ---- | 1 | kg CaCO3/t | **2** | **2** | **2** | **23** | **2** |
| Net Acidity excluding ANC (sulfur units) | ---- | 0.02 | % S | **0.04** | **0.05** | **0.04** | **0.50** | **0.05** |
| Net Acidity excluding ANC (acidity units) | ---- | 10 | mole H+ / t | **28** | **32** | **24** | **313** | **31** |
| Liming Rate excluding ANC | ---- | 1 | kg CaCO3/t | **2** | **2** | **2** | **23** | **2** |

## *Analytical Results*

| Sub-Matrix: SOIL (Matrix: SOIL) | | | Sample ID | 23-13954-71 Site 18, 0.95 | 23-13954-72 Site 62, 0.5m | 23-13954-73 Site 49, 0.5m | 23-13954-74 Site 36, 0.5m | 23-13954-75 Site 54, 2.0m |
|---|---|---|---|---|---|---|---|---|
| | | | Sampling date / time | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 |
| Compound | CAS Number | LOR | Unit | ES2316060-071 | ES2316060-072 | ES2316060-073 | ES2316060-074 | ES2316060-075 |
| | | | | Result | Result | Result | Result | Result |
| **EA033-A: Actual Acidity** | | | | | | | | |
| pH KCl (23A) | ---- | 0.1 | pH Unit | **5.0** | **5.0** | **3.9** | **4.7** | **4.1** |
| Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | **18** | **26** | **261** | **45** | **381** |
| sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | **0.03** | **0.04** | **0.42** | **0.07** | **0.61** |
| **EA033-B: Potential Acidity** | | | | | | | | |
| Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | **0.009** | **0.006** | **0.025** | **0.008** | **0.074** |
| acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | <10 | <10 | **16** | <10 | **46** |
| **EA033-D: Retained Acidity** | | | | | | | | |
| KCl Extractable Sulfur (23Ce) | ---- | 0.02 | % S | ---- | ---- | <0.02 | ---- | **0.03** |
| HCl Extractable Sulfur (20Be) | ---- | 0.02 | % S | ---- | ---- | **0.05** | ---- | **0.06** |
| Net Acid Soluble Sulfur (20Je) | ---- | 0.02 | % S | ---- | ---- | **0.10** | ---- | **0.06** |
| acidity - Net Acid Soluble Sulfur (a-20J) | ---- | 10 | mole H+ / t | ---- | ---- | **47** | ---- | **26** |
| sulfidic - Net Acid Soluble Sulfur (s-20J) | ---- | 0.02 | % pyrite S | ---- | ---- | **0.07** | ---- | **0.04** |
| **EA033-E: Acid Base Accounting** | | | | | | | | |
| ANC Fineness Factor | ---- | 0.5 | - | **1.5** | **1.5** | **1.5** | **1.5** | **1.5** |
| Net Acidity (sulfur units) | ---- | 0.02 | % S | **0.04** | **0.05** | **0.52** | **0.08** | **0.73** |
| Net Acidity (acidity units) | ---- | 10 | mole H+ / t | **24** | **29** | **323** | **50** | **453** |
| Liming Rate | ---- | 1 | kg CaCO3/t | **2** | **2** | **24** | **4** | **34** |
| Net Acidity excluding ANC (sulfur units) | ---- | 0.02 | % S | **0.04** | **0.05** | **0.52** | **0.08** | **0.73** |
| Net Acidity excluding ANC (acidity units) | ---- | 10 | mole H+ / t | **24** | **29** | **323** | **50** | **453** |
| Liming Rate excluding ANC | ---- | 1 | kg CaCO3/t | **2** | **2** | **24** | **4** | **34** |

## Analytical Results

| Sub-Matrix: SOIL (Matrix: SOIL) | | | Sample ID | 23-13954-76 Site 55, 2.0m | 23-13954-77 Site 20, 2.0m | 23-13954-78 Site 45, 0.95m | 23-13954-79 Site 56, 2.0m | 23-13954-80 Site 27, 1.0m |
|---|---|---|---|---|---|---|---|---|
| | | | Sampling date / time | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 |
| Compound | CAS Number | LOR | Unit | ES2316060-076 | ES2316060-077 | ES2316060-078 | ES2316060-079 | ES2316060-080 |
| | | | | Result | Result | Result | Result | Result |
| **EA033-A: Actual Acidity** | | | | | | | | |
| pH KCl (23A) | ---- | 0.1 | pH Unit | **4.5** | **5.2** | **4.6** | **8.5** | **4.6** |
| Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | **74** | **19** | **40** | <2 | **132** |
| sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | **0.12** | **0.03** | **0.06** | <0.02 | **0.21** |
| **EA033-B: Potential Acidity** | | | | | | | | |
| Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | **0.018** | **0.012** | **0.014** | **0.076** | **0.017** |
| acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | **11** | <10 | <10 | **48** | **10** |
| **EA033-C: Acid Neutralising Capacity** | | | | | | | | |
| Acid Neutralising Capacity (19A2) | ---- | 0.01 | % CaCO3 | ---- | ---- | ---- | **14.1** | ---- |
| acidity - Acid Neutralising Capacity (a-19A2) | ---- | 10 | mole H+ / t | ---- | ---- | ---- | **2820** | ---- |
| sulfidic - Acid Neutralising Capacity (s-19A2) | ---- | 0.01 | % pyrite S | ---- | ---- | ---- | **4.51** | ---- |
| **EA033-E: Acid Base Accounting** | | | | | | | | |
| ANC Fineness Factor | ---- | 0.5 | - | **1.5** | **1.5** | **1.5** | **1.5** | **1.5** |
| Net Acidity (sulfur units) | ---- | 0.02 | % S | **0.14** | **0.04** | **0.08** | <0.02 | **0.23** |
| Net Acidity (acidity units) | ---- | 10 | mole H+ / t | **86** | **26** | **49** | <10 | **142** |
| Liming Rate | ---- | 1 | kg CaCO3/t | **6** | **2** | **4** | <1 | **11** |
| Net Acidity excluding ANC (sulfur units) | ---- | 0.02 | % S | **0.14** | **0.04** | **0.08** | **0.08** | **0.23** |
| Net Acidity excluding ANC (acidity units) | ---- | 10 | mole H+ / t | **86** | **26** | **49** | **48** | **142** |
| Liming Rate excluding ANC | ---- | 1 | kg CaCO3/t | **6** | **2** | **4** | **4** | **11** |

## *Analytical Results*

| Sub-Matrix: SOIL (Matrix: SOIL) | | | *Sample ID* | 23-13954-81 Site 19, 0.5m | 23-13954-82 Site 81, 1.0m | 23-13954-83 Site 22, 0.5m | 23-13954-84 Site 96, 0.5m | 23-13954-85 Site 85, 0.4m |
|---|---|---|---|---|---|---|---|---|
| | | | *Sampling date / time* | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 |
| *Compound* | *CAS Number* | *LOR* | *Unit* | ES2316060-081 | ES2316060-082 | ES2316060-083 | ES2316060-084 | ES2316060-085 |
| | | | | Result | Result | Result | Result | Result |
| **EA033-A: Actual Acidity** | | | | | | | | |
| pH KCl (23A) | ---- | 0.1 | pH Unit | **6.2** | **5.0** | **4.4** | **4.7** | **5.5** |
| Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | **2** | **25** | **124** | **83** | **23** |
| sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | <0.02 | **0.04** | **0.20** | **0.13** | **0.04** |
| **EA033-B: Potential Acidity** | | | | | | | | |
| Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | **0.013** | <0.005 | **0.006** | <0.005 | **0.007** |
| acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | <10 | <10 | <10 | <10 | <10 |
| **EA033-D: Retained Acidity** | | | | | | | | |
| KCl Extractable Sulfur (23Ce) | ---- | 0.02 | % S | ---- | ---- | **0.03** | ---- | ---- |
| HCl Extractable Sulfur (20Be) | ---- | 0.02 | % S | ---- | ---- | **0.04** | ---- | ---- |
| Net Acid Soluble Sulfur (20Je) | ---- | 0.02 | % S | ---- | ---- | <0.02 | ---- | ---- |
| acidity - Net Acid Soluble Sulfur (a-20J) | ---- | 10 | mole H+ / t | ---- | ---- | <10 | ---- | ---- |
| sulfidic - Net Acid Soluble Sulfur (s-20J) | ---- | 0.02 | % pyrite S | ---- | ---- | <0.02 | ---- | ---- |
| **EA033-E: Acid Base Accounting** | | | | | | | | |
| ANC Fineness Factor | ---- | 0.5 | - | **1.5** | **1.5** | **1.5** | **1.5** | **1.5** |
| Net Acidity (sulfur units) | ---- | 0.02 | % S | <0.02 | **0.04** | **0.22** | **0.13** | **0.04** |
| Net Acidity (acidity units) | ---- | 10 | mole H+ / t | **10** | **25** | **135** | **83** | **27** |
| Liming Rate | ---- | 1 | kg CaCO3/t | <1 | **2** | **10** | **6** | **2** |
| Net Acidity excluding ANC (sulfur units) | ---- | 0.02 | % S | <0.02 | **0.04** | **0.22** | **0.13** | **0.04** |
| Net Acidity excluding ANC (acidity units) | ---- | 10 | mole H+ / t | **10** | **25** | **135** | **83** | **27** |
| Liming Rate excluding ANC | ---- | 1 | kg CaCO3/t | <1 | **2** | **10** | **6** | **2** |

## Analytical Results

| Sub-Matrix: SOIL (Matrix: SOIL) | | | Sample ID | 23-13954-86 Site 32, 1.8m | 23-13954-87 Site 23, 1.0m | 23-13954-88 Site 86, 1.7m | 23-13954-89 Site 6, 0.9m | 23-13954-90 Site 61, 0.5m |
|---|---|---|---|---|---|---|---|---|
| | | | Sampling date / time | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 |
| Compound | CAS Number | LOR | Unit | ES2316060-086 | ES2316060-087 | ES2316060-088 | ES2316060-089 | ES2316060-090 |
| | | | | Result | Result | Result | Result | Result |
| **EA033-A: Actual Acidity** | | | | | | | | |
| pH KCl (23A) | ---- | 0.1 | pH Unit | **5.3** | **6.4** | **5.0** | **5.0** | **4.9** |
| Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | **34** | <2 | **64** | **23** | **65** |
| sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | **0.06** | <0.02 | **0.10** | **0.04** | **0.10** |
| **EA033-B: Potential Acidity** | | | | | | | | |
| Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | **0.049** | **0.006** | **0.011** | <0.005 | <0.005 |
| acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | **30** | <10 | <10 | <10 | <10 |
| **EA033-E: Acid Base Accounting** | | | | | | | | |
| ANC Fineness Factor | ---- | 0.5 | - | **1.5** | **1.5** | **1.5** | **1.5** | **1.5** |
| Net Acidity (sulfur units) | ---- | 0.02 | % S | **0.10** | <0.02 | **0.11** | **0.04** | **0.10** |
| Net Acidity (acidity units) | ---- | 10 | mole H+ / t | **65** | <10 | **71** | **23** | **65** |
| Liming Rate | ---- | 1 | kg CaCO3/t | **5** | <1 | **5** | **2** | **5** |
| Net Acidity excluding ANC (sulfur units) | ---- | 0.02 | % S | **0.10** | <0.02 | **0.11** | **0.04** | **0.10** |
| Net Acidity excluding ANC (acidity units) | ---- | 10 | mole H+ / t | **65** | <10 | **71** | **23** | **65** |
| Liming Rate excluding ANC | ---- | 1 | kg CaCO3/t | **5** | <1 | **5** | **2** | **5** |

## Analytical Results

| Sub-Matrix: SOIL (Matrix: SOIL) | | | Sample ID | 23-13954-91 Site 17, 1.0m | 23-13954-92 Site 92, 1.0m | 23-13954-93 Site 35, 0.5m | 23-13954-94 Site 71, 0.5m | 23-13954-95 Site 42, 0.5m |
|---|---|---|---|---|---|---|---|---|
| | | | Sampling date / time | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 |
| Compound | CAS Number | LOR | Unit | ES2316060-091 | ES2316060-092 | ES2316060-093 | ES2316060-094 | ES2316060-095 |
| | | | | Result | Result | Result | Result | Result |
| **EA033-A: Actual Acidity** | | | | | | | | |
| pH KCl (23A) | ---- | 0.1 | pH Unit | **5.8** | **5.7** | **5.3** | **5.9** | **5.4** |
| Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | **4** | **6** | **92** | **11** | **18** |
| sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | <0.02 | <0.02 | **0.15** | <0.02 | **0.03** |
| **EA033-B: Potential Acidity** | | | | | | | | |
| Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | <0.005 | **0.007** | <0.005 | **0.008** | <0.005 |
| acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | <10 | <10 | <10 | <10 | <10 |
| **EA033-E: Acid Base Accounting** | | | | | | | | |
| ANC Fineness Factor | ---- | 0.5 | - | **1.5** | **1.5** | **1.5** | **1.5** | **1.5** |
| Net Acidity (sulfur units) | ---- | 0.02 | % S | <0.02 | <0.02 | **0.15** | **0.02** | **0.03** |
| Net Acidity (acidity units) | ---- | 10 | mole H+ / t | <10 | **11** | **92** | **16** | **18** |
| Liming Rate | ---- | 1 | kg CaCO3/t | <1 | <1 | **7** | **1** | **1** |
| Net Acidity excluding ANC (sulfur units) | ---- | 0.02 | % S | <0.02 | <0.02 | **0.15** | **0.02** | **0.03** |
| Net Acidity excluding ANC (acidity units) | ---- | 10 | mole H+ / t | <10 | **11** | **92** | **16** | **18** |
| Liming Rate excluding ANC | ---- | 1 | kg CaCO3/t | <1 | <1 | **7** | **1** | **1** |

