Port of Gladstone
Gatcombe and Golding Cutting
Channel Duplication Project

Environmental Impact Statement

Gladstone Ports Corporation
Growth, Prosperity, Community.

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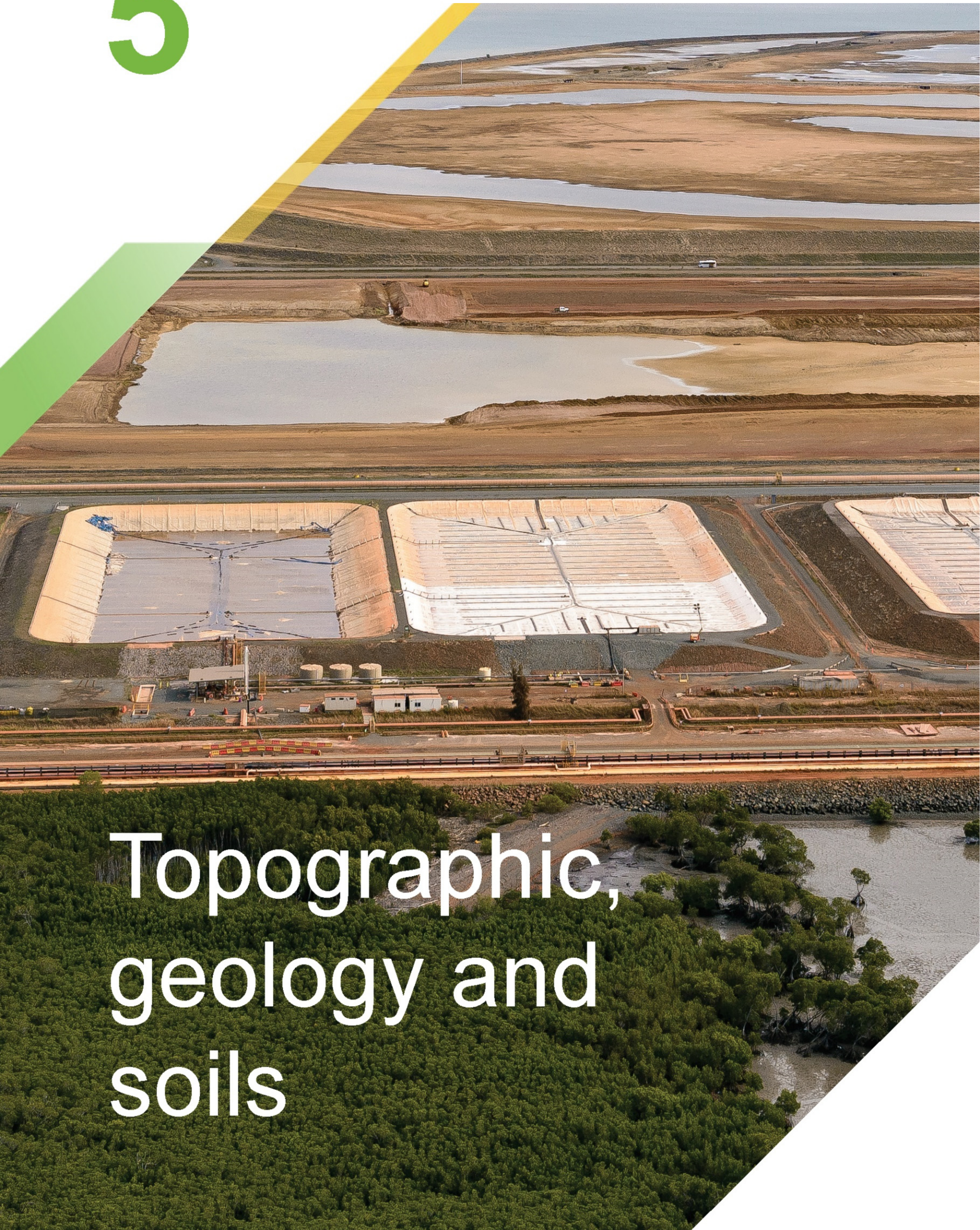

Topographic, geology and soils

Contents

5 Topographic, geology and soils

5.1 Chapter purpose

This chapter details the topography, geology and soils information to describe the existing environmental values and potential impacts from the Project. Baseline information has been sourced from online mapping and previous investigations as well as the following investigations undertaken for the Project EIS:

- Geotechnical investigations
- ASS investigation.

Reports based on these investigations are provided in Appendices E1 to E6.

Sediment quality, including geochemical characteristics, is provided in Chapter 6.

It is important to note that this chapter has a particular focus on the potential for Project activities to disturb PASS and to release acidic leachate into the receiving environment. This chapter also assesses the potential for Project activities to result in land contamination. The potential environmental impacts from PASS and land contamination on environmental values are provided in the relevant EIS environmental aspect chapters, including:

- Potential water quality impacts (refer Chapter 8)
- Potential ecology and MNES impacts (refer Chapter 9).

5.2 Methodology

In order to complete the topography, geology and soils assessment for the Project, the following tasks have been undertaken:

- Review of the Commonwealth and State legislation, policy and guidelines relevant to topography, geology and soils for the pre-construction, construction and operational phases of the Project
- Review of previous investigations and relevant mapping in Port Curtis
- Completion of a geotechnical investigation of the material to be dredged from Gatcombe and Golding Cutting channel duplication and barge access channel
- Completion of an ASS investigation of material to be dredged from Gatcombe and Golding Cutting channel duplication and the barge access channel, as well as the existing sediment quality at the WBE reclamation area
- Assessment of the potential impacts and risks associated with topography, geology and soils for the following activities:
  - WBE reclamation area bund wall and BUF construction
  - Dredging of the barge access channel
  - Dredging for the duplication of shipping channels
  - Placement of dredged material into the WB and WBE reclamation areas, including unloading of dredged material through the BUF
  - Stabilisation and maintenance activities at the WB and WBE reclamation areas
- Identification of management and monitoring measures to minimise impacts from topography, geology and soils.

5.3 Legislative and policy context

5.3.1 National Environment Protection (Assessment of Site Contamination) Measure 2013

The *National Environment Protection (Assessment of Site Contamination) Measure 1999 (Amendment 1, 2013)* (NEPM 2013) was developed under the *National Environment Protection Council Act 1994* (Cth) to establish a nationally consistent approach to the assessment of site contamination. This will ensure best practice environmental management is employed by regulators, site assessors, environmental auditors, landowners, developers and industry.

5.3.2 Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland 1998

The *Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland 1998* (Ahern et al. 1998) outlines the sampling and analysis requirements for the assessment of ASS (in terrestrial areas), including information on the sampling intensity, sample depths and testing requirements.

Ahern et al. (1998) also provides action criteria at which there is a significant environmental risk from ASS. Table 5.1 details the action criteria, which is dependent on the clay content of the sediment and the volume of sediment disturbed. Where action criteria are triggered, a management plan is required.

Table 5.1 Action criteria for acid sulfate soil analysis

Sediment type	Clay content (%)	Action criteria (1-1,000 tonnes disturbed)		Action criteria (> 1,000 tonnes disturbed)	
		Sulfur trail (%S oxidisable)	Acid trail (mol H^+/tonne)	Sulfur trail (%S oxidisable)	Acid trail (mol H^+/tonne)
Coarse (sand – gravel)	≤ 5	0.03	18	0.03	18
Medium (sandy loam – light clay)	5-40	0.06	36	0.03	18
Fine (medium to heavy clay)	≥ 40	0.1	62	0.03	18

Source: Ahern et al. (1998)

Table notes:

%S = percentage of oxidisable inorganic sulfur
mol H^+/tonne = number of moles of hydrogen ions produced per tonne

5.3.3 Queensland Acid Sulfate Soil Technical Manual

The *Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines* (Dear et al. 2014) provides technical advice in managing ASS using best practice.

The Guidelines provide treatment categories and associated management requirements based on the quantity of soil to be disturbed and the existing and potential acidity (Dear et al. 2014). Treatment categories range from low level of treatment to extra high level of treatment.

The preferred management strategy to deal with ASS is avoidance. Where disturbance is unavoidable, the next preferred management strategy is minimisation of disturbance. Once minimisation has been fully explored, the following management strategies are preferred for dealing with any unavoidable disturbances following a risk assessment (Dear et al. 2014):

- Neutralisation
- Hydraulic separation of sulfides
- Strategic reburial.

The Guidelines provide significant environmental risks and management considerations for each of these strategies as well as some higher-risk management strategies.

5.3.4 Regional Planning Interests Act 2014

The *Strategic Cropping Land Act 2011* (Qld) was repealed in June 2014 and replaced with the *Regional Planning Interests Act 2014* (Qld) (RPI Act). The RPI Act identifies and protects areas that are of regional interest to Queensland, including strategic cropping land.

Strategic cropping land is classified by its high suitability for cropping due to a combination of the land's soil, climate and landscape features.

Based on the trigger map provided by the DNRME, the Project activities do not fall within strategic cropping land.

5.4 Description of environmental values

5.4.1 Elevation

The bathymetric map of the area to be dredged is provided in Figure 5.1 and shows the seabed elevation in relation to the LAT. The elevation of the channel duplication area to be dredged ranges from approximately -15.9m LAT in the northern portion (some portions are deeper and will not require dredging) to -7.6m LAT in the southern portion, which will require the removal of up to 12.6Mm^3 of material to achieve the required depth.

The elevation of the initial dredging area ranges between -4.4m LAT and -7.7m LAT in the proposed barge access channel (refer Figure 5.2) and will require the removal of up to 0.25Mm^3 to -7.0m LAT.

Figure 5.2 illustrates the bathymetry within and surrounding the WBE reclamation area in relation to the LAT. Given the WBE reclamation area is intertidal in nature, the elevation ranges from above LAT to -1m LAT. Figure 5.3 illustrates the current material levels within the WB reclamation area.

Tidal planes for Gatcombe Heads and Fisherman's Landing are provided in Table 5.2.

