C2

DREDGING AND DREDGE MOVEMENTS

MARINE GEOLOGY

CONTENTS

FIGURES

TABLES

2.1 INTRODUCTION

2.1.1 Background

This chapter describes the baseline conditions of the Spitfire Realignment Channel in Moreton Bay east of Woorim on Bribie Island. The Port of Brisbane Pty Ltd (PBPL) currently has approval to extract 15 M m^3 of material from the Spitfire Realignment Channel to improve shipping navigation and provide a source of fill for port development. The site is also proposed as a source of sand fill for the Sunshine Coast Airport Expansion Project (the Project) for structural fill and surcharge. This chapter describes the suitability of the material in the Spitfire Realignment Channel for this purpose.

The information in this chapter was also used for the assessment of other issues in Volume C, including water quality, coastal processes, ecology and cultural heritage.

2.1.2 Proposed works

It is proposed to extract up to 1.1 M m^3 of clean sand from the Spitfire Realignment Channel for use as structural fill for the earthworks platform for the Project and to provide surcharge for the western end of the new runway.

As discussed in Chapter C1, a trailing suction hopper dredger will be used to extract sand from the Spitfire Realignment Channel and transport it to a pump-out site east of Marcoola Beach. The sand will then be pumped through a large pipe to the reclamation area.

2.1.3 Methodology

A desktop review of previous investigations and records from dredging of the Spitfire Realignment Channel was conducted to:

- Assess the available depth of the Holocene sand layer
- Assess the silt and clay content of the sand
- Assess the potential for contamination to occur within the sand extraction area
- Assess the likelihood of acid sulphate soils (ASS) occurring within the deposits to be dredged.

The characteristics of the proposed sand extraction area were described based on a review of previous investigations and studies (see **Table 2.1a**). No field investigations were undertaken to describe the sand extraction area for this Environmental Impact Statement (EIS).

Table 2.1a: Information sources used to describe the sand properties at the Spitfire Realignment Channel

Data Source	Information Obtained
Bathymetric Survey (PBPL, 2010)	Existing seabed levels of the Spitfire Realignment Channel
Spitfire Channel Realignment Marine Geophysical Study and Geotechnical Borehole Program (Coffey, 2004)	Geotechnical information, including: • Seismic refractive and reflective survey of the Spitfire Realignment Channel • Nearby borehole logs • Particle size distribution for nearby boreholes • pH analysis.
Moreton Bay Sand Extraction Study Phase 1 (WBM, 2002)	Broad information for Spitfire Channel and surrounds including: • Description of sand resource • Sediment contamination information • Hydrodynamic conditions.
Brisbane Airport New Parallel Runway Environmental Impact Statement (Brisbane Airport Corporation 2006)	Background information on sediment contamination in Moreton Bay.
Spitfire Channel Realignment *Environment Protection and Biodiversity Conservation Act 1999* Referral Form (Port of Brisbane Corporation 2005)	General information on sand characteristics and sediment quality.

2.1.3.1 National Assessment Guidelines for dredging

The National Assessment Guidelines for Dredging 2009 (NAGD) apply to investigations for ocean disposal of dredge spoil. As the Project involves dredging of clean sand (because clean sand could be spoil in some scenarios) and includes only placement to land, rather than ocean disposal, the NAGD are not considered applicable to the Project. Consequently, field investigations in accordance with the NAGD were not undertaken.

2.1.4 Limitations and assumptions

Studies were carried out to inform the EIS assessment based on sand extraction from Spitfire Realignment Channel. Other sources of fill or extraction from other parts of Moreton Bay are not included within this baseline analysis.

Limited borehole information is available within the proposed sand extraction area. However, the seismic survey over the site has been correlated to borehole logs in nearby areas and is considered appropriate for informing the EIS. Additional geotechnical investigations to inform the dredging operations and detailed design will be required in later stages of the Project.

2.2 EXISTING CONDITION – GEOLOGY AND SOILS

2.2.1 Setting

The proposed sand extraction area is known as the Spitfire Realignment Channel. It is located in Moreton Bay approximately 7 km east of Woorim and 7 km west of Bulwer. The Spitfire Realignment Channel, located at the northern end of Western Banks, will remove a dogleg between the Main Channel and Spitfire Channel.

The Spitfire Realignment Channel is within the northern delta banks of Moreton Bay, which are at an interface between the more estuarine conditions of the bay and the oceanic conditions to the north-east. The northern delta deposits consist of sand overlying deeper Pleistocene deposits. It is the clean sand that is proposed as a source of fill.

2.2.2 Geology and stratigraphy

The near-surface geology of the Spitfire Realignment Channel sand extraction area comprises strata deposited during the Pleistocene and Holocene periods.

