Marine Water

This Chapter summarises the existing quality of water and sediment quality in the port development area (and in Darwin Harbour generally) that may be impacted by the proposed EAW extension, during both construction and operations. The full report on water and sediment quality from which this summary is drawn, is presented in **Appendix G**.

9.1 Existing Water and Sediment Quality

9.1.1 Existing Water Quality

Water quality in Darwin Harbour is described as generally high, although naturally turbid most of the time. Water quality parameters vary greatly with the tide (spring versus neap), location of sampling point (inner versus outer harbour), and with the season (wet season versus dry season). The Darwin wet season extends from November to March, and its effects on harbour water quality (due to high surface runoff from the land) can last until April or May, depending on rainfall. Dry season climate conditions prevail from May to September.

There is no evidence of widespread water or sediment pollution in the Harbour, although there is some localised pollution (Padovan, 2003). Anthropogenic influences to Harbour water quality include the EAW port operations, historic industrial activities at Darwin Waterfront, Sadgroves Creek and wastewater outfalls (URS, 2004). There is no evidence of hydrocarbon or pesticide pollution in the Harbour (DHAC, 2007).

In order to characterise the existing conditions in and about East Arm a water-quality survey was undertaken by URS on behalf of Inpex, Browse Pty Ltd (Inpex) from April to August 2008; the study designed to capture the effects of both the wet and dry seasons (URS 2008a). The study included measurement of a range of physico-chemical water quality parameters in the water column. Sampling sites included in the survey are shown in Figure 9-1, while a summary of the average levels recorded is provided in Table 9-1.

Table 9-1 Average Water Quality Levels Recorded in East Arm

Parameter	Dry Season	Wet Season
Temperature	24.5°C	30.6°C
Salinity	25.5 ppt*	29 ppt*
Dissolved oxygen	93.3%	87.8%
pH	8.4	8.1
Turbidity	3 NTU†	10.5 NTU
Total suspended solids (TSS)	14.0 mg/L	14.1 mg/L

* ppt = parts per thousand
† NTU = nephelometric turbidity unit

Source: URS, 2008a

9 Marine Water

Figure 9-1 Water Quality Sampling Sites

Water temperature

Water temperatures in Darwin Harbour are typically high, and some seasonal variations do occur. Temperatures are lowest (23°C) in June-July and highest (33°C) in October-November (Padovan, 1997).

Water temperature measured in the nearshore development area by URS (2008a) ranged from 23.5 to 32.7°C, with an average temperature of 30.6°C in the wet season and 24.5°C in the dry season. Comparison between sites over both the wet and dry seasons found that the water temperature was elevated by about 5°C in the wet season. No significant difference in temperature was observed at any site as a result of either water column position (surface or bottom) or tidal flow (ebb or flood).

Salinity

Salinity in Darwin Harbour varies considerably during the year, particularly in East, Middle and West Arms, where freshwater influence is greatest during the wet season. Salinities throughout the harbour are about 37 ppt during the dry season, with surface and bottom depths having similar levels. At the height of wet season inflow during February to March, areas in the middle of the harbour such as Weed Reef can experience salinities as low as 27 ppt (Parry & Munksgaard, 1995).

Salinity levels recorded in the East Arm area by URS (2008a) ranged from 19.1 to 36.3 ppt. Average salinity in the Harbour was 32.7 ppt, and was higher in the dry season than the wet season. Under dry season conditions, salinity was higher in upstream areas than downstream, but this trend was reversed in the wet season with freshwater input to the arms from rainfall.

Dissolved Oxygen

Harbour waters generally remain well oxygenated throughout the year, with levels ranging from 74% to 96% saturation, typically around 84%. Oxygen levels during a spring tidal cycle were 7% higher at high tide than at low tide (Padovan, 1997).