Table 5.2 Semidiurnal tidal planes at Port of Gladstone

Tidal plane	Tidal level (m LAT) at Gatcombe Heads[1]	Tidal level (m LAT) at Fisherman's Landing[2]
HAT	4.29	5.12
Mean high water springs (MHWS)	3.45	4.20
Mean high water neaps (MHWN)	2.71	3.30
AHD	2.21	2.43
Mean low water neaps (MLWN)	1.37	1.66
Mean low water springs (MLWS)	0.56	0.76
LAT	0.00	0.00

Source:

1 MSQ (2018)
2 BMT WBM (2019)

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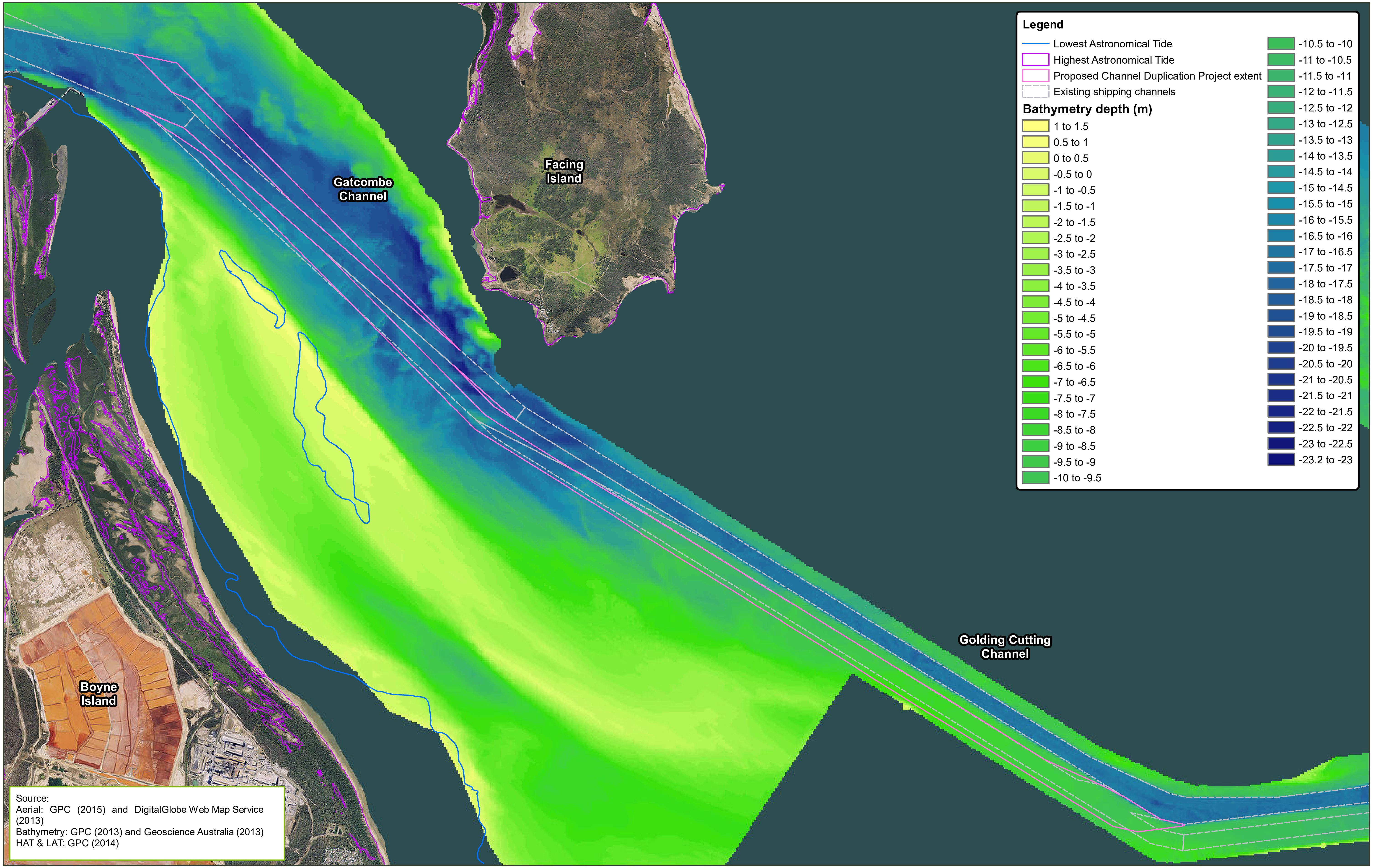

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Figure 5.1: Bathymetry within the area to be dredged

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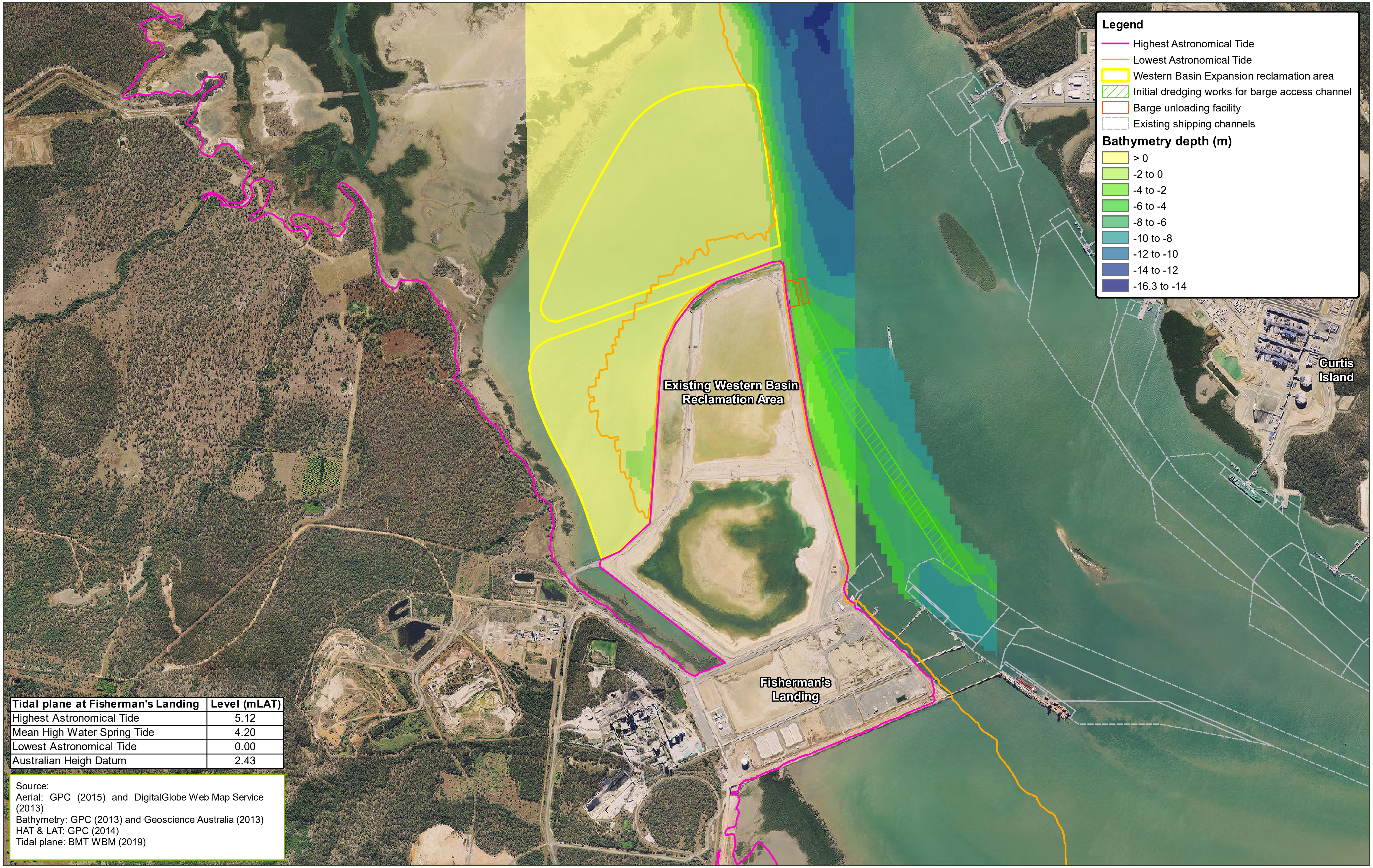

Tidal plane at Fisherman's Landing	Level (mLAT)
Highest Astronomical Tide	5.12
Mean High Water Spring Tide	4.20
Lowest Astronomical Tide	0.00
Australian Heigh Datum	2.43

Source:
Aerial: GPC (2015) and DigitalGlobe Web Map Service (2013)
Bathymetry: GPC (2013) and Geoscience Australia (2013)
HAT & LAT: GPC (2014)
Tidal plane: BMT WBM (2019)

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Figure 5.2: Bathymetry within and surrounding the Western Basin Expansion reclamation area

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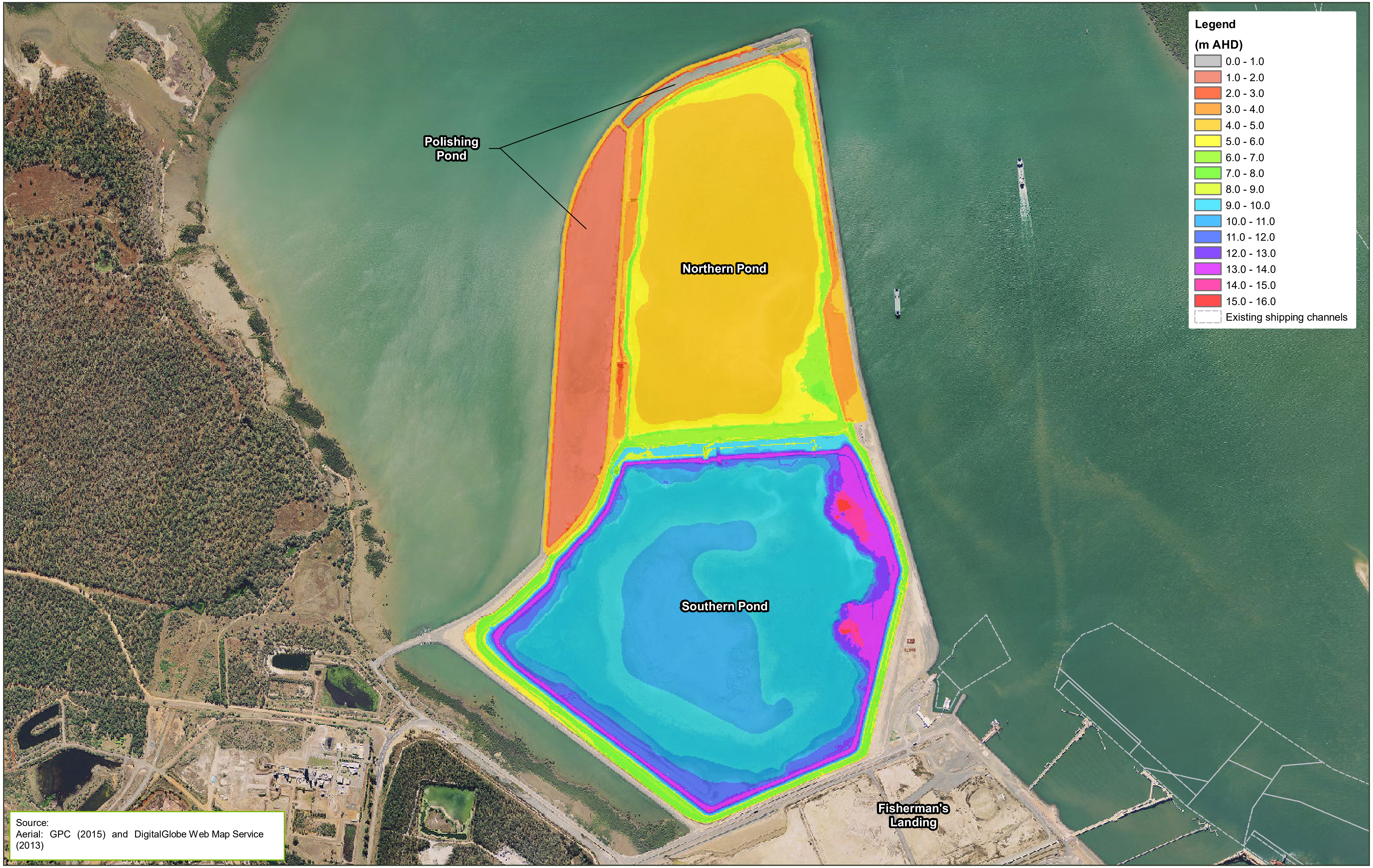

