PROPOSED EXTRACTIVE INDUSTRY OPERATIONS AT DONNYBROOK

Acid sulphate soil management plan

Prepared for:

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1 Introduction

1.1 BACKGROUND

CSR Limited (CSR) have applied to the Caboolture Shire Council for a town planning consent permit for the purpose of 'extractive industry' (extraction, stockpiling, treatment and cartage of sand, gravel and loam), at a site near Donnybrook, in the Caboolture Shire.

Kinhill Pty Ltd (now Brown & Root Services Asia Pacific Pty Ltd) were commissioned to prepare an Environmental Impact Statement (EIS) for the proposed operation, which was submitted in support of the application. The EIS was completed in June 1995, and following review of the EIS, comments were received from a number of referral agencies.

The Department of Natural Resources (DNR) provided comments on Acid Sulphate Soils (ASS) issues in a letter dated 13 January 1997, and at a meeting on 8 April 1997 it was agreed with DNR and Environmental Protection Agency (formerly Department of Environment) officers that a series of supplementary investigations would be undertaken to further characterise ASS at the Donnybrook site (confirmed in a letter from DNR dated 28 April 1997).

A range of other comments on the EIS have also been received. These have been addressed in a separate report prepared in November 1996 by Kinhill and titled, 'Response to EIS Critique and Amended Project Layout Report'.

Kinhill were subsequently commissioned by CSR to carry out a more detailed assessment of ASS at the Donnybrook site. The findings of this investigation, discussion of their implications and the proposed ASS management measures were presented in a Working Paper (Document No. BC4616-G-DO-505 Rev A, February 1998), which was submitted to DNR and Environmental Protection Agency (EPA) officers for review and comment. The contents of the Working Paper were discussed at a meeting on 16 February 1998, attended by representatives from Kinhill, CSR, DNR and EPA. Comments on the Working Paper were subsequently received from DNR in a letter dated 19 March 1998, and from EPA in a letter dated 25 March 1998. Comments contained in these letters and issues discussed at the meeting of 16 February, have been addressed in this ASS Management Plan.

The findings from this ASS Management Plan, and the proposed management and monitoring measures, have also been incorporated into an Environmental Management Plan (EMP), prepared for the proposed operation.

1.2 STUDY SCOPE AND OBJECTIVES

At the meeting between DNR Officers, CSR, and Kinhill (on 8 April 1997), the scope and objectives of the supplementary ASS assessment were agreed.

The objectives for the investigation were:

- to provide a more detailed characterisation of the soils to be disturbed as the result of the proposed extraction operation;
- to determine more closely whether the soils to be disturbed are likely to have a significant acid generating potential;
- identify management issues and potential impacts associated with any ASS present in the extraction area;
- to develop management strategies to mitigate potential ASS related impacts;
- to prepare and submit an ASS Management Plan for the proposed extraction operation.

The scope of the investigation was also discussed, including the development of a field survey methodology which would reflect site specific constraints, provide sufficient information to satisfy study objectives, and could be practically implemented. In particular, access to the area of the proposed operation was constrained by its low lying swampy nature. The following scope for field investigations was adopted:

- A grid pattern of 24 excavator pits established on a 150 m grid pattern across the proposed extraction area to characterise the overburden. These test pits were established to 3–4 m depth, and samples were collected from approximately 0.5 m intervals.
- A series of 5 deep bore holes was established to provide additional information about the sand resource. Where possible, the depth of each of these bore holes was to approximately 0.5 m below the lower limit of the sand resource.
- Test holes were established with a drill rig using a wash boring technique, with an SPT or U50 tube for sample recovery.
- Samples were recovered from approximately 0.5 m depth intervals, or at least one sample from within each distinct soil horizon.
- All samples recovered were tested to determine field pH and pH depression on oxidation.
- A percentage of samples (in the order of 20%) were analysed in a NATA registered laboratory using the POCAS method.
- The location and the surface elevations of test holes were determined by a surveyor.

1.3 ACID SULPHATE SOILS

Background

In this report, the term acid sulphate soils (ASS), has been used to describe any soil which has either an actual or potential acidity (or both). The term potential acid sulphate soil (PASS), has been used to describe soils which have significant potential to generate acid on oxidation, but which have not yet been oxidised. The term actual acid sulphate soil (AASS) is used where specific reference is made to soils which have already been oxidised, and have already developed significant acidity as the result of oxidation of PASS.

In the event that ASS are not managed appropriately, they have the potential to create adverse environmental impacts. These may include:

- acidification of soil, soil pore waters, groundwater, streams and lakes;
- the release of potentially toxic heavy metals and elements (e.g. Al, Fe, Mn) into receiving waters;
- the production of inorganic iron and aluminium precipitates in neutralised leachate, which may cause 'blanketing' effects or water clarity deterioration in receiving waters;
- sickness or death of gilled organisms;
- the reduced growth or death of aquatic plants;
- providing a competitive advantage for acid tolerant species of aquatic organisms;
- the corrosion and impairment of engineering structures.

ASS are generally associated with estuarine (marine) clays, but they also occur as sands and gravels. White and Melville (1993) noted that they are deposited naturally under anaerobic conditions, where sulphate (in seawater and from decomposing organic matter) is reduced to sulphide by bacteria. The sulphide is present in the form of pyrite (FeS_2) which under anaerobic conditions does not present a contamination problem.

When the pyrite (FeS_2) is exposed to oxygen (in the presence of moisture), it oxidises to produce dissolved sulphate and iron in a reaction which involves a number of steps. Under strongly acidic conditions, the oxidation of pyrite is strongly catalysed by bacteria (predominantly *Thiobacillus ferrooxidans*). The degree to which bacteria catalyse the reaction is also dependent on temperature. The reaction rate of the catalysed reaction increases with increasing temperature and conversely, below approximately 10°C the rate is very slow.

The following overall equation summarises this oxidation of pyrite and subsequent acid production (White and Melville, 1993):

$$FeS_2 + {}^{15}/_{4}\,O_2 + 7/2\,H_2O \longrightarrow Fe\,(OH)_3 + 2H_2\,SO_4$$

It is important to note from this equation that each mole of pyrite which is oxidised will ultimately produce two moles of sulphuric acid (H_2SO_4) which are equivalent to four moles of hydrogen ions (H^+). This acid dissolves aluminium, iron and manganese in the soil, which can result in reduced plant productivity, and impaired plant growth. When these products are transported from the soil profile, in ground water, seepage water, or surface runoff, they can cause a range of adverse effects including , in extreme cases, the death of plants and fish.

In some situations, acid drainage may not result from the oxidation and leaching of pyrite soils due to the presence of neutralising materials in the form of carbonates and, to a lesser extent, certain clays and silicates.

The role of carbonates in neutralisation can be shown as follows:

$$FeS_2 + 2CaCO_3 + {}^{15}/_4O_2 + {}^3/_2H_2O \longrightarrow Fe(OH)_3 + 2SO_4^{-2} + Ca^{+2} + 2CO_2$$

As noted above, problems with ASS are generally associated with soils formed under a predominantly marine environment but can also be found in other coastal alluvium where marine influences have been less marked but where anaerobic conditions occur naturally, i.e. waterlogged, peaty soils. Areas which have in the past (geologically) been estuaries or floodplains often were subject to these conditions and are therefore areas where PASS are found.

The magnitude and duration of effects from the oxidation and leaching of PASS depends on the amount of pyrite present in the soil, oxidation and leaching rates; the soil's inherent buffering capacity, and other site specific factors.

To sustainably and effectively manage ASS to prevent adverse effects requires reliable information about the nature and extent of ASS at the site of interest. ASS management should be based on this data, and should demonstrate that potential environmental impacts can be managed in an integrated and sustainable manner.

In recent years, there has been a large improvement in the knowledge and awareness of ASS, and the requirements for their assessment and management. Treatment and management of ASS should be carried out in accordance with best management practice, and is now a routine management issue for most development activities.

There are a number of principles which can be applied in order to manage ASS. These management principles are:

- avoidance
- oxidation prevention
- acid neutralisation
- leachate collection and treatment
- pyrite separation.

The management or treatment strategy which is most appropriate depends on the sensitivity of the site, the proposed activity, the resources available for ASS management, and the nature of the ASS material to be handled. In many cases, it is appropriate to adopt a combination of a number of the strategies outlined above to effectively or practically manage ASS.

Levels of significance for ASS analysis data

As discussed, the magnitude and duration of effects that may arise from the oxidation and leaching of a PASS are influenced by a range of factors. The most important of these when interpreting the results of soil analyses are the permeability of the soil, and the quantity of acid which it would produce on oxidation.

The permeability of a soil is strongly influenced by its texture and clay content. This information is obtained from field assessments of soil morphology.

The potential for a soil to produce acid on oxidation is best quantified by laboratory analysis to determine percentage of oxidisable sulphur (i.e. pyrite), or the number of moles of acid generated on oxidation. The Queensland Acid Sulphate Soils Investigation Team (QASSIT) and the Acid Sulphate Soils Management Committee (ASSMAC) published 'Action Criteria' to define levels above which the acid generating potential of a soil is considered to be significant for projects disturbing greater than 1,000 tonnes of ASS soils and for projects disturbing less than 1,000 tonnes of ASS soils. These 'Action Criteria' for disturbance greater than 1,000 tonnes, are shown in the following table, and take into account both the acid generating potential and the texture of a soil.

Table 1.1 'Action Criteria' of oxidisable sulfur and Total Potential Acidity for a range of soil textures for 1 to 1000 tonnes disturbed (DNR 1998) (ASSMAC, 1998)

Texture, class (McDonald et al. 1990)	Approximate clay content (<0.002 mm) (%)	Action level oxidisable sulfur % S (oven dry basis)	Action level Total Potential Acidity M H^+/t (oven dry basis)
Sands to loamy sands	≤ 5	0.03	18
Sandy loams to light clays	5–40	0.06*	36*
Medium to heavy clays and silty clays	≥ 40	0.1*	62*

Note: For >1000 tonnes disturbed, 0.03% and 18MH+/t

2 Site description and location

2.1 LOCATION AND PROPERTY DESCRIPTION

Location

The subject site is located approximately 12 km to the north-east of Caboolture in Caboolture Shire. The nearest settlements to the site are Donnybrook, approximately 3 km to the north-east and Meldale, approximately 2 km to the south-east. The site has a frontage to both Meldale and Donnybrook Roads. Elimbah Creek is located to the south-west of the site and Bullock Creek is located to the north-east.

Figures 2.1 and 2.2 show the location of the site in regional and local context.

Property description

The site is described as Lot 3 on RP851893, Parish of Toorbul, County of Canning and occupies a total area of 122.3 ha. Figure 2.3 shows the cadastral boundaries of the site and adjacent lands.

2.2 TOPOGRAPHY AND GENERAL FEATURES

Topography

Figure 2.4 shows the topography of the adjacent lands and subject site.

The site of the proposed extraction operation is located on coastal alluvium with an elevation that varies between approximately 2.0 m AHD and 3.5 m AHD. The area proposed for extraction is essentially a low-lying featureless plain. The highest point is in the south-west corner with an elevation of 3.5 m AHD. The general land slope is towards the north-east with an overall grade of approximately 0.2%.