The nature of the Pleistocene deposits was significantly affected by sea level changes that occurred during the past 120,000 years. The deposition of sediments during periods of sea level incursion, which occurred during the Pleistocene, is expected to be analogous with the Holocene tidal delta deposits, which occurred later.

The Pleistocene ice ages resulted in sea level recession. The sea level during recession events was much lower than the present level. During sea level recession, Moreton Bay was a terrestrial environment, which consisted of stream channels and terrestrial vegetation. Sea level recession is also expected to have given rise to erosion of sediments previously laid down during sea level incursion, localised sediment deposition associated with the presence of relict stream channels within Moreton Bay and the onset of soil-forming processes.

The deposition and erosion of sediments during sea level fluctuation that occurred during the Pleistocene are expected to have resulted in a complex profile of the Pleistocene strata.

The current structure of Moreton Bay was formed in the past 6,000 to 7,000 years of the Holocene and is characterised by the formation of an extensive flood tide delta. Northerly long-shore transport is currently supplying Moreton Bay with marine sand.

Sand enters the bay via:

a. South Passage, between North Stradbroke Island and Moreton Island

b. The northern entrance, near the northern end of Moreton Island.

Deposition of sand has formed considerable tidal delta systems, most notably the southern tidal delta and northern tidal delta, indicated on **Figure 2.2a**.

The northern tidal delta comprises a seaward ebb-delta and a landward flood-delta (WBM, 2002). The proposed sand extraction area is located in the landward flood-delta. Sand transport in the landward flood delta is dominated by tide because it is protected from ocean swell by Moreton Island and the ebb-delta, which is located to the north-east. Tidal currents actively shape mobile Holocene sand banks and passages.

2.2.3 Geotechnical assessment

2.2.3.1 Subsurface stratigraphy

The proposed sand extraction area is located within the northern tidal delta, which is known to comprise predominant clean fine to medium-grained marine sand (WBM, 2002). Previous studies indicate an average depth of sand in Spitfire Banks and Western Banks of greater than 13 m (PPK, 1998).

Existing borehole and seismic investigations were available from a program of investigations previously commissioned by PBPL as part of its proposed Spitfire Realignment Channel (Coffey, 2004). The site investigations relevant to the proposed sand extraction included the following:

a. Two boreholes

b. Nine seismic reflection survey lines.

The location of the site investigations is shown in **Figure 2.2b.**

Fine to medium-grained sand was encountered in the boreholes to a depth greater than 11 m (elevation below 16 m relative to lowest astronomical tide). The boreholes were terminated between 11 m and 12 m depth.

The particle size distribution for samples taken at 1 m intervals indicates a sand grading envelope that exhibits the following typical parameters:

- D50 between 200 and 300 μm
- Fines (< 75 μm) fraction less than 6 per cent
- Greater than 99 per cent smaller than 600 μm (medium sand).

