ACID SULPHATE SOILS: IDENTIFICATION AND MANAGEMENT IN NZ'S LARGEST AIRPORT

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ABSTRACT

Whilst the presence and effects of acid sulphate soils on the environment and underground infrastructure are common knowledge in regions such as Northland and the Bay of Plenty, these soils have only been identified in isolated locations within the Auckland region. During November 2016 however, Pattle Delamore Partners Limited (PDP) was called to the Auckland International Airport to investigate a 'potential spill event' that had occurred in the future airport area. Upon arrival to the site, it was clearly apparent from observations that there had been no spill event. The site was however being influenced from the effects of acid sulphate soils.

Preliminary water quality testing of an existing watercourse within the future northern airport area found the pH was 2.8, and the water had significantly elevated sulphate and iron concentrations. The watercourse was starting to be infilled with iron oxide precipitates, a resultant effect of acid sulphate soils caused by acidified groundwater releasing iron minerals from the soil. A wetland that receives the flows from this watercourse was also starting to accumulate iron oxide precipitates. The wetland vegetation was either dead, or looked as though it had been burnt.

Approximately two weeks after these observations, a concrete 600 mm dia culvert that allows the connection from the watercourse to the wetland collapsed as a result of the low pH waters and the elevated sulphate concentrations.

To quickly respond to the above effects and restrict the possibility of persons and other piped infrastructure being further affected, PDP undertook emergency management works (under section 330 of the RMA) by placing 8 tons of Aglime into the watercourse. This elevated the water pH from 2.8 to 6.3 pH units. In addition, a pH monitoring station was installed within the wetland to monitor discharges before they enter into a significant stormwater reticulation network of the airport.

The Auckland Airport is New Zealand's largest and is the gateway for the greatest number of international travelers into New Zealand. The airport has significant infrastructure and stormwater reticulation networks which could be compromised as a result of acid sulphate soils. Furthermore, AIAL are in the process of constructing $1.8 billion of new infrastructure assets over the next 5 years to support new airport terminals, a new runway and auxiliary infrastructure. With such rapid growth and development of the future northern airport, it was imperative for AIAL to understand the effects, management options and infrastructure design methods to deal with acid sulphate soils effects.

As a result of the site observations and preliminary water quality measurements, PDP have subsequently been engaged by Auckland International Airport Limited (AIAL) to:

- Investigate the spatial extent, and strength of acid sulphate soils within the future northern airport precinct.

- Prepare an acid sulphate soil management plan, a document which sets out how acid sulphate soils can be evaluated, what management options should be considered for mitigating the effects of acid sulphate soils, and discusses how future monitoring should be conducted to assess the performance of the implemented management options. This document will also support a resource consent application which is being prepared by Mitchell Daysh and PDP to allow the discharge associated with acid sulphate soils and the implementation of specific management options.

- Work with AIAL project managers to enable successful implementation of acid sulphate soil management methods within new and existing land developments at the airport.

To provide an understanding of acid sulphate soils, PDP have been conducting field pH inspections. Field pH assessments provide a quick means to determine the presence or absence of acid sulphate soils within the area of interest. The assessment also provides a qualitative indication as to the potential strength of the acid sulphate soil.

A field pH assessment requires two tests to be conducted. The two tests are referred to as a pHF and a pHFOX test. These tests provide an understanding of the soil condition in a natural 'current' state and an oxidised 'worst case scenario' state. The presence of acid sulphate soils is potentially indicated if:

- a reaction (a fizz) with hydrogen peroxide (the pHFOX test);

- the pHFOX is at least 1 pH unit below pHF; and,

- the pH measurement for the pHFOX sample is <4 pH units, and one or both of the above conditions apply.

Laboratory assessments have also subsequently been carried out when the presence of acid sulphate soil has been detected from field pH assessments. The purpose of the laboratory analysis is to provide quantitative information regarding the strength of the acid sulphate soil, and it also provides information as to how much lime is required to neutralise the soil. Note that lime application is a common option used to manage acid sulphate soils.

In addition to soil assessments, PDP have also installed ten piezometers (with an additional six piezometers scheduled to be installed during December 2017). The purpose of the piezometers is to assist PDP to understand groundwater flow conditions, and also enable access to the groundwater aquifer so that groundwater samples and physicochemical assessments can be obtained. Parameters assessed at the piezometers are:

- pH;

- Electrical Conductivity;

- Water Temperature;

- Dissolved Oxygen;

- Sulphate; and,
- Chloride.

Based upon monitoring results obtained to date, groundwater measurements indicate that acid sulphate soils are present across all locations assessed. The strength of the acid sulphate soils however do vary. At some monitoring locations, PDP have identified that that the strength of the acid sulphate soil does not pose a significant threat to the life expectancy of underground infrastructure or the environment. At other locations however, acid sulphate soil strength is so elevated it is more than four-fold greater than the recommended maximum thresholds which underground infrastructure can tolerate. These locations with elevated strength also correlated well with earlier field pH assessments, where pHFOX tests were found to explode test vials in the field due the volatility of the reactions that occurred.

PDP has recently prepared an acid sulphate soil management plan. This document sets out management options to mitigate the effects of acid sulphate soils to underground infrastructure and the environment. The management options presented in the plan are in a hierarchical order in which they must be considered. The following mitigation options have been proposed:

- Avoidance of acid sulphate soil disturbance.
    - Relocate development to areas without acid sulphate soil.
    - Cover the acid sulphate soil with cleanfill.
- Minimising disturbance of acid sulphate soils.
    - Directional drilling or underground thrusting for the laying of cables or pipe networks.
    - Use pile foundations (rather than slab foundations).
    - Screw piles for building foundations.
- Prevention of soil oxidation.
    - Soakage practices to elevate the locate groundwater table.
    - Groundwater recharge via pumping.
- Treatment and/or neutralisation of acid soils/discharges.
    - Altering concrete/steel specifications.
    - Liming of soils.
    - Treatment of acidified surface waters in dedicated treatment facilities.
    - Treatment of acidified groundwater by injection of aqueous lime into the aquifer.
- Offsite acid sulphate soil removal.

The purpose of this presentation is to introduce the New Zealand stormwater industry to acid sulphate soils. Using the Auckland Airport as a case study, the presentation will discuss the effects that acid sulphate soils can cause to both stormwater infrastructure and the environment.

We will also outline from PDP's and AIAL's perspectives, the work that has been carried to date including the identification and field work to understand acid sulphate soils and determine the potential for adverse effects. Proposed management options that we have developed for the airport will be explained in greater detail and also the mechanisms for implementing these into an airport that is having its infrastructure rapidly transformed at a capital expenditure rate of $1million per day.

KEYWORDS

Auckland International Airport; Acid Sulphate Soils; NZS 3101; NZS 3404; AS 2159