There are no incised drainage channels within the site, and the overall drainage pattern is extremely diffuse. Following wet spells, boggy conditions are experienced on the site, and this is exacerbated by the presence of mounds formed in straight rows across the natural direction of surface drainage. These mounds run along an approximately north-south alignment, and were developed in the past to assist in the early stages of pine growth.

It is estimated that approximately 3.5 ha of the site is subject to tidal inundation up to the highest astronomical tide (HAT) level.

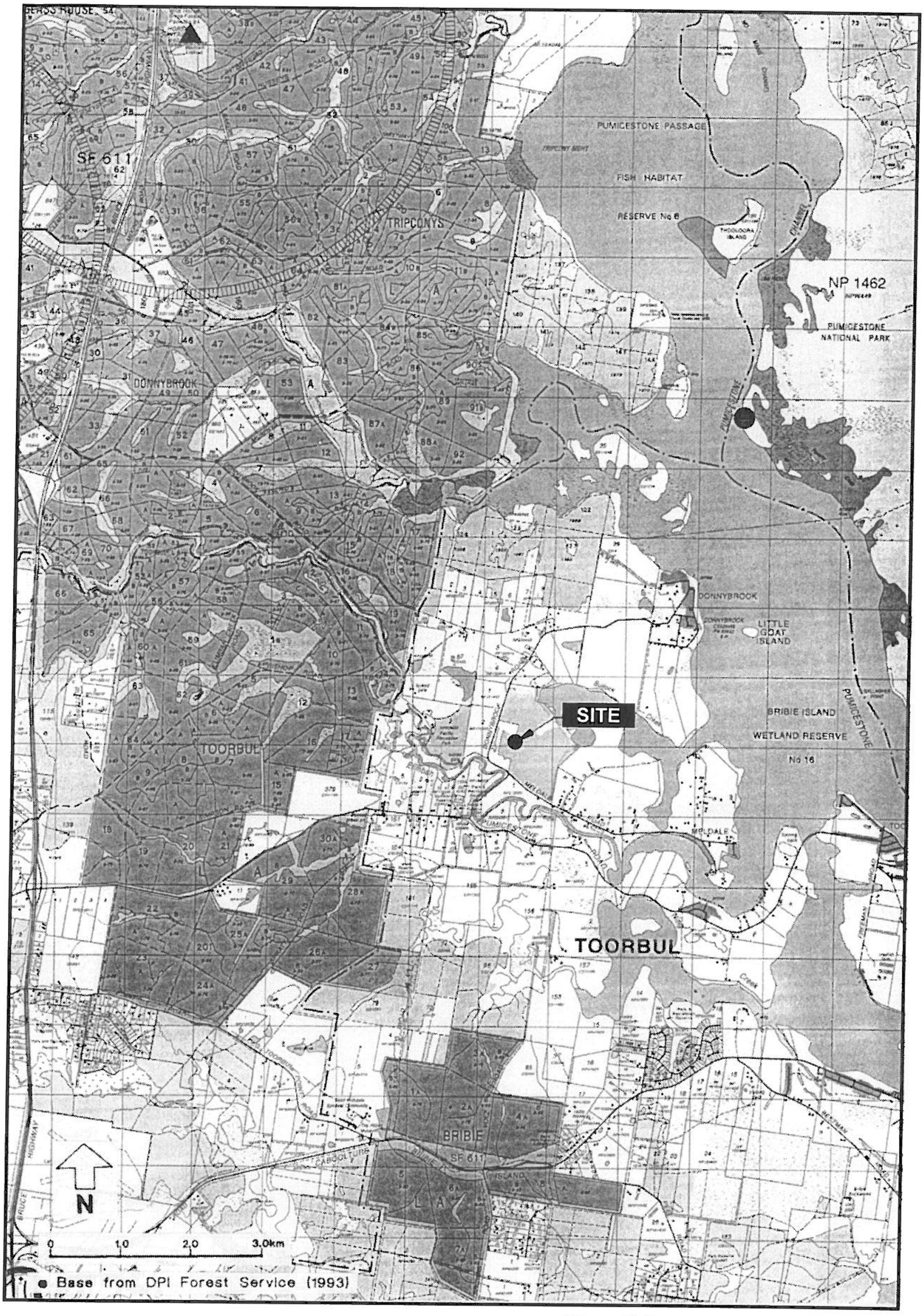

Figure 2.1
LOCATION—REGIONAL CONTEXT

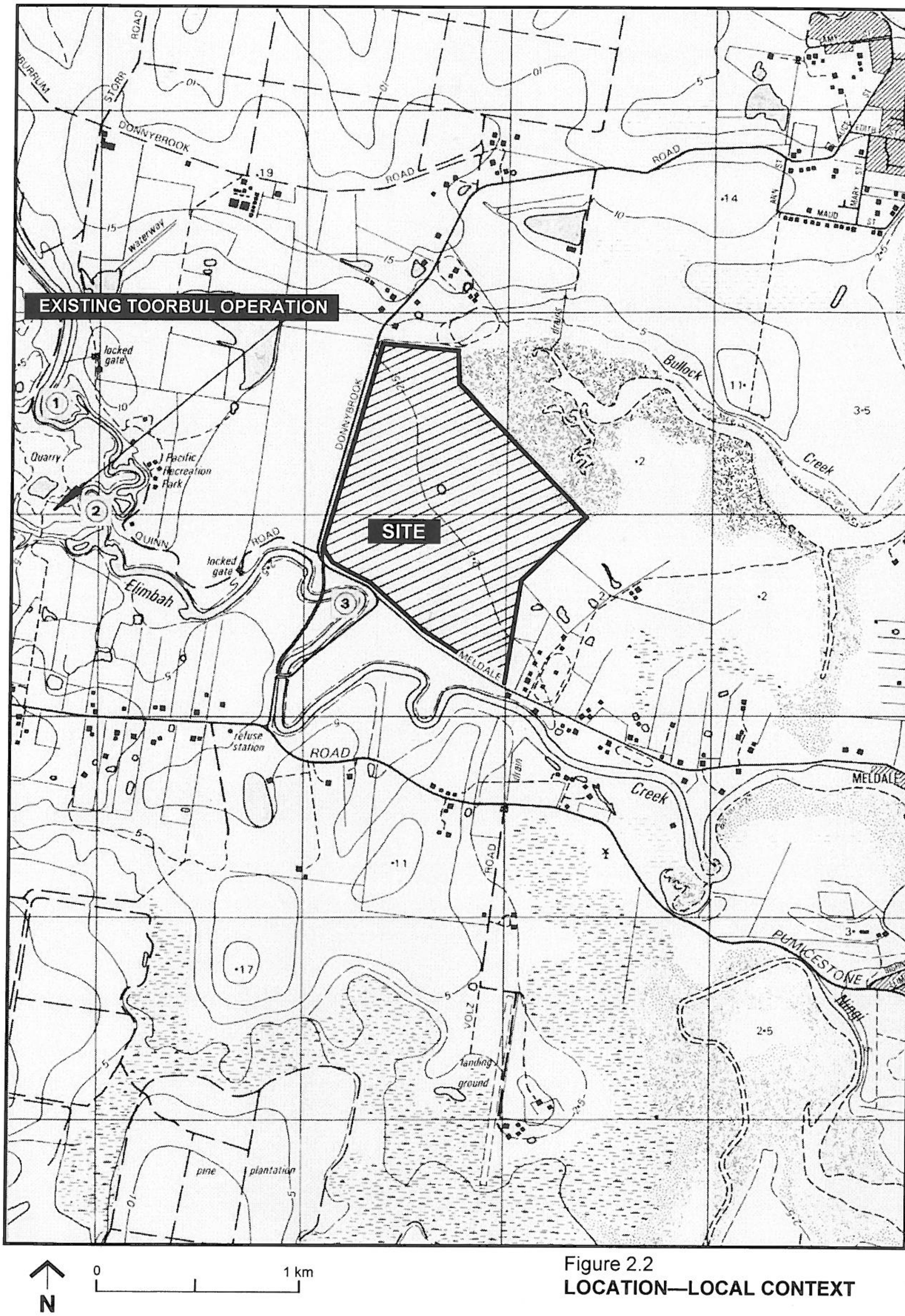

Figure 2.2
LOCATION—LOCAL CONTEXT

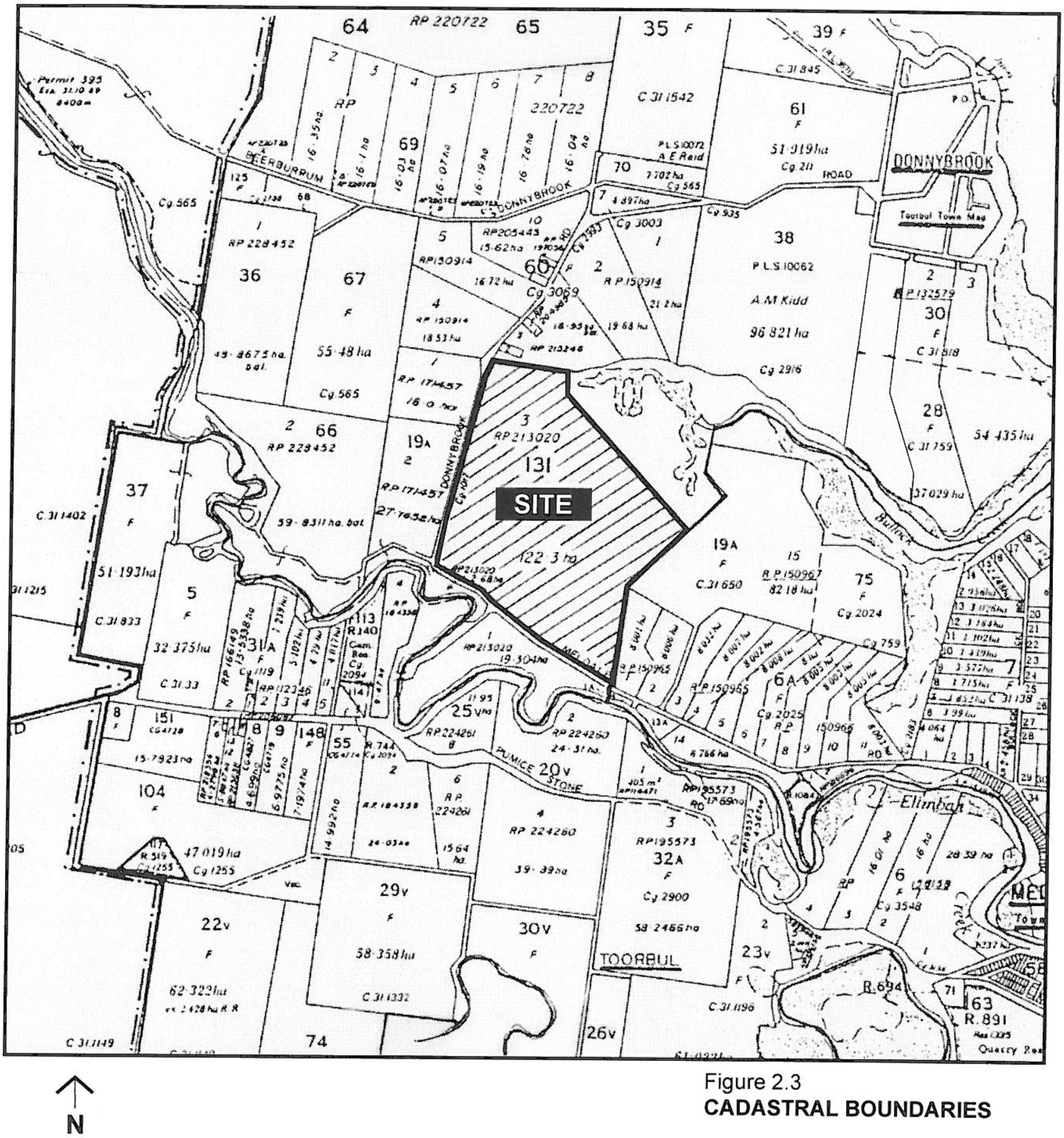

Figure 2.3
CADASTRAL BOUNDARIES

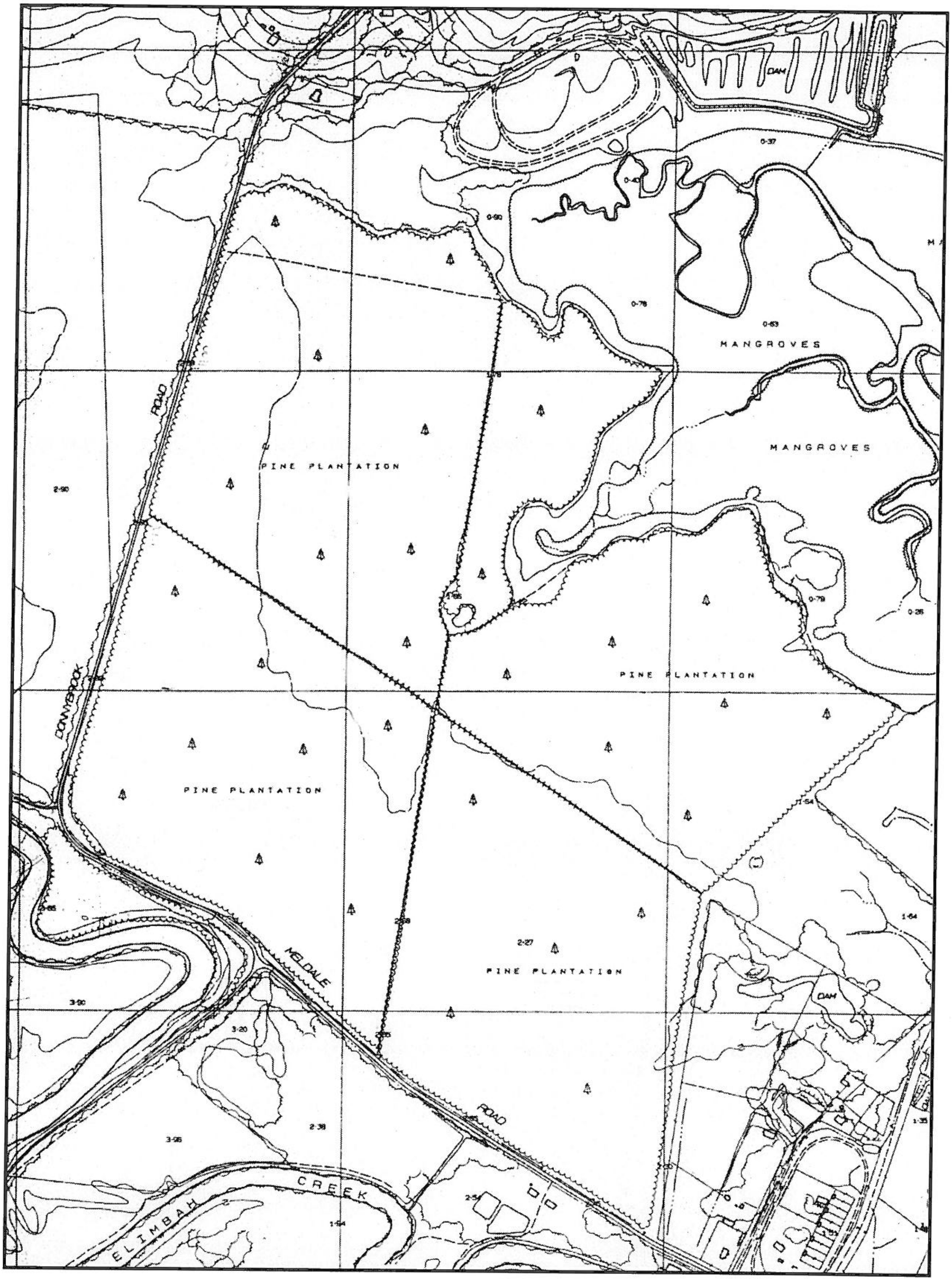

Figure 2.4
LOCAL TOPOGRAPHY

General features

The subject site consists mainly of a recently logged pine plantation with sporadic emergents of native species and pines. Clearing of pine was carried out in 1993 and 1994, and numerous piles of reject pine material are found scattered throughout the site. In addition, numerous logging tracks traverse the proposed extraction area. Intertidal wetlands are found in a small area in the north-east of the site. The vegetation communities present in this area include paperbarked tea-tree open forest, swamp she-oak open woodland and closed sedgeland. Substantial regrowth of native vegetation and pine trees has occurred since the site was cleared of the plantation pine in 1993. Regrowth is particularly advanced in the south and west of the site along Donnybrook Road, and in the north near the intertidal area. This regrowth already provides an effective visual screen of the proposed pond and plant area, particularly from Donnybrook Road and the western section of Meldale Road.

The site has also been used for the illegal dumping of car bodies and other rubbish. A small open pond near the north-east corner of the site is the remains of a small sand extraction operation that is understood to have been active over twenty years ago. At present the site is not used for any particular activity.

Figure 2.5 shows the existing site characteristics.

Geology

Detailed resource investigations of the subject land were conducted by CSR in 1992 and 1994. These investigations have indicated that the surface geology of the Donnybrook site is dominated by sandy clayey soils. A generalised geological sequence in the subject land is as follows:

- Topsoil—a thin veneer of black soil, sandy clay, clayey sand with high organic content.
- Overburden—clay/sandy clay with a thickness of 1–3 m.
- Layer 1—sand/clayey sand 1–2.5 m thick.
- Interburden 1/2—clay/sandy clay, up to 7 m thick.
- Layer 2—sand/clayey sand (+/- clay bands) up to 7 m thick.
- Interburden 2/3—clay/sandy clay to 3.5 m thick.
- Layer 3—sand/clayey sand (+/- clay bands) 2–8 m thick.
- Basement—sandy clays of Landsborough Sandstone.

More detailed three dimensional modelling of the resource has since shown that these inferred layers are discontinuous, and vary across the site. This is consistent with the results of test holes, and with the geological origins of the site soils.

In general, the sand resource is found at varying depths of 1–7 m below the surface (average of 5 m) with a number of interburden layers at lower depths below sand bands. Approximately 90% of the resource material is sand size, with about 60% fine to medium sand. Some samples contain 10% gravel.

AERIAL PHOTO DATED 11/05/98: QUASCO SURVEYS Pty Ltd.

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Figure 2.5
EXISTING SITE CHARACTERISTICS

An assessment of the landforms, elevation, drainage patterns, soil types, and vegetation of the site and its surrounds indicates that the geological history of the site would at times have been conducive to the formation of PASS.

The landforms of the site and its immediate surrounds are below 5 m AHD, and their formation has periodically been influenced by estuarine processes and saline water. As sea levels and the course of the creeks changed, some areas of the site would at times, have been situated in a low energy, depositional environment with a ready source of sulphate and organic material.

In addition, the presence of *Melaleuca quinquenervia* and intertidal vegetation types are often indicators of the possible presence of PASS (White & Melville 1993). ASS have also been identified in the general area at other sand extraction projects (e.g. the CSR Toorbul site and other proposed sand extraction operations in the Beachmere area). It was therefore considered that it was likely that ASS would occur within the subject site.

