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THE PROPOSAL

Overview

Sorell, Clarence and Tasman Councils are jointly proposing to establish a sub-regional refuse disposal facility (landfill) to service each of the municipalities at a site approximately 3.5 kilometres south west of the village Copping in south-eastern Tasmania.

The Subject Site

The subject site comprises Lots 1, 3 and 4 on Plan of Survey, Registered No. 126073 in Land District of Pembroke, Parish of Carlton. It has an area of approximately 704 ha. and is owned by Sorell Council.

The central part of the overall site lies in a broad, relatively flat valley and the landfill is proposed to be located within this valley, with the proposed landfill 'footprint' occupying less than 15% of the overall site. The valley is largely enclosed by ridges which exist around the boundaries of the subject site. An un-named tributary of the Carlton river runs along the northern edge of the valley approximately 200m from the edge of the proposed landfill.

Access to the proposed landfill is via a road within a 20 metre wide 'Right of Way (Private)' owned by Sorell Council (forming Lot 3 on Plan of Survey Reg. No. 126073). The right of way intersects with the Arthur Highway approximately 2.5km west of Copping and the proposed landfill is approximately 3.5km along the right of way from the highway.

The subject site is predominantly used for grazing and forestry purposes. In addition, a small dolerite quarry exists on the upper slope of a ridge above the central valley and a rifle range is located near the quarry. The rifle range is proposed to be relocated elsewhere within the subject site so that there is no risk to landfill employees or to waste trucks accessing the site.

Most of the proposed landfill 'footprint' (including proposed Stage 1) contains indigenous species and weeds which are regenerating following clearfelling logging of the former forest in approximately 1990. Part of the 'footprint' area contains a young pine plantation established since the logging.

The Proposed Landfill

Sorell Council has entered into a formal agreement with Tasman Council and Clarence City Council to jointly manage the proposed landfill. The result of this agreement is that the landfill would be a sub-regional facility.

The strongest population growth figures in Tasmania are experienced in this region, specifically in Sorell and Tasman (2.59% and 1.86% pa. respectively between 1991 and 1995). The three municipalities have a combined population of approximately 62,390 (Australian Bureau of Statistics, 1996) and have a combined waste volume of 48,600 tonnes disposed to landfills (municipal statistics).

The proposed Copping landfill is to be a Category 3 Landfill as defined in the draft Tasmanian Landfill Code of Practice. This would allow the landfill to accept more than 25,000 tonnes per annum of both municipal and non municipal waste. The waste categories proposed to be deposited include:

Municipal - Domestic	Collected at the kerbside
Municipal - Other Domestic	Self Haul to Waste Transfer Stations
	Hardwaste collections
Municipal - Other Council	Street sweepings
	Litter bin contents
	Parks, Gardens and street tree loppings
	Construction spoil
Commercial & Industrial	Wastes arising from institutional, commercial, industrial activities (non hazardous) and being disposed
of to	facilities owned by urban authorities
Building and Demolition	Wastes arising from demolition and building activities.

The landfill is proposed to accept waste only from municipal and commercial waste collection vehicles and will not be available for direct tipping by the general public. A Waste Transfer Station will be available in each municipality for direct receipt of waste from the community. Non-recyclable waste will then be transferred in a compacted form to the landfill.

Stage 1 of the proposal has approximately 2,500,000 m^3 air space capacity which will allow deposition for approximately 26 years based on the calculated waste stream rates expected to be disposed of at the landfill site. The whole of the identified landfill footprint has the capacity for just under 14,500,000m^3. Due to the large volume available it is proposed to be completed as a staged development. Future stages will be dependent on effectiveness of waste minimisation procedures and will incorporate best practise technological principles as they become available.

The construction of the landfill will be guided by the following development processes:

- The total landfill site will be developed as a sequence of stages, with each stage divided into separate cells. Cells are designed to be filled in 1 to 2 years, before being progressively rehabilitated.
- Cell development will commence with Stage 1, which consists of 17 individual cells. Filling of Stage 1 will be done on a cell by cell basis and will begin by filling up against the natural slope of the ridge along the eastern extent of the Stage 1 development.
- Using the existing insitu clays or clays from a suitable borrow area, a 0.5 m thick base liner will be constructed on the landfill floor and side slopes. Permeability of less than 1×10^{-9} m/sec will be achieved by mechanical compaction methods.
- A leachate collection system will be installed on the base liner, diverting excess leachate initially to collection sumps, before draining under gravity to a temporary collection pond. Subject to suitability, excess leachate collected would be disposed of by irrigation of the adjacent pine plantations. The leachate will be diluted with fresh water obtained from stormwater runoff, and potentially by groundwater.
- Surface waters will be diverted around the site by perimeter drains and at the landfill surface water will be diverted around the active tipping area by temporary earthen bunds. Stormwater will drain to sediment settling basins prior to discharge to the Carlton River tributary.

- The landfill will be progressively rehabilitated as each Cell is completed, by covering with a 500mm layer of clayey soil and 300mm depth of cover material suitable for revegetation. The surface will be graded appropriately (3% to 5% slopes) to promote surface drainage of incident rainfall away from the landfill and reduce future leachate production. The final landfill cap will be landscaped to blend with the surrounding topography.

THE APPROVALS PROCESS

The aim of the Development Proposal and Environmental Management Plan as required by the Department of Environment and Land Management (DELM) is to:

- provide a source of information from which interested individuals and groups may gain an understanding of the proposal, the need for the proposal, the environment which it will affect, the impacts which may occur and the measures taken to avoid or minimise potential impacts;
- provide a forum for public consultation and informed comment on the proposal; and
- provide a framework in which decision making agencies may consider the environmental aspects of the proposal.

Application for a discretionary permit for the proposed Copping Landfill is required to be lodged with Council. The planning authority will assess the planning aspects of the proposal and will refer the permit application to the Board of Environmental Management and Pollution Control. The Board and the planning authority will make a decision about the proposal after a public comment period and an integrated environmental and planning assessment has taken place. This decision is subject to appeal by the applicant or the public under the provisions of the *Land Use and Planning Approvals Act, 1993.*

NEED FOR THE PROPOSAL

Existing waste disposal facilities in southern Tasmania in general and specifically in Sorell, Clarence and Tasman, only have limited life remaining before closure at the direction of the Environment and Planning Division of DELM.

The current refuse disposal site for the Sorell Municipality is located at Carlton (Category 2). The site receives approximately 9,000 tonnes of waste per year. Deposition at the Carlton Refuse Disposal site is limited to the year 2001 when the Environment & Planning Division require closure of the site.

Clarence City Council operates a single landfill at Lauderdale (Category 2) with an unknown proportion of municipal wastes being diverted to both Jackson Street (Glenorchy) and McRobies Gully (Hobart). The Lauderdale site receives approximately 37,500 tonnes of waste per year, of which 26,500 tonnes is municipal waste. Council holds a permit for the site from Environment & Planning Division which requires the site to close in 2001.

Tasman Council operates a single landfill at Nubeena (Category 2). The site receives approximately 1200 tonnes of waste per year. The site is due for closure in 2001 in accordance with the permit conditions from the Environment & Planning Division.

With closure of all three existing municipal landfills scheduled for 2001, establishment of a major landfill is needed to meet the immediate, medium and long term waste needs in southern Tasmania.

In the short term, the subject site is suited to receive municipal waste from Sorell, Clarence and Tasman Councils when existing landfills servicing these municipalities reach closure in 2001. In the medium and long term, the Copping site may also be well suited to service further municipalities in southern Tasmania on a broader basis.

CONFORMITY WITH GOVERNMENT POLICIES

The proposed landfill conforms with all relevant Government policies as outlined below.

Regional Waste Disposal Strategy

The Regional Waste Disposal Strategy represents the waste disposal strategy for southern Tasmania for the next 25 years. Reviews of the document are to be conducted every 5 years.

The proposed sub regional facility at Copping is entirely consistent with the Regional Waste Disposal Strategy for Southern Tasmania.

The Strategy proposes three options for waste disposal for southern Tasmania. It is significant to note that the Copping site is central to all three future waste management options proposed for southern Tasmania in the strategy. In considering each of the options it has been assumed that:

- the proposed landfill at Copping will be established and used by at least Clarence, Sorell and Tasman Councils from 2001 onwards.

Draft Tasmanian Landfill Code of Practice

The purpose of the draft Tasmanian Landfill Code of Practice is to launch a consistent environmentally responsible performance based approach to managing landfills in Tasmania. The code provides details on the type of controls to be implemented to manage waste going to landfills to achieve an acceptable standard, categorises landfills, and specifies the operating standards which must be achieved for each category of landfill.

The proposed Copping landfill is to be developed in accordance with the Code as a category 3 landfill. The proposal, however, does not propose disposal of hazardous wastes, so no secure cell is required.

Draft Regional Waste Minimisation Strategy

The Southern Waste Strategy Board has developed a Draft Waste Minimisation Strategy for southern Tasmania. An important element of the strategy will be establishment and monitoring of realistic long term waste reduction targets. The strategy identifies a number of proposed initiatives to encourage waste minimisation in the municipalities of southern Tasmania including Sorell, Clarence and Tasman. It recognises, however, that landfills will be required for the foreseeable future to accommodate waste which cannot be recycled.

Municipal Waste Strategies

The Sorell, Clarence and Tasman Councils have each prepared Municipal Waste Management Strategies which identify various waste minimisation techniques and initiatives as well as the requirement for development of a new landfill at Copping which will be established and operated in accordance with the highest environmental standards.

Planning Scheme Provisions

Use and development of the subject site is governed by the Sorell Planning Scheme 1993. The Planning Scheme contains overall objectives for land use and development as well as specific objectives for particular areas. The proposed development is in conformity with all relevant objectives.

Under the Planning Scheme, the subject site is partly included in a Rural Zone and partly within a Forestry Zone. Within both these zones the land use defined as "Utility Services (Major)", which specifically includes a 'refuse disposal site', is a discretionary use. This means that a refuse disposal site on the subject site requires planning approval.

CONSIDERATION OF ALTERNATIVE SITES

A thorough investigation of potential sites for a future Refuse Disposal Complex was undertaken prior to selection of the proposed Copping site. Each of the three Councils, Sorell, Clarence and Tasman, undertook separate landfill site investigations.

Woodward Clyde was commissioned in 1995 to carry out an alternative landfill site investigation within the municipality of Sorell (*Potential Landfill Site Evaluation - Sorell, 1995*). A total of 15 sites were assessed and the overall conclusion was that Copping is most favourable site for location of a landfill.

A landfill site investigation was also completed in 1995 by Environmental & Technical Services Pty. Ltd. for Clarence City Council (*Environmental Screening for Clarence Municipal and Eastern Shore Regional Tip Sites*). The overall conclusion was that Copping was the most suitable for landfilling.

Tasman Council has more recently completed an inhouse investigation which resulted in a decision to participate in the proposed Copping landfill.

POTENTIAL ENVIRONMENTAL IMPACTS AND THEIR MANAGEMENT

Surface Water

In the absence of surface water management the Carlton River system could potentially be impacted by the following:

- Leachate contaminated water entering the tributary of the Carlton River.
- High suspended solids and sediment loads within runoff discharging to the tributary.

Potential environmental impacts upon the hydrological system will, however, be minimised by the following control measures:

- Surface waters will be diverted around the site by perimeter drains.

- At the landfill, surface water will be diverted around the active tipping area by temporary earthen bunds.
- All water falling within the earthen bunds will be treated as leachate and diverted to the leachate storage pond.
- Water from the truck wash down area and other sources of potentially "dirty" water will be diverted into the leachate storage pond and treated as leachate for precautionary measures.
- The surface water system will use low flow velocity grass lined swales, sediment settling basins and rock stabilisation at scour vulnerable zones.
- All stockpiled material on the site, particularly piles of cover material, will be maintained in a rough condition to ensure that significant erosion does not occur.
- The final capped surface has been designed to minimise erosion.
- Monitoring procedures will be implemented for surface water.

Groundwater

Analysis of Landfill Leachate

The seepage of leachate (liquid which emanates from a putrescible wastes landfill) is an important environmental consideration in the siting and design of a landfill. Landfill leachates are normally contaminated and capable of degrading both surface waters and groundwater. It is of primary importance in landfill design to isolate leachate, as far as possible from natural waters, both groundwater and surface water, at the landfill site.

Leachate that seeps through the basal liner to the water table may affect the beneficial quality of the underlying groundwater. Consequently, design measures should be implemented to protect the beneficial use of the aquifer.

In order to predict leachate generation, and to set realistic design parameters a modelling process was undertaken. This involved a Woodward-Clyde in-house computer program, "LANDFILL", which was used to estimate the volume and quality of the leachate generated. The results were used as input to design the leachate collection, containment and disposal facilities. The program can also be used to test design parameters, and to assess the sensitivity of the site to various hydraulic parameters.

Potential Impact on Groundwater Quality

Under average rainfall conditions LANDFILL predicts for normal conditions at Copping the leachate will generally remain within the matrix of the fill and very little leachate will be collected in the leachate collection system. For these conditions, the analysis indicates that the leachate generation flow rate reaches a maximum of approximately 11 m^3/day after six years of landfilling. It should be noted, however, that for the majority of years the predicted leachate generation flow rate is zero.

Groundwater salinity of the aquifer beneath the site was found to range from 3,600 to 5,700 mg/L, and therefore suitable only for a limited number of livestock watering uses. Under the simulated conditions used, the leachate salinity is predicted to fluctuate between approximately 3,900 mg/L and 8,200 mg/L, during and just after the operation of Stage 1, but then to reduce rapidly once landfilling ceases.

As the leachate is generally predicted to remain within the field capacity of the landfill under average conditions, there is a low potential for leachate seepage to the water table under these conditions. In addition, the TDS of leachate is predicted to remain relatively high for only a limited time.

There will be a minor amount of leachate that will be released through the liner. The beneficial use of the aquifer will however, not be compromised in any way. It should also be recognised that even though the simulations are considered to be realistic of actual conditions, they have erred on the conservative side, and it is likely that impacts will be substantially less than predicted.

Clay Liner Construction

It could be argued, given the results of the modelling and the presence of a highly favourable geological soil profile, that no liner is required. However a 0.5 m thick clay liner with permeability less than 1×10^{-9} m/sec has been recommended for an added degree of security. The presence of a liner would also promote lateral liquid movement by engineered falls and collection systems, rather than ponding at the base of the landfill.

Air

Landfill Gas

Landfill gas will be managed at the Copping landfill site because:

- Methane is a "greenhouse gas".
- Landfill gas is potentially explosive.
- Uncontrolled landfill gas emissions can cause odour problems.
- Methane gas frequently hampers the establishment of vegetation on landfill surfaces.
- Landfill gas is a source of energy which could be harnessed for adjacent landuses (eg Timber Mill)

A landfill gas collection system will be installed in the landfill cap. The relatively low permeability cover of the landfill cap is designed to inhibit landfill gas escape through the surface and cause preferential flow of gas extraction bores.

On capping of the landfill, it is proposed that regular inspections of the site will be undertaken to ensure that the integrity of the low permeability cap is maintained.

Dust

Dust can be generated from the following three main areas in landfilling operations:

- Access roads;
- Landfill tipping face; and
- Excavated/capped areas.

The incidence of dust can result in particle pollutants leaving the site, increase the stormwater sediment load and impact on local amenity. A further consequence of dust, when mixed with rainwater, is the potential for mud.

Dust arising from disturbance of the valley floor or excavated material will be controlled by revegetation of capped areas, wetting of the exposed surfaces and minimum traffic usage.

The access road from the Arthur Highway will be upgraded to an all weather road, and engineered and constructed using select materials that are less prone to producing dust. Access roads within the landfill site would be regularly sprayed with water from the on-site water cart as and when required, to control the generation of dust from this source.

The capped area of the landfill would be vegetated with grass to reduce the dust nuisance. Areas not suitably grassed would be adequately irrigated to prevent dust from posing a problem.

Spraying of active tipping areas with either leachate or freshwater pumped from the stormwater dam would control dust problems at the tipping face. In addition, capped areas of the landfill would be rehabilitated as soon as possible to minimise the potential for dust generation.

Litter

Litter poses problems around poorly managed landfills. Litter may come from windblown waste from the landfill itself, or from vehicles transporting waste to the landfill.

Impacts associated with increased litter include loss of amenity, impact on aesthetic character, and the potential for impact on flora and fauna species.

Unacceptable amounts of windblown litter should not leave the active tipping area at the proposed landfill due to a combination of factors including:

- minimisation of the active cell area through use of the systematic cellular tipping program;
- daily covering of waste;
- use of portable litter screens to trap litter blown from the active landfill cell;
- large fence around the landfill boundary; and
- regular litter patrols.

Flora & Fauna

A specialist survey of the flora of the proposed landfill ‘footprint’ and its surrounds (Mendel, 1996) has revealed that the proposed landfill is within an area that has suffered high levels of disturbance and significant alteration to native vegetation communities. No species or vegetation communities of conservation significance were recorded from the site. It was concluded that the landfill would have no deleterious effects on botanical values.

A specialist survey of the fauna of the site (Michaels, 1996) revealed that all species found were both common and widespread in Tasmania. It was concluded that there are no zoological reasons why the project should not proceed.

Management of Weeds and Vermin

There are relatively large areas of indigenous vegetation adjacent to the proposed landfill site. Although the vegetation has been degraded by past activities it should not be subjected to further deterioration due to spread of weeds from the landfill.

A major vegetation management issue will therefore involve the monitoring and control of potential weed invasion from the landfill, and the access road.

Operational procedures will be designed to minimise potential problems associated with feral animals, scavenging birds, flies and vermin which are often present around landfills as a result of the easy access for animals to sources of food and the various habitats suitable for breeding.

The management procedures proposed below will significantly reduce the likely incidence of weeds and vermin associated with the site. These procedures include:

- compaction of waste;
- wheel wash facility;
- minimisation of the active tipping area;
- regular covering of waste; and
- regular monitoring and implementation of control procedures, if required.

POTENTIAL SOCIAL AND ECONOMIC IMPACTS AND THEIR MANAGEMENT

Buffer Distances from Adjacent Land Uses

The zoning of surrounding land is compatible with development of the proposed landfill. The predominant zoning of land adjacent to the site under the Sorell Planning Scheme comprises Rural and Forestry Zoning. These zones will retain broad-acre landuses compatible with the proposed landfill.

The closest house to the proposed landfill "footprint" is approximately 2.4km to the north. The closest residential area to the proposed landfill "footprint" is the settlement of Copping, approximately 3.5km to the northeast.

There are no primary activities in the locality which would be particularly sensitive to a landfill development. The only notable primary export activity in the region comprises oyster farms in Pittwater, approximately 15km distant.

Traffic

The potential environmental impacts associated with traffic on approach roads would largely be based on the effects associated with increased numbers of trucks. The proposed landfill is however, expected to have a negligible impact in terms of traffic because its greatest trip generation is approximately 37 trucks per day.

The Arthur Highway would be used to transport waste to the site. The Arthur Highway is a State Highway intended to accommodate significant amounts of traffic.

Noise

Noise generated by landfill activities generally arises from machinery operating in the landfill and from vehicles accessing the site. Noise generated at landfill facilities needs to be managed so that noise from any single source does not intrude significantly above the prevailing background noise level at any residential premises.

The consequence of excessive noise would be likely to be potential loss of local amenity for both humans and animal species.

The probable noise impacts associated with the proposal are considered insignificant due to the isolation of the site and the fact the landfill will be incorporated within a valley. Excessive noises are not anticipated because of the limited access to the site and the low frequency of truck traffic. The impact of up to 37 trucks per day on the landfill approach road would be insignificant given the only houses within 3km are in close proximity to the Tasman Highway. It should also be noted that these dwellings are screened from the site by hills and an extensive vegetated buffer zone which will further attenuate any noise impact.

Public Health

The relative remoteness of the site combined with the management procedures identified in this report for control of potential vermin, dust, odour, noise impacts etc will ensure potential health impacts are kept well within the required standards.

A detailed Occupational Health and Safety Plan would be established for on site workers.

Fire

Risk of fire and or explosion is associated with landfills due to the production of landfill gases, the incidence of combustible materials on site and the likelihood of certain fuels and flammables being deposited. However, the fire risk from operating the site is considered minimal if active fire protection measures are implemented.

The following management protection procedures would be implemented to reduce the risk of fire as any spread of fire from the site would be a concern due to the area of adjacent woodland and the relatively isolated locality. These procedures would include:

- compaction and regular application of cover material;
- maintenance of buffer zones;
- availability of cover material for fire suppression;
- presence of over 100,000 litre water supply; and
- fire fighting equipment on site.

The lighting of fires to burn wastes will be banned at the site. Fire ban warning signs will be installed at the site. A detailed safety plan would be prepared in accordance with Tasmanian Fire Service requirements, once approval is granted.

Site Security

Unauthorised entry at a landfill can lead to significant issues such as waste dumping, fires and risk to public safety. Public entry to the proposed landfill will not be permitted so potential risks will be negligible. The site will be enclosed by a 1.8 metre high chainmesh fence and access gates will be securely locked outside operating hours.

Visual Amenity

The proposed development will be almost entirely screened from outside view by the topography within or adjacent to the subject site. It will not be visible from outside the subject site to the north or east would be partially visible from a couple of distant vantage points (over 2km away)to the south and west where it would form a very small part of a broad and distant panorama.

Cultural Heritage Values

The proposed landfill will impact a number of isolated Aboriginal artefact sites in a cultural landscape that is scientifically interesting but not unique. The sites located in the Archaeological survey are represented in other areas of the east coast forest region of Tasmania. In this case the majority of the sites identified can be preserved and further investigated in the future.

The landfill footprint has been modified to leave four artefact sites within its boundaries. Stage 1 would require removal of only one artefact. Application for destroying the 4 artefacts within the landfill footprint will be sought, however it is proposed to liaise closely with the Tasmanian Aboriginal Lands Council (TALC) throughout the landfill development to ensure appropriate actions are taken to preserve the cultural heritage of the region.

Employment

Staff will need to be employed to operate the proposed sub-regional Landfill. The staff members will be sufficient in number to provide:

- OnSite supervision;
- Gatekeeping, and weighbridge operation;
- Machine operation;
- Truck driving; and
- Labouring.

ENVIRONMENTAL MANAGEMENT PLAN

Sorell Council is committed to provision of a best practise landfill facility for waste disposal in southern Tasmania All measures outlined within the DP and EMP will be implemented as stated in the Management Plan to ensure compliance with permit conditions.

Key components of the site management plan are:

- Appointment of trained staff to operate the proposed facility;

- A comprehensive groundwater, surface water and gas/ vapour monitoring program;
- The maintenance of a computer database which will incorporate all information on types and quantities of wastes received; all groundwater and surface water monitoring data on site; and all other pertinent information on the site such as any incidents and complaints and how they were dealt with.
- Regulatory conditions for site construction and operation, stipulated in the licence conditions; and
- Specific site operational specifications.

For effective control of environmental performance, management systems must be flexible, effective and subject to ongoing review and improvement. The EMP will be reviewed after 12 months of operation and at three yearly intervals thereafter.

CONCLUSION

The subject site, after thorough investigation, has been found to be highly suitable for a future landfill because it has:

- Strategic location in relation to the Arthur Highway;
- Capability for provision of significant void space;
- Significant distance from potentially conflicting existing and proposed land uses;
- Ability to provide adequate buffers to support a long term landfilling operation;
- Suitable hydrogeological conditions for a landfill, provided appropriate water management strategies are implemented;
- Significant clay and gravel resources, which could be used in the construction of a landfill; and
- No fatal flaws that would prevent development of a landfill.

The proposed sub regional facility at Copping is entirely consistent with the Regional Waste Disposal Strategy for Southern Tasmania and has been identified as central to the overall waste disposal options, as a potential future regional landfill site, to help meet the waste disposal requirements well into the 21st century. Current landfill sites in the region are nearing capacity (and will reach capacity in 2001 as required by Environment & Planning Division). A landfill site urgently needs to be secured.

Provided operating standards set down in the legislation, and conditions described in this report are maintained, the proposed landfill would not be expected to adversely affect adjacent land-uses or the quality of the environment in the area. It is in summary, considered to be a highly suitable location for development of a municipal waste landfill which will provide a valuable community resource for southern Tasmania.

1.1 OVERVIEW OF THE PROPOSAL

AGC Woodward-Clyde Pty Ltd (Woodward Clyde) has prepared this Development Proposal and Environmental Management Plan (DP & EMP) on behalf of Sorell Council for establishment of a sub-regional Refuse Disposal Facility (landfill) to service Sorell, Clarence City and Tasman Councils at a site approximately 3.5 kilometres south west of Copping in south eastern Tasmania (refer Figure 1).

Sorell Council has entered into a formal agreement with Tasman Council and Clarence City Council to jointly manage the proposed landfill. The result of this agreement is that the landfill would be a sub-regional facility.

The Sorell municipal area is situated 25 kilometres east of Hobart and extends from the Fingerpost Road on the Tasman Highway to approximately 1 kilometre south of the Dunalley Hotel at Dunalley (refer Figure 1). The Clarence municipal area borders Sorell to the west and contains the suburbs of Hobart located on the eastern shore of the Derwent Estuary. The Tasman municipal area borders Sorell to the southeast and comprises the entire Tasman Peninsula. It's sole land access being via the municipality of Sorell

The strongest population growth figures in Tasmania are experienced in this region specifically in Sorell and Tasman. The three municipalities have a combined population of approximately 62,390 (Australian Bureau of Statistics, 1996).

The proposed Copping landfill is to be a Category 3 Landfill as defined in the draft Tasmanian Landfill Code of Practise. This would allow the landfill to accept more than 25,000 tonnes per annum of both municipal and non municipal waste. Municipal waste, as defined in the National Solid Waste Classification System endorsed by ANZECC, is subdivided into three 'Secondary Sources':

- domestic waste,
- other domestic,
- and other Council waste.

These wastes comprise the combined residential, commercial and industrial waste material generated in given municipal areas including household garbage, putrescible waste, and solid inert wastes from manufacturing, processing or service industries. The term also includes hazardous wastes which are generated in the household.

The landfill is proposed to accept waste only from municipal and commercial waste collection vehicles and will not be available for direct tipping by the general public. Transfer Stations will be available in each Council area for direct receipt of waste from the community. The waste will then be transferred in a compacted form to the landfill.

Stage 1 of the proposal has approximately 2,500,000 m^3 air space capacity which would allow deposition for approximately 26 years based on the calculated waste stream rates expected to be disposed of at the landfill site. The whole of the identified landfill footprint has the capacity for just under 14,500,000m^3. Due to the large volume available it is proposed to be completed as a staged development. Future stages would be dependant on effectiveness of waste minimisation procedures and will incorporate best practise technological principles as they become available.

The overall subject site at Copping is 704 hectares in area of which less than 15 % is proposed for the landfill 'footprint'. The site includes a minimum buffer distance of approximately 200 metres to land in separate ownership in all directions except the south west. The distance to separate ownership to the south west is approximately 75 metres, where land comprises native forest.

The subject site has been noted to have the following attributes with respect to landfill development:

- High accessibility, and a limited requirement for traversing residential areas;
- Strategic location in relation to the Arthur Highway;
- Capability for provision of significant void space at a time when the municipalities of Sorell, Clarence and Tasman require future landfill facilities;
- Significant distance from potentially conflicting existing and proposed land uses;
- Ability to provide adequate buffers to support a long term landfilling operation;
- Suitable hydrogeological conditions for a landfill, provided appropriate water management strategies are implemented;
- Significant clay and gravel resources, which could be used in the construction of a landfill;
- Vegetation has been degraded by past clearing and agricultural activities to the extent that a flora survey indicated that the landfill would not have deleterious effects on botanical values;
- No zoological species requiring any special consideration in regards to conservation have been identified; and
- No fatal flaws that would prevent development of a landfill on the site have been identified.

1.2 OVERVIEW OF THE APPROVALS PROCESS

The aim of the Development Proposal and Environmental Management Plan as required by the Department of Environment and Land Management (DELM) is to:

- provide a source of information from which interested individuals and groups may gain an understanding of the proposal, the need for the proposal, the environment which it will affect, the impacts which may occur and the measures taken to avoid or minimise potential impacts;
- provide a forum for public consultation and informed comment on the proposal; and
- provide a framework in which decision making agencies may consider the environmental aspects of the proposal.

Application for a discretionary permit for the proposed Copping Landfill is required to be lodged with Council. The planning authority will assess the planning aspects of the proposal and will refer the permit application to the Board of Environmental Management and Pollution Control. The Board and the planning authority will make a decision about the proposal after a public comment period and an integrated environmental and planning assessment has taken place. This decision is subject to appeal by the applicant or the public under the provisions of the *Land Use and Planning Approvals Act, 1993*.

1.3 LANDFILL DESIGN AND MANAGEMENT PHILOSOPHY

The design and management philosophy behind the proposed Copping landfill was predicated on achieving key goals for landfill performance, construction and operation. The key goals are to dispose of waste at the Copping site in a manner which:

- protects the environment (which includes the community);
- maximises use of the resource (the waste management site area);
- cost effectively utilizes public funds; and
- caters for future flexibility based on site experience.

1.3.1 Protection of the Environment

Environmental issues are high on the community agenda and protection of the environment is of necessity a key aim of landfill design and management. The Copping landfill has been designed to have negligible or acceptable impacts on the surface water, groundwater and air environments and on community health and amenity.

Surface water impacts from landfills can occur through leachate seepage to the surface and discharge of turbid water. The design and management of the site has reduced the likelihood of such releases to negligible proportions by:

- separation of surface water from leachate affected surface water using engineered drainage and leachate collection systems;
- detention of surface water prior to discharge;
- collection and appropriate disposal of any seepages from the landfill surface;
- diversion of off-site surface water via appropriately sized drains and bunds;
- effective monitoring of surface water occurrences and quality; and
- progressive rehabilitation of landfill cells to minimise on site runoff.

Landfills can create impacts on groundwater due to movement of leachate from the waste mass into the substrate and then into the groundwater. The design and management of the Copping landfill ensures that the landfill will not cause groundwater contamination (ie the beneficial use of the groundwater will not be degraded) due to:

- installation of an engineered clay liner (via specified compaction densities, designed falls, and defined collection points) which reduces the rate of leachate escape to very small, acceptable amounts, collects and diverts leachate to sumps, attenuates some contaminants within the leachate; and which is designed to maintain its integrity over time;
- construction of a leachate drainage and collection system which maintains the landfill in an unsaturated state;
- appropriate management and disposal of collected leachate;

- regular monitoring of the landfill performance to detect, at a very early stage, any impacts of leachate on the groundwater;
- development of an effective groundwater remediation strategy in the event of unacceptable impact;
- development of the site using small areas of active landfilling to minimize the rate of leachate production; and
- progressive rehabilitation by capping and revegetation of landfill cells to minimize leachate producion.

Air quality issues from landfills are frequently related to impacts of dust and odour on neighbouring areas. Off-site impacts of dust and odour will negligible due to:

- selection of the site location which is relatively isolated from the general community;
- dust suppression, by watering, of source areas such as roads and hardstands;
- placement and compaction of inert daily cover material;
- prompt installation of a landfill gas collection and management system;
- progressive rehabilitation of cell surfaces; and
- frequent monitoring of air quality by on-site staff.

Impacts on community health and amenity will be negligible due to the contaminant release prevention aspects indicated above, appropriately designed site access, natural screening of the site and the relative isolation of the site with respect to residences.

1.3.2 Maximum use of site resource

Evaluation of suitable landfill sites in Sorell, Clarence and Tasman municipalities has shown that the number of suitable sites is extremely limited. Furthermore, suitable landfill sites in southeastern Tasmania are also very few in number. The Copping site is arguably the best available site within the region. It is therefore logical that the best (maximum) use is made of such a relatively scarce resource.

This aim has been taken into account by:

- obtaining economies of scale by including disposal from regional sources (eg Clarence and Tasman municipalities);
- developing the site as needed in a series of stages which can be modified in response to demand; and
- maximizing the volume of waste which can be accepted at the landfill - through maximizing the landfill footprint area and by raising the waste pile to a maximum elevation determined by batter slope angles and adjacent hillcrest elevations.

1.3.3 Cost effective utilization of public funds

Sorell Council has a responsibility to the public to manage finances in a cost effective manner. Therefore the landfill design and management is appropriate for the site conditions and the nature of waste to be received. For example:

- a section of the access road from the Arthur Highway will be spray sealed for 900m (which is appropriate for the expected traffic volumes and dust control) rather than asphalt, for which the additional expense can not be justified;
- the designed landfill base liner will serve the required functions of leachate collection and groundwater protection, and will be:
  - constructed from clay (rather than a flexible membrane liner such as PVC);
  - the clay will be locally derived (not imported); and
  - the designed liner thickness (0.5m) will remain intact over time and will limit the rate of leachate passage to acceptable levels.

1.3.4 Future flexibility

Flexibility of landfill design and management is essential because the quantity, source and nature of waste needing to be disposed is likely to change.

The Copping site caters for flexibility because:

- the site covers a large area and offers a choice of potential designs and activities;
- cellular construction permits alternative design and management techniques which can be evaluated and introduced based on operating experience at the site; and
- progressive rehabilitation caters for any change in desired potential vegetation cover and/or end use.

The end result of the design and management philosophy applied to the Copping landfill is that a waste disposal facility will be established which will be of considerable benefit to the community without damaging the environment or endangering community health or amenity. Waste management cost will be appropriate and experience gained during operation will be used to modify future design and management of the landfill in a beneficial manner.

2.1 NEED FOR THE PROPOSAL

Existing waste disposal facilities in southern Tasmania in general and specifically in Sorell, Clarence and Tasman, only have limited life remaining before closure at the direction of the Environment and Planning Division of DELM.

The current refuse disposal site for Sorell municipal area is located at Carlton (Category 2). The site is permitted to receive 10,000 tonnes of waste per year but actually receives approximately 9,000 tonnes of waste per year according to the rehabilitation plan for the site. Deposition at the Carlton Refuse Disposal site is limited to the year 2001 when the Environment & Planning Division require closure of the site. Identification and approval of a new refuse disposal site is necessary to service the growing population of Sorell and surrounding areas. Over the last two intercensal periods Sorell has had the highest growth rate in Tasmania.

Clarence City Council operates a single landfill at Lauderdale (Category 2) with an unknown proportion of municipal wastes being diverted to both Jackson Street (Glenorchy) and McRobies Gully (Hobart). Based on 1990/91 Base Year the site receives approximately 37,500 tonnes of waste per year, of which 26,500 tonnes is municipal waste. Council holds a permit for the site from Environment & Planning Division which requires the site to close in 2001.

Tasman Council operates a single landfill at Nubeena (Category 2). The site receives approximately 1200 tonnes of waste per year. The site is due for closure in 2001 in accordance with the permit conditions from the Environment & Planning Division.

With closure of all three existing municipal landfills scheduled for 2001, establishment of a major landfill is needed to meet the immediate, medium and long term waste and recycling needs in southern Tasmania.

In the short term, the subject site is suited to receive municipal waste from Sorell, Clarence and Tasman Councils when existing landfills servicing these municipalities reach closure in 2001.

In the medium and long term, the Copping site may also be well suited to service further municipalities in southern Tasmania on a broader basis.

2.2 POLICY CONTEXT

2.2.1 Regional Waste Disposal Strategy

The Regional Waste Disposal Strategy represents the waste disposal strategy for southern Tasmania for the next 25 years. Reviews of the document are to be conducted every 5 years.

The proposed sub regional facility at Copping is entirely consistent with the Regional Waste Disposal Strategy for Southern Tasmania.

The strategy outlines:

- '*the need to use existing landfills to the maximum possible extent*' given appropriate environmental performance. In the last 3-5 years the environmental performance of all of the main landfills in the region have been reviewed and in general sites have been improved to meet regulatory compliance requirements. Existing southern Tasmanian

Refuse Disposal Sites (RDS) have the capacity to receive waste for periods ranging from one to twenty years.

- *'Landfills should be operated to ensure that environmental harm does not occur'* and all landfills, both new and existing, will be operated to ensure that this objective is met.
- Establishment of a new landfill needs to be examined taking into account *'Sustainable Development'*, the need for the site in terms of social and economic values and its ability to meet appropriate compliance levels.

The Strategy proposes three options for waste disposal for southern Tasmania. It is significant to note that the Copping site is central to all three future waste management options proposed for southern Tasmania in the strategy. In considering each of the options it has been assumed that:

- the proposed landfill at Copping will be established and used by at least Clarence, Sorell and Tasman Councils from 2001 onwards.

The options assume, subject to appropriate environmental performance, continued use of existing sites for their remaining life. As capacity is reached, transfer stations will be established at strategic locations and waste transferred to new sites.

Option 1 involves development of 3 sub-regional landfills to be established at:

- Copping,
- Kingborough (Baretta Extension), and
- a yet to be identified northern sub-regional site.

Option 2 provides for development of two sub regional landfills at:

- Copping, and
- a yet to be identified northern sub-regional site.

Option 3 provides for one large regional landfill site at:

- Copping to be used by all southern Councils with the exception of the Central Highlands.

Option 1 is the preferred option for waste disposal in the southern region, provided the northern sub regional landfill can be located closer than the Copping site is to Hobart and Glenorchy. It is on this basis, as a sub-regional facility, that the DP and EMP has been developed. It is significant to note however, that the Copping site is central to all three future waste management options proposed for southern Tasmania Strategy.

2.2.2 Draft Tasmanian Landfill Code of Practice

The draft Tasmanian Landfill Code of Practice was released in November 1996 with an indication that it would be implemented towards the later half of 1997. The purpose of the Code is to launch a consistent environmentally responsible performance based approach to managing landfills in Tasmania. The code provides details on the type of controls to be implemented to manage waste going to landfills to achieve an acceptable standard, categorises landfills, and specifies the operating standards which must be achieved for each category of landfill.

The proposed Copping landfill is to be developed in accordance with the Code as a category three landfill.

Central to the code is acceptance that environmental performance of landfills must be continually monitored and reviewed, and where appropriate remedial action taken. It is also important that a clearly defined and rational process for the review of both new and existing landfills is developed.

As part of the strategy, a review process has been organised which incorporates the existing Environmental Management Plan (EMP) process, with the five yearly report proposed in the Code.

It is considered that the five yearly reviews of landfills should be coordinated with the proposed five yearly review of the strategy.

