

MANAGEMENT AND REHABILITATION OF THE SILVERMINES AREA

PHASE IV REPORT: CONCEPTUAL DESIGN

Prepared for:

DEPARTMENT OF COMMUNICATIONS, MARINE AND NATURAL RESOURCES

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MANAGEMENT AND REHABILITATION OF THE SILVERMINES AREA PHASE IV REPORT: CONCEPTUAL DESIGN

1 INTRODUCTION

1.1 General

The Silvermines area has been mined for more than one thousand years, and mining finally ceased in September 1992. The Department of Communications, Marine and Natural Resources (DCMNR) intended to provide costed management and implementation plans for closure and rehabilitation measures over the area of approximately 2,300ha, and appointed SRK Consulting to prepare a conceptual design for this purpose. The work includes heritage, ecology and environmental health considerations, and has been carried out in three phases. The Phase I study – Review of Available Information, (SRK report U1606/1, dated May 2001), the Phase II study – Management Options (SRK report U1606/2, dated March 2002) and the Phase III study (SRK report U1606/3– Conceptual Design comprises the conceptual design of the preferred remedial options), was based on the results of the Phase I and Phase II studies and completed in March 2002.

Since 2002 there have been many discussions and reviews of the options for each of the remediation works, with the various stakeholders. The key stakeholders are:

- The DCMNR;
- The Environmental Protection Agency (EPA);
- North Tipperary County Council (NTCC);
- The Silvermines Action Committee;
- The Gortmore Action Committee

The Government has agreed that the State will assume responsibility for the rehabilitation at Silvermines at a cost of €10.6M over a four year period. The actual on site work will be carried out and administered by NTCC. The objective of this report is to consolidate all of the conceptual design information, to enable final designs to be prepared.

The costs in this report, totalling €10.6 million have been updated from the Phase III report, to take account of the changes to the works, updated information as well as inflation.

This present report follows the format of the Phase III report but incorporates the conceptual design of the preferred remedial options, based on the results of the discussions and updated designs and cost estimates. There have been some changes to some of the sites due to activities of various owners. These changes were assessed by SRK during a site visit on 12 September 2005 and have been incorporated into this report.

For completeness, the introductory sections of this Phase IV report contain information also presented in the earlier reports.

Sections 5 to 10 are concerned with the remedial works required at each site and follow the column headings of the Risk/Remediation tables of the Phase II report 1606/2. Copies of these tables are presented in Appendix A of this Phase IV report for reference.

1.2 Terms of Reference and Objectives

The original terms of reference in a DCMNR letter of September 1st, 2000, outlined the following objectives for the work:

1. Preparation of management plans and/or rehabilitation plans for:
 - Tailings Management Facility (TMF) at Gortmore ;
 - Tailings at Shallee;
 - Lagoon and Settlement pond at Garryard;
 - Ballygown area and ground to the south of Silvermines village; and
 - Any other areas within the study area which may be identified during the consultancy as requiring the same.
2. Provision of costs and time-scale for implementing these plans.
3. Consultation with the public and agencies as part of the study and preparation of plans.

4. Assistance and advice to the Department in presenting such plans to the agencies and owners responsible for carrying out and supervising the plans and to the local population.

The consultants are required to identify and cost the necessary works to rehabilitate and/or manage the local environment in relation to mining-related features:

- Openings, vent raises, shafts and declines;
- Mine buildings;
- Tailings;
- Stream sediments enriched in heavy metals;
- Waste rock and other mining residues;
- Scrapped equipment, metals, containers or chemicals used in former mining operations;
- Subsidence, whether mining or natural; and
- Hydrogeological impacts.

1.3 **Key changes to the remedial works**

The following summarises the key issues of concern to the stakeholders, which resulted in changes to the conceptual designs and costs presented in the Phase III report.

1.3.1 **Garryard**

The problem wastes include material from:

- The process wastes at Ballygown on the Silvermines Stream bank;
- Small quantities of sulphide waste at Magcobar
- The Old Stockpile at Garryard;
- The Tailings Lagoon at Garryard;
- The Drum Dump at Shallee;
- Dredgings from streams and drains.

In the Phase II report the proposed option was to remove process and ore waste from Garryard Old Stockpile, Garryard Tailings Lagoon and Shallee Drum Dump and to place on the Gortmore TMF in an engineered facility. Following extensive discussion between the various stakeholders including Mogul and the community the preferred option is to develop a contained facility at Garryard, therefore all wastes previously designated for Gortmore TMF will now be taken to the Garryard site.

It was originally planned to develop a wetland on the site of the Garryard tailings to be able to receive runoff from the surrounding site and further the improvement of the subsoil conditions below the present tailings lagoon after removal of the tailings. A wetland will still be required but the location will be changed to downstream of the site in an adjacent field. Permitting and permissions will be required. Figures 7.1 and 7.2 have been modified to reflect the changes. The wetland can be simplified to a two stage system. The conceptual design for the disposal system is included.

The change has arisen largely due to concerns expressed by the local community that an additional source of potential contamination would be developed at Gortmore as well as a concern that the site could be used for ongoing waste disposal. The Garryard site will be developed as a contained site for the designated wastes after which it will be closed and rehabilitated.

A detailed licensing application will be necessary and an Environmental Impact Statement (EIS) will be required. This is a time-consuming process and therefore must be implemented as soon as possible, and in conjunction with detailed designs.

Detailed site investigations are also required before a design can be prepared. This will involve drilling to assess the geotechnical conditions and geochemical testing of the subsoil, surface water and groundwater.

1.3.2 Gortmore TMF

Rehabilitation of the TMF has been the subject of concern for various stakeholders. The key objective is to ensure stability of a self sustaining vegetation cover to prevent dust blowing from the top surface or the edges of the TMF. Some areas have a good cover of vegetation which appears to be self sustaining. Large areas of the surface have poor or no vegetation.

2 RESULTS OF THE PHASE II REVIEW OF OPTIONS

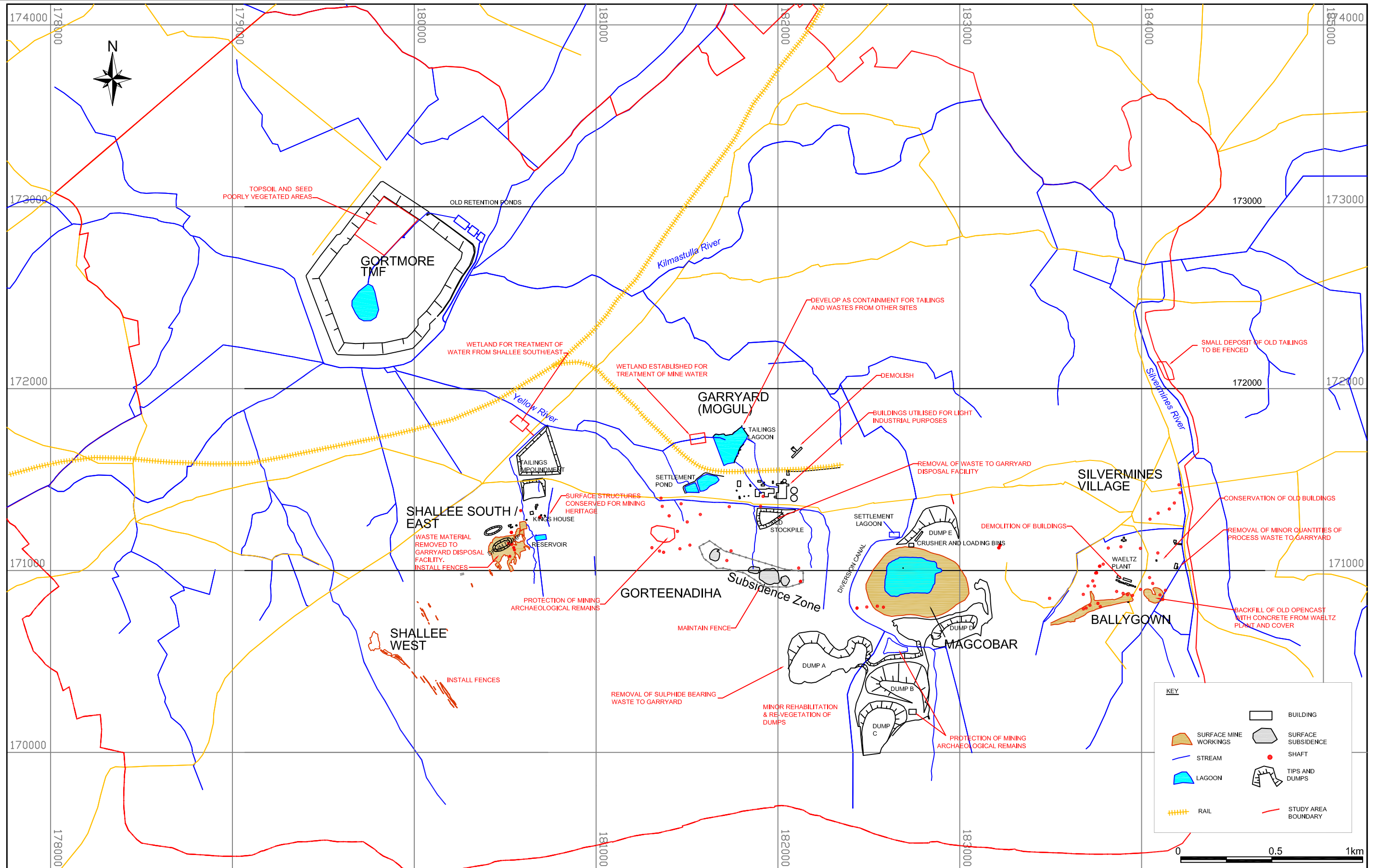
The Phase II study resulted in the identification of various options for the different mine sites in the study area. Following discussion with DCMNR and all the stakeholders, the preferred options for remedial work were selected for conceptual design and costing. Full details are in the Phase II report, and Table 2.1 summarises the remedial works including the more recent changes. The various mining features and key elements of remedial work are shown on Figure 2.1.

The word topsoil has been used as part of remediation on various sites. This refers to a suitable soil forming material with organic additives and not to a true topsoil.

Table 2.1: Main Elements of the Preferred Remedial Options

SITE	ITEM	REMEDIAL WORKS
BALLYGOWN	General	Minor earthworks, re-vegetation, significant demolition, heritage conservation
	Village Field	Capping and re-vegetation
	Opencast area	Partial backfill and re-vegetation
	Shafts, adits and wells	Backfill or fence, pressure relief holes
	Mine water discharges	Clearing of adit and installation of sediment trap
	Waste materials	Install stream bank protection, remove small quantities to Garryard disposal site if necessary, re-vegetate
	Old Engine House	Conservation measures
	Old Furnace Building	Conservation measures
	Waeltz Plant Buildings	Partial demolition, conservation to window or footprint level. Removal of roof covering to Garryard
	Old tailings to north of Silvermines Village	Install fence
MAGCOBAR	General	Minor earthworks, re-vegetation, demolition
	Mine pit	Maintain fencing and investigate pit water geochemistry
	Sediment Lagoons	Fence and maintain
	Archaeological sites	Install protective fences
	Rock dumps	Minor re-shaping, topsoil and re-vegetation
	Surface drainage channels	Repair and maintain
	Small deposits of sulphide waste	Remove to Garryard
	Maintenance workshop	Possible alternative use
	Other buildings and crusher	Remove buildings and backfill lagoon on top of Dump E
	Small sinkhole near entrance	Backfill
GARRYARD	General	Develop waste disposal facility for designated wastes.
	Tailings Lagoon	Develop permanent containment for the existing tailings at Garryard and other designated mine wastes.
	Wetland	Construct wetland downstream of site to polish any runoff from the site.
	Settlement ponds	Maintain as retention pond
	Knight Shaft	No change, but maintain discharge system
	Mogul shafts and vent raises in other areas	Protection as appropriate
	Sulphide and oxidation products - underground mine water	Discharged to existing settlement ponds or new Tailings Lagoon wetland
	Old Stockpile	Removal of mine waste, rehabilitation to pasture
	Existing drainage channels	Repairs and improvements and remove sediment
	Subsidence area	Repair and maintain fences, install diversion drains
GORTEENADIHA	General	Minor drainage works & gabion retention dam,
	Mining heritage	Protected by fence pending archaeological study

SITE	ITEM	REMEDIAL WORKS
	Shafts, underground workings, adits and open pits	Identification, backfilling and fencing as appropriate
	Waste dumps	Install trench drains
	Surface run-off	Small gabion retention dam for sediment control
SHALLEE SOUTH/EAST	General	Conservation of buildings and mine as heritage site, disposal of process waste and wetland development
	Mining heritage	Preparation of conservation schedule and execution of conservation measures.
	Open pits and Underground workings	Make safe by fencing
	Shafts and adits	Improvement of grill on Whim Shaft and fencing of Field Shaft. All other adits and shafts to be treated as appropriate for mining heritage conservation.
	Scrap and waste, Drum Dump and other smaller deposits in-pit and elsewhere	Remove to designated off-site licensed dump. (waste acceptable for the Garryard facility can be taken there)
	Water discharges	Improvement of surface drainage system and establishment of downstream wetland
	Tailings dam run-off	To same wetland
	Tailings dam vegetation	Maintain
	Old Engine House	Conservation
	King's House	Conservation
	Plant foundations and other buildings	Conservation
SHALLEE WEST	General	Minor backfilling
	Trenches and mine waste	Backfilling of trenches with mine waste and fencing of trenches where appropriate.
GORTMORE	General	Selective topsoiling and re-vegetation, establishment of vegetation screen, minor remedial earthworks
	Top surface	Monitor existing vegetation and develop maintenance programme
	Top surface	Placing of limestone gravel and topsoil on approximately 25% of top surface, re-vegetation
	Pool on top surface	New decant and pipeline
	Un-vegetated outer slopes	Selective topsoiling and re-vegetation at crest, planting of tree screen at toe.
	Retention ponds	Determination of water balance, detailed survey and minor works to improve retention time.



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Scale 1:20,000

3 BASIS OF THE CONCEPTUAL DESIGN

The remedial options selected at the end of the Phase II study define the nature of the remedial works. The design is at a conceptual level only. The available existing plans have contours at 10 metre intervals, and this limits the accuracy of the conceptual designs and the estimates of quantities. It is recommended that all mine sites are accurately surveyed to produce 1m contours and to specifically locate key features related to the mining and proposed remedial works.

3.1 Acceptance criteria

The acceptance criteria governing the choice of remedial options have been defined in the Phase II report. The BATNEEC (Best Available Technology Not Entailing Excessive Cost) principle has been applied. Acceptability to the local community and the other involved parties has been an important consideration.

3.2 Access

The ownership of the old mining properties of the Silvermines area is not clear in every case, particularly for the very old mines. For the purpose of the conceptual design, SRK has reviewed the present usage and, where a change of usage has been considered advisable, this has been recommended. Others are investigating the legal ownership of the land required for the works.

3.3 Sources of materials

The construction materials include limestone, low-permeability clay and a “growth medium”. It has been assumed that the limestone will be selected and crushed from the Magcobar dumps, and that the clay and growth medium will come from sites at a nominal 10 to 12km distance.

The local residents have also identified sources of materials in the locality, including material excavated for routine drain clearance, which can be used, subject to planning permission and the geochemical nature of the materials.

3.4 Waste Disposal

The problem wastes include material from:

- The process wastes at Ballygown on the Silvermines Stream bank;
- Small quantities of sulphide waste at Magcobar

- The Old Stockpile at Garryard and drainage channel;
- The Tailings Lagoon at Garryard;
- The Drum Dump at Shallee;
- Dredgings from some streams and drains local to the hazard sources.

These deposits are a hazard and a source of stream contamination, requiring remediation. The preferred option is to remove process and ore waste from Garryard Old Stockpile and Shallee Drum Dump and to take it to Garryard where the existing tailings lagoon will be engineered into a waste containment facility on site. Contaminated stream dredgings and small quantities of ore from other of the old Silvermines mining sites may also be placed on this facility. It is anticipated that stream dredgings after that will be suitable for leaving in the fields as in the past. Any dredgings not meeting requirements in terms of geochemistry after the closure of the Garryard facility will have to be disposed of in a licensed site. It is intended that scrap waste such as steel drums, mainly from Shallee South/East, will be disposed of through a designated scrap metal company. Process waste on the Silvermines Stream bank at Ballygown will be stabilised and protected with gabions, but small quantities may be removed and placed in the Garryard Disposal Facility. Small quantities of acid-generating sulphide mine waste at Magcobar will be taken to Garryard. Asbestos from the roof of the Waeltz Plant at Ballygown will be disposed of at Garryard. Building rubble from the demolition of the Waeltz Plant Buildings will be placed in the Ballygown Opencast for restoration of the site and to make safe. Any remaining building rubble will be placed at Magcobar and covered during the dump reshaping.

3.5 River water quality

The river water qualities in the Silvermines River, the Yellow River and the Kilmastulla River have been affected by run-off from the mining areas, and mainly by sediments eroded from waste dumps or tailings deposits and from metals in solution. The remedial measures presented in the following sections include measures to stop this erosion at source, either by removing the waste or by stabilising it. These measures will be supplemented by various silt retention structures and wetlands for water treatment at Garryard and Shallee South/East. Where dissolved species are a key contaminant, the source materials will be removed where possible, or wetlands will be provided to enhance precipitation of metals.

3.6 Groundwater Quality

Preliminary work has been carried out to characterise groundwater quality. Mining has had an impact on the groundwater chemistry but in general, groundwater quality only shows slightly elevated metal levels and generally close to the key sources of contaminants. There are no groundwater abstractions close to the mining areas. The Shallee Group Scheme borehole is the closest abstraction and there are no signs of contamination.

During the investigation, there was a concern that elevated levels of mercury were identified in the groundwater adjacent to and immediately down hydraulic gradient of the Gortmore TMF. The levels were very low and subsequent check sampling did not reveal mercury. It was concluded that levels of all metals were low and there was no requirement for specific remedial measures.

No particular remedial measures are necessary for the groundwater in the investigation area apart from management of abstraction in areas close to mining features.

3.7 Mining Heritage

The proposed conservation of the mining heritage of the Silvermines area has involved the identification of structures and features to be preserved. The various mining developments to be seen in the Silvermines area provide an excellent view of open pit and underground mining through various ages. The geology, mining, mine development and environmental impacts provide an opportunity for teaching students of geology, mining and environment as well as the general public. An opportunity exists to develop an educational centre and trail from Silvermines to Shallee. This is not considered further in this report, but the recommended remedial works will enable such a trail and education centre to be developed in the future if required.

3.8 Ecology and sustainability

There are no designated areas or habitats for plants, animals or birds that have been identified in the area. Many sites have developed vegetation naturally. Remediation will ensure that the existing ecology, including the mine site ecology, is maintained or enhanced where necessary. This particularly applies to the tailings deposits to ensure sustainability in the long term.

4 REQUIREMENTS FOR IMPLEMENTATION OF THE PROPOSED REMEDIAL WORKS

4.1 Introduction

It is anticipated that the remedial works will be carried out over four years, though long-term monitoring and maintenance will continue after the remedial works are complete. Apart from spreading costs, the four year period will also give the advantage that the cumulative influence of the completed works can be judged, and the required future works adjusted in accordance with these effects.