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Port of Gladstone Long Term Sediment Disposal Plan

Figure 5.3: Current material levels within the Western Basin reclamation area

5.4.2 Geology

5.4.2.1 Published geology

The geology of the Gladstone region has been mapped by the Geological Survey of Queensland, as shown on the 1:100,000 Gladstone Sheet 9150 (Department of Natural Resources and Mines (DNRM) 2006). The geologic map indicates that bedrock for the onshore areas adjacent to the region under investigation generally comprises Late Devonian-Early Carboniferous rocks of the Curtis Island Group; specifically, the Wandilla Formation and the Shoalwater Formation.

The rocks of the Curtis Island Group were locally subjected to amphibolite grade metamorphism and are structurally complex moderately to steep dipping beds, tight folds and slaty and crenulation cleavage (Jell 2013).

According to Geoscience Australia (2015), the Wandilla Formation comprises mudstone, lithic sandstone, siltstone, jasper, chert, slate and local schist. Geology of Queensland (Jell 2013) describes the Wandilla Formation as being dominated by rhythmically interbedded mudstone and graded sandstone derived from intermediate to felsic volcanics. Large chert lenses within this Formation form prominent ridges, particularly on Curtis Island. Sandstone beds within the Formation show soft-sediment deformation and in the middle of the unit is an interval with calcareous or silicified ooids (rounded particles).

The Shoalwater Formation is the easternmost Formation of the Curtis Island Group and is likely to represent “bedrock” for the majority of the area to be dredged. The Formation comprises quartzose sandstone beds up to 3m thick alternating with thinner mudstone beds and rare bands of chert and felsic tuff forming strike ridges. Geoscience Australia (2015) describes this Formation as quartzose sandstone, mudstone, local quartz-muscovite-biotite schist and strongly foliated metasediments.

From geological interpretation of the material, overlying bedrock will comprise a combination of unconsolidated Quaternary (Holocene and Pleistocene) aged marine and fluvial sediments.

The tectonic history of the Gladstone area is complex and involves three major north-north west-trending structural belts; the Coastal Block, the Rockhampton Block and the Eungella-Cracow Mobile Belt (Bureau of Mineral Resources, Geology and Geophysics 1975).

The Coastal Block comprises Palaeozoic sedimentary rock (Curtis Island Group) that have probably undergone repeated tectonism and were finally deformed and metamorphosed in the Early Permian before being uplifted in the Late Permian. Bedding trends from north to north west and dips steeply to the east.

The geological survey mapping for the Port of Gladstone does not extend offshore to the area to be dredged. Geotechnical investigations were undertaken for the channel duplication area to be dredged, the WBE reclamation area and the barge access channel, as discussed in detail in Appendices E1, E2 and E3, and summarised in Section 5.4.2.2.

5.4.2.2 Quarry

For the purpose of the EIS, the Targinnie/Yarwun quarry area will be the source of armour and core rock material for the construction of the WBE reclamation area bund walls, including part of the BUF wall. The GPC Ticor quarry within the quarry area has been used intermittently for various GPC projects, such as Fisherman’s Landing Northern Expansion and the WBDDP. The material from the quarry is reported to be generally massive (although not uniform throughout). In addition, a previous study undertaken by GHD in 2010 reported that the quarry typically consists of deposits that have undergone varying degrees of metamorphism with four main rock types identified, including (Aurecon 2018):

- Lithic meta-sandstone
- Pelite

- Rhyodacite
- Trachyandersite.

Only minor weathering of exposed faces of the quarry has occurred over a 10 year period and it is considered reasonable to assume the rock would not undergo rapid deterioration when placed in a marine environment.

5.4.2.3 Geotechnical investigation

Area to be dredged

The subsurface conditions encountered throughout the area to be dredged within the Gatcombe and Golding Cutting Channels were similar to previous investigations and are consistent with recent seismic surveys of the channels. No high-level bedrock was observed within the area to be dredged, although rock may still be present above the proposed dredging depth.

The sediments were described as cohesive (clays and silts), sands and gravels with variable mixtures and isolated lenses of all soil types recorded.

The main observations made during the geotechnical investigation include:

- The sedimentary deposits observed during the site investigation were comparative to materials encountered in previous investigations being composed primarily of clays, sands and significant gravel deposits
- There was a significant 5m rise of the seabed in the vicinity of borehole GG15 (refer Figure 5.4). This may have been formed by a combination of the complex underlying geological structures of the area, which is known to comprise a series of horst and graben structures and the fluvial action of the Boyne River.
- Bedrock was not encountered during the geotechnical investigation, although the presence of rock cannot be ruled out of the proposed dredging profile completely as the Blain, Bremner and Williams (1980) investigation intersected 'rock' in two boreholes
- Three general layers were observed from the borehole section; clay/silt (Layer 1), sand (Layer 2) and gravel (Layer 3):
  - For the Gatcombe Channel, Layer 1 was absent, although discreet lenses of clay and silt were identified. A layer of sand (Layer 2) overlying a gravel layer (Layer 3) was identified within this area
  - For the Golding Cutting Channel, a significant layer of clay/silt material (Layer 1) was overlying the sand (Layer 2) and gravel (Layer 3)
- A significant gravel deposit was identified in the region of borehole GG12 (refer Figure 5.4). Test results and historic data suggests the likely presence of cobbles and boulders in this deposit, which was probably formed by the Boyne River.
- For Stage 1 dredging (-13.5m LAT):
  - In the Gatcombe Channel, the vast majority of the seabed was below the proposed dredging depth, with the exception of a small area of gravel observed above the dredging depth at GG12
  - For the Golding Cutting Channel, significant amounts of variably stiff to very stiff and medium to high plasticity clay, with impersistent sand lenses, were present above the proposed dredging depth and will require removal
- For the Stage 2 dredging (-16.1m LAT):
  - In the Gatcombe Channel, variably medium dense sand and gravel occurred above the dredging depth

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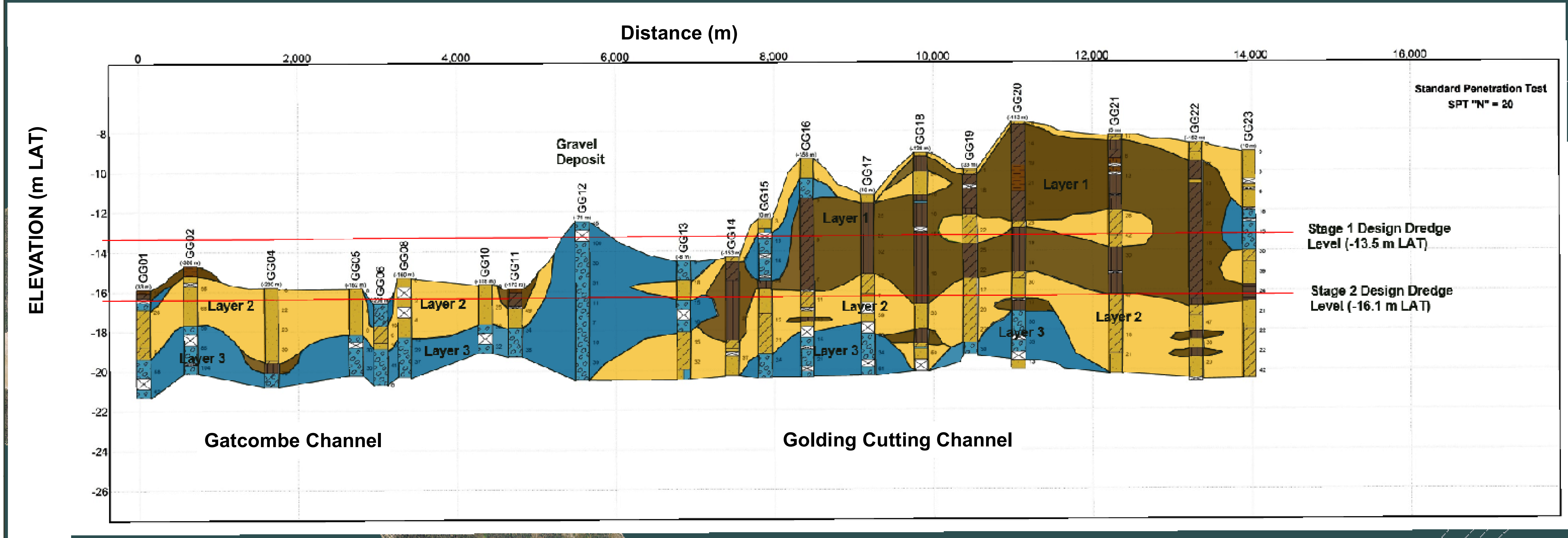