Figure 2.2a: Location of the southern and northern tidal deltas in Moreton Bay

Figure 2.2b: Location of boreholes and seismic reflection survey lines

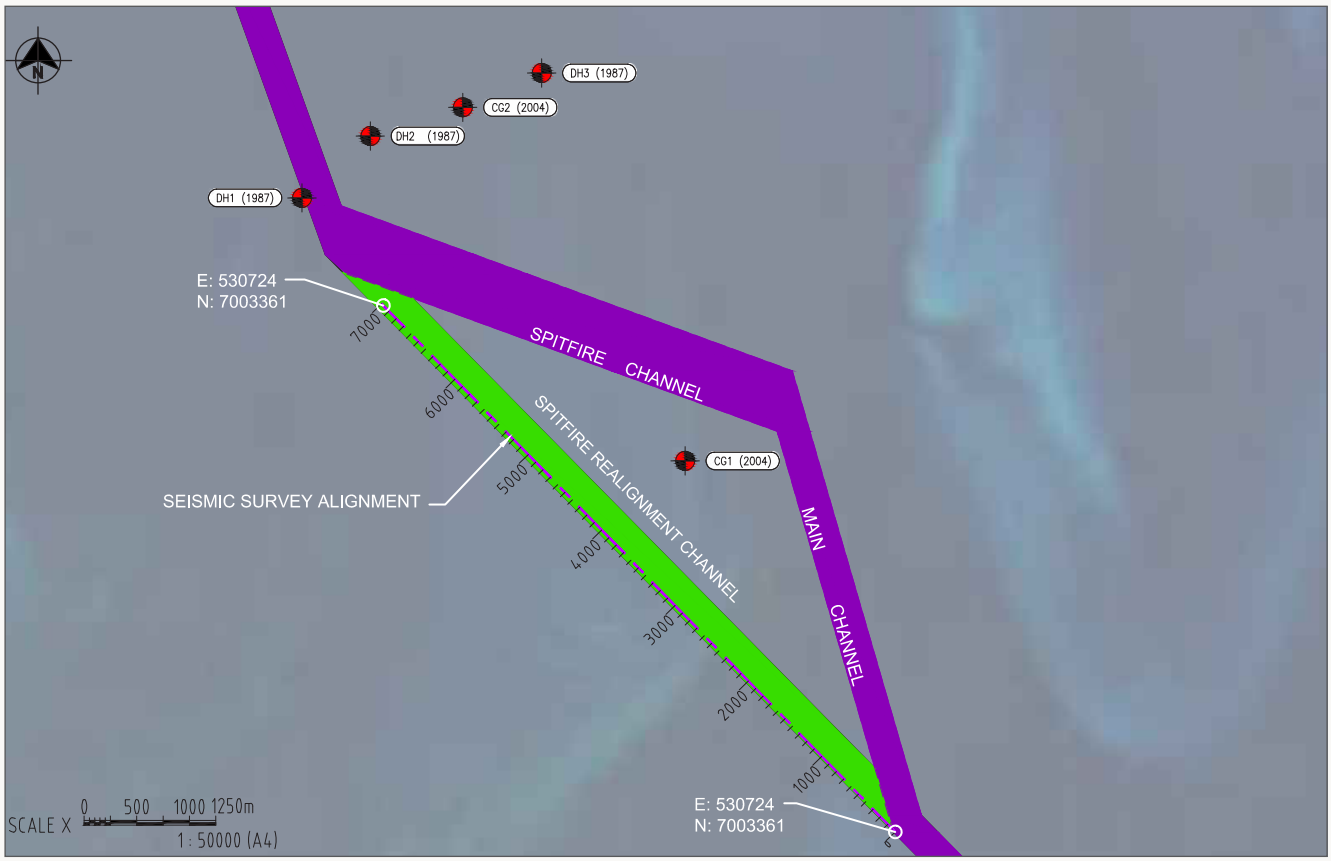
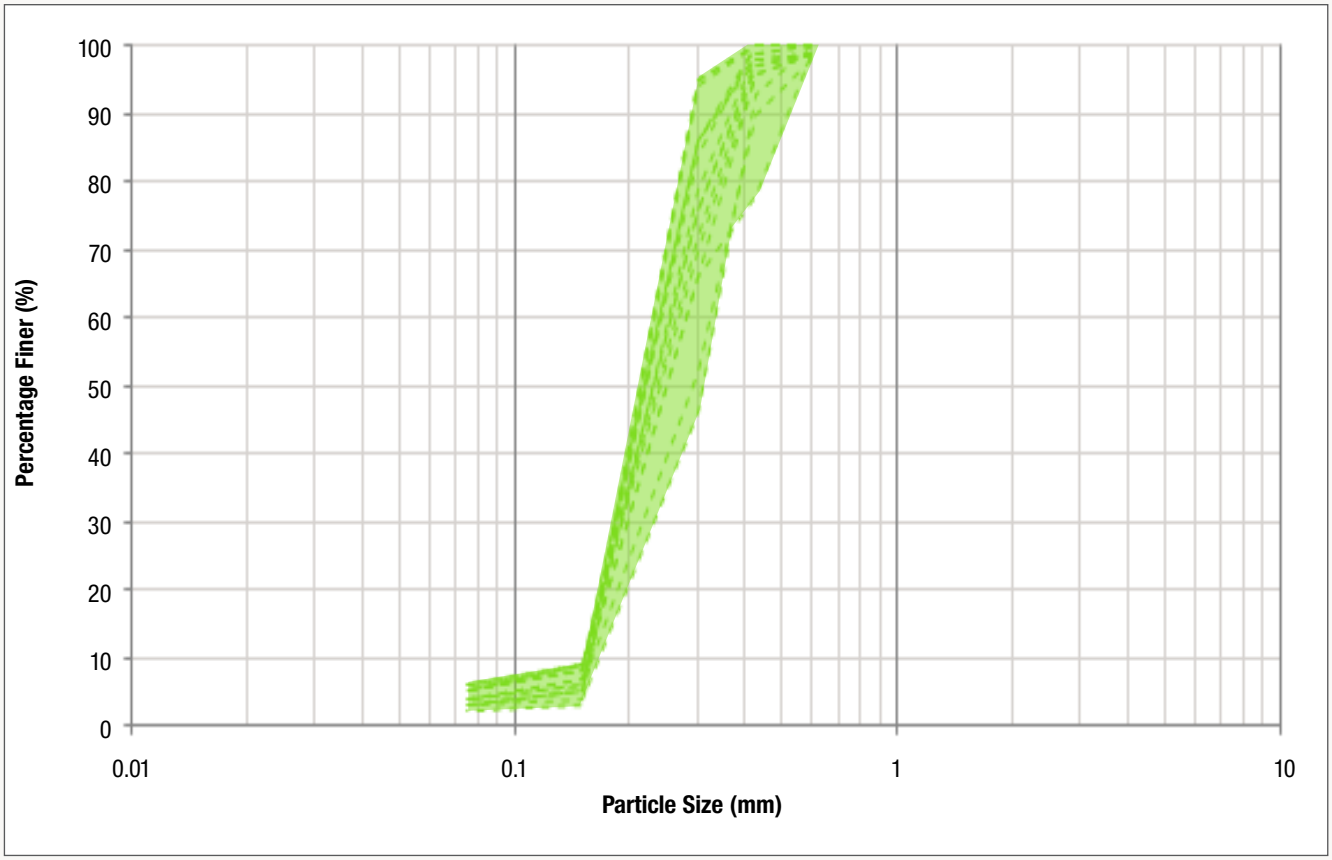