As the works will be carried out at different times, it is anticipated the tasks will be let to qualified contractors as separate contracts. There are a number of specialist tasks required, particularly the site investigation at Garryard, archaeological studies at Ballygown, Magcobar and Gorteenadiha and topographic survey of all sites, before certain engineering works are designed or carried out. Permits will be required for activities such as the movement and disposal of contaminated waste.

4.2 Silvermines Project Management

The works will require consultation, coordination and planning over an extended period of four years or more. Funding has been approved from the Government and it is understood that the NTCC will undertake the proposed remediation project. However the overall funding and accountability will remain the responsibility of the Minister for Communications, Marine and Natural Resources.

Project Management will be required and that role will include:

- Supervision of the Contractors;
- Overall Environmental Management, with development and enforcement of the environmental protocols;
- Management and coordination of the input by technical specialist consultants;
- Community liaison;

The activities on site will involve various levels of expertise, and it is anticipated that the project management will require coordination of the involvement of specialists involved in the works. These specialists will include mining engineers, hydrogeologists, geotechnical and civil engineers and scientists.

4.3 Additional investigations

The present study has been a conceptual design, and the subsequent detailed design will include certain additional investigations.

The components of the design investigations will vary from area to area, and will depend on the nature of the proposed remedial works. They will include, for example, the determination of actual volumes of waste materials to be disposed of, the testing of potential capping materials, and detailed audits of existing stormwater channels.

Preliminary test work has been carried out to characterise the chemistry of different materials. In terms of surface water hydrology, there are no flow records on the site and flows have been estimated for the Phase II report. A flow monitoring programme should be implemented on key streams, to enable some calibration to be done for detailed design purposes. This is particularly important for design of wetlands and engineering structures.

Drilling has been carried out to characterise the groundwater. This work should be complemented with information from some additional boreholes and ongoing monitoring. This will provide additional information for groundwater management and will not impact on the design of remedial works.

Specific site investigations (SI) including drilling will be required at Garryard to confirm founding and groundwater conditions for the design of the disposal facility and at Shallee to assess the nature of the materials and volumes in the drum dump. These investigations should be carried out as soon as possible as they will impact on the design and therefore the permitting applications. Following the SI at Garryard, a detailed quantitative risk assessment will be required, on the conceptual design for the waste facility to confirm the sustainability of the design. This will be a requirement of the licence application and the conceptual design may require change based on the risk assessment and the permitting requirements.

Allowances have been made for heritage conservation works, including fencing, on the sites, and remains at Gorteenadiha and Magcobar have been identified as requiring industrial archaeological investigation. Sums have been allocated for the archaeological investigations at Ballygown, Magcobar, Gorteenadiha and Shallee.

4.4 Detailed design

The detailed design will comprise:

- 1 Detailed topographic survey to provide contours at one metre vertical intervals.
- 2 Appropriate additional investigations (e.g., further site inspections/mapping, archaeological studies, geochemistry of Magcobar pit, identification of sources of suitable fill, drilling at Garryard etc).
- 3 Initiation of a monitoring programme for surface and groundwater.
- 4 Preparation of Environmental Impact Statements.
- 5 Detailed design analyses.
- 6 Preparation of A0 construction drawings and specifications.
- 7 Revised estimate of costs to 25% accuracy.
- 8 Preparation of tender documentation including specifications, bills of quantities and contract environmental management procedures.

The detailed topographic survey is essential for the detailed design. Without a reliable contour plan, including the surface structures, it is not possible to carry out the detailed design or to cost it.

4.5 Permitting

Permits or licenses, as may be appropriate for certain of the rehabilitation activities, will be obtained from the EPA or NTCC before the development commences. Environmental Impact Statements will be required for certain of the activities proposed under the remediation programme. It is anticipated that the licensing/permitting requirements for the remedial work will be critical in terms of the timing of the programme. NTCC, in consultation with the EPA, will at an early stage commence any licensing/permitting process necessary for the undertaking of the remedial works on the individual sites.

Many of the proposed remedial activities discussed in section five could fall under the requirements of the Waste Directive and the Landfill Directive. The materials will need to be classified in terms of the EPA Hazardous Waste Classification System. These Directives could result in significant constraints to the remediation works and it will be important to ensure that permit applications should focus on the land recovery aspect of the works, particularly where materials are being moved from one place to another.

It is understood that it would be possible to permit the Silvermines project area under one permit for the various works except where hazardous wastes are concerned. The latter will require a separate permit.

Activities such as the backfilling of the Ballygown pit with concrete rubble from the Waeltz plant can be permitted. The overburden material around the pit will contain sulphides and is likely to be classified as toxic waste and will require disposal at a Garryard if it is moved, unless it can be demonstrated that it is performing land recovery and that the material is no different from that already in the pit.

It is anticipated that the permitting activities could be critical in terms of the timing of the programme.

4.6 Engineering construction work

The construction activities will comprise:

- 1 Tender letting and tender adjudication.
- 2 Appointment of the Contractors.
- 3 Construction and supervision of the works.
- 4 Acceptance and handover of the works.

4.7 Environmental management and health and safety during remedial works

The period of implementation of the remedial works will require good environmental management procedures to be in place, because the works themselves will have high potential impacts. During the earthworks and prior to successful re-vegetation, for example, there will be an increased potential for the erosion of soil and ecological damage, and it will be necessary to construct temporary silt traps, or to construct intended permanent retention structures at the beginning of the works. Vehicles transporting waste materials will require cleaning prior to moving onto public roads, to prevent contaminated soil from being spread. The special measures and protocols required to ensure good environmental practices during implementation will form part of the Contract Specification for the Contractor, and particular requirements will apply to each site.

It is proposed that the environmental protocols for the sites will be applied by the contractors and enforced by the Project Manager.

Health and Safety will be a key issue firstly for the movement of the various materials and secondly operating in areas of potential danger due to open shafts and

bodies of water. A detailed health and safety protocol should be prepared by NTCC for use by all personnel.

SRK draws attention to the Whim shaft at Shallee which is a vertical shaft protected by an open iron grid but with a large grid size. This is a specific danger to any person or animal on the site and requires immediate attention.

4.7 Monitoring during the remedial works

During the four year remediation period and the Contractor's maintenance period (6 months), the monitoring programme initiated as part of the detailed design (Section 4.4) will be carried out, including surface water, groundwater, air quality, erosion and vegetation monitoring. This data will provide a record of the changes resulting from the remedial works.

4.8 Long-term monitoring and maintenance

After the completion of the Contractor's maintenance period and acceptance of the works, it will be necessary to continue the programme of monitoring and maintenance for a period until sustainability can be demonstrated. This should include:

- 1 Water and atmospheric monitoring.
- 2 Monitoring of erosion and silt transportation.
- 3 Monitoring of vegetation.
- 4 Inspections of structures and fences and minor maintenance and repair.
- 5 Periodic clearing of silt traps and wetlands.

It is assumed that clearing of field drains will be resumed by the land owners once any dredging as part of the remediation works has been completed and accepted.

It is probable that, with time, the extent of monitoring activities will reduce, and that the need to dredge the streams will be reduced or removed by the effectiveness of the remediation measures.

5 REMEDIAL & MANAGEMENT WORKS FOR BALLYGOWN

Figure 5.1 gives a plan of the Ballygown area with the proposed remedial works indicated.

5.1 Access

There is doubt about the ownership of the Ballygown area, but the area to the east of the road, between the road and the Silvermines River has open access, and has been used by the local people for walking. A Village Trail has been established at the north end. The area of the Waeltz Plant Buildings and the Sulphur Mine was used by a farmer, but it appeared from the recent inspection that the use was limited or had been stopped. The Village Field, immediately to the south of the School, has not been touched since the initial investigation and the grass is fairly thick with some gorse growing on the field.

It is proposed that access to the Village Field, the ownership of which is yet to be determined, and the area to the East of the road is provided for use by local people and others, and that controlled public access be provided at Sulphur Mine and the Old Waeltz Plant Buildings. These conditions of access apply to the sites after the completion of remedial works.

5.2 School Playing Field

Remedial works were completed in 2001 and the area is now utilised for school sports.

5.3 Village Field

The Village Field has been levelled and provided with perimeter drains, for use as a sports field. The surface comprises waste rock gravels and the presence of lead and other metals in the surface soil render it unsuitable as a playing field. It is proposed that a limestone cover and a layer of soil be placed over the field, and planted with grass seed. The field will then be suitable for sports use, provided the surface is maintained.

Recent inspection showed that the grass cover is fairly thick and some gorse has developed.

5.4 Mine and process areas

The Ballygown area is of archaeological and heritage value. For that reason, only limited disturbance of the mine areas and the process spoil is envisaged. The re-shaping will be limited to measures designed to reduce the discharge of sediments to the Silvermines River, and to remove the danger posed by the pool in the Old Opencast.

5.5 Opencast area

The Old Opencast includes a small oval shaped excavation with a pool of water in its base and another shallower arc shaped excavation with some marshy areas at the base. It is intended that the oval excavation will be backfilled to a level sufficient to stop the ponding of water, and that there will be minor re-shaping of the area and re-vegetation. The backfill for the Old Opencast will be provided by the re-shaping earthworks and partial demolition of the Waeltz plant. All the above is subject to permitting.

No remedial works are required for the arc-shaped pit.

5.6 Sulphur Mine Pit

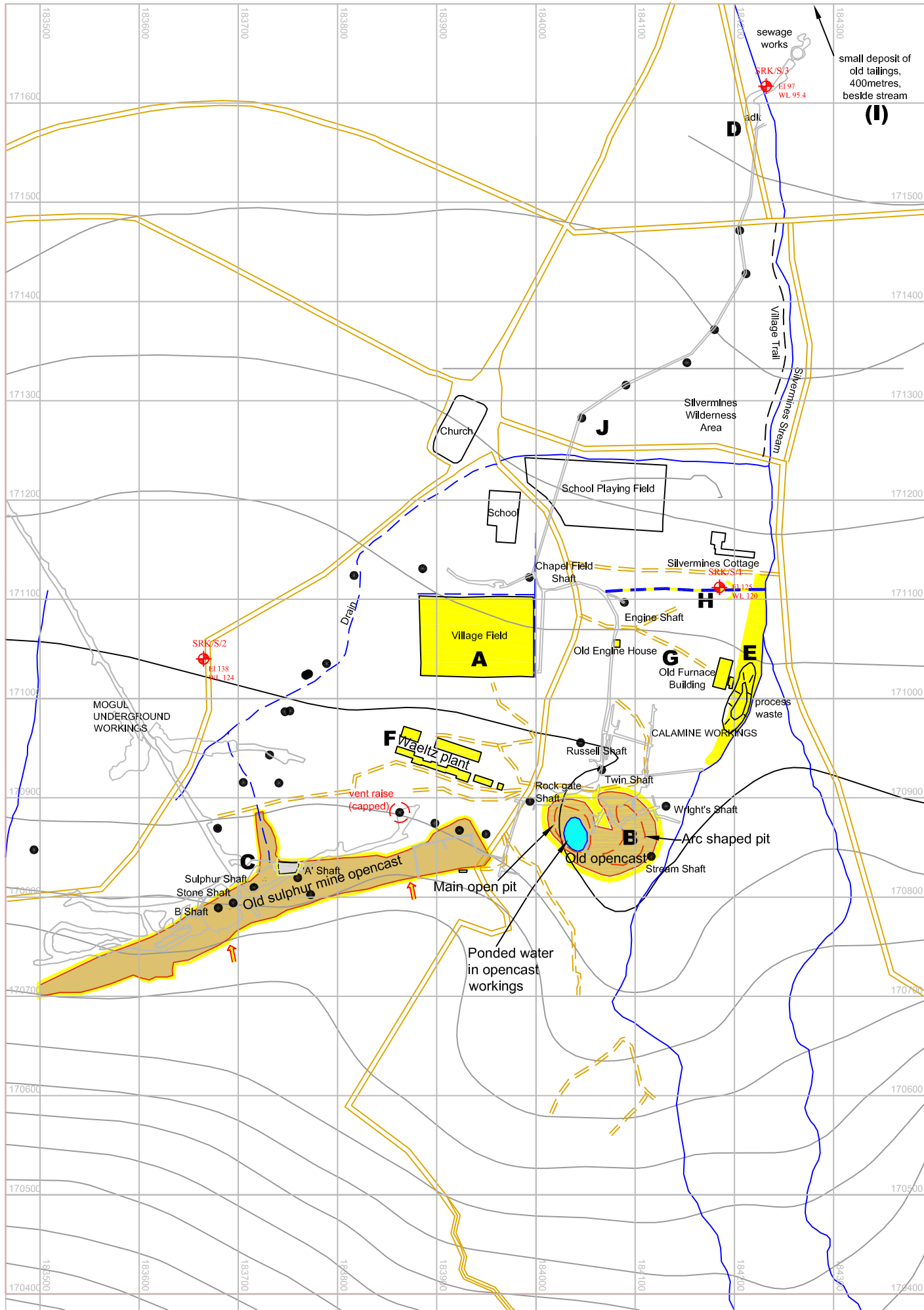
The Sulphur Mine pit is on the Silvermines Fault, and the footwall on the south boundary of the pit exposes the face of the fault. The pit is grassed and, apart from the footwall, has gentle slopes. There are four shafts and two adits that will require various forms of attention. There are also indications of subsidence on the floor of the pit in the vicinity of Shaft A.

It is the intention to:

- Place a grill over the east adit entrance;
- Place a fence around the west adit;
- Backfill and re-vegetate the open shafts and fence them off;
- Fence the area of the pit floor at Shaft A where subsidence is apparent;
- Maintain the existing fence along the upslope crest of the pit.

5.7 Ballygown shafts

Many of the shafts outside the Sulphur Mine area are already backfilled. It is intended that those not yet backfilled will either be backfilled or, if they serve a drainage function as on the drainage adit through Silvermines Village, they will be fenced. Where necessary, pressure relief boreholes will be drilled.

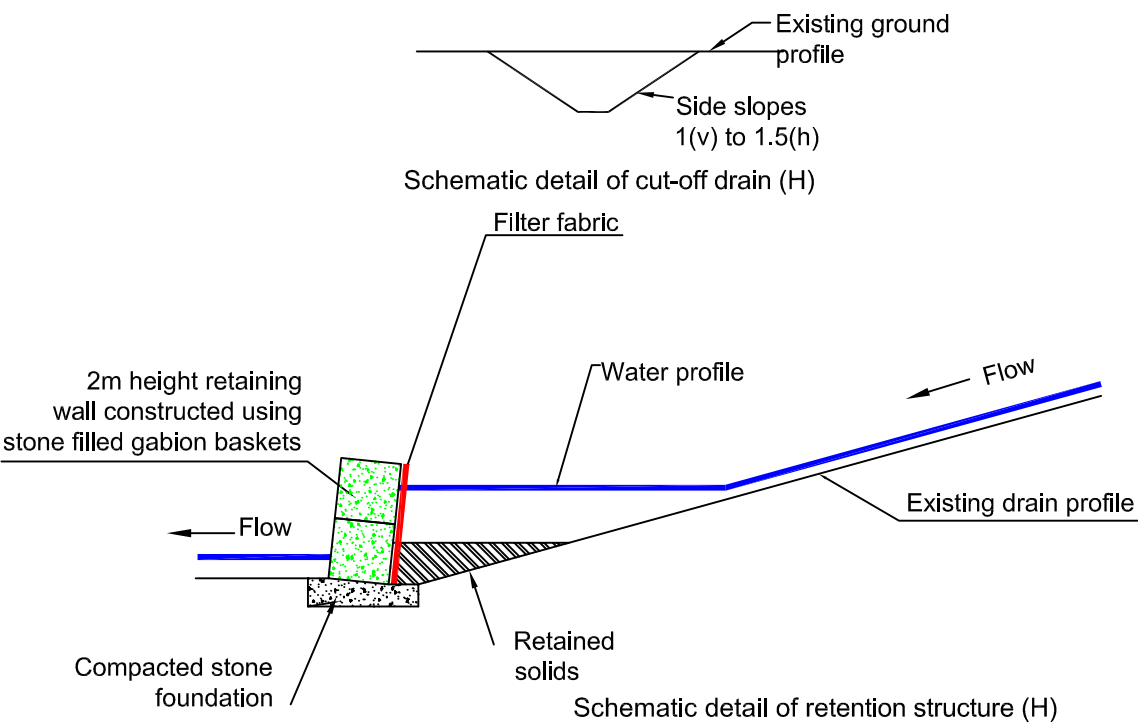


Notes.

DO NOT SCALE

KEY TO MAIN REMEDIAL WORKS

- A - Apply granular limestone capping, topsoil, grass to village field; improve drainage diversion channels.
- B - Partial backfilling with concrete from Waeltz plant and reshaping of Old Opencast.
- C - Backfill shafts, as required, but fence shafts serving drainage function; fence subsidence area, maintain existing pit fence.
- D - Clear sediment from adit entrance and install sediment trap.
- E - Install gabion streambank protection, remove small quantities of process waste to Garryard disposal facility.
- F - Demolish Waeltz plant buildings to window sill level and make safe. Fencing to be installed between upper and lower plant. Specialist removal of asbestos roof to Garryard.
- G - Conservation measures on Old Engine House and Old Furnace Building.
- H - Cut-off drain and retention structure.
- I - Fence old tailings deposits (position shown on Fig 2.1).
- J - Drill pressure relief boreholes;



KEY		SRK/TMF/4	
	Road		Borehole (SRK 2001)
	Track		Collar Elevation
	Underground working		Elevation of phreatic surface
	Adit		
	Surface working		
	Stream		
	Lagoon		
	Building		
	Surface subsidence		
	Contours - 10m Intervals		
	Shaft		
	Mogul Shaft		
	Tips and dumps		
	Existing fence		
	Proposed fence		
	Existing drain		
	Proposed drain		
	Areas requiring remedial measures		

Rvn	Rev. Date:	Description	Drawn	Checked	Approved
A	13-11-01	Remedial works added	DM		
B	26-08-05	Destination of waste amended	GT		
C	03-10-05	Boreholes added, Notes updated	MD		

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U2465 SILVERMINES PHASE IV REPORT

BALLYGOWN REMEDIAL WORKS
Plan showing Ballygown, Calamine and Sulphur Mine Areas

Originator: PB/IB

Date Drawn: AUG_2005

Scale: 1:5000

DRAWING No.:-

FIG.5.1

5.8 **Underground mine**

There are various development tunnels at Ballygown, including a drainage adit. More extensive underground workings were mined under the Sulphur Mine. None of these are considered a subsidence safety hazard, and no remedial works are proposed.

5.9 **Mine water discharges**

The water from the adit at Ballygown and the water in the Silvermines River contain elevated metals in sediments. It is intended that the adit entrance will be cleared of sediment and a sediment trap installed. Sediment will also be removed from the river system as part of the regional plan.

The sediment trap at the entrance to the adit has been costed as a simple gabion structure. The existing sediment will go to the proposed facility at Garryard. Following closure of Garryard, any dredgings will be disposed of according to geochemistry and subsequent permitting.

