East Trinity Property Acid Sulfate Soils Remediation Action Plan

This plan has been prepared by:

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Department of Natural Resources

Queensland Government

ACID SULFATE SOIL REMEDIATION ACTION PLAN

PURPOSE

The purpose of the Acid Sulfate Soil Remediation Action Plan (ASSRAP) is to explain the approach Government is taking to remediate the Acid Sulfate Soils (ASS) on its lands at East Trinity.

Publication of this plan will allow the community to comment on and contribute to the successful application of this plan.

OVERALL APPROACH

This plan addresses the management of acid sulfate soils at East Trinity by utilising the mechanism of tidal exchange as a buffering agent. The intention is to progressively and cautiously replace the existing acidified freshwater/brackish water unmanaged wetland with a managed tidal wetland system.

The proposal assumes the outcome of development of the site will be a general low intensity use, for example, the re-establishment of a wetland. Changes to this intention would require a re-examination of the options.

Tidal exchange is expected to hydraulically suppress acid export from the soil and buffer existing water acidity. Ultimately, a restored wetland environment is expected to inhibit further acid production from oxidation of iron sulfides beyond what would occur in a natural system. Hydrated lime or agricultural lime treatment is proposed to assist the process and reduce the risk to the surrounding environment.

The proposed approach includes the assessment of the natural resources of the site, progressive review to evaluate the level of risk and reduce the proposed approach's level of risk. This cautious approach complies with a general environmental duty of care and is intended to deliver a substantial reduction in the existing environmental risk exhibited by the site.

Attachment 1 provides a general background to the ASS soil problem on the site and treatment options.

Control of offsite impacts – immediate measures

The existing bund wall (earth barrier) and floodgates afford a significant measure of control over acid and metal export at the site. However, to achieve control it is necessary to repair them prior to the implementation of any treatment measures. The bund wall needs to be assessed by an engineer, repaired as necessary and then well maintained. The stability of the inside bund wall should be examined by an engineer with respect to the potential impact of tidal exchange and expansion of the area being inundated, especially north of Hills Creek. Further investigation may also reveal the need for further extension/modification of the bund wall. The importance of the bund wall also lies in its continuing role as an access route to much of the site. Once repaired, the bund wall and floodgates will form an integral part of the treatment process by enabling controlled containment of tidal waters.

All floodgates need to be in fully operational order. In addition, the design of the Hills Creek floodgates needs to be reviewed to ensure the gates are capable of being easily or automatically opened and shut in all tidal and flood conditions. These gates should also be capable of allowing selected partial tidal flow inward as well as controlled discharge.

Rehabilitation of existing acidity

The controlled tidal exchange proposal is considered relatively lower risk. It involves:

1. Partition of the sections of the East Trinity property west of Pine Creek Yarrabah Road into two areas to be managed according to their level of risk. These areas are:
   - The lower risk Hills Creek catchment, which will be separated from the southern part of the site by raising the height of the existing raised pad on which an old cane rail was located; and
   - Firewood-Magazine Creek catchment, an area of higher risks.

2. Any connecting drains between the two areas being blocked at the rail pad that bisects the property.

3. The floodgates on Hills Creek being used to carry out controlled tidal exchange (incremental tidal flooding) upstream of the floodgates to neutralise the existing acidity in the separated Hills Creek catchment. Permanent flooding of the lowest areas would ultimately halt the process of oxidation of the pyritic layers, thereby preventing the generation of more acid. To minimise the possibility of iron floc and sediments (possibly bound with heavy metals) entering East Trinity Inlet, a silt curtain would be installed. Reinstallation and/or repair may be necessary each year.

4. Freshwater ponds and small bunds in the Hills Creek catchment would be installed, if required, to protect adjoining land as the tidal exchange strategy carries with it a risk of saltwater intrusion onto adjacent lands.

5. Managing the risk of acidic water escaping from Firewood and Magazine Creeks by regular water monitoring and treatment. Hydrated lime is an appropriate water treatment product, but it will need to be applied with specialised equipment such as the 'Neutra-Mill' developed for acid mine drainage. (Neutra-Mill is a floating device that uses the water to be treated to mix and dissolve lime and pump a concentrated slurry or solution back to the water body.) Neutralising the water will not treat the source of the acidity in the surrounding lands, but will greatly reduce the risk of acid escape into Trinity Inlet.

Additional effects of seawater

The encroachment of seawater is likely to destroy many of the *Melaleuca* trees that have colonised the site in the past 20 odd years. On balance, the loss of these stands is outweighed by improvements to the existing environmental risk the site currently poses.

