Mineral Resources Tasmania

"The Rehabilitation of Abandoned Tin Mines in North Eastern Tasmania"

Summary of Works Completed

Prepared By

SCIENTISTS
ENGINEERS
MANAGERS &
FACILITATORS

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PROJECT No. 13193

The rehabilitation of abandoned tin mines in north eastern Tasmania : summary of works completed / prepared by SEMF Scientists Engineers Managers & Facilitators July 1998

TABLE OF CONTENTS

		Page
1.0	**INTRODUCTION**	**3**
2.0	**PROJECTS UNDERTAKEN**	**4**
3.0	**CONCLUSION**	**23**

APPENDICES

A Endurance Area - M3
B Monarch Area - S1.1/S2
C Information Bulletin, Rehabilitation Works at Abandoned Monarch Tin Mine Site.
D Endurance Area - N2
E Star Hill Area - S1
F Endurance N6
G Monarch Area SAPS
H Blue Lake Dam Repairs and Spillway.

1.0 INTRODUCTION

Following the establishment of the Rehabilitation of Mining Lands Trust Fund, Mineral Resources Tasmania (MRT) reviewed a number of the States abandoned mine sites and developed a priority list of sites requiring rehabilitation. The first of these sites to be addressed were the abandoned alluvial tin mines known as Monarch, Endurance and Star Hill mine, located in the north east of Tasmania.

In order to facilitate the fast, effective completion of rehabilitation activities, MRT engaged SEMF Holdings Pty Ltd (SEMF) to prepare a rehabilitation concept plan for the three mine sites. The concept plan identified and prioritised areas requiring stabilisation and rehabilitation.

Based on the findings of this report, SEMF were then commissioned to provide preliminary designs and costings for works, and undertake further investigations into areas of concern associated with the mines, such as the structural integrity of dams, water quality assessment and the net acid generation potential (NAG) of tailings.

SEMF were also engaged to prepare tender documents for rehabilitation works, provide assistance in the selection of tenders and to management projects in conjunction with MRT.

2.0 PROJECTS UNDERTAKEN

Projects involving the commissioning of reports and implementation of works were undertaken during the 1997/98 financial year to determine:

- the extent of erosion and degradation at the abandoned tin mines;
- the design and cost of stabilisation and rehabilitation works required to minimise further environmental impact on surrounding areas and to improve safety; and
- the implementation of stabilisation and rehabilitation works.

The projects have been listed below in Table 2.1 and a brief description provided in Tables 2.2 to 2.14.

Table 2.1: Summary of Projects Undertaken in 1997/98 Financial Year

A. Reports	**B. Contracts for Earthworks and Rehabilitation Services**
Stage 1, Rehabilitation Concept Plans.	Endurance Area - M3
Stage 2, Preliminary Designs and Costings.	Monarch Area - S1.1/S2
Information Bulletin, Rehabilitation Works at Abandoned Monarch Tin Mine Site.	Endurance Area - N2
Dam Inspection Report.	Star Hill Area - S1
Water Quality Assessment Report.	Endurance N6
Stage 3 - Preliminary Designs and Costings.	Monarch Area SAPS
Endurance NAG Testing.	Blue Lake Dam Repairs and Spillway.

The tables include the following types of information about each project:

- the dates works commenced and finished;
- the scope or design;
- the name of tender applicants and the successful tender;
- the progress and/or outcome of the project;
- the actual and budgeted costs;

Table 2.2: Stage 1 - Rehabilitation Concept Plans

Project Title: Rehabilitation of Abandoned Alluvial Tin Mines, Stage 1 - Rehabilitation Concept Plans	
Commencement of Works: November 1997	**Completion of Works:** November 1997
Scope/Design: Prepare rehabilitation concept plans for degraded areas at Monarch, Endurance and Star Hill mines (Stage 1), prior to the development of formal rehabilitation designs (Stage 2) and the management of rehabilitation works (Stage 3).	
Tenders: SEMF Holdings Pty Ltd (not tendered)	**Successful Tenderer:**
Progress/Outcomes of Works: The rehabilitation concept plan has been completed. Site evaluation methodology was developed to rank hazard risk according to the following criteria; vegetative cover, erosion, sedimentation, safety and acid mine drainage. Each of three mine sites (Monarch, Endurance and Star Hill) were inspected and a hazard risk rank provided. Methods were recommended for the rehabilitation of the erosional and associated depositional processes and landforms observed at the mine sites. A total of eight areas were identified as requiring immediate attention based on three criteria; initial community consultation, the existing budget and the prioritisation of areas that have the most significant environmental and public safety impacts.	
Estimated Cost of Works: $10,200	**Actual Cost of Works:** $10,500

Table 2.3: Stage 2 - Preliminary Designs and Costings

Project Title: The Rehabilitation of Abandoned Tin Mines in North Eastern Tasmania, Stage 2 - Preliminary Designs and Costings	
Commencement of Works: March 1998	**Completion of Works:** March 1998
Scope/Design: The provision of preliminary designs and costs to Mineral Resources Tasmania regarding the stabilisation and management of extensive gully systems in areas recommended in the Stage 1 report (SEMF, 1997).	
Tenders: SEMF Holdings Pty Ltd (not tendered)	**Successful Tenderer:** (not tendered)
Progress/Outcomes of Works: Preliminary designs and costs have been provided for the following areas: Endurance M3, Monarch S1.1, Monarch S2, Dam Assessment, Endurance area N2, Star Hill area S1, Star Hill area S2, and Water Quality Assessment. The type of erosion present and a breakdown of the cost was provided for each area; including the duration of works proposed, materials and equipment required, labour and supervision.	
Estimated Cost of Works: Charged on an hourly basis	**Actual Cost of Works:** $2000

Table 2.4: Endurance Area - M3

Project Title: The Rehabilitation of Abandoned Tin Mines in North Eastern Tasmania, Endurance Area - M3, Contract for Earthworks and Rehabilitation Services	
Commencement of Works: April 1998	**Completion of Works:** Partially completed, temporarily postponed due to adverse weather conditions.
Scope/Design: To rehabilitate the eroding lateral gullies of a central "Cat Creek gully system, as detailed on plan 13193prop08. These gullies present significant safety, sedimentation and erosion hazards to human users and the surrounding regenerating areas. Rehabilitation works will focus upon the construction of a perimeter catch drain (120m in length) and the preferential guidance of water flow down an existing gully utilising concrete pipework and associated flumes. The general work area will be ripped, ready for revegetation, with exposed gullies smoothed to lessen the impact of water movement, and battering to assist revegetation activities. Refer to Appendix A for design drawings. Due to the dispersibility of white kaolinite clays in the region, incorporation of gypsum is to be used to ameliorate the material and slightly raise the pH to enhance revegetation efforts.	
Tenders: Stornoway Gravel Constructions Pty Ltd Brambles Industrial Services R.G. & S.D. Gerke	**Successful Tenderer:** Stornoway Gravel Constructions Pty Ltd
Progress/Outcomes of Works: Works were completed as follows. Some clearing and grubbing was undertaken for the movement of equipment and personnel across site and in the placement of drainage works within the gully system, with the maintenance of existing pockets of vegetative along either edge of the gullies which are vital in erosion control and as a seed source for future revegetation. Any branches removed for site access were used for brushing and surface protection. Works were commenced on a 120 metre catch drain (lined with Geotextile "Bidim" A24) , to collect all sheet water flow across the western Revegetating Plain prior to it entering the lateral gullies of the M3 system and the resultant stormwater diversion pipework, (as per Drawing 13193prop09) . The onset of heavy rainfall in April 1998 made the completion of these works highly inefficient and the contract was ceased until the 1998/99 financial year. To assist in the preparation of earthworks prior to contract recommencement, the work area was contour ripped (to minimise sheet water flow) and seeded with a ryecorn/native seed mix.	
Estimated Cost of Works: $49,000	**Actual Cost of Works:** $19,853 (not completed)

Table 2.5: Monarch Area - S1.1/S2

Project Title: The Rehabilitation of Abandoned Tin Mines in North Eastern Tasmania, Monarch Area - S1.1/S2 Contract for Earth and Rehabilitation Services	
Commencement of Works: January 1998	**Completion of Works:** February 1998
Scope/Design: The stabilisation and rehabilitation of the central gully at the Monarch Mine (average dimensions 75m length by 10m width by 6m depth) located immediately below a man made dam, as detailed in drawing 13193prop01 (Appendix B). This gully presents significant safety, sedimentation and erosion hazards to human users and the surrounding environment. Rehabilitation works will focus upon the filling in the gully utilising gravel based tailings, the placement of gabions within the gully to lessen the impact of water movement, the easing of slopes and revegetation activities. Gravels for filling of the gully S1.1 and use gabions will be sourced from the adjoining gravel tailings plain S2 which contains minor clay material and little organic matter. The disturbed area will be contoured and the resultant landform ripped and left for revegetation.	
Tenders: Hazell Bros R.G. & S.D. Gerke D.J. Reid Construction Management Pty Ltd Stornoway Gravel Constructions Pty Ltd	**Successful Tenderer:** Stornoway Gravel Constructions Pty Ltd
Progress/Outcomes of Works: Works at Monarch S1.1/S2 have been completed. Clearing and grubbing was undertaken as necessary to allow for the movement of equipment and personnel across site and in the placement of tailings gravels and gabions within the gully system. Existing pockets of vegetative located along either edge of the gully were maintained, or transplanted back upon completion of works as they are vital in erosion control and as a seed source for future revegetation. Tailings were stripped from area S2, as detailed in, 13193prop0, in a manner that maximised future landform stability, visual aesthetics and the viability of existing vegetative stands. A ramp was constructed at the head of the gully system to facilitate the effective deposition of these gravels into the S1.1 gully. Earthworks within the gully focussed upon two key activities; the stabilisation of the existing gully floor and associated banks, and the placement and compaction of tailings gravels with associated gabions. Prior to the placement of tailings gravels within the creek, the existing gully floor was cleared and compacted to enable a stable base for gravel placement. The steepness of gully banks were eased and contoured to protect them from collapse. Gravel placement, compaction, and gabion and reno mattress construction were completed until the six desired levels were achieved (drawing 13193prop02). Gabion and reno mattress structures were zinc coated, PVC cased and fitted with prefabricated geoliner bags "Bidum A24" filled with clean gravel. "Enviromat" was then positioned and secured across all gabion structures to facilitate fast and effective establishment of vegetation. Refer to Appendix B for design drawings.	

Progress/Outcomes of Works (cont.): The eastern escarpment of the S1.1 gully system receives sheet water flow from the S2 area and surrounding environment. Upon completion of S1.1 gully works a catch drain was positioned along erosional channels leading to the S1.1 gully system to displace runoff water towards the northern expanse of the S2 plain. The S2 plain is to be revegetated by students from the Scottsdale High School. Refer to project titled "Information Bulletin, Rehabilitation Works at Abandoned Monarch Tin Mine Site".	
Estimated Cost of Works: $60,200	**Actual Cost of Works:** $65,887

Table 2.6: Information Bulletin

Project Title: Information Bulletin, Rehabilitation Works at Abandoned Monarch Tin Mine Site.	
Commencement of Works: April 1998	**Completion of Works:** April 1998
Scope/Design: The preparation of information bulletin to make students involved in the revegetation of the Monarch area S2 tailings outwash plain aware of the potential environmental constraints associated with the revegetation of an historically mined area (Refer to Appendix C).	
Tenders: SEMF Holdings (not tendered)	**Successful Tenderer:**
Progress/Outcomes of Works: The information bulletin was prepared for the rehabilitation works at Monarch area S2. It included background information about the site, what rehabilitation works were proposed, a description of other stabilisation and rehabilitation works being undertaken at Monarch mine, and problems associated with the rehabilitation of mine sites. The bulletin was provided to relevant teachers at Scottsdale High School for comment. It is intended that students will conduct trials with the propagation of selected plant species, direct seeding and planting of seedlings, as well as fertiliser and gypsum trials (Appendix C).	
Estimated Cost of Works: Charged on an hourly basis.	**Actual Cost of Works:** $1590