## Analytical Results

| Sub-Matrix: SOIL (Matrix: SOIL) | | | Sample ID | 23-13954-96 Site 13, 1.0m | 23-13954-97 Site 72, 1.0m | 23-13954-98 Site 5, 0.5m | ---- | ---- |
|---|---|---|---|---|---|---|---|---|
| | | | Sampling date / time | 09-May-2023 00:00 | 09-May-2023 00:00 | 09-May-2023 00:00 | ---- | ---- |
| Compound | CAS Number | LOR | Unit | ES2316060-096 | ES2316060-097 | ES2316060-098 | -------- | -------- |
| | | | | Result | Result | Result | ---- | ---- |
| **EA033-A: Actual Acidity** | | | | | | | | |
| pH KCl (23A) | ---- | 0.1 | pH Unit | **5.3** | **5.0** | **5.5** | ---- | ---- |
| Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | **28** | **46** | **33** | ---- | ---- |
| sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | **0.04** | **0.07** | **0.05** | ---- | ---- |
| **EA033-B: Potential Acidity** | | | | | | | | |
| Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | **0.007** | **0.007** | <0.005 | ---- | ---- |
| acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | <10 | <10 | <10 | ---- | ---- |
| **EA033-E: Acid Base Accounting** | | | | | | | | |
| ANC Fineness Factor | ---- | 0.5 | - | **1.5** | **1.5** | **1.5** | ---- | ---- |
| Net Acidity (sulfur units) | ---- | 0.02 | % S | **0.05** | **0.08** | **0.05** | ---- | ---- |
| Net Acidity (acidity units) | ---- | 10 | mole H+ / t | **32** | **50** | **33** | ---- | ---- |
| Liming Rate | ---- | 1 | kg CaCO3/t | **2** | **4** | **2** | ---- | ---- |
| Net Acidity excluding ANC (sulfur units) | ---- | 0.02 | % S | **0.05** | **0.08** | **0.05** | ---- | ---- |
| Net Acidity excluding ANC (acidity units) | ---- | 10 | mole H+ / t | **32** | **50** | **33** | ---- | ---- |
| Liming Rate excluding ANC | ---- | 1 | kg CaCO3/t | **2** | **4** | **2** | ---- | ---- |

## Inter-Laboratory Testing

Analysis conducted by ALS Brisbane, NATA accreditation no. 825, site no. 818 (Chemistry) 18958 (Biology).

(SOIL) EA033-C: Acid Neutralising Capacity

(SOIL) EA033-A: Actual Acidity

(SOIL) EA033-D: Retained Acidity

(SOIL) EA033-E: Acid Base Accounting

(SOIL) EA033-B: Potential Acidity

(SOIL) EA029-D: Calcium Values

(SOIL) EA029-E: Magnesium Values

(SOIL) EA029-F: Excess Acid Neutralising Capacity

(SOIL) EA029-H: Acid Base Accounting

(SOIL) EA029-G: Retained Acidity

(SOIL) EA029-A: pH Measurements

(SOIL) EA029-C: Sulfur Trail

(SOIL) EA029-B: Acidity Trail

# CERTIFICATE OF ANALYSIS

| | | | |
|---|---|---|---|
| **Work Order** | : **ES2316061** | Page | : 1 of 3 |
| Client | : **ANALYTICA LABORATORIES LIMITED** | Laboratory | : Environmental Division Sydney |
| Contact | : Default reports | Contact | : Customer Services ES |
| Address | : RUAKURA RESEARCH CENTRE 10 Bisley Road HAMILTON WAIKATO NZ 3240 | Address | : 277-289 Woodpark Road Smithfield NSW Australia 2164 |
| Telephone | : ---- | Telephone | : +61-2-8784 8555 |
| Project | : 23-13973 | Date Samples Received | : 15-May-2023 12:00 |
| Order number | : ---- | Date Analysis Commenced | : 08-Jun-2023 |
| C-O-C number | : ---- | Issue Date | : 08-Jun-2023 11:57 |
| Sampler | : ---- | | |
| Site | : ---- | | |
| Quote number | : EN/222 | | |
| No. of samples received | : 2 | | |
| No. of samples analysed | : 2 | | |

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

**Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.**

## *Signatories*

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

| *Signatories* | *Position* | *Accreditation Category* |
|---|---|---|
| Ben Felgendrejeris | Senior Acid Sulfate Soil Chemist | Brisbane Acid Sulphate Soils, Stafford, QLD |

## General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ASS: EA033 (CRS Suite):Retained Acidity not required because pH KCl greater than or equal to 4.5
- ASS: EA033 (CRS Suite): ANC not required because pH KCl less than 6.5
- ASS: EA033 (CRS Suite): Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime ($CaCO_3$) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from 'kg/t dry weight' to 'kg/m3 in-situ soil', multiply 'reported results' x 'wet bulk density of soil in t/m3'.

## Analytical Results

| Sub-Matrix: SOIL (Matrix: SOIL) | | | Sample ID | 23-13973-1 Site 44, 1.3m | 23-13973-2 Site 95, 0.5m | ---- | ---- | ---- |
|---|---|---|---|---|---|---|---|---|
| | | | Sampling date / time | 09-May-2023 00:00 | 09-May-2023 00:00 | ---- | ---- | ---- |
| Compound | CAS Number | LOR | Unit | ES2316061-001 | ES2316061-002 | -------- | -------- | -------- |
| | | | | Result | Result | ---- | ---- | ---- |
| **EA033-A: Actual Acidity** | | | | | | | | |
| pH KCl (23A) | ---- | 0.1 | pH Unit | **4.8** | **5.6** | ---- | ---- | ---- |
| Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | **32** | **12** | ---- | ---- | ---- |
| sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | **0.05** | <0.02 | ---- | ---- | ---- |
| **EA033-B: Potential Acidity** | | | | | | | | |
| Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | <0.005 | **0.014** | ---- | ---- | ---- |
| acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | <10 | <10 | ---- | ---- | ---- |
| **EA033-E: Acid Base Accounting** | | | | | | | | |
| ANC Fineness Factor | ---- | 0.5 | - | **1.5** | **1.5** | ---- | ---- | ---- |
| Net Acidity (sulfur units) | ---- | 0.02 | % S | **0.05** | **0.03** | ---- | ---- | ---- |
| Net Acidity (acidity units) | ---- | 10 | mole H+ / t | **32** | **20** | ---- | ---- | ---- |
| Liming Rate | ---- | 1 | kg CaCO3/t | **2** | **2** | ---- | ---- | ---- |
| Net Acidity excluding ANC (sulfur units) | ---- | 0.02 | % S | **0.05** | **0.03** | ---- | ---- | ---- |
| Net Acidity excluding ANC (acidity units) | ---- | 10 | mole H+ / t | **32** | **20** | ---- | ---- | ---- |
| Liming Rate excluding ANC | ---- | 1 | kg CaCO3/t | **2** | **2** | ---- | ---- | ---- |

## Inter-Laboratory Testing

Analysis conducted by ALS Brisbane, NATA accreditation no. 825, site no. 818 (Chemistry) 18958 (Biology).

(SOIL) EA033-B: Potential Acidity

(SOIL) EA033-C: Acid Neutralising Capacity

(SOIL) EA033-D: Retained Acidity

(SOIL) EA033-A: Actual Acidity

(SOIL) EA033-E: Acid Base Accounting

# QUALITY CONTROL REPORT

| | | | |
|---|---|---|---|
| **Work Order** | : **ES2316060** | Page | : 1 of 9 |
| Client | : **ANALYTICA LABORATORIES LIMITED** | Laboratory | : Environmental Division Sydney |
| Contact | : Default reports | Contact | : Customer Services ES |
| Address | : RUAKURA RESEARCH CENTRE 10 Bisley Road HAMILTON WAIKATO NZ 3240 | Address | : 277-289 Woodpark Road Smithfield NSW Australia 2164 |
| Telephone | : ---- | Telephone | : +61-2-8784 8555 |
| Project | : 23-13954 | Date Samples Received | : 15-May-2023 |
| Order number | : ---- | Date Analysis Commenced | : 12-Jun-2023 |
| C-O-C number | : ---- | Issue Date | : 14-Jun-2023 |
| Sampler | : ---- | | |
| Site | : ---- | | |
| Quote number | : EN/222 | | |
| No. of samples received | : 98 | | |
| No. of samples analysed | : 98 | | |

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

## *Signatories*

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

| *Signatories* | *Position* | *Accreditation Category* |
|---|---|---|
| Ben Felgendrejeris | Senior Acid Sulfate Soil Chemist | Brisbane Acid Sulphate Soils, Stafford, QLD |

## General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

## Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **SOIL**

| | | | | Laboratory Duplicate (DUP) Report | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Laboratory sample ID* | *Sample ID* | *Method: Compound* | *CAS Number* | *LOR* | *Unit* | *Original Result* | *Duplicate Result* | *RPD (%)* | *Acceptable RPD (%)* |
| **EA029-A: pH Measurements (QC Lot: 5103876)** | | | | | | | | | |
| ES2316060-005 | 23-13954-5 Site 10, 2.0m | EA029: pH KCl (23A) | ---- | 0.1 | pH Unit | 4.3 | 4.3 | 0.0 | 0% - 20% |
| | | EA029: pH OX (23B) | ---- | 0.1 | pH Unit | 3.0 | 3.0 | 0.0 | 0% - 20% |
| **EA029-B: Acidity Trail (QC Lot: 5103876)** | | | | | | | | | |
| ES2316060-005 | 23-13954-5 Site 10, 2.0m | EA029: sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | 0.362 | 0.362 | 0.0 | 0% - 50% |
| | | EA029: sulfidic - Titratable Peroxide Acidity (s-23G) | ---- | 0.02 | % pyrite S | 1.43 | 1.44 | 1.1 | 0% - 20% |
| | | EA029: sulfidic - Titratable Sulfidic Acidity (s-23H) | ---- | 0.02 | % pyrite S | 1.06 | 1.08 | 1.5 | 0% - 20% |
| | | EA029: Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | 226 | 226 | 0.0 | 0% - 20% |
| | | EA029: Titratable Peroxide Acidity (23G) | ---- | 2 | mole H+ / t | 891 | 901 | 1.1 | 0% - 20% |
| | | EA029: Titratable Sulfidic Acidity (23H) | ---- | 2 | mole H+ / t | 664 | 675 | 1.5 | 0% - 20% |
| **EA029-C: Sulfur Trail (QC Lot: 5103876)** | | | | | | | | | |
| ES2316060-005 | 23-13954-5 Site 10, 2.0m | EA029: KCl Extractable Sulfur (23Ce) | ---- | 0.02 | % S | 0.047 | 0.047 | 0.0 | No Limit |
| | | EA029: Peroxide Sulfur (23De) | ---- | 0.02 | % S | 0.370 | 0.359 | 3.1 | 0% - 50% |
| | | EA029: Peroxide Oxidisable Sulfur (23E) | ---- | 0.02 | % S | 0.323 | 0.312 | 3.5 | 0% - 50% |
| | | EA029: acidity - Peroxide Oxidisable Sulfur (a-23E) | ---- | 10 | mole H+ / t | 202 | 195 | 3.5 | 0% - 20% |
| **EA029-D: Calcium Values (QC Lot: 5103876)** | | | | | | | | | |
| ES2316060-005 | 23-13954-5 Site 10, 2.0m | EA029: KCl Extractable Calcium (23Vh) | ---- | 0.02 | % Ca | 0.152 | 0.152 | 0.0 | No Limit |
| | | EA029: Peroxide Calcium (23Wh) | ---- | 0.02 | % Ca | 0.176 | 0.168 | 4.5 | No Limit |
| | | EA029: Acid Reacted Calcium (23X) | ---- | 0.02 | % Ca | 0.024 | <0.020 | 19.4 | No Limit |
| | | EA029: sulfidic - Acid Reacted Calcium (s-23X) | ---- | 0.02 | % S | <0.020 | <0.020 | 0.0 | No Limit |
| | | EA029: acidity - Acid Reacted Calcium (a-23X) | ---- | 10 | mole H+ / t | 12 | <10 | 19.2 | No Limit |

