



Acid Sulfate Soil Management Plan

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Document Control					
Version	Date	Author		Reviewer	
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Draft	15 August 2007	V. Cavanough	VC	A. Greenwood	AG
1	18 October 2007	V. Cavanough	VC	C. Sutcliffe	CS
2	19 October 2007	V. Cavanough	VC	C. Sutcliffe	CS
3	19 November 2007	V. Cavanough	VC	C. Sutcliffe	CS
4	11 July 2008	V. Cavanough	VC	C. Sutcliffe	CAS

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NORTHEAST BUSINESS PARK ACID SULFATE SOIL MANAGEMENT PLAN

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EXECUTIVE SUMMARY

An Acid Sulfate Soil Management Plan (ASSMP) as prepared to provide a statement of commitments to manage acid sulfate soils likely to be disturbed through civil bulk earthworks and river navigation dredging associated with the Northeast Business Park (NEBP) development proposal. That ASSMP was presented as Appendix R4 of the NEBP Environmental Impact Statement (NEBP EIS)

Following public notification of the NEBP EIS, public submissions were received and the ASSMP prepared as Appendix R4 of the NEBP EIS has been revised to support the NEBP Supplementary EIS to:

- justify acid sulfate soil management performance objectives, control measures and monitoring requirements following additional targeted geotechnical investigations; and
- commit to the preparation of activity specific ASSMPs following consultation with appropriate regulatory bodies at the detailed design stage for areas of high disturbance volumes and high risk.

This (and that superseded) ASSMP has been designed to ensure that no significant adverse impact on the receiving environment occurs as a result of the disturbance of actual or potential acid sulfate soils regarding the NEBP development.

Through this ASSMP, should environmental harm be caused or threatened, the Proponent can demonstrate that all reasonable and practicable measures will be taken to comply with relevant acid sulfate soil guidelines.

1. INTRODUCTION

Cardno (Qld) Pty Ltd (Cardno) has been commissioned by Northeast Business Park Pty Ltd (the Proponent) to prepare an Acid Sulfate Soil Management Plan (ASSMP) for the proposed Northeast Business Park (NEBP) development located at within the Caboolture Shire of Queensland. Figure 1 provides a site locality plan defining the project area.

The ASSMP has been revised to inform the Supplementary Environmental Impact Statement (Supplementary EIS) required by the Queensland Coordinator General for the proposed NEBP development in response to submissions relating to acid sulfate soil investigation and management.

The NEBP development proposal involves excavating material within the lower reaches of the Caboolture River and within the NEBP project area which may involve the disturbance of actual or potential acid sulfate soils (ASS). Both dredging and bulk earthworks will enable sufficient construction fill to be generated to raise ground levels above the Q-100 flood level and therefore reduce the flood hazard within the locality.

ASS guidelines requires that testing, treatment and monitoring regimes of ASS are to be set out under an approved ASSMP, thus the preparation of an ASSMP to support the NEBP EIS. In particular the proposed works may impact on the receiving environment in a number of ways including the following.

- Disturbing acid sulfate soils.
- Excavated potential ASS may be placed in aerobic conditions above the water table and directly exposed to oxygen resulting in acid production and potential release of heavy metals.
- Displacing or extruding previously saturated potential ASS above the watertable and aerating these soils or sediments.
- Changes to water chemistry of receiving surface water bodies and groundwater resources due to uncontrolled run-off and leaching.
- Sedimentation and erosion due to loss of aquatic vegetation from changes to water quality.
- Loss of good quality fertile soils through expression of soil acidity.
- Disease and mortality of fauna species in affected ecosystems, particularly within receiving aquatic ecosystems.

The aim of this revised ASSMP is, in addition to proposing appropriate design, management, monitoring and corrective action measures required to minimise the potential impact on the environment caused by the development, demonstrate the Proponent's commitment to undertake additional geotechnical investigations and detailed plans for the management of ASS. This shall justify and/or detail specific management and monitoring tasks required to support operational works development approval applications.

At this stage it is envisaged that further detailed ASS investigation and management will be undertaken and devised for the following proposed activities based on a risk based approach to ASS management and preliminary geotechnical findings:

- Marina Excavation and Dewatering;
- Navigational Dredging;
- Flood Mitigation, including Golf Course;
- Bulk Fill; and

- Dredge Spoil.

It is understood that a staged approach to sampling as per the above activities would be supported by the relevant regulating authority at this early planning stage.

The ASSMP has been prepared with regard to the following preliminary geotechnical investigations for the NEBP project area and Caboolture River prepared to address the Terms of Reference (ToR) for the proposed NEBP development.

1. Coffey Geotechnics Pty Ltd (2007) *Northeast Business Park - Geological Interpretative Report/Appendices*.
2. Coffey Geotechnics Pty Ltd (2007) *Caboolture River Dredging Geo-Environmental Investigations*.

Geotechnical investigations to date were appended to the NEBP EIS as Appendix R1 and R2 respectively. These technical studies were designed with due regard to risk management standards, with the objective of determining the presence of ASS within the proposed excavation and filling zones. Therefore further ASS investigations to determine the extent of actual ASS and potential ASS are proposed pre- and during the construction phases with the aim of complying with the relevant guideline requirements wherever possible following consultation with the Department of Natural Resources and Water (DNRW), the relevant advising regulatory authority.

It is likely that through more detailed ASS investigation the sampling intensity for each terrain unit may be relaxed with regard to the requirements of SPP 2/02 given the risk based approach to the ASS investigation.

The following guidelines have been considered in this revised ASSMP.

- Queensland Government State Planning Policy 2/02 Version 2– *Planning and Managing Development involving Acid Sulfate Soils* (SPP 2/02).
- *Queensland Acid Sulfate Soil Technical Manual – Soil Management Guidelines*, Version 3.8 (November 2002).
- *Instructions for the Treatment and Management of Acid Sulfate Soils* (Queensland Government, July 2001).
- *Acid Sulfate Soils Management Plans for Queensland* (Dear et al, June 2000).
- *Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils in Queensland* (CR Ahern, MR Ahern and B Powel, October 1998).

The SPP 2/02 and its attendant guidelines aim to provide a best management practice for developments involving ASS. By following these guidelines, proponents of developments involving ASS can effectively plan and mitigate the adverse impacts of disturbed ASS on the natural and built environment and human health by:

- investigation to assess the ASS risk;
- planning following the ASS management hierarchy; and
- treatment and verification where ASS is disturbed in significant concentrations and volumes.

The above guidelines have been shown to be effective when implemented judiciously. The acid base accounting methodology used in the management of ASS and described in SPP 2/02 and its attendant guidelines is one example of how the current policy can quantitatively assess the amount of actual and potential acid a soil contains, calculate effective treatment dose rates and validate treated soils.

This ASSMP has also considered Caboolture Shire Council's assessment requirements in proposing control measures for ASS as detailed in *Planning Scheme Policy 1 Acid Sulfate Soils*.

An existing preliminary ASSMP by Douglas Partners (2004) was prepared as part of a previous development proposal for part of the project area. Management options proposed for this development have been integrated into this ASSMP where relevant. The superseded ASSMP by Douglas Partners (2004) is attached as **Appendix A**.

Hence this management plan is intended to:

- respond to submissions from public notification of the NEBP EIS; and
- provide assurance to decision makers that further ASS investigation will be undertaken to satisfy current ASS management or inform activity specific ASSMPs within the NEBP site and Caboolture River at the operational works approval stage.

Following a detailed ASS investigation and the preparation of the corresponding ASSMP, these documents will be submitted to the DNRW for comment and approval.

It is relevant to note that additional technical investigations relating to groundwater were prepared by Coffey Geotechnics and attached to the NEBP EIS to predict any changes to groundwater levels that may occur and that coupled with the described analysis of the underlying soil and sediment, interactions of groundwater with underlying soil and sediment are predicted and inform the monitoring requirements proposed within this ASSMP.

2. DEVELOPMENT PROPOSAL

The NEBP development proposal is a multi-use business park and marina concept that will integrate appropriate business, industry, commercial, marine facilities, residential, heritage and recreational greenspace precinct, providing a place to live, to work and play in a master planned riverside precinct on the Caboolture River. Figure 2 provides an illustration of the NEBP development proposal.

Major landform adjustments that will occur to establish the NEBP will involve excavation of the marina basin to 1.0 metres below AHD. This will be undertaken using dry excavation techniques followed by inundation of the marina area. Fill obtained from the excavation of the marina basin and additional cuts within the property bounds will be used to raise ground levels within residential precincts to protect against flooding and storm surge, as a large proportion of the site is below the Q100 flood level. Following excavation of the marina basin, a lock will be established to connect the marina basin to the Caboolture River.

Overall the development will be designed, constructed and operated with a net benefit to the environment and community through the implementation of sustainable development principles and practices.

Dredging of the Caboolture River in the lower reaches will be required to provide sufficient draft for yachts to access the marina with dredging occurring within the defined navigation channel using cutter suction dredging methodology and piping material to the project area.

3. LOCATION DESCRIPTION

3.1 Project Area

Situated on the southern bank of the Caboolture River approximately 8km inland from the coastline, adjacent to the Bruce Highway and 43km north of Brisbane CBD, the NEBP site encompasses 769 hectares of land which includes the following seven land parcels (the project area).

- Lot 2 on RP902075.
- Lot 10 on RP902079.
- Lot 24 on SP158298.
- Lot 7 on RP845326.
- Lot 15 on RP902073.
- Lot 12 on RP145197.
- Lot 17 on RP902072.

The NEBP project area is vacant privately owned land that is bound:

- to the north by 9km of Caboolture River frontage, with land on the opposite side of the river being primarily rural and used for forestry activity;
- to the west by the Bruce Highway, with land on the opposite side of Bruce Highway developed with residential and open space areas; and
- to the south and east by privately owned rural residential properties with lot sizes ranging from 1-20 ha, bushland, open grassland areas and limited agricultural and recreational land uses.

The project area is relatively flat ranging in elevation from 3m AHD at the northern boundary to a knoll at 16.5m AHD towards the southern area of the site. Tidal levels of the Caboolture River, adjacent to the site are approximately 1.34m AHD for Highest Astronomical Tide and 0.81m AHD for Mean High Water Springs.

The project area has been classified as having various terrain units (geology, landforms and soils) that below 5m AHD may include acid sulfate soils. Geotechnical investigations in section 4 describe those terrain units that have the potential to generate acidic leachate during civil works and which require responsible management. Figure 4 illustrates the extent of terrain units within the project area that are potentially acidic based on preliminary geotechnical findings including borehole locations.

The project area is surrounded by areas of conservation significance as follows.

- The Deception Bay Declared Fish Habitat area, which extends along the entire length of the northern boundary (and intruding into Raff Creek with the project area to a small degree), within the bounds of the Caboolture River. This area is protected by the *Fisheries Act 1995* due to the estuarine habitats that support commercial and recreational fisheries in close proximity to developing communities.
- The Habitat Zone of the Moreton Bay Marine Park which is located within the Caboolture River and begins at the northern boundary of the site then extends eastward along the Caboolture River. This area is protected by the *Marine Parks Act 2004* in order to:

- (a) conserve significant habitats, cultural heritage and amenity values of the marine park;
 - (b) maintain the productivity and diversity of the ecological communities that occur within the marine park; and
 - (c) provide for reasonable public use and enjoyment of the zone consistent with the conservation of the marine park.
- The Moreton Bay RAMSAR wetlands which traverse the same area within the Caboolture River as the Moreton Bay Marine Park. The Moreton Bay RAMSAR wetlands are protected pursuant to international conventions as they are one of only three extensive intertidal areas of seagrass, mangroves and saltmarsh on the eastern coast of Australia that provide habitat for water birds.
 - South East Queensland Wader Bird Sites are mapped approximately 500m to the east of the site. This area is protected via the JAMBA and CAMBA convention to protect habitats of Migratory Birds.

3.2 Caboolture River

Dredging within the Caboolture River shall occur within the defined navigational channel (by Queensland Transport) as shown in Figure 3. **Appendix B** contains a full set of dredging drawings for reference.

The defined navigational channel is described herewith.

From the mouth of the Caboolture River at 6999531.0356 N and 502630.4714 E, 6.5km upstream to 5996685.9708 N and 506134.0922 E. The property descriptions adjacent to the finished defined dredge area on the left bank is Lot 164 on C311334 and on the right bank Lot 16 on SP158298.

The proposed dredging profile includes a channel width of 50m excavated to a depth of RL -4.25m AHD. This channel depth will provide approximately 3.0m of water at Lowest Astronomical Tide (LAT). The side batters of the channel will be shaped with a slope of 1: 3 batters to match existing levels.

The lower reaches of the Caboolture River discharge into the shallow marine waters of Moreton Bay. The river system has seen the development of soil and vegetation types typical of an estuarine ecosystem. Alluvial sediments and mangroves dominate the surface profile. The cleared areas along the banks of the river were associated with boat ramp access facilities and private farm land uses.

Moreton Bay and its catchment has been the subject to extensive studies on water quality, hydrology, sedimentology and aquatic ecology. The Caboolture River is one of several major rivers that flow into the bay with a total catchment area of 589 km².

A key feature of the Caboolture River is the presence of a weir 19 km upstream of the river mouth which affects the water quality, particularly salinity. The health of the Caboolture River has been assessed from 1999 as part of the Ecosystem Health Monitoring Program (EHMP) with report cards grading the estuary of the Caboolture River between "C-" and "D", which is essentially "poor" to "fair" in terms of ecological health. The grades also show a gradual decline in health over the period of assessment with the poor grading attributed to natural and anthropogenic processes.

Natural processes contributing to poor health includes impacts associated with flooding, storm surges, nutrients from oceanic upwelling and poor riparian cover and bank stability. Anthropogenic processes contributing to the poor health of Caboolture River includes the alteration of run-off patterns leading to diffuse pollution sources and point sources

associated with discharges from industry (for example sewage treatment plants) and residential development.

Geotechnical investigations outlined in section 5 of this report provide an indication of the presence of acid sulfate soils in dredge spoil which will be managed within the project area as part of the construction methodology.

4. GEOTECHNICAL INVESTIGATION – BULK EARTHWORKS

Coffey (2007) has undertaken a borehole/trial pit investigation within the project area, attached as Appendix R1 of the NEBP EIS, to determine the presence of soils with the potential for acid sulfate soil contamination.

Coffey (2007) considered all land encompassed by the development outline and determined the frequency and location of boreholes and laboratory tests based on a desktop study of terrain mapping and existing borehole information presented by Douglas Partners (2004). This resulted in a more focused preliminary ASS field investigation with regard to the proposed land uses whilst reducing the requirement for extremely high sampling density (due to the site size) and informing ongoing targeted ASS sampling during construction phases.

It is noted that while sampling did not meet the recommended sampling intensity identified in the *Guidelines for Sampling and Analysis of Lowland Acid Sulphate Soils in Queensland* (Ahern et al. 1998), the investigation does:

- sample the entire project area of the proposed NEBP development;
- include multiple samples with testing undertaken at the recommended frequency within each borehole; and
- provide a basis for a basic but representative assessment of ASS risk for the proposed NEBP development given the size of the subject site.

Based on the terrain mapping and laboratory results, the terrain units containing ASS have been summarised in Table 1. The net acidity varies across terrain units from approximately 0.03 to 0.697%S with all samples recording net acidity above the Action Criteria. No significant or reliable acid neutralising capacity was recorded within any terrain unit.

Terrain units in some cases have recorded potential and actual ASS. Inconsistencies in the levels of sulfur shall be addressed through additional geotechnical investigations.

The sampling undertaken to date should provides enough information to inform the design of a targeted ASS investigation which will enable the production of corresponding activity specific ASSMPs in consultation with the DNRW where required.

Based on the preliminary geotechnical investigations terrain units exhibiting attributes consistent for the formation of ASS are predominantly located within low plains of the project area, below 5.0m AHD, and composed of a clayey soil class. Figure 4 provides an illustration as to the preliminary extent of actual acid sulfate soils (AASS) and potential acid sulfate soils (PASS) and identification of sample locations where these soils was recorded.

The majority of bulk earthworks, including fill, is occurring within terrain units containing AASS or PASS.

Bulk earthworks will be undertaken in the initial development stages. Construction timing and methodology have been prepared by Laing O'Rourke and is detailed in the EIS.

A high to extra high level of treatment may be required for excavated ASS due to the large scale disturbance of soil (>10,000 tonnes) based on net acidity. Therefore an ASSMP is a requirement of the development proposal. However more detailed activity specific ASSMP are proposed to manage ASS based on targeted geotechnical investigations in areas of significant cut and fill works as shown on Figure 5.

Table 1 Summary of ASS Testing

Borehole/Trial Pit	Depth	pH	Total Actual Acidity (TAA)	Total Potential Acidity (TPA)	Total Sulfidic Acidity (TSA)	Net Acidity Equiv. % S (existing + potential acidity)	Potential and/or Actual ASS	Terrain Description	Action Criteria	
			m/tonne (%S)	m/tonne (%S)	m/tonne (%S)	%S			Equiv. Sulfur (%S)	Equiv. Acidity (m/tonne)
TP19	1.5m	3.8 pH _F	21 (0.03)	42 (0.07)	21 (0.03)	0.03	Actual	Qha G.1	0.03%	18
TP20	1.5m	2.7 pH _{FOX}	74 (0.12)	74 (0.12)	<2 (<0.01)	0.12	Potential	Qa C.6	0.03%	18
TP23	1.0m	2.5 pH _{FOX}	59 (0.09)	44 (0.07)	15 (0.02)	0.07	Potential	Qa C.6	0.03%	18
TP24	1.0m	3.7 pH _F	80 (0.13)	97 (0.16)	17 (0.03)	0.13	Actual	Qa C.6	0.03%	18
TP25	1.0m	3.7 pH _F	103 (0.17)	122 (0.2)	19 (0.03)	0.17	Actual	Qa C.6	0.03%	18
TP26	0.5m	2.7 pH _{FOX}	25 (0.04)	51 (0.08)	26 (0.04)	0.04	Potential	Qa C.6	0.03%	18
TP28	1.0m	2.7 pH _{FOX}	23 (0.04)	40 (0.06)	17 (0.03)	0.04	Potential	Qha C.6	0.03%	18
TP31	2.0m	1.6 pH _{FOX}	42 (0.07)	44 (0.07)	2 (<0.01)	0.07	Potential	RJI B.4	0.03%	18
LBH 2	2.5-2.75	4.13 pH _{KCL}	38 (0.06)	9 (<0.01)	0 (<0.01)	0.071	Potential	Qha D.6	0.03%	18
LBH 3	1.75-2.0	4.53 pH _{KCL}	23 (0.04)	12 (0.01)	0 (<0.01)	0.059	Potential	Qha C.5	0.03%	18
LBH 4	0.5-0.75	3.81 pH _{KCL}	49 (0.08)	17 (0.01)	0 (0.02)	0.093	Actual	Qha C.5	0.03%	18
LBH 4	1.0-1.25	3.82 pH _{KCL}	48 (0.08)	15 (0.01)	0 (0.03)	0.097	Actual	Qha C.5	0.03%	18
LBH 4	2.75-3.0	3.84 pH _{KCL}	35 (0.06)	15 (0.01)	0 (0.04)	0.075	Actual	Qha C.5	0.03%	18
LBH 5	1.0-1.25	4.33 pH _{KCL}	15 (0.02)	425 (0.60)	410 (0.08)	0.697	Potential	Qe F.6	0.03%	18
LBH 5	2.0-2.25	8.25 pH _{KCL}	0	173 (0.36)	173 (0.05)	0.387	Potential	Qe F.6	0.03%	18
LBH 5	3.5	5.74 pH _{KCL}	17 (0.03)	14 (0.13)	0 (0.02)	0.163	Potential	Qe F.6	0.03%	18
LBH 6	1.75-2.0	4.71 pH _{KCL}	6 (<0.01)	17 (0.11)	11 (0.01)	0.123	Potential	Qe F.6	0.03%	18
TPK 104	1.0m	3.69 pH _{KCL}	132 (0.21)	64 (0.01)	0 (0.02)	0.222	Actual	Qha C.6	0.03%	18
TPK 105	1.2m	3.77 pH _{KCL}	91 (0.15)	32 (<0.01)	0 (0.01)	0.155	Actual	Qha C.6	0.03%	18
TPK 106	1.2m	6.14 pH _{KCL}	1 (<0.01)	40 (0.10)	39 (0.05)	0.105	Potential	Qe F.6	0.03%	18
TPK 107	1.1m	3.75 pH _{KCL}	114 (0.18)	72 (0.02)	0 (0.01)	0.212	Actual	Qe F.6	0.03%	18
TPK 109	0.6m	4.61 pH _{KCL}	9 (0.01)	5 (<0.01)	0 (<0.01)	0.18	Potential	RJI B.4	0.03%	18
TPK 110	0.9m	3.80 pH _{KCL}	96 (0.15)	45 (0.03)	0 (0.03)	0.183	Actual	Qha C.5	0.03%	18

5. GEOTECHNICAL INVESTIGATION – DREDGING CABOOLTURE RIVER AND SPOIL DISPOSAL

Coffey (2007) has undertaken a borehole investigation within the defined dredge area to determine the dredging properties of soils including acidity and contaminant levels. Figure 3 provides a description of the proposed dredge location.

Three distinct subsurface soil profiles were determined based on borehole investigations including:

- River Mouth Sediments;
- Pre Holocene Sediments; and
- Holocene Estuarine Sediments.

Field screen testing identified that all soil profiles are PASS with oxidised pH values below 4 however no total actual acidity was determined as field pH values were predominantly above 7.

It is noted that while sampling did not meet the recommended sampling intervals for dredging, the investigation does:

- sample the length of the full proposed dredge channel;
- terminate all boreholes one metre below the maximum dredge cut;
- comply with recommended sample frequencies (at 50m intervals); and
- provide a basis for a basic but representative assessment of ASS risk for the proposed dredge works.

Quantitative laboratory testing was undertaken on selected samples from all three soil profiles using the Suspension Peroxide Oxidation Combined Acidity and Sulfate method (SPOCAS). Based on laboratory analysis results provided in Appendix R2 of the NEBP EIS the following assessment conclusions are made.

- No soils within the proposed dredge area are AASS.
- All soils within the proposed dredge area should be considered PASS.
- A high proportion of acid reactive calcium is present in the river mouth and Pre Holocene sediments, which may neutralise some or all total potential acidity generated. However the estuarine sediments show an acid generating capacity greater than the acid neutralising capacity of the soils.

All potential acidity can be managed to avoid environmental harm in accordance with this ASSMP.

Spoil will be dredged by cutter suction dredging equipment. Suction dredges act like underwater vacuum cleaners drawing bed material into the dredge. The cutter head describes arcs in the sediment loosening the material to aid removal. Cutter suction dredgers take the substratum profile down to the required depth at one location before moving onto the next. Slurry (1 part sediment and 5 parts water) is drawn up by this method and dredged material is pumped ashore via a pipeline.

Dredge spoil is proposed to be piped to the NEBP project area using a polyethylene spoil transfer pipeline for treatment and use as construction fill.

The pipeline will extend upriver approximately 500m beyond the upper limit of the dredging and will exit from southern bank of the river at the existing easement for Farry Road.

The pipeline will then be located on land, extending approximately 1.5km along the Farry Road easement to meet the south-eastern corner of the NEBP project area, which is the location of the proposed dredge spoil area.

Dredge spoil shall be disposed of as fill within the NEBP development, on Lot 24 on Plan SP158289. The dredge spoil disposal area forms part of Residential Area 2 of the NEBP development

Following settlement within a disposal area that is suitably bunded, tailwater will be released via a drain or pumps to tailwater treatment ponds. The Dredging Site Based Management Plan provides more details on spoil disposal area preparation.

The sediment component of the spoil will remain in the disposal area where it will be allowed to dry.

The proposed tailwater treatment system includes a series of treatment ponds to be formed within Residential Area 2 of the NEBP development.

Following settlement within a disposal area that is suitably bunded, tailwater will be released via a drain or pumps to tailwater treatment ponds. The sediment component of the spoil will remain in the disposal area where it will be allowed to dry.

The tailwater treatment system will enable further settlement of sediment from the tailwaters, and the water will be tested and if necessary treated to ensure the required water quality parameters are met, prior to being released from this system. Released water will be piped back to the Caboolture River to discharge.

6. INDICATIVE TREATMENT LEVEL

The treatment level for ASS has been identified at this preliminary stage based on net acidity (%S) as determined through laboratory testing and volume of material to be disturbed. The level of treatment for each terrain unit has been tabulated below and is shown on Figure 4 with the bulk earthworks cut and fill volumes layout plan for the entire site development shown as Figure 5.