Table 2.7: Dam Inspection Report

Project Title: The Rehabilitation of Abandoned Tin Mines in North Eastern Tasmania, Dam Inspection Reports	
Commencement of Works: March 1998	**Completion of Works:** March 1998
Scope/Design: The dam inspection reports involved the inspection and reporting on the size and condition of several dams and remnant dam walls situated near Gladstone, NE Tasmania. These included; five dams at Star Hill mine, one at Monarch Mine, Little Blue Lake, and two remnant dam walls. Recommendations were to be provided based on these observations for the stabilisation of these structures and associated preliminary cost estimates.	
Tenders: SEMF Holdings Pty Ltd (not tendered)	**Successful Tenderer:**
Progress/Outcomes of Works: The inspection was undertaken and the resulting report concluded that initial work was required on Little Blue Lake dam and on Star Hill 2, 4, 5 and 6 with future work to be considered on all the dams. Preliminary cost estimates were prepared for the urgent repair of scouring on some dams and for a spillway on Little Blue Lake. An assessment report was also included in the report appendix regarding the condition of bridges over cat gully, the water race at Blue Lake, and one bridge from Endurance south to Mt Cameron.	
Estimated Cost of Works: $4200	**Actual Cost of Works:** $4200

Table 2.8: Endurance Area, N2

Project Title: The Rehabilitation of Abandoned Tin Mines in North Eastern Tasmania, Endurance Area - N2, Contract for Earthworks and Rehabilitation Services.	
Commencement of Works: February 1998	**Completion of Works:** May 1998
Scope/Design: The stabilisation and rehabilitation of two actively eroding Kaolinite clay gully systems, N2(c) and N2(d) at Endurance mine, as detailed on plan 13193prop06 (Appendix D). N2(a) was a more stable gravel tailings area, Gully N2(b) was on average 75m wide by approximately 675m long; Gully N2(c) was on average 50m wide by approximately 450m long; and Gully N2(d) was on average 75m wide by approximately 225m long. These gullies presented significant safety, sedimentation and erosion hazards to human users and the surrounding regenerating areas. Rehabilitation works focussed upon the partial filling in of the gullies utilising gravel based tailings, the placement of gabions within two of the gullies to lessen the impact of water movement, and the battering of side slopes and revegetation activities.	
Tenders: Stornoway Gravel Constructions Pty Ltd Brambles Industrial Services R.G. & S.D. Gerke Hine Hancock	**Successful Tenderer:** Stornoway Gravel Constructions Pty Ltd
Progress/Outcomes of Works: Works have been completed at Endurance area N2, as detailed below. <u>Gullies N2(c) and N2(d)</u> Earthworks within the gully focused upon three key activities; the stabilisation of the existing gully floor and associated side batters, the placement and compaction of tailings gravels with associated gabions, and the mixing of gypsum into any exposed surface layers of kaolinite clay. During the completion of each terrace and gabion weir adjacent gully banks were contoured and battered to the sides of the gravel base and associated gabion and reno mattress structures (section A drawing 13193prop07) to minimise slope angle and the associated velocity of water movement. The water carrying section of each of the three gullies was lined with gravels, then covered with "Enviromat" between each gabion. Fewer gabions were constructed than detailed in the design in order to minimise costs. Any sub surface clays were treated with gypsum. Where remnant vegetative stands occurred, contour activities were minimised so as to protect and promote vegetative establishment and brushing was applied to exposed banks. <u>Gully N2(d)</u> The treatment of this third gully system was similar to the above, fewer gabion structures were constructed. In this case, the gully walls were battered down while preserving as much remnant vegetation as possible.	

Progress/Outcomes of Works (Cont.): Upon completion of the N2 gully works, ripping was positioned around the gully to displace runoff water towards a proficient, stabilised gully head discharge, and disturbed areas where contoured ripped or scarified to allow for the fast and effective development of vegetation. Jute thick mat was layed across the entire N(c) works are to assist in revegetation and prevent erosion. This matting was subsequently sowed with ryecorn and a native seed mix.	
Estimated Cost of Works: $49,000	**Actual Cost of Works:** $56,150

Table 2.9: Star Hill Area S1

Project Title: The Rehabilitation of Abandoned Tin Mines in North Eastern Tasmania, Star Hill Area - S1 Contract for Earthwork and Rehabilitation Services.	
Commencement of Works: February 1998	**Completion of Works:**
Scope/Design: The stabilisation and rehabilitation of Star Hill area S1, a basin of highly friable sands, which has resulted from extensive alluvial extraction activities. The landform can be considered to be slowly stabilising itself into a shallow lake depression. Earthwork activities were to be undertaken to lessen the steepness of perimeter banks, promote revegetation and increase water retention (and resultant wetland development). These activities would also significantly assist the aesthetic and environmental benefits of the area, whilst leaving behind a remnant landscape of mining history. Refer Appendix E for design drawings.	
Tenders: R.G. & S.D. Gerke (Jaignee Holdings Pty Ltd) D.J. Reid Construction Stornoway Gravel Construction Pty Ltd Hine Hancock	**Successful Tenderer:** R.G. & S.D. Gerke
Progress/Outcomes of Works: Works have been completed at Star Hill area S1 as detailed below. The largest component of Star Hill works centred upon contour ripping approximately 35,260 m^2 of sand based soils, as detailed in drawing 13193prop3. Minor clearing activities were required for the movement of equipment and personnel across site during the recontouring and ripping of the site and in the placement of gabions within the basin system. Prior to ripping and levelling activities mining artefacts were marked out for preservation and where required relocated. Pockets of established vegetation were also marked out across the S1 basin for protection. In addition, significant landforms were contoured or scarified to provide a more stable, smoother landform. Benches were placed on all exposed slopes exceeding 4 metres in height within the S1 basin, as per details 1, 2 and 5 in drawing 13193prop04. Benches were scarified and upslope faces battered, to help vegetation establish by collecting sloughing soil, seed and fertiliser. Gabion/reno mattress structures were originally planned to be positioned along existing drainage lines at the narrowest section between the vegetative island and basin wall. These structures were deemed not necessary due to the gently sloping topographic conditions (0.2-2.4%). The exposed remnant summer base of the existing wetland was compacted and trimmed as per drawing 13193prop03 (schematic) and detail 3 and 4 drawing 13193prop04 to achieve the desired final size (12,450m2) and form. Outcrops of remnant soil/subsoil (over 3.5 metres height and 6 metres width) within the wetland design were scarified and terraced as shown in detail 1 or 2 of 13193prop4 to form vegetated islands within the wetland system. Clay was tested for suitability prior to placement for use as the wetland base.	

Progress/Outcomes of Works (cont.): Pockets of existing vegetation were maintained during the implementation of all of these activities, as they are vital in erosion control and as a seed source for future revegetation and grubbed vegetation was placed on excavated batters. All drawings are provided in Appendix E.

Estimated Cost of Works: $29,500	**Actual Cost of Works:** $27,344

Table 2.10: Water Quality Assessment Report

Project Title: The Rehabilitation of Abandoned Tin Mines in North Eastern Tasmania, Water Quality Assessment Report	
Commencement of Works: January 1998	**Completion of Works:** February 1998
Scope/Design: A one off sampling program to assess the quality of water over all accessible lakes and watercourses in the vicinity of the three mines, Monarch, Star Hill and Endurance. The results of the sampling program would be used to determine whether any harmful metals were present in soluble form, and if so in what concentrations. These results ultimately were used to determine whether these lakes are suitable for recreational and drinking water purposes.	
Tenders: SEMF Holdings Pty Ltd (not tendered)	**Successful Tenderer:** (not tendered)
Progress/Outcomes of Works: The water quality assessment report has been completed. It incorporated the following aspects: • an historical review of sample information and regional hydrology; • flow rate calculations of streams and discharges, taken from site measurements, and database information on NE Tasmania; • calculations of mass loading aluminium (the dominant contaminant) in solution within relevant streams and discharge sources; and • comparison of analysis results against relevant guidelines. Lakes, dams, lagoons and sediment retention basins within the vicinity of the three mines were found to contain the highest levels of aluminium and tin in the region. The removal of 80% of the aluminium and 55% of the tin from solution within acid streams was recommended via the implementation of a successive alkalinity producing wetland system. In addition, the slight raising of pH of soils in disturbed areas was also recommended for the enhancement of revegetation. As a precautionary measure, it was recommended that warning signs be erected.	
Estimated Cost of Works: $4100 plus Laboratory costs ($2450)	**Actual Cost of Works:** $4100 plus Laboratory costs ($2450)

Table 2.11: Stage 3 - Preliminary Designs and Costings

Project Title: The Rehabilitation of Abandoned Tin Mines in North Eastern Tasmania, Stage 3 - Preliminary Designs and Costings	
Commencement of Works: March 1998	**Completion of Works:** Work in Progress
Scope/Design: The provision of preliminary costs to Mineral Resources Tasmania (MRT) for the rehabilitation of areas of the abandoned tin mines in north eastern Tasmania as identified in the joint MRT/SEMF meeting (19/3/98).	
Tenders: SEMF Holdings Pty Ltd (not tendered)	**Successful Tenderer:**
Progress/Outcomes of Works: Preliminary designs and costings were provided for the following areas; Endurance N6, Endurance M4/M5, Monarch area Successive Alkalinity Producing System (SAPS), test pits (Endurance) and dam designs. A breakdown of the costing was provided, including the works required, costs of materials and duration of works. The projects were then prioritised with respect to the budget.	
Estimated Cost of Works: Charged on an hourly basis	**Actual Cost of Works:** $2000

Table 2.12: Monarch Area SAPS

Project Title: The Rehabilitation of Abandoned Tin Mines in North Eastern Tasmania, Monarch Area SAPS Contract for Earthwork and Rehabilitation Services.	
Commencement of Works: March 1998	**Completion of Works:** March 1998
Scope/Design: The construction of a Trial Successive Alkalinity Producing System (SAPS) at the Monarch M1 tailings outwash fan. The SAPS was designed to treat a 2.5-3.2 l/second flow from the Monarch central stream, by removing high volumes of Aluminium from solution and raising of the pH of discharge waters. Testing/monitoring of the trial system was also to be undertaken to prove the viability/effectiveness of the system.	
Tenders: SEMF Holdings Pty Ltd (not tendered)	**Successful Tenderer:** (not tendered)
Progress/Outcomes of Works: A trial SAPS was constructed by excavation, approximately 25m length by 4m width in area and 1.5 metres depth. The trench was lined with an approved Geotextile to prevent subsurface water ingress, pipework was installed and the treatment areas of the system were divided using gabions and reno mattresses. The system comprised 5 metre precipitation zone, 10 metres of anoxic limestone drainage, with organic cover and 10 metres of a filtered activated organic matrix. The SAPS is currently being sampled on a monthly basis. Quarterly results show a marked reduction in aluminium (39%) and a increase in pH. Works still in progress.	
Estimated Cost of Works: $19,500	**Actual Cost of Works:** $25,712

Table 2.13: Endurance NAG Testing

Project Title: Endurance NAG Testing	
Commencement of Works: June 1998	**Completion of Works:** July 1998
Scope/Design: Extract sub surface tailings samples from the South Western Tailings Fan at the Endurance mine. Analyse these samples for Net Acid Generating Potential and make a generalised determination on the impact of acid generation (if any).	
Tenders: SEMF Holdings Pty Ltd (not tendered)	**Successful Tenderer:** (not tendered)
Progress/Outcomes of Works: Sampling completed sucessfully and samples submitted to DELM Laboratories for analysis June 1998. (Works in Progress).	
Estimated Cost of Works: $1800 Report, $1500 Laboratory Costs	**Actual Cost of Works:**

Table 2.14: Blue Lake Dam Repairs and Spillway

Project Title: Blue Lake Dam Repairs and Spillway	
Commencement of Works: April 1998	**Completion of Works:** May 1998
Scope/Design: The stabilisation of the scoured areas of the dam wall, repair of the leaking scour pipe that is built into the dam wall and construction of a spillway to lower the water level in the dam.	
Tenders: Stornoway Gravel Constructions Pty Ltd (not tendered)	**Successful Tenderer:**
Progress/Outcomes of Works: Works have been completed at Blue Lake Dam. They included the construction of a rock lined spillway, repair of scoured areas of the dam wall using clays and grouting of the scour pipe in the base of the dam wall to prevent leakage.	
Estimated Cost of Works: $28,800	**Actual Cost of Works:** $17,852

3.0 CONCLUSION

All of the stabilisation and rehabilitation projects associated with the Monarch, Endurance and Star Hill abandoned alluvial tin mines, as detailed in the preceding summaries, have been completed and have typically come in on, or under, budget. The exception being the Endurance M3 which was postponed part way through the implementation of works due to adverse weather conditions.

Further stabilisation and rehabilitation works are proposed for the three mine sites for the 1998/99 financial year. The proposed works have been prioritised below and a brief description provided:

1 **Endurance, Ruby Creek SAPS**
A full scale successive alkalinity producing system should be developed at the Ruby Creek area at Endurance Mine.