Dissolved oxygen (DO) levels measured in the nearshore development area by URS (2008a) ranged from 74.4% to 119.3%, with an average saturation of 93%. Overall, dissolved oxygen was generally found to be higher in the dry season and in the main body of the Harbour, with decreasing levels further upstream. Higher dissolved-oxygen levels were recorded towards the surface than at the bottom of the water column. No significant differences in dissolved oxygen levels were observed between flood and ebb tides (URS, 2008a).

pH

The pH of Darwin Harbour waters generally remains within a narrow range (8.3–8.6 with a mean of 8.5) throughout the main waterbody. Padovan (1997) found no seasonal or spatial effects on pH, and no tidal effects.

Measurements recorded in the nearshore development area by URS (2008a) recorded a mean pH of 8.4, and a range from pH 7.8 to 9.2. In the upper reaches of the Harbour, mean pH levels were found to be lower (more acidic), with pH levels increasing (becoming more alkaline) in the main body of the Harbour in both wet- and dry-season sampling. No significant difference in pH attributable to water column position or tidal state was observed (URS, 2008a).

Turbidity and Light Attenuation

Light levels reaching the sea surface in the Harbour are very high. However, because of the high levels of suspended solids in the water column the light is rapidly dissipated, and even within a depth of a few metres light levels can be greatly reduced. Turbidity is a measure of this “light scattering” effect, and is measured in nephelometric turbidity units (NTU). The turbidity of the main waterbody is typically in the range 1–35 NTU.

Turbidity is higher in the wet season than the dry season because of the influx of terrigenous sediments to Harbour waters through the rivers and, to a lesser extent, from surface-water sheetflow. Even at a depth of only 3 m below the surface, light levels during the wet season can be as low as 7.7% of surface levels. Light levels at the bottom of the Harbour can be as low as 1% of surface levels during the wet season.

Turbidity levels recorded in the nearshore development area by URS (2008a) were up to 73.6 NTU, with a mean reading of 6.9 NTU. Predictably, higher NTU values were found at the bottom of the water column than at the surface, with higher levels also being recorded in the wet season when compared with the dry. During ebb tides turbidity levels were higher upstream than in the Harbour; this was reversed during flood tides (URS, 2008a).

Total Suspended Solids

Measurements of total suspended solids (TSS) provide the weight of solids suspended in the water column, whether of mineral (e.g. soil particles) or organic (e.g. algae) origin.

The Australian Institute of Marine Science (2008) recorded an annual TSS average for the harbour of 6–10 mg/L, with a minimum recording of 3.12 mg/L and a maximum of 73.5 mg/L in 2002-03. TSS levels around Blaydin Point measured by URS (2008a) ranged from 1.5 to 83 mg/L, with an average measurement of 14.6 mg/L. Elevated TSS levels were found to occur in the wet season at the bottom of the water column on a flood tide at all sites. No clear distinction was found between wet and dry season TSS levels at the surface (URS, 2008a).

Nutrients and Phytoplankton

Padovan (1997; 2002) and Sly et al. (2002) found total nitrogen in the main body of the Harbour to be in the range 0.2–0.6 mg/L. The concentration of total nitrogen in most of the inflowing river waters was similar to that found in the Harbour, and therefore wet season inflows are not expected to affect nitrogen concentrations in the main waterbody (Padovan, 1997; Padovan, 2003).

Phytoplankton is an important water quality indicator as its abundance and composition is directly influenced by environmental factors including nutrients and light. The abundance of phytoplankton is typically quantified through the counting of cell numbers and through the measurement of chlorophyll-a, the main light absorbing pigment used in photosynthesis.

No seasonal or inter-annual changes in concentrations of chlorophyll-a in the Harbour have been found, though concentrations vary with tide cycle (Padovan, 1997; Padovan, 2003). Concentrations were highest during the midpoint of a spring tide, suggesting the re-suspension of algal cells from the bottom. Overall, the concentrations measured in the Harbour are similar to those found in other north Australian waters (Padovan, 1997).