Table 2 Treatment Level for ASS based on Terrain Units

Terrain Unit No.	Terrain Unit Description	Bulk disturbance (tonnes)		Level of Treatment
Qha C.5	Near flat to gently undulating plan, slopes < 1% with local low rises (slopes 1-3%); mostly dry surface conditions, with shallow to deep uniform brown clay soils or thin fine sandy to silt loamy surface duplex soils with grey-brown, or yellow brown diffusely mottled stiff sandy clay or medium to heavy clay subsoils (Soil Class 5); in places underlain by sandy alluvium or sandy residual soils – HW sandstone, in the substrate	Cut 572,737 m ³	Fill 1,013,006 m ³	Extra High
Qha C.6	Gently inclined to near flat or broadly undulating plains (slopes 0–0.5%), mostly well-drained dry surficial soil conditions, with deep soft dark grey or brownish black plastic clays over yellow-brown and pale grey mottled, mostly saturated stiff medium to heavy clay subsoils (Soil Class 6).	Cut 107,657 m ³	Fill 560,176 m ³	Extra High
Qha G.1	Flat to gently undulating sand plains and undulating low sand ridges and sandy rises, slopes up to 5% on the steeper slope margins, with deep (203m) uniform fine to medium-grained sand soils (Class 1) underlain by soft to firm and stiff clays and sandy clay substrate materials.	Cut 36,390 m ³	Fill 232,474 m ³	Extra High
Qha E.6	Intermediate and lower flood terraces, stream channels and banks and depressional drainage-ways, (slopes mostly <1%), with dark brown or black plastic silty clay or clay over yellow-brown and grey mottled, stiff medium to heavy clay subsoils underlain by sandy alluvium (Soil Class 6).	Cut 17 m ³	Fill 74 m ³	- (no laboratory analysis)
Qe D.6	Near flat to very gently undulating slightly elevated estuarine flats, surface slopes <0.05%, with deep soft uniform or gradational dark grey or brownish black plastic clays or silty clay surficial soils over dark brown, yellow-brown and grey mottled, saturated medium to heavy clay subsoils (Soil Class 6).	Cut 15,468 m ³	Fill 1,989 m ³	- (no laboratory analysis)
Qe F.6	Estuarine flats, oxbows, abandoned river channels, supratidal flats, tidal inlets with mangroves fringing, seasonal/permanent swampy areas, with dark grey or brown	Cut 473,884 m ³	Fill 184,030 m ³	Extra High

	plastic clay, silty clay and in places silty sand surficial soils, with yellow-brown and grey mottled, saturated sandy clay or medium to heavy clay subsoils (Soil Class 6), underlain by sandy estuarine alluvial deposits.			
Qa C.6	Undulating gently inclined or near flat alluvial plains, moderately to well-drained mostly dry surficial soil conditions (slopes <1%), with deep uniform or gradational dark grey brown or brownish black soft plastic clays with brown, yellow-brown and grey mottled, mostly saturated medium to heavy clay subsoils (Soil Class 6).	Cut 15,616 m ³	Fill 302,408 m ³	Very High
RJI B.4	Gently to moderately inclined mostly planar to concave lower slopes of hills, ridges and low hills, ridges and low rises; slopes variable mostly 2-5%, with sandy loam or sandy surface duplex soils with pale grey (gleyed), yellow-brown or red mottled sandy clay or light, medium or clay subsoils (Soil Class 4).	Cut 215,300 m ³	Fill 186,721 m ³	Very High

It is likely through validation monitoring, the level of treatment for each terrain unit may vary during construction phases as the level of treatment depends on the variability of sulphide concentrations, physical characteristics such as texture and inherent neutralising capacity, and the surface and subsurface hydrology.

The level of treatment given above is described below and management recommendations have been incorporated into this ASSMP.

6.1 Very High Level of Treatment

For disturbances of ASS requiring a very high level of treatment, management strategies should include:

- more detailed plans of disturbance and ASS investigation report (using a higher laboratory analysis intensity if preliminary laboratory analysis was minimal);
- treat soils according to their existing plus potential acidity with appropriate amount of neutralising agent (up to the equivalent of 25 tonnes of fine aglime per tonne of disturbed ASS);
- verification that the ASS have been appropriately treated and that lime has been thoroughly mixed with the soil;
- provide substantial bunding of the site using non-ASS material to collect all site runoff during earthworks;
- monitor pH of any pools of water collected within the bund (particularly after rain) and treat water to keep pH in the range of 6.5–8.5 (or as per site specific conditions);
- prevent infiltration passing through ASS to groundwater or apply extra layer of lime to intercept any infiltration from ASS; and
- provide a simple but adequate environmental management .

6.2 Extra High Level of Treatment

For disturbances of ASS requiring an extra high level of treatment, (greater than 25 tonnes of fine aglime per tonne of disturbed ASS) an ASSMP must be prepared.

An ASSMP must have the following essential components:

- establishment of agreed performance criteria and objectives in relation to environmental and social impacts;
- detailed prevention, minimisation and mitigation strategies (including design standards) for controlling environmental impacts at specific sites;
- details of the proposed monitoring of the effectiveness of remedial measures against the agreed performance criteria in consultation with relevant regulatory agencies and the community. The frequency of monitoring for each parameter and proposed location of monitoring sites should be shown to allow consideration of monitoring in risk assessment;
- details of implementation responsibilities for environmental management (names of responsible positions or persons);
- timing (milestones) of environmental management initiatives;
- reporting requirements and auditing responsibilities for meeting environmental performance objectives and demonstrating 'quality assurance'; and
- corrective actions to rectify any deviation from performance standards.

7. RESPONSIBILITY OF THE CONTRACTOR

The Contractor(s) for bulk earthworks and river dredging shall conduct operations in accordance with this ASSMP. Prior to the commencement of works, the Contractor shall provide the following information to the Principal:

- Contractor's environmental policy.
- Names and responsibilities of supervisory staff involved with the implementation of the ASSMP.
- Schedule of site inspections (and personnel responsible) to identify environmental problems, and maintenance actions to remedy any environmental problems identified.
- An Incidents, Complaints and Enquiries Register, in which all environmental problems identified during inspections and monitoring, and complaints/enquiries received are recorded and acted upon.
- Environmental Training Plan and Training Record Plan for all personnel involved in development of the site.

Emphasis shall be placed upon the timely resolution of any complaints received in relation to development of the site and the implementation of corrective actions in response to non-conformities to the Management Plan (identified by the monitoring process).

The Performance Objective regarding complaint resolution is for the issue causing each complaint to be resolved in such a manner that there is no further complaint for the same reason.

The Contractor is to maintain an "Incidents, Complaints and Enquiries Register" which lists the date of the incident or complaint/enquiry and the type of incident or complaint/enquiry. For each incident/complaint, a record log is to be completed reporting the following.

- Date of incident.
- Nature of incident and associated information.
- Location of incident.
- Name of personnel or complainant that reported incident.
- Employee who received notice of incident.
- Project Manager's review and comment.
- Recommended action to resolve incident.
- List of organisations to be contacted with regard to incident.
- Outcome of actions undertaken subsequent to incident being recorded.
- Date of resolution of incident.

Each incident is to be assigned a number to be entered on the master Register. Further, Council and the Environment Protection Agency (EPA) are to be notified with regard to corrective action(s) for incidents which have the potential to cause environmental harm.

An incident must be notified to the EPA and Council by the registered operator for a site by telephone or fax within 24 hours of becoming aware of the emergency or incident resulting in a release of contaminants not in accordance, or reasonably expected to be in accordance with this ASSMP.

8. ACID SULFATE SOIL MANAGEMENT – BULK EARTHWORKS

8.1 Policy

To minimise as much as reasonably practicable the detrimental impact on the receiving environment from ASS exposure through the effective identification, treatment and management.

To comply with the *Environmental Protection Act 1994* to take all reasonable and practicable measures to prevent or minimise environmental harm and to manage acid sulfate soils in accordance with the *Queensland Acid Sulfate Soil Technical Manual, Soil Management Guidelines* and SPP 2/02.

8.2 Performance Objectives

The objectives of this ASSMP are to ensure the following:

- Adequate treatment of ASS such that they have sufficient acid neutralising capacity and no net acidity (as measured through appropriate field soil testing and laboratory verification), in particular.
 - (a) the neutralising capacity of the treated soil exceeds the existing plus potential acidity of the soil; and
 - (b) post-neutralisation, the soil pH is to be greater than 6.5; and
 - (c) excess neutralising agent remains in the soil until acid generation reactions are complete and the soil has no further capacity to generate acidity.
- Discharge of water from excavation, treatment and fill areas (including runoff and water generated through dewatering activities) complies with the criteria specified in Table 3. This water quality is consistent with requirements the *Environmental Protection (Water) Policy 1997* Schedule 1 and additional reporting supporting the NEBP EIS, specifically the Dredge Site Based Management Plan and the Construction Environmental Management Plan.
- No significant change to groundwater quality indicators and levels from that existing levels/concentrations during excavation and filling activities when groundwater levels are re-established during and post the NEBP construction.
- Implementation of additional assessment procedures during earthworks operations for the effective treatment and management of any drained, disturbed or excavated ASS.

8.3 Identification of ASS through field and soil testing

AASS and PASS, collectively referred to as ASS, are soils containing iron sulphide and exist in an anaerobic state. Upon exposure to oxygen the iron sulphide is converted to iron sulphate, simultaneously releasing acid. When soils release unacceptable quantities of acid, when compared against the action criteria, detailed management is critical.

Preliminary identification of PASS and AASS can be undertaken through field and soil testing.

PASS can be determined through a field investigation, including the field test for peroxide oxidised pH (pH_{FOX}), and confirmed by laboratory analyses using the SPOCAS method, or the chromium reducible sulfur method (S_{CR}). Refer to Appendix G for field testing details.

The characteristics of PASS are as follows:

- often have a pH close to neutral (6.5–7.5);
- contain unoxidised iron sulfides;
- are usually soft, sticky and saturated with water; and
- are usually gel-like muds but can include wet sands and gravels;
- presence of shell; and
- a sulfurous smell e.g. hydrogen sulfide or 'rotten egg' gas.

Water pH is usually neutral but may be acidic in adjacent streams, drains, and groundwater.

A picture of PASS is provided below.



AASS have already undergone oxidation to produce acid, resulting in a soil pH of less than 4. If these soils still contain sulfides, they have the potential to produce more acid if allowed to oxidise further. This would be identified by a further decrease in pH reflected in the pH_{FOX} field test. AASS should also be confirmed by laboratory analyses.

The characteristics of AASS are as follows:

- contain oxidised iron sulfides;
- vary in texture;
- often contain jarosite (a yellow and/or red mottle produced as a by-product of the oxidation process);
- often contain corroded shells; and
- release a sulfurous odour (e.g. hydrogen sulfide or 'rotten egg' gas).

Water and landscape characteristics can also be used to identify AASS including:

- water of pH <5.5 (and particularly below 4.5) in adjacent streams, drains, groundwater or ponding on the surface water (Note: this is not a definitive indicator as organic acids may contribute to low pH in some environments such as melaleuca swamps).
- unusually clear or milky blue-green drain water flowing from or within the area (aluminium released by ASS acts as a flocculating agent);
- extensive iron stains on any drain or pond surfaces;
- unexplained dead, dying, stunted vegetation¹;

¹ may also be due to excessive salinity or to salinity in combination with AASS

- a transition to, or establishment of, a community dominated by acid tolerant species;
- scalded or bare low-lying areas¹; and
- corrosion of concrete and/or steel structures¹.

A picture of AASS is provided below.



8.4 Control Measures

Management of both excavated and in-situ soils are required under this Plan to ensure that the impacts from disturbance of ASS are mitigated to comply with performance objectives.

The SPP 2/02 identifies the following common strategies and options available to manage ASS.

- Avoidance.
- Minimisation of disturbance.
- Neutralisation.
- Strategic reburial (or reinterment).
- Hydraulic separation techniques.

This ASSMP proposes neutralisation as the management strategy for ASS. This strategy has been defined having had due regard to the preferred management strategies in SPP 2/02 given the size and complexity of the project, level of treatment associated with the proposed works, development components and the proximity to and sensitivity of the receiving environment.

The neutralisation process involves the addition of neutralising agents to ensure acid generated by earthworks is collected, neutralised, and that any metals mobilised by the acid are also contained.

8.4.1 Neutralisation of Excavated ASS from Bulk Earthworks

- Neutralising agents must be incorporated within all ASS.
- All cut batters shall be coated with fine aglime and the lime coating should be checked and re-limed as necessary on a daily basis during periods of dewatering. Guard layer rate of application for specific activities should be determined in accordance with the relevant activity specific ASSMP where required
- The base of all fill areas where treated material is to be placed shall be treated with a guard layer of fine aglime per metre depth of fill prior to the placement of any fill soils to neutralise downward seepage of acidic drainage water. This application may need to be increased depending on stockpile height and actual and potential

acidity of the ASS. Guard layer rate of application should be determined in accordance with the activity specific ASSMP following detailed geotechnical investigation. Alternatively ASS shall be placed on an impervious layer. For highly permeable soils, the option of placement of an impervious layer should be adopted where practicable.

- All material to be excavated from the site below a level of 5.0 m AHD shall be subject to validation testing in accordance with section 8.6 of this ASSMP.
- Aglime rates should be as determined through additional targeted environmental contamination investigation and validation testing. Net acidity and liming calculations should be based on TAA + SRAS + SPOS – ANC. A safety factor of 1.5 shall be used when calculating net acidity and liming rates.
- All excavation and treatment areas shall be isolated from major external catchments by perimeter drains and/or bunds covered with an impervious layer or a layer of fine lime to neutralise leachate migrating from the stockpiled material.
- No ASS shall be stockpiled in overland flow areas.
- Stockpiling small volumes of untreated ASS should only be undertaken as a short-term activity. In the event an emerging situation will result in the need for stockpiling, prevent further increases in stockpile volumes or times and as quickly as possible treat the stockpiles that have resulted.
- Engineer-designed erosion and sediment protection measures must be installed in accordance with the Institution of Engineers (Qld Division) Manual for Erosion and Sediment Control (1996) that will adequately contain runoff from all areas of land used for treatment of ASS. Erosion and sediment protection measures shall be designed with regard to soil properties and erosion risk (the risk of erosion based on terrain units subject to ASS is illustrated in Figure 6).
- Soil must be sufficiently dry before liming is commenced so that the lime can be thoroughly mixed through the soil. Where moisture levels in soil are high, the soil must be dried by spreading and leaving open to the atmosphere. Drying can be accelerated by regular aeration by turning with an excavator or backhoe. Drying should be carried out on a guard layer within the fill area and protected from stormwater ingress. Note: At all sites the standing groundwater level is below the cut depth.
- Mixing of ASS material with lime shall be carried out by spreading the soil in layers of not more than 300-400mm thick using an agricultural spreader and disc plough, rotary hoe or similar. Care shall be taken to ensure that mixing occurs throughout the depth of the layer prior to placement of new material.
- Following the successful treatment of the lot (as determined through the validation testing), the material shall be compacted and the next layer of excavated material to be treated shall be placed over the already treated material. This process shall be continued until the required site elevation is achieved.
- Equipment used in the treatment of ASS shall be washed to prevent corrosion.

8.4.2 Neutralising Materials

- A sufficient supply of aglime shall be kept on site at all times for the treatment of acid sulfate soils given excavated materials are slightly acidic and of low solubility.
- The aglime should be fine ground (< 1mm) calcium carbonate (CaCO_3) or calcite (limestone or marble).

- Dolomitic aglime, or magnesium-blend aglime, should not be used as these materials impose environmental risks from overdosing with the potential to damage estuarine ecosystems.
- The supply shall be stored in a covered and bunded area to prevent accidental release to waters and deterioration of neutralising capacity.
- A reasonable quantity of calcium hydroxide solution (hydrated lime) shall be kept on site at all times for treatment of acidic waters. The supply shall be stored in a covered and bunded area to prevent accidental release to waters.
- Neutralising agents must be replenished and or replaced regularly to remain effective against loss by wind or water erosion.

8.4.3 Validation Testing

- Validation testing using field analysis to determine net acidity and therefore a change in the intensity of laboratory sampling shall be undertaken at a minimum rate of one test per 250m³ of material for cut and fill works. Methodology for field sampling is attached as **Appendix C**.
- In the presence of positive field tests validation testing using laboratory analysis to determine net acidity and appropriate liming rate shall be carried out on placed and treated material at a negotiated intensity following additional geotechnical investigations. Validation testing shall have due regard to the risk-based terrain mapping approach to ASS determination, borehole investigations across the site since 2003, volume of material to be excavated and low net acidity.
- In the absence of positive field tests validation testing using laboratory analysis to confirm field results shall be carried out on fill material at a negotiated intensity following additional geotechnical investigations. Validation testing shall have due regard to the risk-based terrain mapping approach to AS determination, borehole investigations across the site since 2003, volume of material to be excavated² and low net acidity.
- Through validation testing the post-neutralisation soil pH must exceed 6.5.
- Validation testing methodology shall be carried out in accordance with the *Acid Sulfate Soils Laboratory Methods Guidelines* (June 2004).
- Samples for laboratory analysis will be obtained by aggregating material from three separate locations within the subject quantity of excavated or treated soil.

8.5 Environmental Monitoring

8.5.1 Surface Water

- All water generated from dewatering activities, seepage and site runoff shall be contained, tested and treated (if necessary) prior to discharge.
- Ponded water shall be tested for pH on a weekly basis, and no water shall be discharged from site unless it complies with the requirements of Table 3 These requirements have been specified in the Construction Environmental Management Plan.

² The volume of material to be extracted for fill is provided in the Environmental Impact Statement prepared for Northeast Business Park Pty Ltd for the Northeast Business Park Development.

- Treatment of ponded water may include the addition of flocculating agents to reduce the suspended solids concentration, and the addition of hydrated or aglime to control pH.

Table 3 Bulk Earthworks Water Quality Release Criteria

Water Quality Parameter	Release Criteria	Limit Type	Test	Frequency
pH	6.5 – 8.5	Maximum	Field	Daily
Dissolved Oxygen (% saturation)	80-105	Range	Field	Daily
Suspended Solids	50 mg/L	Maximum	Laboratory	Weekly and/or prior to a discharge
Aluminium	10% above background*	Medium	Laboratory	Weekly and/or prior to a discharge
Iron	10% above background*	Medium	Laboratory	Weekly and/or prior to a discharge
Oil and grease	No visible film No detectable odour	Nil	Field	Daily
Iron floc and scum	None visible	Nil	Field	Daily
Floating matter	None visible	Nil	Field	Daily
Water Colour	No Change	Nil	Nil	Daily

- Background levels are provided in Table 13 of the report entitled “Redevelopment of Land at Caboolture: Aquatic Ecology Investigations for the proposed Northeast Business Park”, existing as Appendix L2 of the NEBP EIS. It is noted that this report highlighted high background Aluminium and Iron concentrations in the existing site and adjacent waters.
- The Contractor shall monitor the project area on a daily basis for evidence of:
 - iron staining at the batters of the excavation;
 - yellow efflorescence on soil surface; and
 - sulfurous odour.

8.5.2 Groundwater

- Groundwater monitoring bores shall be established, in particular around the perimeter of the marina excavation, and monitored to determine groundwater chemistry and standing water level.
- Groundwater will be monitored during construction as follows:
 - at least monthly for pH and groundwater level (or more frequently as required depending on the location in relation to the disturbance area and level); and
 - at least monthly for total dissolved solids.
- Groundwater management strategies will be implemented in areas where activities are shown as causing permanent drawdown through groundwater monitoring. Options for groundwater management will be investigated as part of the development of specific activity ASSMP.

8.6 Records

- Lime delivery dockets are to be collected and checked against calculated amounts of lime used.
- Records of how and where neutralising agent was used on site must be kept in a dedicated register.
- Records of monitoring results must be maintained in a dedicated register to allow for trend analysis and environmental reporting to Administering Authorities as per approval conditions.

8.7 Corrective Action

The following steps shall be taken to address non-compliances with this ASSMP.

1. The Site Staff shall take appropriate steps to contain the released material.
2. The Site Manager shall be notified and will make an initial assessment of the severity of the release and the nature of the spilt material.
3. The Site Manager shall notify the Environmental Officer of the accidental release of acidic material.
4. The Environmental Officer shall take steps to treat, remove or otherwise manage the acidic material in accordance with this plan or otherwise in accordance with Government requirements. A record log shall be incorporated into the Incidents, Complaints and Enquiries Register.
5. The Environmental Officer shall assess the work procedures and/or cause of the failure and implement any changes deemed to be appropriate, in consultation with the Site Manager to prevent reoccurrence of a similar incident in the future. A Corrective Action Request form shall be completed (attached as **Appendix D**).
6. The Environmental Officer shall make an assessment of the area to confirm the success of the corrective action(s) and whether additional works are required.

9. ACID SULFATE SOIL MANAGEMENT – DREDGE SPOIL

9.1 Policy

To minimise as much as reasonably practicable the detrimental impact on the receiving environment from ASS exposure through the effective identification, treatment and management.

To comply with the *Environmental Protection Act 1994* to take all reasonable and practicable measures to prevent or minimise environmental harm and to manage acid sulfate soils in accordance with the *Queensland Acid Sulfate Soil Technical Manual, Soil Management Guidelines* and SPP 2/02.

9.2 Performance Objectives

The objectives of this ASSMP for dredge spoil are to ensure the following.

- Adequate treatment of PASS such that spoil has sufficient acid neutralising capacity and no net acidity, in particular
 - (a) the neutralising capacity of the treated soil exceeds the existing plus potential acidity of the soil; and
 - (b) post-neutralisation, the soil pH is to be greater than 6.5; and
 - (c) excess neutralising agent remains in the soil until acid generation reactions are complete and the soil has no further capacity to generate acidity.

9.3 Control Measures

Management of dredge spoil may be required to ensure that the impacts from disturbance of PASS are mitigated to comply with performance objectives.

The SPP 2/02 identifies the following common strategies and options available to manage PASS.

- Avoidance.
- Minimisation of disturbance.
- Neutralisation.
- Strategic reburial (or reinterment).
- Hydraulic separation techniques.

This ASSMP proposes neutralisation as the management strategy for PASS. This strategy has been defined having had due regard to the preferred management strategies in SPP 2/02 given the size and complexity of the project, level of treatment associated with the proposed works, development components and the proximity to and sensitivity of the receiving environment.

The neutralisation process involves the addition of neutralising agents to ensure acid generated by earthworks is collected, neutralised, and that any metals mobilised by the acid are also contained.

9.3.1 Neutralisation of Excavated ASS from Dredge Spoil

- Neutralising agents must be incorporated within all PASS.
- The Dredge Spoil Disposal Area (or cells) must be lined with impervious material.
- Spoil reuse as fill shall be undertaken in accordance with Element 10 of the Dredging SBMP "Dredge Spoil Management".
- Bunds shall be placed around the Dredge Spoil Disposal Area (or cells) and shall be treated with a guard layer of 5kg/m² of fine aglime per metre depth of fill prior to the placement of any fill soils to neutralise downward seepage of acidic drainage water.
- Bunds shall prevent entry of stormwater runoff to the spoil disposal areas. Bunds shall be of a sufficient size to protect against flood levels.
- Dredging tailwaters shall be collected via a series of pipes in a tailwater treatment pond (or series thereof) in accordance with the Dredging SBMP for management and treatment prior to offsite release.
- All fill material shall be subject to validation testing at in accordance with section 9.5 of this ASSMP.
- Aglime rates should be as determined through additional targeted environmental contamination investigation and validation testing. Net acidity and liming calculations should be based on TAA + SRAS + SPOS – ANC. A safety factor of 1.5 shall be used when calculating net acidity and liming rates.
- Engineer-designed erosion and sediment protection measures must be installed in accordance with the Institution of Engineers (Qld Division) Manual for Erosion and Sediment Control (1996) that will adequately contain runoff from all areas of land used for treatment of ASS. Erosion and sediment protection measures shall be designed with regard to soil properties and erosion risk (the risk of erosion based on terrain units subject to ASS is illustrated in Figure 6).
- Soil must be sufficiently dry before liming is commenced so that the lime can be thoroughly mixed through the soil. Where moisture levels in soil are high, the soil must be dried by spreading and leaving open to the atmosphere. Drying can be accelerated by regular aeration by turning with an excavator or backhoe. Drying should be carried out on a guard layer within the fill area and protected from stormwater ingress.
- Mixing of ASS material with lime shall be carried out by spreading the soil in layers of not more than 300-400 mm thick using an agricultural spreader and disc plough, rotary hoe or similar.
- Following the successful treatment of the lot (as determined through the validation testing), the material shall be restacked and the process repeated including drying for the next quantity of spoil determined through validation testing as requiring treatment.
- Equipment used in the treatment of PASS shall be washed to prevent corrosion.

