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COMSTOCK MINE
WATER MANAGEMENT PLAN

For
Zeehan Zinc Limited

October 2007
Revision 2

Project No:1292.001

PREFACE

PROJECT: Comstock Mine Water Management Plan **PROJECT NO.:** 1292.001
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1 INTRODUCTION

The aim of this water management plan is to outline the procedures that will be used by Zeehan Zinc (ZZ) to enable compliance with Permit conditions with regard to:

- Management of on-site stormwater run off;
- Mine process water and acid mine drainage management;
- Erosion and sediment control; and
- Temporary and future site disturbances, stockpiling, and rehabilitation.

1.1 BACKGROUND

The Comstock mine is based on a zinc (Zn), lead (Pb), and silver (Ag) deposit. A mill for ore processing was installed at the mine site in 2001/2002 and consists of a crushing, screening and gravity separation plant.

The Comstock mine is located approximately 5km west of the township of Zeehan, on the west coast of Tasmania. The four previous mining leases held by Oceania Tasmania[1] that cover Comstock mine operations were:

ML 123M/1947 (145ha);

ML 43M/1985 (80ha);

ML 9M/1995 (11ha); and

ML 9M/2002 (11ha).

In 2007, the leases were consolidated into a single lease, mining lease ML 5M/2007.

All current and proposed operations of the Comstock mine are limited to the area covered by the mining lease.

The site includes haul and internal access roads, a working open pit and run of mine pad, historic waste rock dump and adit, partially completed tailings storage facility and polishing pond. The historical South Comstock pit is to be reworked and rehabilitated to allow construction of future mine processing plant.

A combination of historic discharge issues from the adit and run off associated with the existing mine layout and new workings are addressed by this plan.

1.2 PURPOSE

The purpose of this plan is to minimise the impact on the site and surrounds due to uncontrolled stormwater, process water and acid mine drainage run off. It shall provide a framework for addressing the current mine layout and discharge requirements, and provide a generic approach to preventing and treating discharge issues which may result from future works.

The plan shall:

- Identify works required to address current run off problems;
- Identify areas and works required to separate “dirty” and “contaminated” streams, where “dirty” streams are stormwater run off affected by sediment, “contaminated” streams are affected by acids, metals or mine processes;
- Specify procedures for future works likely to result in run off issues, and;
- Provide an overall reference point for site water management incorporating Process Water and Acid Mine Drainage.

[1] Oceania Tasmania Pty Ltd is a fully owned subsidiary of Zeehan Zinc Pty Ltd (ZZ).

1.3 ZEEHAN ZINC RESPONSE PRIORITIES

Protection

- **All drainage lines, creeks, streams, rivers etc, flowing to sources of fresh water have a VERY HIGH priority for protection at all times.**

Treatment

- Elements which are comprised of streams of a quality which does not comply with the conditions of the discharge permit have a VERY HIGH priority for treatment at all times.
- Elements subject to scour and erosion, which if left unattended may have the potential for failure, such as tailings and storage dams, have a HIGH priority for treatment.
- Elements subject to scour and erosion, which contribute to maintenance and production programs such as roads and drainage, stockpiles and cleared areas have a MEDIUM priority.

1.4 SCOPE OF THE PLAN

This water management plan applies to the entirety of the Comstock mining lease, as outlined on the mining lease map (Appendix A). This plan is applicable to extensions of the Comstock mining lease as may be approved in the future.

Elements within the lease covered include:

- The external catchment to the north of Trial Harbour Rd where Comstock Creek re-enters the discharge stream;
- The current Allison and Comstock pits;
- The future Allison pit extension;
- Tailings & polishing ponds, acid mine drainage settling pond, future tailings and wastewater treatment ponds;
- Swansea Waste Rock Dump;
- Stockpiles of topsoil and overburden, and;
- Exploration & testing areas.

1.5 HOW TO USE THE PLAN

This plan comprises three components:

- Part I: Strategic Information (Sections 1 and 2);
- Part II: Operational Response (Sections 3, 4, 5 and 6); and
- Part III: Appendices.

All personnel involved in site works resulting in disturbance of ground, movement of stockpiles, rehabilitation works or maintenance of roads and drainage elements must be familiar with the methods described in **Appendix C - Standard Procedure Forms.**

All personnel involved with an active role in monitoring water management elements, including stormwater runoff, acid mine drainage, process water and groundwater monitoring must be familiar with the whole plan. This includes the individual management plans covering acid mine drainage, groundwater monitoring and mine process water.

If in doubt about the procedures to follow, go to Section 6: Operational Plan.

Section 6 describes methodologies for treatment of new and existing works, as well as maintenance and management of elements associated with stormwater runoff, acid mine drainage, groundwater and mine process water.

The appendices include reference information relating to specific aspects of the contingency plan that have been implemented, or require further development by Zeehan Zinc.

2 MINE ENVIRONMENT

2.1 EXISTING ENVIRONMENT

Groundwater discharge from the historical adit enters Comstock Creek adjacent to the Trial Harbour Road. The adit water quality is poor, with high levels of metals and acidity. Preliminary works have been undertaken to redirect the main flow from the adit discharge away from Comstock Creek for treatment. Minor groundwater seeps from excavated batters has been observed at the site.

Run off from disturbed areas, roadways and stockpiles is generally captured by roadside drains, with the topography of the site providing natural fall to the northeast and southwest extremities of the lease.

2.2 FACILITY DESCRIPTION

Access to the mining lease is provided via Trial Harbour Road. This access point is to be the only entry and exit point to the Comstock mining lease. Refer to Appendix A for a detailed map of the facility.

The *Comstock Mine Water Management Plan* is derived such that:

- The existing topography, current and proposed layouts allow the segregation of run off along natural and man-made lines according to the classification of the run off;
- Drainage and treatment layouts shall be located and sized according to the natural delineation of the site topography and areas of works;
- Run off or seepage from current and proposed extraction and processing works as well as adit flow can be expected to require treatment for acidity and metals;
- Run off associated with undisturbed areas, topsoil stockpiles and roadways can be expected to require treatment for sediment only; and
- Discharge from the wash down bay or from vehicles and plant from off site shall be assumed to be contaminated and require separate treatment as per acid contaminated water. Refer to the *Weed and Disease Management Plan* for requirements regarding site security.

All internal roads and the Trial Harbour Road are provided with unlined table drains and piped culvert crossings where necessary. All internal roads allow for the direction of surface run off to sediment basins or treatment ponds via table drains. Future roads, pads and set down/dump areas shall be constructed with the requirement to keep run off streams separated into “dirty” and “contaminated” discharges on the basis of catchment areas.

