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Hexham Train Support Facility

Stormwater Management Plan

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Hexham Train Support Facility *Stormwater Management Plan*

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301020-04881-CI-REP-0002-07 – HEXHAM TRAIN SUPPORT FACILITY

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1	Revised Final	B. Oberdorf	G. Swan	C. Glassock	June 2011		
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1. INTRODUCTION

1.1 Background

Aurizon owns 254ha of land adjacent to the Great Northern Railway in Hexham with the intention of developing the site for the following proposed land-uses:

- A Train Support Facility (*TSF*) is proposed in the eastern portion of the site, adjacent to the Great Northern Railway. The TSF is required by Aurizon to aid its coal logistics operations and would incorporate locomotive and wagon maintenance facilities and associated maintenance infrastructure. The TSF would occupy approximately 19ha of land.
- In Parallel with the TSF, Five relief roads (tracks) and associated infrastructure is proposed by the Australia Rail Track Corporation Ltd (ARTC), This will be infill development to the existing Train Support Facility, and as such, there will be no significant additional impact on the stormwater management for the site Associated infrastructure includes vehicle access tracks, temporary construction compounds and stockpile sites.

A Project Application is being prepared for the TSF development in accordance with Part 3A of the Environment Protection and Assessment Act by Aurizon.

WorleyParsons (WP) was engaged by Aurizon to undertake a stormwater assessment for the TSF including cumulative impacts from ARTC's Relief Roads Project proposed land-uses listed above. The report outlines the Stormwater Management Plan (SWMP) for the development.

This report addresses the impact of the proposed development on stormwater management issues. This study primarily focuses on:

- Site hydrology and changes resulting from the proposed development;
- Water quality management aspects of the proposed development;
- Stormwater control for the TSF.

The SWMP was prepared in accordance with the best practice stormwater management guidelines prepared by Newcastle City Council (*DCP 2005*), and NSW Government agencies (*various guidelines*) and Engineers Australia (*IEAust*). This SWMP forms part of the Environmental Assessment (EA) being undertaken as part of the Development Application (DA) for the Train Support Facility(TSF).

1.2 Study objectives

The following objectives have been adopted for this investigation:

- Assessment of existing site water quality and hydrological conditions.
- Review existing conditions and identify opportunities for improvement in the stormwater management of the site.
- Identification of potential impact of the development proposal on water quality and hydrologic regimes.
- Development of mitigation measures to minimise any adverse impacts on the surrounding environments. Mitigation measures would be developed for both the construction and operational phase of the development.
- Consider cumulative impacts of the ARTC project

1.3 Site Description

The site is located at the southern end of Woodlands Close, Hexham. The site is bound to the east by the Great Northern Railway, which runs parallel to the New England Highway and the south arm of the Hunter River estuary. The Chichester trunk gravity main (CTGM) is located parallel to the western and southern boundaries of the development site. The site is bound by the New England Highway (access road to connect at the Tarro interchange) to the north, low lying privately owned agricultural land to the south and the Hexham Swamp Nature Reserve to the west. **Refer to** Figure 1 **for the locality plan.**

The site is dominated by a large coal reject stockpile located centrally to the site and about 2km south of the Woodlands Close turnoff from the New England Highway. The stockpile is approximately 850m long (north-south) and 500m wide (east-west) and ranges up to RL13.6m (up to 12m above surrounding levels). The coal stockpile is currently heavily grassed and is used by the adjoining land owner to the north-east, Brancourts, to irrigate treated effluent from the factory adjacent to the site.

Between the coal stockpile and the Great Northern Rail line is a flat area that is up to 100m wide. This area comprises a variety of hardstand areas, stockpiles, vegetated areas and access tracks.

South of the stockpile is a flat area some 350m long and 600m wide. This area contains a former rail loop to the site however is now predominantly grassed with some areas of regrowth. An old tailings pond exists on the south-east corner of the site however is largely filled and inactive.

To the north of the site is an abandoned rail corridor and a parcel of low lying land. This area contains a small wastewater treatment facility that is operated by Brancourts. Treated effluent is irrigated in this area.

The current land zonings are summarised below:

- The coal stockpile area is zoned IN3 (Heavy Industry);
- Hexham Swamp is zoned 8a (National Park and Nature Reserves);
- The land to the north and south of the site, and the Hunter Water Pipeline, is Zoned E2 (Environmental Protection Zone); and.
- The rail line to the east is zoned 5a (Special Use Zone).

1.4 Proposed Development

Project Approval for the TSF is currently being prepared. It is expected that the construction works for the Train Support Facility would commence in 2013 and is expected to be completed by Mid-2014. (Refer to **Figure 2**). Taking into account the changes made to the design of the Hexham TSF, the project for which approval is now being sought includes the following:

- Construction of new connections to the Great Northern Railway;
- Construction of seven new train lines (tracks) parallel to the existing Mainline to provide for provisioning, inspections, servicing and maintenance of Aurizon trains, as well as a Shunt Neck at the northern part of the facility providing in total 10.5km of railway track;
- A Provisioning Building generally as described in Section 6.4.2 of the EAR to provide provisioning, inspections and unscheduled rolling stock maintenance on a 24 hour, 7 days per week basis. Provisioning includes replenishing locomotives with fuel, sand, water, oil and other consumables as well as general cleaning and cab preparation;
- A Combined Maintenance Building located generally where the Wagon Maintenance Building was originally proposed in the EAR. The Combined Wagon Maintenance Building would generally be operated between 06:00 and 22:00 hours weekdays – however, with hours of operation driven by demand this could increase to a 7 day per week operation when and if required and approval is being sought for operations 7 day per week maintenance operations;
- The Combined Maintenance Building would include the TSF's main administration centre;
- A Service Vehicle Garage, car park, truck unloading and wheel set storage area located within the internal road turning loop, adjacent to the Combined Maintenance Building and Administration Centre. Car parking will be provided for up to 50 cars and light vehicles in the main car park, with a five space car-park also located near to the provisioning building for occasional parking of vehicles;
- A bulk fuel storage area with capacity for up to 630,000L of diesel fuel in 100,000 litre above ground, self-bunded fuel storage tanks. Bulk storage of sand would be located adjacent to the fuel storage area.
- At the completion of construction the facility will have a maximum of 30 personnel on-site over a 24-hour period..
- Construction of an intersection and a new access road from the Tarro Interchange.
- Construction of internal access roads comprising of sealed single carriage way road

- The protection or diversion of existing utilities, and where appropriate connection of the site to utilities.
- Permanent stockpiling of up to approximately 150,000m^3 of Potential Acid Sulphate Soils or acid generating materials.
- Installation of a package Waste Water Treatment Plant with on-site effluent irrigation to be located within the internal road turning loop, adjacent to the Combined Maintenance Building and Administration Centre.

The project is planned to be constructed continuously over approximately 18 months. It is planned to commence provisioning of locomotives once the Provisioning Building and associated rail infrastructure has been constructed and commissioned. Provisioning would be carried out whilst construction of the maintenance facilities and associated railway track infrastructure is being constructed.

Construction of the ARTC Relief Roads project is expected to be carried out in parallel with the TSF. The Australian Rail Track Corporation (ARTC) has confirmed that it is lodging an application for a relief roads project, which will consist of five rail tracks and associated infrastructure. The works includes:

- Five Up Relief roads (train lines) to the west of the existing Up Main, Down Main and Up Coal including:
  - The removal of the existing Down Coal (located to the west of the Up Coal);
  - The construction of five new train lines for the relief roads;
  - The construction of a new Down Coal to the west and outside of the proposed relief roads;
  - Each relief road to accommodate trains generally comprising two or three locomotives and up to 91 wagons (1543m long) requiring a minimum standing of 1670m;
  - New turnouts, return curves and associated track changes.
- Installation of new signal infrastructure for the five roads including signal location cases, huts and gantries.
- Bulk earthworks and civil works including fill import, cut to fill, track formation, drainage and minor structures.
- Land acquisition and the upgrading of existing rail infrastructure and public facilities as required.

1.5 Previous Studies

Douglas Partners have been engaged to undertake water quality sampling at the above site (TSF site). Results from the monitoring program are discussed in more detail in **Section 2.4**.

BMT WBM prepared the *Environmental Impact Assessment* and *Environmental Assessment (Supplement)* for the Hexham Swamp Rehabilitation Project. These studies investigated the impact of opening floodgates on Iron Bark Creek to allow tidal inflows into Hexham Swamp. This report indicates that Hexham Swamp receives flows from catchments extending from Mt Sugarloaf (14.5km south-west of Hexham), Bluegum Hills, Minmi, Maryland, Ironbark Creek and Canoe Channel. These catchments exhibit a high proportion of residential development.[1] The total catchment area of Hexham Swamp is estimated to be approximately 1950Ha[2].

Parsons Brinckerhoff has performed a Water Quality Assessment which was commissioned by ARTC to examine water quality as part of the wider assessment for the Environmental Impact Assessment relating to the development of the proposed relief roads. The assessment reviews the relief roads project area with particular emphasis on the potential receptors of poor quality water as a result of the development and then outlines methodologies to minimise adverse effects of poor quality on receiving waters.

1.6 Relevant requirements, legislation and guidelines

Director Generals Requirements

This project is being assessed by Department of Planning and Infrastructure. The Director Generals Requirements for the project (*dated 22/3/2010*), relevant to this study, include:

Hydrology and Geology *– including but not limited to:*

> *surface water and stormwater management, including consideration of water quality (sedimentation and acid sulphate soils) and treatment, hydrological regimes, watercourses, riparian and receiving waters (including Hexham Swamp Nature Reserve); taking into account the Managing Urban Stormwater: Soils and Construction (Lancôme) guidelines. Acid Sulfate Soils (ASS) and ASSMAC are to be dealt with by Douglas Partners.*

Australian Rainfall and Runoff

Australian Rainfall and Runoff (AR&R) is a document published in 1987 (reprinted in 1998) by the Institution of Engineers, Australia (IEAust). This document has been prepared to provide designers with the best available information on design flood estimation and is widely accepted as a design guideline for all flood and stormwater related design in Australia.

[1] WBM, Environmental Impact Assessment, 2006, 3.3.3.2
[2] WBM, *Environmental Impact Assessment,* 2006, 3.1.1

Australian Runoff Quality

Australian Runoff Quality (ARQ) is a document published in 2005 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 stormwater harvesting and re-use.

Water Management Act 2000

The *Water Management Act 2000 (WMA)* is administered by the *NSW Office of Water*. The act provides guidelines regarding development constraints and riparian setback for any controlled activity occurring within 40 meters from a river, lake or estuary. The objectives of the WMA are considered best practise and have been applied in principle to the development proposal.

Council DCPs

Newcastle City Council's DCP 2005 – Element 4.5 is the relevant Council document covering stormwater management for the site.

Managing Urban Stormwater Series

This series of documents issued by the *Department of Environment & Climate Change* (DECC) and Sydney Metropolitan Catchment Management Authority (CMA) provide guidance on a wide range of stormwater management issues. Relevant guidelines to this study are:

- DECC & CMA (2008) *Managing Urban Stormwater: Soils and Construction (Volume 2E – Mines and Quarries)*
- DECC & CMA (2007) Managing Urban Stormwater: Environmental Targets (*Consultation Draft*)
- EPA (1998) *Managing Urban Stormwater: Source Control*
- EPA (2007) *Managing Urban Stormwater: Treatment Techniques* (Consultation Draft)
- EPA (2006) *Managing Urban Stormwater: Harvesting and Reuse*
- EPA (2008) *Managing Urban Stormwater: Soils and Construction*

These guidelines recommend the following stormwater quality treatment targets:

- 90% reduction in average annual gross pollutants
- 85% reduction in average annual Total Suspended Solids
- 65% reduction in average annual Total Phosphorus
- 45% reduction in average annual Total Nitrogen
- The post development duration of flows greater than the “stream forming flow” being no greater than 3 to 5 times the natural duration of this flow (refer to note below).

The guidelines indicate that the last target regarding stream forming flows doesn’t apply to estuarine or tidal waters. Estuarine conditions generally occur to the north and south of the site. In addition, following opening of the Iron Bark Creek floodgates, Hexham Swamp may also experience tidal flow patterns. Therefore the last target has been ignored for this study.

1.7 Available data

The following information was used as part of this investigation:

- A recent survey of the site, from which contours were mapped at 0.2m intervals.
- A recent aerial photograph of the site

Additional information was gathered during numerous site inspections.

2. EXISTING CONDITIONS

This section describes the existing hydrologic and water quality conditions within the site and in the immediate downstream receiving waters.

2.1 Historic and Current Land Use

Formerly, the site contained a coal tailings stockpile and washery facility and a section of the former Richmond Vale Railway, which operated between 1856 and the late 1980s. In the 1950s the southern portion of the site was reclaimed and utilised as a Coal and Allied coal preparation, stockpiling and despatch terminal. These operations ceased in 1987, at which time the washery and the majority of the rail facilities were removed. Some concrete foundations remained on the site as well as an estimated 1.5 million tonnes of commercially recoverable coal tailings and 1.8 million tonnes of chitter.

As a result of this previous land-use, there are significant stockpiles of coal washery reject in the central and southern portions of the site. There is also potential for a wide range of soil contamination to be present. A preliminary geo-chemical investigation undertaken by Douglas Partners in 2007 observed some metal and hydrocarbon levels above *NSW EPA Inert Waste Guideline* criteria. Douglas Partners are currently undertaking a more extensive assessment of the site contamination as part of the environmental assessment report for the development (refer to Douglas Partners Report No. 39798-04).

Currently, the site is utilised for cattle grazing and irrigation of treated wastewater effluent from the wastewater treatment plant which is located on-site and operated by Brancourts. Under a license agreement, treated effluent from the plant is spray irrigated over select areas of the site. Areas subject to irrigation are harvested regularly for hay production. Current effluent irrigation areas are indicated in **Figure 3.**

2.2 Water Dependant Ecosystems

The site and adjacent areas are located in an ecologically important environment. Discussion of stormwater related factors for the local environment are detailed in the following sections. Ecological Australia Pty Ltd has been engaged by the Proponent to carry out a threatened species assessment for the site.