Figure 2.2c: Sand particle grading envelope from borehole samples



The grading envelope is shown graphically in **Figure 2.2c**.

The borehole records indicate increasing density with depth. A transition from medium dense-dense to dense-very dense is apparent at between 4 m and 5 m depth in both boreholes. Standard Penetration Tests (SPT) were carried out at 1 m intervals in both boreholes. SPT N values are a measure of penetration resistance, with higher N values indicating more dense material. **Figure 2.2d** provides a plot of the SPT N value against borehole depth, and indicates a general trend between density and depth of material. The shading on the graph indicates the correlation between SPT N value and density.

Figure 2.2e and **Figure 2.2f** show the material fraction passing the 75 μm and 300 μm sieves plotted against elevation. The plots indicate variability in the fines fraction (< 75 μm) and the medium sand fraction (300 μm), but do not indicate a general trend in the change of these parameters with depth.

Seismic reflection profiles along both sides of the sand extraction area are shown in **Figure 2.2g**. Coffey Geosciences (2004) suggest that the seismic reflection surveys indicate the presence of one to two reflectors in the sand extraction area, including the following:

a. A relatively weak continuous sub-planar reflector at 5-10 m depth below the sea floor observed along all seismic profiles. The reflector appears to represent the density contrast between mainly loose sands extending from the sea floor and underlying very dense sands that may contain shell layers.

b. A weak planar reflector dipping to the south with some channel structures mainly in the north. The reflector is not observed along all seismic alignments and is relatively weaker where observed underlying thicker sequence of material (potentially a result of partial or total absorption of seismic energy by overlying materials). The reflector is believed to represent the presence of Pleistocene clays. The reflector is generally well below the anticipated depth of sand extraction.

2.2.4 Particle composition and shape

Analysis of particle composition by Coffey Geosciences (2004) indicates the following general mineralogy:

- Quartz: 92-93%
- Shale fragments: 5-6%
- Calcite: 1-2%
- Opaque grains: 1%
- Feldspar: <1%.

The mineralogy indicates that the sands are mostly comprised of durable, inert material that is likely to be resistant to chemical degradation. The presence of calcite indicates that the sand has some capacity for buffering the possible presence of acidity.

Analysis indicates particle density is likely to fall within a range close to 2.66 t/m^3. The larger-size particles within the samples tend to exhibit a sub-rounded shape, whereas the smaller-sized particles exhibit a sub-angular to angular shape (Coffey, 2004).

Figure 2.2d: Distribution of SPT N values against depth (location of CG1 and CG2 shown in Figure 2.2b: Location of boreholes and seismic reflection survey lines)