2.3 INSPECTIONS

An Inspection Schedule (Appendix C) as part of site Standard Procedures will be developed when operational. The Inspection Schedule will ensure the following elements are monitored:

- Unsealed road surfaces, hardstands and pads for sediment generation and run off to surface drains appropriate to the end treatment;

- Unlined table drains for erosion and direction of run off to the areas appropriate to the end treatment;
- Sediment basins for build up and structural integrity, water quality on discharge (visual);
- Sediment fences and diversion banks for effectiveness around stockpiles and disturbed areas;
- Stockpiles and earthworks for separation of materials, height and placement of the piles;
- Batters to dams, ponds and cut slopes for erosion and seepage;
- Raw and treated water quality of "contaminated" treatment trains (acid mine drainage) – reference to the Permit discharge requirements;
- Groundwater monitoring at locations described in the *Groundwater Monitoring and Management Plan* for water quality; and
- Vehicle washdown bays for sediment build-up and discharge or overflow to the appropriate treatment areas.

3 SEDIMENT RUNOFF ASSESSMENT

3.1 MIGRATION PATTERNS

The site has major catchment areas bound by the existing topography, open pits and internal roads. Overland flow from vegetated and disturbed areas is either collected by mine pits or roadside drains. Sediment is present in all run off, hence all run off will be directed to settling basins prior to leaving the site. Settling basins are required prior to the outlet of all concentrated discharges.

Refer to the site plan **Figure 2** for identification of catchment areas and delineation based on run off quality and resulting treatment. All current and proposed future disturbed areas are directed to the extremities of the site to the northeast and southwest, where settling and treatment basins are located.

Treatment for discrete sediment producing sites such as stockpiles, cleared pads, drilling sites and the like requires sediment fencing only, when these facilities are constructed in accordance with the recommendations of this and other Plans.

Run off which is "contaminated" meaning in contact with adit water or acid generating rock will be directed to the areas associated with the acid mine drainage treatment sites. This will include run off from elements associated with the *Weed and Disease Management Plan* vehicle wash down bays.

3.2 SENSITIVE LOCATIONS

No areas that are considered environmentally sensitive have been identified within the current area of operations. A stand of the threatened species *Epacris curtisiae* (northwest heath) is located to the northwest of Trial Harbour Road outside the current area of operations. Reference to this and the precautions required are contained within the *Weed and Disease Management Plan*. Should sensitive flora or fauna be located within the operational area in future, ZZ will revise the Plan as necessary to ensure no damage is possible form routine operations.

The procedures outlined in the *Weed and Disease Management Plan* for control of possible weed and disease contaminated material and vehicles brought onto site must be read in conjunction with the requirements of this Plan to separate "dirty" and "contaminated" run off.

The diverted Comstock Creek, as outlined on the mining lease map (Appendix A), runs through the western side of the mining lease boundary. Comstock Creek was heavily impacted by acid mine drainage generated predominantly by historical mining operations. Works to separate the adit from the creek have been completed. Stormwater discharge from the site that meets the "dirty" criteria may be directed to the creek via settling basins.

No direct connection of site drains to the creek is permitted without sediment control.

Water released to the environment from settling basins and the polishing pond following treatment is defined as "clean".

3.3 SEDIMENT, EROSION, CONTAMINATION SCENARIOS

Sediment, erosion and contamination scenarios are likely to arise from:

- Poor maintenance of road surfaces with low strength materials generating fines under traffic;
- Poor road cross section and drain grades allowing ponding of water;
- Inappropriately sized or shaped table drains which increase velocities and scour;
- Undersized or overloaded settlement basins, or poor inlet structures;
- Topsoil, bulk earth or run of mine product stockpiles poorly shaped and unfenced, placed over stream lines;
- Disturbed areas (drill pads, hardstands or temporary set down) in "dirty catchments unfenced;
- Batter slopes to basins, dams, cuttings untreated or revegetated;
- Roads and drains crossing catchments without regard to separation of run off streams on the basis of "dirty" and "contaminated" generation;
- Control of bulk material set down without regard for proximity to drains or separation of "dirty" and "contaminated" discharge; and
- Discharge from acid mine drainage treatment areas prior to adequate treatment.

4 MINE ORGANISATION

4.1 RESPONSE ORGANISATION

The Environmental Officer is responsible to the Mine Manager for overall coordination in the event of a release of acid mine drainage from within the Comstock mining lease. The Environmental Officer will inform any related agencies of the release.

The Environmental Officer will be responsible for determining the level of sediment and erosion control for current and future works, and for ensuring the maintenance of existing elements.

The Shift Manager will act as the On Scene Coordinator (OSC). The OSC is the overall coordinator for the programmed or emergency works, and is responsible for on-site strategic decisions and actions throughout each phase of a response operation.

The following section outlines the roles and responsibilities of employees at the Comstock mine. This structure will be reviewed when the mine is operational, and should be considered 'recommended only' until staff response capacity is determined at the site.

4.2 RESPONSE ROLES AND RESPONSIBILITIES

Response Team

The response team will deploy the appropriate equipment under the direction of the site foreman or mine Environmental Officer.

Environmental Officer

1. Overall control of the need for programmed works and urgent / short term works as required.
2. Organises environmental, technical, administrative and logistical support for the Shift Manager (On-Scene Coordinator) and works team.
3. Informs and updates the Mine Manager of any incident.
4. Liaises with Shift Manager for programmed maintenance, new works in conjunction with required treatment and urgent works as required.
5. Ensures that an *Actions and Communication Log* is kept at the Site Office.
6. Notifies outside agencies where necessary.
7. Decides when to remove treatment elements for temporary works.
8. Files, logs and reports photographic/video material of incidents which contravene Permit discharge requirements.
9. Prepares final report on any Permit breach for ZZ.

Shift Manager (On-Scene Coordinator)

1. On-site control of programmed maintenance works.
2. Responds to actions requested by the Environmental Officer and coordinates maintenance team.
3. Ensures that an *Incident Communications Log* is kept.
4. Initial notification and classification of urgent works required.
5. Determines priorities for protection in consultation with Environmental Officer.
6. Prepares situation reports for Mine Manager (Standard Report Form attached in Appendix C- TBA).
7. Orders material consumed through the Environmental Officer.
8. Ensures that the equipment is cleaned and that replacement parts are ordered.

5 RESPONSE NOTIFICATION

Notification of programmed maintenance works or new treatment elements for future works is not required. Uncontrolled release from end of line treatment areas of either “dirty” or “contaminated” run off requires notification. This contingency covers release due to failure or due to exceeding the capacity of treatment elements under major storm events.

5.1 INITIAL ASSESSMENT

The Shift Manager must assess the initial need for urgent works and take immediate action to protect the integrity of treatment elements and the downstream environment from uncontrolled release.

The Environmental Officer must asses the release against the Permit conditions and ongoing audit requirements.

