

APPENDIX

SURFACE WATER ASSESSMENT







The Terminal 4 (T4) Project Surface Water Assessment



**For: Port Waratah Coal Services Ltd
February 2012**

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EXECUTIVE SUMMARY

Background

Port Waratah Coal Services Limited (PWCS) proposes to develop a new coal export terminal at the Port of Newcastle. The Terminal 4 Project (*T4 Project*) at full development will have a maximum coal throughput capacity of 120 million tonnes per annum.

The objective of this report is to assess the surface water impact of the T4 Project. The report outlines the key surface water management considerations and establishes surface water management principles and concepts for the purpose of informing the design and the environmental assessment of the T4 Project.

Existing Surface Water Environment

The existing surface water environment at the T4 project area has been modified by land reclamation. Drainage is engineered and comprises culverts, drains, levees and constructed ponds which fill with surface runoff and ultimately drain to the Hunter River South Arm.

Existing Surface Water Quality

Extensive water quality sampling and testing has been undertaken within and adjacent to the project area by others and shows that at times pollutant levels within the Hunter River and existing water bodies exceed ANZECC guidelines for a number of toxicants. The existing condition of the Hunter River should be taken into account when setting water quality targets of potential discharge water in an Environmental Management Plan.

Potential On-site Impacts to Flow Regime

Construction of the T4 Project will impact the existing flow regime within the T4 project area with a number of the existing artificial ponds proposed to be filled.

Potential Off-Site Impacts to Flow Regime

Construction of the rail embankment in the northern portion of the T4 project area requires the crossing of Mosquito Creek and an unnamed watercourse that is located 850m to the east of Mosquito Creek. The southern portion of both these watercourses was filled when the southern portion of Kooragang Island was developed for industrial land-use in the 1960s and 1970s. As both of these watercourses are estuarine, the construction of the rail embankment has the potential to impact the tidal regime in some portions of wetland area that exist to the north of the T4 project area. Measures including channel realignment works and ground level modifications are proposed to mitigate any impacts to the tidal regime to areas beyond the rail embankment's footprint.

Potential Surface Water Quality Impacts

During the construction phase of the T4 Project, the potential for surface water impacts are predominately related to sediment mobilisation and transport, leaks and spills from construction equipment, and wind-blown sand and sediment.

There is potential for surface water contaminants to be generated during the operational phase of the T4 Project from accidental leaks and spills, run-off from impervious surfaces and the coal stockpiles and corrosion of plant and equipment. Without appropriate surface water management, these contaminants could potentially be transported in surface water runoff.

Proposed Surface Water Management

Surface water management during construction will focus on sediment and erosion control structures, designed and installed in accordance with "*Managing Urban Surface water – Soils and Construction*" (*Landcom 2004 - Blue Book*). Bunds, a settlement pond and silt curtains will be used to contain and treat all dredge water runoff prior to it being returned to the Hunter River. All controls required to mitigate any potential adverse impacts on receiving water quality during the construction stage would be included in a comprehensive Soil and Water Management Plan forming part of the Construction Environmental Management Plan.

A suite of surface water controls will be implemented during the operational phase of the T4 Project. Conceptual surface water management measures have been developed for the T4 Project and are summarised as follows:

- Where practical, separate clean water from dirty water.
- Stockyard perimeter drains to convey all collected surface water to settlement ponds.
- Standard pit and pipe systems to convey surface water from stacker / reclaimer berms and adjoining access roads to the perimeter drains.
- Sumps to capture coarse sediments and accidental oil spills (located at the dump station, conveyor inclines, transfer houses, buffer bins and the sampling area).
- Underdrain network under the coal stockpiles connected to the perimeter drains.
- Local sediment ponds adjacent to the rail batter.
- Local sediment basins for the transfer yard and wharves (surface water will be pumped back to the stockyard drainage system).
- A series of settlement ponds to treat all surface water generated from the dirty areas of the site.

The proposed surface water containment and treatment system is designed to provide adequate and efficient treatment of surface water runoff from the site through surface water capture, sediment removal, surface water reuse and, in prolonged wet weather events, the controlled discharge of runoff to the Hunter River South Arm.

Surface Water Monitoring

It is proposed to develop and implement a water quality monitoring program. The monitoring program will be prepared as part of the environmental management plans and would include monitoring of water quality trends during the pre-construction, construction and operational phases of the T4 Project. Should monitoring results exceed relevant trigger values, a contingency plan will be implemented to identify any deficiency in the surface water management system.

Overall Impact

While construction of the T4 Project will reclaim existing artificial water bodies within the T4 project area, there will be minimal impact on water bodies outside the T4 project area. During construction, the site will be bunded and all water will be managed to reduce sediment prior to being discharged to the Hunter River (under licence). During the operational phase, the site will be a closed system that will not discharge water during normal operating periods. Rather, surface water will be captured, treated and reused to meet over 70% of the project's water demands. During prolonged wet weather events, off-site discharge of surplus surface water would be required. Water balancing modelling predicts that discharge will occur on average every 95 days. Primary sedimentation treatment would be provided prior to offsite discharge. Monitoring of this water quality would be undertaken to ensure significant pollution of the receiving water does not occur.

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1 INTRODUCTION

1.1 Introduction

Port Waratah Coal Services Limited (PWCS) proposes to construct and operate a new coal export terminal at the Port of Newcastle, New South Wales (NSW). PWCS currently owns and operates the existing Kooragang Coal Terminal (KCT) at Kooragang Island and Carrington Coal Terminal (CCT) at Carrington, both in the Port of Newcastle (**Figure 1**). The proposal, known as the Terminal 4 Project (T4 Project), is essentially an extension to KCT. The T4 Project will provide additional port capacity required to accommodate the projected future growth in coal exports from the Hunter Valley and broader NSW.

The T4 Project is proposed to include new rail tracks, coal stockyard, conveyors and ancillary facilities on Kooragang Island, adjacent to KCT. Wharves, berths, ship loaders and ancillary facilities will be constructed and operated within the Hunter River South Arm, along its north and south banks (**Figure 2**).

Approval for the T4 Project is being sought under Part 3A of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). An approval is also being sought under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as the T4 Project has been deemed to be a controlled Action. The Commonwealth has accredited the part 3A process as the appropriate Commonwealth assessment pathway for the T4Project.

An environmental assessment (EA) of the T4 Project is a requirement of the Part 3A approval process. SMEC has been engaged by PWCS to undertake the Surface Water Assessment component of the EA. This report documents the methodology and results of the Surface Water Assessment as well as the proposed mitigation measures.

1.2 T4 project area

The T4 Project is proposed to be located at the Port of Newcastle, in the Newcastle local government area, approximately 6 km north-west of the Newcastle central business district (**Figure 1**). The T4 project area is located on Kooragang Island, adjacent to KCT and the Newcastle Coal Infrastructure Group (NCIG) coal terminal, and on the south bank of the Hunter River South Arm, at Mayfield North (**Figure 2**).

The southern part of Kooragang Island, where the T4 project area is located, is dominated by industrial, transport, distribution and port facilities, including KCT and NCIG. To the north and west of the Kooragang industrial and port area are estuarine wetlands, mangroves, saltmarsh and pastured and forested lands, subject to agricultural and conservation activities. This includes the Hunter Wetlands National Park, part of which is a Ramsar site. The nearest residential areas are at Fern Bay and Stockton to the east and south-east, and Mayfield and Warabrook to the south and south-west (**Figure 1**).

The T4 project area is predominately reclaimed land which has previously been used for disposal of industrial waste and dredge material. It is a largely modified landscape dominated by bare ground, disturbed grassland and artificially constructed drainage depressions and ponds, which now support wetland communities. There is some remnant mangrove and saltmarsh vegetation along the Hunter River, at the locations of the proposed wharves and berths, as well as to the north and west of the existing rail line (**Figure 2**).

1.3 T4 Project Overview

The T4 Project is proposed to be developed progressively over an estimated 10 year timeframe, in response to demand for increased coal export capacity. The maximum coal throughput capacity for the T4 Project will increase from 70 million tonnes per annum (Mtpa) in the first stage to a nominal

120 Mtpa at full development. All coal will be received by rail, stockpiled and then shipped to market. The T4 Project components are illustrated in **Figure 2** and include the following:

- Ground treatments, including pre-loading, to create suitable foundation conditions for development. Sand dredged from the Hunter River South Arm is proposed to be pumped to the proposed stockyard area, to provide pre-load and fill material for the project. This will be supplemented by engineering fill (sand and rock) trucked in from elsewhere.
- Relocation of some existing infrastructure and services, such as electricity transmission lines, gas lines, water lines, fibre optic cable, ship navigation aides, the existing KCT rail tracks and the Ausgrid wind turbine. Minor modification to local roads may also be required.
- Progressive construction and operation of rail receipt infrastructure, generally located along the same alignment as the existing rail lines servicing Kooragang Island. At full development there will be up to eight arrival tracks leading into up to four dump stations and on to eight departure sidings, which combine into a single departure track around the outside of the existing KCT rail loop.
- Progressive construction and operation of a coal stockyard, including coal stockpiles and yard equipment for stacking and reclaiming coal. At full development there will be up to seven stockpiles.
- Progressive construction and operation of coal conveyors, feeders and transfer stations that extend throughout the stockyard to deliver coal from the dump stations to the stockpiles, and to the wharves to deliver coal to the shiploaders, via buffer bins.
- Progressive construction and operation of wharf and berth facilities on both sides of the Hunter River South Arm, near the Tourle Street Bridge. At full development, up to five berths and four shiploaders are proposed, which accommodate vessels ranging from Handy size to Cape size.
- Development of water and wastewater management infrastructure including drainage works, water management ponds, pump stations and water tanks.
- Ancillary facilities, including electricity supply, dust suppression and fire fighting systems, fencing, amenities, landscaping, internal access roads, car parking areas and potentially, washdown facilities, refueling facilities, administration and workshop buildings.
- Use of some existing KCT infrastructure, systems and workforce, including administration and maintenance facilities and environmental management and monitoring systems.
- Habitat creation and enhancement.

Further details on the proposed T4 Project are provided in the EA report.

1.4 Director-General's Requirements

The following Director-General's Requirements (*DGRs*) for the T4 Project are specific to this surface water assessment:

Water Quality and Hydrological Impacts – the EA must include an assessment of the water quality impacts of the project during construction and operation, with particular reference to impacts on surface and groundwater, and climate change adaption measures, including:

- *how the project will alter the surface profile of the site, including landfill areas and impacts to drainage structures and water management facilities.*

The EA must reflect a design goal of no discharge of water to the Hunter River, other than natural surface run-off in extreme weather events, during operation of the project and shall take into account the Floodplain Development Manual (DIPNR, 2005) and the Australian and New Zealand Environment Conservation Council Water Quality Guidelines for Fresh and Marine Waters (ANZECC, 2000).

This report addresses the surface water aspects of the Environmental Assessment. A groundwater assessment of the T4 Project has been prepared by Douglas Partners (2011) and flood assessment has been prepared by WorleyParsons (2011).

1.5 Government Agencies

The following government agencies provided comments on the draft DGRs that are specific to this surface water assessment:

- Department of Environment, Climate Change and Water (DECCW).
- NSW Office of Water (NOW).
- Hunter-Central Rivers Catchment Management Authority (CMA).
- Industry and Investment NSW (I&I).

Appendix A summarises the government agency comments and provides a reference to where the comments are addressed in this report.

1.6 Applicable Legislation and Guidelines

A list of relevant legislation and guidelines specific to surface water considerations for the T4 Project are listed in **Table 1**.

Table 1 – Policies and Statutory Provisions

Policy / Guideline Document	Discussion
Environment Protection and Biodiversity Act 1999 (EPBC Act)	The EPBC Act aims to protect matters deemed to be of national environmental significance including Ramsar wetlands of international significance. A referral to Department of Sustainability, Environment, Water, Population and Communities (DSEWPC) has been prepared by others to assess whether the T4 Project is likely to have a significant impact on threatened species.
Water Management Act 2000	The objectives of the Water Management Act 2000 (WMA) are to provide for the sustainable and integrated management of the water resources within NSW for the benefit of both present and future generations. Specifically, the WMA is used by OEH and NOW to regulate the use of water resources through the provision of water quality and quantity controls on proposed and existing developments and the management of water sharing plans and water extraction licences.
Australian and New Zealand Environment Conservation Council Water Quality Guidelines for Fresh and Marine Waters (ANZECC, 2000)	These guidelines are the benchmark document of the National Water Quality Management Strategy. The guidelines provide an authoritative guide for setting water quality objectives required to sustain current, or likely future, environmental values [uses] for natural and semi-natural water resources in Australia and New Zealand.
Australian Rainfall and Runoff (AR&R, 1987)	AR&R is a document published in 1987 by the Institution of Engineers, Australia (IEAust). This document is widely accepted as a design guideline for all flood and surface water related design in Australia.

Policy / Guideline Document	Discussion
Australian Runoff Quality (ARQ, 2006)	ARQ is a document published in 2006 by IEAust which provides design guidelines for all aspects of Water Sensitive Urban Design (WSUD), including preventative measures, source controls, conveyance controls and end of line controls. Additionally, it provides guidance for water quality modelling as well as surface water harvesting and re-use.
Erosion and Sediment Control Guidelines (NSW Dept of Housing, 2004)	Relevant sections from the document titled 'Managing Urban Surface water: Soils and Construction' are applicable when formulating the erosion and sediment controls for the T4 Project during the construction phase.
Guidelines for Controlled Activities (NOW, 2010)	NOW has developed a series of guidelines that provide information on recommended design and construction methods for controlled activities occurring within 40m of a watercourse or waterfront land.
Hunter-Central Rivers Catchment Action Plan	The Catchment Action Plan outlines the most important natural resource issues in the Hunter Region and provides a number of guiding principles to minimise soil erosion, improve habitat, manage salinity and acid sulphate soils and improve water quality.
Newcastle City Council DCP 2005	Element 4.5 – Water Management, outlines requirements for surface water that will be applicable to the T4 Project, which is located within the Newcastle City Council (NCC) LGA.
NSW Water Quality and River Flow Objectives – Hunter River	The NSW Water Quality Objectives are the agreed environmental values and long-term goals for NSW's surface waters. The Objectives are consistent with the agreed national framework for assessing water quality set out in the ANZECC 2000 guidelines.

1.7 Agency Consultation

A meeting was held with the Office of Environment and Heritage (OEH – former DECCW) on 27 June 2011 to clarify the surface water discharge criteria for the T4 Project. In particular, the meeting sought to clarify a requirement within the DGRs which states '*the EA must reflect a goal of no discharge of water to the Hunter River, other than natural surface run-off in extreme weather events, during operation of the project....*'.

During the meeting it was agreed that: -

- Discharge from the T4 Project is permissible under certain conditions, particularly when the Hunter River is under flood conditions.
- The surface water assessment is to define an 'extreme weather event' and demonstrate how the T4 Project will achieve the requirement.
- The surface water assessment is to consider the performance of the proposed T4 Project's Surface Water Management Systems (SWMS) relative to similar surrounding industry.
- The surface water assessment is to consider the likely quality of receiving water in the Hunter River South Arm compared to the likely quality of surface water during discharge from the site.

2 EXISTING ENVIRONMENT

The T4 project area is predominately reclaimed land which has previously been used for the disposal of industrial waste and dredge material. It is a largely modified landscape dominated by bare ground, disturbed grassland and artificially constructed drainage depressions and ponds that now support wetland communities. There is some remnant mangrove and saltmarsh vegetation along the Hunter River at the locations of the proposed wharves and berths, as well as to the north and west of the existing rail line.

This section outlines the existing environment including the site topography, surface water features present within and adjacent to the site and analysis of existing water quality data for these features. **Figure 3** provides an outline of the existing features of the T4 project area.

2.1 Topography

The Majority of the T4 project area is an engineered site modified by land reclamation and comprises of fill, including industrial waste and dredged material, underlain by alluvial soils. Drainage is engineered and comprises of culverts, open drains, levees and constructed ponds which fill with surface runoff and ultimately drain to the Hunter River South Arm. Runoff from the northern and western rail embankments discharge to existing wetlands.

The west of the T4 project area (~RL0.4 to 1.0m AHD) contains a large water body known as 'Deep Pond' (refer **Section 2.2**). Adjacent to Deep Pond is a general refuse dump (~RL7.5m AHD) and a series of waste disposal ponds, some of which are completely filled (~RL6.3 to 8.8m AHD) while others are not completely filled and currently capture and store surface water (~RL1 to 2.5m AHD).

The central area of the T4 project area currently contains an asbestos disposal cell (~RL10 to 12m AHD), and four landfill cells known as the Delta Electrolysis Manganese Dioxide (EMD) waste site (levels vary considerably from RL3.2 to 10m AHD with much of the area around RL5m AHD). To the north of the asbestos disposal cell is a water feature known as the 'Railway Pond' and to the south of the Delta EMD cells is another water body known as the 'Easement Pond' (both ponds are described in **Section 2.2**).

The east of the T4 project area contains five cells known as the Fines Disposal Facility (FDF) which were used for disposal of dredged fine materials associated with expansion works at KCT. The cell walls of the FDF are generally around RL7.5 to 8m AHD while surface levels within the cells vary from around RL3.5 to 6.5m AHD.

2.2 Surface Water Features within the T4 Site

As outlined above, a number of existing ponds are located within the T4 project area. These ponds have been formed as a result of the placement of engineered fill and the construction of levees. **Figure 3** outlines the existing flow patterns across the site and the inter relationship between the ponds.

A description of the existing ponds within the T4 project area is provided below. This information has been sourced from site investigation, survey information and '*Report on Groundwater Assessment – Stage 1 and 2 Pre-Feasibility Engineering Study*' (Douglas Partners 2011).

2.2.1 Deep Pond

Deep Pond is approximately 27ha in area and is located at the northwest boundary of the T4 Project. Contrary to its name, the pond is shallow with depths generally ranging from 0.5m to 1.0m. The maximum water surface level is controlled by twin 3m x 1.2m box culverts located at the south west corner of the pond.

Deep Pond receives localised site runoff and overflow from Blue Bill Duck Pond (external water body) and Railway Pond. Overflows run along a constructed drain adjacent to the rail line before

passing below the rail loop (via culverts) and into tidal wetlands located along the edge of the south arm of the Hunter River.



Plate 1 – Deep Pond

2.2.2 Railway Pond

Railway Pond is approximately 4.5ha in area and is located at the northern boundary of the T4 project area. The pond receives localised site runoff and overflows from FDF pond (*not the FDF itself*). Railway Pond is connected to Deep Pond by a constructed channel, as Deep Pond fills, water backs up into Railway Pond.

Douglas Partners (2011) advise that limited groundwater seepage from Railway Pond occurs through the railway embankment and then towards OEH Wetlands to the north of the site.



Plate 2 – Railway Pond

2.2.3 FDF (Fines Disposal Facility) Pond

FDF Pond is approximately 1.9ha in area and is located at the north east boundary of the T4 Project. The pond receives localised site runoff and is connected to Railway Pond by a constructed drainage channel.



Plate 3 – FDF Pond

2.2.4 Easement Pond

Easement Pond is approximately 2.6ha in area and is located central to the T4 project area, adjacent to the NCIG Rail Loop. The pond receives localised runoff.

Douglas Partners (2011) suggest there may be vertical leakage through the base of Easement Pond which would limit any surface discharge from the pond. In prolonged wet weather events, it is possible that Easement Pond would flow east along a channel into a depression along the side of Pacific National Road and eventually enter Long Pond which is located beside Cormorant Road.

A small section of Easement Pond has been divided by the NCIG rail line. This area (Easement Pond South) captures local runoff and discharges to the BHPB Wetlands via a series of pipe culverts.



Plate 4 – Easement Pond

2.2.5 Ponds 9, 10, 11 and 12

Ponds 9, 10, 11 and 12 are waste disposal cells that have not been completely filled and currently capture and store surface water. These ponds are located in an area of groundwater mounding and Douglas Partners (2011) suggest they also receive groundwater recharge. The ponds are 'windows' to the groundwater system and water levels fluctuate as a result of groundwater movement, direct rainfall and evaporation. Surface water captured in these ponds is not thought to overflow to any other water body.



Plate 5 – Pond 9



Plate 6 – Pond 10



Plate 7 – Pond 11



Plate 8 – Pond 12

2.2.6 OEH Wetlands #1, #2 and #3

OEH Wetlands #1, #2 and #3 are located to the north of the rail embankment and fall partly within the T4 project area. The OEH Wetlands are further described in **Section 2.3.1**

2.3 Surface Water Features off Site

2.3.1 OEH Wetlands and Swan Pond

Adjacent to the rail line are the OEH Wetlands #1, #2 and #3 and Swan Pond.

OEH Wetlands #1, #2 and #3

Three wetlands are located to the north of the rail embankment and are partly within the T4 project area (refer **Figure 3**).

OEH Wetland #1 is located north of Deep Pond. The pond captures direct rainfall and runoff from the rail line. The pond shows minimal response to tidal fluctuations and has been known to run dry. If overtopped, OEH Wetland #1 would flow along natural drainage lines to Swan Pond.

OEH Wetland #2 is located north of Deep Pond and east of OEH Wetland #1. The pond captures direct rainfall and runoff from the rail line and is inundated during high tide.

