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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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301020-03465-CI-REP-0002-02 – HEXHAM TRAIN SUPPORT FACILITY

REV	DESCRIPTION	ORIG	REVIEW	WORLEY-PARSONS APPROVAL	DATE	CLIENT APPROVAL	DATE
0	Final	B. Oberdorf	B. Patterson	B Patterson	August 2008	P. Drew	August 2008
1	Revised Final	B. Oberdorf	G. Swan	C. Glassock	June 2011		
2	Revised Final	B. Oberdorf	G. Swan	T. Page	22 Aug 2011		
3	Revised Final	C. Doherty	G. Swan	G. Swan	24 May 2012		
4	Revised Final	C. Doherty	G. Swan	G. Swan	01 June 2012		
5	Revised Final	C.D	G.S	G.S	20 Aug 2012		

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1. INTRODUCTION

1.1 Background

QR National owns 255ha 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 QR National to aid its coal logistics operations and would incorporate locomotive and wagon maintenance facilities as well as a freight rail yard and associated maintenance infrastructure. The TSF would occupy approximately 38ha 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 QR.

WorleyParsons (WP) was engaged by QR National 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 (includes ARTC site).

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 generally referred to as 67 Maitland Road, Hexham and incorporates the following properties to be owned by QR National:

- Lot 1 DP 155530
- Lot 2 DP 735456
- Lot 10 DP 735235
- Lot 12 DP 1075150
- Lot 102 DP 1084709
- Lot 104 DP 1084709
- Pt Lot 104 DP 1084709
- Lot 113 DP 755232
- Lot 311 DP 583724
- Lot 1 DP 1062240(Lease from ARTC)

- Lot 101 DP 1084709(Wallin)
- Lot 311 DP 583724(QR Ltd)
- Lot 1 DP128309 (Hunter Water)

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, Dairy Farmers, 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 Dairy Farmers. Treated effluent is irrigated in this area.

The current land zonings are summarised below:

- The coal stockpile area is zoned 4b (Port and Industry);
- Hexham Swamp is zoned 8a (National Park);
- The land to the north and south of the site, and the Hunter Water Pipeline, is Zoned 7b (Environmental Protection Zone); and.
- The rail line to the east is zoned 5a (Special Use Zone).

1.4 Proposed Development

A Project Application 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**): The work consists of the following:

- Train Support Facility comprising up to 7 parallel tracks up to about 3km in length. The tracks sit on a generally level area ranging from 100m to 200m wide. The tracks are formed on a filled formation with ballast support foundations between which are gravel and some sealed pavements for vehicular access.
- Buildings comprising the following:

- Operations and administration offices, associated car parking area and a service vehicle garage;
- Wheel Lathe and associated hardstand;
- Locomotive wash area and associated hardstand;
- Locomotive maintenance shed, associated hardstand and staff parking;
- Wagon wash, associated hardstands and storage areas;
- Wagon maintenance shed;
- Two provisioning sheds and associated hardstands;
- Access roads;
- Rail lines;
- Fuel storage area and associated hardstand.

The hardstands and sheds will be bunded and runoff directed through an oil-separator prior to discharge to a trade waste collection system. The vehicle (locomotive and wagon) wash sheds will collect water and have a treatment system to re-use this water.

- Access road to the site from the Tarro Interchange which is approximately 2.2km north of the coal stockpile.
- An access road to access the property to the south of the site. This road may be utilised by various external parties.
- Stormwater controls described in detail in **Section 5.2.3**.

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,*

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

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.

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 Dips

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 washer 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 Dairy Farmers. 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. The drains in this area have recently been cleaned out.

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 (*QR National – 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.
- 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 QR National 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 off site 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 Eco Logical (August 2012).
- Minimise increases in fresh water discharges to the Coastal Saltmarsh, to prevent changing the composition of these communities.
- 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 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 *QR National – Hexham Train Support Facility State Significant Infrastructure – Ecological Investigations,* May 2012 for further details) will be founded as part of the implementation of a Conservation Management Plan by QR National (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. It is noted that these drains have recently been cleaned out. The composition of vegetation in this area is somewhat transient and would alter depending on changing conditions over time, or as a 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.

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 and Wagon Wash**: Designated wagon and locomotive wash down areas will 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.
  - **QR 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 (2012), the existing effluent disposal operations currently undertaken by Dairy Farmers (owned by Brancourts P/L) 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 leechate 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 leechate 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 QR 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 system will provide details for the construction and operational phases of the proposed TSF.

4. PREVENTATIVE MEASURES

4.1 Administrative Controls

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

- QR National would have a management structure clearly identifying the responsibilities of employees and supervisors on the site.
- QR National 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 QR National.

4.2 Potable Water Usage Reduction Policies

QR National 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 wagon and locomotive wash bays which is discussed in the following section.

4.3 Wagon and Locomotive Wash Down Bays

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 40,000m^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	5	1.3%
Swamp Oak Forest	30.5	0.3	1%	25.5	0.5	1.9%
SEPP14 North	37.2	1.9	5%	52	14.6	28%
SEPP14 South	66.8	3.9	6%	50.7	2.97	6%
Coastal Saltmarsh	32.6	2.8	9%	39.1	8.33	21%

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. This channel is tidal and is therefore regularly flushed at the downstream end. 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 QR National 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. 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 QR National*), 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	31.3	0	0%	Outlet to Hunter River
2	25.5	0.5	2%	Swamp Oak Forest
3	27.8	1.39	5%	Dairy Farmers irrigation plant and area.
4	27	1.62	6%	Eastern portion of Coal Stockpile
5	22.5	1.35	6%	Western portion of Coal Stockpile
6	24	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	13.7	6.85	50%	TSF area draining to south
102	24.2	12.1	50%	Central area of TSF, draining to north
103	3.0	1.5	50%	Northern tip of TSF, draining to north
TOTAL	**479**	**26.9**	**5.6%**	

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

5.1.3 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/culverts 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).

- The culverts connect to a “Cess” Drain (table drain) which runs along the western edge of the S TSF works. The Cess drain is approximately 2.5m in width with slopes of 1V:2H and around 0.6m deep. The drain is level longitudinally and will operate via hydraulic gradient. The drain will act as a vegetated swale to assist in pollutant removal. This swale will contain some standing water and will be vegetated with appropriate species (*e.g. carex*) further enhancing pollutant removal.

- 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 to the proposed water quality control ponds.

- Three basins are located across the site to primarily remove suspended sediments, oil and grease. Two are located on the northern portion of the site and one on the southern side of the site.
  - The northern basin will discharge very close to the outlet to the Hunter River (Location 1).
  - The central basin will discharge to the existing low lying meadows which generally flows to the west (Location 3).
  - The southern basin will discharge to the south of the site approximately at the location of the disused tailings pond.

Refer to **Figure 4** for proposed discharge locations.

5.1.4 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 pipe culverts below the HWC watermain choke flows, causing overflows to discharge to the south of the site. Flows do not overtop the bund supporting the pipeline and adjacent access track.
  - 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	0.79	Increase is considered negligible and is within the culvert capacity.
2	Swamp Oak Forest	0.23	Overflows from the shallow depression now occur in the 1 year ARI event instead of the 2 year event.
3	SEPP14 North	0.1 beneath watermain 0.38 to Location 2	Culverts under HWC main restrict flows causing a slight increase in overflows into Location 2.
4	SEPP14 South	0.1	No developed catchment
5	Coastal Saltmarsh EEC	Total = 0.65 Eastern Outlet = 0.32 Western Outlet = 0.33	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 4 and 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 $0.33m^3/s$ and discharge into an existing Phragmites complex on QR National 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 $5,100m^3$. 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 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.

5.1.5 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	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 $0.96m^3/s$).

- 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	11.3	Negligible change
2	Swamp Oak Forest	Inflows – 3.1 Outflows – 2.72	Negligible change
3	SEPP14 North	0.84 beneath main 1.91 overflows to Location 2	Negligible change
4	SEPP14 South	0.81	decrease
5	Coastal Saltmarsh EEC	Total = 4.47 Eastern Outlet = 2.35 Western Outlet = 2.12	Flows to the eastern outlet (Saltmarsh community) increase from $1.64m^3/s$ to $2.35m^3/s$. Flows to the western outlet (Phragmites complex) of the site increase from $1.14m^3/s$ to $2.12m^3/s$

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

- The peak discharge rate directed to the south of the site increases by about 44% from $3.12m^3/s$ to $4.47m^3/s$ with the majority of the flow discharging to the Coastal saltmarsh to the south-east of the site which increases from $1.68m^3/s$ to $2.35m^3/s$ (Location 5, eastern outlet).
- Flow to the SEPP14 discharge location decreases from $0.96m^3/s$ to $0.81m^3/s$ 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 $2.12m^3/s$) and discharge into an existing Phragmites complex on QR National 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 30273m^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.

5.1.6 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.

5.1.7 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 50% impervious to allow for sealed and unsealed roads and site structures, which provided a conservative approach.

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 Dairy Farmers 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 QR 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 at the University of Newcastle were used for MUSIC water quality simulations. 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-April 2012*). 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**.

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 70% removal rate
- TP – 0% to 60% Adopt 0% removal rate
- TN – 0% to 45% Adopt 0% 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 QR National 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**.

- 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	Volume (m^3)	Surface Area (m^2)	Depth (m)
1	1,230	2,190	0.6m
2	3,900	6,800	0.6m
3	3,800	6,560	0.6m

- **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. Currently the plans prepared for the basins indicate base levels of RL 0.6m for all three ponds. 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, the water quality ponds will be either lined (using HDPE for example) or raised to be located above expected groundwater levels. This would prevent potential movement between groundwater and stormwater in the ponds, as well as ensure that the capacity of the ponds is not reduced due to groundwater ingress.

- A further 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.

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 13** and **Table 14**.

The results for the “site” refer to the area including the TSF.

Table 13 – Annual Average Pollutant Loads - Existing Site

Parameter	Site
Flow (ML/yr)	146
Suspended Solids (kg/yr)	17700
Total Phosphorus (kg/yr)	106
Total Nitrogen (kg/yr)	414
Gross Pollutants (kg/yr)	785

Table 14 - Annual Average Pollutant Loads – Developed Site (No Treatment)

Parameter	Site	
	Annual Load	% Increase from existing conditions
Flow (ML/yr)	358	245%
Suspended Solids (kg/yr)	96400	540%
Total Phosphorus (kg/yr)	171	161%
Total Nitrogen (kg/yr)	875	211%
Gross Pollutants (kg/yr)	7660	975%

Pollutant loads from the developed site utilising the proposed water quality controls described previously are summarised in **Table 15**.

Table 15 - Annual Average Pollutant Loads – Developed Site (with Treatment)

Parameter	Site	
	Annual Load	% Reduction from Developed (No Controls)
Flow (m^3)	163	46%
Suspended Solids (kg/yr)	7490	92%
Total Phosphorus (kg/yr)	32	81%
Total Nitrogen (kg/yr)	311	64%
Gross Pollutants (kg/yr)	0	100%

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. QR National would implement maintenance plans prior to initiating operations on the site.

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 (Douglas Partners 2012). 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

• 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 16** details the recommended locations and monitoring frequencies.

Table 16

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, QR National 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. CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusions

WorleyParsons were engaged by QR National 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.

It is noted that for the area of new rail roads, the volume and rate of stormwater run-off will be equivalent to what is currently experienced as construction material will be pervious. Therefore no reduction in the infiltration rate into the existing soil is expected (UHVA, 2012b).

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, 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).

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.

8.2 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 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.