The formation of cyanobacteria blooms (also known as blue-green algal blooms) occurs naturally in Darwin Harbour occurs naturally during the dry season (Drewry et al., 2010) and remnants of blooms may be found washed up on harbour beaches at this time.

9.1.2 Sediment Quality

The sediments of Darwin Harbour have been divided into four types (Michie, 1988):

- Terrigenous gravels, which occur primarily in the main channel
- Calcareous sands with greater than 50% biogenic carbonate, which are among or close to the small coral communities at East Point, Lee Point and Channel Island. Carbonate sediments, largely derived from molluscan shell fragments, also occur in spits and shoals close to the Harbour mouth
- Terrigenous sands on beaches and spits, with 10–50% carbonate, largely derived from molluscs. This type of sediment is predominantly quartz and clay
- Mud and fine sand on broad, gently inclined intertidal mudflats that occur in areas characterised by low current and tidal velocities, such as in Kitchener Bay (prior to the construction of the Darwin City Waterfront).

It is estimated that 60% of the Harbour's sediments originate from offshore. The remainder is deposited by rivers and creeks, derived predominantly from erosion of channel walls. Direct contribution to the Harbour from sheet erosion is likely to be limited because of the very low hillslope gradients adjacent to the Harbour (DHAC, 2006).

Soft surfaces consisting of muds and fine sand are estimated to cover approximately 80% of the seafloor (Acer Vaughan Consulting Engineers 1993). Soft surfaces with varying amounts of gravel and sand are found in the main channels around reefs, on beaches and on spits and shoals near the mouth of the Harbour. However, the spatial extent of these surfaces is sometimes difficult to determine because of the gradual transition between muddy, sandy and coarser sediments and sediment movement associated with large tidal influences (Fortune, 2006).

Coarser material appears to be located in the central channels of tributaries and the main body of the Harbour, as opposed to the landward margins, demonstrating the influence of tidal movement, bathymetry and potential transport capacity in these regions (Fortune, 2006).

In 2008, URS sampled surface sediments at 145 sites, and subsurface sediments at 18 sites in East Arm and along the route proposed for the gas pipeline route by Inpex within Darwin Harbour. The surface sediments were analysed for a range of parameters: a suite of metals occurring both naturally and as a result of potential man-made contamination (iron, manganese, cobalt, manganese, aluminium, antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, zinc); tributyltin; nutrients (nitrogen and phosphorus); total organic carbon; particle size distribution; total petroleum hydrocarbons; polynuclear aromatic hydrocarbons; and benzene, toluene, ethylbenzene and xylene compounds (BTEX). In addition, organochlorine pesticides, polychlorinated biphenyls and radionuclides were investigated at some sites. Subsurface sediments were analysed for metal concentrations and acid ASS potential.

More recently, a survey of sediments has been undertaken in the proposed dredging areas by AECOM (2011).

Results of both sediment surveys are summarised below and presented in **Appendix E**.

Metals

Previous studies of heavy-metal concentrations in Darwin Harbour sediments (e.g. Peerzada and Ryan, 1987; Peerzada, 1988; Currey, 1988; Hanley and Caswell, 1995; Parry et al, 1995; Padovan 2002) all recorded levels below the ANZECC (Australian and New Zealand Environment and Conservation Council) and ARMCANZ guideline screening levels. In many cases, the readings from these studies were an order of magnitude, and sometimes two orders of magnitude, lower than the recommended 95% upper confidence limit (UCL) of the mean (95% UCL).

Since those studies, Fortune (2006) has undertaken a detailed study of heavy metal concentrations in sediments throughout the Harbour. A number of sites in the study had concentrations of metals above ISQG-Low (Interim Sediment Quality Guideline-Low) values or were considered elevated. Arsenic was the only metal notably higher in the East Arm area however this was considered likely to be an indication of local geology rather than anthropogenic sources.