The strategy is considered to be a positive measure in terms of pest weed and animal control. Saline intrusion will assist to destroy and discourage many of the weed species that are present under current conditions.

The strategy will also be an advantage for the cassowary, which seeks out tidal wetlands for protein by consuming crabs and other invertebrates.

Addressing Hills Creek catchment

It is proposed to address Hills Creek catchment first because it is anticipated that it will be potentially easier to remediate. The site already has a degree of tidal exchange as a result of damaged floodgates and this proposal extends the process in a controlled way.

Hills Creek catchment drains most of the surrounding uplands and currently overflows into the acid pools of the Firewood and Magazine catchment in flood times, substantially adding to the risk of acid and toxic metals being discharged into Trinity Inlet. Partitioning of the two catchments will isolate the floodwaters from the Hills Creek catchment from the far more acidic Firewood-Magazine Creek catchment, thereby lowering the risk of unmanaged acid discharge in the wet season.

The tidal exchange approach

A tidal exchange approach with controlled discharge via floodgates allows the opportunity to treat acid water if necessary. It is also preferred because of its substantially reduced cost compared to a 'dry approach'. The latter involves lime treatment of the acidified layers and a quantum increase in assessment and treatment costs. For example, the estimated cost of total rehabilitation by lime treatment of soil based on available data is estimated to be $62 million, or $55–70 million over the next 25 years for the treatment of acidified waters.

A tidal exchange approach will also result in returning much of the site to a condition approaching its original wet condition through a process that involves minimal disturbance. In the short term, there are concerns about deoxygenation of the water caused by the decomposition of vegetation and the presence of oxygen scavenging forms of iron. Hence monitoring of water quality and fisheries impacts is critical. If necessary, oxygenation techniques may need to be considered prior to water discharge. The proposed use of a Neutra-Mill for lime application to water bodies will assist with oxygenation.

Information on the effectiveness of the tidal exchange strategy in Hills Creek will be essential to the development of a management strategy for the Firewood and Magazine Creek area.

The area north of Hills Creek in the vicinity of George Creek has not been investigated for ASS but there are some indications that it may be highly acidic. George Creek has no floodgate-controlled outlet through the bund wall. Should it prove to have reserves of acidity that prevent the safe discharge of water from Hills Creek (as part of the monitored tidal exchange process), this area may also have to be partitioned and managed separately through use of the 'Neutra-Mill' approach. Additionally, a one-way flow of tidal water into this northern area may occur. If this proves to be the case, there may be a need for a floodgate-controlled exit to be installed where the northern creek meets the bund wall.

STAGED APPROACH

Preliminary Feasibility – Phase 1

A mandatory prerequisite to undertaking effective site remediation is the collection and evaluation of essential resource information to determine the efficacy and environmental impacts of the proposed tidal exchange strategy and related issues.

The feasibility work will involve:

- Collation and evaluation of existing information and reference to an expert panel;
- Detailed topography assessment or Digital Elevation Model (DEM) on which to base a flood model to predict tidal inundation patterns;
- Upgrading of acid sulfate soil information;
- Mapping of stratigraphic layers;
- Investigation of groundwater pathways;
- A study of measures to protect adjoining land from salt intrusion;
- Collection of data on current stream flows and water quality;
- Final assessment of site data to predict tidal exchange effectiveness and consult with expert panel; and

- Reporting and validation of capital and maintenance costs of the implementation phase.

Implementation – Phase 2

Stage 1 – Immediate Tasks

- Firewood and Magazine Creeks to be monitored and treated on demand using lime applied with a specially designed 'Neutra-Mill' (or similar).

Stage 2 – Hill's Creek Tidal Exchange

This stage involves:

- Upgrading rail pads, blocking off drains, constructing low bunds and ponds, repairing the bund wall and installing appropriate tidal floodgate structures and silt curtains;
- Allow progressive, controlled tidal exchange to occur through the Hills Creek floodgates;
- Managing the tidal exchange process and carrying out monitoring of water quality before release;
- Strategic soil monitoring to test the effects of tidal exchange and modify management as necessary according to monitoring results;
- Monitoring water quality parameters of selected outgoing tides from Hills Creek at appropriate points downstream from the floodgates; and
- A review of data collected to facilitate planning the amelioration of the Firewood and Magazine Creek area and, if necessary, the area north of Hills Creek.