2 **Endurance M3**
The Endurance M3 stabilisation and rehabilitation works of highly eroded gully systems off the main Cat Gully system were commenced in 1997/98, but due to adverse weather conditions, were postponed until drier periods. These works should be completed during the 1998/99 financial year.

3 **Monarch Area SAPS**
Water quality monitoring results indicate that the trial successive alkalinity producing system developed at the Monarch site is operating effectively. It is proposed that the system be expanded to cope with the quantity of stormwater run-off from the Monarch tailings area.

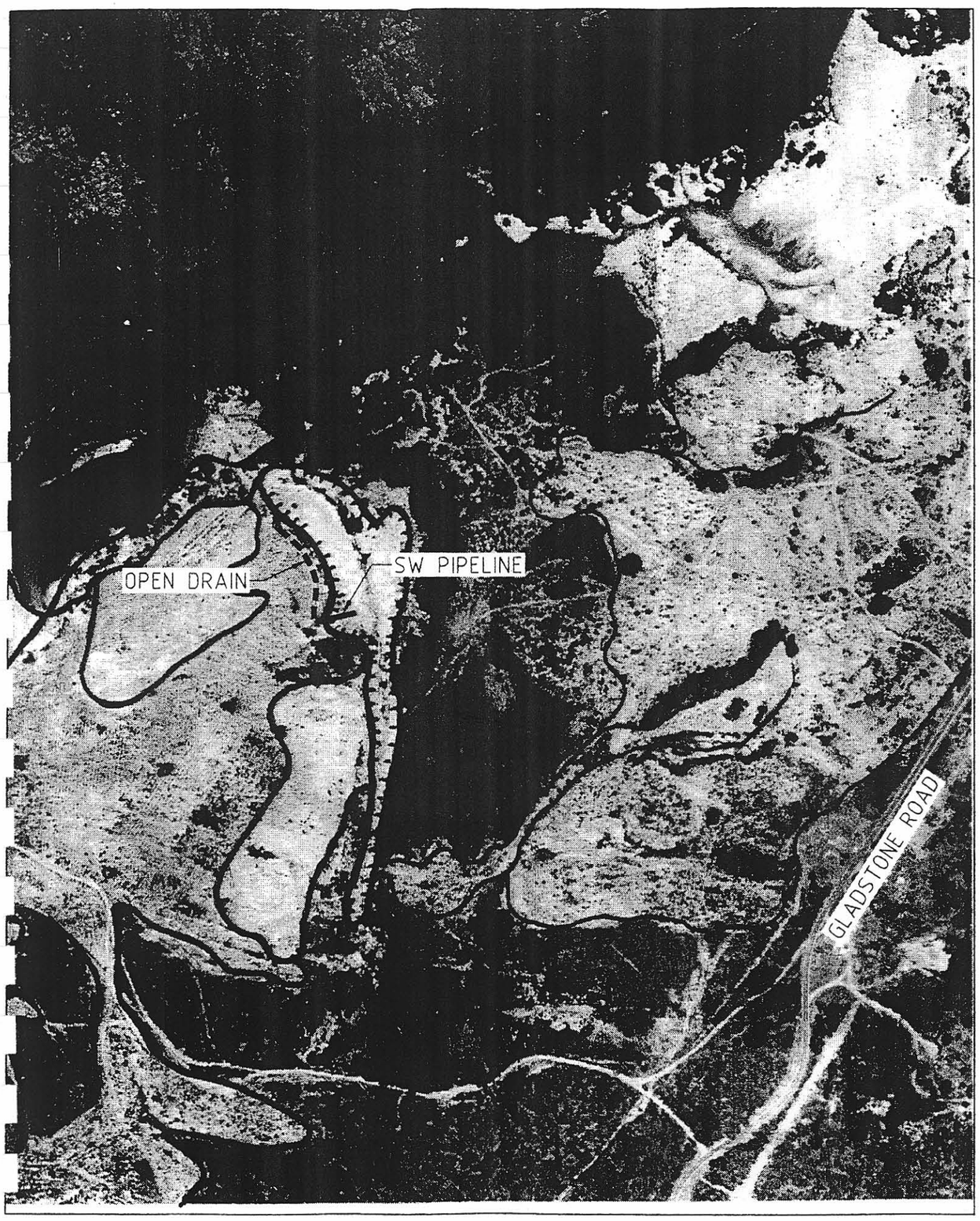
4 **Monarch Revegetation**
Direct seeding and planting rehabilitation trials with selected gypsum and fertiliser applications should be undertaken at Monarch Mine by Students from Scottsdale High School as part of their curriculum.

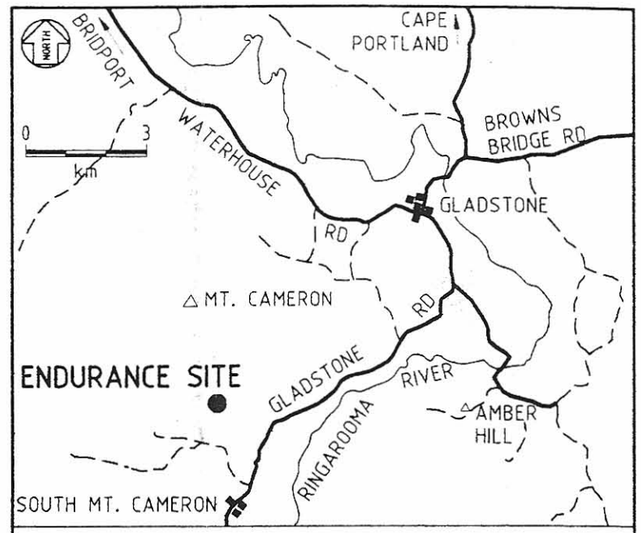
No other broad acre rehabilitation trials should be undertaken at any of the three mine sites until the toxic effects of tailings have been determined. A research project is currently being established.

5 **Star Hill Dam Works**
Dam works at Star Hill mine should be undertaken, as identified in the Dam Inspection Report. These works include the repair of a scoured spillway known as Star Hill 2, and scour to dam walls known as Star Hill 4, 5 and 6.

APPENDIX A

Endurance area M3
13139prop08





LOCATION PLAN

5 cm

			DRAWING CHECK		CO-ORDINATION CHECK	
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			DESIGNED (ENG.):		MECHANICAL (RE):	
			CHECKED (SUP. DO):		ELECTRICAL (RE):	
23.	ISSUED FOR TENDER		APPROVED BY (RE):		CIVIL/ENV. (RE):	
13.	PRELIMINARY ONLY					
DATE	DESCRIPTION	P.E.				

SEMF SCIENTISTS ENGINEERS MANAGERS & FACILITATORS

MINERAL RESOURCES TASMANIA

NORTH EAST MINES SITE REHABILITATION

ENDURANCE TENDER
LOCATION & LAYOUT PLANS

A3

SCALE: N.T.S.

DIMENSIONS IN METRES

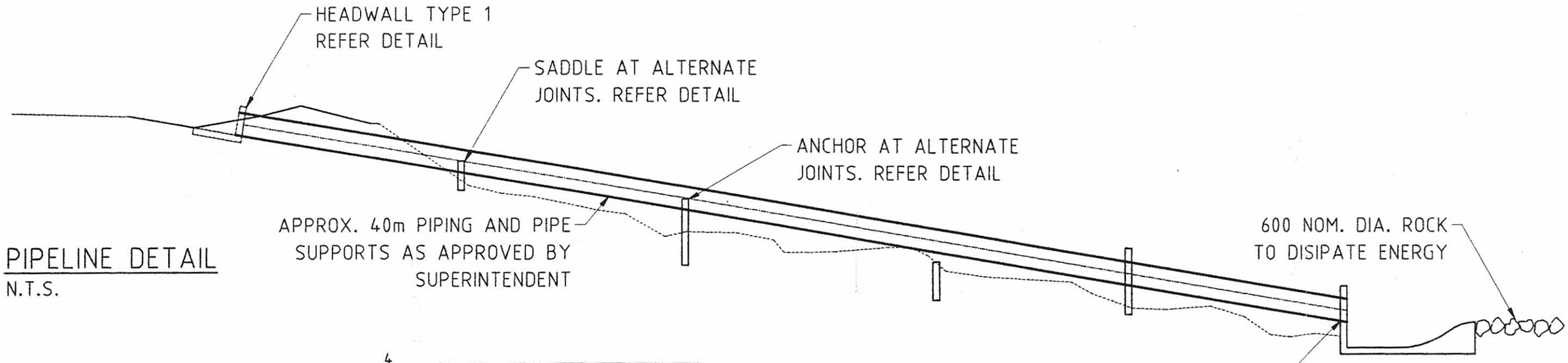
CAD FILE NO. & PLOT SCALE:

DRG. No. 13193\PROP08

REV. B

APPENDIX B

Monarch area S1.1/S2
13193prop01
13193propr02



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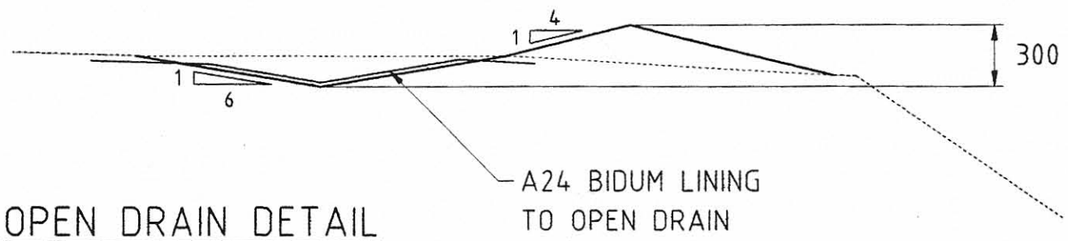

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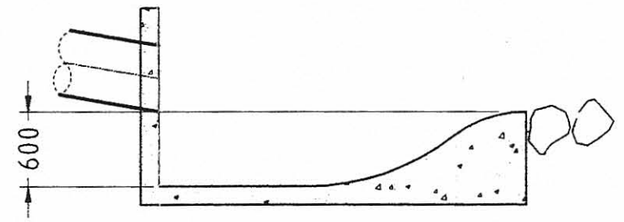

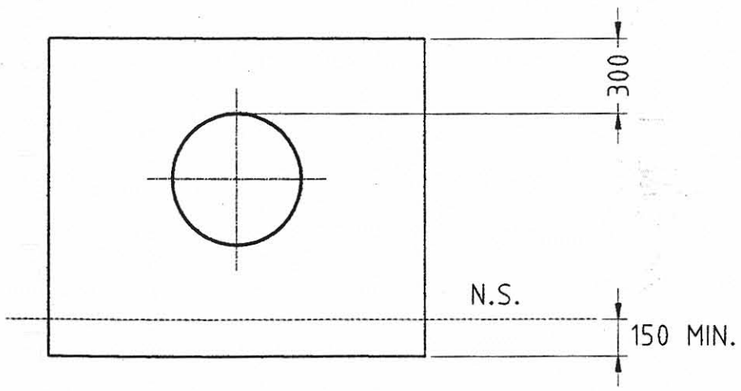

ANCHOR DETAIL
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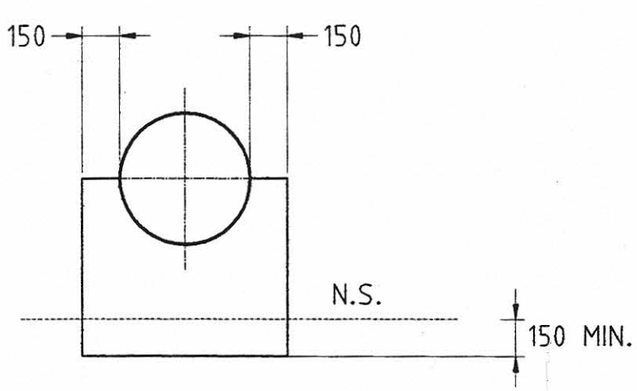
Y12 - 300 E.W. CENTRAL