Soils

Broad studies of regional soil characteristics have been carried out by Capelin (1987) at a mapping scale of 1:100,000.

The soils/land resource area for the general area were described as 'Quaternary alluvia-gently undulating plains on lagoonal and tidal mud and silt deposits; humic gleys with tea-tree open and closed forest and swamp she-oak woodlands; solonchaks with mangrove shrubland, woodland and forest and saltwater couch.' Capelin identified the site as Class 8 lands, i.e. unsuitable lowlands and stream channels-land marginal or unsuitable for horticulture.

Investigations into the nature of the surface soils within the proposed extraction area have been conducted. Based on these investigations, the site was considered to be a Class D (non agricultural) land, which is consistent with the Capelin classification. Table 2.1 provides a summary of the surface soil characteristics for the site obtained from these investigations.

Table 2.1 Soil characteristics (summary)

Land form	Broad level (<1%) plain.
Morphology/pavement material	Quaternary alluvium.
Runoff	Very slow.
Drainage	Very slow profile drainage in clay surface layers-further impeded by construction of mounds across contour to facilitate pine propagation.
Surface condition	Significant organic content.
Disturbance	Highly disturbed due to pine plantation/clearing effects-original surface profile generally obliterated.
Microrelief	Approx. +/- 0.3 to 1 m relief variation due to mounding and other disturbance.
Erosion	No erosion evident.
Groundwater depth/condition	Prevailing groundwater level approximately 1.5 m below ground surface. Predominantly slightly to moderately saline and acidic.
Soil pH (range)	4.0 to 5.0 (surface)—refer acid sulphate investigations for deeper layers.

Table 2.1 continued

General nutrient status	Low—deficiencies likely in major (N, P, K) and minor elements.
Water holding capacity	Moderate to high (low for sandy material).
Erosion potential	Very low.
Colour	Surface horizon (to 500 mm)—grey (2.5Y 4/0) Subsurface—grey with orange/yellow mottle (10YR 6/1)
Great soil group	Predominantly humic gley.

Flooding

Flooding assessments have been conducted for the site and the proposed operation, and are presented in detail in the EIS (Kinhill June 1995), and the response document (Kinhill November 1996). An additional, more detailed flooding assessment has also been carried out, the findings of which are presented in Brown & Root, September 2000. These studies show that flooding of the site occurs during flood events of larger than 5–10 years ARI, but that even in extreme events, flood depths are not very high. In a 100 year ARI, it is predicted that the maximum depth of water at the site of the proposed operation would be approximately 1.5 m, and flood water velocities would generally be quite low. In the worst case for velocities, that is Stage 3 in the floodway channel area, the maximum velocity in a 5 year ARI is 0.8 m/s. In the ARI 100 year event, peak velocities can be up to 1.5 m/s over a small area and generally are less than 1 m/s. Elsewhere over the site, velocities will generally be less than 0.6 m/s.

This means that it will be possible to provide effective flood immunity for the plant area and the dredge pond without causing any significant effects on local flooding, or the hydrology of the buffer areas of the site and its surrounds. This will be achieved by constructing earthen perimeter bunds around the dredge pond, and constructing a raised earthen platform for the plant area. These have been described further in Section 3 of this report.

The location of bunds and platform area has been carefully planned to ensure that there will be no significant effect on flood heights or frequencies, or local hydrology for either small or large flood events.

Because it will be possible to provide a very high level of flood immunity, the operation will be conducted as a closed system. The bunds will ensure that the ponds will not overflow, even in a 100 year ARI event, and plant wash and runoff water from the plant and stockpile area will be directed back to the pond. There will therefore be no discharge of pond or plant water into receiving environments outside the plant and pond area. A minor exception will be surface runoff from the outside batter of the perimeter bund and raised plant area. This runoff would travel only a small distance from the toe of these batters into the heavily vegetated and very flat surrounding buffer areas.