5.2 INITIAL NOTIFICATION

No later than 24 hours after becoming aware of the incident, the Shift Manager is required to notify the Comstock Mine Manager by a telephone call to the 24-hour emergency number **1800 005 171.** Additionally, the Shift Manager will submit to the Mine Manager an 'Incident Report Form' (Appendix I) by facsimile to **03 6233 3800,** or by hand delivery. The Incident Report Form will outline the nature of the release, the circumstances in which the release occurred and the action taken to deal with the release.

The Incident Report Form must be provided irrespective of whether the person responsible for the activity has reasonable grounds for believing that the incident has already come to the notice of the Director or any other officer engaged in the administration or enforcement of the *Environmental Management and Pollution Control Act 1994.*

6 OPERATIONAL PLAN

6.1 DEPLOYMENT

Reference shall be made to the Site Layout plan identifying catchments (Appendix A) and the Standard Procedure Forms (Appendix C) for treatment element types and locations.

Maintenance teams will need to be familiar with the installation requirements of all treatment elements. Subject to weather and safety conditions, the maintenance team and appropriate equipment will be mobilised upon survey and assessment of the site.

The requirements of other Plans when read in conjunction with the *Water Management Plan* are not superseded by the need to perform maintenance work.

6.2 MONITORING

The Environmental Officer shall undertake regular monitoring of the site in general and of specific installations. In particular, inspection should be made of new installations and following heavy rainfall (defined as in excess of 50mm in 6 hours, or greater than 100mm rainfall in 24 hours).

Reporting of site observations made by mine staff shall be able to be logged for action. Site toolbox and safety practice shall include an awareness of issues relating to the erosion and sediment control elements on site, and can be generalised as:

- State of road surfaces with regard to rutting and scouring, build up of fines and windrows;
- State of table drains and diversion banks with regard to scouring, sediment build up or poor function during rainfall;
- Sediment fences and pit inlet filters for integrity, sediment build up, blow out of panels or blockage;
- Stockpiles for integrity of mound, slumping or run off discharging outside sediment control measures;
- Sediment basins for build up of sediment, damage to inlet structures, quality of outflow (visibly turbid);
- Erosion rills in exposed batters to ponds and basins, cut and fill embankments.

Monitoring requirements for the treatment of acid mine drainage (AMD) are outlined in the Conceptual Water Management Model for Zeehan Zinc Ltd. These requirements will be linked to the discharge limits specified in the Permit (TBA).

Elements associated with the AMD treatment train are to be confirmed, however a regular monitoring program is applicable and will address similar issues of integrity, blockage, scour and erosion of the works.

6.3 MAINTENANCE

Maintenance shall be programmed regularly in step with the monitoring program. The need for maintenance and repair for many elements will be self evident due to the nature of the works.

Maintenance of basins will be dependant on the rate of siltation, and must be linked to a regular inspection of the depth of sediment. Sediment from basins receiving run off from areas designated as “clean” – meaning no acid generating material or adit discharge – may be disposed of without special regard to the requirements of the *Waste Rock Management Plan*.

6.4 APPLICATION OF TREATMENT

Reference is made to **Figure 2,** which describes the site in terms of catchments generating “dirty” or “contaminated” run off.

Treatment elements are generally applicable to both areas. The layout indicates the separation of catchments by drainage lines. The Plan requires that run off from one classification not be discharged to another.

New works will always require treatment for control of sediment and run off. The Plan requires that all new works consider firstly the possibility of discharging run off and sediment to the wrong area for treatment, and to incorporate treatment elements accordingly.

The layout of hardstand areas, stockpiles and new roads must recognise the importance of maintaining separate surface drainage from areas which generate sediment only, and areas which may be contaminated with acid mine drainage or weed and disease. No new works or major maintenance and repair is to commence without layout approval by the Environmental Officer.

APPENDICES

Appendix A: Mining Lease Map
Zeehan Zinc Ltd, TBA

Appendix B: Conceptual Water Management Model for Zeehan Zinc Ltd, Comstock Mine
SEMF Pty Ltd

Appendix C: Standard Procedure Forms
SEMF Pty Ltd, TBA

Appendix D: Facility Organisation Contact Details
Zeehan Zinc Ltd, TBA

Appendix A: Mining Lease Map

Zeehan Zinc Ltd, 2007

IN PROGRESS

Appendix B: Conceptual Water Management Model for Zeehan Zinc Ltd, Comstock Mine

L. Koehnknen, 2007

Conceptual Water Management Model for Zeehan Zinc Ltd, Comstock Mine - Update

27 August 2007

V1

A Report to Zeehan Zinc Ltd

L. Koehnken
Technical Advice on Water

Executive summary

Zeehan Zinc plans to source its process water from the Comstock Adit, with water surplus to requirement being discharged from the polishing pond to the environment. A process water management plan has been developed, and Zeehan Zinc has requested that the acidic water management plan developed in March 2006 be updated to reflect these changes. The company also recognises that once the mine becomes operational, discharges from the polishing pond will have to be consistent with Best Practice Environmental Management rather than the '1-pH unit deviation from upstream background levels' presently in the environmental permit.

Because of the elevated concentrations of zinc in the adit water, neutralisation to a minimum of pH 8 will be required to produce discharge water of acceptable environmental quality. The high levels of ferrous zinc in the adit discharge will require aeration after pH adjustment, and the treated water will require days to weeks to settle to ensure efficient removal of the metal hydroxides upstream of the polishing pond.

A quicklime neutralisation system is proposed for installation in the Comstock valley with dosing occurring near the mouth of the adit. There is potential for aeration of the treated water to occur as it flows down the valley towards a settling pond (or series of ponds) upstream of the polishing pond. Minimum capital costs associated with a dosing system are ~$250,000, with reagent costs for treating the adit alone estimated to be approximately $75,000 per year.

Identifying suitable locations for settling ponds, and suitable long-term storage locations for the generated sludges present the biggest challenges in implementing the system.

Diffuse acid sources on the site, including leachate from waste rock dumps, ore stock piles and storm water should be directed towards the Comstock treatment plant so that the Stage 1 tailings storage facility can remain a dry facility. Waters which cannot be directed via gravity should be collected in sumps and pumped to the Comstock treatment plant.

It is recommended that discussions begin as soon as possible with DTAE to establish the required discharge criteria for the polishing pond, that the design of future waste storage facilities include secure areas for metalliferous sludges, and that additional water flow and water quality information be collected to facilitate the design of the neutralisation circuit.

1 Introduction

In March 2006 *Technical Advice on Water* prepared a draft conceptual water management plan for Zeehan Zinc based on available information. Since that time, the process water management scheme has been advanced and it is timely to update the conceptual water management plan for acidic waters based on environmental considerations. The brief for this update also includes suggesting options for the treatment of diffuse acid drainage sources on the lease site.