5.10 **Waste materials**

Most of the Ballygown area is covered by thin deposits of mine and process wastes. In general, these are vegetated and stable but at the west bank of the Silvermines River are bare areas of old process waste, which erodes into the river after rain.

It has been noted that disturbance of the waste is undesirable from an archaeological viewpoint. The stream bank will be stabilised with gabions, and a small amount of waste may be removed to the Garryard disposal facility.

Run-off during rainfall results in silt containing elevated metals washing towards the Silvermines Cottage before discharging into the river. A collection trench and gabion silt trap will be installed to contain this material. This will require routine clearing and removal of sediment to the Garryard disposal facility for a limited period or to Gortmore TMF as a soil forming material if suitable.

To the north of Silvermines Village, to the east of the Silvermines River, are low deposits of tailings which are well-grassed and stable. Cattle deaths have been reported in the vicinity of these deposits. It is proposed that the tailings are fenced to restrict access.

5.11 Mine buildings

The Old Furnace Building and the Old Engine House are stone structures to be conserved. The Waeltz Plant Buildings are recent concrete and block structures, but they do have heritage value. They will be demolished to leave walls below window level of one metre in height and the floor areas, for future heritage interest. It will be necessary to remove and dispose of the asbestos roofs in the Garryard facility. The preferred option is to leave walls of one metre height.

It is intended that concrete waste will be placed in the Old Opencast for land recovery, and it is anticipated that there will be some additional residue for disposal at Magcobar and covered during the reshaping of Dump A.

6 REMEDIAL & MANAGEMENT WORKS FOR MAGCOBAR

Figure 6.1 gives a plan of the Magcobar area with the proposed remedial works indicated.

6.1 Access

At present there is no public access to the mine area. Future controlled public access to certain parts of the Magcobar area is proposed as part of the development of a mining heritage trail.

6.2 Slope stability

There have been minor slips of the southern slopes of the Magcobar pit in the past, but future risks are not considered significant. It is proposed that the fences should be maintained and improved, and that public access to the pit itself should be prohibited.

6.3 Subsidence of underground workings

There is a small area of underground workings to the west of the pit. There is a low risk of subsidence occurring and no special measures are proposed.

There is an existing small sinkhole near the entrance to the Magcobar site which requires backfilling with inert material.

6.4 Deep water in pit

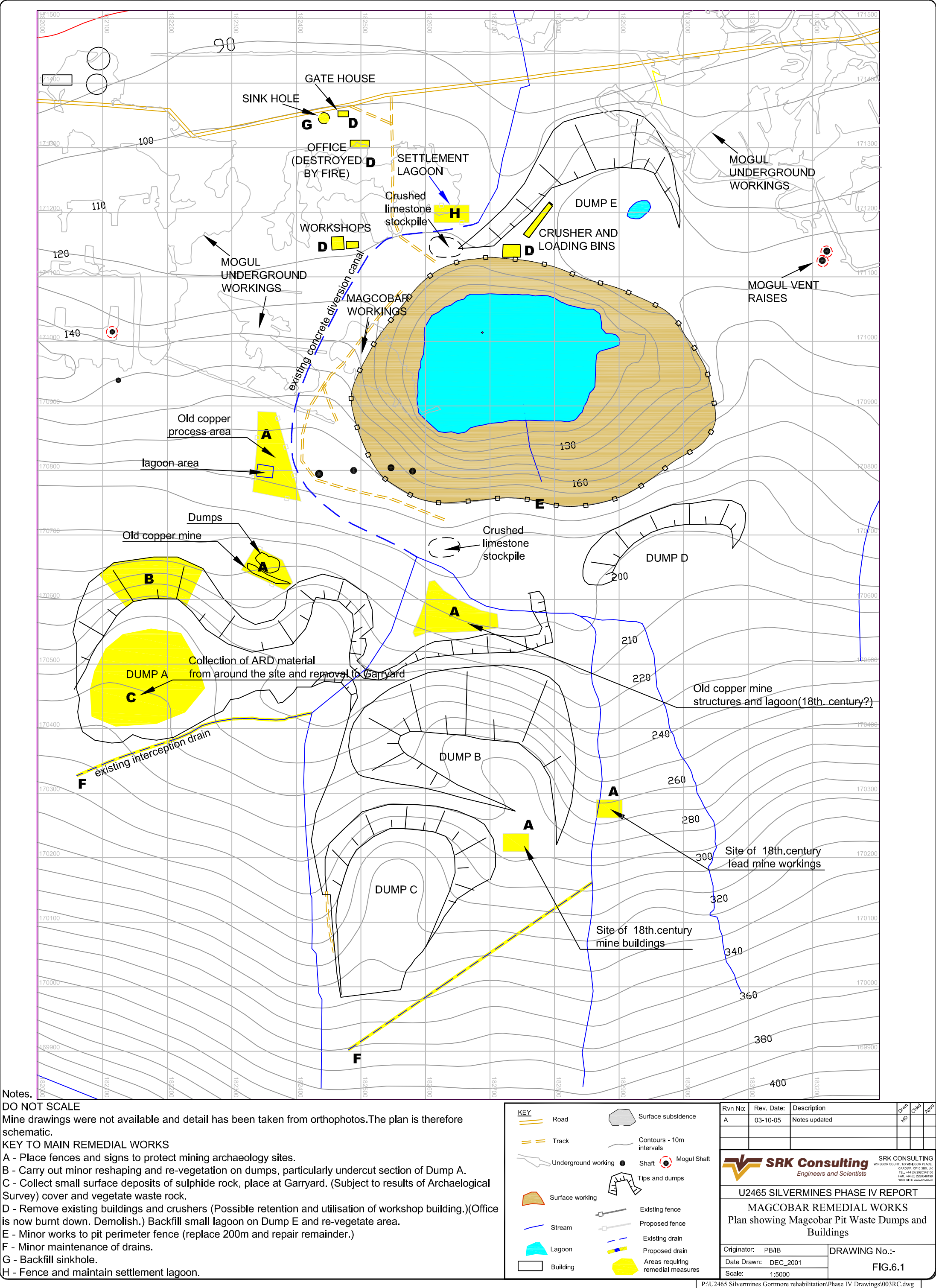
Maintenance of the fencing is proposed.

6.5 Contaminated pit water

The seepage of contaminated pit water is not assessed as a significant risk, but a further evaluation of pit chemistry is proposed. For the purpose of the costing of Table 6.1, three visits during the four year remediation period have been assumed, for depth sampling of water from a boat and laboratory testing.

6.6 Archaeological sites

The Magcobar pit and dumps have partly destroyed or covered old surface manifestations of previous lead and copper mines. Nevertheless, there remain certain workings, ponds and building foundations. It is intended that these will be protected by fences and signs, and investigated by mining archaeologists.



6.7 Visual impact of waste dumps

The Magcobar waste dumps are visible for a considerable distance, though their appearance has been softened by the vegetation, which has become naturally established. From 2003 to 2005 the vegetation cover has improved considerably. It is proposed that limestone from Magcobar Dump A be crushed and used for various remedial works. This will be done using a mobile crushing plant and the source of material will be integrated with improvement works to the dumps. Any remaining material on Dump A will be contoured and vegetated as necessary.

6.8 Waste dump stability

The dumps are granular and free-draining. Stability can be ensured by maintenance of the stormwater diversion channels and the streams. The indiscriminate excavation of material at the toe of Dump A must cease, and minor remedial earthworks be carried out.

6.9 Excavation of lime from waste dumps for use in remedial works

It is intended that limestone from Dump A will be used in remedial works at various locations. This will involve excavation from the dump, crushing and transportation to the site where the limestone is to be placed. The management and scheduling of this work and the final rehabilitation of Dump A will form part of the design for Magcobar. The utilisation of limestone will be in years two and three, and the final rehabilitation of Dump A will take place in year four.

6.10 Sulphides and oxidation products from waste dumps

There are small quantities of sulphide waste on the tops of the waste dumps which result in ochre staining and small flows of acidic water (Dumps C and A). There are probably other deposits within the dumps, but these are partly protected by their encapsulation and are not considered to be a similar problem.

The exposed deposits of sulphide waste will be collected and taken to Garryard.

6.11 Mine buildings and other surface structures

The existing mine buildings consist of a dilapidated prefabricated office building, a gate-house a steel frame, steel clad workshop and core shed buildings in good condition. There is also a crusher and loading bins and a diesel storage tank.

It is proposed that the gate-house, the crusher and bins and the diesel tank will be demolished and removed to an off-site disposal facility, with parts sold as scrap where feasible. The office building has been destroyed by fire and must be demolished and removed. The workshop buildings can be re-used for agricultural or other purposes but, if no such future use can be found, they will be demolished. The lagoon on top of Dump E will be backfilled and re-vegetated.

6.12 Settlement lagoons north of open pit

The settlement lagoons to the north of the open-pit, which discharge into the stream, will be fenced and maintained.

7 REMEDIAL & MANAGEMENT WORKS FOR GARRYARD

Figure 7.1 is a plan of the Garryard area showing the proposed remedial works.

7.1 Access

The Garryard Plant area is being used by a local contractor, as a transport depot. The hard-standing to the West of the plant area has been extended by the deposition of waste and scrap materials, and various changes are being made by demolition of some of the old plant buildings.

The old hostel building is on land owned by a farmer, and is now his property. The building is derelict and without a roof.

The Old Stockpile area is now owned by a farmer.

7.2 Settlement pond

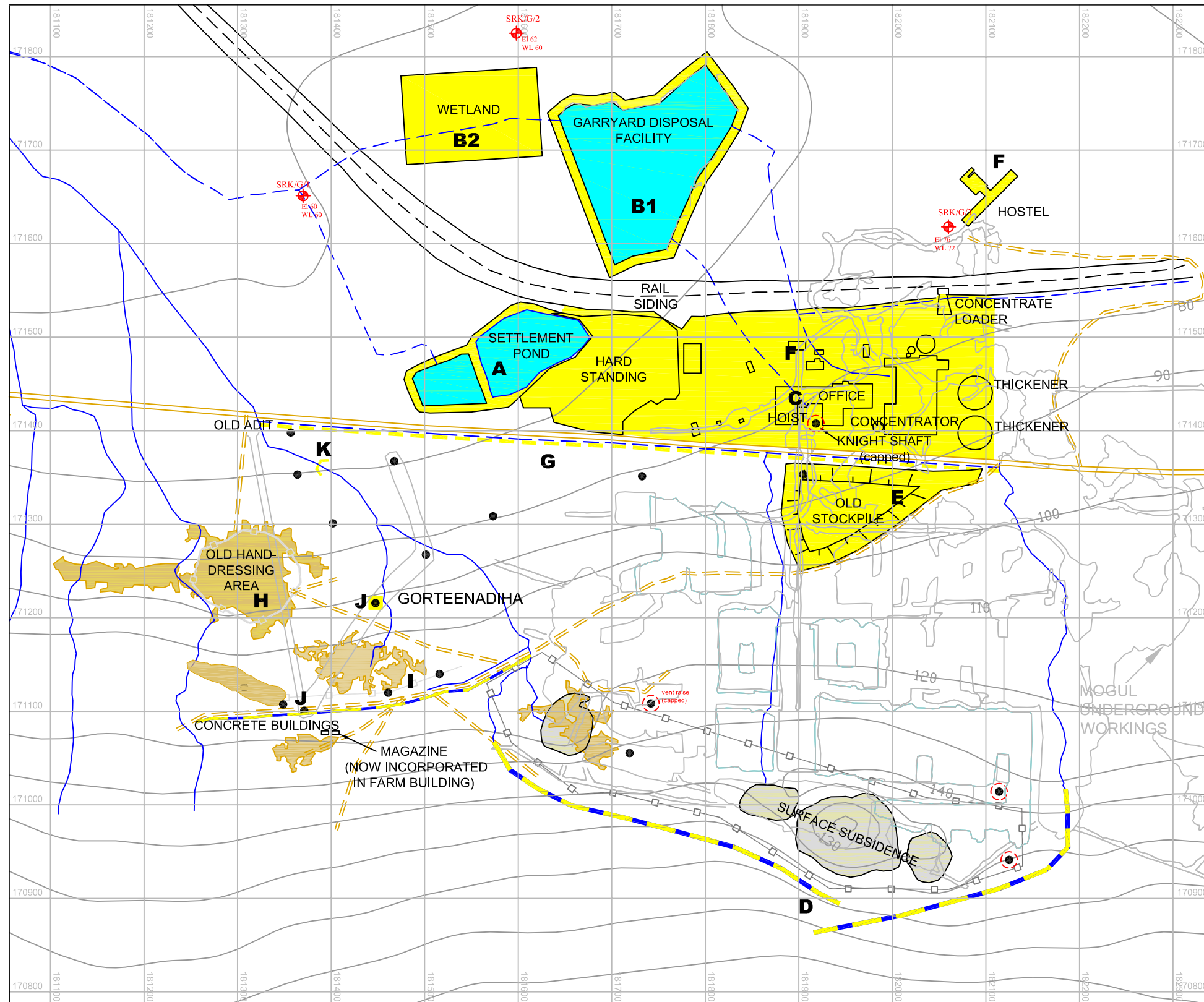
The settlement ponds receive run-off from the Garryard Plant area. They consist of one large pond spilling into a second pond, which discharges to a stream over a weir. It is intended that the ponds will continue to function as holding ponds for plant area run-off, and that minor works will be carried out to tidy the first pond and encourage the development of a wetland. This will not be a designed wetland, and no works will be carried out on the second pond.

The existing fence will be repaired and maintained.

7.3 Tailings Lagoon

The Tailings Lagoon contains deposits of process waste, and the water quality in this lagoon is poor. The sediment contains very high levels of metals. It receives water from the plant area and water from the underground workings issuing from the Knight Shaft. It is intended to construct an engineered facility at the tailings pond to contain the tailings and wastes from other areas as defined in this report. A designed wetland will then be constructed downstream of the facility in the adjacent field, to receive any runoff from the facility with all clean surface run-off diverted around the facility. The size and nature of the wetland will depend on the volume and quality of the water discharged to it, which will be determined as part of the final design of the disposal facility.

For the purpose of the present conceptual design of the disposal facility, assumptions have been made about the requirements for underlining and cover materials. . Figure 7.2 shows a conceptual design.

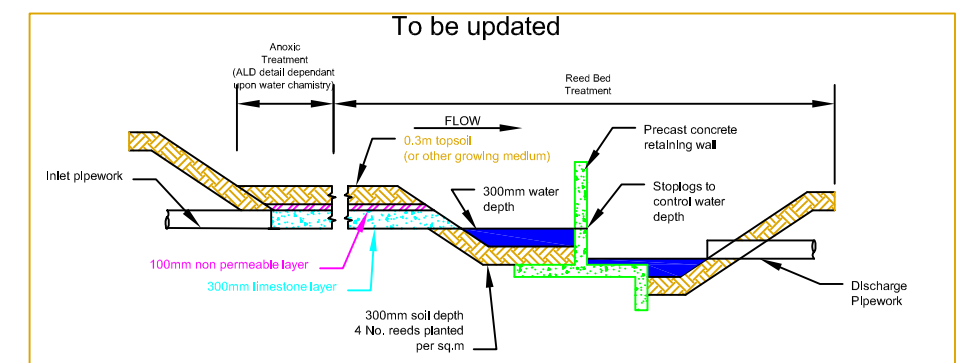


Notes.

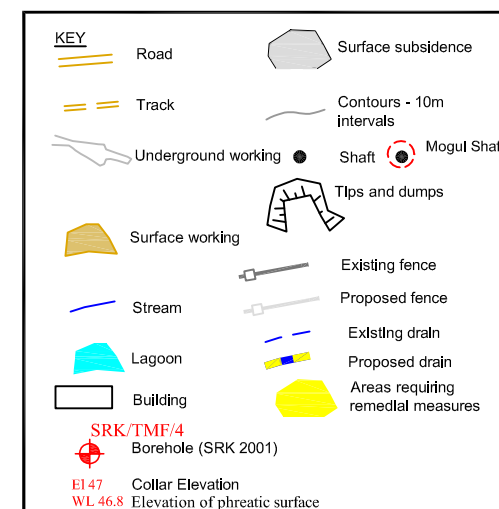
DO NOT SCALE

KEY TO MAIN REMEDIAL WORKS

- A - SETTLEMENT PONDS - Maintain ponds and decant system as natural wetland.
B1 - GARRYARD DISPOSAL FACILITY - Rehabilitate into engineered disposal facility.
B2 - WETLAND - Establish wetland for treatment of streamflow from Garryard Disposal Facility (B1).
C - KNIGHT SHAFT - Maintain discharge flow to Garryard disposal facility.
D - SUBSIDENCE ZONE - Repair and maintain existing fence. Install diversion trench.
E - OLD STOCKPILE - Remove contaminated dumped material to Garryard disposal facility, level, cap and re-vegetate.
F - PLANT AREA - (now used for transport depot) Profile and cover unsurfaced areas; carry out landscaping works; remove hostel building.
G - DIVERSION DRAIN ALONG ROADSIDE - Repair and maintain drainage system (possible culvert to settlement pond).
H - GORTEENADIHA CONSERVATION - Protect mining archaeology sites with fence and signs. (Actual position of fence to be determined by archaeologist.)
I - GORTEENADIHA - Fence existing road and install drain.
J - OPEN SHAFTS - Fence around perimeter of open shafts (not to be backfilled).
K - RETENTION STRUCTURE - Construct gabion sediment trap.