3 Description of the proposal

3.1 LOCATION OF THE PROPOSAL

The location and extent of the proposed dredging pond and plant area are shown in Figure 3.1.

The total area subject to disturbance for the establishment of the proposed extractive industry operation will be approximately 53 ha, of which approximately 45 ha will be ponded area at some stage of the operation. The slope of batters will be a 1V:2.5H grade, and these batters will be stabilised and rehabilitated progressively as the limits of the extraction pond for each of the stages are reached.

The depth of extraction will vary depending on the accessible depth of the resource, but will generally be between 2 m and 18 m below the existing surface level of the pond.

An undisturbed buffer strip of a minimum width of 50 m wide will be maintained between the operations and Donnybrook Road boundary, Meldale Road boundary, the eastern property boundary, and approximately 200 m along the boundary with the intertidal wetlands located on the northern section of the subject land.

3.2 METHOD OF EXTRACTION AND OPERATION

It is proposed to extract approximately 4.7 million tonnes[1] of sand over approximately a thirty year period with an estimated annual production rate of 150,000 t. The output would, however, depend on external factors such as overall economic conditions, the level of infrastructure development in the region, the closure of other sand plants, and alternative sand sources.

A scraper and excavator will be used for topsoil stripping and overburden removal prior to the commencement of dredging. Extraction would primarily be carried out by floating cutter suction dredge. Material to be dredged would be primarily fine to medium grained sand. Dredged material will be pumped to the plant for processing by normal methods. The plant will include a two-stage fines recovery to ensure minimal fines are discharged back into the dredge pond. At the commencement of dredging operations, a small silt pond will be established so that the initial fines discharge did not effect the dredge operation. Sand stockpiles will have a total volume of up to 20,000 m^3, and up to four stockpiles will be maintained at any one time.

It is estimated that an average of approximately 25% (by volume) of the sand resource to be dredged, will be returned as fines or other reject material, to the pond.

[1] 1 m^3 sand ~ 1.5 t.

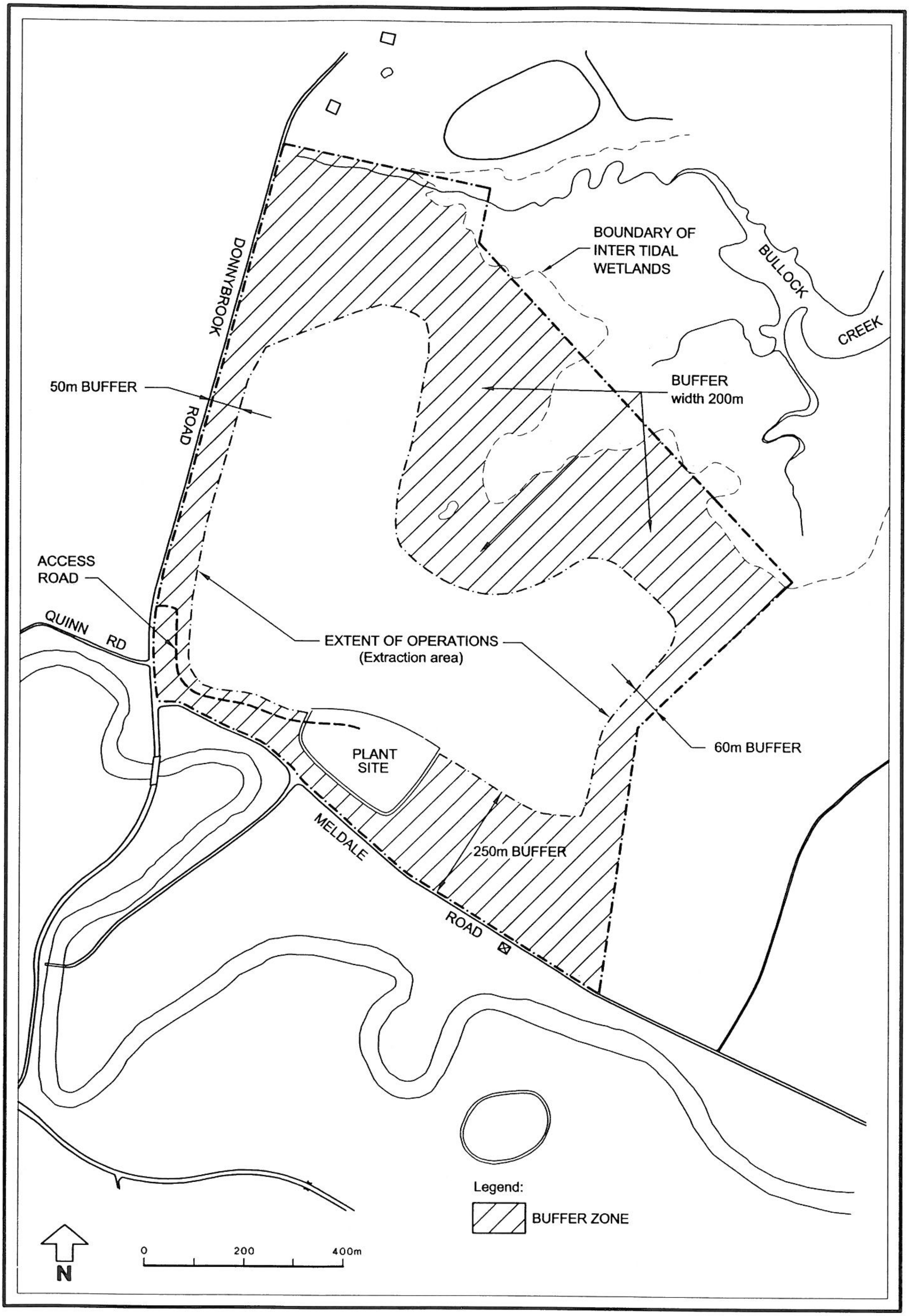

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Figure 3.1
PROPOSED WORK AREA AND BUFFER ZONES

It is proposed to conduct the operation in five stages (shown in Figures 3.2 to 3.7) and these are described below.

Stage 1

- Clear standing vegetation and level/strip topsoil using a scraper or excavator to a depth of 150 mm. Stockpile topsoil in low heaps within the Stage 1 perimeter bund.
- Remove overburden from initial pit and use to construct perimeter bund and pad for the plant.
- Establishment plant site equipment including: process plant; weighbridge; stockpile areas; small silt pond; and access tracks.
- Commence dredging in a south to north direction (see Figure 3.2).
- At completion of dredging of initial pit, commence removal of overburden from the area to the east of the initial pit. Overburden disposed of into the initial pit void to re-establish a floodway. Remainder of overburden to be used to construct perimeter bunds for Stage 2.
- Commence dredging in a west to east direction.

Stage 2

- Clear standing vegetation and strip topsoil. Topsoil to be stockpiled and used for topdressing perimeter bunds.
- Remove overburden and use to re-establish floodway (Area 1 on Figure 3.3).
- Commence dredging in a south to north direction (Area 2).
- Remainder of dredging to be conducted in a west to east direction.
- Remove internal bunds to create large lake area.
- Rehabilitate and landscape perimeter bunds of Lake 1.
- Rehabilitate and landscape Stage 1 area (graded floodway).

Stage 3

- Clear standing vegetation and strip topsoil. Topsoil to be used for topsoiling perimeter bunds.
- Remove overburden and use in bund construction.
- Construct graded floodway on northern side of dredge area (see Figure 3.4).
- Commence dredging of Stage 3 area.

Stage 4

- Clear vegetation and strip topsoil.
- Remove overburden from northern side of existing dredge pond and use to fill small dredge pond to continue re-establishment of floodway (see Figure 3.5).

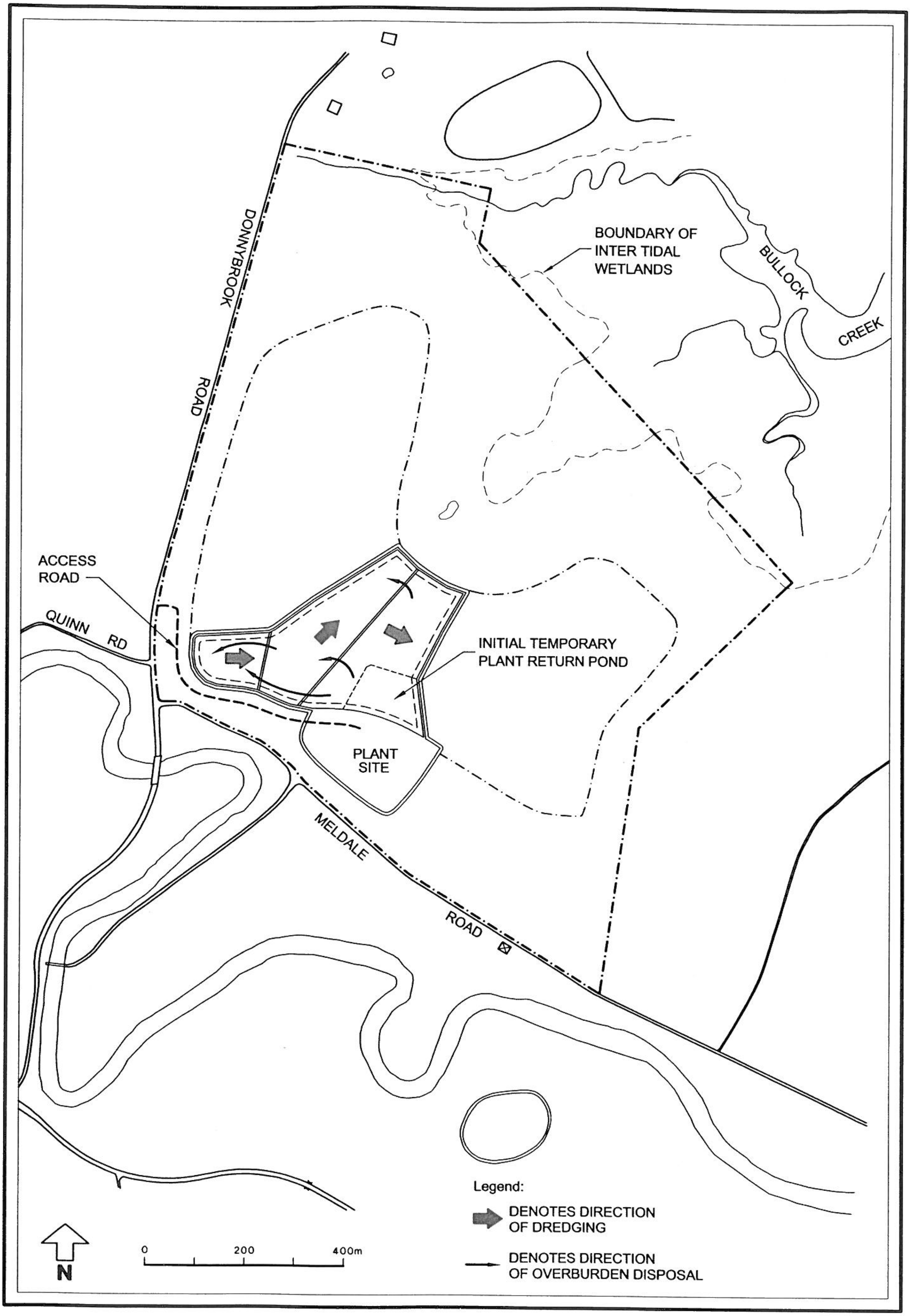

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Figure 3.2
SCHEMATIC DEVELOPMENT STAGES - STAGE 1