Since the 1996 report, a few additional water quality samples have been collected, and in July 2007 a continuous flow and water quality monitoring site was installed at the Comstock adit discharge point. The limited flow results are insufficient to be used as the basis for flow analysis so flow estimates provided in the process water management plan (GHD) are used in this report. Average water quality results from Comstock Adit obtained since 2002 are used in the calculation of acidity loads.

2 Assumptions of water management plan

The following information was derived from the process water management plan and discussions with Zeehan Zinc, and underpins the updated acidic water management plan:

- Zeehan Zinc will recycle process water and source any make-up water from the Comstock adit;
- Mining in the Alison open pit affects water quality in the Comstock adit, so Zeehan Zinc plans on collecting and treating all water flowing from the adit to acceptable environmental standards;
- The Comstock Creek is to be diverted upstream of where the adit discharge enters the river;
- The polishing pond is to discharge into the Comstock Creek downstream of the diversion;
- Although present permit conditions require the discharge of water 'within 1 pH unit of background', Zeehan Zinc recognises that DTAE will alter those discharge conditions prior to issuing an operating permit. 'Best Practice' treatment of the water requires neutralisation to pH 7-8, followed by settling to remove zinc, lead, aluminium, iron and other metal hydroxides. It is assumed that discharge requirements issued by DTAE will be consistent with Best Practice.
- Zinc, iron and aluminium are the main contributors to acidity in the Comstock Adit water. The drop in pH of water samples following collection strongly suggests that ferrous iron is present in the adit water, which will require oxidation during water treatment;
- The tailings storage facility is a 'dry' facility which does not have the capacity to store metal-hydroxides;

- The proposed polishing pond is not to be used as a settling pond for metal hydroxides, as residence time is low and water is to be re-circulated back to the mill;
- The area between the mouth of Comstock adit and the entrance to the polishing pond (approximately 250 m in length) is available for water treatment and the temporary storage of metal hydroxide sludges; and,
- The present life of the tailings storage facility is only a couple of years. A long-term tailings storage facility is presently being designed which could have the capacity to store metal hydroxides as well as tailings and waste rock (need to consult design engineers).

3 Requirements for water treatment

Table 1 contains a summary of water quality in the Comstock Adit based on data collected over the past 5 years (March 2002 – present), showing high total suspended solids, low pH, and elevated concentrations of aluminium, iron, manganese, lead and zinc.

Table 1. Summary of water qualityy results collected from Comstock Adit March 2002 - May 2007. All metals are dissolved (<0.45µm) component.

	TSS	Alk	Acidity	pH	Al	As	Cd	Co	Cu	Fe	Mn
	mg/l	mg/l $CaCO_3$	mg/l $CaCO_3$		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Max	1020	<1	288	5.3	9.6	0.06	1.36	0.08	1.4	58.2	10.6
Med	937	<1	146	3.3	2.55	<0.01	0.027	0.06	0.004	2.74	9.35
Avg	914	<1	157	3.4	3.15	0.02	0.094	0.06	0.07	10.06	9.38
n=	22	22	22	22	22	12	22	22	22	22	22

	Ni	Pb	Zn
	mg/l	mg/l	mg/l
Max	0.17	0.56	44.8
Med	0.11	0.09	28.0
Avg	0.11	0.16	28.9
n=	22	22	22

The steps which are required to treat the adit water to acceptable standards for discharge include:

- Increasing pH levels to promote the oxidation of iron and precipitation of metal hydroxides;
- Aeration to promote the oxidation of iron and formation of iron-hydroxides;
- Storage and settling to ensure the neutralisation reaction goes to completion and metal hydroxides are removed from the water column.

Each of these steps is discussed in the following section.

4 Conceptual design of water treatment system

The components of the water treatment plan need to be completed in sequence to achieve the best environmental outcome. A conceptual design for the process includes a lime dosing plant near the Comstock Adit which doses the discharge either directly in the river channel, or in a separate mixer into which part or all of the flow is

diverted. Following dosing, the water requires aeration, which may be able to be achieved by cascading the flow down an irregular surface.. Finally the dosed and aerated water requires storage in a low energy settling pond to promote the precipitation and settlement of iron hydroxides.

4.1 Neutralisation to pH 8

The high concentration of zinc present in the Comstock Adit water necessitates neutralising the water to a pH of 8 to promote the precipitation of zinc hydroxide. The 'Best Practice' approach is to use quicklime or hydrated lime as it is an efficient and relatively inexpensive neutralising reagent which produces a stable sludge and results in low dissolved solids in the water relative to sodium based neutralising reagents. The negatives of using quicklime are that a suitable storage and mixing (slaker) system must be installed which increase upfront capital costs.

Presently, Zeehan Zinc is proposing to use sodium hydroxide to maintain discharge pH within 1 pH unit of 'background'. This is an efficient neutralisation reagent which is easy to handle (except for high freezing point), but more expensive than quicklime or hydrated lime, and results in the formation of gelatinous sludges. The use of sodium hydroxide as proposed for small pH adjustments is suitable, however, the neutralisation of all flow from the Comstock Adit using sodium hydroxide would be an expensive approach and generate higher volume sludges. The integration of a sodium hydroxide system into a lime-dosing system are discussed in Section 4.6

Capital costs associated with installation of a lime-dosing system are substantial, and can only be determined following refinement of flow estimates, acidity loads and level of mechanisation (will dosing occur in a mixer or will the river channel be used, etc). As a rough guide, a minimum of $250,000 should be assumed.

Based on the estimated average flow of 45 l/s and the average water quality shown in Table 1, it is estimated that 240 tonnes of hydrated lime per year would be required on average. At an estimated cost of $300/tonne delivered to site, average reagent costs would be ~$72,000 per year for treatment of adit water.

Actual lime reagent costs will be determined by the actual flow from the adit, the actual acidity load (which is strongly dependent on the amount of ferrous iron and zinc) and cost of lime reagent. Additional flow and water quality information, including sulphate and ferrous iron concentrations, are required to refine these estimates. The above estimate does not take into consideration the treatment of leachate or storm water from other areas of the lease site.

4.2 Aeration of dosed water

Oxidising the ferrous iron in the adit discharge is important so that the neutralisation reactions can be completed as rapidly as possible, and there is not a continual decrease in pH with time resulting in the re-release of other metals. If it is assumed that all of the total iron in the adit water is ferrous upon discharge from the adit, then 8 – 10 mg/l of oxygen is required to oxidise the average concentration of 53 mg/l. An aeration 'run' can be developed between the dosing point and the entrance to the settling pond which will provide at least some of the required aeration. To maximise aeration, a

serpentine water course should be established with a rough bed to enhance turbulence and air entrainment. If this is insufficient to introduce the required oxygen, an aeration system may need to be integrated in the system at an additional cost.