Schematic section through proposed wetland (B2)



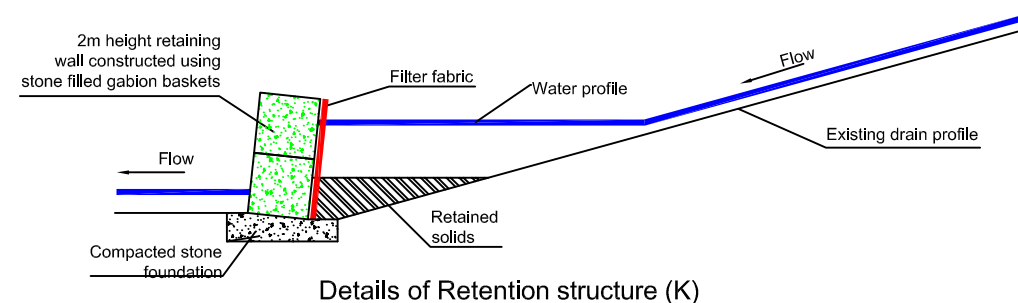
Rvn No:	Rev. Date:	Description	Drawn	Checked	Approved
A	03-10-05	Boreholes added, Notes updated	MD		

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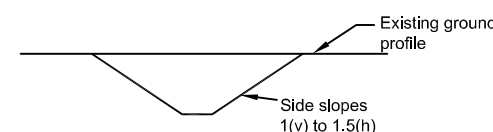
U2465 SILVERMINES PHASE IV REPORT

GARRYARD REMEDIAL WORKS Plan showing Garryard Plant and Lagoons, Subsidence zone and Gorteenadiha workings

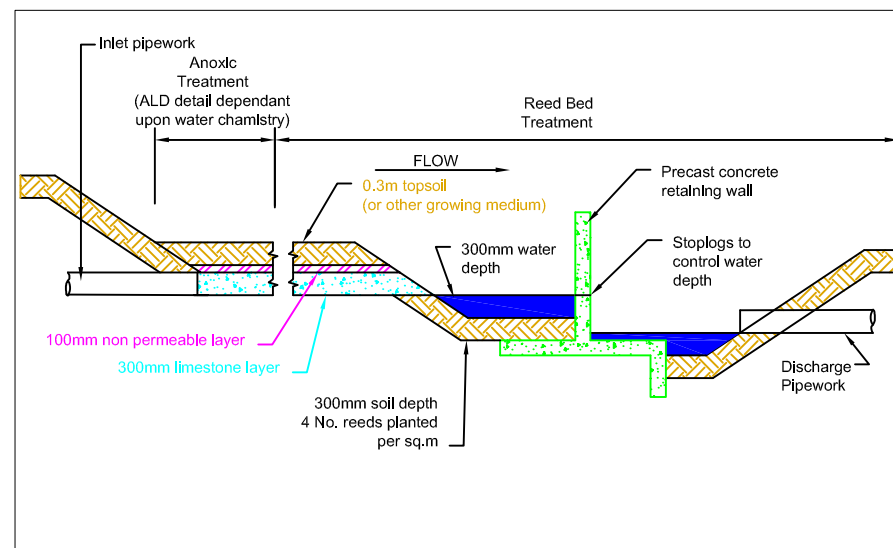
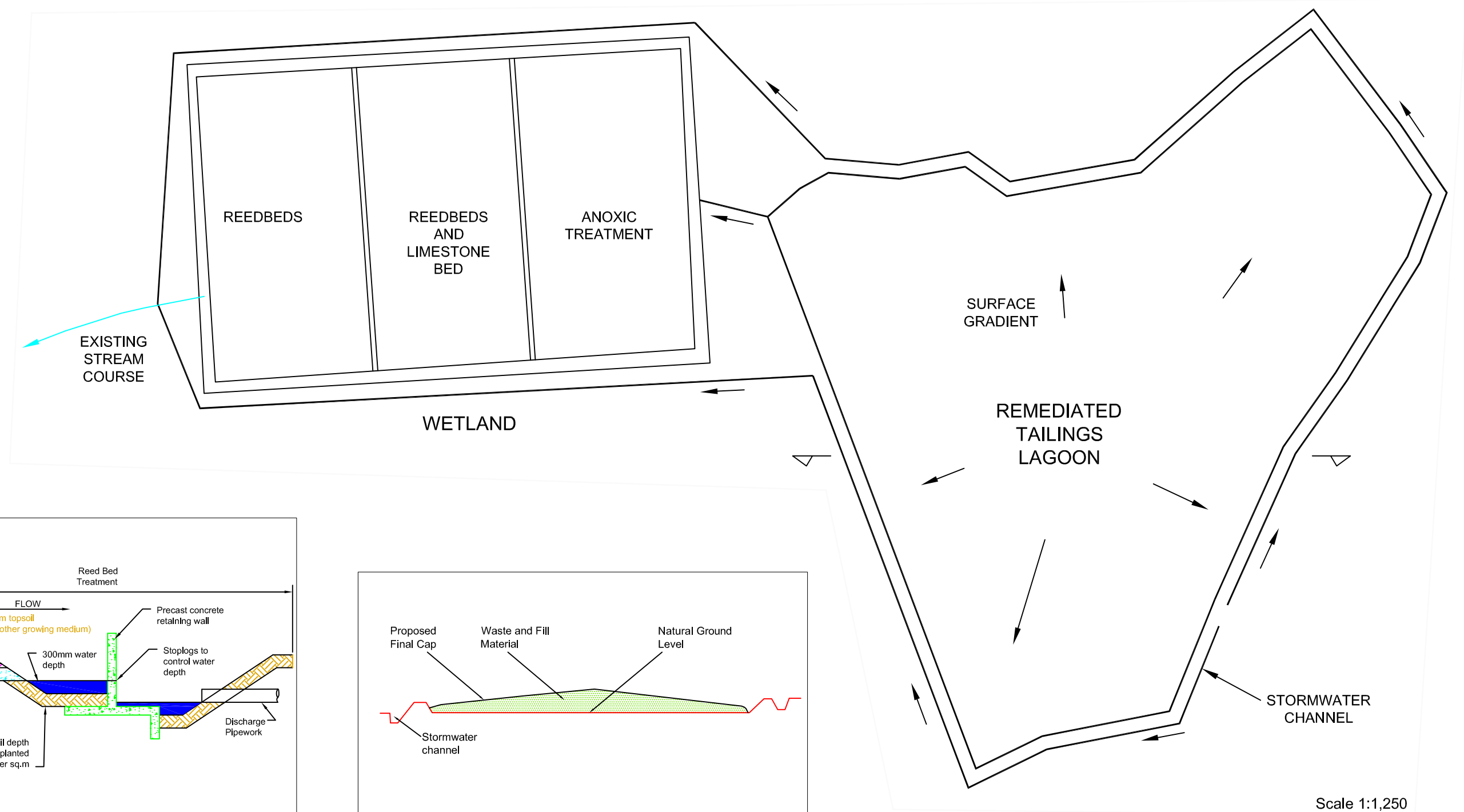
Originator: PB/IB	DRAWING No.:-
Date Drawn: DEC_2001	FIG.7.1
Scale: 1:5000	



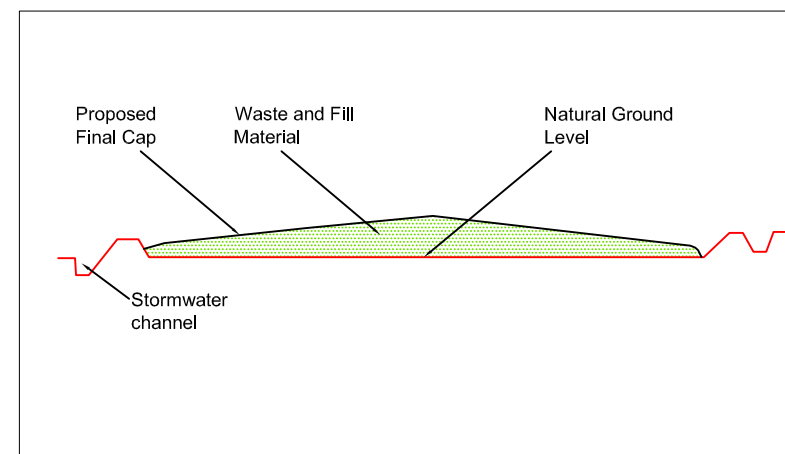
Details of Retention structure (K)



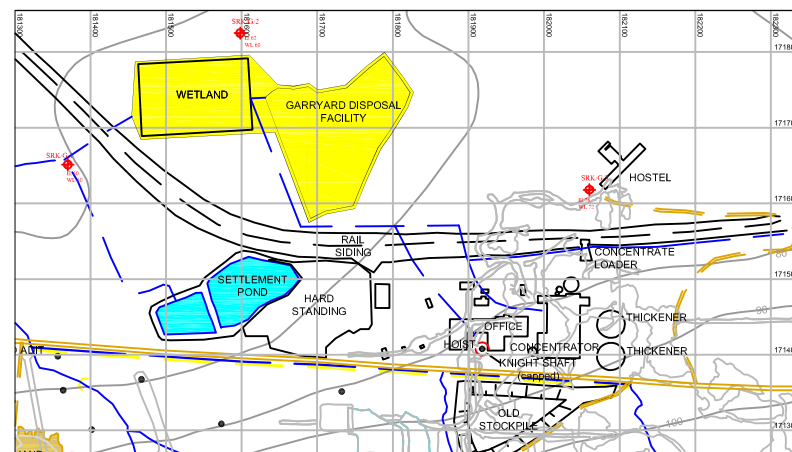
Details of drainage ditch



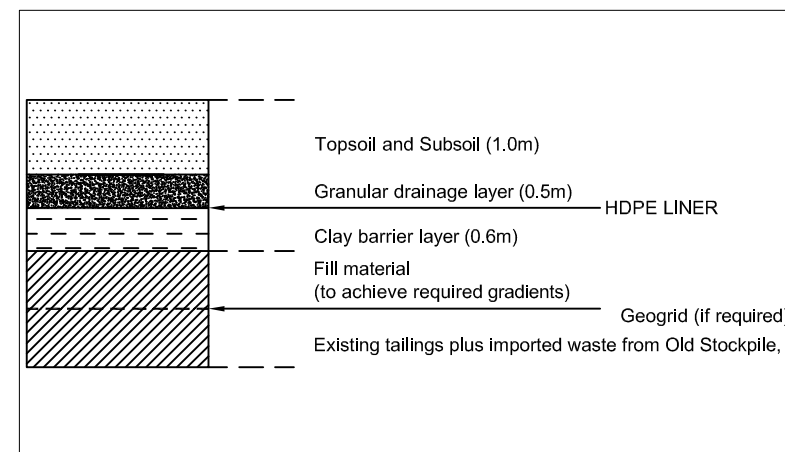
Section through the proposed wetland



Section through remediated tailings lagoon (exaggerated vertical scale)



Location Plan (Scale: 10,000)



Section through the capping on the remediated tailings lagoon

Scale 1:1,250

Notes.

DO NOT SCALE

Rvn No:	Rev. Date:	Description	Drawn	Checked	Approved

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U2465 SILVERMINES PHASE IV REPORT

Plan showing conceptual design for Garryard
tailings lagoon remediation

Originator: GT/IB	DRAWING No.:-
Date Drawn: SEPTEMBER_2005	FIG.7.2

7.4 Main Garryard Shaft, the Knight Shaft

The Knight Shaft, beside the old Hoist Building, has a concrete capping and a discharge pipe. Water flows from this pipe after rain but, for much of the year, no water issues from the shaft. The water is led to the Tailings Lagoon.

No change is to be made to the present arrangements, but an explanatory sign will be erected to ensure that the shaft and its discharge system is protected.

7.5 Other Mogul shafts

The following additional Mogul shafts have been identified:

- Vent shaft above the Waeltz Plant, Ballygown (capped);
- Two vent shafts to the east of the Magcobar pit (to be located during the topographical survey);
- Two vent shafts to east of subsidence zone, Gorteenadiha (to be located during the topographical survey);
- Vent shaft to west of subsidence zone, Gorteenadiha (capped).

It is understood from Mogul that all the Mogul shafts were capped. It is intended that all shafts will be located and the condition of the tops of these shafts will be ascertained and remedial measures undertaken as necessary.

7.6 Subsidence of Mogul underground mine

The large sinkholes over the stopes beside the Silvermines Fault have been fenced. There will be no significant development of the subsidence zone to the south, at the fault, because the workings do not extend beyond the fault. Similarly, the existing subsidence covers the full east-west extent of the workings next to the fault, and will not progress further. To the north, there may in the future be some further subsidence (Fig.9.2, Phase II report). However, as the land is used only for grazing, no special precautionary measures are proposed, other than routine inspections. It is not anticipated that sudden sinkhole formation will occur, because of the depth of the workings and the amount of underground backfill, but that visible surface settlement will give prior indication of future subsidence.

The adequacy of the existing fencing will be assessed. Repairs and extensions to the fencing will be carried out as required. For the purpose of the conceptual design a nominal allowance has been made for extensions and repairs.

A topographical survey will be carried out, and surface drains will be installed to divert run-off around the subsidence zone. This measure is required because the uncontrolled ingress of water facilitates the development of subsidence.

7.7 Production of sulphides and oxidation products in the water from the Mogul underground mine

There is periodic discharge from the underground workings from the Knight Shaft. As explained in Section 7.4 above, this water will be discharged to a wetland to be constructed downstream of the Garryard disposal facility.

7.8 Garryard Old Stockpile

The Old Stockpile contains deposits of process residues, ore and scrap. This material will be excavated. The contaminated soil and rock waste will be placed in the Garryard facility, and the scrap will be taken off-site for disposal on a designated waste disposal site. A layer of imported soil will then be placed on the Old Stockpile area and grassed, to restore the area to pasture. Minor works will be carried out to ensure the integrity of the surface drainage system, which includes a channel along the road and a small natural water course.

7.9 Garryard Mine buildings at the plant site

The remaining plant buildings include steel-frame steel-clad Concentrator, Office and Hoist Buildings, two old farm cottages pre-dating the mine and several other small mine buildings. Some of the buildings have been demolished by the present occupier and the material used to extend the parking area for trucks and goods laydown.

There has been a change of usage, with the site now used as a transport depot. The following process is proposed:

- (a) Preparation of schedule of remedial works;
- (b) Preparation of specification for allowable usage;
- (c) Removal of derelict Hostel building;
- (d) Preservation of old farm cottages;
- (e) Re-profiling and covering of unsurfaced areas;
- (f) Landscaping works;
- (g) Control and management of drainage.

It appears that trucks are washed on site and this could result in oils, grease and chemicals draining offsite. The present drainage is to the tailings pond but the site drainage must be properly designed by the present owner and agreement reached for treatment.

The railway sidings belong to CIE and have not been included in the remedial programme. Much of the rolling stock previously in the siding has been removed but

there is some remaining. Discussions should be held with the CIE to determine their plans for the future and to ensure compatibility with the proposed remedial works.

7.10 Mogul Shafts

Ventilation shafts associated with the Mogul workings appear to have been capped with a concrete cover. The details of capping are not known, but an allowance must be made for locating all shafts and capping or fencing where necessary.

8 REMEDIAL & MANAGEMENT WORKS FOR GORTEENADIHA

Figure 7.1 gives a plan of the Garryard area with the proposed remedial works for Gorteenadiha indicated.

8.1 Access

The Gorteenadiha workings are on a farm property, and there is no public right of access. Unauthorised access on foot is very easy, however, as there is an open track from the main Silvermines road. It is proposed that this access be closed with a fence, and that future access be restricted.

8.2 Drainage system along road

The drain along the south side of the main road extends from the Garryard Old Stockpile to the culvert taking the Gorteenadiha stream under the road to the Yellow River. The purpose of this drain has been to lead run-off past the Garryard Plant site.

A sum has been allowed for the repair and maintenance of this system, and an additional contingency sum has been allowed for the possible future diversion of water to the Settlement Pond, involving a new culvert. The purpose of this possible diversion would be to detain water from Gorteenadiha which may be contaminated, and the need for such measures will only be known after monitoring of the system.

8.3 Gorteenadiha Mining Heritage

The archaeological inspection revealed mining remains, particularly in the hand-dressing area, which are valuable and which have not been investigated or catalogued. It is necessary to protect these remains for archaeological study, and it is intended that the areas will be fenced with 3-strand barbed wire and that information signs will be erected. The danger is not of vandalism but of disturbance occurring through ignorance.

The existing building structures, which are an intact magazine and the floor and columns of an accommodation for soldiers guarding the explosives, will be conserved. No remedial works are required. The recent site inspection showed that the landowner has incorporated the buildings into a storage shed. This was not inspected in detail and the condition of the original structures needs to be determined.

The owner also improved the access road to the magazine, along the route of the Cromwell road.

8.4 Gorteenadiha waste dumps

The waste dumps are small and scattered, but only partly vegetated and often waterlogged. They discharge sediment-laden water to the streams. A system of surface drainage control will be designed and a small gabion retention structure will be constructed to retain silt. This structure will be important during the execution of the remedial works, and subsequently, while vegetation is being established. The proposed works will be submitted to a mining archaeologist for approval, to ensure that there is no disturbance of valuable heritage areas. Fencing and information signs will be erected to prevent public access to sensitive areas.

8.5 Gorteenadiha underground and surface workings

The Gorteenadiha underground and surface workings, including shafts, adits and pits, represent a danger to humans and livestock. There are no available plans of the underground workings, though their approximate positions can be gauged from the known positions of shafts (See Fig.7.1). There is also known to be an old adit, presumably for drainage, running south-north but the entrance was not visible during the field inspection.

Most of the shafts appear to be backfilled although some are open. These need to be accurately located during the topographical survey, backfilled and fenced where necessary.

Fencing and information signs will be erected. The system of surface drainage control will include the area of the workings.

9 REMEDIAL & MANAGEMENT WORKS FOR SHALLEE SOUTH/EAST AND SHALLEE WEST

Figure 9.1 gives a plan of the Shallee South/East area with the proposed remedial works indicated. Shallee South/East consists of surface workings, underground workings, various historic mine buildings, plant structure bases, a reservoir, waste dumps and tailings impoundments.

During the present assessment of the mining archaeology and the tourist potential, it was concluded that, although the mining heritage of Shallee South/East, and indeed of the entire Silvermines area, is of great value to Ireland and the local community, the potential for a large-scale tourist development is limited, because the site is not directly on a major tourist route. It is proposed, therefore, that the Shallee South/East site should be conserved and made accessible to the public within certain limits of expenditure, but that no extensive tourist facilities should be constructed. This action would allow a review of the situation in the future, should the tourist potential alter.

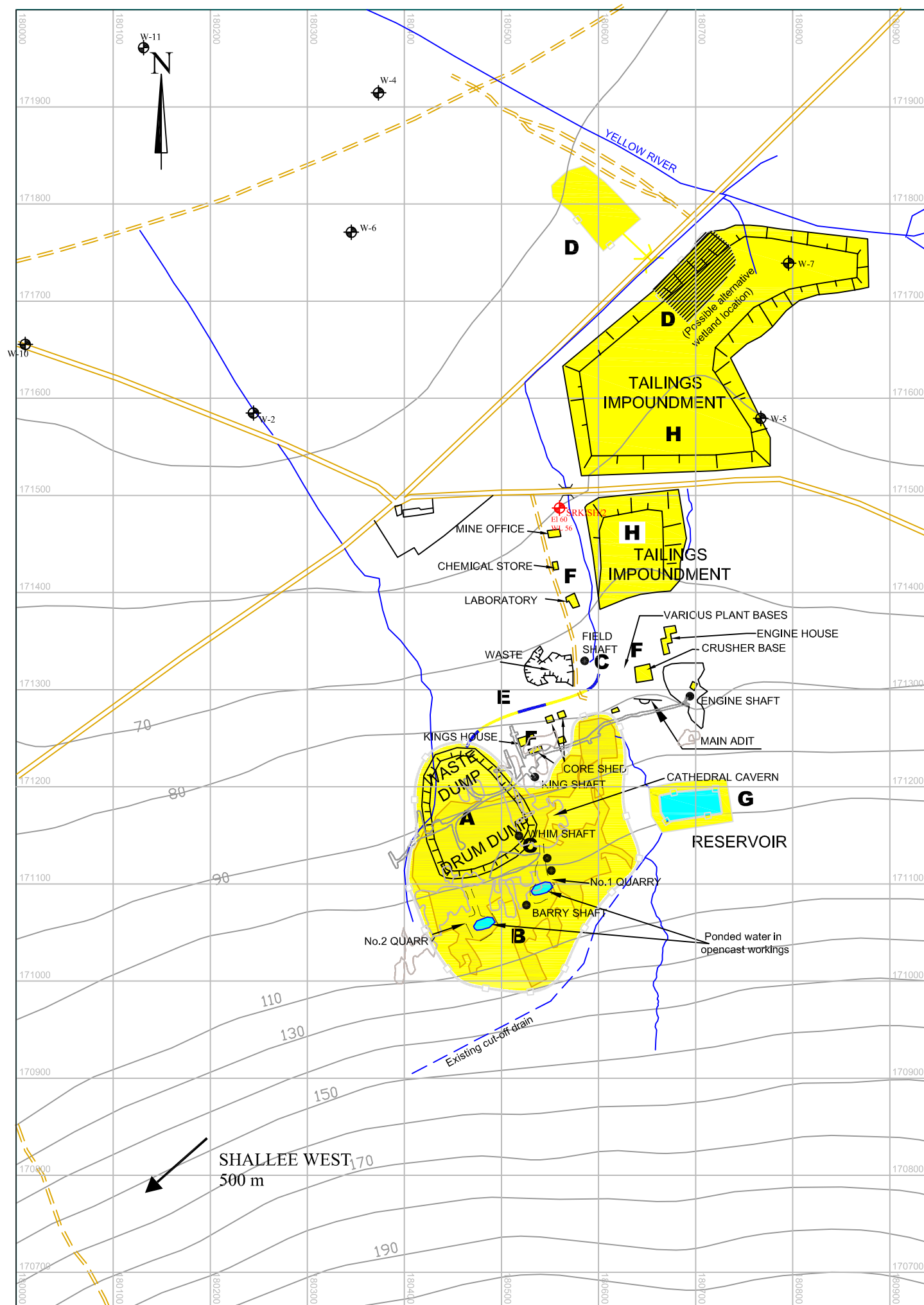
9.1 Feasibility Study for Mining Heritage Centre

This site has been proposed by Shannon Development as a Mining Heritage Site, and work has been carried out by others on the nature of this development, including layouts of tourist facilities and approximate costings. Although this option has not been adopted as the preferred option, the estimated costs are of interest for comparison to those of the preferred option.