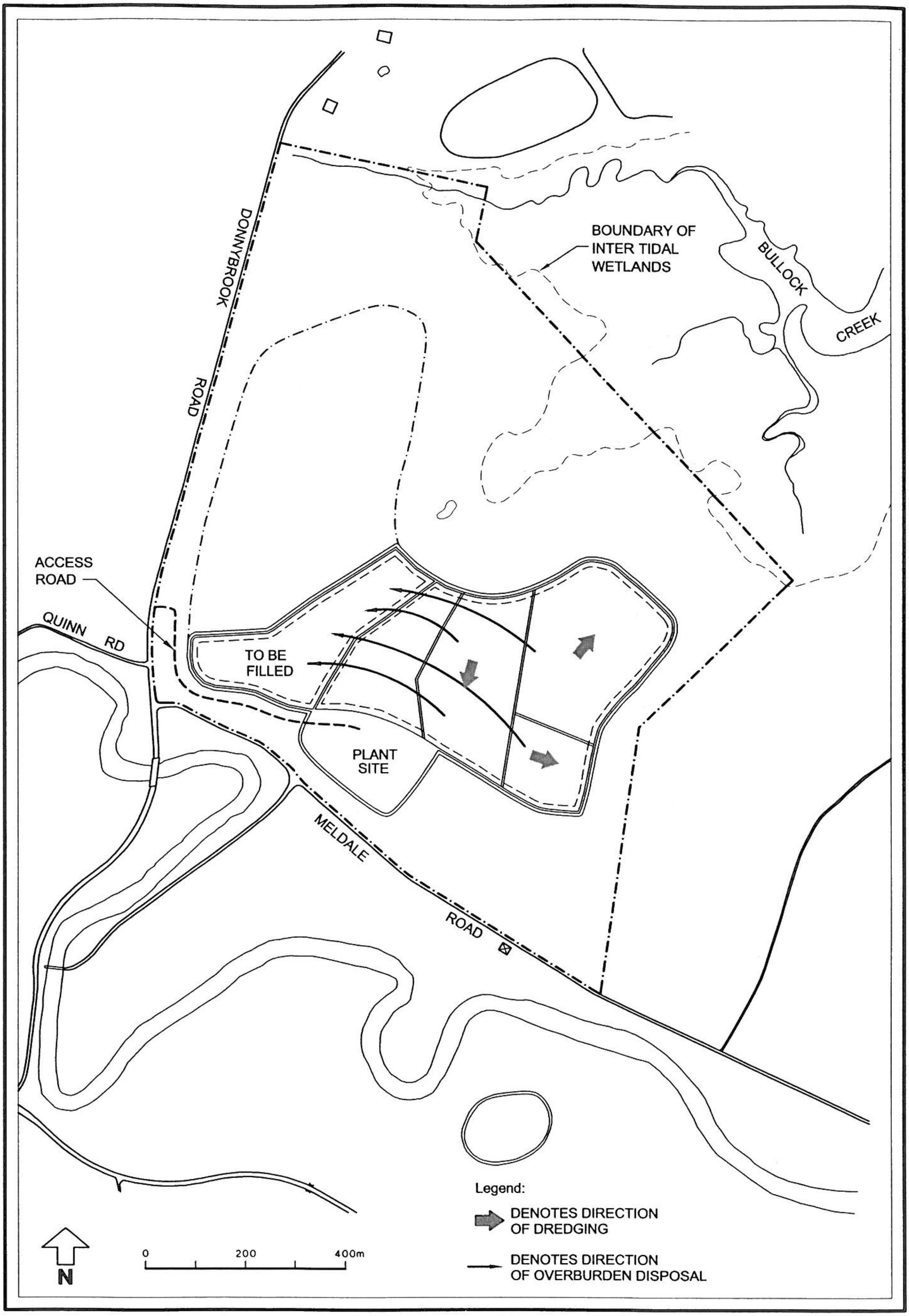

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Figure 3.3
SCHEMATIC DEVELOPMENT STAGES - STAGE 2

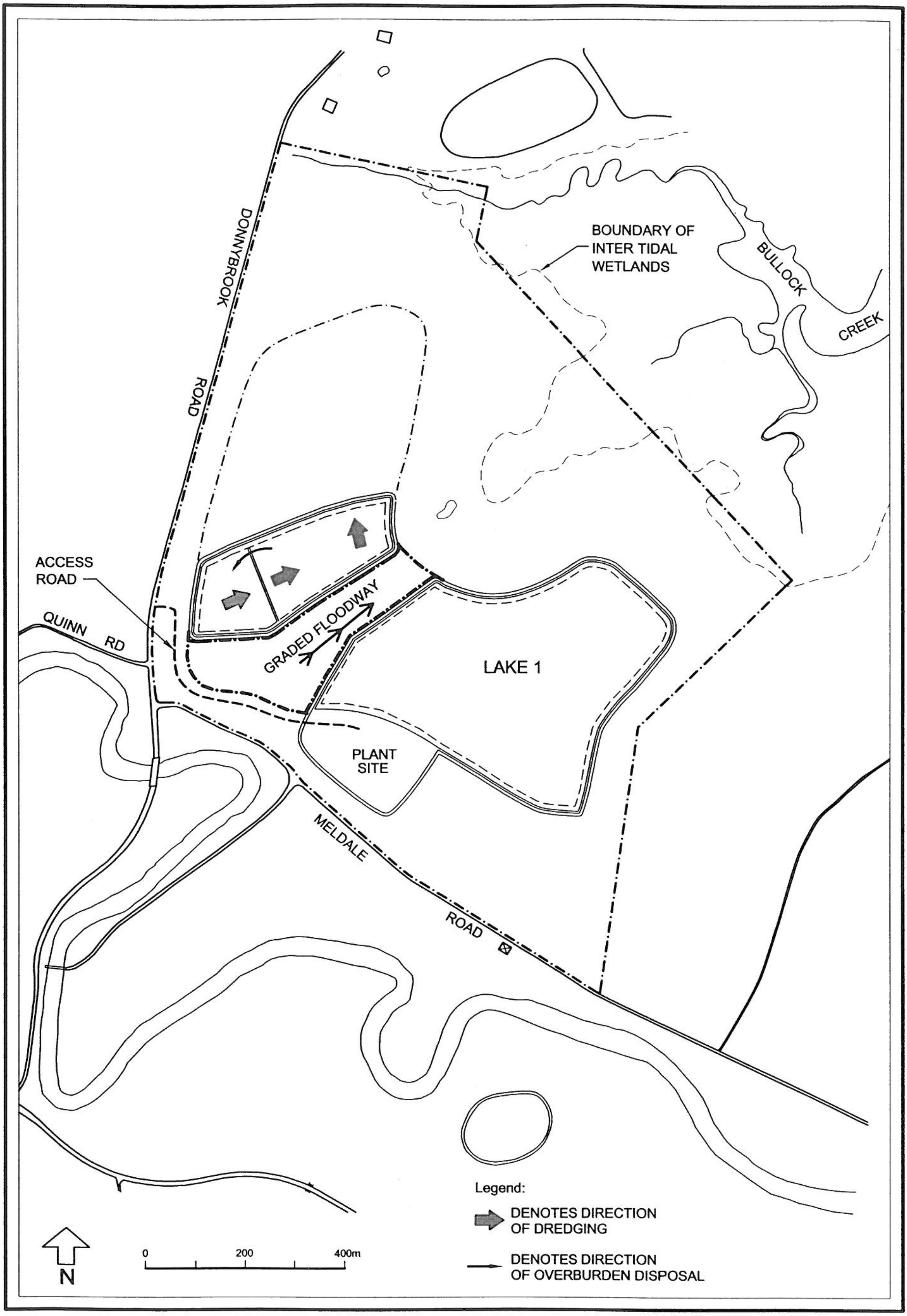

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Figure 3.4
SCHEMATIC DEVELOPMENT STAGES - STAGE 3

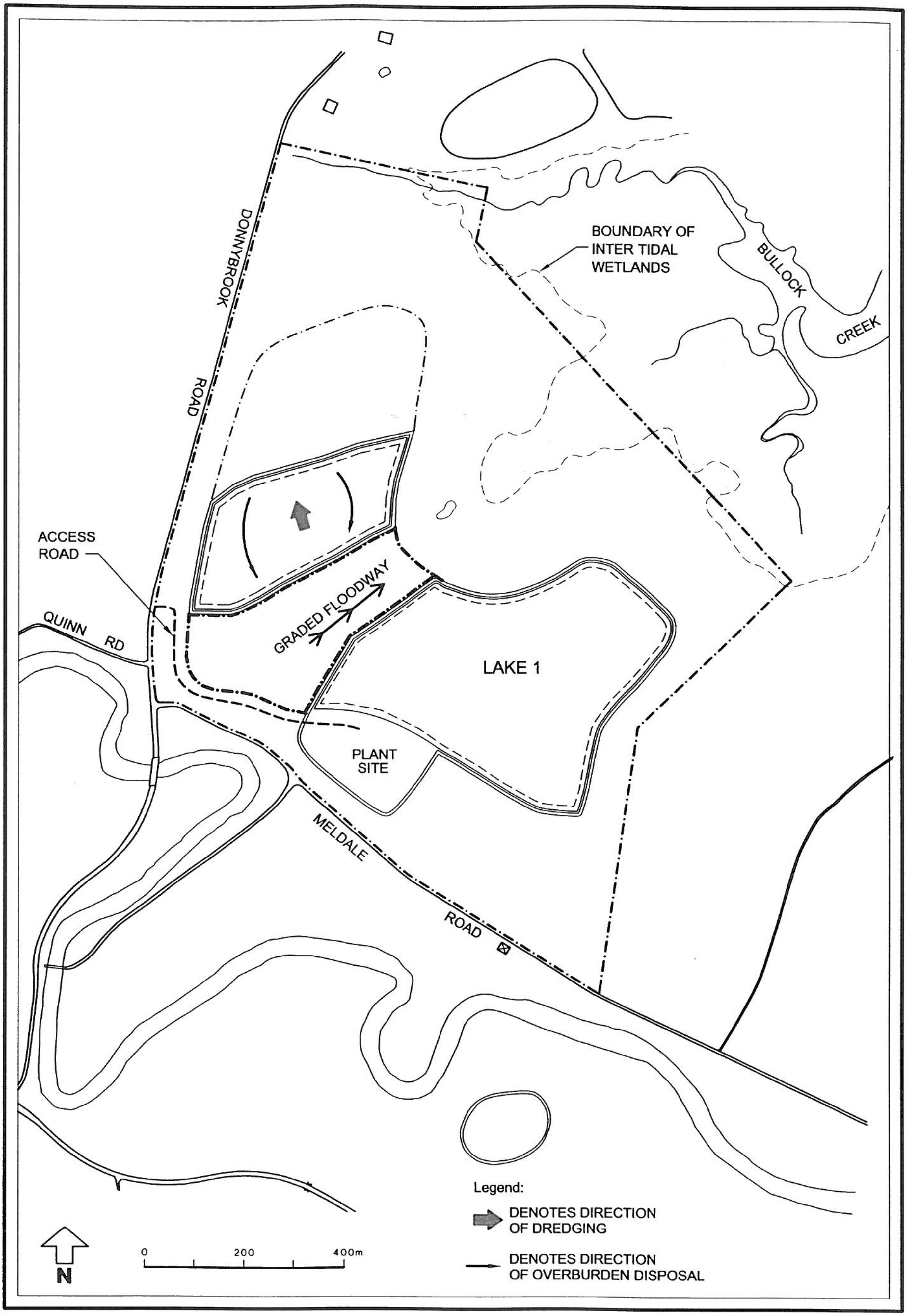

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Figure 3.5
SCHEMATIC DEVELOPMENT STAGES - STAGE 4