2.2.1 Hexham Swamp

Hexham Swamp Nature Reserve is located to the west of the site and is approximately 1950ha[3] in area. In conjunction with the Kooragang Nature Reserve to the east, it is the largest estuarine reserve in NSW with a total combined area of around 3000ha[4]. It is acknowledged that Hexham Swamp is recognised as a regionally important system.

The WBM report indicates that Hexham Swamp receives flows from catchments extending from Mt Sugarloaf (14.5km south-west of Hexham) Bluegum Hills, Minmi, Maryland, Ironbark Creek and Canoe Channel. These catchments exhibit a high proportion of residential development[5] with future significant development planned in the short to medium term. Newcastle City Council's Stormwater Management Plan indicates that the total catchment for the Iron Bark Creek system is approximately 12,500ha[6].

In addition to the ecological aspects, Hexham Swamp is also important as a storage during major flooding events. Although under the operation of flood gates since the 1970's, the swamp is inundated by flows from the Hunter River during floods generally around the 10 year ARI.

2.2.2 Endangered Ecological Communities (EEC)

Site investigations by Ecological Australia have identified the following EEC communities on the site (refer to **Figure 3** for approximate locations):

- Swamp Oak Forest.
- Swamp Oak Floodplain Forest (Swamp)
- Swamp Oak Floodplain Forest (Phragmites Swamp)
- Coastal Saltmarsh

Portions of the Swamp Oak Floodplain Forest (Swamp and Phragmites Swamp) are also designated as SEPP14 wetland areas.

The Swamp Oak Forest communities are generally located in waterlogged or periodically inundated areas. Based on survey information on the site it appears that the forest forms a basin up to about 0.2m below existing levels. This area is currently grazed and is adjacent to effluent irrigation areas from the Dairy Farmers site.

[3] WBM, *Environmental Impact Assessment,* 2006, 3.1.1
[4] Kooragang Nature Reserve And Hexham Swamp Nature Reserve Plan Of Management, August 1998, NSW NPWS.
[5] WBM, *Environmental Impact Assessment,* 2006, 3.3.3.2
[6] Newcastle Stormwater Management Plan, 2004, pg 120

The Coastal Saltmarsh is generally located to the south-east of the site and on the adjacent Lot 312 DP583724 to the south.

To the west of this area is the Phragmites community, which also extends to the west of the Hunter Water water main. The Phragmites community to the south of the site is probably beyond the extent of tidal inundation and supported by run off from the drains at the base of the coal reject stockpiles.

2.2.3 SEPP 14 Wetlands

The SEPP 14 wetlands are described above and in the Flora and Fauna Report carried out by Ecological Australia (*Aurizon – Hexham Train Support Facility State Significant Infrastructure – Ecological Investigations,* May 2012).

2.3 Site Hydrology

Prior to European settlement of the Hexham area, the site formed part of the Hexham Swamp Estuarine wetlands. However, over the past 150 years, anthropogenic alterations on both a local and regional scale have significantly altered the local and regional hydrodynamic regimes. Key anthropogenic alterations include:

- Construction of the Richmond Vale and Great Northern railways in the mid-1800s.
- Installation of Hunter Water Corporation watermain and raised access track through the swamp in the 1920's. Further, subsequent replacement of causeways with pipe culverts reducing east-west flows in the swamp.
- Infilling of the southern portion of the site in the 1950s to construct a coal stockpile and preparation facility. Additionally, numerous drainage swales and tailings ponds were constructed.
- Construction of the Iron Bark Creek Flood Gates in 1971, which have prevented tidal exchange into the Hexham Swamp area. These gates however, have been reopened gradually since 2008 as part of the ongoing rehabilitation of Hexham Swamp. The gates are now only closed when there is a flood warning for the Hunter River or it's main tributaries;
- Irrigation of treated wastewater effluent from the on-site Dairy Farmers treatment plant.
- Staged re-opening of Iron Bark Creek flood gates in 2008 and 2010.

As discussed above, the hydrodynamics within the existing site have been significantly altered by coal stockpiling, infilling of wetlands, construction of tailings ponds and drainage swales and irrigation of waste water effluent. The resulting landform is considered highly disturbed.

Given the highly disturbed state, it is difficult to numerically assess the existing hydrological behaviour of the site. The existing catchment features and surface runoff behaviour of the site are described spatially in **Figure 3**. It is noted that due to the relatively flat terrain, restricted pipe culverts and mounding, there are significant overflows between catchments and ponding over large areas that limits accuracy of hydrologic and hydraulic modelling. In view of this, a combination of qualitative and quantitative approaches has been used to determine stormwater management measures appropriate to the development.

The site currently drains to three locations:

- Hunter River via culverts to the north of the site below the existing Great Northern railway line.
- Hunter River via culverts to the south of the site below the existing Great Northern railway line;
- To the west to Hexham Swamp via pipe culverts above Hunter Waters watermain.

The groundwater regimes for the site have been investigated by Douglas Partners (August 2012) as part of the Preliminary Contamination Assessment. Elevated groundwater levels were identified to the south and within the south-eastern portion of the coal tailings stockpile, which was considered to be associated with effluent irrigation and the presence of fill material (ie perched groundwater). In the area of the proposed TSF facility along the existing railway corridor, groundwater levels generally ranged from RL 3.0m at the edge of the existing coal stockpiles, down to RL 1.0 in the west, and RL 1.5m to the east.

It was also noted that the site sub-surface materials do not form a continuous layer and therefore this may result in groundwater flow variations along variable fill horizons.

2.4 Water Quality

Given the historic and current land-uses, there is potential for a wide range of surface water contamination to exist on-site. As a result of these historic land-uses, the following contamination could potentially be present on the existing site:

- Coal washery and stockpile areas have not been disturbed for over 20 years and are likely to be stabilised. Notwithstanding there is potential for :
  - High Total Dissolved Solids and low pH is commonly observed in leachate from coal tailings stockpiles
  - Potential for a wide range of metal and hydrocarbon contamination as a result of the past coal handling related land-uses.
- Effluent Irrigation Areas are likely to contribute to:
  - Elevated Biological Oxygen Demand (BOD)
  - Elevated Chemical Oxygen Demand (COD)
  - Elevated nutrient loads

- Cattle Grazing Areas commonly observed
  - Increased sediment loads were cattle trampling occurs within water bodies
  - Elevated nutrient loads from cattle faeces
  - High faecal coliforms from cattle faeces

As noted in **Section 2.1**, Douglas Partners have been engaged by Aurizon to undertake a geochemical investigation to identify any existing soil or groundwater contamination (*Report on Preliminary Contamination Assessment Proposed Train Support Facility Maitland Road and Woodlands Close, Hexham,* May 2012). As part of this work, Douglas Partners undertook surface water monitoring in order to establish existing water quality trends for the site. To date only limited test results are available and are shown below in **Tables 1** and **2** (refer to Douglas Partners Report for sample locations and additional discussion). The results to date generally indicate the absence of gross contamination within the soil, groundwater and surface water samples tested. Elevated levels of nutrients and faecal coliforms were encountered in groundwater and surface samples taken from the site. Based on field observation and laboratory results, it was considered that the elevated nutrient and faecal coliforms concentrations may be attributed to the infiltration of irrigated treated effluent.

In addition, slightly elevated levels of heavy metal contamination were encountered in groundwater and surface water samples taken at the site. Leachability testing is needed to confirm the leachability characteristics of onsite fill materials to confirm it as a source of the observed heavy metals. It was also noted that the slightly elevated heavy metal concentrations in the groundwater and surface water are consistent with regional groundwater and surface water quality.

It was considered by the report that there is a potential for offsite migration of groundwater and surface water containing elevated heavy metals, hydrocarbons, nutrients and faecal coliforms, which recommended additional investigation to further assess identified areas of contamination and areas not assessed or inaccessible during the time of fieldwork.

As previously mentioned, water quality assessment was carried out by Parsons Brinckerhoff on behalf of ARTC (*Water Quality Assessment – Hexham Relief Roads*, April 2012) to examine water quality within the proposed development area for five relief roads which will lie on an 18ha parcel of land between the proposed TSF development area and the Great Northern Railway, The water quality data showed high nutrient, low dissolved oxygen and low pH along with turbid water. This indicated eutrophic conditions in the proposed project area watercourses which were subject to high nutrient and sediment inflows. As such, the Hexham swamp and Hunter River were found to be a degraded aquatic ecosystem in the vicinity of the proposed site.

Table 1 - Surface Water Quality Test Result (14 April 2008)[7]

Results outside of ANZECC Criteria are shaded

Laboratory Test Results													ANZECC Criteria		
Sample	Units	SW201	SW202	SW203	SW204	SW205	SW206	SW207	SW208	SW209	SW210	SW211	Toxicant Levels[8]	Lowland River	Estuaries
pH	pH Units	7.3	7	6.9	7.4	7.3	7.6	7.6	7.1	**6.4**	8.5	7	~	6.5 to 8.0	8.0 to 8.4
DO	%Saturation	**57**	**60**	**73**	**86**	**77**	**39**	**37**	**36**	**80**	92	**24**	~	85 to 110	80 to 110
Turbidity	NTU	20.8	48.8	4.8	28.8	**57.5**	12.6	20	**53.5**	9.9	12	**2610**	~	6 to 50	0.5 to 10
Electrical Conductivity	µS/cm	**2300**	**4100**	1800	1500	**2700**	3100	**11000**	1200	450	**2300**	**2600**	~	125 to 2200	~
Total Dissolved Solids	mg/L	1200	2300	1000	820	1700	2000	7400	770	290	1600	1600	~	~	~
Biochemical Oxygen Demand	mg/L	5	27	8	5	7	6	7	22	8	10	28	~	~	~
Chemical Oxygen Demand	mg/L	130	140	94	120	120	79	150	70	49	340	150	~	~	~
Nutrients															
Total Kjeldahl Nitrogen	mg/L	2.6	2.9	2.4	0.4	1	1.9	0.9	0.9	1.1	4.7	2.8	~	~	~
Total Nitrogen	mg/L	**2.6**	**2.9**	**2.4**	0.36	**1**	**2**	**0.92**	**0.94**	**1.1**	**4.7**	**2.8**	~	0.5	0.3
Total Phosphorus	mg/L	**0.53**	**0.63**	**0.74**	**1.4**	**1.8**	**2**	**0.09**	**0.9**	**0.18**	**0.27**	**0.27**	~	0.05	0.03
Anions															
Ammonia as N	mg/L	**0.33**	**1.2**	**0.05**	0.02	**0.12**	**0.3**	**0.02**	**0.04**	**0.03**	**0.09**	**0.06**	~	0.02	0.015
Nitrate as N	mg/L	0.01	<0.005	<0.005	<0.005	<0.005	0.04	<0.005	0.006	0.006	0.02	<0.005	0.7	~	~
Nitrite as N	mg/L	0.01	<0.005	0.009	<0.005	<0.005	0.02	<0.005	<0.005	<0.005	0.02	0.008	~	~	~
Total NOX	mg/L	0.024	<0.01	<0.014	<0.01	<0.01	0.058	<0.01	<0.011	<0.011	0.046	<0.013	~	0.04	0.015
Metals															
Arsenic	µg/L	1.2	2.6	1.2	2	1.8	1.8	1.3	1.2	<1	16	1.1	13	~	~
Cadmium	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	~	~
Chromium	µg/L	<1	<1	**1.2**	<1	<1	**1.8**	**1.4**	<1	<1	<1	<1	1	~	~
Copper	µg/L	<1	<1	<1	<1	<1	<1	<1	<1	1	**7.3**	<1	1.4	~	~
Iron*	µg/L	1100	190	1200	520	630	190	33	260	270	1400	190	~	~	~
Nickel	µg/L	9.6	3	2.5	4	8.2	9.1	7.4	5.3	2.4	6	5.5	11	~	~
Lead	µg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.8	<1	3.4	~	~
Zinc	µg/L	5.3	1.4	4.3	1.8	3.4	4	5.9	1.7	**20**	**22**	2.2	8	~	~
Mercury (Dissolved)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.00006	~	~
TRH															
TRH C_6 - C_9 P&T in µg/L	µg/L	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40	~	~	~
TRH C_{10} - C_{14}	µg/L	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40	~	~	~
TRH C_{15} - C_{28}	µg/L	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	~	~	~
TRH C_{29} - C_{36}	µg/L	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	~	~	~
BTEX															
Benzene	µg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	950	~	~
Toluene	µg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	~	~	~

[7] Douglas Partners, "Report on Preliminary Contamination Assessment, Proposed Hexham Redevelopment for Queensland Rail", August 2012
[8] Based on Slightly to Moderately disturbed systems

Laboratory Test Results													ANZECC Criteria		
Sample	Units	SW201	SW202	SW203	SW204	SW205	SW206	SW207	SW208	SW209	SW210	SW211	Toxicant Levels[8]	Lowland River	Estuaries
Ethyl benzene	µg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	~	~	~
Total Xylenes	µg/L	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	550	~	~
PAH															
Total PAHs	µg/L	<4.10	<1.90	<1.90	<1.80	<1.70	<1.70	<1.50	<1.50	<1.50	<1.50	<1.50	~	~	~
Naphthalene	µg/L	2.7	<0.5	<0.5	<0.4	<0.3	<0.3	<0.1	<0.1	<0.1	<0.1	<0.1	16	~	~
OPP	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		~	~
OCP															
Total OCP	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	~	~	~
Aldrin + Dieldrin	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	~	~	~
Chlordane	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.00003	~	~
DDT	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.000006	~	~
Heptochlor	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.00001	~	~
PCB	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.0003	~	~
Faecal Coliforms	cfu/100mL	550	30	1090	260	420	60				2150	860	~	~	~

Table 2 – Measured Surface Water pH and EC – 2011 Inspection

Surface Water Location	Surface water ID	pH	EC (mS/cm)
West of former bailing shed. Low lying recently disturbed area, directly adjacent to gravel access road	SW 301	7.5	2.7
Unlined drainage channel west of coal tailings stockpile	SW 302	7.3	1.8
Bike track area - dirtectly east of GHD excavation	SW 303	9.5	1.2
	SW 304	8.1	1.1
GHD excavation	SW 305	8.6	1.2
Disturbed area associated with pipeline installation - southern side of former balloon rail loop	SW 306	3.3	2.8
	SW 307	3.4	2.2
	SW 308	5.5	2.4
	SW 309	5.7	1.9
	SW 310	6.5	1.9

3. POTENTIAL SURFACE WATER IMPACTS & MANAGEMENT OBJECTIVES

This section outlines the stormwater management system proposed for the development. The background information and objectives will be explained, followed by a qualitative and semi-quantitative assessment of the site and then description of the adopted stormwater management system.