OEH Wetland #3 is located to the north of Railway Pond. The pond captures direct rainfall and runoff from the rail line and is inundated during high tide. Douglas Partners (2011) advise that groundwater interaction can be expected in this wetland.

Swan Pond

Swan Pond is a salt marsh pond located to the north west of the T4 project area. The pond is connected to Wader Pond which is connected tidally to the south arm of the Hunter River by several drains (most notably Wader Creek and Fish Fry Creek).

2.3.2 Industrial Area Ponds

The following three water bodies are located to the south of the proposed T4 project area:

Blue Billed Duck Pond

Blue Billed Duck Pond is approximately 2ha in area and is located to the south east of Deep Pond. The pond receives localised runoff as well as overflows from BHPB Wetlands. Overflows from the pond flow to Deep Pond via pipe culverts located under the NCIG rail line. Douglas Partners (2011) advise that the pond is a window to the groundwater system and receives groundwater inflows.

BHPB Wetlands

BHPB Wetland is approximately 5.8ha in area and is located south of the T4 project area and east of Blue Billed Duck Pond. The pond receives localised runoff as well as overflows from Easement Pond South. Overflows from the pond flow to Blue Billed Duck Pond via a drainage channel. Douglas Partners (2011) advise that the pond is a window to the groundwater system and receives groundwater inflows.

Long Pond

Long Pond is approximately 3.4ha in area and is located to the south of the NCIG rail loop and north of Cormorant Road. The pond receives localised runoff and groundwater recharge. Douglas Partners (2011) advise Long Pond has no direct surface water connection to the south arm of the Hunter River, apart from following prolonged/heavy rainfall when the surface flow overtops the road and discharges to the river (e.g. this occurred during the June 2007 flood event).

2.3.3 The Hunter River

The T4 project area is located adjacent to the South Arm of the Hunter River in close proximity to the river mouth. The Hunter River is a major river with a length of over 450km and a catchment area of approximately 20,000 km². The river is tidal in proximity to the T4 site and is considered an estuarine environment.

Land use upstream of the T4 site includes farm land, vineyards, open cut and underground coal mines and industrial facilities (including an Aluminum smelter). This land use has impacted water quality within the Hunter River which is classed as a 'waterway affected by urban development'.

2.3.4 Hunter Wetlands National Park

To the north and northwest of the Kooragang Island rail line and Special Purpose zone is the Hunter Wetlands National Park. The estuary consists primarily of intertidal wetlands bordered by lowland floodplain forest, riparian woodlands and small areas of freshwater wetlands. The Hunter Estuary Wetlands comprises of 2,926ha on Kooragang Island, part of which is Ramsar listed.

Section 8, provides a qualitative assessment of the existing hydrologic regime in the Hunter Wetland National Park and identifies a number of potential impacts on the existing hydrological regime that are associated with the construction of the rail line in the northern portion of the T4 project area. Proposed mitigation measures are also discussed in **Section 8**.

2.4 Existing Water Quality

Extensive water quality sampling and testing has been undertaken within and adjacent to the project area by others and has been provided to SMEC for this assessment. **Figure 3** indicates the approximate location of water quality sampling undertaken to date. Additional water quality monitoring is presented in Douglas Partners (2011) groundwater assessment submitted with the EA.

Table 2 outlines a statistical analysis of a number of analyte concentrations tested within water bodies in and around the T4 project area. These values are compared to ANZECC guidelines for slightly–moderately disturbed aquatic systems (shaded values in Table 3.4.1 of ANZECC 2000) with grey shading of mean values indicative of exceedance of listed trigger levels. Note that the differentiation between fresh water and estuarine has been based on the mean electrical conductivity of the water bodies. These pollutant levels of the Hunter River and existing water bodies should be taken into account when setting water quality targets of potential discharge water in the Environmental Management Plan.

It can be seen from **Table 2** that at times the existing water quality of the Hunter River and surrounding water bodies exceed ANZECC guidelines for slightly-moderately disturbed ecosystems for a number of toxicants, including TP, Cd, Cr, Cu, Hg, and Zn. The results also indicate that pH change has occurred compared to typical freshwater and estuarine systems.

Table 2 - Summary of Surface Water Monitoring within the T4 project area

Analyte	ANZECC Default Trigger Values		Statistic ^{2.5}	Fresh Water Wetlands			Estuarine Wetlands / Estuary			
	Fresh Water	Estuarine		Blue Billed Duck Pond	Easement Pond	Railway Pond	Deep Pond	Long Pond	OEH Wetlands	Hunter River
pH	6.5 - 8	7 - 8.5	Count	7	42	28	89	36	76	119
			90%ile or max	9.2	9.1	8.8	9.6	9.4	8.7	8.1
			Mean	8.8	8.3	8.3	8.8	8.6	7.7	7.9
			10%ile or min	8.2	7.7	7.8	7.9	7.9	7.0	7.6
EC (µS/cm)	125 - 2,200	-	Count	7	42	28	90	36	77	55
			90%ile or max	1,822	3,882	4,708	30,210	36,000	36,700	55,000
			Mean	1,236	2,925	3,419	13,238	15,980	17,340	45,110
			10%ile or min	802	2,180	2,565	2,516	3,350	5,048	33,200
TSS (mg/L)	~ 15.6 – 130 (6-50 NTU)	~ 1.3-26 (0.5-10 NTU)	Count	2	0	0	48	12	27	76
			90%ile or max	59.7	-	-	32.3	39.0	26.8	41.0
			Mean	46.5	-	-	16.5	39.1	15.7	24.9
			10%ile or min	33.3	-	-	2.0	1.0	6.0	5.5
TP (mg/L)	0.05	0.03	Count	3	0	0	2	0	1	46
			90%ile or max	0.60	-	-	-	-	-	0.18
			Mean	0.34	-	-	0.30	-	0.24	0.08
			10%ile or min	0.14	-	-	-	-	-	0.01
Ammonia (mg/L)	0.90	0.91	Count	6	0	0	82	24	73	71
			90%ile or max	0.40	-	-	0.69	0.27	0.73	0.50
			Mean	0.21	-	-	0.45	1.01	0.93	0.17
			10%ile or min	0.07	-	-	0.02	0.01	0.02	0.09
Cyanide (mg/L)	0.007	0.004	Count	7	2	0	40	22	49	73
			90%ile or max	0.005	0.005	-	0.030	0.050	0.123	0.004
			Mean	0.004	0.005	-	0.012	0.021	0.039	0.004
			10%ile or min	0.004	0.005	-	0.004	0.004	0.004	0.004
Phenol (mg/L)	0.32	0.40	Count	6	0	0	46	31	45	19
			90%ile or max	0.050	-	-	0.050	0.050	0.224	0.120
			Mean	0.035	-	-	0.017	0.028	0.058	0.058
			10%ile or min	0.006	-	-	0.000	0.001	0.001	0.010
Al (mg/L)	0.055	-	Count	4	17	8	8	0	1	54
			90%ile or max	0.95	0.10	0.10	0.78	-	-	1.05
			Mean	0.42	0.07	0.08	0.32	-	0.07	0.60
			10%ile or min	0.03	0.01	0.02	0.04	-	-	0.16
Cd (mg/L)	0.0002	0.0007	Count	3	13	7	53	12	28	47
			90%ile or max	0.080	0.090	0.050	0.010	0.010	0.010	0.002
			Mean	0.034	0.042	0.036	0.018	0.010	0.011	0.002
			10%ile or min	0.000	0.000	0.000	0.010	0.010	0.010	0.000
Cr (mg/L)	0.001	0.0044	Count	2	14	8	79	35	74	44
			90%ile or max	0.016	0.100	0.100	0.020	0.024	0.025	0.010
			Mean	0.010	0.072	0.075	0.011	0.010	0.012	0.008
			10%ile or min	0.003	0.001	0.001	0.001	0.001	0.001	0.001

Analyte	ANZECC Default Trigger Values		Statistic ^{2.5}	Fresh Water Wetlands			Estuarine Wetlands / Estuary			
	Fresh Water	Estuarine		Blue Billed Duck Pond	Easement Pond	Railway Pond	Deep Pond	Long Pond	OEH Wetlands	Hunter River
Cu (mg/L)	0.0014	0.0013	Count	3	17	8	53	12	28	47
			90%ile or max	0.017	0.020	0.020	0.040	0.030	0.050	0.020
			Mean	0.009	0.013	0.016	0.018	0.017	0.054	0.015
			10%ile or min	0.003	0.002	0.003	0.006	0.010	0.010	0.003
Fe (mg/L)	-	-	Count	3	13	7	78	34	74	57
			90%ile or max	1.26	0.10	0.10	1.03	0.95	6.88	1.63
			Mean	0.63	0.08	0.09	1.05	0.52	3.08	0.87
			10%ile or min	0.12	0.05	0.05	0.06	0.11	0.18	0.17
Hg (µg/L)	0.06	0.1	Count	3	8	3	54	32	49	45
			90%ile or max	0.38	2.0	1.62	0.28	0.14	0.10	0.10
			Mean	0.27	0.58	0.73	0.14	0.08	0.07	0.13
			10%ile or min	0.14	0.10	0.10	0.05	0.05	0.05	0.10
K (mg/L)	-	-	Count	2	15	8	2	0	1	4
			90%ile or max	40.3	91.4	146	374	-	-	430
			Mean	29.5	58.2	105	230	-	515	360
			10%ile or min	18.7	44.3	63.9	86	-	-	250
Mn (mg/L)	1.9	0.08	Count	1	10	6	50	32	49	32
			90%ile or max	-	0.10	0.20	0.17	0.06	0.09	0.01
			Mean	0.41	0.10	0.13	0.09	0.03	0.03	0.01
			10%ile or min	-	0.10	0.10	0.02	0.01	0.01	0.01
Na (mg/L)	-	-	Count	2	15	8	3	0	1	4
			90%ile or max	564	538	821	8078	-	-	11000
			Mean	385	446	477	3463	-	13900	9075
			10%ile or min	205	361	284	78	-	-	6170
Ni (mg/L)	0.011	-	Count	2	17	8	24	8	1	8
			90%ile or max	0.019	0.020	0.020	0.100	0.100	-	0.030
			Mean	0.013	0.013	0.015	0.066	0.058	0.010	0.013
			10%ile or min	0.007	0.001	0.002	0.005	0.010	-	0.004
Pb (mg/L)	0.034	0.044	Count	2	12	6	82	36	76	40
			90%ile or max	0.060	0.100	0.100	0.050	0.050	0.020	0.010
			Mean	0.034	0.084	0.100	0.026	0.031	0.011	0.008
			10%ile or min	0.008	0.011	0.100	0.001	0.001	0.001	0.005
Zn (mg/L)	0.008	0.015	Count	2	17	8	82	35	76	40
			90%ile or max	0.298	0.024	0.020	0.205	0.212	0.160	0.052
			Mean	0.169	0.018	0.017	0.091	0.107	0.098	0.056
			10%ile or min	0.039	0.005	0.009	0.006	0.008	0.005	0.026

Note 1: 10th and 90th Percentile values were reported when 10 or more samples were available. Minimum and maximum values are reported when less than 10 samples were available.

Grey Shading denotes applicable ANZECC Default Trigger values for slightly to moderately disturbed ecosystems are exceeded.

3 POTENTIAL SURFACE WATER IMPACTS

The potential surface water impacts of the T4 Project have been considered for the construction and operational phases. Note that this surface water assessment does not include groundwater or flooding impacts, these are addressed in other reports within the EA.

3.1 Construction Phase

3.1.1 Wharves

The T4 Project incorporates wharves that are located on the northern and southern banks of the Hunter River's South Arm. The following construction activities will be required for both wharves.

- Land clearing / preparation.
- Installation of sheet piling.
- Installation of a dredge pipeline from the river to the T4 project area.
- Construction of rock revetment.
- Bulk earthworks (cutting and filling).
- Establishment of services.
- Construction of access roads and parking areas.
- Construction of wharves.

If not appropriately managed there is potential for surface water runoff to erode exposed soil or stockpiled material, which could potentially result in elevated suspended solids concentrations in the surface water runoff.

Construction activities on and near the river bank will be carried out in accordance with the requirements of a Construction Environmental Management Plan (CEMP), to be prepared prior to commencement of construction. This will include measures to minimise the potential for off-site surface water impacts. **Section 5.1** outlines the conceptual surface water control measures that will be implemented as part of the CEMP.

3.1.2 Stockyard Area

Preliminary Works

The existing ground conditions within the stockyard area (*particularly the northern area*) will require ground treatments potentially including pre-loading, deep soil mixing, capping and / or geofabric reinforcement. While the ground improvement works are being undertaken, sand will be pumped from the dredging operations to the proposed stockyard area via a pipeline. It is anticipated that the pipeline would be located along the eastern T4 project area boundary. This will be refined during detailed design.

A bund will be constructed along the southern and northern boundaries of the proposed stockyard area in order to contain all dredge water and surface water within the construction site. The existing FDF bund will be used to contain water at the eastern end of the site.

Dredge water will be collected and pumped to a series of water quality control ponds located within the Deep Pond footprint where fines will settle out before water is returned to the Hunter River via a lined drainage channel located adjacent to the western rail line. A silt curtain would be located at the Hunter River discharge location. It should be noted that discharge of clarified dredge waters to the Hunter River South Arm has been an approved activity undertaken as part of dredging campaigns completed over the past decade.

If not appropriately managed there is potential for surface water and dredge water runoff to erode exposed soil or stockpiled material and to transport highly turbid and saline water to existing water

bodies. **Section 5.1** outlines the conceptual surface water control measures that will be implemented as part of the CEMP.

Finishing Works

Following the placement of fill, works will include shaping (*detailed cutting and filling*), construction of settlement ponds, establishment of services, construction of coal stockpiles, rail lines, access roads, conveyors, transfer points and all other plant.

Potential impacts to surface water run-off at this stage include erosion of stockpiled material, which could potentially result in elevated turbidity and hydrocarbon spillages related to construction equipment.

Section 5.1 details the proposed control measures that will be implemented during the construction phase of the project to mitigate the surface water impacts described above. This includes a surface water monitoring program to assess the effectiveness of the control measures and to demonstrate compliance with the CEMP.

3.2 Operation Phase

3.2.1 Potential Contaminants

The main sources of surface water pollutants include runoff from the coal storage area, wharf areas, rail loop and minor leaks and spills from vehicles and plant equipment. Minor concentrations of surface water pollutants may also arise from the corrosion of structures and plant, particulate loads from vehicles and atmospheric deposition.

Runoff from the coal stockpiles may contain many of the constituents found in the coal including suspended solids, dissolved inorganic salts and heavy metals (typically copper, iron, aluminium, nickel) and can either be alkaline or acidic. The concentration of these pollutants in the stockpile runoff is dependent upon the size and source of stockpiled coal, rainfall, temperature, the acidity of the coal and the quality of pre-processing undertaken prior to stockpiling (Noyes 1993).

A study undertaken by the Australian Coal Association Research Program (Riley, 2003) investigated the leachability of environmentally sensitive trace elements from stockpiles of Australian Export Coals. The results of the study indicated that runoff from stockpiles of Australian Export Coals typically contained a pH between 7 and 9 and that the concentrations of most trace elements were less than those recommended as trigger values for slightly to moderately disturbed ecosystems (ANZECC, 2000).

Treatment measures proposed to mitigate these potential impacts are outlined in **Section 5.2**.

3.2.2 Expected Operational Water Quality

PWCS provided water quality sampling results from Settling Pond 1 and Clarified Pond 1 that are located within the PWCS operated KCT. Settling Pond 1 collects surface runoff and return process water from the majority of the KCT site. Water is pumped from Settling Pond 1 into Clarified Pond 1, prior to it being reused for on-site process water uses. Accordingly, the KCT water quality results are indicative of the likely process water quality from the T4 project area, which will have similar catchment characteristics. **Table 3** compares the KCT water quality results to the baseline water quality results and ANZECC (2000) Trigger values that are presented in **Table 2**.

Table 3 – KCT Water Quality Sampling Data

Analyte	ANZECC Default Trigger Values		Statistic ¹	Baseline Water Quality Results – Existing Watercourses							KCT Water Quality Data	
				Fresh Water Wetlands			Estuarine Wetlands / Estuary					
	Fresh Water	Estuarine		Blue Billed Duck Pond	Easement Pond	Railway Pond	Deep Pond	Long Pond	OEH Wetlands	Hunter River	Settling Pond 1	Clarified Pond 1
pH	6.5 - 8	7 - 8.5	Count	7	42	28	89	36	76	119	5	5
			90%ile or max	9.2	9.1	8.8	9.6	9.4	8.7	8.1	8.5	8.3
			Mean	8.8	8.3	8.3	8.8	8.6	7.7	7.9	8.2	8.0
			10%ile or min	8.2	7.7	7.8	7.9	7.9	7.0	7.6	7.9	7.4
EC (µS/cm)	125 - 2,200	-	Count	7	42	28	90	36	77	55	0	0
			90%ile or max	1,822	3,882	4,708	30,210	36,000	36,700	55,000	-	-
			Mean	1,236	2,925	3,419	13,238	15,980	17,340	45,110	-	-
			10%ile or min	802	2,180	2,565	2,516	3,350	5,048	33,200	-	-
TSS (mg/L)	~ 15.6 – 130 (6-50 NTU)	~ 1.3-26 (0.5-10 NTU)	Count	2	0	0	48	12	27	76	5	0
			90%ile or max	59.7	-	-	32.3	39.0	26.8	41.0	30.8	-
			Mean	46.5	-	-	16.5	39.1	15.7	24.9	19.1	-
			10%ile or min	33.3	-	-	2.0	1.0	6.0	5.5	7.0	-
TP (mg/L)	0.05	0.03	Count	3	0	0	2	0	1	46	5	0
			90%ile or max	0.60	-	-	-	-	-	0.18	0.15	-
			Mean	0.34	-	-	0.30	-	0.24	0.08	0.10	-
			10%ile or min	0.14	-	-	-	-	-	0.01	0.03	-
Ammonia (mg/L)	0.90	0.91	Count	6	0	0	82	24	73	71	5	5
			90%ile or max	0.40	-	-	0.69	0.27	0.73	0.50	0.06	0.05
			Mean	0.21	-	-	0.45	1.01	0.93	0.17	0.03	0.03
			10%ile or min	0.07	-	-	0.02	0.01	0.02	0.09	<0.001	0.02
Cyanide (mg/L)	0.007	0.004	Count	7	2	0	40	22	49	73	5	5
			90%ile or max	0.005	0.005	-	0.030	0.050	0.123	0.004	0.01	0.03
			Mean	0.004	0.005	-	0.012	0.021	0.039	0.004	0.005	0.001
			10%ile or min	0.004	0.005	-	0.004	0.004	0.004	0.004	<0.004	<0.004
Phenol (mg/L)	0.32	0.40	Count	6	0	0	46	31	45	19	5	5
			90%ile or max	0.050	-	-	0.050	0.050	0.224	0.120	<1.0	<1.0
			Mean	0.035	-	-	0.017	0.028	0.058	0.058	<1.0	<1.0
			10%ile or min	0.006	-	-	0.000	0.001	0.001	0.010	<1.0	<1.0
Al (mg/L)	0.055	-	Count	4	17	8	8	0	1	54	5	5
			90%ile or max	0.95	0.10	0.10	0.78			1.05	1.11	1.01
			Mean	0.42	0.07	0.08	0.32		0.07	0.60	0.59	0.39
			10%ile or min	0.03	0.01	0.02	0.04			0.16	0.26	0.08
Cd (mg/L)	0.0002	0.0007	Count	3	13	7	53	12	28	47	5	5
			90%ile or max	0.080	0.090	0.050	0.010	0.010	0.010	0.002	0.0019	0.0021
			Mean	0.034	0.042	0.036	0.018	0.010	0.011	0.002	0.0005	0.0005
			10%ile or min	0.000	0.000	0.000	0.010	0.010	0.010	0.000	<0.0001	<0.0001
Cr (mg/L)	0.001	0.0044	Count	2	14	8	79	35	74	44	5	5
			90%ile or max	0.016	0.100	0.100	0.020	0.024	0.025	0.010	0.002	0.001
			Mean	0.010	0.072	0.075	0.011	0.010	0.012	0.008	0.001	0.001
			10%ile or min	0.003	0.001	0.001	0.001	0.001	0.001	0.001	<0.001	<0.001

Analyte	ANZECC Default Trigger Values		Statistic ¹	Baseline Water Quality Results – Existing Watercourses								KCT Water Quality Data	
				Fresh Water Wetlands			Estuarine Wetlands / Estuary						
	Fresh Water	Estuarine		Blue Billed Duck Pond	Easement Pond	Railway Pond	Deep Pond	Long Pond	OEH Wetlands	Hunter River	Settling Pond 1	Clarified Pond 1	
Cu (mg/L)	0.0014	0.0013	Count	3	17	8	53	12	28	47	5	5	
			90%ile or max	0.017	0.020	0.020	0.040	0.030	0.050	0.020	0.003	0.003	
			Mean	0.009	0.013	0.016	0.018	0.017	0.054	0.015	0.002	0.001	
			10%ile or min	0.003	0.002	0.003	0.006	0.010	0.010	0.003	0.001	<0.001	
Fe (mg/L)	-	-	Count	3	13	7	78	34	74	57	5	5	
			90%ile or max	1.26	0.10	0.10	1.03	0.95	6.88	1.63	0.870	0.890	
			Mean	0.63	0.08	0.09	1.05	0.52	3.08	0.87	0.370	0.250	
			10%ile or min	0.12	0.05	0.05	0.06	0.11	0.18	0.17	0.120	<0.05	
Hg (µg/L)	0.06	0.1	Count	3	8	3	54	32	49	45	5	5	
			90%ile or max	0.38	2.0	1.62	0.28	0.14	0.10	0.10	<0.0001	<0.0001	
			Mean	0.27	0.58	0.73	0.14	0.08	0.07	0.13	<0.0001	<0.0001	
			10%ile or min	0.14	0.10	0.10	0.05	0.05	0.05	0.10	<0.0001	<0.0001	
K (mg/L)	-	-	Count	2	15	8	2	0	1	4	0	0	
			90%ile or max	40.3	91.4	146	374	-	-	430	-	-	
			Mean	29.5	58.2	105	230	-	515	360	-	-	
			10%ile or min	18.7	44.3	63.9	86	-	-	250	-	-	
Mn (mg/L)	1.9	0.08	Count	1	10	6	50	32	49	32	5	5	
			90%ile or max	-	0.10	0.20	0.17	0.06	0.09	0.01	0.149	0.112	
			Mean	0.41	0.10	0.13	0.09	0.03	0.03	0.01	0.055	0.050	
			10%ile or min	-	0.10	0.10	0.02	0.01	0.01	0.01	0.022	0.019	
Na (mg/L)	-	-	Count	2	15	8	3	0	1	4	0	0	
			90%ile or max	564	538	821	8078	-	-	11000	-	-	
			Mean	385	446	477	3463	-	13900	9075	-	-	
			10%ile or min	205	361	284	78	-	-	6170	-	-	
Ni (mg/L)	0.011	-	Count	2	17	8	24	8	1	8	5	5	
			90%ile or max	0.019	0.020	0.020	0.100	0.100	-	0.030	0.002	0.002	
			Mean	0.013	0.013	0.015	0.066	0.058	0.010	0.013	0.002	0.001	
			10%ile or min	0.007	0.001	0.002	0.005	0.010	-	0.004	0.001	0.001	
Pb (mg/L)	0.034	0.044	Count	2	12	6	82	36	76	40	5	5	
			90%ile or max	0.060	0.100	0.100	0.050	0.050	0.020	0.010	0.002	0.002	
			Mean	0.034	0.084	0.100	0.026	0.031	0.011	0.008	0.001	0.001	
			10%ile or min	0.008	0.011	0.100	0.001	0.001	0.001	0.005	<0.001	<0.001	
Zn (mg/L)	0.008	0.015	Count	2	17	8	82	35	76	40	5	5	
			90%ile or max	0.298	0.024	0.020	0.205	0.212	0.160	0.052	0.052	0.042	
			Mean	0.169	0.018	0.017	0.091	0.107	0.098	0.056	0.035	0.028	
			10%ile or min	0.039	0.005	0.009	0.006	0.008	0.005	0.026	0.019	0.014	

Note 1: 10th and 90th Percentile values were reported when 10 or more samples were available. Minimum and maximum values are reported when less than 10 samples were available.