9.3.2 Neutralising Materials

- A sufficient supply of aglime shall be kept on site at all times for the treatment of acid sulfate soils given spoil is defined as PASS.
- The aglime should be fine ground (< 1mm) calcium carbonate (CaCO₃) or calcite (limestone or marble).

- Dolomitic aglime, or magnesium-blend aglime, should not be used as these materials impose environmental risks from overdosing with the potential to damage estuarine ecosystems.
- The supply shall be stored in a covered and bunded area to prevent accidental release to waters and deterioration of neutralising capacity.
- A reasonable quantity of calcium hydroxide solution (hydrated lime) shall be kept on site at all times for treatment of acidic waters in the tailwater treatment ponds. The supply shall be stored in a covered and bunded area to prevent accidental release to waters.
- Neutralising agents must be replenished and or replaced regularly to remain effective against loss by wind or water erosion.

9.3.3 Validation Testing

- Validation testing using laboratory analysis to determine net acidity and appropriate liming rate shall be carried out on dredge spoil at a rate of one test per 500m³ given the geotechnical findings that all materials in PASS.
- Validation testing methodology shall be carried out in accordance with the *Acid Sulfate Soils Laboratory Methods Guidelines* (June 2004).
- Samples for laboratory analysis will be obtained by aggregating material from three separate locations within the subject quantity of excavated or treated soil.

9.4 Environmental Monitoring

9.4.1 Surface Water

- All water generated from spoil disposal shall be contained, tested and treated (if necessary) prior to discharge on site in accordance with Element 4 of the Dredging SBMP and any additional parameters highlighted in Table 3 above.
- Treatment of ponded water may include the addition of flocculating agents to reduce the suspended solids concentration, and the addition of hydrated lime or aglime to control pH.

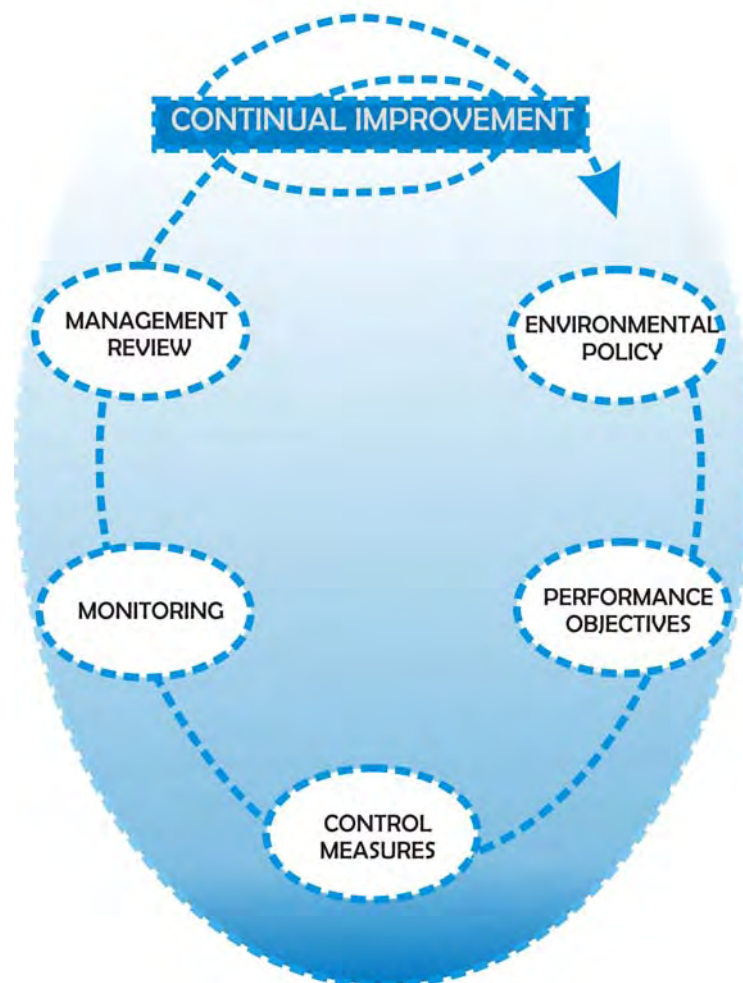
10. SYSTEM REVIEW

The suitability, adequacy and effectiveness of this and any activity specific ASSMP must be reviewed annually following a continual improvement procedure and changes incorporated into the relevant ASSMP. The review should consider the following matters.

- Suitability of the objectives.
- The extent to which the objectives have been met.
- Monitoring results (validation monitoring and water monitoring).
- Audit findings.
- Technical reviews.
- Changes to organisational structure, plant and equipment, or procedures and practices.

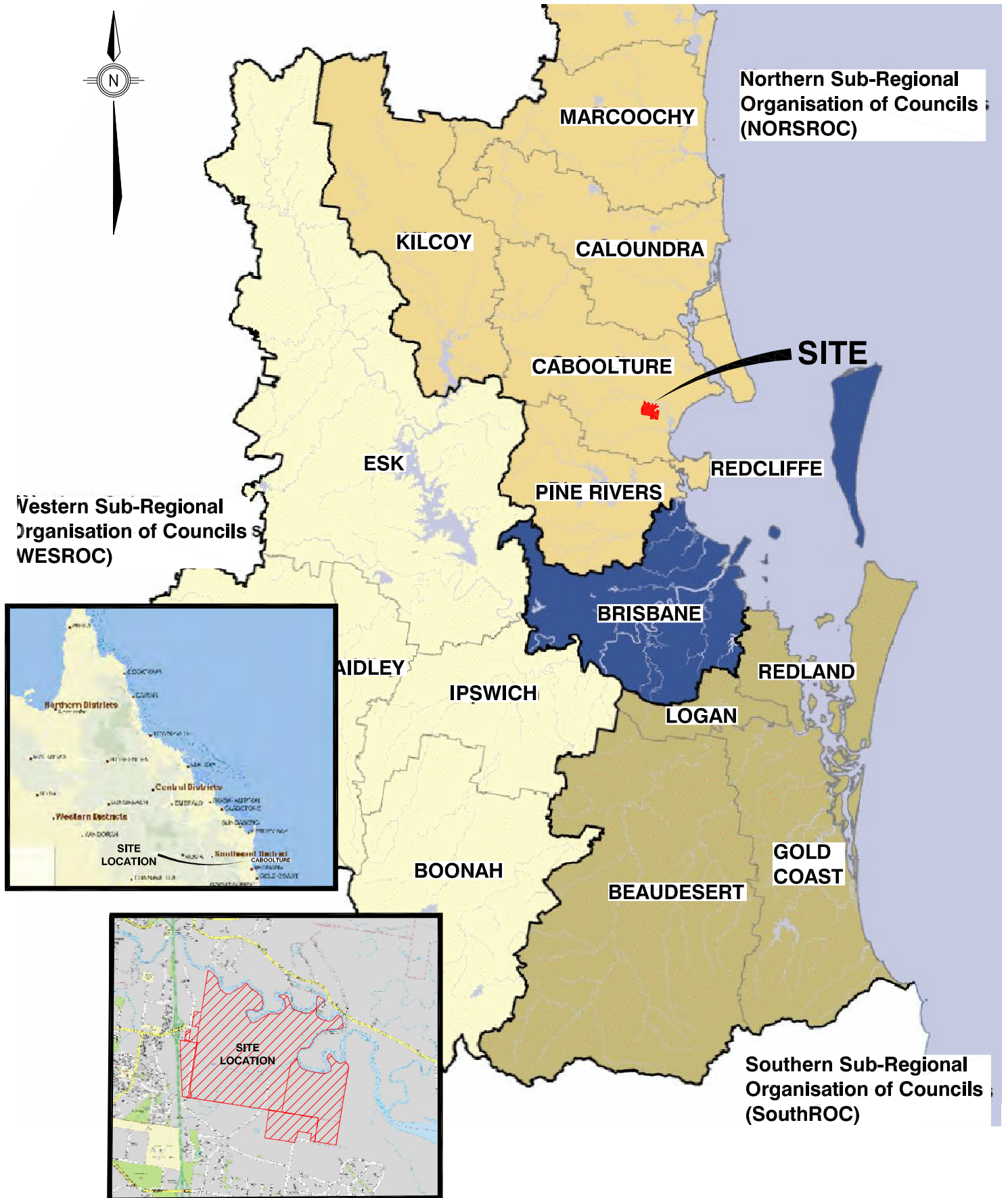
The ASSMP must not be implemented or amended in a way that contravenes any condition of the relevant development approval.

Details of any amendment to the ASSMP must be provided to the Administering Authority at the time of Annual Return.



FIGURES

- Figure 1 Site Locality**
- Figure 2 Development Proposal**
- Figure 3 Caboolture River Dredging**
- Figure 4 Extent of Acid Sulfate Soils based on Terrain Units**
- Figure 5 Bulk Earthworks Cut and Fill Volumes Layout Plan**
- Figure 6 Acid Sulfate Soils and Erosion Risk**



Queensland Map sourced from "South East Queensland Regional Plan 2005-2006"

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Rev: 2. Date: 19 October 2007

Northeast Business Park Pty Ltd

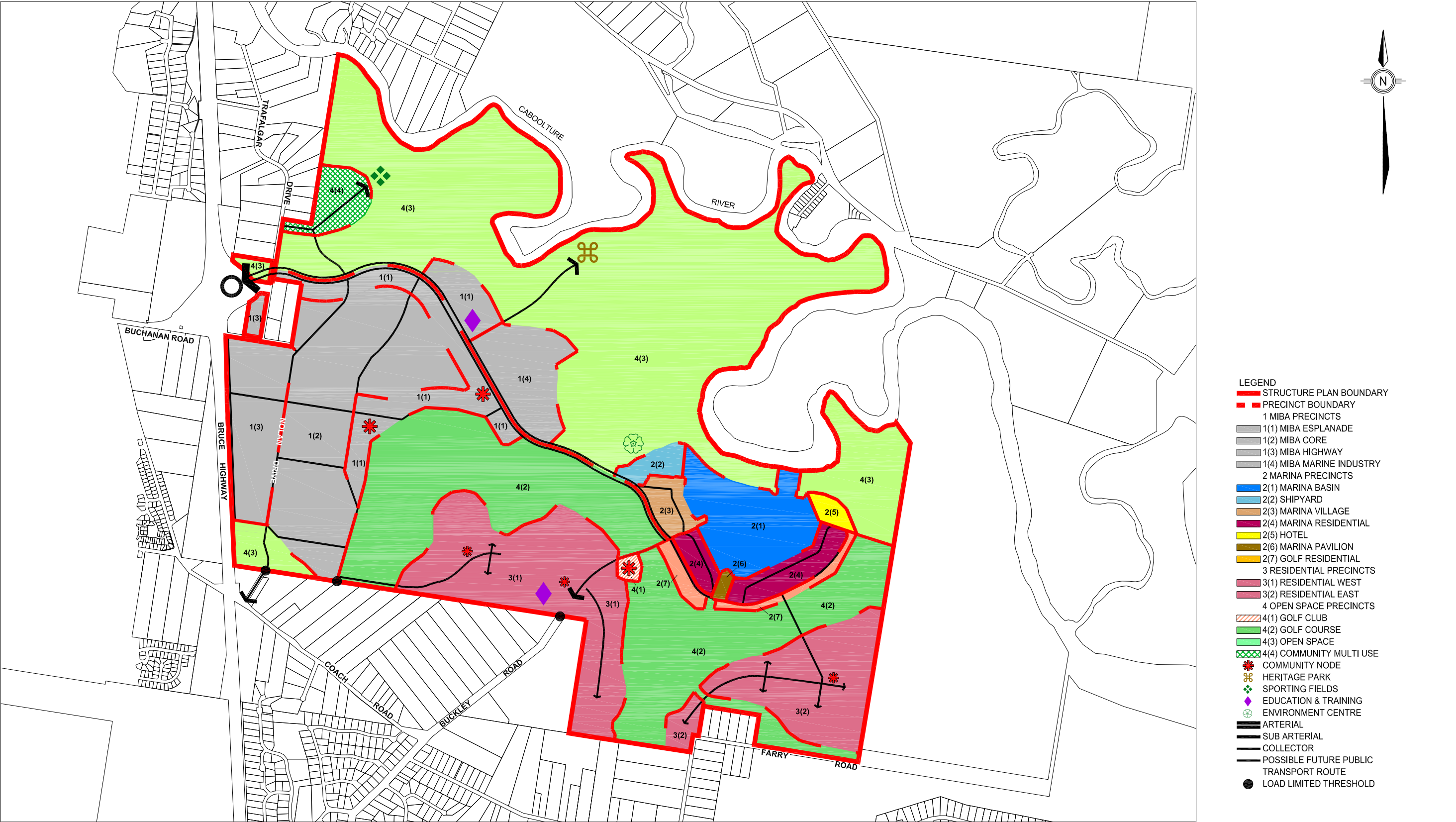
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XREF's: Caboolture_mga94

Not To Scale

FIGURE 1 SITE LOCALITY

Project No.: 7900/33

PRINT DATE: 19 October, 2007 - 3:49pm



Plan sourced from PMM Brisbane Pty Ltd, Dwg name 20430STRUCTURE,
Plan Ref 20430-10F, 25 September 2007.

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CAD FILE: I:\7800-40\ACAD\Acid Sulphate Soil Management Plan\Figure 2 - Development Proposal.dwg

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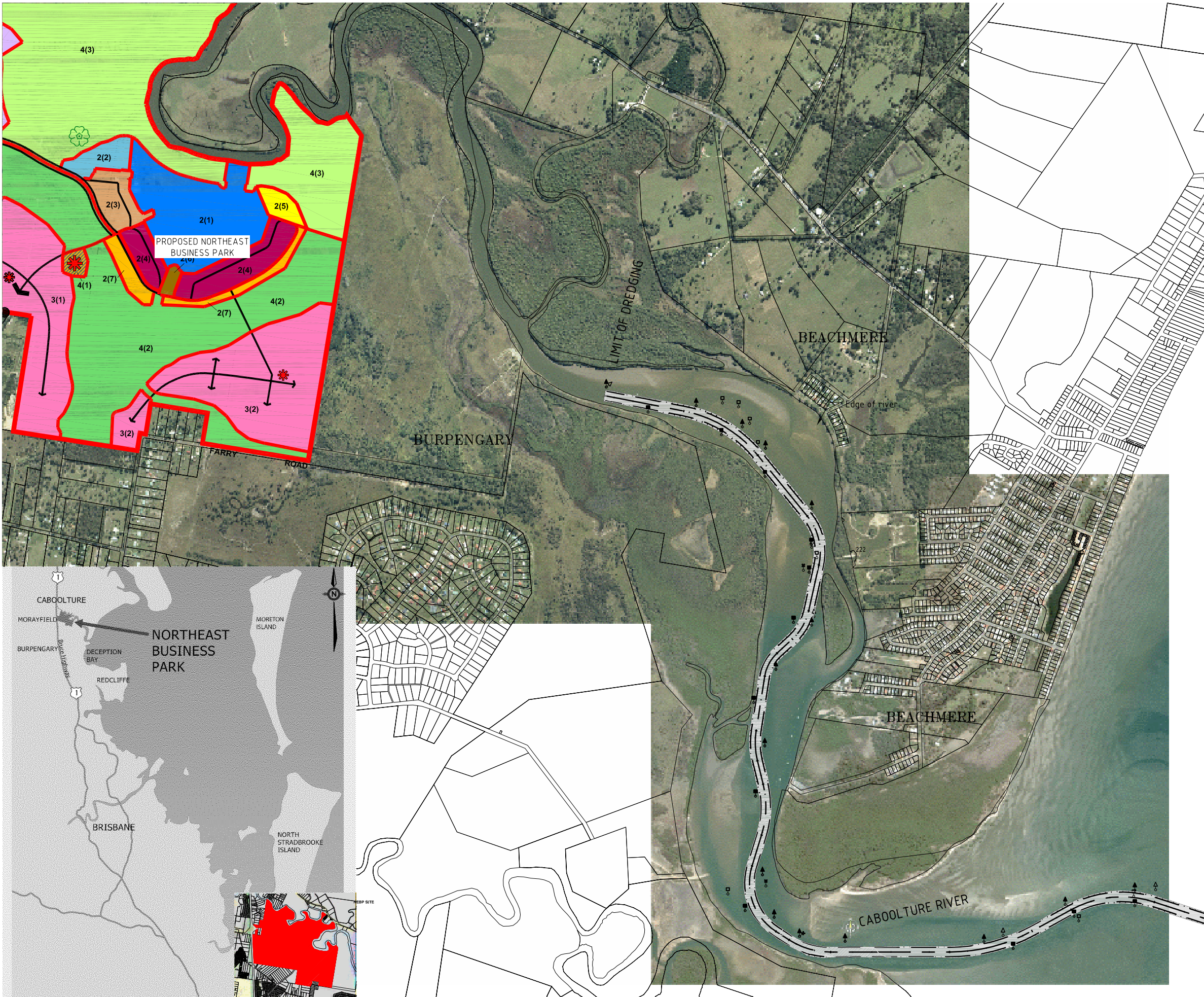
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FIGURE 2 DEVELOPMENT PROPOSAL

Project No.: 7900/33

PRINT DATE: 19 October, 2007 - 3:02pm



NAVIGATION AID LOCATIONS
SPECIFIED BY THE HARBOUR MASTER

PROPOSED NAVIGATION AIDS - GDA94 MGA Zone 56

No.	NAV AID	EASTING	NORTHING
1.	STBD BCN	505818.000	6996864.000
2.	PORT BCN	505776.000	6996683.000
3.	STBD BCN	505391.000	6996926.000
4.	PORT BCN	505391.000	6996845.000
5.	STBD BCN	505028.000	6996844.000
6.	PORT BCN	505098.000	6996766.000
7.	STBD BCN	504604.000	6996657.000
8.	PORT BCN	504756.000	6996622.000
9.	STBD BCN	503879.000	6996660.000
10.	PORT BCN	503357.000	6996820.000
11.	STBD BCN	503641.000	6996686.000
12.	PORT BCN	503412.000	6997417.000
13.	STBD BCN	503509.000	6996785.000
14.	PORT BCN	503402.000	6997905.000
15.	STBD BCN	503448.000	6997007.000
16.	PORT BCN	503610.000	6998323.000
17.	STBD BCN	503460.000	6997679.000
18.	PORT BCN	503691.000	6998585.000
19.	STBD BCN	503518.000	6998078.000
20.	PORT BCN	503713.000	6998729.000
21.	STBD BCN	503705.000	6998309.000
22.	PORT BCN	503505.000	6999127.000
23.	STBD BCN	503695.000	6998908.000
24.	PORT BCN	503251.000	6999319.000
25.	STBD BCN	503464.000	6999231.000
26.	PORT BCN	502851.000	6999420.000
27.	STBD BCN	503343.000	6999343.000
28.	STBD BCN	503102.000	6999453.000
29.	PORT BCN	502633.000	6999551.000

LEGEND

- Proposed and Existing Green Navigation Beacon
- Proposed and Existing Red Navigation Beacon
- Existing Yellow Navigation Beacon

NOTE:

- Total dredging cut quantity is 545,300m³
- Total dredging area is 356,553m²
- Minimum depth of dredging is 0.000m
- Maximum depth of dredging is 3.210m

100 0 100 200 300 400 500m
SCALE BEFORE REDUCTION 1:10000

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A1 DATUM: A.H.D.

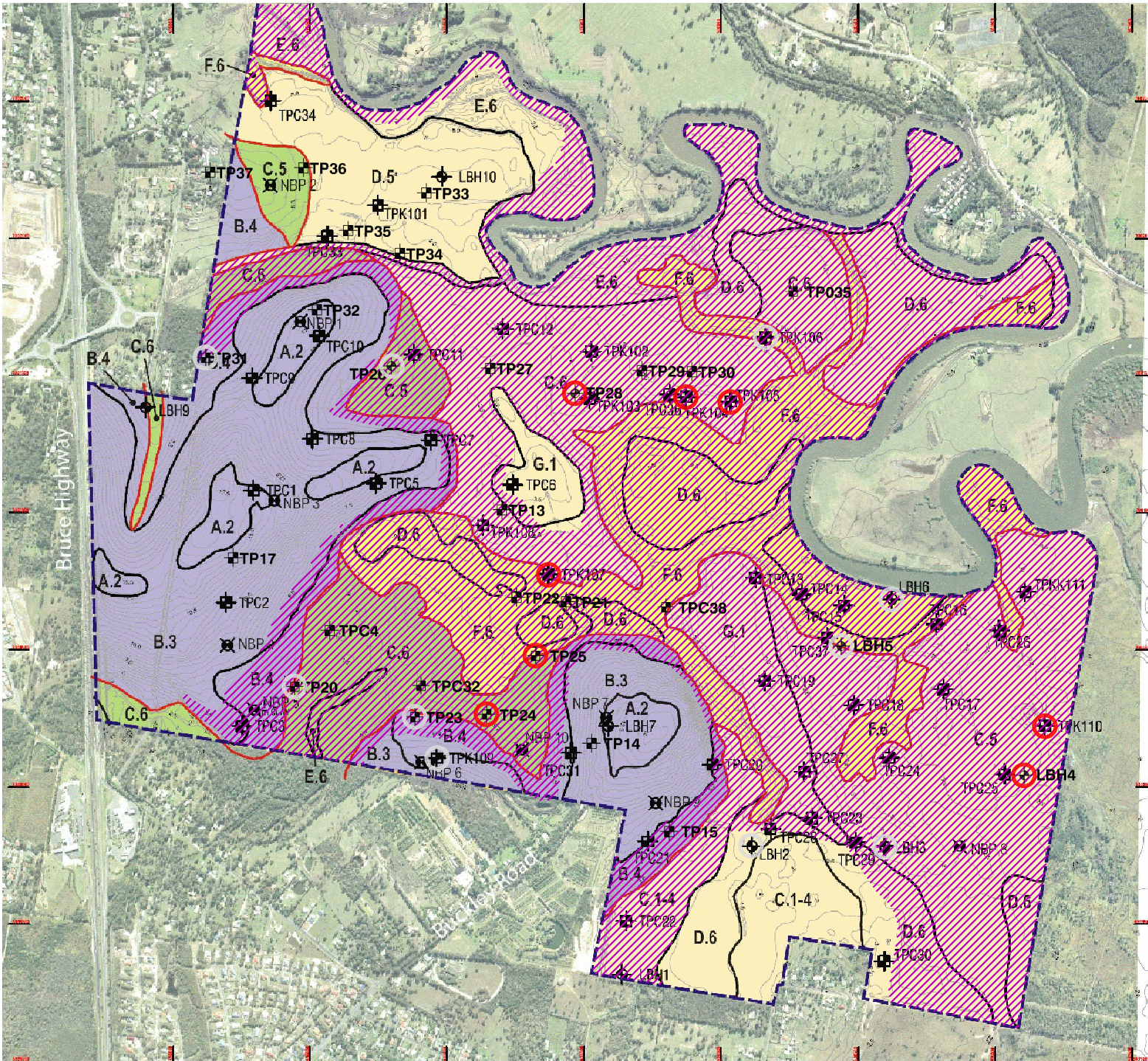
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Level 1, 5 Gardner Close, Milton 4064
P.O. Box 388, Toowoong 4066.
ACN: 051 074 992

**NORTHEAST
BUSINESS PARK**

Queensland Transport Preferred
Navigational Channel
for Dredging Works

DATE: 14-11-2007








Figure 3



Geological Regimes	
Symbol	Description
Qha	Quaternary Holocene Alluvium – clay/silt and sand deposits in active floodplains, stream channels and intertidal and lower stream terraces.
Qe	Quaternary Estuarine Alluvium – clay/silt and sand deposits in mapped, includes tidal channels and flats with mangroves fringing river inlets.
Qa	Quaternary Alluvium – floodplains and older alluvial plain deposits, clay, silt sand and gravel.
RJ1	Triassic Jurassic Landborough Sandstone – comprising inter-tidal sandstone, siltstone and shale.

Landform Categories	
Category	Description
A.	Broadly rounded coastal areas and upper marginal slopes on low hills, ridges and broad low rises.
B.	Gently to moderately inclined slopes of low hills, ridges and low rises.
C.	Undulating gently inclined or near flat plains, well drained mostly dry surface conditions.
D.	Near flat to broadly depressional or gently undulating plains, locally low-lying and poorly drained with seasonally wet surface conditions.
E.	Stream channels, banks and low flood terraces.
F.	Estuarine flats, oxbows, abandoned river channels, tidal mangrove flats, tidal areas with mangroves fringing, seasonal intermittent swampy areas.
G.	Flat, gently undulating sand plains and undulating low sand ridges and sandy rises.