The Code addresses the issue of hazardous waste by defining the types of waste which can be accepted by each category of landfill. Category 1 sites are only permitted to accept domestic garbage, solid inert waste and certain quantities of putrescible waste. Category 2 sites can also accept certain hazardous waste such as medical and related waste, sludges and asbestos at the discretion of DELM.

Category 3 sites may accept all the wastes outlined in Category 1 & 2 landfills and some hazardous wastes. There is a need to incorporate secure cells for the disposal of hazardous waste if it is to be disposed. This proposal does not propose to dispose of hazardous wastes.

2.2.3 Draft Regional Waste Minimisation Strategy

The Southern Waste Strategy Board has developed a Draft Waste Minimisation Strategy for southern Tasmania. An important element of the strategy will be establishment and monitoring of realistic long term waste reduction targets. The strategy identifies a number of proposed initiatives to encourage waste minimisation in the municipalities of southern Tasmania including Sorell, Clarence and Tasman.

The initiatives proposed are primarily to be the responsibility of Councils. Relevant to this proposal, the initiatives to be undertaken include:

- Increased participation and improved kerbside recycling of paper and containers;
- Introduction of organics recycling collection and processing for the domestic sector;
- Increased participation and improved recycling from Municipal - Other Domestic (self haul-private traffic) waste sector, including organics;
- Further diversion of waste by increased recycling and source separation, where possible, through:
  - Investigation and development of markets for recycled organic materials;
  - Installation of recycling receptacles in public places, major events;
  - Recycling of all park and garden wastes; and
  - Upgrading of Council recording mechanisms for other Council waste disposal and recycling activities.
- Waste avoidance and re-use to also contribute to landfill waste diversion; and

- Residual waste treatment, which provides further opportunities for volume and weight reduction, to also increase landfill diversion.

It is internationally acknowledged that landfills will be required for the foreseeable future. Recognising that 100% recovery is currently impossible; the Strategy target for diversion from landfill are estimated at 46% within the next 5 years (from the 1990 level). Whilst this may be achievable through increased recycling alone, measures for waste avoidance and re-use must be implemented. Ultimate diversion scenarios however, will be dependent on the endeavour of councils and regions to implement the identified initiatives.

2.2.4 Municipal Waste Strategies

The Sorell, Clarence and Tasman Councils have each prepared Municipal Waste Management Strategies which identify various waste minimisation techniques and initiatives as well as the requirement for development of a new landfill at Copping which will be established and operated in accordance with the highest environmental standards.

2.3 CONSIDERATION OF ALTERNATIVE SITES

2.3.1 Introduction

A thorough investigation of potential sites for a future Refuse Disposal Complex was undertaken prior to selection of the proposed Copping site. Each of the three Councils, Sorell, Clarence and Tasman, undertook separate landfill site investigations.

Woodward Clyde was commissioned in 1995 to carry out an alternative landfill site investigation within the municipality of Sorell (*Potential Landfill Site Evaluation - Sorell, 1995*). A total of 15 sites were assessed.

A landfill site investigation was also completed in 1995 by Environmental & Technical Services Pty. Ltd. (*Environmental Screening for Clarence Municipal and Eastern Shore Regional Tip Sites*) for the Municipality of Clarence, where 16 sites were assessed.

Tasman Council has more recently completed an inhouse investigation.

2.3.2 Potential Landfill Site Evaluation - Sorell, 1995

The assessment of alternative sites conducted by Woodward Clyde was broadly based on the 'Tasmanian Solid Waste Management Policy' which states that no landfill site shall be established or extended in the following areas:

- National Parks, Reserves and World Heritage Areas;
- water supply catchments;
- lakes and wetlands;
- critical habitats of taxa and communities of flora and fauna;
- Crown land;
- land liable to flooding if determined to be so liable by the responsible drainage authority;
- land located within 10km of any aerodrome;

- landslip potential and high erosion areas (eg granites, sandstones and quartzites), sinkholes, limestones, highly fractured rock, underground mining (past or present) or along known fault lines.

In addition, other exclusionary criteria were developed by Woodward Clyde to suit the local and regional conditions. These included:

- urban areas;
- areas with unsuitable hydrogeology;
- areas of intensive agriculture; and
- Local conditions which may affect the suitability of an area.

Urban areas were excluded from further evaluation on the basis of public amenity issues, unavailability of suitably sized land areas and high land costs.

Areas with unsuitable hydrogeology were excluded in order to prevent any contamination from waste disposal entering the groundwater system or wider environment. Unsuitable areas on the basis of hydrogeology are areas which have highly permeable substrate materials which enable water entering the groundwater system to move into sensitive environments. Basalts and coastal sands are present in the municipality and fall into this category. In addition, areas where groundwater is currently being used are also exempt from further analysis.

Areas of intensive agriculture are not considered appropriate for a future RDS due to the high value placed on arable land and the public recognition of the importance of retaining high quality agricultural land.

Altogether 15 potential sites were identified. Nine of the sites were identified by Woodward-Clyde on the basis of map analysis and field observations. The other six sites were identified in a previous consultants report (Bakker, 1994).

A list of the prospective sites is detailed in Table 1:

A set of site selection criteria was established which generally defines the requirements of a potentially suitable site. Each of the 15 sites was assessed according to each of the criteria. Any sites or areas considered to have fatal flaws were eliminated from the list of potential sites and not included in further analysis. The sites were then ranked in terms of potential for achieving approval.

The site selection criteria used for determining the suitability of a potential landfill site in the Municipality of Sorell are outlined in Table 2:

Assessment of the suitability of each site was assisted by ranking the sites according to the criteria detailed above. Two methods were utilised to develop the ranking's. The unweighted method assumes that all of the criteria have equal weight. This method has limitations because not the entire criterion has equal importance. For example, distance from Sorell is a more important criterion than rainfall within the Sorell region. The weighted method takes relative importance of each criterion into account, but is also subjective in relation to assignment of the quantum of weighting to each criterion.

Unweighted Rankings

The sites comprising Copping and White Hill were the most favoured sites based on these unweighted analysis and show similar levels of suitability. The next most favoured sites are

Sugarloaf Rd (Front and Rear) and Fulham. The Lovely Bottom site is slightly more suitable than the average for the whole suite of potential sites. The remaining 7 sites are less suitable than the average.

Weighted Rankings

The weight is subjective and reflects the relative importance of that particular criterion. For example, the visibility criterion was considered to be a very important determinant of site suitability so a weighting of 1 was applied to those criteria. Size, on the other hand, is only considered to be half as important (with a weighting factor of 0.5) as all sites placed on the list of potential sites are of generally suitable size.

The sites at White Hill and Copping are the most favoured sites. Fulham, Lovely Bottom and Sugarloaf Rd (Front and Rear) are the next most favoured sites and are all more suitable than the average.

Table 3 summarises the results outlined in the above sections by listing the top five results for each of the unweighted and weighted suitability analyses. Six sites shared the top five ranks in both methods of analysis.

Evaluation of the site ranking analysis has been combined with observations made in the field for a short list of the most suitable sites in order to derive a prioritised list of the most suitable potential sites.

Site inspection by walkover, was conducted at: Copping, White Hill and Sugarloaf Rd (Front and Rear). The remaining short-listed sites were not visited or were viewed from the road.

The results of the visit to Copping and White Hill are detailed below.

Copping

The Copping site, as previously identified, is located approximately 3.5 km south east of the township of Copping, and is the largest of the short-listed sites. The topography of the area is gently undulating with broad flat valleys.

The area is cleared and potential for daily cover is available from on site. Road works would need to be undertaken as roads within the site are un-made and few in number. The distance from Sorell is a potential drawback as the township is located approximately 25 kilometres from the site.

The geology of the southern part of the site consists mainly of shales and mudstones deposited during the Triassic period (Rsm). Dolerite (Jurassic age) occurs within the site and mainly underlies the northern area of the site. Soil types over the site consist mainly of silty clay(becoming quite gritty in places) in the mudstone areas to heavy doleritic clays. The clays may be up to 5 metres thick in some areas. The area is not visible from the Arthur Highway, except part of the site is visible from one small section of road, which is approximately 5 km to the east of the site. Screening should not be required due to the distance of the site from the Highway. The site offers considerable potential as a regional refuse disposal centre. The site is very large and would accommodate all of the three municipalities requirements as a Regional Disposal Facility.

White Hill

White Hill is located approximately 7 km east of the township of Forcett along White Hill Rd. The site covers an approximate area of 194 hectares and is made up of several property parcels. There are potentially up to two areas contained within the site which may satisfy all requirements for a RDS. There is a nearby quarry in Wiggins Road which is currently being worked and may provide material for daily cover.

A septic tank disposal centre is located nearby and consequently contractors are currently using the existing access road infrastructure. This would need to be addressed if development was to be considered at this site. The topography of the area is gently undulating with broad flat valleys. The area is not entirely cleared and up to 25 acres of land is currently forested. Potential for daily cover appears to be high. The site is located near the top of a catchment and White Hill Rd forms a drainage divide in the area.

There is a small dip in the topography in the eastern section of the site where groundwater seepage has occurred. Access to the site is off White Hill Road and a new access road from the public road would need to be constructed. Substantial road works may be required to the 8 kilometre unsealed section of White Hills Road which is quite narrow in parts. There are 22 houses along White Hill Rd, from the Arthur Highway turn off to the site. Twelve of these houses are in the outskirts of the township of Forcett. Consequently this could become an issue with regard to transport along White Hill Rd. However, the public road is currently used to transport quarry products from an adjacent property and the impacts of additional traffic may be relatively minor. The distance from Sorell is an issue for this site as Sorell is some 14 kilometres away.

The area is very well screened. The eastern part of the site is sometimes visible from Nugent Road (8 km distant) when the weather is very clear. The site does offer potential as a RDS. The western area of the site appears to be favourable, as does the eastern section. The eastern part is larger in area and access out of the site is possible through the rear of the property. However, there may be some drainage problems associated with this area. A proposed quarry is currently being considered for the western part of the site, and within 5 years time may provide significant void space for a landfill site. In the meantime, the eastern area may be developed. Alternatively, the eastern area may be developed as a regional site or as the Sorell municipal landfill site. The main disadvantage in developing this site appears to relate to access routes and amenity impacts.

Conclusion

The overall conclusion was that Copping is the most favourable site for the future location of a refuse disposal complex. Copping is a good potential site because, although it is located 25 km from Sorell, it is large, well screened, appears to have good geological and hydrogeological conditions and is contained within two properties. Copping has advantages over all of the 15 sites addressed as potential landfill sites within the Sorell municipality.

2.3.3 Environmental Screening for Clarence Municipal and Eastern Shore Regional Tip Sites

Part of the Waste Management Strategy being developed by Clarence City Council involved identification of a future tip site to service the municipality, and potentially other Eastern

ShoreCouncils. Environmental and Technical Services Pty Ltd were commissioned by Clarence City Council to undertake the potential landfill site evaluation.

Potential sites were considered in two categories:

- those within Clarence considered suitable for a municipal tip; and
- those anywhere in an area extending from South Arm to Mangalore and from the Derwent River to Copping, suitable for an regional tip.

A total of sixteen sites were assessed, 6 municipal and 10 eastern shore regional sites (refer Table 4).

Environmental criteria were adopted for the screening of potential sites in general accordance with the guidelines of DELM and recent practice by the Hobart Municipal Councils Association (HMCA). The final screening process adopted was ultimately more detailed and sophisticated than previously undertaken and incorporated a range of environmental and economic parameters.

Exclusory Criteria were applied in the first instance to exclude a tip location on one or more of a variety of grounds. Following this, common criteria was applied to those sites that survived the exclusionary criteria so a relative ranking was achieved.

The process essentially involved:

- consultation with Council to determine requirements;
- a literature review of relevant literature;
- examination/refinement of environmental criteria;
- examination of land tenure/zoning information;
- preparation of an exclusion map;
- selection of potential sites;
- application of the ranked and weighted criteria, development of a score; and ultimately
- determination of most appropriate location.

From an environmental viewpoint alone, there were three possible sites that held potential within Clarence City Council namely:

- Bourbon Creek;
- Mt Mather; and
- Sandford.

On a regional scale the Copping site was considered the most acceptable, with four other sites Grahams/Burrows Gullies, Tier Gully, White Hill and Fluffem Creek, the next most suitable exhibiting similar acceptability. The five mentioned regional locations all exhibit preferable environmental conditions over the municipal sites.

Economic analysis was also undertaken to compare the long term costs of owning and operating the sixteen sites. The main determinant of cost differences was in the initial development costs and transportation costs to more distant locations.

The transport options considered for the regional sites involved all waste deposited at a central compacting transfer station, or self haul wastes being received at a central compacting transfer station with municipal waste and contract waste transported straight to the tip face in municipal compactor trucks or contractor vehicles.

The economic ranking for both the municipal and Eastern Shore regional site favoured the Clarendon Vale location, followed closely by Cove Hill.

A method of combining the environmental and economic ranking was developed to address these often conflicting issues. The combined 'environomic' score takes into consideration both the environmental and economic ranking.

Of the sixteen sites assessed, Copping was considered the most highly suitable for landfilling. The Copping site displays exceptional environmental conditions for landfilling. Copping is the best ranked regional site, and despite having an 'environomic' score in excess of three of six of the municipal based sites because of the increased expenses associated with developing and operating a regional facility, it is still considered the most appropriate for landfill.

2.3.4 Tasman Desktop Study

A desktop study conducted in-house at Tasman Council resulted in the decision to participate in the proposed Copping landfill development for a number of reasons. This was based on the following:

- The Tasman Peninsula is National Estate Listed, and as such, is of significant value for comprising a relatively intact habitat. The siting of a landfill and the necessary buffers could therefore compromise the integrity of the area;
- A sub-regional approach is a preferred approach because of the economic and environmental considerations that influenced the other proposed member Councils investigations;
- It is considered by Tasman, that a sub regional RDF should be proximate to the source of waste generation. As the waste generation from Tasman is the smallest of the three participating Councils, it is considered that a location more proximate to the greater proportion of waste stream is most appropriate; and
- Location of the facility within Tasman would mean increased transportation costs associated with the landfill as traversal would be required through both the Municipalities of Sorell and Clarence.

2.3.5 Summary

Significant research has been undertaken in southern Tasmania in regard to the most appropriate site for a new landfill. The subject site, selected after considerable environmental and economic analysis, has significant advantages over all other identified sites. The Regional Waste Disposal Strategy for southern Tasmania (1997) also identifies the site as critical to the future direction of waste management in southern Tasmania. There is no other site located in southern Tasmania with more appropriate conditions for development of sub-regional landfill.

3.1 SITE LOCATION

The subject site is located in a rural environment approximately 3.5km (directly) southwest of the village of Copping in southeastern Tasmania, as shown on Figures 1 and 2. The site has an area of approximately 704 ha. and is accessed from the Arthur Highway approximately 2.5km west of Copping via a gravel road in a 20m wide Right of Way.

The proposed landfill "footprint" forms less than 15% of the overall site and commences approximately 3.5km along the access road from Arthur Highway (as shown as Figure 2).

The subject site is within the 'Blackman Hill' land system as described by Davies (1988) as part of the Land Systems of Tasmania survey. The extensive 'Blackman Hill' land system includes dolerite hills and associated flats and marshes.

The central part of the overall site lies in a broad, relatively flat valley. The landfill is proposed to be located within this valley and the landfill 'footprint' is shown on Figure 2. The central valley is largely enclosed by ridges, which exist around the boundaries of the subject site. An unnamed tributary of the Carlton River runs along the northern edge of the valley (see Figure 2).

A ridge containing Castles Hill forms the northern boundary of the overall site, a ridge containing Little Blue Hill runs through the eastern part of the site and ridges also exist close to the southern and western boundaries of the overall site.

That part of the overall site comprising the 'footprint' of the proposed landfill and associated facilities, is located against the slopes of the ridge-which forms the eastern edge of the broad valley (see Figure 3). It commences approximately 200m south of the Carlton River tributary and 800m southeast of the Carlton River.

It should be noted that approvals are currently sought for Stage 1 of the development. Stage 1 covers an area of approximately 20 ha on the northeastern side of the valley. The approximate footprint for Stage 1 is shown on Figure 4.

3.2 PHYSICAL CHARACTERISTICS AND PLANNING CONTEXT

3.2.1 Site Tenure

The subject site comprises Lots 1, 3 and 4 on the Plan of Survey, Registered Number 126073 in Land District of Pembroke, Parish of Carlton. It has an area of approximately 704 ha. and is owned by the Sorell Council (refer Figure 5).

Access to the subject site is provided by a 20 metre wide 'Right of Way (Private)' from Arthur Highway. This Right of Way comprises Lot 3 on Plan of Survey Reg. No. 126073 and has an area of 6.41 ha.

3.2.2 Planning Provisions

Strategic Objectives

Use and development of the subject site is governed by the Sorell Planning Scheme 1993. The Planning Scheme contains overall objectives (reproduced in Appendix A) which essentially provide for:

- continuing development of the municipality with future residential growth concentrated at Sorell township and Midway Point;
- coordinating future growth with the economic provision of an appropriate level of services; and
- minimising the impact of development on the natural environment and managing rural resources in a sustainable manner.

The proposed development is in conformity with these overall objectives. It provides an essential service for the continuing development of Sorell (as well as Clarence and Tasman municipalities), is located well away from planned future urban areas and is designed to minimise impact on the natural environment.

The Planning Scheme also contains area specific objectives, several of which are relevant to the proposed development. The specific objectives for rural areas (reproduced in Appendix A) are relevant because the subject site is within a rural zoned area. The objectives essentially provide for:

- protection and promotion of the rural resource, including agriculture, quarrying, intensive animal husbandry, aquaculture and forestry;
- a "land resource for future residential, commercial and other urban requirements, the provision of refuse disposal, recreational areas and the protection of scenic quality"; and
- ensuring that rural activities are not compromised through incompatible development.

It is relevant to note that 'provision of refuse disposal' is specifically referred to as a use of land resource in rural areas.

The Planning Scheme's objectives for "minor rural settlements" specifically refer to Copping, the closest settlement to the subject site, amongst other settlements. These objectives include:

- "To restrict future residential development to areas within or immediately adjacent to existing closer settlement; and
- To retain the rural character of these settlements".

It is evident, therefore, that the subject site, at some 3.5km from the rural settlement of Copping, is not within or close to an area planned for future urban development.

The activity specific objectives for transport refer to the need:

- "to protect the Arthur Highway and Tasman Highway as the State's major tourist roads with special emphasis on:
  - retaining and enhancing existing views;
  - limiting the number of vehicle access points; and

. providing an adequate corridor for services and future upgrading".

It is important to recognise in this context that the proposed landfill "footprint" is not visible from Arthur Highway except from one point on Arthur Highway over 2 km away. The access road to the subject site intersects the Arthur Highway at a point with good sight lines and room for road widening.

Zone Provisions

Under the Planning Scheme, the subject site is partly included in a Rural Zone and partly within a Forestry Zone, as shown on Figure 6.

The Planning Scheme specifies that the intent of the Rural Zone is:

- To maintain the current and future opportunity for agriculture, forestry, extractive industry and other primary industries.
- To restrict the fragmentation of land and development, principally for residential use.
- To maintain and improve environmental quality standards which reflect the necessary impacts of rural activities.
- To restrict adverse impacts on the environmental qualities of adjacent zones.
- To include land that is not considered appropriate for more intensive development".

The intent of the Forestry Zone as specified in the Planning Scheme is:

- To identify areas for the establishment, management and harvesting of trees and forest produce.
- To protect the resource from competing and incompatible land uses.
- To prevent adverse impacts on the environmental quality of adjacent zones".

Within both the Rural and Forestry Zones, the land use defined as "Utility Services (Major)', which specifically includes a 'refuse disposal site', is a discretionary use. This means that a refuse disposal site on the subject site requires planning approval.

3.2.3 Present Condition and Use of Site

The subject site is currently used predominantly for grazing and forestry purposes. In addition, a small dolerite quarry exists on the north western slope of Little Blue Hill (refer plate 1) and a rifle range is located near the quarry (refer to Figure 2).

The rifle range is proposed to be relocated elsewhere within the subject land so that there is no risk to landfill employees or to waste trucks accessing the site. A number of options have been determined for the Rifle Range location, as detailed in Figure 6b. Final selection of a safe location will occur at a later stage following appropriate consultation with the Copping Sporting Shooters Club.

The northern part of the subject site (north of the tributary of Carlton River) and the slopes of both Little Blue Hill in the south-east and the unnamed hill adjacent to the western boundary of the site, contain Eucalypt-dominated open forest. This forest has been selectively logged and has a grazed understorey (refer Plate 2).

The south western part of the subject site, comprising the sandy slopes of the ridge to the west of Little Blue Hill and the southern part of the flat central valley, contains a pine (Pinus radiata) plantation. It is Councils intention that the Forestry Leases which exist on the plantations referred to in Figure 6b continue, to enable conclusion of the agreements.

Lot One was planted in 1994, Lot 2 was planted in 1996, Lot 3 was planted in 1990. Lot Numbers 1,2 and 3 are subject to joint venture agreements between Australian Newsprint Mills ANM and W.B. Downie for 30 year periods from year of planting.

Lot 4 planted in 1990 has its Forestry Right registered on title to Australian Newsprint Mills Ltd. for a 30 year period from year of planting, and a joint venture agreement between ANM and R.B. Downie for this period. Council has leased the subject area to Downie to allow the joint venture to continue.

That part of the subject site located northeast of Little Blue Hill and most of that part south of Little Blue Hill is cleared and sown to pasture.

The gravel road, which accesses the site, forks at approx. 3.2km from Arthur Highway. One fork runs over the ridge north of Little Blue Hill, past the quarry and rifle range, across the southern slopes of the central valley within the site and into the adjacent property to the west. The other fork runs below the northeastern slopes of Little Blue Hill, through Lot 4 and into the adjacent property to the south.

3.2.4 Surrounding Land Use and Development

All properties adjacent to the subject site comprise large land holdings, which are used for grazing and or forestry. Land to the north comprises a mixture of pasture and indigenous woodland, which has been modified by grazing and forestry operations. A sawmill is currently under construction on the adjacent property to the north. Land to the east predominantly contains pasture, land to the south predominantly comprises modified indigenous woodland and land to the west comprises a mixture of pine plantation, pasture and woodland.

The closest house to the proposed landfill "footprint" is approximately 2.4km to the north, as shown on Figure 2. This house, known as "Hazelwood", is on the opposite side of Castles Hill from the proposed landfill, on the south side of Arthur Highway approximately 500 metres west of its intersection with the site access road.

The next closest houses to the proposed landfill "footprint" are approximately:

- 2.7km to the north-east
- 3.0km to the north-east
- 2.8km to the north-east
- 3.2km to the east, as shown on Figure 2.

Topography screens the proposed landfill "footprint" from all existing residences.

The closest residential area to the proposed landfill "footprint" is the settlement of Copping, approximately 3.5km to the northeast.

There are no primary activities in the locality, which would be particularly sensitive to a landfill development. The only notable primary export activity in the region comprises oyster farms in Pittwater, approximately 15km to the west.

The Arthur Highway is one of the State's major tourist roads. It traverses scenic landscapes and provides access to some of the State's most significant tourist attractions including the

Port Arthur Convict Settlement Ruins and coastal formations around Eaglehawk Neck. The closest tourist facility to the proposed landfill "footprint" is the Colonial and Convict Museum on Arthur Highway in Copping, approximately 3.5km to the northeast. The proposed landfill will be almost entirely screened from view from Arthur Highway. Part of the site is visible from one point on Arthur Highway approximately 2.5km to the northeast (refer Plate 3). From this point the visible part of the subject site forms a minute component of a broad vista.

3.3 CLIMATE

Climate records for the Copping region have been obtained from the Bureau of Meteorology. Data from the following sites were obtained.

- Copping; and
- Hobart Airport.

The locations of the meteorology stations are annotated on Figure . These stations are considered to give the closest representation of meteorological conditions at the site. The following data were obtained for Hobart Airport and where available, for Copping:

- monthly total rainfall (mm);
- temperature;
- monthly wind speed and direction; and
- daily pan evaporation (mm).

The years of records vary from 27 to 43. The data have been summarised below, and included in Table 5.

Temperature data for Copping are not available. The nearest Bureau of Meteorology station is at Hobart Airport. The Hobart Airport data indicates a temperate climate, with average daily maximum temperatures ranging from 22.3 °C in January to 12.2 °C in July and daily minimums ranging from 11.8 °C in February to 4 °C in July.

Rainfall data at Copping has been included in Table 5. The average annual rainfall at Copping is 792.4 mm, and 90th percentile rainfall at Copping is 1038.7 mm (1969).

Evaporation records for Copping are not available. The nearest representative station is Hobart Airport. The average annual pan evaporation is 1314 mm. Mean daily pan evaporation data have been included in Table 5.

Wind direction in the Hobart Airport Area has been assessed on the basis of 35 years of records. These records indicate that winds are predominantly from the northwest (Figure 7).

The meteorological conditions of the region indicate that the site will require appropriate water management controls to ensure protection of the environment. For instance evaporation of leachate will not always be possible due to the high rainfall, however with careful planning leachate generation can be minimised, and irrigation of adjacent pine plantations with a diluted mix is possible.

The wind direction is predominantly northwest.

3.4 GEOMORPHOLOGY

The land surrounding the site has developed a gentle to mild undulating topography. The topography that has developed in the region is primarily the result of varying weathering resistance between the geological units. Dolerite typically forms the high ground, whilst sandstone has been eroded forming valleys. Scree slopes have developed along the base of hills, and small colluvial plains have formed on the low-lying areas, along with occasional marsh areas associated with minor creeks.

The landfill is proposed to be located in a broad valley formed by six distinct peaks (refer Figure 10). Moderate slopes flank each of the peaks, dropping away to a relatively flat valley floor. The valley drains to a tributary of the Carlton River which runs across the northern end of the valley.

Soil profiles are typically the result of weathered bedrock, although colluvial deposits exist in low-lying areas. Field investigations indicate soil depth ranges from 0.5 to greater than 3.0 metres.

3.5 SURFACE WATER SYSTEM

Generally the drainage in the Copping area has developed a NE - SW trend, a reflection of the topographic features of the region. The landscape is transected by numerous ephemeral streams which discharge to more pronounced creeks. Ultimately, the majority of the drainage paths discharge to the Carlton River, which discharges to Fredrick Henry Bay.

An un-named tributary of the Carlton River forms the northern boundary of the sub-catchment (Figure 3). This tributary drains a total catchment of approximately 900 ha, of which the sub-catchment containing the proposed landfill covers approximately 225 ha..

Surface water runoff from the landfill sub-catchment, formed by the valley described in Section 3.4, is characterised by a distinct lack of drainage paths.

Surface water runs overland down the slopes in sheet form, before reaching the valley floor. This distinct change in slope results in formation of marsh areas to the north of the proposed site. The marsh is ephemeral, the approximate extents, as observed during June of 1996 are depicted on Figure 8.

On the basis of site inspections and test pit excavations, it is inferred that shallow groundwater and surface water interact in the vicinity of the marsh. Water from the marsh area discharges to the tributary of the Carlton River.

Surface water discharge through the system has not been observed during extreme events. However, an analytical assessment of the capacity of the tributary of the Carlton River to convey waters up to and exceeding peak flows expected from a 1 in 100 year storm event has been made at the northern boundary of the landfill valley. Whilst locally, this sort of event may cause some backwater effects, it is not considered likely that the system will inundate to the extent that the Valley floor in the vicinity of the proposed landfill is covered by water.

3.6 GEOLOGICAL SETTING

3.6.1 Regional Geology

A review of the regional geology and hydrogeology of the area has been undertaken. The basis for the review was previous work carried out by Woodward-Clyde, the 1:50,000 geology map of the area and "The Geology of Tasmania", a publication by the Journal of the Geological Society of Australia.

Regionally, the area is underlain by Permian sediments, consisting of siltstones, mudstones and sandy mudstones.

Overlying the Permian sediments is a Triassic system between 400 and 600 metres thick. The Triassic system consists of:

- quartzose sandstones which dominate the lower part of the succession;
- "Felspathic" sandstone which is a widespread lithic arsenite group, and is host for coal bearing deposits in Tasmania; and
- lutites (shales) which are widespread, although in general sandstones are more abundant. Generally the shales are quartz to carbonaceous shales.

Large scale intrusion of theolitic magma (dolerite) took place during the middle Jurassic period. The dolerite occurs widely throughout Tasmania in a variety of forms; most prominent are the slightly discordant sheets or sills, but in some places steep-sided dykes are found. Generally the dolerite forms distinct ridges that tend to have a grain running NE-SW.

The regional geology is depicted on Figure 9.

3.6.2 Site Geology

Several important geological units were identified on or around the site. The following description and extent of their occurrence are the result of both a literature review and field investigations. A site specific geological map has been shown on Figure 10.

The test pit and borehole geology has been summarised in Tables 6 and 7 and the geological logs have been presented in Appendices B & C. Locations for the test pits and bore holes are annotated on Figure 11.

Triassic Sediments

Triassic carbonaceous shale (also known as a lutite or mudstone) underlies felspathic sandstone. The lutite is generally quartz shale, although micaceous and chlorotic mudstone does occur. Colours are typically light grey through to black. Generally the shale weathers. extremely quickly, developing a clayey silt type soil.

The shales encountered on the site included felspar fragments and occasional quartz: The strength of the material encountered varied, but generally was low.

One exposure of hornfels was found on the site. Hornfels is formed from mudstone by contact metamorphism associated with intrusion of dolerite.

Felspathic sandstone overlies the carbonaceous shale and consists of quartz, rock fragments, mica with felspar and some clay cement. Fragments returned from drilling indicate low quartz and high felspar content. The larger pieces returned were breakable by hand, suggesting relatively low strength.

The sandstone sediments are even-grained and well sorted, and except for angular quartz, the grains are sub angular to rounded. Sedimentary structures within the beds are apparent. The rocks are characterised by their texture and distinctive blue or green colouration, which becomes buff on weathering.

The geology encountered in each of the bores was generally the same, excepting BH 4 where a fractured sandstone layer was encountered between 10.5 and 12 metres below the surface.

The weathering product of the sandstone is generally a clayey sand towards the base to sandy clay higher in the profile, and typically a light brown to yellow colour. Generally the material is stiff, moist with a moderate plasticity, and consists of varying proportions of weathered felspar fragments, occasional rounded ironstone nodules and quartz grains.

In general surficial material which covers the majority of the site consists of at least 0.7m of sandy clay to clayey sand on top of the felspathic sandstone bedrock.

Permeability results obtained indicate that the permeability of soils across the site ranges from 4.5 x 10^{-9} m/sec to 8 x 10^{-11} m/sec (3.9 x 10^{-4} m/day to 6.9 x 10^{-6} m/day). These values are typical of very low permeability clay. The laboratory certificates are provided in Appendix D.

Dolerite

The dolerite is harder and more weathering resistant than the felspathic sandstone, largely resulting in a topography of dolerite ridges and sandstone valleys in the vicinity of the site.

The weathering product of the dolerite found around the site is generally a brown/orange mottled sandy clay to clayey sand. It is firm to moist with moderate to high plasticity.

The ridges around the site and land to the east have developed sandy clay on top of weathered dolerite bedrock.

Test Pit 10 was excavated to the east of Little Blue Hill and met refusal on dolerite after 2.2 metres of sandy clay. The possibility exists for this region to become a clay borrow area.

Scree Deposits

Scree deposits at the site have formed on the flanks and at the base of steep slopes. The deposits were formed during the last glacial age by solifluction processes. Solifluction is the process of rock breaks up by freeze and thaw action, and subsequent gravity creep of the resulting fragments.

The composition of scree at the site varies, depending on the type of material on the hill and the degree of weathering before detachment. Generally the deposits are a gravelly sand/clay to clayey/sandy gravel. The gravel is a typically angular dolerite fragment, and the sand/clay matrix is dolerite weathering product.

Colluvial Deposits

Colluvial deposits exist in the base of valley and marsh areas. Generally they are reworked scree deposits. The colluvium at the site has been washed, or has crept from local hills and been deposited on the lower topographic areas. Often the colluvium interfingers with the scree deposits.

The colluvial deposits encountered on the site consist of sandy to silty clay, which is dark brown, moist with moderate to high plasticity, and moderately stiff.

3.7 HYDROGEOLOGY

3.7.1 Regional Hydrogeology

Groundwater in the region occurs within two main units - the Jurassic dolerite and the Triassic sandstone.

Triassic Sandstone

The Triassic sandstone aquifer is generally considered to be a marginally better aquifer than the Jurassic dolerite aquifer. The sandstone is a predominantly fine to medium grained cross-bedded felspathic sandstone, with interbedded siltstone/shale. Groundwater within the sandstone occurs predominantly within fractures, rather than within the intergranular pore spaces.

The salinity of the groundwater derived from the Triassic sandstone varies markedly, from water suitable for stock and domestic usage through to more saline water that has little beneficial use. Bores deriving water from the Triassic sandstone frequently show variable yields, but generally they are low.

Jurassic Dolerite

The groundwater in the Jurassic dolerite generally has moderate to high salinity, and bores drilled into the dolerite provide relatively poor yields. The dolerite is a fine to medium grained crystalline rock, which is variably fractured. The fractures are highly variable in size and distribution and are often plugged with weathering products at shallow depths.

Quaternary Sediments

Groundwater, where present in these thin overlying sediments, is generally only suitable for stock and irrigation supply, and does not form any significant aquifer in the region.

Regional Groundwater Flow

There is no specific published regional groundwater information currently available. It is considered that groundwater occurrence is controlled by the various regimes of recharge and discharge. Recharge occurs principally through infiltration of rainfall and runoff, and discharge occurs mainly through seepage to watercourses and via evaporation. It is assumed that regional groundwater flow essentially follows the topography. Groundwater discharge to the Carlton River occurs to the north and west of the site.

Well Inventory

Bore records provided by Mineral Resources Tasmania did not identify any bores within two kilometres of the site. Of the bores drilled in the greater region most derive water from the Triassic sediments. The yields are typically low, and the water is suitable for stock watering.

3.7.2 Site Hydrogeology

The site specific hydrogeology is based on field observations, drilling and testing conducted on the site from four groundwater observation bores (BH 1, BH 2, BH 3 and BH 4), and the excavation of fourteen test pits (Figure 11).

All of the bores were drilled into the bedrock and represent groundwater conditions within the fractured Triassic sediments in the area. Negligible inflows were derived from the shales, and most flows were derived from fractures within the sandstones. Such fractured rock systems usually display large variation in aquifer characteristics and bore yield.

Aquifer tests were performed on the four monitoring bores to assess the hydraulic characteristics of the underlying aquifers. The following section outlines the evaluation of the test data.

Groundwater Levels

Groundwater was encountered in 6 of the 14 test pits. Groundwater in the soil deposits generally occurred on top of the weathered bedrock, indicating a shallow unconfined aquifer. Groundwater depths ranged from 0.4 to 1.8 metres below the ground surface in TP 12 and TP 2, 9 and 10 respectively.

Groundwater was also encountered in all of the monitoring bores (refer Table 8). For monitoring bores BH 1, BH 2 and BH 3 the majority of the inflow was derived from an unconfined aquifer lying on the bedrock, ranging from 0.7 to 5.3 metres below the ground surface. Each of these bores encountered slightly damp layers within the shale, representing zones of minor fractures through which groundwater can flow. The contribution from the shale layers is very small.

Groundwater was encountered in two major zones in BH 4. Groundwater inflow from the surficial deposits over the depth interval 1.1 m to 2.5 m, and groundwater inflow from a deeper zone was associated with fractured sandstone between 10.5 and 12 metres below ground surface. The static water level is approximately 1.14 metres below ground surface.

The groundwater levels have been reduced to Australian Height Datum (AHD), plotted, and contoured to assist definition of groundwater flow direction (Figure 8).

The groundwater contours indicate that flow is ultimately north out of the valley. Recharge of the system is primarily occurring on the slopes around the site, and to a lesser extent, the valley floor. The groundwater flow path essentially follows the surface topography into the valley, where it either replenishes the marsh system at the northern boundary of the landfill site, or evaporates through the soil column. The marsh system is considered to be the last major residence of groundwater before it discharges from the valley.

The average hydraulic gradient across the landfill 'footprint' site is around 0.02. The hydraulic gradient is greater on the hill slopes, and decreases towards the valley floor.

Aquifer Tests

Aquifer testing is a generic term for a group of tests conducted within an aquifer to assess the groundwater flow regime, ie. the hydraulic properties of the aquifer.

Two types of tests were carried out at the site:

- Drawdown Test - Is conducted by pumping a known volume at a known rate and measuring the water level drawdown in the well. The drawdown and time are recorded and calculations performed to assess the aquifer properties near the bore.
- Recovery Test - Is conducted by removing a known volume of water from a bore at a known rate and time, thereby temporarily lowering the groundwater level within and near the bore. The recovery of the groundwater within the monitoring bore is recorded and calculations performed to assess the aquifer properties near the bore.

Aquifer Test Analysis

Both drawdown and recovery level data were recorded for the monitoring bores. A copy of the aquifer evaluation tests is given in Appendix E. The aquifer test results are summarised in Table 9.

The aquifer test results showed a mild variability - which is typical of fractured rock aquifer systems. For a fractured rock aquifer system the characteristics of the aquifer are dependant on the degree, type, extent and connection of fractures within the host rock.

Bores BH 1, BH 2 and BH 3 show consistently low aquifer transmissivity (around 0.2 m^2/day) and represent the broader aquifer system as a whole. Bore BH 4, on the other hand, intersected a major fracture within the aquifer and represents the characteristics of the highly transmissive fracture zones, which is a very small proportion of the aquifer system.

Estimated transmissivities for BH 1, BH 2 and BH 3 range from 0.06 to 0.4 m^2/day, while the estimated transmissivity for BH 4 is approximately 20 m^2/day.

Groundwater Chemistry

Four water samples were collected and submitted to East Melbourne Laboratories (EML) for chemical analysis. EML are authorised by the National Association of Testing Authorities (NATA) for the analyses undertaken. Field measurements were also taken at the time of sample collection. A list of field parameters and chemical parameters analysed for each of the water samples is as follows.

Field parameters recorded include:

- pH;
- electrical conductivity (EC);
- dissolved oxygen (DO);
- redox potential (Eh); and
- temperature.