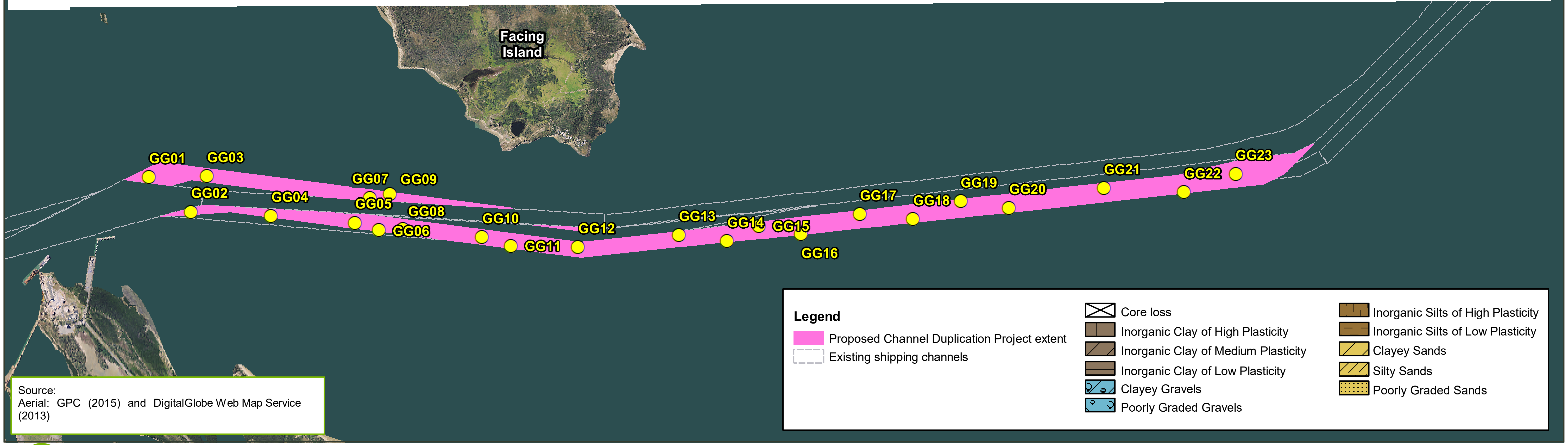

Legend

- Proposed Channel Duplication Project extent
- Existing shipping channels
- Core loss
- Inorganic Clay of High Plasticity
- Inorganic Clay of Medium Plasticity
- Inorganic Clay of Low Plasticity
- Clayey Gravels
- Poorly Graded Gravels
- Inorganic Silts of High Plasticity
- Inorganic Silts of Low Plasticity
- Clayey Sands
- Silty Sands
- Poorly Graded Sands

Source:
Aerial: GPC (2015) and DigitalGlobe Web Map Service (2013)

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Gatcombe and Golding Cutting Channel Duplication Project

Figure 5.4: Interpreted geological section for the combined Gatcombe and Golding Cutting Channels

- In the Golding Cutting Channel, medium to high plasticity, stiff to very stiff cohesive material was generally encountered. In addition, pockets of low strength cohesive material were also encountered around GG16. Below this, a layer of generally medium dense sand was present.

The geotechnical investigation report for the area to be dredged is provided in Appendix E1.

Western Basin Expansion reclamation area

A thin layer of sand material with a significant fines content was observed in the central and southern part of the WBE reclamation area that was investigated. In the northern part of the reclamation, clay soils were predominantly encountered.

Predominantly cohesive material in the form of clay was recorded from near sea bed level to at least -11m LAT. The clay material had a high plasticity with a soft to very soft consistency from the sea bed to between -5.1m LAT and -6.2m LAT, becoming stiff to very stiff and hard.

The clay sediments were underlain by sand at depth. The sand was found to be medium dense and contained up to 26% fines.

Bedrock was not encountered in the WBE reclamation area during the investigation.

The geotechnical investigation report for the WBE reclamation area is provided in Appendix E2.

Barge access channel

Subsurface conditions encountered within the barge access channel comprised layers of very soft to soft silty clays interlayered with loose sands to depths ranging between 6.9m and over 12.5m LAT. This was underlain with stiff to hard clays and medium dense sands/gravels. Rock was not encountered. The geotechnical investigation report for the barge access channel is provided in Appendix E3. Since the completion of the geotechnical investigation, the initial area to be dredged for the barge access channel has been reduced and the alignment shifted. However, it is considered that the findings of the geotechnical investigation remain relevant given their proximity to the revised initial area to be dredged.

Chapter 2 (Project description), Section 2.4.3 provides additional information of the material to be dredged and its influence on the Project dredging methodology.

5.4.3 Soils

The only component of the Project which includes land based operations is the extraction of the rock material from the Targinnie/Yarwun quarry area located 2km southwest of Fisherman's Landing.

The geology of the quarry consists of Devonian-Carboniferous aged Doonside Formation, comprising chert, jasper, mudstone, siltstone, lithic sandstone, limestone and altered basalt. According to the Atlas of Australian Soils (Northcote et al. 1960-1968), the Targinnie/Yarwun quarry area is located in steep hilly to mountainous country and contains hard pedal mottled-yellow duplex soils, classified as Sodosols and Chromosols under the Australian Soil Classification and based on the Commonwealth Scientific Industrial Research Organisation (CSIRO) Australian Soils Resource Information System (CSIRO 2014). Sodosols are generally found in poorly drained sites and have very low agricultural potential due to high erodibility, poor structure and low permeability. Chromosols have moderate agricultural potential with moderate chemical fertility and water-holding capacity.

5.4.4 Acid sulfate soils

5.4.4.1 Review of existing information

Published reports, maps and data have been used to determine the likely ASS conditions within the dredged material and reclamation area. Results from the ASS investigation will be used to develop management measures for the disturbance of both the dredged material and the existing sediment during placement (or construction of reclamation bund walls and the BUF).

The ASS Tannum Sands – Gladstone mapping (1:50,000) (DNRM 2002) illustrates the location and extent of onshore ASS in the Gladstone region based on investigations by the Queensland Acid Sulfate Soils Investigation Team.

The coastline to the west of the WB and WBE reclamation areas is classified as ‘Moderate’ to ‘High’ potential for acid generation and delineated as containing PASS from the surface to a 1.0m depth. The coastline north of the WB and WBE reclamation areas is described by the ASS The Narrows Area mapping (1:50,000) (Department of Natural Resources, Mines and Water 2005) as containing PASS from the surface to a 1.0m depth, although some AASS is present in areas further north.

An additional ASS investigation was conducted by Ross in 2004 on behalf of DNRM along the central Queensland coast, from Tannum Sands to St Lawrence. Samples were collected from Kangaroo Island, just north of the WB and WBE reclamation areas, in a lower energy environment the project area, and generally indicated an ASS hazard rating of ‘High’ to ‘Extreme’, from the surface to depths of up to 1.5m (Ross 2004).

The ASS mapping for the Port of Gladstone does not extend to the offshore components of the Project. An ASS investigation was undertaken for the area to be dredged, the barge access channel, and the WBE reclamation area, as discussed in detail in Appendices E4, E5 and E6, and summarised in Section 5.4.4.2.

It is not considered that monosulfides occur within the areas to be dredged. Monosulfides are commonly found in the bottom sediments of coastal lakes and streams were a fresh source of organic material causes the active formation of sulfides (Ahern et al. 1998). Monosulfides were not identified during the ASS investigations (or any previous investigations as part of previous dredging activities in the port) and the areas to be dredged are high energy environments not suitable for the formation of sulfides. As such, it is considered highly unlikely for monosulfides to be present in the dredged material.

5.4.4.2 Methodology

An ASS investigation was undertaken in conjunction with the geochemical investigation, as described in Chapter 6 (sediment quality), to determine the likelihood of AASS and PASS being present in the dredged material and the WBE reclamation area.

During the ASS investigations, at each borehole location (as described in Chapter 6 (sediment quality)), grab samples of approximately 200g were collected at 0.25m intervals along the length of the core and placed in plastic bags for ASS analysis. Samples collected at 0.0m, 0.5m, 1.0m and every 0.5m interval along the core were analysed for Suspension Peroxide Oxidation Combined Acidity and Sulfur (SPOCAS), while samples collected at 0.25m, 0.75m, etc. were analysed for field pH.

These tests were conducted along the length of the core until refusal. It is noted that the vibrocore was unable to achieve the full depth of dredging, despite three attempts at each location, due to encountering consolidated natural geological materials (i.e. rock, dense sands/gravels or stiff to very stiff clays). However, sufficient information has been able to be collected through this and previous investigations to assess potential risk and develop suitable management actions to manage potential risk.

The number of ASS samples collected during the investigations is provided in Table 5.3.

Table 5.3 Number of samples from Project direct impact areas

Sample type	Number of primary samples	Number of quality assurance/ quality control samples
Area to be dredged within Gatcombe and Golding Cutting Channel		
Field pH	78	-
SPOCAS	124	8
WBE reclamation area		
Field pH	41	-
SPOCAS	62	9
Barge access channel (Project investigation)		
Field pH	16	-
SPOCAS	47	7
Barge access channel (previous sampling from WBDDP)		
Field pH	115	-
SPOCAS	58	-

Further information regarding the ASS investigations is provided in Appendices E4, E5 and E6.

5.4.4.3 Results

Area to be dredged

The laboratory analysis for ASS within the area to be dredged is detailed in Appendix E4.

There was generally an absence of ASS across the majority of sediments sampled within the area to be dredged. However, two borehole locations were identified as containing elevated amounts of net acidity and will require management. The location of this ASS ‘hot-spot’ is illustrated in Figure 5.5. In addition, a number of samples from discrete locations and horizons indicated presence of AASS and PASS based on field pH results.

The excess acid neutralising capacity (ANC_E) of the sediments was substantially higher than the net acidity of the sediments throughout the area to be dredged, likely due to the presence of shell material. It is considered that this overall ANC_E will be available for neutralisation of potential acid material that may be generated.

Western Basin Expansion reclamation area

The laboratory analysis for ASS within the WBE reclamation area is detailed in Appendix E5.

The presence of ASS was evident across the majority of sediments sampled within the WBE reclamation area, as illustrated in Figure 5.6. While there was no evidence of the presence of AASS, almost all sampling locations indicated the presence of PASS throughout the vertical profile.

Sediments within the WBE reclamation area also contained a high level of acid neutralising capacity.

Barge access channel

The laboratory analysis for ASS within the barge access channel is detailed in Appendix E6.

The presence of ASS was evident predominately in the clay and silt material within the barge access channel, although the dredged material contained a high level of acid neutralising capacity, substantially above the net acidity of the sediments, likely due to the presence of shell material.