Soil Type	
Class	Description
1	Deep uniform fine to medium-grained sand soils; Siliceous Sands, Gruffy Sands.
2	Sandy to loamy surface granular red massive earth soils, Red Earths.
3	Sandy to loamy surface mainly gradational yellow massive earth soils; Yellow Earths, some Yellow Podzolic soils.
4	Sandy surface duplex soils with pale grey and yellow-brown or red mottled sandy clay to light, medium or heavy clay subsoils; Cleaved Podzolic soils.
5	Mixed occurrences of uniform or gradational clay soils and rain forest surface duplex soils with dark brown, red brown or yellow brown still sandy or silty clay to medium or heavy clay subsoils; Alluvial Soils, Brown or Grey Clay soils.
6	Mostly deep soft uniform or gradational dark grey brown or brownish black plastic clays with dark brown, yellow-brown and pale grey mottled, mostly saturated medium to heavy clay subsoils; Heavy Grey and Alluvial Black Earth soils.

Legend	
	TEST PIT
	DRILL HOLE
	DRILL HOLE (PLACE)
	SITE BOUNDARY
	TESTPIT THAT TESTED POSITIVE FOR AASS
	TESTPIT THAT TESTED POSITIVE FOR PASS
	POTENTIAL ACID SULPHATE SOIL

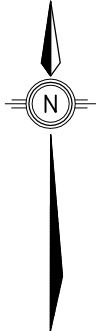


Image as per "Terrain Units", Dwg No./Issue NEP01_02/A,
PLACE ENVIRONMENTAL, February 2007

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Rev: 2. Date: 19 October 2007

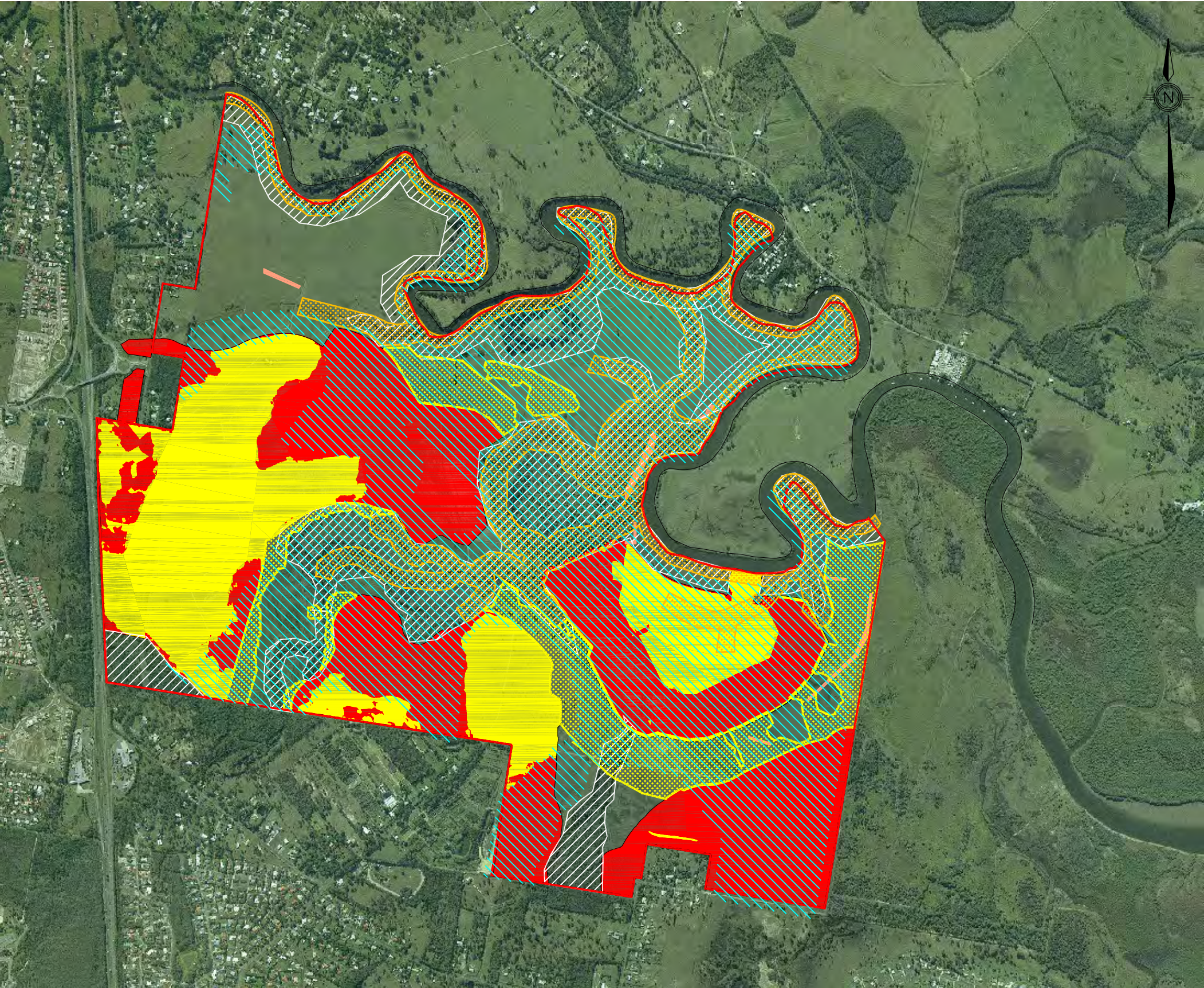
Northeast Business Park Pty Ltd
CAD FILE: \\17800-40\ACAD\Acid Sulphate Soil Management Plan\Figure 4 - Extent of Acid Sulphate Soil based on Terrain Units.dwg
XREF's:

200 0 200 400 600 800 1000m
1:20,000

Scale 1:20,000 (A3)

FIGURE 4
EXTENT OF ACID SULPHATE SOILS BASED ON TERRAIN UNITS

Project No.: 7900/33
PRINT DATE: 19 October, 2007 - 2:55pm



LEGEND:

- CUT
- FILL
- MITIGATED CUT
- COASTAL MANAGEMENT DISTRICT (CMD)
- ENVIRONMENTAL PROTECTION ZONE
- POTENTIAL ACID SULPHATE SOIL
- DIVERSION BUNDS
- SITE BOUNDARY

CUT TO FINISHED DESIGN LEVELS

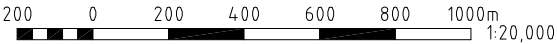
CUT VOLUMES & AREAS			
	CUT	AREA	AVERAGE DEPTH
INDUSTRIAL AREA	1,170,886m ³	952,443m ²	1.235m
RESIDENTIAL AREA 1	772,774m ³	315,207m ²	2.452m
RESIDENTIAL AREA 2	1,761m ³	4,580m ²	0.384m
MARINA	861,748m ³	322,605m ²	2.671m
CUT MITIGATION (A)	89,445m ³	151,257m ²	0.591m
CUT MITIGATION (B)	76,826m ³	77,709m ²	0.989m
CUT MITIGATION (C)	7,451m ³	23,526m ²	0.317m
CUT MITIGATION (D)	778,744m ³	529,766m ²	1.470m
RIVER DREDGING	545,304m ³		
TOTAL CUT	4,304,939m ³	2,377,093m ²	1.811m

FILL TO FINISHED DESIGN LEVELS

FILL VOLUMES & AREAS			
	FILL	AREA	AVERAGE DEPTH
INDUSTRIAL AREA	1,105,504m ³	786,482m ²	1.406m
RESIDENTIAL AREA 1	730,708m ³	416,247m ²	1.755m
RESIDENTIAL AREA 2	1,237,860m ³	513,419m ²	2.411m
MARINA	649,655m ³	435,716m ²	1.491m
DIVERSION BUNDS	21,224m ³	19,690m ²	1.078m
TOTAL FILL	3,744,951m ³	2,171,554m ²	1.725m

TOTAL FILL VOLUME = 3,744,951m³
TOTAL CUT VOLUME = 4,304,939m³
CUT TO FILL RATIO = 115%

STRIPPING QUANTITIES (100mm DEPTH)	
	VOLUMES
INDUSTRIAL AREA	174,199m ³
RESIDENTIAL AREA 1	72,232m ³
RESIDENTIAL AREA 2	51,807m ³
MARINA	72,496m ³
CUT MITIGATION (A)	15,125m ³
CUT MITIGATION (B)	7,770m ³
CUT MITIGATION (C)	2,352m ³
CUT MITIGATION (D)	52,976m ³
TOTAL STRIP QUANTITY	448,957m ³

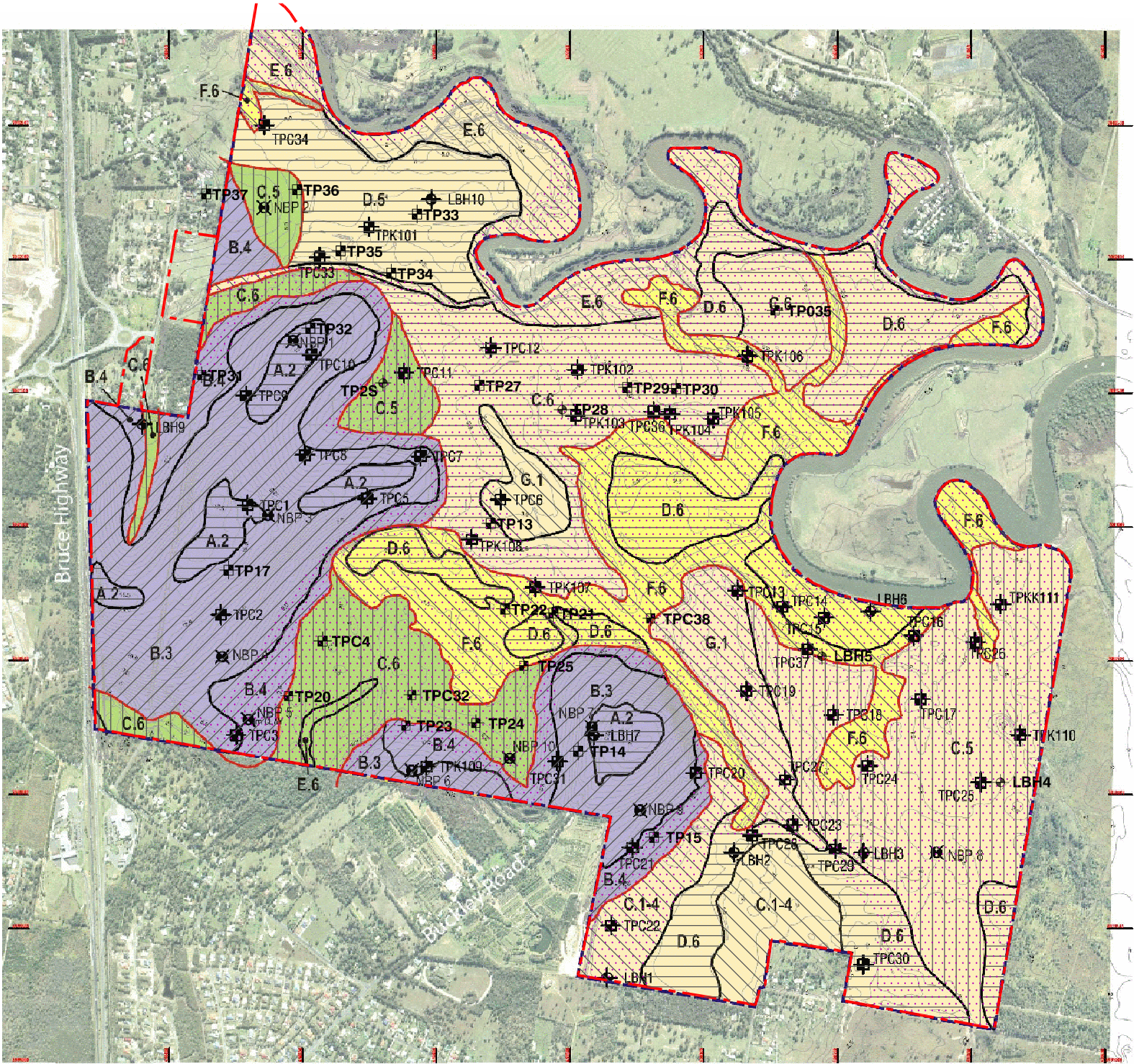


Scale 1:20,000 (A3)

FIGURE 5
BULK EARTHWORKS CUT AND FILL LAYOUT PLAN

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Geological Regimes	
Symbol	Description
Qfa	Quaternary Holocene Alluvium – clay silt and sand deposits in active floodplains, stream channels and abandoned and lower stream outcrops.
Qe	Quaternary Estuarine Alluvium – clay, silt and sand deposits as mapped, includes tidal channels and flats with mangroves fringing river inlets.
Qa	Quaternary Alluvium – floodplains and older alluvial plain deposits, clay, silt sand and gravel.
RJ1	Fossils Jurassic Landsborough Sandstone – comprising litho-feldspar, calcareous sandstone, siltstone and shale.

Landform Categories	
Category	Description
A	Broadly rounded coastal areas and upper marginal slopes on low hills, ridges and broad low rises.
B	Gently to moderately inclined slopes of low hills, ridges and low rises.
C	Undulating gently inclined or near flat plains, well drained mostly dry surface conditions.
D	Near flat to broadly depressional or gently undulating plains, locally low-lying and poorly drained with seasonally wet surface conditions.
E	Stream channels, banks and low flood terraces.
F	Estuarine flats, oxbows, abandoned river channels, tidal mangrove flats, tidal inlets with mangroves fringing, seasonal barrages or swampy areas.
G	Flat, locally undulating sand plains and undulating low sand ridges and sandy rises.

Soil Type	
Class	Description
1	Deep uniform fine to medium-grained sand soils; Siliceous Sands, Grassy Sands.
2	Sandy to loamy surface granular red massive earth soils; Red Earths.
3	Sandy to loamy surface mainly gradational yellow massive earth soils; Yellow Earths, some Yellow Podzolic soils.
4	Sandy surface duplex soils with pale grey and yellow-brown or red mottled sandy clay to light, medium or heavy clay subsoils; Cleaved Podzolic soils.
5	Mixed occurrences of uniform or gradational clay soils and rain forest duplex soils with dark brown, red brown or yellow-brown still sandy or silty clay to medium or heavy clay subsoils; Alluvial Soils, Brown or Grey Clay soils.
6	Mostly deep soft uniform or gradational dark grey brown or brownish black plastic clays with dark brown, yellow-brown and pale grey mottled, mostly saturated medium to heavy clay subsoils; Heavy Grey and Alluvial Black Earth soils.

Legend	
	TPK TEST PIT
	TPC TEST PIT
	LBH DRILL HOLE
	NBP DRILL HOLE (PLACE)
	SITE BOUNDARY
	LOW EROSION POTENTIAL
	LOW - MEDIUM EROSION POTENTIAL
	MEDIUM EROSION POTENTIAL
	MEDIUM - HIGH EROSION POTENTIAL
	POTENTIAL ACID SULPHATE SOIL

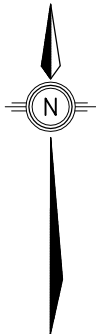


Image as per "Terrain Units", Dwg No./Issue NEP01_02/A,
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Rev: 2. Date: 19 October 2007

Northeast Business Park Pty Ltd

CAD FILE: I:\7800-40\ACAD\Acid Sulphate Soil Management Plan\Figure 6 - Acid Sulphate Soil and Erosion Risk.dwg
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Scale 1:20,000 (A3)

FIGURE 6 ACID SULPHATE SOIL AND EROSION RISK

Project No.: 7900/33

PRINT DATE: 19 October, 2007 - 3:37pm

APPENDIX A

Douglas Partners (2004) Preliminary Acid Sulfate Soil Management Plan

ACL:al
Project 33454B
22 July 2004

PRELIMINARY ACID SULFATE SOIL MANAGEMENT PLAN
PARCEL 62, 2-32 AND 34 NOLAN DRIVE, MORAYFIELD

1.0 INTRODUCTION

PMM Group commissioned this Acid Sulfate Soil Management Plan (ASSMP) on behalf of the Lensworth Group Ltd to apply during proposed development works at the Morayfield site. Preliminary testing has been carried out to determine the presence of acid sulfate soils (ASS) within proposed excavation zones at the site and is reported in the following document:

- Douglas Partners (DP) (February, 2004) *Report on Acid Sulfate Soil and Preliminary Geotechnical Investigation, 2-32 and 34 Nolan Drive, Morayfield*. Project No 33454A.

The ASS investigation in February 2004 was preliminary only, and additional investigations for ASS are proposed. Hence, this ASSMP is intended to be indicative of the likely neutralisation rates and environmental protection measures required.

The objective of this ASSMP is to outline management options for prevention of environmental impacts resulting from the disturbance of potential acid sulfate soil materials. The ASSMP is aimed at controlling or remediating the generation of acid potential.

The ASSMP is based on procedures described by QASSIT (1998)¹, as well as Dear *et al* (2000)² and Dear *et al* (2002)³.

¹ QASSIT (Queensland Acid Sulfate Soil Investigation Team (1998). *Sampling and Analysis Procedure for Lowland Acid Sulfate Soils in QLD*, October 1998, Revision 4.0.

² Dear SE, Ahern CR and Moore NG (2000). Acid Sulfate Soil Management Plans for Queensland, in *Acid Sulfate Soils: Environmental Issues, Assessment and Management*. Technical Papers, Queensland Department of Natural Resources, Brisbane.

2.0 PROPOSED DEVELOPMENT

It is understood that the Lensworth Group propose to redevelop the site into a modern business and industrial precinct. Material from low lying areas of the site is proposed to be excavated and used as fill elsewhere on the site.

3.0 PREVIOUS ACID SULFATE SOIL INVESTIGATIONS

The Acid Sulfate Soil Investigation was only preliminary and further investigations would be required as described in S 3.1 to accurately determine acid sulfate soil potential at the site.

In the previous investigation 78 soil samples were retrieved from the upper 2.0m depth in Test Pits 18 - 37 and were field screened for Potential Acid Sulfate Soils (PASS) and Actual Acid Sulfate Soil (AASS). Results are shown in Appendix A.

In summary, positive field screening results indicated that potential and actual ASS were found in test pits 18 - 37. Test results also yielded negative or inconclusive results in some test pits. Following the results of the screening tests, Peroxide Oxidation Combined Acidity and Sulfate (POCAS) and Chromium Reducible Sulfur (CRS) testing was carried out on 21 soil samples, and the results are summarised in Table 1.

³ Dear SE, Moore NG, Dobos SK, Watling KM and Ahern CR (2002) Soil Management Guidelines. In *Queensland Acid Sulfate Soil Technical Manual*. Department of Natural Resources and Mines, Indooroopilly, Queensland, Australia.

Table 1: ASS Test Results

Fill Source Area (Dwg. 1)	Location / Depth	Total Potential Acidity (TPA) m/tonne	Total Sulfidic Acidity (TSA) m/tonne	Total Actual Acidity (TAA) m/tonne	Peroxide Oxidisable Sulfur (S _{Pos}) %	Chromium Reducible Sulfur %	Equiv. %S existing + potential Acidity	Action Criteria
								Equiv. Sulfur %S
3	TP18-1.50m	<2	<2	<2	<0.02	-	-	0.03
3	TP19-0.50m	-	-	-	-	0.04	0.04	0.03
3	TP19-1.50m	42	21	21	<0.02	-	0.03	0.03
3	TP20-1.50m	74	<2	74	<0.02	-	0.12	0.03
6	TP21-0.50m	17	4	13	<0.02	-	0.02	0.03
6	TP22-1.00m	25	21	4	<0.02	-	0.006	0.03
4	TP23-0.50m	-	-	-	-	<0.02	-	0.03
4	TP23-1.00m	59	15	44	<0.02	-	0.07	0.03
4	TP24-1.00m	97	17	80	<0.02	-	0.13	0.03
5	TP25-1.00m	122	19	103	<0.02	-	0.17	0.03
1	TP26-0.50m	51	26	25	<0.02	-	0.04	0.03
1	TP27-0.50m	42	36	6	<0.02	-	0.01	0.03
2	TP28-1.00m	40	17	23	<0.02	-	0.04	0.03
2	TP29-0.50m	30	30	<2	<0.02	-	-	0.03
2	TP30-1.50m	27	19	8	<0.02	-	0.01	0.03
1	TP31-2.00m	44	2	42	<0.02	-	0.07	0.03
1	TP32-1.00m	21	8	13	<0.02	-	0.02	0.03
1	TP34-1.00m	17	17	<2	<0.02	-	-	0.03
1	TP35-1.00m	10	10	<2	<0.02	-	-	0.03
1	TP36-0.50m	32	28	4	<0.02	-	0.006	0.03
1	TP37-0.50m	50	39	1	<0.02	-	0.001	0.03

Shaded cells contain values equal to or greater than action criteria.

Based on results of the POCAS and CRS tests and screening tests, it was concluded that natural soil between 0.5m and 2.0m depth contains low to moderate levels of ASS and will require lime treatment upon excavation. Because of the volume of soil to be excavated, this operation would be classified as a 'extra high' level of treatment and necessitated the preparation of this ASSMP, as well as management, monitoring and bunding during site works.

3.1 Future Acid Sulfate Soil Investigations

As stated in S 3.0, the previous ASS investigation was only preliminary and further investigations would be required to fully characterise ASS potential at the site.

According to the QASSIT Guidelines the following would be required:

- A detailed Acid Sulfate Soil Investigation with a sampling intensity of 2 sample locations/ha;
- Laboratory testing at 0.5 m intervals from each sample location to fully characterise the soil profile;

- A detailed groundwater investigation to determine the effects of filling on groundwater and Acid Sulfate Soils; and
- An Acid Sulfate Soil Management Plan to guide the treatment of ASS during and after the construction phase.

It is expected that the above sampling and testing regime would be carried out unless a scientifically rigorous justification was provided for an investigation of different intensity.

3.2 Neutralisation of Excavated ASS Soil

Soil excavated from the site will need to be neutralised with lime at the rates shown in Table 2. Fill Source Areas are shown on Drawing 1.

Table 2: Neutralisation Rates of ASS

Location	Adopted Equivalent %S	Neutralisation Rate with Aglime		
		kg lime/tonne of soil ^a	kg lime/m ³ of soil (<i>in-situ</i>) ^b	kg lime/m ³ of soil (<i>ex-situ</i>) ^c
Fill Source Areas 1 and 2	0.07	2.2	3.3	2.3
Fill Source Areas 3-6	0.17	5.2	7.8	6.0

Note a no bulking factor applied
 b assumes 1.5 tonnes in 1 m³ of soil *in-situ*
 c assumes bulking factor after excavation of 1.3

4.0 POTENTIAL ON-SITE AND OFF-SITE IMPACTS FROM ASS

As the site is close to the Caboolture River, any acidic leachate flowing directly into nearby waterways would have adverse impacts on aquatic flora and fauna, as well as on man-made structures, particularly those formed from concrete and steel.

Coastal, low-lying alluvial and estuarine soils, located generally below about RL 5.0 AHD, may contain framboidal pyrite or other sulfides. These are rounded, microbially generated microscopic mineral grains which are stable in soils below the water table, or in dense clay-rich soils that are periodically re-wetted. In such situations, where the sulfides are kept out of contact with air, they are relatively stable, and generally in "equilibrium" with the local environment. Soils which have appreciable pyrite or other sulfides which have not yet reacted significantly with air are referred to as Potential Acid Sulfate Soils, or PASS.

If such sulfide-bearing or pyritic soils are disturbed by excavation, thereby allowing ready access of oxygen to the sulfides from air, an oxidation reaction takes place. This results in the generation of sulfuric acid, or acid sulfates. (Pyritic soils, which have begun to generate acid, are referred to as Acid Sulfate Soils, or ASS). The acid is transported by water, and if allowed to build up in sufficient concentrations, poses a direct environmental threat to plants and organisms that come in contact with such waters.

Additionally, increasingly acidic waters can dissolve many metal ions in soils which would otherwise remain insoluble. The dissolved metallic ions will then be available for uptake by organisms. These ions comprise aluminium and iron, plus a suite of heavy metals such as zinc, lead and cadmium, which at elevated levels can be toxic to plants, animals and humans.

Most organisms can cope with pH in the neutral range (ideally between 5.5 to 8.5). In natural waters, pH values below five are undesirable, and below four are unacceptable.

Mitigation of impacts is not an objective of this ASSMP, which aims to prevent impacts occurring by careful management of ASS.

PART 1 - GENERAL

5.0 ORGANISATION AND RESPONSIBILITY FOR ACID SULFATE MANAGEMENT

5.1 Project Team

- Proponent – Lensworth Group Ltd;
- Construction Contractor – T.B.A.
- Environment Officer – Douglas Partners, Alan Lee, Tel. 3237 8900, 0413 886 050.