The feasibility study of September 1994 by Brady Shipman Martin Architects, Mayday Marketing Ltd., Tourism and Leisure Consultants and Michael Punch and Partners, Consulting Engineers, proposed an underground tour, a substantial visitor centre, interpretative exhibits, and the conservation and repair of the various buildings and other structures. The projected lower scale of costs, increased by 20% for inflation since 1994, was estimated as follows:

Visitor Centre Building	€1,550,000
Site works and services (underground and surface)	€ 550,000
Interpretation (mine, site, centre)	€ 620,000
TOTAL	€2,720,000

Additional options could increase the cost by €480,000.

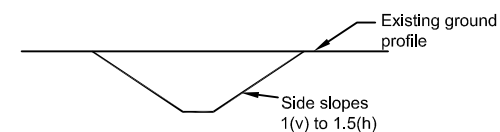


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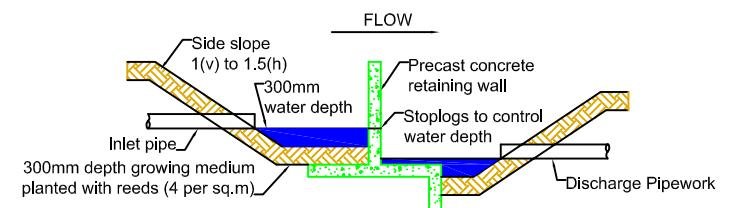
DO NOT SCALE

KEY TO MAIN REMEDIAL WORKS

- A - DRUM & WASTE DUMP - Remove waste from Drum and Waste Dump, from old opencast and other areas, and dispatch to Garryard, reshape surface and re-vegetate. Metal waste to be disposed of by specialist contractor.
- B - UNDERGROUND MINE AND MINE PITS - Conserve for heritage purposes and make safe with perimeter fence. Remove rubbish from pit lakes, and dispatch to Garryard.
- C - OPEN SHAFTS - Fence Field shaft; improve grill on Whim shaft. Treat other shafts as appropriate.
- D - WETLAND - Establish wetland for treatment of streamflow from Shallee South/East.
- E - DRAINAGE DIVERSIONS - Install diversion trenches to stream near Kings House.
- F - SURFACE STRUCTURES - Conserve Engine House, Kings House, and other mine structures in accordance with heritage plan.
- G - RESERVOIR - Install fence.




Schematic details of drainage ditch



Schematic section through proposed wetland (D)

KEY		SRK/TMF/4	
	Road		Surface subsidence
	Track		Contours - 10m intervals
	Underground working		Shaft
	Surface working		Tips and dumps
	Stream		Existing fence
	Lagoon		Proposed fence
	Building		Existing drain
			Proposed drain
			Areas requiring remedial measures
			SRK/TMF/4 Borehole (SRK 2001)
			E1 47 Collar Elevation
			WL 46.8 Elevation of phreatic surface
			W-6 Borehole (Mogul water supply-1966)

Rvn No:	Rev. Date:	Description	Drawn	Chkd	Apprd
A	03-10-05	Boreholes added, Notes updated	MD		



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U2465 SILVERMINES PHASE IV REPORT	
SHALLEE REMEDIAL WORKS Plan showing Shallee South/East mine area	
Originator: PB/IB	DRAWING No.:- FIG.9.1
Date Drawn: DEC_2001	
Scale: 1:5000	

P:\U2465 Silvermines Gortmore Rehabilitation\Phase IV Drawings\1606_14a.dwg

9.2 Access

Access to Shallee South/East and Shallee West by livestock and public is not controlled, but will be controlled as part of the heritage development.

9.3 Toxicity of ponded water in opencast areas

There is ponded water in parts of the opencast areas. No direct action is proposed to deal with the possible toxicity of this water, but all water leaving the site is to be treated in a wetland (dealt with in a later sub-section).

9.4 Scrap and waste in opencast

45 gallon drums, steel cable and other miscellaneous scrap has been deposited in the opencast pits. This will be removed to a designated scrap metal site.

9.5 Safety of ponds and rock faces, opencast pits and trenches

Fencing and signs will be erected.

9.6 Shafts

The Whim vent shaft is a vertical shaft covered by an open grill with large grill openings. This is deemed to be unsafe and requires urgent attention to make safe for humans and animals, who have easy access to the site. The Field Shaft is a conduit for mine water, and is effectively a spring. This shaft will be fenced. Other shafts and adit entrances will be treated as appropriate to the proposed conservation of the area.

9.7 Underground mine subsidence, collapse and rock falls

It is anticipated that part of the underground workings will be made accessible to the public. A geotechnical assessment of the safety of these areas has previously been made. The surface above the workings will be fenced as necessary, and access will be controlled in accordance with the proposed development as a heritage site.

9.8 Sulphide and oxidation products from the underground workings

Surface water will be diverted around the mine area. Water issuing from the mine out of the Field Shaft will be discharged to a proposed wetland for retention and treatment before entering the Yellow River. This wetland will be to the north-west of

the northern tailings impoundment, and the water from Shallee South/East will enter this wetland via a culvert under the tar road.

An alternative site for a wetland is at the northern end of the northern tailings facility but the elevation and size needs survey before it can be considered. This site would remove the need to construct a culvert under the road.

9.9 Tailings dust

The tailings impoundments to the south and north of the road are well-vegetated, and the generation of significant quantities of dust is not anticipated. Some areas require attention to vegetation. Livestock access will be prevented, public access will be controlled and the establishment and maintenance of vegetation will be encouraged.

9.10 Tailings stability

The risk of instability is low, and no action is required.

9.11 Tailings leachate and tailings erosion

The production of contaminated leachates and the discharge of sediment to the natural stream will be managed by livestock and public access controls, by surface drainage controls and by establishment of vegetation. The run-off from the tailings impoundments will be discharged to a wetland (9.9 above) for treatment before release to the Yellow River.

9.12 Waste dumps –mine waste

No action is required to stabilise or remove the small volumes of mine waste generated from the Shallee Mine which are spread over the site. They are stable and covered in natural vegetation.

9.13 Waste dumps – scrap and process wastes (Drum Dump etc.)

The scrap comprises drums, steel cable and general scrap, mixed with ore process waste and waste ore. The ore process waste and waste ore will be segregated from the scrap and taken to Garryard.

The scrap will be removed to an off-site designated disposal area.

9.14 Mine buildings and Plant Site

All the mine buildings and surface structures are to be conserved. In the case of structures such as the concrete plant bases, no action is required apart from trimming of reinforcing steel and protruding bolts to make safe. The old engine house requires minor works such as repointing to prevent further deterioration, but it is not proposed that it will be completely restored. Other buildings require works to prevent further deterioration and, where a specific use is proposed, to carry out restoration. The following procedure is proposed:

- (a) Preparation of schedule of conservation for all surface structures and their restoration needs;
- (b) Execution of conservation measures and landscaping.

For the purpose of costing the conceptual design, a nominal sum has been allowed for the full restoration of King's House, and for works to prevent further deterioration of other structures. The recent inspection showed that the house has been extensively vandalised inside although the exterior structure is intact.

9.15 Water reservoir

It is intended that the existing water reservoir will be maintained and fenced.

9.16 Shallee West

The remaining surface manifestations of mining at Shallee West are surface trenches and small deposits of the excavated waste.

There is some ponded water in the trenches. Remediation will comprise the fencing of the deeper trench areas for safety and limited backfilling of the waste piles into the open pits as considered necessary.

10 REMEDIAL & MANAGEMENT WORKS FOR GORTMORE TMF

Figure 10.1 gives a plan of the Gortmore TMF area with the proposed remedial works indicated. There were large dust blows from the TMF in the 1980s. However, since that time, the surface of the impoundment has been vegetated, and there have been no recurrences of these major dust blows. However, dust from Gortmore TMF is considered by the local community to remain a major problem.

The potential contamination of the groundwater by seepage from the TMF was investigated and reported in Phase II.

Although there is some evidence of contamination, levels of metals are not a cause for concern. Future evaluation of groundwater quality may require restrictions on use of groundwater for certain purposes immediately downstream of the TMF.

10.1 Access

The Gortmore TMF has been sold by Mogul to a farmer, who commenced to graze sheep on the surface, and to construct a ramp at the northern corner. NTCC issued an instruction to remove the ramp and restore the tailings impoundment to its previous state at that point. This has been done. The Council also ordered the farmer to remove livestock from the impoundment, and he has complied.

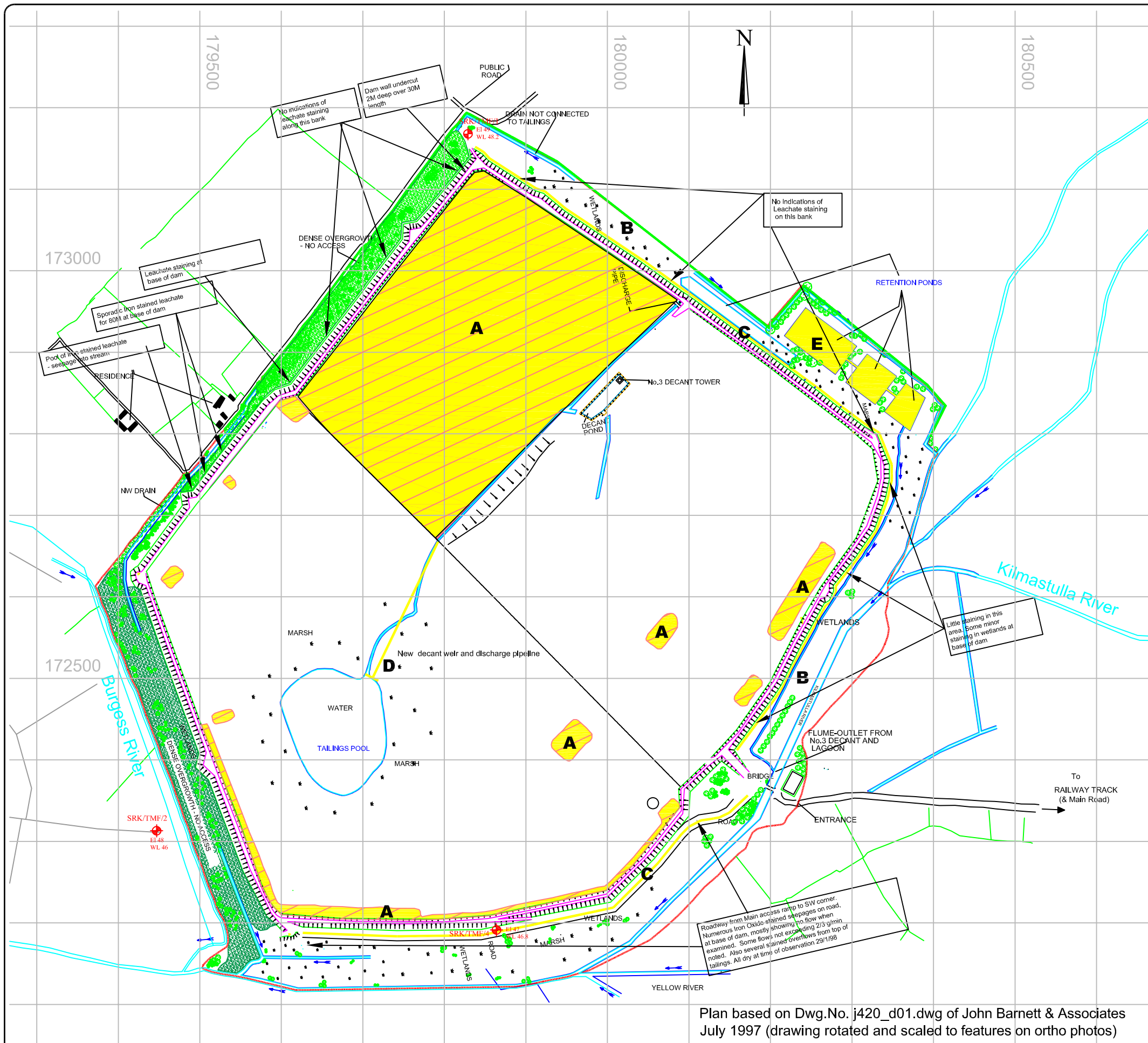
There is no public access to the Gortmore TMF.

10.2 Tailings dust

Although there is a low risk of a significant dust blow at present, there is a potential high risk for the future if vegetation is not maintained.

Poorly-vegetated areas have been identified. Additional growth medium will be applied to these areas, and re-vegetated. The successful vegetation windbreaks at the crest of the slopes will be extended, and a tree screen will be planted at the bottom of the outer slopes.

The crests of tailings dam slopes are a major source of dust when the dams are not vegetated. The establishment of crest vegetation has proved to be very effective in reducing dust, even in situations where the surface of the dam is not well-vegetated. This is because the crest vegetation traps dust emanating from the upper surface of the impoundment and breaks up the air currents which lift additional dust from the crest area and slope.

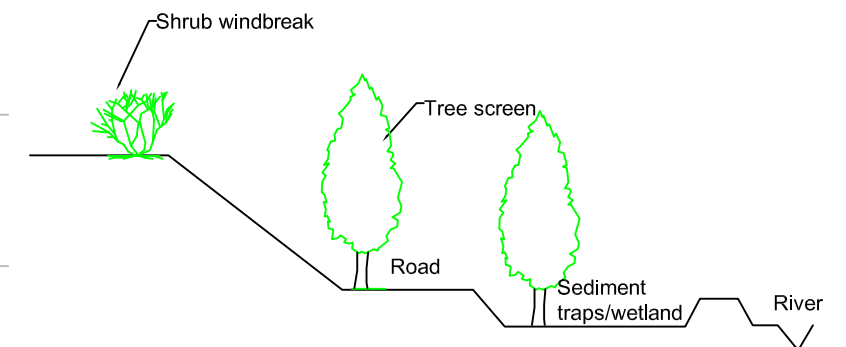


Notes.

DO NOT SCALE

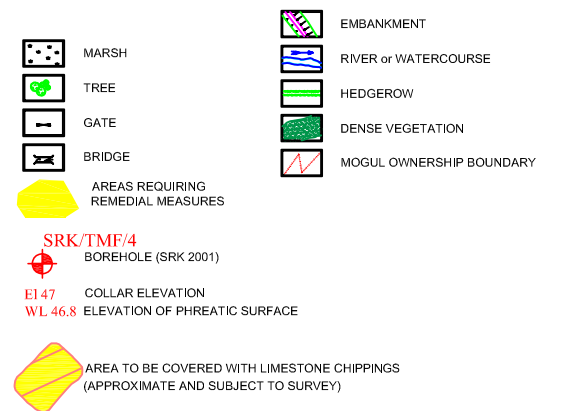
KEY TO MAIN REMEDIAL WORKS

- A - Growth medium to be placed on areas of poor vegetation; existing windbreak shrubs at crest to be extended. (Area to be re-vegetated to be determined, yellow area on plan is approximate only)
- B - Plant tree screen at toe.
- C - Improve existing sediment traps at toe and repair gulleys.
- D - Construct new decant weir and discharge pipeline from Tailings Pool.
- E - Carry out remedial repairs to Retention Ponds and optimise wetland operations.



Schematic section through outer slope showing windbreak at crest and proposed tree screen

KEY



Rvn No:	Rev. Date:	Description	Dwn	Chkd	Appd
A	03-10-05	Boreholes added, Notes updated	MD		



U2465 SILVERMINES PHASE IV REPORT

GORTMORE REMEDIAL WORKS Plan of tailings impoundment

Originator: PB/IB	DRAWING No.:-
Date Drawn: DEC_2001	FIG.10.1
Scale: 1:5000	

10.3 **Visual**

Although the outer slopes are of rockfill, and not a main source of dust, they are un-vegetated and unsightly. As they are too steep to vegetate successfully, and as a pushdown would be problematic and very costly, it is proposed as described in 10.2 that additional growth medium will be placed and vegetated on the bare strip around the crest, and that trees will be planted at the toe, to provide an eventual effective visual screen.

10.4 **Leaching of metals**

The leaching of metals to surface water is controlled by the existing system of retention ponds and controlled discharges, and the control will be enhanced by the prevention of grazing, the improvement of surface drainage and upgrading of the existing retention ponds, which serve as wetland water treatment systems. There is very little impact of the TMF on the quality of the Kilmastulla River.

Leaching of metals to groundwater is occurring but it appears to be at a low rate. There is some local contamination of groundwater but attenuation and dilution appears to provide natural remediation. Improving drainage and vegetation on the TMF surface will reduce leaching. The existing groundwater monitoring holes should be maintained and monitored during the project and periodically in the future.

10.5 **Erosion**

Tailings erosion will be controlled by the re-vegetation programme, by the proposed restricted access and prevention of grazing, by the repair of existing erosion gulleys, and by the improvement of the existing sediment traps around the toe.

10.6 **Instability**

The risk of failure of the slopes of the TMF is low. Maintenance and repair of existing surface drainage systems will be carried out.