9. REFERENCES

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

2) Bureau of Meteorology Website (*www.Bom.gov.au*)

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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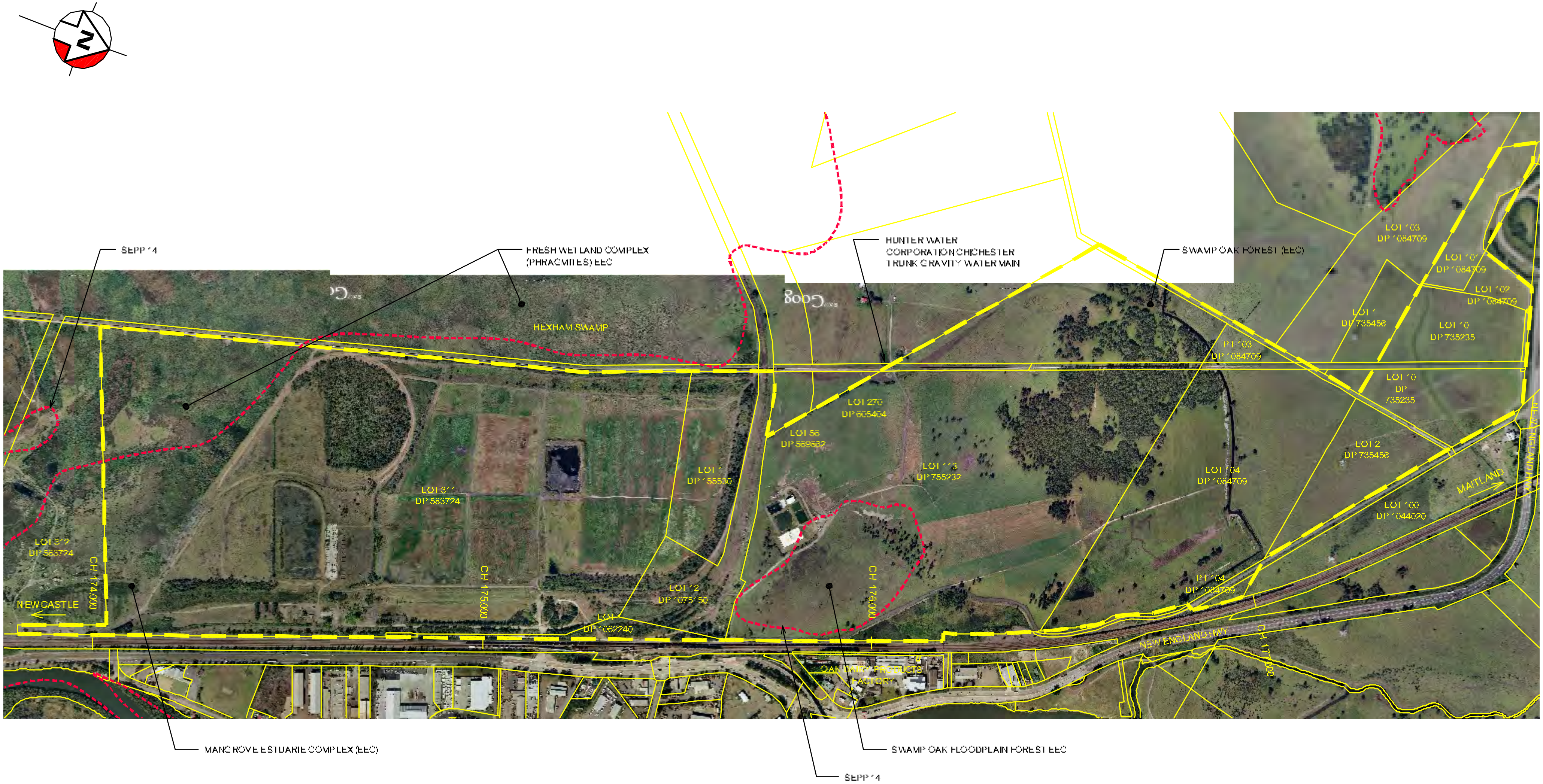
SITE LOCALITY PLAN

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.dp.nsw.gov.au)

PROPERTY BOUNDARY

0 400 m
1:10000

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SITE PLAN

O:\301020\03465 – QR TSF (GS)\12.0 Drawings\12.01 Civil Infrastructure\CAD\STORMWATER FIGURES\FIG 1-2_SITE PLAN.dwg 20/08/2012

FIGURE 2

LEGEND

- TRAIN SUPPORT FACILITY BOUNDARY
- PROPERTY BOUNDARY
- WATER RECYCLING & WASTEWATER TREATMENT SYSTEM
- HWC PROPOSED WATER MAIN
- EXISTING WATER MAIN
- PROPOSED ARTC RELIEF ROADS (TRACKS)
- TSF ROADS (TRACKS)
- STORMWATER DRAINAGE NETWORK
- COAL TAILINGS STOCKPILE EXTENTS
- PROPOSED CESS DRAIN
- PROPOSED WASTEWATER DRAINAGE LINE
- PROPOSED RISING MAIN

0 200m
1: 5000

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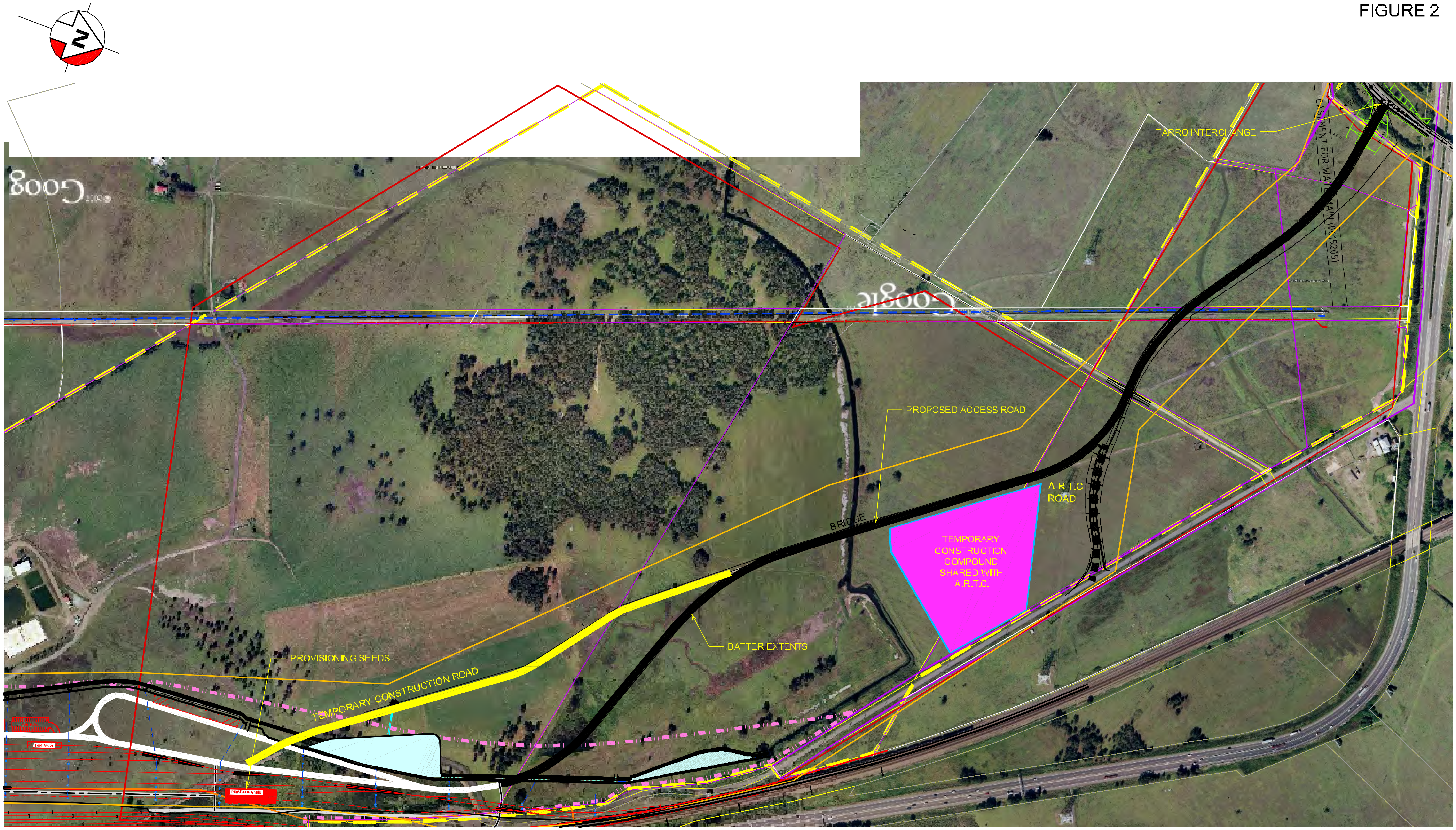
PROPOSED ARRANGEMENT
TRAIN SUPPORT FACILITY
SHEET 1 OF 2

O:\301020\03465 – QR TSF (GS)\12.0 Drawings\12.01 Civil Infrastructure\CAD\STORMWATER FIGURES\FIG 2-1_2-2_PROPOSED ARRANGEMENT.dwg 13/09/2012

FIGURE 2



LEGEND

- TRAIN SUPPORT FACILITY BOUNDARY
- PROPOSED CESS DRAIN
- PROPERTY BOUNDARY
- WATER RECYCLING & WASTEWATER TREATMENT SYSTEM
- TRUCK SHAKEDOWN AND WASHDOWN BAY (IF REQUIRED)

0 200m
1: 5000

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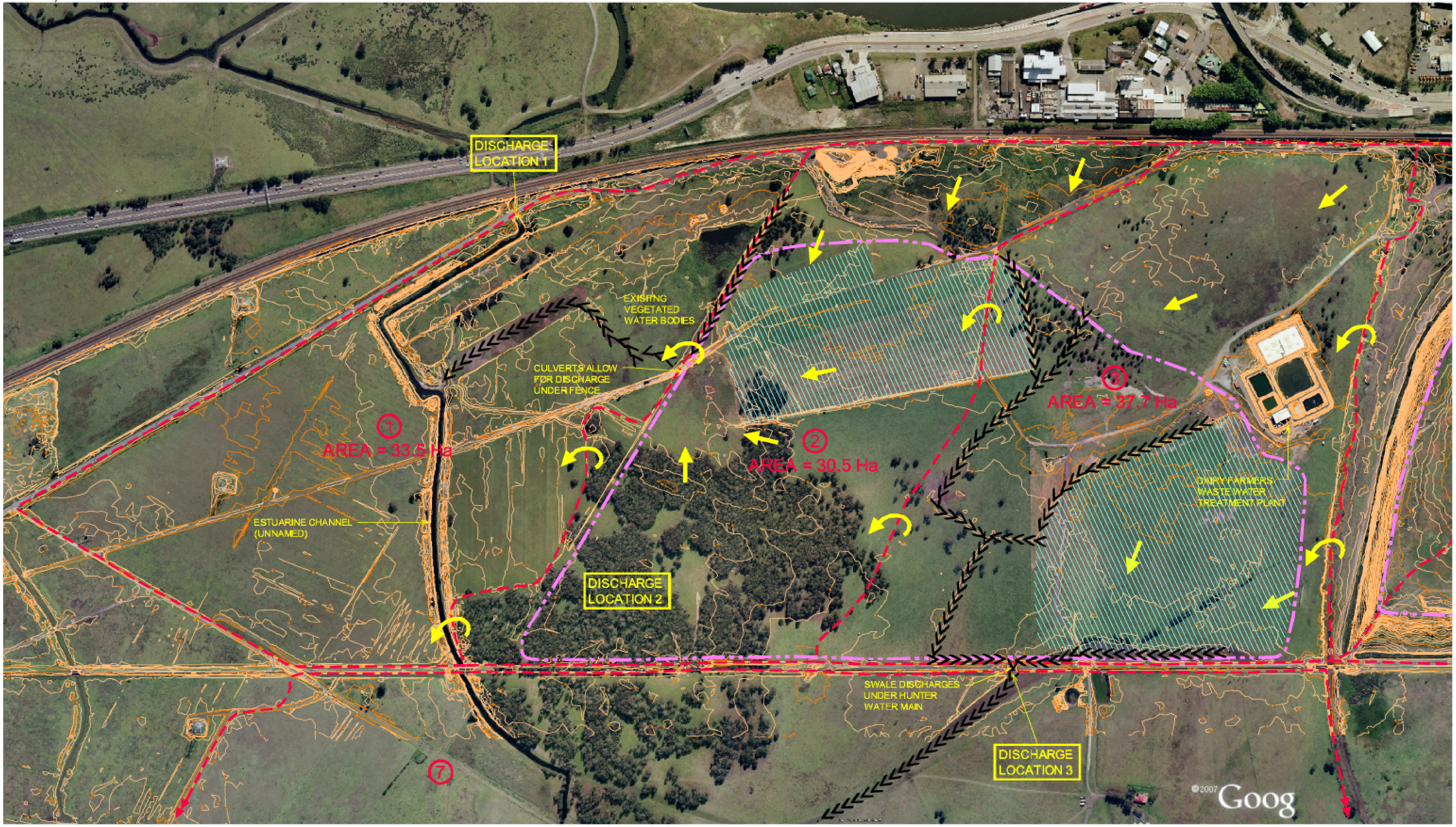
PROPOSED ARRANGEMENT
TRAIN SUPPORT FACILITY
SHEET 2 OF 2