As presently planned, the Comstock adit water is to be piped from the dosing plant to the diversion dam. This will reduce aeration, and should be modified to take advantage of the gradient in the valley to promote oxidation. Alternatively, the adit water could be dosed with an oxidising agent during or following dosing, or an aeration tank could be incorporated in the system.

4.3 Settlement of metal hydroxides

The precipitation and settlement of metal hydroxides requires an extended residence time within a settling pond due to the small size of the metal hydroxides. The largest holding pond feasible should be established within the Comstock valley between the adit and polishing pond. To achieve a high rate of capture of metal hydroxides, a residence time of 1-2 weeks should be designed for, although the actual settlement time required needs to be refined through test work. Maximising the residence time of treated water in a settlement pond will reduce the risk of precipitating metal hydroxides in the polishing pond and improve discharge water quality.

Achieving retention times of this order during the winter months will be a challenge given the limited space available, and consideration should be given during the planning of the stage 2 tailings storage facility for the inclusion of a large settling pond.

If the polishing pond could be used for the settling of metal hydroxides, the volume of upstream storages could be reduced. However, this would require the identification of a long-term sludge storage facility (as the volume of the polishing pond would be insufficient to store sludges over the long-term), and the low-density sludge would need to be moved, which is an added cost.

Based on the average water quality in Table 1, and assuming a sludge density of 10% solids, a rough estimate of the sludge volume to be generated is 1,500 m^3/year to 2,000 m^3/year. This estimate assumes complete removal of iron and zinc, no removal of manganese, and does not include any gypsum formation which cannot be estimated as no sulphate analyses of the adit water are available.

4.4 Long-term storage of metal hydroxide sludges

The metal hydroxides precipitated during neutralisation need to be permanently stored in a secure environment with a pH in excess of 6.5. The Stage 1 tailings storage facility is unsuitable for long-term sludge storage as it is a dry facility. In the short term (~2 years), the sludges may be stored in the settling pond if there is sufficient volume. Longer-term, a permanent storage facility will need to be established as part of the stage 2 tailings storage facility. The identification of a suitable long-term repository for the sludges is very important and should be addressed as soon as possible.

4.5 Alternative neutralisation system

If it is found that there is insufficient space for settling ponds in the Comstock valley, a high-density sludge lime treatment system could be investigated. In these systems, lime-dosing takes place in a mixer, with the slurry reporting to a clarifier. A large portion of the lime-rich underflow from the clarifier is recirculated back to the mixer. The recirculated sludge provides surface area for the precipitation of additional metal hydroxides resulting in larger particles which settle more readily. The capital cost associated with these systems is higher than a lime dosing plant ($2,000,000+ depending on size) but the sludge that is produced settles rapidly to a higher density which makes handling and storage easier.

4.6 Integration with sodium hydroxide dosing system

In the short-term, a sodium hydroxide dosing plant will be installed near the mouth of the adit. Following diversion of Comstock Creek, the dosed water will be transported via a pipeline to aeration ponds in the Comstock Creek valley. As described in the process water management plan, the objective of this system is to adjust pH levels in the adit water to within 1-pH unit of 'background' levels. There is no consideration of the oxidation of iron or the capture and storage of any resulting metal hydroxides. Given the small size and hence short residence time of the weir ponds, it is likely that sludges will accumulate in the polishing pond, which is undesirable from a waste management perspective.

This approach may satisfy the environmental permit requirements of Zeehan Zinc as long as only 1 pH unit of adjustment is required, and the accumulation of sludges in the polishing pond is acceptable. If/when discharge criteria require neutralisation to 'Best Practice' standards (eg. pH 7-8) this system will not be suitable as:

- There is insufficient retention time in the system to allow for the neutralisation reactions and settling of metal hydroxides;
- There is insufficient holding capacity upstream of the polishing pond for the generated metal hydroxide sludges; and,
- The pipeline inhibits oxidation of ferrous iron which needs to be accomplished rapidly to ensure complete neutralisation is achieved.

Changes to the proposed sodium hydroxide dosing system which would make the system more compatible with future needs include:

- Excavating / constructing a large volume settling pond or ponds in the Comstock Creek valley rather than cascading weirs which can be used to settle and capture metal hydroxides now and into the future. This requires identification of a suitable site; and ,
- Promoting oxidation of iron immediately following dosing. This requires a re-think of the pipeline. A turbulent open flume which promoted aeration would be preferable to maximise aeration potential as the water flows down the valley (let gravity provide the energy for aeration). Alternatively, an aeration tank could be incorporated in the system.

If the system is changed to a lime-dosing plant in the future, test-work should be completed to ascertain how the two sludges will interact with respect to settling and long-term stability.

5 Treatment of diffuse acid drainage sources

There are a number of diffuse acid drainage sources on the Zeehan Zinc lease site and some point sources which are not presently being collected and treated. No detailed investigations have been completed related to these sources, but the following dot points provide some guiding principles for the management of diffuse and isolated point sources.

- The production of acid drainage should be minimised on site by not using Potentially Acid Forming rock for any construction purposes (roads, dams, etc) and all PAF rock should be encapsulated in clay lined waste rock dumps;
- Stormwater diversion drains should direct clean water away from the active mine site;
- Ore stock pile volumes should be minimised and used as soon as practicable. Guidelines for acceptable storage times should be established based on geochemical testing. If ore is to be stored for extended periods, limestone or lime should be placed over and within the stockpile to reduce acid creation. All stockpiles should be created on clay-lined and bunded pads with leachate collected and treated;
- Where possible acidic drainage originating from stock piles or waste rock dumps should be directed into limestone lined drains which report to the Comstock water treatment facility. If drainage cannot be gravity fed to the Comstock, then lined sumps should be established which are periodically pumped to the treatment facility;
- Acidic drainage should be directed away from the tailings storage facility as this is a 'dry' facility with no capacity to treat acidic waters;
- The Alison open pit drains into Comstock Adit, so acidic drainage water could be directed into the pit for eventual treatment. This approach may increase metal loads as the acid water percolates through the mine workings. It is preferable to maintain acidic drainages in lined surface drains and sumps.