SADDLE DETAIL
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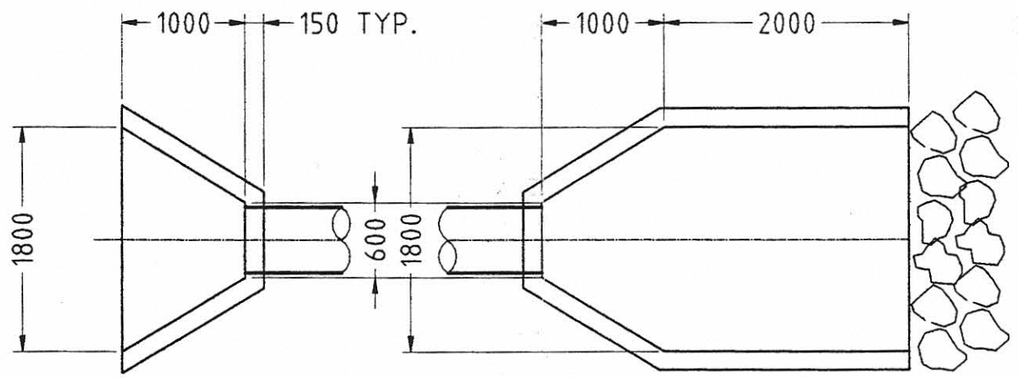
150 THK.
Y12 - 300 E.W. CENTRAL



HEADWALL TYPE 1
SCALE 1:50
150 THK.
Y12 - 300 E.W. CENTRAL

HEADWALL TYPE 1
SCALE 1:50
150 THK.
Y12 - 300 E.W. CENTRAL

5 cm

			DRAWING CHECK	SIGNATURE	DATE	CO-ORDINATION CHECK	SIGNATURE / DATE
2	ISSUED FOR TENDER		DRAWN (DO):	A.N.R.	26.2.98	STRUCTURAL (RE)	
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DATE	DESCRIPTION	P.E.	CHECKED (SUP. DO):			ELECTRICAL (RE)	
			APPROVED BY (RE):			CIVIL/ENV. (RE)	

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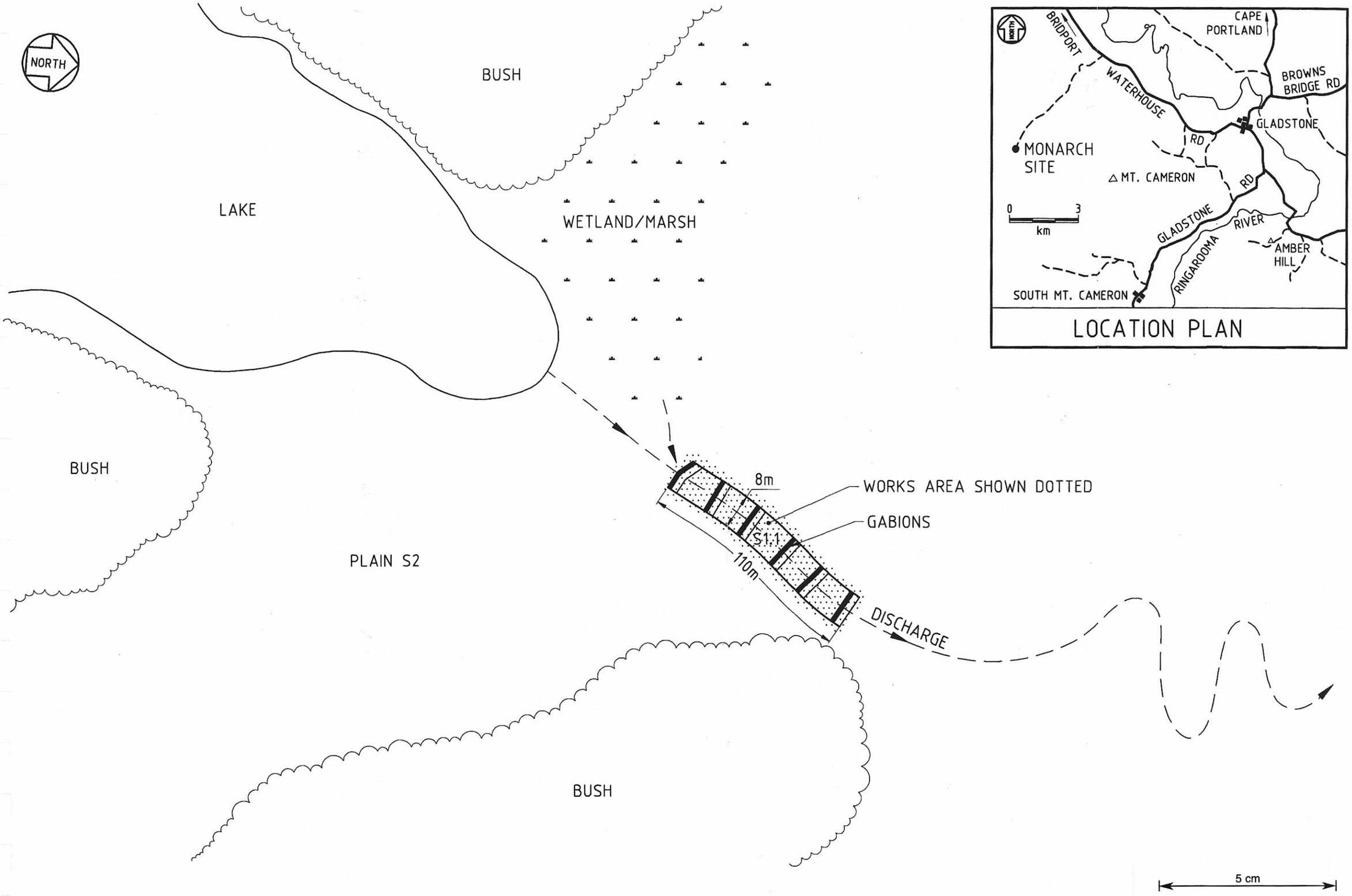
45 Murray Street, Hobart Tasmania 7000
Tel. (03) 6231 1291
Fax. (03) 6234 8709
E-mail: smf@smf.com.au
67 Cameron Street, Launceston Tasmania, 7250
Tel. (03) 6334 2999
Fax. (03) 6334 3260
E-mail: launceston@smf.com.au

MINERAL RESOURCES TASMANIA

NORTN EAST MINES SITE REHABILITATION
ENDURANCE TENDER
PIPEWORK DETAILS

A3
SCALE: N.T.S.
DIMENSIONS IN MILLIMETRES
CAD FILE NO. & PLOT SCALE MRT\13193\PROP\PROP09.....N.T.S
DRG. No. 13193\PROP09
REV. B



LOCATION PLAN

REV.	DATE	DESCRIPTION	P.E.
B	7.98	PRELIMINARY ONLY	
A	.98	PRELIMINARY ONLY	

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CHECKED (SUP. DO):		
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CO-ORDINATION CHECK	SIGNATURE	DATE
STRUCTURAL (RE)		
MECHANICAL (RE)		
ELECTRICAL (RE)		
CIVIL/ENV. (RE)		

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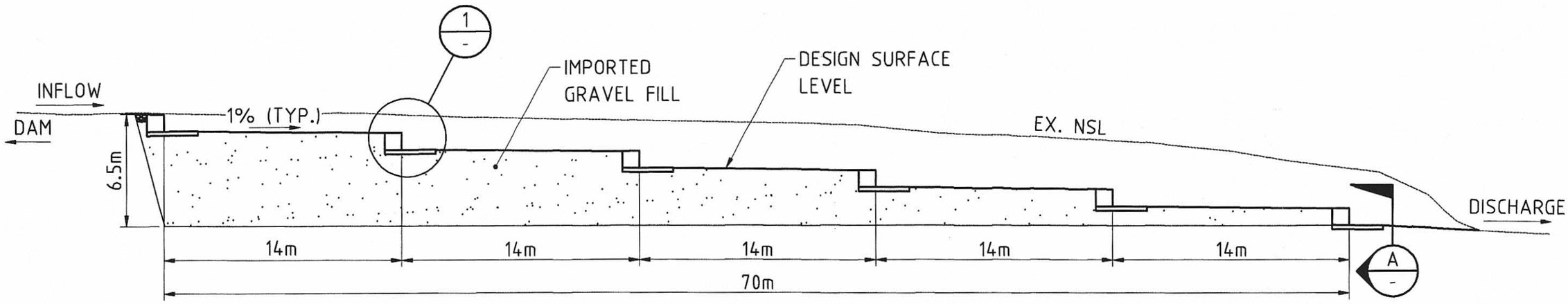
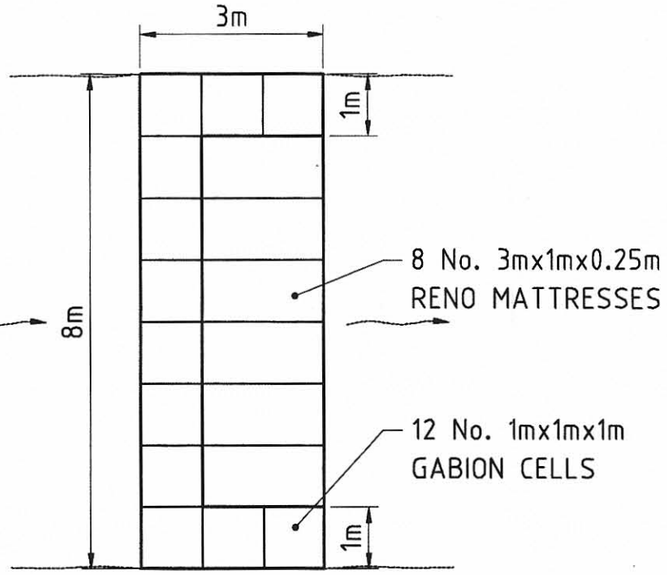
45 Murray Street, Hobart Tasmania, 7001
Tel. (03) 6231 1211
Fax. (03) 6234 8789
E-mail. semf@semf.com.au
47 Cameron Street, Launceston Tasmania, 7250
Tel. (03) 6334 2899
Fax. (03) 6334 3269
E-mail. launceston@semf.com.au

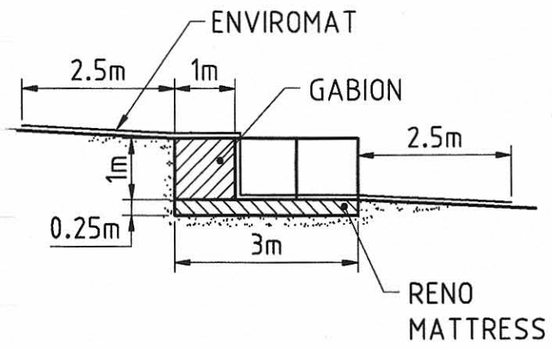
NORTH EAST MINES SITE REHABILITATION
LOCATION AND LAYOUT PLAN

A3
SCALE: N.T.S.
DIMENSIONS IN MILLIMETRES
CAD FILE NO. & PLOT SCALE \NE-MINES\13193\PROP01...1:1
DRG. No. 13193\PROP01
REV. B

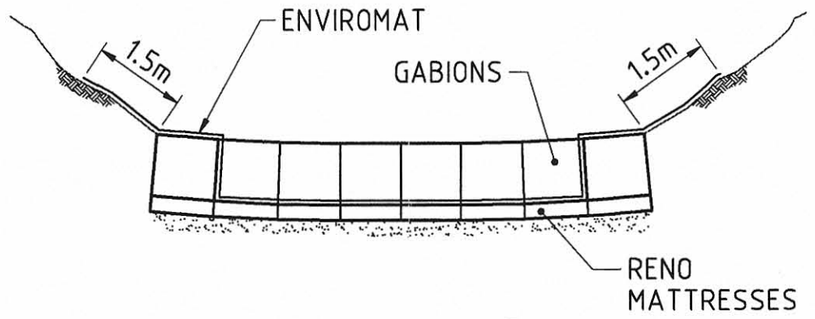


LONGITUDINAL SECTION





DETAIL 1 / - 1:100



SECTION A / - 1:100

PLAN

GABION/RENO MATTRESS LAYOUT

SCALE 1:100

5 cm

REV.	DATE	DESCRIPTION	P.E.
A	1.98	PRELIMINARY ONLY	

DRAWING CHECK	SIGNATURE	DATE
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DESIGNED (ENG.):		
CHECKED (SUP. DO):		
APPROVED BY (RE):		

CO-ORDINATION CHECK	SIGNATURE	DATE
STRUCTURAL (RE)		
MECHANICAL (RE)		
ELECTRICAL (RE)		
CIVIL/ENV. (RE)		

SEMF
SCIENTISTS
ENGINEERS
MANAGERS &
FACILITATORS
45 Murray Street, Hobart
Tasmania, 7000
Tel. (03) 6231 1211
Fax. (03) 6234 0799
E-mail: semf@semf.com.au
47 Cameron Street, Launceston
Tasmania, 7250
Tel. (03) 6334 3099
Fax. (03) 6334 3269
E-mail: launceston@semf.com.au