O:\301020\03465 – QR TSF (GS)\12.0 Drawings\12.01 Civil Infrastructure\CAD\STORMWATER FIGURES\FIG 2-1_2-2_PROPOSED ARRANGEMENT.dwg 23/08/2012

FIGURE 3



LEGEND

	CATCHMENT BOUNDARY		OVERFLOWS EXISTING MAJOR CONTOURS (1m INTERVAL)
	EXISTING SWALE		EXISTING MINOR CONTOURS (0.2m INTERVAL)
	ACTUAL EXISTING WASTE WATER IRRIGATION AREAS	6	SUB-CATCHMENT NUMBER
	ESTIMATED OVERLAND FLOW DIRECTION	DISCHARGE LOCATION 5	SIGNIFICANT DISCHARGE LOCATION
	OVERFLOW TO ADJACENT CATCHMENT		EXISTING LICENCED WASTEWATER IRRIGATION AREA

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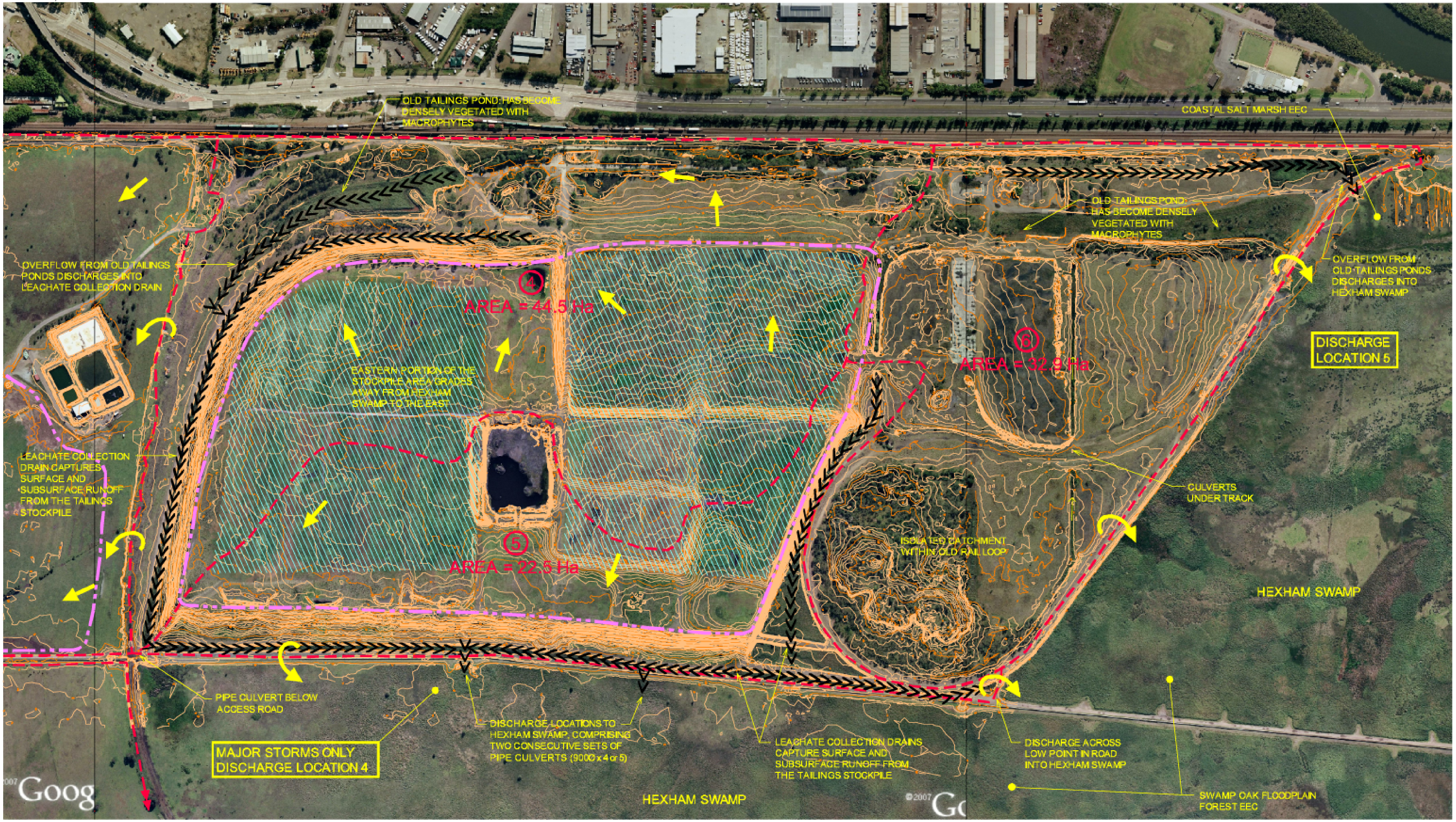
0 200m
1: 5000

EXISTING HYDROLOGY
TRAIN SUPPORT FACILITY
SHEET 1 OF 2

O:\301020\03465 – QR TSF (GS)\12.0 Drawings\12.01 Civil Infrastructure\CAD\STORMWATER FIGURES\FIG 3_EXISTING HYDROLOGY.dwg 20/08/2012

FIGURE 3



LEGEND

- CATCHMENT BOUNDARY
- EXISTING SWALE
- ACTUAL EXISTING WASTE WATER IRRIGATION AREAS
- ESTIMATED OVERLAND FLOW DIRECTION
- OVERFLOW TO ADJACENT CATCHMENT
- OVERFLOWS EXISTING MAJOR CONTOURS (1m INTERVAL)
- EXISTING MINOR CONTOURS (0.2m INTERVAL)
- 6 SUB-CATCHMENT NUMBER
- DISCHARGE LOCATION 5 SIGNIFICANT DISCHARGE LOCATION
- EXISTING LICENCED WASTEWATER IRRIGATION AREA

0 200m
1: 5000

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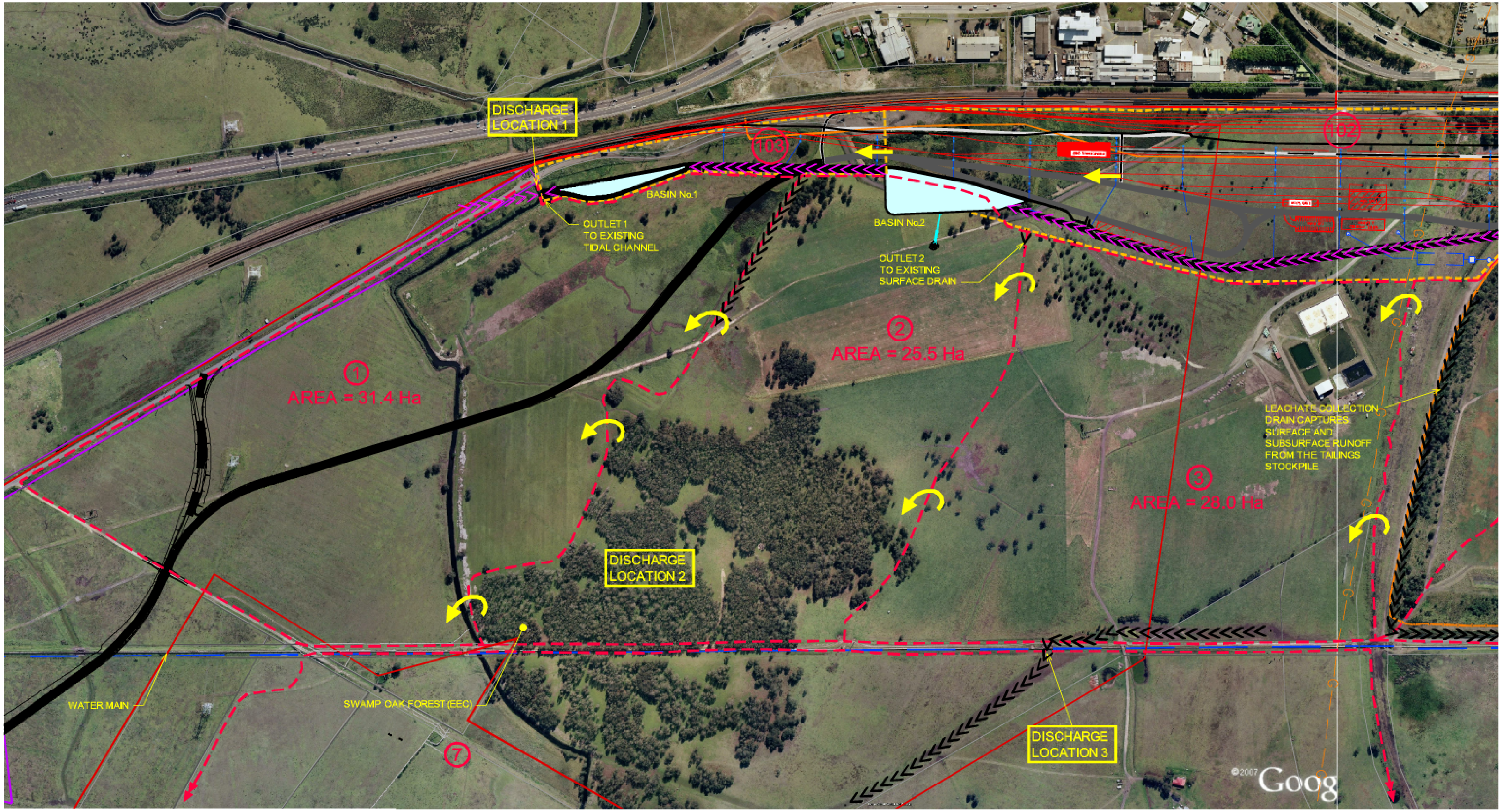
EXISTING HYDROLOGY
TRAIN SUPPORT FACILITY
SHEET 2 OF 2

O:\301020\03465 – QR TSF (GS)\12.0 Drawings\12.01 Civil Infrastructure\CAD\STORMWATER FIGURES\FIG 3_EXISTING HYDROLOGY.dwg 20/08/2012



0 200m
1:5000

LEGEND

CATCHMENT BOUNDARY
CATCHMENT BOUNDARY
EXISTING SWALE
PROPOSED CESS DRAIN
SUB-CATCHMENT NUMBER
PROPOSED OVERLAND FLOW DIRECTION
OVERFLOW TO ADJACENT CATCHMENT
SIGNIFICANT DISCHARGE LOCATION
COAL TAILINGS STOCKPILE EXTENTS
WATER QUALITY CONTROL POND