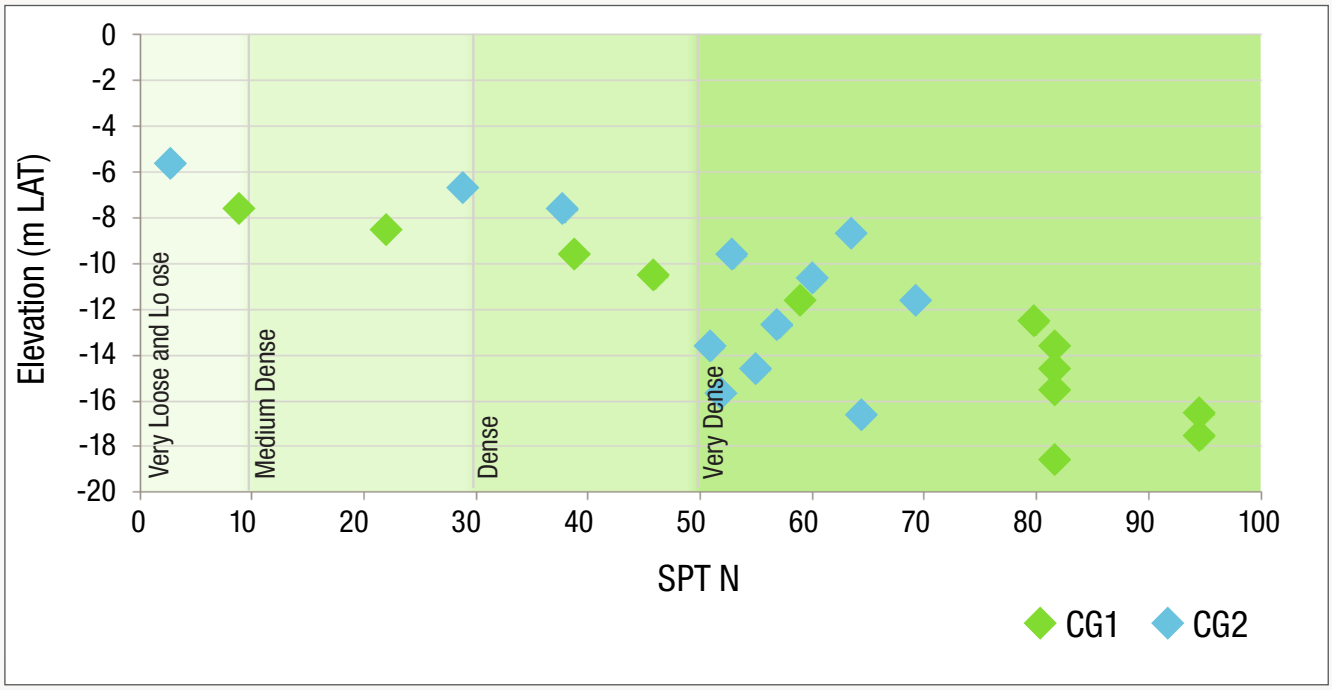


Figure 2.2e: Fines fraction (< 75 µm) against depth (location of CG1 and CG2 shown in Figure 2.2b: Location of boreholes and seismic reflection survey lines)