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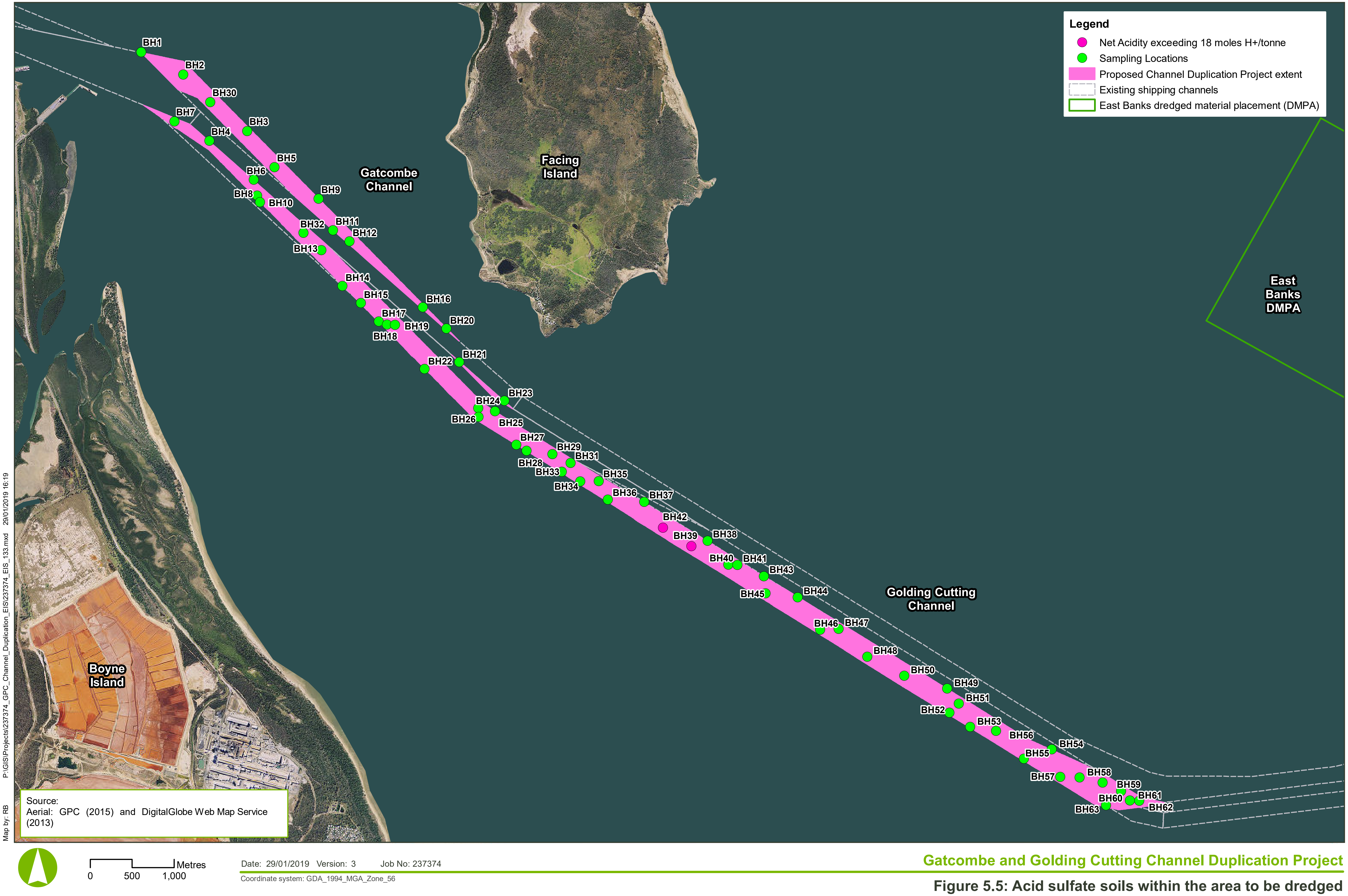

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Figure 5.5: Acid sulfate soils within the area to be dredged

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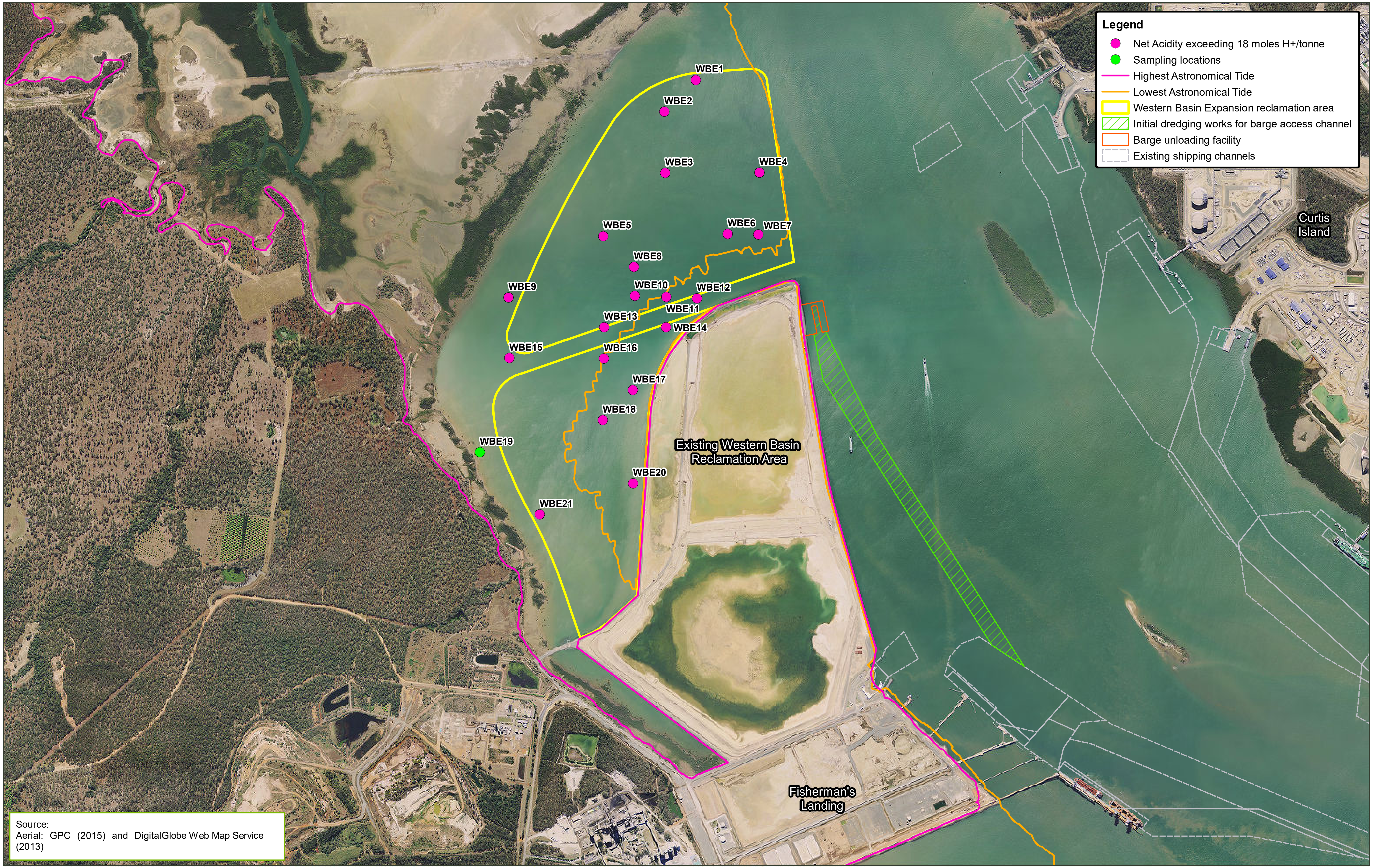

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Figure 5.6: Acid sulfate soils within the Western Basin Expansion reclamation area

5.4.4.4 Potential for self-neutralisation

While larger shell fragments (> 2mm) were sieved and removed during sample preparation and as such, were not analysed or included in the acid-base accounting, these fragments will remain in the dredged material. In addition, despite the removal of these larger shells during the sample preparation, the dredged material will contain a high level of acid neutralising capacity, substantially above the net acidity of the sediments.

The Project dredging is a two stage process that involves dredging by a TSHD which loads the dredged material into four barges which will transport the material to the BUF adjacent to the existing WB reclamation area to be unloaded using large excavators into trucks for placement within the WB and WBE reclamation areas, as described in Chapter 2 (Project description). The dredged material (which contains the shell material) will be mechanically mixed and ground into finer fragments during dredging and the unloading of material from barges by excavators, allowing the majority (if not all) of the neutralising capacity to become available. Upon placement within the WB and WBE reclamation areas, earthworks (e.g. bulldozers, graders, etc.) will further mix and grind the dredged material during formation of the final Project landform, making available the full self-neutralising capacity of the sediments.

Self-neutralisation will not be relied upon as the sole treatment of potential ASS within the dredged material. In order to manage potential impacts to the environment, pH will be monitored in the WB and WBE reclamation areas, as per the Dredging Environmental Management Plan (refer Appendix Q1), with adjustments made to the pH should the water within the reclamation areas be too acidic or alkaline, prior to release. Ongoing validation of sediments within the reclamation areas above LAT (i.e. the sediment that will not be permanently saturated by water) will occur at a rate of one sample per 1,000m^3. Validation sampling will confirm whether additional treatment is required and the appropriate liming rate to apply. Further details are provided in Section 5.6.1.

5.5 Potential impacts

5.5.1 Bund wall and barge unloading facility construction

Material for the bund walls and part of the BUF wall will be sourced from the Targinnie/Yarwun quarry area. Quarry material to be used for the outer bund wall will be selected based on specifications to withstand the marine environment (e.g. waves, currents) within the inner harbour. The potential environmental impacts from the placement of the bund wall material are provided in the relevant EIS environment aspect chapter, including:

- Potential water quality impacts (refer Chapter 8)
- Potential ecological and MNES impacts (refer Chapter 9).

During bund wall construction, sediments on and below the seafloor containing PASS may oxidise if exposed to the atmosphere and release acidic leachate into the receiving environment, which may potentially mobilise metals/metalloids. This impact may occur from the creation of a ‘mud wave’ from lateral movement of soft material due to the weight of rock being placed for the bund wall.

The potential impacts from the release of acidic leachate into the receiving environment are provided in the relevant EIS environmental aspect chapter, including:

- Potential water quality impacts (refer Chapter 8)
- Potential ecological and MNES impacts (refer Chapter 9).

5.5.2 Dredging activities

During dredging activities, there is potential for the generation of acidic leachate from the dredged material if saturation is not maintained throughout the process. As a result, the release of PASS materials and potentially acidic leachate into Port Curtis may occur during dredging activities (e.g. during the barges overflow process).

The potential impacts from the release acidic leachate into the receiving environment are provided in the relevant EIS environmental aspect chapter, including:

- Potential water quality impacts (refer Chapter 8)
- Potential ecological and MNES impacts (refer Chapter 9).

5.5.3 Placement of dredged material

During placement of dredged material into the WB and WBE reclamation areas, there is potential for the oxidation of PASS material and the subsequent generation of acidic leachate that migrates into Port Curtis. This may also activate the transport of metals/metalloids, such as iron, which has the potential to produce red/orange iron staining in the water, on infrastructure and boats/vessels. In addition, the concentration of nutrient heavy sediments at the reclamation area may result in algal blooms through the discharge of nutrient heavy water to the Port. The intertidal channel to the north west of the WBE reclamation area where reduced flushing occurs will be most affected by an increase in metal/metalloid and nutrient concentrations.