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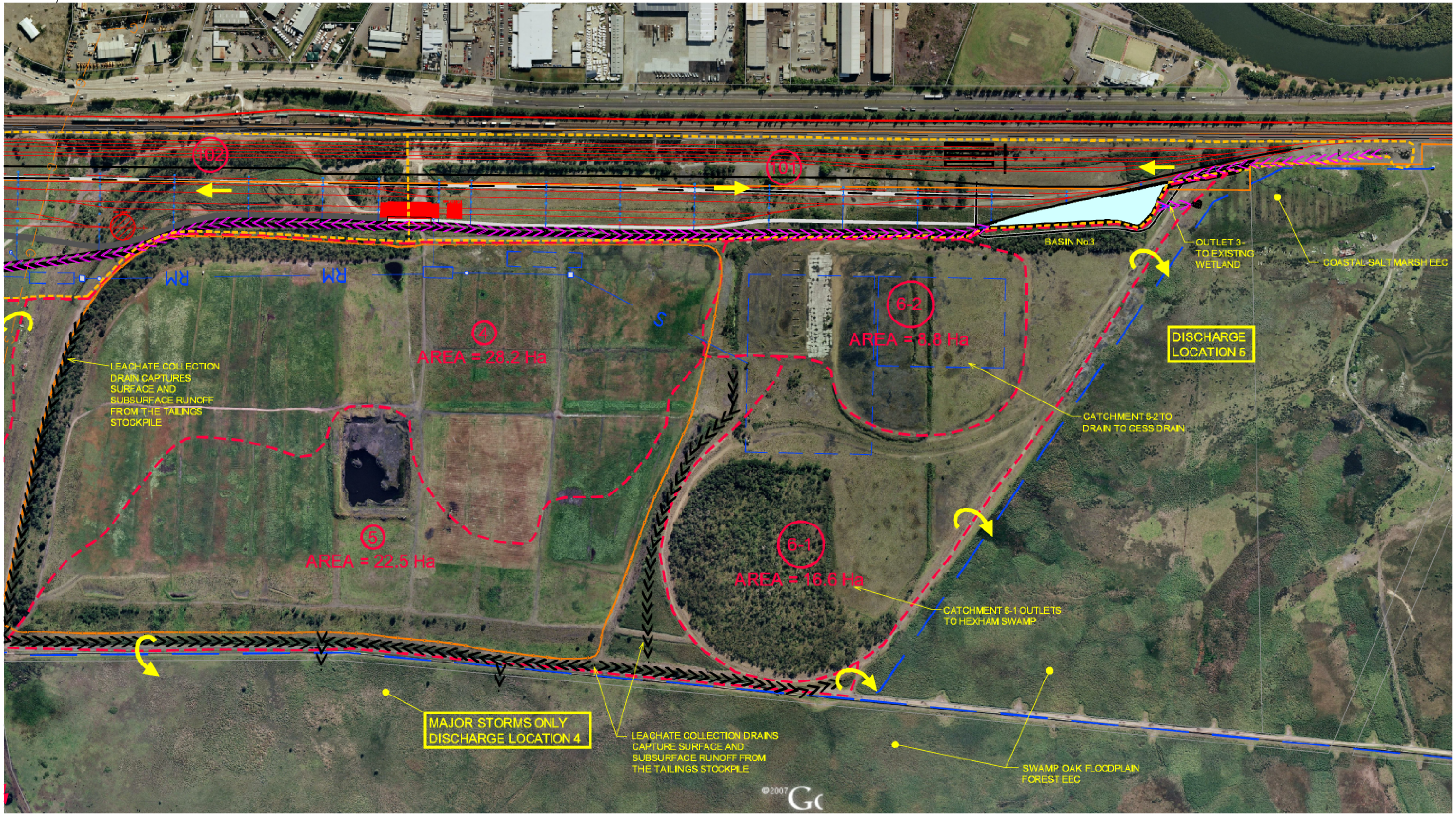
PROPOSED HYDROLOGY
TRAIN SUPPORT FACILITY
SHEET 1 OF 2

O:\301020\03465 – QR TSF (GS)\12.0 Drawings\12.01 Civil Infrastructure\CAD\STORMWATER FIGURES\FIG 4_PROPOSED HYDROLOGY.dwg 23/08/2012

FIGURE 4



0 200m

1:5000

LEGEND

- CATCHMENT BOUNDARY
- CATCHMENT BOUNDARY
- EXISTING SWALE
- PROPOSED CESS DRAIN
- 7 SUB-CATCHMENT NUMBER
- PROPOSED OVERLAND FLOW DIRECTION
- OVERFLOW TO ADJACENT CATCHMENT
- DISCHARGE LOCATION 5 SIGNIFICANT DISCHARGE LOCATION
- COAL TAILINGS STOCKPILE EXTENTS
- WATER QUALITY CONTROL POND

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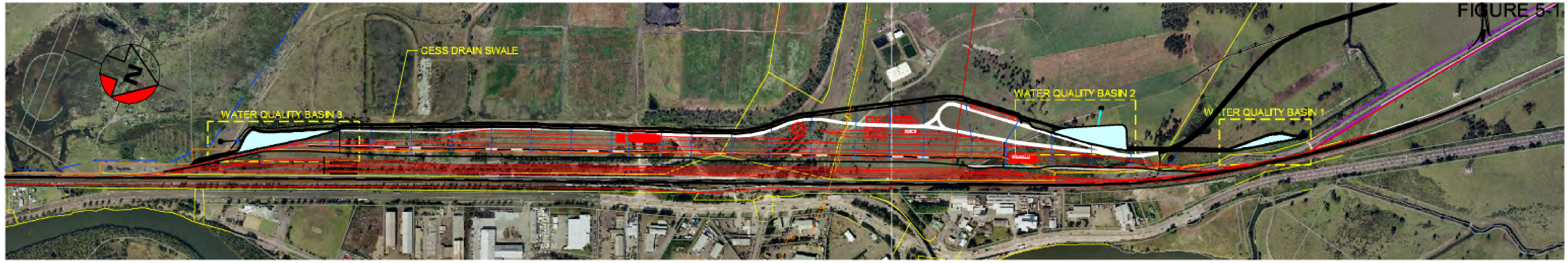
PROPOSED HYDROLOGY
TRAIN SUPPORT FACILITY
SHEET 2 OF 2

O:\301020\03465 – QR TSF (GS)\12.0 Drawings\12.01 Civil Infrastructure\CAD\STORMWATER FIGURES\FIG 4_PROPOSED HYDROLOGY.dwg 23/08/2012

FIGURE 5-1



PLAN
SCALE 1:10000

BASIN 3
SCALE 1:1250

LEGEND

- MAJOR GROSS POLLUTANT TRAP
- MINOR GROSS POLLUTANT TRAP (e.g. HUMES)

BASIN 1
SCALE 1:1250

BASIN 2
SCALE 1:1250

0 400m
1:10000

0 50 m
1:1250

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STORMWATER MANAGEMENT PLAN
TRAIN SUPPORT FACILITY

O:\301020\03465 – QR TSF (GS)\12.0 Drawings\12.01 Civil Infrastructure\CAD\STORMWATER FIGURES\FIG 5-1_SWMP TRAIN FACILITY.dwg 23/08/2012

FIGURE 5-2

LEGEND

SEDIMENT BASIN

CATCH DRAIN
(USED TO DIRECT FLOWS TO SED. BASIN)

SEDIMENT FENCING

TRUCK SHAKE DOWN & WASH BAY

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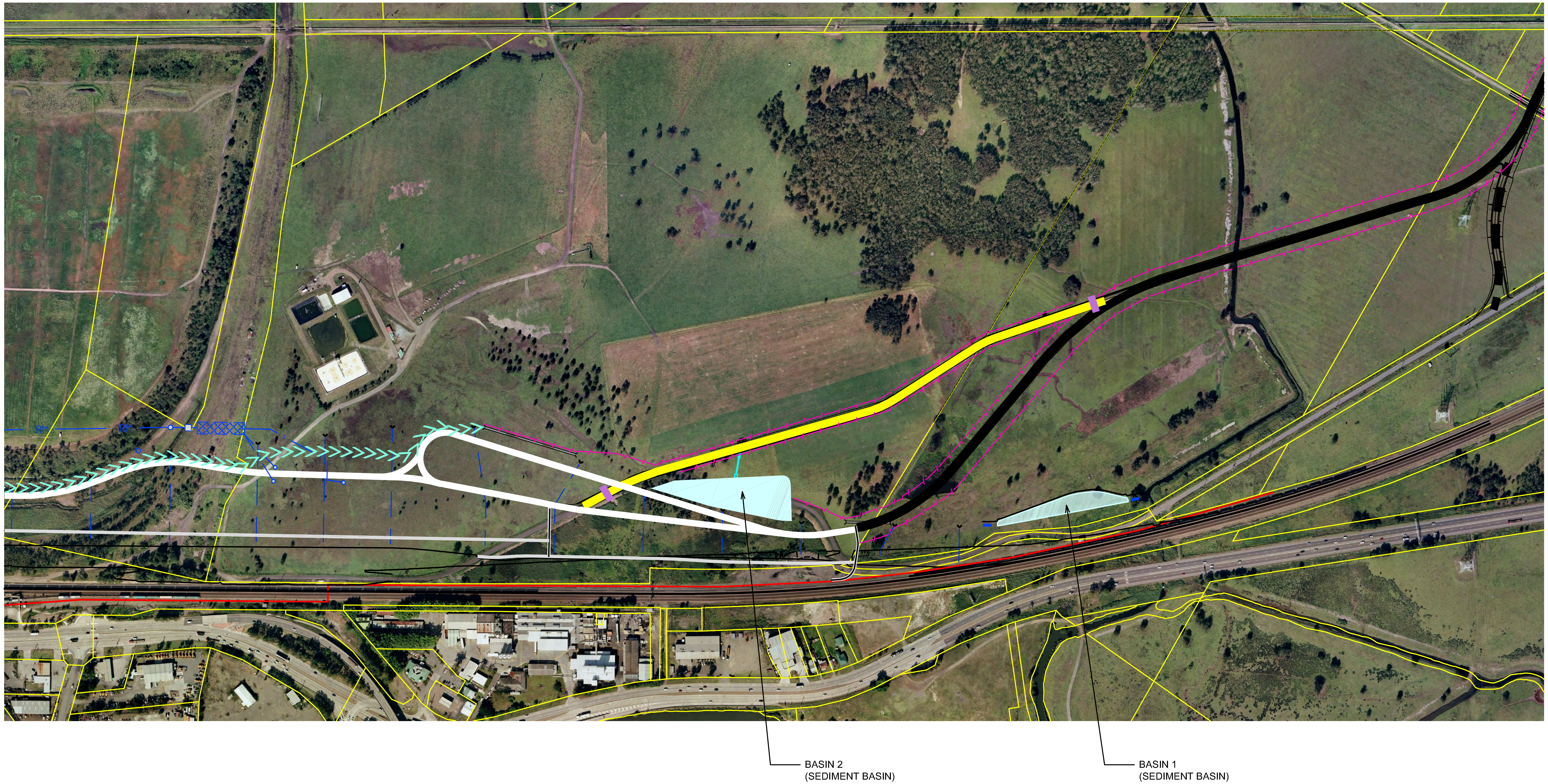
0 200 m
1: 5000

STAGE 1 PRELIMINARY CONSTRUCTION
STORMWATER MANAGEMENT PLAN
TRAIN SUPPORT FACILITY
SHEET 1 of 2

O:\301020\03465 – QR TSF (GS)\12.0 Drawings\12.01 Civil Infrastructure\CAD\STORMWATER FIGURES\FIG 5-2 5-3 PRLIM CONSTRUCT SWMP TRAIN FACILITY.dwg 13/09/2012

FIGURE 5-2



LEGEND

SEDIMENT BASIN

CATCH DRAIN
(USED TO DIRECT FLOWS TO SED. BASIN)