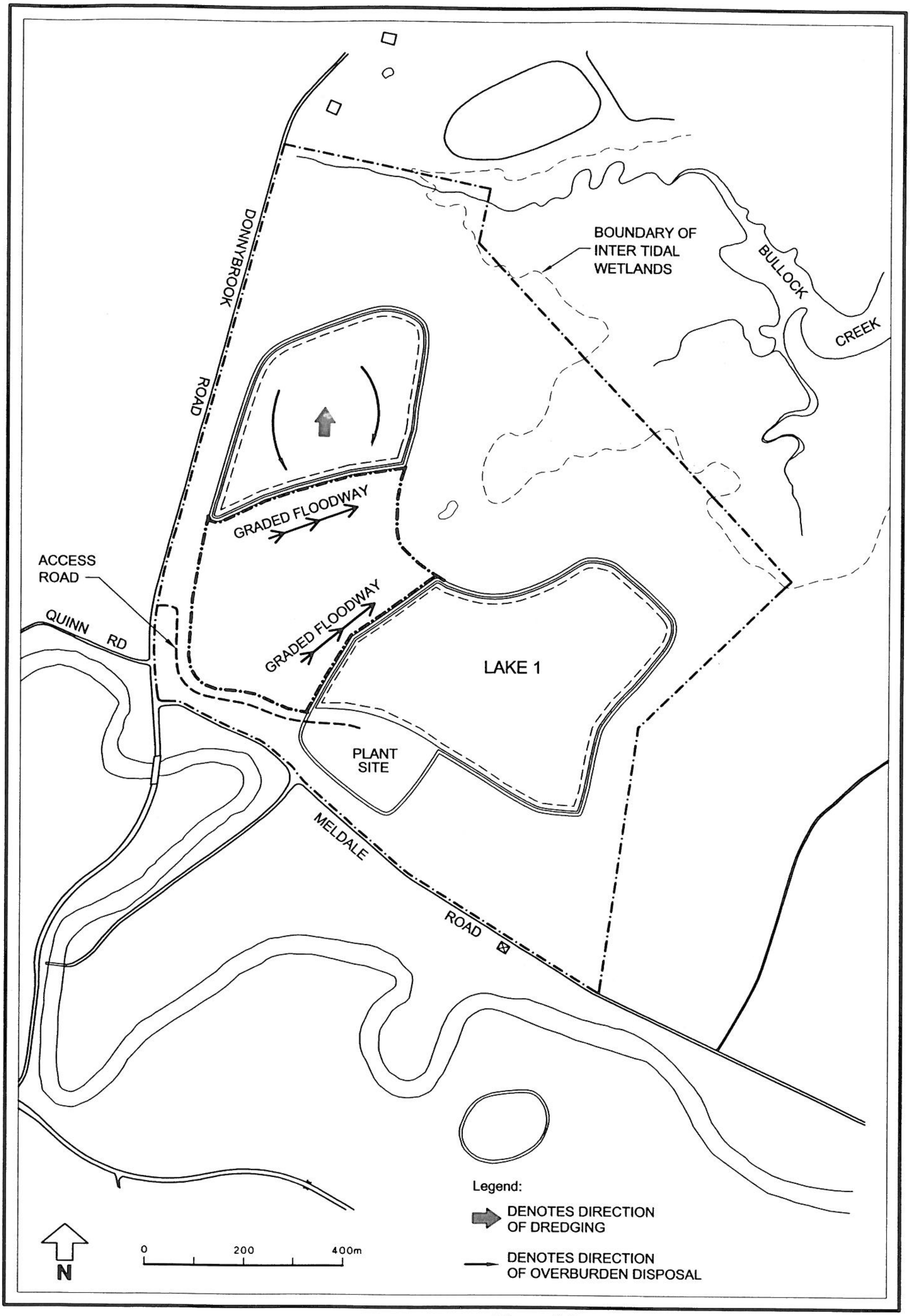

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Figure 3.6
SCHEMATIC DEVELOPMENT STAGES - STAGE 5

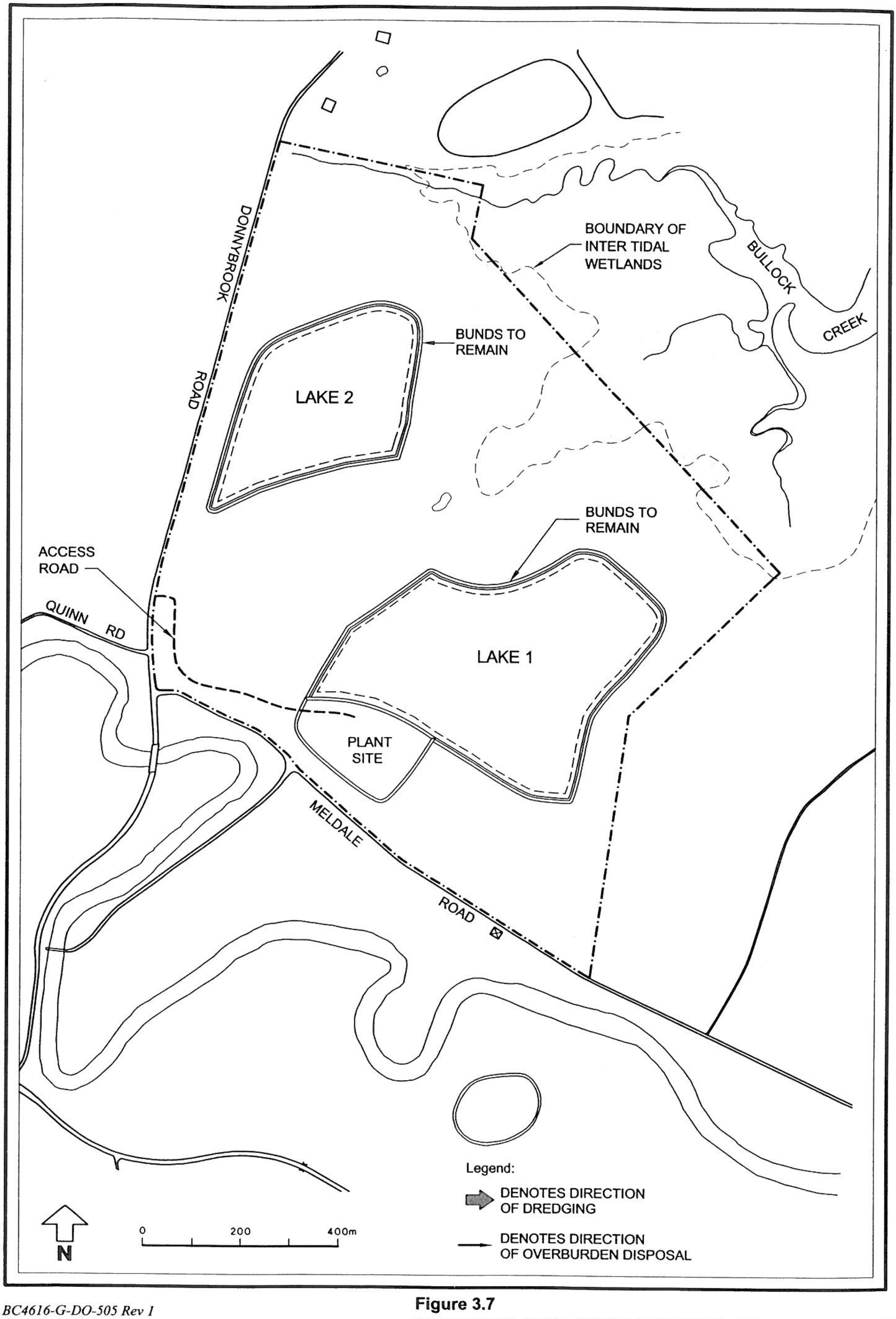

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Figure 3.7
SCHEMATIC DEVELOPMENT STAGES - FINAL LANDFORM

- Continue dredging in a south to north direction.
- Retain northern bund wall.

Stage 5

- Clear vegetation and strip topsoil. Topsoil to be used for topsoiling perimeter bunds.
- Remove overburden and use to progressively fill void from Stage 4 to continue to re-establish floodway.
- Commence dredging in a west to east direction.
- Remainder of dredging conducted in a south to north direction (see Figure 3.6).
- At completion of dredging remove internal bund wall.
- Rehabilitate and landscape perimeter bunds of Lake 2.

Final landform

The proposed final landform is shown in Figure 3.7. It consists of two lakes and a large landscaped area between the lakes. This area will act as a graded floodway and the direction of flow is to the north-east. The ultimate lake area for the final landform will be approximately 30 ha. This corresponds to the ultimate size of the lakes following some fill and rehabilitation of the 45 ha progressively utilised as pond during extraction.

3.3 WATER MANAGEMENT

Water for the process plant will be derived from the dredge intake. This water would be returned to the pond and be constantly recycled. There is no need for a water supply from external sources.

On development of the operation, it is expected that an equilibrium pond level would form at between approximately 0.6 m AHD and 0.8 m AHD, and that for much of the year the pond would act as a 'sink' receiving groundwater inflow. There would be no discharge of process or pond water to areas outside the perimeter bund, and inadvertent releases or releases caused by extreme climatic conditions are not likely to occur. The waters of the dredge pond would always be contained below the existing surface level and there would be negligible likelihood of surface seepage to outside areas. It is expected that the pond will act as a groundwater "sink" with flow towards rather than away from the pit. The perimeter bunds would be established to prevent the ingress of floodwaters up to an ARI 100 year flood frequency. This will require bund heights to be set generally at approximately 1.2 m above the existing ground surface or higher. To facilitate the construction of the bunds and to provide a 'safety' margin, it is proposed to construct bunds 1.5 m or 2 m above the existing ground surface. Where bund heights are higher than this, it is to provide noise attenuation.

A two pond system would be used to manage and treat (as required) the plant water. A small pond would be constructed adjacent to the plant area. This pond would receive tailwater from the plant, and any runoff from the plant and stockpile area. This water would then be pumped or drain via pipe back to the dredge pond.

During the early stages of the operation when the dredge pond is in close proximity to the plant area, the tailwater is likely to be transported back to the main pond by open channel. Any routine dosing of pond water which may be required to control pond pH would be carried out at the plant or at the small pond.

Stringent water quality management procedures would be implemented for the pond water, with a focus on maintaining pond pH at an acceptable level. The water quality of pond waters would be aimed to meet ANZECC 1992 guideline levels for Level 2 (Secondary contact recreation). New draft guidelines (ANZECC 1999) are currently available for public comment, and once these are reviewed and endorsed, they will be used in place of the ANZECC 1992 guidelines.