Surface sediments were sampled by URS (2008a) from a total of 145 sites throughout East Arm and the main body of Darwin Harbour, in areas proposed for disturbance by the INPEX LNG project. Sampling was conducted using a Van Veen grab, as well as a piston corer in some areas. Metals concentrations recorded during laboratory testing were compared against the *National Ocean Disposal Guidelines for Dredged Materials*, developed by Environment Australia (2000).

Metals levels recorded in East Arm were generally below screening levels, with the exception of arsenic, chromium and mercury. Arsenic levels were elevated above maximum guideline levels at six of the sites. Tests using acid digests showed that this arsenic is unlikely to be toxic in the marine environment as only a very small proportion is bio-available. Arsenic levels also exceeded screening levels in various subsurface samples in East Arm, and slightly elevated nickel levels were recorded at one site. When averaged across all sites, all metals were below screening levels.

Testing by AECOM in 2010 also found levels of arsenic and chromium elevated above the screening level, with all other metals tested returning levels below the screening level [AECOM, pers. com. 2011].

Hydrocarbons

Potential sources of hydrocarbons around Darwin Harbour include:

- Seasonal stormwater inflow from Darwin and Palmerston storm water drainage networks
- The Naval Fuel Installation, Stokes Hill
- Former fuel storage at the Channel Island Power Station
- Bulk hydrocarbon storage at EAW
- Bulk hydrocarbon storage at the Darwin LNG plant
- Inventories in recreational, commercial vessels and shipping
- Cullen Bay and Fishermans Wharf refuelling locations.

There are no guideline screening levels for petroleum hydrocarbons. They are determined by practical quantification limits (PQLs), the lowest concentrations that can be accurately measured as opposed to just being detected.

A survey by URS (2004) sampled 12 sites around the Darwin Wharf Precinct and one reference site in Elizabeth River. The highest concentrations of petroleum hydrocarbons (11–16 mg/kg) were present at sites in Kitchener Bay, Fort Hill Wharf and landward of the Iron Ore Wharf. Concentrations at the remaining sites were between 6 and 10 mg/kg. Petroleum hydrocarbons were also present at the reference site (Elizabeth River), though the concentration (4.9 mg/kg) was lower than in any of the sample from the Wharf Precinct sites.

In sampling conducted in 2008, URS detected petroleum hydrocarbons, particularly in the C15–C28 range, in surface sediments at a number of sites in East Arm. However, the BTEX compounds were below PQLs at all sites, as were polynuclear aromatic hydrocarbons at the majority of sites (URS 2008a).

Petroleum hydrocarbons were not detected above the minimum limits of the laboratory tests in subsurface sediments (URS, 2008a).

Sampling by AECOM at the proposed dredging sites in 2010 (AECOM, 2011) did not return reportable levels of BTEX, PAHs or petroleum hydrocarbons.

Tributyltin

Tributyltin compounds (TBTs) are chemicals that contain the (C_4H_9)3Sn group, forming the main active ingredients in broad-spectrum biocides. In the late 1960s, TBTs, especially tributyltin oxide, came into widespread use as antifoulant additives to marine paints applied to the hulls of vessels. The leaching of TBT from the paint was effective in preventing the growth of fouling organisms on hulls, but also had detrimental environmental effects on biota in the surrounding waters. These compounds are persistent organic pollutants that biomagnify up the marine food chain and also tend to accumulate in sedimentary environments, particularly in fine sediments.

A survey of marine sediment quality by URS (2004) found detectable levels of TBTs across Darwin Harbour. However, although they were detected at most sites, the guideline screening level (5 ng/g) was exceeded at only one location - Fort Hill Wharf, which has received large numbers of vessels since the late 1960s.

Recent sampling of marine sediments in the adjacent Inpex nearshore development area at Blaydin Point did not detect TBTs above the PQL in surface or subsurface sediments at any of the sampling sites (URS 2008a).