However, the majority of PASS material to be disturbed by the Project has been identified within the barge access channel, which will be dredged first and as such, placed into the WB reclamation area where dredged material will remain in a saturated state. This will allow the majority of PASS material to remain under water and limits the ability of the sediment to oxidise. In addition, the barge access channel and the Gatcombe and Golding Cutting Channels have sufficient acid neutralising capacity in the remainder of the dredged material (i.e. from shell material), that self-neutralisation is likely to occur. An ASS Management Plan will be developed at least three months prior to the commencement of Project activities.

During reclamation works, there is a minor possibility that erosion of the surface of the reclamation area may occur during reclamation activities due to wind and rainfall, potentially causing dust and water quality impacts.

There is also potential for the WB and WBE reclamation areas, including the construction compound, to become contaminated during construction through oil and fuel spills from construction equipment or the storage any oil, fuel, chemicals or hazardous materials within the compound. The potential impacts of contamination are further discussed in Chapter 8 (water quality).

5.5.4 Installation of navigational aids

The removal and installation of navigational aids will not involve the removal of soils. As such, there is minimal impact anticipated from removal and installation of navigational aids on topography, geology and soils.

5.5.5 Stabilisation and maintenance activities on the reclamation area

During stabilisation and maintenance activities, there is potential for excavation activities to occur to install below ground infrastructure or to create the final design surface level. These excavation activities may expose buried PASS material to the atmosphere, consequently generating acid leachate.

Decant water that is stored in the stormwater ponds and routinely discharged into Port Curtis has the potential to be impacted by the acid leachate. The potential impacts from the release acidic leachate into the receiving environment are provided in the relevant EIS environmental aspect chapter, including:

- Potential water quality impacts (refer Chapter 8)
- Potential ecological and MNES impacts (refer Chapter 9).

During stabilisation and maintenance activities, there is potential for land contamination through the storage and use of oils, fuels, chemicals and hazardous materials for the operation of machinery, vehicles and other equipment. Incidents involving fuel/oil spills and other contaminants may result in soil contamination or contamination of marine waters of Port Curtis.

In addition, there is a minor possibility that erosion of the surface of the reclamation area may occur during stabilisation and maintenance activities due to wind and rainfall, potentially causing dust and water quality impacts.

5.6 Mitigation measures

5.6.1 Acid Sulfate Soil Management Plan

5.6.1.1 Key objectives

An ASS Management Plan will be prepared at least three months prior to the commencement of construction to detail site-specific management measures for all stages of construction on the Project (i.e. bund wall construction, dredging activities and placement of dredged material). The ASS Management Plan will be developed in accordance with the Queensland Acid Sulfate Soils Technical Manual (Dear et al. 2014).

Potential direct and indirect impacts associated with exposure of ASS through the disturbance of the soil profile can be avoided or minimised, through appropriate management and mitigation measures. These measures will aim to:

- Prevent contamination of the marine environment from the disturbance and/or oxidation of ASS material
- Ensure no impacts to surface water or marine water quality occurs resulting from the disturbance of ASS material
- Ensure no damage to infrastructure or equipment occurs from ASS disturbance and/or handling
- Ensure all personnel attend the environmental induction that will include ASS awareness training.

5.6.1.2 Performance indicators

The following performance indicators will assist to determine the effectiveness of the mitigation measures during Project activities:

- No exceedances of trigger values outlined in the ASS Management Plan
- No visual observations of ASS impacts during routine inspections
- No decline in terrestrial or marine plant health as a result of exposure to ASS material
- No decline in the water quality of localised watercourses or the marine environment.

5.6.1.3 Bund wall and barge unloading facility construction

Actions

As a minimum, the following actions will be implemented under the ASS Management Plan to manage the risk of potential ASS disturbance during construction of the bund and BUF walls:

- During detailed design, the WB and WBE reclamation areas groundwater will be modelled to determine the predicted permanent groundwater table in order to include PASS below this level (i.e. the safe PASS reinternment level (SPRL))
- Design specifications will avoid disturbance of marine and terrestrial surface and subsurface soils, where practical. Where disturbance is unavoidable, the design specification will endeavour to minimise the disturbance footprint.
- Key construction personnel will be provided mandatory training in the identification and control procedures for ASS. A register of construction personnel who have completed the relevant ASS training will be maintained.
- To prevent the oxidation of PASS material through the potential creation of a 'mud wave' during bund wall construction:
  - Unconsolidated materials (i.e. the mud wave, if generated) above the mean high water neap will be excavated and contained separately in a designated treatment area
  - Excavated materials will be tested by a National Association of Testing Authorities accredited laboratory for SPOCAS and treated with the required amount of aglime
  - Sediments will be validated at a rate of 1 sample/1,000m^3, prior to re-instatement into the reclamation area. Validation shall confirm, using SPOCAS analysis, that the sediment has no potential acidity and the laboratory calculated liming rate is < 1kg $CaCO_3$/tonne.
- Material within the bund walls will be re-distributed as required so that it remains permanently under water where practicable, or if exposed to the atmosphere for a significant length of time, it is treated appropriately in compliance with the ASS Management Plan
- Daily inspection of the base of the bund wall for potential impacts of mud wave, resulting in soil being excavated above the natural level and exposed to oxygen. Should daily inspections observe excavated soil above the natural level, this will be collected and transported to a containment area for treatment.
- Removal of intertidal vegetation will be restricted to the minimum required, to enable the safe construction and operation of the WBE reclamation area, including minimising disturbance to ecologically sensitive areas, such as adjacent seagrass and mangrove communities
- Mangroves will be removed at ground level, with roots left in-situ (where practical), to maintain soil stability and reduce sediment disturbance.

Monitoring, reporting and corrective actions

Compliance with legislation, environmental standards and relevant management plans will be demonstrated through the implementation of monitoring and reporting strategies during bund wall construction, as detailed below.

- Regular auditing will be undertaken to confirm that bund wall construction is carried out in accordance with the defined requirements set out in the ASS Management Plan and associated management documentation
- The design specification will not be approved where it does not demonstrate an attempt to avoid, or minimise, the disturbance to ASS material
- Bund wall construction will not commence until an ASS Management Plan has been prepared and approved for implementation during all phases of the Project

- Daily inspection of the base of the bund wall for potential impacts of mud wave, resulting in sediment being excavated above the natural level and exposed to oxygen. Should daily inspections observe excavated sediment above the natural level, this will be collected and transported to a containment area for treatment.
- In the event of an incident relating to the release of acid leachate, runoff or sediment occurring:
  - The GPC Environment Manager should be notified as soon as practicable, as per the Dredging EMP (refer Appendix Q1)
  - The area will be identified and hydraulically isolated using suitable mitigation measures
  - The runoff/sediment is to be treated with an adequate quantity of fine aglime and samples analysed for pH. Runoff/sediment to have a pH between 6.5 and 8.5 prior to release.
  - An investigation into to the cause of the incident will be conducted, and a review of the mitigation measures be initiated.
- All records and associated permits will be provided to the relevant authority as required, upon request and/or at the completion of construction activities.

5.6.1.4 Dredging activities and placement of dredged material

Actions

As a minimum, the following actions below will be implemented under the ASS Management Plan to manage the risk of potential ASS disturbance during dredging activities and placement of dredged material:

- Key construction personnel will be provided mandatory training in the identification and control procedures for ASS. A register of construction personnel who have completed the relevant ASS training will be maintained.
- The dredged material will remain in a saturated state in the barges to minimise the potential for oxidation of PASS. Dredged materials will not be stored in the barges or trucks for more than 24 hours and will be kept saturated.
- Dredging of identified 'hot spot' areas will occur within the early stages, where practicable, to allow strategic placement of sediments containing PASS (refer Figure 5.5 and Figure 5.7), within the SPRL
- Dewatering and lowering of the water table within the WB and WBE reclamation areas will be avoided to maximise the volume of sediment that remains saturated
- Any runoff from the WB and WBE reclamation areas (sediment above water level) will be directed towards a series of internal ponds and tested (for pH, metals, etc.) prior to discharge into Port Curtis via the licenced discharge point. Decant water to be discharged into Port Curtis is to have a pH between 6.5 and 8.5 and adjustments will be made to the pH prior to licenced releases, should the water within the WBE reclamation area be too acidic or alkaline. Other decant water release limits are provided in Chapter 6 (sediment quality) and the Project Environmental Monitoring Procedure (refer Appendix Q3).
- Ongoing validation sampling of sediments above LAT within the WB and WBE reclamation areas (at a rate of 1 sample/1,000m^3), and treatment of PASS materials if required. Validation shall confirm, using SPOCAS analysis, that the sediment has no potential acidity and the laboratory calculated liming rate is < 1kg $CaCO_3$/tonne.

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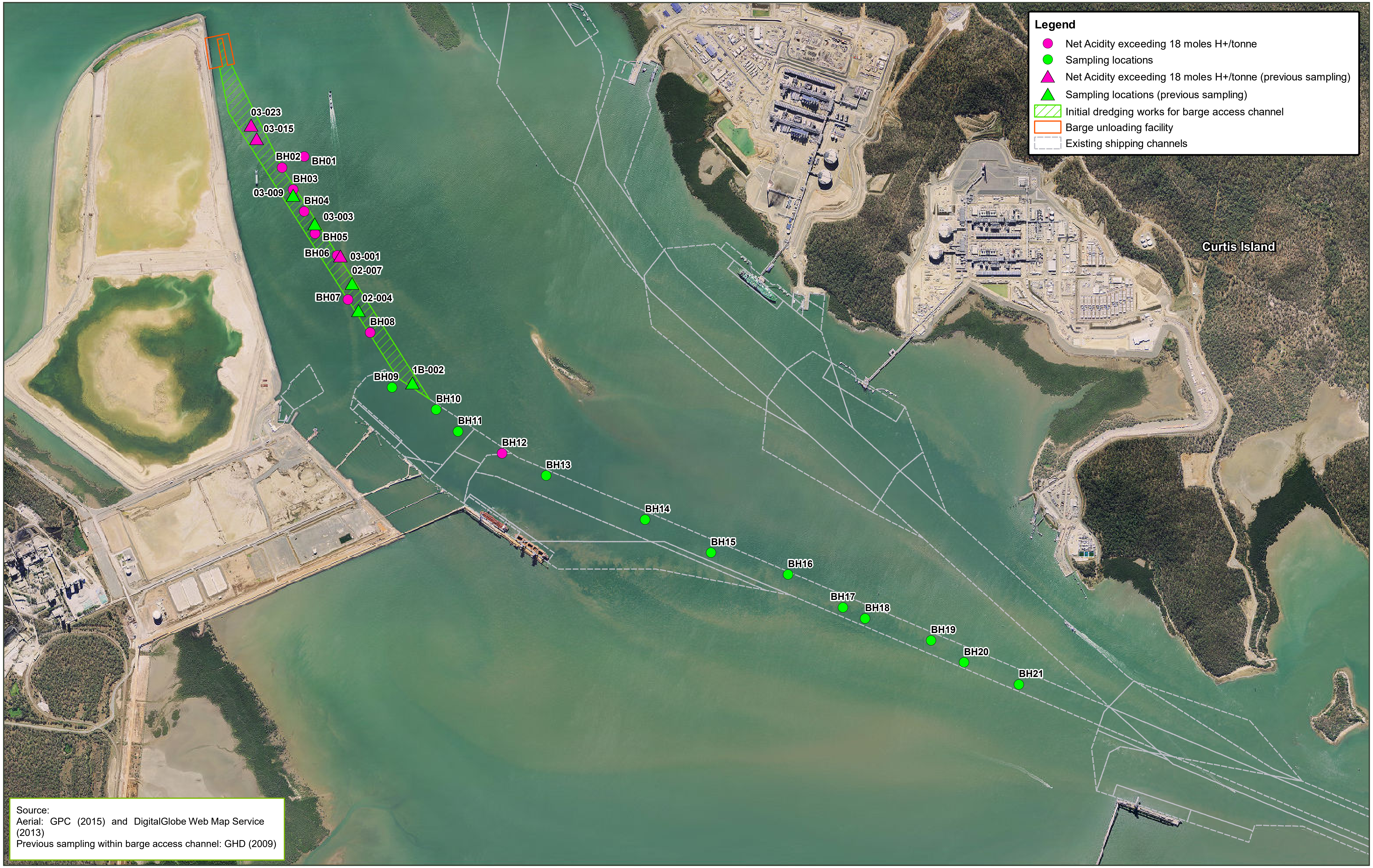