10.7 **Tailings pool**

The pool on the upper surface of the TMF is formed by rainwater in a depression on the south-west side. It is intended to maintain this pool at a constant maximum size by upgrading the decant overflow system. At present, the water flowing from the pool passes along an open trench to the retention ponds, and the water quality

becomes poor. This channel will be upgraded by lining and erosion protection with limestone gravel from Magcobar. The chemistry of the pool must be evaluated in more detail and if found to be poor, consideration should be given to draining the pool and to design the long term drainage to prevent development of a pool. Although the pool has developed as a small haven for birdlife, it could be causing harm.

10.8 Retention ponds

During the operation of the mine, these ponds collected decant water for return to the plant. Now they receive stormwater run-off from the tailings pool, and discharge it through a drain along the south-east side of the TMF to the Kilmastulla River.

A detailed study will be carried out to review the water balance and assess the performance of the wetlands to remove metals. Minor works will be carried out to repair the ponds, to lengthen the water retention time and thus enhance the quality of the discharge water.

10.9 Delivery pipeline

The slurry pipeline delivered tailings from the plant to the TMF. It is common for pipe breaks to occur during operation and for discharges of tailings to occur. If these discharges are not cleared, they may contaminate farmland.

It is known that there was at least one pipe break and tailings discharge during the operation of the plant but this occurred adjacent to the TMF. Some tailings entered the Kilmastulla River. An inspection of the pipe route revealed no tailings deposits and the pipeline has been removed. It is concluded that what discharges occurred were minor or were cleared up by Mogul. No action is proposed.

10.10 Vegetation

A large part of the Gortmore TMF is vegetated (Figure 10.1), but in certain areas the vegetation has died. The procedure for revegetation and for maintenance will be as follows:

- Placement of a limestone gravel layer as required;
- Placement of soil or soil-forming material as growing medium and reseeded of grass;

- Monitoring of vegetation and remedial topsoiling and planting as necessary, with the aim of achieving a self-sustaining cover within five years.

(Further details of options are in Appendix G of the Phase II report.)

10.11 Soil forming material

The soil forming material will be from various sources including those offered by the local landowners. This will be mainly stream and drain dredgings. Borrow material from suitable sources may be required. The material can comprise any silt sand or loam provided the clay content is not high. This will be mixed with manure or other acceptable compost or organic material to help to form a growth medium.

On bare or poorly vegetated areas, a 75mm layer of crushed limestone will be placed as a buffer horizon and capillary break. 75mm of soil material will be placed over this and seeded.

The estimated area requiring cover is approximately 12 Ha.

10.12 Maintenance of vegetation

The objective is that the vegetation will be self sustaining. Apart from the works to establish or re-establish vegetation, annual routine maintenance of existing and new vegetation may be required for a limited period. This maintenance work has been assumed to include re-seeding and adding topsoil (0.15m) to 1ha of the TMF for the limited period.

11 SUMMARY OF QUANTITIES OF WASTE TO BE MOVED

Table 11.1 gives a summary of the hazardous and non-hazardous waste to be moved. It will be necessary to confirm these quantities during the detailed design.

Table 11.1: Summary of Hazardous and Non-Hazardous Materials to be moved

LOCATION	MATERIAL	NATURE	QUANTITY	DESTINATION	COMMENT
Ballygown - Silvermines stream bank	Process waste	Hazardous - Acid-generating, high metals content	Assumed none at present, but some reshaping	Reshaping or movement to Garryard Tailings Lagoon (GTL)	Strong local objections to excavation and removal of waste from Ballygown
Ballygown - Old Opencast	Granular ore material	Sand containing sulphides	2,000 m ³	Pushed into Old Opencast for land recovery and , landscaping	Material moved will be identical to material already in final location.
Ballygown – Walls at Waeltz plant	Concrete blocks	Non-hazardous	1,000 m ³	Placed in Old Opencast	
Ballygown – Roof sheets at Waeltz plant	Asbestos sheets	Hazardous	2,000 m ²	Garryard	
Magcobar – surface of waste dumps	Sulphidic rock	Hazardous, acid-generating	1,000 m ³	Garryard	Surface deposits which are clearly acid-generators
Garryard - Old Stockpile	Process waste and ore	Hazardous, acid-generating, high metals content	14,000 m ³	Garryard	Actual quantity to be determined by site investigation.
Garryard – Tailings Lagoon	Process waste	Hazardous, acid-generating, high metals content	22,000 m ³	Remain on site	Actual quantity to be determined by site investigation.
Shallee – Drum Dump and elsewhere	Process waste	Process waste acid-generating, possible cyanide residues, high metals content	4,000 m ³	Garryard	Actual quantity to be determined by site investigation.
Shallee – Drum Dump and elsewhere	Metal scrap	Scrap non-hazardous, process waste acid-generating, high metals content	100 tonnes	Scrap off-site for recycling	
Streams and river	Dredgings	Non-hazardous	500 m ³ /year, reducing annually	Gortmore TMF for soil building and land recovery	
Streams and river	Dredgings	Hazardous	500 m ³ /year, reducing annually to negligible quantity after three years.	Garryard	For period during which facility remains open Subsequent small quantities to be removed to designated licensed site.

NOTE: Quantities are estimates, but have not yet been measured.

12 PROPOSED TIME SCHEDULE FOR IMPLEMENTATION OF REMEDIAL WORKS

12.1 General

The proposed programme has been designed to:

- (a) Prioritise works, which are considered urgent. The initial work will comprise the planning and permitting as well as fencing in some areas. The most important remedial works will include the works to the upper surface and embankments of the Gortmore TMF, and the development of the Garryard disposal facility.
- (b) Provide a sequential programme, which will allow an assessment of the effectiveness of the implemented measures before the execution of the next stage. This will optimise expenditure and ensure that no unnecessary works are carried out.
- (c) Spread the costs over the project period, to improve cashflow.

The programme has been prepared for a four year period although the majority of the contractual work will be done in years 2 and 3.

The programme given in Figure 12.1 is indicative only. It is considered that adequate preparation and planning is vital to ensure the success of the works and the efficient use of the available resources.

12.2 Preliminary works

The initial works to be carried out prior to the detailed design will be:

- Topographical surveys
- Archaeological assessment for protection of sites
- Some of the fencing
- Site investigation and risk analysis for proposed Garryard waste facility
- Permitting

12.3 Detailed design phase

The detailed design, including any additional site investigations, will be carried out for the entire project area, and will include tender documentation and tender adjudication. Some of the design work will be required for the permitting process.

12.4 Construction

The construction contracts will be let to suitably qualified contractors by competitive bid. The execution of the works will be supervised by the design consultant, including certification, and with the involvement of specialists as appropriate.

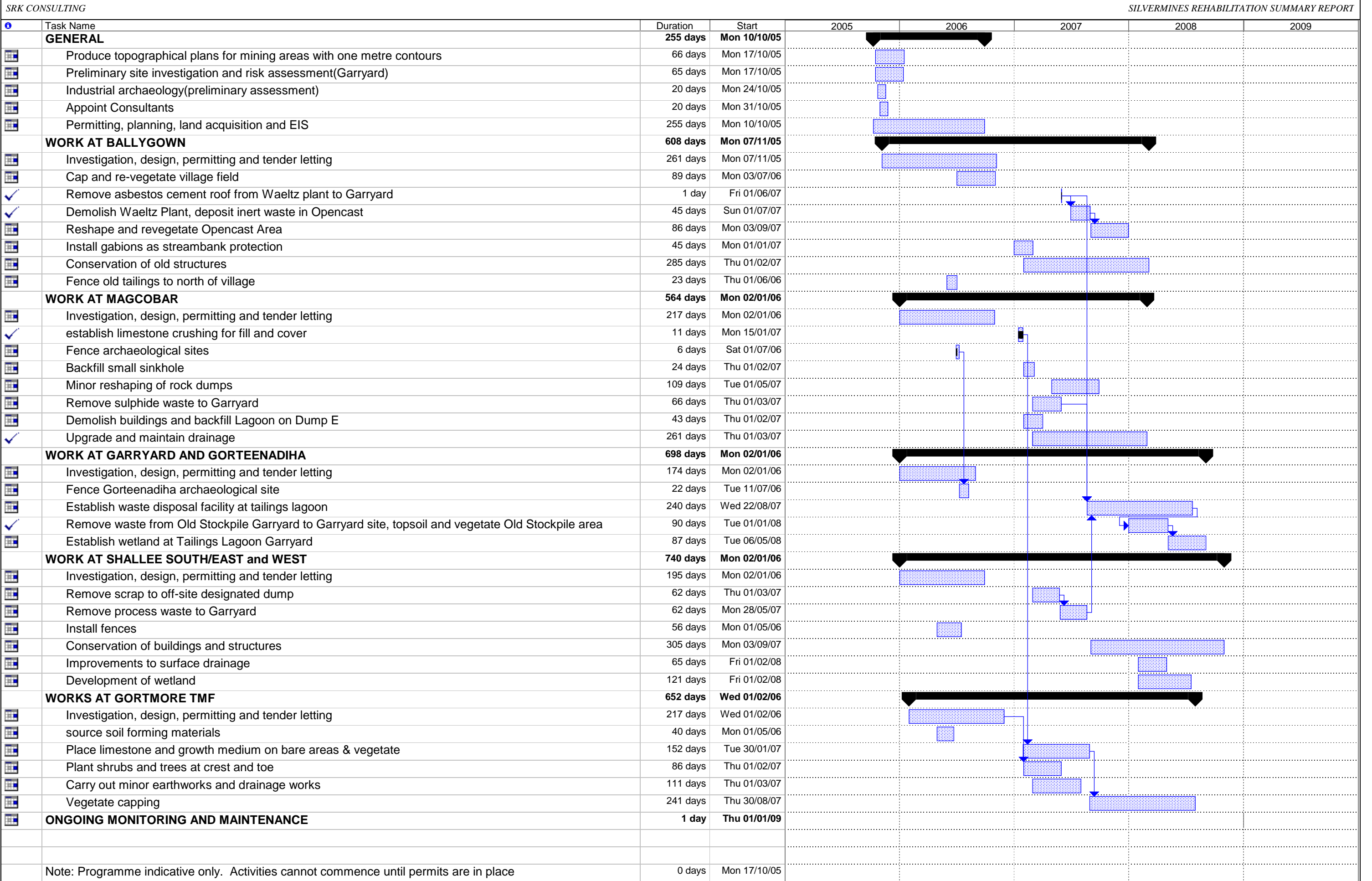


Figure 12.1: Indicative Time Schedule for Main Remedial Works

13 CONCLUDING REMARKS

The conceptual design presented in this report has been based on the available information, on consultations with interested and affected parties and on the results of site investigations. It presents the preferred remediation options selected in the Phase II report and an update of the phase III report.

The conceptual design gives the manner in which the environmental impacts will be mitigated. An overall Environmental Impact Statement, based on the work carried out, will be required to confirm the acceptability of this design. An example is the proposed removal of hazardous waste from the Garryard Old Stockpile and Shallee South/East areas and its storage at Garryard, which requires permitting before the measure can be adopted.


The Silvermines area, sitting against the side of the Silvermines Mountain, is a fascinating amalgam of historic mining sites, the Silvermines Village and attractive farmland. The proposed remedial works will restore the site to local people and to tourists interested in the mining history of the area as well as to provide a facility for educational purposes.

For and on behalf of SRK Consulting (UK) Ltd



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Dr Ian Brackley
Principal Engineer



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Richard Connelly
Principal Hydrogeologist

APPENDIX A
RISK AND PREFERRED OPTION TABLES
FROM PHASE II REPORT

Table 14.2: Site - Ballygown

Source	School playing field (I2.1)	Village field ⁺ (I2.2)	Opencast area (two pits) (I2.3)	Sulphur mine pit (I2.4)	Shafts (I2.5)	Underground mine (I2.6)	Mine water discharge (I2.7)	Waste materials (I2.8)	Mine buildings/plant site (I2.9)
Hazard/issue	<ul style="list-style-type: none"> Contaminated soil 	<ul style="list-style-type: none"> Contaminated soil <p>* (Village field is club field above school, not school playing field)</p>	<ul style="list-style-type: none"> Stability Leaching of metals Depth of water 	<ul style="list-style-type: none"> Open shafts/adits Footwall cliff 	<ul style="list-style-type: none"> Open shafts/adits Collapse of backfill Discharge of mine water 	<ul style="list-style-type: none"> Mine workings 	<ul style="list-style-type: none"> Sulfides/ oxidation products 	<ul style="list-style-type: none"> Sulfides/oxidation products Erosion of contaminants 	<ul style="list-style-type: none"> Historic stone structures (Engine House and Furnace Building) Concrete buildings at Waeltz Plant with asbestos roof
Pathway	<ul style="list-style-type: none"> Human ingestion/exposure Erosion and seepage 	<ul style="list-style-type: none"> Human ingestion/exposure Erosion and seepage 	<ul style="list-style-type: none"> Leaching of metals Seepage to surface & groundwater Ingestion by animals Instability of excavations Access 	<ul style="list-style-type: none"> Access to shafts/adits Access to cliff 	<ul style="list-style-type: none"> Access to shaft Flooding or discharge to surface water through shafts Proximity of buildings (two instances) 	<ul style="list-style-type: none"> Subsidence 	<ul style="list-style-type: none"> Seepage to groundwater/ surface water 	<ul style="list-style-type: none"> ARD/ metal leaching Seepage to groundwater/ surface water 	<ul style="list-style-type: none"> Collapse Toxic dust
Receptors	<ul style="list-style-type: none"> Human Streams 	<ul style="list-style-type: none"> Human Streams 	<ul style="list-style-type: none"> Surface water Groundwater Human & livestock safety 	<ul style="list-style-type: none"> Humans and livestock 	<ul style="list-style-type: none"> Human & livestock safety Proximity of buildings 	<ul style="list-style-type: none"> Livestock Human 	<ul style="list-style-type: none"> Surface water Groundwater 	<ul style="list-style-type: none"> Surface water (local stream in village) Groundwater 	<ul style="list-style-type: none"> Human Livestock
Impact	<ul style="list-style-type: none"> Toxicity Stream quality 	<ul style="list-style-type: none"> Toxicity Stream quality 	<ul style="list-style-type: none"> Human & Livestock safety & health, herbage toxicity Unstable slopes 	<ul style="list-style-type: none"> Human and livestock safety 	<ul style="list-style-type: none"> Building/road damage Human and livestock safety Flooding and shaft erosion 	<ul style="list-style-type: none"> Loss of land use Livestock & human safety 	<ul style="list-style-type: none"> Human health Livestock & herbage 	<ul style="list-style-type: none"> Human health Livestock & herbage Transport of contaminants 	<ul style="list-style-type: none"> Human & Livestock safety & health
RISK	<ul style="list-style-type: none"> LOW 	<ul style="list-style-type: none"> MEDIUM (both) 	<ul style="list-style-type: none"> LOW (stability danger) LOW (toxicity danger) MEDIUM (drowning) 	<ul style="list-style-type: none"> HIGH (shaft/adit danger to humans and livestock) LOW (cliff danger to humans and livestock) 	<ul style="list-style-type: none"> HIGH (damage to structures) HIGH (danger to humans & livestock) MEDIUM (water discharge) 	<ul style="list-style-type: none"> LOW (land-use) LOW (property) LOW (danger to humans & livestock) 	<ul style="list-style-type: none"> LOW (humans) MEDIUM (livestock) 	<ul style="list-style-type: none"> MEDIUM (humans) LOW (livestock) MEDIUM (transportation of contaminants) 	<ul style="list-style-type: none"> LOW (danger to humans of stone and concrete structures) MEDIUM (human toxicity from asbestos) LOW (livestock toxicity from asbestos)
Potential end use	<ul style="list-style-type: none"> School playing field 	<ul style="list-style-type: none"> Recreational area * Derelict land 	<ul style="list-style-type: none"> Fenced pit lagoon Backfill to derelict land 	<ul style="list-style-type: none"> *Derelict land 	<ul style="list-style-type: none"> Grazing Controlled public use * Derelict land 	<ul style="list-style-type: none"> Rough grazing * Derelict land 	<ul style="list-style-type: none"> Drain for underground workings 	<ul style="list-style-type: none"> * Derelict land 	<ul style="list-style-type: none"> Heritage Site Continued farm usage at Waeltz Plant
Potential Remediation Options	<ul style="list-style-type: none"> Completed (one metre of inert cover soil and gravel placed) 	<ul style="list-style-type: none"> Requires cover and improved drainage for recreational use Information signs 	<ul style="list-style-type: none"> Partial re-shaping Control of public access Partial backfilling Re-vegetation 	<ul style="list-style-type: none"> Cap shafts Backfill shafts Fence adits 	<ul style="list-style-type: none"> Backfill shafts Water pressure release Information signs Capping shafts 	<ul style="list-style-type: none"> No action Information signs 	<ul style="list-style-type: none"> Sediment trap and clearance at adit entrance Removal of sediment from Silvermines River None 	<ul style="list-style-type: none"> Remove and dispose contaminated material Remove contaminated sediment from stream Partial removal from stream bank/erosion control Cover waste rock to minimise leaching Reprofile Intercept run-off Re-vegetate Information signs 	<ul style="list-style-type: none"> Possible use of some of Waeltz Plant buildings for farm purposes Conservation of Waeltz Plant buildings for future heritage restoration with removal of roofs Reduce Waeltz plant buildings to window cell height and conserve Conservation of Old Engine House and Furnace Building
Preferred option	<ul style="list-style-type: none"> School playing field 	<ul style="list-style-type: none"> Recreational area 	<ul style="list-style-type: none"> Partial backfilling and re-vegetation 	<ul style="list-style-type: none"> * Derelict land 	<ul style="list-style-type: none"> As appropriate for individual shafts (details in Section I2.5) 	<ul style="list-style-type: none"> No action 	<ul style="list-style-type: none"> Sediment trap and clear adit entrance. 	<ul style="list-style-type: none"> Remove minor quantities from stream bank and re-profile Intercept run-off 	<ul style="list-style-type: none"> Demolish Waeltz Plant, retain footprint Conserve Old Engine House and Furnace Building
Actions	<ul style="list-style-type: none"> Completed 	<ul style="list-style-type: none"> Design and cost works Install cover layer, vegetate and improve drainage Monitor stream quality as part of regional system 	<ul style="list-style-type: none"> Backfilling and re-shaping Establishment of vegetation Ownership and access to be determined 	<ul style="list-style-type: none"> Grill over east adit entrance Fence round west adit Backfill and re-vegetate open shafts Information signs 	<ul style="list-style-type: none"> Survey all shafts and adits Geophysical survey to locate drainage tunnel below road Backfill shafts, fence shafts which serve drainage function Drill pressure release boreholes (2 number) and construct overflow drainage pipeline to river (I2.7) Drill holes to confirm tunnel location/condition (integrate with I2.7) 	<ul style="list-style-type: none"> None Information signs 	<ul style="list-style-type: none"> Sediment trap and clear adit entrance. Monitor discharge, and maintain integrity of drainage <p>(Sediment removed from River as part of regional plan).</p>	<ul style="list-style-type: none"> Detailed survey Removal material from stream bank, deposit in opencast and re-vegetate banks. Monitor stream water quality Install signs Construct run-off interception and silt trap 	<ul style="list-style-type: none"> Conservation and development as Heritage Site Conservation of old engine house and furnace building structures Demolition and removal of Waeltz Plant structures, retaining footprint Specialist removal and disposal of asbestos on designated site