5.2 Proponent

The Proponent, Lensworth Group Ltd, is responsible for reinstatement of any on-site or off-site damage caused directly or indirectly from the exposure of ASS.

5.3 Construction Contractor (“Contractor”) – Civil Works

The Contractor will appoint a management representative who, irrespective of other responsibilities, has defined responsibility for ensuring that the requirements of this ASSMP are implemented and maintained. The Contractor is responsible for the correct implementation of the protocols. The Contractor is not empowered to vary any specific management protocols or procedures unless the Proponent has given explicit written approval.

Where ambiguity or conflict exists as to the procedure to be followed, it is the Contractor's responsibility to seek clarification from the Proponent, in writing if necessary.

It is the Contractor's responsibility to inform the Proponent immediately on discovery of non-compliance of the ASSMP or exceedences of monitoring trigger levels, and with the latter's approval, implement immediate remedial measures. The Proponent should prepare a report of such incidents for retention.

The requirements of ASS management are in addition to, but do not override any other standard procedures such as safety considerations. Where conflict results, or may result from the implementation of ASS management plan as against other performance criteria, it is the Contractor's responsibility to obtain specific directives from the Proponent.

5.4 Environment Officer

An Environmental Officer (EO) must be appointed to conduct appropriate supervision and monitoring to a level and schedule agreed with the Proponent and Contractor, or to that stated in the individual ASS management elements. Monitoring requirements are described in this management plan. Logs of monitoring should be kept by the Contractor, and signed copies should be forwarded to the Proponent weekly, or as requested.

It is anticipated that the EO will inspect and monitor the site on both a regular and random basis, and carry out such sampling and/or in-situ measurements as are necessary to check compliance with the ASSMP. The Contractor must offer appropriate assistance / co-operation to the EO.

The EO will be authorised for initiation action to prevent the occurrence or recurrence of non-conformance. The EO will identify training requirements and will authorise appropriate induction and training of all relevant personnel.

5.5 Personnel Induction and Training

All relevant personnel will be made aware of the ASSMP policies and objectives through environmental awareness induction to include the following information:

- Importance of conformance to all procedures and requirements within the ASSMP;
- Potential for environmental impacts of work activities;
- Environmental benefits of good work practices;
- Potential environmental consequences of departure from established work practices.

The Contractor must induct relevant construction staff into the site to make them aware of acid sulfate issues such as avoidance of unnecessary excavations, surface water and groundwater management, monitoring, neutralisation *etc.*

5.6 Management Reviews

The ASSMP must be reviewed regularly by the management team to ensure its continued suitability and effectiveness. These meetings shall be chaired by the Contractor and shall include review of the following:

- Results from audits;
- Complaints from neighbours or other personnel or government agencies;
- Corrective Action requests;
- Suitability and effectiveness of the ASSMP for achieving environmental objectives;
- Suggestions for improvement of the environmental management.

5.7 Monitoring and Control of Environmental Impact

The Contractor must carry out the monitoring program to ensure that performance criteria were achieved during construction works. All results from the monitoring would be made available to the Proponent, and any activities that caused breaches of criteria would be stopped immediately to enable a solution to be found and implemented.

All monitoring methods and equipment would meet EPA and Australian Standards prior to and following a monitoring event, and the following standards would apply:

Soils	Guidelines for Sampling and Analysis Procedure for Lowland Acid Sulphate Soils (ASS) in Queensland 1998, QASSIT, Revision 4.0.
-------	--

Water and Wastewater	Standard Methods for the Examination of Water and Wastewater - APHA/AWWA/WEF USA.
EPA	Environmental Protection Policies (Water, Air, Noise) Water Quality Sampling Manual.

PART 2 - CONSTRUCTION PHASE

6.0 ELEMENT 1 – ACID SULFATE SOILS (CONSTRUCTION PHASE)

6.1 Policies

- Manage acid sulphate soils (ASS) in areas to be disturbed or excavated during construction. In particular, areas where ASS have been identified;
- Identification and handling of ASS must follow the QASSIT Guidelines, Revision 4.0, October 1998;
- Prevention of any ASS from becoming oxidised by exposure to the atmosphere, either above or below ground. Strategies to minimise draw down of groundwater during construction are given in Element 2 *Groundwater*;
- Prevention of any disturbance of ASS layers by excavations in filled areas;
- Prevention of any exposure of ASS in batter slopes of excavations or trenches during excavation;
- Neutralisation of any acidic leachate produced; and
- Prevention of any acidic leachate moving off-site.

6.2 Avoidance of Disturbance of ASS

Avoidance or minimisation of earthworks is required for those areas where ASS materials have been found. This especially applies where ASS are either too voluminous to remove and rebury, or too difficult to remove and neutralise with lime, or where there would be too much risk of contaminating groundwater or runoff.

Hence, excavations at the site should be targeted to avoid disturbance of PASS wherever possible.

6.3 Performance Criteria

- ASS disturbed or excavated will be neutralised with fine agricultural lime at the rates shown in Table 2 in s.3.1.
- Water quality tests will determine if retained water is suitable for discharge from site. If necessary, any acidic leachate resulting from disturbance of ASS will be neutralised before release. Thresholds that apply to the quality of surface water before discharge are given in Element 3 *Surface Water – Construction*.
- No significant reduction in groundwater levels during construction works, and no design features that would tend to lower groundwater levels during the operational period.

6.4 Implementation Strategy

6.4.1 Neutralisation of Excavated ASS

This section describes neutralisation required for ASS soil that is excavated and intended to be used as filling.

- Prepare the liming pad/stockpile sites of appropriate area for the volume of soil to be excavated. The pad area(s) should be prepared on gently sloping ground to minimise the risk of any potential instability issues, with a natural fall to the local drainage sump (natural or excavated as appropriate).
- An impervious layer (compacted clay) or a layer of fine lime 25 mm in depth should be placed on the pad to prevent or neutralise downward seepage of acidic drainage water. For highly permeable soils, the option of placement of an impervious layer should be adopted where practical.
- Liming pads should be either bunded off, or a circumference drain excavated to collect and localise leachate. Bunds can also be made using sandbags that are filled with sand and lime. The drain/bunding should be covered with an impervious layer or a layer of fine lime to neutralise leachate migrating from the stockpiled material. Any collected leachate pH should be monitored daily or until time trends are established, and a calcium hydroxide solution used for spot neutralisation if required.
- Soil must be sufficiently dry before liming is commenced so that the lime can be thoroughly mixed through the soil. As moisture levels in the soil may be high, the soil must be dried by spreading and leaving open to the atmosphere. Drying can be accelerated by regular aeration by turning with an excavator or backhoe. Drying can be carried out on the liming pad.
- The excavated soil (after drying, if necessary) should be spread onto the liming pad in layers of 300-400 mm, leaving a 1 m flat area between the toe of the layer and the bund or drain. When spreading the first soil layer, care should be taken not to churn up the basal lime layer.
- Apply aglime (kg/m^2 determined from liming rates in Table 2 of s.3.1) over spread soil and mix by harrowing or rotary hoeing for thorough mixing.
- Spread aglime liberally (around 10 kg/m^2) over the toe of the stockpile, the 1 m flat perimeter between the stockpile and the bund or drain, and into the drain or onto the bund itself (both sides).
- If there are weep points for any leachate that have washed away the aglime, add extra lime at and below those points. If the flow is heavy, lime aggregate should be added.

- Monitor leachate weep points and ponded water daily, until no more leachate is generated. If the pH of ponded leachate falls below 6.5, add aglime directly over the surface of the leachate pond and drain, and over the stockpile toe and 1 m perimeter. In the unlikely event that pH falls significantly, neutralisation with calcium hydroxide solution may be required.
- Following any rain, recommence the monitoring cycle, and treat accordingly.

Liming of each excavation site should be pre-planned, and appropriate liming pads constructed. Allowances should be made during construction planning to reserve sufficient land to allow for these liming pads, or other arrangements made with local landowners. Leachate collection location, lining and construction should be similarly pre-planned.

There may be some areas where excavated soil does not display apparent signs of acid sulfate potential. In these exceptional cases, such material should be stockpiled at a separate location to other sediments and verification analysis (*ie* SPOCAS/ CRS suite testing) should be conducted to confirm the status of the material. The verification analysis should be conducted by the EO in all such events.

6.5 Validation Testing

Validation testing of the soil must be conducted on each batch of soil after addition of lime to test whether mixing has been adequate prior to its reuse on-site. This would consist of at least two samples per 500 m³ of neutralised soil tested for field screening and Net Acidity as described in Table 3.

Table 3 - Target Levels of Neutralised Soil

TEST	TARGET LEVEL
Field pH/SPOCAS/CRS suite	<ul style="list-style-type: none"> • pH > 6 • Net Acidity < 0.03 % S
Field peroxide pH	<ul style="list-style-type: none"> • No change in colour • No effervescence • No release of sulfurous odour • No depression in pH below field pH • pH > 3

6.6 Temporary Stockpiling of Progressive Excavations

In instances where it is intended to excavate the PASS materials, all disturbance, excavation and temporary stockpiling is to be carried out in a staged manner to minimise the cost of mitigation and long term supervision. ASS should be separated from other soils during excavation to reduce the quantities of soil requiring treatment.

Unless the excavated materials are to be immediately reburied below the water table, neutralising agents must be incorporated with all the ASS (*ie* soils that are to be replaced

following construction of trenches, left above ground, or disposed of by any means). Thorough mixing with the neutralising agent (lime) is necessary.

6.7 Neutralising Materials

Medium-fine agricultural lime (aglime) should be used as the preferred neutralisation material for the management of ASS as this material is slightly acidic and of low solubility. The aglime should be fine ground (< 1 mm) calcium carbonate or calcite (limestone or marble). Coarse-grained calcite is not recommended, as one of the products of the neutralisation reaction is gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) which has a relatively low solubility and tends to coat the reacting calcite grain, forming a partial barrier against further reaction. Gypsum may also give off hydrogen sulfide in reaction with acidic conditions and can itself result in the generation of sulfuric acid.

Dolomitic aglime, or magnesium-blend aglime, should not be used as these materials impose environmental risks from overdosing with the potential to damage estuarine ecosystems.

The aglime purity should preferably be 90% or better, (ie. $\text{NV} > 90$, where NV is the neutralising value, a term used to rate the neutralising power of different forms of materials relative to pure, fine calcium carbonate which is designated $\text{NV} = 100$). There could be economic justification for using a less pure grade of aglime, however, under these circumstances the individual lime dosing rates would need to be increased by a factor of $100/\text{NV}$.

Consideration should be given to the use of greater amounts of aglime of lower purity when assessing the supplies of this material, as the cost savings from using less pure material may be offset by the corresponding increase in transportation costs. The aglime should also be fine and dry, as texture and moisture can also decrease the effective neutralising value.

It is suggested that the contractor set up an aglime dump in a central location near the excavations at this stage of construction. Aglime is non-corrosive and requires no special handling, however, it would be advisable to cover the stockpile with a tarpaulin both to minimise wind erosion and wetting, as the material is more difficult to spread when wet.

6.8 Monitoring

- The EO and Contractor are responsible for monitoring of ASS including within neutralisation and validation work areas;
- The EO will be prior-consulted about all intended excavations in natural earth, and have co-authority on-site to guide excavations, stockpiling of soils, general earthworks etc, including halting of excavations or any other works where necessary.
- Observations of excavated material will be conducted by the EO, as well as sampling for Field pH and Field Peroxide tests. Positive field sulfide identification will depend on the following results:
 - Strength of reaction with peroxide (rated);
 - pH_{FOX} at least one unit below pH_{F} . The greater the difference (ΔpH), the more indication of PASS. The lower the final pH_{FOX} , the better the indication of a positive result;

- If $\text{pH}_{\text{FOX}} < 3$, and the other two conditions apply, then it strongly indicates PASS. The more pH_{FOX} drops below 3, the more positive the presence of sulfides.
- Laboratory analyses of samples for SPOCAS and CRS may also be conducted on a selected basis to confirm the trends of field tests and observations;
- Validation testing by Net Acidity analysis on neutralised soil will be carried out at the rate of one sample per 300-500 m³ of treated soil. During the period of testing, no more fill will be placed on the batch of soil being tested. If neutralisation is not adequate, more lime will be added and the batch re-tested.

6.9 Reporting

- The EO and Contractor will keep a daily log of excavation activities such as locations and descriptions of soil horizons encountered, samples taken and tested, results of tests, stockpile dates, lime application calculations, methods of mixing lime, positions of spoil placement within the site, personnel and contractors involved, and any other information relevant to handling excavated soils and ASS;
- Representative samples of excavated soils and ASS will be retained and stored appropriately to maintain their original condition until all issues with ASS are resolved;
- The Contractor will report to the EPA under Section 37 of the *EP Act* any occurrences of serious or material environmental harm and any perceived changes or breaches of the intent of acid sulphate management or protection works as described in the EMP.

6.10 Corrective Action

If monitoring results indicate the presence of ASS, or if a potential or real breach of performance criteria occurs, one or more of the following steps will be taken:

- The Contractor is responsible for corrective action taken at the site to meet the requirements of the EMP;
- Handling and management of ASS will be given the highest priority to remove the risk of acidic leachate occurring;
- Remediation measures will be taken such as isolation of the affected area from the surrounding environment by appropriate bunding *etc* so that any unacceptable leachate will not be discharged from the site;
- Advice will be obtained from the EPA if necessary to control or mitigate the situation; and
- Particular attention will be given to monitoring the situation.

7.0 ELEMENT 2 – GROUNDWATER (CONSTRUCTION STAGE)

7.1 Groundwater Policy

- Maintain groundwater quality and quantity during the construction and operational phases similar to current baseline levels;
- Manage discharge of groundwater during construction so that surface water quality criteria are achieved.

7.2 Groundwater Performance Criteria

- No significant reduction in groundwater levels during the construction phase.

7.3 Groundwater Implementation Strategy

- Design of the project will incorporate groundwater considerations, including quality, quantity, recharge and direction of flow.

7.4 Monitoring of Groundwater

Observations of any groundwater will be carried out daily.

7.5 Corrective Action - Groundwater

If monitoring results indicate decreasing groundwater quality or quantity, or if a potential or real breach of performance criteria occurs, one or more of the following steps will be taken:

- The Contractor is responsible for corrective action taken at the site to meet the requirements of the EMP;
- Handling and management of groundwater quality will be given the highest priority to remove the risk of decreasing quality;
- Remediation measures will be taken as appropriate;
- Advice will be obtained from the EPA if necessary to control or mitigate the situation; and
- Particular attention will be given to monitoring the situation.

8.0 ELEMENT 3 – SURFACE WATER (CONSTRUCTION STAGE)

8.1 Policy

- Maintain an acceptable level of discharge water quality during construction; and
- Ensure that the design and construction of permanent works will enable water quality in receiving waters to be maintained at acceptable levels.

During and after excavations, a large proportion of surface water will drain inwards towards these excavations without direct external discharge. Hence, the excavation void will act as a large sediment basin that will trap stormwater for a potentially indefinite period and allow the silt to fall out. The supernatant water can then be pumped out.

Similarly, the excavation can act as a stormwater basin for other disturbed areas including the neutralisation area for ASS, which can drain into the excavation for clarification before removal. If necessary, this water can be treated in the pit by neutralisation before off-site disposal.

8.2 Performance Criteria

Quality of discharge water from the site during construction will be maintained within the following parameters and thresholds:

- pH 6.5-8.5;
- Turbidity <20 NTU
- Total nitrogen <450 µg/L
- Total phosphorous <60 µg/L
- Suspended solids 90 percentile <100 mg/L for wet weather flows
- Copper <5 µg/L
- Lead <5 µg/L
- Nickel <15 µg/L
- Zinc <50 µg/L
- No visible oil, scum or litter should be present in discharges;
- Colour and clarity of discharges should be consistent with that of the river.

8.3 Leachate Control

Excavated ASS to be stockpiled for more than one day is to be placed in stockpiles with adequate bunding to collect any leachate. To ensure an effective leachate collection system an impervious layer or layer of lime under the stockpile is required.

Prior to release of temporarily stored leachates to natural waters, or reuse, water quality should be checked to ensure appropriate pH, dissolved oxygen and total suspended solids (TSS). Appropriate steps should be taken to meet discharge criteria if water quality does not meet standards. These may include pH adjustment of the ponded water by lime dosing, or flocculation to reduce TSS.

8.4 Monitoring and Discharge

Monitoring frequencies will be based on the volumes of leachate water produced, and this cannot be estimated at present. However, following rainfall periods, or other events causing leachate production within the stockpiles, the stockpiles should be inspected and tested. Further, all stockpiles should be inspected daily and tested for pH. If signs of leachate are observed leachate should also be tested for pH. Special precaution should be taken after weekends or other non-work periods to record the results of any rain events that occurred in this period. A written log of results should be maintained.

Wherever possible, discharges of leachates should be conducted in a controlled manner and discharges during substantial flows in the natural water systems would be preferable, due to the beneficial effect in attenuation of leachates prior to arriving at the receiving waters.

All surface water is to be treated to an acceptable level prior to release (typically pH 6.5–8.5, although this suggested range may need reassessment once the baseline conditions are known at the proposed discharge point(s). Water quality should be checked several days before projected discharge, to allow for any additional remediation if required. pH adjustment may be necessary by lime dosing prior to discharge.

Depending on the depth of excavation and location of the water table, excavation pits or voids may fill with groundwater that is derived from PASS materials. This groundwater will generally be clear and non-acidic initially, but will readily turn orange-red or blue-green in colour and become acidic as oxygen diffuses into it. These waters will require treatment by pH adjustment before discharge. If the volumes in question are low, dosing the surface of the water and the sides of the pit or void with aglime will be expected to produce the required improvement in a few days. If the water is too deep for effective diffusion (> 0.5 m), or the volume of water is too large for treatment with aglime, then application of calcium hydroxide will be required.

Prior to discharge, such waters must meet the same criteria as leachates, with pH typically 6.5 – 8.5, and not less than 5.5. Monitoring of ASS potential and effectiveness of neutralisation must be conducted as prescribed in Table 4.

Table 4 - Monitoring Frequencies and Target Levels of Surface Water

MATERIAL	TEST	FREQUENCY	TARGET LEVEL
Ponded leachate	pH	Weekly, following rain events and non work periods	<ul style="list-style-type: none"> pH 6.5 - 8.5, but not less than 5.5
Discharged leachate	pH, DO, TSS	Prior to discharge	<ul style="list-style-type: none"> pH 6.5 - 8.5, but not less than 5.5 for freshwater receptor pH less than 0.2 unit change at discharge point for marine water receptor DO > 4 mg/L TSS <50 mg/L

It is therefore required that the water quality standard be maintained at all times in the leachate holding ponds of larger, more "permanent" stockpiles. In this way, unexpected heavy rainfall presents no immediate problem for leachate overflows.

8.5 Neutralisation of Acidity in Surface Water

Where ponded leachates need neutralising before discharge to natural waterways, a calcium hydroxide solution must be used for rapid neutralisation. This solution could be produced using either slaked lime or quicklime, by stirring approximately 0.3 kg of either material into water, in a container of sufficient volume (for example, a plastic 200 litre drum). The slurry should be allowed to settle, and the clear solution (which will be caustic, with a pH of around 12.2) can be pumped or sprayed into the standing water in small amounts, with some agitation and monitoring. This procedure should be continued until the pH is reduced to acceptable levels. Great care should be taken not to overdose with calcium hydroxide.

Quicklime is very reactive, and relatively corrosive (caustic). Therefore, special handling and safety procedures are required. When quicklime is mixed with water, the resulting reaction generates heat, therefore, the 0.3 kg amount should be added slowly to a large amount of water to control the reaction.

8.6 Storage of Water Neutralising Agent

The Contractor must have several bags of quicklime or slaked lime readily available at all times, with necessary equipment to produce, transport and apply the hydroxide solution as required. These products are highly soluble and must be stored on-site under cover, preferably inside secure locked storage.

8.7 Reporting

- Reporting of all water quality testing is to be maintained by the Contractor;
- The Contractor will report to the EPA any occurrences of serious or material environmental harm and any perceived changes or breaches of the intent of water quality protection works as described in the EMP.

8.8 Corrective Action

If monitoring results indicate decreasing water quality, or if a potential or real breach of performance criteria occurs, one or more of the following steps must be taken:

- The Contractor is responsible for taking corrective action to meet the requirements of the ASSMP;
- Handling and management of surface water quality will be given the highest priority to remove the risk of decreasing quality;
- Remediation measures will be taken such as isolation of the affected area from the surrounding environment by appropriate bunding etc so that contaminated water will not reach the lake or be discharged from the site;
- Advice will be obtained from the EPA if necessary to control or mitigate the situation; and
- Particular attention will be given to monitoring the situation.

9.0 LIMITATION OF REPORT

We have prepared this report for Lensworth Group Ltd as well as review by various government agencies in accordance with generally accepted consulting practice. No other warranty, expressed or implied, is made as to the professional advice included in this report. The report has not been prepared for the use by other parties other than the client and their respective advisers and government agencies. It may not contain sufficient information for the purposes of other parties or for other uses.

It is recommended that any plans or specifications prepared by others relating to the content of this report or amendments to the original plans or specifications be reviewed by Douglas Partners to verify that the intent of our recommendations is properly reflected in the design.

Whilst to the best of our knowledge, the information contained in this report is accurate at the date of issue, various site conditions may change, including groundwater levels and contamination from illegal dumping etc. This should be considered if the report is used after a protracted delay.

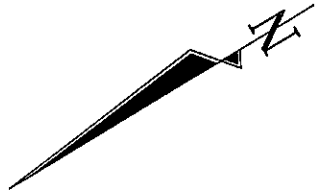
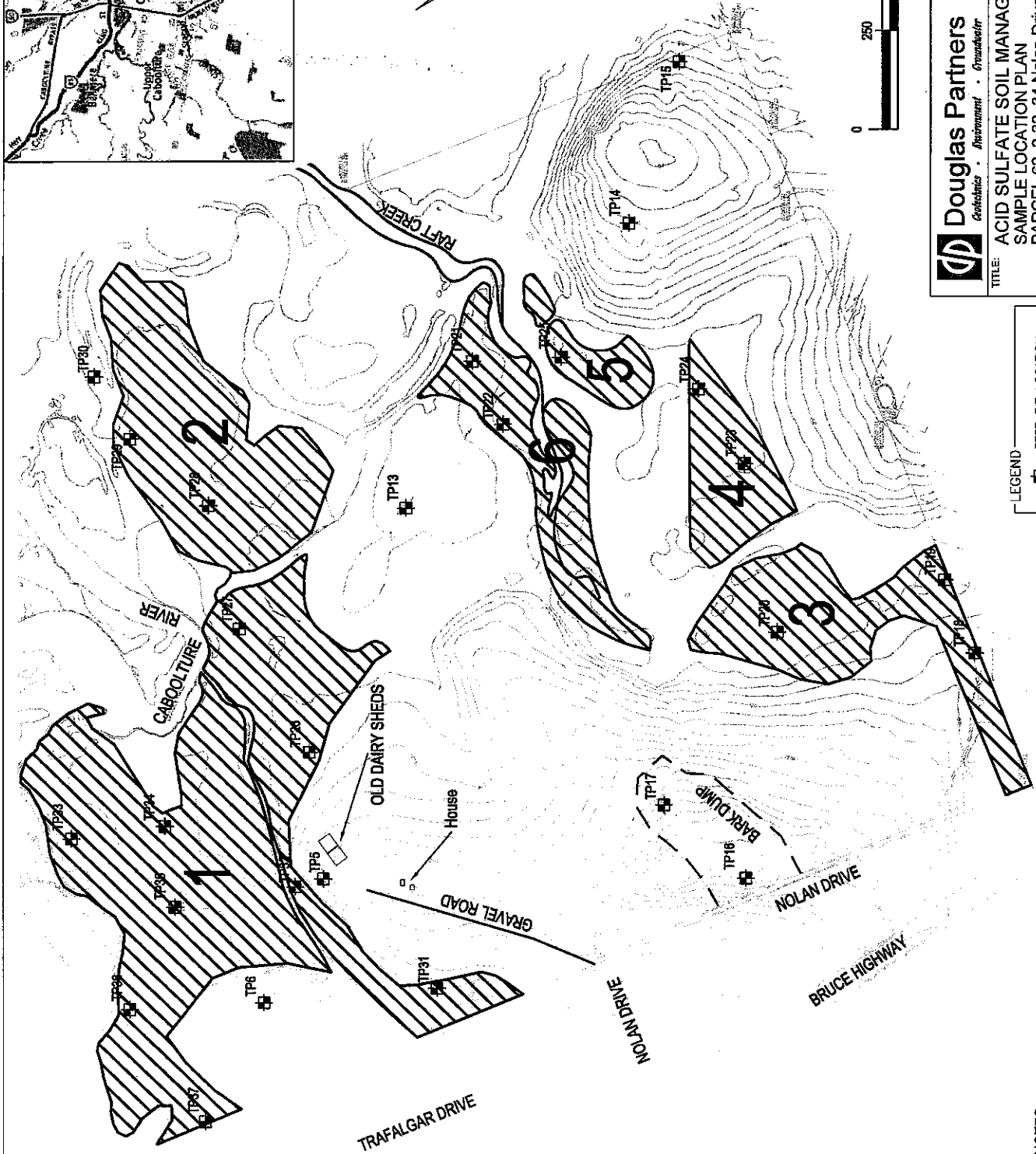
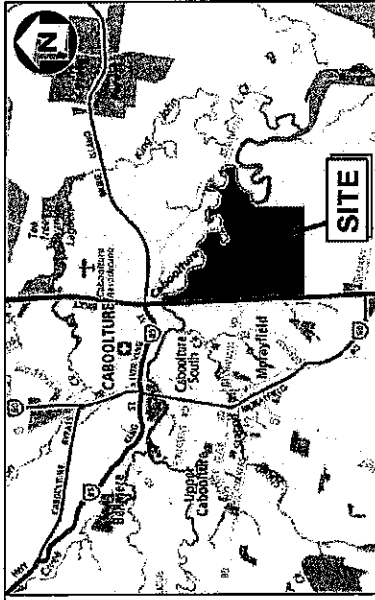
There are always some variations in subsurface conditions across a site that cannot be fully defined by investigation. Hence the comments made here may not represent the extremes of conditions that exist within the site.