Grey Shading denotes applicable ANZECC Default Trigger values for slightly to moderately disturbed ecosystems are exceeded. The KCT water quality results were assessed against the fresh water default trigger values.

The results in **Table 3** indicate the following water quality trends:

- Mean TSS concentrations in the KCT ponds were generally lower than the reported values in the existing watercourses.
- Mean nutrient concentrations (TP and Ammonia) in the KCT ponds were generally lower than the reported values in the existing watercourses.
- Mean metal concentrations in the KCT ponds were generally similar or below the reported concentrations in the existing watercourses, with the exception of Aluminium which was 2 times higher.
- ANZECC default trigger values were exceeded for a number analytes sampled in the KCT ponds. With the exception of Aluminium, exceedances of similar or greater magnitude were generally reported for the existing watercourses.

3.2.3 Alteration of Natural Flow Regimes - Onsite

Most of the existing project area is a modified and disturbed reclaimed area and could not be described as exhibiting a natural flow regime. Many of the existing ponds within the proposed stockyard area are the result of levees created for the containment of contaminated material or areas that have not yet been filled. Connections between the ponds have been established by engineered culverts or drainage channels. Water bodies within the Hunter Wetlands National Park are more natural however some have been disturbed (albeit to a lesser extent) by historic works including the construction of roads and power lines.

The T4 Project will alter the existing (modified) surface flow regime within the T4 project area. Investigations by Douglas Partners (2011) show that there are limited interactions between the surface flow regime within the T4 project area and existing water bodies outside the project area. Consequently, the flow regime of existing water bodies outside the project area is not expected to be significantly affected by the proposed development.

To compensate for the loss of the existing (modified) surface water features within the T4 project area, it is proposed to construct a series of pond habitats that will provide a corridor linking the OEH Wetlands, Deep Pond (south), Blue-Billed Duck Pond, BHPB Wetlands, Easement Pond South and through to Long Pond. This habitat corridor is outlined in the ecological assessment section of the EA.

Figure 3 outlines the existing flow patterns in and around the T4 project area while **Figure 4** shows the modified flow regime.

Deep Pond

Deep Pond, north of the proposed NCIG northern rail spur, would be modified. During the construction phase of the works, sections of the Deep Pond would be used as a settlement basin to treat dredge water before it is returned to the Hunter River via a lined drainage channel. Following initial dredging activities, Deep Pond (north) would be replaced by a series of settling and clarification ponds. During the operation phase, the lined drainage channel would be removed and the existing downstream flow regime re-established.

It is proposed to retain the section of Deep Pond located south of the proposed NCIG northern rail spur. Prior to dredging, a bund would be constructed to prevent dredge water from entering the pond. Flows from Blue Billed Duck Pond would still be able to enter the pond and a drainage channel would be constructed linking Deep Pond (south) to the existing drainage culverts under the rail loop. The western section of Deep Pond, adjacent to the rail embankment, will also be protected with a bund. This section of Deep Pond will form part of the proposed habitat corridor outlined above.

During the operation phase, prolonged storm events would cause treated surface water to discharge from the T4 Project's surface water management system and fill Deep Pond (south). The surface water interaction within existing wetlands and ponds downstream of Deep Pond (south) would not be affected by the proposed development.

Railway Pond and Ponds #9, #10, #11 and #12

These ponds would be completely filled as part of the T4 Project.

Easement Pond

Easement Pond would be completely modified as part of the T4 Project. The southern part of Easement Pond would be filled while the northern part of the pond would be incorporated into the surface water treatment system.

BHPB Wetlands, Blue Billed Duck Pond and Long Pond

These wetlands and ponds, located to the south of the proposed stockyard area, are not expected to be adversely affected by the proposed development. The existing hydraulic connection between Blue Billed Duck Pond and Deep Pond (south) would remain unchanged. Flows from Deep Pond (south) would be directed to the Hunter River and would not discharge to Blue Billed Duck Pond.

Swan Pond and OEH Wetlands #1, #2 and #3

As described previously, Douglas Partners have confirmed that there is very limited surface water interaction between ponds within the active T4 project area and the Hunter Wetlands National Park. The proposed railway embankment will encroach into the OEH Wetlands. Other than reducing the size of OEH Wetlands #2 and #3, the existing flow regime will not be significantly affected by the T4 Project.

It is estimated that a total of 4 ha of the existing OEH Wetland area will be reclaimed as part of the railway embankment widening. This compares to a total OEH Wetland area of approximately 21 ha. Ecological impacts related to the loss of wetland area are assessed in relevant sections of the EA by others.

3.2.4 Alteration of Natural Flow Regimes - Offsite

Potential impacts to the wetlands that exist to the north of the T4 project area, which includes the Hunter Wetlands National Park, are discussed in **Section 8**.

4 SURFACE WATER MANAGEMENT OBJECTIVES

This section discusses the adopted Surface Water Management System (SWMS) design objectives for both the construction and operational phases of T4 Project.

4.1 Construction Phase Water Management Objectives

The principal objective of the construction phase surface water management will be to prevent contamination of surface and ground waters during construction of the T4 Project. To achieve this, the following broad objectives have been adopted:

- Where practical, separate clean water (i.e. runoff from undisturbed areas), and potentially dirty water within the T4 project area.
- Maximise surface water reuse within the site where possible (e.g. for dust suppression).
- Install and maintain best practice sediment and erosion controls to treat runoff from all disturbed areas.
- The following water quality targets have been adopted:
 - Total Suspended Solids (TSS) concentrations less than 50mg/L or consistent with background concentrations at downstream monitoring locations.
 - pH downstream of the discharge locations is to be between 6.5 and 8.5.
 - Ensure no visible oil or grease is discharged from the site.
- Monitor the effectiveness of the SWMS to ensure these objectives are being met and identify poorly performing elements of the construction phase SWMS to allow for continuous improvement over the duration of the project.

Refer to **Section 10** for further discussion on the conceptual monitoring plan and monitoring locations.

4.2 Operational Water Management Objectives

This section details the operational water management objectives.

4.2.1 General Objectives

The principal objective of the SWMS will be to prevent contamination of surface and ground waters during the operation of the T4 Project. To achieve this, the following broad design and operational objectives have been adopted:

- Where practical, separate clean water (i.e. runoff from non-operational areas), and potentially dirty water (operational areas) within the T4 project area.
- Discharge from the site to the Hunter River is to be limited to significant rainfall events and/or periods of extended wet weather. This is discussed in detail in **Section 4.2.2**.
- During discharge events, water quality treatment is to be provided to achieve water quality targets. Water quality targets are discussed in **Section 4.2.3**.
- Maximise surface water reuse within the site.
- Assess potential climate change impacts on the SWMS.
- Monitor the effectiveness of the surface water measures to ensure these objectives are being met and identify poorly performing elements of the operational phase surface water management system to allow for continuous improvement over the life of the project.

4.2.2 Water Quantity Management Objectives

The DGRs outlined in **Section 1.4** requires the T4 Project's SWMS to reflect a design goal of '*no discharge of water to the Hunter River, other than natural surface run-off in extreme weather events, during operation of the project*'.

A meeting was held with OEH (refer **Section 1.7**) to clarify the surface water discharge expectations for the project. OEH advised that offsite discharge is permissible under certain conditions and that the surface water assessment is to define an 'extreme weather event' and show how the T4 Project will achieve the requirement.

This section discusses:

- Historic design criteria adopted for 'nil discharge' SWMS at Kooragang Island.
- The factors that govern site discharge.
- The most representative method for assessing site discharge.
- Adopted water quantity design criteria for the T4 Project.

Historic Definition of Extreme Weather Event

There is no known relevant guideline that characterises an extreme weather event in the context of water management systems for industrial sites such as the T4 Project. Historically, the 100 year Average Recurrence Interval (ARI) 2 hour duration storm has been adopted as a "nil discharge" design criteria for similar industrial developments at Kooragang Island including the KCT Stage 4 Project (*KCT Stage 4, Environmental Assessment (2009)*) and Newcastle Coal Infrastructure Group Coal Export Terminal (*Operational Water Management Plan (2010)*). The 100 year ARI 2 hour storm at Kooragang Island comprises a total rainfall depth of 94mm (BoM 2011). While this event is extreme in terms of rainfall intensity, due to the relatively short event duration, the rainfall depth and likely runoff volume is similar to what would be expected during a relatively infrequent (i.e. greater than 80th percentile) 10 to 20 day rain period. This is evidenced by the data in **Table 3** that provides rainfall depths for a range (75th to 95th Percentile) of 2, 5, 10 and 20 day rainfall periods (Landcom, 2004). Accordingly, the use of a 100 year ARI short duration storm as design criteria misrepresents the actual capacity of the SWMS. The following sections discuss the factors that govern site discharge and outline the most representative method for assessing site discharge.

Table 3 – 75th, 80th, 85th, 90th and 95th Percentile 2,5,10 and 20 day rainfall depths at Newcastle (Landcom, 2004)

Period	Rainfall Depths at Newcastle (mm over rainfall period)				
	75 th Percentile	80 th Percentile	85 th Percentile	90 th Percentile	95 th Percentile
2 day	14	18	23	32	48
5 day	24	31	39	52	77
10 day	44	53	65	83	114
20 day	86	99	115	140	182

Shaded cells denote rainfall depths less than the 100 year ARI 2 hour duration storm event.

Factors That Govern Site Discharge

The frequency and magnitude of site discharge is governed by the following factors:

- Climatic conditions such as rainfall intensity and frequency and, to a lesser degree, evaporation rates.
- The hydrologic characteristics of the catchments within the SWMS that define the volume of runoff from a given rainfall event.
- The ratio of available storage volume to catchment area. The available storage for any given rainfall event is governed by the antecedent storage volume.
- The drawdown rate of water retained during rainfall periods. At the T4 Project, drawdown will occur from both water harvested for on-site use and evaporation. The draw down rate

defines how quickly the storage recovers following a given rainfall event. A higher drawdown rate increases the probability that sufficient storage is available to contain the next rainfall event.

Methods for Assessing Site Discharge

As explained above, the factors that govern discharge include climatic conditions and associated runoff volumes, available storage volumes and storage drawdown rates. As such, any assessment of the site discharge characteristics should capture all of these contributing factors. Accordingly, the most representative method for determining the effectiveness of the SWMS is to assess site discharge characteristics such as discharge frequency and volume of discharge. This is considered more representative than a rainfall based assessment criteria that does not consider all the factors that govern site discharge.

Assessment of site discharge characteristics requires the development of a Site Water Balance Model (SWBM) that captures all of the factors that govern site discharge. **Section 6** discusses the water balance model methodologies, assumptions and results.

Adopted Discharge Criteria

Based on the above discussion, the following discharge criteria have been adopted for this assessment:

- The average frequency of site discharge is to be less than 1 in 3 months. A site discharge event is defined as a period of continuous discharge associated with a particular wet weather event.
- The average volumetric discharge from the site is to be less than 25% of total surface water runoff (i.e. 75% of average volumetric runoff is reused on-site).

Section 6.6, which presents the T4 Project SWBM results, demonstrates that the above discharge criteria result in a similar SWMS performance to a system that is designed to capture runoff from a 100 year ARI 2 hour duration storm event.

4.2.3 Water Quality Management Objectives

As discussed in **Section 4.2.2**, discharge from the site will occur during periods of significant rainfall. The following water quality management objectives have been adopted to ensure that the quality of water discharged does not diminish the water quality or ecological values of the receiving water.

- **SWMS Design Objectives** The following water quality treatment design objectives have been adopted for discharge from the site:
 - 90% removal efficiency of TSS (mean particle size of 20 µm) during a 90th percentile discharge event.
 - No visible oil and grease in the discharge.
- **Performance Monitoring Objectives** Surface water monitoring will be undertaken to assess the performance of the SWMS. The surface water monitoring programme will comprise sampling at:
 - various locations within the SWMS
 - discharge locations; and
 - near-field receiving water locations.

Water quality trigger values are to be established in an Operation Environmental Management Plan (OEMP) using the methods outlined in ANZECC (2000).

5 SURFACE WATER MANAGEMENT PLAN

5.1 Construction Phase

This section outlines conceptual surface water management for the construction phase of the T4 Project. The CEMP will include best practice surface water controls which will be designed to mitigate the potential pollutant processes that are identified in **Section 3** for the construction phase of the T4 Project.

During construction of the T4 Project the following measures would be implemented.

5.1.1 Construction Erosion and Sediment Control Plan

A CEMP will be prepared covering the protection of environment features including surface water runoff. As part of the CEMP, an Erosion and Sediment Control Plan (ESCP) would be designed, installed and maintained in accordance with “*Managing Urban Surface water – Soils and Construction*” (Landcom 2004). The controls specified in the ESCP will ensure that there are no significant adverse impacts on receiving water quality during the construction stage. In particular, the following measures would be adopted:

- Install site drainage works (site perimeter bunds, drainage diversions, silt fences) to contain and safely convey surface water and dredge water to treatment devices.
- Where possible, divide the site into smaller, more manageable catchments and separate clean water from dirty water. Dirty water is to be directed to sediment settling basins.
- Existing ponds that are near construction areas and are to be retained will be marked as ‘no go’ areas.
- Deep Pond will be modified through installation of bunds to separate the southern and north western portions as shown in **Figure 4**. The remaining pond area will be used as a settling basin. Wherever possible, habitat values of Deep Pond will be retained.
- Construction plant and materials are to be stored and maintained away from temporary and permanent drainage features.
- Refuel plant / machinery within bunded areas.
- Monitor captured runoff prior to discharging to the south arm of the Hunter River during / after prolonged or significant rainfall events.
- Installation of a silt curtain (skirt with floats and ballast) in the south arm of the Hunter River during dredging, the construction of the wharf facilities and at the dredge water return point.
- Where necessary, watering of any stockpiles and exposed areas to reduce the likelihood of sediment entrainment through wind driven processes.
- Where appropriate early re-vegetation or sealing of completed elements of the development will be undertaken to reduce sediment laden run off.
- Regular inspection of construction areas and surface water controls.
- Regular inspection of all plant and machinery to reduce the likelihood of oil/grease leaks
- Provision of appropriately sized spill kits to facilitate the rapid remediation of any accidental spill of potential contaminants.

Douglas Partners (2011) advise that low levels of acid sulphate soils are likely to be encountered during excavation activities. An Acid Sulphate Management Plan will need to be prepared as part of the CEMP prior to the commencement of excavation activities.

It is expected that up to 1 ML/day of water will be required for construction activities such as bulk earth works. This water will be sourced from either on-site sediment dams or local potable supply.

5.1.2 Management of Dredge Waters

Sand dredged from the Hunter River South Arm is proposed to be pumped to the proposed stockyard area, to provide pre-load and fill material for parts of the stockyard, rail corridor and wharf area. Bunds will be used along the site perimeters to contain all dredge water and surface water within the stockyard construction area. Deep Pond will be modified through installation of bunds to

separate the southern and north western portions with the remaining pond area to be used as a settling basin.

It is noted that the approved NCIG rail flyover may be constructed across Deep Pond prior to T4 dredging commencing. In this scenario, the rail flyover would effectively serve as the bund to the southern portion of Deep Pond (although culverts may need to be temporarily blocked). Flow from Blue Bill Duck Pond would still enter Deep Pond (south) in order to maintain the existing flow regime.

As the sand slurry is pumped into the site, sediment laden dredge water will flow west towards the existing Deep Pond where fines will settle out before water is returned to the Hunter River via a lined drainage channel (and bypassing Deep Pond (south)).

Silt curtains would be installed in the Hunter River at the return water discharge location. Water quality downstream of the silt curtains, at defined monitoring points, would meet the specified levels defined in the environmental management plan and restricted by the dredging licence (e.g. limit suspended solids to 50mg/L or below background concentrations).

5.2 Operational Phase

This section outlines conceptual surface water management measures proposed to be implemented during the operational phase of the T4 Project to mitigate the potential pollutant processes that are identified in **Section 3.2**.

To optimise the management of surface water, the site will be separated into clean and dirty runoff areas. Clean water is characterised as surface flow from areas external to the operations. This includes the Stage 2 Project Area prior to its construction. Dirty water is runoff from the active operational areas of the site.

Water generated from clean and dirty areas will be managed separately. Where possible, surface water runoff from clean areas will be collected by catch drains and returned to the existing undisturbed drainage systems. Dirty surface water runoff will be conveyed to settlement basins for treatment and subsequent onsite reuse.

Surface water from dirty areas will only discharge to the Hunter River (via Deep Pond (south)) during prolonged wet weather conditions (refer **Section 6**).

Figure 4 shows the conceptual surface water drainage layout for the T4 project area while **Plate 9** shows a schematic of the conceptual surface water layout. A description of each component of the drainage network is provided below. Note that final landform, levels and drainage systems are subject to detailed to design and will be subject to further refinement.

5.2.1 Stockyard Area

The stockyard drainage system comprises of:

- main drainage lines
- pit and pipe system
- clean out sumps
- underdrain system

Main drainage lines are located to the east, west and north of the stockyard area and convey all collected surface water to the settlement ponds.

The pit and pipe system will convey surface water from the stockyard and adjoining access roads to the eastern and western main drainage lines.

