Ports North

APPENDIX D.11

Draft : Environmental Impact Statement

Appendix D.11

Health Impact Assessment

Cairns Shipping Development Health Impact Assessment of Land Based Dredge Material Placement (East Trinity Site)

Prepared for : ARUP

10 November 2014

EnRiskS

Document History and Status

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Limitations

Environmental Risk Sciences has prepared this report for the use of ARUP and Ports North in accordance with the usual care and thoroughness of the consulting profession. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report.

It is prepared in accordance with the scope of work and for the purpose outlined in the Section 1 of this report.

The methodology adopted and sources of information used are outlined in this report. Environmental Risk Sciences has made no independent verification of this information beyond the agreed scope of works and assumes no responsibility for any inaccuracies or omissions. No indications were found that information contained in the reports provided by ARUP for use in this assessment was false.

This report was prepared from July to November 2014 and is based on the information provided and reviewed at that time. Environmental Risk Sciences disclaims responsibility for any changes that may have occurred after this time.

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Glossary of Terms

CHETRE	Centre for Health Equity Training, Research and Evaluation
CSD	Cairns Shipping Development
DMPA	Dredge material placement area
DoE	Commonwealth Department of the Environment
DoFD	Commonwealth Department of Finance and Deregulation
DP&E	Department of Planning and Environment
DP&I	NSW Department of Planning and Infrastructure
EIS	Environmental Impact Statement
HIA	Health Impact Assessment
ILUA	Indigenous land use agreement
SEWPaC	Australian Department of Sustainability, Environment, Water, Population and Communities

Executive Summary

As part of the assessment of activities relevant to the Cairns Shipping Development (CSD), options for the land disposal of dredge materials have been evaluated, with a preferred land disposal site at East Trinity identified. To assist in the evaluation of the preferred land disposal site a Health Impact Assessment (HIA) has been prepared by Environmental Risk Sciences Pty Ltd (enRiskS).

The overall objective of the HIA is to provide a structured assessment of the direct and indirect impacts associated with the disposal of dredge materials at the East Trinity site on the health of the surrounding (local) community. Outcomes of the HIA are used to determine recommendations for the collection of further data and/or measures that may be able to be implemented to minimise or mitigate identified negative impacts, and maximise positive impacts.

The HIA assessment has been conducted in accordance with national guidelines available from the Centre for Health Equity Training, Research and Evaluation (CHETRE) (Harris et al., 2007) and enHealth (2001). Based on these guidelines the HIA has included an assessment of the proposed land disposal project, the demographics and health of the surrounding (local) population and the potential for the project to impact on the health and wellbeing of this population.

Land placement of dredge material poses a number of potential health and safety risks. The assessment undertaken has identified a range of impacts that have the potential to impact on the health of the local community and site workers.

Potential health related impacts to the community have been identified in relation to:

- traffic congestion and accidents/safety (in the local area),
- amenity aspects - noise, light spill, air quality and odour,
- pests/mosquitos,
- site safety hazards (trespassers only) and
- land use and economic aspects (i.e. future use of the site – positive and negative potential impacts),
- contamination of land (only where final site use may be for residential purposes),
- community concern associated with Aboriginal cultural heritage and native title aspects.

Potential human health risks to workers include:

- Safety/construction risks (pipe blow outs, bund failures, working in soft reclamation material e.g. machine rollover, person falling in),
- inhalation or contact with harmful substances, including hydrated lime used to treat acid sulfate soils,
- potential contact with hazardous fauna species e.g. crocodiles, snakes etc,
- contact with mosquitos and/or biting insects which can have a variety of health risks ranging from irritation to ongoing illness i.e. Ross River Fever.

Most of the potential impacts to workers and the community can likely be effectively managed through measures such as good communication, traffic management plans, health and safety plans etc. The risk of the public trespassing on the site and falling into unstable material or being injured by contact with hazardous fauna (e.g. snakes and crocodiles) is more difficult to mitigate. East Trinity is isolated, and its size makes it difficult to effectively restrict public access if standard fencing

and signage are not an adequate deterrent. The current site managers' report regular illegal access to the site despite signage and fencing as it is a popular location for fishing/crabbing.

Section 1. Introduction

1.1 The Project

Far North Queensland Ports Corporation Limited (trading as Ports North) has initiated planning for the Cairns Shipping Development (CSD) Project. The aim of this project is to expand tourism cruise ship opportunities by expanding the channel to enable larger cruise vessels to enter the Port of Cairns.

The CSD project involves upgrading of the following Port infrastructure:

- Widening and deepening of the existing outer shipping channel which will result in some lengthening of the existing channel.
- Widening and deepening of the existing inner harbour channel and cruise shipping swing basin, and establishment of a new shipping swing basin to enable future expansion of the HMAS Cairns Navy base.
- Structural upgrade of the existing cruise shipping wharves 1-5 to accommodate larger and heavier cruise ships.
- Provision and upgrade of ship services to the cruise shipping wharves, including fuel supply, potable water and firefighting services.

The proposed CSD works will involve the dredging of approximately 4.4 million m^3 (M m^3) of in-situ sediment material. The National Assessment Guidelines for Dredging provides the framework to manage dredge material placement, and specifically requires the evaluation of alternatives to marine placement. A number of options for the disposal of dredge materials have been considered as part of the EIS process, with disposal to East Trinity identified as the preferred land disposal option.

The focus of this report relates to the assessment of health impacts of the preferred land disposal site, East Trinity. This report had not addressed any other aspects associated with the EIS (associated with dredging activities).

1.2 Environmental impact assessment requirements

This Report has been prepared by Environmental Risk Sciences Pty Ltd (enRiskS) to assist in assessing the 'appropriateness' of the preferred land based dredge placement site (East Trinity) as guided by the National Assessment Guidelines for Dredging 2009). The Health Impact Assessment (HIA) of the East Trinity Site will also inform the impact assessment of land based dredge placement options as required in the Final EIS Guidelines (DSEWPaC, March 2013).

The conduct of a HIA is intended to provide a structured, solution-focused and action-oriented approach to maximising the positive and minimising the negative health impacts of the Project. The scope of the HIA assessment:

- involves the identification and assessment of the severity and likelihood of positive and negative impacts (either direct or indirect);
- identifies ways in which the Project can enhance or strengthen health;
- identifies and addresses underlying social, economic and environmental impacts of the Project on health; and
- communicates any risks to stakeholders.

1.3 Objectives

In contrast to marine placement, land placement of dredge material poses a number of potential health and safety risks. The overall objective of the HIA is to provide a structured assessment of the direct and indirect impacts on the health of the surrounding (local and regional) community and site workers associated with the proposed disposal of dredge materials to land, at the preferred location of East Trinity.

More specifically the HIA has addressed the following:

- The relevant characteristics of the preferred land based site (East Trinity) that relate to health, including the intended end use of the site. For these sites the key receptors and values, relevant to health will be identified, which may include:
    - Definition of health and health equity;
    - Identification of specific groups, communities or populations (including the geographical area), including sensitive receptors, to be considered in terms of impacts (both direct and indirect);
    - Statistics relevant to the existing population in the areas of interest, including employment status and key health indicators;
- The relevant characteristics of the dredge material based on existing information (to be provided upon award of contract) that relate to health and the associated health effects from potential contamination or land, air and water;
- Impacts to health due to potential breeding of mosquitos and other vectors of disease;
- Potential impacts to health from a range of amenity and other factors that include (but not limited to):
    - Impacts from noise
    - Effects of lighting and/or visual changes to the landscape
    - Employment and industry opportunities won or lost
    - Mental and emotional wellbeing of those affected by the project
    - Recreational opportunities
    - Other economic benefits
- Workplace health and safety issues during disposal (e.g. handling of materials), and how they relate to public safety (e.g. increased traffic); and
- Worker and public safety related to the dredge material consolidation stage (e.g. if people access the area, are there safety risks concerning surface stability).

The HIA has been undertaken as a qualitative and quantitative (where relevant) assessment that has addressed the number of people who may be exposed, the pathways of exposure (direct and indirect), the duration of that exposure and the vulnerability or sensitivity individuals who are exposed.

Outcomes of the HIA are used to determine recommendations for the collection of further data and/or measures that may be able to be implemented in the Project to avoid, minimise or mitigate identified potential negative impacts, and maximise potential positive impacts.

1.4 Approach

Overall, the HIA is in accordance with the following guidance (and associated references as relevant):

- Harris, P., Harris-Roxas, B., Harris, E. & Kemp, L., Health Impact Assessment: A Practical Guide, Centre for Health Equity Training, Research and Evaluation (CHETRE). Part of the UNSW Research Centre for Primary Health Care and Equity. University of New South Wales, Sydney (Harris 2007).
- Health Impact Assessment Guidelines. Published by the Environmental Health Committee (enHealth), which is a subcommittee of the Australian Health Protection Committee (AHPC) (enHealth 2001).

The HIA presented in this report is a desk-top assessment. The term desk-top assessment is used to describe that the HIA has been conducted on the basis of existing information including Project specific EIS technical studies and published statistics on the existing population with additional detail obtained via literature review only.

1.5 Definitions

For the conduct of the HIA the following definitions are relevant and should be considered when reading this report.

Health:

The World Health Organisation defines health as "*a (dynamic) state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity*".

Hence the assessment of health should include both the traditional/medical definition that focuses on illness and disease as well as the more broad social definition that includes the general health and wellbeing of a population.

Health Hazard:

These are aspects of the Project, or specific activities that present a hazard or source of negative risk to the health or well-being.

In relation to the HIA these hazards may be associated with specific aspects of the proposed land disposal activities, dredge characteristics, incidents or circumstances that have the potential to directly affect health. In addition some activities may have a flow-on effect that results in some effect on health. Hence health hazards may be identified on the basis of the potential for both direct and indirect effects on health.

Health Outcomes:

These are the effects of the activity on health. These outcomes can be negative (such as injury, disease or disadvantage), or positive (such as good quality of life, physical and mental wellbeing, reduction in injury, diseases or disadvantage).