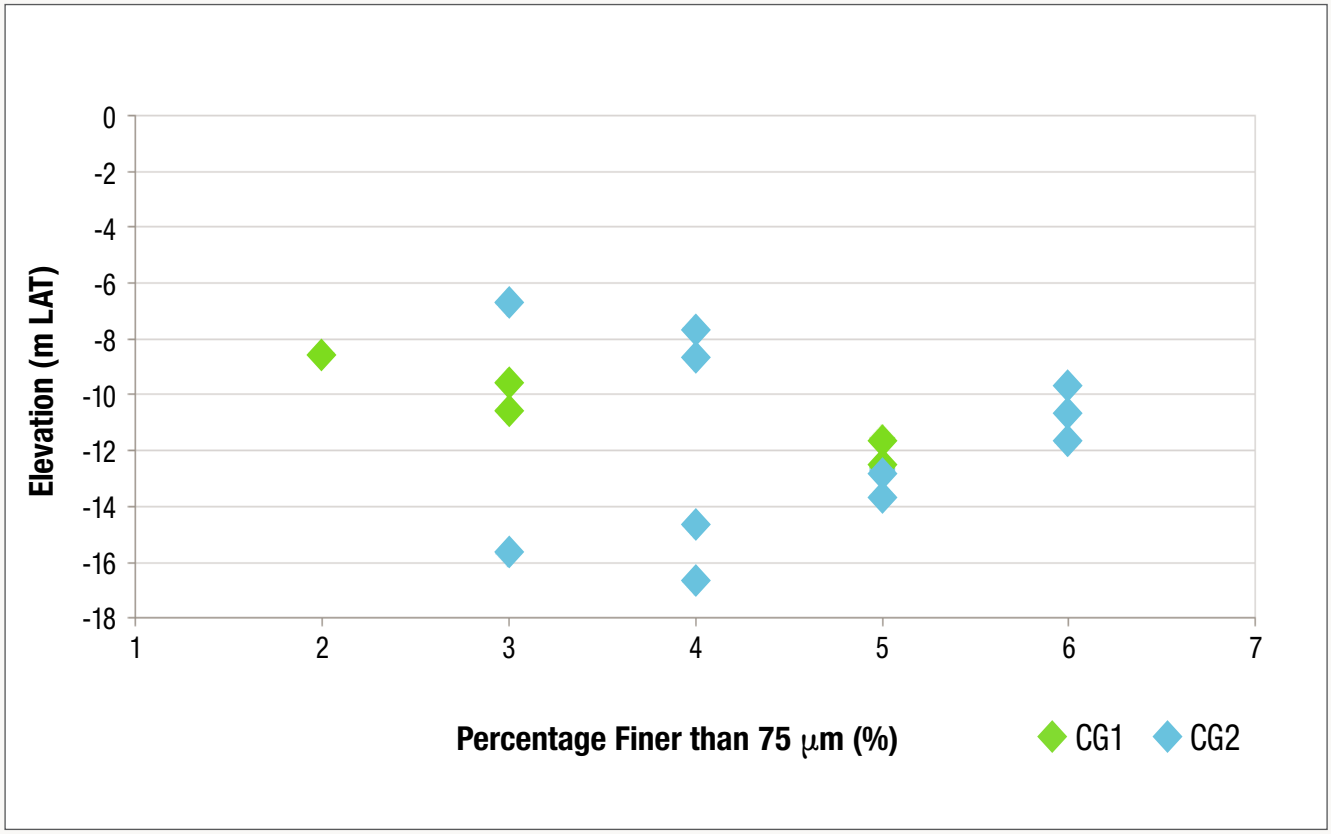


Figure 2.2f: Medium sand fraction (< 300 µm) against depth (location of CG1 and CG2 shown in Figure 2.2b)