Clean out sumps are located in areas of the stockyard where coal is likely to be spilt. These areas include the dump station, conveyor inclines, transfer houses, buffer bins and the sampling area. The clean out sumps act as gross pollutant traps and will capture coarse coal sediments and any accidental oil spills. Following settlement of the coarse sediments, the surface water is pumped to

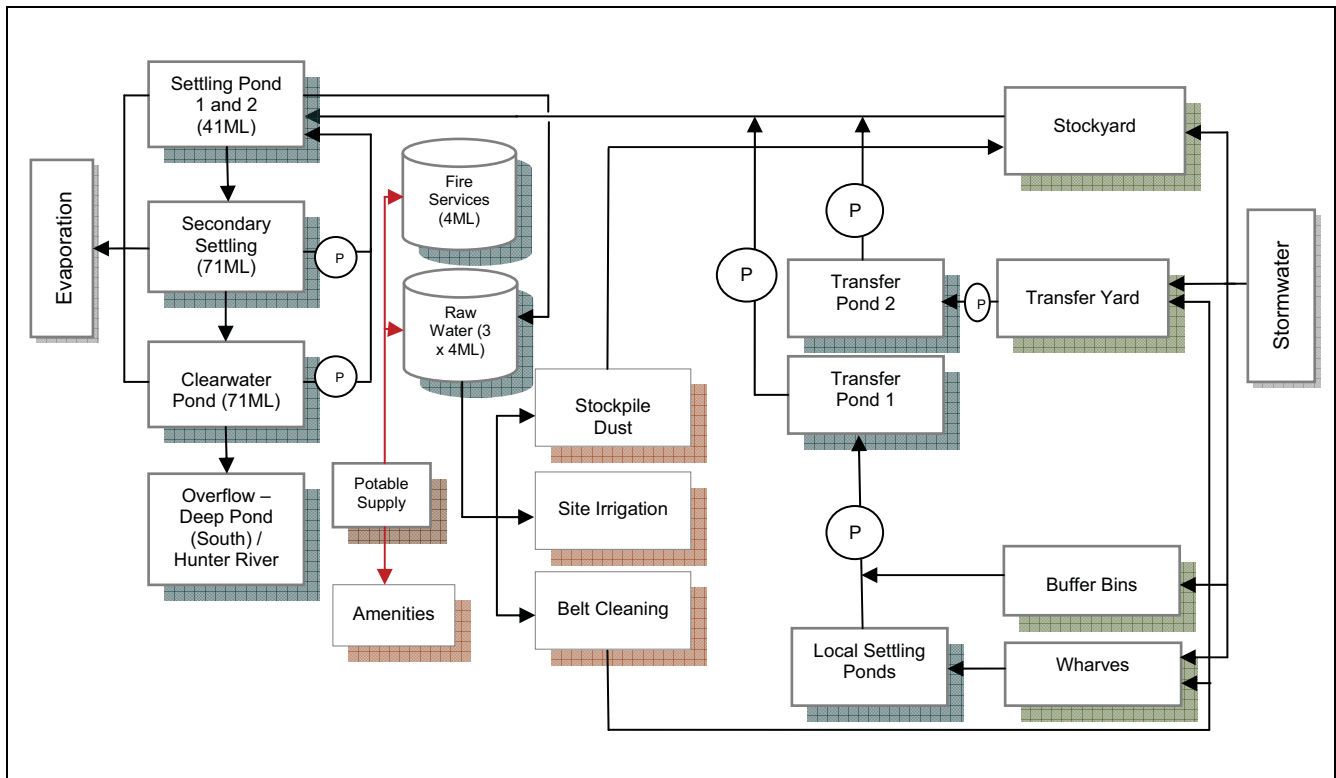


Plate 9 – Schematic of the conceptual surface water system

the nearest main drainage line or settlement pond. Should an oil spill occur, the clean out sump can be pumped to a truck and disposed of to an appropriate waste disposal facility.

An underdrain network is located under the stockpile areas and passes captured surface water through crushed rock prior to discharging to the northern main drainage line.

5.2.2 Rail Infrastructure

To receive coal, the T4 Project will provide additional rail lines to the north and west of the existing rail lines servicing Kooragang Island.

Surface water runoff from the northern and western rail embankment would be directed to local swales that will provide water quality treatment prior to off site discharge. Where possible the top of the rail embankment will be cambered towards the stockyard so runoff will enter the dirty water system.

5.2.3 Transfer Yard

Surface water captured within the transfer yard would be directed to a local sediment basin. The basin will settle out coarse sediments and surface water will be pumped back to the stockyard treatment and recycling system.

5.2.4 Wharves

The wharf areas will be designed to ensure surface water drains away from the Hunter River. The wharves will be serviced with pit and pipe systems draining to local settlement basins. The basins will be sized to capture all runoff occurring during a 100 year ARI 2hour duration storm event. Captured surface water will be pumped back to the stockyard treatment and recycling system.

5.2.5 Transfer Ponds

Transfer Pond 1 is a settling basin located south of the stockpile area, which receives surface water pumped from the buffer bin, wharf sediment sumps as well as clean-out sumps located along the southern access road. Collected surface water is pumped to the western main drainage line.

Transfer Pond 2 is a settling basin located adjacent to the transfer station to the east of the stockpiles. The pond receives surface water from cleanout sumps located to the east of the stockpiles and then pumps this collected surface water to the eastern main drainage line.

5.2.6 Deep Pond (North)

Deep pond will be bisected by the proposed NCIG rail line. It is proposed to transform the northern section of Deep Pond into a series of four lined ponds. The ponds collect and treat all surface water generated from the 'dirty' areas of the site.

Primary Settling Pond 1 and 2 have a combined storage of approximately 41ML and will remove coarse and median sized sediments. Following primary treatment, surface water will enter the Secondary Settling Pond, with a volume of approximately 71ML, where finer sediments will be removed. Following treatment by the Secondary Settling Pond, surface water is pumped back into Primary Settling Pond 2 for subsequent reuse.

A pump station will transfer water from the Primary Settling Pond 2 to three 4ML storage tanks raw water tanks which will supply water for dust suppression and wash-down. A separate 4ML storage tank will be reserved for fire fighting purposes. Water will be sourced from Hunter Water Corporation for potable purposes and during periods when water cannot be supplied by Clearwater Pond.

5.2.7 Deep Pond (South)

Deep Pond (south) is proposed to be incorporated into a proposed habitat corridor that will link OEH wetlands, Blue-Billed Duck Pond, BHPB Wetlands, Easement Pond South and Long Pond. This habitat corridor is outlined in the ecological assessment as part of the EA.

The existing inflows from Blue Billed Duck Pond would be maintained and would flow to Deep Pond (south). Overflows would be directed to the existing culverts under the NCIG rail loop via a constructed drainage channel.

Excess water generated during prolonged wet weather will overtop the Clearwater Pond and flow to Deep Pond (south).

6 WATER QUANTITY ASSESSMENT

A Site Water Balance Model (SWBM) was developed for the operational phase of the T4 Project. The SWBM was used to assess the effectiveness of the SWMS in meeting the water quality objectives detailed in **Section 4.2.2** and to provide an estimate of the potential efficiency of surface water harvesting to meet on-site process water demands.

This section details the methodologies and assumptions applied to the development of the SWBM as well as the results.

6.1 Modelling Approach

The SWBM was developed using a scripted water balance model that has been developed by SMEC. The water balance model is a continuous simulation model that simulates the performance of the proposed SWMS under a range of climatic conditions. The key features of the model are described below:

- The model runs on a daily time step and requires daily rainfall and evaporation rates as model inputs. The model results are available on a daily time step, but are reported as annual averages to simplify the model results.
- The model applies a long term rainfall record that includes a wide range of imbedded dry and wet periods as well as major flood events. The model results are processed to provide a statistical representation of the performance of the proposed SWMS, under a full range of climatic conditions.
- Water demands and sources can be applied at constant rates or through the use of custom functions. Time series data can also be applied when known or observed data is available.
- Water transfers between storages, demands and sources can be controlled using transfer rules that are based on storage levels, demand requirements and/or source availability. This function can be used to ensure elements of the SWMS, such as maintaining low levels in flood mitigation storages, can be captured in the water balance simulation.

Confirmation of Assumptions

The SWBM model assumptions reflect the engineering design for the T4 Project that was undertaken at the prefeasibility stage of the project. At this time of writing this report, the project is currently being progressed to the detailed design phase. Accordingly, the SWMB model assumptions will require review when the additional design detail is available. If this review indicates that the objectives outlined in **Section 4** won't be achieved, additional measures such as increased storage will be provided to ensure the objectives are achieved.

Appendix B contains a summary of all SWBM assumptions.

6.2 Rainfall and Evaporation

6.2.1 Rainfall Data

Daily rainfall and climatic data was available from the following BoM weather stations that are located within 15km of the T4 project area:

- Newcastle Nobbys (BoM station 61055) which is located 5.0 km to the southeast
- Williamtown RAAF (BoM station 61078) which is located 11 km to the northeast
- Grahamstown (HWC) (BoM station 61311) which is located 12.5 km to the north

Table 4 presents statistical rainfall data derived from the BoM rainfall records for the above stations.

Table 4 – Comparison of Annual Rainfall Data

Statistics	Newcastle Nobbys BoM 61055 1867 to 2011	Williamstown RAAF BoM 61078 1942 to 2011	Grahamstown (HWC) BoM 61311 1971 to 2011
Elevation	33 (m AHD)	9 (m AHD)	11 (m AHD)
5 th Percentile Rainfall (mm)	764	756	729
10 th Percentile Rainfall (mm)	795	788	819
Mean Rainfall (mm)	1134	1127	1075
90 th Percentile Rainfall (mm)	1543	1497	1388
95 th Percentile Rainfall (mm)	1629	1566	1437

Source: Bureau of Meteorology

Comparison of the statistical rainfall data from the three regional weather stations indicates that all stations have recorded a similar mean rainfall. Given its closer location, and long records, the data from the Newcastle Nobbys station (*BoM Station 61055*) was adopted to assess long-term rainfall trends in the vicinity of the T4 project area. A 110 year (from 1900 to 2010) continuous daily rainfall time-series was applied to the SWBM.

6.2.2 Evaporation Data

Average monthly areal and point potential evapotranspiration (*PET*) rates at the T4 project area were extracted from PET maps provided by the BoM (BoM 2011). BoM advises that areal PET is conceptually the upper limit to actual evapotranspiration in most rainfall-runoff modelling studies. BoM also advises that point PET may be taken as a rough preliminary estimate of evaporation from small water bodies such as shallow water storages. For the water balance, point PET was applied to water bodies while areal PET was applied to pervious areas.

The adopted PET depths are presented in **Table 5**.

Table 5 – Average Potential Evapotranspiration at the T4 project area

Month	Areal Potential Evapotranspiration (mm/month)	Point Potential Evapotranspiration (mm/month)
January	180	210
February	135	160
March	135	150
April	90	120
May	60	70
June	50	65
July	50	65
August	65	95
September	80	120
October	135	150
November	150	180
December	165	200

6.3 Site Catchment Areas

Table 6 presents the distribution of the various catchment areas within the T4 Project SWMS.

Table 6 – Adopted Site Areas for Water Balance Modelling

Catchment	Area (ha)	Impervious % ¹	Daily Rainfall Loss (mm/day)	Average Annual Runoff Coefficient
Water Treatment Ponds	8.2	100	0	1.00
Stockyard Area ² (excl. stockpiles)	110.0	100	2	0.80
Stockpile Area	47.2	100	5	0.63
Wharf Areas (north & south bank) and Buffer Bin Area	33.9	50	7 ³	0.55
Total	199.3			0.72

Note1: Impervious percentages for stockyard and wharf areas have been measured from pre-feasibility plans provided by Aurecon Hatch (2011).

Note2: Stockyard Areas are assumed to be 100% impervious as the area will be capped with a low permeability liner. The Daily Rainfall Loss rate of 2mm/day was adopted to achieve an Average Annual Runoff Coefficient of 0.8, which is within the expected range recommended by Douglas Partners (2011).

Note 3: Loss rate of 7mm calculated by applying a 10mm/day loss rate for pervious areas and a 2mm/day loss rate for impervious areas.

6.4 On-site Storages

The following storages were included in the SWMB (refer to **Figure 4** for storage locations):

- **Pond 1:** 26.3 ML – maintained at 50% full, overflows into Pond 2.
- **Pond 2:** 14.9 ML – Maintained at 50% full, overflows into Pond 2. Process water extracted from pond 2.
- **Pond 3:** 71 ML – Overflow storage, all water captured returns back to Pond 2. Overflows to Pond 4.
- **Pond 4:** 70.7 ML - Overflow storage, all water captured returns back to Pond 2. Overflows to the Deep Pond South.
- **Wharf Area Ponds:** 30 ML – Comprises three separate ponds that capture runoff from the northern and southern Wharf Areas as well as the Buffer Bin Area.

The total volume of storage is 212.9 ML which is equivalent to 107 mm of runoff from the 199.3ha catchment area. Deep Pond (south) which is downstream from Pond 4, was conservatively not included in the SWBM.

6.5 Site Water Demands

Only small quantities of water will be required during the construction phase of the T4 Project. Water requirements would be limited to amenities, dust suppression and moisture conditioning of earthworks. Potable water required during the construction phase would be sourced from a temporary connection to the HWC system.

During the operation phase, the T4 project will require water for the following purposes:

- stockpile dust suppression
- chute / conveyor dust suppression

- belt cleaning
- washdown bays
- amenities
- ship supply
- fire fighting
- landscaping

Water demands during the operational phase of the T4 Project will initially be met through a combination of surface water re-use and water purchased from Hunter Water Corporation (HWC). In future, alternative water sources such as recycled treated sewage effluent from HWC may become available and their feasibility would be investigated. The SWBM was established for the ultimate development (*120Mtpa coal throughput*) in order to estimate the relative requirements of recycled surface water and HWC supplied water. Opportunities to link and integrate the T4 water management system to the KCT water management system are also expected to be examined.

It was assumed for the SWBM that on average all process water is to comprise a minimum 5% potable water and up to 95% harvested water. The ratio of potable water in the water make will increase during dry periods when there is a limited supply of surface water.

6.5.1 Stockpile Dust Suppression

The dust suppression system will be automated and based on the stockpile moisture content and the prevailing meteorological conditions. The SWBM applies the volume of water required for dust suppression based on rainfall and evaporation (*refer Section 6.2*). The model was calibrated to actual volumes reported at Carrington Coal Terminal stockyard which is approximately 30% of the area of the proposed T4 Stockyard Area. Estimated daily volumes and equivalent irrigation depths (*for non-rain days*) for the various seasons are:

- Summer 4.2ML (8.9mm)
- Autumn 3.5ML (7.4mm)
- Winter 2.3ML (4.8mm)
- Spring 3.5ML (7.4mm)

The SWBM assumes that stockpile dust suppression is not applied on rainy days, with rainy day being defined as more than 10mm of rainfall per day.

6.5.2 Chute / Conveyor Dust Suppression

Aurecon Hatch (2011) has estimated that the T4 Project will require approximately 247 ML of water per annum for the chute dust suppression spray bars. This is based on three coal streams operating 3,880 hours per year.

6.5.3 Belt Cleaning

Aurecon Hatch (2011) has estimated that the T4 Project will require approximately 340 ML of water per annum for the belt cleaning spray bars. This is based on three coal streams operating 3,880 hours per annum. It is estimated that 33% of the water used for belt cleaning can be recovered and directed to the sediment treatment ponds for subsequent re-use.

6.5.4 Wash Down Bays

Aurecon Hatch (2011) has estimated the T4 Project will require approximately 19.7 ML of water per annum for wash down water. This is based on two hoses operating 50% of the time over a 10 hour period. It is estimated that 50% of the water used for wash down can be recovered and directed to the sediment treatment ponds for subsequent re-use.

6.5.5 Amenities

Amenities potable water consumption would be limited to that of visitors and onsite personnel. It is estimated that an equivalent of 10 people would use approximately 0.4ML/yr of potable water for amenities.

6.5.6 Ship Water Supplies

Aurecon Hatch (2011) has estimated the T4 Project will require approximately 136 ML of potable water per annum for ship water supplies. This is based on 20 ships per week and 130kL of potable water demand per ship.

6.5.7 Demand Summary

In summary, the theoretical maximum water demand (accounting for return water) for the T4 Project, at 120 Mtpa is estimated to be 1,847 ML/year which comprises a minimum of 228 ML/year of potable water and up to 1,619 ML/year of harvested surface water (subject to surface water availability). However, as stockpile dust suppression is only applied on non-rain days, the actual demand will be moderately lower than the theoretical maximum demand.

In terms of draw down rate, a 1,619 ML/year demand equates to an average daily draw down rate of 4.44 ML/day, which is equivalent to 2 mm/day of runoff from the 199.3 ha catchment area. At a draw down rate of 4.44 ML/day, Ponds 3 and 4 would take approximately 30 days to empty. It is noted that actual draw down rate is likely to be longer due to additional surface water runoff and reduced demand due to rainfall during the draw down period.

6.6 Water Balance Results

The SWBM was used to simulate the performance of the SWMS using 110 years of continuous rainfall data. The 110 years of data contains a wide range of climatic conditions including droughts, major flood events as well as many average, wet and dry periods. The SWBM results are presented in the following formats:

- **Table 7 - SWBM Results:** SWBM results incorporate all years of data and are the simplest measure of the performance of the SWMS. It is noted that as the SWBM results include major rainfall events (such as the June 2007 storm), the results are not representative of average conditions.
- **Table 8 - Typical results for dry, average and wet years:** Typical water balance results were calculated for dry (10th percentile), average (50th Percentile) and wet (90th Percentile) rainfall years. For each set of results, 5 representative rainfall years were selected. The average results from the 5 yearly data sets were adopted.

SWBM Results

Table 7 – SWBM Results or 110 Year Record

	Model Results	Water Quantity Objective
Discharge Frequency ¹	1 in 3 months (95 days)	1 in 3 months (90 days)
Discharge Coefficient ²	0.24	0.25
Surface Water Re-use Efficiency ³	73 %	N/A

Note 1: A discharge event is defined as a period of continuous discharge. The discharge event is counted following a 72 hour period of no discharge.

Note 2: Discharge Coefficient is the total discharge volume / total surface water runoff over the 110 year record.

Note 3: Surface Water Re-use Efficiency is the percentage of potential process water demand that is met by surface water re-use. Potable water demands are not included in this calculation.

The model results presented in **Table 7** indicate that site discharge will occur at an average frequency once every 95 days which marginally exceeds the 1 in 3 month objective outlined in **Section 4.2.2**. The average discharge coefficient represents the portion of total site runoff that is discharged from site. Accordingly, the predicted discharge coefficient of 0.24 indicates that 24% of runoff would discharge from site and 76% would be captured and re-used. The predicted discharge coefficient meets the 0.25 objective outlined in **Section 4.2.2**.

Typical Results for Dry, Average and Wet Years

The SWBM results presented in **Table 8** demonstrate the likely range of operating conditions for the SWMS. Model results indicate that surface water runoff will vary from 1,110 ML/year in dry years to 2,359 ML/year in wet years. Water demand is relatively constant, with a 65 ML/year variation between dry and wet years predicted due to the increase in the number of days stockpile dust suppression is required in dry years.

Table 8 – Typical Water Balance for Dry, Average and Wet Years

	Units	Dry Year ⁴	Average Year ⁴	Wet Year ⁴
Rainfall (mm)	(mm/Year)	795	1134	1543
Water Sources				
Surface Water Runoff	(ML/Year)	1,110	1,640	2,359
Potable Water Supply				
a) Process Water Use (top up)	(ML/Year)	627	224	223
b) Potable Water Use	(ML/Year)	221	219	218
Total Potable Water Supply	(ML/Year)	848	443	441
Total Sources	(ML/Year)	1,958	2,083	2,800
Water Demands				
Net Water Demands				
a) Stockpile Dust Suppression	(ML/year)	1,151	1,107	1,085
b) Chute Dust Suppression	(ML/Year)	247	247	247
c) Belt Cleaning	(ML/Year)	228	228	228
d) Wash Down	(ML/Year)	10	10	10
e) Ship Supply	(ML/Year)	136	136	136
Total Net Demands	(ML/Year)	1,771	1,728	1,706
Water harvesting Efficiency	(by Calc)	60%	85%	85%
Evaporation Losses	(ML/Year)	85	102	103
Total Water Loss	(ML/Year)	1,856	1,830	1,809
Site Discharge				
Average Discharge Volume	(ML/Year)	102	253	991
Discharge Frequency¹	Typical number of annual discharge events	1 to 3	2 to 6	3 to 10
Site Discharge Coefficient²	Discharge/Total Runoff	0.09	0.15	0.42

Note 1: A discharge event is defined as a period of continuous discharge. The discharge event is counted following a 72 hour period of no discharge.

Note 2: Average Discharge Coefficient is the total discharge volume / total surface water runoff.

Note 3: Average Surface Water Re-use Efficiency is the percentage of potential process water demand that is met by surface water re-use. Potable water demands are not included in this calculation.

Note 4: Results for dry, average and wet years are representative of 10th Percentile, average and 90th Percentile rainfall years respectively. Reported results from each category have been determined based on the average results from 5 representative rainfall years.

The SWBM differentiates between potable water demand and surface water demand. Modelling indicates that total surface water loss exceeds the estimated surface water runoff in dry years by 746 ML/year. As such, average water demand exceeds water supply in dry years and therefore discharge events are limited to imbedded wet weather periods within the year where total runoff exceeds the available storage. This is referred to as storage constrained discharge. In average years, surface water runoff volumes (1,640 ML/year) are slightly below the total surface water loss (1,830 ML/year), indicating that discharge events will be primarily storage constrained. In wet years, the estimated surface water runoff volume exceeds the surface water demand by 550 ML/year. Accordingly, modelling indicates that discharge events during wet years will occur due to both storage and demand constraints.

6.6.1 Compliance with Water Quantity Objectives

Section 4.2.2 discussed the factors that govern site discharge and established water quantity management objectives. The following points summarises the SWBM results in context with **Section 4.2.2**:

- The collective storage volume of Ponds 1, 2, 3 and 4 and the wharf area storages is 212.9 ML which is equivalent to 107 mm of runoff from the 199.3ha catchment area. This would exceed the historic design objective of providing sufficient storage to contain a 100 year ARI, 2 hour duration design storm event which comprises 94mm of rainfall and approximately 90mm of runoff.
- This section identified climatic conditions and associated runoff volumes, available storage volumes and storage drawdown rates as the factors that contribute to site discharge characteristics. The SWBM incorporates all of these factors and therefore provides a representative estimate of the site discharge characteristics.
- **Section 4.2.2** identified the following two performance criteria:
 - The average frequency of site discharge is to be less than 1 in 3 months.
 - The average volumetric discharge from the site is to be less than 25% of total surface water runoff (i.e. 75% of average volumetric runoff is reused on-site).