Nutrients

Nitrogen and phosphorus are major plant nutrients and their availability in marine systems most often determines the limits on plant growth. An overabundance of bio-available nitrogen and phosphorus can lead to the eutrophication of waterways and the proliferation of macroalgae and phytoplankton, which can choke estuaries and other confined marine systems. Large quantities of these nutrients can be held in sediments, mostly in non-bio-available forms.

Sediment sampling in the nearshore development area indicated average total nitrogen levels of 581 mg/kg in the main body of the Harbour, and 355.6 mg/kg in East Arm. Mean total phosphorus levels ranged from 314.5 mg/kg in the main body of the Harbour to 508.5 mg/kg in East Arm, which is within the range of that reported by Parry et al. (2002) in a similar study. Total sulphur, another essential plant nutrient, was present in concentrations ranging from 0.18% to 0.8% (URS, 2008a).

No guideline criteria are available for sediment nutrient levels.

9.1.3 Beneficial Uses and Water Quality Objectives

The water quality objectives for Darwin Harbour are included in a Water Quality Protection Plan initiated in 2006 as part of the National Water Quality Management Strategy, (a long term plan developed by the Commonwealth, State and Territory governments). The plan aims to maintain the current quality of water resources in Darwin Harbour and a key component of this management strategy has been the development of water quality guidelines and objectives (NRETAS, 2009).

These are based on the “declared beneficial uses” under the Water Act (NT), which are defined for the Harbour as “protection of aquatic ecosystems, recreational water quality and aesthetics” (NRETAS, 2009). The Project will aim to conform to the existing water quality objectives for Darwin Harbour.

Beneficial Uses for Darwin Harbour, including the waters in which the port is located, have been declared under the Water Act as:

- Aquatic Ecosystem Protection (habitat for plants and animals)
- Cultural: aesthetics (visual amenity), recreation (e.g. swimming or fishing) , collecting food (fish, crabs, shellfish) and spiritual values

In order to protect these uses, water quality objectives have been determined for various areas within the harbour, appropriate to the physical setting (e.g. outer harbour and upper estuary) in which they are located. This is typically determined by freshwater input and flushing times. These water quality guidelines can be used to assess whether the objectives are being met and, by extension, whether the nominated beneficial uses can be sustained.

The waters in which EAW is located, and where the modelling indicates that most effects of dredging will be seen, are defined as Upper Estuary. However the port lies close to the boundary with the Middle Estuary, which has slightly more stringent guidelines for some physico-chemical water quality parameters.

Key water quality objectives for East Arm Port and adjacent areas are (Fortune & Maly, 2009):

- Maintain dissolved oxygen between 80 and 100% saturation
- Maintain pH between 6.0 and 8.5 (upper estuary) and 7.0 and 8.5 (mid estuary)
- Maintain TSS less than 10 mg/L

In the absence of site specific guidelines for Darwin Harbour, toxicant concentrations are referred to the ANZECC / ARMCANZ (2000) Guidelines for Fresh and Marine Water Quality. The guidelines also provide levels for many heavy metals, at both a “screening” concentration (below which toxic effects on organisms are not expected), and a “maximum” concentration (at which toxic effects on organisms could occur).

9.2 Potential Impacts

Construction and associated activities will result in temporary impacts on water quality in and about EAW, and more generally in East Arm.

Specific activities which will generate impacts on water quality are:

- dredging of approximately 1,363,000 m^3 of estuarine sediment
- disposal at sea of approximately 1,000,000 m^3 of sediment at the offshore disposal area
- disposal within reclamation areas of approximately 270,000 m^3 of dredge spoil
- return to the harbour of decant water of estuarine origin
- excavation of intertidal and shallow subtidal sediments, bund wall construction, and armouring
- pile driving generating minor localised turbidity
- increases to general shipping/ vessel traffic (pre, during and post construction) including operational emissions and accidental spills.