Stage 3 – Firewood and Magazine Creeks Tidal Exchange

This stage includes:

- Formulation of treatment strategies/options and implementation of the preferred strategy for Firewood and Magazine Creeks (and possibly the area north of Hills Creek); and
- Establishment of long-term procedures for maintenance of structures and clearing of waterways and drains for whole site.

TIMETABLE

This site is very wet, which limits actions occurring on the site in the wet season. The timeframes specified below are therefore dependent on weather conditions.

Preliminary Feasibility – Phase 1

Prerequisite information collected and evaluated **December 2000–August 2001**

Implementation – Phase 2

Stage 1 – Immediate Tasks

Monitoring and treatment of Firewood, Magazine and George Creeks
December 2000 to end of Stage 2

Stage 2 – Hill's Creek Tidal Exchange

Preparatory Engineering Works

Upgrade rail pad and block off drains
Repair/install floodgates, silt curtain,
Construct low bunds and ponds as salinity barriers **April–May 2001**
(Earlier if wet season allows)

Commencement of Tidal Exchange

Initial tidal exchange of Hills Creek **September–October 2001**
(weather permitting)

A review of data collected to facilitate planning the amelioration of the Firewood/Magazine Creek area (and, if necessary, the area north of Hills Creek). **June 2002**

Stage 3 – Firewood and Magazine Creeks Tidal Exchange
Earliest possible commencement of treatment **September 2002**
Anticipated treatment period **2 years**

Note: Stage 3 timing is indicative only as the outcome of Stage 2 may dictate the need for additional site investigation and other measures.

RISK ASSESSMENT

The current level of scientific knowledge on tidal exchange indicates that the plan is potentially feasible and a comparatively low cost means of ameliorating the acidity problem at East Trinity. However, in the absence of adequate knowledge of the land proposed for tidal exchange, this approach has potential risks.

One of the conclusions of the recent CSIRO work on 110 hectares of the site was that re-flooding would require 540 recharges, each to a depth of one metre. This calculation is based on the very high level of acidity in the Firewood and Magazine Creek area. The Hills Creek area has much lower levels of acidity and hence has been chosen as a first stage site to demonstrate and prove the suitability of the method prior to addressing the more acidified areas.

Another issue raised by the CSIRO researchers is that re-flooding had not been successful in the few instances trialed in Australia. The soon-to-be-released NSW Acid Sulfate Soil Remediation Guidelines (2000) recommend seawater re-flooding as a remediation technique and there are now successful examples in the Kempsey area. Additionally, there are documented examples of successful seawater remediation from overseas. As an added security, the Neutral-Mill will be employed to neutralise products and assist the process when necessary.

It is therefore possible to be confident about the principle of acid buffering and the creation of chemically reducing conditions through tidal exchange. However, until the feasibility studies have been completed it is not possible to confidently predict the level of risk that tidal exchange poses at East Trinity.

An inherent risk of the tidal exchange strategy that requires appropriate management is the possible intrusion of salt water into adjacent land.

DRAIN MAINTENANCE

The current state of drains and creeks is impacting on adjacent landholders. The feasibility studies will assess the implications of carrying out maintenance to the existing agricultural drainage system and whether it is prudent to 'de-silt' Hills Creek. Both an on-site inspection and the benefit of elevation data are needed to make these judgements. However, while any drain clearing and/or silt removal will likely reduce the degree to which re-introduced saline water will spread across the site (and hence reduce the neutralisation effect), the impact is unlikely to be significant.

PROJECTED AREAS OF TIDAL WETLAND AND NON-TIDAL LAND

Phase 2, Stage 2 – Hill's Creek Tidal Exchange

Restoring the natural tidal regime to Hills Creek will create wetlands comprising ponded areas and intertidal (frequently tide affected) and supratidal (infrequently inundated) flats. The extent to which this occurs can be more confidently predicted when precise elevation data is available (Preliminary Feasibility Study).

With current information, up to 10 to 20 per cent of the site may become permanently ponded (including the ponds to protect adjoining land). Tidal flats will possibly occupy 30 per cent of the East Trinity site.

Phase 2, Stage 3 – Firewood and Magazine Creeks Tidal Exchange

If the Firewood and Magazine Creek area is opened to tidal influence, the tidal flats will increase to almost 60 per cent of the whole site.

Current information indicates that about 30 per cent of the site will be above any tidal influence. Much of this land is very steep, leaving some 50 hectares not affected by tidal influences or located on the natural vegetated hill slopes.

Attachment 1

BACKGROUND

Site history

Prior to the establishment of a sugar cane farm in the 1970's, much of the East Trinity site was a tidally affected zone. Mangrove communities covered much of the site, while a salt marsh, covered by salt scald and samphire species, occupied about a fifth of the site.