Sub-Matrix: **SOIL**

| Laboratory sample ID | Sample ID | Method: Compound | CAS Number | LOR | Unit | Original Result | Duplicate Result | RPD (%) | Acceptable RPD (%) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Laboratory Duplicate (DUP) Report | | | | | |
| **EA029-E: Magnesium Values (QC Lot: 5103876)** | | | | | | | | | |
| ES2316060-005 | 23-13954-5 Site 10, 2.0m | EA029: KCl Extractable Magnesium (23Sm) | ---- | 0.02 | % Mg | 0.059 | 0.059 | 0.0 | No Limit |
| | | EA029: Peroxide Magnesium (23Tm) | ---- | 0.02 | % Mg | 0.072 | 0.069 | 4.3 | No Limit |
| | | EA029: Acid Reacted Magnesium (23U) | ---- | 0.02 | % Mg | <0.020 | <0.020 | 0.0 | No Limit |
| | | EA029: sulfidic - Acid Reacted Magnesium (s-23U) | ---- | 0.02 | % S | <0.020 | <0.020 | 0.0 | No Limit |
| | | EA029: Acidity - Acid Reacted Magnesium (a-23U) | ---- | 10 | mole H+ / t | 10 | <10 | 0.0 | No Limit |
| **EA029-G: Retained Acidity (QC Lot: 5103876)** | | | | | | | | | |
| ES2316060-005 | 23-13954-5 Site 10, 2.0m | EA029: sulfidic - Net Acid Soluble Sulfur (s-20J) | ---- | 0.02 | % pyrite S | <0.020 | <0.020 | 0.0 | No Limit |
| | | EA029: Net Acid Soluble Sulfur (20Je) | ---- | 0.02 | % S | <0.020 | <0.020 | 0.0 | No Limit |
| | | EA029: HCl Extractable Sulfur (20Be) | ---- | 0.02 | % S | 0.057 | 0.057 | 0.0 | No Limit |
| | | EA029: acidity - Net Acid Soluble Sulfur (a-20J) | ---- | 10 | mole H+ / t | <10 | <10 | 0.0 | No Limit |
| **EA029-H: Acid Base Accounting (QC Lot: 5103876)** | | | | | | | | | |
| ES2316060-005 | 23-13954-5 Site 10, 2.0m | EA029: ANC Fineness Factor | ---- | 0.5 | - | 1.5 | 1.5 | 0.0 | No Limit |
| | | EA029: Net Acidity (sulfur units) | ---- | 0.02 | % S | 0.70 | 0.69 | 1.6 | 0% - 20% |
| | | EA029: Net Acidity excluding ANC (sulfur units) | ---- | 0.02 | % S | 0.70 | 0.69 | 1.6 | 0% - 20% |
| | | EA029: Liming Rate | ---- | 1 | kg CaCO3/t | 33 | 32 | 0.0 | 0% - 20% |
| | | EA029: Liming Rate excluding ANC | ---- | 1 | kg CaCO3/t | 33 | 32 | 0.0 | 0% - 20% |
| | | EA029: Net Acidity (acidity units) | ---- | 10 | mole H+ / t | 437 | 430 | 1.6 | 0% - 20% |
| | | EA029: Net Acidity excluding ANC (acidity units) | ---- | 10 | mole H+ / t | 437 | 430 | 1.6 | 0% - 20% |
| **EA033-A: Actual Acidity (QC Lot: 5103875)** | | | | | | | | | |
| ES2316060-001 | 23-13954-1 Site 80, 1.65m | EA033: sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | 0.10 | 0.12 | 10.1 | No Limit |
| | | EA033: Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | 66 | 73 | 10.1 | 0% - 20% |
| | | EA033: pH KCl (23A) | ---- | 0.1 | pH Unit | 5.0 | 5.0 | 0.0 | 0% - 20% |
| ES2316060-011 | 23-13954-11 Site 53, 2.0m | EA033: sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | 0.14 | 0.12 | 14.8 | No Limit |
| | | EA033: Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | 86 | 74 | 14.8 | 0% - 20% |
| | | EA033: pH KCl (23A) | ---- | 0.1 | pH Unit | 4.9 | 4.7 | 3.7 | 0% - 20% |
| **EA033-A: Actual Acidity (QC Lot: 5103877)** | | | | | | | | | |
| ES2316060-021 | 23-13954-21 Site 99, 0.2m | EA033: sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | 0.08 | 0.06 | 17.7 | No Limit |
| | | EA033: Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | 48 | 40 | 17.7 | 0% - 20% |
| | | EA033: pH KCl (23A) | ---- | 0.1 | pH Unit | 5.1 | 5.1 | 0.0 | 0% - 20% |
| ES2316060-031 | 23-13954-31 Site 89, 1.0m | EA033: sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | 0.29 | 0.27 | 7.5 | 0% - 50% |
| | | EA033: Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | 182 | 169 | 7.5 | 0% - 20% |
| | | EA033: pH KCl (23A) | ---- | 0.1 | pH Unit | 3.9 | 3.9 | 0.0 | 0% - 20% |
| **EA033-A: Actual Acidity (QC Lot: 5103878)** | | | | | | | | | |
| ES2316060-041 | 23-13954-41 Site 77B, 0.8m | EA033: sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | <0.02 | <0.02 | 0.0 | No Limit |
| | | EA033: Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | 8 | 7 | 14.4 | No Limit |
| | | EA033: pH KCl (23A) | ---- | 0.1 | pH Unit | 5.4 | 5.4 | 0.0 | 0% - 20% |

Sub-Matrix: **SOIL**

| Laboratory sample ID | Sample ID | Method: Compound | CAS Number | LOR | Unit | Original Result | Duplicate Result | RPD (%) | Acceptable RPD (%) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Laboratory Duplicate (DUP) Report | | | | | |
| **EA033-A: Actual Acidity (QC Lot: 5103878) - continued** | | | | | | | | | |
| ES2316060-051 | 23-13954-51 Site 91, 1.0m | EA033: sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | 0.57 | 0.60 | 4.9 | 0% - 20% |
| | | EA033: Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | 358 | 377 | 4.9 | 0% - 20% |
| | | EA033: pH KCl (23A) | ---- | 0.1 | pH Unit | 4.2 | 4.3 | 0.0 | 0% - 20% |
| **EA033-A: Actual Acidity (QC Lot: 5105718)** | | | | | | | | | |
| ES2316060-061 | 23-13954-61 Site 8B, 0.5m | EA033: sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | 0.67 | 0.60 | 10.9 | 0% - 20% |
| | | EA033: Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | 416 | 373 | 10.9 | 0% - 20% |
| | | EA033: pH KCl (23A) | ---- | 0.1 | pH Unit | 4.2 | 4.2 | 0.0 | 0% - 20% |
| ES2316060-071 | 23-13954-71 Site 18, 0.95 | EA033: sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | 0.03 | 0.03 | 0.0 | No Limit |
| | | EA033: Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | 18 | 17 | 6.7 | No Limit |
| | | EA033: pH KCl (23A) | ---- | 0.1 | pH Unit | 5.0 | 5.0 | 0.0 | 0% - 20% |
| **EA033-A: Actual Acidity (QC Lot: 5105719)** | | | | | | | | | |
| ES2316060-081 | 23-13954-81 Site 19, 0.5m | EA033: sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | <0.02 | <0.02 | 0.0 | No Limit |
| | | EA033: Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | 2 | <2 | 0.0 | No Limit |
| | | EA033: pH KCl (23A) | ---- | 0.1 | pH Unit | 6.2 | 6.2 | 0.0 | 0% - 20% |
| ES2316060-091 | 23-13954-91 Site 17, 1.0m | EA033: sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | <0.02 | <0.02 | 0.0 | No Limit |
| | | EA033: Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | 4 | <2 | 63.8 | No Limit |
| | | EA033: pH KCl (23A) | ---- | 0.1 | pH Unit | 5.8 | 5.9 | 0.0 | 0% - 20% |
| **EA033-B: Potential Acidity (QC Lot: 5103875)** | | | | | | | | | |
| ES2316060-001 | 23-13954-1 Site 80, 1.65m | EA033: Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | 0.187 | 0.188 | 0.0 | 0% - 20% |
| | | EA033: acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | 117 | 117 | 0.0 | 0% - 50% |
| ES2316060-011 | 23-13954-11 Site 53, 2.0m | EA033: Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | 0.022 | 0.023 | 0.0 | No Limit |
| | | EA033: acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | 14 | 14 | 0.0 | No Limit |
| **EA033-B: Potential Acidity (QC Lot: 5103877)** | | | | | | | | | |
| ES2316060-021 | 23-13954-21 Site 99, 0.2m | EA033: Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | <0.005 | 0.006 | 22.4 | No Limit |
| | | EA033: acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | <10 | <10 | 0.0 | No Limit |
| ES2316060-031 | 23-13954-31 Site 89, 1.0m | EA033: Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | 0.016 | 0.009 | 49.8 | No Limit |
| | | EA033: acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | <10 | <10 | 0.0 | No Limit |
| **EA033-B: Potential Acidity (QC Lot: 5103878)** | | | | | | | | | |
| ES2316060-041 | 23-13954-41 Site 77B, 0.8m | EA033: Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | 0.008 | 0.008 | 0.0 | No Limit |
| | | EA033: acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | <10 | <10 | 0.0 | No Limit |
| ES2316060-051 | 23-13954-51 Site 91, 1.0m | EA033: Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | 0.025 | 0.029 | 17.1 | No Limit |
| | | EA033: acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | 15 | 18 | 17.1 | No Limit |

Sub-Matrix: **SOIL**

| Laboratory sample ID | Sample ID | Method: Compound | CAS Number | Laboratory Duplicate (DUP) Report LOR | Unit | Original Result | Duplicate Result | RPD (%) | Acceptable RPD (%) |
|---|---|---|---|---|---|---|---|---|---|
| **EA033-B: Potential Acidity (QC Lot: 5105718)** | | | | | | | | | |
| ES2316060-061 | 23-13954-61 Site 8B, 0.5m | EA033: Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | 0.022 | 0.025 | 10.6 | No Limit |
| | | EA033: acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | 14 | 15 | 10.6 | No Limit |
| ES2316060-071 | 23-13954-71 Site 18, 0.95 | EA033: Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | 0.009 | 0.007 | 28.6 | No Limit |
| | | EA033: acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | <10 | <10 | 0.0 | No Limit |
| **EA033-B: Potential Acidity (QC Lot: 5105719)** | | | | | | | | | |
| ES2316060-081 | 23-13954-81 Site 19, 0.5m | EA033: Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | 0.013 | 0.010 | 28.8 | No Limit |
| | | EA033: acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | <10 | <10 | 0.0 | No Limit |
| ES2316060-091 | 23-13954-91 Site 17, 1.0m | EA033: Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | <0.005 | 0.006 | 21.2 | No Limit |
| | | EA033: acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | <10 | <10 | 0.0 | No Limit |
| **EA033-D: Retained Acidity (QC Lot: 5103877)** | | | | | | | | | |
| ES2316060-031 | 23-13954-31 Site 89, 1.0m | EA033: sulfidic - Net Acid Soluble Sulfur (s-20J) | ---- | 0.02 | % pyrite S | 0.03 | 0.03 | 0.0 | No Limit |
| | | EA033: Net Acid Soluble Sulfur (20Je) | ---- | 0.02 | % S | 0.04 | 0.04 | 0.0 | No Limit |
| | | EA033: KCl Extractable Sulfur (23Ce) | ---- | 0.02 | % S | <0.02 | <0.02 | 0.0 | No Limit |
| | | EA033: HCl Extractable Sulfur (20Be) | ---- | 0.02 | % S | 0.02 | 0.02 | 0.0 | No Limit |
| | | EA033: acidity - Net Acid Soluble Sulfur (a-20J) | ---- | 10 | mole H+ / t | 19 | 20 | 0.0 | No Limit |
| **EA033-D: Retained Acidity (QC Lot: 5103878)** | | | | | | | | | |
| ES2316060-051 | 23-13954-51 Site 91, 1.0m | EA033: sulfidic - Net Acid Soluble Sulfur (s-20J) | ---- | 0.02 | % pyrite S | 0.06 | 0.06 | 0.0 | No Limit |
| | | EA033: Net Acid Soluble Sulfur (20Je) | ---- | 0.02 | % S | 0.08 | 0.08 | 0.0 | No Limit |
| | | EA033: KCl Extractable Sulfur (23Ce) | ---- | 0.02 | % S | <0.02 | <0.02 | 0.0 | No Limit |
| | | EA033: HCl Extractable Sulfur (20Be) | ---- | 0.02 | % S | 0.04 | 0.04 | 0.0 | No Limit |
| | | EA033: acidity - Net Acid Soluble Sulfur (a-20J) | ---- | 10 | mole H+ / t | 38 | 36 | 6.6 | No Limit |
| **EA033-D: Retained Acidity (QC Lot: 5105718)** | | | | | | | | | |
| ES2316060-061 | 23-13954-61 Site 8B, 0.5m | EA033: sulfidic - Net Acid Soluble Sulfur (s-20J) | ---- | 0.02 | % pyrite S | 0.07 | 0.07 | 0.0 | No Limit |
| | | EA033: Net Acid Soluble Sulfur (20Je) | ---- | 0.02 | % S | 0.09 | 0.10 | 0.0 | No Limit |
| | | EA033: KCl Extractable Sulfur (23Ce) | ---- | 0.02 | % S | <0.02 | <0.02 | 0.0 | No Limit |
| | | EA033: HCl Extractable Sulfur (20Be) | ---- | 0.02 | % S | 0.05 | 0.05 | 0.0 | No Limit |
| | | EA033: acidity - Net Acid Soluble Sulfur (a-20J) | ---- | 10 | mole H+ / t | 44 | 46 | 4.3 | No Limit |