It is noted that where health effects are considered these are also associated with a time or duration with some effects being experienced for a short period of time (acute) and other for a long period of time (chronic). The terminology relevant to acute and chronic effects is most often applied to the assessment of negative/adverse effects as these are typically the focus of technical evaluations of various aspects of the Project.

Likelihood:

This refers to how likely it is that an effect or health outcome will be experienced. It is often referred to as the probability of an impact occurring.

Risk:

This is the chance of something happening that will have an impact on objectives.

In relation to the dredge disposal option considered, the concept of risk more specifically relates to the chance that some aspect of the Project will result in a reduction or improvement in the health and or well-being of the local and regional community. The assessment of risk has been undertaken primarily on the basis of a qualitative basis.

Equity:

Equity relates to the potential for the Project to lead to impacts that are differentially distributed in the surrounding population. Population groups may be advantaged or disadvantaged based on age, gender, socioeconomic status, geographic location, cultural background, aboriginality, and current health status and existing disability.

In relation to the Project, equity has been addressed by:

- determining if there are any impacts that are likely to be more significant for any particular group in the surrounding community and ensuring that these impacts are effectively assessed;
- considering if these impacts are significant, unfair and can be changed or modified (such that the changes or modifications will improve equity and reduce the chance of unfair and avoidable impacts occurring for specific population groups).

Section 2. Project Description

2.1 General

The following project description information was made available to EnRiskS for the purposes of undertaking the HIA. Further details are contained in EIS Part A of the EIS.

2.2 History of Dredging

Although Trinity Inlet is a natural harbour, access to the sea is across a broad shallow mudflat. Hence for the operation of a port, it has been necessary to maintain an access channel through these mudflats by regular dredging to remove sediment which collects in the channel.

Following the ports declaration in 1876, the first capital dredging works were undertaken within the access channel and berths by *the Platypus* dredge in 1887. Unable to keep up with the task of maintaining required depths, *the Trinity Bay* dredge took up operations from 1913, deepening the channel and increasing its width to 45 m by 1929. By the early 1940s the channel had been widened progressively to 60 m. During the 1970s a dredging contractor undertook a further widening of the channel (75 m) and deepened the entrance to 8.2 m. *The Sir Thomas Hiley* dredge replaced *the Trinity Bay* dredge during the early 1970s, and conducted the most recent capital dredging expansion during 1990, widening the channel to 90 m and a design depth of 8.3 m.

Maintenance dredging is undertaken annually at Cairns Port. Average annual *in-situ* quantity dredged is approximately 350,000 m^3 of which 90% is removed from the Channel and 10% is removed from the Inner Port area.

2.3 Characteristics of Dredge Materials

Detailed sediment quality characterisation studies have been undertaken within Cairns Port since 1995. The proposed CSD Project involves the dredging of 4.4 M $m^{3.}$

Sediments within the Port of Cairns are noted to be typically uncontaminated, with the majority of contaminant substances not exceeding the National Assessment Guidelines for Dredging (NAGD) screening levels. These guidelines are relevant for the disposal of dredge materials to a marine environment, and based on the available data dredge material has been considered of suitable quality for unconfined sea disposal.

For the assessment of land disposal, different guidelines are applicable, which relate to the protection of human health and/or terrestrial environments.

In relation to the presence of inorganic and organic compounds in dredge materials WorleyParsons (2010) provides a summary of available data for dredge areas (reported from 2005-2009), included in **Appendix A**. The significance of these compounds in relation to land disposal has been further evaluated in **Section 4.3.3**.

Further sediment quality testing will be undertaken as part of the sampling and analysis plan (SAP) developed for the Project.

Based on the investigations undertaken some dredge materials have the potential to be classified as acid sulfate soil (ASS). The evaluation identified the following:

- Potential acid sulfate soil (PASS) is only expected to be present in the very soft to soft clay and silt materials (about 3.67 M m^3). Firm, stiff and very stiff materials are unlikely to be PASS or require lime treatment.
- The majority of samples tested by BMT WBM indicated self-neutralizing PASS within the top 1m along most of the channel (i.e. these samples had shell or other neutralising material).
- PASS materials that are not self-neutralising were detected in a total of 17 samples results from all investigations to date. These 'positive' samples were typically from depths of more than 1m below the existing surface.

2.4 Disposal Activities

The disposal of dredge materials to land requires a range of activities that include the following:

- If a trailer suction hopper dredging (TSHD) method of dredging is used, materials dredged can be pumped ashore (in a slurry form). This requires the vessel to be moved to a designated anchor site for the materials to be pumped onshore to the land disposal site. Where this occurred the materials would need to be pumped into a bunded area to allow the dredge material to dewater, consolidate and be treated. Treatment with lime is likely to be required to address potential acid sulphate soil identified in the very soft to soft clay and silt dredge below 1m depth. Treatment with lime can also improve the strength characteristics of the material. This treatment is likely to occur using a land farming methodology within a lined (with an appropriate geosynthetic liner) bunded area.

- Dewatering is required as the pumped dredge materials will have an initial moisture content of approximately 90%. To be able to be rehandled (by machinery) is estimated that the water content need to be reduced to approximately 40-50%. This is proposed to be undertaken using the land farming process. The dewatering process will produce tailwater that will be required to be discharged from the bunded area. The discharge of tailwater will be strictly controlled to ensure it is maintained within acceptable water quality limits for discharge to a marine environment. The management and monitoring requirements would be specified in the Dredge Material Placement Area Management Plan.

- For materials determined unsuitable for pumping (e.g. potentially some stiff clays). These materials will be placed on barges for transport to shore, where they would be placed on dump trucks for road transport (taking approximately 20 minutes) to the land disposal site.

- Placement and/or re-use of the dredge materials at the land disposal site will require equipment such as excavators and bulldozers to spread out the materials. Water pumps will also be required at the placement site.

Dredging, with land disposal is estimated to take up to 44 weeks.

2.5 Preferred Land Disposal Option

An assessment of Dredge Material Placement Options for the CSD Project has been undertaken as part of the project feasibility study and the preferred land disposal option identified as the East Trinity site (refer to EIS Section A2, Dredge Material Placement Options). The East Trinity site comprises an area immediately along the eastern edge of Trinity Inlet. The East Trinity area (including the site) consists of natural conservation areas which contribute significantly to biodiversity around Cairns and is included in the Conservation Zone under the *CairnsPlan* as a

reflection of its environmental values. The area located inland adjacent to this environmentally-significant strip is zoned Rural and as such is intended for agricultural or undeveloped rural purposes.

A summary of key information regarding the East Trinity site is provided below. Further details are provided in Part D of the EIS. :

- The East Trinity site is approximately 920ha in area and was originally a mangrove/saltmarsh wetland that was bought by CSR Pty Ltd in the 1970's to grow sugar cane.
- A bund wall (rock levee) was constructed through foreshore mangroves to prevent salt water entering the site, floodgates were installed to allow water to leave the site (but not enter) and the enclosed area was drained. Draining of the area exposed acid sulfate soils (ASS) leading to acidification of onsite soils and discharges of sulphuric acid and heavy metals to Trinity Inlet following rainfall. Sugar cane production was not successful (as a result of the soil becoming acidic) and the remaining natural vegetation onsite was seriously degraded. Fish kills in, and near the site, were common.
- In 2000, the Queensland Government purchased the site, designated it as an Environmental Reserve (the East Trinity Reserve) and has been undertaking a variety of management measures to rehabilitate the site and reduce acidic discharges to Trinity Inlet. Progress has been significant but slow given the scale of the problem. A variety of native flora and fauna are returning to the site.
- Ninety per cent of East Trinity Reserve lies below 2 m above mean sea level and virtually all of this area contain at least some ASS. Tidal inundation of the site is controlled via flood gate to manage the ASS on site and maintain pH levels.
- The site can accommodate the required total volume of proposed CSD dredge material for land farming (estimated to be 12M m^3).
- Perimeter bunding of the site is required to be constructed to approximately 3.06m AHD to account for storm tide surge and includes an allowance for future sea level rise. .

A number of constraints also exist on the East Trinity site, which include

- A buffer of at least 100m has been provided either side of Hills Creek (middle of the site) and Firewood Creek (southern-most creek). These existing creeks have been most heavily rehabilitated compared to other areas on site. Magazine and George Creeks still need some rehabilitation work, from which it is considered that their habitat value is reduced and as such, a 50m buffer has been used.
- The northern wetland is protected under state legislation and has a good existing migratory bird population.
- The northernmost part of the site, which contains endangered and 'of concern' vegetation communities.
- The East Trinity Reserve is part of the Mandingalbay Yidinji Indigenous Protected Area (IPA).

Based on the above, the areas available to receive the dredge material are indicated in **Figure 2.1**. This shows two sites, East Trinity North and East Trinity South, due to the Hills Creek buffer in the middle of the site.

With consideration of the above restrictions and a fill level of 2.8 m AHD, the areas are able to cater for the 12 M m^3 of fill material.

In relation to the two disposal areas, there would be two land farming areas with tailwater discharge at two locations into Trinity Inlet (as shown schematically on **Figure 2.1**).