3.4 PRODUCT STORAGE AND END USE

The materials extracted from the proposed extraction operation will include:

- clay and sandy clay overburden
- clay and sandy clay interburden
- sand and clayey sand, some gravel.

The bulk of the material produced will be sand for processing into quality fine and coarse aggregates. Almost all of this material will be used for the production of concrete. Most of the material produced by the plant will be sold in the Brisbane/North Coast corridor for use mainly in the construction industry. Small volumes of product may be sold for non-concrete uses.

Clay and sandy clay overburden will be used for bund construction and pond batter rehabilitation within the site. Overburden material will be used to refill disused sections of pond and create floodways.

3.5 SITE REHABILITATION AND FUTURE USE

The focus of rehabilitation will be on the stabilisation and revegetation of the perimeter bunds, the buffer zone, the floodways and the pond verges. This stabilisation and rehabilitation will be carried out progressively as bunds are established, and the extraction limits around the pond perimeter are reached.

4 Acid sulphate soils assessment methodology

4.1 PREVIOUS INVESTIGATIONS

In the course of preparing the EIS for the proposed extractive operation, a range of techniques were used to assess the potential for ASS related impacts as the result of the proposal. These included:

- excavator test pits and hand auguring of test holes within the area of the proposed dredge pond. A sample was recovered from each soil profile encountered, and analysed in the field to determine field pH. Field spot tests for the presence of pyrite (the Neckers and Walker method) were also conducted, and soils were inspected for visual evidence of ASS or PASS;
- an assessment of water quality within the site including pH, salinity, aluminium, iron and sulphate determinations;
- the establishment of six deeper bore holes (to maximum depth of 18.5 m);
- the field analysis of approximately eighty samples to detect the presence of pyrite, and the detailed laboratory analysis of eight samples.

In addition, good information about the soil profiles of the area of the proposed dredge pond was available from the geotechnical investigations conducted by CSR in 1992 and 1994, when 'proving' the sand resource (Siemon Pty Ltd, 1994). This information was reviewed to estimate the depth of drilling which would be required for ASS investigations, the types of material which would be encountered, and to select appropriate locations for test holes. This information also contributed to an understanding of the geological formation of the site, and the probability that ASS may be present.

4.2 DETAILED INVESTIGATIONS

As discussed in Section 1.1, a more detailed assessment of ASS issues potentially associated with the proposal was requested by the DNR, following their review of the EIS. The DNR scope reflected the investigation procedures that had been recently defined in the QASSIT (1997) Guidelines. Prior to these guidelines, there were no clearly defined investigation requirements defined by the DNR. The scope of this follow-up investigation was defined in a subsequent meeting with DNR staff (refer Section 1.2).

The following section describes the methodology employed during this ASS assessment.

Field survey and sample analysis

On 11, 12, 13, 18 and 19 June 1997, twenty-four excavator pits were established on a surveyed 150 m grid pattern across the proposed extraction area. These holes were established to the maximum depth which could be achieved by the 'reach' of the excavator. This varied from 3.0–4.8 m depth and samples were collected by hand.

On 8 and 9 August, and 4 and 5 December 1997, five deep bore holes were established by a drill rig mounted on an all wheel drive truck (8–9 August) and a tracked bombardier (4–5 December) using wash boring technique and collecting samples using an 'SPT' split tube. The locations of these bore holes corresponded to locations where excavator test pits had already been established.

Samples were collected from approximately 0.5 m intervals, with at least one sample from within each soil horizon encountered. Where several samples were recovered from within the same soil horizon, the sampling interval was, at times, extended to 1.0–1.5 m. Test holes were terminated at 'refusal' (i.e. when it was no longer possible to advance the hole), or when the residual clay layer which underlies the sand resource was encountered. Termination depth ranged from 14.1–18.5 m.

In total, 183 soil samples were recovered from the test holes established (142 from the excavator test pits and 41 from the deep bore holes). All samples were analysed in the field to determine field pH and pH on oxidation. Of these, seventy-one samples (approximately 40%) were analysed in a NATA registered laboratory by the Peroxide Oxidisable Combined Acidity and Sulphate (POCAS) method developed by DNR.

The location of the twenty-four test holes established has been shown with respect to existing site features, and the proposed extraction boundary on Figure 4.1.

Sample collection and handling was carried out in accordance with the 1 September 1997 revision of the 'Draft ASS Sampling Procedure' produced by the DNR Queensland Acid Sulphate Soils Investigation Team (QASSIT), and which were current at the time. The methodology has remained consistent with subsequent editions of these guidelines. Soil profile morphology was recorded for each test hole, including observations of iron staining, and the presence of jarosite or shell material.

Field tests to determine soil pH and pH after oxidation (approximately 70 minutes oxidation with 30% hydrogen peroxide) were carried out within three hours of sample recovery, and the strength and temperature of the reaction with peroxide was also noted. Samples were stored in plastic bags on dry ice until they were lodged at the analytical laboratory within seventy-two hours of recovery.

The field testing to determine soil pH and oxidised pH was utilised as a screening method. It was carried out in a semi-quantitative manner (10 mL of soil measured using volumetric syringe and mixed with 50 mL of deionised water, or 40 mL deionised water, plus 10 mL 30% hydrogen peroxide), but it is recognised that this technique can be affected by interference caused by organic acids formed from the partial oxidation of organic material.

For this reason, confirmatory laboratory analyses using the POCAS method were carried out. This method is a recently developed improvement on previous analytical methodology involving the use of both the Peroxide Oxidisable Sulphuric Acidity

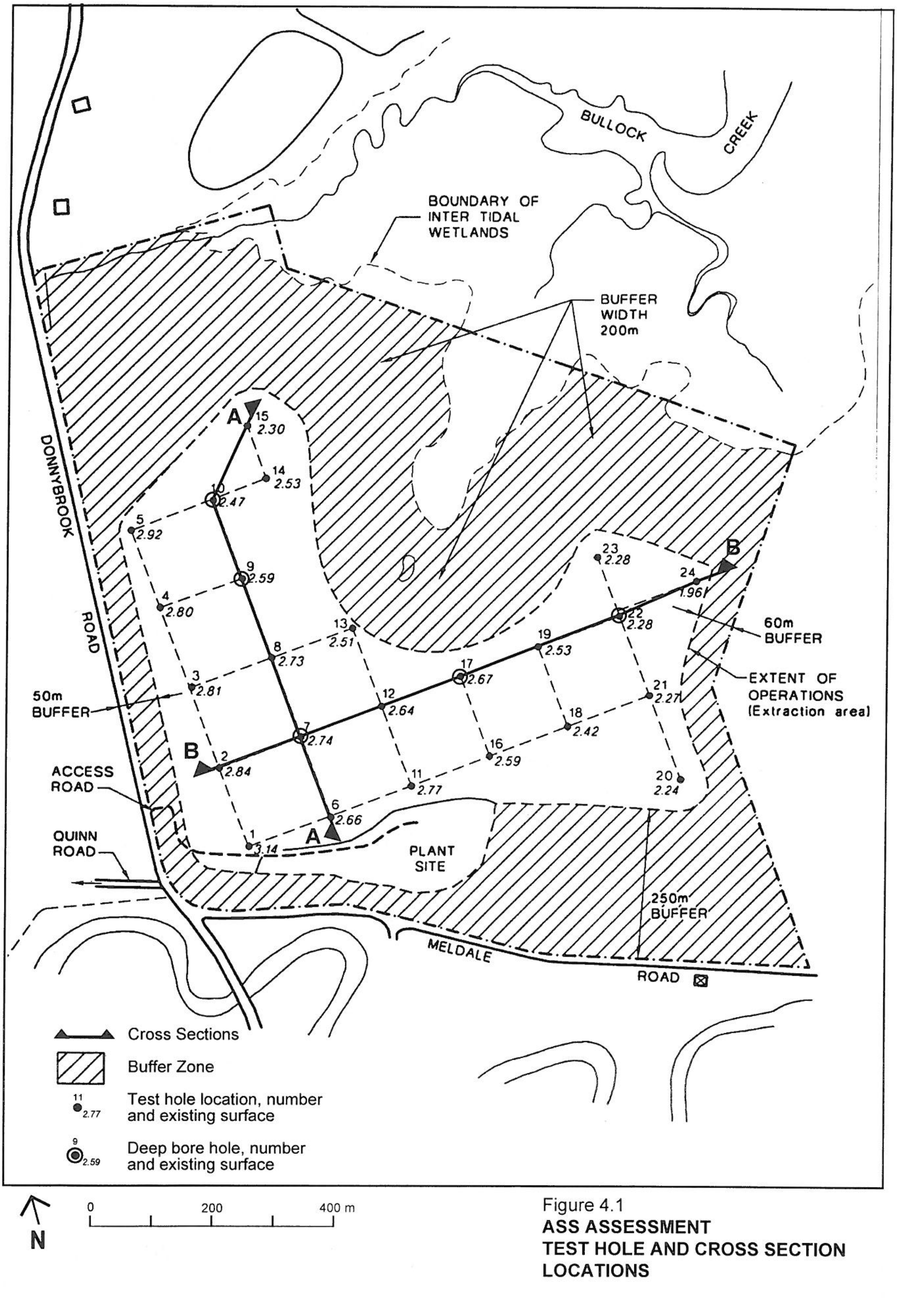

Figure 4.1
ASS ASSESSMENT
TEST HOLE AND CROSS SECTION
LOCATIONS

(POSA) and Total Potential Acidity (TPA) methods. Initial and oxidised soil pH, and the amount of calcium liberated in the oxidation reaction were also determined.

This method represents an improvement on previous methodology in that it standardises the approach to acid sulphate soil analyses, and it can detect interference from either organic acids (false positives), or from the presence of shell material (false negatives or artificially low results).

Groundwater levels were also recorded for each test hole and recorded on bore hole logs.

5 Site characteristics

5.1 SOIL PROFILE MORPHOLOGY

Information about the soil profile morphology of the area of the proposed dredge pond is available from two principle sources; the test hole logs from the ASS assessment conducted for CSR during resource proving investigations (August 1994); and the test hole logs from this ASS assessment.

CSR resource proving and EIS investigations

The resource proving investigations commissioned by CSR in 1992 and 1994 found that soils on the site are primarily grey and light grey clays (overburden), underlain by sandy clays and fine to coarse grained sand (sand resource) layers often containing clay bands (interburden). The basement material underlying the site consists of sandy clays of Landsborough Sandstone.

These investigations included over ninety test holes across the site, of which approximately thirty intersected the basement material. The location of these test holes and the cross-sections developed from these investigations have been presented in Appendix A. They provide a good understanding of the geology of the site.

As discussed in Section 4.1 of this report, site soil profile morphology was also investigated during preparation of the EIS. The results of these assessments are presented in the EIS (Kinhill 1995).

ASS investigation test hole logs

The test hole logs from the twenty-four test holes established as part of this ASS investigation have been included as Appendix B. In addition, Figures 5.1 and 5.2 (sections A-A and B-B) show representative cross-sections developed from these test hole logs. The locations of these sections have been shown on Figure 4.1.

The soil profiles described during these investigations were generally consistent with those described in the CSR resource proving investigation.