SEDIMENT FENCING

TRUCK SHAKE DOWN & WASH BAY

0 200 m
1:5000

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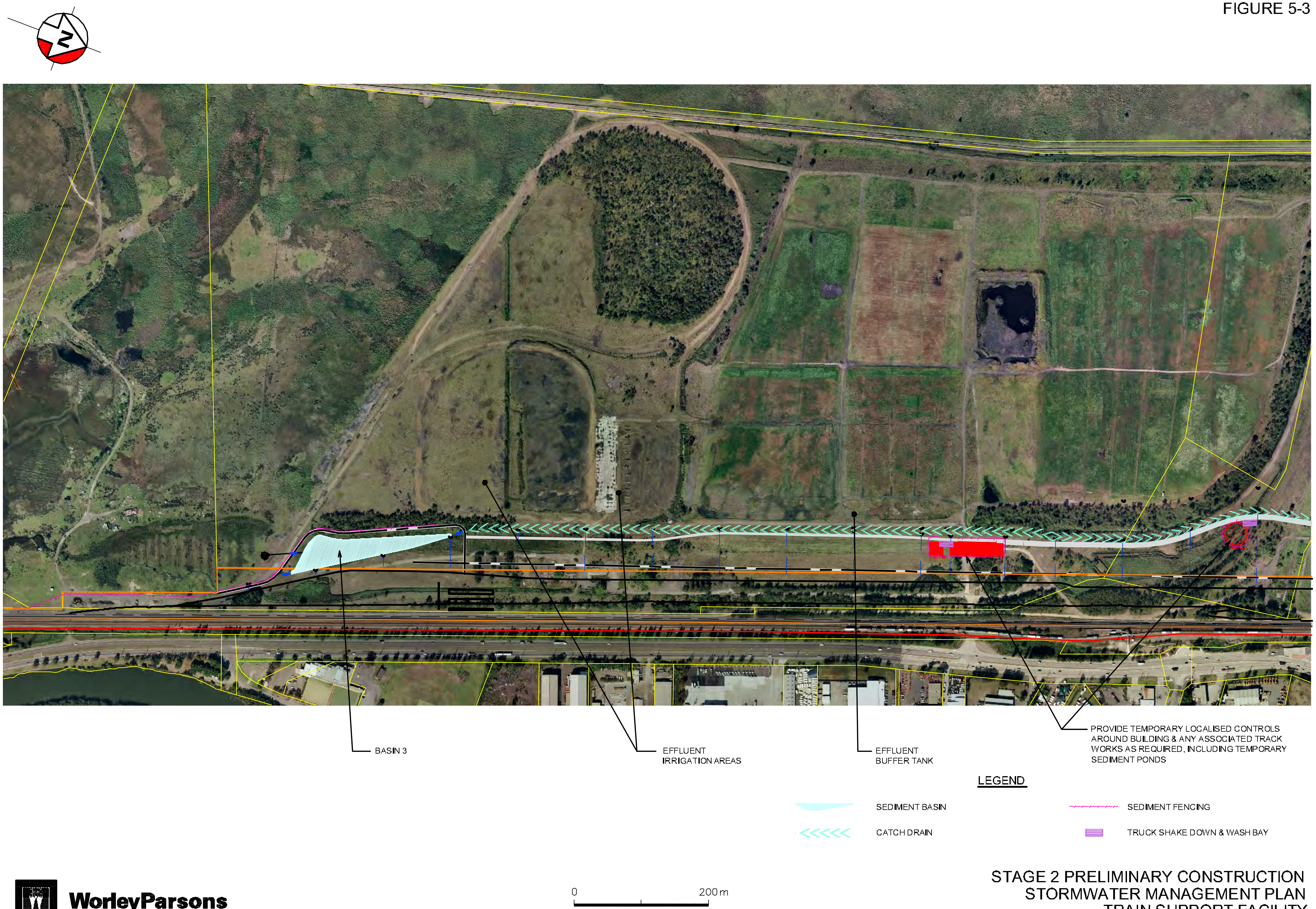
STAGE 1 PRELIMINARY CONSTRUCTION
STORMWATER MANAGEMENT PLAN
TRAIN SUPPORT FACILITY
SHEET 2 OF 2

O:\301020\03465 – QR TSF (GS)\12.0 Drawings\12.01 Civil Infrastructure\CAD\STORMWATER FIGURES\FIG 5–2_5–3 PRLIM CONSTRUCT SWMP TRAIN FACILITY.dwg 13/09/2012

FIGURE 5-3



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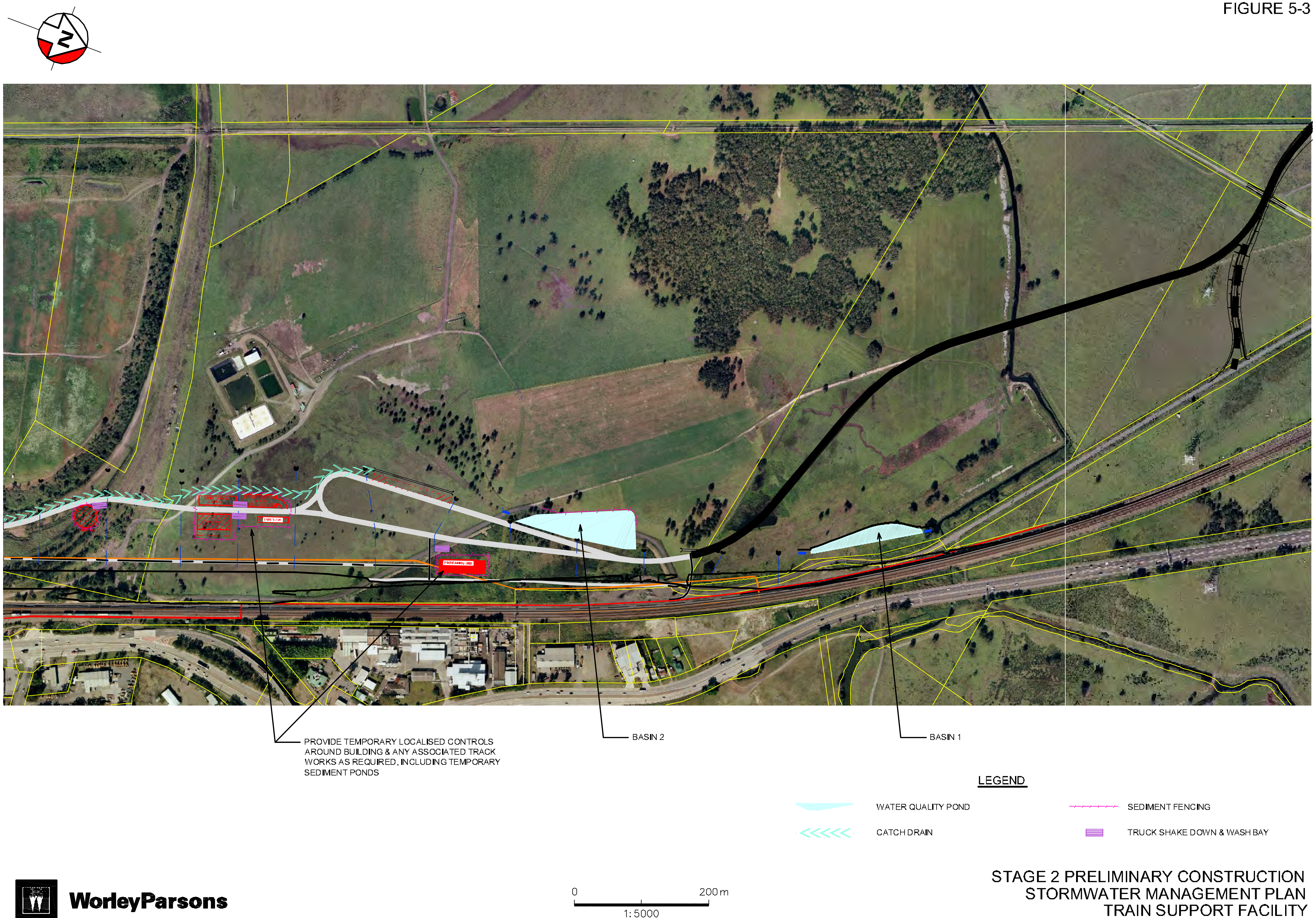
STAGE 2 PRELIMINARY CONSTRUCTION
STORMWATER MANAGEMENT PLAN
TRAIN SUPPORT FACILITY
SHEET 1 OF 2

O:\301020\03465 – QR TSF (GS)\12.0 Drawings\12.01 Civil Infrastructure\CAD\STORMWATER FIGURES\FIG 5-2_5-3 PRLIM CONSTRUCT SWMP TRAIN FACILITY.dwg 23/08/2012



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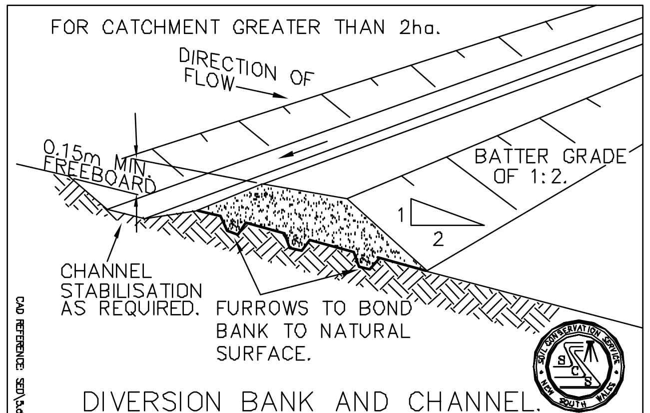
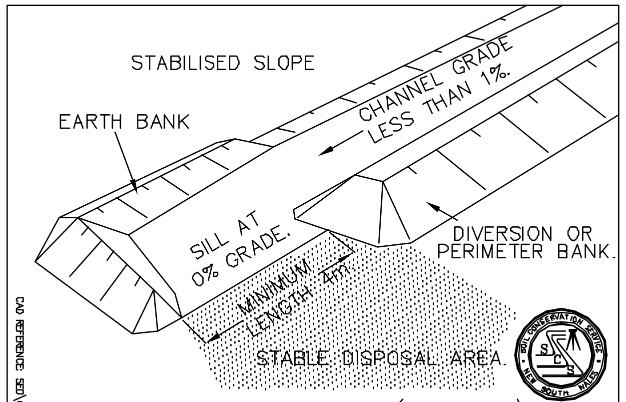
STAGE 2 PRELIMINARY CONSTRUCTION
STORMWATER MANAGEMENT PLAN
TRAIN SUPPORT FACILITY
SHEET 2 OF 2

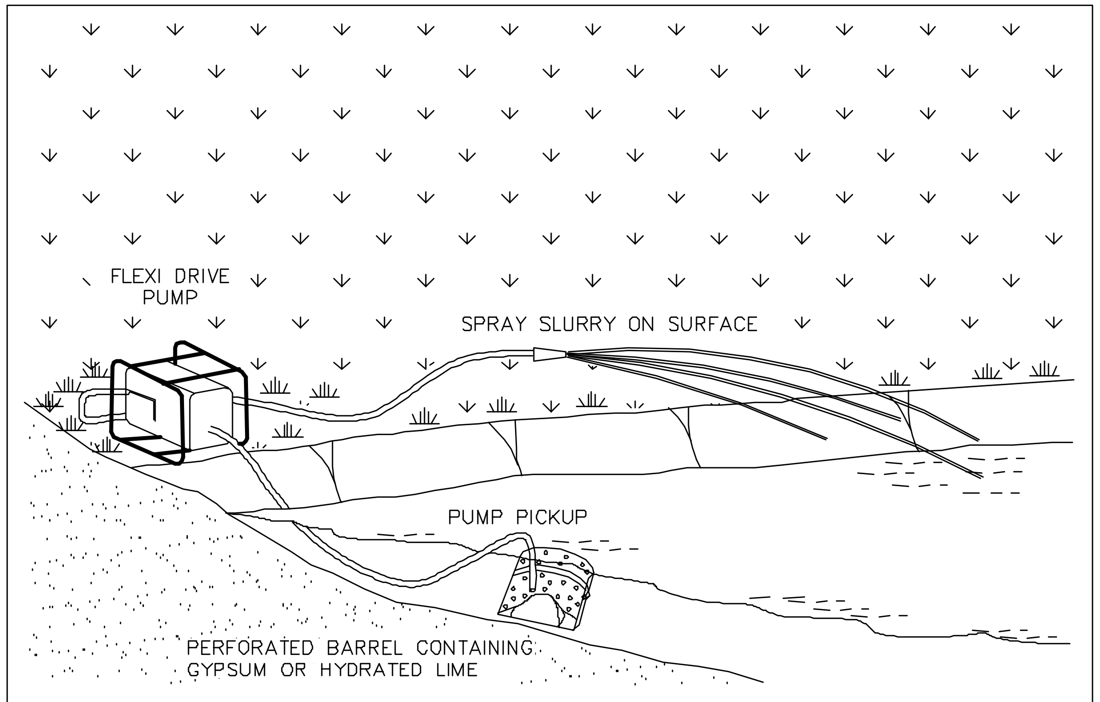
O:\301020\03465 – QR TSF (GS)\12.0 Drawings\12.01 Civil Infrastructure\CAD\STORMWATER FIGURES\FIG 5-2_5-3 PRLIM CONSTRUCT SWMP TRAIN FACILITY.dwg 23/08/2012



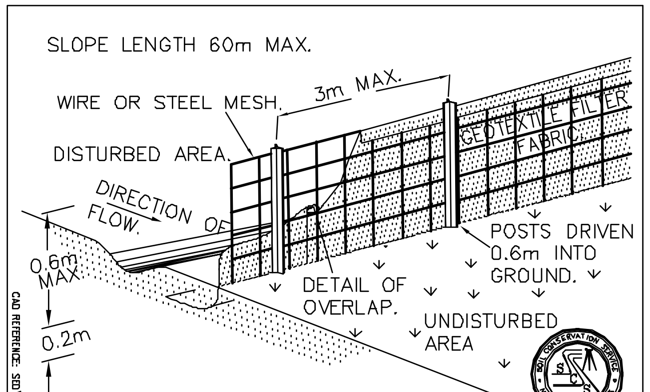
DIVERSION BANK AND CHANNEL.