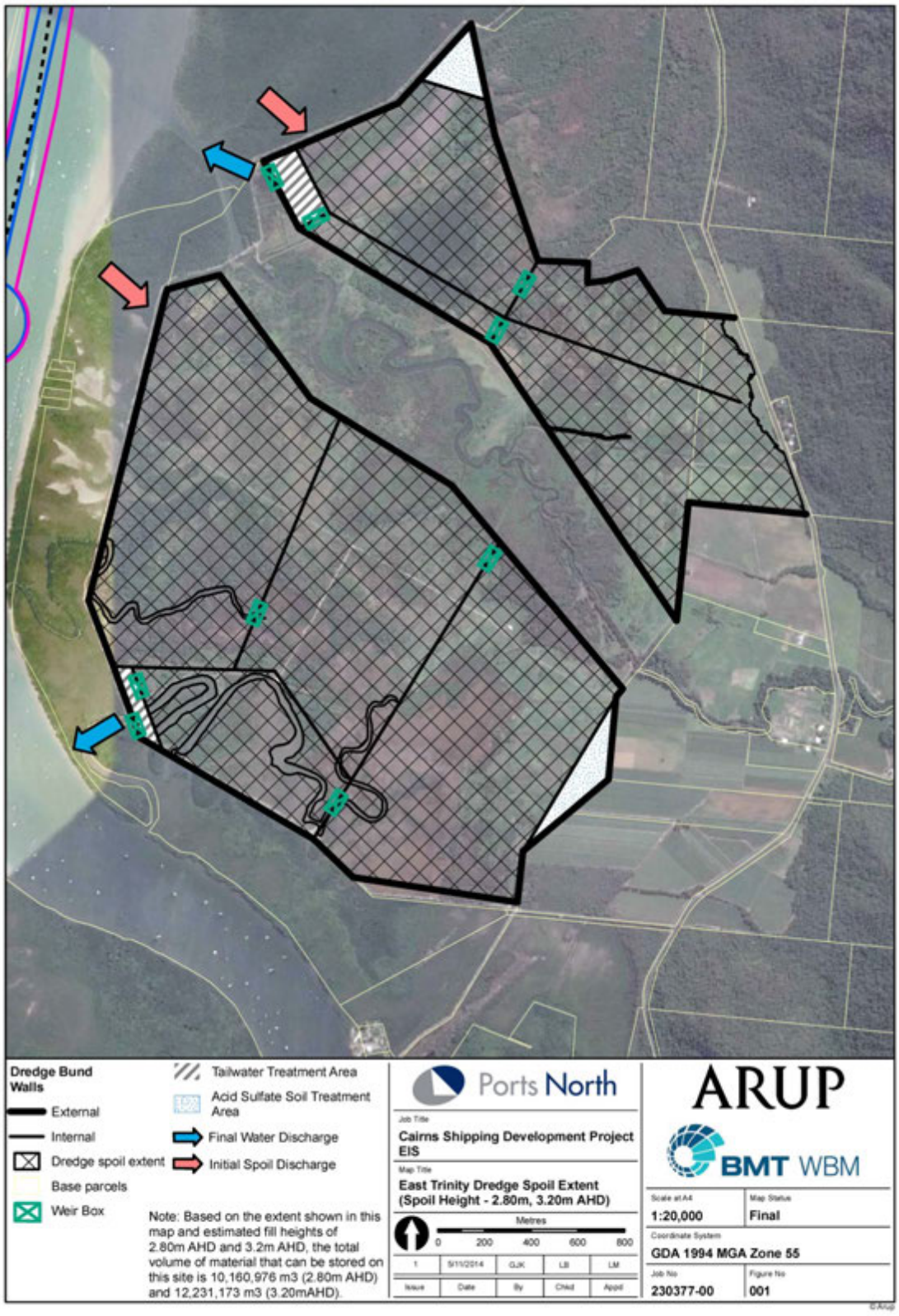

Figure 2.1 Extent of Suitable Dredge Material Disposal Areas – East Trinity

Section 3. Community Profile

3.1 Project Area

This section aims to provide an overview of the community potentially impacted by the proposed Project.

The East Trinity disposal site is located within the East Trinity Reserve. East Trinity Reserve is located approximately 37 km south-east of Cairns on the southern shores of Trinity Inlet. The Reserve was former farming land that has been designated as a rehabilitation area.

The area is subject to a range of rehabilitation activities. The Department of National Parks, Recreation, Sport and Racing (NPRSR) has repaired infrastructure, implemented pest control programs and devised an acid sulfate remediation plan involving controlled, lime-assisted tidal exchange. The acid remediation plan is implemented and monitored by DSITIA with a fulltime staff of 4 personnel based at their office and depot facility adjacent the site. The program is further supported by Brisbane based DSITIA scientists. Fisheries Queensland, Department of Employment, Economic Development and Innovation have undertaken some on-site and off-site aquatic impact assessments. These studies show that remediation works have substantially improved water, soil and vegetation quality, and encouraged many native animals and plants to return to the site[1]. Within NPRSR, Queensland Parks and Wildlife Service (QPWS) manages the reserve and the Queensland Acid Sulfate Soils Implementation Team (QASSIT) is responsible for the acid sulfate soils remediation project.

In 2006 with NPRSR as trustee, East Trinity was declared a reserve for community purposes - an environmental reserve under the *Land Act 1994*. There is no public access to the reserve.

East Trinity Reserve lies within the suburb or East Trinity, which is predominantly reserve areas, with some rural properties (including the village of Glen Broughton located approximately 760m southeast of the site boundary) located along Pine Creek Road. East Trinity rises up approximately 700m to the east to a mountain range. Further east (approximately 6km to the east and north east of the site boundary) includes other parts of the East Trinity Reserve, the Yarrabah Aboriginal Community and the Yarrabah township.

The East Trinity Reserve is part of the Mandingalbay Yidinji Indigenous Protected Area (IPA). The Mandingalbay Yidinji Corporation established a separate entity in Djunbunji Ltd to conduct land management activities under their Land and Sea (Rangers) Program. The program employees approximately 8-10 staff that work from a base directly adjacent the Reserve and routinely work on the Reserve area on control of feral animal, weed, and sea debris as well as cultural heritage project activities.

Additional rural properties, and reserve/park areas, are located further south of East Trinity. More populated areas are located across Trinity Inlet, where the city of Cairns is located, with urban

[1] http://www.nprsr.qld.gov.au/parks/east-trinity/about.html

suburbs extending south of Cairns to the suburb of Edmonton (located approximately 9km to the southwest of the site boundary).

The disposal site is expected to remain an environmental reserve. Hence there are no communities (human) that are directly affected by the land disposal proposed. While public access to the site is prohibited, rangers and contractor involved in rehabilitation works, as well as trespassers may directly access the site. Due to the abundance of fish and crab catch trespassers are observed to be an ongoing regular occurrence by the current site managers.

Any future development of the site, for urban use, would require consideration of the need to change the land use classification of the site, and reach agreement with the traditional owners as to the future desired use.

Communities in the areas surrounding the site may be indirectly affected by the Project.

3.2 Population Profile

The communities relevant to and surrounding the site are located in the suburbs of East Trinity, Green Hill (which includes the site) and Yarrabah. These suburbs are located with the larger statistical population area of Cairns. **Table 3.1** presents a summary of the key demographics of the population in these areas, based on the 2011 Census data available from the Australian Bureau of Statistics. This includes the SEIFA Index of Relative Socio-Economic Disadvantage (IRSD) scores[2] which provides a measure of community disadvantage.

Table 3.1 Selected Demographic Characteristics: Local Area

INDICATOR	Wider Area	Local Suburb		
	Cairns	Green Hill	East Trinity	Yarrabah
SEIFA IRSD 2011	975	1001	843	554
SEIFA Ranking - QLD	55 (out of 70 local government areas)	1058 (out of 1797 suburbs)	86 (out of 1797 suburbs)	2 (out of 1797 suburbs)
Total Population	224436	498	111	2409
Population 0 – 4 years	*7.2%*	*5.6%*	*5.4%*	*12.6%*
Indigenous	10.3%	2.4%	54.5%	97%
Median Age	37	40	42	22
Born overseas	18.2%	16.3%	5.4%	0%
Speak other language at home	10.1%	7%	2.7%	17%
Median weekly household income	$1,057	$1,101	$1,375	$1,007
Married	44.2%	45.8%	28.6%	22%
Single parent families	5.3%	4%	17.1%	10%
Unemployed	7.0%	6.2%	33.3%	61.5%
Home owned outright	28%	41.3%	8.6%	8.5%
Home being purchased	31.3%	31.7%	28.6%	0

[2] The five yearly Australian Census of Population and Housing ('the census') conducted by the Australian Bureau of Statistics (ABS) collects a variety of social and demographic information for individuals and households in Australia. As well as the data generated by discrete census questions, the ABS also compiles a series of indices which attempt to quantify the socio-economic status of small areas relative to each other. These are known as the Socio-Economic Indexes for Areas (SEIFA). In particular, the Index of Relative Socio-Economic Disadvantage (IRSD) incorporates attributes such as low income, low educational status, high unemployment and other variables which reflect disadvantage – lower scores indicate relatively greater disadvantage Australian Bureau of Statistics 2003, Socio-Economic Indexes for Areas: Australia 2001.

INDICATOR	Wider Area	Local Suburb		
	Cairns	Green Hill	East Trinity	Yarrabah
Home rented	37.1%	23.3%	51.4%	87.5%
Median rent per week	$240	$140	$170	$120
Median monthly mortgage repayments	$1647	$1,885	$542	$0

Source: ABS Census 2006 and 2011

The above data shows a significant difference in the demographics in Yarrabah, and to a lesser extent East Trinity, compared with Green Hill and the Cairns area as a whole. Yarrabah is a largely indigenous community with a significantly younger average age, high unemployment (61.5%), no news homes being purchased and a high level (i.e. low score) of socio-economic disadvantage, ranking 2 (i.e. the second lowest) in the state of Queensland.

3.3 Existing Health of Population

The health of the community is influenced by a complex range of interactive factors including age, socio-economic status, social capital, behaviours, beliefs and lifestyle, life experiences, country of origin, genetic predisposition and access to health and social care.

Broadly, the community in the area of interest is captured within the Cairns and Hinterland Health Service District (part of Queensland Health). In comparison to Queensland, Cairns and Hinterland Health Service District has (Queensland Health 2009):

- a higher proportion of Aboriginal and Torres Strait Islander people;
- a higher general fertility rate for women of childbearing age;
- a 13 per cent higher rate for all causes of death;
- a 7 per cent higher rate of all causes of hospitalisation;
- higher rate of potentially avoidable deaths;
- higher mortality rates for musculoskeletal conditions, cancer, diabetes, mental conditions, suicide and injury;
- lower hospital separation rates for asthma, musculoskeletal conditions, cancer, mental conditions and self-harm;
- higher rates of hospital separations for coronary heart disease and injury;
- higher participation rates for breast screening and cervical screening by women;
- generally higher immunisation rates in children;
- generally higher crude notification rates of diseases such as vector-borne conditions and sexually transmitted infections.