The SWBM results presented in **Table 7** demonstrate that the SWMS would achieve both of these objectives.

6.7 Potential Climate Change Impacts

The most recent and comprehensive estimate of projected climate change impacts in the Hunter Valley is documented in '*NSW Climate Impact Profile: The Impacts of Climate Change on the Biophysical Environment of New South Wales*' (DECCW 2010). The report projects the following climate change impacts in the Hunter Valley to occur by 2050:

- Increased evaporation rates are likely in all seasons.
- Increased rainfall is likely to occur in Spring, Summer and Autumn and a decrease is likely in Winter.

Table 8 presents the reported range of projected climate change impacts by 2050 in the eastern portion of the Hunter Region. The SWBM was revised to incorporate the project climate change impacts. **Table 8** presents the adopted adjustments made to seasonal rainfall and evaporation rates as well as stockpile dust suppression water use as this is likely to increase in line with evaporation rates. **Table 9** compares the SWBM results for the existing and projected 2050 climate scenarios.

Table 8 – Projected climatic changes in the eastern portion of the Hunter Region by 2050 (DECCW, 2010)

Season	Rainfall		Evaporation		
	Projected change	Adopted increase	Projected change	Adopted increase	Adopted Increase in Stockpile Dust Suppression
Spring	5 to 20% increase	12.5% increase	20 to 50% increase	35% increase	35% increase
Summer	10 to 50% increase	30% increase	10 to 20% increase	15% increase	15% increase
Autumn	5 to 10% increase	7.5 % increase	5 to 20% increase	12.5% increase	12.5% increase
Winter	5 to 20% decrease	12.5 % decrease	10 to 20% increase	15% increase	15% increase

Table 9 – SWBM Results for existing and project 2050 climate scenarios.

	Existing Climate Conditions	Projected 2050 Climate Conditions	Water Quantity Objective
Discharge Frequency ¹	1 in 3 month (95days)	1 in 3 month (88 days)	1 in 3 month (90 days)
Discharge Coefficient ²	0.24	0.25	0.25
Surface Water Re-use Efficiency ³	73 %	71 %	N/A

Note 1: A discharge event is defined as a period of continuous discharge. The discharge event is counted following a 72 hour period of no discharge.

Note 2: Discharge Coefficient is the total discharge volume / total surface water runoff.

Note 3: Surface Water Re-use Efficiency is the percentage of potential process water demand that is met by surface water re-use. Potable water demands are not included in this calculation.

With reference to **Table 9**, the SWBM results indicate that the projected 2050 climate would not significantly alter the performance of the SWMS (relative to existing climatic conditions). Model results indicate that a minor increase in the frequency and magnitude of discharge events would occur as well as a minor reduction in the average surface water re-use efficiency.

7 WATER QUALITY ASSESSMENT

7.1 Construction Phase

A priority in the control of surface water, especially during construction, is the capture of suspended solids. There is a strong association between suspended solids and many other contaminants, including hydrocarbons and heavy metals that adhere to suspended solids (*Duncan 1999*). The percentage of adherence for some surface water pollutants (*for example*) is explored by Fowler (2008) and includes iron (85%) and lead (55%).

During the construction phase, the basin sizing methods outlined in 'Managing Urban Surface water: Soils and Construction' Landcom (2004) (*Blue Book*) and 'Managing Urban Surface water: Soils and Construction Volume 2E Mines and Quarries' DEC (2008) will be adopted where appropriate.

DEC (2008) recommend that sediment retention basins in sensitive environments with operating durations greater than 12 months be designed for the 2 year ARI design storm event. The flow from a 2 year ARI design storm event was determined using the rational method.

Landcom (2004) suggest, in the absence of alternative criteria being nominated (e.g. in a Council Surface Water Management Plan), a design particle size of 20µm be adopted. This is typical of a fine to medium silt and has been adopted to size the sediment settling basins.

7.2 Construction Water Quality Results

7.2.1 Dredge Operations

The area of the proposed stockyard is approximately 160ha and preliminary calculations indicate that, during dredging operations (*when the site is pervious*), a minimum settling volume of approximately 26,000m³ would be required to meet the requirements of Landcom (2004). The volume of Deep Pond is estimated to be over 100,000m³ and as such would meet settlement requirements during the dredging process.

7.2.2 Remaining Construction

Following the filling of the site, the settling ponds would be constructed to contain any sediment movement within the site. Preliminary calculations (refer **Section 7.3.1**) indicate that a minimum settling volume of approximately 61,000m³ would be required to meet the requirements of the Blue Book (Landcom, 2004). The settling volume offered by the two primary ponds and the secondary pond is approximately 94,000m³ and therefore this requirement is satisfied.

A surface water quality monitoring program would be developed and implemented to monitor water quality within the onsite settlement ponds to ensure the quality objectives defined in the environmental management plan are met.

7.3 Operation Phase

During operational phase of the T4 Project, a priority of surface water systems is to capture suspended solids generated from the coal stockpile and from site. Due to the strong association between suspended solids and many other contaminants, including hydrocarbons and heavy metals that adhere to suspended solids (*Duncan 1999*), a system that is efficient in removing suspended solids will perform well in removing other contaminants.

7.3.1 Sediment Capture Efficiency in Storm Events

As outlined in **Section 6**, during periods of extended wet weather, the ponds storage capacity may be exceeded and may discharge. To assess the water quality of the discharge, an assessment of the sediment removal efficiency of the basin system was undertaken (following Fair and Geyer 1954).

Table 10 shows the sediment removal efficiency at the outlet of Clearwater Pond during a 90th, 95th and 99th percentile peak daily discharge flow (obtained from the SWBM). A sediment size of 0.02mm with a settling velocity of 0.27mm/s has been adopted for this assessment.

Table 10 – Sediment Removal Efficiency

Discharge Event (%ile)	Peak Daily Flow (m ³ /s) ¹	Capture Efficiency (%)
90 th	0.97	98.7
95 th	1.4	97.7
99 th	2.1	96.0

Note 1: the peak daily flow is the peak daily flow predicted during a discharge event, which may occur for a number of days. The reported peak flow is the average flow over the day.

As shown in **Table 10**, the sediment removal efficiency of the SWMS exceeds the objectives of 90% sediment removal as outlined in **Section 4.2.3**.

8 POTENTIAL OFF SITE HYDROLOGIC IMPACTS

The northern extent of the T4 project area comprises coal dump stations and associated rail sidings. The proposed rail sidings will require the construction of an embankment that will be approximately 90m wide and aligned immediately to the north of the existing rail line that services the KCT. While the proposed rail embankment will be constructed outside of the Hunter Wetlands National Park and within the SPI Special Activities Zone, there is potential for the embankment to alter the existing tidal regime in some sections of the Hunter Wetlands National Park through obstruction of estuarine channels that convey tidal flows to the wetland complex.

With reference to **Figure 5**, the proposed rail embankment alignment crosses both Mosquito Creek (also known as Moscheto Creek) and an unnamed watercourse that is located approximately 850m to the east of Mosquito Creek. This watercourse is referred to as the Eastern Watercourse in the remainder of this report. A freshwater wetland exists to the east of the Eastern Watercourse. This wetland is referred to as the Eastern Freshwater Wetland in the remainder of this report.

An assessment that included site inspections of Mosquito Creek and the Eastern Watercourse and the installation of water level meters in both watercourses was undertaken in order to:

- Gain an understanding of the existing tidal regime in both Mosquito Creek and the Eastern Watercourse;
- Identify potential impacts to the existing tidal regime that may result from the construction of the rail embankment; and
- Develop appropriate measures to mitigate identified impacts.

8.1 Historical Disturbance

Prior to industrialisation of the southern portion of Kooragang Island, Mosquito Creek connected the North and South Arm of the Hunter River. **Plate 10** is an aerial image from 1954 which shows the former alignment of Mosquito Creek. As noted in **Plate 10**, Mosquito Island, which was the name given to land to the east of Mosquito Creek, was modified for pastoral land-uses some time before 1954 (the date of the photo).

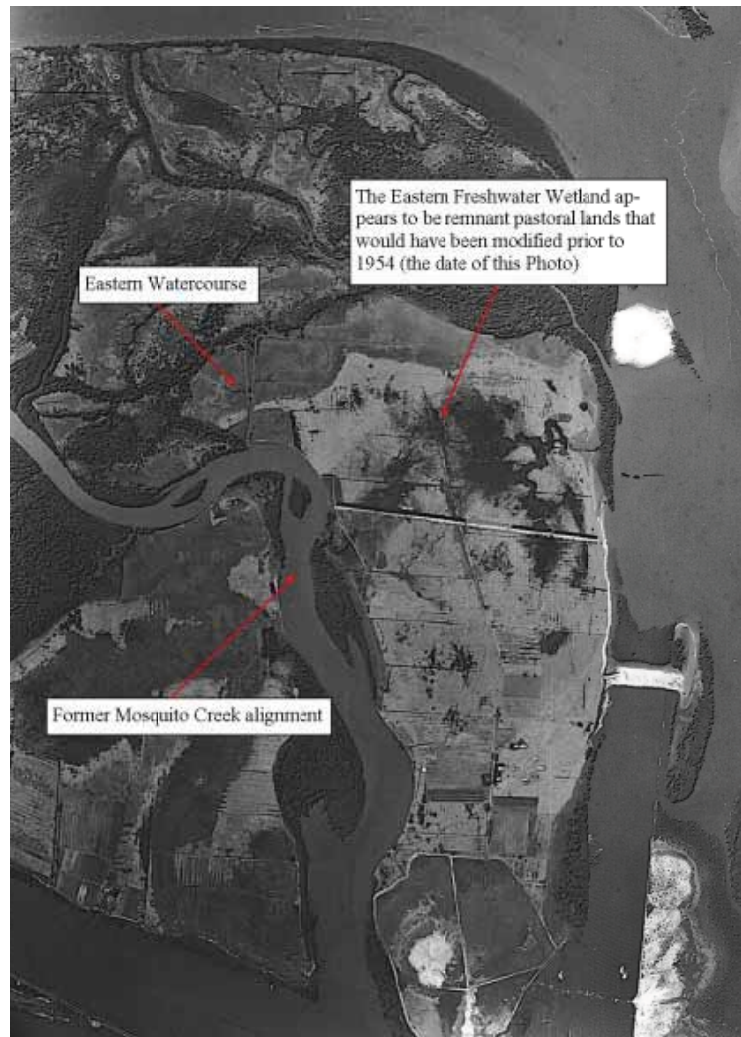


Plate 10 – Aerial Photograph from 1954 (Source: Douglas Partners)

Land reclamation works commenced in 1958, connecting Walsh and Mosquito Island (Williams, 2000). In 1960, Kooragang Island was zoned for Industrial Land-use, which initiated numerous industrial developments on Kooragang Island over the subsequent decades (Williams, 2000). In 1966, the rail line that currently services the KCT was constructed, forming a complete blockage of the Mosquito Creek Channel (Williams, 2000).

Plate 11 shows an aerial photograph from 1979, which shows a partly filled Mosquito Creek Channel and the rail line that was constructed in 1966. Of note, the salt lagoon that forms the southernmost section of the existing Eastern Watercourse is a remnant portion of the Mosquito Creek Channel.



Plate 11 – Aerial Photograph from 1979 (Source: Douglas Partners)

8.2 Mosquito Creek Crossing

Mosquito Creek is an estuarine watercourse that conveys tidal flows from the North Arm of the Hunter River to adjoining areas of the Hunter Wetlands National Park. As noted in **Figure 5** Mosquito Creek was partly filled in 1966 when the KCT was constructed (Williams, 2000). The proposed rail embankment crosses Mosquito Creek immediately to the north of the existing rail line.

As noted in **Figure 6**, the proposed rail embankment will disturb the southernmost 350m reach of Mosquito Creek as well as a tributary that branches from Mosquito Creek approximately 50m to the north of the existing rail embankment. This tributary is referred to as Mosquito Creek Tributary in the remainder of this report. It is noted that during the next stage of the T4 Project design, the potential to realign the rail embankment to the south to abut the existing rail embankment at the Mosquito Creek crossing location will be investigated. If adopted, this design change will reduce the northern extent of the disturbance footprint.

8.2.1 Existing Hydrologic Conditions

Description

Mosquito Creek is an estuarine watercourse that is hydraulically connected to the North Arm of the Hunter River Estuary and conveys tidal flows to the adjoining wetland complex. The creek channel is approximately 60m wide. The channel depth exceeded 2.5m during a 1.8m spring tide that occurred on 13 January 2012. **Plate 12** shows a typical section of Mosquito Creek at high tide.



Plate 12- *Mosquito Creek at high tide (looking south)*

Mosquito Creek Tributary is also an estuarine watercourse that conveys tidal flow from Mosquito Creek to the wetland complex that is located to the north-east of the tributary. Aerial photography indicates that Mosquito Creek Tributary extends 350 to 400m to the north-east of the confluence with Mosquito Creek. Smaller channels are likely to continue further into the wetland to the north, east and west. Field measurements indicated that the channel width (at the proposed rail embankment location) ranges from 8 to 10m. Typically depths ranged between 1.5 to 2m during a 1.8m spring tide that occurred on 13 January 2012. **Plate 13** shows the downstream section of the Mosquito Creek Tributary.



Plate 13 – *Mosquito Creek Tributary at high tide looking to the north-east from Mosquito Creek.*

Water Level Monitoring

Continuous water level meters were installed at the upstream (WL 1) and downstream (WL 2) extents of Mosquito Creek. Refer to **Figure 5** for meter locations. The meters were installed at

12pm on 13 January 2012 and retrieved at 10am on 20 January 2012. **Plate 14** presents the water level monitoring results.

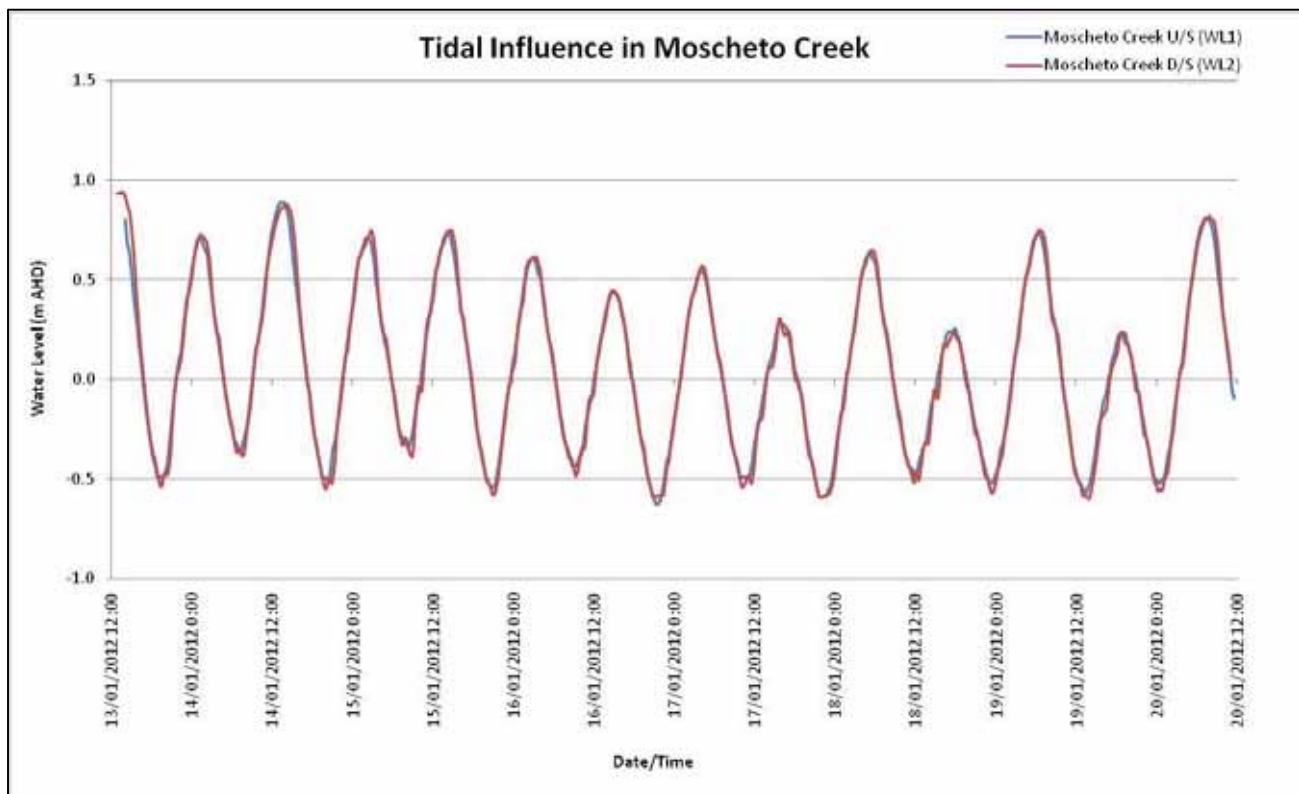


Plate 14 – Mosquito Creek water level monitoring results (Data source: Douglas Partners)

The water level monitoring trends presented in **Plate 14** demonstrate that Mosquito Creek is actively tidal and that there is negligible attenuation of the tidal prism between the upstream and downstream extents of the creek.

8.2.2 Potential Impacts and Proposed Mitigation Measures

Potential Impacts

The qualitative assessment undertaken for this study identified the following potential hydrodynamic impacts associated with the proposed rail embankment:

- **Mosquito Creek:** The existing rail embankment that was constructed in 1966 has completely obstructed tidal flows from progressing further south past the embankment. Accordingly, the construction of the proposed rail embankment adjacent to the existing embankment is unlikely to result in further restriction or obstruction of tidal flows to any part of the existing wetland areas that are located to the north-west, north and north-east of the proposed embankment.
- **Mosquito Creek Tributary:** The proposed rail embankment has the potential to obstruct or restrict tidal flows in the lower section of Mosquito Creek Tributary. If this occurs, it is likely that significant impacts to the existing tidal regime would occur in the wetland complex that is fed by this creek.

It is noted that during the next stage of the T4 Project design, the potential to realign the rail embankment to the south to abut the existing rail embankment at the Mosquito Creek crossing location will be investigated. If deemed practical, this design change will reduce the northern extent of the disturbance footprint and substantially reduce the length of the constructed channel.

Proposed Mitigation Measures

As discussed above, the proposed rail embankment could potentially restrict or obstruct tidal flows in the lower section of Mosquito Creek Tributary. Accordingly, it is proposed to construct a realigned estuarine channel to the north of the rail embankment. The constructed channel will be designed and constructed to have similar hydraulic characteristics to the existing lower section of Mosquito Creek Tributary and will therefore maintain the existing tidal flow regime to the upstream wetland complex.

With reference to **Figure 6**, the constructed channel will be aligned to the north of the proposed rail embankment. As noted above, it is proposed to move the proposed rail embankment to the south. This will substantially shorten the length of constructed channel and allow sufficient room for a mangrove buffer to be established between the rail embankment and the constructed channel.

The following detailed investigations will be undertaken to determine the most appropriate configuration of the constructed channel:

- Additional water level monitoring will be undertaken at both the downstream and upstream sections of the Mosquito Creek Tributary. The results from this monitoring will be used to establish the characteristics of both the existing tidal regime in the upper portions of the Mosquito Creek Tributary and the hydraulic characteristics of the estuarine channel in the lower section of the tributary.
- Detailed survey of the bathymetry of the existing Mosquito Creek Tributary.
- Detailed hydraulic analysis to determine the existing hydraulic characteristics of the Mosquito Creek Tributary Channel and to establish the most appropriate alignment and geometry of the constructed channel.
- A detailed investigation into the most appropriate construction and re-vegetation methods will be undertaken.

8.3 Eastern Watercourse Crossing

The Eastern Watercourse is an estuarine watercourse that is located approximately 850m to the east of Mosquito Creek. With reference to **Figure 7**, the proposed rail embankment will disturb the southernmost 100m section of the Eastern Watercourse.

8.3.1 Existing hydrologic Conditions

Description

As discussed in **Section 8.1**, the Eastern Watercourse is a former tributary to Mosquito Creek, which was filled when the Kooragang Island Industrial Area was established. The southernmost portion of the Eastern Watercourses is characterised by a salt lagoon that is approximately 200m long and 20 to 30m wide. With reference to **Plate 11**, this lagoon is a remnant portion of the former Mosquito Creek Channel. **Plate 15** shows the salt lagoon looking to the south west.



Plate 15 – Salt Lagoon that is located in the southernmost portion of the Eastern Watercourse

With reference to **Figure 7**, a levee has been constructed across the Eastern Watercourse approximately 150m to the north of the salt lagoon. During a site inspection, no culverts were identified through the levee indicating that this levee forms a complete blockage of the estuarine channel. **Plate 16** shows the levee looking to the north-west. As noted in **Figure 7**, fresh water plant species were observed on land to the east and west of the levee indicating areas that have been filled above the intertidal zone.