Map by: RB

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Gatcombe and Golding Cutting Channel Duplication Project

Figure 5.7: Acid sulfate soils within the barge access channel

Monitoring, reporting and corrective actions

Compliance with legislation, environmental standards and relevant management plans will be demonstrated through the implementation of monitoring and reporting strategies during dredging activities and placement of dredged material, as detailed below.

- Validation testing of the sediments placed above LAT at a rate of 1 sample/1,000m^3 after placement in the WB and WBE reclamation areas will be conducted to confirm sediments have sufficient buffering capacity. If samples fail the validation testing, then additional sampling will be conducted to determine extent and location of the ASS material. Management options will be assessed on a case by case basis but will include containment, treatment and validation as per the ASS Management Plan.
- Daily monitoring of water quality (e.g. pH, dissolved oxygen, etc.) within internal ponds
- Daily inspection of surface waters, and stormwater drainage, in the vicinity of the site, for evidence of impacts, resulting from disturbance of ASS (e.g. fish kill, aquatic/riparian flora mortality and/or iron staining)
- The visual monitoring plan and checklist provided in the ASS Management Plan will be used to identify signs of ASS oxidisation, including:
  - Unexplained scalding, degradation, or death of vegetation
  - Unexplained death, or disease, in aquatic organisms
  - Formation of the mineral jarosite, and other acidic salts, in exposed or excavated soils
  - Areas of blue-green water, or extremely clear water, indicating high concentrations of aluminium
  - A transition to, or establishment of, a community dominated by acid tolerant species
  - Rust coloured deposits on plants, or on the banks of drains, water bodies, and watercourses, indicating iron precipitates
  - Black, to very coloured waters, indicating de-oxygenation
  - Sulfurous (rotten egg gas) smells
  - Corrosion of concrete, and/or steel structures, in contact with soil or water
  - Invasion of a community, or area, by acid tolerant species.
- Daily inspection of the base of the bund wall for potential impacts of mud wave, resulting in sediment being excavated above the natural level and exposed to oxygen. Should daily inspections observe excavated sediment above the natural level, this will be collected and transported to a containment area for treatment.
- Weekly reports will be completed onsite for the duration of construction activity and will incorporate any identification of ASS
- In the event of an incident relating to the release of acid leachate, runoff or sediment occurring:
  - The GPC Environment Manager should be notified as soon as practicable, as per the Dredging EMP (refer Appendix Q1)
  - The area will be identified and hydraulically isolated using suitable mitigation measures
  - The runoff/sediment is to be treated with an adequate quantity of fine aglime and samples analysed for pH. Runoff/sediment to have a pH between 6.5 and 8.5 prior to release.
  - An investigation into to the cause of the incident will be conducted, and a review of the mitigation measures be initiated.

5.6.1.5 Stabilisation and maintenance activities on the reclamation area

Actions

As a minimum, the following actions will be implemented under the ASS Management Plan to manage the risk of potential ASS disturbance during stabilisation and maintenance activities on the WB and WBE reclamation areas:

- Establishment of a groundwater monitoring network and monitoring plan for the WB and WBE reclamation areas once dredged material placement and earthworks have been completed and the WB and WBE reclamation areas are stable. Groundwater monitoring piezometer installation will not be undertaken during the construction of the WBE reclamation area as piezometers are likely to be broken/demolished if installed prior to finalisation of earthworks.
- Groundwater monitoring for acidity will occur on a regular basis, with samples analysed for:
  - Field measurements: water level, pH, electrical conductivity, redox potential and total alkalinity
  - Laboratory analysis: pH, electrical conductivity, total titratable acidity, total alkalinity, dissolved iron and aluminium and dissolved ions (chloride and sulphate).

Dredged material from maintenance dredging activities will be placed within the existing East Banks DMPA. No mitigation measures for minimising the potential ASS impacts are considered necessary for this activity.

Monitoring, reporting and corrective actions

Compliance with legislation, environmental standards and relevant management plans will be demonstrated through the implementation of monitoring and reporting strategies during stabilisation and maintenance activities, as detailed below.

- Monitoring parameters and provisional limits for groundwater are to be based on established ‘baseline’ values and set at:
  - pH – outside 6.5 to 8.5
  - Acidity – < 40mg/L
  - Alkalinity – > 60mg/L
- If the pH of groundwater falls outside the ‘baseline values’, the following steps will be undertaken:
  - Initially increase monitoring frequency at affected location(s) to fortnightly until corrective measures are implemented or parameters return to within performance criteria
  - If the performance criterion in groundwater wells is not being met after two months, and the non-compliance cannot be attributed to short term heavy rainfall or external influences, consideration is to be given to the installation of lime cut off trench or other additional treatment measures in consultation with the GPC Environmental Manager.

5.6.2 Other mitigation measures

5.6.2.1 Bund wall and barge unloading facility construction

The rock obtained from the Targinnie/Yarwun quarry area for the construction of the bund walls will be screened at the quarry site to remove the fine fraction (< 20mm) to reduce the likelihood of turbid plumes from the introduction of fines into Port Curtis.

5.6.2.2 Dredging activities, barge unloading and placement of dredged material

To minimise erosion of the surface of the WB and WBE reclamation areas from wind and rainfall, the following mitigation measures will be implemented:

- Preparation of an erosion and sediment control plan by a suitably qualified and experienced professional in accordance with the requirements of the International Erosion Control Association Guidelines (2008)
- A stormwater drainage system will be implemented on the final reclamation area to direct runoff to be captured and tested, prior to release into the harbour. Any stormwater that is unable to be released into the harbour should either be treated, where practicable, or disposed at a licensed waste facility.
- Vegetation of the final reclamation area with suitable vegetation to prevent wind erosion of the surface.

Potential contamination during unloading and placement of dredged material and stabilisation and maintenance activities of the WB and WBE reclamation areas will be managed through the implementation of the following mitigation measures:

- All maintenance, servicing and re-fuelling of vehicles and equipment will be undertaken offsite
- Daily inspections of all plant and machinery will be conducted
- Spill kits will be provided at the site, near where equipment is being used, and staff will be trained in the use of spill kits
- If a spill occurs, this will be cleaned up immediately with appropriately absorbent materials with the area remediated if required
- Store oils, fuels, chemicals and hazardous materials in clearly designated and appropriating bunded storage areas, as far as practicable from marine waters. Cover the storage areas to prevent stormwater infiltration.

5.7 Risk assessment

5.7.1 Methodology

To assess and appropriately manage the ASS and land contamination risks to the environmental values as a result of Project activities, a risk assessment process has been implemented (herein referred to as 'risk assessment'). The risk assessment methodology adopted is based on principles outlined in the:

- AS/NZS ISO 31000:2009 Risk management – Principles and guidelines
- HB 203:2012 Handbook: Managing environment-related risk.

The risk assessment identifies and assesses the ASS risks to environmental values/receptors for both the establishment of the reclamation area, dredging activities, installing navigational aids and stabilisation and maintenance activities at the WB and WBE reclamation areas.

The purpose of this risk assessment is to identify potential impacts to environmental values/receptors, prioritise environmental management actions and mitigation measures, and to inform the Project decision making process.

The risk management framework incorporates the Australian/New Zealand Standard for Risk Management (AS/NZS 4360:2004) and contains quantitative scales to define the **likelihood** of the potential impact occurrence and the **consequence** of the potential impact should it occur.

An overview of the interaction between Project activities (drivers/stressors), sensitive values/receptors and the risk impact assessment process is provided in Figure 5.8.