NORTH EAST MINES SITE REHABILITATION

SECTIONS & DETAILS

A3

SCALE: 1:250 U.N.O

DIMENSIONS IN METRES

CAD FILE NO. & PLOT SCALE \NE-MINES\13193\PROP02...1:250

DRG. No. 13193\PROP02

REV. A

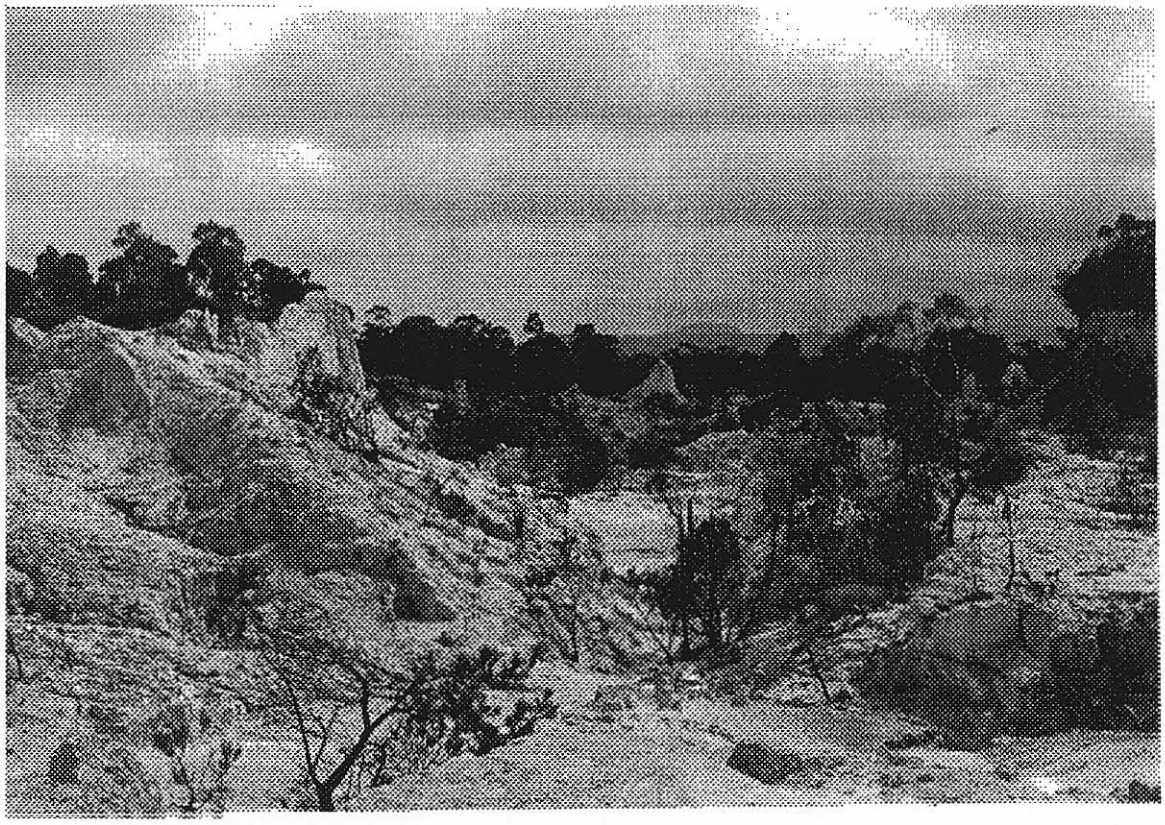
APPENDIX C

Information Bulletin: Rehabilitation Works at Abandoned Monarch Tin Mine Site

❖ Information Bulletin ❖

Volume 1 Issue 1 April 1998

Rehabilitation Works at Abandoned Monarch Tin Mine Site



Inside This Issue:

Background
What is Proposed?
Recent Stabilisation Works Undertaken
Problems Associated With the Rehabilitation of Mine Sites

Background

The Abandoned Monarch Tin Mine site is situated approximately 8 kilometres due west of Gladstone. Alluvial tin mining was conducted at the site using high pressure hoses to losen material from an exposed face. The dislodged material was then passed through a race, or other form of gravity separation unit, to differentiate tin metal from other composite materials. The outwash tailings material settled out downslope of the mining process essentially covering the site which is now observed as a barren landscape.

What is Proposed?

It is proposed that an area of the mine site, which has remained unvegetated since tin mining ceased at the site in the early 1980's will be rehabilitated with the assistance of Scottsdale High School Students.

The long term exposure of the site to the elements has resulted in considerable erosion impacting on the area. In light of this, the area has been recontoured to provide a more uniform surface for planting.

The primary objective of rehabilitation works at this site will therefore be the creation of a stable and self-sustaining community of native plants that are similar to those in surrounding bushland. The establishment of a good vegetative cover should in turn minimise potential soil erosion and sedimentation.
Rehabilitation works will involve the sowing seed of selected native plant species and the propogation of some species for future plantings.

Trials will be established to compare the success of plantings with different fertiliser application rates. The fertiliser to be utilised at this site is an inorganic N:P:K fertiliser, ratio 10:17:8. Although native plant species have adapted to low nutrient levels in Australian soils, a high nutrient fertiliser will be used to encourage improved early growth and provide a better chance of successful establishment.

In addition, gypsum will be applied to improve the soil structure in these heavy clay soils. Improved soil structure should provide a better plant growing media by allowing for greater water infiltration, root penetration, and soil aeration.

Recent Stabilisation Works Undertaken

A significant area of gully erosion at the abandoned Monarch Tin Mine site has recently been stabilised using gabions systems to lessen the gradient of the watercourse established within the gully. This lessening of slope should result in a slowing of flow, and reduce the potential for future erosion. This area will be revegetated to further stabilise the modified area. Additional material for these works were sourced from a disturbed area that is now proposed for rehabilitation.

Problems Associated With Mine Site Rehabilitation

Many interacting factors may exist at the Monarch mine site which have prevented revegetation of disturbed areas. The main factors may be related to soil properties, for example:

- soil texture and structure;
- water holding capacity;
- surface instability and erodibility;
- nutrient defficiency; and
- general lack of organic material.

Or climatic aspects such as:

- ground surface temperatures;
- the irregularity of rainfall; and
- wind induced damage.

Mine specific issues such as the pH of the soil material and the availability of heavy metals are also major factors that may impact on the effectiveness of plant establishment.

These interrelating factors have been discussed further below.

Soil Texture and Structure
The alluvial mining techniques used at the Monarch site, are likely to have resulted in well sorted outwash tailings material settling out down slope of the mine operation. The similar sized soil particles that form what is now the soil material is unlikely to allow for good aeration or infiltration of water which are essential for plant growth.

Water Holding Capacity
The heavy clay soils in the region tend to have a very low porosity and are impervious to water. Given these properties, root penetration tends to be impeded, make plant establishment difficult. The material in the actual rehabilitation area, however, has a higher gravel content which may result in more rapid drainage and drought stress to plants.

Surface Instability and Erodibility
The outwash tailings material is highly erodible due to its high kaolinitic clay and gravel content, and the unstable landforms that have resulted.

It should be noted that kaolinitic clays are typically very dispersive (ie. they break up and remain in suspension when wetted making them prone to erosion, such as gully, sheet or rill erosion).

Nutrient Deficiency
In addition, the tailings are likely to be lacking in essential plant nutrients and microbial organisms which are advantageous for plant growth. For example, koalinitic clays tend to be low in micronutrient potassium, but relatively high in macronutrient phosphorus.

Lack of Organic Material
The outwash tailings material which now covers the site is low in organic matter and lacking in topsoil.

Ground Surface Temperatures
The very light colour of the outwash material may also reflect high levels of light and temperature causing physiological stress to the vegetation (ie. plant damage).

Irregularity of Rainfall
The relatively low and infrequent nature of rainfall in the north east may make plant establishment at certain times of the year more difficult.

Wind Induced Damage
The exposed surface outwash tailings material may also result in physical plant damage, as wind erosion of soil may lead to sand blasting of plants.

Soil pH and Heavy Metals
The soil pH is expected to be very acidic (low pH) as a result of the acid mine drainage potential of mine tailings. Acid mine drainage is a polluted leachate from

Problems Associated With Mine Site Rehabilitation *(continued)*

a mined area which is typically very acidic and high in soluble heavy metals. Heavy metals go into solution (ie. dissolving in water) and become more available when solid minerals are mixed with water resulting in heavy metals (such as copper, aluminium, lead and zinc).

It should be noted that heavy metals do not typically cause adverse impacts on plant development when in solid state, but when they enter solution in high concentrations, they can damage plant tissue and inhibit plant growth. It should be noted that the kaolinitic clays present at the site are typically high in aluminium, so aluminium toxicity may impact on plant development.

Other Factors
Tailings may also be potentially high in salts and other plant toxins.

With respect to poor revegetation at the site, natural regeneration may also have been due to the large scale of the mine workings, the lack of natural seed supply and/or the large distance to healthy mature seed trees.

It is noted that one or all of these chemical and phyical characteristics may have an integrated effect that can adversely impact on plant development.

Response to Potential Problems

The proposed rehabilitation site has been recontoured and reworked to provide a friable, but stable landform in preparation for revegetation works.

Given the constraints of the outwash tailings material, its lack of topsoil cover and organic matter, and impervious nature, the area will be ameliorated with gypsum to improve the soil structure and suitability for root establishment. Indirectly the improved soil structure should allow for improved water holding capacity. Gypsum should also provide an initial increase in pH for the plant establishment period. An increase in pH may provide some precipitation of heavy metals and reduce their potential impact on plant development.

A high N:P:K fertiliser will be applied to overcome any existing nutrient deficiencies and to encourage early establishment of the native vegetation and subsequently stabilisation of surface material.

Further Information

Should your require further information on the problems associated with the rehabilitation of mine sites or the stabilisation works that have been conducted at abandoned mine sites in the north east you are invited to contact:

Simon Talbot
SEMF Holdings Pty Ltd
45 Murray Street, Hobart, Tasmania, 7000
Telephone: 6231 1211 Facsimile 6234 8709

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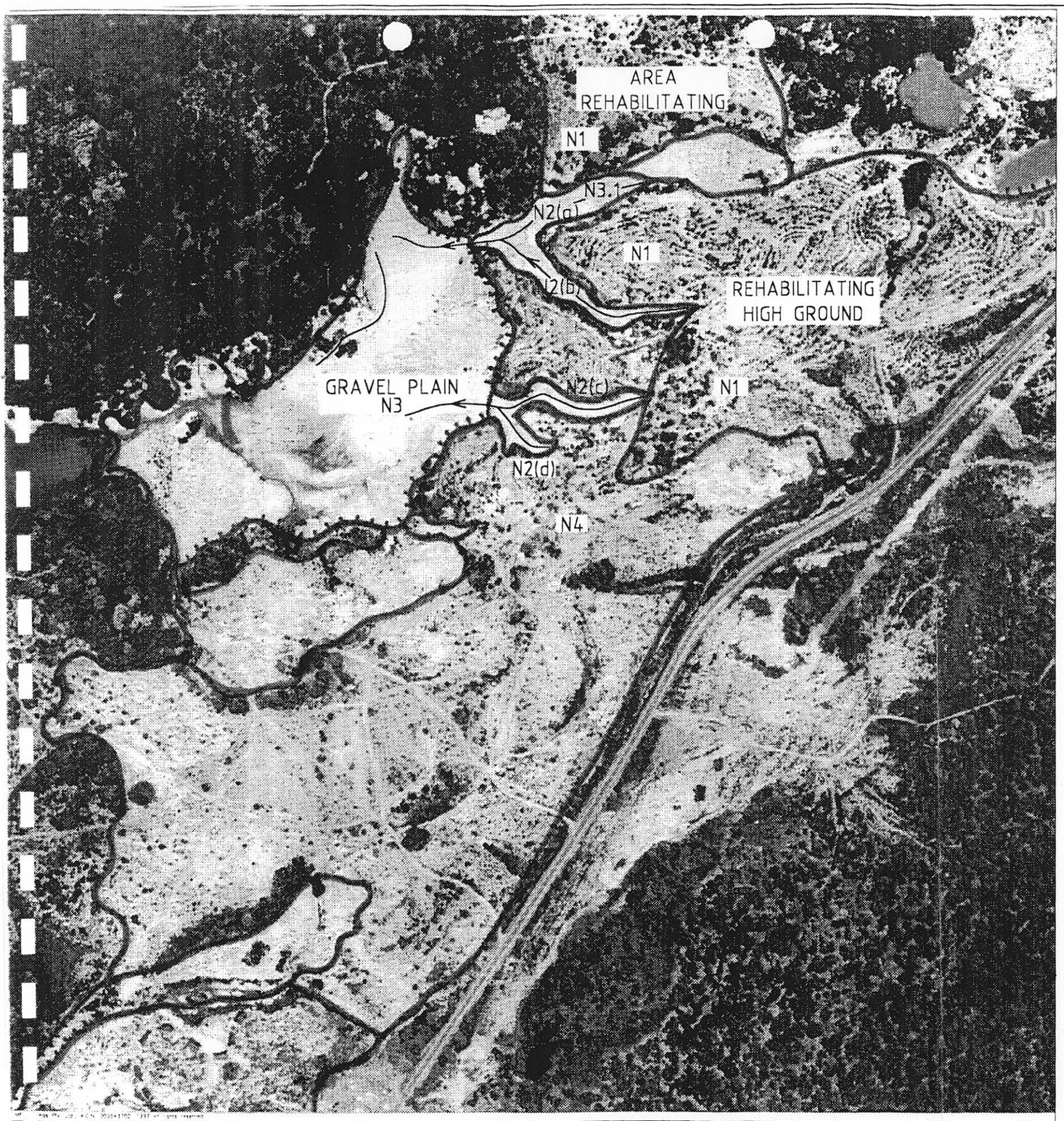
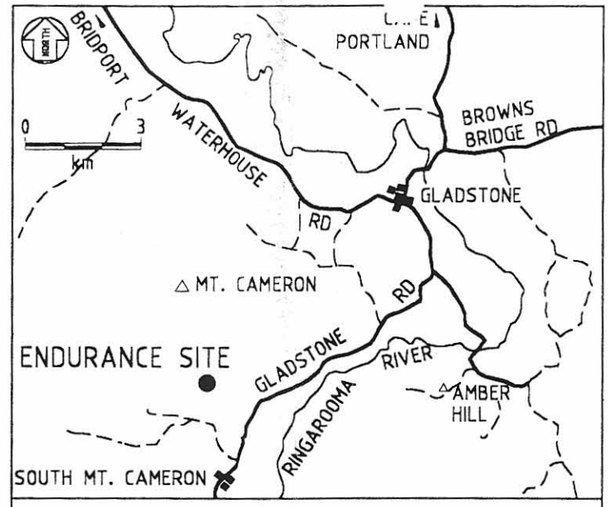
APPENDIX D