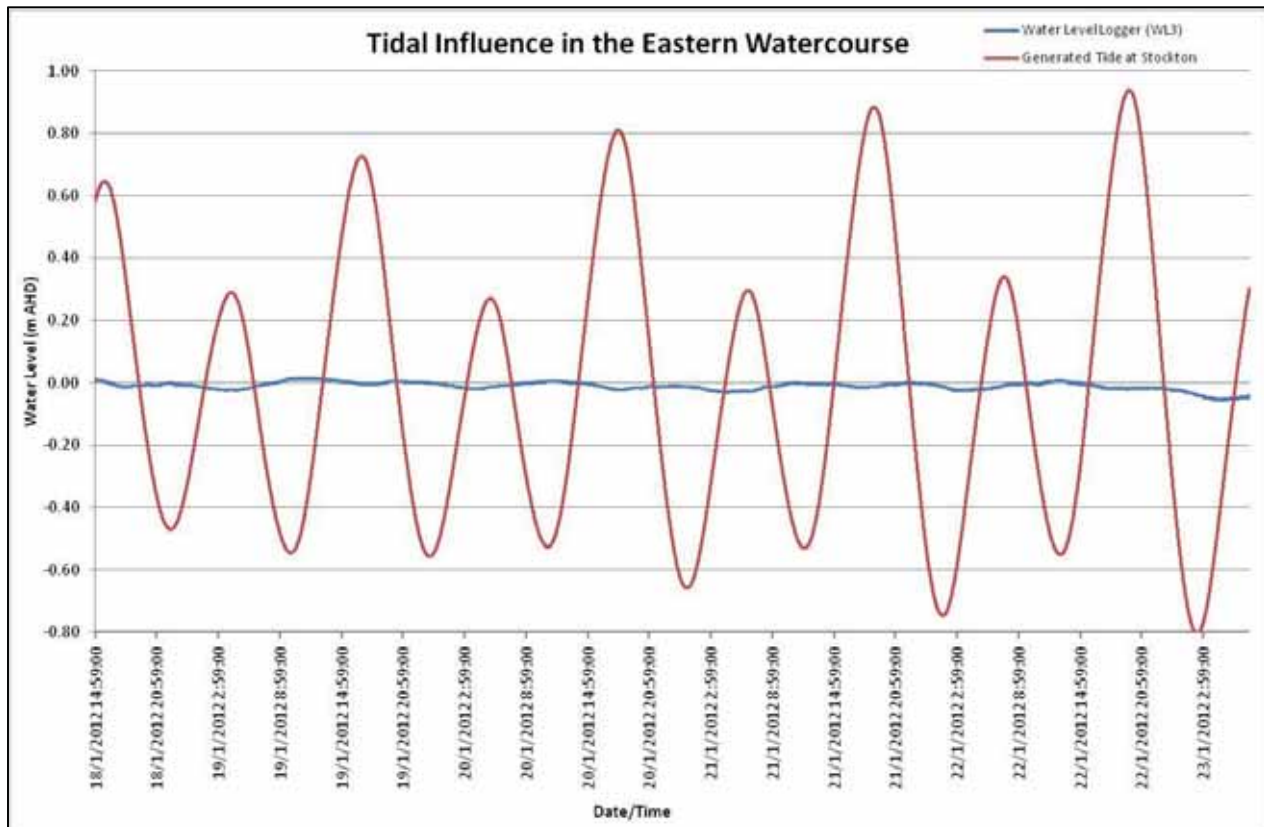
Plate 16 – Constructed levee across the Eastern Watercourse (looking north-west)

It is likely that the constructed levee and other filling to the east and west of the levee prevent lower level tidal exchange from occurring between the salt lagoon and the northern portion of the Eastern Watercourse. This is evidenced by Electrical Conductivity (EC) measurements of 18 mS/cm in the salt lagoon compared to 40 mS/cm to the north of the levee on 13 January 2012. However, some tidal exchange between the salt lagoon and the greater wetland area may occur through the mangroves that populate land to the west of the salt lagoon (as indicated in **Figure 7**). As there

were no connecting estuarine channels identified to the west of the salt lagoon, it is likely that tidal exchange only occurs during high spring and king tides when the intertidal zone is fully inundated.

Water Level Monitoring

A continuous water level meter was installed in the southern extent of the Eastern Watercourse (WL 3). Refer to **Figure 5** for meter locations. The meter was installed at 3pm on 18 January 2012 and retrieved at 3pm on 23 January 2012. **Plate 17** compares the water level monitoring results from WL3 over the five day period to a generated tide at Stockton Bridge (North Arm of the Hunter River).



Note: The WL 3 gauge was not surveyed. Accordingly, no datum could be established. A datum of 0m AHD was assumed for illustrative purposes.

Plate 17 – Eastern Watercourse water level monitoring results.

Water level monitoring in the salt lagoon over the five day period observed nominal (2 to 3 cm) tidal signals indicating that the water level is predominantly influenced by the local groundwater levels. These results confirm that the salt lagoon does not receive tidal exchange on a daily basis. The highest tide during the five day period was a 1.9m tide (in Newcastle Harbour) that occurred on 22 January 2012. Further monitoring is required to establish whether tidal exchange occurs during tides above 1.9m. For reference, the Highest Astronomical Tide (HAT) in Newcastle Harbour is 2.1m (Australian National Tide Tables, 2011).

8.3.2 Potential Impacts and Proposed Mitigation Measures

Potential Impacts

With reference to **Figure 7**, the proposed rail embankment will disturb the salt lagoon and mangrove area that is located to the west of the salt lagoon. The construction of the embankment is unlikely to alter the existing tidal regime in areas of the wetland that are outside of the direct disturbance area for the following reasons:

- The embankment will not obstruct or restrict any estuarine channels that convey tidal flows to other areas of the wetlands.
- Available information indicates that the salt lagoon is poorly flushed.

- The embankment is located on the periphery of the wetland area.

The disturbance of the mangrove area located to the west of the salt lagoon may restrict tidal exchange between the salt lagoon and greater wetland area during king tides. This may affect the wetland complex located between the proposed rail embankment and the constructed levee (which prevents tidal exchange from occurring from the north). The potential impact area is indicated in **Figure 7**.

Proposed Mitigation Measures

It is proposed to modify or remove the levee to maintain tidal flows to the wetland complex located between the proposed rail embankment and the levee. The following detailed investigations will be undertaken to determine the most appropriate mitigation works:

- Water level meters will be installed in both the salt lagoon and to the north of the levee. The monitoring data will enable the characteristics of the existing tidal regime in both sections of the watercourse to be established.
- Detailed topographic survey of the levee and surrounding land will be undertaken.
- In collaboration with the ecology consultant, the most appropriate mitigation solution will be established.

As any proposed works to modify the levee will require work to be undertaken within the National Park, all works will be subject to a secondary approval from OEH. However, it is noted that the proposed works would be consistent with the objectives of the *Kooragang Nature Reserve and Hexham Swamp Nature Reserve Plan of Management* (NPWS, 1998) which states that “saltmarsh areas to the west of Fullerton Cove (i.e. Kooragang Island) will be managed by modification of the levee banks and reintroduction of a tidal regime”.

There is also potential to recreate some saltmarsh landscape by regrading some of the previously filled wetland area to a level that would create favourable conditions for saltmarsh.

8.4 Eastern Freshwater Wetland

With reference to **Figure 8**, to the east of the Eastern Watercourse, the proposed rail line narrows to a single track that will be aligned parallel to the existing rail embankment. The proposed rail embankment at this location will disturb the periphery of a freshwater wetland that exists to the east of the Eastern Watercourse. This wetland is referred to as the Eastern Freshwater Wetland in the remainder of this report. The Eastern Freshwater Wetland is located in **Figure 8**.

With reference to **Plate 10**, it appears that the Eastern Freshwater Wetland is remnant pastoral land that was modified in the early 1900s. It is likely that the modifications included the construction of levees to prevent the ingress of tidal flows onto the pastoral lands. It is likely that the phragmites that currently populate the Eastern Freshwater Wetland became the dominate flora species following the removal of livestock.

On review of aerial photography, it appears that the Eastern Freshwater Wetland receives fresh water from direct rainfall and possibly some minor runoff from areas around its periphery (namely the existing rail line to the south and possibly some land to the north and east). Hence, the hydrologic regime is likely to be governed by:

- Direct rainfall and evapotranspiration losses that would characterise the wetting and drying regime of the wetland.
- Groundwater influences that are likely to keep the open water bodies permanently full, with some seasonal variation expected.

Potential Impacts

Potential hydrologic impacts associated with the construction of the proposed rail embankment are likely to be limited to:

- The proposed rail embankment will result in a small net increase in the volume of fresh water entering the Eastern Freshwater Wetland as the removal of vegetation would result in reduced evapotranspiration losses from the embankment footprint area. However, given the relatively minor footprint area of the embankment, when compared to the Eastern Freshwater Wetland area, any impact is likely to be negligible.
- The proposed embankment has the potential to block or divert any surface flows to the Eastern Freshwater Wetland that originate from catchment areas that are located to the south of the proposed embankment (namely from the existing rail line).

Proposed Mitigation Measures

Drainage would be provided within the rail embankment (eg drainage from rail ballast to jump-up pits) to allow the existing contributing catchment area to the Eastern Freshwater Wetland to be maintained.

9 PREDICTED SURFACE WATER IMPACTS

9.1 Construction Phase

The potential surface water impacts during the construction phase, outlined in **Section 3.1**, can be adequately managed if the recommendations in this report are adopted and a suitable Construction Environmental Management Plan is followed. As such, it is predicted that there will be no adverse surface water impacts during the construction phase of the T4 Project.

9.2 Operational Phase

Section 3.2 outlined the potential surface water impacts arising from the operation of T4 Project. Impacts arise from the potential containments and pollutants entrained in surface water runoff. This assessment has proposed a surface water system to treat, store and reuse runoff that may contain pollutants. The system is predicted to meet the targets set in **Section 4.2** only discharging in periods of extended wet weather. It has been shown in **Table 10** of **Section 7.3.1** that discharges from the surface water system would still receive sufficient treatment to reduce TSS loading to acceptable levels during a 99th percentile discharge event.

10 MONITORING AND CONTINGENCY MEASURES

10.1 Construction Phase

Before construction, a surface water quality monitoring program would be developed and implemented to monitor water quality within the site and selected locations within the receiving waters. Compliance monitoring points would be established *both upstream and downstream of the discharge location* as will be required under expected Environmental Protection License conditions.

Monitoring would measure the following parameters:

- Turbidity (calibrated to approximate suspended solids concentration of 50mg/L)
- Electrical conductivity
- pH

Monitoring would be required daily whenever there is a discharge event to the Hunter River and monthly at all other times. During dredging operations, weekly monitoring of existing water bodies external to the T4 Project would be undertaken to ensure dredge waters are not escaping the surface water management controls.

In addition to water quality testing, the monitoring program would require regular inspection of all erosion and sediment control structures. Structures would also require inspection following significant rainfall (eg >25mm in 24 hours) to ensure their integrity.

Final, refined details of construction monitoring and contingency measures will be included in the Construction Environmental Management Plan.

10.2 Operational Phase

Surface water quality monitoring would be undertaken at a number of locations within the operational area. **Table 11** details the recommended locations and monitoring frequencies and **Figure 4** spatially locates the monitoring locations.

Table 11 – Water Quality Monitoring Locations and Frequencies

Monitoring Location	Analyte	Monitoring Frequency
Primary Settling Pond 1 and 2	pH, EC, TSS, Turbidity, DO	monthly
	TSS, TP, TN, Oil & Grease, Metals	every 3 months
Secondary Settling Pond and Clear Water Pond	pH, EC, TSS	monthly
	TSS, TP, TN, Oil & Grease, Metals	every 3 months
Outfall from Clearwater Pond	pH, EC, Turbidity, DO	daily during discharge
	TSS, TP, TN, Oil & Grease, Metals	every 3 months and twice during a discharge event
Inflows from Blue Billed Duck Pond	pH, EC, Turbidity, DO	daily during discharge
	TSS, TP, TN, Oil & Grease, Metals	every 3 months
Outfall from Deep	TSS, TP, TN, Oil & Grease, Metals	every 3 months and twice

Monitoring Location	Analyte	Monitoring Frequency
Pond (south)		during a discharge event
Receiving waters (foreshore wetlands)	pH, EC, Turbidity, DO	monthly
	TSS, TP, TN, Oil & Grease, Metals	every 3 months and twice during a discharge event
Receiving waters (Hunter River)	pH, EC, Turbidity, DO	monthly
	TSS, TP, TN, Oil & Grease, Metals	every 3 months and twice during a discharge event

Metals = Al, Co, Cu, Fe, Mg, Mn, Ni, K, Na, Zn

All monitoring results would be documented annually in a written report that presents summary data and assesses all results and water quality trends. All monitoring data would be retained in an appropriate database that would be available to relevant agencies on request.

In addition to water quality sampling, the monitoring program would indicatively require:

- Monitoring of water levels in settling ponds following rainfall events to assess pond capacity
- Annual monitoring of sediment levels within settling ponds.
- Weekly inspection of sediment sumps, oil traps and transfer ponds (to ensure the capture of any oil spills).
- Annual internal audit to ensure monitoring and recording of data is being undertaken in accordance with the OEMP.
- Annual (and as needed) review of the monitoring program to reflect regulatory or operational changes.

Final, refined details of operational monitoring and contingency measures will be included in the Operation Environmental Management Plan.

10.3 Contingency Measures

The proposed surface water treatment system will be designed to provide adequate and efficient treatment and management of surface water runoff from the site through containing, collecting/treating, reusing and, when required, disposal of runoff. A comprehensive monitoring program will be undertaken with results entered into a database. If results exceed relevant trigger values, the following contingency measures would be implemented:

- Undertake data validation (eg review database for false entries, repeat sampling).
- Consider increased monitoring frequency and sampling points to identify and confirm the source of any suspected degradation to water quality.
- Identify contaminant source and rectify any operational procedure, storage, delivery and bunding systems as required.
- Review the OEMP in order to identify opportunities to improve or rectify any identified problem. The data collected as part of the monitoring program will enable fully informed decisions to be made.
- If any component of the surface water management framework is identified as creating an unacceptable environmental impact, remedial actions will be established in liaison with relevant agencies.

11 CONCLUSION

Port Waratah Coal Services Limited proposes to construct and operate a new coal export terminal at the Port of Newcastle in order to provide additional port capacity required to accommodate the projected future growth in coal exports. The T4 Project is proposed to include new rail tracks, coal stockyard, conveyors and ancillary facilities on Kooragang Island, adjacent to KCT, and wharves, berths, ship loaders and ancillary facilities along the north and south banks of the Hunter River South Arm.

This surface water assessment was undertaken by SMEC to investigate the key surface water management issues and to establish management principles and concepts for the site for the purpose of providing information on the concept design and for the EA. It is noted that groundwater and flood assessments are documented in separate specialist reports. It should also be noted that the proposed water management system will be refined during the detailed design phase of the project.

The existing T4 project area is a largely engineered site modified by land reclamation (comprising fill, including industrial waste and dredged material, underlain by alluvial soils). Drainage is engineered and comprises culverts, drains, levees and constructed ponds which fill with surface runoff and ultimately drain to the Hunter River South Arm. Runoff from the northern and western rail embankments discharge to existing wetlands.

Construction of the T4 Project will impact the existing flow regime within the T4 project area with a number of existing ponds being completely or partially filled. Surface water interaction within existing water bodies outside the project area will not be significantly affected by the proposed development.

Surface water management during construction will require a focus on sediment and erosion control structures, designed and installed in accordance with *"Managing Urban Surface water – Soils and Construction"* (2004). These controls would ensure that there are no significant adverse impacts on receiving water quality during the construction stage.

During construction, the site will be filled using sand won from the wharf, channel and swing basin dredging operations. Bunds will be used along the site perimeters in order to contain all dredge water and surface water within the construction site. The north eastern portion of Deep Pond will be modified through installation of bunds to separate the southern and north western portions of the remaining pond area to be used as a settling basin to treat sediment laden dredge water before it is returned to the Hunter River via a lined drainage channel. Silt curtains would be installed in the Hunter River at the return water discharge location and within the Hunter River during the construction of the wharf facilities and swing basin.

Construction of the rail embankment in the northern part of the T4 project area requires the crossing of Mosquito Creek and an unnamed watercourse that is located 850m to the east of Mosquito Creek. The southern portion of both these watercourses was filled when the southern portion of Kooragang Island was developed for industrial land-use in the 1960s and 1970s. As both of these watercourses are estuarine, the construction of the rail embankment has the potential to impact the tidal regime in some portions of wetland area that exist to the north of the T4 project area. Mitigation measures including channel realignment works and ground level modifications are proposed to negate any impacts to the tidal regime to areas beyond the rail embankment's footprint.

Following filling of the site, a series of settling basins would be constructed to contain any sediment movement within the site during the remaining construction activities. These basins would also be retained during the operational phase of the project.

The operation of the terminal may generate potential contaminants including sediments, coal, soluble salts, oils, fuels, acidic or alkaline water, heavy metals and other contaminants. The main sources of surface water pollutants include the coal storage area, conveyors, wharf areas, rail loop and minor leaks and spills from vehicles and plant.

A conceptual surface water management plan was developed that recommends a range of measures to mitigate contaminant movement from the site. This would consist of the following:

- Stockyard perimeter drains to convey all collected surface water to settlement ponds.
- Standard pit and pipe systems to convey surface water from the stockyard and adjoining access roads to the perimeter drains.
- Clean out sumps to capture coarse sediments and accidental oil spills (dump station, conveyor inclines, transfer houses, buffer bins and the sampling area).
- Underdrain network under the coal stockpiles connected to the perimeter drains.
- Local settling ponds adjacent to the rail batter.
- Local sediment basins for the transfer yard and wharves (surface water will be pumped to the stockyard drainage system).
- A series of settlement ponds to treat all surface water generated from the dirty areas of the site.
- Retain and enhance the southern and western sections of Deep Pond to establish a habitat corridor.
- Establish an automated dust suppression system (for stockyards, chutes, conveyors).

Water balance modelling indicates that 76% of surface water runoff would be captured and reused onsite to meet 73% of the projects operational process water demands. 24% of runoff would discharge from the site during periods of extended wet weather. Modelling indicates that the discharge frequency would be on average once every 95 days.

It is proposed to develop and implement a water quality monitoring program. The monitoring program will be prepared as part of the environmental management plan and would include monitoring of water quality trends during the pre-construction, construction and operational phases of the T4 Project.

The proposed surface water containment and treatment system is designed to meet to requirements of the DGRs and other government agency requirements to provide an efficient treatment of surface water runoff from the site through containing, collecting/treating, reusing and in prolonged weather events, adequately disposing of the treated runoff. The proposed surface water containment and treatment system will protect the water quality of surrounding wetlands and the Hunter River, consistent with OEH guidelines.

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APPENDIX A – GOVERNMENT AGENCY COMMENTS

Table A1 – Comments from Department of Environment, Climate Change and Water

Comment	Succinct Response	Reference
The EA must provide sufficient information to demonstrate that the proposed development can be operated whilst complying with the POEO Act, in particular, the protection of water quality, including groundwater, during construction and operation of the project.	Part 5.3 of the POEO Act prohibits pollution of waters. This surface water assessment shows that best practice controls will be in place during both construction and operation to prevent pollution of surface water.	Surface water quality results are presented in Section 7.3.1. Refer to Douglas Partners (2011) groundwater assessment for impacts on groundwater.
The EA should include a comprehensive assessment of all potential surface and groundwater impacts associated with the project, including any proposal to de-water and place fill material, to be reclaimed from the south arm of the Hunter River on the coal stockyard area of the project site.	Surface water impacts have been identified and mitigation controls designed.	Potential surface water impacts are outlined in Section 3.
The methodology, data and assumptions used to design any pollution control works and assess the potential impact of the proposal on water quality, must be fully documented and justified.	Completed.	The methodology, data and assumptions in the design of pollution control works are outlined in Sections 6 and 7.
The EA should demonstrate that any discharge to the Hunter River will meet NSW Water Quality Objectives. DECCW has adopted the ANZECC 2000 guidelines as a guide for the assessment of environmental impacts on aquatic ecosystems. The proposal should be assessed against these guidelines.	The design of surface water controls has been undertaken with reference to the ANZECC 2000 guidelines. It is noted that final trigger levels would be determined as part of the environmental management plans and would be based on discussion with the relevant authorities taking into account ANZECC Guidelines and base-line monitoring undertaken within the Hunter River and adjacent water bodies	Water quality targets are discussed in Section 4.2.3 The method used to assess surface water controls in line with ANZECC guidelines is outlined in Section 4.2.3. Expected operational water quality is outlined in Section 3.2.2.
The EA should include the details of the mitigation measures proposed to manage groundwater and surface contamination at the site	Completed.	Construction mitigation measures are outlined in Section 4 while monitoring is outlined in Section 10.

Comment	Succinct Response	Reference
including any groundwater and/or surface water monitoring program that will be employed at the project site.		Operational mitigation measures are outlined in Section 5.2 while monitoring is outlined in Section 10.1.
The EA should include a detailed assessment of any water quality, river hydrology monitoring required during the construction phase and on-going operation of the project to ensure that the development achieves a satisfactory level of environmental performance. The evaluation should include a detailed description of the monitoring locations, sample analysis methods and frequencies as well as and the level of reporting proposed.	Completed	Construction monitoring is outlined in Section 5.1. Operational monitoring is outlined in Section 10.