The stormwater management system for the TSF development is provided in detail in the following sections. The intention of the SWMP is to clearly demonstrate that stormwater management for the development is feasible and effective, and will also greatly improve the current environmental outcomes for the site and surrounding receiving waters.

The stormwater management system has been designed in accordance with current standards and regulatory requirements. As described in detail in later sections, there are numerous existing site factors which impact stormwater quality and quantity on the site. In particular, the impact of effluent irrigation, grazing and leachate/runoff from the coal stockpile is difficult to quantify without significant monitoring. Therefore, the approach adopted has been to consider the impacts of the TSF without attempting to consider other existing background factors. The site contamination and groundwater assessments would be expected to address the other issues.

3.1 Potential Impacts

The following extract from Table 13.2 in the *Australian Runoff Quality (ARQ)* summarises the key adverse impacts of urban/industrial and commercial developments on downstream waterways:

1) Increased rate and volume of runoff;
2) Increased frequency of high velocity flows;
3) Increased rates of erosion, sedimentation and channelisation;
4) Reduction in the loss of riparian zones;
5) Reduction in the loss of in-stream habitat;
6) Decreased water quality;
7) Containment of sediments;

8) Introduction of barriers to the dispersal of biota and the loss of continuity between up-stream and downstream communities; and

9) Reduced diversity of indigenous flora and fauna and the introduction of pests and weeds.

The intention of this water quality assessment is to develop a water quality mitigation strategy for the proposed development. This strategy would address the above potential impacts of development on local waterways listed above. This assessment includes:

- Establishment of water quality treatment targets;
- Establishment of water quality control strategies; and
- Indicative sizing of water quality and quantity control devices.

The following Sections outline some site specific potential impacts of the proposed development.

3.1.1 Ecological

The receiving waters and areas for stormwater discharges from the site will need to consider several sensitive ecological environments. In particular, this report will focus on changes to the quantity, peak flow rates and quality of stormwater discharged from the site. The sensitive environmental areas are described below:

SEPP14 Wetlands/EEC Communities

Based on principles of wetland hydrology discussed by LHCCREMS (WSUD Solutions for Catchments above wetlands, the following considerations have been incorporated into the stormwater management plan with the intention of minimising adverse impacts on the existing sensitive environments.

- Minimise changes in flow regimes to the Swamp Oak Forest for smaller low flow (high frequency) storm events. It is considered that changes in larger storm events (say greater than 1 or 2 year frequency) will not adversely impact these areas, provided any potential erosion issues are addressed. The potential impacts on existing vegetation are discussed in the Report prepared by Ecological (*Aurizon – Hexham Train Support Facility State Significant Infrastructure – Ecological Investigations).*
- Minimise increases in fresh water discharges to the Coastal Saltmarsh, to prevent changing the composition of these communities. In addition, no impediment to continued tidal flushing of these areas should occur.
- Minimise impoundment of water due to the construction of the access road. (refer **Section 5.1.6**)

- Discharges to the Swamp Oak Floodplain Forest (Phragmites Swamp) will be expected to have a negligible impact due to the relative size of the contributing catchment areas to these systems. However, in accordance with LHCCREMS recommendations (WSUD Solutions For Catchment Above Wetlands, May 2007) continuous wetting from frequent discharges from low recurrence interval storm events should be minimised in areas adjacent to the floodplain complex to prevent these areas changing composition, which may result from changes in wetting/drying patterns, which influences both physical characteristics (eg gas diffusion) and chemical (eg redox) characteristics of the substratum.

Land Offsets

Since the proposed access road will pass through a SEPP14/EEC area in the northern part of the TSF site (refer to ***Figure 2***), offset areas (environmentally managed through pest control, weed control, monitoring, replanting, creation of habitat etc. Refer to *Aurizon – Hexham Train Support Facility State Significant Infrastructure – Ecological Investigations* for further details) will be founded as part of the implementation of a Conservation Management Plan by Aurizon (Director Generals Requirements). It may be beneficial to direct some stormwater to certain areas in order to promote the development of Swamp Oak Floodplain Forest communities.

This stormwater management plan provides a basis for stormwater management for the development. A strategy has been developed that can adapted if required following monitoring.

3.1.2 Hydrologic Conditions

Hydrologic conditions relate to the rainfall runoff characteristics of the subject site over a wide range of rainfall events, ranging from frequently occurring wet weather periods to larger rainfall events which can be the precursor to downstream flooding.

Surface Water Runoff

Surface water runoff is generally a function of the contributing catchment area and the hydrologic efficiency of the catchment (*i.e. the rate at which runoff occurs as impacted by drains and impervious areas for example*). The development could potentially alter the existing hydrologic regimes by:

- Altering existing catchment boundaries; and
- Altering the catchment hydrologic efficiencies by increasing impervious areas and improving drainage systems.

As the overall site is predominately flat, runoff would currently occur slowly, with the majority of rainfall being stored on-site in the lower lying areas. It is likely that runoff would only occur during/after extended periods of rainfall.

Following development there will be a moderate increase in impervious area and stormwater drainage systems, although due to site constraints, the proposed drainage systems have been designed to fall at absolute minimum gradients (sometimes flat). Although not hydraulically desirable, this will act to minimise time of concentration changes and maximise infiltration. As a result, the following impacts will need to be addressed:

- Potential changes to the hydrologic response of catchments contributing to sensitive areas during normal wetting and drying cycle events (i.e. events <<1 year ARI return period);
- Peak flows from frequent storm events (e.g. 1 to 2 year ARI events) which affect "stream forming" flows in the downstream drains, etc. Note that many of the existing surface drains within the neighbouring properties are recent human constructions;
- Large return period events (e.g. 10 year ARI) where significant changes in peak flow may cause localised erosion, should controls not be implemented at the point of discharge to the surrounding landscape.

Tidal exchange

The northern end of the proposed Train Support Facility would traverse an existing estuarine channel, which exchanges tidal flows between the Hunter River and the Northern Hexham Swamp area. Any bridge crossings over this channel would be designed to ensure that there was no alteration to the existing channel's hydraulic capacity, such that there is no impact on the hydrodynamics of the upstream wetlands.

Apart from the channel crossings, there are no proposed modifications within the tidal zone or modifications to any channels conveying tidal flows.

The area to the south of the site is also potentially estuarine. The extent of saltwater intrusion is generally dependant on the conveyance of drains in the adjacent site. The composition of vegetation in this area is somewhat transient and would alter depending on changing conditions over time and as result of the opening of the floodgates. For example, as the drains and culverts become blocked over time, the estuarine communities would decrease in area and the Phragmites communities increase correspondingly. No change to infrastructure are proposed by this project which would impact on tidal flushing of Coastal Salt Marsh areas.

3.1.3 Water Quality

The following contamination process and pathways have been identified as potentially occurring for both the existing site conditions and during the construction and operation phases of the TSF development proposal:

Construction Phase: The construction of the TSF and relief roads is to involve significant earthworks to achieve required site grading. As a result of the soil disturbances, there is potential for increased sediment loads to occur from the site. If disturbed soils are contaminated from previous land uses, then disturbance of these soils could potentially result in contaminated sediment being exported from the site in surface water runoff. Mitigation measures such as defining the extent and nature of contamination and providing sediment and erosion controls would be adopted to minimise the occurrence of both sediment (and any attached contaminants) being exported from the site. Surface water quality monitoring and appropriate contingency planning would be required to gauge the effectiveness of the proposed controls.

Fuel and oil spills pose a risk to water quality, however the potential impact is mitigated by the strict guidelines and Australian Standards required for their management.

- **Operation Phase:** During operation, the following potential contaminant sources have been identified:
  - **Locomotive Wash**: Designated locomotive wash down areas will be bunded to prevent runoff. Runoff would be treated (via sediment traps and oil/grease separators) prior to discharge to the proposed wash down recycling system. These systems are totally separate from the stormwater system.
  - **Locomotive and Wagon Maintenance Facilities**: Again Locomotive and wagon Maintenance facilities will be contained within specifically designed building structures that are protected from all weather, and have separate bunded collection, treatment and disposal systems, such that no contaminates can enter the stormwater system.
  - **Provisioning and Refuelling Areas**: Proposed provisioning and refuelling areas would be covered and bunded so that there is no runoff from these areas into the environment. Hence, it is unlikely that the provisioning/refuelling operation would be a source of hydrocarbon contamination into the environment.
  - **Rail Yard**: It is likely that the rail yard would have a low coal particulate load, primarily through the coal particulate either falling off wagons or washing off during periods of rainfall. Additionally, there is potential for hydrocarbon and metal contamination resulting from the rail yard operations. Runoff from the rail yard would be treated in gross pollutant traps and constructed wetlands prior to discharge. Monitoring of the discharge quality is required to verify the treatment effectiveness.
  - **Roads and car parking Areas:** Stormwater runoff from roads and parking areas would be expected to contain low to medium levels of hydrocarbons, metals, suspended sediments and nutrients resulting from the operation of vehicles and machinery. There would also be a small risk of potential spills of oil and other fluids from vehicles.
  - **Aurizon Effluent Disposal Area:** The effluent disposal area would be provided with bunds and diversions to prevent stormwater run-on and run-off. Douglas Partners have prepared an Effluent Disposal Report (2012) which discusses the issues of ground and surface water impacts in relation to the effluent disposal area.

- **Existing Effluent Disposal Operations:** As outlined in the Preliminary Contamination Assessment prepared by Douglas Partners (15 March 2013), the existing effluent disposal operations currently undertaken by Brancourts are likely to have had an impact on ground and surface water quality on the site. It is expected that as part of the TSF development, alteration to the existing leachate collection drains on the eastern side of effluent irrigation area will be undertaken where required to avoid direct effluent runoff into the TSF stormwater system (refer **Figure 5-1**). The amendment to the leachate collection system would be expected to be undertaken so as to maintain current flow directions / outlet locations. In the Preliminary Contamination Assessment Report, Douglas Partners note that the requirements for groundwater/surface water remediation (if any) should be discussed with NSW EPA, with due regard to the existing NSW EPA licence No 816 held by Brancourts and considering the proposed land use and regional water quality.

3.2 Stormwater Management Objectives

The following stormwater management objectives have been adopted for the site:

- Minimise the disturbance to the local and regional hydrologic regimes during low recurrence interval rainfall events. In particular:
  - Identify areas of the proposed development which could potentially produce significant surface water contamination. These areas are to be isolated from the greater stormwater system and all runoff would be either treated through an engineered process or discharged to trade waste.
  - Provide stormwater controls on the remainder of the site to minimise the impact on receiving waters and communities; and
  - Provide monitoring and contingency measures to allow for the containment of an accidental spill or major leak

3.3 Stormwater Management Strategy

The proposed stormwater management strategy is summarised as follows:

- **Prevention:-** The following preventative measures would be adopted as development controls to reduce the generation of pollutants under normal conditions as well as provide contingencies in the event of an accidental spill of potentially polluting substances: -
  - Minimise area of development footprint by providing a compact and efficient design.
  - Provision of industry best practice arrangements for the dispensing of fuel and other provisions (sand, lubricating oil, coolant, water, etc) to both locomotives and on-site vehicles

and machinery. Management is to be in accordance with all relevant Australian Standards and guidelines.

– Development and implementation of operational procedures which define how to operate the site in an environmentally responsible manner. Procedures would include, disposal of hazardous and potentially hazardous material and contingencies in the case of a potentially damaging environmental event (*such as a fuel spillage*).

- **Isolation**:- Operational activities identified as potentially generating significant contamination are to be isolated from the greater stormwater system. These areas include wagon and locomotive wash down bays, maintenance areas and refuelling/provisioning areas. All water generated in these areas would be either disposed of to trade waste or treated onsite and re-used.
- **Treatment:-** Runoff would be treated or controlled by a series of stormwater management devices prior to discharge into the environment.
- **Contingencies:-** There is a potential for an accidental spill/leak to occur at any point in the rail yard. Therefore appropriate measures will be in place to isolate an area for clean-up purposes.
- **Monitoring:-** A comprehensive surface water and groundwater monitoring plan would be undertaken by Aurizon to establish existing baseline parameters and observe the surface and ground water quality during the construction and operation phases of the TSF development.

Subsequent sections provide further detail of the aspects of the stormwater management strategy listed above.

As noted above the Stormwater management plan will provide details for the construction and operational phases of the proposed TSF.

4. PREVENTATIVE MEASURES

4.1 Administrative Controls

Aurizon would draw on existing protocols and systems to develop a site specific operational procedures manual. This is expected to comprise:

- Aurizon would have a management structure clearly identifying the responsibilities of employees and supervisors on the site.
- Aurizon would provide training for all staff to ensure awareness of environmental operational procedures.

It is noted that much of the above are standard practice for companies such as Aurizon.