Chemicals analysed from the water samples include:

- metals (copper, lead, zinc, iron, cadmium, chromium, mercury and arsenic);
- major cations and anions;
- nutrient parameters (nitrate, ammonia, organic nitrogen, total organic carbon (TOC), chemical oxygen demand (COD) and total phosphorous; and
- organochlorins/organophospherous pesticides (OC/OP)

A summary of chemicals encountered in the groundwater is presented in Table 10, and laboratory certificates are included in Appendix F.

Field parameters

The results from the field parameters are presented in Table 11. All pH values register within current acceptable ANZECC (Australian and New Zealand Environment and Conservation Council) limits. Field pH ranged from 6.5 to 7.0, indicating that the groundwater is slightly acidic. Laboratory results reported for pH indicate the sample water to be slightly basic. The difference between the two measurements is a common occurrence, and is attributable to de-gassing of carbon dioxide from the water between sampling and analysis. For this reason the field measurements of pH are considered more accurate.

Field EC measurements from the bores range between 4,980 µS/cm and 8,210 µS/cm. Each of the field EC results is consistent with TDS results measured in the laboratory.

DO and Eh measurements indicate that the groundwater system resides in an oxidised state.

TDS

TDS range between 3,600 mg/l to 5,700 mg/l. The TDS results indicate that the beneficial use of the groundwater would be limited to stock watering applications under restricted circumstances (ANZECC 1992).

Metals

The following metals were not detected in the samples analysed;

- cadmium;
- lead;
- chromium;
- arsenic; and
- mercury.

Copper was detected at 0.01 mg/l in each of the bores, zinc ranged from 0.03 to 0.06 mg/l, and iron levels ranged from 0.03 to 0.04 mg/l. All these levels are well below ANZECC guidelines for potable water.

Cations and Anions

Major cations and anions are plotted on a Piper Trilinear Diagram, a Durov and an Expanded Durov Diagram (Appendix G). The major cations and anions have also been plotted on a Scholler Diagram. These diagrams show the relative proportions of anions and cations measured in the water samples.

The results indicate that the groundwater is of the sodium chloride type. Generally groundwater that has had long residence time has a high proportion of sodium and chloride due to cation/anion exchange. Groundwater can also have a high proportion of sodium and chloride if the groundwater has remobilised salts in the soil column. This is commonly seen in regions where natural forest has been cleared in the past, and groundwater levels have risen.

The soils across the site have a high potential for cation exchange due to their chemical structure. The low permeability's of the surficial material, and the highly variable nature of the bedrock indicate it is likely that the groundwater has resided in the system for a moderate extent of time, leading to the sodium chloride type groundwater.

Nutrient Parameters

Nitrogen as nitrate was not detected in any of the samples. Ammonia was detected at low levels in BH 1 and BH 3. Organic nitrogen ranged form 0.06 mg/l to 0.12 mg/l, which lies in a common background range. Total Organic Carbon levels ranged from not detected in BH 3 to 2.5 mg/l in BH 4, which again lies within background ranges. The chemical oxygen demand in the samples was low, although the actual values may vary slightly from those reported due to masking effects in the analysis by chloride ions.

Organochlorines/Organophosphorous Pesticides (OC/OP)

None of the specified OC/OP's were detected.

3.7.3 Hydrogeological Summary

The subject site lies in a valley underlain by a succession of sandstones and shales. Bounding the valley are dolerite ridgelines. In addition to a soil profile concurrent with this geology is a colluvial deposit, these soils generally consist of sandy to silty clays. Minor scree slopes flank the ridges.

The geological system has formed a fractured rock type aquifer with varying physical charachteristics. TDS values of the groundwaters make it suitable for limited stock watering, other paramaters are within ranges expected for such waters.

3.8 BIOLOGICAL CHARACTERISTICS OF SITE AND SURROUNDS

In October 1996 Louise Mendel of Unitas Consulting Ltd. conducted a flora survey of the subject site. (Mendel, 1996 is Appendix H to this document). A comprehensive survey of the flora of the landfill "footprint" was undertaken and a reconnaissance survey of vegetation was carried out on land adjacent to the "footprint". All plant species and communities within the study area were documented and described. The conservation status and significance of these species and communities were assessed and comments provided on the suitability of the proposed landfill site with respect to the botanical values.

Mendel identified a total of 55 species within the landfill "footprint". Forty-eight of these are native to Tasmania, and seven are introduced (exotic) species. All species identified on site are common and well reserved in Tasmania. No species or vegetation communities of conservation significance were recorded.

Mendel noted that the entire landfill "footprint" was logged, approximately 1990, and vegetation largely comprises natural regeneration of wet heath communities, dominated by low eucalypt regrowth. The vegetation contains a large complement of native species, but these occur in a setting of high level disturbance.

Eucalyptus ovata and E. *pulchella are* dominant on the site, with an understorey that varies from wet heath in poorly drained situations to a mixture of grassy and healthy species, where drainage is less impeded. As the entire landfill 'footprint' area has been logged, no large eucalypt trees remain. Most of the eucalypt growth is in the form of resprouting from stumps remaining *in situ*. Common understorey and ground cover species in the area include, *Leptospermum scoparium, Acacia dealbata, Acacia genistifolia, Lomandra longifolia, Themeda triandra, Poa* sp., *Epacris impressa, Leucopogon virgatus, Gahnia grandis and Lepidosperma* spp.

The areas adjacent to the landfill "footprint" suffer varying degrees of disturbance. To the south of the "footprint", native vegetation has been completely removed and replaced with a *Pinus radiata* plantation. Slopes to the north of the site are vegetated with *E. pulchella-E. viminalis* open forest, with an understorey of *Acacia dealbata* and *Bursaria spinosa* and a predominantly grassy ground layer dominated by *Themeda triandra* and *Poa* sp. *E. globulus* and *E. pulchella.* Open forests are dominant on Little Blue Hill, to the east of the site, and the more protected slopes to the immediate northwesterly margin of the footprint area.

All of these surrounding areas have been selectively logged, and suffer significant disturbances to understorey and ground layer vegetation, with associated loss of species. There is evidence that the land has been utilised for rough stock grazing.

Mendel (1996) provided the following conclusion and recommendation:

"The proposed Sorell Council landfill site occurs in an area that has suffered high levels of disturbance and significant alteration to native vegetation communities. No species or vegetation communities of conservation significance were recorded from the site. Land adjacent to the proposed landfill site has been similarly altered through agricultural and forestry activities.

It is recommended, from a botanical perspective, that if the area is utilised by the Sorell Council as a landfill site, this will have no deleterious effects on botanical values".

In October 1996 Karyl Michaels of Unitas Consulting Ltd. conducted a zoological survey of the subject site and made an assessment of the likely impact of the proposed development on the fauna of the surrounding area. (Michaels 1996 is Appendix I to this document) Information was collected on terrestrial vertebrates (amphibians, reptiles, birds and mammals) and terrestrial invertebrates (ie, insects, spiders etc).

Michaels (1996) provided the following conclusions and recommendation:

"The avian and mammalian species recorded were generally typical of dry sclerophyll and open woodland or savannah habitats and were not restricted to the actual site. Most other fauna species found were typical of disturbed and/or pastoral areas. All species found were both common and widespread in Tasmania. No rare or threatened species were found. No species found require any special consideration in regards to conservation.

There are no zoological reasons why this project should not proceed".

3.9 CULTURAL HERITAGE OF SITE AND SURROUNDS

3.9.1 Archaeological Characteristics

Woodward Clyde on behalf of Sorell Council, commissioned Ms D. Robertson, a Consulting Archaeologist to undertake an archaeological survey within the study area, during late October 1996. The survey undertaken by Ms Robertson and an Aboriginal Cultural Heritage Officer and their report has been included as Appendix J. The area is well documented as having rich hunting ground for Kangaroos and other mammals and for marine and riverine resources. The study area was part of the range of the Moomairremener people of the Oyster Bay Tribe and was used also by the Leenowwenne and Pangerninghe people of the Big River Tribe whose home range was to the west (Ryan 1982).

Thirteen Aboriginal sites were found, these ranged from isolated artefacts to scatters of up to thirteen artefacts. The types of artefacts - the raw material and their form, and the types of sites located are well represented in the East Coast forest region of Tasmania.

Of the thirteen sites, four are located in the area defined as the landfill footprint, (Figure 12). The landfill footprint has been modified to leave four artefact sites within its boundaries.. Application for destroying the 4 artefacts within the landfill footprint will be sought however, it is proposed to liaise closely with the Tasmanian Aboriginal Lands Commission (TALC) throughout the landfill development to ensure appropriate actions are taken to preserve the cultural heritage of the region. This could include relocation of artefacts to nearby sites protected from landfill development.

The archaeological survey outlines certain procedures to minimise disruption to artefacts, these procedures would be incorporated into a management plan for the construction and use of the landfill. The artefacts within the adjacent areas and buffer zones can be preserved without any disruption.

The environment of the recorded sites is disturbed, which diminishes the scientific significance of the sites but key natural elements remain and if the majority of sites in the study area are protected, the cultural landscape - the context and evidence of Aboriginal life in this area - will remain largely intact.

3.9.2 Historic Characteristics

Enquiries with the National Trust of Tasmania regarding post European contact sites of significance has revealed no recorded sites within close proximity to the subject site. Appendix K contains a copy of correspondence with the National Trust.

3.10 ON SITE RESOURCES FOR LANDFILL DEVELOPMENT

Two potential resources suitable for use in the construction and maintenance of a landfill have been identified within the subject site.

Two quarries have been excavated on the flanks of Little Blue Hill (Figure 9). The quarries have targeted dolerite deposits. Dolerite, when in a relatively non-weathered state and crushed, is a hard coarse angular rock, very similar to basalt gravel, and can be used in road construction and drainage layers.

It is likely that there are additional suitable deposits of dolerite on other hills surrounding the landfill site.

In addition, two locations have been identified that are suitable for clay borrow regions (refer Figure 2).

The soil on the plain to the east of Little Blue Hill is composed of a weathered dolerite profile underlying colluvium material. Both of these soils are clays with low permeability's. TP 10 was excavated in this area to 2.2 metres before refusal on dolerite. It is expected that the deposit is laterally extensive, and given the area of the plain, a conservative estimate of available clay is 60,000 cubic metres.

The second potential borrow area is adjacent to the western boundary of the footprint of the landfill. TP 13 was excavated in this area and encountered a clay to a depth of 2.4 metres. It is unknown how deep the clay extends.

The clay would be suitable for use as a recompacted liner or final cap.

3.11 CURRENT AND PROJECTED SUB-REGIONAL POPULATION

The most recent population estimates for the three municipalities is from the 1996 Australian Bureau of Statistics Census. The population of Sorell was 10,114 (ABS,1996). The population of the municipality grew by an average of around 2.59% per annum between 1991 and 1995, one of the highest municipal growth rates in Tasmania.

Clarence City Council borders Sorell Council to the west and contains the suburbs of Hobart located on the eastern shore of the Derwent Estuary. In 1996 Clarence City Council had a population of 49,550 (ABS, 1996). The average annual rate of population growth for the municipality in the 1991-1995 period was 0.24%. Clarence City Council has a relatively large population with a relatively low growth rate.

TasmanCouncil borders Sorell Council to the southeast and comprises the entire Tasman Peninsula. It's sole land access is viaSorell Council. According to 1996 ABS statistics Tasman Council had a full time serviced population of 2,210. The average annual rate of population growth for the municipality in the 1991-1995 period was 1.06%.

Sorell and Tasman Councils have a significant number of unoccupied dwellings, which have implications for realistic population assumptions. Whilst Tasman has a relatively small permanent population it has a large seasonal population accommodating an increase of up to approximately 2500 people in Summer months (LGB Submission, Sep 97). Significantly, Sorell also has an increased summertime population of approximately 3,600 people (LGB Submission, Sep 97). These figures indicate a total summertime increase of over 6000 persons.

The strongest population growth figures for the southern region of Tasmania are Sorell and Tasman Councils, and although there is evidence to suggest this growth rate has abated, it is still the fastest growing region in the State.

The landfill is proposed to service the combined population of Sorell, Tasman and Clarence City Councils from 2001. The combined population of the three municipalities would be approximately 62,800 at this time if current population rates of change continue (not considering seasonal variations).

There is no published longer term information on population projections on an LGA basis for Tasmania. The only published information shows population projections for Tasmania (as a whole and the southern region) over the period 1996 to 2021. These figures show population growth rates unlikely to alter significantly.

3.12 CURRENT AND PROJECTED SOLID WASTE DISPOSAL IN SUB REGION

3.12.1 Current Waste Disposal Arrangements

The Municipality of Sorell currently disposes of approximately 9,000 tonnes of solid waste per annum to a Refuse Disposal Facility (RDS) at Carlton. It is anticipated that the new RDS would replace the current operation and service the whole municipality as well as Clarence and Tasman Councils.

The municipality of Clarence generates approximately 37,500 tonnes of total wastes per annum of which 26,500 tonnes is municipal waste. The majority of Clarence's waste is deposited at its facility in Lauderdale. An unknown proportion of municipal waste is also being diverted to both Jackson Street (Glenorchy) and McRobies Gully (Hobart). The Lauderdale site is due to close in 2001 in accordance with the permit conditions from Environment & Planning Division.

Tasman operates a single landfill at Nubeena (Category 2). The site receives approximately 1200 tonnes of waste per year. The site is due to close 2001 in accordance with the permit conditions from Environment & Planning Division. Table 12 details the Existing Landfill Capacity servicing the three member municipalities.

3.12.2 Current Waste Minimisation Arrangements

Waste disposal should be viewed as just one of several important components of a total waste management system. The 'Tasmanian Solid Waste Management Policy' (Department of Environment and Land Management, 1994) details a modern approach to waste management which begins at the source and comprises the following strategic principles:

- waste minimisation;
- recycling and reuse;
- energy recovery;
- safe and secure disposal; and
- rehabilitation and future use.

It is internationally acknowledged that landfills will be required in the foreseeable future as 100% recovery of waste for re-use is impossible under current technology. Waste minimisation is the major element underpinning the policy and has arisen from the recognition of the need to reduce waste going to landfill in order to conserve natural resources and reduce the economic, environmental and social costs of disposing of wastes. The policy adopts the targets set in the 'National Waste Minimisation and Recycling Strategy' (Department of Art Sport Environment and Tourism, 1991) for reducing waste going to landfill by 50 per cent by the year 2000, measured by weight per capita based on 1990 levels. A major thrust of the policy is to encourage Local Governments to instigate recycling programs.

Current recycling measures implemented by the three municipalities from kerbside collection account for:

Sorell	1,470 tonnes of waste
Clarence	6,020 tonnes of waste
Tasman	20 tonnes tonnes of waste

3.12.3 Projected Future Waste Disposal

Potential residual waste figures for the municipalities indicate 20,000 tonnes of residual waste in Clarence, 5,500 tonnes of residual waste in Sorell and 1,000 tonnes of residual waste in Tasman.(Waste Minimisation Strategy for Southern Tasmania, SWSB). This would indicate that based on current practice, the landfill at Copping would be accepting approximately

26,500 tonnes per year of Municipal waste compared to 34,010 tonnes if no municipal recycling was provided.

These figures have been used for the modelling calculations, and are based on information provided by the three councils from a variety of sources. A slight descrepancy in the figures has arisen due to information being resourced from a variety of sources, and recycling figures referred to above relating solely to kerbside recycling initiatives.

If national policy objectives are achieved then this should result in a reduction in municipal waste volumes by 50%. Clarence has an adopted Waste Management Strategy which identifies a 46% reduction in waste to landfill within the next five years from the 1990 level.

At this stage, real savings in landfill cannot be fully assured until a detailed program of waste reduction and resource recovery has been developed. The Draft Waste Minimisation Strategy discussed in Section 2.2.3 proposes to provide the strategic basis for such a program.

Additional recycling and waste minimisation measures will prolong the life of the Copping sub-regional landfill rather than replace the need for such a facility. Success of recycling initiatives is dependent upon the markets for recovered materials as municipal recycling programmes do not recycle material but recover material for recycling. Re use and reduction processes will need to be encouraged to assist diversion from landfill to supplement recycling programmes.

4.1 INTRODUCTION TO DEVELOPMENT CONCEPT

Development of the site has been divided into several stages due to the large volume of available airspace, and the current relatively low volumes of waste generation. Stage 1, indicated on Figure 4, 13 and 13A, has been chosen for initial development for a number of reasons, including:

- Site access: The proposed Stage 1 development is close to the site access, and would not interfere with further development of the site;
- Drainage considerations: The footprint of Stage 1 has a very small contributing catchment, making surface water control a relatively easily manageable issue;
- Future establishment: Infrastructure associated with Stage 1 could serve in future development of the site ;
- Development size: Stage 1 has a projected life of 26 years, an ideal time frame for a landfill development; and
- Progressive rehabilitation: Stage 1 can be progressively rehabilitated, and incorporated into potential future development at the site.

4.2 AVAILABLE AIRSPACE AND LANDFILL LIFE

Potential airspace volume calculations have been undertaken for the site by establishing digital terrain models (DTMs) of the existing site topography, the design landfill base and the design landfill cap.

The airspace available for landfilling in Stage 1, for the cell configuration shown in Figure 13, is approximately 2,500,000 m^3 . Based on the calculated waste stream rates expected to be disposed of at the landfill site, Stage 1 will have a life of approximately 26 years. A linear population growth rate (reflecting current values) for the three municipalities has been assumed in estimating the expected life of the landfill. It should be noted that it is unrealistic to predict with certainty ongoing growth rates, waste generation rates and waste disposal trends. The table, therefore, is a best indication.

Greater design detail for each cell within the Stage 1 Development is presented in Table 13. Figures showing the sequence of development of each cell, and the discrete staging are given in Figures 14A through 14Q.

It is proposed that waste will be compacted by mechanical means to at least 850 kg/m^3. This is in all likelihood a conservative estimate. Modern landfills are consistently achieving compactions in excess of 1000 kg/m^3.

The site as a whole has a potential airspace in excess of 14 million cubic metres. It is unrealistic to predict waste disposal growth rates over the time required to fill the entire site. It is obvious, however, that the site has the potential to last for a substantial period of time, or receive wastes from a wider variety of sources.

Conceptual drawings showing both Stage 1 development and a possible site development upon completion have been provided (refer Figures 20 and 21).

4.3 WASTE CHARACTERISTICS

Waste deposited to the proposed landfill is to consist of wastes as identified in the Tasmanian Landfill Code of Practice for Category Three Landfills. These sites are capable of receiving more than 25,000 tonnes of municipal and non municipal waste per annum. The waste categories proposed to be deposited include:

Municipal - Domestic	Collected at the kerbside
Municipal - Other Domestic	Self Haul to Waste Transfer Stations
	Hard Waste Collections
Municipal - Other Council	Street sweepings
	Litter bin contents
	Parks, Gardens and street tree loppings
	Construction spoil
Commercial & Industrial	Wastes arising from institutional, commercial, industrial activities (non hazardous) and being disposed of to facilities owned by urban authorities
Building and Demolition	Wastes arising from demolition and building activities.

General public access to the Copping sub-regional landfill will be denied. Casual tipping will be allowed at transfer stations operated for the Councils.

Recycling depots will be established at each transfer station and where possible, as much material as possible will be recycled, and recycling programs in line with current trends would be employed.

4.4 CONCEPTUAL LANDFILL DESIGN

The construction of the landfill will be guided by the following development processes (refer also figures 14, 17 - 21):

- The total landfill site would be developed as a sequence of stages, with each stage divided into separate cells (refer Figure 14, 15 -16). Cells are designed to be filled in 1 to 3 years, before being progressively rehabilitated.
- Cell development would commence with Stage 1, which consists of 17 individual cells. Immediately prior to Stage 1 being completed, Stage 2 development would be undertaken. Any site design features such as fencing and drainage would be extended to service this new stage.
- Filling of Stage 1 would be done on a cell by cell basis and would begin by filling up against the natural slope of the ridge along the eastern extent of the Stage 1 development (Refer Figure 13).
- Using the existing insitu clays or clays from a suitable borrow area, a 0.5 m thick base liner would be constructed on the landfill floor and side slopes. Permeability of less than 1×10^{-9} m/sec will be achieved by mechanical compaction methods. Bunds located along

the western extents of Stage 1 would also be constructed from this low permeable site clay. (Refer Figure 17 for proposed base construction).

- A leachate collection system would be installed on the base liner, diverting excess leachate initially to collection sumps, before draining under gravity to a temporary collection pond. This system would comprise a series of slotted drains as illustrated in Figure 18 and 19. It may be necessary for pumps to be installed in some sumps to transfer leachate to the pond, alternatively a second pond could be constructed at the northern end of the Stage 1 development.
- The majority of the final cap would be formed and graded with slopes of 1 in 10 to increase surface water run off and reduce future leachate production, excepting faces of the completed landfill which would have grades of 1 in 4. These faces would form part of future development stages. The surface would be landscaped to blend with the surrounding topography. The conceptual design of the final cap for Stage 1 is shown on Figure 20 and a conceptual capping for the whole site is shown on Figure 21.
- Subject to suitability, excess leachate collected would be disposed of by irrigation of pine plantations within the development footprint. The leachate would be diluted with fresh water obtained from stormwater runoff, and potentially by groundwater.

4.5 SITE CLEARANCE AND ESTABLISHMENT

Stage 1 would be progressively cleared of vegetation ahead of development. Generally this would be achieved by running a dozer over the surface. Trees with diameters larger than 200mm could be cut up and sold as firewood, the remainder of the material could be stockpiled and burnt, landfilled or alternatively could be mulched, composted and sold to the general public.

Topsoil material would be removed and stockpiled adjacent to the active cells for later use as cover material and/or final capping material.

4.6 SITE ACCESS

Access to the landfill will be gained from a Right of Way owned by Sorell Council directly from the Arthur Highway. The entrance at the Highway is defined by a cattle grid

The existing gravel access road within the Right of Way will be upgraded by spray sealing for the first 900 metres from the Arthur Highway intersection and re-gravelling elsewhere, where required. Internal roads will be constructed and maintained for all-weather operation.

Vehicle access along the existing Right of Way will not be impeded. Access to the landfill will be via a turn-off from the main through road. The trucks will travel through a weighbridge/office facility, from which they will travel down hill along the southern boundary of the landfill, before turning into the active cell. Access to upper levels will be via benches cut into the established bunds.

After dumping, the trucks will exit the active cell via the north, and join the access road along the eastern boundary of the landfill. The trucks will pass through a wheel washer adjacent to the weighbridge facility before leaving the site through the same gate they entered (refer Figure 13A). These facilities could also be used for operation of future landfilling stages.

The landfill would be open to waste collection contractors from the three municipalities or their private contractors only. There will be no access or provision for general public waste disposal.

Waste Transfer Stations located in each of the three council areas will provide services for the disposal of wastes from the general public. These wastes will then be transferred to the landfill site by means of waste collection contractors.

Waste from the three municipalities will be transported from the transfer stations to the landfill site by waste disposal trucks averaging 20 m^3. The weighbridge and associated site office located within the site boundary at the site entrance will be used to record and monitor the quantities and rates of incoming waste.

The total increase in number of trucks for Stage 1 of the proposal would be up to approximately 37 truck movements per day. This is discussed further in Section 5.2.7.

The Arthur Highway has an annual daily traffic in the order of 1,900 which increases to around 2,800 vehicles during the summer months. These figures are increasing annually at about 2.5% per annum. Due to the likely continued increase in traffic along the Arthur Highway and the truck movements which will be required at the intersection of the Arthur Highway and the Right of Way a left hand passing bay will be developed (refer Plates 4 & 5).

4.7 CELL OPERATION AND DEVELOPMENT

Stage 1 has been divided into 17 cells in order to minimise leachate generation and allow for progressive site rehabilitation.

Initially, filling would begin in the southeast corner of the footprint. Waste would be laid against the slope of the hill, and progressively filled downslope. Trucks would access the cell by a road running along the southern boundary, and exit to the north via another road, which would run back along the eastern boundary of the landfill "foot print". (Refer Figure 13.)

A dozer would be used to compact the waste in the 2 metre lifts, and internal cell bunds would be constructed to allow for benching, thereby allowing access to the upper levels of the landfill.

At the end of daily landfilling operations, active tipping areas would be covered with at least 150 mm of cover material.

The cell arrangements and cutaways showing the filling sequence have been given on Figures 13 through 21.

The cells would be progressively rehabilitated upon their completion. Subsequent cells would be laid against the previous cell, and would be accessed via the same roads.

A sequence of figures illustrating the cell development has been given on Figures 14A through 14Q. The cell development has been staged to fill from east to west, on the natural slope of the hill, while progressively moving north.

Internal access roads would be arranged in a manner to minimise travel distances by progressively moving the northern road ahead of the landfilling operations.

An intermediate fence would be constructed to the north of cells 1-4 (Fig.13). The fence would be moved before landfilling in subsequent cells commenced.

4.8 LEACHATE MANAGEMENT

The leachate management system would comprise a collection and disposal system. A key element of the landfill is the minimisation of leachate generation by diversion of surface waters away from the site. The landfill will be designed in such a way as to ensure collection of leachate and segregation of contaminated water from surface runoff. This will be achieved by adopting the following procedures:

- The landfill will be developed in cells.
- The base of the landfill cells will be placed on a 0.5 m clay liner, constructed using a series of 150-200mm compacted clay lifts with permeability not exceeding 1×10^{-9} m/sec.
- The cells will be graded to facilitate rapid stormwater runoff where appropriate and effective collection of leachate.
- The cell floors will be subdivided into sections by flood control berms of compacted clay to allow for segregation of leachate and stormwater.
- Drains will be placed in the floor of the landfill to collect leachate at each flood berm as the compartments are progressively filled. The drains will be slotted in the area of the sump enclosed by the flood berms, but will not be slotted outside of the collection area.
- Any excess leachate produced will be drained to a collection sump and then to a temporary leachate holding pond (Refer Figure 13 for pond location). The location and extent of the leachate holding pond will change based on the future development of the stages.
- Surface drainage will be diverted to separate settling basins before discharge.
- Any excess leachate collected in the temporary holding pond will be disposed through diluted irrigation of the adjacent pine plantations, or if required over the landfill mass or irrigation of the rehabilitated landfill cap.

4.9 SURFACE WATER MANAGEMENT

It is recognised that surface water management will be a key requirement for the continuing success of the landfill. A proposed drainage system has been developed for Stage 1 of the landfill. The proposed system meets, or exceeds guidelines suggested in the document "Draft Tasmanian Landfill Code of Practice". The design process was undertaken in accordance with "Australian Rainfall and Runoff", the recognised industry benchmark for rainfall and runoff analysis and design

Included as key considerations in this process were the following:

- The sub-catchment within which the site is located is not transected by any established creeks. There is, however, some marshland that develops at the northern end of the catchment during wet periods.
- The site drains to the north to a tributary of the Carlton River which has capacity far in excess of the flows expected from a 100-year storm event, provided adequate stream maintenance is continued.

The design objectives were as follows:

- Minimise rainwater runout passing into the landfill, thereby minimising leachate generation rates.
- Contain contaminants associated with activities on the site (ie leachate and suspended solids) within the site and avoid impacts on any of the surrounding surface water bodies.
- Create a drainage system that promotes conveyance, particularly through the northern end of the catchment, thereby minimising the potential for marsh conditions.
- Integrate the system in such a manner as to combine with other necessary infrastructure, and also provide a supply of water at strategic locations for fire fighting and dust suppression uses.

The key components of the system are outlined below and also shown on Figures 13 through 138.

Cut off drains are specified running the perimeter of the Stage 1 development. All drains are designed for sufficient capacity to cater for flows in excess of the peak 1 in 50 year storm event. Zones where grades will result in acceptable velocities have erosion control measures specified. The drains will be grass lined and designed for low flow velocity in order to minimise erosion potential and aid in improving water quality.

The perimeter drains discharge to two sediment settling basins (The northern and eastern drain to Basin 1, the southern and western drain to Basin 2). The design of these basins is to ensure that the water is "stilled" sufficiently, prior to entry into the main settling basin.

Settling Basin 2, adjacent to the western side of the landfill will have a component of permanent storage, supplemented by a groundwater bore. Water contained here could be used for dust suppression and fire fighting purposes.

Temporary stormwater drains and diversion bunds would be constructed around individual active cells to minimise stormwater coming into contact with the landfill. To further protect the landfill from water, intrusion bunds upslope are also specified.

The marshland area to the north of the sub-catchment will be dewatered by the construction of a branched trunk drain. It is proposed that the drain would be installed as soon as permission to proceed with the development was given.

The drains purpose would be twofold:

- Because of the depth of drain, and because the drain will be keyed down to the top of the underlying soft rock, the drain will ultimately serve to dewater the soils of the low-lying land.
- By providing a defined and adequate drainage path the drain would serve to convey waters from storm events of at least 100 year recurrence interval directly to the unnamed tributary of Carlton River. This would also avoid the existing situation whereby waters bank up on the low lying ground before eventually discharging to the tributary.

It is recognised that the design process for the proposed landfill will be an ongoing exercise. This means that all cells of the landfill will not be constructed at once, rather the landfill construction would be divided into construction components of suitable size. For example, cells 1,2,3 and 4 would be constructed and filling well underway before preparation of cell 5 would begin.

There is an intended degree of flexibility within the construction guidelines highlighted in this document. The site may require an ongoing design optimisation process in order to overcome issues such as shallow groundwater problems.

In the instance of shallow groundwater, it may become apparent during detailed design that other options should be pursued for an adequate degree of certainty with respect to design integrity. Additional measures may include:

- Cut-off drains keyed through the soil profile on the eastern and southern boundaries of Stage 1.
- The base of the landfill may need to be raised in areas that cannot be adequately drained.
- Under drainage beneath the liner may be used in areas where shallow groundwater is causing ongoing problems.

With this in mind, it is proposed that the landfill design and construction would be closely monitored. Annual measures of landfill performance would include a review of conditions in the vicinity of proposed new cells (ie cells 5-8 would be inspected whilst filling cells 1-4) by competent personnel familiar with landfill design and construction. In this way, the optimum design for the landfill, and in particular the liner of the landfill, can be ensured.

Ultimately, the final constructed form of the landfill may vary from the concept proposed in this document. Any variance would be to the benefit of the ultimate performance of the landfill, and designed to minimise impacts on the immediate environment.

Ongoing monitoring of landfill gas bores drilled at the site would be continued. Results of this monitoring would be included as a part of the review of the landfills ongoing performance post-closure.

4.10 LANDFILL GAS MANAGEMENT

A landfill gas collection system would be installed in the landfill cap, as detailed below. The relatively low permeability cover of the landfill cap is designed to inhibit landfill gas escape through the landfill surface and to cause preferential flow of gas towards the gas extraction bores.

Gas observation bores would be drilled into the landfill to monitor the rate of gas production within the landfill, which will largely depend on the rate and volume of waste disposal. The bores would be drilled approximately 10 m into the landfill, with a slotted 50 mm pipe installed within the bore. The pipes are slotted across the entire length of the pipe below the landfill surface and surrounded by gravel pack.

The gas bores would be interconnected by pipework (fitted with valves and condensate collection points) and gas would be extracted via a centrifical air pump, if required. Varying gas flow rates and pressures would be controlled by means of gate valves fitted to each bore. If there was no desirable use for the gas at the time of production (such as use at the nearby timber mill), gas derived from the landfill would be flared off.

Based on initial tipping rates, landfill gas produced at low rates of tipping and collected in the extraction system will simply be flared off. As tipping rates rise the need and availability for landfill gas utilisation, such as for the adjacent timber mill, will be investigated.

Any landfill gas condensate collected in the gas extraction system would be treated in the same manner as leachate.

4.11 HOURS OF OPERATION AND SUPERVISION

The landfill would be open for operation between 7.00am and 5.00pm daily, and accept receipt of wastes between 8.00 am and 4.00 pm Mondays to Fridays and from 9.00 am to 4.00 pm on Saturdays and Sundays. It would be fully supervised throughout these hours of operation. The landfill gates would be locked outside these times and no access would be available except for management and emergency vehicles.

4.12 RESPONSIBILITIES

The joint authority constituted by participating Councils would be responsible for the operation and management of the proposed site. Ultimate responsibility would be maintained by the General Manager and by the appointed Site Manager.

4.13 STAFF AND EQUIPMENT

Staff will need to be employed to operate the proposed sub-regional Landfill. The staff members will be sufficient in number to provide:

- OnSite supervision;
- Gatekeeping, and weighbridge operation;
- Machine operation;
- Truck driving; and
- Labouring.

The site supervisor would be on site during all working hours. This person would be suitably qualified and would oversee and be responsible for all aspects of the landfill activity.

The equipment to be used on the site includes the following:

- Caterpillar 816 landfill compactor or equivalent;
- Komatsu D755 traxcavator or equivalent;
- Dump truck, when required; and
- Roll-on Roll-off water tank and pump.

There will also be a weighbridge and other tools and equipment may be required for servicing the equipment.

4.14 BOUNDARY FENCES

The Stage 1 development will be fenced with a 1.8m high chain mesh fence. Particular sections surrounding Stage 1 will be relocated at the completion of the Stage 1 development and the total landfill site progressively fenced as the various stages are undertaken (Refer Figure 13 for fence location). Access through the fence will be through lockable gates.

A five metre cleared area either side of the fence will be maintained for vehicle access. In addition this will act as a firebreak.

Portable internal litter fences will also be set up close to the active landfilling area, to control the spread of windblown litter. Should it be considered necessary portable litter screens could be used around active tipping areas.

4.15 COVER MATERIAL

A stockpile of suitable material for at least two weeks supply of refuse cover will be maintained on site. The stockpile will be stored alongside the active landfill area and be readily available for use on a daily basis.

Batters on the stockpiles will not exceed 1:3 (vertical:horizontal). Stockpile surfaces will be left in as rough a condition as possible to minimise erosion. Stockpiles will not be located within 100 metres of a drainage line, including the landfill perimeter drain.

4.16 WHEEL WASHER

Upon completion of tipping, each truck leaving the site will travel along the access road to the wheel washer. The wheel washer will consist of a concrete slab sloped towards a collection pit at one end of the area. The wheels will be washed down using ponded water from settling basin 1. The wastewater will flow into the collection pit from where it will be directed, by pipe, into a wastewater collection pond.

A coarse mesh basket in the collection pit will collect any large refuse. This material will then be disposed of in a waste receptacle adjacent to the washdown area.

4.17 PROGRESSIVE SITE REHABILITATION

The landfill will be progressively rehabilitated as each Stage is completed, by covering with a 500mm layer of clayey soil and 300mm depth of cover material suitable for revegetation. The surface will be graded appropriately (at least 3% to 5% slopes in the main) to promote surface drainage of incident rainfall away from the landfill.

The completed landfill surface will be designed to limit water infiltration by increasing surface runoff and evapotranspiration from the rehabilitated surface. Surface runoff will be encouraged by capping the landfill with low permeability soil and grading the land surface to the surface drains.

The final cover layer would be at least 300mm thick and would cover the entire landfill. When combined with the 500mm clayey soil layer already placed on the refuse, this depth of soil would be sufficient to support vegetation growth. After revegetation, this depth of soil is considered sufficient to prevent excessive surface water infiltration, but the land surface would be graded to prevent ponding in the event of future settlement. Successive revegetation of the landfill surface would be facilitated by the planting of species tolerant to local conditions. A methane gas collection system would also increase the success of revegetation.

Runoff from the landfill cap will be diverted to the on-site water retention dam and used for watering site vegetation if required.

A water balance has been conducted for the proposed capping profile for both the average rainfall year, and in addition for the 90th percentile wet year (Tables 14 and 15). This shows that the proposed cap will adequately shed water without needing a drainage layer, and in addition, will maintain a more stable moisture content in the clay, thereby avoiding the development of cracks etc.

A program of progressive rehabilitation of the landfill surface will be carried out after the landfill has been capped, a ground cover of vegetation has been established and installation of the gas collection system has taken place.

The long term rehabilitation of the landfill will be established through sequential planting. The vegetation of the landfill will follow the following general sequence after the capping of each landfill cell:

Year 1:	Stabilisation with suitable vegetation. Planting of wind breaks and shelter belts in clumps. Planting of colonising plants. Planting of trees on stable ground areas. Control of weeds.
Years 2-5:	Maintenance of above. Supplementary planting as required. Weed control.
Years 6-15:	As for Years 2-5. Additional shrub planting on ground that is still subject to settlement.

Initial rehabilitation of the landfill surface will distinguish between the stable and unstable areas. The unstable areas will be colonised with ground cover and low shrubs. The stable areas, which will be located around the perimeter of the landfill, will be used for tree and shrub planting. In this way the landscape screening and integration of the site with its environs will be implemented during the early landfill rehabilitation works.

The selected plant species will be indigenous and tolerant of the clayey landfill cap.. Extraction of landfill gas will minimise the impact on the vegetative cover.

All trees and shrubs selected for planting will have shallow roots in order to prevent penetration of the capping layer. Therefore, the selected species on the cap are likely to be only 1 or 2m high in order to remain structurally stable.

Irrigation of the plants may be required during their establishment period. The water applied would be sufficient to moisten the root zone only in order to prevent water infiltration into the landfill and production of excess leachate. Application of water therefore would be carried out on a systematic basis dependent on weather conditions, plant requirements and soil water storage.

Monitoring of the rehabilitation works will be essential and will be carried out to ensure that areas where rehabilitation has failed are re-worked as quickly as possible. The monitoring period will be on going, however the first two years are critical. Monitoring would include:

- watering of seedlings until sufficiently established;
- maintenance of fences and guards to exclude vermin;
- weed control by herbicides or other means;
- replacement of non-thriving, dead or diseased plants;
- re-fertilisation if required; and
- control of erosion that occurs.

At this stage, it is expected that the after use of the site would be for grazing.

4.18 FINANCIAL GUARANTEES

Financial guarantees are a means of ensuring that landfill owners adequately plan for closure, post closure care, and for site rehabilitation by providing a specific mechanism to accumulate funding during the life of the landfill. While considerable financial planning would be undertaken for the proposed landfill, including detailed costing of closure, remediation and post closure care and monitoring works, it is not the intention of Sorell Council on behalf of the member councils to post a financial guarantee as the local government authority is unlikely to become insolvent.