* **Note: Derelict land** – Means land for which there will be no benefit in restoration, refer to Section 13.6 of Phase II Report for definition

Table 14.3: Site – Magcobar

Source	Open pit & adjacent limited underground workings				Archaeological sites	Rock dumps			Mine buildings/plant site
Hazard/issue	<ul style="list-style-type: none"> Slope stability (I3.1) 	<ul style="list-style-type: none"> Subsidence of underground workings (I3.2) 	<ul style="list-style-type: none"> Deep water (I3.3) 	<ul style="list-style-type: none"> Contaminated water (I3.3) 	<ul style="list-style-type: none"> Destruction of old lead and copper mine remains (I3.4) 	<ul style="list-style-type: none"> Visual (I3.5) 	<ul style="list-style-type: none"> Stability (I3.6) 	<ul style="list-style-type: none"> Sulphides/oxidation products (I3.7) 	<ul style="list-style-type: none"> Safety (I3.8)
Pathway	<ul style="list-style-type: none"> Contact 	<ul style="list-style-type: none"> Contact 	<ul style="list-style-type: none"> Contact 	<ul style="list-style-type: none"> Seepage to groundwater Leaching from sidewalls Ingestion by animals & birds 	<ul style="list-style-type: none"> Remedial works 	<ul style="list-style-type: none"> Visible from a distance 	<ul style="list-style-type: none"> Slope failure 	<ul style="list-style-type: none"> ARD/ metal leaching Seepage to groundwater/ surface water 	<ul style="list-style-type: none"> Access
Receptors	<ul style="list-style-type: none"> Humans and livestock 	<ul style="list-style-type: none"> Humans and livestock 	<ul style="list-style-type: none"> Livestock & human 	<ul style="list-style-type: none"> Groundwater Livestock & human 	<ul style="list-style-type: none"> Historic mine remains 	<ul style="list-style-type: none"> Human 	<ul style="list-style-type: none"> Humans and livestock 	<ul style="list-style-type: none"> Surface water Groundwater 	<ul style="list-style-type: none"> Humans and livestock
Impact	<ul style="list-style-type: none"> Injury and death Ravelling back outside present boundary 	<ul style="list-style-type: none"> Injury and death Subsidence affecting pit stability 	<ul style="list-style-type: none"> Human & Livestock safety & health 	<ul style="list-style-type: none"> Groundwater contamination Human & Livestock safety & health 	<ul style="list-style-type: none"> Loss of mining heritage 	<ul style="list-style-type: none"> Visual 	<ul style="list-style-type: none"> Injury Exposure of fresh material 	<ul style="list-style-type: none"> Contamination of water Human health Livestock toxicity 	<ul style="list-style-type: none"> Human and livestock safety
RISK	<ul style="list-style-type: none"> MEDIUM (danger to humans and livestock) MEDIUM (waste dump stability at crest) 	<ul style="list-style-type: none"> LOW (danger to humans and livestock) LOW (pit stability) 	<ul style="list-style-type: none"> HIGH (danger to humans and livestock) 	<ul style="list-style-type: none"> MEDIUM (human toxicity) LOW (livestock toxicity) LOW (groundwater contamination) 	<ul style="list-style-type: none"> HIGH 	<ul style="list-style-type: none"> LOW 	<ul style="list-style-type: none"> MEDIUM (human and livestock safety Dump A) LOW (human and livestock safety (other dumps) 	<ul style="list-style-type: none"> MEDIUM (human & livestock toxicity) MEDIUM (acid drainage to streams) 	<ul style="list-style-type: none"> LOW (risk to humans and livestock)
Potential end use	<ul style="list-style-type: none"> Landfill None 	<ul style="list-style-type: none"> Rough pasture. 	<ul style="list-style-type: none"> Pit lake or landfill 	<ul style="list-style-type: none"> Pit lake or landfill, 	<ul style="list-style-type: none"> Heritage site Archaeological investigation, then derelict land 	<ul style="list-style-type: none"> * Derelict land 	<ul style="list-style-type: none"> * Derelict land Source of aggregate for fill 	<ul style="list-style-type: none"> * Derelict land 	<ul style="list-style-type: none"> Possible alternative commercial use for workshop Demolition and removal of other buildings
Potential Remediation Options	<ul style="list-style-type: none"> Prevent access by fencing (There is an existing fence) Partial backfill Remove waste rock pile from pit edge Backfill (Landfill) 	<ul style="list-style-type: none"> Do nothing Extend boundary fence over undermined area 	<ul style="list-style-type: none"> Prevent access to pit by fence (existing, but requiring improvement) 	<ul style="list-style-type: none"> Pump and treat Increase alkalinity Limit surface run-off Prevent access 	<ul style="list-style-type: none"> Protective fence and signs Archaeological investigation 	<ul style="list-style-type: none"> Re-profile to blend with natural topography Prevent uncontrolled removal of stone from toe of dump Promote vegetation 	<ul style="list-style-type: none"> Prevent uncontrolled removal of stone from toe of slopes, Dump A Flatten slopes Maintain drainage channels around and under dumps Use as aggregate/fill source Institutional controls (signage) 	<ul style="list-style-type: none"> Intercept and treat seepage Cover waste rock to minimise leaching Consolidate and cover acid generating material 	<ul style="list-style-type: none"> Remove crusher plant Remove oil tanks Remove office Consider alternative use for workshops
Preferred option	<ul style="list-style-type: none"> Fencing to prevent access and leave as pit lake 	<ul style="list-style-type: none"> Extend fence as precautionary measure 	<ul style="list-style-type: none"> Fencing to prevent access and leave as pit lake 	<ul style="list-style-type: none"> Fencing to prevent access and leave as pit lake 	<ul style="list-style-type: none"> Protective fence and signs for future archaeological investigation 	<ul style="list-style-type: none"> Minor re-shaping and re-vegetation 	<ul style="list-style-type: none"> Prevent uncontrolled removal of stone at Dump A, carry out minor re-shaping and re-vegetate Use as fill source Institutional controls (signage) 	<ul style="list-style-type: none"> Consolidate and cover 	<ul style="list-style-type: none"> Removal or re-use of buildings
Actions	<ul style="list-style-type: none"> Improve and maintain fences to prevent public access 	<ul style="list-style-type: none"> Survey Extend fence (see I3.4 and I3.1) 	<ul style="list-style-type: none"> Improve and maintain fences to prevent public access 	<ul style="list-style-type: none"> Improve and maintain fences to prevent public access Monitor water quality (depth profile of quality) Evaluate pit lake chemistry 	<ul style="list-style-type: none"> Install protective fence and information signs 	<ul style="list-style-type: none"> Carry out minor reshaping Establish new vegetation 	<ul style="list-style-type: none"> Prevent uncontrolled removal of material Assess and use dump material as fill where required for remediation Maintain drainage channels Carry out minor reshaping 	<ul style="list-style-type: none"> Consolidate and cover Place cover on selected areas of crest Maintain and improve surface drainage 	<ul style="list-style-type: none"> Evaluate existing structures Schedule removal or new usage.

* **Note: Derelict land** – Means land for which there will be no benefit in restoration, refer to Section 13.6 of Phase II Report for definition

Table.14.4: Garryard (Mogul), including subsidence zone

Source	Settlement pond (I4.1)	Tailings Lagoon (I4.2)	Main Garryard Shaft (I4.3) (a)	Other Mogul Shaft (I4.3) (b)	Mogul underground mine (I4.4)		Garryard Old Stockpile (I4.5)	Garryard Mine Buildings at the Plant Site (I4.6)
Hazard/issue	<ul style="list-style-type: none"> Contaminated water 	<ul style="list-style-type: none"> Contaminated water Contaminated sediment 	<ul style="list-style-type: none"> Open shaft Water discharge 	<ul style="list-style-type: none"> Open shaft 	<ul style="list-style-type: none"> Subsidence 	<ul style="list-style-type: none"> Sulfides/oxidation products in underground water 	<ul style="list-style-type: none"> Sulfides/oxidation products Mill concentrate spillage 	<ul style="list-style-type: none"> Buildings Contaminated land
Pathway	<ul style="list-style-type: none"> Seepage to surface & groundwater Ingestion by animals 	<ul style="list-style-type: none"> Leaching of metals from sludge in pond Seepage to surface & groundwater Ingestion by animals 	<ul style="list-style-type: none"> Cap damage Water head in workings 	<ul style="list-style-type: none"> Cap damage Open shaft 	<ul style="list-style-type: none"> Access 	<ul style="list-style-type: none"> Seepage to groundwater Discharge to surface due to blocking shaft discharge 	<ul style="list-style-type: none"> ARD/ metal leaching Seepage to groundwater/ surface water Erosion to drains Livestock access 	<ul style="list-style-type: none"> Access Leaching of chemicals from contaminated land
Receptors	<ul style="list-style-type: none"> Surface water Groundwater Livestock 	<ul style="list-style-type: none"> Surface water Groundwater Livestock 	<ul style="list-style-type: none"> Human Surface water 	<ul style="list-style-type: none"> Human Livestock 	<ul style="list-style-type: none"> Surface dwellings, livestock, human health 	<ul style="list-style-type: none"> Groundwater surface water 	<ul style="list-style-type: none"> Surface water Groundwater 	<ul style="list-style-type: none"> Livestock, Human Streams
Impact	<ul style="list-style-type: none"> Contamination of local water Human health Livestock 	<ul style="list-style-type: none"> Contamination of local water Human health Livestock & herbage toxicity 	<ul style="list-style-type: none"> Human Contamination of local water 	<ul style="list-style-type: none"> Death or injury 	<ul style="list-style-type: none"> Loss of land use, Property damage Livestock & human safety 	<ul style="list-style-type: none"> Contamination of groundwater and surface water 	<ul style="list-style-type: none"> Contamination of local water Human health Livestock & herbage toxicity 	<ul style="list-style-type: none"> Human and livestock safety (buildings) Livestock health & safety Human and livestock health (contaminated land)
RISK	<ul style="list-style-type: none"> MEDIUM (metals and TDS in sediment and streams) MEDIUM (human toxicity of ponds) HIGH (livestock toxicity of ponds) 	<ul style="list-style-type: none"> HIGH (metals and TDS in sediment and streams) MEDIUM (human toxicity) HIGH (livestock toxicity) 	<ul style="list-style-type: none"> LOW (damage) HIGH (discharge of contaminated water) 	<ul style="list-style-type: none"> LOW/UNKNOWN 	<ul style="list-style-type: none"> HIGH (loss of land-use, but only in specified area) LOW (surface dwellings) HIGH (safety) 	<ul style="list-style-type: none"> LOW 	<ul style="list-style-type: none"> HIGH (contamination of streams) MEDIUM (human toxicity) HIGH (livestock toxicity) 	<ul style="list-style-type: none"> LOW (danger to humans and livestock) LOW (human and livestock toxicity) MEDIUM (toxicity – drains to tailings lagoon)
Potential end use	<ul style="list-style-type: none"> Run-off pond and wetland 	<ul style="list-style-type: none"> Redevelop as wetland for mine water treatment 	<ul style="list-style-type: none"> Light industrial 	<ul style="list-style-type: none"> Farmland/derelict 	<ul style="list-style-type: none"> Farmland, but *derelict land with prohibited fenced access where subsidence risk high 	<ul style="list-style-type: none"> None 	<ul style="list-style-type: none"> Pasture 	<ul style="list-style-type: none"> Light industrial use for plant area and infrastructure * Derelict land
Potential Remediation Options	<ul style="list-style-type: none"> Encourage wetland development for Garryard surface drainage treatment, water flowing from plant area and hard standing Water treatment plant 	<ul style="list-style-type: none"> Engineered Cover Intercept and treat seepage and ponded water Divert clean water Remove contaminated sediment to Gortmore TMF Constructed wetland 	<ul style="list-style-type: none"> Monitor shaft flows Backfill shaft Information sign Drain shaft flows to wetland Treatment plant. 	<ul style="list-style-type: none"> Ascertain state of cap and carry out remedial works as appropriate. 	<ul style="list-style-type: none"> Fence off high risk areas Backfill subsidence with rock Divert surface water 	<ul style="list-style-type: none"> Divert surface water Maintain drainage of Knight Shaft water 	<ul style="list-style-type: none"> Intercept and treat seepage Profile and engineer cover & restore to pasture Remove waste to engineered containment 	<ul style="list-style-type: none"> Removal and site restoration Preserve old farm cottages Utilise buildings Profile and cover unsurfaced areas to prevent infiltration Landscaping around old plant area Manage drainage
Preferred option	<ul style="list-style-type: none"> Run-off ponds & wetland 	<ul style="list-style-type: none"> Remove sediment, construct wetland 	<ul style="list-style-type: none"> No change Information sign 	<ul style="list-style-type: none"> Make safe. 	<ul style="list-style-type: none"> Fence off and divert surface water Divert surface water 	<ul style="list-style-type: none"> Divert surface water Maintain shaft drainage 	<ul style="list-style-type: none"> Remove waste, cover and restore to pasture 	<ul style="list-style-type: none"> Light industrial use and manage drainage
Actions	<ul style="list-style-type: none"> Monitor inflows Works for natural wetland development, Pond A, no works required, Pond B Prevent further extension of existing hard standing 	<ul style="list-style-type: none"> Remove contaminated sediments Dispose of sediments on Gortmore TMF Design wetland Re-establish diversion canals 	<ul style="list-style-type: none"> Monitor shaft flows and cap condition Establish explanatory sign Drain to tailings lagoon wetland. 	<ul style="list-style-type: none"> Lock and inspect caps. Repair as necessary 	<ul style="list-style-type: none"> Carry out geotechnical assessment of potential subsidence Review existing and required fencing Topographic survey and design drainage 	<ul style="list-style-type: none"> Divert surface water Maintain shaft drainage to tailings lagoon Monitor 	<ul style="list-style-type: none"> Intercept and treat surface run-off and seepage Separate soil and metal waste Remove soil waste materials to Gortmore TMF and metal waste to designated off-site dump Place capping layer and re-vegetate 	<ul style="list-style-type: none"> Prepare schedule of remedial works Prepare specification for permissible usage Preserve old farm cottages Remove hostel Profile and cover unsurfaced areas Carry out landscaping works

* **Note: Derelict land** – Means land for which there will be no benefit in restoration, refer to Section 13.6 of Phase II Report for definition

Table.14.5: Gorteenadiha

Source	Gorteenadiha mining heritage (I4.7)	Gorteenadiha waste dumps (I4.8)	Gorteenadiha underground and surface workings (I4.9)
Hazard/issue	<ul style="list-style-type: none"> Loss of heritage structures 	<ul style="list-style-type: none"> Contaminated ground Discharge of contaminated water 	<ul style="list-style-type: none"> Subsidence Open shafts and pits Capped shafts
Pathway	<ul style="list-style-type: none"> Remedial works, agricultural works, etc. 	<ul style="list-style-type: none"> Access and contact Seepage to groundwater/surface water Water courses from site 	<ul style="list-style-type: none"> Access
Receptors	<ul style="list-style-type: none"> Heritage structures 	<ul style="list-style-type: none"> Human Livestock Surface water to Yellow River Groundwater 	<ul style="list-style-type: none"> Human Livestock
Impact	<ul style="list-style-type: none"> Destruction or damage to mining remains, including hand washing structures 	<ul style="list-style-type: none"> Human and livestock safety and toxicity Contamination of water courses and groundwater 	<ul style="list-style-type: none"> Human and livestock safety
RISK	<ul style="list-style-type: none"> HIGH 	<ul style="list-style-type: none"> MEDIUM (human toxicity) MEDIUM (livestock toxicity) MEDIUM (contamination of surface water) 	<ul style="list-style-type: none"> MEDIUM (subsidence) HIGH (danger to humans and livestock)
Potential end use	<ul style="list-style-type: none"> Heritage site * Derelict land 	<ul style="list-style-type: none"> Heritage Site * Derelict land 	<ul style="list-style-type: none"> Heritage site * Derelict land
Potential Remediation Options	<ul style="list-style-type: none"> Fence and erect information signs Carry out archaeological investigation and conserve (to be done before remedial works carried out) 	<ul style="list-style-type: none"> Placement of cover layer and vegetate Control of access Surface drainage works Water diversion and treatment Gabion retention structure to hold sediments Information signs Conservation and heritage 	<ul style="list-style-type: none"> Fence Backfill or cap shafts Surface drainage works Water diversion and treatment Information signs Conservation and heritage
Preferred option	<ul style="list-style-type: none"> Protect for future archaeological investigation 	<ul style="list-style-type: none"> Protect and conserve, install run-off controls 	<ul style="list-style-type: none"> Protect and conserve
Actions	<ul style="list-style-type: none"> Erect fences and information signs 	<ul style="list-style-type: none"> Design and construct system for drainage control Construct small gabion dam to retain silt during and after execution of remedial works Erect fencing and signage 	<ul style="list-style-type: none"> Map shafts and adits and backfill any open areas Design and construct system for drainage control Erect fencing and signage

* **Note: Derelict land** – Means land for which there will be no benefit in restoration, refer to Section 13.6 of Phase II Report for definition