## Method Blank (MB) and Laboratory Control Sample (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

| | | | | Method Blank (MB) Report | Laboratory Control Spike (LCS) Report | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Spike | Spike Recovery (%) | Acceptable Limits (%) | |
| *Method: Compound* | *CAS Number* | *LOR* | *Unit* | *Result* | *Concentration* | *LCS* | *Low* | *High* |
| **EA029-A: pH Measurements (QCLot: 5103876)** | | | | | | | | |
| EA029: pH KCl (23A) | ---- | 0.1 | pH Unit | <0.1 | 4.4 pH Unit | 101 | 70.0 | 130 |
| EA029: pH OX (23B) | ---- | 0.1 | pH Unit | <0.1 | 4.2 pH Unit | 110 | 70.0 | 130 |
| **EA029-B: Acidity Trail (QCLot: 5103876)** | | | | | | | | |
| EA029: Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | <2 | 16 mole H+ / t | 101 | 70.0 | 130 |
| EA029: Titratable Peroxide Acidity (23G) | ---- | 2 | mole H+ / t | <2 | 25 mole H+ / t | 114 | 70.0 | 130 |
| EA029: Titratable Sulfidic Acidity (23H) | ---- | 2 | mole H+ / t | <2 | ---- | ---- | ---- | ---- |
| EA029: sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | <0.020 | ---- | ---- | ---- | ---- |
| EA029: sulfidic - Titratable Peroxide Acidity (s-23G) | ---- | 0.02 | % pyrite S | <0.020 | ---- | ---- | ---- | ---- |
| EA029: sulfidic - Titratable Sulfidic Acidity (s-23H) | ---- | 0.02 | % pyrite S | <0.020 | ---- | ---- | ---- | ---- |
| **EA029-C: Sulfur Trail (QCLot: 5103876)** | | | | | | | | |
| EA029: KCl Extractable Sulfur (23Ce) | ---- | 0.02 | % S | <0.020 | 0.055 % S | 87.9 | 70.0 | 130 |
| EA029: Peroxide Sulfur (23De) | ---- | 0.02 | % S | <0.020 | 0.152 % S | 85.7 | 70.0 | 130 |
| EA029: Peroxide Oxidisable Sulfur (23E) | ---- | 0.02 | % S | <0.020 | ---- | ---- | ---- | ---- |
| EA029: acidity - Peroxide Oxidisable Sulfur (a-23E) | ---- | 10 | mole H+ / t | <10 | ---- | ---- | ---- | ---- |
| **EA029-D: Calcium Values (QCLot: 5103876)** | | | | | | | | |
| EA029: KCl Extractable Calcium (23Vh) | ---- | 0.02 | % Ca | <0.020 | 0.201 % Ca | 104 | 70.0 | 130 |
| EA029: Peroxide Calcium (23Wh) | ---- | 0.02 | % Ca | <0.020 | 0.191 % Ca | 100 | 70.0 | 130 |
| EA029: Acid Reacted Calcium (23X) | ---- | 0.02 | % Ca | <0.020 | ---- | ---- | ---- | ---- |
| EA029: acidity - Acid Reacted Calcium (a-23X) | ---- | 10 | mole H+ / t | <10 | ---- | ---- | ---- | ---- |
| EA029: sulfidic - Acid Reacted Calcium (s-23X) | ---- | 0.02 | % S | <0.020 | ---- | ---- | ---- | ---- |
| **EA029-E: Magnesium Values (QCLot: 5103876)** | | | | | | | | |
| EA029: KCl Extractable Magnesium (23Sm) | ---- | 0.02 | % Mg | <0.020 | 0.204 % Mg | 86.5 | 70.0 | 130 |
| EA029: Peroxide Magnesium (23Tm) | ---- | 0.02 | % Mg | <0.020 | 0.234 % Mg | 93.6 | 70.0 | 130 |
| EA029: Acid Reacted Magnesium (23U) | ---- | 0.02 | % Mg | <0.020 | ---- | ---- | ---- | ---- |
| EA029: Acidity - Acid Reacted Magnesium (a-23U) | ---- | 10 | mole H+ / t | <10 | ---- | ---- | ---- | ---- |
| EA029: sulfidic - Acid Reacted Magnesium (s-23U) | ---- | 0.02 | % S | <0.020 | ---- | ---- | ---- | ---- |
| **EA029-G: Retained Acidity (QCLot: 5103876)** | | | | | | | | |
| EA029: Net Acid Soluble Sulfur (20Je) | ---- | 0.02 | % S | <0.020 | ---- | ---- | ---- | ---- |
| EA029: acidity - Net Acid Soluble Sulfur (a-20J) | ---- | 10 | mole H+ / t | <10 | ---- | ---- | ---- | ---- |
| EA029: sulfidic - Net Acid Soluble Sulfur (s-20J) | ---- | 0.02 | % pyrite S | <0.020 | ---- | ---- | ---- | ---- |

Sub-Matrix: **SOIL**

| Method: Compound | CAS Number | LOR | Unit | Method Blank (MB) Report | Laboratory Control Spike (LCS) Report | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Spike | Spike Recovery (%) | Acceptable Limits (%) | |
| | | | | Result | Concentration | LCS | Low | High |
| **EA029-G: Retained Acidity (QCLot: 5103876) - continued** | | | | | | | | |
| EA029: HCl Extractable Sulfur (20Be) | ---- | 0.02 | % S | <0.020 | 0.696 % S | 102 | 70.0 | 130 |
| **EA029-H: Acid Base Accounting (QCLot: 5103876)** | | | | | | | | |
| EA029: ANC Fineness Factor | ---- | 0.5 | - | <0.5 | ---- | ---- | ---- | ---- |
| EA029: Net Acidity (sulfur units) | ---- | 0.02 | % S | <0.02 | ---- | ---- | ---- | ---- |
| EA029: Net Acidity (acidity units) | ---- | 10 | mole H+ / t | <10 | ---- | ---- | ---- | ---- |
| EA029: Liming Rate | ---- | 1 | kg CaCO3/t | <1 | ---- | ---- | ---- | ---- |
| EA029: Net Acidity excluding ANC (sulfur units) | ---- | 0.02 | % S | <0.02 | ---- | ---- | ---- | ---- |
| EA029: Net Acidity excluding ANC (acidity units) | ---- | 10 | mole H+ / t | <10 | ---- | ---- | ---- | ---- |
| EA029: Liming Rate excluding ANC | ---- | 1 | kg CaCO3/t | <1 | ---- | ---- | ---- | ---- |
| **EA033-A: Actual Acidity (QCLot: 5103875)** | | | | | | | | |
| EA033: pH KCl (23A) | ---- | ---- | pH Unit | ---- | 4.4 pH Unit | 101 | 91.0 | 107 |
| EA033: Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | <2 | 16 mole H+ / t | 101 | 70.0 | 124 |
| EA033: sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | <0.02 | ---- | ---- | ---- | ---- |
| **EA033-A: Actual Acidity (QCLot: 5103877)** | | | | | | | | |
| EA033: pH KCl (23A) | ---- | ---- | pH Unit | ---- | 4.4 pH Unit | 97.9 | 91.0 | 107 |
| EA033: Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | <2 | 16 mole H+ / t | 101 | 70.0 | 124 |
| EA033: sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | <0.02 | ---- | ---- | ---- | ---- |
| **EA033-A: Actual Acidity (QCLot: 5103878)** | | | | | | | | |
| EA033: pH KCl (23A) | ---- | ---- | pH Unit | ---- | 4.4 pH Unit | 98.4 | 91.0 | 107 |
| EA033: Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | <2 | 16 mole H+ / t | 107 | 70.0 | 124 |
| EA033: sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | <0.02 | ---- | ---- | ---- | ---- |
| **EA033-A: Actual Acidity (QCLot: 5105718)** | | | | | | | | |
| EA033: pH KCl (23A) | ---- | ---- | pH Unit | ---- | 4.4 pH Unit | 98.7 | 91.0 | 107 |
| EA033: Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | <2 | 16 mole H+ / t | 115 | 70.0 | 124 |
| EA033: sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | <0.02 | ---- | ---- | ---- | ---- |
| **EA033-A: Actual Acidity (QCLot: 5105719)** | | | | | | | | |
| EA033: pH KCl (23A) | ---- | ---- | pH Unit | ---- | 4.4 pH Unit | 96.3 | 91.0 | 107 |
| EA033: Titratable Actual Acidity (23F) | ---- | 2 | mole H+ / t | <2 | 16 mole H+ / t | 118 | 70.0 | 124 |
| EA033: sulfidic - Titratable Actual Acidity (s-23F) | ---- | 0.02 | % pyrite S | <0.02 | ---- | ---- | ---- | ---- |
| **EA033-B: Potential Acidity (QCLot: 5103875)** | | | | | | | | |
| EA033: Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | <0.005 | 0.246 % S | 95.1 | 77.0 | 121 |
| EA033: acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | <10 | ---- | ---- | ---- | ---- |
| **EA033-B: Potential Acidity (QCLot: 5103877)** | | | | | | | | |
| EA033: Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | <0.005 | 0.246 % S | 89.8 | 77.0 | 121 |