4.19 MONITORING

4.19.1 Groundwater Monitoring

The hydrogeological and landfill analyses carried out indicate that the landfill can be operated without adversely affecting the groundwater system. It is, however, important that monitoring of the site be carried out on a regular basis to ensure that any impacts of the landfill remain acceptable. Groundwater monitoring would detect if the landfill operations are impacting beyond expected levels and, if so, allow for modifications in the operation or design of the landfill.

Six groundwater monitoring bores have been specified for the site. (Figure 11). The monitoring program will incorporate regular water level measurement and groundwater quality testing. As an added precaution, one of the monitoring bores is specified as a sacrificial bore, ie it will be decommissioned and then the landfill will continue over the top.

The sacrificial bore, immediately to the north of cells 1 through 4, will allow for a quicker response to any potential problems that may occur. It will be important that the bore is decommissioned in a manner that will not allow for preferential flow to the aquifer.

Groundwater sampling would be carried out in accordance with DELM guidelines and the samples will be analysed by a laboratory accredited by the National Association of Testing Authorities (NATA). The analyses for the first year would cover the following analytical parameters:

- Field Measurements (pH, Electrical Conductivity, Dissolved Oxygen, Redox Potential and Temperature);
- Major cations and anions (Sodium, Potassium, Calcium, Magnesium, Chloride, Bicarbonate Alkalinity, Carbonate Alkalinity, Sulphate and Total Dissolved Solids);
- Organics (Nitrate Nitrogen, Ammonia Nitrogen, Total Phosphorous, Trace Organic Screen, Chemical Oxygen Demand and Total Organic Carbon); and
- Metals (Arsenic, Cadmium, Chromium, Copper, Iron, Lead, Manganese, Mercury and Zinc).

Quarterly monitoring would be carried out over a one year period, to ensure that adequate background levels are recorded. Biannual or annual water quality monitoring of a revised analyte list for the site may then be adopted.

Monitoring of leachate chemistry, for the same parameters given above plus grease and oils, enterococci and faecal Coliforms, will be conducted initially on a quarterly basis. Again the analyte list and frequency of analysis may be revised.

The analysis results would be submitted to DELM, with a record of date and time of sampling, and showing the stamp of endorsement from the testing laboratory.

4.19.2 Surface Water Monitoring

Surface water in the vicinity of the site will be managed in a way to minimise any detrimental environmental impacts. Surface water discharges will be monitored initially for the first year on a quarterly basis and the results reviewed. The samples will be collected from Basin 1 of Stage 1 and analysed by a laboratory authorised by NATA for the following parameters:

- Field Measurements (pH, Electrical Conductivity, Dissolved Oxygen, Redox Potential and Temperature);
- Major cations and anions (Sodium, Potassium, Calcium, Magnesium, Chloride, Bicarbonate Alkalinity, Carbonate Alkalinity, Sulphate, Total Suspended Solids and Total Dissolved Solids);
- Organics (Nitrate Nitrogen, Ammonia Nitrogen, Total Phosphorous, Trace Organic Screen, Chemical Oxygen Demand, Total Organic Carbon, Grease and Oil);
- Microbiological parameters (faecal Coliforms and enterococci); and
- Metals (Arsenic, Cadmium, Chromium, Copper, Iron, Lead, Manganese, Mercury and Zinc).

4.19.3 Landfill Gas Monitoring

The landfill gas bores drilled at the site will be constantly monitored, as they provide a potential energy source for any nearby industry such as the timber mill facilities adjacent to the site. The monitoring program would also take into account the requirements of DELM. In addition, landfill gas condensate would be treated as leachate and disposed of accordingly.

Based on initial tiping rates, landfill gas produced at low rates of tiping and collected in the extraction system will simply be flared off. As tipping rates rise the need and availability for landfill gas utilisation, such as for the adjacent timber mill, will be investigated.

4.19.4 Complaints Monitoring And Follow Up

A complaints register will be maintained to log any public complaints regarding operation of the landfill. The date, time and nature of the complaint will be recorded and information regarding actions taken to help minimise or eliminate the concerns logged. The site manager will be responsible for maintenance of the complaints register.

4.19.5 Post-Closure Monitoring

Typically, before landfill closure, it is standard practice to prepare a Landfill Closure Plan. Generally this encompasses issues such as landfill rehabilitation, surface and groundwater management, ongoing leachate generation potential, landfill gas production, and other considerations necessary as a part of landfill closure. The Landfill Closure Plan draws on all data collected during landfilling operations, such as groundwater monitoring, surface water monitoring etc., and provides a scope for works required for satisfactory landfill closure.

Post-closure it is still necessary to monitor the ongoing performance of the landfill. Typically the post closure plan consists of four components:

- Environmental monitoring plan;
- Remedial action plan;
- Landfill gas management plan; and
- Landfill rehabilitation plan.

It is proposed that these issues would be incorporated into an annual or biennial review.

Environmental Monitoring Plan

Monitoring of environmental parameters is necessary in order to:

- Detect any changes that may occur in the environment.
- Identify sources of degradation.
- Form a basis for development of remedial action.
- Form a rational basis for ongoing monitoring requirements.

Results of the ongoing monitoring would be incorporated into a review of the post-closure performance of the landfill.

Remedial Action Plan

In the event that assessment of the monitoring information indicates that environmental degradation is likely, then a remedial action plan would be initiated to ensure protection of the environment. The action plan is likely to involve:

- Further, more regular review of monitoring data.
- Detailed investigation of contamination sources and severity.
- Prevention of any contamination derived from the site from moving into the wider environment.

Landfill Gas Management Plan

Ongoing monitoring of landfill gas bores drilled at the site would be continued. Results of this monitoring would be included as a part of the review of the landfill's ongoing performance post-closure.

Landfill Rehabilitation Plan

Detailed in other sections of this document are guidelines for the landfill rehabilitation. In addition to this, the preparation of a Landfill Closure Plan would aid in the identification of rehabilitation issues pertinent to the site. It is expected that the rehabilitation process will be a progressive one. As discussed, completed cells would be capped and revegetated as soon as is practically possible.

However, it will still be necessary to monitor the success of the rehabilitation works, particularly as settlement of the refuse may result in adverse conditions developing on capped sections of the landfill. Generally, site inspection by personnel familiar with the performance of landfill capping would be undertaken on a quarterly or bi-annual basis. Results of these inspections would be incorporated into a review of the ongoing post-closure performance.

5.1 POTENTIAL ENVIRONMENTAL IMPACTS AND THEIR MANAGEMENT

5.1.1 Surface Water

The hydrologic regime can potentially be impacted by the following:

- Leachate contaminated water entering the tributary of the Carlton River.
- High Suspended Solids (SS) and sediment loads within runoff discharging to the tributary.

Potential environmental impacts upon the hydrological system will be minimised by the following control measures:

- Surface waters will be diverted around the site by perimeter drains (Figure 13).
- At the landfill, surface water will be diverted around the active tipping area by temporary earthen bunds.
- All water falling within the earthen bunds will be treated as leachate and diverted to the leachate storage pond. The leachate collection system is described in Section 4.4.
- Water from the truck wash down area and other sources of potentially "dirty" water will be diverted into the leachate storage pond and treated as leachate for precautionary measures.

The potential for elevated sediment loads entering the tributary will be controlled by the following:

- The surface water system uses low flow velocity grass lined swales, sediment settling basins and rock stabilisation at scour vulnerable zones (Refer to Figure 13).
- All stockpiled material on the site, particularly piles of cover material, will be maintained in a rough condition to ensure that significant erosion does not occur.
- The final capped surface has been designed to minimise erosion.
- The surface of the landfill cap will be progressively revegetated to further reduce the potential for erosion and sediment runoff.

Monitoring procedures for Surface Water are detailed in Section 4.21.

In addition to the risks present during average climatic conditions the affect of extreme rainfall events with respect to the integrity of the site needs to be considered. Extreme rainfall events have the potential to impact on the site in 2 ways:

- Breaching of the surface water drainage system in and around the site due to excessive flows; and
- Inundation of the site via the development of backwaters in discharge paths.

The drainage system for the site has been designed in accordance with methods documented in Australian Rainfall and Runoff (ARR), the industry recognised standard for runoff routing. Guidelines provided in the Tasmanian Landfill Code of Practice have been exceeded.

The designed system's capacity exceeds flows expected from a peak flow 50 year recurrence interval rainfall event. In addition to the designated drainage paths, bunds around the landfill have been specified. The combined protection of these two measures gives a level of protection far greater than that required for 100 year recurrence interval flows.

A zone has been identified as having potential susceptibility to the development of backwaters. This area is to the northern end of the site, adjacent to the tributary of the Carlton River. Primarily this area is prone to inundation due to a broadening of the tributary flow valley, and due to a distinct lack of discharge from the subject sites' valley.

The construction of the dewatering drain improves the capability of this flat area to convey flood waters in excess of 100 year recurrence intervals to the tributary (Figure 13). In addition to this the capacity of the tributary to convey floodwaters from the entire catchment was checked, again in accordance with methods outlined in ARR.

It was found that the tributary has a capacity in excess of 100 year flows, and with the added conveyance capacity of the dewatering drain will not inundate to the level where the landfill is threatened. Again, it should be noted that the landfill will have a protective bund in addition to it's aspect on higher ground.

It will be important, however, to ensure that drainage paths remain free from obstructions and are maintained in an operable state. Sediment will require collection from the sediment pond, and it is recommended that the tributary of the Carlton River will require regular inspections to ensure that flow restrictions are not occurring.

5.1.2 Groundwater

Landfill Leachate

The seepage of leachate (liquid which emanates from a putrescible wastes landfill) is an important environmental consideration in the siting and design of a landfill. It is of primary importance in landfill design to isolate leachate, as far as possible from natural waters, both groundwater and surface water, at the landfill site

Leachate in a landfill derives from decomposition of putrescible wastes, infiltration of rainfall, inflows of surface water from runoff, inflows of groundwater and infiltration of irrigation water. Generally leachate begins to flow from a landfill once the moisture content in the landfill exceeds field capacity. Field capacity is defined as the maximum moisture content which a soil or solid material can retain in a gravitational field without producing continuous downward percolation (Lu et al, 1985).

Landfill leachates are normally contaminated and capable of degrading both surface waters and groundwater. They are chemically affected by the waste products of decomposition and by solution of components within and adjacent to the landfill mass which are rendered soluble by the leachate chemistry.

In general, there are three components of leachate:

- The leachate that emanates from the landfill and requires disposal.
- The leachate which seeps through the base of the landfill to the water table.
- Leachate that is stored in the landfill itself.

The relative proportion of each varies throughout the life of the site according to the climatic conditions and the landfilling operation.

Leachate that seeps through the basal liner to the water table may affect the beneficial quality of the underlying groundwater. Consequently, design measures are implemented to protect the beneficial use of the aquifer. Typically these measures include:

- a low permeability basal liner;
- an active leachate collection system; and
- active minimisation of leachate generating potential via progressive rehabilitation and stormwater diversion.

In order to predict leachate generation, and to set realistic design parameters a modelling process was undertaken. This is described in the following sections.

Basis of Analysis

A Woodward-Clyde in-house computer program, "LANDFILL", has been used to assist in the conceptual landfill design. The LANDFILL program was used to estimate the volume and quality of the leachate generated. The results were used as input to design the leachate collection, containment and disposal facilities. The program can also be used to test design parameters, and to assess the sensitivity of the site to various hydraulic parameters.

The program has the following basic inputs:

- Average depth of landfill cells.
- Volumes and type of refuse and the rate of filling of landfill cells.
- Climatic data for the area.
- The vertical hydraulic conductivity of the clay liner material, as determined from permeability tests.
- Groundwater underflow beneath the site.
- The areas of tipping on a year by year basis.
- The rehabilitation program. It is assumed that the landfill is progressively covered and rehabilitated each year throughout the simulation period.
- The hydrochemical parameters, defined on the basis of chemical concentrations in samples recovered from the monitoring bores installed, which are considered to represent natural conditions.
- A simulation period to cover the period of the landfill operation and beyond for leachate dissipation.

Processes

Leachate strength, chemical character and composition are dependent on the volume of infiltrated water, the levels of compaction within the landfill, the age of the fill, the rate of addition and nature of degradable matter, oxidising and pH conditions within the landfill, and the extent and type of daily cover.

Decomposition within a municipal landfill generates inorganic salts, organic compounds and complexes, gases, water and metals. Three stages of decomposition are recognised as:

- Aerobic.
- Anaerobic (fermentative).
- Anaerobic (methanogenic).

The aerobic or composting decomposition phase occurs rapidly (within months) after placement of refuse. Leachates produced are often acidic and have high concentrations of inorganic salts, heavy metals and nitrate.

The anaerobic fermentative decomposition process follows as the moderately degradable refuse continues to stabilise. Under these conditions acidic leachates are produced with high levels of BOD, TOC, nitrate and heavy metals.

Within a couple of years, leachate chemistry is dominated by anaerobic methanogenic decomposition. The leachate generally has a neutral pH, high ammonia levels, low levels of TOC and heavy metals, and a relatively low salinity.

Rate of Decomposition

Leachate concentration has been predicted by estimating the proportions of rapidly degradable and moderately degradable refuse in the waste stream. The LANDFILL program assumes a half life of one year for rapid degradation, and 15 years for moderate degradation. The program assumes that leachate concentration is directly proportional to the volume of refuse decomposed. The leachate salinity is calculated at any time by multiplying the maximum leachate concentration by the ratio of the volume of refuse decomposed to the maximum available for decomposition and combining with the water accessions.

Products of Decomposition

The Copping landfill is to be used as a repository for putrescible wastes. Such wastes are a source of chemical leachates, comprising salts, organic complexes and heavy metals, and gases. The prediction of leachate quality is difficult because of variability in the conditions outlined above.

The LANDFILL program has been used to estimate the strength of leachate using typical leachate composition data from municipal landfills which are considered comparable with the Copping situation.

Potential Impact on Groundwater Quality

Under average rainfall conditions LANDFILL predicts for normal conditions at Copping the leachate will generally remain within the matrix of the fill and very little leachate will be collected in the leachate collection system. For these conditions, the analysis indicates that the leachate generation flow rate reaches a maximum of approximately 11 m^3/day after six years of landfilling. It should be noted, however, that for the majority of years the predicted leachate generation flow rate is zero. The LANDFILL output is shown in Appendix L. Predicted leachate volumes are shown on Figure 22.

Groundwater salinity of the aquifer beneath the site was found to range from 3,600 to 5,700 mg/L, and therefore suitable only for a limited number of livestock watering uses. Under the simulated conditions used, the leachate salinity is predicted to fluctuate between approximately 3,900 mg/L and 8,200 mg/L, during and just after the operation of Stage 1, but then to reduce rapidly once landfilling ceases (Figure 23).

As the leachate is generally predicted to remain within the field capacity of the landfill under average conditions, there is a low potential for leachate seepage to the water table under these conditions. In addition, the TDS of leachate is predicted to remain relatively high for only a limited time.

There will, however, be a minor amount of leachate that will be released through the liner. The impacts of the leachate on the underlying aquifer have been shown on Figures 24 through 26. It can be seen that the beneficial use of the aquifer will not be compromised in any way. It should also be recognised that even though the simulations are considered to be realistic of actual conditions, they have erred on the conservative side, and it is likely that impacts will be substantially less than predicted.

Clay Liner Construction

It could be argued, given the results of the modelling and the presence of a highly favourable geological soil profile, that no liner is required. However a 0.5 m thick clay liner with permeability less than 1×10^{-9} m/sec has been recommended for an added degree of security. The presence of a liner would also promote lateral liquid movement by engineered falls and collection systems, rather than ponding at the base of the landfill.

Suggested guidelines documented in the Tasmanian Landfill Code of Practice indicates that a Category 3 landfill may require a 1 metre thick liner, with a permeability less than 1×10^{-9} m/sec. In the instance of the Copping site this is felt unnecessary.

Liquid movement through a porous media is described by Darcy's Law. Darcy's Law relates volumetric flow rate proportionally to the hydraulic conductivity, area over which the flow is occurring, and the head differential across the thickness of the material.

By doubling the thickness of the liner there is no change to the amount of leachate collected at the base of the landfill. The effect of doubling the liner thickness serves only to double the <u>time</u> taken for the residual leachate to break through the liner.

The modelling has shown that the volume of residual leachate transgressing the 0.5 metre thick liner will not adversely impact on the quality of the aquifer, even given the shorter time period. Consequently, the construction of a 1 metre thick liner could only be described as an over-engineering exercise.

There are several cases where modelling with LANDFILL has indicated that a 0.5 metre thick liner is adequate, and these considerations have been incorporated into the subsequent design. For example the Mt Gambier landfill, sited above one of Australia's most valuable aquifers, was constructed with a 0.5 metre thick liner. To date there have been no detectable impacts on the quality of the aquifer.

Implications for Development

It is important to minimise the generation of leachate so as to minimise the cost and impact of management of leachate collected from the in-landfill drainage system and requiring disposal by on-site management.

The modelling undertaken assumes that cells remain uncapped for a given period of time (based on the cell volume and the expected tipping rate). Details of these estimates are given in Table 11. Consequently if there is a slowdown in the rate of landfill filling then there may be a need for further subdivision of cells in order to minimise the time that the cell remains open, and hence the leachate generating potential.

5.1.3 Air

Landfill Gas

Landfill gas will be managed at the Copping landfill site because:

- Methane is a "greenhouse gas";
- Landfill gas is potentially explosive;
- Uncontrolled landfill gas emissions can cause odour problems;
- Methane gas frequently hampers the establishment of vegetation on landfill surfaces; and,
- Landfill gas is a source of energy which could be harnessed for adjacent landuses (eg Timber Mill).

A landfill gas collection system will be installed in the landfill cap as described in Section 4.10.

On capping of the landfill, it is proposed that regular inspections of the site will be undertaken to ensure that the integrity of the low permeability cap is maintained.

Dust

Dust can be generated from the following three main areas in landfilling operations:

- Access roads;
- Landfill tipping face; and
- Excavated/capped areas.

The incidence of dust can result in particle pollutants leaving the site, increase the stormwater sediment load and impact on local amenity. A further consequence of dust, when mixed with rainwater, is the potential for mud.

The environment at Copping should not be susceptible to excessive dust. The potential for generation of dust in the area is expected to be minimal. Well-maintained access roads and proper management procedures, as outlined below, will eliminate unacceptable environmental impacts associated with dust.

Dust arising from disturbance of the valley floor or excavated material will be controlled by revegetation of capped areas, wetting of the exposed surfaces and minimum traffic usage.

The access road from the Arthur Highway will be upgraded to an all weather road, and engineered and constructed using select materials that are less prone to producing dust (typically this involves specifying a sieve range for the material used in construction). Access roads within the landfill site would be regularly sprayed with water from the on-site water cart as and when required, to control the generation of dust from this source. The frequency of spraying would be increased during windy periods.

The capped area of the landfill would be vegetated with grass to reduce the dust nuisance. Areas not suitably grassed would be adequately irrigated to prevent dust from posing a problem.

Spraying of active tipping areas with either leachate or freshwater pumped from the stormwater dam would control dust problems at the tipping face. In addition, capped areas of the landfill would be rehabilitated as soon as possible to minimise the potential for dust generation.

5.1.4 Soil

Soil may affect the environment via erosion and subsequent discharge from the site, adding sediment loadings to watercourses in the vicinity of the site, or via a landslip.

The proposed landfill will have adequate erosion protection measures including:

- grassing of all exposed surfaces other than the active tipping area and stockpiles of cover material;
- final landfill surface with grassed slopes no steeper than 4 horizontal to 1 vertical (25%);
- sediment basins, through which runoff must flow before discharge from the site; and
- drains designed for low erosion potential, via broad swales and grassed surfaces.

There is no threat of landslip within or adjacent to the landfill 'footprint' due to the nature of the terrain. The geology is sufficiently stable and the slopes inadequate to generate landslip hazard.

5.1.5 Flora & Fauna

Management of Weeds and Vermin

There are relatively large areas of indigenous vegetation adjacent to the proposed landfill site. Although the vegetation has been degraded by past activities it should not be subjected to further deterioration due to spread of weeds from the landfill.

A major vegetation management issue will therefore involve the monitoring and control of potential weed invasion from the landfill, and the access road.

A weed management program will be implemented as a component of the landfill management. It will be aimed at early preventative action. The program will involve:

- The monitoring of the perimeters of the landfill area (within 100 metres) and any weed outbreaks controlled twice each year (spring and summer).
- Monitoring of the riparian vegetation along the tributary of the Carlton River (200m north) twice each year (Spring and Summer) for weeds, particularly Blackberry `Rubus discolour'. Control action will be undertaken, where appropriate.
- Patrol of the entire remainder of the subject land for weeds on an annual basis and control action undertaken, where appropriate.

The weed management program will be supervised by a qualified botanist.

Operational procedures will be designed to minimise potential problems associated with feral animals, flies and vermin which are often present around landfills as a result of the easy access for animals to sources of food and the various habitats suitable for breeding.

The management procedures proposed below will significantly reduce the likely incidence of weeds and vermin associated with the site. These procedures include:

- compaction of waste;
- regular covering of waste;
- wheel wash facility;
- minimisation of the active tipping area; and
- regular monitoring and control of vermin.

Birds

Birds are present around landfills as a result of the easy access to sources of food and the various habitats suitable for breeding. The incidence of such species can cause environmental hazard, spread of disease and potential for aviation accidents when in proximity to airports.

The subject site is not within a locality where attraction of birds would be likely to create a particular problem, however, management procedures outlined below would significantly reduce the likely incidence of birds at the proposed landfill. These procedures include:

- minimisation of the active tipping area;
- regular covering of waste 150mm;
- compaction of waste; and
- regular monitoring and implementation of control procedures, if required.

The proposed facility is over 18 kilometres from the closest airport, therefore air traffic should not be exposed to hazards from any birds associated with the site.

5.2 POTENTIAL SOCIAL AND ECONOMIC IMPACTS AND THEIR MANAGEMENT

5.2.1 Buffer Distances from Adjacent Land Uses

The zoning of surrounding land is compatible with development of the proposed landfill. The predominant zoning of land adjacent to the site under the Sorell Planning Scheme comprises Rural and Forestry Zoning. These zones will retain broad-acre landuses compatible with the proposed landfill.

The closest house to the proposed landfill "footprint" is approximately 2.4km to the north. The closest residential area to the proposed landfill "footprint" is the settlement of Copping, approximately 3.5km to the northeast.

There are no primary activities in the locality which would be particularly sensitive to a landfill development. The only notable primary export activity in the region comprises oyster farms in Pittwater, approximately 15km distant.

5.2.2 Litter

Litter poses problems around poorly managed landfills. Litter may come from windblown waste from the landfill itself, or from vehicles transporting waste to the landfill.

Impacts associated with increased litter include loss of amenity, impact on aesthetic character, and the potential for impact on flora and fauna species.

A build up of litter in any area may cause a stigma, which could ultimately impact on the community's opinion of the development. Unsightliness would be a likely cumulative effect from excess litter and odour could also become a problem.

Unacceptable amounts of windblown litter should not leave the active tipping area at the proposed landfill due to a combination of factors including:

- daily covering of waste;
- use of portable litter screens to trap litter blown from the active landfill cell;
- large fence around the landfill boundary; and
- regular litter patrols.

Litter will be managed by the minimisation of the active cell area through use of the systematic cellular tipping program and rapid cover placement over the refuse. The majority of waste being deposited will be compacted prior to deposition.

A temporary litter fence around the perimeter of the active cell will be installed if this is assessed as being necessary. The temporary litter fence would be erected on the same level as the active cell to ensure litter does not move over the fence. The fence would trap most windblown litter within the active cell area. A weekly litter patrol would collect any windblown litter from along the perimeter fence lines and in the vicinity of the landfill.

5.2.3 Traffic

The potential environmental impacts associated with traffic on approach roads would largely be based on the effects associated with increased numbers of trucks. The proposed landfill is however, expected to have a negligible impact in terms of traffic because its greatest trip generation is approximately 37 trucks per day.

The Arthur Highway would be used to transport waste to the site. The Arthur Highway is a State Highway intended to accommodate significant amounts of traffic.

Presently, the Arthur Highway has an Annual Average Daily Traffic flow of 1,900 vehicles which increases to around 2,800 vehicles per day during summer months. These figures are increasing annually at about 2.5% per annum.

Due to the increased turning movements now proposed at the junction of the access road with the Arthur Highway the following will be implemented to ensure safety and compliance with the Tasmanian Transport Department requirements:

- upgrading of the entrance to a sealed surface with a left hand passing bay to conform with the basic design criteria stipulated on the correspondence as detailed in Appendix M;
- establishment of a bond to cover the cost of all works by the Department until the developer has obtained notification in writing that all works in the junction area or affecting the State Road have been completed to this Department's satisfaction.

5.2.4 Noise

Noise generated by landfill activities generally arises from machinery operating in the landfill and from vehicles accessing the site. Noise generated at landfill facilities needs to be managed so that noise from any single source does not intrude significantly above the prevailing background noise level at any residential premises.

The consequence of excessive noise would be likely to be potential loss of local amenity.

The probable noise impacts associated with the proposal are considered insignificant due to the isolation of the site and the fact the landfill will be incorporated within a valley. Excessive noises are not anticipated because of the limited access to the site and the low frequency of truck traffic. The impact of up to 37 trucks per day on the landfill approach road would be insignificant given the only houses within over 3km are in close proximity to the Tasman Highway. It should also be noted that these dwellings are screened from the site by hills and an extensive vegetated buffer zone which will further attenuate any noise impact.

5.2.5 Public Health

Impacts on public health are not considered to be a significant issue in relation to this proposal because:

- No scheduled wastes are proposed to be accepted at the proposed landfill, reducing the potential for risk to humans;
- The strategic location of the landfill in relation to the Arthur Highway and little requirement for traversing residential areas;
- The expected increases in traffic associated with the proposal are considered to be minimal and would be easily assimilated;
- The site is a significant distance from potentially conflicting existing and proposed land uses;
- The site has the ability to provide adequate buffers to support a long term landfilling operation;
- The site has suitable hydrogeological conditions for a landfill, provided appropriate water management strategies are implemented; and
- strict environmental procedures, controls and monitoring mechanisms would be implemented to minimise potential for health impacts.

The relative remoteness of the site combined with the management procedures identified in this section for control of potential vermin, dust, odour, noise impacts etc will ensure potential health impacts are kept well within the required standards.

A detailed Occupational Health and Safety Plan would be established for on site workers.

5.2.6 Fire

Risk of fire and or explosion is associated with landfills due to the production of landfill gases, the incidence of combustible materials on site and the likelihood of certain fuels and flammables being deposited. However, the fire risk from operating the site is considered minimal if active fire protection measures are implemented.

The following management protection procedures would be implemented to reduce the risk of fire as any spread of fire from the site would be a concern due to the area of adjacent woodland and the relatively isolated locality. These procedures would include:

- compaction and regular application of cover material;
- maintenance of buffer zones;
- availability of cover material for fire suppression;
- presence of over 100,000 litre water supply; and
- fire fighting equipment on site.

The lighting of fires to burn wastes will be banned at the site. Fire ban warning signs will be installed at the site. A detailed safety plan outlining fire fighting procedures, the location and access routes to water storage, and the location of fire fighting equipment would be prepared in accordance with Tasmanian Fire Service requirements, once approval is granted.

The fire management plan for the development will address:

- access to fire fighting water supply;
- establishment and maintenance of appropriate fire breaks around all filled areas, stock piles of combustibles and site buildings;
- completion of training requirements for staff in fire fighting techniques, fire fighting equipment maintenance etc;
- signage;
- accessibility; and
- the banning of smoking on the site.

5.2.7 Site Security

Unauthorised entry at a landfill can lead to significant issues such as waste dumping, fires and risk to public safety. Public entry to the proposed landfill will not be permitted so potential risks will be negligible. The site will be enclosed by a 1.8 metre high chainmesh fence and access gates will be securely locked outside operating hours.

5.2.8 Visual Amenity

The proposed development will be almost entirely screened from outside view by the topography within or adjacent to the subject site. It will not be visible from outside the subject site to the north or east but may be partially visible from a couple of distant vantage points to the south and west, as discussed below.

The upper part of the landfill and the proposed buildings could be partly visible from one point on the Arthur Highway around 2 km to the west. The upper slopes of the ridge running north from Little Blue Hill are partly visible from this point in the highway due to the break in the intervening hills which accommodates the Carlton River valley. The upper part of the landfill will be formed against the side of this ridge and the buildings will be located on the saddle of the ridge near the existing quarry, as shown on Figure 13. The buildings will be screened from view by a screen of trees and shrubs to their west, as shown on Figure 13. It may not be possible to screen the upper part of the landfill, by measures within the subject site, from the distant view from Arthur Highway. The landfill would, however, only be partly visible and would form a minute part of a vista of distant view which is gained from one point on the highway which is not a wayside stop.

Part of the upper levels of later stages of the landfill would be visible from Big Blue Hill, a forested hill approximately 2.5km to the south-east of the proposed landfill within a large rural property. As with the distant view from Arthur Highway, the landfill would form a very small part of a broad and distant panorama.

The only other location from where the proposed landfill would not be screened from view by topography is the hill on the adjacent property to the south of the landfill 'footprint'. The view from this hill, which is approximately 0.5km from the edge of the proposed landfill 'footprint' would however, be screened by the pine plantation within the subject site.

Screen planting will be initiated at the turn off from the Arthur Highway and along spray sealed section of the access road, as deemed neccessary.

5.2.9 Cultural Heritage Values

The proposed landfill will impact a number of isolated Aboriginal artefact sites in a cultural landscape that is scientifically interesting but not unique. The sites located in the Archaeological survey are represented in other areas of the east coast forest region of Tasmania. In this case the majority of the sites identified can be preserved and further investigated in the future.

The landfill footprint has been modified to leave four artefact sites within its boundaries. Stage 1 would require removal of only one artefact. Application for destroying the 4 artefacts within the landfill footprint will be sought, however it is proposed to liaise closely with the Tasmanian Aboriginal Lands Commission (TALC) throughout the landfill development to ensure appropriate actions are taken to preserve the cultural heritage of the region. This could include relocation of artefacts to nearby sites protected from landfill development.

5.2.10 Employment

As outlined in Section 4, the following staff will need to be employed to operate the proposed sub-regional Landfill:

- Site supervisor (full time);
- One weighbridge/gatekeeper operator (initially part-time);
- One machine operator (initially part-time);
- One truck driver (initially part-time); and
- One labourer (initially part-time).

The site supervisor would be on site during all working hours. This person would be suitably qualified and would oversee and be responsible for all aspects of the landfill activity.

Staff training will ensure that:

- all operators of compaction or earthworks equipment are skilled at undertaking all tasks required;

- all operators involved in testing and sampling are familiar with required testing and sampling protocols;
- all operators involved in inspection of wastes are capable of accurate data recording and identification; and,
- staff are familiar with the Permit conditions and the requirements for the operation of the landfill, and also have access to a copy of the Permit conditions.

6.1 ENVIRONMENTAL MANAGEMENT PLAN

Sorell Council is committed to provision of a best practise landfill facility for waste disposal in southern Tasmania All measures outlined within the DP and EMP will be implemented as stated in the Management Plan to ensure compliance with permit conditions.

Key components of the site management plan are:

- Appointment of trained staff to operate the proposed facility as outlined in Section 5;
- A comprehensive groundwater, surface water and gas/ vapour monitoring program outlined in Section 4;
- The maintenance of a computer database which will incorporate the following:
  - All information on types and quantities of wastes received;
  - All groundwater and surface water monitoring data on site;
  - All other pertinent information on the site such as any incidents and complaints and how they were dealt with.
- Regulatory conditions for site construction and operation, stipulated in the licence conditions and outlined in Section 5; and
- Specific site operational specifications as outlined in Section 5.

The management of environmental impacts at the proposed landfill site must address operations in all its life cycle stages, namely:

- Stage 1 Construction
- Stage 2 Operation and Maintenance
- Stage 3 Decommissioning
- Stage 4 Rehabilitation.

For effective control of environmental performance, management systems must be flexible, effective and subject to ongoing review and improvement.

6.2 COMMUNITY CONSULTATION

In general, concerns traditionally raised by residential communities when landfills are being sited and designed include their proximity to residential areas, increased noise and odours, and poor site management. In order to allay potential community concerns over the Copping site, Sorell Council intends to undertake the following:

- Construction of a state-of-the-art landfill founded on the principles of best international waste management practice. The facility would be operated within the framework of a comprehensive Environmental Management Plan developed for the site.
- Maintenance of adequate buffer zones around the landfill site to maintain sufficient buffers between the landfill and incompatible land use such as residential areas.
- Continuation of the community consultation program to ensure local residents and key stakeholders receive information on the landfill prior to consideration of a permit

application. The program would include mechanisms for the community to feedback their concerns and questions to the Council, and for appropriate responses to be developed.

Sorell Council intend to take a pro active approach in involving the community in their developments at the site in Copping. Sorell Council have involved the public in the process of identifying the future site for waste disposal by making the supplementary report entitled "Potential Landfill Site Evaluation, 1995" available for public comment between. Feedback from the community on the report has been favourable.

Council distributes a quarterly "Sorell News" which informs the community of developments occurring within the municipality. The selection of the site, purchasing of land and subsequent development of the DP and EMP have been detailed in editions of the Sorell News (refer Appendix N).

Residents of the municipality have been made clearly aware of the proposal. A Council Briefing Note following a public forum at Copping is also included in Appendix N. This public forum involved discussion about the proposal. The only issue of concern raised being regarding the traffic implications for the Arthur Highway.

Further community initiatives will be implemented as the approval process continues to ensure that community concerns are addressed and minimised.

6.3 REVIEW

Specific procedures at the proposed site will be implemented to ensure compliance with the permit conditions placed on the facility. Any incidents that may cause environmental harm, and or which may lead to a breach of permit conditions would be communicated to the Environment & Planning Division immediately.

As identified in section 4.18.4 above, a complaint register will be maintained on site to enable communication of issues to appropriate bodies as and if they arise.

As required by the Environment and Planning Division and specified in the Guidelines for preparation of a 'Development Proposal and Environmental Management Plan' for a Refuse Disposal Site:

- an annual report will be prepared for detailing the total tonnage of wastes received at the landfill;
- the Environmental Management Plan will be reviewed after twelve months of operation, and at three yearly intervals thereafter; and
- A five yearly report will be provided in support of the Environmental Management Plan review which will include:
  - a Summary report including total wastes received, composition and fate;
  - an independent surveyors report of the volume of airspace consumed;
  - an estimate of remaining landfill capacity;
  - a hydrogeological report;
  - a leachate collection report;
  - a record of complaints received;

- a summary of important incident; and
- a landfill gas emission report.

This report has described how the proposed landfill development at Copping within the Sorell Council area will provide a valuable community resource for southern Tasmania, and demonstrates how the proposal will have minimal impacts on the environment.

The proposed landfill site at Copping is highly suitable as a future landfill because it has:

- Significant buffers from conflicting landuses;
- Strategic location with high accessibility;
- Huge potential for void space; and
- Suitable geological and hydrogeological conditions.

The proposed sub regional facility at Copping is entirely consistent with the Regional Waste Disposal Strategy for Southern Tasmania and has been identified as central to the overall waste disposal options, as a potential future regional landfill site to help meet the waste disposal requirements well into the 21st century. Current landfill sites in the region are nearing capacity (and will reach capacity in 2001 as required by Environment & Planning Division). A potential landfill site urgently needs to be secured.

The site currently offers in excess of 2,500,000 m^3 for Stage 1. The site as a whole has a potential airspace in excess of 14 million cubic metres. It is unrealistic to predict waste disposal growth rates over the time required to fill the site however, the site has the potential to last for a substantial period of time, or receive wastes from a wider variety of sources.

The site currently has excellent road access from the Arthur Highway via the privately owned Right of Way. Roadworks to be implemented along this Right of Way will further enhance the strategic accessibility of the site.

The site, after thorough investigation, has been found to be suitable for establishment and operation of a Category 3 landfill. The site has non conflicting adjacent zoning and landuse, provides significant buffers in relation to incompatible landuses and is suitable in terms of the identified need for future landfill space in the region. Provided operating standards set down in the legislation, and conditions described in this report are maintained, the proposed landfill would not be expected to adversely affect adjacent land-uses or the quality of the environment in the area. It is, in summary, considered to be a highly suitable location for development of a municipal waste landfill.

TABLES

TABLE 1 Sorell Council Potential Landfill Sites

1. Fulham:	9. Crawler's Iron Gully:
2. White Hill:	10. Burrows Gully:
3. Wiggins Ck:	11. Fluffen Ck:
4. Copping:	12. Wombat Ck:
5. Lovely Bottom:	13. Tier Gully:
6. Sugarloaf Rd I:	14. Gordon's Sugarloaf:
7. Sugarloaf Rd II:	15. Ephriam Ridges:
8. Valleyfield:	

TABLE 2 **Sorell Council - Site Selection Criteria**

	Criteria
Distance from Waste Source	The distance over which refuse must be transported (and hence cost) clearly affects the suitability of a potential site. The site should be as close as possible to where the wastes are generated or treated to reduce transport costs as well as amenity impacts of traffic.
Distance to Public Road	The distance from the potential site to the nearest public road affects the suitability of a potential site, as road building expenditure can add considerable cost to the establishment of a new refuse disposal site.
Distance to secondary Road	The distance to a secondary road affects the suitability of a potential refuse disposal site as it affects the potential impacts of increased traffic on unsealed roads. Little or no access increases the cost to establish a new refuse disposal site. The number of residents along routes to the potential landfill affect the impact of amenity issues such as traffic, noise and dust.
Visibility	The potential visual impact of a landfill can vary considerably from almost no impact through to high visual intrusion. The need for screening works and planting can also represent a major cost factor. In this study potential sites are only considered if they are not visible from major tourist routes of the Arthur Highway and Brinktop Road through Richmond and Sorell.
Site Capacity or size	The land must offer sufficient area to allow a viable landfilling operation. Areas less than 25 hectares are considered unsuitable.
Average Slope	Steep slopes are not desirable due to the difficulty of access and landfilling operation. Suitable sites should be relatively level (2 to 10° slope) or capable of being economically levelled.
Vegetation	Use of the site should not adversely affect unique habitats, wetlands, or habitats important to the survival of endangered species. The more favourable sites would be cleared or consist predominantly of pasture land. Highly cultivated land is considered less favourable
Drainage	The ability to protect and manage surface water at a site is important. Potential sites located in large catchments are considered unfavourable due to the cost of drainage diversion. Swampy areas which cannot be easily drained are also considered undesirable.
Soil Thickness	Sites with relatively thick soil cover are more desirable due to the potential to excavate airspace at the site and to stockpile soil for use as daily cover. Sites with thick weathering profiles allow more convenient earthworks.