Table A2 – Comments from NSW Office of Water

Comment	Succinct Response	Reference
Identify site water demands, and the adequate and secure supply of water.	Water demands will be met through a combination of surface water reuse and water purchased from HWC. In future, alternative water sources such as recycled sewage effluent from HWC may become available and their feasibility would be investigated.	Site water demands are outlined in Section 6.5. Expected total surface water and potable water demands are summarised in Section 6.5.
Baseline monitoring of surface water sources.	Completed.	Baseline monitoring is summarised in Section 10.2.
Assess impacts on adjacent surface water sources.	Completed	Potential surface water impacts are outlined in Section 3. In particular Section 3.2 discusses potential impacts to adjacent flow regimes. Section 8 addresses potential hydrologic impacts to the Hunter Wetlands National Park.
Identify contingency measures to remediate, reduce or manage potential impacts to the existing surface water resource.	Completed.	Construction and operational contingency measures are outlined in Section 10.
Provide details of any proposed surface water extraction	Completed.	Expected surface water demands are summarised in Section 6.
Describe any proposed development or diversion works including all construction, clearing, draining, excavation and filling	Details on the proposed T4 Project are provided in the EA.	A summary of the T4 Project is provided in Section 1.3.
Describe potential environmental impacts.	Completed.	Potential surface water impacts are outlined in Section 3. Section 8 addresses potential hydrologic impacts to the Hunter Wetlands National Park.

Comment	Succinct Response	Reference
Describe design features to guard against long term actual and potential environmental disturbances	Completed.	Operational measures to guard against surface water disturbance are outlined in Section 5.2.

Table A3 – Comments from Hunter-Central Rivers Catchment Management Authority

Comment	Succinct Response	Reference
Take into account the guiding principles outlined in the Hunter-Central Rivers Catchment Action Plan.	The Hunter-Central Rivers Catchment Action Plan has been consulted to determine suitable water quality objectives.	Refer Section 4.2.3.
Surface water pollution is to be minimised using best practice surface water management.	Best practice controls will be in place during both construction and operation to prevent pollution of surface water.	Construction and operational contingency measures are outlined in Section 10. Surface water quality results are presented in Section 7.3.
Consider any future effects of the greenhouse effect such as a rise in sea-levels and changes in climate and weather patterns.	Completed.	Climate change has been considered in Section 6.7.
The individual and cumulative impacts on receiving bodies of water should be considered for all development.	Water bodies within the site are not subject to cumulative impacts by other development. Wetlands between the T4 project area and the Hunter River would not be adversely affected by cumulative impacts resulting from this and other development. The BHPB Emplacement Facility is located between the T4 project area and the Hunter River. Any potential development of this site would need to meet best practice methods and as such the quality of surface water runoff would likely improve rather than decline. The Hunter River is recognised as a waterway affected by urban development. Surface water will leave the site infrequently and quality will be in line with ANZECC Guidelines and baseline monitoring undertaken within the Hunter River and adjacent water bodies. As other sites along the Hunter River are redeveloped, and subject to best practice management, the quality of the Hunter River would likely improve rather than decline.	Potential surface water impacts are outlined in Section 3. Section 8 addresses potential hydrologic impacts to the Hunter Wetlands National Park.

Table A4 – Comments from Industry and Investment NSW

Comment	Succinct Response	Reference
Water quality of runoff from the site and the loading facilities must be included in the assessment.	Completed.	Expected operational water quality is outlined in Section 3.2.2.
For each freshwater body identified on the plan, the plan should include, either by annotation or by accompanying table, hydrological and stream morphology information such as: flow characteristics, including any seasonal variations, bed substrate and bed width.	This surface water assessment outlines the existing ponds within and adjacent to the site. Additional information is provided by Douglas Partners (2011) groundwater assessment.	The existing surface water environment is summarised in Section 2.2.

APPENDIX B – WATER BALANCE RESULTS

T4 Water Balance - Catchment and Storage Assumptions

Catchment	Area (ha)	Percentage Impervious (%)	Daily Rainfall Loss (mm/day)	Average Annual Runoff Coefficient (by calc)
Water Treatment Ponds	8.2	100	0	1.00
Stockyard Area	110.0	100	2	0.80
Stockpile Area	47.2	100	5	0.63
Wharf Area	33.9	50	7	0.55
Total	199.3			0.72

Storage Assumptions

Storage	Volume (ML)	Effective Storage (ML)	Comments
Pond 1	26.3	13.15	Assumed to kept 50% full for water treatment purposes
Pond 2	14.9	7.45	Assumed to kept 50% full for water treatment purposes
Pond 3	71.0	71.0	
Pond 4	70.7	70.7	
Wharf Area Ponds	30.0	30.0	
Total	212.9	192.3	

T4 Water Balance Demand Assumptions

Stockpile Dust Suppression Assumptions

Stockpile Area 47.2 ha

Assumed Seasonal Application Rates

	Application Rate	
	mm/day	ML/day
Summer	8.9	4.2
Autumn	7.4	3.5
Winter	4.8	2.3
Spring	7.4	3.5

Note: Stockpile dust suppression not applied on days where 5mm or more rainfall has occurred

	Belt Cleaning	Chute DS	Wash Down	Ship Supply	Stockpile DS
Total Annual (ML/yr)	340	247	19.7	136	1230
%return	33%	0%	50%	0%	0%
% min Potable make	5%	5%	5%	100%	5%

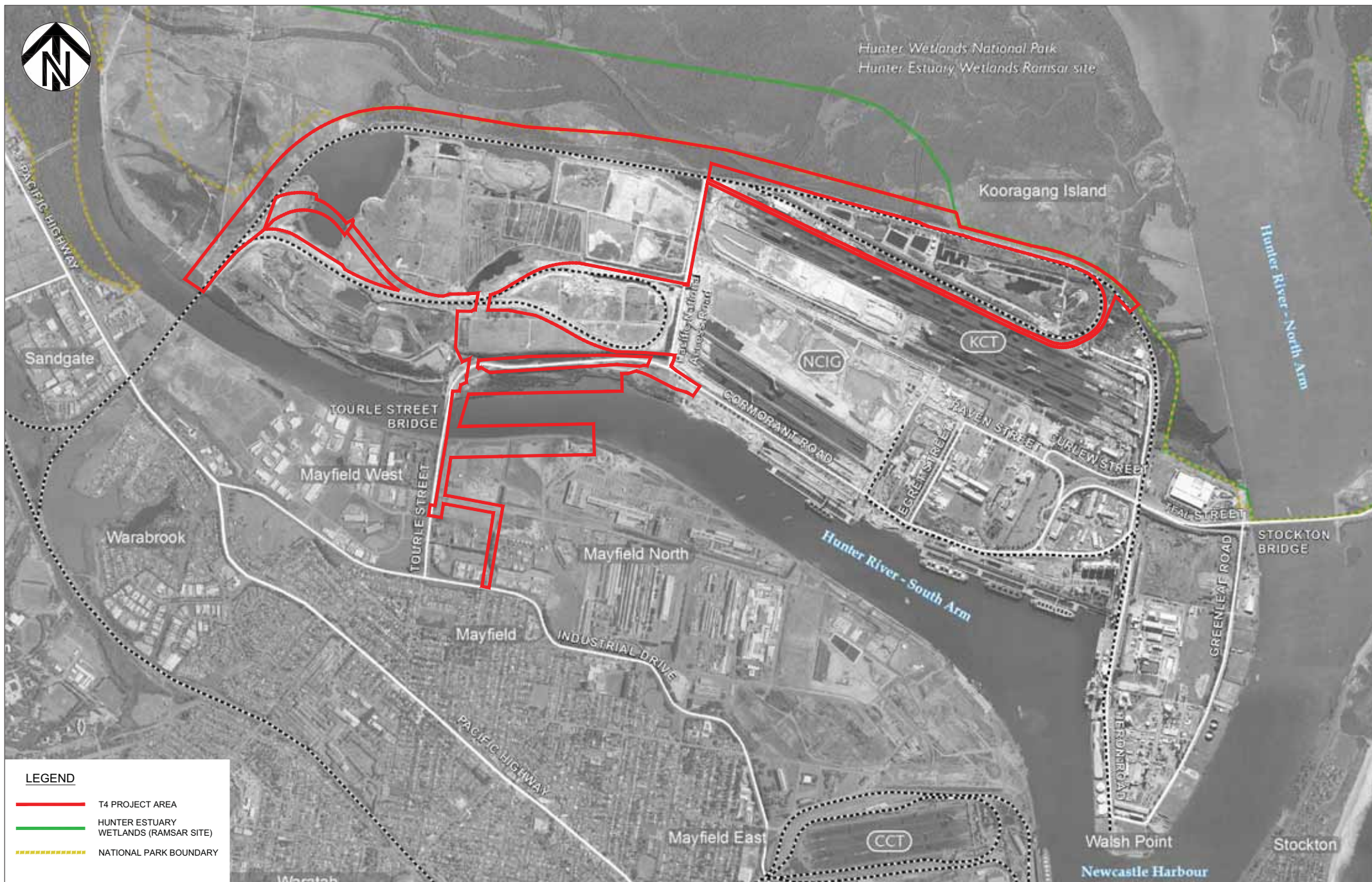
Total Demand								
	Units	Days	Belt Cleaning	Chute DS	Wash Down	Ship Supply	Stockpile DS	Total
January	ML/month	31	29	21	2	12	130	193
February	ML/month	28	26	19	2	10	118	175
March	ML/month	31	29	21	2	12	108	171
April	ML/month	30	28	20	2	11	105	166
May	ML/month	31	29	21	2	12	108	171
June	ML/month	30	28	20	2	11	68	129
July	ML/month	31	29	21	2	12	70	133
August	ML/month	31	29	21	2	12	70	133
September	ML/month	30	28	20	2	11	105	166
October	ML/month	31	29	21	2	12	108	171
November	ML/month	30	28	20	2	11	105	166
December	ML/month	31	29	21	2	12	130	193
Annual	ML/year	365	340	247	20	136	1226	1968

Minimum Potable Water Demand								
	Units	Days	Belt Cleaning	Chute DS	Wash Down	Ship Supply	Stockpile DS	Total
January	ML/month	31	1	1	0	12	7	21
February	ML/month	28	1	1	0	10	6	19
March	ML/month	31	1	1	0	12	5	20
April	ML/month	30	1	1	0	11	5	19
May	ML/month	31	1	1	0	12	5	20
June	ML/month	30	1	1	0	11	3	17
July	ML/month	31	1	1	0	12	4	18
August	ML/month	31	1	1	0	12	4	18
September	ML/month	30	1	1	0	11	5	19
October	ML/month	31	1	1	0	12	5	20
November	ML/month	30	1	1	0	11	5	19
December	ML/month	31	1	1	0	12	7	21
Annual	ML/year	365	17	12	1	136	61	228

Process Water Demand (Total Demand - Potable + Return Water)								
	Units	Days	Belt Cleaning	Chute DS	Wash Down	Ship Supply	Stockpile DS	Total
January	ML/month	31	18	20	1	0	124	162
February	ML/month	28	16	18	1	0	112	147
March	ML/month	31	18	20	1	0	103	141
April	ML/month	30	17	19	1	0	100	137
May	ML/month	31	18	20	1	0	103	141
June	ML/month	30	17	19	1	0	65	102
July	ML/month	31	18	20	1	0	67	105
August	ML/month	31	18	20	1	0	67	105
September	ML/month	30	17	19	1	0	100	137
October	ML/month	31	18	20	1	0	103	141
November	ML/month	30	17	19	1	0	100	137
December	ML/month	31	18	20	1	0	124	162
Annual	ML/year	365	211	235	9	0	1164	1619

Notes:

1) Process water demand assumed to comprise a minimum 5% potable water make to account for unforeseen events such as pump failures



LEGEND

- T4 PROJECT AREA
- HUNTER ESTUARY WETLANDS (RAMSAR SITE)
- NATIONAL PARK BOUNDARY

FIG NO. 1 FIGURE TITLE Locality Plan

DATE
04/11/2011

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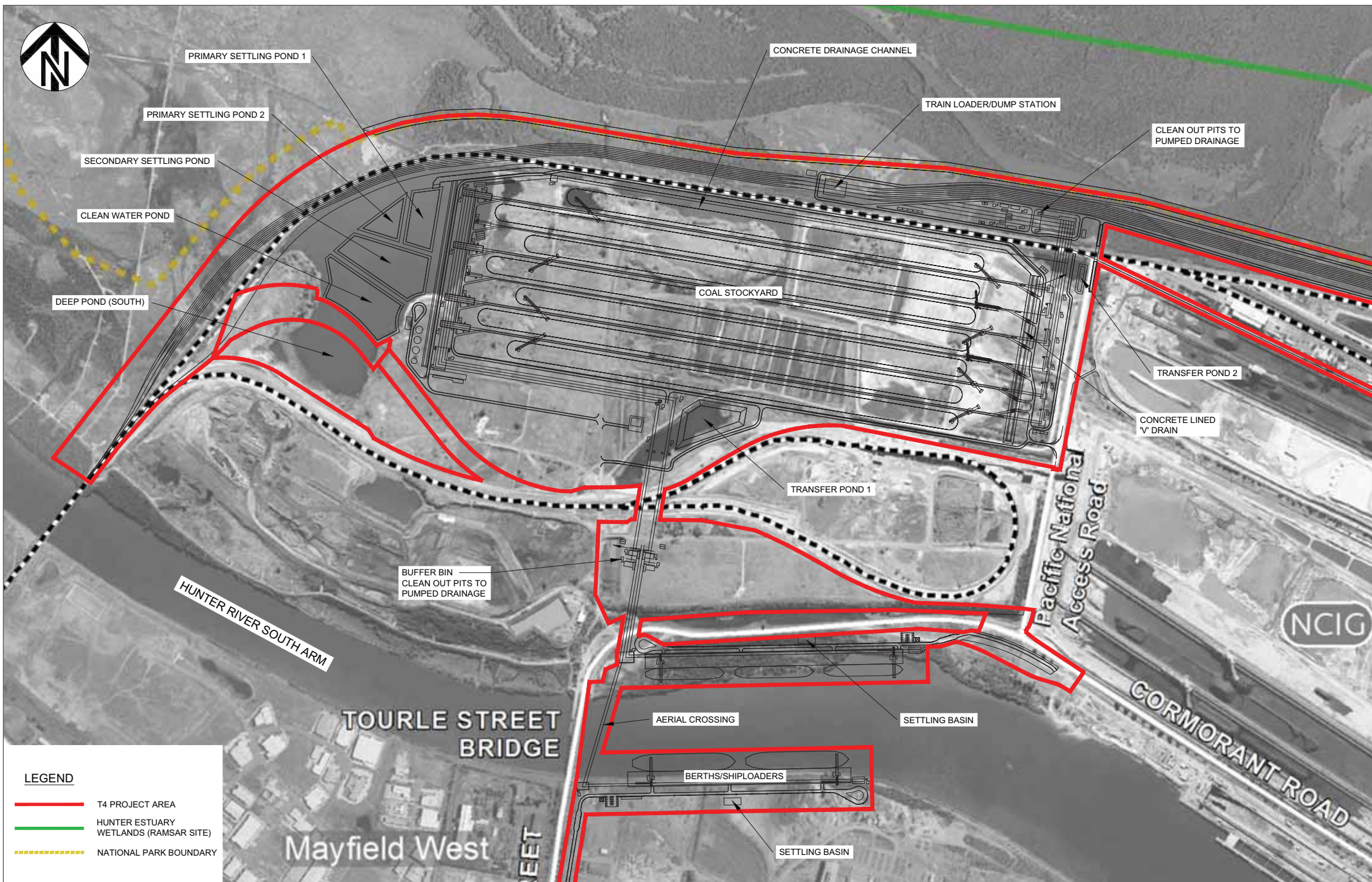
COORDINATE
SYSTEM

PROJECT NO. 30011123 PROJECT TITLE PWCS T4
Surface Water Management Assessment

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SOURCES

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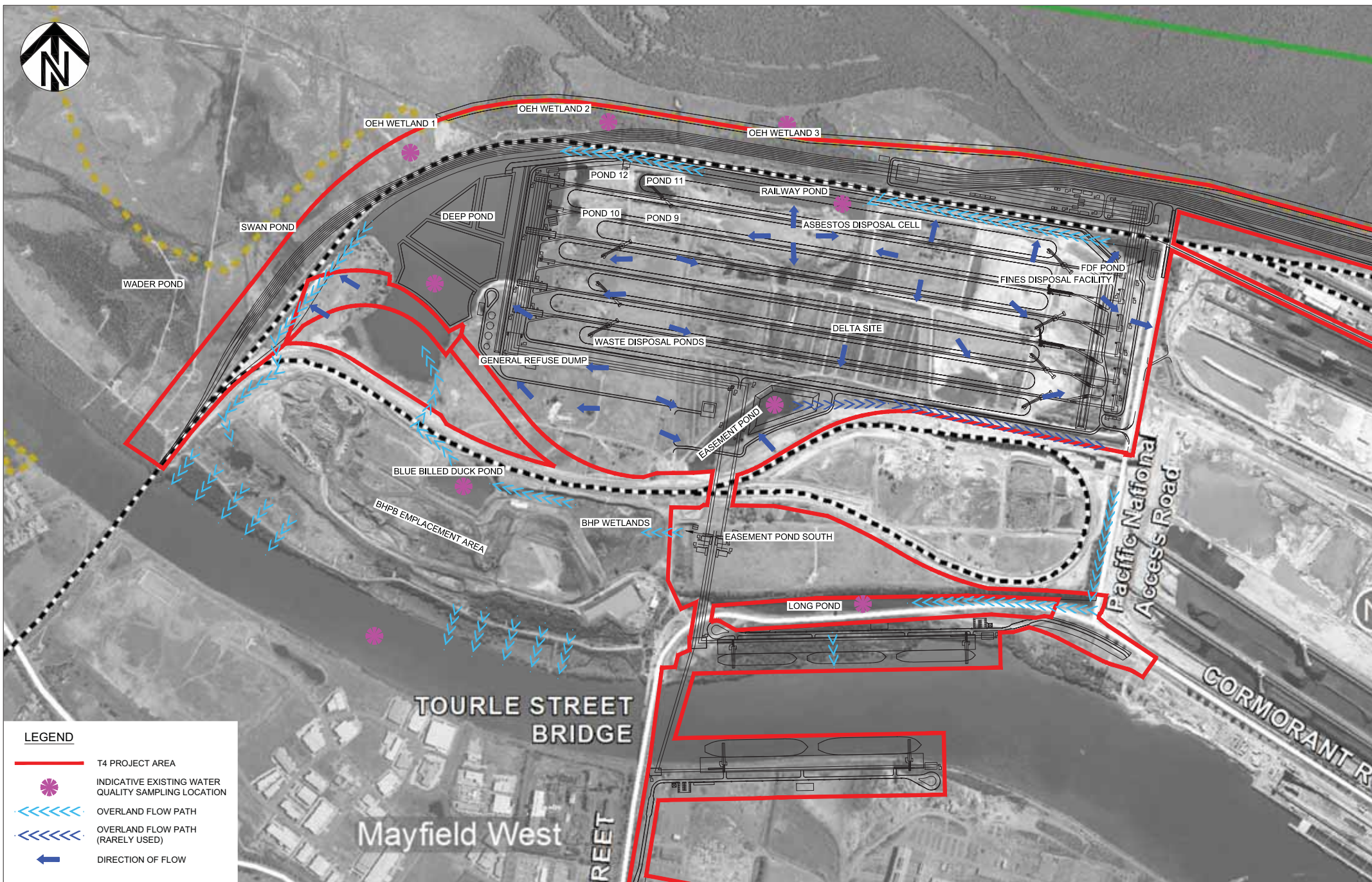