5.2 ACID SULPHATE POTENTIAL

The results of field testing to determine soil pH and pH after rapid oxidation, are presented in Appendix C. Observations of reaction temperature and vigour are also presented.

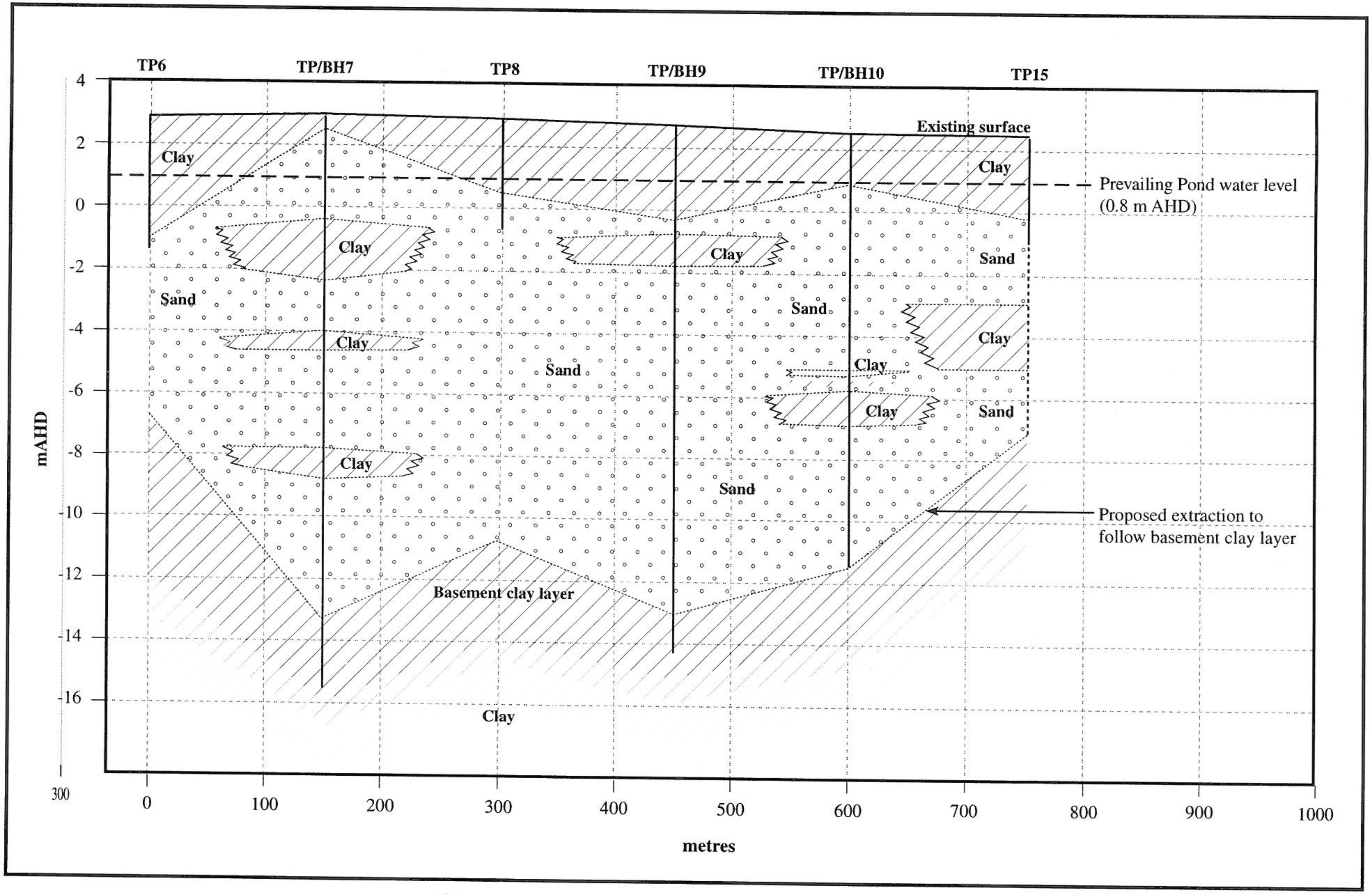

Figure 5.1
SECTION A—A
CSR DONNYBROOK
—SOIL PROFILE MORPHOLOGY

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September 2000

Notes:

- Boundaries inferred between test holes
- Soil textures grouped as those predominantly 'clay' and those predominantly 'sand'
- Supplementary data obtained from EIS (1995) and Resource Investigations (1994) (eg data from below 2.9m in TPI5 was derived from holes AS2+AS3 in EIS investigation)

TP Excavator Test Pit
BH Bore Hole

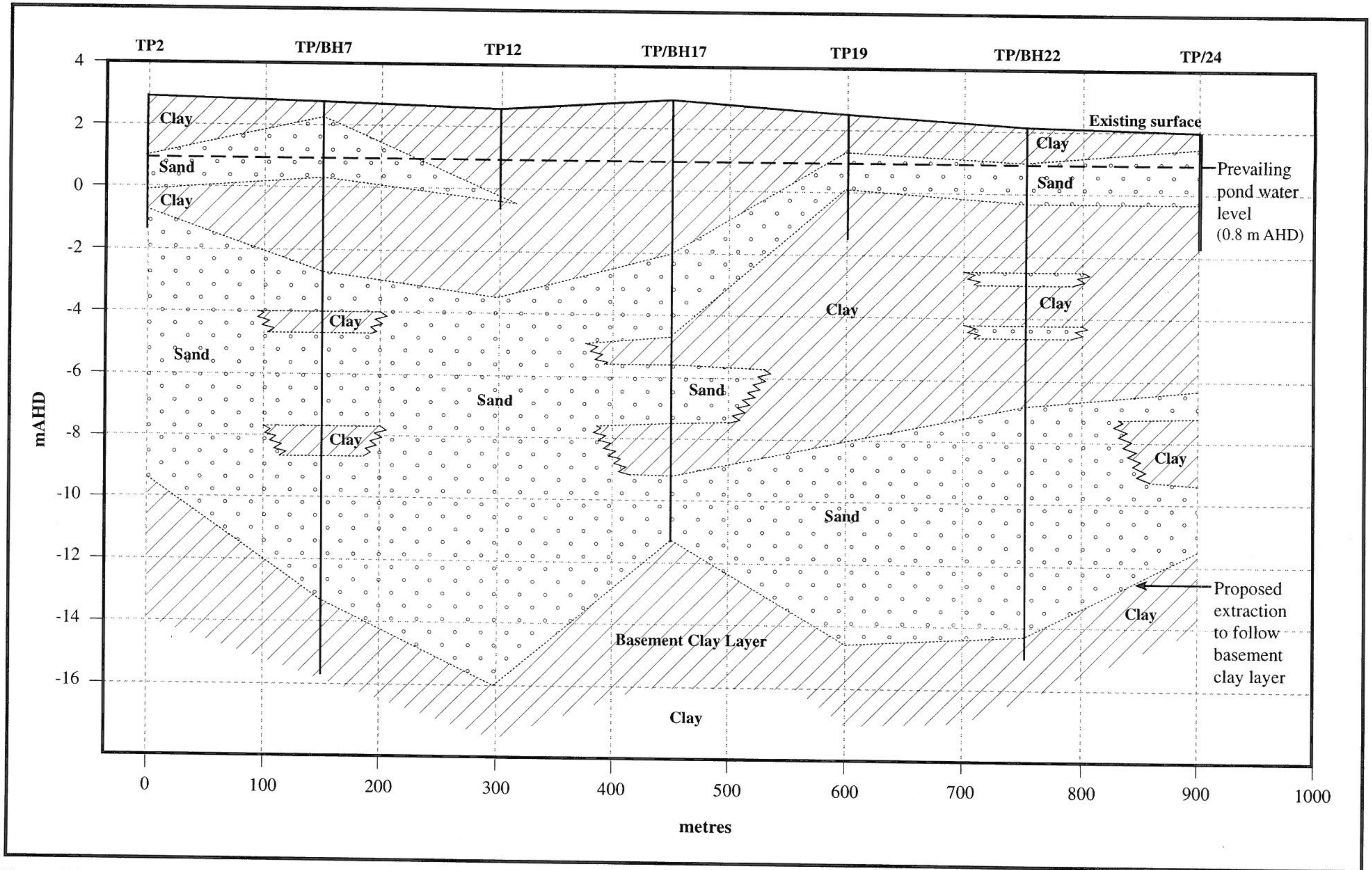

Figure 5.2
SECTION B—B
CSR DONNYBROOK
—SOIL PROFILE MORPHOLOGY

BC4616-G-DO-505 Rev.1
September 2000

Notes:

- Boundaries inferred between test holes
- Soil textures grouped as those predominantly 'clay' and those predominantly 'sand'
- Supplementary data obtained from EIS (1995) and Resource Investigations (1994) (eg data from below 2.9m in TPI5 was derived from holes AS2+AS3 in EIS investigation)

TP Excavator Test Pit
BH Bore Hole

The results of laboratory testing using the POCAS method are presented in Appendix D, which also shows corresponding field analysis results for the samples analysed in the laboratory. The test hole logs presented in Appendix B have also been annotated with field and laboratory analysis data.

As discussed in Section 4.2, all samples were analysed using the field screening method, and 40% of these were subjected to confirmatory laboratory analysis. A comparison between the results using each of these methods was made to determine the reliability of the field method in identifying material with a significant acid generating potential. Reference to the table in Appendix D and Graphs E1 and E2 in Appendix E, shows that there was very good agreement between field and laboratory methods.

There was very little calcium carbonate (shell material) present in any of the samples recovered, and there was therefore no interference from this source. This was confirmed by the low reacted calcium concentrations (Ca_A) for all the samples analysed. There was however, some interference from the presence of organic acids in fine textured surface soils (overburden). In a few cases, partial oxidation of organic material and the presence of organic acids caused quite low initial pH and oxidised pH, and slightly elevated TAA.

The conclusions from a comparison between field and laboratory analytical data were therefore that:

- materials with significant acid generating potential (TSA >18 MH^+/t) can be identified by a pH_{FOX} (approximately 70 minutes oxidation time) of less than 3.0, and a field pH depression of greater than 2.5 pH units;
- some materials had elevated total actual acidity (TAA) but these were attributable to organic acids (as evidenced by declining acidity after oxidation and comparisons with sulphur pathway data) and TSA was therefore a more reliable measure of acid sulphate potential.

Figures 5.3 and 5.4 have been produced to show a cross-sectional representation of the acid generating potentials of the soils within the proposed dredge pond. The ASS characteristics of each of the major soil layers encountered within the site are described below.

Overburden—brown to grey silty clay to sandy clays

The upper soil profile was predominantly brown to grey silty clays with some brown sandy clays. These were predominantly located above the prevailing watertable and did not have any significant acid generating potential. Soil pH typically varied between 4.0 and 5.7 at the surface, and 3.7 to 5.4 below the prevailing watertable.

Field oxidised pH values (pH_{FOX}) for the surface layer of soil where organic contents were high varied between 2.7 and 7.7, but were predominantly 4.0 or higher. The TPA values obtained for these soils were elevated in a few cases however the results of the sulphur pathway indicate that these acids are the result of the partial oxidation of organic matter, and this is supported by the very low TSA values. The nature of the reaction of these soils with peroxide also indicated that the depressed pH_{FOX} values were the result of the formation of weak organic acids. The reactions proceeded very slowly with low reaction temperatures.