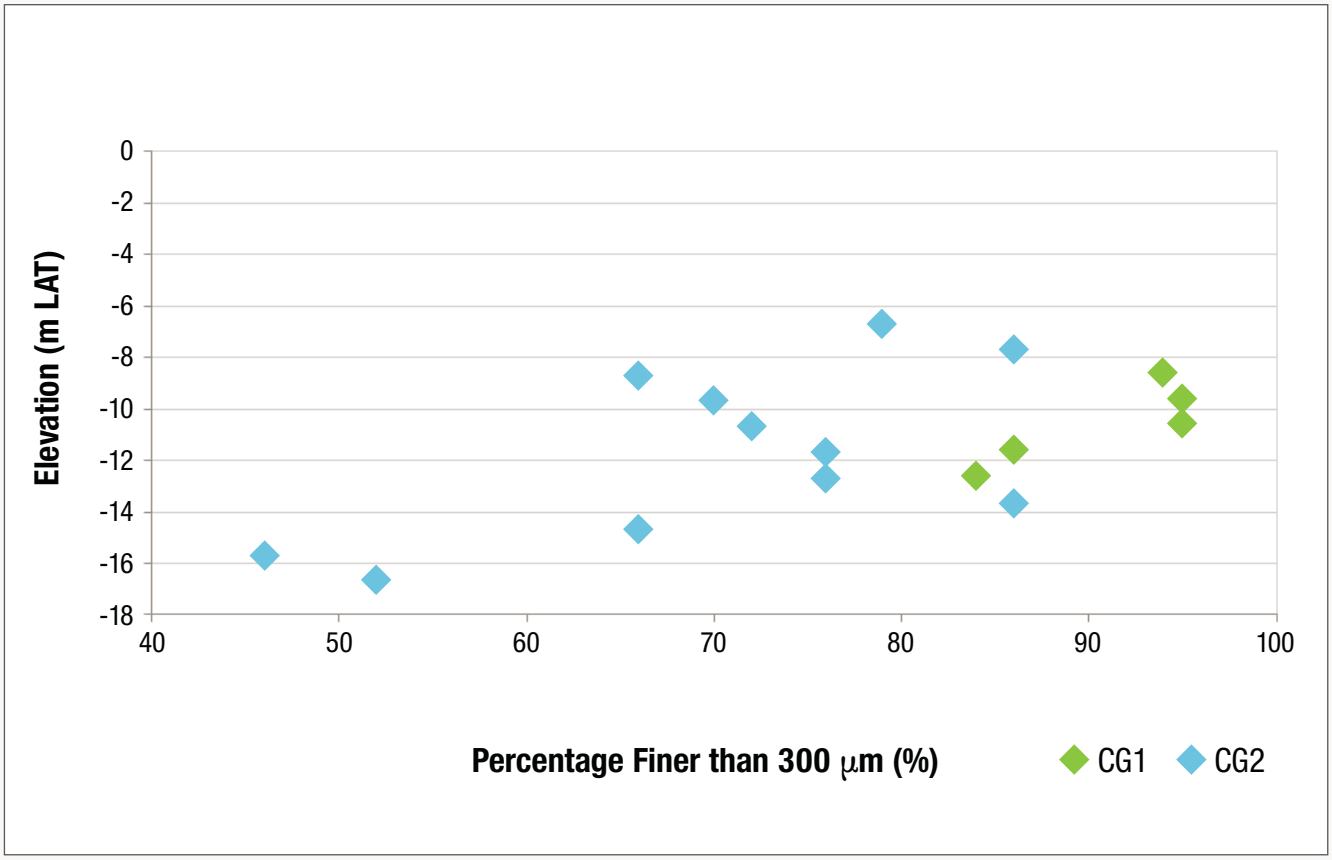
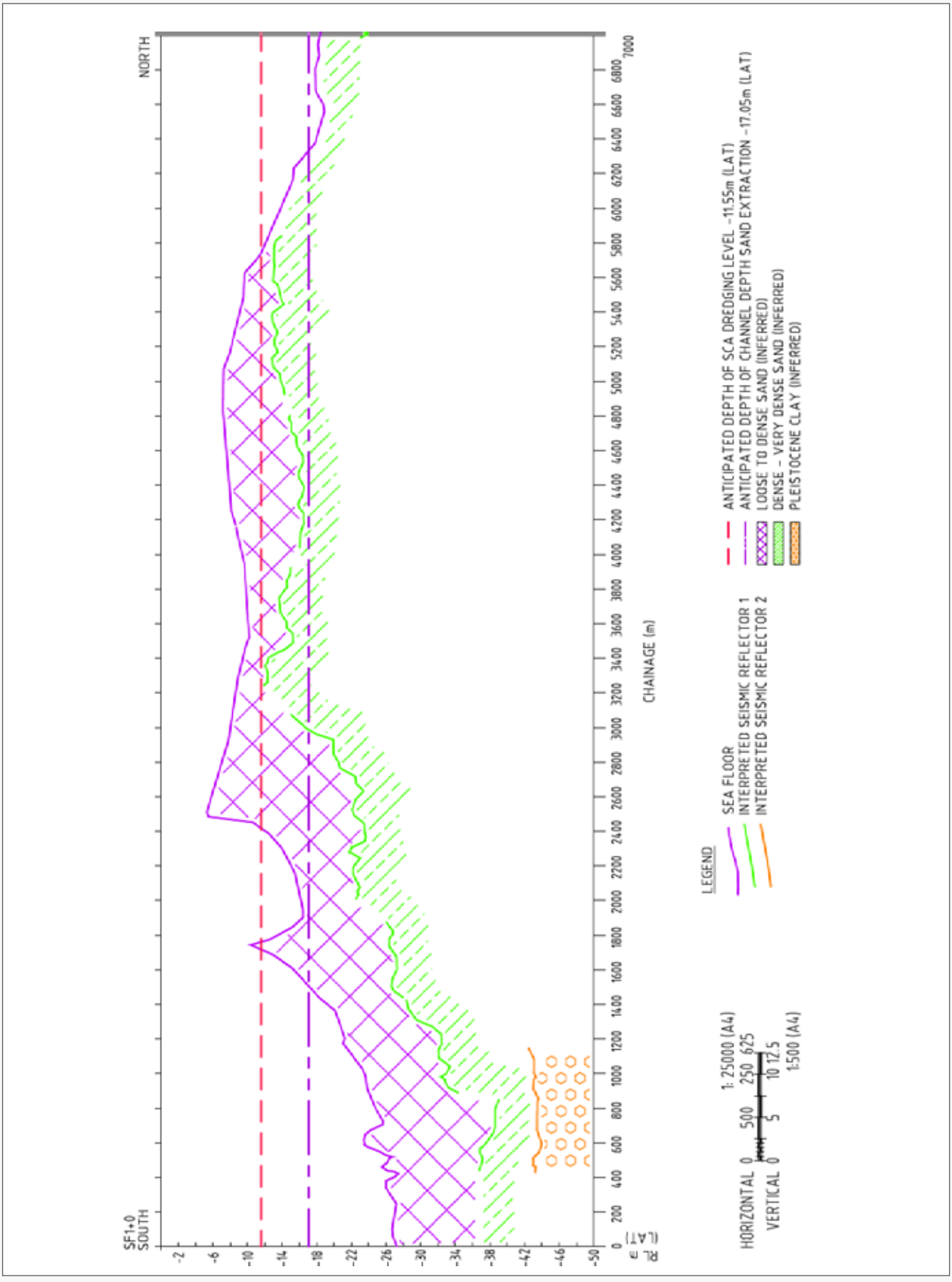


Figure 2.2g: Seismic reflection profiles



2.2.5 Assessment of acid sulphate soils (ASS)

ASS are typically associated with Holocene deposits of marine muds and sands in low energy coastal environments. In the coastal environment, ASS are formed when seawater interacts with sediments containing iron oxide and organic matter in an anaerobic environment.

ASS mapping prepared by the Department of Natural Resources and Mines does not include mapping of marine environments. Preliminary screening of the pH value of sand samples from CG1 and CG2 indicate a pH value of 6.5, suggesting the potential presence of acidity. Soil acidity of the sand deposits is likely to be buffered to some degree by the presence of calcareous material (calcite) and salinity of the marine environment.