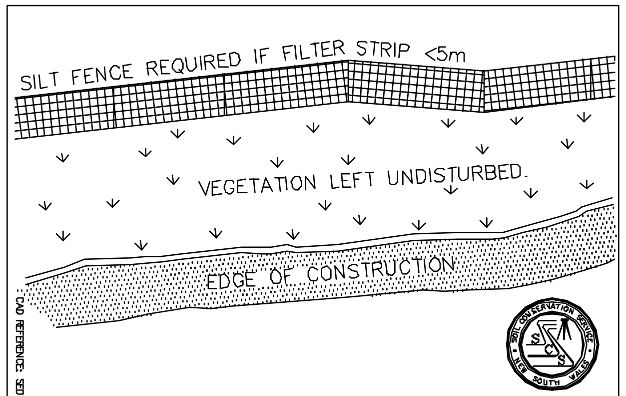
LEVEL SPREADER (OR SILL)



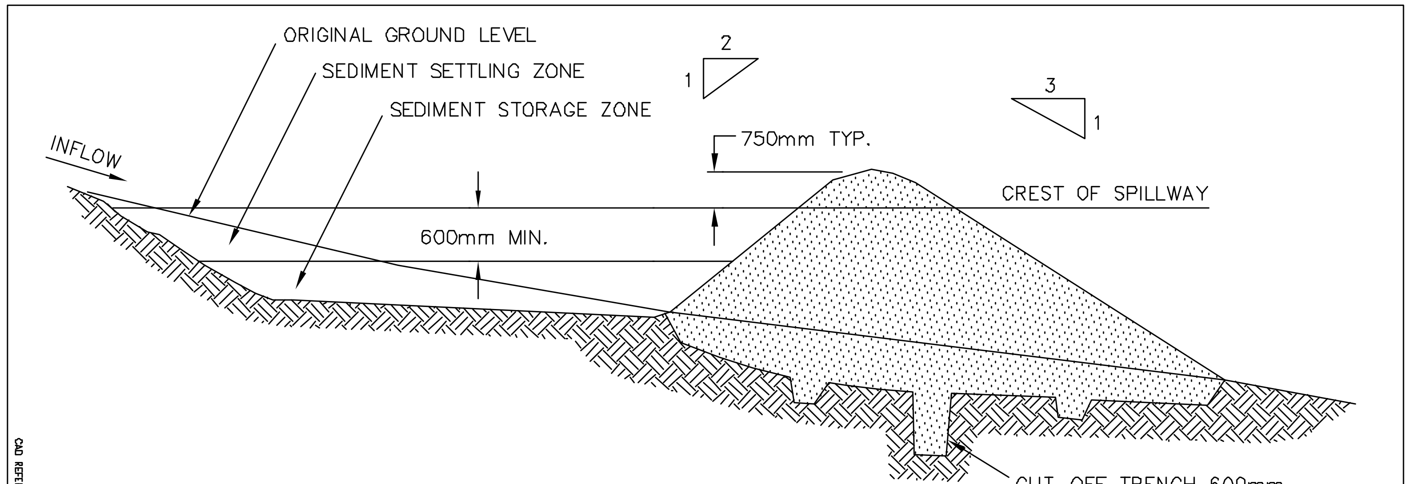
DOSING OF SEDIMENT PONDS



SEDIMENT FENCE

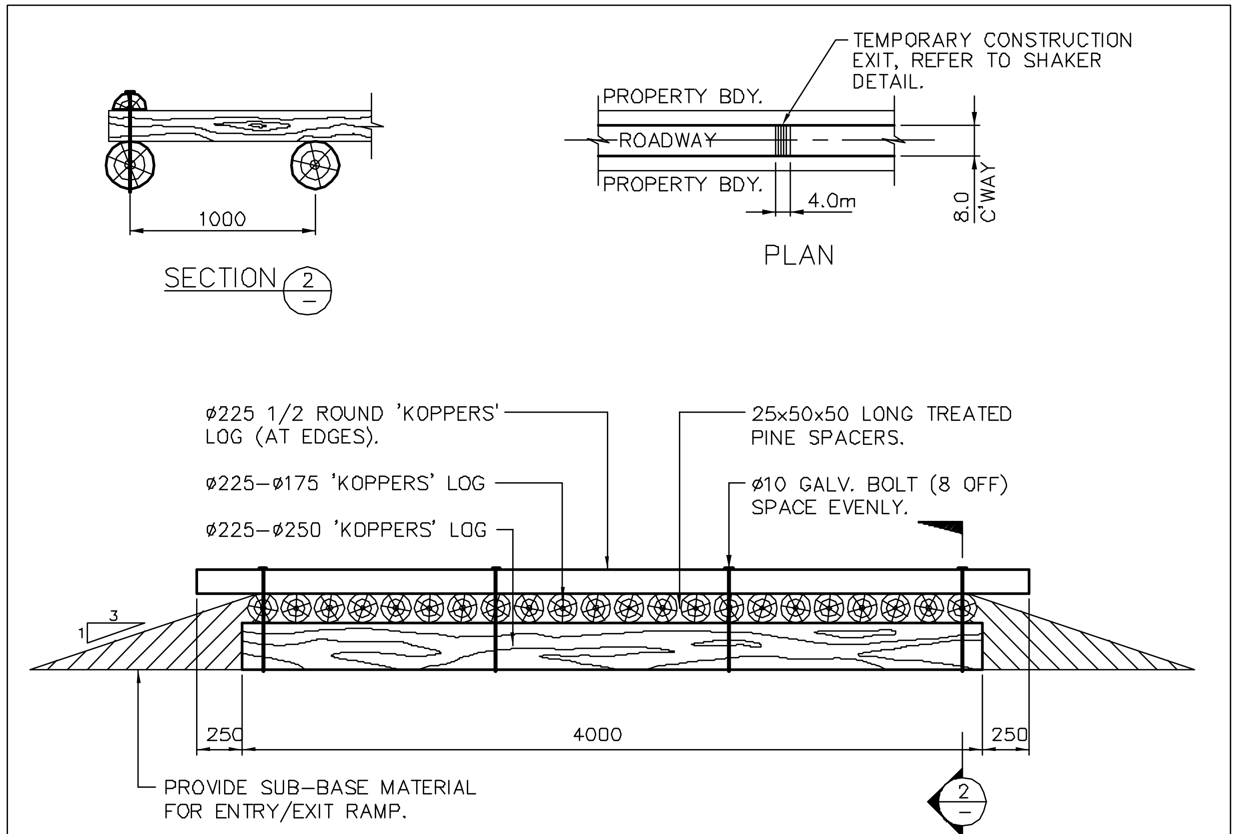


VEGETATIVE FILTER STRIP.



- VOLUME DETAIL IN REPORT
- FLOCCULATION (WITH GYPSUM) MAY BE REQUIRED
- pH ADJUSTMENT MAY BE REQUIRED
- LENGTH / WIDTH RATIO 3:1 MIN

CROSS SECTION
SEDIMENT BASIN



SAMPLE SHAKER DETAIL

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EROSION & SEDIMENT CONTROL DETAILS

Appendix A Drains Stormwater Modelling Results

INPUT DATA - EXISTING

PIT / NODE DETAILS Version 10

Name	Type	Family	Size	Ponding Volume (cu.m)	Pressure Change Coeff. Ku	Surface Elev (m)	Max Pond Depth (m)	Base Inflow (cu.m/s)	Blocking Factor	x	y	Bolt-down lid	id	Part Full Shock Loss	Inflow Hydrograph
N59	Node					0.625		0		-18.896	-460.106		170		
N7	Node					0.2		0		-413.295	-221.642		196		
n1	Node					2		0		265.187	-115.888		182		
out-hunter	Node					1		0		611.893	198.884		193		
Out-smithy	Node					1.2		0		621.846	-1403.594		244		
N202	Node					0.6		0		649.218	-1786.795		247		
N134	Node					10		0		263.528	-609.82		485		
out-SWAM	Node					0.8		0		-453.108	-779.025		228		
n6	Node					2		0		936.868	-1195.072		575		

DETENTION BASIN DETAILS

Name	Elev	Surf. Area	Init Vol. (cu	Outlet Type	K	Dia(mm)	Centre RL	Pit Family	Pit Type	x	y	HED	Crest RL	Crest Leng	id
n3	0.6	1000	0	Culvert	0.5					248.598	-507.798	No			156
	1	15000													
n2	0	1000	0	None						253.575	-291.315	No			198
	0.2	16000													
	1	16500													
Swale 4	1.2	786	0	Culvert	0.5					832.955	-654.012	No			546
	1.6	5145													
	1.7	6000													
Swale 5	1	3010	0	Culvert	0.5					230.981	-822.422	No			553
	1.6	13903													

SUB-CATCHMENT DETAILS

Name	Pit or Node	Total Area (ha)	Paved Area %	Grass Area %	Supp Area %	Paved Time (min)	Grass Time (min)	Supp Time (min)	Paved Length (m)	Grass Length (m)	Supp Length (m)	Paved Slope(%) %	Grass Slope %	Supp Slope %	Paved Rough	Grass Rough	Supp Rough	Lag Time or Factor	Gutter Length (m)
c3	n3	30.5	6	94	0	0	0	0	10	300	0	0.5	0.5	0	0.02	0.1	0	0	
c7	N7	280	0	100	0	0	0	0	0	1400	0	0	0.5	0	0.02	0.1	0	0	
c1	n1	30.3	0	100	0	0	0	0	0	250	0	0	0.5	0	0.02	0.1	0	0	
c2	n2	22.4	2	98	0	0	0	0	10	500	0	1	0.5	0	0.02	0.1	0	0	
Cat163	Swale 4	45.75	6	94	0	0	0	0	0	250	0	1	3	0	0.013	0.1	0	0	
C5	Swale 5	21.12	5	95	0	0	0	0	10	140	0	1	5	0	0.03	0.1	0	0	
c6	n6	32	9	91	0	0	0	0	10	500	0	1	0.5	0	0.03	0.1	0	0	