FIG NO. 3 FIGURE TITLE Existing Surface Drainage

DATE
04/11/2011

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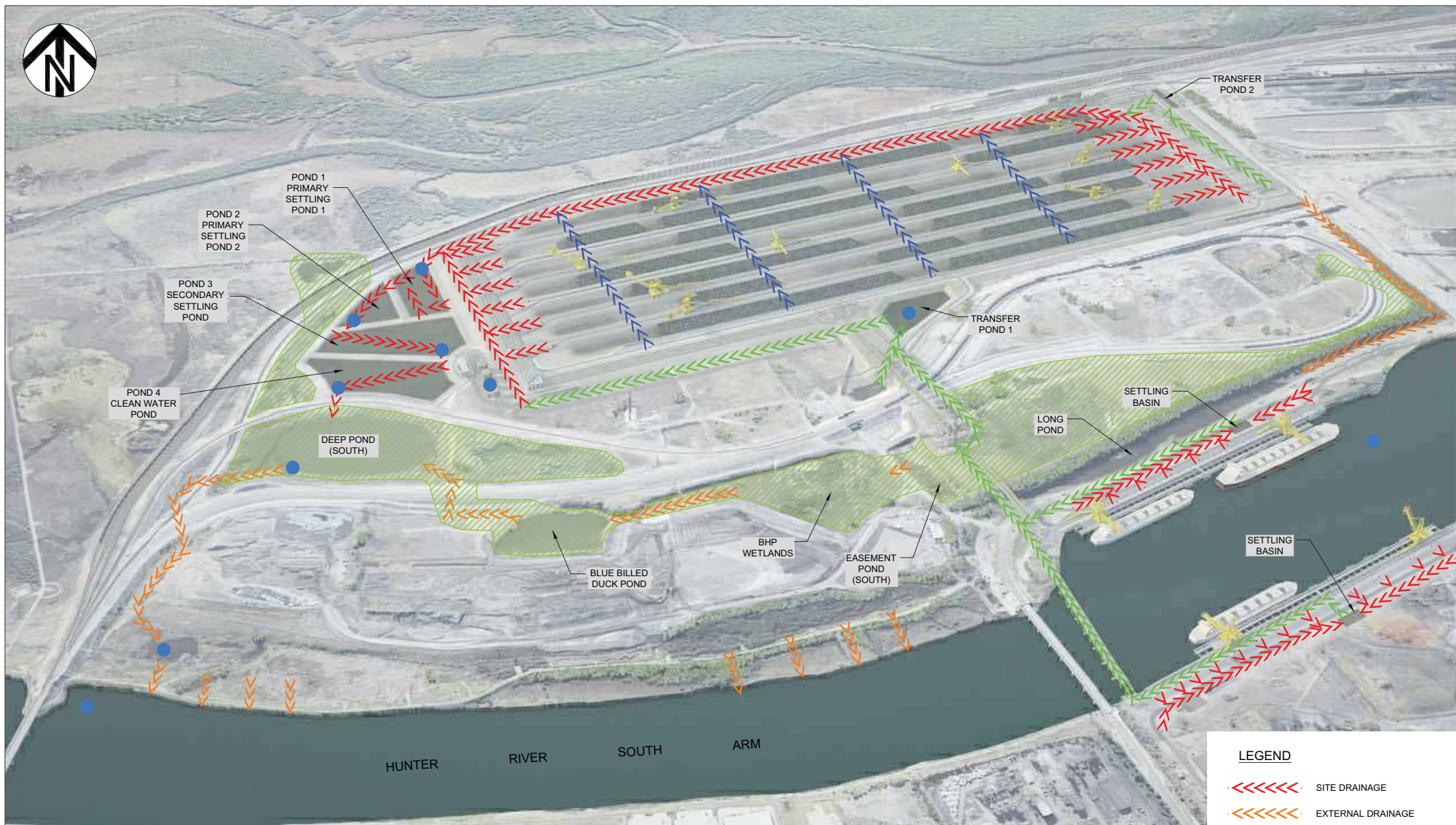


FIG NO. 4 FIGURE TITLE Conceptual Surface Water Management Plan

DATE
04/11/2011

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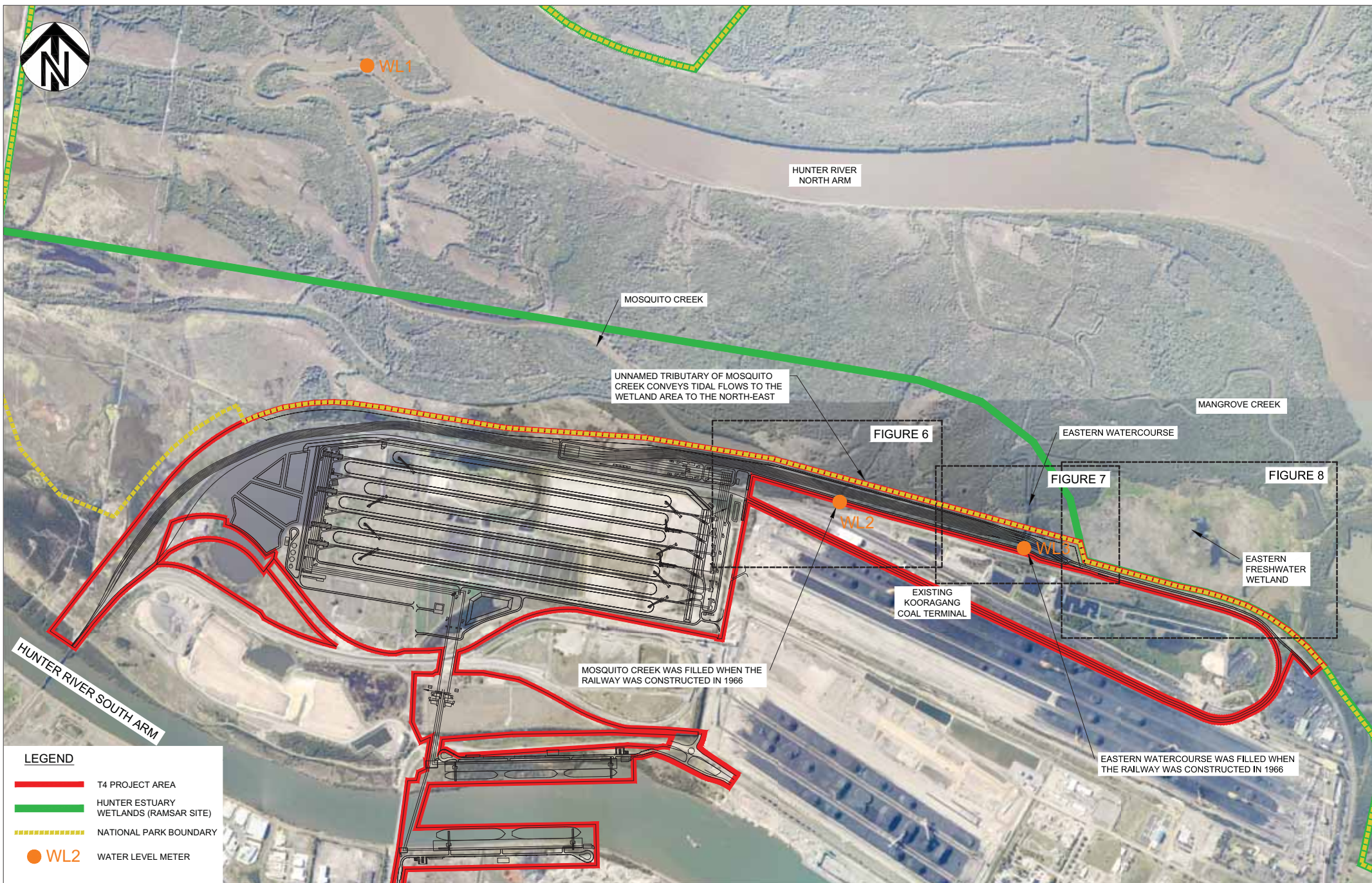


FIG NO. 5 FIGURE TITLE Existing Watercourses and Potential Impacts Hunter Wetlands National Park

DATE 23/01/2012

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SCALE 1:15000

PAGE SIZE A3

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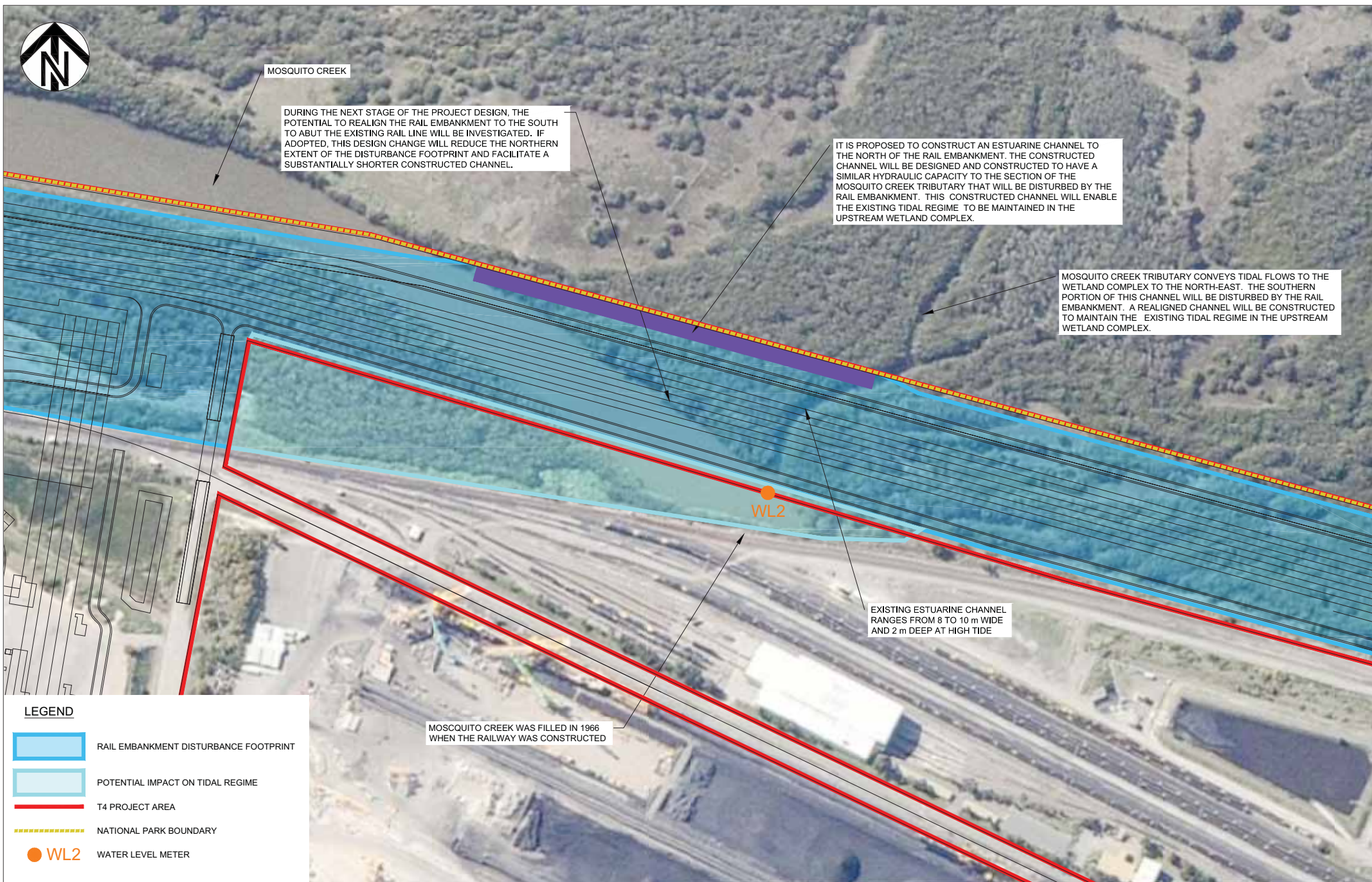


FIG NO. 6 **FIGURE TITLE** Mosquito Creek
Potential Hydrologic Impacts and Mitigation Measures

DATE
23/01/2012

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SCALE 1:2500

PAGE SIZE
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PROJECT NO. 30011123 **PROJECT TITLE** PWCS T4
Surface Water Management Assessment

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A LEVEE HAS BEEN CONSTRUCTED ACROSS THE CHANNEL THAT COMPLETELY BLOCKS SURFACE FLOW AND FISH PASSAGE. NO CULVERTS WERE IDENTIFIED THROUGH THE LEVEE DURING A SITE INSPECTION. FURTHER INVESTIGATIONS WILL BE UNDERTAKEN TO DETERMINE IF REMOVING OR LOWERING THIS LEVEE WOULD RESULT IN A BENEFICIAL ECOLOGICAL OUTCOME.

LIGHT GREEN VEGETATION IS A FRESH WATER SPECIES AND INDICATES LAND THAT IS ABOVE THE INTERTIDAL ZONE. FURTHER INVESTIGATIONS WILL BE UNDERTAKEN TO ESTABLISH IF LOWERING THIS AREA WILL RESULT IN AN IMPROVED ECOLOGICAL OUTCOME

SOME TIDAL EXCHANGE BETWEEN THE SALT LAGOON AND THE GREATER WETLAND AREA IS LIKELY DURING KING TIDES.

LIGHT GREEN VEGETATION IS A FRESH WATER SPECIES AND INDICATES LAND THAT IS ABOVE THE INTERTIDAL ZONE. FURTHER INVESTIGATIONS WILL BE UNDERTAKEN TO ESTABLISH IF LOWERING THIS AREA WILL RESULT IN AN IMPROVED ECOLOGICAL OUTCOME.

IMPACTS TO THE EXISTING TIDAL REGIME ARE POSSIBLE IN THE WETLAND COMPLEX LOCATED BETWEEN THE LEVEE AND THE PROPOSED RAIL EMBANKMENT. IT IS PROPOSED TO REMOVE OR MODIFY THE LEVEE TO MAINTAIN THE EXISTING TIDAL REGIME IN THIS AREA. THIS WILL BE SUBJECT TO SECONDARY APPROVALS.

EASTERN FRESHWATER WETLAND

LEGEND

-  RAIL EMBANKMENT DISTURBANCE FOOTPRINT
-  POTENTIAL IMPACT ON TIDAL REGIME
-  T4 PROJECT AREA
-  HUNTER ESTUARY WETLANDS (RAMSAR SITE)
-  NATIONAL PARK BOUNDARY
-  WATER LEVEL METER

POORLY FLUSHED SALT LAGOON IS A REMNANT PORTION OF THE FORMER MOSQUITO CREEK CHANNEL

THE EASTERN WATERCOURSE WAS FILLED IN 1966 WHEN THE RAILWAY WAS CONSTRUCTED.

NO CULVERTS WERE IDENTIFIED UNDER THE RAIL EMBANKMENT DURING A SITE INSPECTION

FIG NO. 7 FIGURE TITLE Eastern Watercourse
Potential Hydrologic Impacts and Mitigation Measures

DATE
23/01/2012

20 0 20 40 60m
SCALE 1:2000

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COORDINATE
SYSTEM

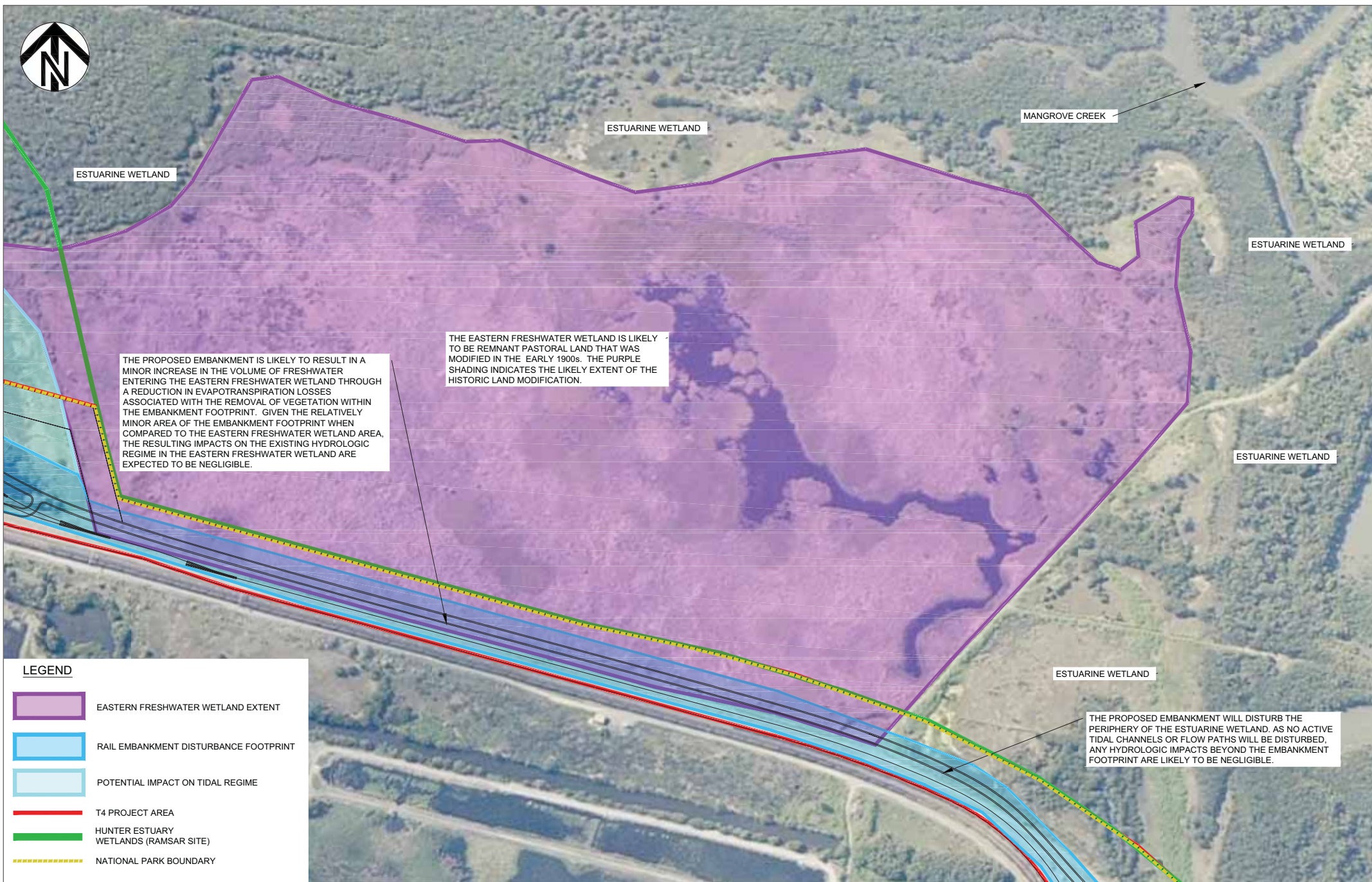
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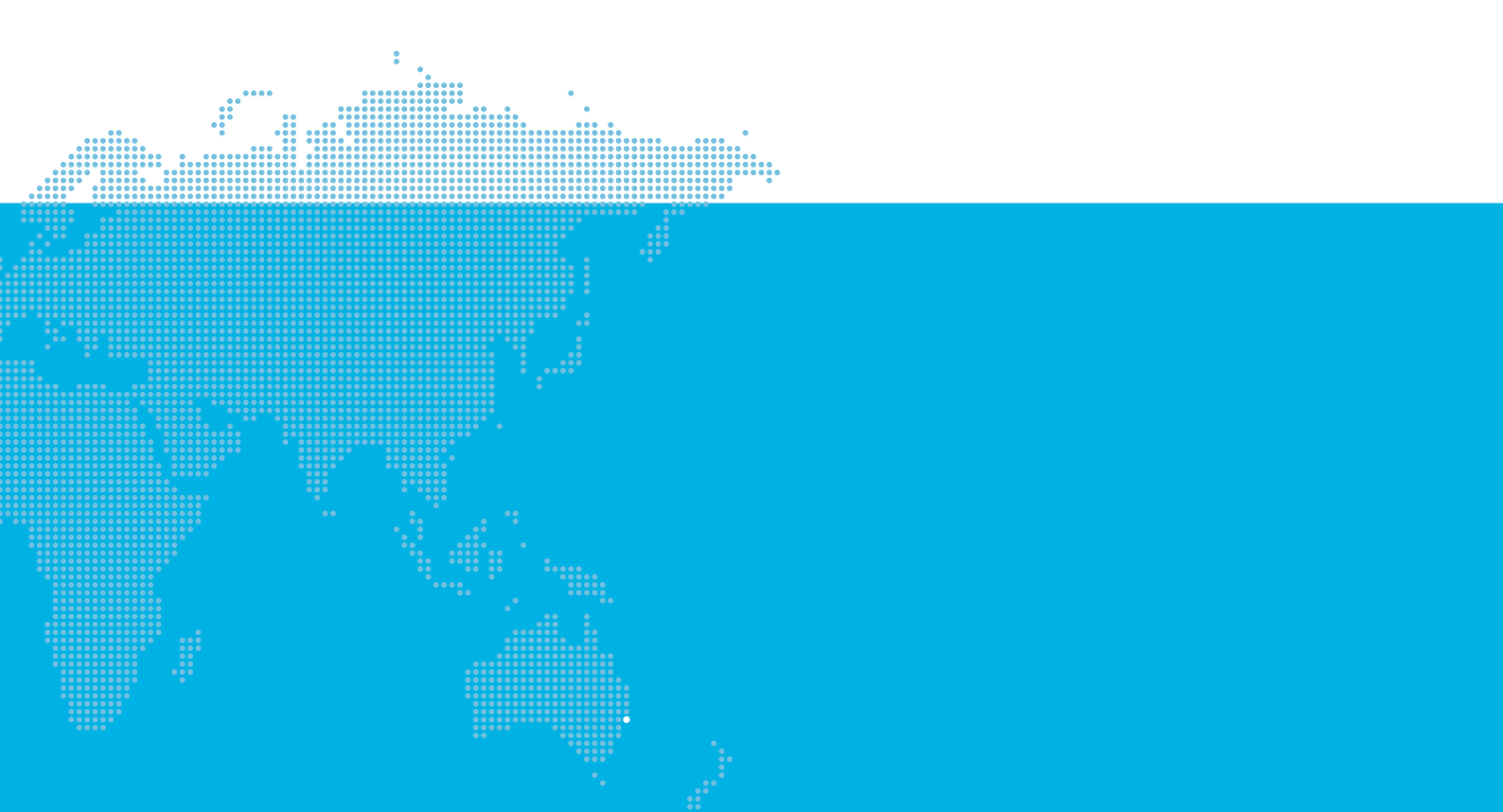


PROJECT NO. 30011123 PROJECT TITLE PWCS T4
Surface Water Management Assessment

CREATED BY S Worlin

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