4.2 Potable Water Usage Reduction Policies

Aurizon are committed to incorporating Ecologically Sustainable Development (ESD) principles into the development, and this will include reductions in potable water usage and investigation of water reuse/recycling opportunities within the site. It is also proposed to incorporate rainwater harvesting and reuse for toilet flushing and landscape requirements where possible. One of the key water recycling opportunities is the locomotive wash bays which is discussed in the following section.

4.3 Locomotive Wash Down Bays

The wash down bays will be operated as a totally separate system to the stormwater system. Wash down bays will be bunded and covered (i.e. in a building), with runoff directed to a treatment system before being directed back to a header tank for reuse. Treatment of wash down water will comprise the following components:

- Gross pollutant trap to remove larger coal fragments;
- pH and flocculent dosing to settle fine sediments;
- Oil/grease separator and sludge removal. These waste streams will be stored in tanks and tankered from site as required;
- Chlorination of water to be reused in wash down bays.

The wash down system will be topped up with rain water and/or potable water to maintain the salinity levels within an acceptable range. As a result of this top up, periodically wash down water will be discharged to the site wastewater treatment system, which is discussed further in **Section 4.6**.

4.4 Fuel Storage and Refuelling Areas

All refuelling areas will comprise sealed hardstand areas draining to a dedicated system for treatment with an oil separator. Clean water (e.g. from roof areas or upslope) will be kept separate from bunded areas and discharged to either the stormwater system or via rainwater collection systems for re-use to the wash down water recycling system with overflow to the main stormwater system.

All provisioning areas will be roofed to minimise the volume of water to be contained and treated. Storage tanks will be bunded in accordance with the relevant Australian Standards (e.g. fuel storage tanks to be double skinned and bunded).

4.5 Workshop and Maintenance Facilities

Workshop and maintenance facilities will be housed in sheds. Drainage within the shed will be collected and treated with an oil separator. Again clean water (e.g. from roof areas) will be kept separate from bunded areas and re-used with overflow discharged to the main stormwater system.

4.6 Wastewater Treatment and Disposal

Wastewater from the administration buildings, toilets, showers, lunch rooms, etc will be treated using a package treatment plant and disposed via irrigation (refer to **Figure 4** for location of the irrigation areas). The primary irrigation area is approximately 41,000m^2 in area with a 20,000m2 secondary irrigation area. Modelling indicates that overflows from the disposal area are likely to occur approximately every 3 to 5 years (due to prolonged wet periods). To avoid overflows, a buffer storage has been included in the design as well as a secondary irrigation area of 10,000m^2 (Refer Douglas Partners Effluent Disposal Report, May 2012). During prolonged wet weather, excess flows will be stored in the buffer storage and if required, tankered offsite as trade waste. The secondary irrigation area will be available to dispose of excess effluent in the buffer storage following the wet periods.

4.7 Monitoring Programs

A water quality monitoring program for the TSF project will be developed to include:

- Monitoring water quality at onsite treatment systems (e.g. ponds), key discharge locations to sensitive areas (e.g. Hexham Swamp, EEC communities) and critical downstream areas (Swamp Oak Forest EEC).
- Maintenance of onsite systems – oil separators, silt sumps, ponds, gross pollutant traps, ponds and swales (clearing out and vegetation maintenance).

5. OPERATIONAL STORMWATER MANAGEMENT PLAN

This section outlines a conceptual Surface Water Management Plan (*SWMP*) for the proposed TSF. The SWMP implements best practice surface water controls which will be designed to mitigate the potential pollutant processes that are identified in **Section 3** for both the construction and operational phases of the project.

The objectives and overall strategy of the SWMP have also been previously outlined in **Section 3**, the following Sections outline the proposed controls to be included within the SWMP for the TSF, as well as the modelling methodology and results obtained in determining indicative sizing for the required controls.

5.1 Hydrology

The purpose of this section of the report is to outline the systems to be put in place to control stormwater from the proposed development as well as the background, assumptions and impacts from this system.

5.1.1 Background

The Hexham Swamp area provides flood storage during large storm events. At about the 10 year ARI storm event, floodwaters overtop the Pacific Highway and enter the Hexham Swamp area. Under the new flood gate management regime, the Department of Environment and Resource Management[9] will close the floodgates when a Hunter River flood warning is issued.

As a result, the design of the stormwater system for this site is limited to the 1 in 10 year event because beyond this point, the Hexham Swamp will be inundated by flood waters. For larger storm events stormwater from the site will discharge to the swamp via overland flows, and lower portions of the site will be inundated.

[9] WBM, *Environmental Impact Assessment (Supplement),* 2006, Section 5.5

5.1.2 Assessment of Low Flow Events

For this section, low flow events refer to the regular daily rainfall patterns on a site typically ranging from a few millimetres per day up to about the 1 year ARI storm event. An important part of this is the periods of dry weather (*no rainfall*) during which time the soil and waterlogged communities dry out.

It is difficult to model frequent, low rainfall events generally, but even more so given the difficult hydraulic conditions on the site (*e.g. pipes, drains, culverts and large, very flat areas with falls that are difficult to quantify*). A model using a long term continuous rainfall pattern could be employed however it is considered that this would provide inaccurate and ambiguous results and be of little benefit. This is because this model relies on the availability of detailed data on soil types, vegetation evapotranspiration rates, irrigation quantities, micro flow paths, etc, to be accurate.

In view of this, it was considered that the best way to reflect the impact of the development was to compare contributing catchment areas to key environmentally sensitive areas. That is, provided there is little change in the contributing catchment and the amount of impervious area, the expected hydrological changes should also be insignificant.

Based on previous feedback from Department of Primary Industries (Fisheries), the two areas most sensitive to changes in low flow events are the Swamp Oak Forest (EEC) and the Coastal Saltmarsh (EEC). The other areas are less sensitive as they occur in relatively waterlogged and semi-permanent submerged environments, in large flat areas where depth changes are negligible, or are within areas that represent relatively minor changes to significantly larger catchments.

The following areas have been identified as being important and are shown on **Figure 3**:

- Location 1 - Culvert to Hunter River north of the site.
- Location 2 - Swamp Oak Forest (EEC) north of the site.
- Location 3 - SEPP14 west of HWC watermain and North of Railway.
- Location 4 - SEPP14 west of HWC watermain within Hexham Swamp and South of Railway.
- Location 5 – Coastal Saltmarsh (EEC) south of the site.

Table 3 highlights approximate changes to catchment areas a result of the proposed development at each of the above locations:

Table 3 - Comparison of Catchment Areas

Catchment Description (Outlet Location)	Existing			Developed Area		
	Total Area (Ha)	Impervious Area (Ha)	% Impervious	Total Area (Ha)	Impervious Area (Ha)	% Impervious
Culvert to Hunter River	379.0	2.3	1%	381.1	6.5	1.7%
Swamp Oak Forest	30.5	0.3	1%	25.8	0.5	1.9%
SEPP14 North	37.2	1.9	5%	41.6	9.55	23%
SEPP14 South	66.8	3.9	6%	63	2.97	4.7%
Coastal Saltmarsh	32.6	2.8	9%	33.2	8.02	24.2%

A detailed assessment of each section follows. Generally it is noted that there is an increase in impervious area and in some cases total area as well. This is addressed further in **Section 5.2**. For details of the following site locations, refer to **Figure 3**.

- **Location 1** – The change in area discharging to the culverts is considered negligible. It is noted that the change to impervious area increases, however this still is a relatively negligible increase compared to the overall catchment area. The increased impervious area will drain directly to the culvert to the Hunter River, therefore this will not impact the adjacent sensitive environments.
- **Location 2** – The area draining to the swamp oak forest decreases slightly, with a small increase in impervious percentage. Therefore there will not be a significant change to low flow patterns discharging to this sensitive area.
- **Location 3** – There is an increase in impervious catchment area and total area draining to this location. Flows through this area discharge along a defined channel and drain back to Location 1. Further the upstream end receives flows from a considerably larger catchment (in the order of 280ha). It is therefore considered that the increase in flows from small rainfall events will be negligible in comparison to these larger catchment flows. Notwithstanding, the impacts from larger storm events will be discussed in following sections.
- **Location 4** – There is no increase in impervious catchment area or total area draining to this location. Currently low flows from this area drain to a Phragmites community in the Hexham Swamp to the west of the site. Further it may be beneficial to discharge flows to the southern end of the Aurizon site into the Phragmites community, in preference to discharging to Hexham Swamp.
- **Location 5** – There is an increase in impervious catchment area and an increase in total area draining to this location. Currently flows from this area drain to a Coastal Saltmarsh EEC. As noted earlier, this section is regularly flushed by tidal flows. Therefore the increase in runoff from minor storm events is not considered significant. It is noted that there may be a minor impact in composition of flora communities as a result of increased low flows (i.e. Phragmites, a fresh water species, will colonise preferentially around the outlet of the site). However given the large amount of Phragmites species in this area already, this is expected to have a

negligible impact. More significantly to species composition will be the conveyance of the main drainage lines on the adjoining site, which have recently been cleaned out. Following cleaning out, the Phragmites communities would be expected to recede and be replaced by the saltmarsh communities.

In summary, it is considered that the changes to low flow patterns at the site will generally have a negligible impact. Refer to **Figure 4** for the proposed drainage details.

5.1.3 Assessment of Peak Flows

Assessment of low recurrence interval peak flow events was carried out using the stormwater modelling program DRAINS, a program for modelling urban stormwater systems and flooding behaviour for rural and agricultural flows.

The site was divided into seven sub-catchments as shown in **Figure 3**. Estimates of impervious area, overland flow path (length and roughness) and overflow routes were estimated based on site survey, aerial photographs, site inspections and the proposed design plans. The existing catchment areas are summarised in the **Table 4**.

Table 4 - Existing Site Catchment Summary

Catchment	Total Area (Ha)	Impervious Area (Ha)	% Impervious	Comment
1	34.3	0	0%	Outlet to Hunter River
2	30.5	0.31	1%	Swamp Oak Forest
3	37.2	1.9	5%	Dairy Farmers irrigation plant and area.
4	44.5	2.7	6%	Eastern portion of Coal
5	22.5	1.4	6%	Western portion of Coal Stockpile
6	32.7	2.8	9%	Incorporating old rail loop and southern area of site –
7	280	0	0%	Large, flat agricultural catchment to west of site.
TOTAL	**482**	**9**	**2%**	

Catchment 7 includes a significant portion of land to the north-west of the site that drains through the site. Catchment 1 also includes areas of land formerly owned by Dairy Farmers (*now owned by Aurizon*), as well as land to the north of the site that drains through the property. A small section of land on the south-western corner of the site which will essentially remain unchanged was excluded from the model for simplicity. This area is Zoned 7b and currently contains a considerable area of Phragmites.

The developed site was divided into 10 catchments as shown in **Figure 4**. Estimates of impervious area, overland flow path (length and roughness) and overflow routes were estimated based on design plans and aerial imagery. The catchment areas are summarised in the **Table 5**. It is noted that the existing catchment areas were modified and new catchments (101 to 103) specifically relating to the TSF development were added.

Table 5 - Developed Site Catchment Summary

Catchment	Total Area (Ha)	Impervious Area (Ha)	% Impervious	Comment
1	31.1	0	0%	Outlet to Hunter River
2	25.8	0.5	2%	Swamp Oak Forest
3	32.09	1.39	5%	Dairy Farmers irrigation plant and area.
4	28.24	1.62	6%	Eastern portion of Coal Stockpile
5	22.5	1.35	6%	Western portion of Coal Stockpile
6	25.2	2.06	9%	Incorporating old rail loop and southern area of site
7	280	0	0%	Large, flat agricultural catchment to west of site.
101	1.54	0	0%	TSF area draining to south
102	9.55	3.07	32%	Central area of TSF, draining to north
103	8.02	8.02	100%	Northern tip of TSF, draining to north
ARTC1	7.4	0	0%	ARTC site drains to the south via existing culver
ARTC2	6.11	0	0%	ARTC site drains to the north via culvert to Hunter River
TOTAL	**477**	**18.5**	**3.9%**	

As is evident from **Table 5** above, Catchment 1 will outlet to the Hunter River via the existing channel system to the north of the site. Catchments 2, 3 and 4 ultimately drain to the Hexham Swamp Reserve, which would eventually runoff to the north to the Hunter River via the existing discharge point. Catchment 5 drains west to the Hexham Swamp Reserve, and would eventually runoff to the Hunter River via the existing southern discharge point during a storm event. In terms of catchment 6, the majority (16.6ha) will runoff to the south of the site to the Hexham Swamp, while another portion (approx. 8.8 ha) as well as the proposed development catchments (101, 102, 103) will runoff via the proposed drainage system and discharge to the Coastal Saltmarsh to the south of the site before making it's way to the Hunter River via the existing culvert system.

As is evident from **Table 5** above, the proposed ARTC Relief Roads site has also been taken into consideration in the modelling of the TSF site. The relief roads site is approximately 13.5ha and in accordance with ARTC's Preferred Infrastructure Report (March 2013), will be split into two roughly equal catchment areas, with one draining south to the Coastal Salt Marsh before entering the Hunter River, while the other drains north to Mid Site Creek. Similarly to the TSF project, the Relief roads site will grade east to west where runoff will be collected in a swale which carries runoff north and south to the discharge points. The ARTC development site has been included in the modelling to analyse it's contributions to runoff volumes and peak flows and assess the effects on sensitive downstream environments, such as the Coastal Saltmarsh EEC to the south of the site.

It would be intended that further modelling would be carried out to refine the proposed Stormwater Management Plan during the detailed design stage to determine the final size of stormwater controls.

5.1.4 Stormwater Controls

This section outlines the main features of stormwater controls on the site. Stormwater treatment is outlined in the following **Section 5.2**.

The TSF stormwater controls comprise the following components. The rail track area is generally completely level without appreciable surface grading for operational reasons.