Endurance area N2
13193prop06
13193prop07





LOCATION PLAN

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	DESIGNED (ENG.):		MECHANICAL (RE):	
	CHECKED (SUP. DDR):		ELECTRICAL (RE):	
	APPROVED BY (RE):		CIVIL/ENV. (RE):	

13. PRELIMINARY ONLY
DA DESCRIPTION P.E.

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MINERAL RESOURCES TASMANIA

NORTH EAST MINES SITE REHABILITATION
LOCATION & LAYOUT PLANS

0

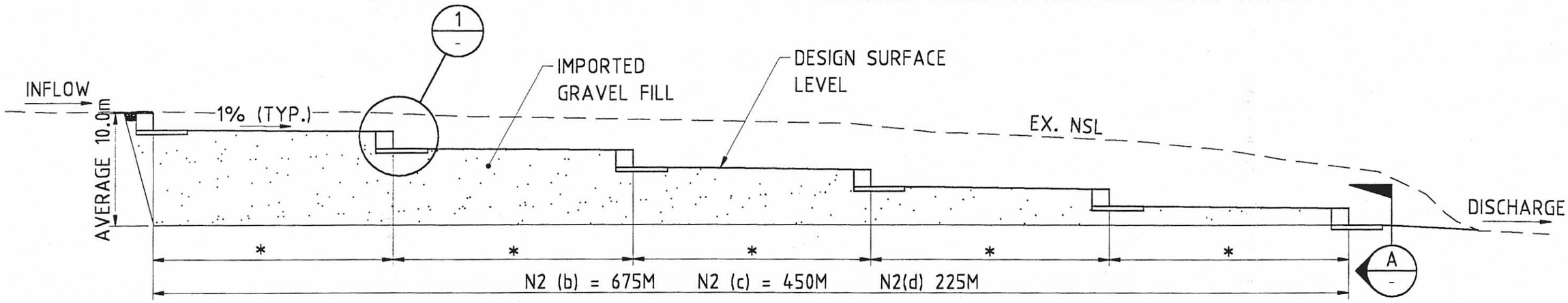
SCALE: N.T.S. | DIMENSIONS IN METRES

A3

ARTWORK NO. & PLOT SCALE | NE:\MINES\13193\PROP06...\13193

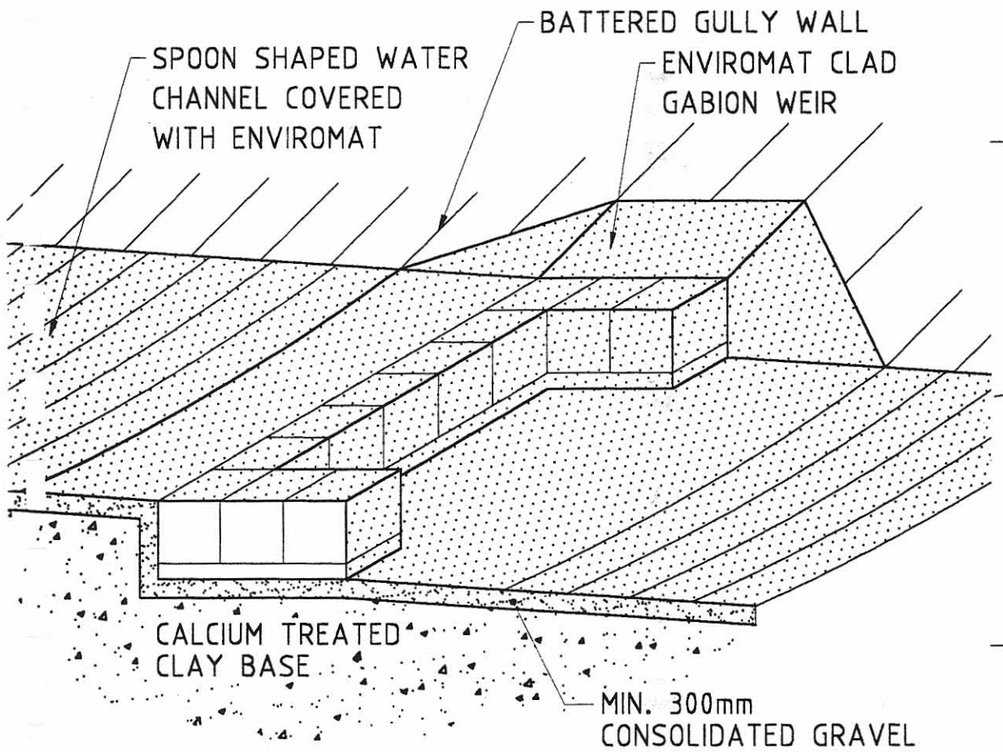
DRG. No. 13193\PROP06 | REV. A

* DISTANCE VARIES FOR EACH GULLY REFER TABLE 1



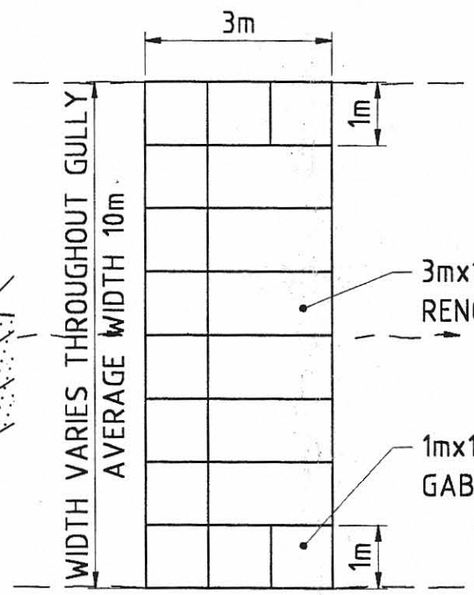
TYPICAL LONGITUDINAL SECTION

N.T.S.



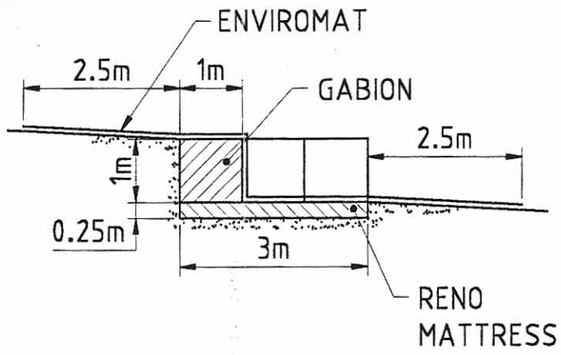
TYPICAL ISOMETRIC VIEW OF SITE

SCALE 1:100



TYPICAL PLAN

SCALE 1:100



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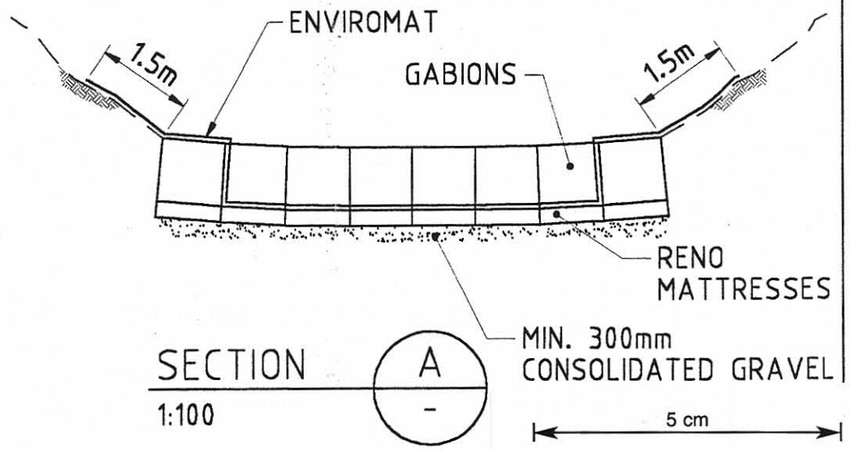

SECTION A / 1:100

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NO.	DATE	DESCRIPTION	P.E.
2.		PRELIMINARY ONLY	

SCIENTISTS ENGINEERS MANAGERS & FACILITATORS
45 Murray Street, Hobart Tasmania 7000
Tel. (03) 6231 1711 Fax. (03) 6234 6799
E-mail: jean@smf.com.au
47 Cameron Street, Launceston Tasmania 7250
Tel. (03) 6334 2899 Fax. (03) 6334 3269
E-mail: launceston@smf.com.au