6 Recommendations

The implementation of a lime dosing system in the Comstock valley between the adit and the polishing pond will fulfil the requirements of Zeehan Zinc and is consistent with Best Practice Environmental Management. To progress the implementation of such a system, the following steps are recommended:

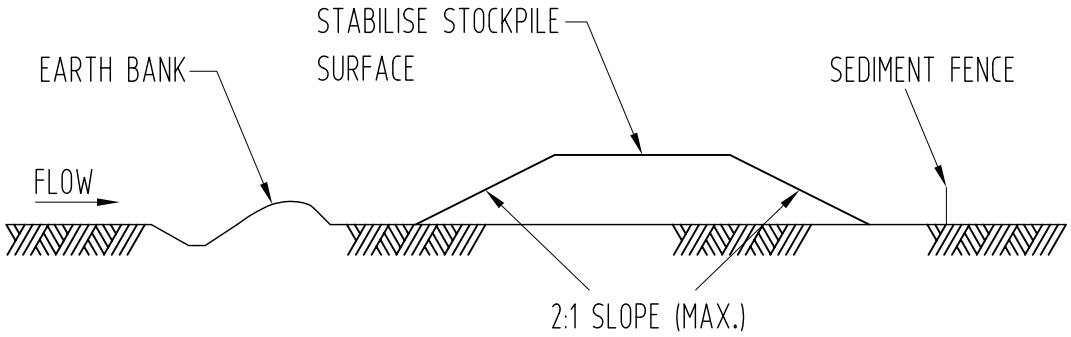
1. Discussions should be held with DTAE as soon as possible to establish the pH and metal discharge criteria for the polishing pond. This is of utmost importance as it will establish the operating parameters for the water treatment system. Until or unless these criteria are agreed upon, it is difficult to progress

planning of a water treatment system. This discussion paper has assumed that 'Best Practice Environmental Management' will be required to minimise the release of metals into the environment. This assumption underpins the shift from a sodium hydroxide to quicklime based dosing system, and has major operational and financial implications for Zeehan Zinc. This issue needs to be resolved as soon as possible;

2. The conceptual design for the lime dosing plant should be advanced by identifying potential sites for a settling pond or ponds and determining the potential volume of each pond, and identifying a suitable site for the lime dosing plant. The length and location of the aeration run between the dosing plant and settling pond should be a secondary consideration compared to the size of the settling pond;
3. The engineers designing the present and future tailings storage facility should be consulted regarding potential secure storage locations for metal hydroxide sludges in the short- and long-term;
4. Water quality analyses should include sulphate to evaluate the potential for gypsum formation during neutralisation. Ideally, ferrous iron analyses of the adit discharge should be completed to refine neutralisation reagent requirements;
5. A detailed analysis of flow from the adit should be completed to assist with the sizing of the settlement pond and estimates of reagent usage.

Appendix C: Standard Procedure Forms

SEMF Pty Ltd



STOCKPILE DETAIL

N.T.S.

USE AND PLACEMENT

1. STOCKPILES MUST BE SEGREGATED SUCH THAT STRIPPED TOPSOIL IS NOT PLACED TOGETHER WITH BULK EXCAVATION WORKS.
2. STOCKPILES OF ACID PRODUCING ROCK SHALL NOT BE LOCATED WITHIN CATCHMENT AREAS DEEMED TO GENERATE SEDIMENT-ONLY LADEN RUN OFF.
3. REFER TO THE *WASTE ROCK MANAGEMENT PLAN* FOR STORAGE AND DISPOSAL OF ACID GENERATING ROCK.

CONSTRUCTION NOTES

1. LOCATE STOCKPILE AT LEAST 5m FROM EXISTING VEGETATION, CONCENTRATED WATER FLOWS, ROADS AND HAZARD AREAS.
2. CONSTRUCT ON THE CONTOUR AS A LOW, FLAT, ELONGATED MOUND.
3. WHERE THERE IS SUFFICIENT AREA TOPSOIL STOCKPILES SHALL BE LESS THAN 2m IN HEIGHT.
4. REHABLITATE IN ACCORDANCE WITH THE DP&EMP.
5. CONSTRUCT EARTH BANK (REFER DETAIL) ON THE UPLSOPE SIDE TO DIVERT RUN OFF AROUND THE STOCKPILE AND A SEDIMENT FENCE (REFER DETAIL) 1 TO 2m DOWNSLOPE OF STOCKPILE.

REV.	DESCRIPTION	APP	DATE

SCIENTISTS ENGINEERS MANAGERS & FACILITATORS
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DRAWN	DATE	CHECKED	DATE
DESIGNED	DATE	VERIFIED	DATE

PROJECT: ZEEHAN ZINC COMSTOCK MINE

TITLE: WATER MANAGEMENT PLAN - STOCKPILES

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A4

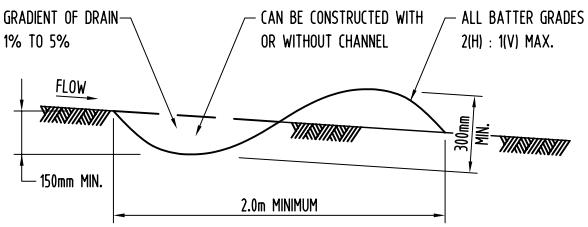
STATUS: PRELIMINARY ONLY
NOT TO BE USED FOR CONSTRUCTION

SCALE @ A4: N.T.S.

DIMENSIONS IN: MILLIMETRES

DRAWING No.: 1292.001-SK01

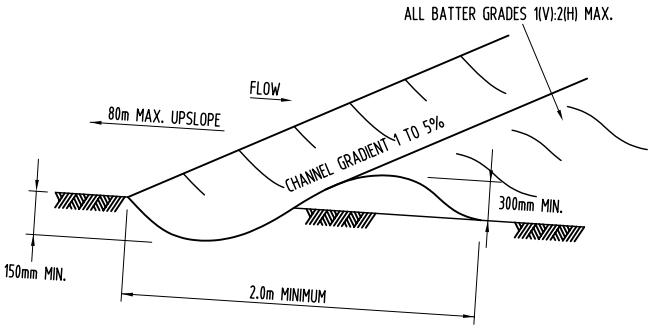
REV.: A



NOTE: ONLY TO BE USED AS TEMPORARY BANK
WHERE MAXIMUM UPSLOPE LENGTH IS 80m

EARTH BANK (LOW FLOW) DETAIL

N.T.S.



NOTE: ONLY TO BE USED AS TEMPORARY BANK
WHERE MAXIMUM UPSLOPE LENGTH IS 80m

CATCH DRAIN DETAIL

N.T.S.

USE AND PLACEMENT

1. BANKS AND DIVERSIONS ARE REQUIRED TO PROTECT STOCKPILES, EXCAVATION AND WORK AREAS FROM OVERLAND FLOW GENERATED IN UPSTREAM CATCHMENTS.
2. DIVERSIONS SHALL DISCHARGE TO EXISTING OR SPECIFICALLY CONSTRUCTED TABLE DRAINS AND SEDIMENT BASINS.
3. DRAINS SHALL NOT DISCHARGE DIRECTLY TO STREAMS OR THE SURROUNDING AREA BEYOND THE LEASE.
4. REFERENCE SHALL BE MADE TO THE OVERALL SITE PLAN DEFINING CATCHMENT BOUNDARIES. "CONTAMINATED" RUN OFF ORIGINATING FROM MINE WORKINGS, ADITS OR ORE STOCKPILES SHALL NOT BE DIRECTED TO TREATMENT AREAS FOR "DIRTY" OR SEDIMENT-ONLY RUN OFF.