- Track areas drain to pipes (southern portion of site only) falling to the west of the site. The culverts are spaced at approximately 100m centres. Stormwater pits are located between each set of rail lines within roadways. At the end of some culverts (those draining directly to the ponds) proprietary gross pollutant control units will be located within collection pits (including oil/grease separating capability). Preliminary design of cross drainage structures has confirmed that sufficient conveyance capacity is available despite expected standing water levels.
- As per GHD Track Lowered Option Design Plans (March 2013), from approx. CH. 176km to the north, the finished surface level has been lowered by approximately 1.2m. This is required to mitigate potential flood impacts created by the development. This lower track level has eliminated a traditional pit and pipe stormwater system as a viable option, as longitudinal grade on the system would be impossible to achieve relative to existing site discharge points. This has resulted in a permeable ballast layer being nominated for the lowered part of the site, which will grade east to west, directing flows to the proposed 'Cess drain' which will skirt the western edge of the TSF site.
- The pipes outlet via a headwall, to a "Cess" Drain which runs along the western edge of the TSF works. The Cess drain is approximately 2m in base width with slopes of 1V:2H and around 0.8m deep. The drain is level longitudinally (~0.1%) and will operate via hydraulic gradient. GHD have confirmed the cess drain capacity is sufficient despite standing water levels.
- At the end of the outlets from the Cess Drain, gross pollutant traps will be provided to separate vegetative matter, litter, coarse sediment and oil/grease prior to discharge offsite.
- Three basins are located across the site to primarily remove suspended sediments, nutrients, oil and grease. Basin 1 is at the northern end of the site, with basin 2 located centrally and basin three situated at the southern end adjacent to the existing coal tailings stockpile.
  - The northern basin (Basin 1) will discharge very close to the outlet to the Hunter River (Location 1).
  - The central basin (Basin 2) will discharge to the existing low lying meadows which generally flows to the west (Location 3).

– Basin 3 discharges water to the adjacent Coastal Saltmarsh to the south of the site (Location 5), which then crosses Maitland Road via an existing culvert where it makes it's way into the Hunter River. As mentioned, Basin 3 is to be positioned at the site of the existing coal tailings dam. It is proposed that earthworks requirements for construction of the basin including compaction, filling and material replacement (if necessary) will be specified as a part of the detailed design phase, however there is no current plan to utilise the existing tailings dam in it's current state.

Refer to Figure 4 for proposed discharge locations.

5.1.5 Minor Storm Events (1 Year ARI)

Results of modelling for the 1 year ARI storm are summarised in the following section. To interpret the results, the changes in flow patterns to the sensitive receiving environments used in the above section are again considered. The critical storm duration ranged from 1hr to 18hrs depending on the catchment.

Table 6 - Results from 1 Year Storm Event on Existing Site

	Location	Peak Flow (m^3/s)	Comment
1	Culvert to Hunter River	1.16	
2	Swamp Oak Forest	0	This area acts as a storage with no overflows in the 1 year storm event. Water depth is up to about 0.3m. Overflows do occur for the two year storm event.
3	SEPP14 North	0.1 beneath watermain 0.34 to Location 2	Culverts under HWC main restrict flows causing overflows into Location 2.
4	SEPP14 South	0.3	Pipe culverts under HWC main restrict flows. Up to about 0.37m^3/s overflows to the south.
5	Coastal Saltmarsh EEC	Total = 0.8 Eastern Outlet = 0.57 Western Outlet = 0.12	 Eastern Outlet – saltmarsh Community Western Outlet – Phragmites Community

The following observations are made (refer to **Figure** 3):

- At Location 2 (Swamp Oak Forest) the surface levels within this area are generally below the surrounding levels. Therefore this area would fill with water and would remain inundated for extended periods of time (depending on evaporation and infiltration losses). Water overflows from this area when it reaches about 0.35m depth. Modelling indicates that the area would overflow during the 2 year ARI storm event.

- Runoff from the Coal Stockpile (to Location 4 and 5) currently drains to perimeter drains along the northern and western boundary. The flows are choked at a number of locations due to structures. Flow rates (and subsequently overflow paths) are highly dependent on maintenance of culverts and channels.
  - At the north western corner of the stockpile, there are culverts below an access track. This causes overflows to the north across the former rail embankment, eventually flowing to Location 2 and 3.
  - The drains around the coal stockpile are currently inundated, heavily vegetated and possibly full of sediment, reducing the amount of detention and conveyance. However the shallow depth would be beneficial for treatment of minor flows.

- The southern portion of the site (the old rail loop and adjacent areas to the west) drain to a tailings pond that is typically full of water during normal conditions. There is a channel system through the centre of this area that directs flows to the east, through the tailings dam and discharging to the south-east in a controlled manner. The system hasn't been maintained for some time and therefore there are signs of flows spilling over at several points along the southern boundary. Also at least one culvert and pipe crossing exist in this area, however this is overgrown with significant vegetation and the discharge point couldn't be located (filled over or overgrown). Water was observed draining slowly through this pipe.

- Flows at Location 1 are tidal. Due to the size and flatness of the total catchment draining to this area, flows from this development would generally leave the site prior to the peak flows from the remaining, much larger western area of the site, and therefore any impacts are expected to be insignificant.

Results of modelling for the 1 year ARI storm on the Developed site are summarised in **Table 7**. Again the results are compared to the sensitive receiving environments used in the assessment of low flows (**Table 7**). The critical storm duration again ranged depending on the catchment.

Table 7 - Results from 1 Year Storm Event on Developed Site (including detention basins)

	Location	Peak Flow (m^3/s)	Comment
1	Culvert to Hunter River	1.13	Increase is considered negligible and is within the culvert capacity.
2	Swamp Oak Forest	0.26	Overflows from the shallow depression now occur in the 1 year ARI event instead of the 2 year event.

	Location	Peak Flow (m^3/s)	Comment
3	SEPP14 North	0.16 beneath water-main 0.49 to Location 2	Culverts under HWC main restrict flows causing a slight increase in overflows into Location 2.
4	SEPP14 South	0.38	No developed catchment
5	Coastal Saltmarsh EEC	Total = 0.74 Eastern Outlet = 0.31 Western Outlet = 0.43	Flows to the eastern outlet (saltmarsh community) Flows to the western outlet (Phragmites complex)

The following observations are made (refer to **Figure 4**):

- Following development, Location 2 (Swamp Oak Forest) would overflow on a yearly basis whereas in the natural state this would occur on average once every two years. Ponded depths do not change as the overflows to the estuarine channel, discharging to Location 1, control the depth of water in this area. However, the peak water level increases slightly, but this occurs only for a couple of hours at most. Flows occur generally as sheet flow and at numerous locations, therefore erosion/scouring in this area is not likely.

- Flow to the SEPP14 discharge location decreases from $0.3m^3/s$ to $0.1m^3/s$ as a larger catchment is directed to the south in the developed case

  – The peak discharge rate directed to the south east during the 1 year storm event is decreased by development as flows from catchment 6(partial) are detained within basin 3 before being discharged to the Coastal Saltmarsh.

  – The flows to the south-west of the site increase from $0.12m^3/s$ to $0.43m^3/s$ and discharge into an existing Phragmites complex on Aurizon land.

  – Runoff volume to the south of the site increases overall. As a guide, the volume from the 1 year, 12 hour storm (critical duration for existing and developed cases) increases from around $3200m^3$ to $11814m^3$. Given the large area to the south of the site, the increase is considered negligible. In addition, there is a culvert relatively close to this area and therefore the area would drain relatively quickly. As a guide if the culvert was completely blocked (i.e. the water ponded rather than drained to the Hunter River), the increased volume of water would account for less than 1mm over the 1950ha area of the Hexham Wetland reserve.

- There is a negligible increase in the peak flow rate at Location 1 – Hunter River Outlet to the north of the site. In addition, there is a negligible change to peak flow rate to Location 3.

In conclusion, it is anticipated that stormwater management from the proposed development will not have an adverse impact on the receiving waters during minor storm events. Although the site is somewhat hydraulically constrained by flat gradients, there are also future opportunities to redirect water flows to different locations to assist achieving environmental improvements in the general area.

5.1.6 Major Storm Events (10 Year ARI)

Results of modelling for the 10 year ARI storm are summarised in the following tables. Again, changes to flow patterns at sensitive receiving environments used in the assessment of low flows (**Section 5.1.2**) are considered as outlet descriptions. The critical storm duration was between 1 to 2 hours depending on the catchment.

Table 8 - Results from 10 Year Storm Event on Existing Site

	Location	Peak Flow (m^3/s)	Comment
1	Culvert to Hunter River	12.3	
2	Swamp Oak Forest	Inflows – 3.1 Outflows – 2.8	
3	SEPP14 North	0.86 beneath main 1.94 overflows to Location 2	Culverts under HWC main restrict flows and cause overflows into Location 2.
4	SEPP14 South	0.96 2.42 overflows to location 3	Pipe culverts under HWC main restrict flows. Up to about 0.2m^3/s overflows to the south.
5	Coastal Saltmarsh (EEC)	Total = 3.12 Eastern Outlet = 1.68 Western Outlet = 1.44	Eastern Outlet – Saltmarsh Community Western Outlet – Phragmites Community

The following observations are made (refer to **Figure 4**):

- Location 2 (Swamp Oak Forest) receives significant overflows from Location 3, which in turn receives significant overflows from the Coal stockpile (up to 2.42m^3/s).

- Runoff from the Coal Stockpile (to Location 4 and 5) currently drains to perimeter drains along the northern and western boundary of the stockpile. The flows are choked at a number of locations along these drains. As a result, considerable overflows drain to the south of the site, into a Phragmites community.

- The old rail loop and adjacent areas to the west drains to a tailings pond on the south-east corner of the site. The tailings pond has a water level at the top of the pond level. There is a channel system through the centre of this area that directs flows to the east to the tailings dam and discharging from the tailings pond to the south-east in a controlled manner. The system hasn't been maintained for some time and there are signs of flows spilling over at several points along the southern boundary of the site. Also at least one pipe culvert exists in this area, however it was overgrown and the discharge pipe couldn't be located onsite (filled over or overgrown). Water was observed draining slowing through this pipe.

Results of modelling for the 10 year ARI storm on the Developed site are summarised in **Table 9**. Again the results are compared to the sensitive receiving environments used in the assessment of low flows (refer to **Section 5.1.2**). The critical storm duration was the 1 to 2 hour storm depending on the catchment.

Table 9 - Results from 10 Year Storm Event on Developed Site (including detention basins)

	Location	Peak Flow (m^3/s)	Comment
1	Culvert to Hunter River	12.9	Negligible change
2	Swamp Oak Forest	Inflows – 3.38 Outflows – 3.18	Negligible change
3	SEPP14 North	0.95 beneath main 2.03 overflows to Location 2	Negligible change
4	SEPP14 South	0.91	decrease
5	Coastal Saltmarsh EEC	Total = 3.42 Eastern Outlet = 1.02 Western Outlet = 2.4	Flows to the eastern outlet (Saltmarsh community) decrease from 1.64m^3/s to 1.02m^3/s. Flows to the western outlet (Phragmites complex) of the site increase from 1.14m^3/s to 2.4m^3/s

The following observations are made (refer to **Figure** 4):

- The peak discharge rate directed to the south of the site increases by about 9% from 3.12m^3/s to 3.42m^3/s with the majority of the flow discharging to the Coastal saltmarsh to the south-east of the site which decreases from 1.68m^3/s to 1.02m^3/s (Location 5, eastern outlet).
- Flow to the SEPP14 discharge location decreases from 0.96m^3/s to 0.91m^3/s as a larger catchment area is directed to the southern discharge points in the developed case.
- The flows to the south-west of the site have increased (1.14m^3/s to 2.4m^3/s) and discharge into an existing Phragmites complex on Aurizon land.
- Overall runoff volumes increase overall to the south of the site increase. As a guide, the volume from the 10 year, 9hr storm (critical duration for existing and developed) increases from around 24424m^3 to 34694m^3. Given the large area to the south of the site the net increase in runoff is considered negligible and not significant. It is noted that during the 10 year ARI storm event it is likely that flooding, from the Hunter River and elsewhere, will also be impacting the site. As a guide if the culvert was completely blocked (i.e. the water ponded rather than drained to the Hunter River), the increased volume of water would account for less than 1mm over the 1950ha area of the reserve. Further floodwaters from the Hunter River start to spill into the Hexham Reserve during this flood event.

Based on the above, it is considered that the proposed stormwater controls for the TSF development are adequate to limit any significant impact on Hexham Swamp or the Hunter River.

5.1.7 Main Access Road Culverts

The main access road to the proposed TSF facility will need to include the installation of culverts to ensure that the road does not increase inundation upstream which could potentially negatively impact on existing vegetation communities. Whilst this would have been addressed in part by the Flood Study prepared by BMT WBM (August 2012), it is also important that the culverts are designed to ensure no increase in flooding in storm events less than the 1:20 year ARI.

5.1.8 ARTC Relief Roads Project

Parsons Brinckerhoff have prepared a separate Stormwater Management Report for the Relief Roads project which included consideration of the potential increase in stormwater peak flows from the development of the relief roads site. The report concluded that as the majority of the works consist of constructing additional rails which included considerable depth of ballast, it is unlikely that peak flows during small storm events will be impacted. This is due to the porosity of the ballast material which will allow water to infiltrate and slowly drain away through natural subsurface drainage paths.

The proposed Relief roads project site was included as part of the drainage modelling performed using DRAINS for the TSF. The site was considered to be 100% pervious to mimic the proposed ballast site surfacing.

Modelling concluded that the proposed development did not have a significant effect on overall peak flows and volumes (contributed by the relief roads and the TSF) experienced by the sites surrounding catchments and outlet points.