Sub-Matrix: **SOIL**

| Method: Compound | CAS Number | LOR | Unit | Method Blank (MB) Report Result | Laboratory Control Spike (LCS) Report Spike Concentration | Spike Recovery (%) LCS | Acceptable Limits (%) Low | Acceptable Limits (%) High |
|---|---|---|---|---|---|---|---|---|
| **EA033-B: Potential Acidity (QCLot: 5103877) - continued** | | | | | | | | |
| EA033: acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | <10 | ---- | ---- | ---- | ---- |
| **EA033-B: Potential Acidity (QCLot: 5103878)** | | | | | | | | |
| EA033: Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | <0.005 | 0.246 % S | 87.4 | 77.0 | 121 |
| EA033: acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | <10 | ---- | ---- | ---- | ---- |
| **EA033-B: Potential Acidity (QCLot: 5105718)** | | | | | | | | |
| EA033: Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | <0.005 | 0.246 % S | 91.6 | 77.0 | 121 |
| EA033: acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | <10 | ---- | ---- | ---- | ---- |
| **EA033-B: Potential Acidity (QCLot: 5105719)** | | | | | | | | |
| EA033: Chromium Reducible Sulfur (22B) | ---- | 0.005 | % S | <0.005 | 0.246 % S | 81.4 | 77.0 | 121 |
| EA033: acidity - Chromium Reducible Sulfur (a-22B) | ---- | 10 | mole H+ / t | <10 | ---- | ---- | ---- | ---- |
| **EA033-C: Acid Neutralising Capacity (QCLot: 5103875)** | | | | | | | | |
| EA033: Acid Neutralising Capacity (19A2) | ---- | 0.01 | % CaCO3 | <0.01 | 10 % CaCO3 | 106 | 91.0 | 112 |
| EA033: acidity - Acid Neutralising Capacity (a-19A2) | ---- | 10 | mole H+ / t | <10 | ---- | ---- | ---- | ---- |
| EA033: sulfidic - Acid Neutralising Capacity (s-19A2) | ---- | 0.01 | % pyrite S | <0.01 | ---- | ---- | ---- | ---- |
| **EA033-C: Acid Neutralising Capacity (QCLot: 5103877)** | | | | | | | | |
| EA033: Acid Neutralising Capacity (19A2) | ---- | 0.01 | % CaCO3 | <0.01 | 10 % CaCO3 | 107 | 91.0 | 112 |
| EA033: acidity - Acid Neutralising Capacity (a-19A2) | ---- | 10 | mole H+ / t | <10 | ---- | ---- | ---- | ---- |
| EA033: sulfidic - Acid Neutralising Capacity (s-19A2) | ---- | 0.01 | % pyrite S | <0.01 | ---- | ---- | ---- | ---- |
| **EA033-C: Acid Neutralising Capacity (QCLot: 5105718)** | | | | | | | | |
| EA033: Acid Neutralising Capacity (19A2) | ---- | 0.01 | % CaCO3 | <0.01 | 10 % CaCO3 | 106 | 91.0 | 112 |
| EA033: acidity - Acid Neutralising Capacity (a-19A2) | ---- | 10 | mole H+ / t | <10 | ---- | ---- | ---- | ---- |
| EA033: sulfidic - Acid Neutralising Capacity (s-19A2) | ---- | 0.01 | % pyrite S | <0.01 | ---- | ---- | ---- | ---- |
| **EA033-D: Retained Acidity (QCLot: 5103875)** | | | | | | | | |
| EA033: Net Acid Soluble Sulfur (20Je) | ---- | 0.02 | % S | <0.02 | ---- | ---- | ---- | ---- |
| EA033: acidity - Net Acid Soluble Sulfur (a-20J) | ---- | 10 | mole H+ / t | <10 | ---- | ---- | ---- | ---- |
| EA033: sulfidic - Net Acid Soluble Sulfur (s-20J) | ---- | 0.02 | % pyrite S | <0.02 | ---- | ---- | ---- | ---- |
| EA033: KCl Extractable Sulfur (23Ce) | ---- | 0.02 | % S | <0.02 | 0.055 % S | 86.3 | 70.0 | 128 |
| EA033: HCl Extractable Sulfur (20Be) | ---- | 0.02 | % S | <0.02 | 0.696 % S | 102 | 70.0 | 120 |
| **EA033-D: Retained Acidity (QCLot: 5103877)** | | | | | | | | |
| EA033: Net Acid Soluble Sulfur (20Je) | ---- | 0.02 | % S | <0.02 | ---- | ---- | ---- | ---- |
| EA033: acidity - Net Acid Soluble Sulfur (a-20J) | ---- | 10 | mole H+ / t | <10 | ---- | ---- | ---- | ---- |
| EA033: sulfidic - Net Acid Soluble Sulfur (s-20J) | ---- | 0.02 | % pyrite S | <0.02 | ---- | ---- | ---- | ---- |
| EA033: KCl Extractable Sulfur (23Ce) | ---- | 0.02 | % S | <0.02 | 0.055 % S | 86.3 | 70.0 | 128 |
| EA033: HCl Extractable Sulfur (20Be) | ---- | 0.02 | % S | <0.02 | 0.696 % S | 102 | 70.0 | 120 |

Sub-Matrix: **SOIL**

| Method: Compound | CAS Number | LOR | Unit | Method Blank (MB) Report | Laboratory Control Spike (LCS) Report | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Spike | Spike Recovery (%) | Acceptable Limits (%) | |
| | | | | Result | Concentration | LCS | Low | High |
| **EA033-D: Retained Acidity (QCLot: 5103878)** | | | | | | | | |
| EA033: Net Acid Soluble Sulfur (20Je) | ---- | 0.02 | % S | <0.02 | ---- | ---- | ---- | ---- |
| EA033: acidity - Net Acid Soluble Sulfur (a-20J) | ---- | 10 | mole H+ / t | <10 | ---- | ---- | ---- | ---- |
| EA033: sulfidic - Net Acid Soluble Sulfur (s-20J) | ---- | 0.02 | % pyrite S | <0.02 | ---- | ---- | ---- | ---- |
| EA033: KCl Extractable Sulfur (23Ce) | ---- | 0.02 | % S | <0.02 | 0.055 % S | 90.0 | 70.0 | 128 |
| EA033: HCl Extractable Sulfur (20Be) | ---- | 0.02 | % S | <0.02 | 0.696 % S | 102 | 70.0 | 120 |
| **EA033-D: Retained Acidity (QCLot: 5105718)** | | | | | | | | |
| EA033: Net Acid Soluble Sulfur (20Je) | ---- | 0.02 | % S | <0.02 | ---- | ---- | ---- | ---- |
| EA033: acidity - Net Acid Soluble Sulfur (a-20J) | ---- | 10 | mole H+ / t | <10 | ---- | ---- | ---- | ---- |
| EA033: sulfidic - Net Acid Soluble Sulfur (s-20J) | ---- | 0.02 | % pyrite S | <0.02 | ---- | ---- | ---- | ---- |
| EA033: KCl Extractable Sulfur (23Ce) | ---- | 0.02 | % S | <0.02 | 0.055 % S | 90.0 | 70.0 | 128 |
| EA033: HCl Extractable Sulfur (20Be) | ---- | 0.02 | % S | <0.02 | 0.696 % S | 102 | 70.0 | 120 |
| **EA033-D: Retained Acidity (QCLot: 5105719)** | | | | | | | | |
| EA033: Net Acid Soluble Sulfur (20Je) | ---- | 0.02 | % S | <0.02 | ---- | ---- | ---- | ---- |
| EA033: acidity - Net Acid Soluble Sulfur (a-20J) | ---- | 10 | mole H+ / t | <10 | ---- | ---- | ---- | ---- |
| EA033: sulfidic - Net Acid Soluble Sulfur (s-20J) | ---- | 0.02 | % pyrite S | <0.02 | ---- | ---- | ---- | ---- |
| EA033: KCl Extractable Sulfur (23Ce) | ---- | 0.02 | % S | <0.02 | 0.055 % S | 90.0 | 70.0 | 128 |
| EA033: HCl Extractable Sulfur (20Be) | ---- | 0.02 | % S | <0.02 | 0.696 % S | 102 | 70.0 | 120 |

## *Matrix Spike (MS) Report*

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

- **No Matrix Spike (MS) or Matrix Spike Duplicate (MSD) Results are required to be reported.**

# QA/QC Compliance Assessment to assist with Quality Review

| | | | |
|---|---|---|---|
| **Work Order** | : **ES2316060** | Page | : 1 of 15 |
| Client | : **ANALYTICA LABORATORIES LIMITED** | Laboratory | : Environmental Division Sydney |
| Contact | : Default reports | Telephone | : +61-2-8784 8555 |
| Project | : 23-13954 | Date Samples Received | : 15-May-2023 |
| Site | : ---- | Issue Date | : 14-Jun-2023 |
| Sampler | : ---- | No. of samples received | : 98 |
| Order number | : ---- | No. of samples analysed | : 98 |

**This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.**

Brief method summaries and references are also provided to assist in traceability.

## *Summary of Outliers*

### *Outliers : Quality Control Samples*

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

### *Outliers : Analysis Holding Time Compliance*

- **NO Analysis Holding Time Outliers exist.**

### *Outliers : Frequency of Quality Control Samples*

- **NO Quality Control Sample Frequency Outliers exist.**

## *Analysis Holding Time Compliance*

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

| *Method* | | *Sample Date* | *Extraction / Preparation* | | | *Analysis* | | |
|---|---|---|---|---|---|---|---|---|
| *Container / Client Sample ID(s)* | | | *Date extracted* | *Due for extraction* | *Evaluation* | *Date analysed* | *Due for analysis* | *Evaluation* |
| **EA029-A: pH Measurements** | | | | | | | | |
| **80* dried soil (EA029)** | | | | | | | | |
| 23-13954-5 - Site 10, 2.0m,<br>23-13954-26 - Site 60, 2.0m,<br>23-13954-36 - Site 82, 1.0m,<br>23-13954-41 - Site 77B, 0.8m,<br>23-13954-55 - Site 12, 2.0m | 23-13954-20 - Site 3, 2.0m,<br>23-13954-27 - Site 63, 2.0m,<br>23-13954-37 - Site 94, 1.0m,<br>23-13954-54 - Site 47, 1.0m, | **09-May-2023** | **12-Jun-2023** | 01-Feb-2026 | ✓ | **14-Jun-2023** | 10-Sep-2023 | ✓ |
| **EA029-B: Acidity Trail** | | | | | | | | |
| **80* dried soil (EA029)** | | | | | | | | |
| 23-13954-5 - Site 10, 2.0m,<br>23-13954-26 - Site 60, 2.0m,<br>23-13954-36 - Site 82, 1.0m,<br>23-13954-41 - Site 77B, 0.8m,<br>23-13954-55 - Site 12, 2.0m | 23-13954-20 - Site 3, 2.0m,<br>23-13954-27 - Site 63, 2.0m,<br>23-13954-37 - Site 94, 1.0m,<br>23-13954-54 - Site 47, 1.0m, | **09-May-2023** | **12-Jun-2023** | 01-Feb-2026 | ✓ | **14-Jun-2023** | 10-Sep-2023 | ✓ |
| **EA029-C: Sulfur Trail** | | | | | | | | |
| **80* dried soil (EA029)** | | | | | | | | |
| 23-13954-5 - Site 10, 2.0m,<br>23-13954-26 - Site 60, 2.0m,<br>23-13954-36 - Site 82, 1.0m,<br>23-13954-41 - Site 77B, 0.8m,<br>23-13954-55 - Site 12, 2.0m | 23-13954-20 - Site 3, 2.0m,<br>23-13954-27 - Site 63, 2.0m,<br>23-13954-37 - Site 94, 1.0m,<br>23-13954-54 - Site 47, 1.0m, | **09-May-2023** | **12-Jun-2023** | 01-Feb-2026 | ✓ | **14-Jun-2023** | 10-Sep-2023 | ✓ |
| **EA029-D: Calcium Values** | | | | | | | | |
| **80* dried soil (EA029)** | | | | | | | | |
| 23-13954-5 - Site 10, 2.0m,<br>23-13954-26 - Site 60, 2.0m,<br>23-13954-36 - Site 82, 1.0m,<br>23-13954-41 - Site 77B, 0.8m,<br>23-13954-55 - Site 12, 2.0m | 23-13954-20 - Site 3, 2.0m,<br>23-13954-27 - Site 63, 2.0m,<br>23-13954-37 - Site 94, 1.0m,<br>23-13954-54 - Site 47, 1.0m, | **09-May-2023** | **12-Jun-2023** | 01-Feb-2026 | ✓ | **14-Jun-2023** | 10-Sep-2023 | ✓ |

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

| Method / Container / Client Sample ID(s) | Sample Date | Extraction / Preparation: Date extracted | Due for extraction | Evaluation | Analysis: Date analysed | Due for analysis | Evaluation |
|---|---|---|---|---|---|---|---|
| **EA029-E: Magnesium Values** | | | | | | | |
| **80* dried soil (EA029)** | | | | | | | |
| 23-13954-5 - Site 10, 2.0m, 23-13954-20 - Site 3, 2.0m, 23-13954-26 - Site 60, 2.0m, 23-13954-27 - Site 63, 2.0m, 23-13954-36 - Site 82, 1.0m, 23-13954-37 - Site 94, 1.0m, 23-13954-41 - Site 77B, 0.8m, 23-13954-54 - Site 47, 1.0m, 23-13954-55 - Site 12, 2.0m | **09-May-2023** | **12-Jun-2023** | 01-Feb-2026 | ✓ | **14-Jun-2023** | 10-Sep-2023 | ✓ |
| **EA029-F: Excess Acid Neutralising Capacity** | | | | | | | |
| **80* dried soil (EA029)** | | | | | | | |
| 23-13954-5 - Site 10, 2.0m, 23-13954-20 - Site 3, 2.0m, 23-13954-26 - Site 60, 2.0m, 23-13954-27 - Site 63, 2.0m, 23-13954-36 - Site 82, 1.0m, 23-13954-37 - Site 94, 1.0m, 23-13954-41 - Site 77B, 0.8m, 23-13954-54 - Site 47, 1.0m, 23-13954-55 - Site 12, 2.0m | **09-May-2023** | **12-Jun-2023** | 01-Feb-2026 | ✓ | **14-Jun-2023** | 10-Sep-2023 | ✓ |
| **EA029-G: Retained Acidity** | | | | | | | |
| **80* dried soil (EA029)** | | | | | | | |
| 23-13954-5 - Site 10, 2.0m, 23-13954-20 - Site 3, 2.0m, 23-13954-26 - Site 60, 2.0m, 23-13954-27 - Site 63, 2.0m, 23-13954-36 - Site 82, 1.0m, 23-13954-37 - Site 94, 1.0m, 23-13954-41 - Site 77B, 0.8m, 23-13954-54 - Site 47, 1.0m, 23-13954-55 - Site 12, 2.0m | **09-May-2023** | **12-Jun-2023** | 01-Feb-2026 | ✓ | **14-Jun-2023** | 10-Sep-2023 | ✓ |
| **EA029-H: Acid Base Accounting** | | | | | | | |
| **80* dried soil (EA029)** | | | | | | | |
| 23-13954-5 - Site 10, 2.0m, 23-13954-20 - Site 3, 2.0m, 23-13954-26 - Site 60, 2.0m, 23-13954-27 - Site 63, 2.0m, 23-13954-36 - Site 82, 1.0m, 23-13954-37 - Site 94, 1.0m, 23-13954-41 - Site 77B, 0.8m, 23-13954-54 - Site 47, 1.0m, 23-13954-55 - Site 12, 2.0m | **09-May-2023** | **12-Jun-2023** | 01-Feb-2026 | ✓ | **14-Jun-2023** | 10-Sep-2023 | ✓ |