During the project construction the water quality will be influenced by dredging, which will, at least locally, increase the turbidity and suspended sediment levels present in the water. Clearing of land for reclamation bunds, excavation of the shallow sediments and construction of reclamation bunds (including that for the rail loop), rock armouring, pile driving, sediment run-off from cleared land and the return of reclamation decant water to the harbour will also impact on physical water quality to varying degrees.

Other potential operational impacts include routine discharges of waste water, including storm water and domestic waste water and accidental fuel spills.

9.2.1 Construction Impacts

Impacts from Planned Construction Activities

The major contribution to impacts on water quality arising during construction is from the disturbance of sediments and release of particulates into the water column associated with the following activities:

- dredging and spoil disposal operations
- pile driving
- bund wall excavation/construction and reclamation
- propeller wash from construction vessels associated with each of the above activities.

Dredging and Spoil Disposal

The dredging proposed for the three proposed port development projects comprises a total volume of approximately 1.36 Mm^3, of which it estimated that approximately 1% or 14,000 m^3 will be lost into the water column at the dredge head over the period of dredging.

URS/Scott Wilson has undertaken sediment fate modelling to predict the dispersal of turbid plumes from dredging activities, and to predict the areas in which suspended sediments will accumulate. The results of the modelling are presented in **Appendix E**.

Modelling of the dispersion and resettlement of this volume of suspended sediment predicts that suspended sediment concentrations will rise during dredging by 5 to 10 mg/L in the vicinity of the dredging operation, falling to <2 mg/L outside of the immediate port area, against a background range of 6-10 mg/L.

The deposition of unconsolidated fine sediments is expected to be similarly small, with thicknesses of 5 mm occurring in the deeper portions of a number of the embayments either side of the port, and lesser thicknesses (0.1 to 1.0 mm) accreting onshore (refer **Appendix E**).

Depending on the management of the spoil, further losses may be experienced during transfer to barges for disposal offshore, or through the return of decant water from spoil disposed of onshore. The Water Research Laboratory (Wasko *et al*., 2010) examined options for the management of sediments from the dredging of a conceptual design for the MSB.

One scenario, based on 100% onshore disposal with return of turbid decant water with a suspended sediment load some 25 times higher than that modelled for dispersion at the dredge cutter head, showed potential accumulation on small areas of the harbour bed in the vicinity of the port of up to 50 mm of sediment and shoreline accretion over a wider area of up to 20 mm.

It is noted that the proposed construction methodology will result in less than 25% of the total dredged volume being discharged onshore and management of the decant water quality would result in a smaller than modelled quantity of sediment being returned to the harbour. Consequently, it is anticipated that the actual outcome (in terms of suspended sediment levels), depending on the method of spoil handling and disposal adopted and the management measures applied, will lie at the lower end of the range described by the values quoted above.

It is likely that, when added to background levels, the suspended sediment concentration in the immediate vicinity of dredge operation will exceed the water quality guideline value of 10 mg/L while the dredge is working. However, such levels are expected to reduce to within guideline concentrations within a short time of the dredge ceasing operations.

9 Marine Water

The sediments of East Arm have been shown to have low levels of contamination (URS, 2008a; [AECOM, pers. com. 20 January 2011]). Based on the results of construction monitoring studies for East Arm Port, the Darwin LNG plant and Darwin City Waterfront projects, disturbance of the sediments by dredging and other construction activities is not expected to result in release of contaminants at concentrations likely to exceed water quality guideline values for other water quality parameters (DO, pH and toxicants) or, in the case of substances occurring at naturally elevated levels such as arsenic, to exceed natural background concentrations for Darwin Harbour.

Similarly, disturbance of sediments due to dredging, when considering the high levels of mixing which occur through tidal exchange, is considered highly unlikely to result in the presence of nutrients at concentrations that would lead to the development of nuisance phytoplankton blooms.