DOUGLAS PARTNERS PTY LTD

Reviewed by

Adam Lupton
Environmental Scientist

Alan Lee
Principal - Environment



Douglas Partners <i>Environment • Infrastructure</i>	<i>Sydney, Newcastle, Brisbane, Melbourne, Perth, Darwin</i>	<i>Campbelltown, Newcastle, Newcastle, Cairns, Wollongong, Sydney</i>
	CLIENT: ACID SULFATE SOIL MANAGEMENT PLAN SAMPLE LOCATION PLAN PARCEL 62, 2-32, 34 Nolan Drive, MORAYFIELD	OFFICE: BRISBANE
CLIENT: PIKE MIRLS MCKNOULTY	PROJECT No: 33454B	DRAWING No: 1
DRAWN BY: SAR	SCALE: 1:10000	DATE: JULY 2004
APPROVED BY:		

LEGEND
TEST PIT LOCATION
FILL SOURCE AREAS

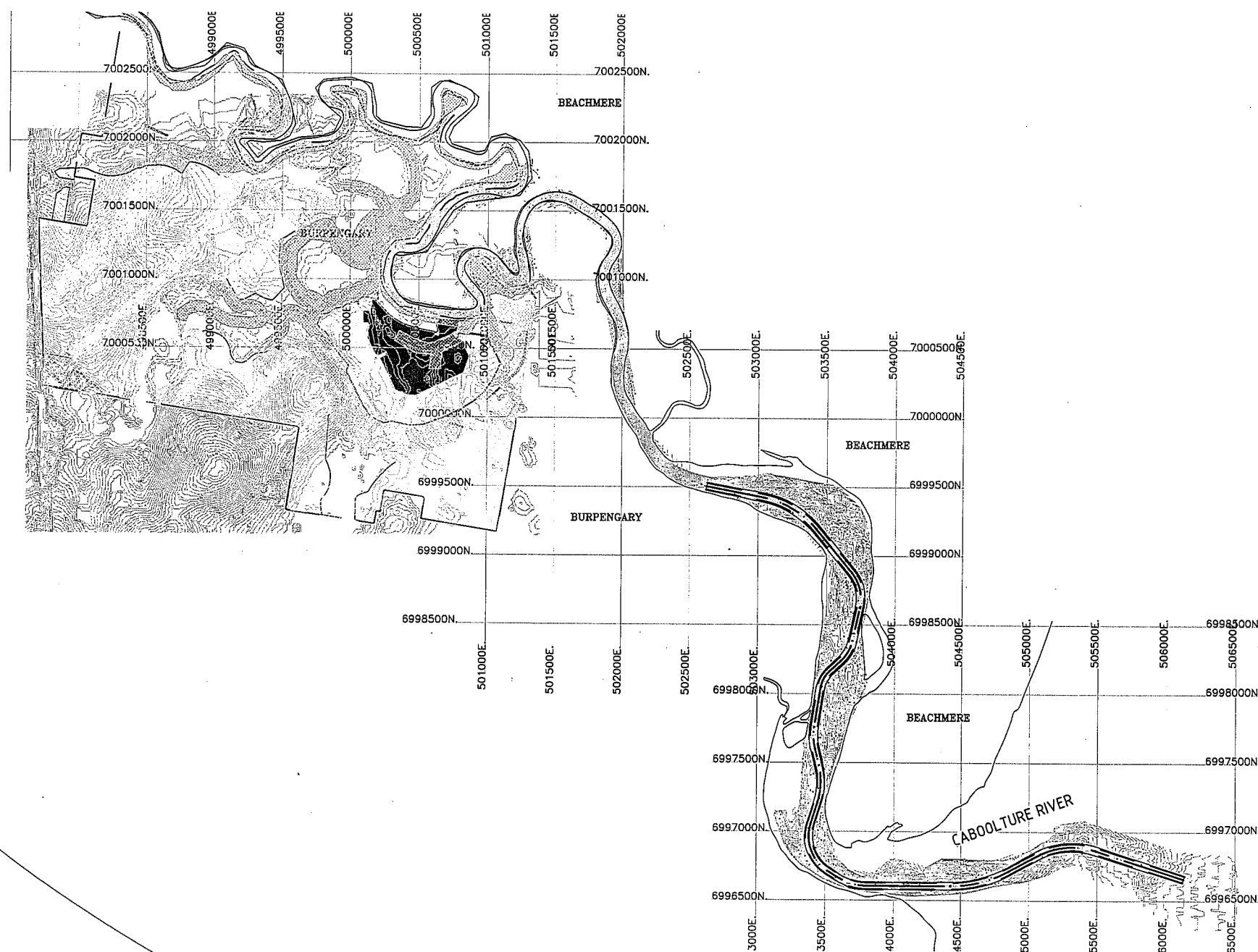
NOTES:-
1. Test Locations are approximate only and are shown with reference to existing and proposed site features

APPENDIX B

Drawing Set - Caboolture River Dredging

NORTHEAST BUSINESS PARK

CABOOLTURE RIVER DREDGING MARITIME SAFETY QUEENSLAND PREFERRED ALIGNMENT



SITE PLAN
1:20000

Cardno (Qld) Pty Ltd
ABN 57 051 074 992

Level 1, 5 Gardner Close, Milton QLD 4064
PO Box 388, Toowong QLD 4066 Australia

Telephone: 07 3369 9822
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BURPENGARY

PROPOSED NORTHEAST
BUSINESS PARK

BURPENGARY

BEACHMERE

Edge of river

222

BEACHMERE

CABOOLTURE RIVER

NAVIGATION AID LOCATIONS
SPECIFIED BY THE HARBOUR MASTER

PROPOSED NAVIGATION AIDS - GDA94 MGA Zone 56

No.	NAV AID	EASTING	NORTHING
1.	STBD BCN	505818.000	6996864.000
2.	PORT BCN	505776.000	6996683.000
3.	STBD BCN	505391.000	6996926.000
4.	PORT BCN	505391.000	6996845.000
5.	STBD BCN	505028.000	6996844.000
6.	PORT BCN	505098.000	6996766.000
7.	STBD BCN	504604.000	6996657.000
8.	PORT BCN	504756.000	6996622.000
9.	STBD BCN	503879.000	6996660.000
10.	PORT BCN	503357.000	6996820.000
11.	STBD BCN	503641.000	6996686.000
12.	PORT BCN	503412.000	6997417.000
13.	STBD BCN	503509.000	6996785.000
14.	PORT BCN	503402.000	6997905.000
15.	STBD BCN	503448.000	6997007.000
16.	PORT BCN	503610.000	6998323.000
17.	STBD BCN	503460.000	6997679.000
18.	PORT BCN	503691.000	6998585.000
19.	STBD BCN	503518.000	6998078.000
20.	PORT BCN	503713.000	6998729.000
21.	STBD BCN	503705.000	6998309.000
22.	PORT BCN	503505.000	6999127.000
23.	STBD BCN	503695.000	6998908.000
24.	PORT BCN	503251.000	6999319.000
25.	STBD BCN	503464.000	6999231.000
26.	PORT BCN	502851.000	6999420.000
27.	STBD BCN	503343.000	6999343.000
28.	STBD BCN	503102.000	6999453.000
29.	PORT BCN	502633.000	6999551.000

LEGEND

Proposed and Existing Green
Navigation Beacon



Proposed and Existing Red
Navigation Beacon



Existing Yellow Navigation
Beacon



NOTE:

- Total dredging cut quantity is 545,300m³
- Total dredging area is 356,553m²
- Minimum depth of dredging is 0.000m
- Maximum depth of dredging is 3.210m

LAYOUT PLAN
Scale 1:10000

100 0 100 200 300 400 500m
SCALE BEFORE REDUCTION 1:10000

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DRAWN: *SB*

CHECKED: *SB*

RECOMMENDED: PROJ. MAN. *SB*

APPROVED: PROJ. DIR. *SB*

CAD FILE: LA7900-33/SUB 01/ACAD/7900-33-302.dwg

XREF: X-A1-B0-SHT FINAL; X-B0-Design 3; Caboolture_msa94

A1

DATUM: A.H.D.



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NORTHEAST
BUSINESS PARK



NORTHEAST BUSINESS PARK

CABOOLTURE RIVER DREDGING
MARITIME SAFETY QUEENSLAND PREFERRED ALIGNMENT
LAYOUT PLAN

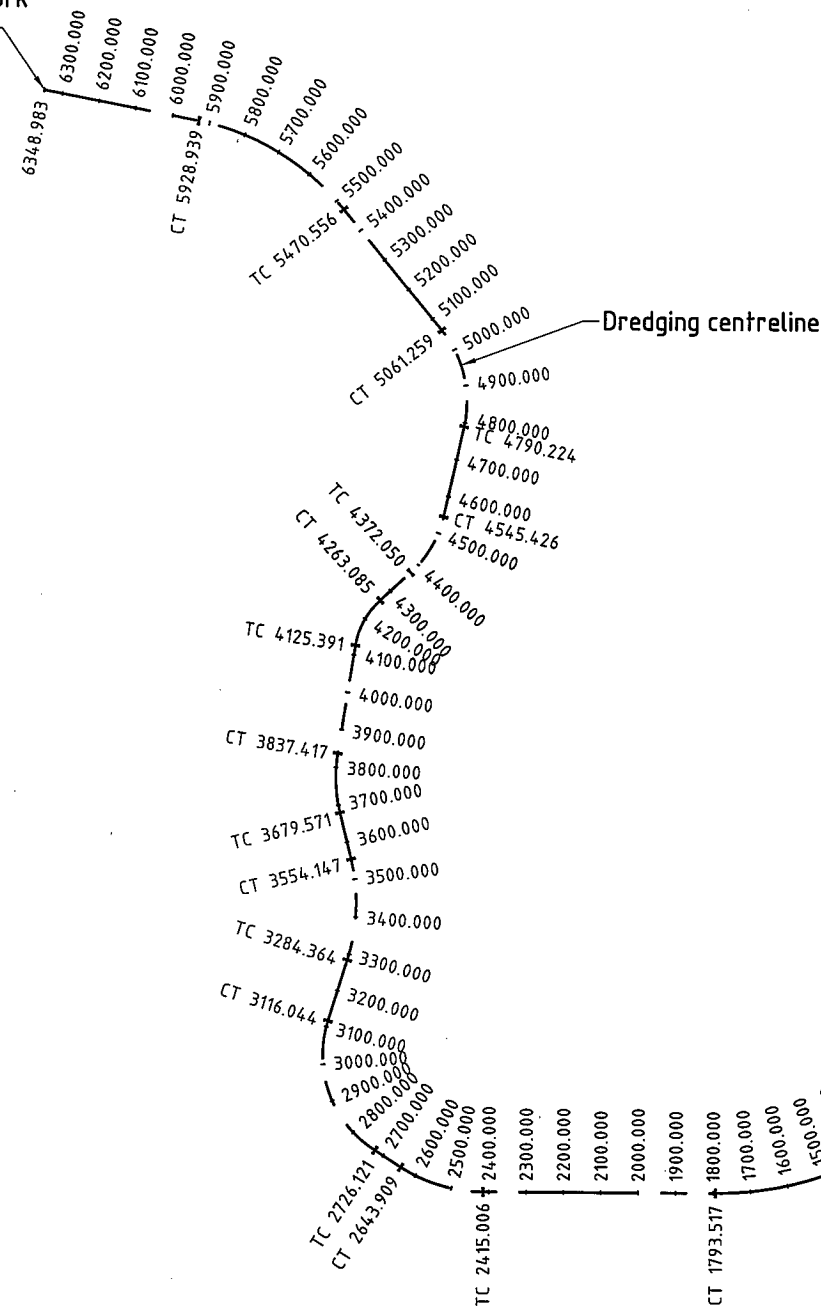
DATE: 19-10-2007

DRAWING No:

7900/33/01-302

Rv.

Limit of dredging work
Chainage 6348.983



CONTROL LAYOUT
Scale 1:1000

HORIZONTAL CENTRELINE CONTROL DETAILS

Pt	Chainage	Easting	Northing	Bearing	Rad/Spiral	A.Length	D.Angle
IP1	0.000	506125.109	6996658.439				
TC	665.113	505492.803	6996864.751	288°04'15"			
IP2	888.924	505267.453	6996938.280		550.000	-447.623	46°37'51"
CT	1112.736	505059.255	6996824.955	241°26'24"			
TC	1345.433	504854.873	6996713.708	241°26'24"			
IP3	1569.475	504653.925	6996604.330		-900.000	448.083	28°31'33"
CT	1793.517	504425.138	6996604.193	269°57'57"			
TC	2415.006	503803.648	6996603.824	269°57'57"			
IP4	2529.458	503685.968	6996603.754		-400.000	228.903	32°47'16"
CT	2643.909	503586.998	6996667.422	302°45'14"			
TC	2726.121	503517.858	6996711.901	302°45'14"			
IP5	2921.082	503326.108	6996835.257		-300.000	389.923	74°28'12"
CT	3116.044	503393.620	6997053.033	17°13'25"			
TC	3284.364	503443.460	6997213.805	17°13'25"			
IP6	3419.255	503484.400	6997345.867		500.000	-269.783	30°54'53"
CT	3554.147	503451.675	6997480.200	346°18'32"			
TC	3679.571	503421.988	6997602.061	346°18'32"			
IP7	3758.494	503403.062	6997679.752		-400.000	157.846	22°36'35"
CT	3837.417	503415.459	6997758.749	8°55'07"			
TC	4125.391	503460.104	6998043.240	8°55'07"			
IP8	4194.238	503471.198	6998113.933		-205.000	137.695	38°29'04"
CT	4263.085	503523.874	6998162.367	47°24'11"			
TC	4372.050	503604.087	6998236.118	47°24'11"			
IP9	4458.738	503669.945	6998296.670		285.000	-173.376	34°51'19"
CT	4545.426	503689.381	6998383.998	12°32'53"			
TC	4790.224	503742.565	6998622.949	12°32'53"			
IP10	4925.742	503774.188	6998765.027		300.000	-271.034	51°45'50"
CT	5061.259	503682.162	6998877.799	320°47'03"			
TC	5470.556	503423.386	6999194.910	320°47'03"			
IP11	5699.748	503272.362	6999379.980		660.000	-458.383	39°47'35"
CT	5928.939	503037.872	6999425.523	280°59'28"			
END	6348.983	502625.533	6999505.607				

Limit of dredging work
Chainage 0.000

100 0 100 200 300 400 500m
SCALE BEFORE REDUCTION 1:10000

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DRAWN: *SK*
CHECKED: *SK*

RECOMMENDED: PROJ. MAN.

APPROVED: PROJ. DIR.

CAD FILE: L:\7900-33\SUB 01\ACAD\7900-33-303.dwg

XREF: X-A1-B0-SHT FINAL

A1 DATUM: A.H.D.

Cardno

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NORTHEAST BUSINESS PARK

NORTHEAST BUSINESS PARK

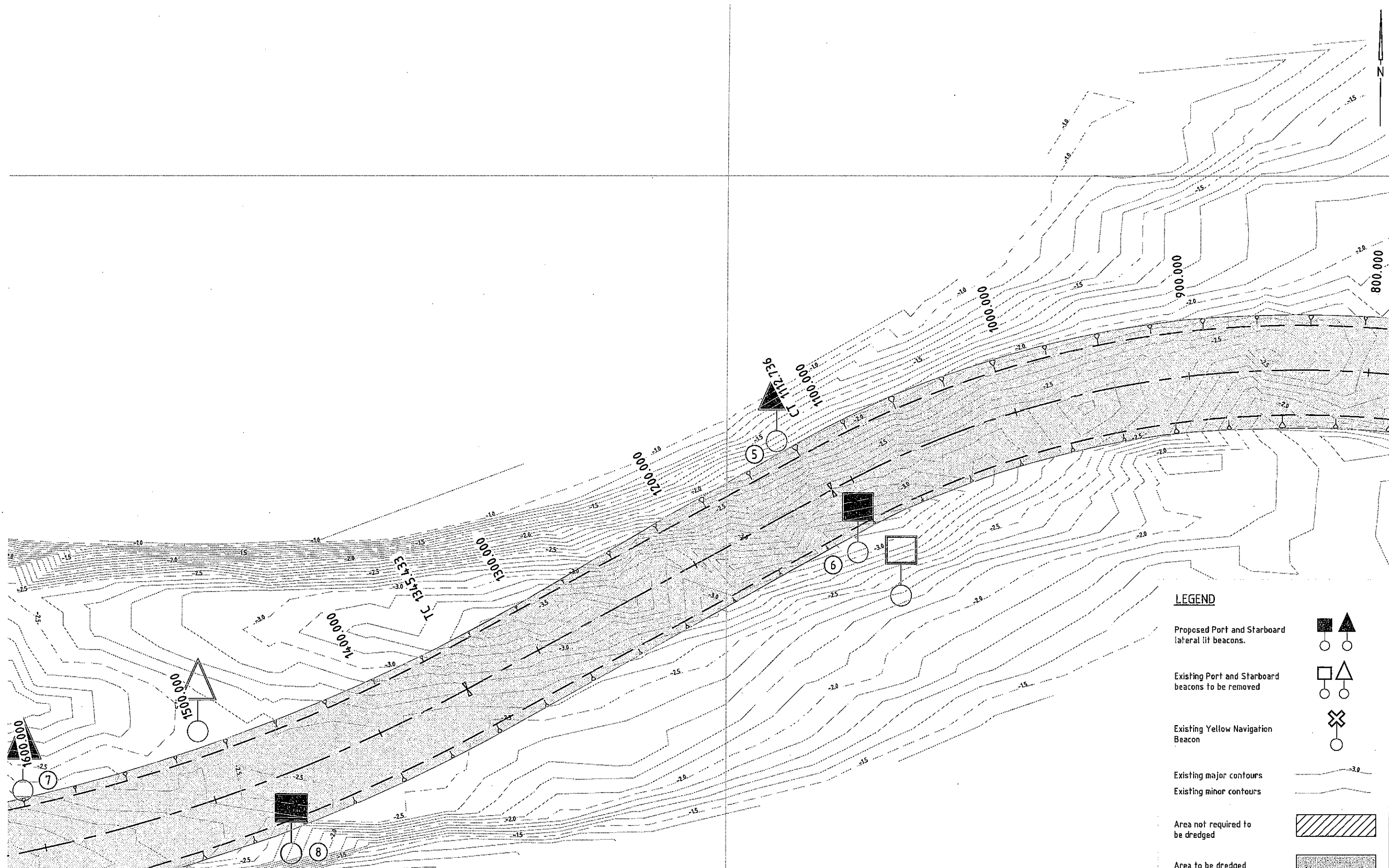
CABOOLTURE RIVER DREDGING
MARITIME SAFETY QUEENSLAND PREFERRED ALIGNMENT
CENTRE LINE SETOUT

DATE: 19-10-2007

DRAWING No:

7900/33/01-303

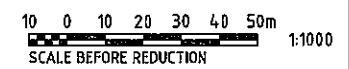
Rv.



LEGEND

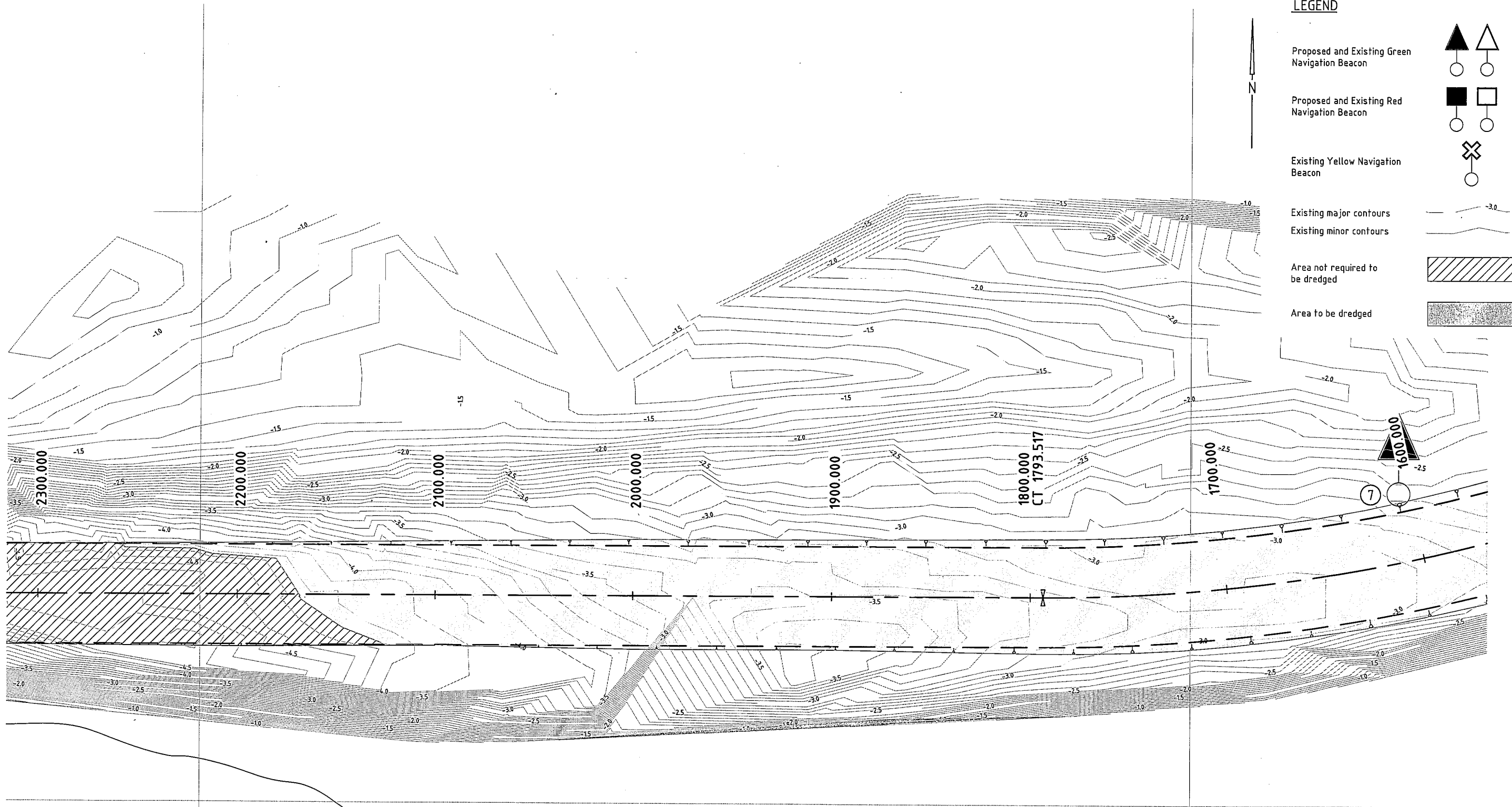
- Proposed Port and Starboard lateral lit beacons.
- Existing Port and Starboard beacons to be removed
- Existing Yellow Navigation Beacon
- Existing major contours
- Existing minor contours
- Area not required to be dredged
- Area to be dredged