5.2 Water Quality

As noted in **Section 1.6**, stormwater quality needs to be addressed for this development. This **Section** outlines the background and methods adopted to assess site stormwater quality, and the recommended treatment systems proposed for the site. As discussed earlier, stormwater quality at the site is currently heavily influenced by irrigation of effluent by Brancourts and grazing on the site. Initial water quality monitoring has been undertaken (refer to **Section 2.4**) and it is expected that further testing will be carried out by Aurizon to allow a surface quality baseline to be established.

5.2.1 Water Quality Targets

Ideally water quality targets are set based on the receiving environments. However this would require accurate long term water quality monitoring that captured a range of conditions (intense storms, light rain and prolonged dry periods.

The most current water quality treatment targets are in the *Managing Urban Stormwater: Environmental Targets* (*DECC & CMA, October 2007*) document, which is currently in the consultation draft stage.

Newcastle City Council DCP (2011 draft section 7.06 Stormwater) outlines water quality criteria which are to be met for a new residential/commercial/industrial development. **Table 10** outlines pollutant targets to be satisfied as part of the water quality criteria. While DCP 2005 is still the relevant development control plan (Section 4.5.14) applying to the site until the Draft DCP 2011 is adopted, the water quality criteria of Draft DCP 2011 is considered more rigorous and has therefore been adopted for the purposes of this assessment. However it should be noted that this proposal also meets the requirements of DCP 2005 in regards to water quality. In order to assess the effectiveness of the stormwater quality strategy against the defined water quality objectives, it is necessary to model the proposed developed catchments and the water quality control structures.

Water Quality modelling software called MUSIC has been adopted as the tool to undertake this modelling. An outline of MUSIC modelling is included below.

Table 10 - Managing Urban Stormwater - Environmental Targets

Parameter	Target
Suspended Solids (TSS)	85% retention of the developed average annual load
Total Phosphorous (TP)	65% retention of the developed average annual load
Total Nitrogen (TN)	45% retention of the developed average annual load

5.2.2 Modelling

MUSIC is a continual-run conceptual water quality assessment model developed by the Cooperative Research Centre for Catchment Hydrology (*CRCCH*). MUSIC can be used to estimate the long-term annual average stormwater volume generated by a catchment as well as the expected pollutant loads. MUSIC is able to conceptually simulate the performance of a group of stormwater treatment measures (*treatment train*) to assess whether a proposed water quality strategy is able to meet specified water quality objectives.

MUSIC simulates the generation, mobilisation and removal of the following pollutants:-

- Total Suspended Solids (*TSS*);
- Total Phosphorus (*TP*); and
- Total Nitrogen (*TN*).

It is noted that removal of these target pollutants would also generally result in the removal of a percentage of heavy metals, oils and grease.

In order to establish a MUSIC model, rainfall and evaporation records in the vicinity of the site were sought. In addition, catchment parameters are required to determine pollutant generation rates and treatment efficiencies need to be adopted for various components of the treatment system. The pollutant loadings for each catchment are proportional to the land use and the impervious area fraction.

It is noted that MUSIC simplifies a complex environment where many physical and bio-chemical processes can potentially influence the water quality. As MUSIC algorithms are based on observed average water quality performances (*which are highly variable*), it does not consistently represent a modelled scenario. All efforts have been made in this study to realistically represent the water quality scenario, however, the MUSIC results should be only considered as estimates of average conditions. As with any statistical representation, results could potentially be above or below average conditions. Hence, some degree of variability is to be expected in the performance of the proposed SWMP.

Notwithstanding the above, the intention of this modelling is to demonstrate the feasibility of a stormwater treatment system to reduce pollutant loads from the developed site to acceptable levels.

RAINFALL

Rainfall information (6 minute pluviograph data) from BoM Station (No. 61390) at the University of Newcastle was used for MUSIC water quality simulations. The data extends from 1/07/1998 to 31/05/2010. This site was selected as it represents the closest BOM station to the Hexham site, as well as having relatively complete data with a representation of high (90%ile), average and low rainfall years (10%ile) for the site. The University is approximately 6km to the south of the site and a similar distance from the coast.

EVAPORATION

Monthly areal potential evapotranspiration (*PET*) rates for the site was estimated from PET data provided by the Climate Atlas of Australia (BoM). The monthly average PET adopted for the MUSIC model are shown in **Table 11.**

Table 11 - Monthly Areal Potential Evapotranspiration

Month	Areal Potential Evapotranspiration (mm)
January	180
February	135
March	128
April	85
May	58
June	43
July	43
August	58
September	88
October	127
November	152
December	163

CATCHMENT PARAMETERS

Catchment parameters for the site have been adopted from '*Australian Runoff Quality*' (*Engineers Australia, 2006*). This is considered to be the most comprehensive, authoritative and up to date information available.

Previously the area was primarily an industrial site, but has not been used in this capacity for many years. Considerable portions of the site have been vegetated with grass, and regrowth is evident. Notwithstanding the above, there are still considerable areas of gravel tracks, stockpiles and recent upgrade works on the site (e.g. access roads along the rail corridor). It is also likely that pollutants may continue to leach from the coal stockpile and the initial water quality monitoring indicates some areas of existing contamination (refer Douglas Partners Preliminary Contamination Assessment August 2012). The irrigation of effluent and the presence of coal tailings is expected to increase nutrient and other pollutants from the existing site via surface and groundwater paths.

The primary purpose of this stormwater management plan is to address the surface water quality of the proposed development, and does not consider potential sub-surface groundwater pollution sources such as the coal stockpiles. This would be addressed as part of the site contamination assessment prepared by Douglas Partners (August 2012) and the subsequent more detailed contamination assessments that will need to be undertaken. The surface of the coal stockpiles is heavily vegetated due to many years of effluent irrigation and grazing which have been undertaken, and it has been assumed for the purposes of the surface water quality modelling in MUSIC that the most applicable designation for this area is Agricultural Land. This designation will most accurately represent the higher nutrient loadings and cattle grazing practices that occur on the surface of this land.

The proposed development areas will be modelled as "Industrial" land use. It is noted that mean agricultural pollutant concentrations are consistent with values measured onsite and used by Parsons Brinckerhoff (*Water Quality Assessment-Hexham Relief Roads-March 2013)*. TSS mean pollutant loadings for the proposed site are also similar to those used by Parsons Brinckerhoff to account for unsealed roads which will run in between each rail and relief track.

The future site will be modelled as an "Industrial" land use category as this is considered to be consistent with the intended land use. Consideration of the proposed development suggests the following:

- Nutrient loadings are likely to be low. Areas where nutrient pollutant sources are likely to be generated have been contained in bunded hardstand areas and/or within sheds. Runoff from these areas will be collected in a separate drainage system and treated typically with an oil separator prior to reuse or disposal to trade waste. In view of these management/design approaches, nutrient loadings at the TSF are considered negligible.
- Oils – some hydrocarbon pollutants are expected. The majority of hydrocarbon usage occurs in the provisioning sheds, service sheds, wash down bays or fuel storage areas. All these areas are bunded and/or roofed to separate them from the stormwater system. Therefore the most likely source of hydrocarbon pollution is low volume and/or very infrequent spillage from trains parked on the track system.

Catchment parameters (area and impervious areas) are detailed in **Table 4** and **Table 5** within **Section 5.1.3.**

TREATMENT EFFICIENCIES

MUSIC incorporates treatment efficiencies for many system components (wetlands, sediment ponds, swales, bioretention areas, etc) and the modelling for this site has adopted these where possible. It is noted that MUSIC automatically adjusts treatment efficiency based on various parameters, primarily flow rates, retention times, etc.

It is proposed to use several varieties of Gross Pollutant traps (GPT's) on the site. It is likely that a mix of the following GPT's will be used on the site:

- CDS unit by Rocla (or equivalent);
- Concrete stilling basins with trash racks and baffled outlets for trapping oils;

For GPT's, quoted pollutant efficiencies range considerably, and are summarised below together with the adopted removal efficiencies. It is proposed to disregard nutrient removal rates for GPT's as this is drastically reduced due to leaching when the trapped material goes through wetting and drying cycles.

- TSS – 65% to 95% Adopt 90% removal rate
- TP – 0% to 60% Adopt 30% removal rate
- TN – 0% to 45% Adopt 30% removal rate

5.2.3 Proposed Water Quality Control Strategies

The following treatment trains are proposed for the site and have been developed in consultation with Aurizon to ensure that they are compatible with the proposed management of the site.

- Areas of high sediment, oil & grease and nutrient loads will be separated from the stormwater system (e.g. wash bays, provisioning sheds, servicing sheds). These areas will be treated separately and discharged to trade waste or for re-use in wash down. This will be achieved by the use of separate drainage systems, bunds, roofing and hardstands in these areas.

- Where possible, runoff will be directed over gravel/ballast areas prior to entering the drainage system to encourage pollutant removal, infiltration and decreased run off rates. Given the porosity of the ballast, it is considered that reasonably heavy storms would infiltrate through the gravel and eventually drain to the cess drain running the length of the site.

- Gross Pollutant Traps will be utilised to provide primary screening of stormwater. This will comprise formed concrete stilling basins with trash racks located at the outlet to basins. Areas draining directly to the ponds will utilise stormwater GPT's. The GPT's will be located offline to prevent re-suspension of material during larger storm events. A baffled outlet will be provided to trap hydrocarbons and other floating material in the GPT.

- Water Quality Control Ponds (WQCP) – three ponds are proposed across the site to facilitate removal of suspended solids. The characteristics of these ponds are summarised in **Table 12**. These ponds are to feature floating wetlands which have been included to provide nutrient and enhanced sediment removal from stormwater discharged from the site. The difference between a floating wetland and a conventional wetland is that the plants in a floating wetland are on floating booms so that the root mass is in the water which forms the media for biological treatment of the stormwater whereas a conventional wetland has the leaf material as the prime media for biological treatment. The performance of these wetlands as compared to a conventional wetland has been investigated (Headley and Tanner (2012), Tanner, Sukias, Park, Yates and Headley (2011) and Duncan (2011)) with the results indicating improved nutrient removal as well as enhanced Heavy metals uptake.

- Access roads are to be provided with road side swales that will provide treatment through flow attenuation and sedimentation of suspended sediments.

Table 12 - WQCP Details

WQCP	PPV (m^3)	Surface Area (m^2)	Depth (m)
1	520	2,780	0.3m
2	390	8,500	0.2m
3	240	6,400	0.3m

- **Figure 5-1** illustrates the location and concept layout for the water quality ponds. The characteristics of these ponds would be further developed and refined during the detailed design stage. A key consideration during the detailed design stage will be the existing groundwater levels, which have previously been noted by Douglas Partners to range between RL 1.0m and RL 1.5m along the existing Great Northern Railway. Based on these groundwater levels, it has been deemed necessary to line the water quality ponds in order to minimise surface water and groundwater interaction.

- A GPT will be located at the outlet of each pond as a final barrier to remove suspended solids, remaining floating debris (e.g. plant material) and hydrocarbons. Low flows will pass through the GPT with larger flows discharging over a spillway.

- It should be noted that the floating wetlands were sized to 1% of the upstream catchment as specified by a potential supplier (SPEL). Based on this requirement, the proposed wetland areas for each catchment are summarised in **Table 13** below.

Table 13 - WQCP Details

WQCP	Floating Treatment Wetland Area (m^2)
1	150
2	1,400
3	1,000
Total	2,350

5.2.4 Modelling Results

Based on MUSIC modelling, average annual pollutant loads from the existing site and developed site (no treatment) are detailed in **Table 14** and **Table 15**.

The results for the “site” refer to the area including the TSF and the ARTC relief roads site.

Table 14 – Annual Average Pollutant Loads - Existing Site

Parameter	Site
Suspended Solids (kg/yr)	107,000
Total Phosphorus (kg/yr)	72.3
Total Nitrogen (kg/yr)	268
Gross Pollutants (kg/yr)	446

Table 15 - Annual Average Pollutant Loads – Developed Site (No Treatment)

Parameter	Site	
	Annual Load	% Increase from existing conditions
Suspended Solids (kg/yr)	108000	1%
Total Phosphorus (kg/yr)	199	275%
Total Nitrogen (kg/yr)	769	287%
Gross Pollutants (kg/yr)	7320	1600%

The above includes the existing catchment areas for the proposed ARTC Relief Roads Site, which may utilise the same discharge points as the Aurizon TSF site. It is assumed that the ARTC site once developed, will have its own water quality treatment infrastructure which will not interact with that of the TSF.

Pollutant loads from the developed site utilising the proposed water quality controls described previously are summarised in **Table 16**.

Table 16 - Annual Average Pollutant Loads – Developed Site (with Treatment)

Parameter	Site	
	Annual Load	% Reduction from Developed (No Controls)
Suspended Solids (kg/yr)	9250	91.5%
Total Phosphorus (kg/yr)	37.3	81%
Total Nitrogen (kg/yr)	146	80%
Gross Pollutants (kg/yr)	162	98%

In view of the above, it is considered that the proposed water quality control system, as outlined above, satisfies or exceeds the treatment targets outlined in **Section 5.2.1**. Further refinement of the water quality control system is possible, which should be undertaken during the detailed design stage.

As noted above, maintenance of stormwater treatment devices are critical to ensure performance in accordance with the requirements of this SWMP. Aurizon would implement maintenance plans prior to initiating operations on the site. A suggested maintenance frame work is included **Section 8.m**

6. CONSTRUCTION STORMWATER MANAGEMENT PLAN

In accordance with the requirements of Newcastle City Council and the Director General, the framework for a Construction Stormwater Management Plan has been prepared for the TSF site.

The following sections outline the physical sediment and erosion controls proposed for the site. These are also outlined in **Figure 5-2, 5-3 and 6**. The final section covers implementation of the plan (Inspection and Test Plans).

A Construction Environmental Management Plan (CEMP) will be prepared by the proponent prior to construction commencement. A detailed construction stormwater management plan will be included in the CEMP. This section of the report therefore aims to provide a framework for the Contractor to further develop, and would represent the minimum requirements to be included.

The civil works and building works contractors will produce their own CEMP to match the requirements of the proponents CEMP.