More specifically within the Cairns sub-region, which includes the site and surrounding areas, the following can be noted (Queensland Health 2011a):

Yarrabah:

- Yarrabah residents have access to general practice and primary care services through Gurriny Yealamucka Health Service.
- Health services have been transitioning to community control with full transition target set for 2014.
- Limited data is available that specifically relates to Yarrabah, however it is important to note that chronic disease rates and risk factors, and mental health issues may be significantly higher for Yarrabah given relevant socio-economic factors previously summarised and well known evidence regarding prevalence of chronic disease and mental health issues amongst

Indigenous populations in Australia. Data on the indigenous population in North Queensland indicate (Queensland Health 2011b):

- Higher levels of infant mortality;
- Higher rates of child and teenage mortality, particularly relating to self-harm, asthma and ischemic heart disease;
- Higher rates of mortality in older adults for ischemic heart disease, lung cancer and diabetes.

- In Yarrabah, the percentage of children assessed as being developmentally vulnerable on one or more domains of the Australian Early Development Index (AEDI) is alarmingly high across all areas of development.

Other suburbs:

For other suburbs in the Cairns sub-region the following is noted:

- These areas have a high population mix of young families.
- Infrastructure and services are in place and expanding.
- There are 7 General Practices in the surrounding southern suburbs (Edmonton, Gordonvale and Yarrabah). Gordonvale has two GP practices; Edmonton residents have access to a GP practice and a GP Super Clinic. A GP practice is also located at White Rock and Mt Sheridan.
- Local residents can also access the home visiting service of Dial-a-Doctor (excluding Yarrabah and Gordonvale) or drive to Cairns 24 Hour Medical Centre or the Emergency Department at the Cairns Base Hospital to access after-hours and emergency medical care.
- Chronic disease rates within Cairns are generally consistent with the wider region, State and Australian rates.
- Respiratory system diseases are lower than the Queensland and Australian rates
- Overall, chronic disease risk factor rates in the Cairns are consistent with the FNQ Medicare Local region, Queensland and Australian rates. However, high/risky alcohol consumption is higher in the Cairns area.
- Within Cairns LGA, the Trinity area has a high percentage of children rated as being developmentally vulnerable.

Section 4. Health Impact Assessment

4.1 Approach

The assessment of potential health impacts associated with the proposed disposal of dredge materials at the East trinity site has been undertaken by considering the following:

- Identify all potential impacts (both positive and negative) associated with the proposed works when compared to the existing use of the East Trinity Site;
- Determine whether these impacts have the potential to affect the health of workers (on the site) and the community (surrounding the site). The assessment of potential health impacts is based on the nature (including magnitude) of the impact and potential for workers or the community to be exposed in some way;
- Where there is the potential for a health impact to occur, identify is measures can be implemented to mitigate negative impacts/risks, or to enhance positive impacts.

These aspects have been considered for the disposal in the following sections.

4.2 Economic/Land Environment

The CSD Project Economics Analysis Report (Appendix D9 of the EIS) has identified a wide range of economic benefits associated with the proposed Cairns Shipping Development Project as described in EIS Part A.4 Project Description, and includes marine disposal of the dredge material. The economic analysis identifies the local and wider economic benefits associated with increased cruise tourism opportunities of the project.

As outlined in the EIS Part D6.1, should a land based dredge disposal option be considered, the disposal of dredged materials to land at East Trinity has the following potential implications in relation to economics, planning and logistics:

- The East Trinity site is already owned by the Queensland Government and does not require acquisition of private property for the project. However an ILUA (Indigenous land use agreement) or similar agreement to use the land for dredge material placement with recognised native title claimants as well as a Cultural Heritage Management Plan under the State Aboriginal Cultural Heritage Act. Such an agreement would need to be in place before the site could be used in this project.
- The site is currently classified as “Environmental Reserve” under the Regional Plan. Current ongoing rehabilitation of the site from former use as cane fields requires ongoing expenditure.
- The Regional Plan does not indicate a community need / desire to change the future land use of the site, however should the CSD project provide the opportunity for redevelopment for residential, commercial or industrial purposes, the land may represent an economic value to the community. Such land would provide social benefits such as employment opportunities and additional areas for housing and industry and public access areas. Such development would require changing the classification of the site from “Environmental Reserve” to a more suitable category for community uses. Any future uses would need to consider the desired uses of the site by the traditional owners.
- The placement of dredge materials on the site may result in the further rehabilitation of the site, making it more suitable for redevelopment at some point in the future (if such uses were

desired in the community). This would have some economic benefit in terms of employment and housing opportunities.

- However if the site is not proposed to be redeveloped, then this offers limited economic value and has the potential for ongoing costs associated with the maintenance and further rehabilitation of these materials.
- Costs for dredging and placement of dredge material at East Trinity are estimated to be 700 - 800% higher than dredging and marine placement of materials. This is a significant cost difference between the two options, diverting funds that could be used for other purposes/projects.

Potential Health Outcomes in Community

The disposal of dredge material at East Trinity offers little economic benefit to the local community. The cost of the works is significantly higher than marine disposal diverting funds from other purposes/projects.

If the project went ahead there may be some opportunity for locals to be employed in relation to the site works (placement, management and treatment of dredge materials). Given the high rate of unemployment in the area this may result in improved health outcomes (lower levels of anxiety and stress) for those who can obtain skills and employment through the project. The opportunities for positive health outcomes would be greater in the event that the East Trinity site was redeveloped in the future.

The future use of the site has not been yet been agreed with the traditional owners. The placement of dredge materials on the site is not a desired use of the site by the traditional owners and may result in reduction in existing employment levels for Land and Sea Rangers and increased stress and anxiety in the local community if there is any disagreement/dispute over the use of this site or loss of cultural values, aspirations or resources. The timeframe to reach any agreement for the future use of the site is unknown.

Can outcomes be enhanced/mitigated

If the East Trinity site is to be used as a disposal site for dredge materials it is important that a suitable agreement for the use of the site, and for the future (desired) use of the site is established with the traditional owners as soon as possible to minimise the potential for disputes and associated stress/anxiety in the local community.

Any opportunities for the training and employment of locals in any future development (if future development at the site is desired, which is not yet known) should be encouraged as this offers the potential to improve health and wellbeing in the local community.

4.3 Transport

Placement of dredge material on land would likely involve the road transport of materials by truck for treatment of the dredge material (e.g. lime) and for construction purposes (e.g. fill for bund construction). A high level estimate of heavy vehicle use has been determined for the East Trinity site and potential impacts and management measures are outlined in EIS Part D6.11, Transport.

Increases in traffic volumes and associated potential impact on the operation of key intersections such as the Bruce Highway / Warner Road Intersection have the potential to result in an increase in

accidents. In addition additional congestion on the roads can lead to an increase in anxiety and perceptions of safety for other road users (particularly where intersections no longer feel safe).

Can outcomes be enhanced/mitigated

Any significant increase in traffic volumes carries an inherent health and safety risk for road users due to increased potential for accidents. If the land disposal option at East Trinity were to proceed, a more detailed Road Traffic Impact Assessment would be required to be undertaken. It is expected that such an assessment would include recommendations to address any traffic issues related to the project to minimise residual impacts on the local community and other road users.

4.4 Natural Environment

Part D.6 of the EIS provides a Review of Environmental Factors for land disposal at the East Trinity site. The potential implications to human health from land placement activities are discussed below.

4.4.1 Noise

Potential sources of noise from construction works include:

- Machinery used for construction of the bund wall and treatment areas
- Pumping of dredge material (e.g. booster pumps)
- Machinery used to treat the dredge material (e.g. lime dosing equipment, graders, bulldozers and trucks)
- Road traffic associated with:
    - Bringing fill to site for construction of the bund wall
    - Placement of material dredged by backhoe dredges
    - Delivering lime to site for treatment of acid sulfate soils.

Once the placement of material is completed, there is likely to be occasional ongoing noise associated with machinery maintaining the site.

Noise impacts from the placement of material at the site may consist of annoyance to human comfort or sleep disturbance as well as disturbance to the typical behaviours of the sites fauna e.g. nesting, breeding.

Dredging and therefore placement of dredge spoil is proposed to be undertaken over a 24 hour period. Noise would be generated during the initial dredging and placement period and further over a period of years (up to five to ten years depending on soil treatment methods) during site preparation, placement of material and its subsequent treatment.

At the East Trinity site there are very few receptors that are located on or close to the site, however given the likely low level of background noise currently in the area, any noise from the project is expected to be noticeable in areas surrounding the site, particularly at night-time.

Environmental noise has been identified (I-INCE 2011; WHO 2011) as a growing concern in the growth of urban areas because it has negative effects on quality of life and well-being and it has the potential for causing harmful physiological health effects. With increasingly urbanised societies impacts of noise have the potential to increase within the community.

Deciding on the most effective noise management option in a specific situation is not just a matter of defining noise control actions to achieve the lowest noise levels or meeting arbitrarily chosen criteria for exposure to noise. The goal should be to achieve the best available compromise between the benefits to society of reduced exposure to community noise versus the costs and technical feasibility of achieving the desired exposure levels. On the one hand there are the rights of the community to enjoy an acceptably quiet and healthy environment. On the other are the needs of the society for a new or upgraded facilities, industries, roads, recreational opportunities, etc., all of which typically produce more community noise (I-INCE 2011; WHO 2011).

Sound is a natural phenomenon that only becomes noise when it has some undesirable effect on people or animals. Unlike chemical pollution, noise energy does not accumulate either in the body or in the environment but it can have both short-term and long-term adverse effects on people. These health effects include (WHO 1999, 2011):

- Sleep disturbance.
- Annoyance.
- Hearing impairment.
- Interference with speech and other daily activities.
- Children's school performance (through effects on memory and concentration).
- Cardiovascular health.

Other effects for which evidence of health impacts exists, but for which the evidence is weaker, include:

- Effects on mental health (usually in the form of exacerbation of existing issues for vulnerable populations rather than direct effects).
- Effects on the performance of cognitive tasks.
- Some evidence of indirect effects such as impacts on the immune system.