The majority of the spoil from the dredging operations is proposed to be disposed of at the offshore spoil ground, i.e. outside of Darwin Harbour in Beagle Gulf. The dumping of each barge load of spoil, at a rate of approximately one barge load every three hours, is predicted to give rise to an instantaneous suspended sediment concentration of 10.0 - 20.0 mg/L within a plume 50 - 100 m in diameter.

The plume will then disperse following the prevailing current direction, increasing in diameter and reducing in concentration to generally less than 5.0 mg/L. Modelling results show the suspended sediment concentration arising from dredging remaining below 3.0 mg/L in Beagle Gulf over the period of dredging (refer **Appendix E**).

Subsequent accretion of fine sediment in Darwin harbour is predicted to occur only at the entrance to the Harbour, however, the thickness of sediment deposition is again predicted to be less than 0.5 mm over the dredging period.

Management of potential impacts from the dredging and reclamation works are addressed in the draft DMP (refer **Appendix B**).

Pile Driving, Bund Wall Excavation/Construction and Reclamation

Pile driving, bund wall excavation/construction and reclamation and placement of rock armour will all cause sediment disturbance of a localised nature. These activities will be principally shore-based and in all cases sediment disturbance leading to increased turbidity and suspended sediment concentrations is expected to be less than that associated with dredging.

Propeller Wash

The operation of construction vessels (tugs, workboats, survey vessels, anchor handling boats, etc.) in the comparatively shallow water of the construction area, particularly at low tide, can be expected to resuspend sediment due to the turbulence created by propellers, known as propeller wash. This typically results in localised redistribution of sediment, raises the concentration of suspended sediments in the water column and causes increased levels of turbidity in the immediate vicinity of the vessel.

Accidental Discharges during Construction

Accidental spills into the harbour during construction may occur during refuelling (diesel fuel) or less frequently due to fractured hoses (diesel fuel/hydraulic oil) or as a result of rupture of a fuel tank due to a collision between vessels or between a vessel and a wharf or other solid structure.

9 Marine Water

The incidence of spills of more than a few litres is infrequent. The management of any spills will be addressed under the Port's Oil Spill Contingency Plan.

Impacts Associated with Routine Operations

Impacts on water quality as a result of routine operations may include:

- disturbance of sediments due to propeller wash
- maintenance dredging
- over-water maintenance (e.g. of steel piles)

Propeller Wash

The operation of additional vessels in the port area can be expected to result in more frequent re-suspension of sediment due to propeller wash. This is expected to result in more frequent increases in the concentration of suspended sediments in the water column and increased levels of turbidity in the port area.

Maintenance Dredging

There may be a requirement to undertake periodic maintenance dredging to maintain the navigable depth of the channels and berthing basins, however the required frequency is yet to be determined, but is expected to be of order of a 10-year basis. The need for dredging would be based on the results of periodic bathymetry surveys.

The impacts would be similar in nature to those previously discussed under construction impacts, but the volumes of material to be dredged and the resultant suspended sediment loads and resettlement depths would be much smaller. Maintenance dredging will be undertaken under separate environmental approvals to be sought when the requirements are more fully understood.

Over-water Maintenance

Over-water maintenance of steel structures will be periodically required for corrosion control. This typically involves abrasive blasting or grinding/sanding of surfaces to remove paint and anti-fouling residues and corrosion (rust). The majority of this material will comprise inert particulates (paint chips, rust flakes, blasting grit, etc.) but there may be a release of toxins (most likely copper-based) from anti-fouling coatings. Procedures have previously been developed for use in Darwin Harbour to minimise the quantity of particulates entering the water during such operations.

Routine Discharges during Operations

The main discharge from the port area to the harbour will be stormwater, and this will increase as a result of the development owing to the additional hard stand area created. The discharge of the stormwater in itself poses no threat to water quality; however there is a need to manage potential contaminants including solids, hydrocarbons from grease or oil spills and leaks, and any material from vessel repair/maintenance that may accumulate on the hard stand between rainfall events. The stormwater will be directed through oil separaters, gross pollutant traps and possibly through sediment basins prior to harbour discharge.