MINERAL RESOURCES TASMANIA

NORTH EAST MINES SITE REHABILITATION

SECTIONS & DETAILS FOR N2 GULLIES
TYPICAL DISPERSION PRONE SITES

A3

SCALE: 1:100 | DIMENSIONS IN METRES

CAD FILE NO. & PLOT SCALE: \NE-MINES\13193\PROP07...:100

DRG. No. 13193\PROP07 | REV. A

APPENDIX E

Star Hill area S1
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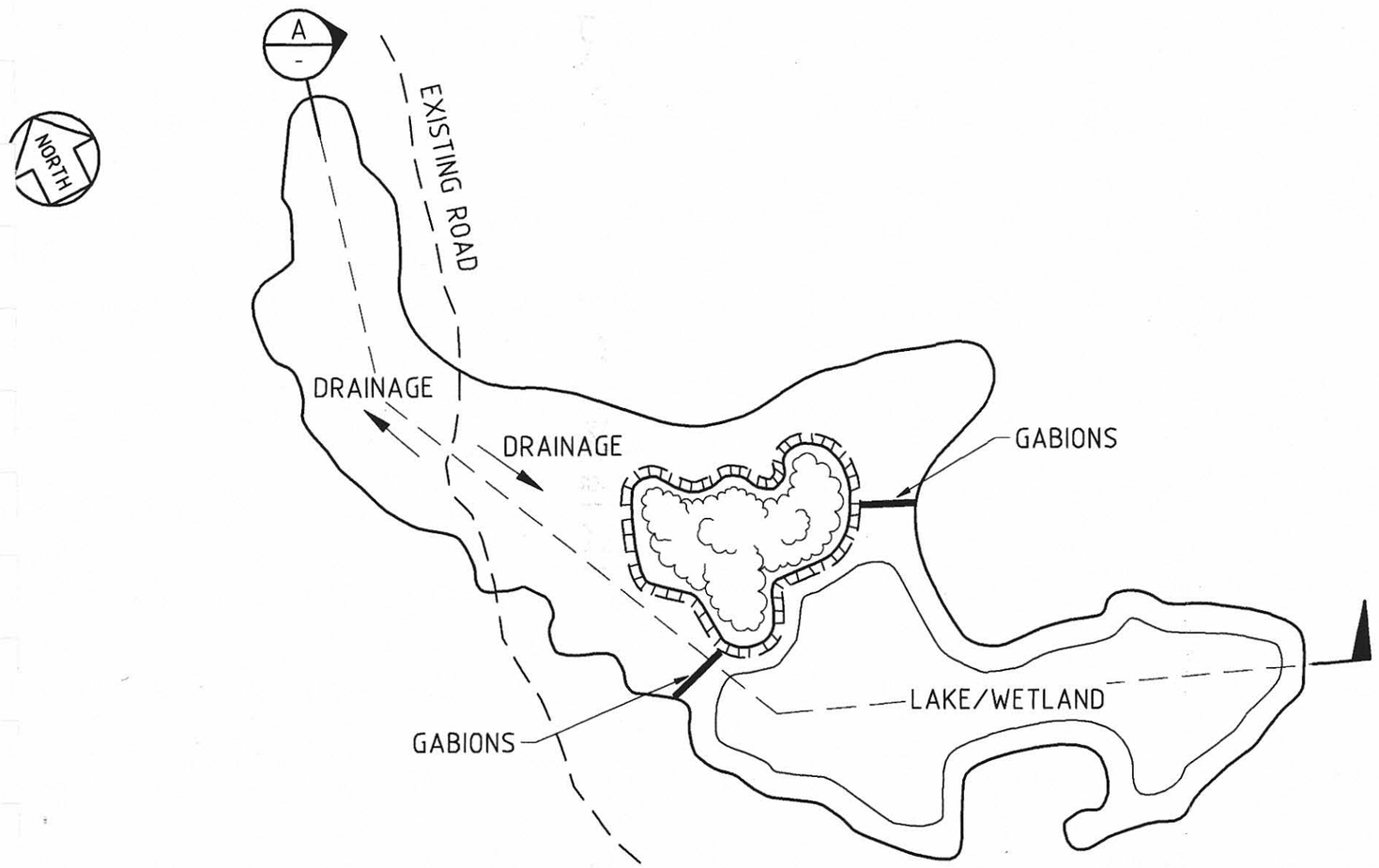
13193prop04
13193prop05



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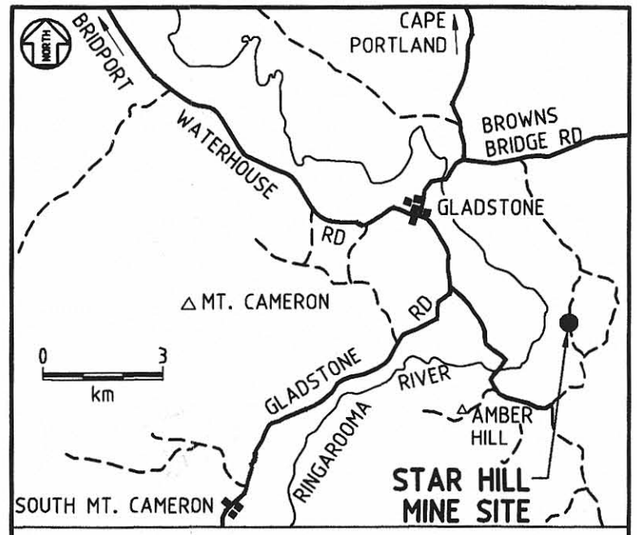
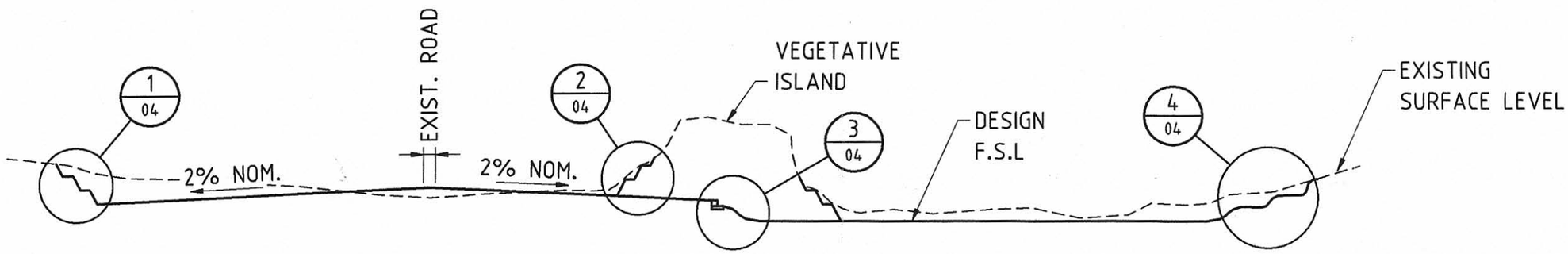


LOCATION PLAN



SECTION A
N.T.S

5 cm

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CO-ORDINATION CHECK	SIGNATURE	DATE
STRUCTURAL (RE)		
MECHANICAL (RE)		
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45 Murray Street, Hobart Tasmania, 7001 Tel. (03) 6231 1211 Fax. (03) 6234 8769 E-mail. semf@semf.com.au
47 Cameron Street, Launceston Tasmania, 7250 Tel. (03) 6334 2899 Fax. (03) 6334 3269 E-mail. launceston@semf.com.au

MINERAL RESOURCES TASMANIA

STAR HILL MINE SITE REHABILITATION
LOCATION AND LAYOUT PLAN AND CROSS SECTION

A3
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DIMENSIONS IN METRES
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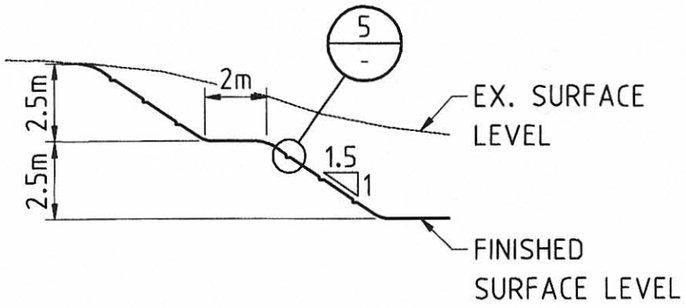

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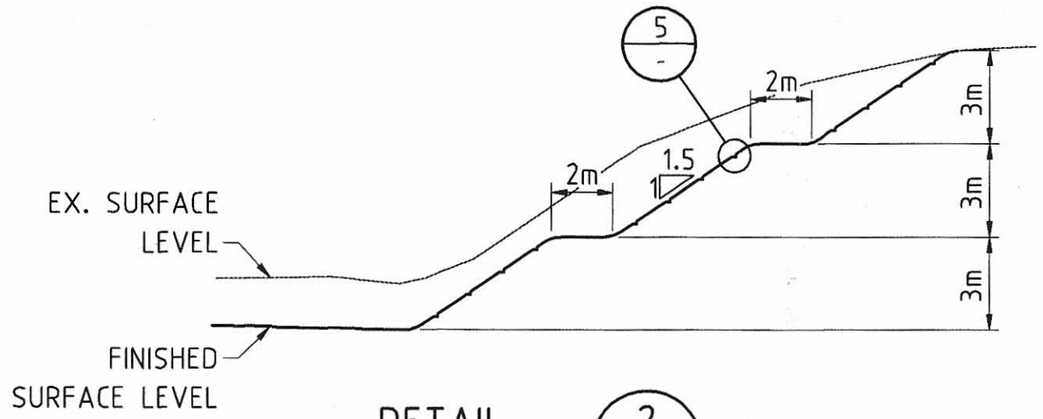

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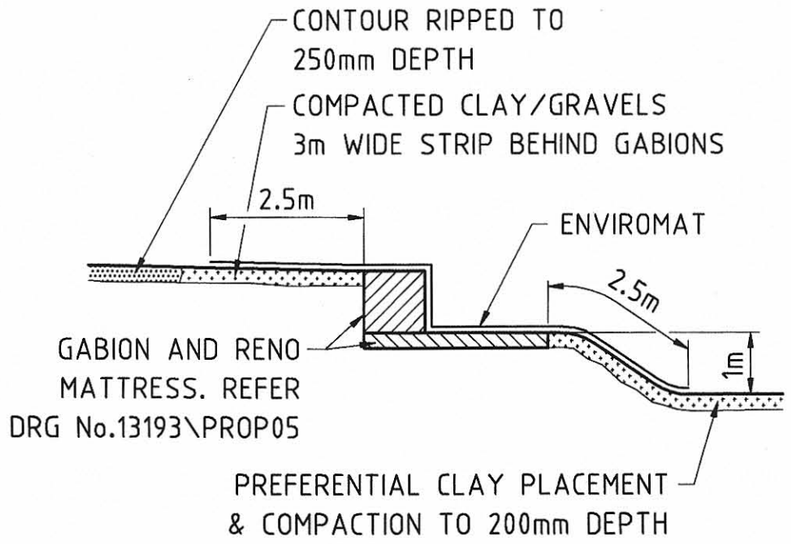

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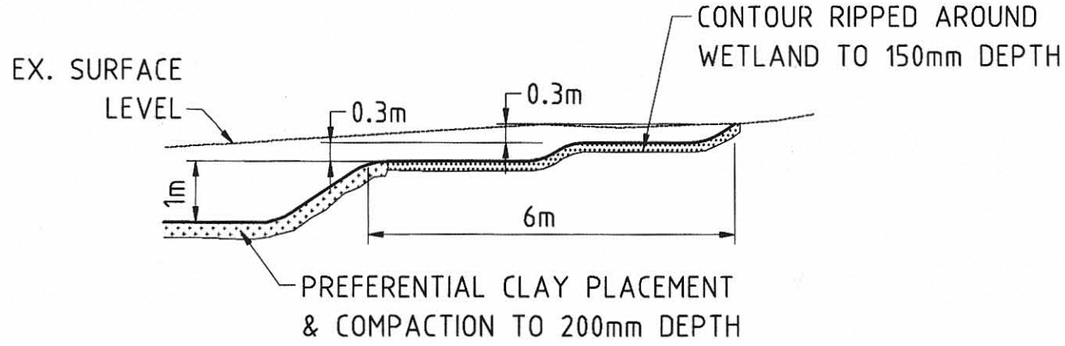

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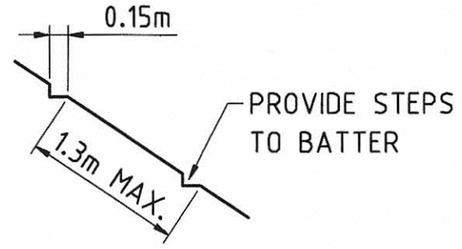

DETAIL 5 / -
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CIVIL/ENV. (RE)		

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MANAGERS &
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45 Murray Street, Hobart
Tasmania, 7000
Tel. H/O 6231 1311
Fax. H/O 6234 6749
E-mail: semf@semf.com.au
47 Cameron Street, Launceston
Tasmania, 7250
Tel. H/O 6334 3999
Fax. H/O 6334 3369
E-mail: launceston@semf.com.au