Often, annoyance is the major consideration because it reflects the community's dislike of noise and their concerns about the full range of potential negative effects.

There are many possible reasons for noise annoyance in different situations. Noise can interfere with speech communication or other desired activities. Noise can contribute to sleep disturbance, which can obviously be very annoying and has the potential to lead to long-term health effects. Sometimes noise is just perceived as being inappropriate in a particular setting without there being any objectively measurable effect at all. In this respect, the context in which sound becomes noise can be more important than the sound level itself.

Different individuals have different sensitivities to different types of noise and this reflects differences in expectations and attitudes more than it reflects any differences in underlying auditory physiology. A noise level that is perceived as reasonable by one person in one context (for example in their kitchen when preparing a meal) may be considered completely unacceptable by that same person in another context (for example in their bedroom when they are trying to sleep). In this case the annoyance relates, in part, to the intrusion from the noise. Similarly a noise level, which is considered to be completely unacceptable by one person, may be of little consequence to another even if they are in essentially the same room. In this case the annoyance depends almost entirely on the personal preferences, lifestyles and attitudes of the listeners concerned.

It is against this background that regulators in various communities have established sound level criteria above which noise is deemed to be unacceptable and below which it is deemed to be acceptable. Any assessment of noise impacts needs to consider the relevant criteria established for a new or existing (or upgraded) facility or activity. Where there are impacts in excess of these guidelines an assessment of noise mitigation is required to be undertaken.

Can outcomes be enhanced/mitigated

In relation to the proposed disposal of dredge materials at East Trinity, no detailed noise assessment has been undertaken. The project will result in the generation of noise and the operation of the site would need to comply with the relevant noise guidelines. Noise criteria are available in Queensland[3] (and nationally) that have been established on the basis of the relationship between noise and health impacts, and are based on guidance and reviews published in the following:

- World Health Organisation - Guidelines on Community Noise – Health effects of noise (WHO 1999).
- World Health Organisation - Night Noise Guidelines for Europe (WHO 2009).
- Environmental Health Council of Australia - The health effects of environmental noise – other than hearing loss (enHealth 2004).

Noise levels that meet these guidelines are not considered to result in health effects in the community. Hence it is important that a noise survey and assessment is undertaken at East Trinity to ensure that the relevant guidelines are met. If there is the potential for noise levels to exceed these guidelines then mitigation measures should be implemented to mitigate/reduce the impacts to an acceptable level. Mitigation measures include reducing noise levels at the source (using measures such as using sound enclosures on pumps, changing the tone of reversing buzzers etc.) or barriers between the source and the location where noise impacts may occur. These aspects can be evaluated in detail if the East Trinity disposal option was to occur.

Noise levels in the workplace are required to meet (and be managed) requirements under the Work Health and Safety Regulation 2011.

4.4.2 Light Spill

Dredging is proposed to be undertaken over a 24 hour period and hence there will be the need for lights to be used at the disposal location to ensure safe operation of equipment at all hours of the day.

Excessive light at night can cause sleep, gastrointestinal, mood and cardiovascular disorders so it is important to ensure light spill is controlled well from new developments (EU 2012 - SCENIHR [Scientific Committee on Emerging and Newly Identified Health Risks], Health effects of artificial light, 19 March 2012).

[3] Refer to the Environmental Protection Act 1994, Environmental Protection Regulation 2008 and EPA Ecoaccess Guideline, Planning for Noise Control 2004.

No one lives on the site, or close to the site, hence the potential for light spill to be of significant impact to health is considered to be very low. However there are rural residential areas in the suburbs surrounding the site, and Cairns city located across Trinity Inlet. Those with a direct line of sight to the East Trinity location have the potential to be affected by lighting at night-time if it is not properly designed to limit light spill.

Can outcomes be enhanced/mitigated

Light spill depends on the installation and aiming of each luminaire and hence the impact of light spill will depend on the final design and implementation. Lighting is available that provides more directed light (with little light spill) that should be considered for use at East Trinity to minimise the impacts of lighting in the surrounding areas from the 24 hour operations.

4.4.3 Existing and Potential Impacts to Land

The East Trinity site is noted to have a history of contamination from ASS. Extensive rehabilitation works have been, and are still being undertaken on the site to address the ASS issues (acidic soil and mobilisation of metals in the environment). These works have placed limitation on the area of land that could be used for the disposal of dredge materials, as outlined in **Section 2.4**.

The proposed project requires that dredge materials are treated prior to being placed on the site. The treatment includes addressing and ASS issues (through the addition of lime) and dewatering. This will be undertaken in the designated land farm areas (illustrated in **Figure 2.1**), with the discharge of treated water to Trinity Inlet.

Once ASS aspects have been addressed (and the materials dewatered) they will be spread across the disposal area. The chemical concentrations in the dredge materials (as summarised in **Appendix A**) have been reviewed against health based guidelines that are protective of exposures that may occur by the following groups:

- Workers involved in moving and handling the dredge materials on the site – this may include direct contact (incidental ingestion and dermal contact) and inhalation of dust (generated during the works), lime and vapours (if there are any volatile compounds present). Review of the available data against guidelines that are based on the protection of long-term workers (such as in a commercial/industrial setting) is considered to be adequately protective of exposures that may occur during the proposed site works.
- Future use – if the site is not redeveloped future use of the site is likely to be consistent with the current use (where there is no public access), where exposures (direct contact and inhalation of dust/volatiles) may occur by rangers, contractors on the site for the purpose of rehabilitation activities and trespassers. Review of the available data against guidelines that are based on commercial/industrial use as well as recreational/open space use of land (typically an urban playground) provides a conservative screening tool to determine if there is the potential for any future health risks.
- Future use – in the event the site is redeveloped in the future as an urban area, there is the potential for exposure (via direct contact and inhalation of dust/vapours) to dredge materials by future residents. Review of the available data against guidelines that are based on low-density residential use of land provides an appropriate screening tool to determine if there is the potential for any future health risks

Based on the above the 95th percentile upper confidence limit (UCVL) concentrations reported in dredge materials have been compared against published national and international screening level guidelines. These guidelines have been derived from the following:

- **NEPM Health Based Investigation Levels.** The NEPM (1999 amended 2013) provides risk-based Health Investigation Levels (HIL) and Health Screening Levels (HSLs) for selected organic and inorganic chemicals in soils. Different levels are provided for a variety of exposure settings including residential, open-space / parks / recreational and commercial / industrial land uses. The NEPM HILs and HSLs have been developed to be protective of human health and do not take into account environmental concerns. In relation to the presence of volatile compounds in soil, the HSLs for petroleum hydrocarbons presented within the NEPM are the most relevant. These have been developed to be protective of the vapour inhalation pathway. Additional criteria are also available in the source documentation prepared by CRC CARE (Friebel & Nadebaum 2011) that specifically relate to direct contact exposures (where relevant);
- **US EPA Screening Levels (US EPA RSLs), 2014**. Where no guideline value was available from the above sources, the US EPA RSLs have been used – for industrial or residential soil (assuming HI of 1 for non-carcinogenic effects and 1x10^{-5} for carcinogenic effects). The RSLs are conservative, human health risk-based values for soil, tap water and air. It should be noted that the RSLs are currently not recognised in Australia. However, the RSLs have been used in this assessment to provide a screening level for the purpose of identifying the issues. It is noted that these guidelines do not address vapour intrusion indoors, hence where a volatile compound is present the RSL has been adjusted by a factor of 100[4] to ensure that vapour intrusion risk issues are adequately addressed at a screening level.

Table 4.1 presents a summary of the compounds detected in dredge materials, the maximum concentration reported and comparison with the relevant screening criteria.

[4] The 100 fold factor adopted to convert the outdoor soil screening value for volatile compounds to one that is protective of vapour intrusion indoors is based on professional judgement derived from the modelling of volatile compounds in soil to outdoor air environments compared with indoor air environments. Depending on the building type, the factor may range from 3 to 1000. For the proposed development a 100 fold factor has been adopted for the purpose of screening. It is noted that the outcome of the screening level assessment remains unchanged if the most conservative value of 1000 is adopted.

Table 4.1 Review of Dredge Materials – Worker Exposures and Future Use of Site

Analyte detected (in at least 1 sample)	Maximum 95% UCL (refer to Appendix A)	Health-Based Screening Criteria		
		Protection of Worker Health	Protection of Health – Recreational/Open Space Use	Protection of Health – Low Density Residential
Arsenic	31.8	3000 N	300 N	100 N
Cadmium	1.9	900 N	90 N	20 N
Chromium	45.9	3600 N	300 N	100 N
Copper	87.6	240000 N	17000 N	6000 N
Lead	36.6	1500 N	600 N	300 N
Manganese	908	60000 N	19000 N	3800 N
Nickel	42.2	6000 N	1200 N	400 N
Silver	0.6	5800 U	1170 UR	390 U
Zinc	180	400000 N	30000 N	7400 N
Mercury	0.13	730 N	80 N	40 N
TPH C10-C14	4.7	20000 C	3800 C	110 NV
TPH C15-C36	360	27000 C	5300 C	4500 C
Tributyltin (TBT)	**40.8**	250 U	54 UR	**18 U**
Diuron	3.2	1600 U	360 UR	120 U

Notes:

UCL = upper confidence limit

N = NEPM (1999 amended 2013), HILs for worker health (HIL-D), recreational open space (HIL-C) and low-density residential (HIL-A). These are screening levels that are based on the protection of public health.

NV = NEPM (1999 amended 2013) HIL for volatile compound, where the vapour inhalation pathway is the most dominant exposure pathway. The HIL adopted is the lowest value (i.e. for sand where impacts are at the ground surface). For other land uses the direct contact exposure pathway is the most significant.

C = CRC CARE (Friebel & Nadebaum 2011) HSLs for worker health (HIL-D), recreational open space (HIL-C) and low-density residential (HIL-A). These are screening levels that are based on the protection of public health associated with direct contact exposures with soil.