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

| Method<br>Container / Client Sample ID(s) | Sample Date | Extraction / Preparation | | | Analysis | | |
|---|---|---|---|---|---|---|---|
| | | Date extracted | Due for extraction | Evaluation | Date analysed | Due for analysis | Evaluation |
| **EA033-A: Actual Acidity** | | | | | | | |
| **80* dried soil (EA033)** | | | | | | | |
| 23-13954-1 - Site 80, 1.65m, 23-13954-2 - Site 79, 2.0m, 23-13954-3 - Site 76, 0.5m, 23-13954-4 - Site 78, 2.0m, 23-13954-5 - Site 10, 2.0m, 23-13954-6 - Site 4, 1.0m, 23-13954-7 - Site 26, 1.0m, 23-13954-8 - Site 39, 0.75m, 23-13954-14 - Site 9, 1.0m, 23-13954-9 - Site 51, 1.55m, 23-13954-10 - Site 52, 1.0m, 23-13954-11 - Site 53, 2.0m, 23-13954-12 - Site 11, 0.5m, 23-13954-13 - Site 37, 0.5m, 23-13954-15 - Site 7, 1.0m, 23-13954-16 - Site 65, 1.0m, 23-13954-17 - Site 1, 1.0m, 23-13954-18 - Site 33, 0.95m, 23-13954-19 - Site 14, 1.0m, 23-13954-20 - Site 3, 2.0m, 23-13954-21 - Site 99, 0.2m, 23-13954-22 - Site 2, 0.5m, 23-13954-23 - Site 87, 0.5m, 23-13954-24 - Site 57, 2.0m, 23-13954-25 - Site 75, 1.0m, 23-13954-26 - Site 60, 2.0m, 23-13954-27 - Site 63, 2.0m, 23-13954-28 - Site 88, 0.5m, 23-13954-29 - Site 74, 0.5m, 23-13954-30 - Site 46, 2.0m, 23-13954-31 - Site 89, 1.0m, 23-13954-32 - Site 38, 0.75m, 23-13954-33 - Site 97, 1.55m, 23-13954-34 - Site 66, 0.5m, 23-13954-35 - Site 29, 1.0m, 23-13954-36 - Site 82, 1.0m, 23-13954-37 - Site 94, 1.0m, 23-13954-38 - Site 93, 0.5m, 23-13954-39 - Site 30, 0.5m, 23-13954-40 - Site 59B, 1.0m, 23-13954-41 - Site 77B, 0.8m, 23-13954-42 - Site 98B, 1.6m, 23-13954-43 - Site 34B, 1.0m, 23-13954-44 - Site 50B, 1.35m, 23-13954-45 - Site 40B, 0.5m, 23-13954-46 - Site 69, 2.0m, 23-13954-47 - Site 70, 0.5m, 23-13954-48 - Site 83B, 1.0m, 23-13954-49 - Site 15, 1.0m, 23-13954-50 - Site 43B, 2.0m, 23-13954-51 - Site 91, 1.0m, 23-13954-52 - Site 84B, 1.0m, 23-13954-53 - Site 58B, 0.5m, 23-13954-54 - Site 47, 1.0m, 23-13954-55 - Site 12, 2.0m, 23-13954-56 - Site 31, 2.0m, 23-13954-57 - Site 100, 0.5m, 23-13954-58 - Site 21, 0.8m, 23-13954-59 - Site 16, 1.15m, 23-13954-60 - Site 64B, 2.0m | **09-May-2023** | **12-Jun-2023** | 08-May-2024 | ✓ | **12-Jun-2023** | 10-Sep-2023 | ✓ |
| **80* dried soil (EA033)** | | | | | | | |

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

| Method | | Sample Date | Extraction / Preparation | | | Analysis | | |
|---|---|---|---|---|---|---|---|---|
| Container / Client Sample ID(s) | | | Date extracted | Due for extraction | Evaluation | Date analysed | Due for analysis | Evaluation |
| **EA033-A: Actual Acidity - Continued** | | | | | | | | |
| 23-13954-61 - Site 8B, 0.5m, | 23-13954-62 - Site 41C, 1.0m, | **09-May-2023** | **13-Jun-2023** | 08-May-2024 | ✓ | **13-Jun-2023** | 11-Sep-2023 | ✓ |
| 23-13954-63 - Site 28B, 1.0m, | 23-13954-64 - Site 68, 0.5m, | | | | | | | |
| 23-13954-65 - Site 67, 0.9m, | 23-13954-66 - Site 24, 1.55m, | | | | | | | |
| 23-13954-67 - Site 48, 2.0m, | 23-13954-68 - Site 73, 0.8m, | | | | | | | |
| 23-13954-69 - Site 90, 2.0m, | 23-13954-70 - Site 25, 2.0m, | | | | | | | |
| 23-13954-71 - Site 18, 0.95, | 23-13954-72 - Site 62, 0.5m, | | | | | | | |
| 23-13954-73 - Site 49, 0.5m, | 23-13954-74 - Site 36, 0.5m, | | | | | | | |
| 23-13954-75 - Site 54, 2.0m, | 23-13954-76 - Site 55, 2.0m, | | | | | | | |
| 23-13954-77 - Site 20, 2.0m, | 23-13954-78 - Site 45, 0.95m, | | | | | | | |
| 23-13954-79 - Site 56, 2.0m, | 23-13954-80 - Site 27, 1.0m, | | | | | | | |
| 23-13954-81 - Site 19, 0.5m, | 23-13954-82 - Site 81, 1.0m, | | | | | | | |
| 23-13954-83 - Site 22, 0.5m, | 23-13954-84 - Site 96, 0.5m, | | | | | | | |
| 23-13954-85 - Site 85, 0.4m, | 23-13954-86 - Site 32, 1.8m, | | | | | | | |
| 23-13954-87 - Site 23, 1.0m, | 23-13954-88 - Site 86, 1.7m, | | | | | | | |
| 23-13954-89 - Site 6, 0.9m, | 23-13954-90 - Site 61, 0.5m, | | | | | | | |
| 23-13954-91 - Site 17, 1.0m, | 23-13954-92 - Site 92, 1.0m, | | | | | | | |
| 23-13954-93 - Site 35, 0.5m, | 23-13954-94 - Site 71, 0.5m, | | | | | | | |
| 23-13954-95 - Site 42, 0.5m, | 23-13954-96 - Site 13, 1.0m, | | | | | | | |
| 23-13954-97 - Site 72, 1.0m, | 23-13954-98 - Site 5, 0.5m | | | | | | | |

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

| Method<br>Container / Client Sample ID(s) | | | Sample Date | Extraction / Preparation<br>Date extracted | Due for extraction | Evaluation | Analysis<br>Date analysed | Due for analysis | Evaluation |
|---|---|---|---|---|---|---|---|---|---|
| **EA033-B: Potential Acidity** | | | | | | | | | |
| **80* dried soil (EA033)** | | | | | | | | | |
| 23-13954-1 - Site 80, 1.65m, | 23-13954-2 - Site 79, 2.0m, | | **09-May-2023** | **12-Jun-2023** | 08-May-2024 | ✓ | **12-Jun-2023** | 10-Sep-2023 | ✓ |
| 23-13954-3 - Site 76, 0.5m, | 23-13954-4 - Site 78, 2.0m, | | | | | | | | |
| 23-13954-5 - Site 10, 2.0m, | 23-13954-6 - Site 4, 1.0m, | | | | | | | | |
| 23-13954-7 - Site 26, 1.0m, | 23-13954-8 - Site 39, 0.75m, | | | | | | | | |
| 23-13954-14 - Site 9, 1.0m, | | | | | | | | | |
| 23-13954-9 - Site 51, 1.55m, | 23-13954-10 - Site 52, 1.0m, | | | | | | | | |
| 23-13954-11 - Site 53, 2.0m, | 23-13954-12 - Site 11, 0.5m, | | | | | | | | |
| 23-13954-13 - Site 37, 0.5m, | 23-13954-15 - Site 7, 1.0m, | 23-13954-16 - Site 65, | | | | | | | |
| 1.0m, | | | | | | | | | |
| 23-13954-17 - Site 1, 1.0m, | 23-13954-18 - Site 33, 0.95m, | | | | | | | | |
| 23-13954-19 - Site 14, 1.0m, | 23-13954-20 - Site 3, 2.0m, | | | | | | | | |
| 23-13954-21 - Site 99, 0.2m, | 23-13954-22 - Site 2, 0.5m, | | | | | | | | |
| 23-13954-23 - Site 87, 0.5m, | 23-13954-24 - Site 57, 2.0m, | | | | | | | | |
| 23-13954-25 - Site 75, 1.0m, | 23-13954-26 - Site 60, 2.0m, | | | | | | | | |
| 23-13954-27 - Site 63, 2.0m, | 23-13954-28 - Site 88, 0.5m, | | | | | | | | |
| 23-13954-29 - Site 74, 0.5m, | 23-13954-30 - Site 46, 2.0m, | | | | | | | | |
| 23-13954-31 - Site 89, 1.0m, | 23-13954-32 - Site 38, 0.75m, | | | | | | | | |
| 23-13954-33 - Site 97, 1.55m, | 23-13954-34 - Site 66, 0.5m, | | | | | | | | |
| 23-13954-35 - Site 29, 1.0m, | 23-13954-36 - Site 82, 1.0m, | | | | | | | | |
| 23-13954-37 - Site 94, 1.0m, | 23-13954-38 - Site 93, 0.5m, | | | | | | | | |
| 23-13954-39 - Site 30, 0.5m, | 23-13954-40 - Site 59B, 1.0m, | | | | | | | | |
| 23-13954-41 - Site 77B, 0.8m, | 23-13954-42 - Site 98B, 1.6m, | | | | | | | | |
| 23-13954-43 - Site 34B, 1.0m, | 23-13954-44 - Site 50B, 1.35m, | | | | | | | | |
| 23-13954-45 - Site 40B, 0.5m, | 23-13954-46 - Site 69, 2.0m, | | | | | | | | |
| 23-13954-47 - Site 70, 0.5m, | 23-13954-48 - Site 83B, 1.0m, | | | | | | | | |
| 23-13954-49 - Site 15, 1.0m, | 23-13954-50 - Site 43B, 2.0m, | | | | | | | | |
| 23-13954-51 - Site 91, 1.0m, | 23-13954-52 - Site 84B, 1.0m, | | | | | | | | |
| 23-13954-53 - Site 58B, 0.5m, | 23-13954-54 - Site 47, 1.0m, | | | | | | | | |
| 23-13954-55 - Site 12, 2.0m, | 23-13954-56 - Site 31, 2.0m, | | | | | | | | |
| 23-13954-57 - Site 100, 0.5m, | 23-13954-58 - Site 21, 0.8m, | | | | | | | | |
| 23-13954-59 - Site 16, 1.15m, | 23-13954-60 - Site 64B, 2.0m | | | | | | | | |
| **80* dried soil (EA033)** | | | | | | | | | |