LAYOUT PLAN
Scale 1:1000



DATE PLOTTED: 22 January, 2008 - 3:53pm

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		<p>RECOMMENDED PROJ. MAN.</p> <p>APPROVED: PROJ. MGR.</p>		<p>REVISIONS</p>						<p>Rev. DATE REVISIONS REC. APPR.</p>		
		<p>CAD FILE: L:\7900-33\SUB 01\Acad\79003301-305.dwg</p> <p>XREFs: X-Base, EXISTING UNCLIPPED CONTOURS, X-A1-B0-SHT FINAL, Caboolture map</p>										



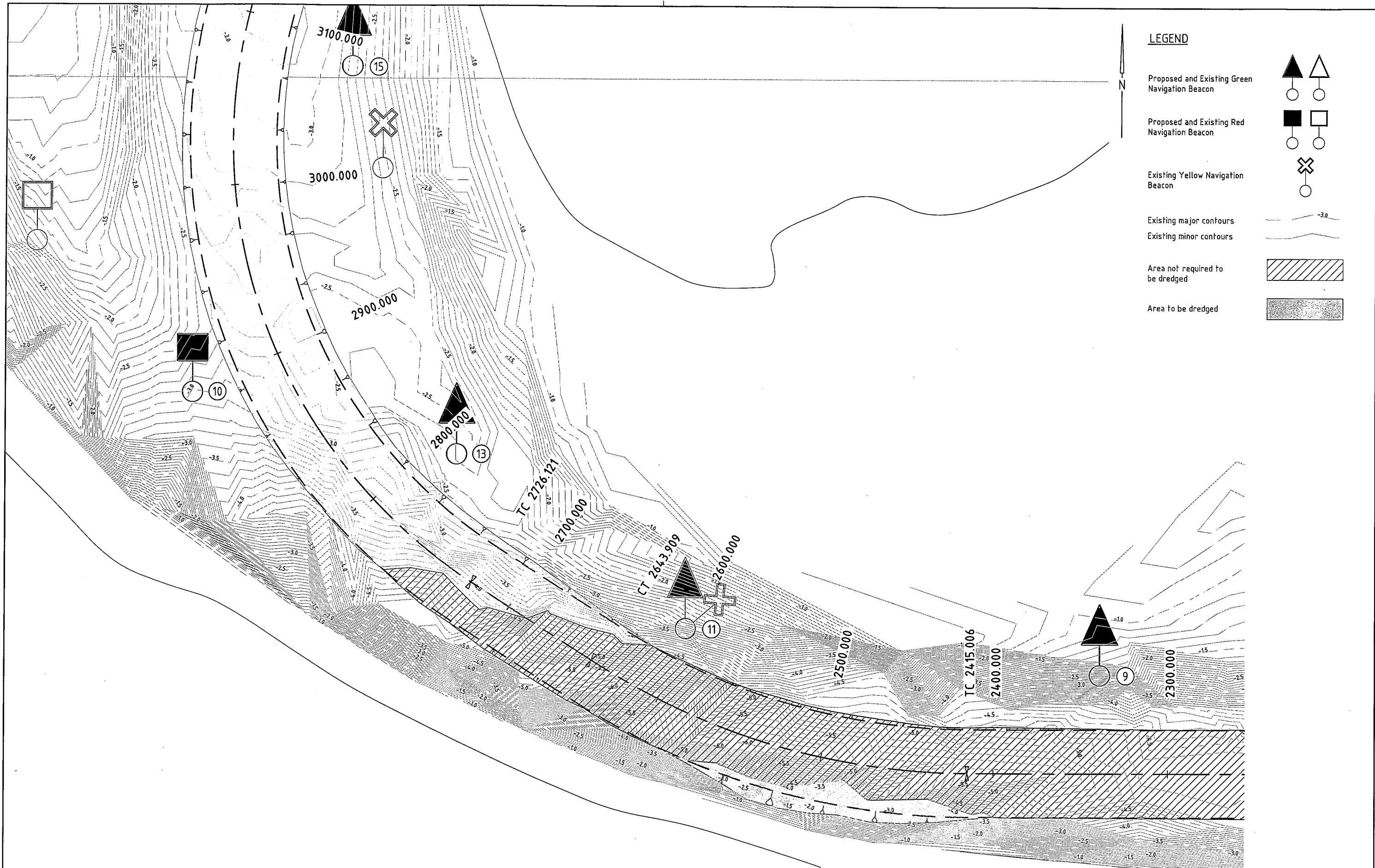
LAYOUT PLAN
Scale 1:1000

LEGEND

- Proposed and Existing Green Navigation Beacon
- Proposed and Existing Red Navigation Beacon
- Existing Yellow Navigation Beacon
- Existing major contours
- Existing minor contours
- Area not required to be dredged
- Area to be dredged

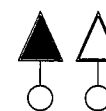
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SCALE BEFORE REDUCTION 1:1000

DATE PLOTTED: 20 November, 2007 - 3:50pm Rv. DATE REVISIONS REC. APPR.		© Cardno (Qld) Pty Ltd All Rights Reserved 2006. Copyright in the whole and every part of this drawing belongs to Cardno (Qld) Pty Ltd and may not be used, sold, transferred, copied or reproduced in whole or in part in any manner or form or on any media, to any person other than by agreement with Cardno (Qld) Pty Ltd. This document is produced by Cardno (Qld) Pty Ltd solely for the benefit of and use by the client in accordance with the terms of the contract. Cardno (Qld) Pty Ltd does not and shall not assume any responsibility or liability whatsoever to any third party arising out of any use or reliance by third party on the content of this document.		DESIGNED: <i>SS</i> DRAWN: <i>SS</i> CHECKED: <i>SS</i> RECOMMENDED: PROJ. MAN. <i>SS</i> APPROVED: PROJ. MGR. <i>SS</i> CAD FILE: LA7900-33/SUB 01/ACAD/7900-33-01-306.dwg XREF: X-BASE; EXISTING UNCLIPPED CONTOURS; X-A1-80-SHT FINAL; Caboolture.mxd Web: www.cardno.com.au		A1 DATUM: A.H.D. Cardno Cardno (Qld) Pty Ltd Level 1, 5 Gardner Close, Milton 4064 P.O. Box 388, Toowong 4066 Email: cardno@cardno.com.au ACN: 051 074 992		NORTHEAST BUSINESS PARK CABOOLTURE RIVER DREDGING MARITIME SAFETY QUEENSLAND PREFERRED ALIGNMENT LAYOUT PLAN - CH 1600.000 - CH 2300.000 SHEET 3 OF 10		DATE: 19-10-2007 DRAWING No: 7900/33/01-306 Rv.	
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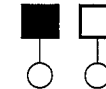


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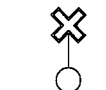
Proposed and Existing Green Navigation Beacon



Proposed and Existing Red Navigation Beacon



Existing Yellow Navigation Beacon



Existing major contours



Existing minor contours



Area not required to be dredged



Area to be dredged



LAYOUT PLAN
Scale 1:1000

10 0 10 20 30 40 50m
SCALE BEFORE REDUCTION 1:1000

DATE PLOTTED: 20 November, 2007 - 3:53pm

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RECOMMENDED: PROJ. MAN. *SS*

APPROVED: PROJ. DIR. *SS*

CAD FILE: L:\1790-33\SUB 01\Acad\1790-33-307.dwg

XREF's: X-Base; EXISTING UNCLIPPED CONTOURS; X-A1-B0-SHT FINAL; Caboolture.mxd

A1 DATUM: A.H.D.



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NORTHEAST BUSINESS PARK



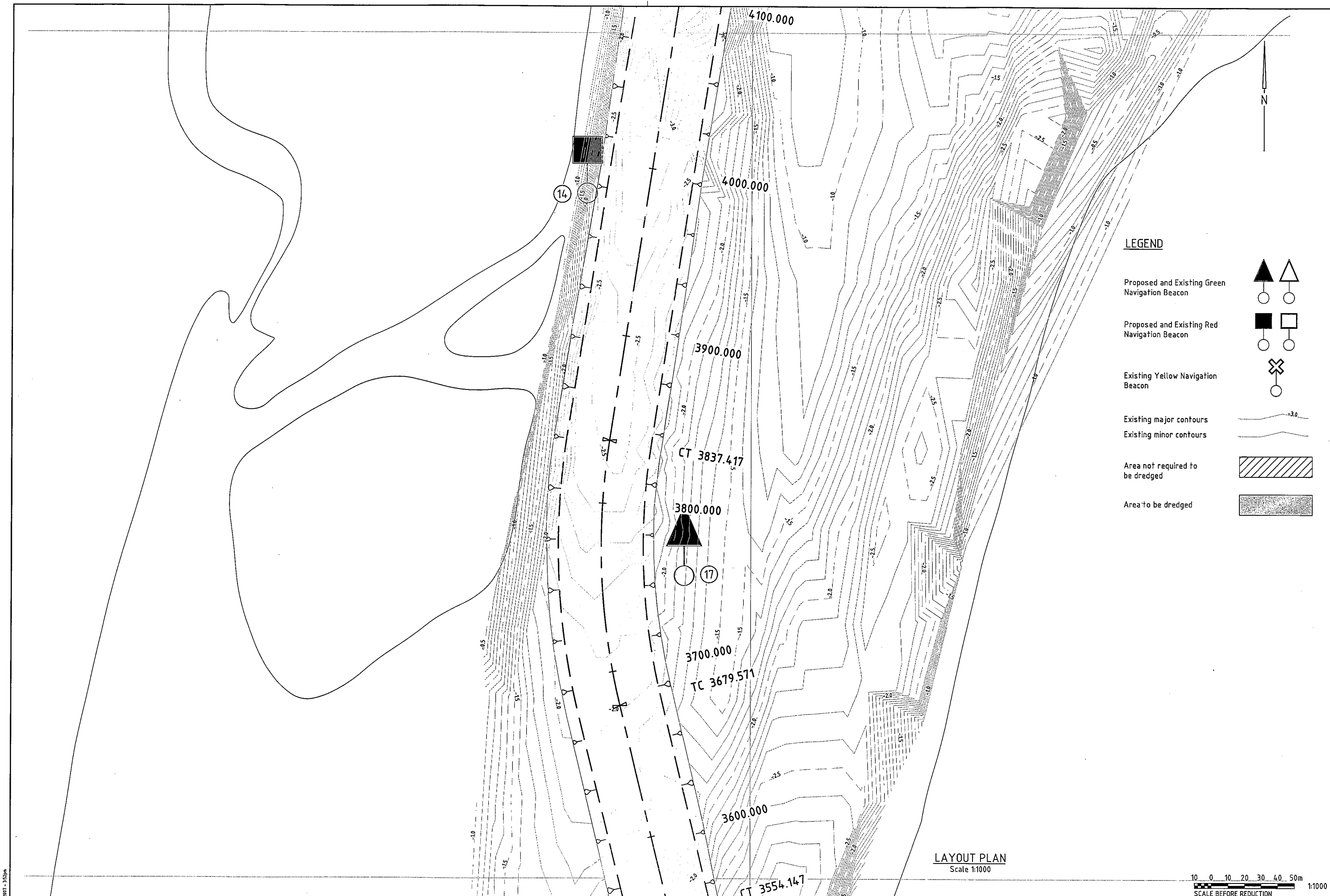
NORTHEAST BUSINESS PARK

CABOOLTURE RIVER DREDGING
MARITIME SAFETY QUEENSLAND PREFERRED ALIGNMENT
LAYOUT PLAN - CH2300.000 - CH3100.000
SHEET 4 OF 10

DATE: 19-10-2007

DRAWING No:

7900/33/01-307



LEGEND

- Proposed and Existing Green Navigation Beacon
- Proposed and Existing Red Navigation Beacon
- Existing Yellow Navigation Beacon
- Existing major contours
- Existing minor contours
- Area not required to be dredged
- Area to be dredged

LAYOUT PLAN
Scale 1:1000



DATE PLOTTED: 20 November 2007 - 3:52pm

DESIGNED: <i>[Signature]</i>		DRAWN: <i>[Signature]</i>		CHECKED: <i>[Signature]</i>		RECOMMENDED: PROJ. MAN. <i>[Signature]</i>		APPROVED: PROJ. DIR. <i>[Signature]</i>		CAD FILE: L:\7900-33\SUB 01\ACAD\7900-33-01-309.dwg		XREF'S: X-A1-B0-SHT FINAL; X-B0-1 EXISTING UNCLIPPED CONTOURS; Caboolture.mxd	
A1		DATUM: A.H.D.		Cardno (Qld) Pty Ltd		ACN: 051 074 992		NORTHEAST BUSINESS PARK		CABOOLTURE RIVER DREDGING		MARITIME SAFETY QUEENSLAND PREFERRED ALIGNMENT	
LAYOUT PLAN - CH 3554.147 - CH 4100.000		SHEET 6 OF 10		DATE: 19-10-2007		DRAWING No: 7900/33/01-309		Rv.		Rv.		Rv.	

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Rv.	DATE	REVISIONS	REC.	APPR.

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NPEQ: 1470

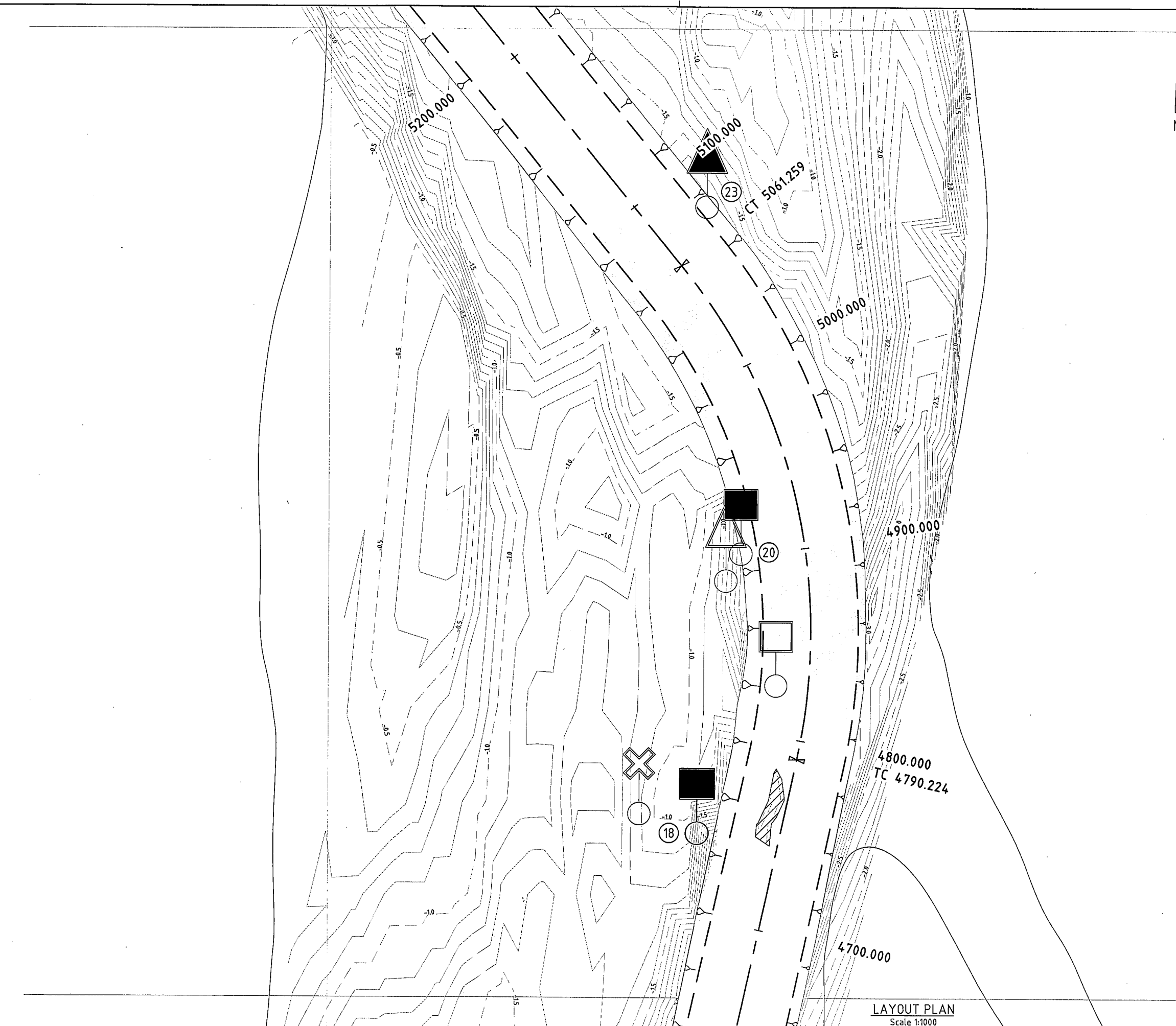
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XREF's: X-A1-B0-SHT FINAL; EXISTING UNCLIPPED CONTOURS; X-Base; Caboolture.mxd

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NORTHEAST BUSINESS PARK

NORTHEAST BUSINESS PARK
CABOOLTURE RIVER DREDGING
MARITIME SAFETY QUEENSLAND PREFERRED ALIGNMENT
LAYOUT PLAN - CH 4700.000 - CH 5200.000
SHEET 8 OF 10

DATE: 19-10-2007
DRAWING No: 7900/33/01-311
Rv.



LEGEND

- Proposed and Existing Green Navigation Beacon:
- Proposed and Existing Red Navigation Beacon:
- Existing Yellow Navigation Beacon:
- Existing major contours:
- Existing minor contours:
- Area not required to be dredged:
- Area to be dredged:

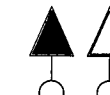
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SCALE BEFORE REDUCTION 1:1000

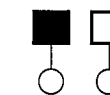


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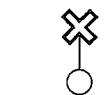
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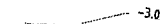
Proposed and Existing Red Navigation Beacon



Existing Yellow Navigation Beacon



Existing major contours



Existing minor contours



Area not required to be dredged



Area to be dredged



LAYOUT PLAN
Scale 1:1000

10 0 10 20 30 40 50m
SCALE BEFORE REDUCTION 1:1000

DATE PLOTTED: 20 November, 2007 - 3:52pm

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CHECKED: *SK*
RECOMMENDED: PROJ. MAN. *SK*
APPROVED: PROJ. MGR. *SK*
CAD FILE: L:\1990-33\SUB 01\A\cardno\1990-33-312.dwg
XREF: X-Base: EXISTING UNCLIPPED CONTOURS; X-A1-BD-SHT FINAL; Caboolture.mxd

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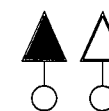
NORTHEAST BUSINESS PARK

NORTHEAST BUSINESS PARK
CABOOLTURE RIVER DREDGING
MARITIME SAFETY QUEENSLAND PREFERRED ALIGNMENT
LAYOUT PLAN - CH 5200.000 - CH 5700.000
SHEET 9 OF 10

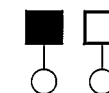
DATE: 19-10-2007
DRAWING No: 7900/33/01-312
Rv.

LEGEND

Proposed and Existing Green Navigation Beacon



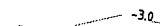
Proposed and Existing Red Navigation Beacon



Existing Yellow Navigation Beacon



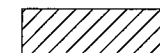
Existing major contours



Existing minor contours



Area not required to be dredged



Area to be dredged



LAYOUT PLAN
Scale 1:1000

10 0 10 20 30 40 50m
SCALE BEFORE REDUCTION 1:1000

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DRAWN: SB

CHECKED: RC

RECOMMENDED: PROJ. MAN.

APPROVED: PROJ. DIR.

CAD FILE: LA7900-33/SUB 01/Access/19-10-2007-313.dwg

XREF: X-BASE, EXISTING UNCLIPPED CONTOURS, X-A1-BD-SHT FINAL, Caboolture.mxd

A1

DATUM: A.H.D.



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NORTHEAST BUSINESS PARK

NORTHEAST BUSINESS PARK

CABOOLTURE RIVER DREDGING
MARITIME SAFETY QUEENSLAND PREFERRED ALIGNMENT
LAYOUT PLAN - CH 5700.000 - CH 6348.983
SHEET 10 OF 10

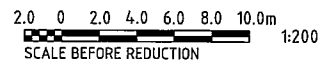
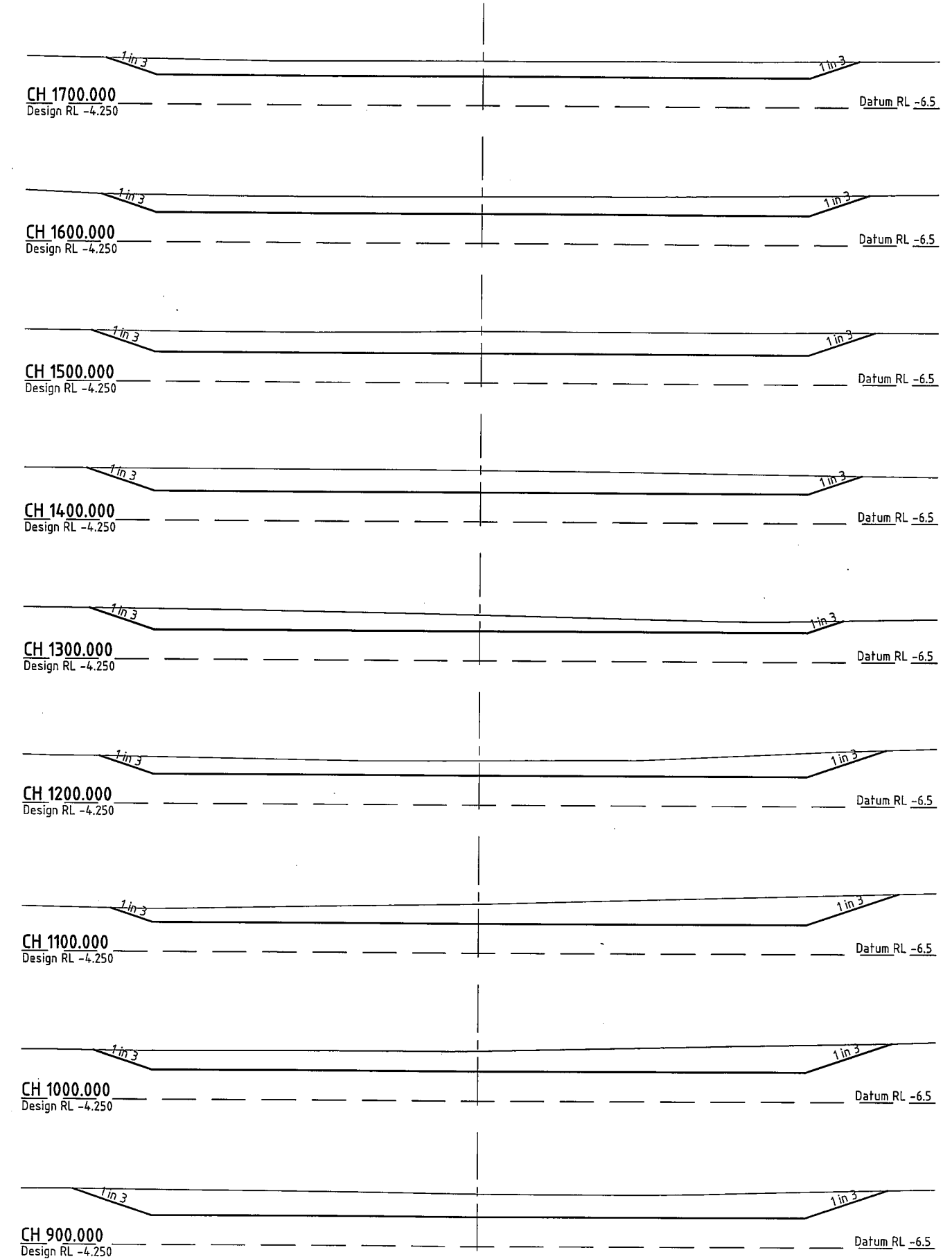
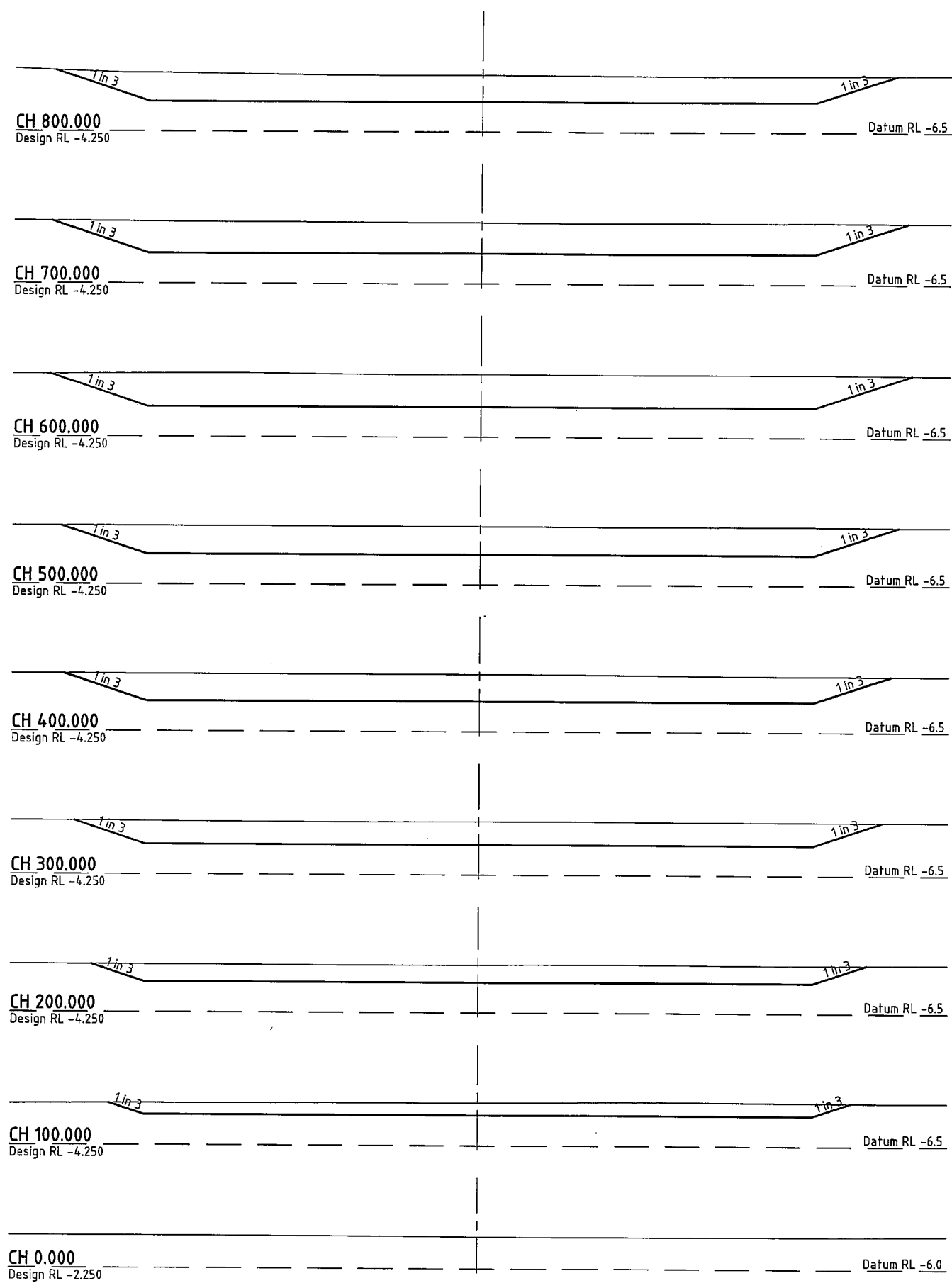
DATE: 19-10-2007

DRAWING No:

7900/33/01-313

REV.