TABLE 2 CONT....

Aquifer type	The type of aquifer (geological unit that can store and transmit water at rates fast enough to supply reasonable amounts to wells, Fetter (1988)) is an important factor as it determines the potential for contamination of groundwater by leachate (contaminated water which drains from the refuse). Sites underlain by high permeability (high potential for water penetration) or fractured bedrock combined with good quality regional groundwater are less suitable or will require substantial engineering. There should be no contact with groundwater and the base of waste should be above the highest expected water table level.
Heritage features	The presence of heritage features on the site will most likely result in a fatal flaw and such sites are usually excluded from further analysis. Heritage features may include aboriginal burial sites, or historic buildings and ruins.
No. of properties in a 1km radius	This criterion gives an indication of the population density and the potential degree of amenity impact of the landfill. Suitable areas have few properties within a short distance from the site.
No. of property parcels contained in site	Property acquisition is facilitated where the potential site lies solely within one property boundary. Negotiations for acquisition of sites with several owners are frequently more complicated.
Distance to nearest residential cluster	The nearest dwellings should be at least 500 metres from the proposed site, as recommended for a municipal waste management centre by the 'Tasmanian Solid Waste Management Policy'. A residential cluster here is a collection of 3 or more dwellings, which is an indicator of population density and the potential impact of amenity issues.
Sensitivity of Surrounds	Potential sites located close within sensitive areas are less favourable than those located within degraded areas for example. Sensitive areas here are considered to be: high quality bushland, recreational areas, coastal dune areas and tourist sites.
Cover material	Sites which have cover material (material used to cover the refuse on a daily basis) available on-site or nearby are favoured. The 'Tasmanian Solid Waste Management Policy' states that cover material will need to be utilised daily for a landfill servicing a population between 8 000 to 20 000, which includes the Sorell Municipality.
Rainfall zone	More favourable sites are located in areas of relatively low rainfall due to relatively low production of leachate and the need for lower levels of surface water management.

TABLE 3: Results of ranking analysis

Rank	Unweighted	Weighted
First	White Hill	White Hill
Second	Copping	Copping
Third	Sugarloaf Rd - Rear	Fulham
Fourth	Sugarloaf Rd - Front	Lovely Bottom
Fifth	Fulham	Sugarloaf Rd - Rear

TABLE 4 Clarence City Council Potential Landfill Sites

1. Mt Maher	9. Boral Quarry
2. Sandford sand pits	10. Mangalore Tier
3. Cape Contrariety	11. Mt Elizabeth
4. Clarendon Vale	12. Fluffem Creek
5. Cross Rivulet	13. Tier Gully
6. Bourbon Creek	14. Grahams/Burrows Gullies
7. Jews Hill	15. WhiteHill
8. Cove Hill	16. Copping

(light shading)	Municipal Sites
(hatched shading)	Municipal & Regional Sites

Table 5
Meteorology Summary
Copping Region

Orford

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Mean Daily Maximum Temperature	22	22	20.6	18.6	15.8	13.3	13.1	14	15.6	17.5	18.6	20.2	17.6
Mean Daily Minumum Temperature	11.5	11.8	10.5	8.3	6	3.8	3.3	4	5.2	7	8.9	10.3	7.5
Mean No. Days Strong Wind	1.3	0.5	0.6	0.5	0.3	0.2	0.9	0.5	1	0.9	0.9	1.4	9.6
Mean Monthly Rainfall (mm)	48.6	45.8	46.6	62	64.7	53.6	63.2	62.2	49.6	66.5	66.5	69.4	693.9
Mean No. Rain Days	9.2	7.9	9.7	11	12.2	11.6	13.2	13.2	12	12.8	14.1	12.1	139.1

Hobart Airport

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Mean Daily Maximum Temperature	22.3	22.1	20.6	18.1	15	12.7	12.2	13.2	15.1	17.2	18.8	20.4	17.3
Mean Daily Minumum Temperature	11.8	11.8	10.6	8.8	6.4	4.5	4	4.5	5.8	7.3	9	10.6	7.9
Mean No. Days Strong Wind	3.6	2.7	2.4	3.2	1.9	1.8	2.3	3.4	4.1	4.8	4.4	3.6	38.2
Mean No. Days of Gales	0.3	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.3	0.2	0.3	0.2	2.1
Mean Daily Pan Evaporation (mm)	6.2	5.5	4.1	3	1.8	1.3	1.4	2.1	2.9	4.1	4.9	5.9	1314
Mean Monthly Rainfall (mm)	40.5	35.9	35.7	47.1	37.3	29	48.3	49.6	40.6	49.2	45.2	58.9	517.4
Mean No. Rain Days	9.4	7.8	10	11.2	11.8	11.4	13.7	14	13.4	13.6	13.5	12.3	142.3

Copping Composite

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL TOTAL
Rainfall (average) (mm)	60.6	54.2	57.1	58.7	65.7	54.6	79.7	84	63.5	64.3	75.7	82.1	800.2
Rainfall (90th percentile - 1969) (mm)	30.4	147.3	40.9	73.7	165.7	46.1	26.2	63	27.2	43.5	203.6	171.1	1038.7

Table 6
Summary of Soil Geology at Copping Site

Test Pit Number	Depth Range (m)	Geology	Water Intrusion Yes/No	Refusal on
1	0-0.2	Sandy/Clayey SILT		
	0.2-1.6	Sandy CLAY		
	1.6-2.2	Clayey SAND	Yes	Sandstone
2	0-0.4	Sandy/Clayey SILT		
	0.4-1.7	Sandy CLAY		
	1.7-2.7	Clayey SAND	Yes	Sandstone
3	0-0.2	Sandy/Clayey SILT		
	0.2-0.9	Sandy CLAY		
	0.9-1.3	Clayey SAND	No	Sandstone
4	0-0.2	Sandy/Clayey SILT		
	0.2-0.9	Sandy CLAY		
	0.9-1.3	Clayey SAND	No	Sandstone
5	0-0.3	Sandy/Clayey SILT		
	0.3-0.5	Sandy CLAY		
	0.5-0.8	Clayey SAND	No	Sandstone
6	0-0.4	Sandy/Clayey SILT		
	0.4-1.2	Sandy CLAY		
	1.2-1.5	Clayey SAND	Yes	Sandstone
7	0-0.15	Sandy/Clayey SILT		
	0.15-0.45	Sandy CLAY		
	0.45-0.6	Clayey SAND	No	Sandstone
8	0-0.15	Sandy/Clayey SILT		
	0.15-0.45	Sandy CLAY		
	0.45-0.6	Clayey SAND	No	Sandstone
9	0-0.2	Sandy/Clayey SILT		
	0.2-1.4	Silty CLAY		
	1.4-1.8	Sandy CLAY		
	1.8-2	Clayey SAND	Yes	Sandstone
10	0-0.2	Sandy/Clayey SILT		
	0.2-2.2	Sandy CLAY	Yes	Dolerite
11	0-0.2	Sandy/Clayey SILT		
	0.2-0.4	Sandy CLAY		
	0.4-0.7	Clayey SAND	No	Sandstone
12	0-0.2	Sandy/Clayey SILT		
	0.2-0.4	Sandy CLAY		
	0.4-0.9	Clayey SAND	Yes	Sandstone
13	0-0.2	Sandy/Clayey SILT		
	0.2-2.4	Silty CLAY	No	Insufficient Reach
14	0-0.2	Sandy/Clayey SILT		
	0.2-0.6	Sandy CLAY		
	0.6-1.0	Clayey SAND	No	Sandstone

Table 7
Summary of Rock Geology at Copping Site

Bore Hole Number	Depth Range (m)	Geology	Water Intrusion Depth (m)	Hole Terminated at (m)
1	0-1.5	Silty CLAY Topsoil	1.3	
	1.5-3.5	Feldspathic SANDSTONE		
	3.5-23.5	Carbonaceous SHALE		23.5
2	0-1.5	Clayey SAND Topsoil	1.3	
	1.5-3.5	Feldspathic SANDSTONE		
	3.5-11.5	Carbonaceous SHALE	10.5	11.5
3	0-3.5	Silty SAND Topsoil	3.3	
	3.5-7.5	Feldspathic SANDSTONE	6.5	
	7.5-20.8	Carbonaceous SHALE	14.5	20.8
4	0-2.5	Silty CLAY Topsoil		
	2.5-7.5	Feldspathic SANDSTONE	6.5	
	7.5-10.5	Carbonaceous SHALE		
	10.5-12	Fractured SANDSTONE	10.5	12

Table 8

Summary of monitoring bores

Bore Construction Details

Location	Date of Installation	Total Depth of Borehole (m)	Top of uPVC Casing (TOC) Elevation (mAHD)	Static Water Level (m)	Date Taken	Reduced Static Water Level from TOC (mAHD)
BH 1	1/7/96	23.5	56.494	5.300	3/7/96	51.194
BH 2	1/7/96	11.5	43.800	0.740	3/7/96	43.060
BH 3	2/7/96	20.8	49.397	5.745	3/7/96	43.652
BH 4	2/7/96	12.0	45.237	1.140	3/7/96	44.097

Table 9

Transmissivty and Storativity Results

Bore Number	Test Peformed	T (m^2/day)	Storativity ($*10^{-3}$)	Test Date	Reference
BH 1	Jacob Drawdown	0.04	4.82	3rd July 1996	Figure 9a
	Recovery Analysis	0.06			Figure 9b
BH 2	Jacob Drawdown	0.39	4.92	3rd July 1996	Figure 9c
	Recovery Analysis	0.23			Figure 9d
BH 3	Jacob Drawdown	0.39	4.91	3rd July 1996	Figure 9e
	Recovery Analysis	0.13			Figure 9f
BH 4	Jacob Drawdown	22.38	2800	3rd July 1996	Figure 9g
	Recovery Analysis	19.47			Figure 9h

Table 10
Laboratory Analytical Results
All Results Expressed as mg/L Unless Stated

		Laboratory Detection Limits	BH 1	BH 2	BH 3	BH 4	ANZECC Guidelines Potable Water	ANZECC Guidelines Irrigation Water	ANZECC Guidelines Stock Water	ANZECC Guidelines Protection of aquatic ecosystems
Calcium		0.5	350	240	250	310	200	na	1000	na
Magnesium		0.3	300	250	190	370	150	na	na	na
Sodium		6	330	350	900	930	270	na	na	na
Pottasium		0.2	6.3	4.9	5.6	5.2	na	na	na	na
Total Alkalinity as Ca CO3		5	640	470	340	610	na	na	na	na
Bicarbonate Alkalinity as HCO3		5	770	570	420	750	na	na	na	na
Carbonate Alkalinity as CO3		10	0	0	0	0	na	na	na	na
Total Dissolved Solids		20	4300	3600	4300	5700	1000	1000	3000	1000
Sulphate as SO4		4	98	86	110	210	400	na	1000	na
Chloride		0.7	1600	1300	1900	2300	600	700	na	na
pH			7.5	7.8	7.7	7.6	6.5-8.5	4.5-9.0	na	6.5-9.0
Specific Conductivity	µS/cm		5600	4700	6200	7500	na	na	na	na
Total Phosphorous		0.01	0.027	0.04	0.02	0.033	na	na	na	na
OC/OP			nd	nd	nd	nd	na	na	na	na
Nitrate Nitrogen as N		0.1	nd	nd	nd	nd	10	na	30	na
Ammonia Nitrogen as N		0.3	0.05	nd	0.08	nd	0.1	na	na	0.2-0.3
Organic Nitrogen as N		0.3	0.07	0.06	0.12	0.06	na	na	na	na
C.O.D.		4	12	12	22	32	na	na	na	na
Total Organic Carbon		0.5	1.4	1.9	nd	2.5	na	na	na	na
Cadmium		<0.005	nd	nd	nd	nd	0.01	0.01	1	0.0002-0.005
Lead		<0.05	nd	nd	nd	nd	0.05	0.2	0.1	0.0001-0.005
Chromium		<0.03	nd	nd	nd	nd	0.05	1	1	0.01
Copper		<0.01	0.01	0.01	0.01	0.01	1.5	0.2	0.5	0.0002-0.005
Zinc		<0.02	0.06	0.06	0.03	0.04	15	2	20	0.005-0.05
Iron		<0.02	0.04	0.03	0.04	0.04	1	1	na	1
Arsenic		<0.005	nd	nd	nd	nd	0.05	0.1	0.5	0.05
Mercury		<0.0005	nd	nd	nd	nd	0.001	0.002	0.002	0.0001

Note:
nd - below laboratory detection limit
na - not applicable

(light dotted shading) Exceeds potable water guidelines
(dense hatching) Exceeds potable, irrigation and stock water guidelines
(diagonal hatching) Exceeds potable and irrigation water guidelines

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TABLE 11
FIELD CHEMISTRY DATA
SORELL GREENFIELD SITE

	Temperature	pH	Electrical Conductivity	Redox Potential	Dissolved Oxygen		Comments
	°C		µS/cm	mV	mg/l	%	
BH1	13.4	6.93	5790	104	2.5	25	Brown, slightly turbid
BH2	13.9	6.52	4980	104	8.6	84	Brown, slightly turbid
BH3	11.1	6.96	6350	108	3.6	32	Brown, slightly turbid
BH4	12	6.61	8210	117	5.5	54	Clear, some fine sand

TABLE 12 Existing Landfill Capacity

Council Area	Landfill	Category	Waste TPA	Closure Date	Est. Life	Disposal Strategy	Council Approved	Environment & Planning Division Approved
Clarence	Lauderdale	2	24,000	Dec 2001	3.5	Y	Y	Y
Sorell	Carlton	2	9, 000	Sept 2001	3.5	Y	Y	Y
Tasman	Nubeena	2	1200	2001	3.5	Y	Y	Y

Table 13a
Copping Landfill
Stage One Cell Volumes and Cell Life
Option 1 - Density 850 kg/m^3, 20% Daily Cover

Cell Number	Cumulative Volume (Cubic metres)	Cumulative Cell Area (Square metres)	Cell Area (max) (Square metres	Cell Volume (Cubic metres)	Approx. time to fill cell (Years)	Cumulative time (Years)	Average cell area (Square metres)	Average cell depth (Metres)	Estimated amount of refuse deposited - less daily cover (tonnes)	Estimated amount of refuse deposited - less daily cover, Cumulative (tonnes)
1	88098	13668.4	13668.4	88098	1	1	9000	9.8	62403	62403
2	183517.2	22011.4	22011.4	95419	1	2	9000	10.6	67589	129991
3	311424	31664.2	9652.8	127907	2	4	7500	17.1	90601	220592
4	420460.9	39330.6	7666.4	109037	2	6	8250	13.2	77234	297826
5	557694.2	51331.3	12000.7	137233	2	8	15000	9.1	97207	395033
6	721811.4	68661.7	17330.4	164117	2	10	11000	14.9	116250	511283
7	868069.3	73811.6	5149.9	146258	1	11	6500	22.5	103599	614882
8	1002783.2	79490.8	5679.2	134714	1	12	5600	24.1	95422	710305
9	1165830.4	89650.5	10159.7	163047	2	14	14000	11.6	115492	825797
10	1314259.4	105265.5	15615	148429	1	15	12100	12.3	105137	930934
11	1522596.9	112992.5	7727	208338	2	17	4800	43.4	147572	1078506
12	1659577.2	118191.3	5198.8	136980	1	18	5200	26.3	97028	1175534
13	1802075.8	126911.4	8720.1	142499	2	20	16500	8.6	100937	1276470
14	2008833	145892.4	18981	206757	2	22	16900	12.2	146453	1422923
15	2156792.3	149786.6	3894.2	147959	1	23	5200	28.5	104805	1527728
16	2360835.4	158612.1	8825.5	204043	2	25	18200	11.2	144531	1672258
17	2466653.3	170485.4	11873.3	105818	1	26	18400	5.8	74954	1747213

Table 14:
WATER BALANCE FOR PROPOSED CAP USING AVERAGE RAINFALL

Table 14
Water Balance for proposed cap using Average Rainfall
Sorell Landfill: Climatic data, Expected Infiltration, Proposed Cap Design.

Soil Storage =	Soil Depth (mm) x Porosity x (Field Capacity - Pellicular Limit)			**Clay Capping Stats**	
Soil Depth=	300			Clay Depth=	500
Porosity=	0.4	Clay Permeability (m/day)	0.0001	Clay Porosity=	0.5
Field Capacity=	0.3			Clay Field Capacity=	0.4
Pell Limit=	0.1			Clay O.M=	0.25
Soil Stor=	24 mm			Clay Soil Stor=	37.5 mm
Soil at Pellicular limit at end of summer (ie soils storage empty)				Monthly clay infiltrati	3.37 mm
ET ratio in clay	0.1				

	Month	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Tot		
Additions																
Av Rainfall (mm)		58.7	65.7	54.6	79.7	84	63.5	64.3	75.7	82.1	60.6	54.2	57.1	800.2		
Runoff Coeff		0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3			
Runoff (mm)		17.61	19.71	16.38	23.91	25.2	19.05	19.29	22.71	24.63	18.18	16.26	17.13			
Add Soil Store (mm)		41	46	38	56	59	44	45	53	57	42	38	40			
Losses																
Evaporation (Pan)(mm)		90	55.8	39	43.4	65.1	87	127.1	147	182.9	192.2	154	127.1	1310.6		
ET (mm)		68	42	29	33	49	65	95	110	137	144	116	95	983		
Nett Add		-26	4	9	23	10	-21	-50	-57	-80	-102	-78	-55			
Water in Store (mm)	0	0	4	13	24	24	3	0	0	0	0	0	0			
Store + Add	0	0	4	13	36	34	3	0	0	0	0	0	0			
Volume Available (mm)		0	0	0	12	10	0	0	0	0	0	0	0	22		
Sat height above clay (mm)		0	0	0	44	36	0	0	0	0	0	0	0		max	44
Clay Infiltration Estimates																
Excess Volume		0	0	0	12	10	0	0	0	0	0	0	0			
Vol Entering Clay		-7	-4	-3	0	-2	-7	-10	-11	-14	-14	-12	-10	-92		
Water in Store (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0			
Store + Add	0	0	0	0	0	0	0	0	0	0	0	0	0			
Volume infiltrated (mm)		0	0	0	0	0	0	0	0	0	0	0	0	0		

ET - Evapotranspiration (0.75 x pan evaporation)
O.M - Optimum Moisture Content

Table 15:
WATER BALANCE FOR PROPOSED CAP USING 90TH PERCENTILE DATA FROM 1969

TABLE 15
Copping Landfill: Climatic data, Expected Infiltration, Proposed Cap Design.
90th Percentile Rainfall - Historic data from 1969

Soil Storage =	Soil Depth (mm) x Porosity x (Field Capacity - Pellicular Limit)				**Clay Capping Stats**	
Soil Depth=	300				Clay Depth=	500
Porosity=	0.4	Clay Permeability (m/day)	0.0001		Clay Porosity=	0.5
Field Capacity=	0.3				Clay Field Capacity=	0.4
Pell Limit=	0.1				Clay O.M=	0.25
Soil Stor=	24 mm				Clay Soil Stor=	37.5 mm
Soil at Pellicular limit at end of summer (ie soil storage empty)					Monthly clay infiltration	3.37 mm
ET ratio in clay	0.1					

	Month	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Tot		
Additions																
Av Rainfall (mm)		73.7	165.7	46.1	26.2	63	27.2	43.5	203.6	171.1	30.4	147.3	40.9	1038.7		
Runoff Coeff		0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3			
Runoff (mm)		22.11	49.71	13.83	7.86	18.9	8.16	13.05	61.08	51.33	9.12	44.19	12.27			
Add Soil Store (mm)		52	116	32	18	44	19	30	143	120	21	103	29			
Losses																
Evaporation (Pan)(mm)		90	55.8	39	43.4	65.1	87	127.1	147	182.9	192.2	154	127.1	1310.6		
ET (mm)		68	42	29	33	49	65	95	110	137	144	116	95	983		
Nett Add		-16	74	3	-14	-5	-46	-65	32	-17	-123	-12	-67			
Water in Store (mm)	0	0	24	24	10	5	0	0	24	7	0	0	0			
Store + Add	0	0	74	27	10	5	0	0	32	7	0	0	0			
Volume Available (mm)		0	50	3	0	0	0	0	8	0	0	0	0	61		
Sat height above clay (mm)		0	179	11	0	0	0	0	30	0	0	0	0		max	179
Clay Infiltration Estimates																
Excess Volume		0	50	3	0	0	0	0	8	0	0	0	0			
Vol Entering/leaving Clay		-7	-1	0	-3	-5	-7	-10	-8	-14	-14	-12	-10	-89		
Water in Store (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0			
Store + Add	0	0	0	0	0	0	0	0	0	0	0	0	0			
Volume infiltrated (mm)		0	0	0	0	0	0	0	0	0	0	0	0	0		

ET - Evapotranspiration (0.75 x pan evaporation)
O.M - Optimum Moisture Content

Table 16:
Water Budget Calculations

Water Budget Calculations for Copping Landfill (Average Year)

WATER BUDGET - refer to "GUIDELINES FOR WASTEWATER IRRIGATION"

9-Apr-97
FILE -
SITE -
USER -

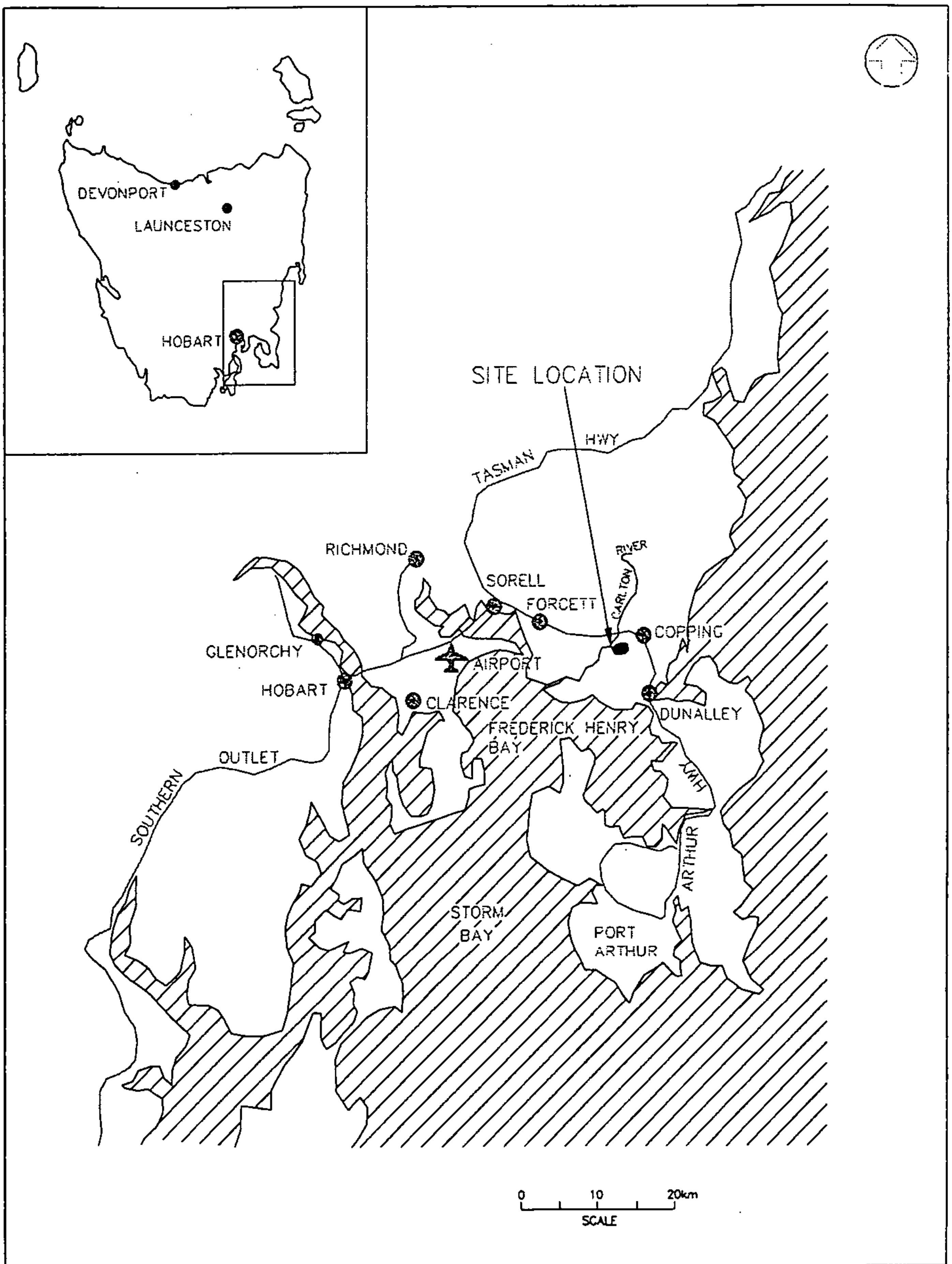
0.16	(Pond area, ha)
2	(Crop areas, ha)
100	% pasture
0	% 1 YO eucalypts
0	% 2 YO eucalypts
0	% >4 YO eucalypts

Runoff Coefficient	0	
Evaporation Factor	0.8	
Permeability	0.0001	m/day
Liner Thick	2	m
Water Depth	0.78	m
Leachate Flow	7	m3/day
Leachate Salinity	7500	mg/L
Max Irrig Salinity	2000	mg/L
Dilution Required	3.75	:1

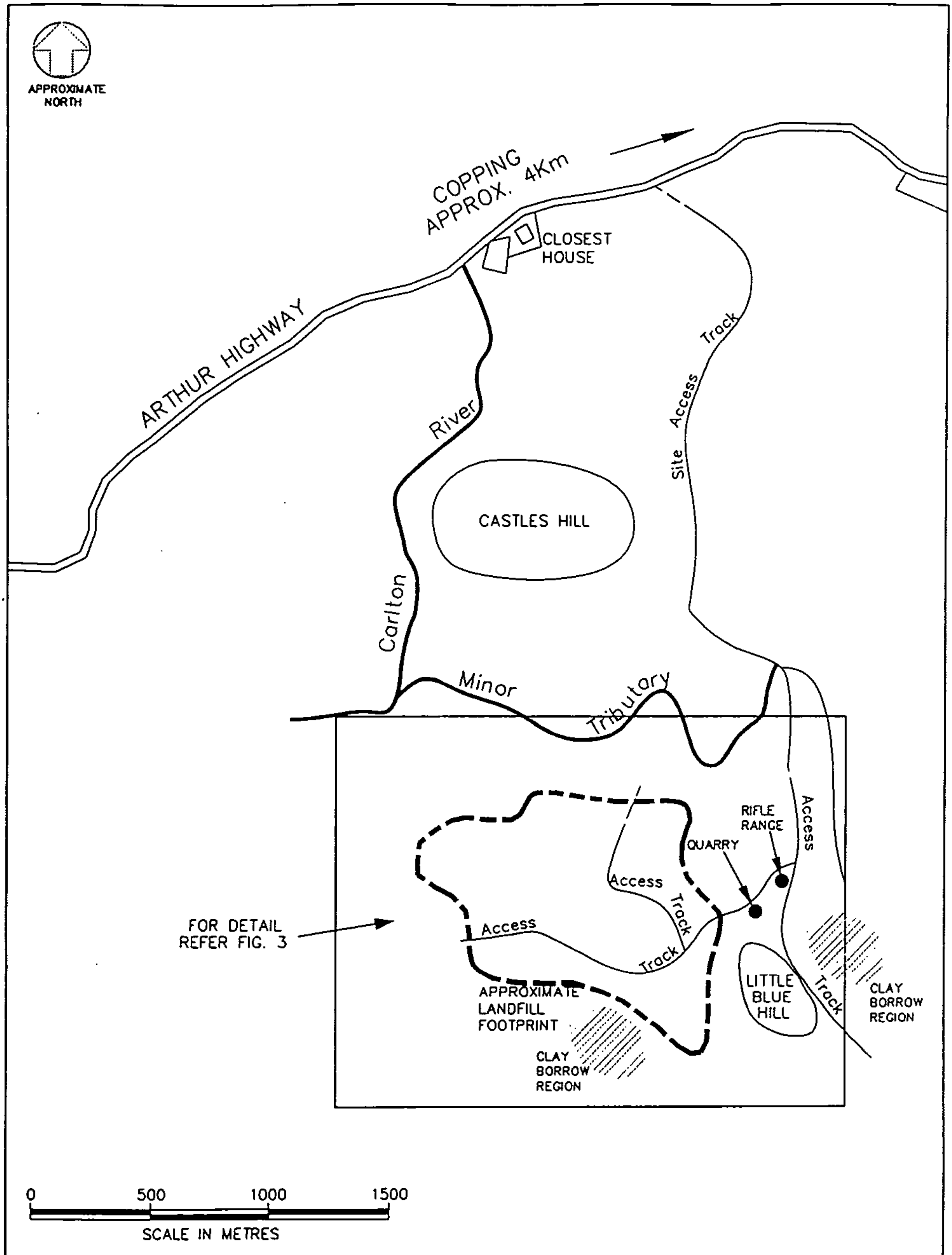
	UNIT	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	YEAR
AVERAGE YEAR														
Evaporation	mm	90	55.8	39	43.4	65.1	87	127.1	147	182.9	192.2	154	127.1	1311
Rainfall	mm	58.7	65.7	54.6	79.7	84	63.5	64.3	75.7	82.1	60.6	54.2	57.1	800
Effective Rainfall	mm	59	66	55	80	84	64	64	76	82	61	54	57	800
Estimated Crop ET	mm	63	33	20	20	26	39	70	96	128	135	108	89	825
Net Pond Accumulation from Rain	m3/mth	-21	34	37	72	51	-10	-60	-67	-103	-149	-110	-71	-397
Net Pond Accumulation from Rain	m3/day	-1	1	1	2	2	0	-2	-2	-3	-5	-4	-3	
Crop Water Req	m3/day	-41	0	0	0	0	0	-47	-62	-85	-87	-70	-64	
Leachate Flow Rate	m3/day	7	7	7	7	7	7	7	7	7	7	7	7	
Total Water Accumulation	m3/day	-5	8	8	9	9	7	-7	-12	-19	-21	-15	-12	
Monthly Storage Requirements	m3	-140	244	254	282	268	-207	-223	-360	-576	-650	-468	-350	
Cumulative Storage Requirements	m3	0	244	498	780	1048	1255	1033	673	98	0	0	0	

PLATES

FIGURES

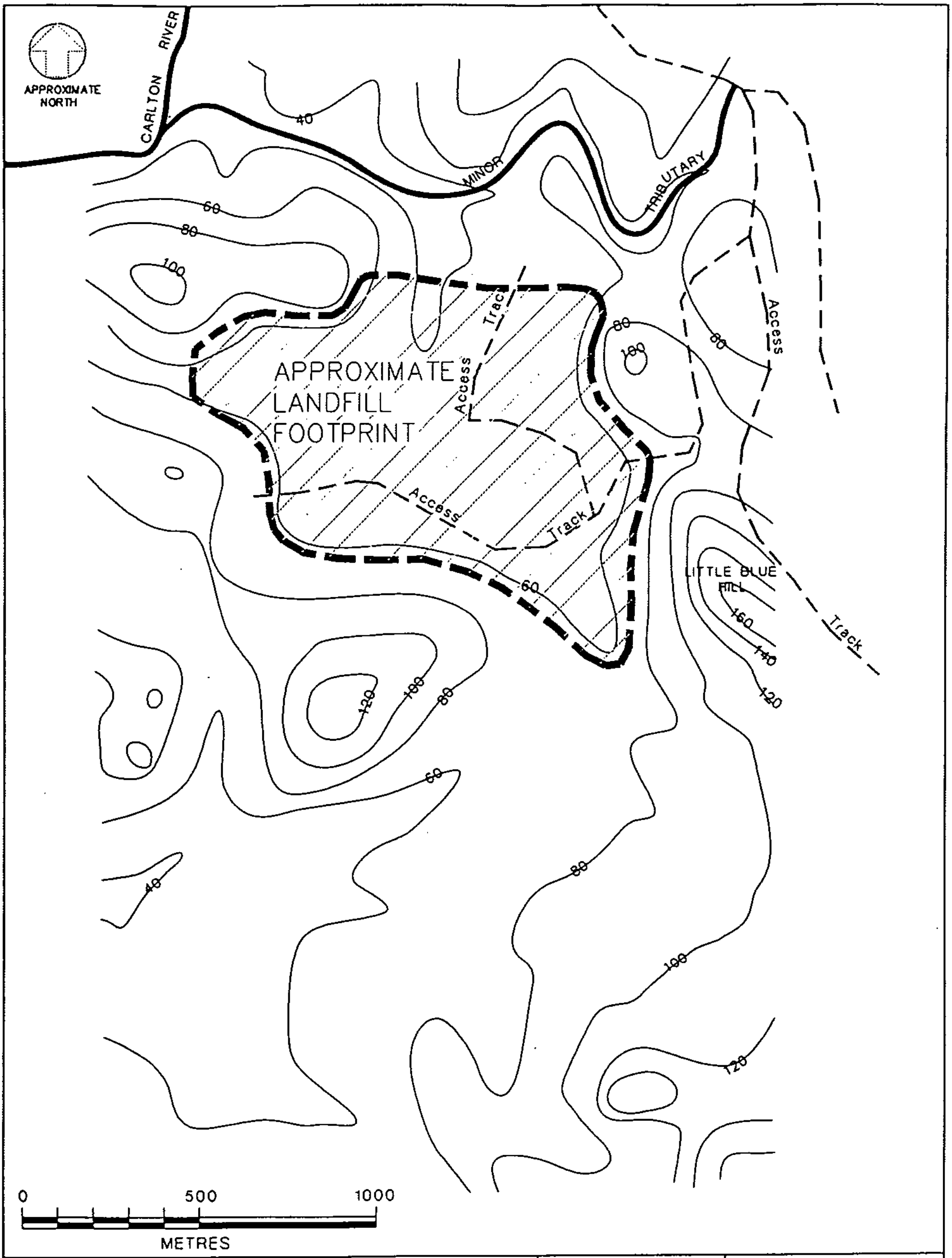


Woodward Clyde	CLIENT SORELL COUNCIL PROJECT COPPING LANDFILL DP AND EMP	REVISION: A SCALE: AS SHOWN DRAWING No: A31/182/1 CAD FILE NO: 0182M003 DATE: MAY 1996	DESIGNED: M.B.J. DRAWN: S.J.L. CHECKED: APPROVED: STATUS:	TITLE LOCALITY PLAN FIGURE 1



Woodward Clyde	CLIENT SORELL COUNCIL PROJECT COPPING LANDFILL DP AND EMP	REVISION: A SCALE: AS SHOWN DRAWING No: A31000182/0001 CAD FILE NO: 0182M005 DATE: MAY 1998	DESIGNED: M.J. DRAWN: L.L.B. CHECKED: APPROVED: STATUS:
			TITLE SITE ASPECTS FIGURE 2

A4



Woodward Clyde

CLIENT
SORELL COUNCIL

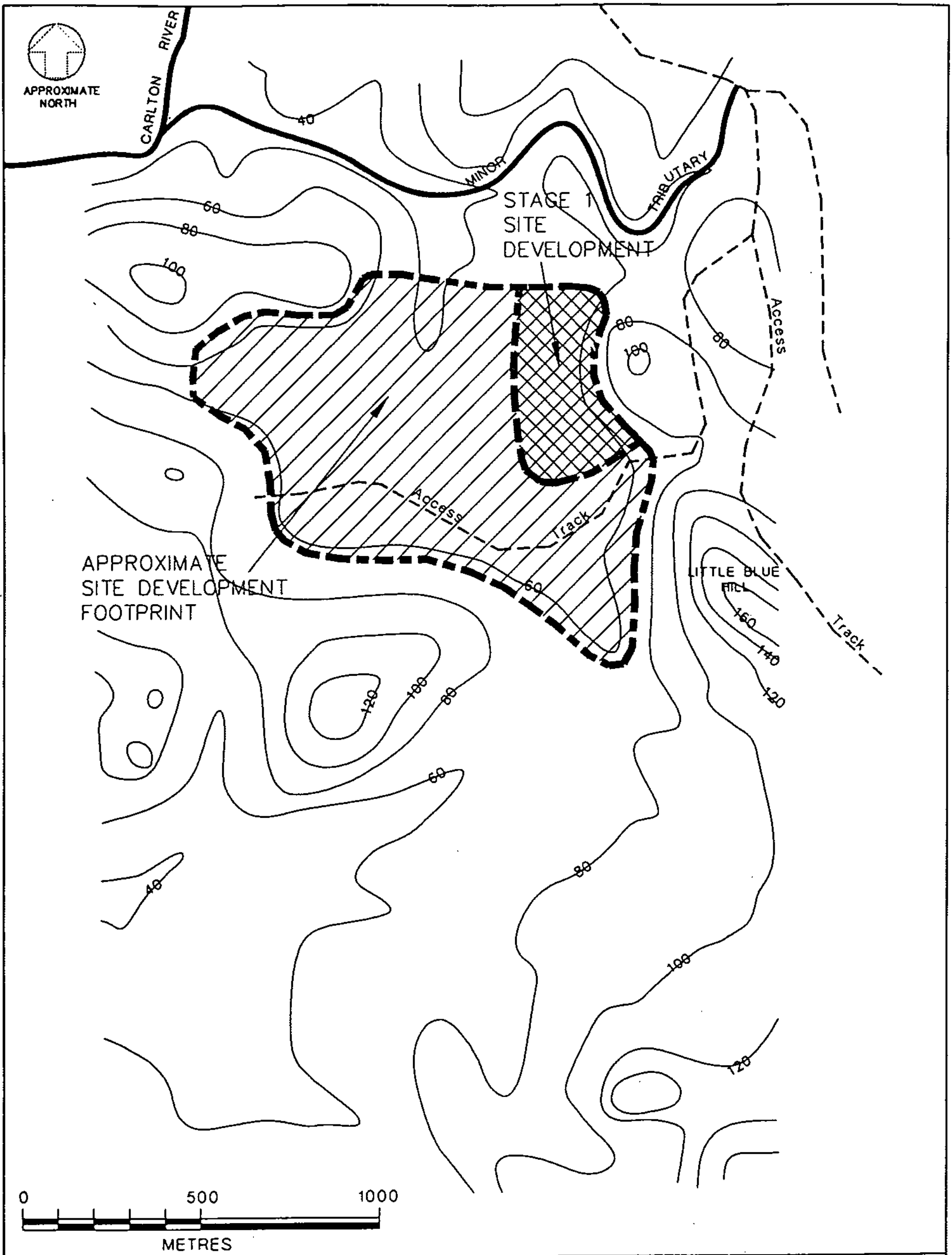
PROJECT
COPPING LANDFILL
DP AND EMP

REVISION: A	DESIGNED: M.J.
SCALE: AS SHOWN	DRAWN: L.L.B.
DRAWING No: A31000182/0001	CHECKED:
CAD FILE NO: 0182M012	APPROVED:
DATE: MAY 1998	STATUS:

TITLE
SITE PLAN / LAYOUT

FIGURE
3

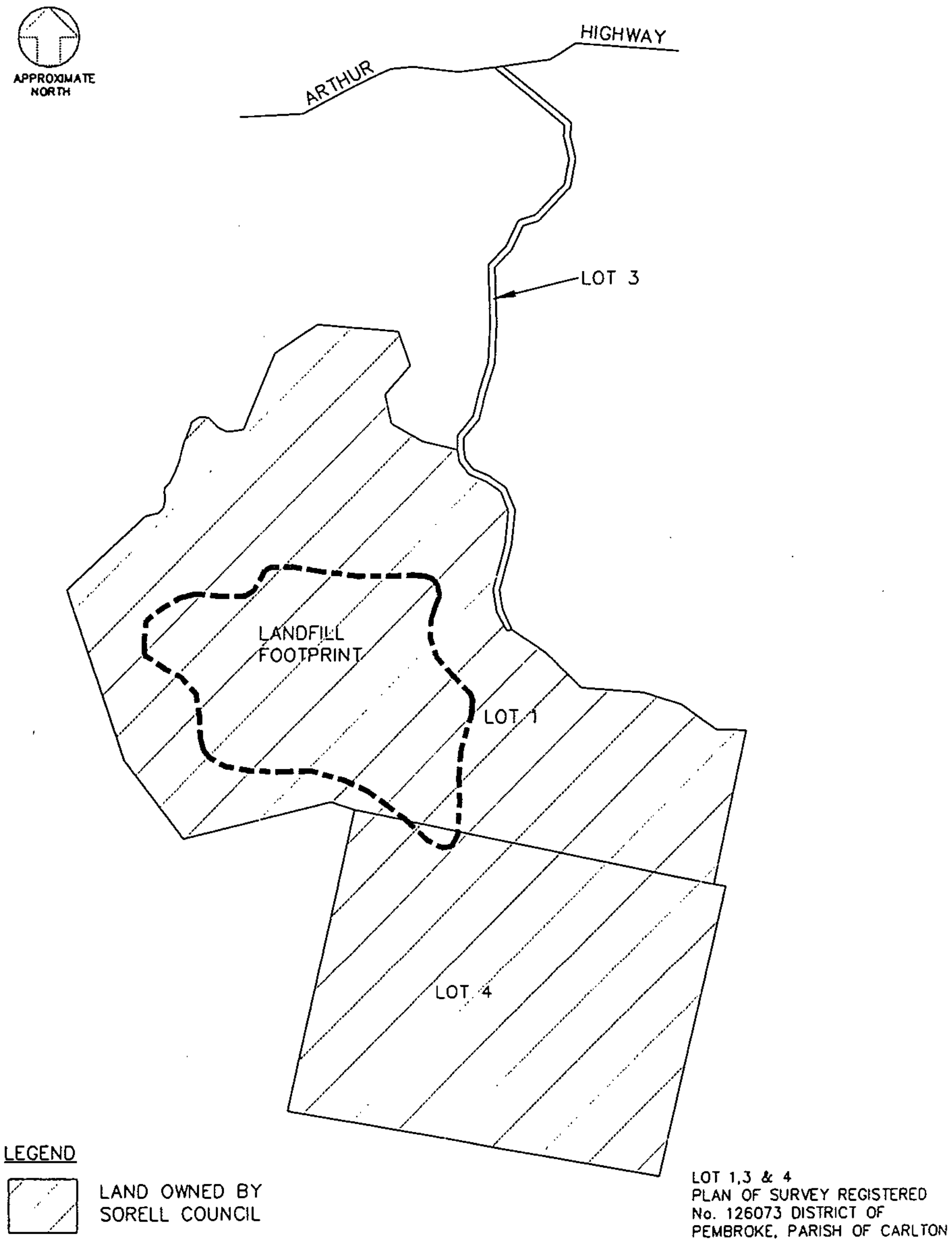
A4



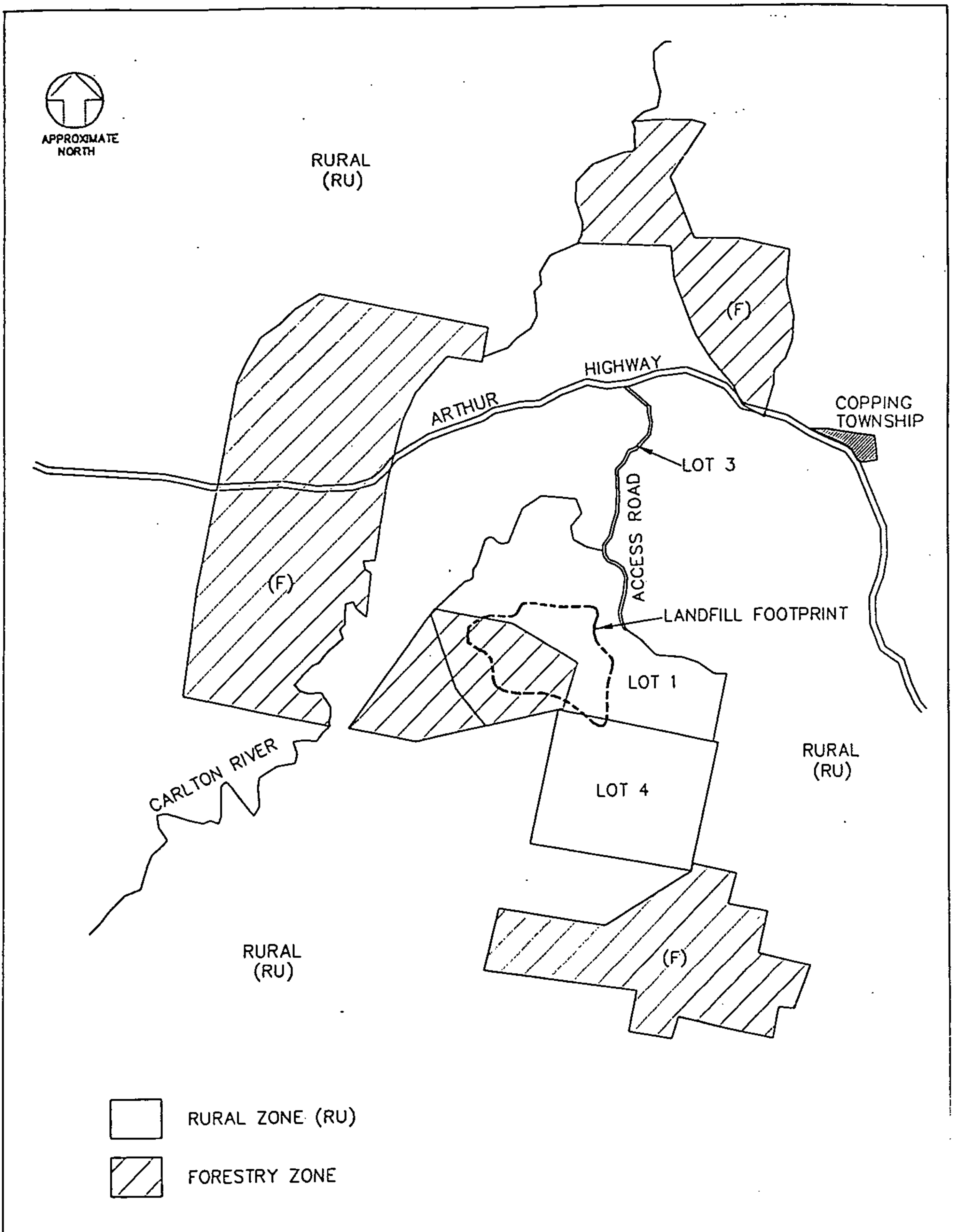
CLIENT SORELL COUNCIL PROJECT COPPING LANDFILL DP AND EMP	REVISION: A SCALE: AS SHOWN DRAWING No: A31000182/0001 CAD FILE NO: 0182M076 DATE: MAY 1998	DESIGNED: M.J. DRAWN: L.L.B. CHECKED: APPROVED: STATUS:	TITLE SITE DEVELOPMENT FIGURE 4

Woodward Clyde

A4

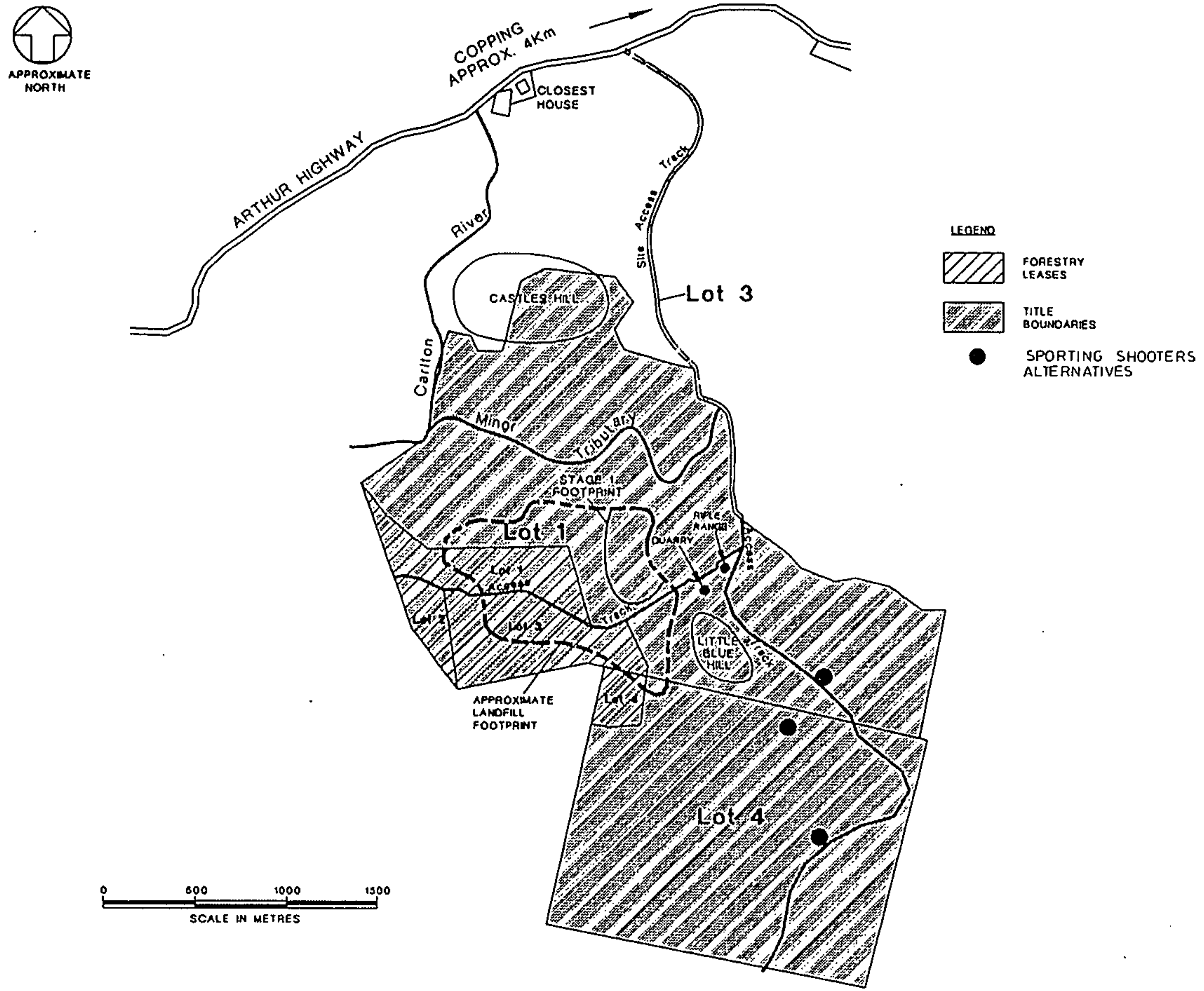


Woodward Clyde	CLIENT SORELL COUNCIL PROJECT COPPING LANDFILL DP AND EMP	REVISION: A SCALE: N.T.S. DRAWING No: A31000182/0001 CAD FILE NO: 0182N073 DATE: MAY 1998	DESIGNED: M.J. DRAWN: S.J.L. CHECKED: APPROVED: STATUS:	TITLE LAND TENURE FIGURE 5 A4



AKEN FROM SORELL PLANNING SCHEME

Woodward Clyde	CLIENT SORELL COUNCIL PROJECT COPPING LANDFILL DP AND EMP	REVISION: A SCALE: N.T.S. DRAWING No: A31000182/0001 CAD FILE NO: 0182N074 DATE: MAY 98	DESIGNED: M.J. DRAWN: S.J.L. CHECKED: APPROVED: STATUS:	TITLE LAND ZONING FIGURE 6 A4



REVISION:	A	DESIGNED:	M.D.J.
SCALE:	AS SHOWN	DRAWN:	L.L.B.
DRAWING No:	A3100182/0001	CHECKED:	
CAD FILE NO:	9182m044	APPROVED:	
DATE:	MAY 1998	STATUS:	D

REV	REV DESCRIPTION	REV	DATE

CLIENT
SORELL COUNCIL

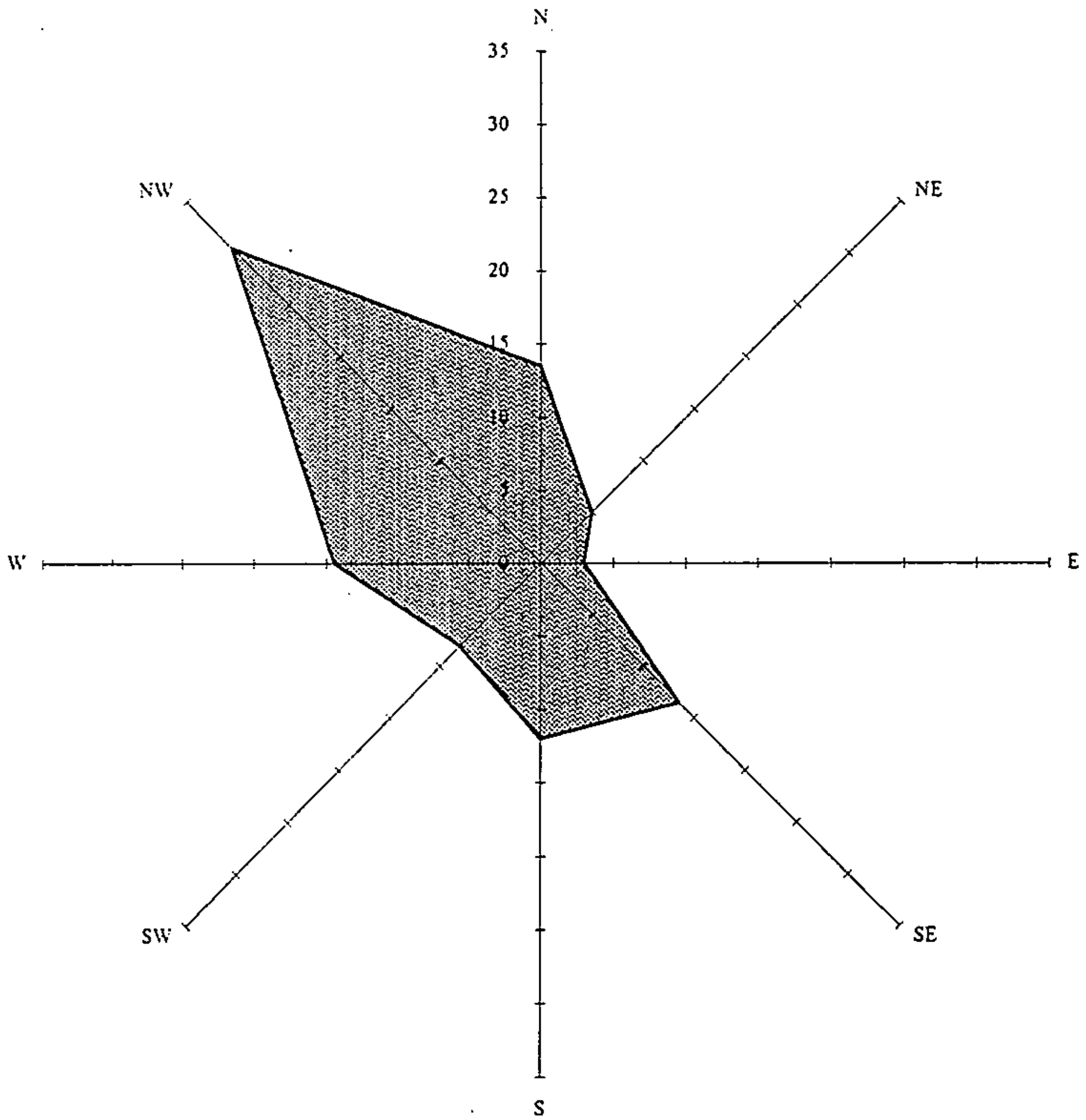
PROJECT
COPPING LANDFILL
DP AND EMP

TITLE
FORESTRY LEASES FOR COPPING LANDFILL SITE AND SPORTING SHOOTERS ALTERNATIVES

Figure 6b

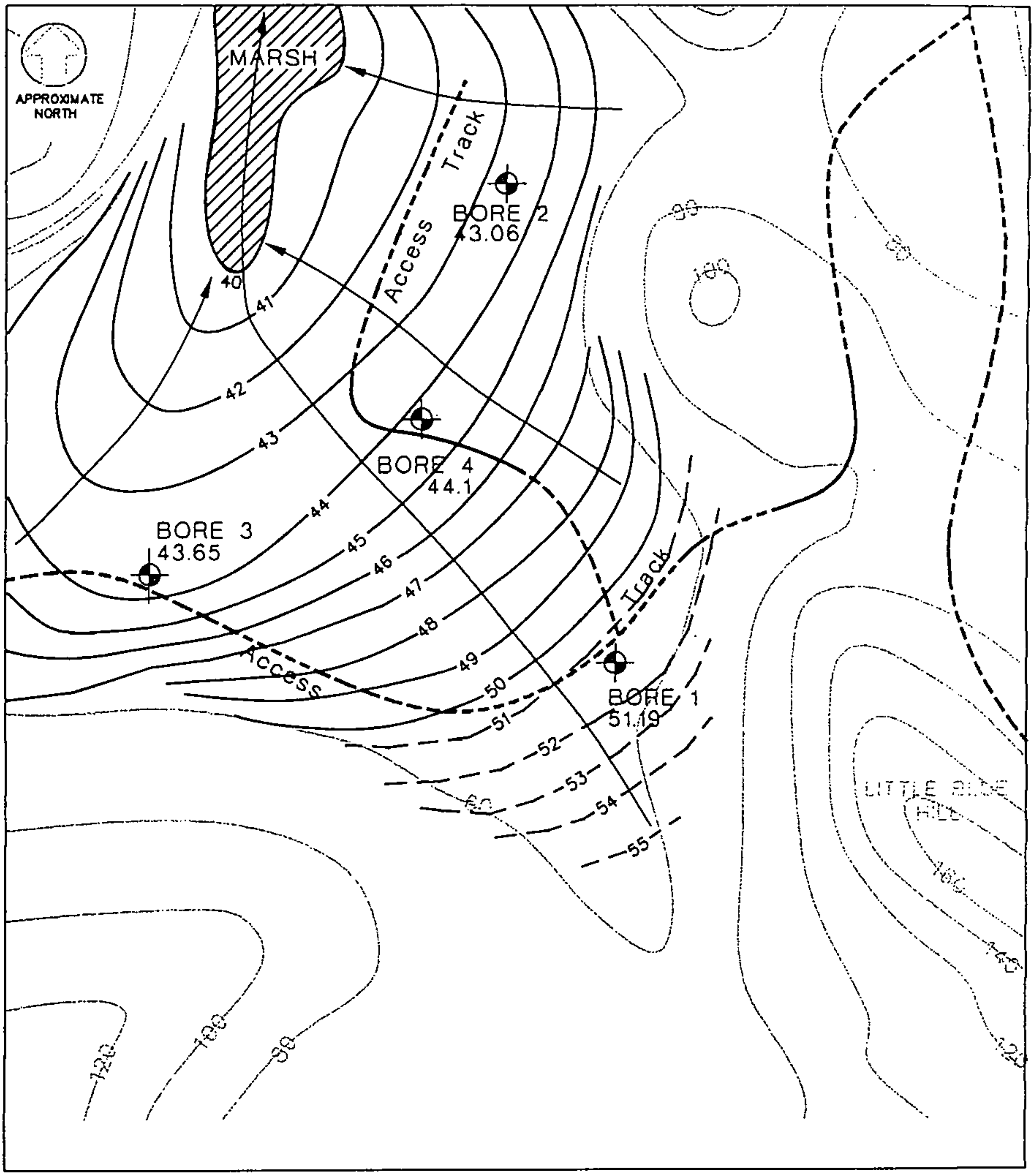
A3

Woodward Clyde



	CLIENT SORELL COUNCIL PROJECT COPPING LANDFILL DP AND EMP	REVISION: A SCALE: N.T.S. DRAWING No: A31/182/1 CAD FILE NO: 0182M006 DATE: MAY 1998	DESIGNED: M.B.J. DRAWN: S.J.L. CHECKED: APPROVED: STATUS:
Woodward Clyde			TITLE WIND DIRECTION DIAGRAM FIGURE 7

A4



0 100 200 300 400 500

METRES

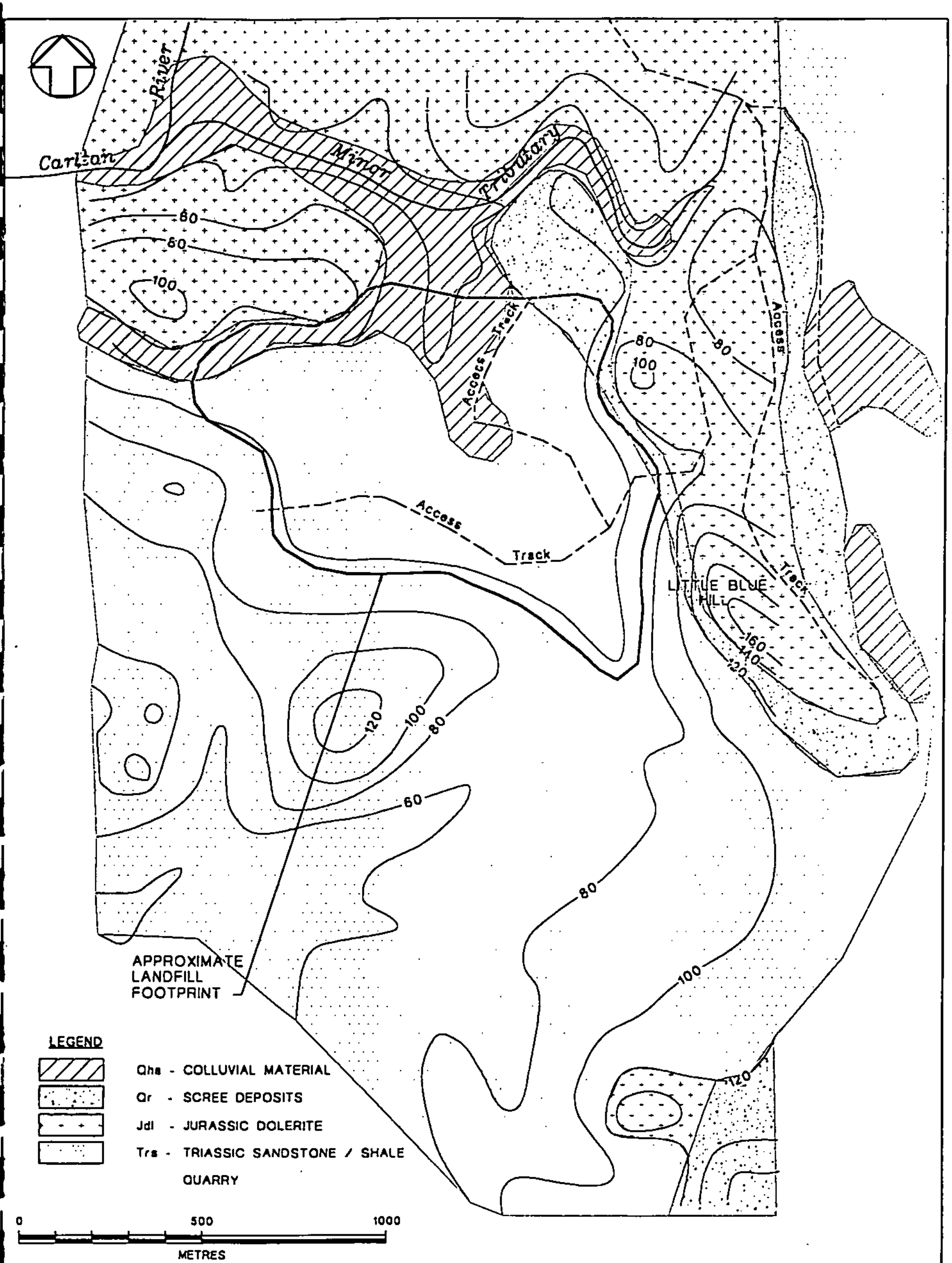
LEGEND

BORE 3 — MONITORING BORE LOCATION

50.00 — INTERPRETED GROUNDWATER CONTOURS - JUNE 1996

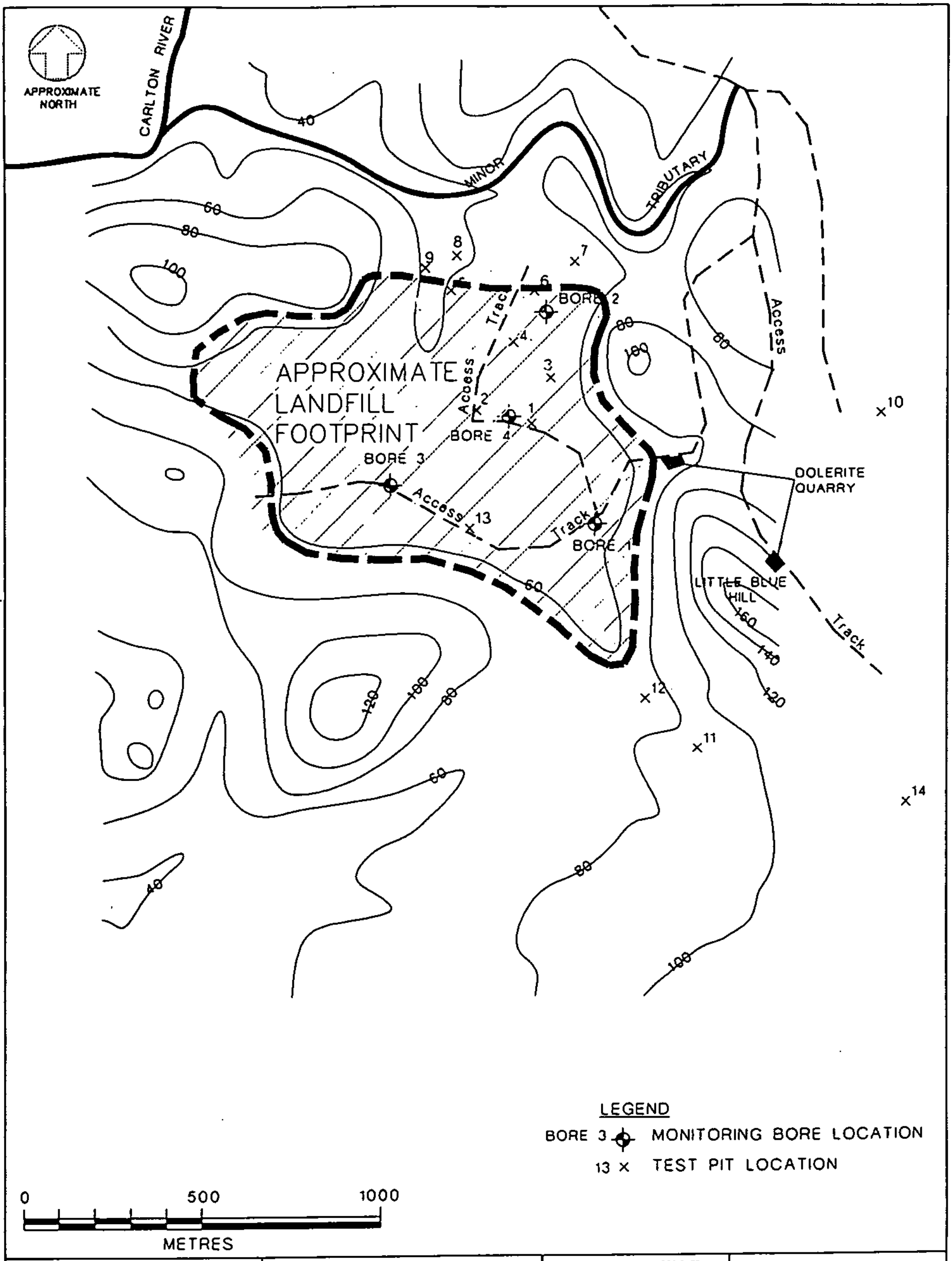
Woodward Clyde

CLIENT SORELL COUNCIL PROJECT COPPING LANDFILL DP AND EMP	REVISION: A SCALE: AS SHOWN DRAWING No: A31000182/0001 CAD FILE NO: 0182M018 DATE: MAY 1996	DESIGNED: M.J. DRAWN: S.J.L. CHECKED: APPROVED: STATUS:	TITLE GROUNDWATER FLOW CONTOURS AND INFERRED FLOW DIRECTIONS FIGURE 8



Woodward Clyde

CLIENT SORELL COUNCIL	REVISION: A	DESIGNED: M.J.	TITLE SITE GEOLOGY MAP
	SCALE: AS SHOWN	DRAWN: L.L.B.	
PROJECT COPPING LANDFILL DP AND EMP	DRAWING No: A3100182/0001	CHECKED:	
	CAD FILE NO: 0182m078	APPROVED:	FIGURE 10
	DATE: MAY 1998	STATUS:	A4

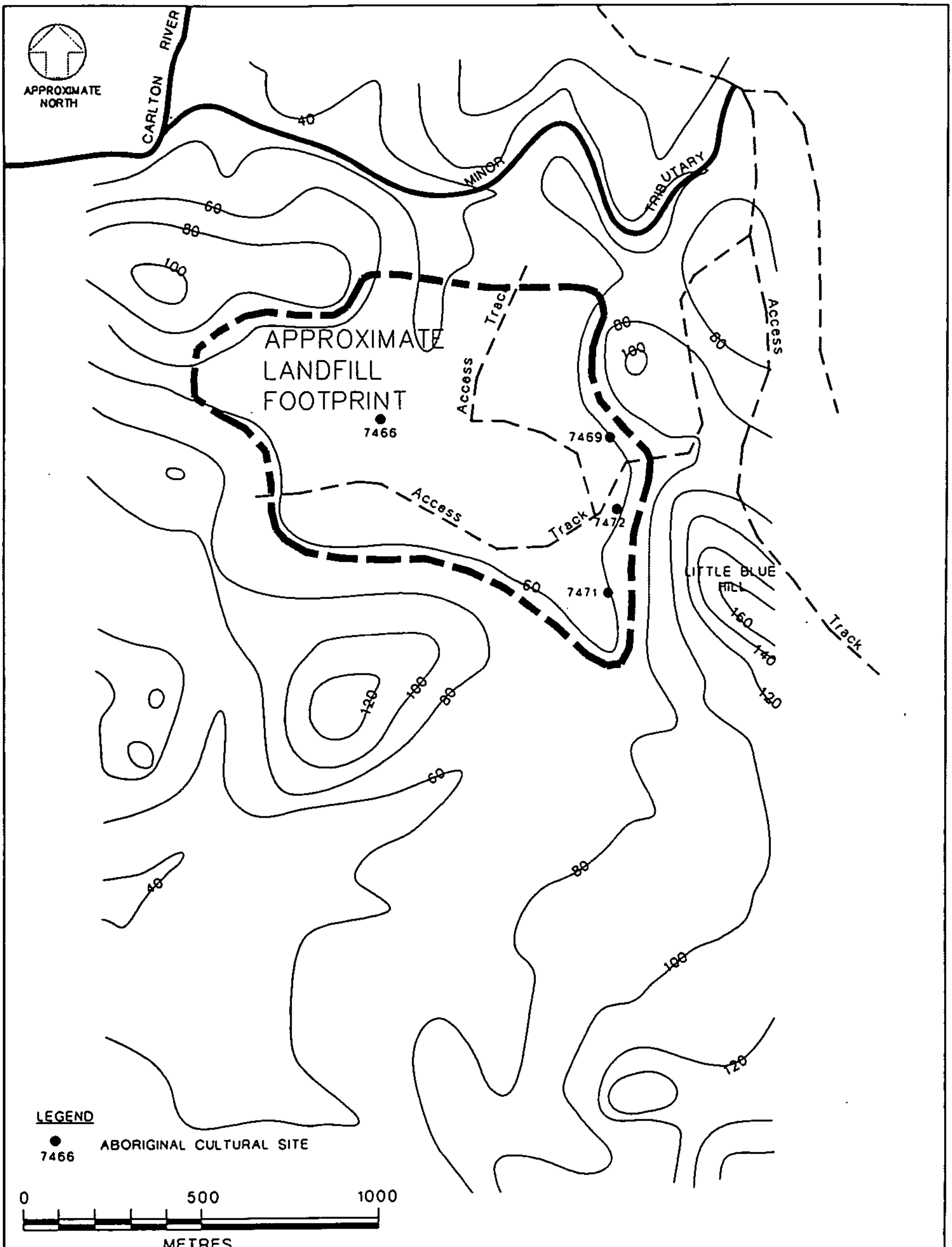


Woodward Clyde	CLIENT SORELL COUNCIL PROJECT COPPING LANDFILL DP AND EMP	REVISION: A SCALE: AS SHOWN DRAWING No: A31000182/0001 CAD FILE NO: 0182M014 DATE: MAY 1998	DESIGNED: M.J. DRAWN: L.L.B. CHECKED: APPROVED: STATUS:

TITLE
MONITORING BORE / TEST PIT LOCATIONS

FIGURE
11

A4



CLIENT
SORELL COUNCIL

PROJECT
COPPING LANDFILL
DP AND EMP

REVISION: A
SCALE: AS SHOWN
DRAWING No: A31000182/0001
CAD FILE No: 0182N073
DATE: MAY 1998

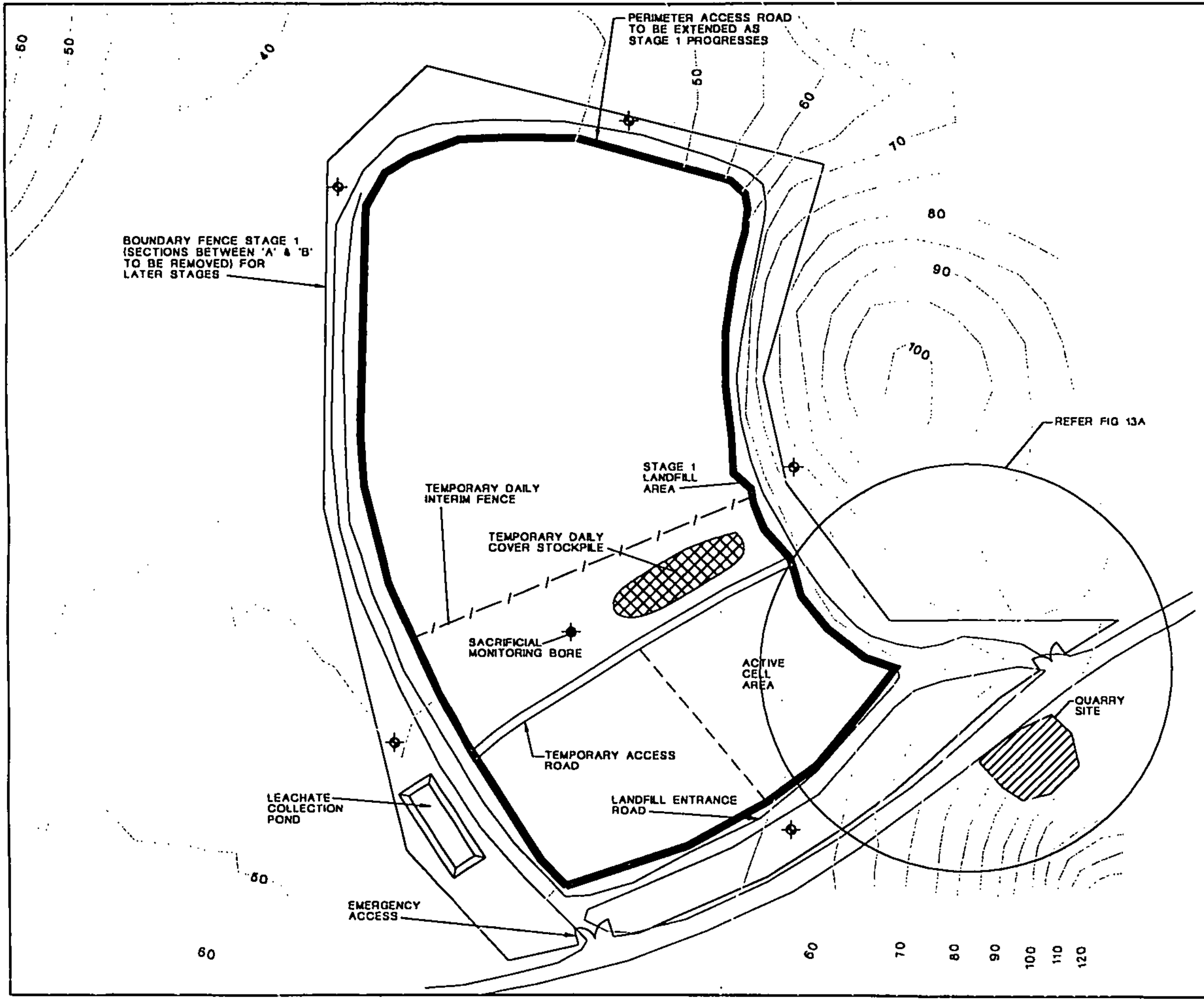
DESIGNED: M.J.
DRAWN: S.J.L.
CHECKED:
APPROVED:
STATUS:

TITLE
ARCHAEOLOGICAL SITES AFFECTED BY LANDFILL DEVELOPMENT

FIGURE
12

A4

Woodward Clyde



REVISION: A
DESIGNED: M.B.J.
SCALE: AS SHOWN
DRAWN: L.L.B.
DRAWING No: A3100183
CHECKED:
CAD FILE NO: 0182a048
APPROVED:
DATE: MAY [illegible]
STATUS:

LEGEND

Wire mesh fence

80 Existing contours

Proposed groundwater monitoring bore

REV	REV DESCRIPTION	REV	DATE

RELEVANT SCALE HERE

CLIENT
SORELL COUNCIL

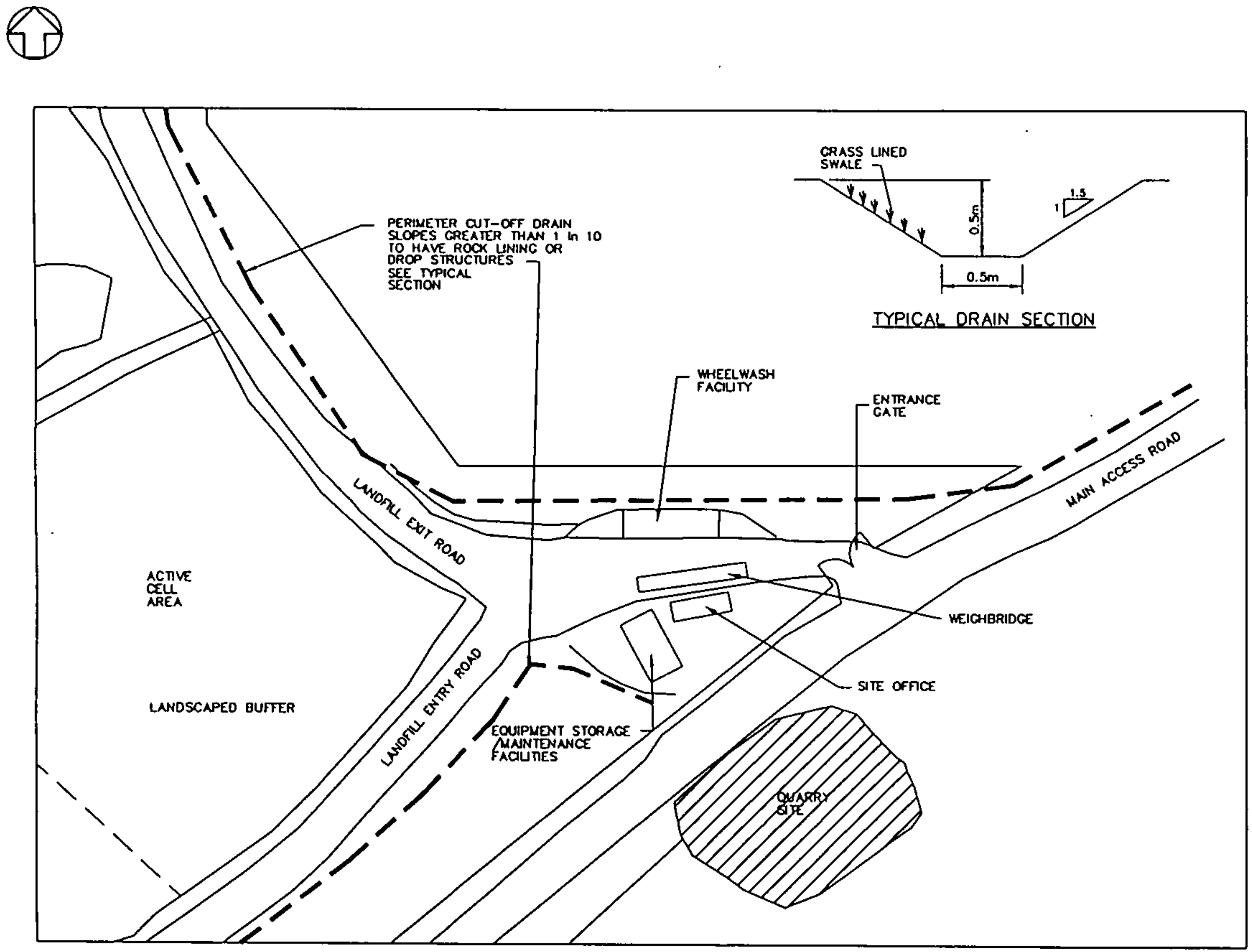
PROJECT
COPPING LANDFILL DP AND EMP

TITLE
PROPOSED STAGE 1 SITE FEATURE LAYOUT DETAILS

FIGURE
13

A3

Woodward Clyde



REVISION: A | DESIGNED: M.B.J.
SCALE: AS SHOWN | DRAWN: L.L.B.
DRAWING No: A3100182 | CHECKED:
CAD FILE NO: 0182m049 | APPROVED:
DATE: MAY 1998 | STATUS:

REV	REV DESCRIPTION	REV	DATE

CLIENT
SORELL COUNCIL

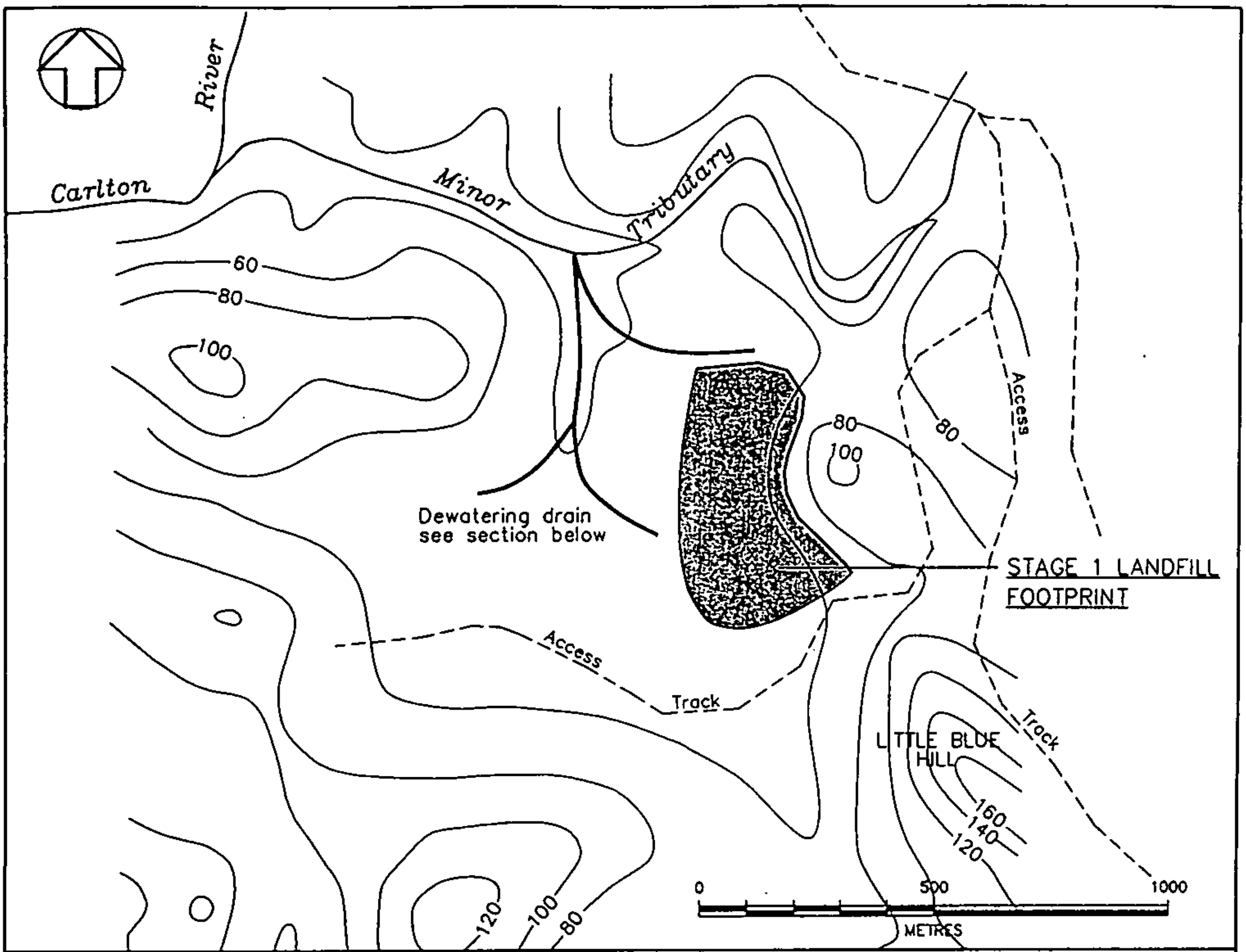
PROJECT
COPPING LANDFILL
DP AND EMP

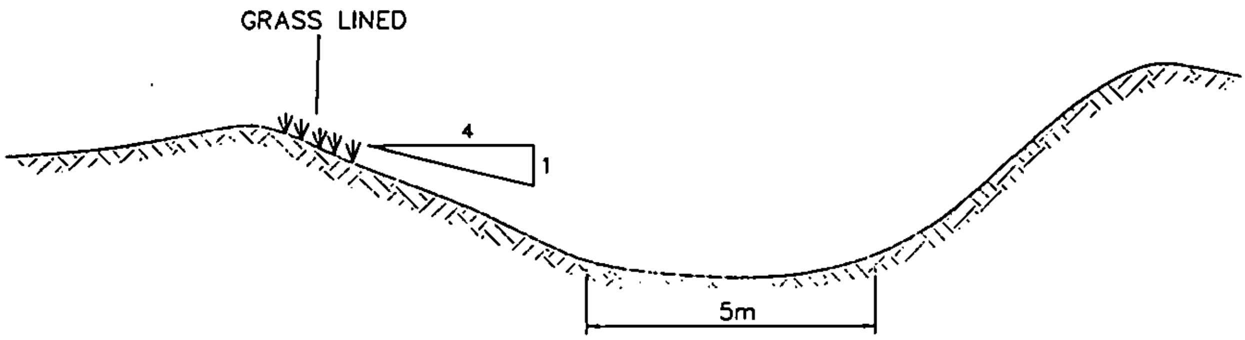
TITLE
PROPOSED STAGE 1
SITE LAYOUT
DETAILS

FIGURE
13A

A3

Woodward Clyde





TYPICAL DEWATERING DRAIN SECTION

Woodward Clyde

CLIENT
SORELL COUNCIL

PROJECT
COPPING LANDFILL
DP AND EMP

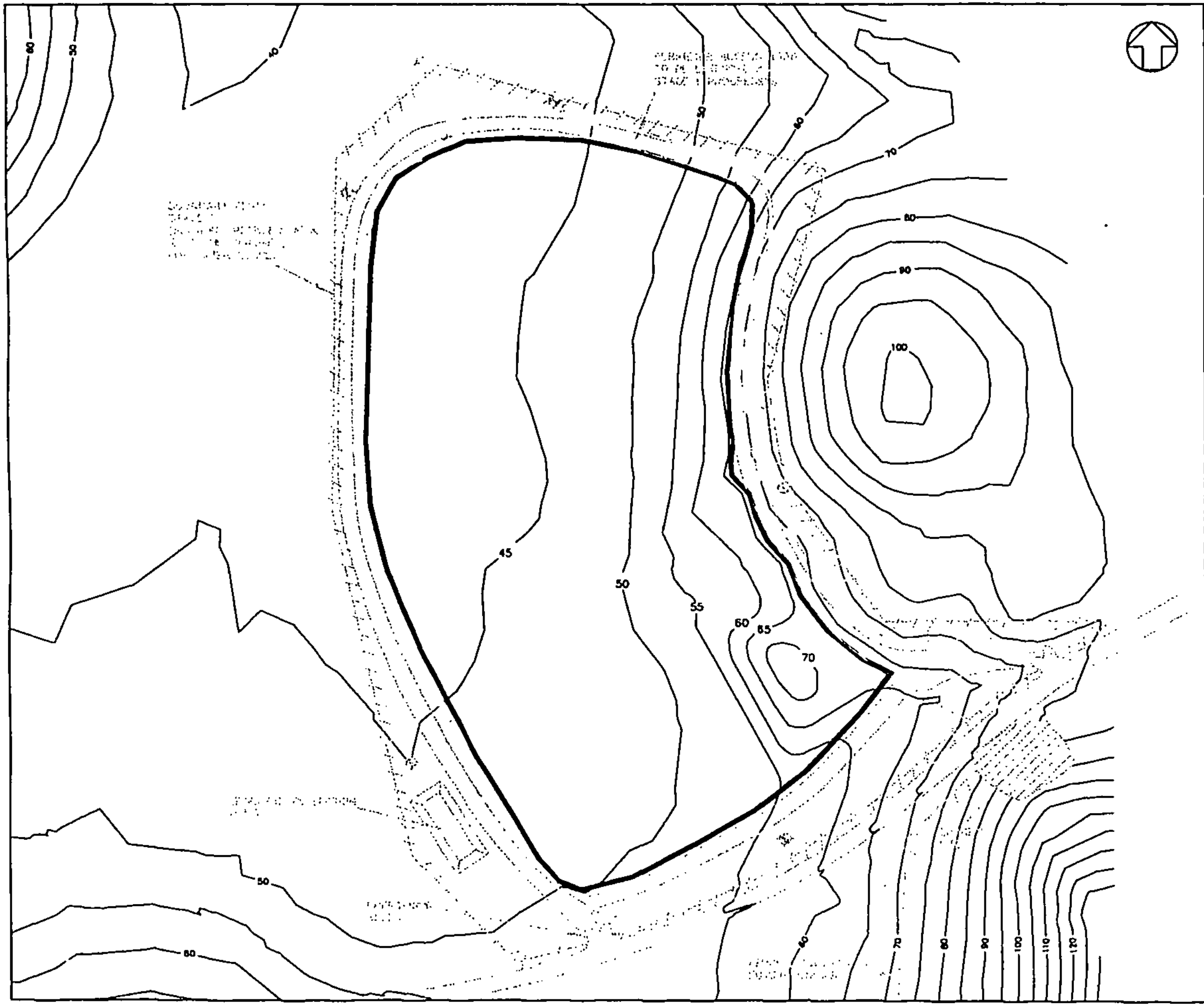
REVISION: A
SCALE: AS SHOWN
DRAWING No: A3100182/0001
CAD FILE NO: Drainage
DATE: MAY 1998

DESIGNED: M.J.
DRAWN: L.L.B.
CHECKED:
APPROVED:
STATUS:

TITLE
SITE DRAINAGE

FIGURE
13b

A4



REVISION: A
SCALE: AS SHOWN
DRAWING No: A3V00182
CAD FILE NO:
DATE: 27/3/97
DESIGNED: N.S.J.
DRAWN: S.J.L.
CHECKED:
APPROVED:
STATUS:

LEGEND

DRAIN
WIRE MESH FENCE
EXISTING CONTOURS
PROPOSED GROUNDWATER MONITORING BORE

REV	REV DESCRIPTION	REV	DATE

50 25 0 50 100
SCALE IN METRES

CLIENT
SORELL COUNCIL

PROJECT
COPPING LANDFILL DP AND EMP

TITLE
PROPOSED STAGE 1 CELL 1 COMPLETED CONTOURS

FIGURE
14A

A3

Woodward Clyde

REVISION: A	DESIGNED: M.B.J.
SCALE: AS SHOWN	DRAWN: S.J.L.
DRAWING No: A3V00162	CHECKED:
CAD FILE NO: 0162m062	APPROVED:
DATE: 27/3/97	STATUS:

LEGEND

DRAIN

WIRE MESH FENCE

EXISTING CONTOURS (60)

PROPOSED GROUNDWATER MONITORING BORE

REV	REV DESCRIPTION	REV	DATE

50 25 0 50 100

SCALE IN METRES

CLIENT

SORELL COUNCIL

PROJECT

COPPING LANDFILL
DP AND EMP

TITLE

PROPOSED STAGE 1
CELL 3
COMPLETED CONTOURS

FIGURE

14C

A3

Woodward Clyde

REVISION A
SCALE: AS SHOWN
DRAWING No: A3/V00162
CAD FILE NO: 0162m066
DATE: 21/3/97
DESIGNED: M.B.J.
DRAWN: S.J.L.
CHECKED:
APPROVED:
STATUS:

LEGEND

DRAIN
WIRE MESH FENCE
EXISTING CONTOURS
PROPOSED GROUNDWATER MONITORING BORE

REV	REV DESCRIPTION	REV	DATE

50 25 0 50 100
SCALE IN METRES

CLIENT
SORELL COUNCIL

PROJECT
COPPING LANDFILL
DP AND EMP

TITLE
PROPOSED STAGE 1
CELL 6
COMPLETED CONTOURS

FIGURE
14F

A3

Woodward Clyde

REVISION A

SCALE: AS SHOWN

DRAWING No: A3V/00162

CAD FILE NO: 9162m068

DATE: 27/3/97

DESIGNED: M.B.J.

DRAWN: B.J.L.

CHECKED:

APPROVED:

STATUS:

LEGEND

DRAIN

WIRE MESH FENCE

EXISTING CONTOURS

PROPOSED GROUNDWATER MONITORING BORE

REV	REV DESCRIPTION	REV	DATE

50 25 0 50 100
SCALE IN METRES

CLIENT
SORELL COUNCIL

PROJECT
COPPING LANDFILL DP AND EMP

TITLE
PROPOSED STAGE 1 CELL 9 COMPLETED CONTOURS

FIGURE
141

A3

Woodward Clyde

REVISION A
SCALE: AS SHOWN
DRAWING No: A3V00182
CAD FILE NO: 0182m060
DATE: 31/3/97

DESIGNED: M.B.J.
DRAWN: S.J.L.
CHECKED:
APPROVED:
STATUS:

LEGEND

DRAIN
WIRE MESH FENCE
60 EXISTING CONTOURS
PROPOSED GROUNDWATER MONITORING BORE

REV	REV DESCRIPTION	REV	DATE

50 25 0 50 100
SCALE IN METRES

CLIENT
SORELL COUNCIL

PROJECT
COPPING LANDFILL
DP AND EMP

TITLE
PROPOSED STAGE 1
CELL 10
COMPLETED CONTOURS

FIGURE
14J

A3

Woodward Clyde

REVISION A

SCALE: AS SHOWN

DRAWING No: A3V00162

CAD FILE NO: 0162m060

DATE: 27/3/97

DESIGNED: M.B.J.

DRAWN: B.J.L.

CHECKED:

APPROVED:

STATUS:

LEGEND

DRAIN

WIRE MESH FENCE

EXISTING CONTOURS

PROPOSED GROUNDWATER MONITORING BORE

REV	REV DESCRIPTION	REV	DATE

50 25 0 50 100

SCALE IN METRES

CLIENT

SORELL COUNCIL

PROJECT

COPPING LANDFILL
DP AND EMP

TITLE

PROPOSED STAGE 1
CELL 11
COMPLETED CONTOURS

FIGURE

14K

A3

Woodward Clyde

REVISION: A
SCALE: AS SHOWN
DRAWING No: A3/00182
CAD FILE NO: 0182m061
DATE: 27/3/97

DESIGNED: M.B.J.
DRAWN: S.J.L.
CHECKED:
APPROVED:
STATUS:

LEGEND

DRAIN
WIRE MESH FENCE
EXISTING CONTOURS (60)
PROPOSED GROUNDWATER MONITORING BORE

REV	REV DESCRIPTION	REV	DATE

50 25 0 50 100
SCALE IN METRES

CLIENT
COPPING COUNCIL

PROJECT
SORELL LANDFILL
DP AND EMP

TITLE
PROPOSED STAGE 1
CELL 12
COMPLETED CONTOURS

FIGURE
14L

A3

Woodward Clyde

REVISION A	DESIGNED: M.B.J.
SCALE: AS SHOWN	DRAWN: S.J.L.
DRAWING No: A3V00182	CHECKED:
CAD FILE NO: 0182m042	APPROVED:
DATE: 27/3/97	STATUS:

LEGEND

DRAIN

WIRE MESH FENCE

EXISTING CONTOURS

PROPOSED GROUNDWATER MONITORING BORE

REV	REV DESCRIPTION	REV	DATE

50 25 0 50 100

SCALE IN METRES

CLIENT

SORELL COUNCIL

PROJECT

COPPING LANDFILL DP AND EMP

TITLE

PROPOSED STAGE 1 CELL 13 COMPLETED CONTOURS

FIGURE

14M

A3

Woodward Clyde

REVISION A
DESIGNED: M.B.J.
SCALE: AS SHOWN
DRAWN: S.J.L.
DRAWING No: A31/00182
CHECKED:
CAD FILE NO: 0182w063
APPROVED:
DATE: 27/3/97
STATUS:

LEGEND

DRAIN

WIRE MESH FENCE

60 EXISTING CONTOURS

PROPOSED GROUNDWATER MONITORING BORE

REV	REV DESCRIPTION	REV	DATE

50 25 0 50 100
SCALE IN METRES

CLIENT
SORELL COUNCIL

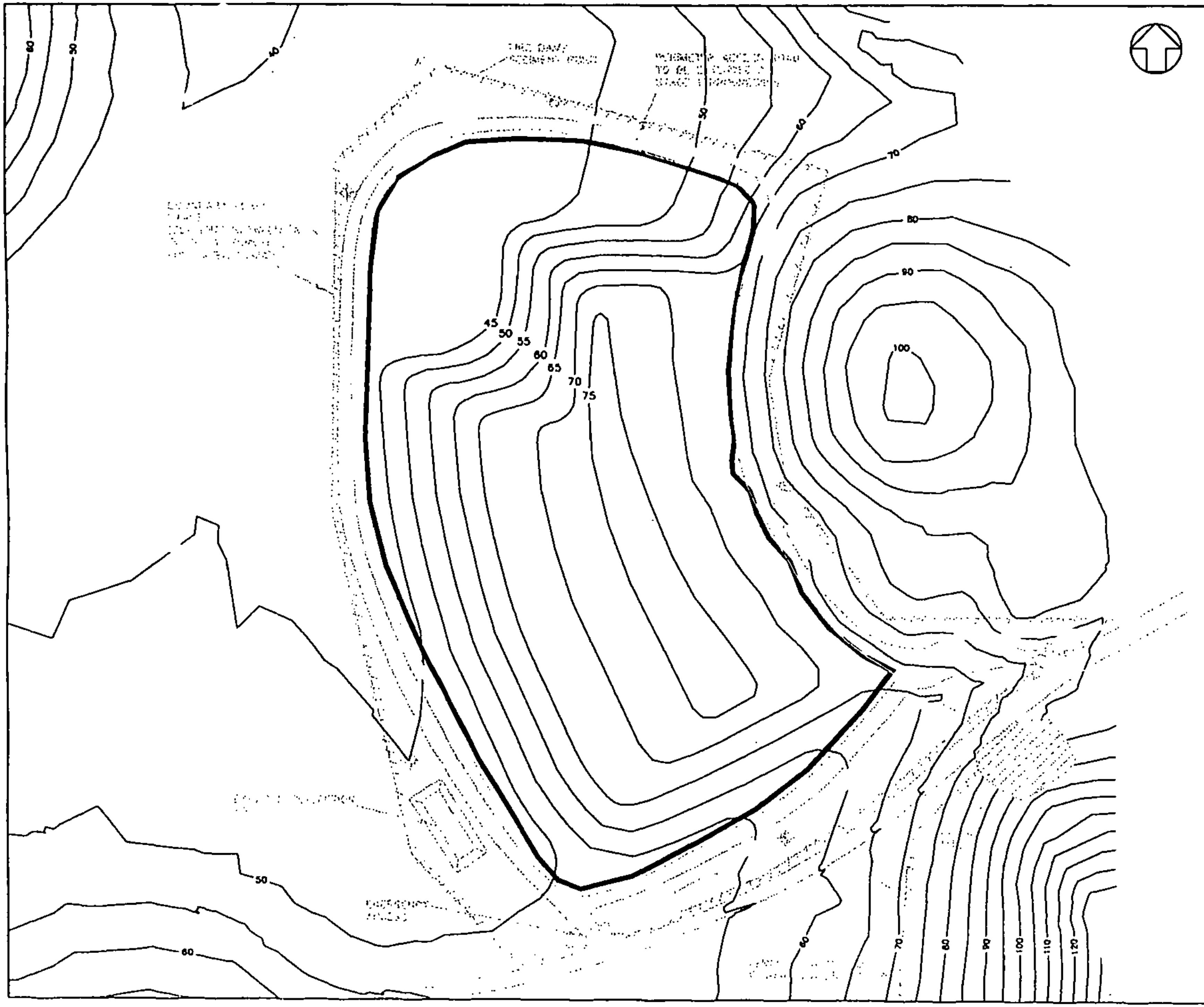
PROJECT
SORELL LANDFILL DP AND EMP

TITLE
PROPOSED STAGE 1 CELL 14 COMPLETED CONTOURS

FIGURE
14N

A3

Woodward Clyde



REVISION A
SCALE: AS SHOWN
DRAWING No: A3V00183
CAD FILE NO: 0182m064
DATE: 27/3/97

DESIGNED: M.B.J.
DRAWN: S.J.L.
CHECKED:
APPROVED:
STATUS:

LEGEND

DRAIN
WIRE MESH FENCE
EXISTING CONTOURS (60)
PROPOSED GROUNDWATER MONITORING BORE

REV	REV DESCRIPTION	REV	DATE

50 25 0 50 100
SCALE IN METRES

CLIENT
SORELL COUNCIL

PROJECT
COPPING LANDFILL
DP AND EMP

TITLE
PROPOSED STAGE 1
CELL 15
COMPLETED CONTOURS

FIGURE
140

A3

Woodward Clyde

REVISION A | DESIGNED: M.S.J.
SCALE: AS SHOWN | DRAWN: S.J.L.
DRAWING No: A3V/00162 | CHECKED:
CAD FILE NO: 0162m066 | APPROVED:
DATE: 27/3/97 | STATUS:

LEGEND

DRAIN

WIRE MESH FENCE

EXISTING CONTOURS

PROPOSED GROUNDWATER MONITORING BORE

REV	REV DESCRIPTION	REV	DATE

50 25 0 50 100
SCALE IN METRES

CLIENT
SORELL COUNCIL

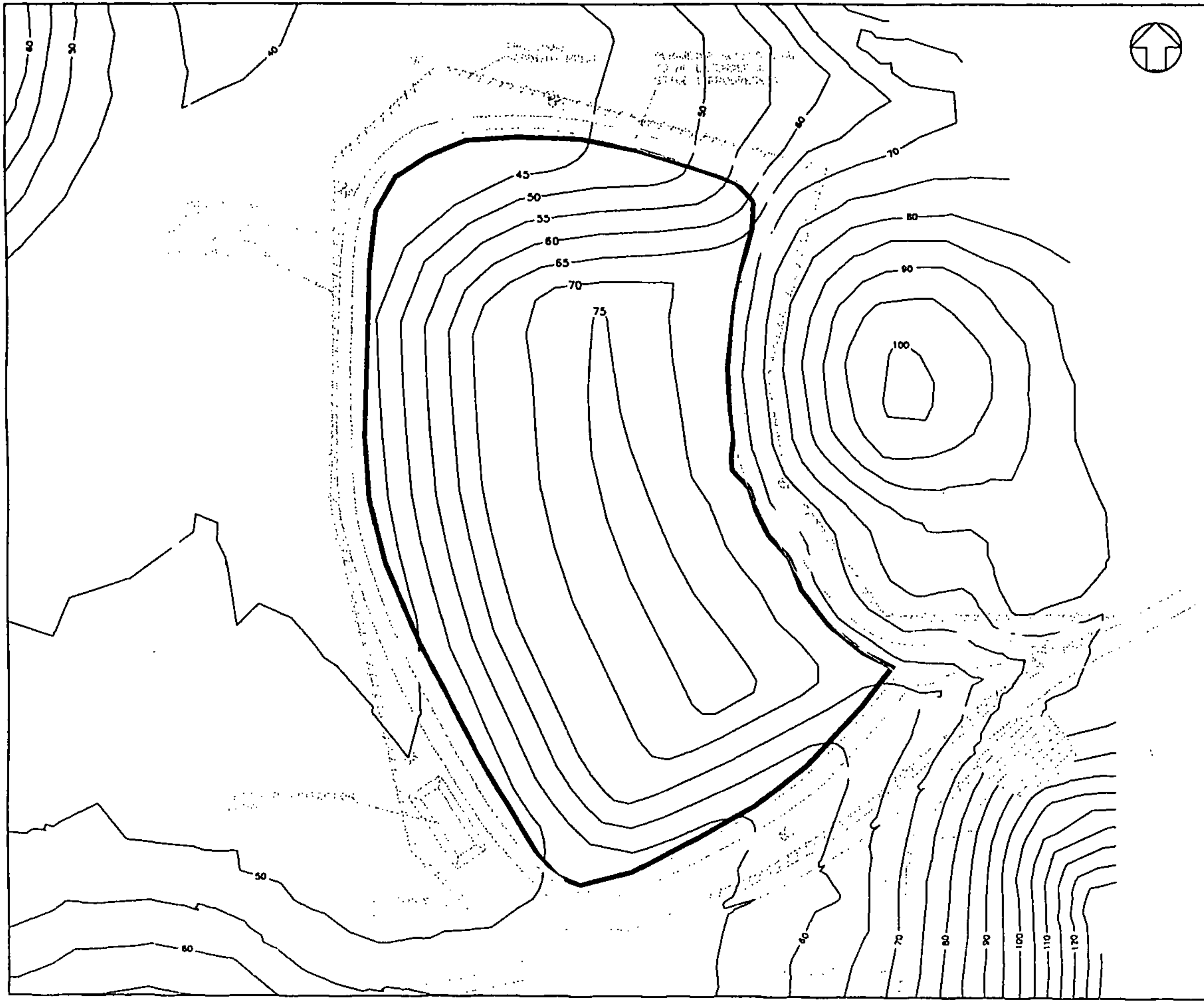
PROJECT
COPPING LANDFILL
DP AND EMP

TITLE
PROPOSED STAGE 1
CELL 1B
COMPLETED CONTOURS

FIGURE
14P

A3

Woodward Clyde



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SCALE: AS SHOWN | DRAWN: S.J.L.
DRAWING No: A3/V00182 | CHECKED:
CAD FILE NO: 9182a068 | APPROVED:
DATE: 27/3/97 | STATUS:

LEGEND

DRAIN
WIRE MESH FENCE
EXISTING CONTOURS
PROPOSED GROUNDWATER MONITORING BORE

REV	REV DESCRIPTION	REV	DATE

50 25 0 50 100
SCALE IN METRES

CLIENT
SORELL COUNCIL

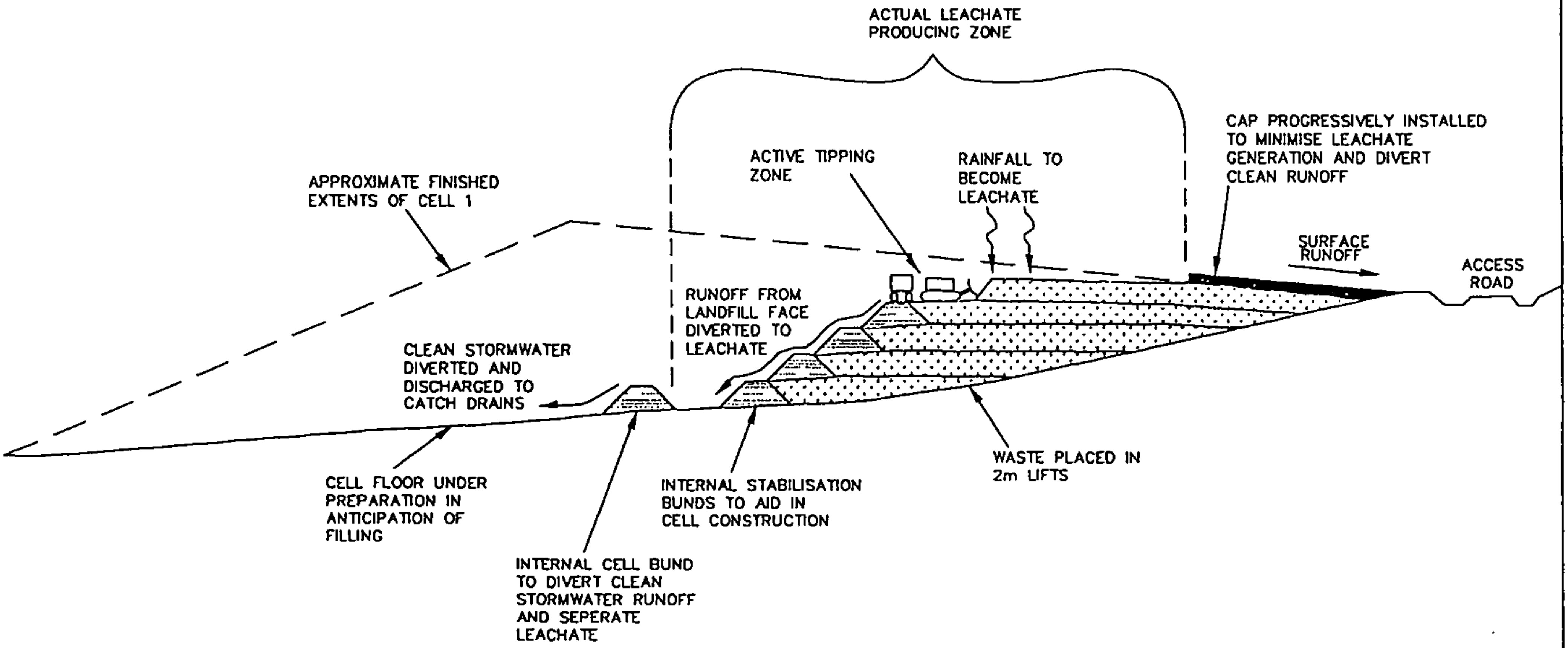
PROJECT
COPPING LANDFILL DP AND EMP

TITLE
PROPOSED STAGE 1 CELL 17 COMPLETED CONTOURS

FIGURE
14Q

A3

Woodward Clyde



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SCALE: N.T.S.	DRAWN: S.J.L.
DRAWING No: A3V182	CHECKED:
CAD FILE NO: 0182M043	APPROVED:
DATE: MAY 98	STATUS:

TITLE
CELL 1 SECTION

FIGURE
16

A4

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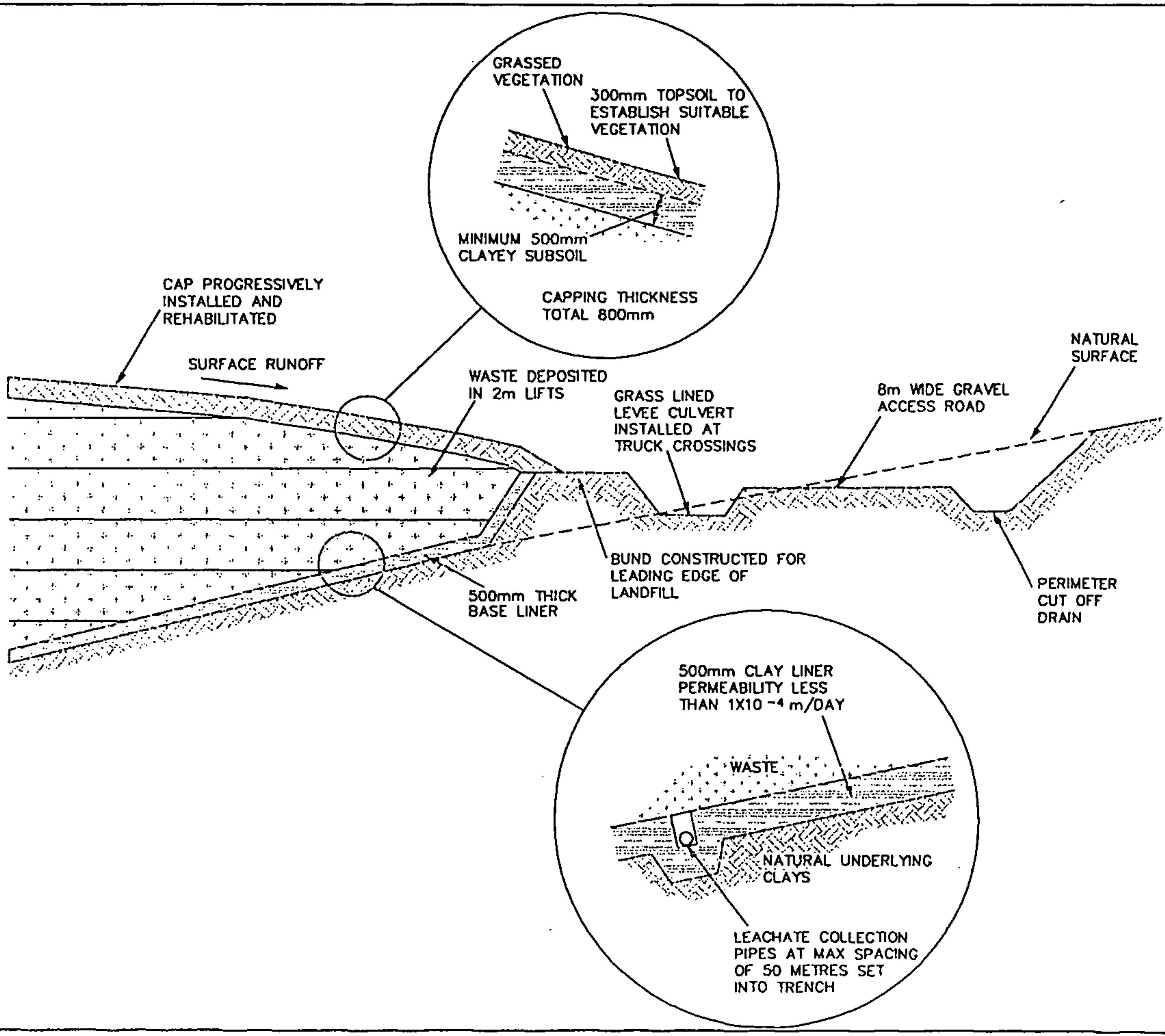