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

| Method / Container / Client Sample ID(s) | | Sample Date | Extraction / Preparation | | | Analysis | | |
|---|---|---|---|---|---|---|---|---|
| | | | Date extracted | Due for extraction | Evaluation | Date analysed | Due for analysis | Evaluation |
| **EA033-B: Potential Acidity - Continued** | | | | | | | | |
| 23-13954-61 - Site 8B, 0.5m, | 23-13954-62 - Site 41C, 1.0m, | **09-May-2023** | **13-Jun-2023** | 08-May-2024 | ✓ | **13-Jun-2023** | 11-Sep-2023 | ✓ |
| 23-13954-63 - Site 28B, 1.0m, | 23-13954-64 - Site 68, 0.5m, | | | | | | | |
| 23-13954-65 - Site 67, 0.9m, | 23-13954-66 - Site 24, 1.55m, | | | | | | | |
| 23-13954-67 - Site 48, 2.0m, | 23-13954-68 - Site 73, 0.8m, | | | | | | | |
| 23-13954-69 - Site 90, 2.0m, | 23-13954-70 - Site 25, 2.0m, | | | | | | | |
| 23-13954-71 - Site 18, 0.95, | 23-13954-72 - Site 62, 0.5m, | | | | | | | |
| 23-13954-73 - Site 49, 0.5m, | 23-13954-74 - Site 36, 0.5m, | | | | | | | |
| 23-13954-75 - Site 54, 2.0m, | 23-13954-76 - Site 55, 2.0m, | | | | | | | |
| 23-13954-77 - Site 20, 2.0m, | 23-13954-78 - Site 45, 0.95m, | | | | | | | |
| 23-13954-79 - Site 56, 2.0m, | 23-13954-80 - Site 27, 1.0m, | | | | | | | |
| 23-13954-81 - Site 19, 0.5m, | 23-13954-82 - Site 81, 1.0m, | | | | | | | |
| 23-13954-83 - Site 22, 0.5m, | 23-13954-84 - Site 96, 0.5m, | | | | | | | |
| 23-13954-85 - Site 85, 0.4m, | 23-13954-86 - Site 32, 1.8m, | | | | | | | |
| 23-13954-87 - Site 23, 1.0m, | 23-13954-88 - Site 86, 1.7m, | | | | | | | |
| 23-13954-89 - Site 6, 0.9m, | 23-13954-90 - Site 61, 0.5m, | | | | | | | |
| 23-13954-91 - Site 17, 1.0m, | 23-13954-92 - Site 92, 1.0m, | | | | | | | |
| 23-13954-93 - Site 35, 0.5m, | 23-13954-94 - Site 71, 0.5m, | | | | | | | |
| 23-13954-95 - Site 42, 0.5m, | 23-13954-96 - Site 13, 1.0m, | | | | | | | |
| 23-13954-97 - Site 72, 1.0m, | 23-13954-98 - Site 5, 0.5m | | | | | | | |

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

| Method / Container / Client Sample ID(s) | | Sample Date | Extraction / Preparation | | | Analysis | | |
|---|---|---|---|---|---|---|---|---|
| | | | Date extracted | Due for extraction | Evaluation | Date analysed | Due for analysis | Evaluation |
| **EA033-C: Acid Neutralising Capacity** | | | | | | | | |
| **80* dried soil (EA033)** | | | | | | | | |
| 23-13954-1 - Site 80, 1.65m, | 23-13954-2 - Site 79, 2.0m, | **09-May-2023** | **12-Jun-2023** | 08-May-2024 | ✓ | **12-Jun-2023** | 10-Sep-2023 | ✓ |
| 23-13954-3 - Site 76, 0.5m, | 23-13954-4 - Site 78, 2.0m, | | | | | | | |
| 23-13954-5 - Site 10, 2.0m, | 23-13954-6 - Site 4, 1.0m, | | | | | | | |
| 23-13954-7 - Site 26, 1.0m, | 23-13954-8 - Site 39, 0.75m, | | | | | | | |
| 23-13954-14 - Site 9, 1.0m, | | | | | | | | |
| 23-13954-9 - Site 51, 1.55m, | 23-13954-10 - Site 52, 1.0m, | | | | | | | |
| 23-13954-11 - Site 53, 2.0m, | 23-13954-12 - Site 11, 0.5m, | | | | | | | |
| 23-13954-13 - Site 37, 0.5m, | 23-13954-15 - Site 7, 1.0m, 23-13954-16 - Site 65, 1.0m, | | | | | | | |
| 23-13954-17 - Site 1, 1.0m, | 23-13954-18 - Site 33, 0.95m, | | | | | | | |
| 23-13954-19 - Site 14, 1.0m, | 23-13954-20 - Site 3, 2.0m, | | | | | | | |
| 23-13954-21 - Site 99, 0.2m, | 23-13954-22 - Site 2, 0.5m, | | | | | | | |
| 23-13954-23 - Site 87, 0.5m, | 23-13954-24 - Site 57, 2.0m, | | | | | | | |
| 23-13954-25 - Site 75, 1.0m, | 23-13954-26 - Site 60, 2.0m, | | | | | | | |
| 23-13954-27 - Site 63, 2.0m, | 23-13954-28 - Site 88, 0.5m, | | | | | | | |
| 23-13954-29 - Site 74, 0.5m, | 23-13954-30 - Site 46, 2.0m, | | | | | | | |
| 23-13954-31 - Site 89, 1.0m, | 23-13954-32 - Site 38, 0.75m, | | | | | | | |
| 23-13954-33 - Site 97, 1.55m, | 23-13954-34 - Site 66, 0.5m, | | | | | | | |
| 23-13954-35 - Site 29, 1.0m, | 23-13954-36 - Site 82, 1.0m, | | | | | | | |
| 23-13954-37 - Site 94, 1.0m, | 23-13954-38 - Site 93, 0.5m, | | | | | | | |
| 23-13954-39 - Site 30, 0.5m, | 23-13954-40 - Site 59B, 1.0m, | | | | | | | |
| 23-13954-41 - Site 77B, 0.8m, | 23-13954-42 - Site 98B, 1.6m, | | | | | | | |
| 23-13954-43 - Site 34B, 1.0m, | 23-13954-44 - Site 50B, 1.35m, | | | | | | | |
| 23-13954-45 - Site 40B, 0.5m, | 23-13954-46 - Site 69, 2.0m, | | | | | | | |
| 23-13954-47 - Site 70, 0.5m, | 23-13954-48 - Site 83B, 1.0m, | | | | | | | |
| 23-13954-49 - Site 15, 1.0m, | 23-13954-50 - Site 43B, 2.0m, | | | | | | | |
| 23-13954-51 - Site 91, 1.0m, | 23-13954-52 - Site 84B, 1.0m, | | | | | | | |
| 23-13954-53 - Site 58B, 0.5m, | 23-13954-54 - Site 47, 1.0m, | | | | | | | |
| 23-13954-55 - Site 12, 2.0m, | 23-13954-56 - Site 31, 2.0m, | | | | | | | |
| 23-13954-57 - Site 100, 0.5m, | 23-13954-58 - Site 21, 0.8m, | | | | | | | |
| 23-13954-59 - Site 16, 1.15m, | 23-13954-60 - Site 64B, 2.0m | | | | | | | |
| **80* dried soil (EA033)** | | | | | | | | |

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

| Method<br>Container / Client Sample ID(s) | | Sample Date | Extraction / Preparation | | | Analysis | | |
|---|---|---|---|---|---|---|---|---|
| | | | Date extracted | Due for extraction | Evaluation | Date analysed | Due for analysis | Evaluation |
| **EA033-C: Acid Neutralising Capacity - Continued** | | | | | | | | |
| 23-13954-61 - Site 8B, 0.5m, | 23-13954-62 - Site 41C, 1.0m, | **09-May-2023** | **13-Jun-2023** | 08-May-2024 | ✓ | **13-Jun-2023** | 11-Sep-2023 | ✓ |
| 23-13954-63 - Site 28B, 1.0m, | 23-13954-64 - Site 68, 0.5m, | | | | | | | |
| 23-13954-65 - Site 67, 0.9m, | 23-13954-66 - Site 24, 1.55m, | | | | | | | |
| 23-13954-67 - Site 48, 2.0m, | 23-13954-68 - Site 73, 0.8m, | | | | | | | |
| 23-13954-69 - Site 90, 2.0m, | 23-13954-70 - Site 25, 2.0m, | | | | | | | |
| 23-13954-71 - Site 18, 0.95, | 23-13954-72 - Site 62, 0.5m, | | | | | | | |
| 23-13954-73 - Site 49, 0.5m, | 23-13954-74 - Site 36, 0.5m, | | | | | | | |
| 23-13954-75 - Site 54, 2.0m, | 23-13954-76 - Site 55, 2.0m, | | | | | | | |
| 23-13954-77 - Site 20, 2.0m, | 23-13954-78 - Site 45, 0.95m, | | | | | | | |
| 23-13954-79 - Site 56, 2.0m, | 23-13954-80 - Site 27, 1.0m, | | | | | | | |
| 23-13954-81 - Site 19, 0.5m, | 23-13954-82 - Site 81, 1.0m, | | | | | | | |
| 23-13954-83 - Site 22, 0.5m, | 23-13954-84 - Site 96, 0.5m, | | | | | | | |
| 23-13954-85 - Site 85, 0.4m, | 23-13954-86 - Site 32, 1.8m, | | | | | | | |
| 23-13954-87 - Site 23, 1.0m, | 23-13954-88 - Site 86, 1.7m, | | | | | | | |
| 23-13954-89 - Site 6, 0.9m, | 23-13954-90 - Site 61, 0.5m, | | | | | | | |
| 23-13954-91 - Site 17, 1.0m, | 23-13954-92 - Site 92, 1.0m, | | | | | | | |
| 23-13954-93 - Site 35, 0.5m, | 23-13954-94 - Site 71, 0.5m, | | | | | | | |
| 23-13954-95 - Site 42, 0.5m, | 23-13954-96 - Site 13, 1.0m, | | | | | | | |
| 23-13954-97 - Site 72, 1.0m, | 23-13954-98 - Site 5, 0.5m | | | | | | | |

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

| Method<br>Container / Client Sample ID(s) | | | Sample Date | Extraction / Preparation | | | Analysis | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Date extracted | Due for extraction | Evaluation | Date analysed | Due for analysis | Evaluation |
| **EA033-D: Retained Acidity** | | | | | | | | | |
| **80* dried soil (EA033)** | | | | | | | | | |
| 23-13954-1 - Site 80, 1.65m, | 23-13954-2 - Site 79, 2.0m, | | **09-May-2023** | **12-Jun-2023** | 08-May-2024 | ✓ | **12-Jun-2023** | 10-Sep-2023 | ✓ |
| 23-13954-3 - Site 76, 0.5m, | 23-13954-4 - Site 78, 2.0m, | | | | | | | | |
| 23-13954-5 - Site 10, 2.0m, | 23-13954-6 - Site 4, 1.0m, | | | | | | | | |
| 23-13954-7 - Site 26, 1.0m, | 23-13954-8 - Site 39, 0.75m, | | | | | | | | |
| 23-13954-14 - Site 9, 1.0m, | | | | | | | | | |
| 23-13954-9 - Site 51, 1.55m, | 23-13954-10 - Site 52, 1.0m, | | | | | | | | |
| 23-13954-11 - Site 53, 2.0m, | 23-13954-12 - Site 11, 0.5m, | | | | | | | | |
| 23-13954-13 - Site 37, 0.5m, | 23-13954-15 - Site 7, 1.0m, | 23-13954-16 - Site 65, | | | | | | | |
| 1.0m, | | | | | | | | | |
| 23-13954-17 - Site 1, 1.0m, | 23-13954-18 - Site 33, 0.95m, | | | | | | | | |
| 23-13954-19 - Site 14, 1.0m, | 23-13954-20 - Site 3, 2.0m, | | | | | | | | |
| 23-13954-21 - Site 99, 0.2m, | 23-13954-22 - Site 2, 0.5m, | | | | | | | | |
| 23-13954-23 - Site 87, 0.5m, | 23-13954-24 - Site 57, 2.0m, | | | | | | | | |
| 23-13954-25 - Site 75, 1.0m, | 23-13954-26 - Site 60, 2.0m, | | | | | | | | |
| 23-13954-27 - Site 63, 2.0m, | 23-13954-28 - Site 88, 0.5m, | | | | | | | | |
| 23-13954-29 - Site 74, 0.5m, | 23-13954-30 - Site 46, 2.0m, | | | | | | | | |
| 23-13954-31 - Site 89, 1.0m, | 23-13954-32 - Site 38, 0.75m, | | | | | | | | |
| 23-13954-33 - Site 97, 1.55m, | 23-13954-34 - Site 66, 0.5m, | | | | | | | | |
| 23-13954-35 - Site 29, 1.0m, | 23-13954-36 - Site 82, 1.0m, | | | | | | | | |
| 23-13954-37 - Site 94, 1.0m, | 23-13954-38 - Site 93, 0.5m, | | | | | | | | |
| 23-13954-39 - Site 30, 0.5m, | 23-13954-40 - Site 59B, 1.0m, | | | | | | | | |
| 23-13954-41 - Site 77B, 0.8m, | 23-13954-42 - Site 98B, 1.6m, | | | | | | | | |
| 23-13954-43 - Site 34B, 1.0m, | 23-13954-44 - Site 50B, 1.35m, | | | | | | | | |
| 23-13954-45 - Site 40B, 0.5m, | 23-13954-46 - Site 69, 2.0m, | | | | | | | | |
| 23-13954-47 - Site 70, 0.5m, | 23-13954-48 - Site 83B, 1.0m, | | | | | | | | |
| 23-13954-49 - Site 15, 1.0m, | 23-13954-50 - Site 43B, 2.0m, | | | | | | | | |
| 23-13954-51 - Site 91, 1.0m, | 23-13954-52 - Site 84B, 1.0m, | | | | | | | | |
| 23-13954-53 - Site 58B, 0.5m, | 23-13954-54 - Site 47, 1.0m, | | | | | | | | |
| 23-13954-55 - Site 12, 2.0m, | 23-13954-56 - Site 31, 2.0m, | | | | | | | | |
| 23-13954-57 - Site 100, 0.5m, | 23-13954-58 - Site 21, 0.8m, | | | | | | | | |
| 23-13954-59 - Site 16, 1.15m, | 23-13954-60 - Site 64B, 2.0m | | | | | | | | |
| **80* dried soil (EA033)** | | | | | | | | | |