Previous investigation of the ASS potential at Middle Banks in Moreton Bay (south of the proposed sand extraction area) indicates that low to moderate levels of oxidisable sulphur in clean sands are adequately buffered by the presence of calcareous material in the sand matrix (BAC, 2006). Underlying clayey sands contained moderate to high levels of potential ASS (BAC, 2006).

2.2.6 Sediment quality

An assessment of the conditions at the Spitfire Realignment Channel indicates that there is a very low likelihood of contamination occurring for the following reasons:

a. No contamination has been identified within the northern delta, including the Spitfire Realignment Channel

b. Under normal circumstances there are very low inputs of nutrients and toxicants to the area, which indicates contaminants are unlikely to be introduced to the site by ocean currents

c. Spitfire Realignment Channel is located in an active zone, experiencing strong tidal currents and wave climate, reducing the potential for contaminated sediments or low density contaminants to settle in the area

d. Previous investigations indicate the material in Spitfire Realignment Channel comprises clean sand with low fines concentrations. Contaminants are typically associated with fine sediments rather than sands, which are relatively inert. A low fraction of fines in the sand is associated with lower potential for contaminants to be present.

Each of the points above is discussed in the following sections. The Moreton Bay Sand Extraction Study (MBSES) (WBM, 2002) is the principal study into the suitability of extracting sand from Moreton Bay to provide for construction projects, and forms the basis of much of this assessment.

Whilst the MBSES was completed 10 years ago, only the surface layers of sand at the site would have been affected by coastal processes. Consequently, only a very small amount of material over the sand deposit would have changed composition in that time, indicating that the quality of almost all the sand within the proposed dredge footprint is unlikely to have changed since the study.

2.2.6.1 Previous sediment quality assessments

The assessment of sediment quality, undertaken for the northern delta as part of the MBSES, indicated there was no contamination present across the delta and there were low inputs of contaminants to the area.

Nutrients

The proposed sand extraction area is located in an area of Moreton Bay that is remote from potential nutrient sources that exist predominantly along the western shoreline of the bay. Previous investigations have established that the northern tidal delta area is subject to strong tidal currents that continually resuspend and maintain aerobic conditions in the surface sediments (Dennison & Abal, 1999). The investigations identified little or no nutrient exchange from the sediments (Dennison & Abal, 1999).

Inorganic contaminants (heavy metals and toxicants)

Previous sampling and analysis of inorganic contaminants in the North West Channel/Spitfire Channel area of the northern tidal delta was reported in the MBSES. The results of the analysis are presented in **Table 2.2a**.

The findings of previous analysis indicate very low levels of inorganic contaminants in the sediments sampled. The investigations also found organic contaminants (polyaromatic hydrocarbons and total petroleum hydrocarbons) to be below laboratory detection limits (WBM, 2002). The findings of previous sampling and analysis for sediment contaminants are consistent with the absence of a contaminant source in this part of the bay.

Table 2.2a: Results of contamination testing undertaken for the Moreton Bay Sand Extraction Study (WBM, 2002)

Metal	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Copper (Cu)	Mercury (Hg)	Nickel (Ni)	Lead (Pb)	Zinc (Zn)
Analysed Content (mg/kg)	0.38-2.3	<0.01	0.7-1.8	0.08-0.25	<0.01	0.39-0.66	0.51-0.79	0.68-1.2
NAGD (2009) Screening Level (mg/kg)	20	1.5	80	65	0.15	21	50	200

2.2.6.2 Hydrodynamic conditions

The Spitfire Realignment Channel is located in the northern tidal delta of Moreton Bay, which is characterised by strong tidal currents and wave environment. Generally, the entire northern delta is active under tidal currents, with wave action from ocean swell and local seas adding to sand mobility. The system is very well flushed by tidal exchange (WBM, 2002).

The presence of strong currents and waves indicates that fine sediments or low-density contaminants (such as oil) are unlikely to settle within the northern delta, including the Spitfire Realignment Channel. Consequently, the potential for contaminated sediments to be present within the proposed sand extraction area is considered very low.

In the 10 years since completion of the Moreton Bay Sand Extraction Study, the 2011 floods and 2010 oil spill are major events within Moreton Bay that could affect sediment quality. While contaminants from these events may have reached the Spitfire Realignment Channel, contaminants are unlikely to have settled at the site because of the relatively strong tidal currents and wave environment, as discussed above.

2.2.6.3 Sand characteristics

As discussed in the previous sections, material at the sand extraction area is expected to consist predominantly of fine sands, with a small fraction of fines.