U = USEPA RSL (2014) for residential or industrial soil. These are screening levels that are based on the protection of public health.

UR = No guideline is available for recreational/open space areas, hence the residential soil guideline available from the USEPA RSLs (2014) has been modified by a factor of 3 fold. This is generally consistent with the difference between the NEPM HIL-A and HIL-C values, and essentially means that exposures by the public (on the site) occur for approximately 2 days per week for 35 years rather than 7 days per week for 35 years. This is conservative for the current use of the site as no public access is permitted. In addition it is noted that the most sensitive receptor for the HIL-A and HIL-C is a young child (aged 0-5 years). Where there is no public access, young children will not access the site, only teenagers (as trespassers) and adults.

Based on the assessment presented above the concentrations expected within dredged material that may be placed at the East Trinity site (after treatment) will not be of concern to human health for workers on the site (involved in the handling, management and rehabilitation of the site during the project), rangers and site contractors and trespassers.

If the site were to be redeveloped in the future for low-density residential purposes most of the concentrations reported are lower than health risk based guidelines, with the exception of tributyltin (TBT). The concentrations reported in dredge materials that may be derived from a number of areas (Navy Base, CFB1 and Inner Port) exceed the health based guideline. If these materials are placed on the site in accessible areas the site may not be suitable for low-density residential use without some future management. No future uses of the site are planned.

Can outcomes be enhanced/mitigated

The only impacts identified relate to potential exposures to TBT in the event that the East Trinity site is to be redeveloped for low-density residential purposes. These risks can be mitigated through the conduct of a more site specific contaminated land site investigation and risk assessment following placement of the materials and/or management of materials placement to ensure TBT impacted dredge materials are placed at the base of any filled areas, or in an area not to be used for a residential lot (i.e. a recreational area).

4.4.4 Water Quality

Tailwater from the dewatering of dredge materials will be required to be removed from the landfarm area, tested and treated prior to release to Trinity Inlet. Water to be released to Trinity Inlet will be required to meet the guidelines for marine water quality as outlined in the National Water Quality Management Strategy (ANZECC/ARMCANZ 2000). These guidelines address potential risks to the aquatic environment. Once discharged into Trinity Inlet, tailwaters will be well diluted and where this water met the marine water quality guidelines, it is not considered to pose a risk to recreational users of the waterway.

During the treatment process tailwater will be confined to the landfarm area or the tailwater treatment area. Exposure to water in these areas will be limited to workers involved in the management/treatment of dredge materials.

Limited data is available in relation to the concentrations that may be present in tailwater and the presence of PASS, and treatment of ASS, may result in the mobilisation (or binding) or contaminants from the dredge materials. The available elutriate data (refer to **Appendix A**) indicates the potential for arsenic and diuron to be present in tailwater. The maximum concentration reported in elutriate for these compounds is lower[5] than a health based recreational water guideline[6] (where a higher level of potential exposure is assumed than will occur to workers on the site). This suggests that no health impacts are expected for worker involved in the handling/treatment of tailwater on the site.

Can outcomes be enhanced/mitigated

While no health impacts have been identified in relation to water quality, it is recommended that a more detailed analysis of tailwater be undertaken if the project is to proceed to ensure that all contaminants (and potential for mobilisation) are adequately considered. The concentrations reported in tailwater should be reviewed against recreational water guidelines to ensure that worker health is protected.

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[5] Maximum concentration of arsenic in elutriate is 0.0548 mg/L, which is lower than a recreational water guideline of 0.1 mg/L.

Maximum concentration of diuron in elutriate is 0.000088 mg/L, which is less than the recreational water guideline of 0.2 mg/L.

[6] Recreational water guideline is 10 times higher than the drinking water guideline (NHMRC 2011 Updated 2013, Australian Drinking Water Guidelines, National Water Quality Management Strategy) as outlined in the NHMRC recreational water guidelines (NHMRC 2008, Guidelines for Managing Risks in Recreational Water)

4.4.5 Pests and other hazardous fauna

Mosquitoes have been identified as being a pest of major and significant threat to both human health and lifestyle. More than 220 mosquito species can be found in Queensland and a substantial number of these have been implicated as vectors of some human diseases. A variety of species of mosquito occur in association with salt, brackish or fresh waters and they are particularly prevalent in natural low-lying areas and watercourses.

Mosquito numbers are known to have the potential to increase after floods, storms and cyclones as standing water from rainfall and flooding provides suitable conditions for mosquito breeding. The construction of wetlands on the site, as part of the rehabilitation program that has been conducted to date has the potential to increase breading areas for mosquitos.

In addition if the proposed placement of dredge material at the site proceed there is the potential for the increased potential for mosquito breeding in the land farm (where the materials are dewatered) and where the tailwater is treated, prior to discharge. The potential is higher following rainfall where there may be pooling of water in these areas, as well as in surface pools created in uneven ground surface areas.

In addition the East Trinity site and surrounding areas are habitat for saltwater crocodiles, snakes and other fauna that provide a potential hazard when they come into humans such as on-site workers and trespassers.

Health Outcomes

Increased numbers of mosquitos increases the risk of bites and mosquito-borne disease. These diseases include Ross River virus, Baramah Forest virus, Kunjin virus, Murray Valley encephalitis and Dengue Fever virus (which has become established in the Torres Strait Islands and the northern most tip of Cape York) (Queensland Government 2010). In Queensland, Ross River virus is most prevalent disease.

Ross River virus and Baramah Forest virus infections are not life threatening, although symptoms such as polyarthritis and lethargy can be debilitating and last for prolonged periods of time. There is no specific treatment for, or vaccines to prevent Ross River virus infection, Baramah Forest virus infection and dengue, despite continued research in this area. Hence prevention is an important public health measure.

An increase in mosquitos at the East Trinity site is of potential concern to the local community as some of the surrounding communities have a number of social/health issues where the burden of disease may be greater.

Contact with Saltwater Crocodiles and venomous animals such as snakes can cause significant injury and ultimately can be fatal for humans in the case of an attack.

Can outcomes be enhanced/mitigated

The most effective measure to reduce the risk of mosquito-borne transmission is to prevent or reduce mosquito breeding.

Mosquito control in Queensland is the legislative responsibility of local government. For the East Trinity site, the responsibility lies with the Cairns Regional Council. The council has a Vector Control Unit that works to reduce the number of mosquitos to an acceptable level and limit the spread of vector-borne disease. The activities include:

- Proactive chemical spraying in known breeding areas for nuisance mosquito control
- Response to complaints of vector breeding
- Cooperation with Queensland Health in anti-Dengue Fever procedures
- Proactive on-site monitoring procedures to determine breeding sites and vector species
- Development of biological control measures, such as specific fish breeds, to lessen the reliance on chemical means of control of nuisance mosquito larvae
- Maintenance of a Mosquito Chemical Allergy Register

Cairns Regional Council can (and has) issued property owners with Public Health Orders and fines (based on advice from Queensland Health Dengue Response Team) where they have failed to implement appropriate measures to minimise mosquito breeding areas.

In relation to the dredge material disposal project it is important that a vector/mosquito management plan is developed to provide measures that can be implemented on the site to minimise the potential for mosquito breeding areas to be present. The plan should be developed in line with requirements of the Cairns Regional Council Vector Control Unit and include regular inspections of areas where water may accumulate or be stored (including tanks and pipes) and a range of measures that can be implemented to minimise/prevent the breeding of mosquitos.

For workers on the site it would be appropriate to require cover-all work clothing to be worn to minimise exposure to bites and to provide insect repellent, containing DEET or Picaridin, for use as an extra level of protection (as mosquitos may be present on the site, given its location, from a range of other sources in the area).

Risks from hazardous fauna such as crocodiles and snakes can primarily be mitigated through fencing and signage to minimise incidental human contact. The East Trinity is however isolated, and its size makes it difficult to effectively restrict public access from trespassers and therefore mitigate this risk. The current site managers' report regular illegal access to the site despite signage and fencing as it is a popular location for fishing/crabbing.

The risk to on-site workers however can be effectively managed through site fencing and layout planning of work areas, education and good communication of health and safety plans etc.

4.4.6 Air Quality Impacts

The placement of dredge material is likely to generate emissions from a number of sources during the transport and placement of the material. The works are likely to generate particulate and dust emissions through vehicle movements on-site and to-site via access roads, disturbance of soils, materials handling and wind erosion of exposed surfaces. Dust generated on site would be controlled where accessible with water trucks, chemical dust treatments or temporary covering of materials as appropriate.

The material to be disposed will be mostly anaerobic sediment, containing hydrogen sulphide. On exposure to air during drying processes this can cause temporary nuisance odour (e.g. duration of a few days). The extent of the odour impact will be dependent on the drying method and prevailing wind conditions; the on-shore winds at the site are predominantly south-easterly which would blow odours and dust away from sensitive receptors, however other conditions may blow towards receptors and result in potential impacts.

Exposure to dust that may be derived from the dredge materials after placement (with no consideration of dust controls) is one of the pathways of exposure included in the health based screening levels used to review the contamination characteristics of the material (as presented in **Table 4.1**). No health risk issues have been identified for the dust inhalation pathway (including for TBT, where the dust inhalation pathway contributes very little to the screening criteria).

The material to be disposed will be mostly anaerobic sediment, containing hydrogen sulphide. On exposure to air during drying processes this can cause temporary nuisance odour (e.g. duration of a few days). The extent of the odour impact will be dependent on the drying method and prevailing wind conditions however as there are no receptors located close to the site the potential for odours to be detected and at a level where they are annoying is low. Should odours be reported, mitigation measures (such as odour control sprays and covers) can be used.

No health impacts are expected for workers or the off-site community in relation to air quality aspects of the proposal.

Can outcomes be enhanced/mitigated

No significant health impacts have been identified, due in part to the limited number of sensitive receivers in proximity to the site. In the event that odours are noticeable in the surrounding community additional measures to mitigate odours should be considered (including the use of odour control sprays and covers). However it is noted that the site is in a location that receives gusty and variable winds which would make the mitigation of odours more difficult. Such issues would require further consideration to determine of odour mitigation could be effective.