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SCALE: N.T.S.	DRAWN: S.J.L.
DRAWING No: A3V182	CHECKED:
CAD FILE NO: [illegible]	APPROVED:
DATE: MAY 98	STATUS:

REV	REV DESCRIPTION	REV	DATE

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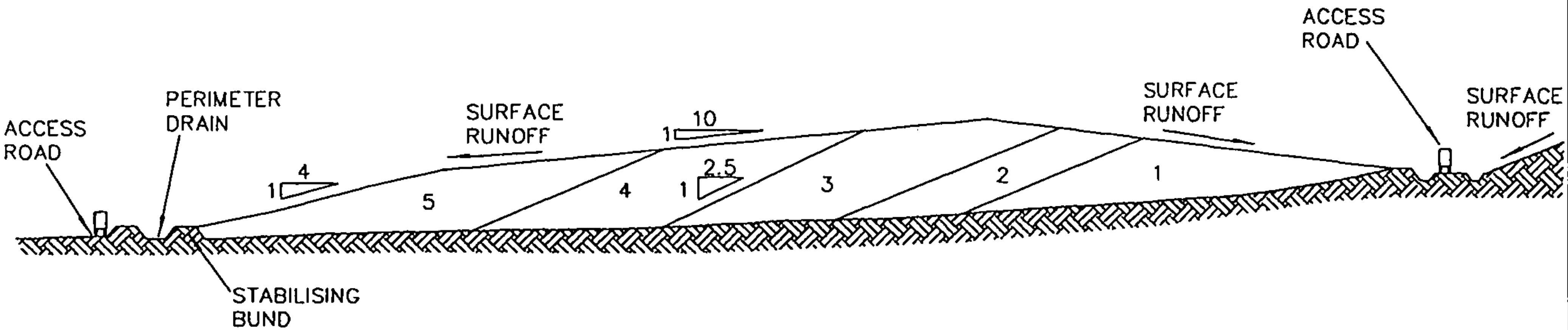
COPPING LANDFILL DP AND EMP

TITLE
CAP AND LINER DETAILS

FIGURE
17

A3

Woodward Clyde



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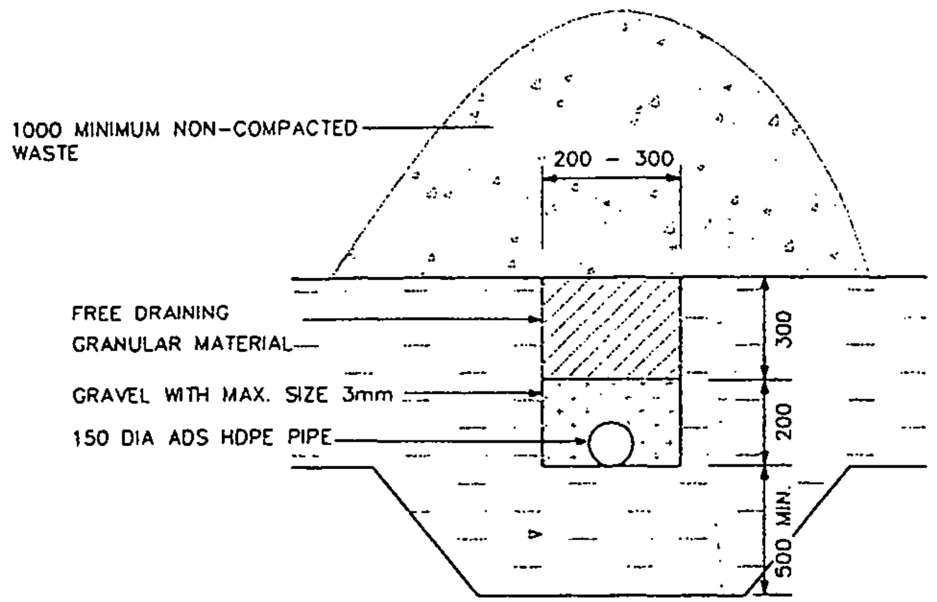
REVISION: A
DESIGNED: M.B.J.
SCALE: N.T.C.
DRAWN: S.J.L.
DRAWING No: A31/182
CHECKED:
CAD FILE NO: 0182M041
APPROVED:
DATE: MAY 98
STATUS:

TITLE
LEACHATE MANAGEMENT PLAN LANDFILL SECTION

FIGURE
18

A4

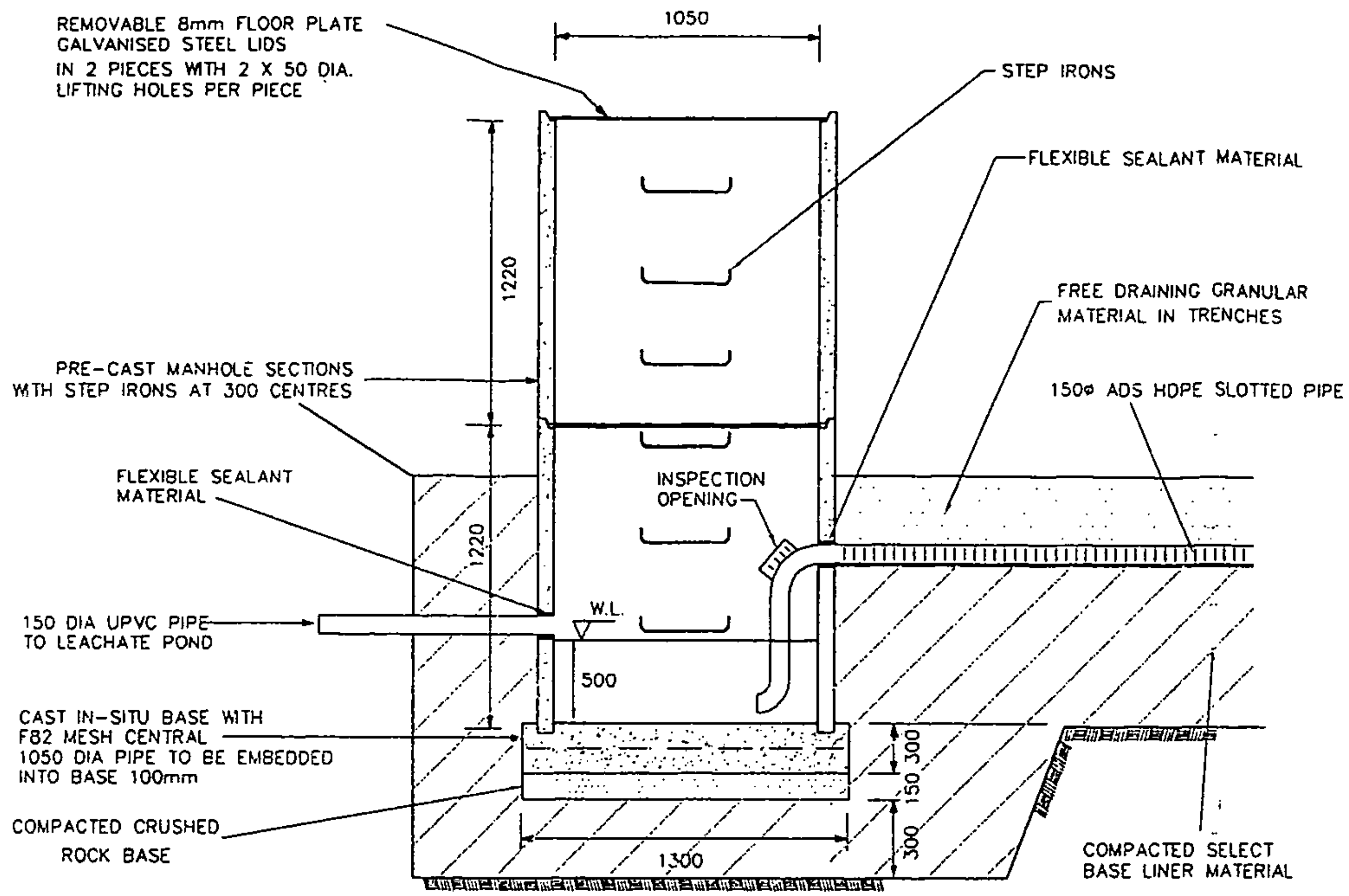
MELB/SJL/10-95



LEACHATE COLLECTION PIPES

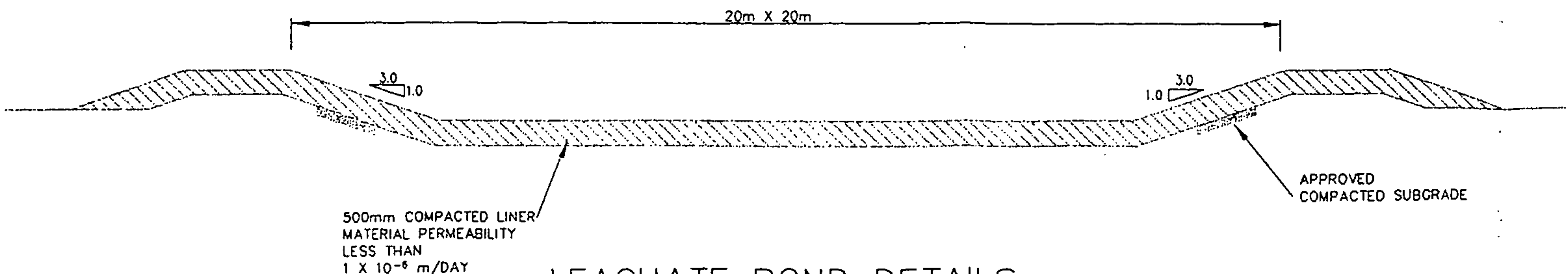
PIPE BEDDING DETAIL

N.T.S.



LEACHATE SUMP DETAIL

NOT TO SCALE



LEACHATE POND DETAILS

NOT TO SCALE

REVISION: A
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SCALE: N.T.S.
DRAWN: S.J.L.
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CAD FILE NO: 0182M039
APPROVED:
DATE: MAY 96
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COPPING LANDFILL DP AND EMP

TITLE
LEACHATE DETAILS

FIGURE
19

A1

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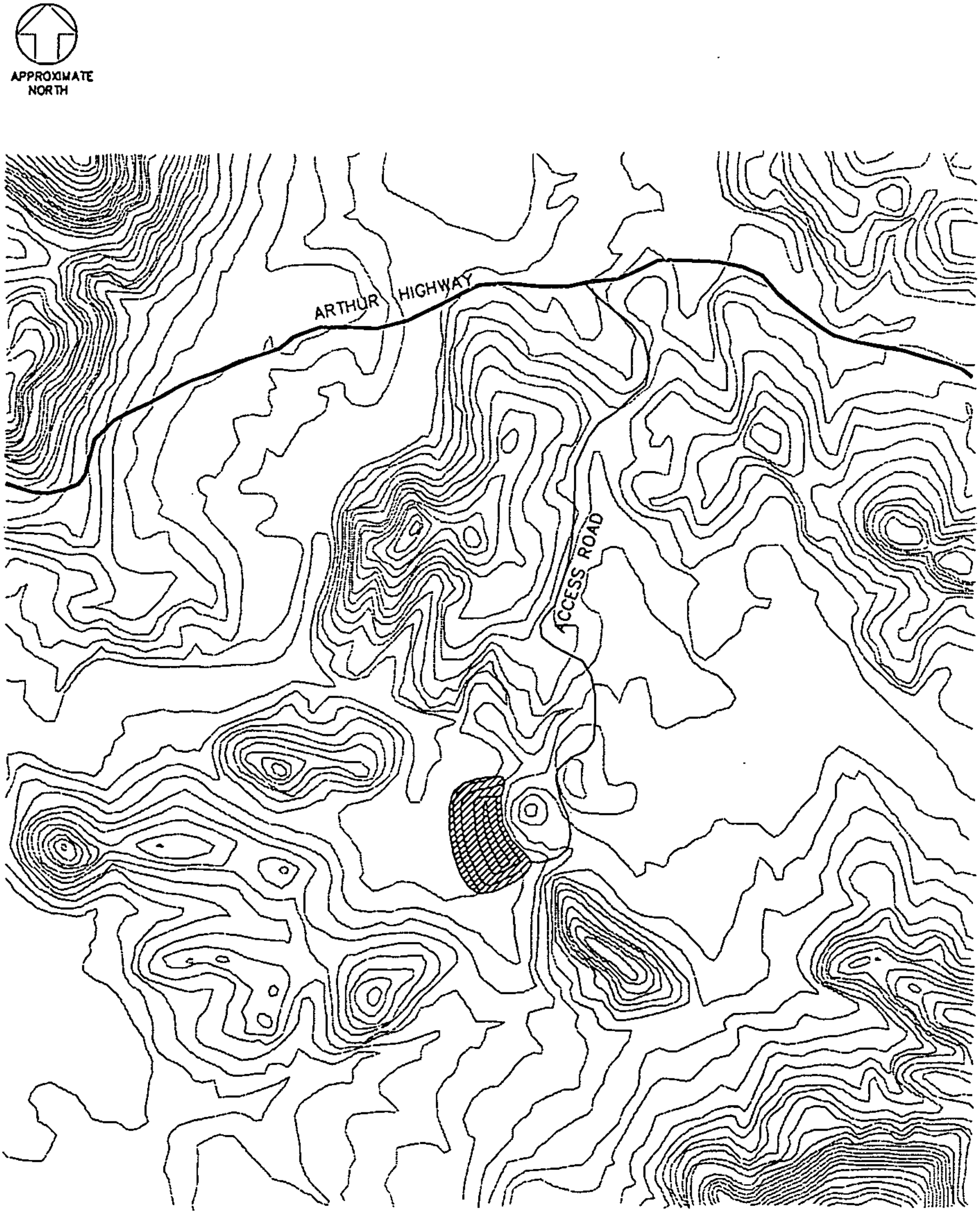

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TITLE
FINALISED CONTOUR MAP - STAGE 1

FIGURE
20

A4

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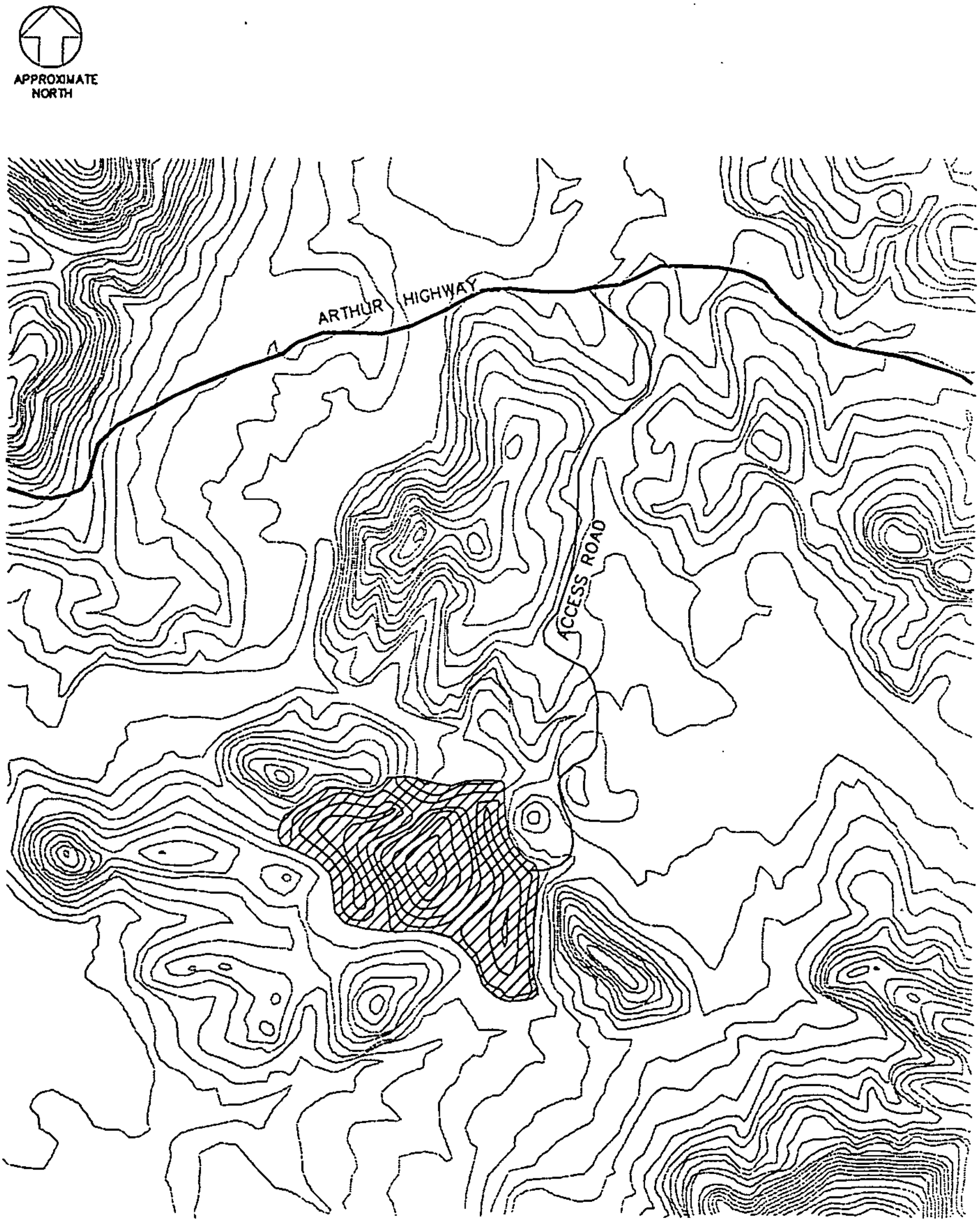

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PROJECT: COPPING LANDFILL DP AND EMP

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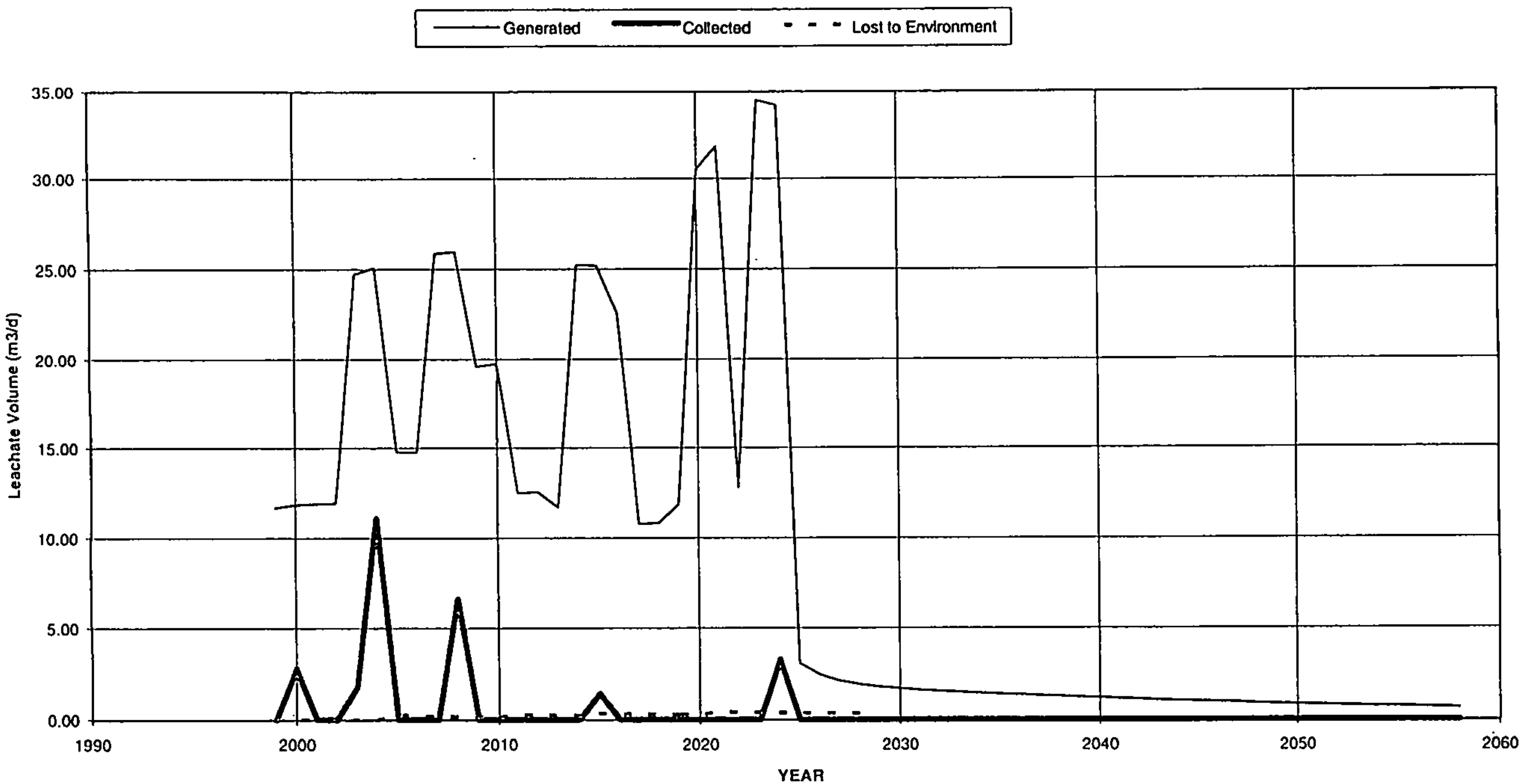
TITLE: CONCEPTUAL SITE DEVELOPMENT CONTOUR MAP

FIGURE: 21

A4



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CAD FILE No: 0182M078
DATE: MAY 96

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DRAWN: S.J.L
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APPROVED:
STATUS:

TITLE
PREDICTED LEACHATE VOLUMES

FIGURE 22

A4

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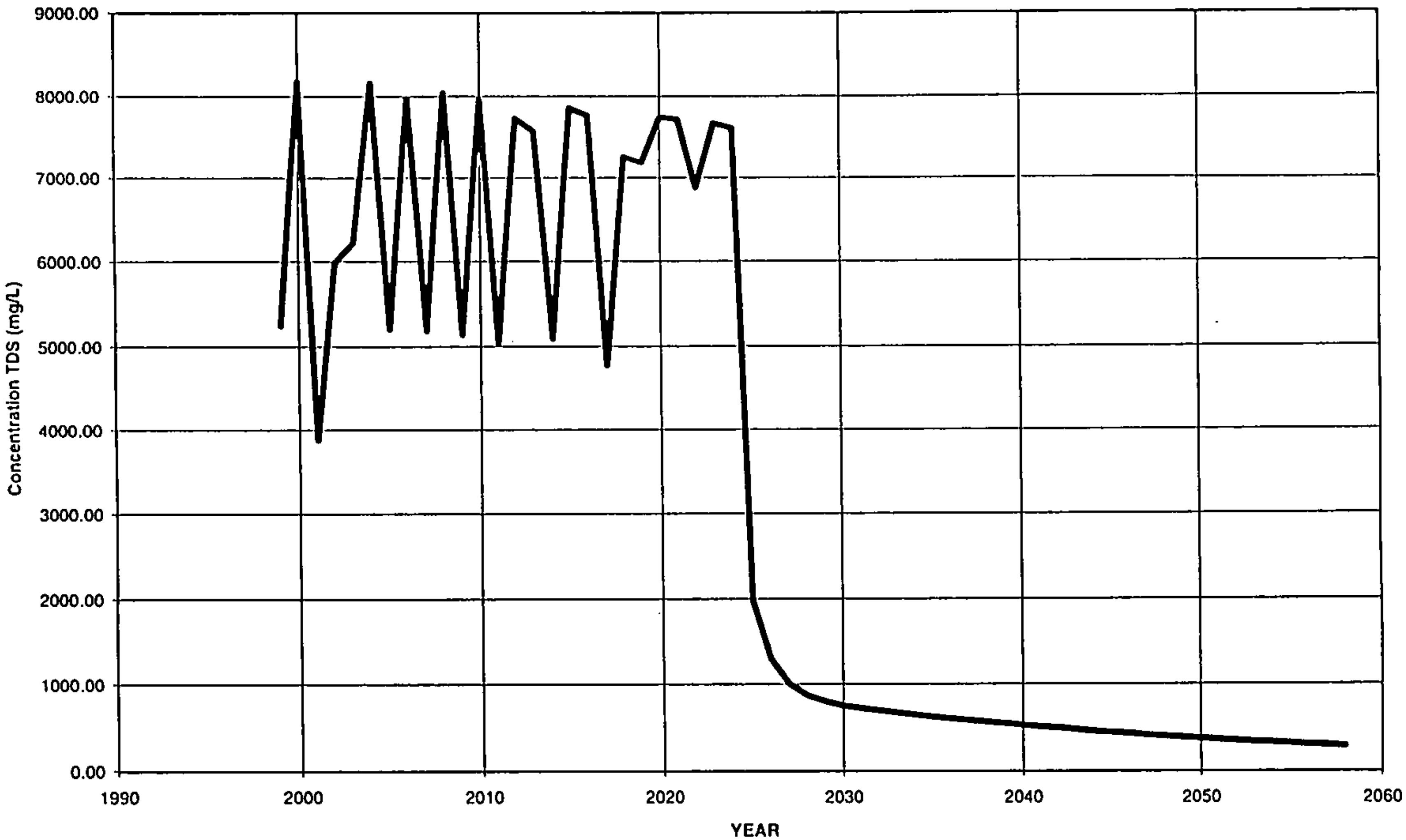

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CAD FILE NO: 0182M079
DATE: MAY 98

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DRAWN: S.J.L
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STATUS:

TITLE
PREDICTED LEACHATE SALINITY

FIGURE 23

A4

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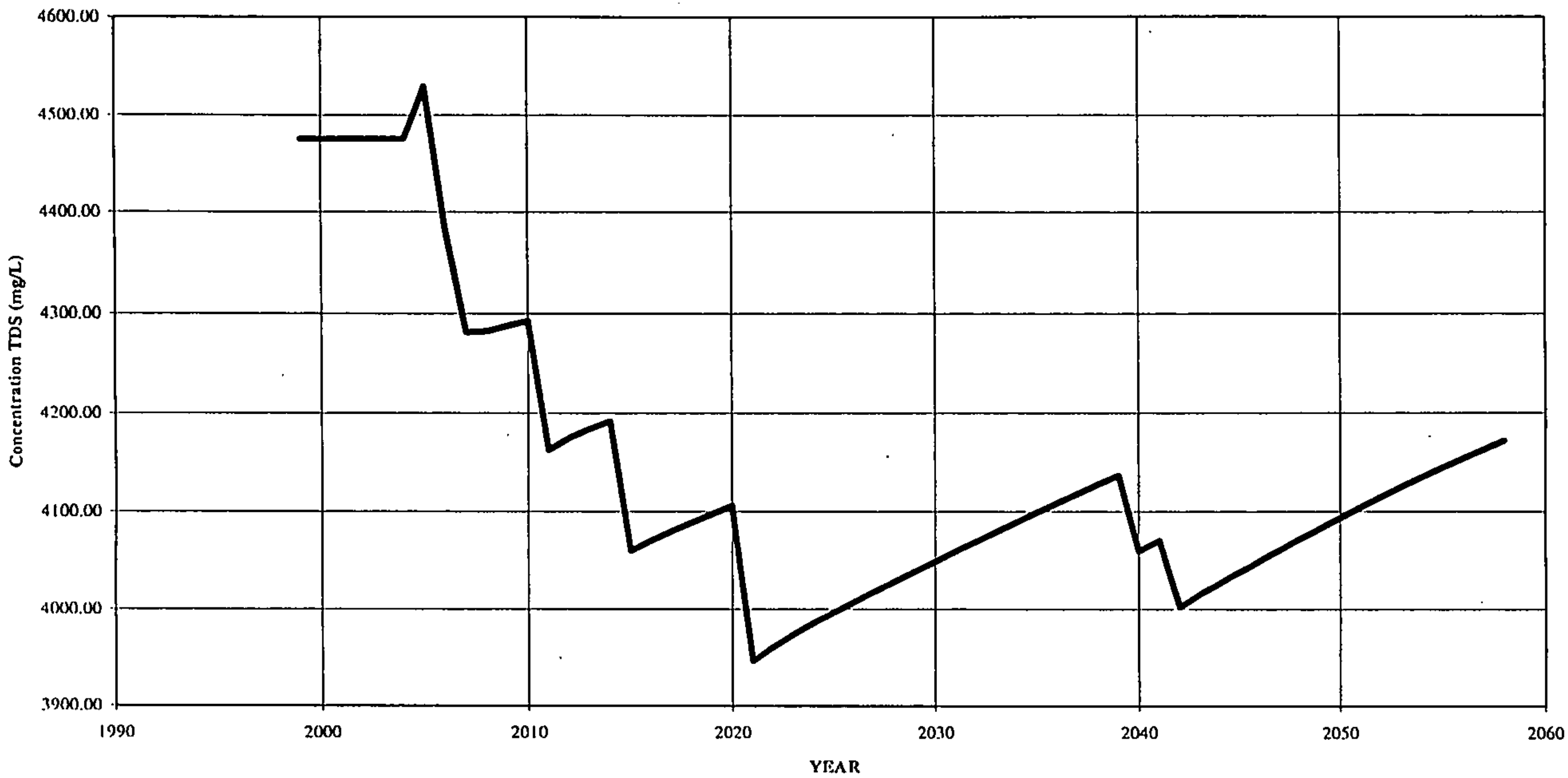

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REVISION: A
SCALE:
DRAWING No: A31/00182
CAD FILE NO: 0182M080
DATE: MAY 98

DESIGNED: M.B.J.
DRAWN: S.J.L
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STATUS:

TITLE
GROUNDWATER TDS CONCENTRATION AT SITE BOUNDARY
FIGURE 24

A4

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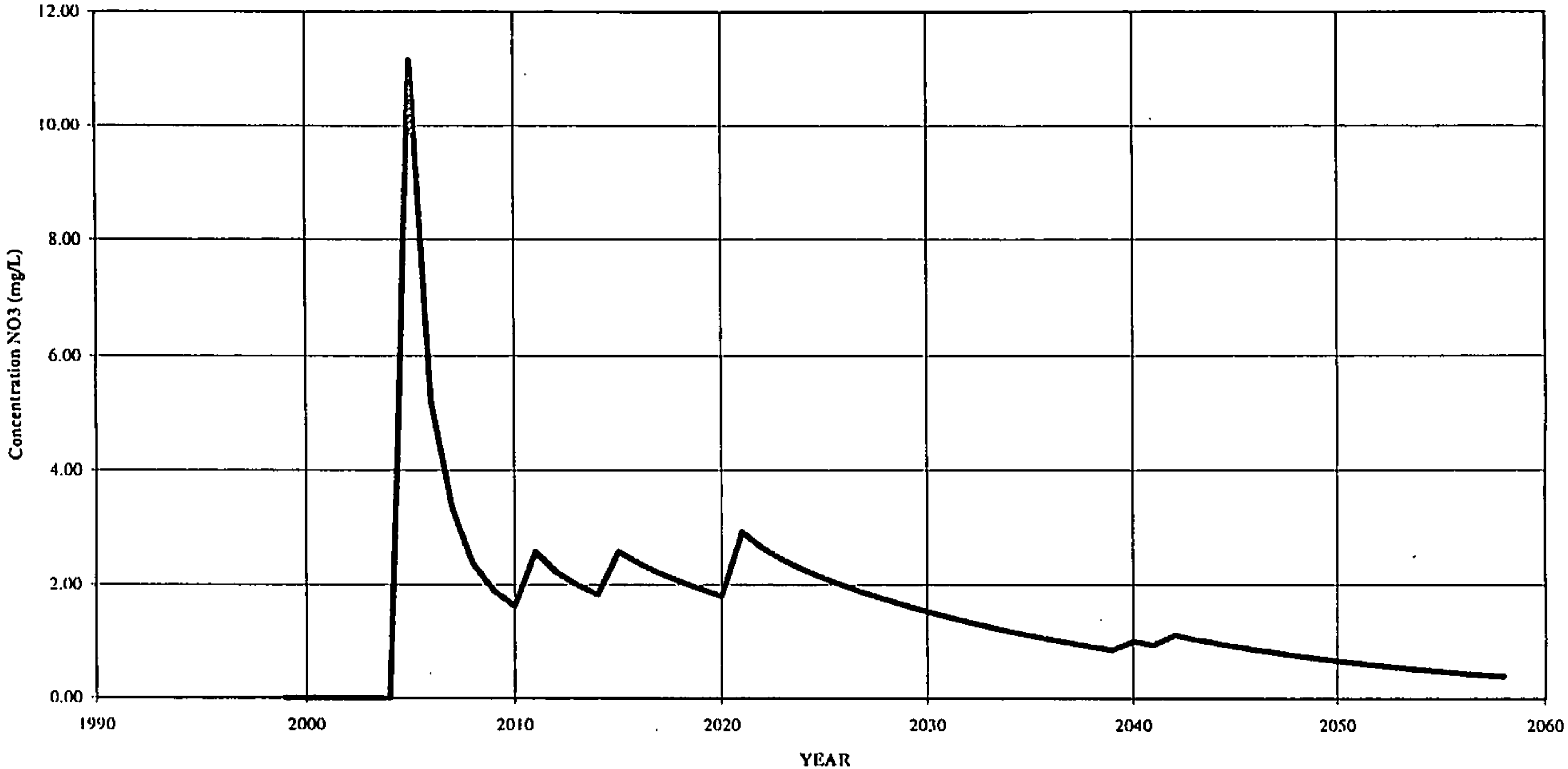

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PROJECT
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REVISION: A
SCALE:
DRAWING No: A31/00182
CAD FILE NO: 0182M081
DATE: MAY 98

DESIGNED: M.B.J.
DRAWN: S.J.L.
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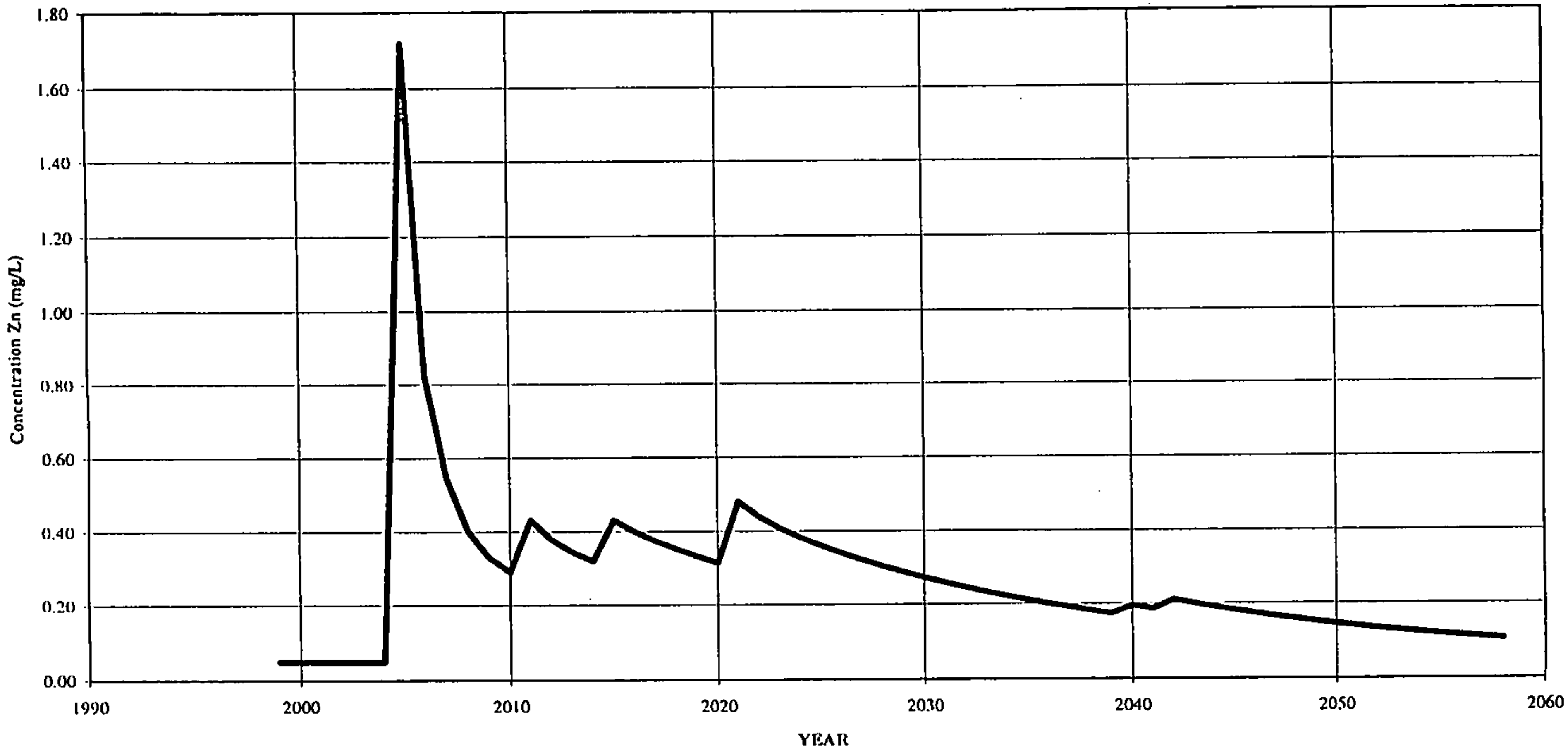
STATUS:

TITLE
GROUNDWATER NITRATE CONCENTRATION AT SITE BOUNDARY

FIGURE 25

A4

MELB/SJL/10-95



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DP AND EMP

REVISION: A
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DATE: MAY 98

DESIGNED: M.B.J.
DRAWN: S.J.L
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APPROVED:
STATUS:

TITLE
GROUNDWATER ZINC CONCENTRATION AT SITE BOUNDARY
FIGURE 26

A4

MELB/SJL/10-95