MINERAL RESOURCES TASMANIA

STAR HILL MINE SITE REHABILITATION
TYPICAL DETAILS

A3
SCALE: AS SHOWN
DIMENSIONS IN METRES
CAD FILE NO. & PLOT SCALE
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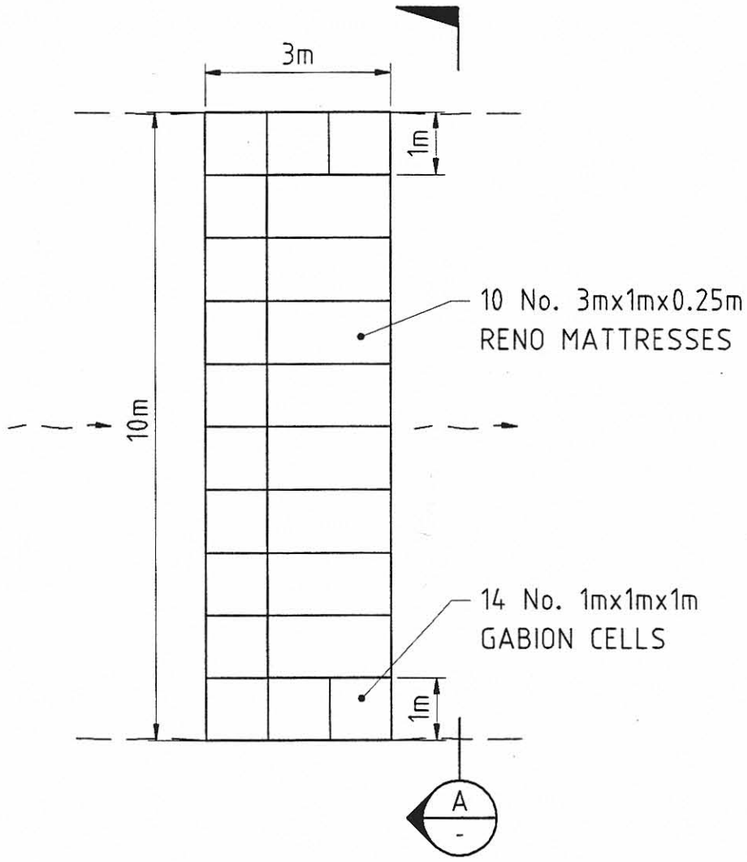
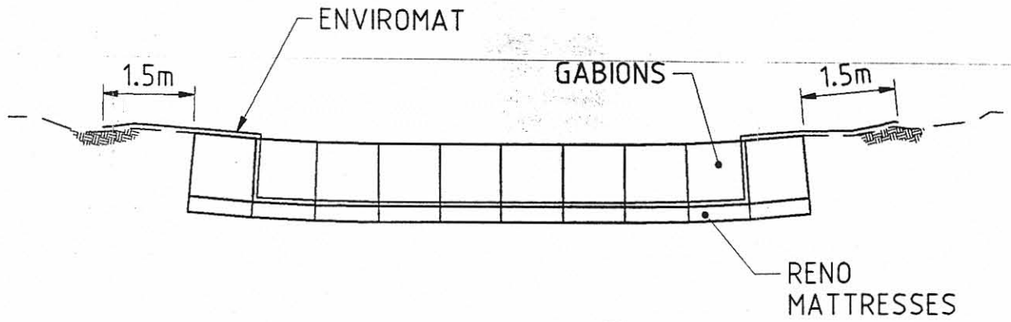
DRG. No. 13193\PROP04
REV. A



PLAN

GABION/RENO MATTRESS LAYOUT

SCALE 1:100



SECTION A - A

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CHECKED (SUP. DO):			ELECTRICAL (RE)	
APPROVED BY (RE):			CIVIL/ENV. (RE)	

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45 Murray Street, Hobart Tasmania 7000 Tel. (03) 6231 1211 Fax. (03) 6234 8789 E-mail: semf@semf.com.au
47 Cameron Street, Launceston Tasmania 7250 Tel. (03) 6334 2699 Fax. (03) 6334 3269 E-mail: launceston@semf.com.au

MINERAL RESOURCES TASMANIA

STAR HILL MINE SITE REHABILITATION

GABIONS/RENO MATTRESS DETAIL

A3

SCALE: 1:100 | DIMENSIONS IN METRES

CAD FILE NO. & PLOT SCALE: \MRT\13193\PROP05...1:100

DRG. No. 13193\PROP05 | REV. A

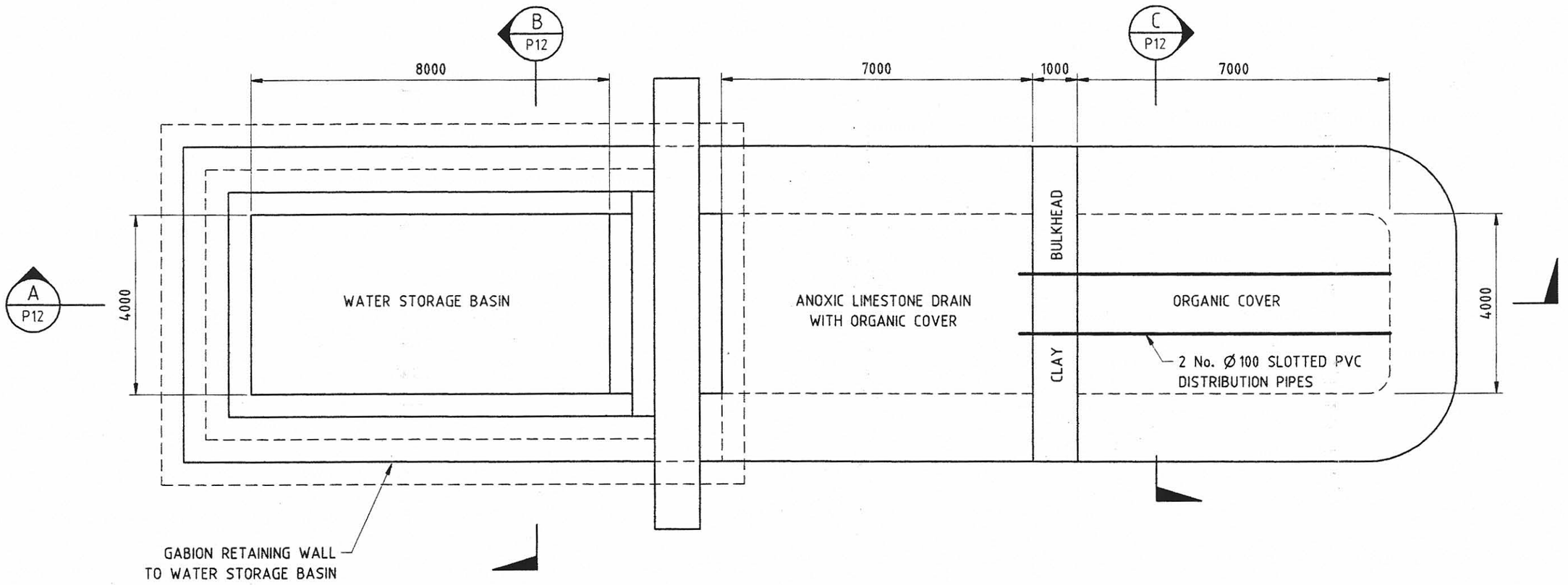
APPENDIX F

Endurance N6

Field Sketches Utilised

APPENDIX G

Monarch Area SAPS



PLAN

NOTE

1 ORGANIC COVER TO CONSIST OF A MIXTURE OF THE FOLLOWING:
10 cu. m SHEEP MANURE
28 cu. m PYRETHERA
8No. 50kg BAGS FERTILISER
4 No. 50kg BAGS CHICKEN MANURE
TOTAL VOLUME REQUIRED APPROX. 40 cu. m

5 cm

DATE	DESCRIPTION	P.E.
6.	PRELIMINARY ONLY	

DRAWING CHECK	SIGNATURE	DATE
DRAWN (DO):	S.A.P	o.4.98
DESIGNED (ENG.):		
CHECKED (SUP. DO):		
APPROVED BY (RE):		

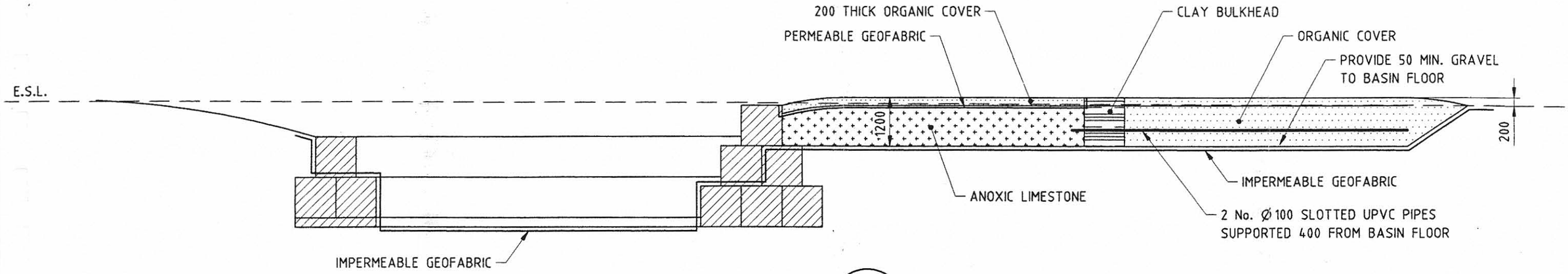
CO-ORDINATION CHECK	SIGNATURE	DATE
STRUCTURAL (RE)		
MECHANICAL (RE)		
ELECTRICAL (RE)		
CIVIL/ENV. (RE)		

SEMF SCIENTISTS ENGINEERS MANAGERS & FACILITATORS
45 Murray Street, Hobart Tasmania, 7000 Tel. (03) 6231 1211 Fax. (03) 6234 8769 E-mail: semf@semf.com.au
47 Cameron Street, Launceston Tasmania, 7250 Tel. (03) 6334 2899 Fax. (03) 6334 3269 E-mail launceston@semf.com.au

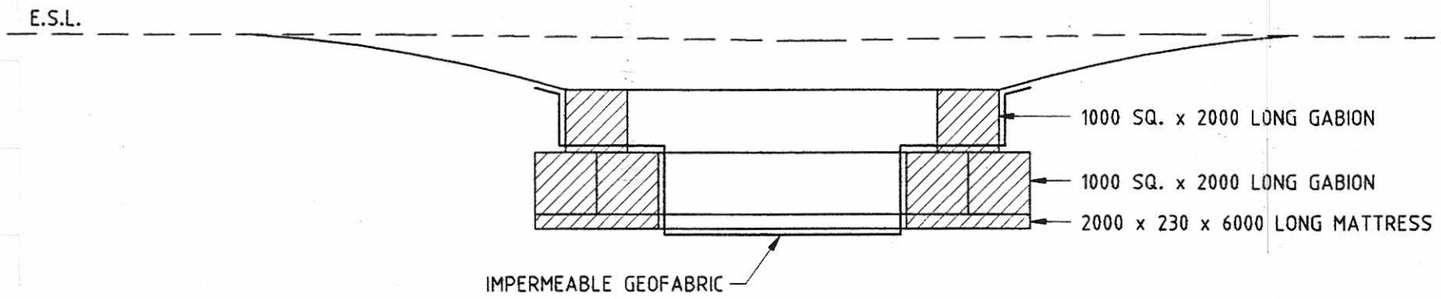
MINERAL RESOURCES TASMANIA

NORTH EAST MINES SITE REHABILITATION
MONARCH ALKALINITY WETALND SYSTEM
PLAN

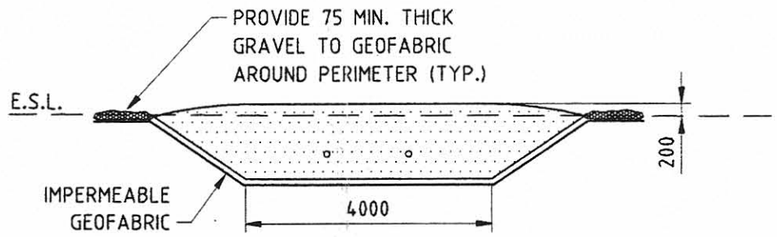
A3
SCALE: 1:100
DIMENSIONS IN MILLIMETRES
CAD FILE NO. & PLOT SCALE \13193\PROP\PROP11 1:100
DRG. No. 13193\PROP11
REV. A



SECTION A
1:100
PROP11



SECTION B
1:100
PROP11



SECTION C
1:100
PROP11

5 cm

			DRAWING CHECK		CO-ORDINATION CHECK	
			SIGNATURE	DATE	SIGNATURE	DATE
			DRAWN (DO): S.A.P	6.4.98	STRUCTURAL (RE)	
			DESIGNED (ENG.):		MECHANICAL (RE)	
6.4	PRELIMINARY ONLY		CHECKED (SUP. DO):		ELECTRICAL (RE)	
DATE	DESCRIPTION	P.E.	APPROVED BY (RE):		CIVIL/ENV. (RE)	

SCIENTISTS ENGINEERS MANAGERS & FACILITATORS
45 Murray Street, Hobart Tasmania, 7000 Tel. (03) 6231 1277 Fax. (03) 6234 8789 E-mail: semf@semf.com.au
67 Cameron Street, Launceston Tasmania, 7250 Tel. (03) 6334 2899 Fax. (03) 6334 3269 E-mail: launceston@semf.com.au

MINERAL RESOURCES TASMANIA

NORTH EAST MINES SITE REHABILITATION
MONARCH ALKALINITY WETLAND SYSTEM
SECTIONS

A3
SCALE: 1:100
DIMENSIONS IN MILLIMETRES
CAD FILE NO. & PLOT SCALE \13193\PROP\PROP11 1:100
DRG. No. 13193\PROP12
REV. A