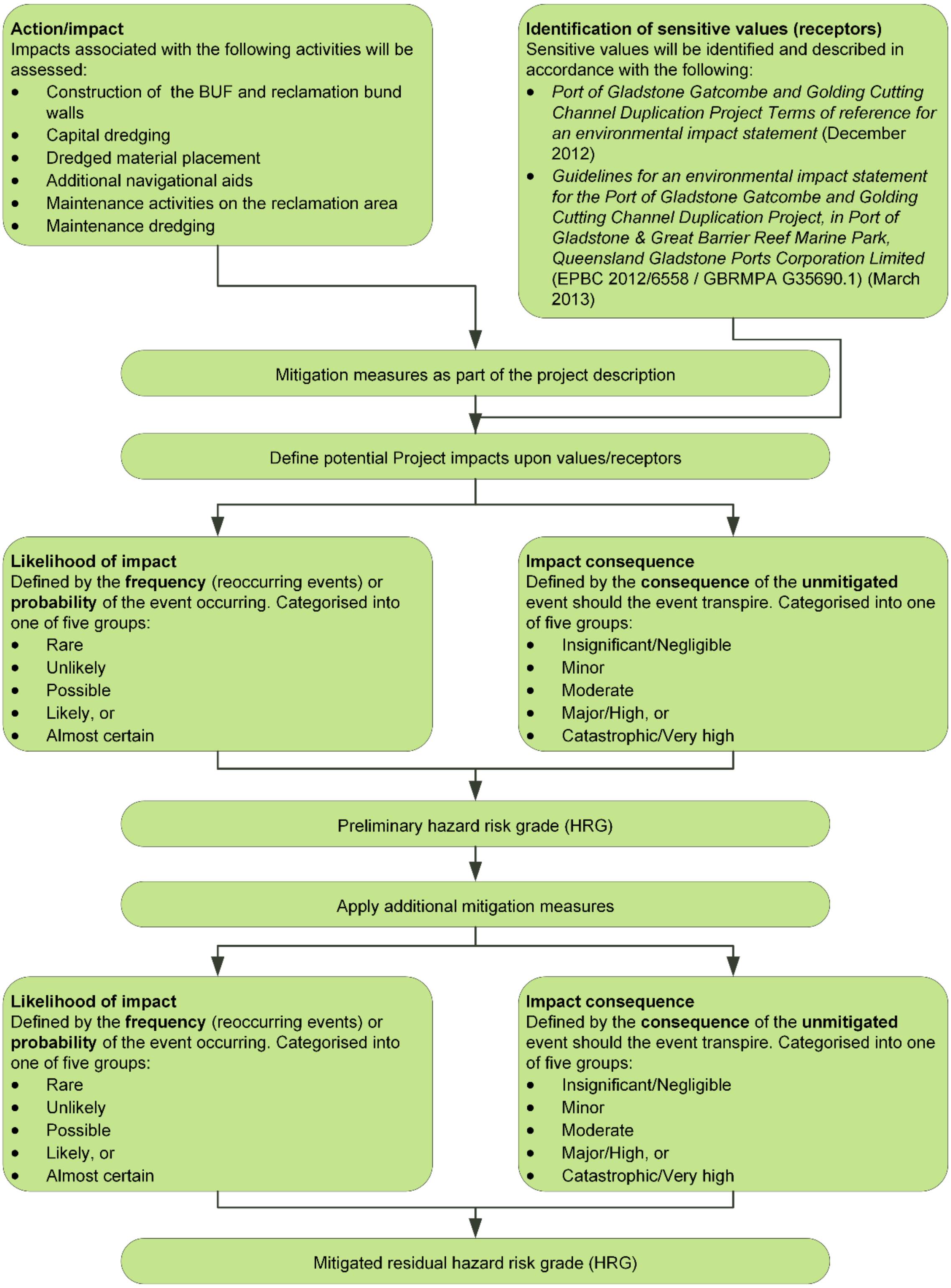

Figure 5.8 Risk assessment framework

Criteria used to rank the **likelihood** and **consequence** of potential impacts are provided in Table 5.4 and Table 5.5, respectively.

Table 5.4 Environmental (ecosystem), public perception and financial consequence category definitions (adapted from GBRMPA 2009)

Description	Definition/quantification[1]		
	Environmental*	**Public perception**	**Financial**
Negligible (Insignificant)	No impact or, if impact is present, then not to an extent that would draw concern from a reasonable person No impact on the overall condition of the ecosystem	No media attention	Financial losses up to $500,000
Low (Minor)	Impact is present but not to the extent that it would impair the overall condition of the ecosystem, sensitive population or community in the long term	Individual complaints	Financial loss from $500,001 to $5 million
Moderate	Impact is present at either a local or wider level Recovery periods of 5 to 10 years likely	Negative regional media attention and region group campaign	Financial loss from $6 million to $50 million
High (Major)	Impact is significant at either a local or wider level or to a sensitive population or community Recovery periods of 10 to 20 years are likely	Negative national media attention and national campaign	Financial loss from $51 million to $100 million
Very high (Catastrophic)	Impact is clearly affecting the nature of the ecosystem over a wide area **or** impact is catastrophic and possibly irreversible over a small area or to a sensitive population or community Recovery periods of greater than 21 years likely **or** condition of an affected part of the ecosystem irretrievably compromised	Negative and extensive national media attention and national campaigns	Financial loss in excess of $100 million

Table notes:

1 Quantification of impacts should use the impact with the greatest magnitude in order to determine the consequence category

* For Matters of National Environmental Significance (MNES) protected under the provisions of the EPBC Act the *Matters of National Environmental Significance – Significant Impact Guidelines 1.1 – Environmental Protection and Biodiversity Conservation Act 1999* (DoE 2013) are to be used to determine the consequence category

Table 5.5 Likelihood category definitions (adapted from GBRMPA 2009)

Description	Frequency	Probability
Rare	Expected to occur once or more over a timeframe greater than 101 years	0-5% chance of occurring
Unlikely	Expected to occur once or more in the period of 11 to 100 years	6-30% chance of occurring
Possible	Expected to occur once or more in the period of 1 to 10 years	31-70% chance of occurring
Likely	Expected to occur once or many times in a year (e.g. 1 to 250 days per year)	71-95% chance of occurring
Almost certain	Expected to occur more or less continuously throughout a year (e.g. more than 250 days per year)	96-100% chance of occurring

Once the likelihood and the consequence has been defined, determination of the HRG of the potential hazard will be determined through the use of a five by five matrix (refer Table 5.6).

Table 5.6 Hazard risk assessment matrix (adapted from GBRMPA 2009)

Likelihood	Consequence rating				
	Negligible (insignificant)	Low (minor)	Moderate	High (major)	Very high (catastrophic)
Rare	Low	Low	Medium	Medium	Medium
Unlikely	Low	Low	Medium	Medium	High
Possible	Low	Medium	High	High	Extreme
Likely	Medium	Medium	High	High	Extreme
Almost certain	Medium	Medium	High	Extreme	Extreme

Table note:

Hazard risk categories identified in Table 5.6 are defined in Table 5.7

Table 5.7 Risk definitions and actions associated with hazard risk categories (adapted from GBRMPA 2009)

Hazard risk category	Hazard risk grade definition
Low	These risks should be recorded, monitored and controlled. Activities with unmitigated environmental risks that are graded above this level should be avoided.
Medium	Mitigation actions to reduce the likelihood and consequences to be identified and appropriate actions (if possible) to be identified and implemented.
High	If uncontrolled, a risk event at this level may have a significant residual adverse impact on MNES, MSES, GBRWHA and/or social/cultural heritage values. Mitigating actions need to be very reliable and should be approved and monitored in an ongoing manner.
Extreme	Activities with unmitigated risks at this level should be avoided. Nature and scale of the significant residual adverse impact is wide spread across a number of MNES and GBRWHA values.

5.7.2 Summary of risk assessment.

The potential sediment quality impacts risk assessment is summarised in Table 5.8.

The implementation of mitigation measures (refer Section 5.6) will result in the ASS and land contamination impacts being generally assessed as a low to medium risk.

Table 5.8 Potential sediment quality impacts and risk assessment ratings

Potential impact	Project phase					Preliminary HRG			Post mitigation HRG		
	Reclamation area and BUF establishment	Dredging	Navigational aids	Demobilisation	Maintenance	Likelihood	Consequence	HRG	Likelihood	Consequence	HRG
Oxidation of PASS during bund wall and BUF construction											
▪ Mobilisation of metals and contamination of marine water ▪ Increased acidity of marine water ▪ Toxicity to marine and/or intertidal flora and fauna ▪ Public health risks	✓					Likely	Moderate	High	Unlikely	Moderate	Medium
Oxidation of PASS within dredged material during dredging activities											
▪ Mobilisation of metals and contamination of marine water ▪ Increased acidity of marine water ▪ Toxicity to marine and/or intertidal flora and fauna ▪ Public health risks		✓				Possible	Moderate	High	Rare	Moderate	Medium
Oxidation of PASS within dredged material during unloading and placement											
▪ Mobilisation of metals and contamination of marine water ▪ Increased acidity of marine water ▪ Iron staining in marine water, infrastructure and boats/vessels ▪ Toxicity to marine and/or intertidal flora and fauna ▪ Increased algal blooms ▪ Public health risks		✓				Likely	High	High	Unlikely	High	Medium

Potential impact	Project phase					Preliminary HRG			Post mitigation HRG		
	Reclamation area and BUF establishment	Dredging	Navigational aids	Demobilisation	Maintenance	Likelihood	Consequence	HRG	Likelihood	Consequence	HRG
Oxidation of PASS during stabilisation and maintenance activities of the reclamation area											
■ Mobilisation of metals and contamination of marine water ■ Increased acidity of marine water ■ Iron staining in marine water, infrastructure and boats/vessels ■ Toxicity to marine and/or intertidal flora and fauna ■ Increased algal blooms ■ Public health risks					✓	Unlikely	Low	Low	Rare	Low	Low
Land contamination from use and storage of oils, fuels and chemicals											
■ Contamination of soil and sediment through leaching ■ Contamination of marine waters ■ Health risks to construction workers ■ Public health risks ■ Toxicity to marine and/or intertidal flora and fauna ■ Odours	✓				✓	Unlikely	High	Medium	Rare	Moderate	Low

5.8 Summary

The geology of the areas to be dredged is mapped as the Curtis Island Group, specifically the Wandilla Formation and the Shoalwater Formation. The geotechnical investigation determined that the dredged material in the Gatcombe Channel is medium dense sand and gravel, while in the Golding Cutting Channel, the dredged material is medium to high plasticity, stiff to very stiff cohesive material with pockets of low strength cohesive material and a layer of medium dense sand. The geotechnical investigation within the barge access channel identified very soft to soft silty clays within the dredged material.

The ASS investigation identified a small pocket of PASS within the material to be dredged at the Golding Cutting Channel as well as more substantial areas of PASS within the barge access channel. However, the acid neutralising capacity of the material to be dredged was substantially higher than the net acidity of the sediments and as such, self-neutralisation is likely to occur. In addition, the WBE reclamation area was identified to contain PASS both laterally and vertically, although these sediments also contain a high level of acid neutralising capacity.

There is potential for impacts related to oxidation of PASS material and subsequent increase in acidity and migration of metals/metalloids into the marine water. An ASS Management Plan will be implemented during all phases of the Project to manage PASS impacts and risks. The ASS Management Plan will be incorporated into the Project EMP, Dredging EMP and the contractors' EMPs. With these measures effectively implemented, the residual PASS impacts and risks to human health and environmental values from Project activities are assessed as being low to medium.

There is potential that during the placement of dredged material into the WB and WBE reclamation areas and stabilisation and maintenance activities, that land contamination may occur through the storage and use of oils, fuels, chemicals and hazardous materials for the operation of machinery, vehicles and other equipment. Mitigation of the potential effects from any spills or leaks during construction and operation of the WB and WBE reclamation areas will include maintenance of all plant, availability of spill kits and appropriate raining in the use of spill kits. The residual impacts from land contamination and risks to human health and environmental values from Project activities are assessed as being low.