PIPE DETAILS

Name	From	To	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Type	Dia (mm)	I.D. (mm)	Rough	Pipe Is	No. Pipes	Chg From	At Chg	Chg (m)	Rl (m)	Chg (m)	RL (m)	etc (m)
p3.7	n3	N59	10	0.6	0.59	0.1	Concrete, r	900	900	0.013	NewFixed	2	n3	0					
culvert	n1	out-hunter	40	0.4	0	1	Box culvert	2.7W x 1.5H		0.013	Existing	1	n1	0					
p4-5	Swale 4	Swale 5	5	1.2	1.15	1	Concrete, r	900	900	0.013	NewFixed	2	Swale 4	0					
p3-out1	Swale 5	out-SWAM	10	1	0.8	2	Concrete, r	600	600	0.013	NewFixed	4	Swale 5	0					

DETAILS of SERVICES CROSSING PIPES

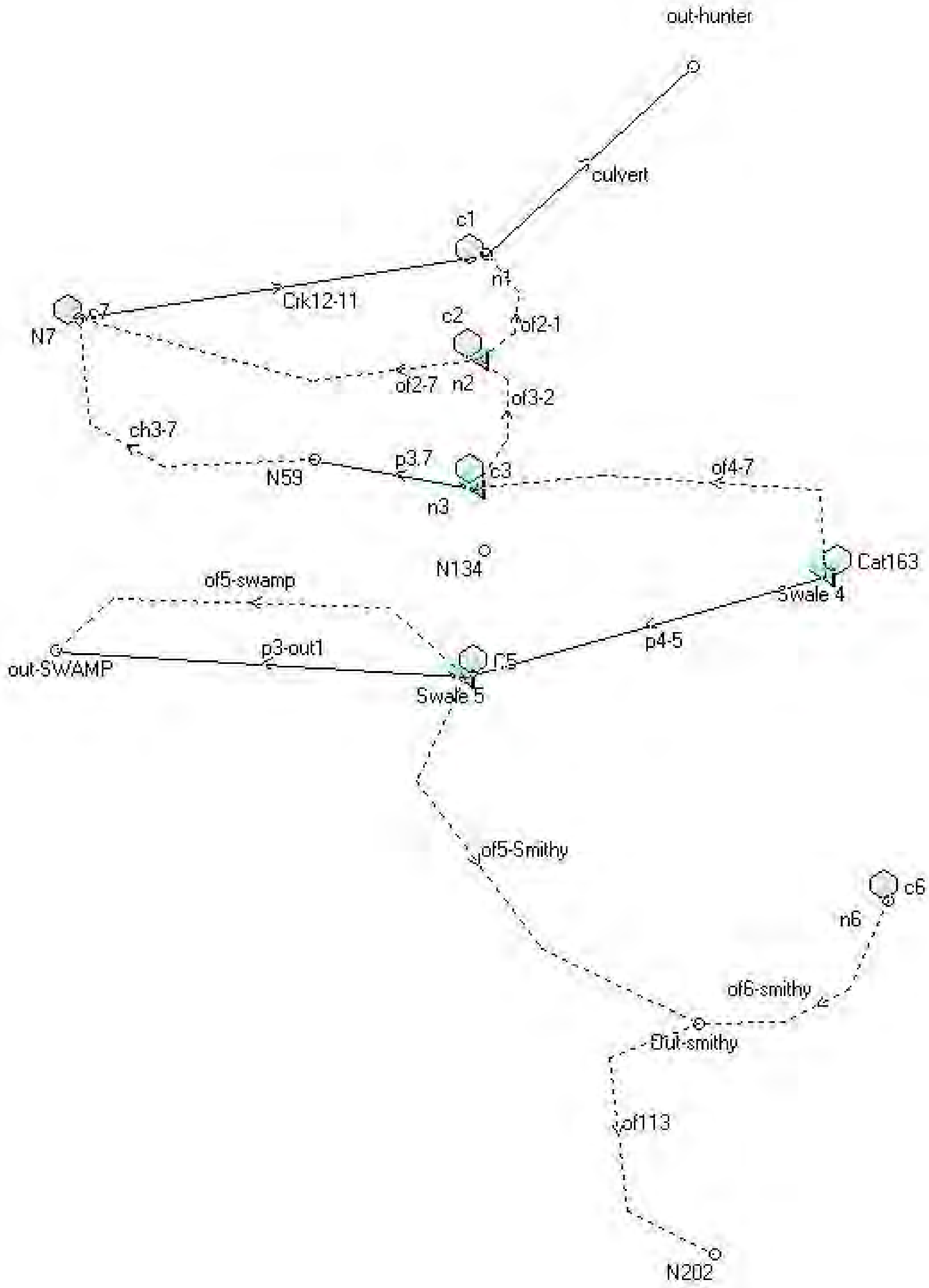
Pipe	Chg (m)	Bottom Elev (m)	Height of S (m)	Chg (m)	Bottom Elev (m)	Height of S (m)	Chg (m)	Bottom Elev (m)	Height of S (m)	etc etc

CHANNEL DETAILS

Name	From	To	Type	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Base Widtl (m)	L.B. Slope (1:?)	R.B. Slope (1:?)	Manning n	Depth (m)	Roofed
Crk12-11	N7	n1	Irregular	600	0.061	0.01							

OVERFLOW ROUTE DETAILS

Name	From	To	Travel Time (min)	Spill Level (m)	Crest Length (m)	Weir Coeff. C	Cross Section	Safe Deptl Major Storr (m)	SafeDepth Minor Storr (m)	Safe DxV (sq.m/sec)	Bed Slope (%)	D/S Area Contributing %		id
of3-2	n3	n2	5	0.75	10	2	10m path	0.3	0.3	0.6	0.1	0		202
ch3-7	N59	N7	20				10m path	0.3	0.3	0.6	1	0		210
of2-7	n2	N7	1	0.2	4	2	4m path	0.3	0.3	0.6	1	0		212
of2-1	n2	n1	5	0.6	10	2	10m path	0.3	0.3	0.6	0.1	0		205
of113	Out-smithy	N202	1				4m path	0.3	0.3	0.6	1	0		254
of4-7	Swale 4	n3	10	1.55	10	2	10m path	0.3	0.3	0.6	1	0		548
of5-swamp	Swale 5	out-SWAM	1	2	100	2	HWC track	0.3	0.3	0.6	1	0		231
of5-Smithy	Swale 5	Out-smithy	1	1.3	10	2	10m path	0.3	0.3	0.6	1	0		252
of6-smithy	n6	Out-smithy	1				10m path	0.3	0.3	0.6	1	0		577


out-hunter
culvert
c1
n1
Crk12-11
c7
N7
c2
of2-1
of2-7
n2
of3-2
ch3-7
p3.7
c3
N59
n3
of4-7
Cat163
Swale 4
N134
of5-swamp
p4-5
p3-out1
out-SWAMP
C5
Swale 5
of5-Smithy
c6
n6
of6-smithy
Out-smithy
of113
N202

Existing 1yr ARI

PIT / NODE DETAILS				Version 8			
Name	Max HGL	Max Pond HGL	Max Surfac Flow Arrivi (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
N59	0.71		0				
N7	1.02		5.706				
n1	1.02		5.034				
out-hunter	1		0				
out-SWAM	0.93		0				

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
c3	0.362	0.362	0.006	4.22	85.3	0	AR&R 1 year, 2 hours storm, average 16.5 mm/h, Zone 1
c7	0.838	0	0.838	0	335.79	0	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
c1	0.254	0	0.254	0	119.44	0	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
c2	0.13	0.027	0.122	5.35	181.04	0	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
Cat163	0.647	0.168	0.591	0	69.78	0	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
C5	0.427	0.065	0.404	6.83	42.27	0	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
c6	0.57	0.57	0.004	4.37	115.89	0	AR&R 1 year, 2 hours storm, average 16.5 mm/h, Zone 1

Outflow Volumes for Total Catchment (8.96 impervious + 453 pervious = 462 total ha)

Storm	Total Rainf cu.m	Total Runo cu.m (Runc	Impervious cu.m (Runc	Pervious Runoff cu.m (Runoff %)
AR&R 1 ye	116441.6	1988.89 (1	1988.89 (8	0.00 (0.0%)
AR&R 1 ye	152483.1	2708.12 (1	2687.69 (9	20.42 (0.0%)
AR&R 1 ye	177434.9	3171.62 (1	3171.62 (9	0.00 (0.0%)
AR&R 1 ye	230665.3	5940.81 (2	4203.50 (9	1737.32 (0.8%)
AR&R 1 ye	268647.5	17188.16 (	4939.63 (9	12248.53 (4.6%)
AR&R 1 ye	299975.8	20791.27 (	5549.29 (9	15241.98 (5.2%)
AR&R 1 ye	355147	16649.31 (	6616.06 (9	10033.25 (2.9%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
p3.7	0.099	0.62	0.792	0.756	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
culvert	1.164	0.7	1.02	1	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
p4-5	0.338	1.79	1.386	1.336	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
p3-out1	0.372	2	1.133	0.933	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)			Due to Storm
Crk12-11	0.92	-1.#J			AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1

OVERFLOW ROUTE DETAILS

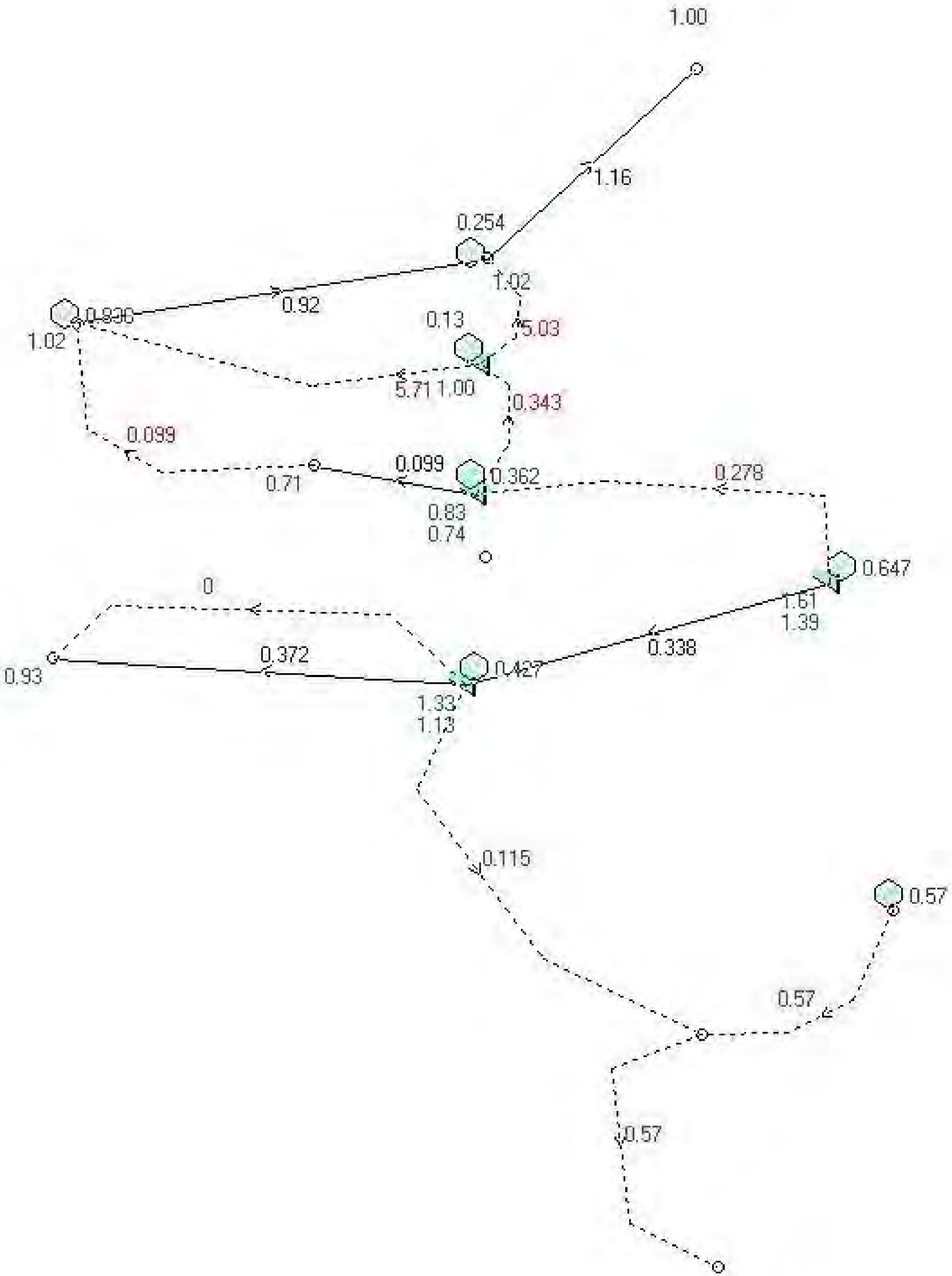
Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
of3-2	0.343	0.343	0.136	0.532	0.03	10	0.06	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
ch3-7	0.099	0.099	0.431	0.123	0.01	10	0.08	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
of2-7	5.706	5.706	0.163	1	1.43	4	1.43	AR&R 1 year, 1 hour storm, average 25.2 mm/h, Zone 1
of2-1	5.034	5.034	0.136	1	0.5	10	0.5	AR&R 1 year, 1 hour storm, average 25.2 mm/h, Zone 1
of113	0.57	0.57	0.163	0.675	0.14	4	0.21	AR&R 1 year, 2 hours storm, average 16.5 mm/h, Zone 1
of4-7	0.278	0.278	0.431	0.229	0.03	10	0.12	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
of5-swamp	0	0	44.636	0	0	0	0	
of5-Smithy	0.115	0.115	0.431	0.134	0.01	10	0.09	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
of6-smithy	0.57	0.57	0.431	0.356	0.06	10	0.16	AR&R 1 year, 2 hours storm, average 16.5 mm/h, Zone 1