6.1 Erosion & Sediment Control Measures

The sediment and erosion controls proposed for the construction phase of the Train Support Facility are detailed in **Figure 5-2, 5-3** and **6** and summarised below. These requirements have been based on Managing Urban Stormwater: Soils and Construction (*Landcoms "Bluebook" Volume 1, 4th edition March 2004*).

- TSF Facility Construction
  - The proposed water quality ponds would be used as sediment basins during the construction phase. These ponds should be installed before any other works take place on site. All ponds would be inspected following rainfall events to ensure stormwater meets the necessary quality requirements prior to being discharged off site;
  - Construction of temporary surface drains to minimise the flow of clean runoff into the construction site. Surface flows should also be directed away from material stockpiles and open trenches;
  - Creation of designated no-go areas to minimise site disturbance;
  - Silt fences or similar will be required around exposed ground and material stockpiles, including the use of bunding where considered appropriate;
  - Provision of shaker pads or other similar devices at all site entry locations to ensure construction vehicles are not tracking material off site;
  - Minimise areas of earthworks and trenches under construction at any one time;

- Progressive revegetation of disturbed areas;
- Regular cleaning of public roads which are used by construction traffic;
- Where possible, vegetated filter strips will be provided between construction works and areas of sensitive vegetation;
- Construction plant and materials to be stored and maintained away from watercourses and high water tables;
- Inspection *(on a daily basis*) of construction areas, stormwater devices (*silt fences, sediment basins, etc*) and any other appropriate areas;
- 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;
- During construction, there is a possibility that Acid Sulphate Soils (*ASS*) may be disturbed (refer Douglas Partners Report). Any water produced from ASS as a result of the dewatering will be treated using standard practices such as neutralisation prior to infiltration to the groundwater table. Areas for treatment of ASS have been set aside within the project area. In construction areas with a high risk of encountering ASS (eg low track area formation excavation), it is expected that ASS management plans would dictate controls and construction methodology required which would also address stormwater management requirements.

* Access roads to the TSF
  - Sediment fencing will be maintained on each side of the access road from Woodlands Close, and the access road from the Tarro Interchange (to edge of property boundary).
  - Road side swales and small temporary sediment ponds could be established to ensure retention of sediment laden runoff prior to discharging into adjacent areas;
  - All disturbed areas and batters are to be revegetated progressively;
  - Where a sufficient width filter strip cannot be located between a natural drainage line and the construction works, sediment fences will be located beyond the available filter strip.
  - Check dams are to be located within intermittent drainage lines.

6.2 Management Plans

In accordance with the requirements of the Blue Book, draft “Inspection and Test Plans” have been developed for the proposed works to guide future detailed plans to be prepared and implemented by the contractor. Generally these plans will be incorporated into the Construction Contractors Environmental Management Plan for the site, together with other relevant plans for the project (e.g.

flora/fauna, acid sulfate soils, etc) proposed inspection and test plans for the site are provided in **Appendix C**.

The plans should contain the following components:

- Issue/Activity
- Standards/Specification
- Responsibility
- Acceptance Criteria
- Monitoring Requirements
- Frequency
- Remediation
- Reporting and Notification

The following Inspection and testing plans have been prepared are provided in **Appendix C**.

- Establishment/Monitoring of Sediment & Erosion Controls
- Dust Monitoring
- Water Quality Monitoring
- Release of Water From Site

7. MONITORING AND CONTINGENCY PROCEDURES

As part of the SWMP for the TSF it is proposed to develop and implement a surface water quality monitoring programme. This section outlines a preliminary framework for the surface water monitoring plan, a final detailed surface water monitoring plan will be prepared in consultation with relevant authorities and land owners and will be submitted as part of the Environmental Management Plan for the TSF Project.

7.1 Baseline Surface Water Monitoring

It is recommended that 'baseline' surface water monitoring be undertaken to analyse the existing water quality conditions within the Primary Project Area. The locations previously outlined in **Table 1** are recommended as a minimum, as sampling has previously been undertaken at these locations by Douglas Partners (2008), but will be reviewed further in consultation with relevant agencies and land owners, plans showing the sample locations are contained in Douglas Partners Report (August 2012).

A minimum six month program comprising monthly samples is recommended. Permanent water is only likely during periods of wet weather. Sampling is only required if water is present and 6-monthly sampling is considered adequate to establish baseline characteristics. Samples would be tested for all of the analytes in **Table 1** and would form the baseline conditions to meet for water quality during the construction and operation phase of the TSF.

7.2 Construction and Operation – Surface Water Monitoring

Monitoring is recommended during construction and throughout the operational lifetime of the TSF. It is recommended that surface water quality monitoring be undertaken at a number of locations within the Primary Project Area. **Table 17** details the recommended locations and monitoring frequencies.

Table 17

Sample Location	Monitoring Frequency
Sediment Basins (during *construction phase*)	Prior to discharge off site
Permanent Water within Constructed Wetlands	Quarterly
Outfall from Constructed Wetlands	Daily when discharge is occurring

Remaining Surface Water Sample locations (Locations as per Table 1)	Monthly

Note (i) Groundwater sampling and sampling associated with Effluent disposal area to be as outlined in relevant Douglas Partners Reports (August 2012).

It is recommended that each surface water sample is tested for the following analytes:

- Physical Parameters including pH, Electrical Conductivity and Total Suspended Solids;
- Oil and Grease;
- Nutrients including Total Nitrogen and Total Phosphorous; and
- A full suite of Metals.

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

It is recommended that the monitoring plan is reviewed on an annual basis.

7.3 Further Operational Requirements

In addition to water quality sampling, Aurizon would continue to:

- Monitor all key water movements around the TSF site. Monitoring will be recorded on a minimum quarterly basis or following significant rainfall events;
- Monitor constructed wetlands storage levels. Levels will be checked on a monthly basis and following significant rainfall events to determine their continued effectiveness. Periodic maintenance and cleaning out of all basins will be required to ensure their continued operation;
- Undertake routine inspection of all wetlands, road side swales, drains, sumps, culverts and any other water quality treatment systems on a monthly basis and following significant rain. The following routine maintenance would be undertaken:
  - Removal of accumulated sediment from wetlands, infiltration ponds, sumps and drains as required;
  - Repair and installation of erosion control measures as required; and
  - Inspection and maintenance of the sediment chambers and oil and grease traps treating runoff from bunded areas as well as roads and any car parking areas.

7.4 Contingency Measures

The proposed stormwater treatment system and containment system will be designed to provide adequate and efficient treatment of surface water runoff from the site through containing, collecting/treating and adequately disposing of the runoff. A comprehensive monitoring programme will be undertaken to assess the performance of the surface water controls and to identify any unacceptable levels of impact. In the event that unacceptable water quality is identified, the following contingency measures would be implemented:

- Identify contaminant source and rectify chemical use, storage, delivery and bunding systems as required;
- Increased monitoring frequency and sampling points to identify and confirm the source of any suspected degradation to water quality;
- Review the SWMP in order to identify opportunities to improve or rectify any identified problem. The data collected as part of the monitoring programme will enable fully informed decisions to be made; and
- If any component of the surface water management framework is identified as creating an unacceptable environmental impact, remedial actions will be established in close liaison with relevant agencies.

8. MAINTENANCE REQUIREMENTS

As mentioned previously, following construction, the stormwater infrastructure will need to be regularly inspected in order to assess it's performance and to schedule any required maintenance. Inspections have been divided into two categories:

- Routine Inspections for Maintenance – which are to be carried out by any responsible person, including property management staff or maintenance;
- Engineering Inspections for Maintenance – which are to be carried out by professional/qualified civil engineering personnel.

8.1 Routine Inspections

All maintenance performed is to be done in accordance with the individual manufacturers guidelines (where appropriate) and done by suitably qualified persons. Any specific training and certifications required by maintenance persons working on the Aurizon storm water system are to be detailed by the supplier with documentation and training requirements that are supplied on delivery of the units and handed over by the contractor.

Routine inspections are to be carried out to assess the need for maintenance and are primarily concerned with checking the functionality of the storm water drainage and treatment facilities; items such as drains, pipe systems, open channels, drainage pits, GPT's and detention basins. Maintenance of these items is vitally important to ensure the stormwater network is capable of operating to it's intended design standard. Items that are to be subject to routine inspections and maintenance may comprise, but not be limited to those listed below.

8.2 Stormwater Pits and Pipes

The site has an extensive storm water pit-pipe network across the site and represents a significant investment on the site. The maintenance and inspection requirements for this system will include:

- Inspecting surface access points to underground pits and pipes as well as surface in the area of the access points. Particular attention should be paid to damage or blockage; and
- Removal of sediments and debris captured or intercepted by the pipes and pits via jetting and vacuuming the pit sumps.

8.3 Cess Drains

The open channel drain running along the site conveys water from the storm water pipes to the basins. Due to the low grade and hydraulic requirements the channel will need to be routinely maintained which would involve:

- Periodic removal of sediments will be required to maintain channel capacity and prevent blockages to the outlet pipes from the rail formation;
- Weed management to include the spraying and removal of weeds to maintain flow conveyance, minimise sediment deposition and prevention of introduced plant species from propagating within the floating wetland area;
- Inspection of the pipe outlets for scour and potential erosion issues. Where evident, the placement of rock mattress or rip rap as required;
- Inspect banks for settlement, erosion, scouring, cracking, sloughing, seepage and rilling; and
- Inspect culverts, headwalls and overflow weirs for signs of deterioration (scouring), blockage, or damage.

8.4 Sedimentation Basin

The sediment basins (which make up part of basins 1, 2 and 3) will require de-silting approximately every 5 years. The process will involve the pumping of water from the sediment basins down to the sludge level. The captured sediment sludge at the base of the pond is then removed and locally stockpiled within the site to further dewater. Once dried, the extracted sediments are to be disposed to an EPA accredited waste facility.

The inlets to the sediment pond should also be checked for scour and erosion and where damaged, the area should be trimmed and armoured with placed rock in the affected area.

8.5 Detention Basin and Floating Wetlands

The detention basin and its outlets will require the following maintenance requirements:

- Cleaning of material from the outlets weekly;
- Structural inspection of the outlet pits and weir structure;
- Inspection of the outlets for scour and erosion and place riprap or rock on scour prone areas; and
- Floating wetlands maintenance program is to be specified the supplier and will typically require the following:

- Three monthly inspections of the floating mats and tethers fir structural integrity and plant health. Replace plants as required.
- Checking of mats and tethers before and after a heavy rainfall event.
- Weekly inspections of the wetlands and the water levels to ensure that the wetlands do not dry out. If the water levels get too low, then supplement the wetland with external water sources to prevent wetland plants from dying and roots from attaching to the floor.
- Inspection of the outer berm along the site for excessive settlement or embankment piping failures. For areas exhibiting excessive settlement or piping failure consult geotechnical engineer for further remediation requirements.

8.6 Maintenance Frequency

The maintenance schedule for the system will consist of routine inspection and removal of captured pollutants every 3 months or following heavy rainfall.

It is possible that through good site management a lower than average pollutant load may be achieved, which may result in a decrease in maintenance frequency. This will need to be verified over the establishment phase of the site where the proposed maintenance actions and records will identify the actual loads and hence the potential for a reduction in maintenance frequency.

It should also be noted that product substitution may also require amendments to the frequency of maintenance due to the intrinsic nature of the chosen devices.

8.7 Documentation

Records detailing each of the routine inspections for maintenance should be completed during the inspection, and describe in detail any required maintenance. The inspection records are to be provided to Aurizon for action and then filed appropriately. Records of any maintenance carried out as a result of the inspection should be completed immediately after the works have been finalised, and filed appropriately.

The maintenance log will also provide Aurizon with a means to demonstrate to authorities the ongoing commitment to stormwater compliance as required in the Environmental Assessment for the development.

8.8 Engineering Inspections

8.8.1 Overview

Engineering inspections for maintenance will generally comprise a walk over survey of the site, along with additional investigation activities as considered necessary. These inspections are primarily concerned with checking engineering aspects of the drainage and treatment facilities that are not likely to be picked up during a routine inspection for maintenance, such as pit damage, pipe misalignment, and concrete deterioration.

During the inspections for engineering maintenance, care is needed to look for signs of pipe blockages. This can only be checked at the inlet and outlet of pits, and on the base of pits.

The purpose of the Engineering Inspections is to:

1. Identify discrepancies between previous records and the current site conditions, and assess if these have implications for drainage and treatment efficiency, significant or otherwise;
2. Provide supplementary advice with regard to items requiring Routine Maintenance;
3. Check that the routine inspections for maintenance have been carried out thoroughly, documented accordingly and maintenance activities carried out;
4. Re-assess the required frequency of routine and engineering inspections based on the results of the previous inspections and current drainage and treatment performance; and
5. Identify if any repairs are required where the integrity of the system is compromised, or if the element is likely to deteriorate without repair.

Should the inspection reveal that maintenance of any item is required, this is to be reported to Aurizon for action.

Prior to undertaking an Engineering Inspection for Maintenance, the Engineer should make themselves familiar with the design of the drainage and treatment system, construction records and also review all previous inspection reports.

8.8.2 Frequency

Engineering inspections for maintenance shall be carried out over the life of the development.

Engineering inspections for maintenance shall be divided into two categories:

1. Periodic inspections (over the life of the development); and
2. Heavy Rainfall Inspections.

PERIODIC INSPECTIONS

Periodic inspections shall commence during the construction period, and shall continue on a yearly basis for the first two (2) years following the expiry of the Defects Liability Period (DLP). Should the first two years of inspections subsequent to the DLP reveal limited or no significant issues; the Engineering Inspections for Maintenance can be spaced further apart as follows:

- Spaced up to three (3) years for up to ten (10) years following construction, and then
- Spaced up to five (5) years thereafter.