REV.



DATE PLOTTED: 20 November, 2007 - 3:59pm

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REV.	DATE	REVISIONS	REC.	APPR.					

CH 2600.000
Design RL -4.250

Datum RL -8.5

CH 2500.000
Design RL -4.250

Datum RL -8.0

CH 2400.000
Design RL -4.250

Datum RL -8.0

CH 2300.000
Design RL -4.250

Datum RL -7.0

CH 2200.000
Design RL -4.250

Datum RL -7.0

CH 2100.000
Design RL -4.250

Datum RL -6.5

CH 2000.000
Design RL -4.250

Datum RL -6.5

CH 1900.000
Design RL -4.250

Datum RL -6.5

CH 1800.000
Design RL -4.250

Datum RL -6.5

CH 3500.000
Design RL -4.250

Datum RL -6.5

CH 3400.000
Design RL -4.250

Datum RL -6.5

CH 3300.000
Design RL -4.250

Datum RL -6.5

CH 3200.000
Design RL -4.250

Datum RL -6.5

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Design RL -4.250

Datum RL -6.5

CH 3000.000
Design RL -4.250

Datum RL -6.5

CH 2900.000
Design RL -4.250

Datum RL -6.5

CH 2800.000
Design RL -4.250

Datum RL -6.5

CH 2700.000
Design RL -4.250

Datum RL -7.5

2.0 0 2.0 4.0 6.0 8.0 10.0m
SCALE BEFORE REDUCTION 1:200

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DRAWN: *SB*

CHECKED: *AC*

RECOMMENDED: PROJ. MAN.

APPROVED: PROJ. DIR.

CAD FILE: L:\7900-33\SUB 01\A\79003301-315.dwg

XREF: X-A1-B0-SHT FINAL

A1

DATUM: A.H.D.



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NORTHEAST BUSINESS PARK



NORTHEAST BUSINESS PARK

CABOOLTURE RIVER DREDGING
MARITIME SAFETY QUEENSLAND PREFERRED ALIGNMENT
CROSS SECTIONS - CH 1800.000 - CH 3500.000
SHEET 2 OF 4

DATE: 19-10-2007

DRAWING No:

7900/33/01-315

Rv.

DATE PLOTTED: 20 November, 2007 - 3:53pm

CH 4300.000
Design RL -4.250

Datum RL -6.5

CH 4200.000
Design RL -4.250

Datum RL -6.5

CH 4100.000
Design RL -4.250

Datum RL -6.5

CH 4000.000
Design RL -4.250

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Design RL -4.250

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CH 3700.000
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Datum RL -6.5

CH 3600.000
Design RL -4.250

Datum RL -6.5

CH 5100.000
Design RL -4.250

Datum RL -6.5

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CH 4900.000
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CH 4600.000
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Datum RL -6.5

CH 4500.000
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Datum RL -6.5

CH 4400.000
Design RL -4.250

Datum RL -6.5

2.0 0 2.0 4.0 6.0 8.0 10.0m
SCALE BEFORE REDUCTION 1:200

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DRAWN: SB
CHECKED: MC

RECOMMENDED: PROJ. MAN.
APPROVED: PROJ. DIR.
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A1 DATUM: A.H.D.

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**NORTHEAST
BUSINESS PARK**

NORTHEAST BUSINESS PARK

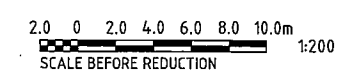
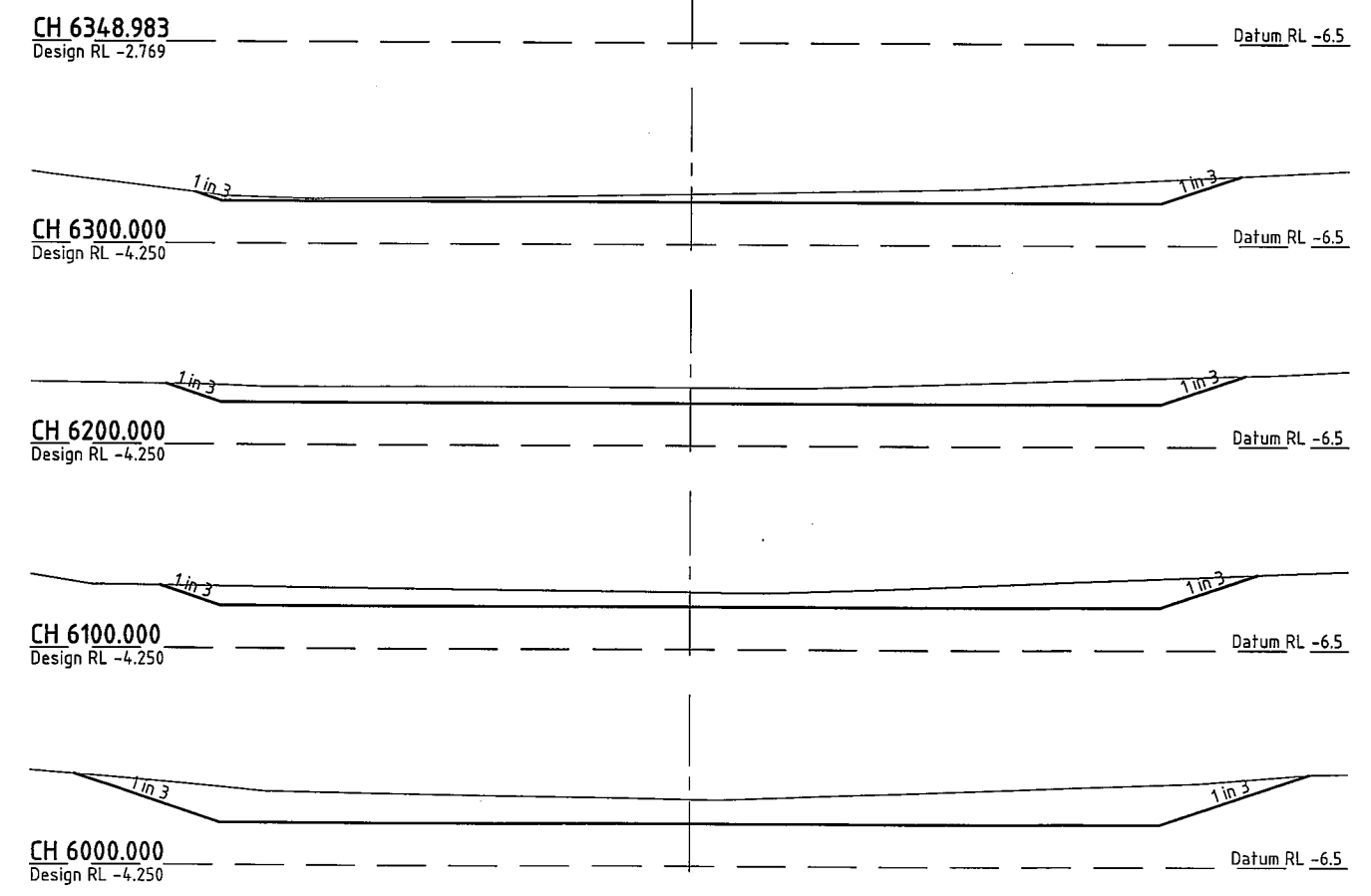
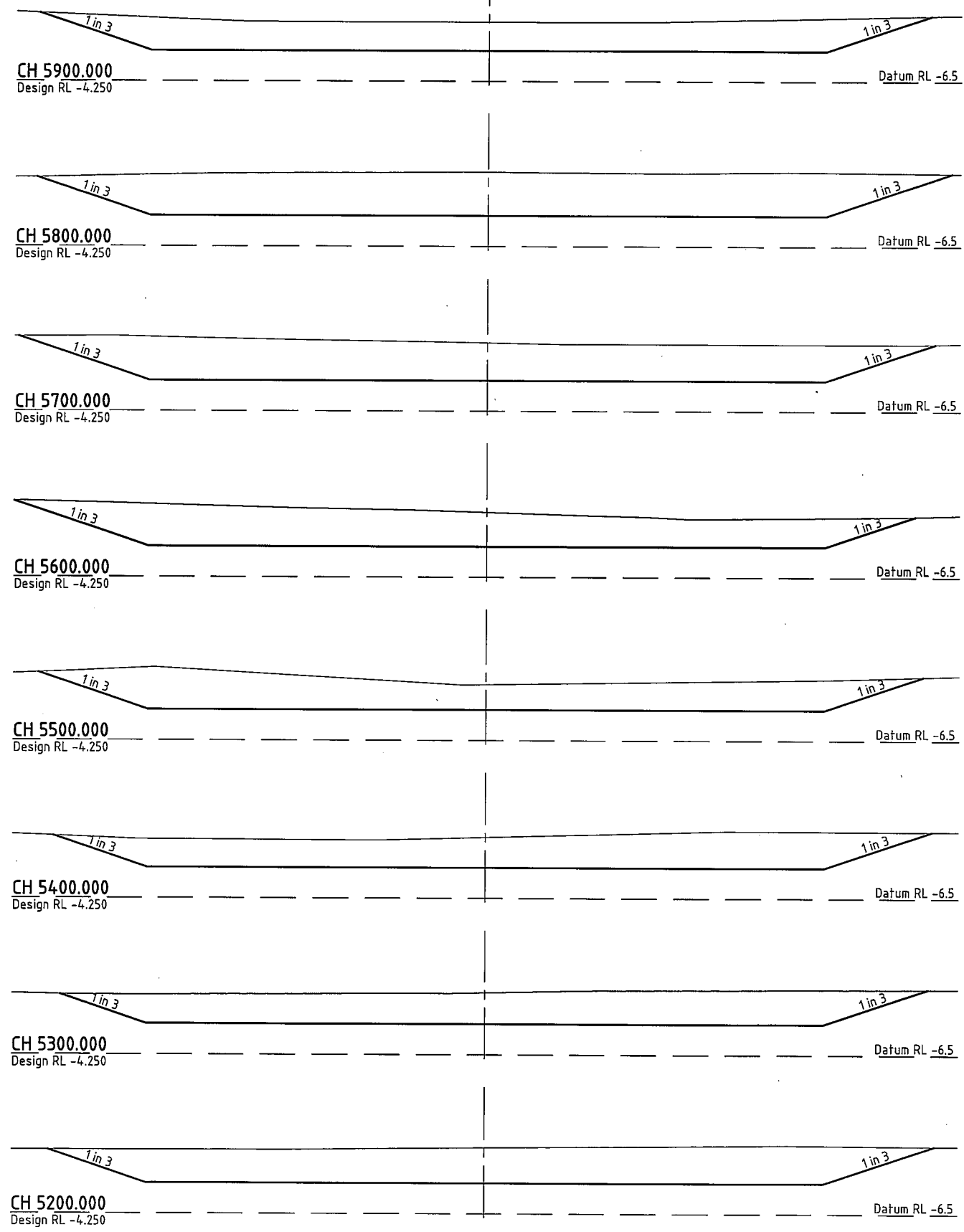
CABOOLTURE RIVER DREDGING
MARITIME SAFETY QUEENSLAND PREFERRED ALIGNMENT
CROSS SECTIONS - CH 3600.000 - CH 5100.000
SHEET 3 OF 4

DATE: 19-10-2007

DRAWING No:

7900/33/01-316

Rv.



DATE PLOTTED: 20 November, 2007 - 3:59pm

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APPENDIX C

Field Sampling Methodology

ACID SULFATE SOIL FIELD ASSESSMENT

Policy

To minimise as much as reasonably practicable the detrimental impact on the receiving environment from ASS exposure through effective identification.

To comply with the *Environmental Protection Act 1994* to take all reasonable and practicable measures to prevent or minimise environmental harm and to manage ASS in accordance with the *Queensland Acid Sulfate Soil Technical Manual, Soil Management Guidelines* and SPP 2/02.

Implementation

ASS Field Assessment is required as part of the neutralisation methodology to identify ASS and inform validation monitoring intensity.

In the event ASS soils are exposed which do not have sufficient acid neutralising capacity, section 8 of this ASSMP applies.

Identification of ASS

Potential ASS (PASS) and Actual ASS (AASS), collectively referred to as ASS, are soils containing iron sulphide and exist in an anaerobic state. Upon exposure to oxygen the iron sulphide is converted to iron sulphate, simultaneously releasing acid. When soils release unacceptable quantities of acid, when compared against the Action Criteria in SPP 2/02, detailed treatment and management as detailed in section 8 of this ASSMP is critical.

It is a requirement of this ASS Field Assessment to determine the presence of PASS or AASS in a daily monitoring program through visually characterising soils and screening using field pH tests (both pH_F and pH_{FOX}).

The field pH tests (both pH_F and pH_{FOX}) should be conducted at 0.25 m intervals on the soil profile, ensuring at least one test per horizon. It is recommended that field tests be conducted on-site, in the field. If the tests can't be performed in the field on-site, tests should be conducted within 24 hours of soil sample collection, ensuring appropriate sample handling procedures. Samples suspected of containing monosulfides should undergo field pH testing immediately in the field.

pH Field Test

The procedure for the field pH test (pH_F) is documented in section H of the Ahern CR, McElnea AE, Sullivan LA (2004) *Acid Sulfate Soils Laboratory Methods Guidelines* published by the Queensland Department of Natural Resources, Mines and Energy, Indooroopilly, Queensland, Australia.

The procedure for the pH_F test is provided below.

1. Calibrate battery powered field pH meter according to manufacturer's instructions.
2. Prepare the test tubes in the test tube rack. Use of separate racks for the pH_F and pH_{FOX} tests is recommended as contamination may occur when the pH_{FOX} reactions are violent. As the soil: water paste is inclined to stick to the walls of tubes, it is best to use shallow, broad test tubes as this makes cleaning easier.
3. Conduct tests at intervals on the soil profile of 0.25 m or at least one test per horizon whichever is lesser.
4. Remove approximately 1 teaspoon of soil from the profile. Place approximately ½ teaspoon of that soil into the pH_F test tube and place ½ teaspoon of the soil into the

pH_{FOX} test tube for the corresponding depth test. It is important that these two sub-samples come from the same depth and that they are similar in characteristics. For example, DO NOT take ½ teaspoon of soil from the 0–0.25m depth that is grey mud, while selecting ½ teaspoon from the same depth that is a yellow mottled sample. These will obviously give different results independent of the type of test conducted.

5. Place enough deionised water (or demineralised water if deionised water is not available; never use tap water) in the pH_F test tube to make a paste similar to 'grout mix' or 'white sauce', stirring the soil: water paste with a skewer, strong tooth pick or similar to ensure all soil 'lumps' are removed. Do not leave the soil samples in the test tubes without water for more than 10 minutes. This will reduce the risk of sulfide oxidation—the pH_F is designed to indicate the existing pH of a soil in the field; any oxidation subsequent to the soil's removal from the ground will not reflect the true field pH. In some instances, in less than 5 minutes, monosulfidic material may start to oxidise and substantially affect the pH_F results.
6. Immediately place the spear point electrode (preferred method) into the test tube, ensuring that the spear point is totally submerged in the soil: water paste. Never stir the paste with the electrode. This will damage the semi-permeable glass membrane.
7. Measure the pH_F using a pH meter with spear point electrode.
8. Wait for the reading to stabilise and record the pH measurement.
9. All measurements should be recorded on a data sheet.

Field pH Peroxide Test (pH_{FOX})

The procedure for the field pH peroxide test (pH_{FOX}) is documented in section H of the Ahern CR, McElnea AE, Sullivan LA (2004) *Acid Sulfate Soils Laboratory Methods Guidelines* published by the Queensland Department of Natural Resources, Mines and Energy, Indooroopilly, Queensland, Australia.

The procedure for the pH_{FOX} test is provided below.

1. Adjust the pH of the hydrogen peroxide to pH 4.5–5.5 before going into the field. This can be done by adding a few drops of dilute NaOH stirring and checking the pH with the electrode regularly until the correct range is reached. NaOH is highly caustic so safety precautions must be exercised. NaOH can raise the pH quickly or slowly, so the pH needs to be monitored. Recheck the pH after allowing the peroxide to stand for 15 minutes. Do NOT buffer a large quantity of hydrogen peroxide at one time. Only buffer the amount to be used in the field for about a month. This must be kept in a fridge, well labelled with only small quantities to be taken into the field at one time. This will ensure the longevity of the peroxide. Further, over time, the pH of the peroxide that has already been buffered may change. It is important to check the pH of the peroxide in the morning before departing to the field. Having a small quantity of NaOH in the field kit is recommended so the peroxide can be buffered if required.
2. Calibrate battery powered field pH meter according to manufacturer's instructions.
3. Prepare the test tubes in the test tube rack as for pH_F test. It is important to use heat-resistant test tubes for the pH_{FOX} test as the reaction can generate considerable heat (up to 90°C). It is recommended that a tall, wide tube be used for this test as considerable bubbling may occur, particularly on highly sulfidic or organic samples.
4. Conduct pH_{FOX} tests at intervals on the soil profile of 0.25 m or at least one per horizon whichever is lesser.
5. From the teaspoon of soil previously collected for the pH_F test, place approximately ½ teaspoon of the soil into the pH_{FOX} test tube for the corresponding depth test. It is important that these two sub-samples come from the same depth and that they are similar in characteristics. For example, DO NOT take ½ teaspoon of soil from the 0–0.25m depth that is grey mud, while selecting ½ teaspoon from the same depth that is a yellow mottled sample. These will obviously give different results independent of the type of test conducted.

6. Add a few millilitres of 30% H₂O₂ (adjusted to pH 4.5–5.5) to the soil (sufficient to cover the soil with peroxide) and stir the mixture. Do NOT add the peroxide to the test tube in which the pH_F test was conducted, that is, the pH_{FOX} test tube should not have any deionised water in it. Beakers can be used, however glass is usually easily broken when conducting field work, and when multiple tests are being conducted it is difficult to handle large beaker sizes efficiently. Do NOT add more than a few millilitres at a time. This will prevent overflow and wastage of peroxide. A day's supply of peroxide should be allowed to reach room temperature prior to use (cold peroxide from the fridge may be too slow to react).
7. Rate the reaction of soil and peroxide using a XXXX scale (see below and Table 6).
8. Ideally, allow approximately 15 minutes for any reactions to occur. If substantial sulfides occur, the reaction will be vigorous and may occur almost instantly. In this case, it may not be necessary to stir the mixture. Careful watch will be needed in the early stages to ensure that there is no cross contamination of samples in the test tube rack. If the reaction is violent and the soil: peroxide mix is escaping from the test tube, a small amount of deionised water (or demineralised water; not tap water) can be added (using a wash bottle) to cool and calm the reaction. Usually this controls overflow. Do NOT add too much deionised water as this may dilute the mixture and affect the pH value. It is important to only use a small amount of soil otherwise violent reactions will overflow and the sample will be lost.
9. Steps 6 to 8 may be repeated until the soil: peroxide mixture reaction has slowed. This will ensure that most of the sulfides have reacted. In the lab this procedure would be repeated until no further reaction occurs, however in the field, best judgement is recommended. Usually one or two extra additions of a few millilitres of peroxide are sufficient.
10. If there is no initial reaction, individual test tubes containing the soil: peroxide mixture can be placed into a container of hot water (especially in cooler weather) or in direct sunlight. This will encourage the initial reaction to occur. When the sample starts to 'bubble', remove the test tube immediately from the hot water and replace into test tube rack.
11. Wait for the soil: peroxide mixture to cool (may take up to 10 minutes). The reactions often exceed 90°C. Placing an electrode into these high temperature situations may result in physical damage and inaccurate readings. Check the temperature range of the pH meter and probe to see what temperature is suitable. Note that a more exact pH is achieved if a temperature probe is also used, however this may be impractical in some field situations.
12. Use an electronic pH meter (preferred method) to measure the pH_{FOX}. Place a spear point electrode into the test tube, ensuring that the spear point is totally submerged in the soil: peroxide mixture. Never stir the mixture with the electrode. This will damage the semipermeable glass membrane.
13. Wait for the reading to stabilise and record the pH_{FOX} measurement.
14. All measurements should be recorded on a data sheet.

The rate of the reaction generally indicates the level of sulfides present, but depends also on texture and other soil constituents. A soil containing very little sulfides may only rate an 'X' however a soil containing high levels of sulfides (remember the exact level of sulfides cannot be determined using the pH_{FOX} test) is more likely to rate a 'XXXX' although there are exceptions. This rating scale alone should not be used to identify ASS. It is not a very reliable feature in isolation as there are other factors including manganese and organic acids which may trigger reactions. Reactions with organic matter tend to be more 'frothing' and don't tend to generate as much heat as sulfidic reactions. Manganese reactions will be quite extreme, but don't tend to lower the pH_{FOX}. Table 4 indicates the reaction scale for pH_{FOX} tests.

Table 4 Soil reaction rating scale for the pH_{FOX}

Reaction Scale	Rate of Reaction
X	Slight reaction
XX	Moderate reaction
XXX	High reaction
XXXX	Very vigorous reaction, gas evolution and heat generation commonly >80°C

APPENDIX D

Corrective Action Request Form

CORRECTIVE ACTION REQUEST

Report No: _____

Date: _____

DETAILS OF NON-CONFORMANCE:

Inspected by: _____

DETAILS OF PROPOSED ACTION

Passed to Environmental Officer/Consultant (as applicable):y/n Date: _____
Reply required by: _____

ENVIRONMENTAL OFFICER/CONSULTANT ADVICE (as required):

Date action required by (if applicable): _____
Signed (by Environmental Officer or Consultant's representative): _____ Date: _____

AUTHORITY TO PROCEED

Sign: _____ Date: _____

ACTION CARRIED OUT

Sign: _____ Date: _____

ELEMENT RE-INSPECTED BY

Sign: _____ Date: _____

COPY ISSUED TO GENERAL MANAGER Date: _____

Sign: _____