CONSTRUCTION NOTES

1. CONSTRUCT WITH GRADIENT OF 1% TO 5%
2. AVOID REMOVING TREES AND SHRUBS IF POSSIBLE.
3. DRAINS TO BE CIRCULAR, PARABOLIC OR TRAPEZOIDAL CROSS SECTION, NOT V-SHAPED.
4. EARTH BANKS TO BE ADEQUATELY COMPACTED IN ORDER TO PREVENT FAILURE.
5. PERMANENT OR TEMPORARY STABILISATION OF THE EARTH BANK TO BE COMPLETED WITHIN 10 DAYS OF CONSTRUCTION.
6. ALL OUTLETS FROM DISTURBED LANDS ARE TO FEED INTO A SEDIMENT BASIN OR SIMILAR.
7. DISCHARGE RUNOFF COLLECTED FROM UNDISTURBED LANDS ONTO EITHER A STABILISED OR AN UNDISTURBED DISPOSAL SITE WITHIN THE SAME SUBCATCHMENT AREA FROM WHICH THE WATER ORIGINATED.
8. COMPACT BANK WITH A SUITABLE IMPLEMENT IN SITUATIONS WHERE THEY ARE REQUIRED TO FUNCTION FOR MORE THAN FIVE DAYS.
9. EARTH BANKS TO BE FREE OF PROJECTIONS OR OTHER IRREGULARITIES THAT WILL IMPEDE NORMAL FLOW.

REV.	DESCRIPTION	APP	DATE

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DRAWN	DATE	CHECKED	DATE
DESIGNED	DATE	VERIFIED	DATE

PROJECT: ZEEHAN ZINC COMSTOCK MINE

TITLE: WATER MANAGEMENT PLAN - DIVERSION BANKS

0

A4

STATUS: PRELIMINARY ONLY
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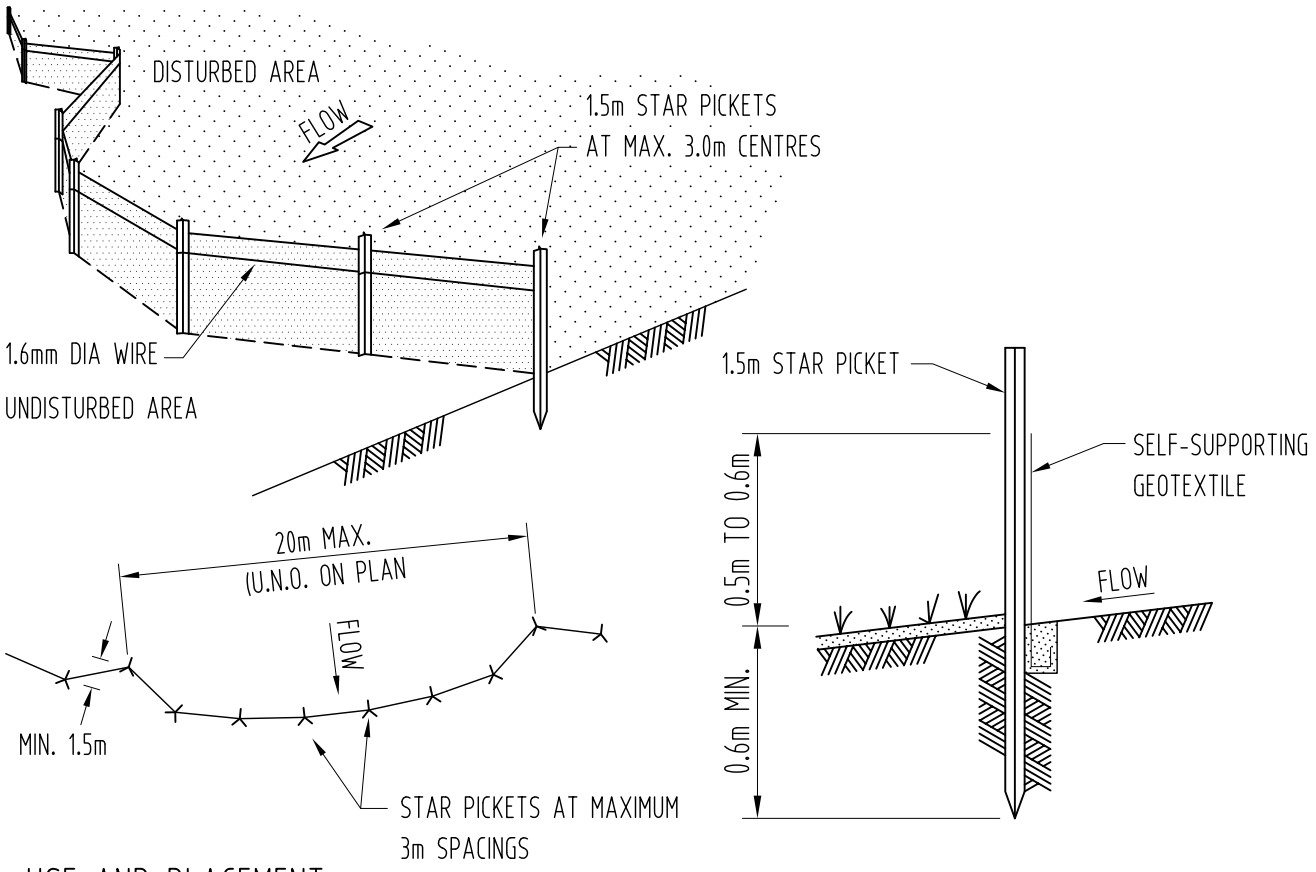
SCALE @ A4: N.T.S.

DIMENSIONS IN: MILLIMETRES

DRAWING No.: 1292.001-SK02

REV.: A



USE AND PLACEMENT

1. SEDIMENT FENCES SHALL BE PROVIDED DOWNSTREAM WHEREVER DIVERSION BANKS AND DRAINS HAVE NOT BEEN PROVIDED TO DIRECT RUN OFF FROM DISTURBED AREAS TO A SEDIMENT BASIN.
2. FENCES MAY BE USED IN CONJUNCTION WITH DIVERSION BANKS WHERE THE LENGTH BECOMES IMPRACTICAL.
3. CONCENTRATED DISCHARGE FROM TABLE DRAINS OR DIVERSION BANKS SHALL NOT BE DIRECTED TOWARDS A SEDIMENT FENCE. DISPERSAL OF THE OVERLAND FLOW IS REQUIRED BY MEANS OF LOW LEVEL LEVEE BANKS AND THE LIKE.