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

| Method | | Sample Date | Extraction / Preparation | | | Analysis | | |
|---|---|---|---|---|---|---|---|---|
| Container / Client Sample ID(s) | | | Date extracted | Due for extraction | Evaluation | Date analysed | Due for analysis | Evaluation |
| **EA033-D: Retained Acidity - Continued** | | | | | | | | |
| 23-13954-61 - Site 8B, 0.5m, | 23-13954-62 - Site 41C, 1.0m, | **09-May-2023** | **13-Jun-2023** | 08-May-2024 | ✓ | **13-Jun-2023** | 11-Sep-2023 | ✓ |
| 23-13954-63 - Site 28B, 1.0m, | 23-13954-64 - Site 68, 0.5m, | | | | | | | |
| 23-13954-65 - Site 67, 0.9m, | 23-13954-66 - Site 24, 1.55m, | | | | | | | |
| 23-13954-67 - Site 48, 2.0m, | 23-13954-68 - Site 73, 0.8m, | | | | | | | |
| 23-13954-69 - Site 90, 2.0m, | 23-13954-70 - Site 25, 2.0m, | | | | | | | |
| 23-13954-71 - Site 18, 0.95, | 23-13954-72 - Site 62, 0.5m, | | | | | | | |
| 23-13954-73 - Site 49, 0.5m, | 23-13954-74 - Site 36, 0.5m, | | | | | | | |
| 23-13954-75 - Site 54, 2.0m, | 23-13954-76 - Site 55, 2.0m, | | | | | | | |
| 23-13954-77 - Site 20, 2.0m, | 23-13954-78 - Site 45, 0.95m, | | | | | | | |
| 23-13954-79 - Site 56, 2.0m, | 23-13954-80 - Site 27, 1.0m, | | | | | | | |
| 23-13954-81 - Site 19, 0.5m, | 23-13954-82 - Site 81, 1.0m, | | | | | | | |
| 23-13954-83 - Site 22, 0.5m, | 23-13954-84 - Site 96, 0.5m, | | | | | | | |
| 23-13954-85 - Site 85, 0.4m, | 23-13954-86 - Site 32, 1.8m, | | | | | | | |
| 23-13954-87 - Site 23, 1.0m, | 23-13954-88 - Site 86, 1.7m, | | | | | | | |
| 23-13954-89 - Site 6, 0.9m, | 23-13954-90 - Site 61, 0.5m, | | | | | | | |
| 23-13954-91 - Site 17, 1.0m, | 23-13954-92 - Site 92, 1.0m, | | | | | | | |
| 23-13954-93 - Site 35, 0.5m, | 23-13954-94 - Site 71, 0.5m, | | | | | | | |
| 23-13954-95 - Site 42, 0.5m, | 23-13954-96 - Site 13, 1.0m, | | | | | | | |
| 23-13954-97 - Site 72, 1.0m, | 23-13954-98 - Site 5, 0.5m | | | | | | | |

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

| Method<br>Container / Client Sample ID(s) | Sample Date | Extraction / Preparation | | | Analysis | | |
|---|---|---|---|---|---|---|---|
| | | Date extracted | Due for extraction | Evaluation | Date analysed | Due for analysis | Evaluation |
| **EA033-E: Acid Base Accounting** | | | | | | | |
| **80* dried soil (EA033)**<br>23-13954-1 - Site 80, 1.65m, 23-13954-2 - Site 79, 2.0m,<br>23-13954-3 - Site 76, 0.5m, 23-13954-4 - Site 78, 2.0m,<br>23-13954-5 - Site 10, 2.0m, 23-13954-6 - Site 4, 1.0m,<br>23-13954-7 - Site 26, 1.0m, 23-13954-8 - Site 39, 0.75m,<br>23-13954-14 - Site 9, 1.0m,<br>23-13954-9 - Site 51, 1.55m, 23-13954-10 - Site 52, 1.0m,<br>23-13954-11 - Site 53, 2.0m, 23-13954-12 - Site 11, 0.5m,<br>23-13954-13 - Site 37, 0.5m, 23-13954-15 - Site 7, 1.0m, 23-13954-16 - Site 65, 1.0m,<br>23-13954-17 - Site 1, 1.0m, 23-13954-18 - Site 33, 0.95m,<br>23-13954-19 - Site 14, 1.0m, 23-13954-20 - Site 3, 2.0m,<br>23-13954-21 - Site 99, 0.2m, 23-13954-22 - Site 2, 0.5m,<br>23-13954-23 - Site 87, 0.5m, 23-13954-24 - Site 57, 2.0m,<br>23-13954-25 - Site 75, 1.0m, 23-13954-26 - Site 60, 2.0m,<br>23-13954-27 - Site 63, 2.0m, 23-13954-28 - Site 88, 0.5m,<br>23-13954-29 - Site 74, 0.5m, 23-13954-30 - Site 46, 2.0m,<br>23-13954-31 - Site 89, 1.0m, 23-13954-32 - Site 38, 0.75m,<br>23-13954-33 - Site 97, 1.55m, 23-13954-34 - Site 66, 0.5m,<br>23-13954-35 - Site 29, 1.0m, 23-13954-36 - Site 82, 1.0m,<br>23-13954-37 - Site 94, 1.0m, 23-13954-38 - Site 93, 0.5m,<br>23-13954-39 - Site 30, 0.5m, 23-13954-40 - Site 59B, 1.0m,<br>23-13954-41 - Site 77B, 0.8m, 23-13954-42 - Site 98B, 1.6m,<br>23-13954-43 - Site 34B, 1.0m, 23-13954-44 - Site 50B, 1.35m,<br>23-13954-45 - Site 40B, 0.5m, 23-13954-46 - Site 69, 2.0m,<br>23-13954-47 - Site 70, 0.5m, 23-13954-48 - Site 83B, 1.0m,<br>23-13954-49 - Site 15, 1.0m, 23-13954-50 - Site 43B, 2.0m,<br>23-13954-51 - Site 91, 1.0m, 23-13954-52 - Site 84B, 1.0m,<br>23-13954-53 - Site 58B, 0.5m, 23-13954-54 - Site 47, 1.0m,<br>23-13954-55 - Site 12, 2.0m, 23-13954-56 - Site 31, 2.0m,<br>23-13954-57 - Site 100, 0.5m, 23-13954-58 - Site 21, 0.8m,<br>23-13954-59 - Site 16, 1.15m, 23-13954-60 - Site 64B, 2.0m | **09-May-2023** | **12-Jun-2023** | 08-May-2024 | ✓ | **12-Jun-2023** | 10-Sep-2023 | ✓ |
| **80* dried soil (EA033)** | | | | | | | |

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

| Method<br>Container / Client Sample ID(s) | | Sample Date | Extraction / Preparation | | | Analysis | | |
|---|---|---|---|---|---|---|---|---|
| | | | Date extracted | Due for extraction | Evaluation | Date analysed | Due for analysis | Evaluation |
| **EA033-E: Acid Base Accounting - Continued** | | | | | | | | |
| 23-13954-61 - Site 8B, 0.5m, | 23-13954-62 - Site 41C, 1.0m, | **09-May-2023** | **13-Jun-2023** | 08-May-2024 | ✓ | **13-Jun-2023** | 11-Sep-2023 | ✓ |
| 23-13954-63 - Site 28B, 1.0m, | 23-13954-64 - Site 68, 0.5m, | | | | | | | |
| 23-13954-65 - Site 67, 0.9m, | 23-13954-66 - Site 24, 1.55m, | | | | | | | |
| 23-13954-67 - Site 48, 2.0m, | 23-13954-68 - Site 73, 0.8m, | | | | | | | |
| 23-13954-69 - Site 90, 2.0m, | 23-13954-70 - Site 25, 2.0m, | | | | | | | |
| 23-13954-71 - Site 18, 0.95, | 23-13954-72 - Site 62, 0.5m, | | | | | | | |
| 23-13954-73 - Site 49, 0.5m, | 23-13954-74 - Site 36, 0.5m, | | | | | | | |
| 23-13954-75 - Site 54, 2.0m, | 23-13954-76 - Site 55, 2.0m, | | | | | | | |
| 23-13954-77 - Site 20, 2.0m, | 23-13954-78 - Site 45, 0.95m, | | | | | | | |
| 23-13954-79 - Site 56, 2.0m, | 23-13954-80 - Site 27, 1.0m, | | | | | | | |
| 23-13954-81 - Site 19, 0.5m, | 23-13954-82 - Site 81, 1.0m, | | | | | | | |
| 23-13954-83 - Site 22, 0.5m, | 23-13954-84 - Site 96, 0.5m, | | | | | | | |
| 23-13954-85 - Site 85, 0.4m, | 23-13954-86 - Site 32, 1.8m, | | | | | | | |
| 23-13954-87 - Site 23, 1.0m, | 23-13954-88 - Site 86, 1.7m, | | | | | | | |
| 23-13954-89 - Site 6, 0.9m, | 23-13954-90 - Site 61, 0.5m, | | | | | | | |
| 23-13954-91 - Site 17, 1.0m, | 23-13954-92 - Site 92, 1.0m, | | | | | | | |
| 23-13954-93 - Site 35, 0.5m, | 23-13954-94 - Site 71, 0.5m, | | | | | | | |
| 23-13954-95 - Site 42, 0.5m, | 23-13954-96 - Site 13, 1.0m, | | | | | | | |
| 23-13954-97 - Site 72, 1.0m, | 23-13954-98 - Site 5, 0.5m | | | | | | | |

## Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

| Quality Control Sample Type | | Count | | Rate (%) | | | Quality Control Specification |
|---|---|---|---|---|---|---|---|
| *Analytical Methods* | *Method* | *QC* | *Regular* | ***Actual*** | ***Expected*** | *Evaluation* | |
| **Laboratory Duplicates (DUP)** | | | | | | | |
| Chromium Suite for Acid Sulphate Soils | EA033 | 10 | 98 | **10.20** | **10.00** | ✓ | NEPM 2013 B3 & ALS QC Standard |
| Suspension Peroxide Oxidation-Combined Acidity and Sulphate | EA029 | 1 | 9 | **11.11** | **10.00** | ✓ | NEPM 2013 B3 & ALS QC Standard |
| **Laboratory Control Samples (LCS)** | | | | | | | |
| Chromium Suite for Acid Sulphate Soils | EA033 | 5 | 98 | **5.10** | **5.00** | ✓ | NEPM 2013 B3 & ALS QC Standard |
| Suspension Peroxide Oxidation-Combined Acidity and Sulphate | EA029 | 1 | 9 | **11.11** | **5.00** | ✓ | NEPM 2013 B3 & ALS QC Standard |
| **Method Blanks (MB)** | | | | | | | |
| Chromium Suite for Acid Sulphate Soils | EA033 | 5 | 98 | **5.10** | **5.00** | ✓ | NEPM 2013 B3 & ALS QC Standard |
| Suspension Peroxide Oxidation-Combined Acidity and Sulphate | EA029 | 1 | 9 | **11.11** | **5.00** | ✓ | NEPM 2013 B3 & ALS QC Standard |

## Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

| *Analytical Methods* | *Method* | *Matrix* | *Method Descriptions* |
|---|---|---|---|
| Suspension Peroxide Oxidation-Combined Acidity and Sulphate | EA029 | SOIL | In house: Referenced to Ahern et al 2004 - a suspension peroxide oxidation method following the 'sulfur trail' by determining the level of 1M KCL extractable sulfur and the sulfur level after oxidation of soil sulphides. The 'acidity trail' is followed by measurement of TAA, TPA and TSA. Liming Rate is based on results for samples as submitted and incorporates a minimum safety factor of 1.5. |
| Chromium Suite for Acid Sulphate Soils | EA033 | SOIL | In house: Referenced to Ahern et al 2004. This method covers the determination of Chromium Reducible Sulfur (SCR); pHKCl; titratable actual acidity (TAA); acid neutralising capacity by back titration (ANC); and net acid soluble sulfur (SNAS) which incorporates peroxide sulfur. It applies to soils and sediments (including sands) derived from coastal regions. Liming Rate is based on results for samples as submitted and incorporates a minimum safety factor of 1.5. |

| *Preparation Methods* | *Method* | *Matrix* | *Method Descriptions* |
|---|---|---|---|
| Drying at 85 degrees, bagging and labelling (ASS) | EN020PR | SOIL | In house |

GHD