4.4.7 Green Space, Ecology and Visual Amenity

The East Trinity site is currently zoned as an Environmental Reserve and the rehabilitation and ongoing management of the site is effecting restoration of the local ecology. At present there is no community access allowed to the site and hence use of the site for placement of dredge materials will not change community use/enjoyment of the green space or ecology. On this basis there would not be expected to be a change to access to the local community, however current site managers' report regular illegal access (trespassing) to the site despite signage and fencing as it is a popular location for fishing/crabbing.

The site is visible from numerous CBD and Esplanade high rise, high value residential and holiday apartments. In addition the site can be viewed from the western faces of the surrounding mountains to the east (that include a number of residences), the hinterland west of Cairns and from aircraft landing or taking off from Cairns Airport, from visiting cruise ships and from the numerous Cairns CBD and Esplanade high rise buildings.

As the landscape is dominated by vegetation communities such as mangrove forest, cane lands and degraded lands, the view of East Trinity from Pine Creek Road and the surrounding mountain areas would be considered semi-natural and rural.

Visual amenity of the area will be impacted by the proposed use of the site. Land will need to be cleared to allow site access and placement of the dredge material. During placement, machinery will be on site to manage the dredge material. After placement is finished, the site will consist of a raised area of marine sediment surrounded by a bund wall. Plant colonisation is likely to be hindered until salts and potential acidity have leached from the sediment. This will require further rehabilitation of the site.

Given the visibility of the site from surrounding areas, there is the potential for visual impacts to be of concern. These impacts would require assessment and management.

4.4.8 Safety

The placement of dredge materials at East Trinity will involve works extending over a period of 5 to 10 years. These works will involve earthworks and construction-type activities that include the regular movement of heavy machinery across the site. The site is underlain by swampy soft ground and numerous creeks and gullies and therefore has a higher risk on machinery accident. In addition the slurry material to be handled on the site is not stable and may pose a safety hazard to machinery operation and to anyone entering the site. Other hazards on the site include the potential for ASS (to be managed and treated as part of the works as outlined in **Section 4.4.3**) and the presence of pooled water in the tailwater treatment area (as discussed in **Section 4.4.4**) which maintains the risk of crocodile attack.

Most of the potential impacts can likely be effectively managed through measures such as good communication, traffic management plans, health and safety plans etc. The risk of most concern is that of members of the public illegally entering the site and falling into unstable material. East Trinity is isolated, and its size makes it difficult to effectively restrict public access. The current site managers' report regular illegal access to the site despite signage and fencing as it is a popular location for fishing/crabbing.

4.5 Social Environment

The placement of dredge materials at East Trinity, where the site is not to be redeveloped, will not employ significant numbers of personnel that they would change the demand for housing, community resources or the general demographics of the local community. If the site is to be redeveloped for urban use then additional pressure on community resources may occur.

As outlined in EIS Section D6.10, the indigenous history of the Cairns region is rich, and its environs have been extensively used by Aboriginal people and continue to hold cultural significance. Consultants who have conducted surveys in the Cairns southern corridor region have all noted the importance of the landscape as a whole to the Aboriginal people they consulted. There is specific mention of Trinity Inlet as an important sacred site and birthing place. Admiralty Island is associated with a number of women's stories and noted as a sacred and significant place. The foot of the hills in the vicinity of Hills Creek (East Trinity site) is also noted. Further the importance of the area as a food resource in both pre-contact and historic periods is emphasised.

The Mandingalbay Yidinji people have been granted native title over coastal land immediately adjacent to the East Trinity site; this land would need to be traversed to gain access to East Trinity, and some infrastructure installed e.g. landing areas, pumps and pipes.

Native title has been extinguished over the placement area as it was previously designated Freehold Land when purchased by CSR Sugar in 1974 (under the Act, native title is extinguished on Freehold Land). There is an Indigenous Protected Area (IPA) over the northern part of the site. IPAs do not have a formal legal framework in place and do not impact native title rights or public access; however they allow indigenous people to work with government agencies to manage country. Under this agreement, the Mandingalbay Yidinji people have been actively engaged in management of East Trinity. They have indicated an interest in utilising the site for the development of cultural tourism.

An Indigenous Land Use Agreement (ILUA) would need to be negotiated to access lands over which native title has been granted to the immediate west of the site. Consultation in regards to the IPA and ongoing management of the site would also be required. Native title and Aboriginal cultural heritage aspects associated with the site need to be appropriately identified and addressed prior to any works. Disagreement over these aspects can lead to increased levels of stress and anxiety ion the local community. These impacts can be mitigated through effective communication with the local community, establishing an appropriate ILUA and Cultural Heritage Management Plan for the project but may also have potential to delay the project and further constrain the material placement area.

Section 5. Summary of HIA Outcomes

Based on the evaluations presented in the assessment undertaken (**Section 4**) a range of impacts and outcomes (both positive and negative) have been identified in relation to health impacts. These, along with measures that could be implemented to enhance or mitigate the identified health impacts, are summarised in **Table 5.1.**

Table 5.1 Summary of HIA Outcomes of Land Disposal at East Trinity and Enhancement / Mitigation Measures

Health Aspect/Issue	Outcome of assessment	Impact Identified (positive or negative)	Health Impacts	Types of measures that could be implemented to enhance positive impacts or mitigate negative impacts
Economic/Land Environment	CSD project provides economic benefit in terms of facilitating increased shipping and tourism opportunities. The land disposal option offers little direct economic benefit to the local community relative to the large additional economic cost of land disposal. Potential positive local economic benefit for redevelopment of final land use. Future use of the site has not yet been agreed to the traditional owners (including use of the site for land disposal)	Neutral/Positive Negative Negative	None No specific impacts, however diversion of funds aswell as economic benefits and land use changes may affect the community of different ways Reaching an agreement is expected to take some time. The time taken and the potential for disputes in reaching an agreement can lead to increased stress and anxiety in the community	Encourage training and employment of members of the local community where possible – improve health and well-being in a community considered to be disadvantaged. Establishing relevant and suitable agreements for land access and the desired use of the land (including potential development) early in the process.
Transport	Increased traffic volumes in the local area.	Negative	Increase in accidents and levels of anxiety and stress where there is increased traffic congestion (particularly if intersections no longer feel safe)	Preparation of a detailed Road Traffic Impact Assessment, where any impacts identified are appropriately managed to maintain safety and minimize impacts on the community.
Natural Environment				
Noise	Activities associated with the project have the potential to result in an increase in noise, particularly at night-time as operations are expected to be 24 hours per day. Potential for impacts considered low due to the distance between the site and surrounding community.	Negative	The project will generate noise. Excess noise levels are associated with sleep disturbance, annoyance, children's school performance and cardiovascular health.	Preparation of a Noise Impact Assessment. The assessment can determine if noise levels in the local community will meet noise guidelines (based on protecting health and wellbeing) and identify mitigation measures (at the source or between source and receptors) to ensure the noise guidelines can be met. Occupational noise levels on the site need to be managed to protect workers on the site.
Light spill	Operations over 24 hours per day will require lighting which may impact on the community where there is a direct line of sight.	Negative	Excessive light at night can cause sleep disturbances, gastrointestinal, mood and cardiovascular disorders so it's important to ensure light spill is controlled well from new developments.	Implementation of a range of lighting design measures to minimise light spill from the Project.
Existing and potential impacts to land	The placement of dredge materials on the site has the potential to introduce contaminated materials onto the site. Review	Neutral Negative (where the site is to be used for residential	No health impacts expect for residential use, where there is potential for exposure to elevated	If the site is to be redeveloped for residential purposes a more detailed site assessment and risk assessment will be required, and management of contamination

Health Aspect/Issue	Outcome of assessment	Impact Identified (positive or negative)	Health Impacts	Types of measures that could be implemented to enhance positive impacts or mitigate negative impacts
	of these against health based guidelines has not identified any potential health impacts for workers or expected future users of the site, expect in the event that the site is proposed to be redeveloped for residential use.	purposes)	levels of tributyltin	may be required to mitigate health impacts.
Water quality	Tailwater that may be discharged to Trinity Inlet is not of concern for recreational use of the area. Exposure to tailwater by workers on the site is not expected to be of concern in relation to health, however the nature of tailwater is not well characterised.	Neutral Neutral	None identified	More detailed monitoring of tailwater is required. The nature of this water needs to be further assessed to ensure that exposures to workers on the site is adequately assessed. If elevated concentrations are present in tailwater, an appropriate water safety management plan should be implemented to minimize exposure to workers.
Pests – Mosquitos, and other hazardous fauna (e.g. crocodiles, snakes)	If not appropriately managed there is the potential for increased number of mosquitos as a result of the Project Potential for human contact with crocodiles and snakes that reside in the area	Negative	Transmission of mosquito-borne diseases included Ross River virus, Baramah Forest virus, Kunjin virus, Murray Valley encephalitis and dengue Potential serious injury if attacked by crocodile or bitten by venomous snake	Implementation of a Vector/Mosquito Management Plan to prevent mosquito breeding. Providing insect repellent to workers on the site (as mosquitoes may be present from other sources in the area). Fencing of areas to exclude crocodiles where possible. Worker education, PPE and emergency response as part of Health and Safety Plan.
Air quality	Impacts from vehicle, plant and equipment as well as dust considered to be low.	Neutral	None identified	Dust and Odour management plan to be developed.
Green space, ecology and visual amenity	Visual amenity will be affected by the Project over an extensive period particularly when viewed from elevated vantage points and high rise buildings near the Port and CBD. No direct community impacts in relation to loss of use of green space or ecology identified.	Negative	Increased levels of stress and anxiety with negative changes to the landscape and views from a number of locations including tourist areas and the CBD	Final landform planning of the site to ensure visual amenity is addressed as far as practicable. Such issues will require more detailed assessment and management.
Safety	Proposed works will present hazards on the site for the duration of the activity (movement of heavy equipment, unstable ground, ASS and pooling of tailwater)	Negative	Safety hazard to workers, visitors and trespassers	Safety issues for workers and visitors can be managed through implementation of an appropriate health and safety plan. Access by trespassers to be minimised through the placement and maintenance of fencing and signage. It is noted that due to the isolated nature of the site, existing fences and signage do not keep trespassers out of the site. The risk of trespassers entering the site will be difficult to manage and control.
Social Environment				
Demand on local	No impacts identified in the local community	Neutral	None identified	NA

Health Aspect/Issue	Outcome of assessment	Impact Identified (positive or negative)	Health Impacts	Types of measures that could be implemented to enhance positive impacts or mitigate negative impacts
infrastructure, community resources and demographics				
Native title and Aboriginal cultural heritage	These aspects are important for the local community. Disputes that may arise may result in creased stress and anxiety in the community.	Negative, where issues are in dispute	Increase in stress and anxiety	Good communication with the local community and establishing appropriate ILUA and Cultural Heritage Management Plan for the Project.