CONSTRUCTION NOTES

1. CONSTRUCT SEDIMENT FENCE AS CLOSE AS POSSIBLE TO PARALLEL TO THE CONTOURS OF THE SITE.
2. DRIVE 1.5m LONG STAR PICKETS INTO THE GROUND, 3m APART. PROVIDE PLASTIC CAPS TO ALL PICKETS.
3. DIG A 150mm DEEP TRENCH ALONG THE UPSLOPE LINE OF THE FENCE FOR THE BOTTOM OF THE FABRIC TO BE ENTRENCHED.
4. BACKFILL TRENCH OVER BASE FABRIC.
5. FIX SELF-SUPPORTING GEOTEXTILE TO UPSLOPE SIDE OF POSTS WITH WIRE TIES OR AS RECOMMENDED BE GEOTEXTILE MANUFACTURER.
6. JOIN SECTIONS OF FABRIC AT A SUPPORT POST WITH A 150mm OVERLAP.
7. PROVIDE WEIR OVERFLOW SECTIONS FOR DISCHARGE TO NATURAL LINES AT APPROPRIATE LOCATIONS, OR AS NOTED. WEIR TO BE A MINIMUM OF 300MM DEPTH OPENING AND 1000MM LENGTH. PROVIDE STAR PICKET SUPPORT EACH END WITH TRANSVERSE WIRE BRACING.

REV.	DESCRIPTION	APP	DATE

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DRAWN	DATE	CHECKED	DATE
DESIGNED	DATE	VERIFIED	DATE

PROJECT: ZEEHAN ZINC COMSTOCK MINE

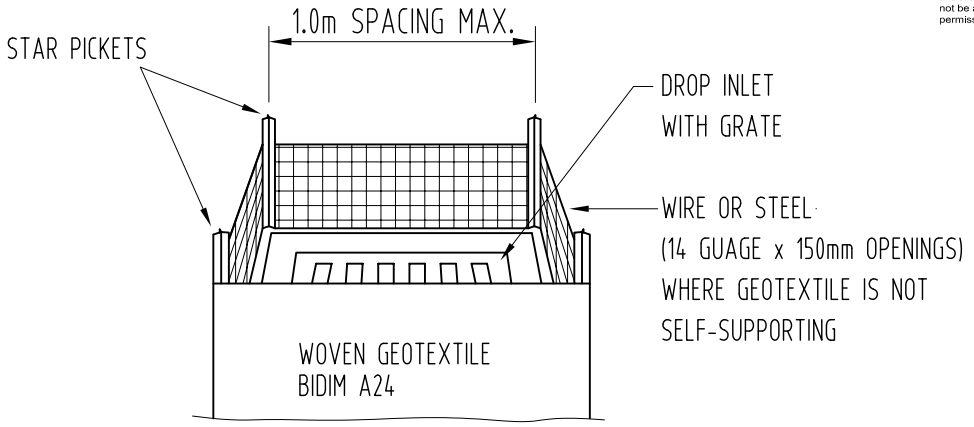
TITLE: WATER MANAGEMENT PLAN - FENCES

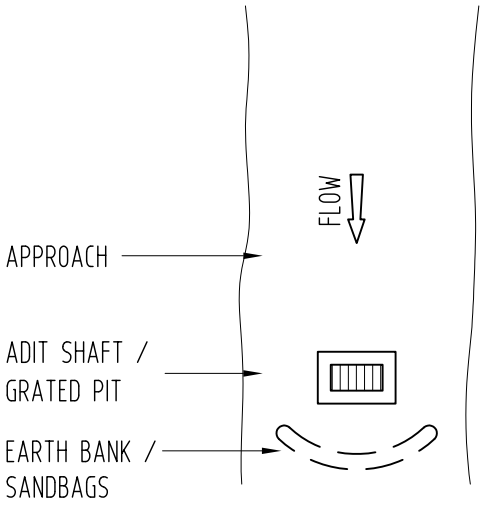
A4

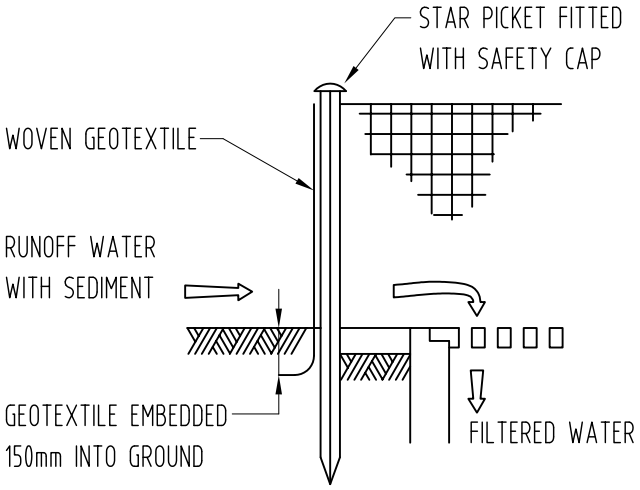
STATUS: PRELIMINARY ONLY
NOT TO BE USED FOR CONSTRUCTION

SCALE @ A4: N.T.S. DIMENSIONS IN: MILLIMETRES

DRAWING No.: 1292.001-SK03 REV.: A







USE AND PLACEMENT

1. FOR TREATMENT OF ALL SEDIMENT LADEN RUN OFF ENTERING THE ADIT OR OTHER PITS AND UNDERGROUND STRUCTURES.
2. BIDIM SHALL BE INSPECTED REGULARLY FOR BLOCKAGE, TEARING OR COLLAPSE. REPLACE REGULARLY TO ENSURE EFFECTIVENESS OF THE FILTER.
3. SEDIMENT BUILDUP AROUND THE INLET SHALL BE REMOVED REGULARLY AND DISPOSED OF IN ACCORDANCE WITH THE *WASTE ROCK MANAGEMENT PLAN*.

REV.	DESCRIPTION	APP	DATE

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DRAWN	DATE	CHECKED	DATE
DESIGNED	DATE	VERIFIED	DATE

PROJECT: ZEEHAN ZINC COMSTOCK MINE

TITLE: WATER MANAGEMENT PLAN - INLETS

0

A4

STATUS: PRELIMINARY ONLY
NOT TO BE USED FOR CONSTRUCTION

SCALE @ A4: N.T.S.

DIMENSIONS IN: MILLIMETRES

DRAWING No.: 1292.001-SK04

REV.: A

Appendix D: Facility Organisation Contact Details

Zeehan Zinc Ltd, TBA

UNDER DEVELOPMENT