Sewage will be transported offsite and will not be discharged to the harbour.

Accidental Discharges during Operations

Potential accidental spills to the marine environment during operations include:

- animal feaces during cattle shipments
- contaminated stormwater runoff (e.g. from oily surfaces or where product spills may have occurred)
- refuelling spills
- sewage pump-out spills
- waste handling spills.

The potential for such spills occurs across all areas of port operations, and will be addressed in specific procedures under the EAW EMP and the Oil Spill Contingency Plan.

It is noted that the Marine Supply Base may in future handle a significant volume of waste from offshore rigs and platforms, including potentially hazardous wastes, e.g. naturally occurring radioactive materials (NORMs), spent mercury filter beds, etc. Additional specific procedures may be required under the EAW EMP to ensure safe handling of such materials and avoid spillage during unloading or while stored on the hardstand, with subsequent potential to wash off into the harbour. This may include the use of interceptor drains on all drainage lines and on any ramp where maintenance work on hulls is undertaken.

9.3 Management of Impacts

A number of new and existing management plans will be developed or upgraded to meet project specific requirements of the Project. These will include the proposed management controls to be undertaken to reduce the risk of adverse environmental impacts on harbour water and sediment quality resulting from the Project. The provisional plans will form the basis for more detailed plans as the Project proceeds. The plans will outline the objectives, targets, actions and monitoring that will be undertaken to manage potential impacts.

Management of dredging impacts, in particular the turbidity arising from dredging and spoil disposal, will be addressed under the project specific draft DMP. The plan will identify dredging management protocols and set limits to turbidity which will be monitored for exceedance. Exceedance of criteria will result in the dredging program being modified or suspended until water quality improves to a specified level. A draft DMP has been completed by AECOM and is included as **Appendix B**.

The management of other sediment disturbing activities with a potential impact on water quality (e.g. excavation and bund wall construction) will be addressed as part of the project specific CEMP to be developed for the port expansion. This plan will contain similar provisions and monitoring requirements to the draft DMP with respect to water quality protection.

The management of oil spills will be addressed through the EAW Oil Spill Contingency Plan (OSCP). This plan will be amended as necessary to address any perceived additional risks associated with construction activities and subsequently with the operations of the expanded port. DPC's oil spill preparedness (equipment and training) will be upgraded as necessary to address any increased risk identified.

The EAW EMP will be upgraded as necessary to address any perceived additional risks associated with increased stormwater management and waste handling associated with construction activities. and subsequently with the expanded EAW operations. The plan will address onshore storage requirements (including the need for sealed, bunded storage areas) and the pre-discharge capture and treatment of stormwater.

9.4 Commitments

- *The disturbance footprint will be minimised where possible within the constraints of infrastructure engineering and operability. Dredges will be equipped with navigational aids to ensure that dredging occurs within the specified dredging footprint.*
- *A draft DMP has been prepared to address the impacts associated with dredging and dredge spoil disposal, including monitoring to protect environmental values (refer Appendix B). The DMP will be finalised following review through the EIS process and implemented during the construction period.*
- *Other sediment disturbing activities with a potential impact on water quality (e.g. pile driving, excavation and bund wall construction) will be addressed through the CEMP. This plan will contain similar provisions and monitoring requirements to the draft DMP with respect to water quality protection.*
- *The EAW management plans will be amended as necessary to address any perceived additional risks associated with construction activities and subsequently with the operations of the expanded port.*
- *DPC's oil spill preparedness (equipment and training) will be upgraded as necessary to address any increased risk identified.*
- *The EAW EMP will be upgraded as necessary to address any perceived additional risks associated with increased stormwater management and waste handling associated with construction activities and subsequently with expanded port operations.*

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