A bund wall was constructed and floodgates placed on the creek outlets at the time of establishing the cane land. A large pump was sited at the floodgates on Hills Creek, to remove water from the site.

The intention of these measures was to eliminate tidal water and lower the natural water table to facilitate cane production. The lowering of the water table also drained extensive areas of acid sulfate soils. This exposed large areas of formerly benign soils/sediments containing iron sulfide (pyrite) to the air, resulting in the production of quantities of sulfuric acid.

Acid sulfate soil behaviour

The inevitable consequence of this oxidation of pyrite is to cause sulfuric acid and associated heavy metals to be released from the soil, which in turn creates a serious environmental hazard. These soils are referred to as acid sulfate soils (ASS). The oxidised upper layers are actual acid sulfate soils (AASS) that pose an immediate environmental threat. The undrained layers below the watertable are potential acid sulfate soils (PASS) and pose a potential threat if further lowering of the water table or excavation occurs.

ASS at East Trinity

The recent scientific investigation by CSIRO on part of the site provides irrefutable evidence that the ASS hazard is significant in that area. Other work suggests that a large proportion of the site is similarly affected, but further investigation is needed to determine the level of hazard.

The hazard posed by ASS at this site in the absence of any remediation measures is a chronic long-term one. The hazard over time is a function of seasonal and local conditions. Extended dry periods followed by heavy rainfall will cause highly concentrated flushes of acid to be released to surrounding ground water and streams. The effect will be less pronounced in wetter years. The condition of receiving waters during a 'flush' will determine the degree of consequent environmental harm.

Current scientific investigation suggests that the most concentrated acid problem occurs in the vicinity of Firewood and Magazine Creeks, the area studied by CSIRO.

Floodgates and ASS

The various floodgates on the site are in poor condition and this has ramifications for the ASS hazard. Leaking gates allow some intrusion of tidal water providing some acid neutralising effect up to a point, depending on the level of upstream acidity. On the other hand, leaking floodgates could allow acidic waters to readily escape into the surrounding aquatic environment of Trinity Inlet during rainfall.

Neighbouring sugarcane farms

There is an existing cane farm on the eastern boundary of the site that benefits from the current exclusion of tidal water from the site. When tidal exchange is reinstated on the site, measures will be taken to protect this farm.

ASS MANAGEMENT OPTIONS

The management of ASS depends, in the first instance, on whether potential or actual ASS is being treated and secondly, whether the treatable material is to be left in-situ or excavated.

Excavation Option

The standard procedure involves the addition of large quantities of agricultural lime to neutralise the existing or potential acidity. As ASS are variable in nature, the first imperative of this approach is a thorough drilling, sampling and laboratory analysis program. The sampling and analysis must occur at regular intervals down the profile to below the proposed depth of excavation, and the frequency of drilling is intense.

Excavated AASS material is thoroughly mixed with a quantity of lime determined by laboratory results. To achieve effective mixing with pyritic materials, particularly muds, they usually need to be spread in thin layers and dried before lime addition.

Excavated PASS material is treated similarly, if it is to be used in any way. If not, it can be buried below a permanent watertable without treatment.

Non-Excavation Option

Treatment regimes are far less onerous and the intensity of assessment is reduced. One possible form of treatment is to use the neutralising effect of seawater. This has the potential to handle the existing acidity in the AASS layers, as well as preventing oxidation of the PASS layers – due to the return to a permanently wet state – eliminating the opportunity for this layer to oxidise. This approach may require some form of liming of the AASS layers as a precautionary measure if it is determined that tidal exchange will not cope with the level of acidity in the AASS layer.

A critical issue in tidal exchange is to ensure that the water returned to open waters does not contain harmful amounts of acidity or heavy metals. Hence a capability to contain, test and treat the contained water before allowing it to exit is important. A second issue is the need to be able to predict the hydrological implications of a restored tidal regime on ASS land that has usually been significantly altered (for example, lowered, as a consequence of drainage). The extent of inundation on a lowered land surface will need to be predicted accurately. Some confidence in predicting the movement of groundwater through any permeable strata in the landscape is also important. If these subsurface flow paths are located in situations where they can transport acid to waters to the external environment in an uncontrolled way, they may pose a substantial risk.

In summary, while ASS treatment of excavated material requires exhaustive assessment of the landscape compared to a tidal exchange approach, there is still a critical need to have a thorough understanding of certain facets of the landscape.