HEAVY RAINFALL INSPECTIONS

Heavy rainfall inspections should be carried out as soon as practicable following an intense period of rainfall, or following a request for an Engineering Inspection made during a Routine Inspection for Maintenance.

Should the staff completing Routine Inspections for Maintenance be concerned with a particular area or issue, an Engineering Inspection must be arranged to assess the issue.

Heavy rainfall inspections shall occur within the following time periods;

a) 48 hours subsequent to a relatively high rainfall event; or

b) 1 week following a Routine Inspection that has requested an Engineering Inspection.

9. CONCLUSIONS AND RECOMMENDATIONS

9.1 Conclusions

WorleyParsons were engaged by Aurizon to prepare a SWMP for the proposed TSF development, which would form part of an Environmental Assessment Report.

The objectives of the SWMP were to:

- Identify and isolate, where possible, areas of potential future significant surface water contamination;
- Provide stormwater management measures to minimise the impact on receiving waters and vegetation/fauna communities;
- Provide water quality control measures which minimise the export of contaminants from the site. Stormwater treatment targets adopted for the SWMP are summarised below:
  - Suspended Solids (TSS) - 85% retention of the developed average annual load
  - Total Phosphorous (TP) - 65% retention of the developed average annual load
  - Total Nitrogen (TN) - 45% retention of the developed average annual load

Based on the investigation, it is concluded that the proposed Train Support Facility can feasibly be developed in accordance with current best practice guidelines, and will not have a significant impact on the adjacent areas.

The results of the SWMP are outlined below together with recommendations covering additional works.

HYDROLOGY

The hydrodynamics within the existing site have been significantly altered by previous land use practices of coal stockpiling, infilling of wetlands, construction of tailings ponds and drainage swales and irrigation of waste water effluent. The resulting landform is considered highly disturbed. Given the highly disturbed state, it is difficult to numerically assess the existing hydrological behaviour of the site. In view of this, a combination of qualitative and quantitative approaches has been used to assess stormwater management measures appropriate to the development. Quantitative modelling was carried out using DRAINS to assess low frequency, high intensity storm events. Qualitative methods were used to assess high frequency, low rainfall and the effects on wetting/drying periods.

To aid interpretation of the results the following discharge locations have been identified as being important (refer to **Figure 3**) and were used to assess potential impacts from the proposed development:

- Location 1 - Culvert to Hunter River north of the site.
- Location 2 - Swamp Oak Forest (EEC) north of the site.
- Location 3 - SEPP14 west of HWC watermain and North of abandoned railway.
- Location 4 - SEPP14 west of HWC watermain within Hexham Swamp and South of abandoned railway.
- Location 5 – Coastal Saltmarsh (EEC) south of the site.

The SWMP in conjunction with LHCCREMS guidelines, identified two discharge locations that would be sensitive to changes in low flow events (wetting/drying cycles), these being Location 2 - Swamp Oak Forest (EEC) and Location 5 – Coastal Saltmarsh (EEC).

At Discharge Location 1 - Swamp Oak Forest there is a minor change in catchment area draining to Location 1. It is concluded that this will not impact minor flow regimes, however it will increase the frequency of inundation from every second year to yearly. As the percentage of the catchment that is impervious doesn't appreciably change, there will be a negligible change to existing wetting and drying periods. The ongoing surface water monitoring plan should include monitoring of this sensitive area in order to confirm that no negative impacts to the Swamp Oak Forest occur.

At Location 5 – Coastal Saltmarsh EEC, there is an increase in the volume of fresh water discharged to this location (developed case increases runoff to this location. Refer **Tables 4, 5, 6, 7**) which is considered to be a negligible volume in comparison to the overall size and quantity of water within the estuarine environment. As above with the Swamp Oak Forest, impacts should be monitored as ratios of fresh to salt water will vary depending on tides and annual rainfall patterns.

Provided erosion issues are addressed, the other areas are not considered sensitive to minor changes in flow rates. This is because these areas are relatively waterlogged and/or semi-permanent submerged environments, in large, flat, open areas where depth changes are negligible, or are within areas where the proposed development represents relatively minor changes to significantly larger catchments. Any incidental ponding as a result of the access road embankment will be addressed with piped drainage during detailed design of the access road.

Modelling indicated that there are opportunities for stormwater management on the site to assist in creating favourable conditions for restoration of suitable environments as an offset for the area of the site lost due to the proposed development. This can be achieved by changing the discharge and overflow locations, and frequencies to specific areas as part of the ongoing design.

WATER QUALITY

Based on the above, the stormwater quality management measures outlined in this report have been developed. MUSIC modelling was undertaken to determine the treatment efficiencies of the proposed measures. These measures are summarised below:

- *Prevention* of stormwater pollution by implementation of appropriate administrative controls on the site;
- *Isolation* of areas of high pollutants (e.g. wash down bays, fuel storage and refuelling areas, workshop and maintenance facilities, provisioning sheds) from the stormwater system. These areas will involve separate treatment systems, bunding and/or disposal to trade waste.
- *Re-use* and recycling of water where possible, including rainwater harvesting from the roof areas of key buildings and sheds proposed within the site, and recycling (following treatment) of water used at the wagon and locomotive wash bays.
- *Treatment* of stormwater runoff via gross pollutant traps with baffled outlets to trap hydrocarbons and floating material. WQCP's then further remove fine sediment (refer to **Table 10** for sizes and **Figure 4** for locations) and any nutrients or metals. At the outlet to each WQCP will be a further gross pollutant trap with a baffled outlet to remove hydrocarbons and to capture spills. Considerable redundancy has been built into the treatment train.

Modelling indicates that the proposed treatment trains will achieve the adopted stormwater treatment targets for the site. The adopted treatment measures are considered conservative and have not included the significant additional benefits of the removal of grazing and effluent irrigation from the site.

CONSTRUCTION SWMP

A draft Construction SWMP has been prepared for the site. As part of the SWMP, preliminary Inspection and Test Plans (ITP) have been prepared for the specific activities (relevant to the SWMP) in accordance with Managing Urban Stormwater: Soils and Construction (*Landcoms "Bluebook" Volume 1, 4th edition March 2004*).

It is concluded that the Construction SWMP demonstrates that the proposed development can be feasibly constructed in accordance with current best practice, and will therefore minimise impacts to the surrounding areas during this phase.

ARTC RELIEF ROADS PROJECT

In terms of ARTC's relief roads development, it is expected that stormwater runoff volume and velocity will not increase as a result of the development. This is due to the fact that train lines formation will be constructed on ballast and gabion rock. The surface roughness of the material is higher than the current bare earth of 0.03 to 0.04 which will help decrease stormwater runoff rates and attenuate the peak flows. The result will be a flattening of the discharge hydrograph profile (UHVA, 2012b). It is also expected that the development will have a stormwater conveyance system similar to the TSF site, with the site draining to an open channel on the western edge of the site conveying flows both north and south via a number of detention basin before discharging offsite.

The cumulative impacts of the proposed ARTC Relief Roads Project have been considered in this report, with the modelling incorporating catchments covering both projects, All stormwater quality and quantity measures therefore consider overall impact from both projects and it has found that the proposed developments will have a negligible impact on the overall flows and volumes discharging from the site to surrounding catchments and the Hunter River.

9.2 Recommendations

In view of the above, the following stormwater recommendations are made for detailed design of the proposed development:

- Additional considerations in relation to existing site contamination, specifically the existing effluent irrigation operations and existing coal stockpile which will be included in more detailed contamination assessments may influence the detailed design of the stormwater management system;
- The stormwater management system design should be reviewed to ensure it satisfies the objectives of this SWMP;
- The stormwater management system should be reviewed during the detailed design phase to examine potential opportunities to create favourable hydrologic conditions for restoration of suitable ecosystems. This may require input from government authorities as part of the approval process;
- Erosion control needs to be addressed at discharge locations and spill ways;
- Surface water monitoring should be continued to establish existing water quality baselines for the site, and to provide assurance that the proposed treatment strategy is achieving an overall improvement in water quality for the site;
- Operating procedures should be developed to ensure ongoing compliance with this SWMP;

- Preparation of a stormwater management plan component of the Construction Environmental Management Plan for the works, to ensure that the plan is compatible with the proposed construction techniques;
- Update the ITP's for the construction phase of the project, and incorporate ITP's with other aspects of construction (e.g. Acid Sulfate Soils management, traffic control, revegetation works, etc);
- Three lined water quality/detention basins with GPT's will be required to regulate stormwater runoff quantity and quality;
- A network of catch drains (cess drains) will be required to drain the proposed TSF site; and
- Stormwater crossings for the main access road will be required to be sized sufficiently to prevent any ponding increase upstream due to potential impacts on existing vegetation.

10. REFERENCES

1) Institution of Engineers (*1987*), *'Australian Rainfall and Runoff – A Guide to Flood Estimation'*; edited by DH Pilgrim.

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3) Duncan, H. P. (February, 1999) '*Urban Stormwater Quality: A Statistical Overview*'.

4) Institution of Engineers, Australia (2006) '*Australian Runoff Quality*'

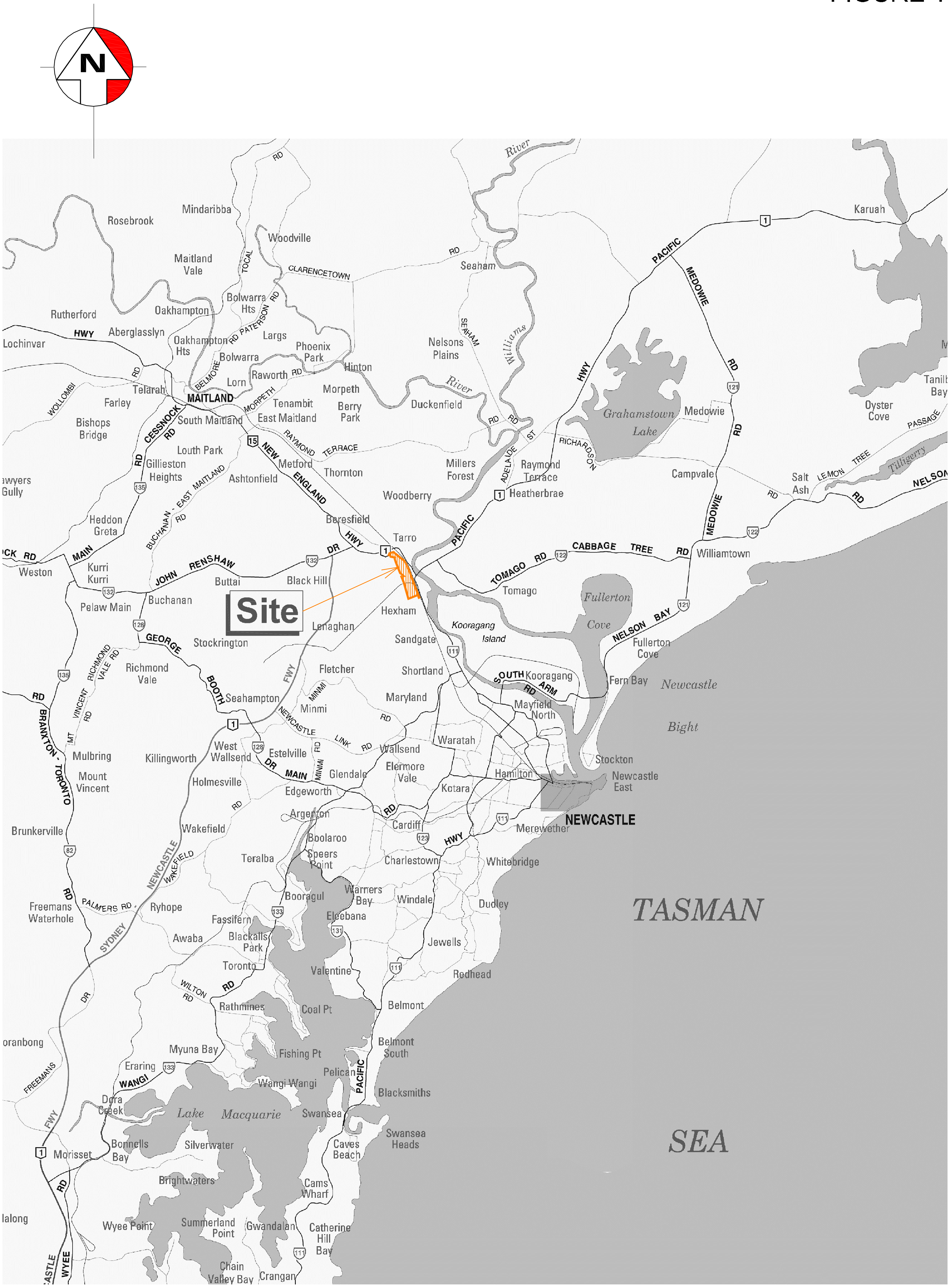
5) NSW Department of Water and Energy, 2002, 'Water Management Act 2002

6) Preliminary Geotechnical Investigation Report, Douglas Partners, 2006

7) Department of Environment and Climate Change & CMA, 2007, 'Managing Urban Stormwater: Environmental Targets-Consultation Draft'

8) Douglas Partners 2012 Preliminary Contamination Assessment Report, Hexham Redevelopment

FIGURE 1



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SITE LOCALITY PLAN

O:\301020\03465 – QR TSF (GS)\12.0 Drawings\12.01 Civil Infrastructure\CAD\STORMWATER FIGURES\FIG 1-1_LOCALITY.dwg 25/05/2012

FIGURE 1-2

LEGEND

SEPP 14 BOUNDARY
DEPARTMENT OF PLANNING
(www.canri.nsw.gov.au)

PROPERTY BOUNDARY

0 400 m
1:10000

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SITE PLAN

W:_Infrastructure\Projects\301020\301020-04881 Hexham Train Support Facility\Data In\13-04-04 Original Files From Newcastle\Drawings and xrefs\FIG 1-2_SITE PLAN.dwg 10/04/2013