Table.14.6: Site: Shallee South/East and Shallee West

Source	Opencast areas (pits and trenches) (I5.1)			Shafts (I5.2)	Underground mine (I5.3)			Tailings (I5.4)			Waste dumps (I5.5)		Mine buildings/plant site (I5.6)	Water reservoir (I5.7)	Shallee West (I5.8) Open Pit	Shallee West (I5.9) Waste Dumps
Hazard/issue	<ul style="list-style-type: none"> Toxicity of ponded water in opencast areas 	<ul style="list-style-type: none"> Scrap and waste in opencast 	<ul style="list-style-type: none"> Safety (ponds and rock faces) 	<ul style="list-style-type: none"> Open shaft Shaft collapse 	<ul style="list-style-type: none"> Subsidence/collapse/rock falls 	<ul style="list-style-type: none"> Safety (drowning, falls) 	<ul style="list-style-type: none"> Sulfides/oxidation products Surface contamination 	<ul style="list-style-type: none"> Dust 	<ul style="list-style-type: none"> Stability 	<ul style="list-style-type: none"> Leaching of metals from tailings Erosion of tailings 	<ul style="list-style-type: none"> Mine waste (rock spoil) 	<ul style="list-style-type: none"> Scrap and process wastes (Drum Dump, etc.) 	<ul style="list-style-type: none"> Buildings and mine area 	<ul style="list-style-type: none"> Flooding from reservoir Safety 	<ul style="list-style-type: none"> Safety 	<ul style="list-style-type: none"> Mine waste (rock spoil)
Pathway	<ul style="list-style-type: none"> Seepage to surface & groundwater Ingestion by animals Access 	<ul style="list-style-type: none"> Visual Toxicity 	<ul style="list-style-type: none"> Access 	<ul style="list-style-type: none"> Access 	<ul style="list-style-type: none"> Access 	<ul style="list-style-type: none"> Access 	<ul style="list-style-type: none"> Seepage to groundwater/surface water 	<ul style="list-style-type: none"> Aerial dispersion 	<ul style="list-style-type: none"> Slope failure and possible flow 	<ul style="list-style-type: none"> Seepage to surface & groundwater Erosion from embankments 	<ul style="list-style-type: none"> Instability and contamination 	<ul style="list-style-type: none"> ARD/ metal leaching Seepage to groundwater/ surface water Erosion to drains Livestock access 	<ul style="list-style-type: none"> Access 	<ul style="list-style-type: none"> Surface flow after wall breach Access 	<ul style="list-style-type: none"> Access 	<ul style="list-style-type: none"> Contamination
Receptors	<ul style="list-style-type: none"> Human Livestock Groundwater Surface stream 	<ul style="list-style-type: none"> Human Livestock Groundwater Surface stream 	<ul style="list-style-type: none"> Human Livestock 	<ul style="list-style-type: none"> Human Livestock 	<ul style="list-style-type: none"> Human Livestock 	<ul style="list-style-type: none"> Human 	<ul style="list-style-type: none"> Surface water Groundwater 	<ul style="list-style-type: none"> Local soil & herbage, Livestock, Local residents 	<ul style="list-style-type: none"> Deposition on surrounding land Flow into river 	<ul style="list-style-type: none"> Surface water Groundwater Ingestion by animals 	<ul style="list-style-type: none"> Seepage to groundwater and surface water Human safety 	<ul style="list-style-type: none"> Surface water Groundwater Visual Health and safety 	<ul style="list-style-type: none"> Safety Visual 	<ul style="list-style-type: none"> Humans and structures 	<ul style="list-style-type: none"> Humans Livestock 	<ul style="list-style-type: none"> Seepage to groundwater and surface water Livestock Safety
Impact	<ul style="list-style-type: none"> Human toxicity Livestock toxicity Surface water quality Groundwater quality 	<ul style="list-style-type: none"> Human toxicity Livestock toxicity Surface water quality Groundwater quality Visual 	<ul style="list-style-type: none"> Injury and death 	<ul style="list-style-type: none"> Injury and death 	<ul style="list-style-type: none"> Injury and death 	<ul style="list-style-type: none"> Injury and death 	<ul style="list-style-type: none"> Contamination 	<ul style="list-style-type: none"> Dust nuisance Loss of land use due to toxicity in herbage 	<ul style="list-style-type: none"> Contamination of land and water 	<ul style="list-style-type: none"> Contamination of surface water and groundwater Livestock toxicity 	<ul style="list-style-type: none"> Contamination to surface water and groundwater Slope failure and slides 	<ul style="list-style-type: none"> Contamination of surface water and groundwater 	<ul style="list-style-type: none"> Injury 	<ul style="list-style-type: none"> Injury and property damage Drowning 	<ul style="list-style-type: none"> Drowning Injury and Death 	<ul style="list-style-type: none"> Contamination to surface water and groundwater Livestock toxicity
RISK	<ul style="list-style-type: none"> LOW (human toxicity) LOW (livestock toxicity) 	<ul style="list-style-type: none"> LOW (visual) MEDIUM (toxicity) 	<ul style="list-style-type: none"> MEDIUM (human and livestock) 	<ul style="list-style-type: none"> MEDIUM 	<ul style="list-style-type: none"> MEDIUM 	<ul style="list-style-type: none"> MEDIUM 	<ul style="list-style-type: none"> MEDIUM 	<ul style="list-style-type: none"> LOW (herbage) LOW (dust) 	<ul style="list-style-type: none"> LOW (risk of failure) 	<ul style="list-style-type: none"> LOW (contamination) LOW (livestock) 	<ul style="list-style-type: none"> MEDIUM (contamination) MEDIUM (instability) 	<ul style="list-style-type: none"> HIGH (stream contamination) MEDIUM (human toxicity) HIGH (livestock toxicity) HIGH (aesthetics) 	<ul style="list-style-type: none"> LOW (injury) HIGH (visual) 	<ul style="list-style-type: none"> LOW (danger of injury) LOW (danger of property damage) MEDIUM (drowning) 	<ul style="list-style-type: none"> Medium 	<ul style="list-style-type: none"> LOW (contamination) LOW (toxicity)
Potential End-use	<ul style="list-style-type: none"> Heritage site, with controlled public access *Derelict land 	<ul style="list-style-type: none"> None 	<ul style="list-style-type: none"> Heritage site, with controlled public access *Derelict land 	<ul style="list-style-type: none"> Heritage structures None 	<ul style="list-style-type: none"> Heritage site with controlled public access to Cathedral cavern and beyond *Derelict land 	<ul style="list-style-type: none"> Heritage site with controlled public access *Derelict land 	<ul style="list-style-type: none"> Heritage site with controlled public access * Derelict land 	<ul style="list-style-type: none"> Heritage site with controlled public access Derelict land 	<ul style="list-style-type: none"> Heritage site with controlled public access * Derelict land 	<ul style="list-style-type: none"> Heritage site with controlled public access * Derelict land 	<ul style="list-style-type: none"> Heritage Site with controlled public access * Derelict land 	<ul style="list-style-type: none"> Heritage Site with controlled public access *Derelict land 	<ul style="list-style-type: none"> Heritage site with controlled public access * Derelict land 	<ul style="list-style-type: none"> Heritage site with controlled public access Drained *derelict land 	<ul style="list-style-type: none"> * Derelict land Heritage site 	<ul style="list-style-type: none"> * Derelict land
Potential Remediation Options	<ul style="list-style-type: none"> None required 	<ul style="list-style-type: none"> Remove scrap and waste 	<ul style="list-style-type: none"> Backfill or re-profile Clear vegetation to expose trenches Fence off 	<ul style="list-style-type: none"> Fence off Engineered cap Safety grill for observation and bats 	<ul style="list-style-type: none"> Collapse or backfill underground workings Restrict access to designated routes by fencing Install rock support 	<ul style="list-style-type: none"> Restrict access to designated routes Prevent access 	<ul style="list-style-type: none"> Intercept and treat seepage (wetland) Divert surface water 	<ul style="list-style-type: none"> Prevent surface disturbance by control of access Improve surface vegetation cover by addition of organic layer and reprofile where necessary 	<ul style="list-style-type: none"> None required 	<ul style="list-style-type: none"> Cover tailings to reduce leaching/erosion Re-profile and cover Intercept and treat seepage water in wetland Construct sediment traps 	<ul style="list-style-type: none"> No action Remove waste dumps 	<ul style="list-style-type: none"> Intercept and treat seepage Profile and engineer cover Remove waste to engineered containment Divert surface water 	<ul style="list-style-type: none"> Removal of buildings and site restoration Re-profile waste and building areas and cover Conservation of buildings and all remnant structures Landscaping in accordance with heritage requirements None 	<ul style="list-style-type: none"> Maintenance of reservoir and utilisation of water Draining of reservoir and diversion of feeder channels Fencing 	<ul style="list-style-type: none"> Draining Fencing 	<ul style="list-style-type: none"> No action Remove waste dumps
Preferred option	<ul style="list-style-type: none"> None 	<ul style="list-style-type: none"> Remove scrap and waste 	<ul style="list-style-type: none"> Safety fence Notices 	<ul style="list-style-type: none"> Safety grill (Vent Shaft) Field shaft to be fenced, but allowed to discharge water As appropriate (other shafts) 	<ul style="list-style-type: none"> Restrict access by fencing 	<ul style="list-style-type: none"> Restrict access by fencing 	<ul style="list-style-type: none"> Surface water diversion Wetland 	<ul style="list-style-type: none"> Control access and improve vegetation 	<ul style="list-style-type: none"> No action 	<ul style="list-style-type: none"> Restrict access and maintain vegetation Improve and maintain surface drainage system Run-off to pass into wetland 	<ul style="list-style-type: none"> No action 	<ul style="list-style-type: none"> Remove waste 	<ul style="list-style-type: none"> Conservation of all buildings and structures for heritage: King's House Engine House Core shed Laboratory Office Plant foundations, etc 	<ul style="list-style-type: none"> Maintain as reservoir Install fence 	<ul style="list-style-type: none"> Install fence 	<ul style="list-style-type: none"> Push into open slot and cover with soil for growth medium
Actions	<ul style="list-style-type: none"> None 	<ul style="list-style-type: none"> Remove scrap and waste Identify disposal site Assess quantities Segregate and remove 	<ul style="list-style-type: none"> Survey fence requirements Erect fencing Notices (integrate with I5.3 + I 5.7)) 	<ul style="list-style-type: none"> Locate and assess shafts and adits, treat as appropriate Safety grill on vent shaft Fence field shaft and others as appropriate 	<ul style="list-style-type: none"> Fencing, clearing and control access as part of development of heritage area (integrate with I 5.1 and I 5.7) 	<ul style="list-style-type: none"> Fencing and control access as part of development of heritage area (integrate with I 5.1 and I 5.7) 	<ul style="list-style-type: none"> Survey Surface water diversion, clean and extend Site water to wetland (with I 5.4) 	<ul style="list-style-type: none"> Prevent livestock access (maintain fences) Control public access (signage) Re-establish vegetation and monitor 	<ul style="list-style-type: none"> No action 	<ul style="list-style-type: none"> Establish monitoring Improve and maintain surface drainage system Maintain dump profile and vegetation Integrate with wetland for D5.3 	<ul style="list-style-type: none"> No action 	<ul style="list-style-type: none"> Remove waste to containment, off-site or on-site, re-vegetate and stabilise area 	<ul style="list-style-type: none"> Prepare schedule of conservation of all surface structures and restoration needs Carry out conservation, landscaping and restoration measures 	<ul style="list-style-type: none"> Carry out safety inspection Install fence Monitor (integrate with I 5.3 and I 5.1) 	<ul style="list-style-type: none"> Survey Install fence 	<ul style="list-style-type: none"> Survey quantity Implement preferred option above

* **Note: Derelict land – Means land for which there will be no benefit in restoration, refer to Section 13.6 of Phase II Report for definition**

Table.14.7: Site : Gortmore TMF

Source	Tailings (dust I6.1)	Tailings (visual I6.2)	Tailings (Leach I6.3)	Tailings (Erosion I6.4)	Tailings (instability I6.5)	The tailings pool (I6.6)	The three retention ponds (I6.7)	Delivery pipe line (I6.8)
Hazard/issue	<ul style="list-style-type: none"> Metals in dust from wind erosion 	<ul style="list-style-type: none"> Un-vegetated outer slopes 	<ul style="list-style-type: none"> Leaching of metal from tailings 	<ul style="list-style-type: none"> Erosion of tailings by water run-off 	<ul style="list-style-type: none"> Deep-seated slope instability 	<ul style="list-style-type: none"> Contaminated water 	<ul style="list-style-type: none"> Contaminated water 	<ul style="list-style-type: none"> Sediment from pipe breaks during mine operation
Pathway	<ul style="list-style-type: none"> Aerial dispersion 	<ul style="list-style-type: none"> View 	<ul style="list-style-type: none"> Seepage to surface and groundwater 	<ul style="list-style-type: none"> Erosion from crest and embankments 	<ul style="list-style-type: none"> Slope failure and possible flow 	<ul style="list-style-type: none"> Seepage to groundwater Flow to retention ponds along discharge channel 	<ul style="list-style-type: none"> Seepage to groundwater Flow to river 	<ul style="list-style-type: none"> Access
Receptors	<ul style="list-style-type: none"> Local soil & herbage, Kilmastulla river, Livestock, Farmhouses and residents 	<ul style="list-style-type: none"> Local community 	<ul style="list-style-type: none"> Surface water Groundwater 	<ul style="list-style-type: none"> Deposition on surrounding land Flow into river 	<ul style="list-style-type: none"> Deposition on surrounding land Mass flow into river 	<ul style="list-style-type: none"> Groundwater Kilmastulla River 	<ul style="list-style-type: none"> Groundwater Kilmastulla river 	<ul style="list-style-type: none"> Local soil & herbage, Humans, Livestock
Impact	<ul style="list-style-type: none"> Elevated metals in soils Pollution of the Kilmastulla River, Yellow River and drains around the TMF by metals in dust Animal & human toxicity Dust nuisance 	<ul style="list-style-type: none"> Appearance of exposed rock slopes in rural setting 	<ul style="list-style-type: none"> Elevated metals in surface water Elevated metals in groundwater Human toxicity Livestock toxicity 	<ul style="list-style-type: none"> Contaminates agricultural land Metal sediments in river Human toxicity Livestock and herbage toxicity 	<ul style="list-style-type: none"> Contaminates agricultural land Metal sediments in river Human toxicity Livestock & herbage toxicity 	<ul style="list-style-type: none"> Contamination of groundwater Contamination of Kilmastulla River Human toxicity Livestock, bird and herbage toxicity 	<ul style="list-style-type: none"> Contamination of groundwater Contamination of Kilmastulla river Human toxicity Livestock, bird & herbage toxicity 	<ul style="list-style-type: none"> Human health, Livestock & herbage toxicity
Risk	<ul style="list-style-type: none"> LOW (all, in present mitigated conditions) HIGH (all, in future, without further maintenance and mitigation measures) 	<ul style="list-style-type: none"> MEDIUM 	<ul style="list-style-type: none"> MEDIUM (surface water) MEDIUM (groundwater) LOW (human) LOW (livestock) 	<ul style="list-style-type: none"> LOW (land) LOW (river) LOW (human) LOW (livestock & herbage) 	<ul style="list-style-type: none"> LOW (land) LOW (river) LOW (human) LOW (livestock & herbage) 	<ul style="list-style-type: none"> MEDIUM (groundwater) LOW (river) Low (human) MEDIUM (livestock, bird, herbage) 	<ul style="list-style-type: none"> MEDIUM (groundwater) LOW (river) LOW (human) MEDIUM (livestock, bird, herbage) 	<ul style="list-style-type: none"> LOW
Potential End-use	<ul style="list-style-type: none"> * Derelict land Wildlife sanctuary with limited public access, no livestock access Pasture 	<ul style="list-style-type: none"> *Derelict land Wildlife sanctuary with limited public access, no livestock access Pasture 	<ul style="list-style-type: none"> * Derelict land Wildlife sanctuary Limited public access, no livestock access Pasture 	<ul style="list-style-type: none"> * Derelict land Wildlife sanctuary Limited public access, no livestock access Pasture 	<ul style="list-style-type: none"> * Derelict land Wildlife sanctuary Limited public access, no livestock access Pasture 	<ul style="list-style-type: none"> Maintain pool as wildlife resource Drain and backfill as derelict land Backfill and cover for pasture 	<ul style="list-style-type: none"> Maintain ponds for water retention Drain and backfill as derelict land Backfill and cover for pasture 	<ul style="list-style-type: none"> Pipe previously removed
Potential Remediation Options	<ul style="list-style-type: none"> Prevent surface disturbance by exclusion for general access and grazing Improve surface vegetation cover by addition of organic layer growth medium Construct engineered cover with low-permeability layer, capillary break and growth medium – for grazing end-use Push-down and re-vegetate outer slopes 	<ul style="list-style-type: none"> Re-vegetate crest of slope, plant crest windbreaks, plant trees at toe to hide slope Pushdown slope, topsoil and re-vegetate 	<ul style="list-style-type: none"> Construct engineered cover with low-permeability layer & capillary break, to reduce leaching Improve surface vegetation cover by addition of organic layer growth medium Water treatment plant Collect toe seepage into toe wetlands 	<ul style="list-style-type: none"> Prevent surface disturbance by exclusion for general access and grazing Improve surface vegetation cover by addition of organic layer growth medium Improve sediment traps and vegetate Push-down and re-vegetate outer slope Repair erosion gulleys 	<ul style="list-style-type: none"> Push-down outer slopes Repair eroded gulleys Maintain surface water drainage system Minor repairs to slope at decant pipe exit 	<ul style="list-style-type: none"> Treat decant water Drain pool, backfill and vegetate Upgrade pond decant system with buried pipeline Construct engineered cover with low-permeability layer, capillary break and growth medium – for grazing end-use Maintain in present state Prevent access for livestock 	<ul style="list-style-type: none"> Treat pond water before discharge Cover over pond area to restore site Improve wetland system Repair embankment crest Information signs 	<ul style="list-style-type: none"> None
Preferred option	<ul style="list-style-type: none"> * Derelict land, restrict access, place growth medium selectively and improve vegetation 	<ul style="list-style-type: none"> Vegetation screen to hide view of bare slope and plant trees at toe. 	<ul style="list-style-type: none"> * Derelict land, place growth medium selectively and improve toe wetlands 	<ul style="list-style-type: none"> * Derelict land, restrict access, place growth medium selectively and improve sediment traps 	<ul style="list-style-type: none"> * Derelict land, maintain drainage 	<ul style="list-style-type: none"> Maintain pool in present state, but upgrade decant system 	<ul style="list-style-type: none"> Improve and maintain wetland system and discharge structures (retention time to be maximised) 	<ul style="list-style-type: none"> None
Actions	<ul style="list-style-type: none"> Detailed survey of quantities and prepare specs, schedule, design, costs Re-vegetation of selected areas Restricted access; prevent surface disturbance by exclusion for general access and grazing Improve surface vegetation cover by addition of organic layer growth medium Plant vegetation wind breaks (some already established) Establish vegetation monitoring programme and maintenance schedule Establish dust monitoring programme and contingency response (integrate with EPA programme) 	<ul style="list-style-type: none"> Detailed survey of quantities and prepare specs, schedule, design, costs Survey for quantities prepare schedule and specs Place soil layer and re-vegetate crest of slope Plant crest windbreaks Plant trees at toe to hide slope 	<ul style="list-style-type: none"> Detailed survey of quantities and prepare specs, schedule, design, costs Restricted access; prevent surface disturbance by exclusion for general access and grazing Monitor surface and groundwater quality Information signs Improvement works to existing wetlands (integrate with D.6.4) 	<ul style="list-style-type: none"> Detailed survey of quantities and prepare specs, schedule, design, costs Re-vegetation of selected areas Restricted access; prevent surface disturbance by exclusion for general access and grazing Improve surface vegetation cover by addition of organic layer growth medium Establish vegetation monitoring programme and maintenance schedule Improve sediment traps around the toe (integrate with D.6.3) Repair erosion gulleys 	<ul style="list-style-type: none"> Detailed survey of quantities and prepare specs, schedule, design, costs Repair and maintain surface water drainage Routine inspections Integrate drainage with I6.1 and 6.6 	<ul style="list-style-type: none"> Detailed survey of quantities and prepare specs, schedule, design, costs Upgrade decant and penstock system by installation of a penstock at the pool and a buried decant pipeline to retention ponds. Maintain pool at precise minimum size by operation of the decant system 	<ul style="list-style-type: none"> Detailed survey of quantities and prepare specs, schedule, design, costs Carry out detailed survey and water balance calculations Optimise wetland operation Carry out repairs to ponds and discharge system as required 	<ul style="list-style-type: none"> None

* **Note: Derelict land** – Means land for which there will be no benefit in restoration, refer to Section 13.6 of Phase II report for definition

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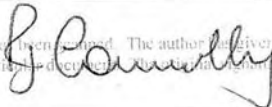
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