Section 6. Equity Issues

As noted in Harris et al. 2007 when undertaking a Health Impact Assessment:

"equity is concerned with making clear if a proposal will differentially impact on different groups. Differential impacts refer to whether the benefits of the proposal may be experienced to a greater extent by one group and not others, and whether the negative impacts of a proposal may be experienced to a greater extent by one group and not others. For example, a freeway may make it easier for people to travel to and from work but may also have negative impacts on the air quality and noise for people who live near the freeway but make little use of it.

In an HIA, this involves an assessment of whether this difference is significant in health terms, whether it is likely to be considered unfair by affected people and whether the proposal can be modified to eliminate or reduce the potential impact. This is especially true if one group is seen to carry a higher burden of disadvantage or risk of being disadvantaged. For example, when major roads go through poor neighbourhoods and avoid more wealthy ones."

In considering issues of equity for this development there are two types of equity related impacts identified - spatial impacts and sensitive receivers.

Spatial impacts

The impacts identified are relatively confined to the East Trinity site and community adjacent to the site. There are no impacts that extend beyond these areas to affect a larger community.

Sensitive receivers

The community of Yarrabah, and to a lesser extent East Trinity is considered to be disadvantaged and vulnerable to health impacts, where present. It is important that the mitigation measures identified are implemented to ensure that any negative health impacts are effectively addressed. In addition where there are opportunities to reduce existing inequalities, in particular employment, these should be considered where appropriate.

Section 7. References

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Appendix A Summary of Data – Dredge Material Characteristics

Table 4-3 Summary of 95%UCLs for dredge areas: 2005 – 2009

Contaminant (organics normalised to 1%TOC)		Guideline			2009							2008								2007							2006							2005						
					Ocean Disposal Site	Channel	Inner Port	Navy Base	Marlin Marina	CFB1	CFB2	Ocean Disposal Site	Channel	Inner Port	Navy Base	Marlin Marina	CFB1	CFB1 inc 3 additional sites	CFB2	CFB2 second round	Ocean Disposal Site	Channel	Inner Port	Navy Base	Marlin Marina	CFB1	CFB2	Ocean Disposal Site	Channel	Inner Port	Navy Base	Marlin Marina	CFB1	CFB2	Ocean Disposal Site	Channel	Inner Port	Navy Base	Marlin Marina	CFB1	CFB2
	Unit	SGL	MGL	ANZECC																																				
As	mg/kg	20	70		18.3	19.4	20.2	21.9				18.2	20.6	24.2	25.0	19.7	20.3	20.7	28.5		13.2	21.4	17.4	15.8	18.2	31.8	19.1	18.1	15.5	20.2	19.8	16.5	16.9	19.5	14.8	12.5	13.6	13.4	13	14	15
Cd	mg/kg	2	10		<0.1	<0.1	<0.1	<0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		1.7	1.3	1.9	1.6	1.7	0.9	1.77	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cr	mg/kg	80	370		36.7	32.7	38.8	44.9				36.5	35.0	39.3	45.9	34.2	34.4	35.5	36.0				32.6	34.9			39.3			31.5	33.0	31.2	34.1	33.0							
Cu	mg/kg	65	270		11.9	12.6	29.3	29.8				21.1	14.0	47.7	30.2	23.9	35.8	34.6	49.7		8.7	10.8	20.7	24.1	25.4	61.8	87.6	7	10.1	25.8	22.6	20.9	54.1	40.5	10.9	9.4	22.5	24.7	26	43	22.5
Pb	mg/kg	50	220		16.8	16.1	21.0	23.1				18.1	18.0	26.0	26.3	20.6	22.0	22.4	36.6		25.0	17.8	29.2	29.4	30.1	25.0	33.9	15.3	10.3	18.5	14.4	16.8	17.3	25.1	14.3	12.6	16.9	16.3	20	28	16.9
Mn	mg/kg	-	-		693.8	691.2	700.9	757.8				614.0	759.0	866.0	908.0	647.0	689.0	689.0	498.0				843.9	613.7			634.6			754.9	682.5	655.5	628.8	448.6							
Ni	mg/kg	21	52		16.0	13.5	17.7	20.1				16.2	16.0	17.9	20.9	15.6	16.0	15.9	16.5			42.2	<0.5	10.6			15.48		8.7	11.2	10.2	10.3	10.8	10.5	12	10.1	8.9	10.9	9	9	10
Ag	mg/kg	1	3.7		<0.1	<0.1	<0.1	<0.1				0.3	0.1	0.3	0.1	0.3	0.1	0.2	0.3		0.6	0.4	0.5	0.6	0.6	0.5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Zn	mg/kg	200	410		44.2	42.3	68.4	80.3				57.0	52.0	79.8	88.0	69.7	85.0	85.4	147.0		37.6		108.1	69.8	97.1	126.1	159.6	31.9	38.1	76.2	72.5	60.4	95.2	91.3	46	40.8	74.1	70.5	60	180	82
Hg	mg/kg	0.15	1		0.03	0.025	0.043	0.046				0.05	0.053	0.083	0.069	0.09	0.13	0.11	0.046				<0.05	<0.05			<0.05			<0.05	<0.05	<0.05	<0.05	<0.05							
Sb	mg/kg																					<0.5	<0.5	<0.5			<0.5		<5	<5	<5	<5	<5	<3	<3	<3	<3	<3	<3	<3
Total N	mg/kg	-	-		679	807	2270	1428				890	1638	2760	1833	1410	2958	2374	2145		1176	938.3	1300	3494			3040													
Total P	mg/kg	-	-		527	292	771	506				551	325	839	680	507	917	737	660		356	292.9	280				378.4													
TPH(C10-14)	mg/kg	-	-		<3		<3	1.6				<3	2	2.7	3	<3	<3	1.9	<3								nd			<2	4.7	nd	5.2	nd	<4		<4	<4	<4	<4	<4
TPH(C15-28)	mg/kg	-	-		<3		42.3	32.5				27	39	37	15	38	31	36	13.9								180			35.8	48.4	30.1	83.5	66.4	14		31	25	31	43	84
TPH(C29-36)	mg/kg	-	-		<14		21.4	24.4				24	35	26	20	30	30	34	22.1								180			83	95	60	120	137	46		58	78	62	100	140
Total PCB's	ug/kg	23	-									<5	<5	<5	<5	<5	<5	<5	<5				-				nd			nd	<0.02	nd	nd	nd	nd		nd	nd	nd	nd	nd
Sum of PAH	ug/kg	4000	45000									84	70	495	114	69.8	178	154	106.2				1.01				90			350	300	483	300	460	3		8	0.9	nd	8	nd
TBT	ug/kg	5 or 9	70		1.27	4.15	10.74	19.56				2.1	2.7	10.7	6.9	9.3	28.8	23.2	9.5		1.63	1.88	8.4	8.49	6.72	20.97	17.98	1.4	2.1	11.3	9.6	8.6	16.7	12	1.1	1.9	38.8	13.5	9.3	40.8	1
BTEX	mg/kg																													nd	nd	nd	nd	nd	nd		nd	nd	nd	nd	nd
OCPs	mg/kg																										nd			nd	nd	nd	nd	nd	nd		nd	nd	nd	nd	nd
OPPs	mg/kg																										nd			nd	nd	nd	nd	nd	nd		nd	nd	nd	nd	nd
VOCs	mg/kg																										nd			nd	nd	nd	nd	nd							
Diuron	ug/kg	2*										-	<1	2.7	1.2	<1	2.9	1	3.2		<1	<0.1	<0.1	0.41	1.84		1			<0.05		<0.05	<0.05	<0.05							
Further testing																																									
Total As by ICPMS	mg/kg													23				22.7		30.4																					
Elutriate As	ug/L			2.3 & 4.5										4.2				18.7		54.8							29.7														
Stage 1 DAE As	mg/kg	20	70										8.62	10.6	10.45		10.6		4.68				5.63	6.25	5.69	7.26															
DAE-As	mg/kg	20	70											3.5				2.13		2.7							8.48														
PW-As	ug/L																																								
Total TBT	ugSn/kg						14.6	21.47						20.7		12.4		14.5		7.2					12.51																
Elutriate TBT	ngSn/L			6			<2	<2						<2		1		<2		<2			0	<2	<2	<2	<5			<2	<4	<2	5	<2			<2	<2	<2	<2	
PW-TBT	ngSn/L			6			<2	<2						<7		<25		<33		na			0		<6	<4														
Elutriate Cu	ug/L	1.4																									<0.1														
DAE Cu	mg/kg	65	270																					13	13	221	125														
PW-Cu	ug/L																																								
Total Diuron	ug/kg	2*												0.6				1.9		<1																					
Elutriate Diuron	ug/L			1*										<0.005				0.088		0.069																					
PW-Diuron	ug/L			1*										<0.005				<0.005																							

* Note that Diuron had agreed values of 2 ug/kg for sediments and 1ug/L for elutriate and porewaters in the absence of published guideline values.

95% UCL's
- >MGL
- >SGL but <MGL
- <SGL
- tested but not detected

95%ile
- > ANZECC 95% Ecosystem Protection Level
- < ANZECC 95% Ecosystem Protection Level