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
n3	0.83	801.2	0.443	0.099	0.343
n2	1	14383.5	10.74	0	10.74
Swale 4	1.61	1099.2	0.616	0.338	0.278
Swale 5	1.33	1769.7	0.486	0.372	0.115

CONTINUITY CHECK for AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Ch (cu.m)	Difference %
n3	3261.33	3190.73	70.47	0
N59	1489.76	1489.76	0	0
N7	8958.39	8963.5	0	-0.1
n1	10580.8	10587.97	0	-0.1
out-hunter	10587.97	10587.97	0	0
n2	2866.48	1365.59	-12868.21	501.3
Out-smithy	3249.62	3249.46	0	0
N202	3249.46	3249.46	0	0
N134	0	0	0	0
Swale 4	4354.3	4326.47	28.21	0
Swale 5	5649.57	5491.91	157.81	0
out-SWAM	5203.69	5203.69	0	0
n6	2961.41	2961.41	0	0



1.00
1.16
0.254
1.02
0.92
0.836
1.02
0.13
5.03
5.71
1.00
0.343
0.099
0.099
0.362
0.278
0.71
0.83
0.74
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0
1.61
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0.372
0.338
0.427
0.93
1.33
1.13
0.115
0.57
0.57
0.57

Existing 10yr

PIT / NODE DETAILS				Version 8			
Name	Max HGL	Max Pond HGL	Max Surfac Flow Arrivi (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
N59	0.97		0				
N7	1.71		10.247				
n1	1.29		12.428				
out-hunter	0.89		0				
out-SWAM	1.02		0				

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
c3	1.97	0.214	1.835	4.73	95.63	0	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
c7	8.804	0	8.804	0	258.54	0	AR&R 10 year, 12 hours storm, average 10.4 mm/h, Zone 1
c1	2.18	0	2.18	0	59.26	0	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
c2	1.173	0.052	1.158	3.84	129.92	0	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
Cat163	4.856	1.028	4.633	0	34.62	0	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
C5	3.241	0.386	3.132	2.87	17.76	0	AR&R 10 year, 1 hour storm, average 47.3 mm/h, Zone 1
c6	1.684	1.053	1.248	2.87	76.05	0	AR&R 10 year, 1 hour storm, average 47.3 mm/h, Zone 1

Outflow Volumes for Total Catchment (8.96 impervious + 453 pervious = 462 total ha)

Storm	Total Rainf cu.m	Total Runo cu.m (Runc	Impervious cu.m (Runc	Pervious Runoff cu.m (Runoff %)
AR&R 10 y	288331.7	114716.17	5321.62 (9	109394.55 (38.7%)
AR&R 10 y	338235.3	142037.43	6288.85 (9	135748.58 (40.9%)
AR&R 10 y	395069.8	164284.83	7390.52 (9	156894.31 (40.5%)
AR&R 10 y	515670.1	202807.98	9729.85 (9	193078.13 (38.2%)
AR&R 10 y	576663.4	219793.92	10914.00 (	208879.92 (36.9%)
AR&R 10 y	688669.2	244806.73	13086.87 (	231719.86 (34.3%)
AR&R 10 y	218559.1	73297.33 (	3968.83 (9	69328.50 (32.3%)
AR&R 10 y	778495.6	242097.34	14826.57 (	227270.77 (29.8%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
p3.7	0.855	1.07	1.219	1.132	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
culvert	12.252	5.08	1.293	0.893	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
p4-5	1.164	2.17	1.595	1.566	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
p3-out1	0.964	2.63	1.216	1.017	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm
Crk12-11	10.185	-1.#J	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
of3-2	1.94	1.94	0.136	1	0.19	10	0.19	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
ch3-7	0.855	0.855	0.431	0.457	0.09	10	0.19	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
of2-7	0.905	0.905	0.163	0.922	0.23	4	0.25	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
of2-1	1.891	1.891	0.136	1	0.19	10	0.19	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
of113	3.041	3.041	0.163	1	0.76	4	0.76	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
of4-7	2.422	2.422	0.431	0.881	0.24	10	0.27	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
of5-swamp	0	0	44.636	0	0	0	0	
of5-Smithy	1.436	1.436	0.431	0.632	0.14	10	0.23	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
of6-smithy	1.684	1.684	0.431	0.7	0.17	10	0.24	AR&R 10 year, 1 hour storm, average 47.3 mm/h, Zone 1

DETENTION BASIN DETAILS

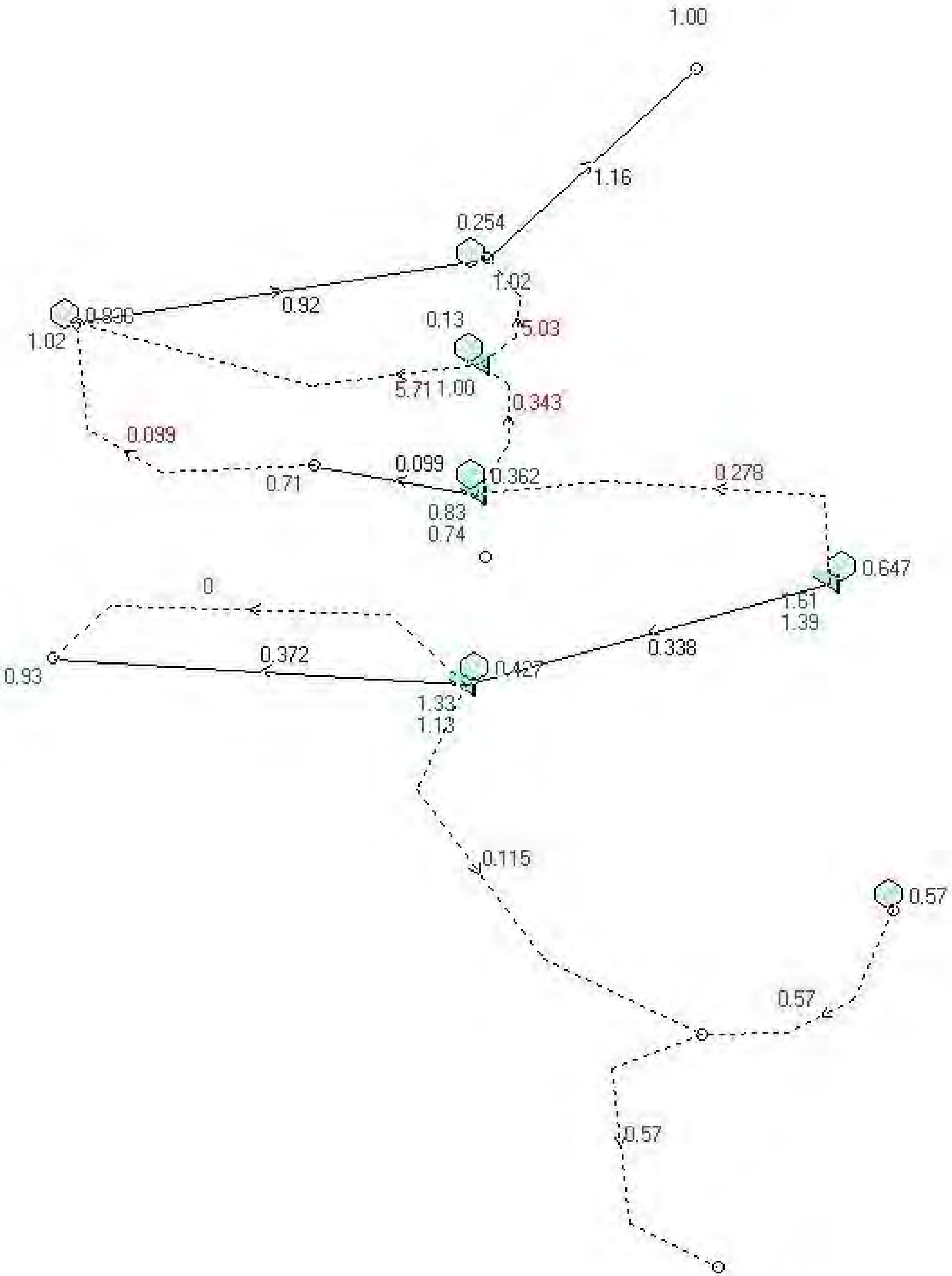
Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
n3	1.31	0	2.796	0.855	1.94
n2	0.81	0	2.796	0	2.796
Swale 4	2	0	3.586	1.164	2.422
Swale 5	1.57	0	2.399	0.964	1.436

CONTINUITY CHECK for AR&R 10 year, 1 hour storm, average 47.3 mm/h, Zone 1

Node	Inflow	Outflow	Storage Ch	Difference
	(cu.m)	(cu.m)	(cu.m)	%
n3	11522.33	10332.71	1190.01	0
N59	2858.23	2858.01	0	0
N7	43647.85	34781.63	0	20.3
n1	40362.72	32368.92	0	19.8
out-hunter	32368.92	32368.92	0	0
n2	11245.08	3118.01	8127.16	0
Out-smithy	9341.71	9341.7	0	0
N202	9341.7	9341.7	0	0
N134	0	0	0	0
Swale 4	9369.62	9101.85	267.76	0
Swale 5	7854.07	6673.92	1180.17	0
out-SWAM	3538.5	3538.5	0	0
n6	6206.3	6206.3	0	0

Run Log for QR Hexham A run at 12:09:02 on 30/5/2012

The maximum flow exceeded the safe value in the following overflow routes: of6-smithy, of4-7, of113, of5-Smithy, of2-7, ch3-7, of2-1, of3-2



1.00
1.16
0.254
1.02
0.92
0.836
1.02
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5.71 1.00
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0.099
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0.647
0
1.61
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0.372
0.338
0.93
0.427
1.33
1.13
0.115
0.57
0.57
0.57

INPUT - DEVELOPED CASE

PIT / NODE DETAILS Version 10

Name	Type	Family	Size	Ponding Volume (cu.m)	Pressure Change Coeff. Ku	Surface Elev (m)	Max Pond Depth (m)	Base Inflow (cu.m/s)	Blocking Factor	x	y	Bolt-down lid	id	Part Full Shock Los	Inflow Hydrograph
n102.5	Node					1.25		0		2048.483	-640.509		1		
n102.4	Node					1.24		0		1834.902	-640.509		2		
n102.3	Node					1.2		0		1642.058	-642.582		3		
n102.2	Node					1.23		0		1420.182	-636.362		7		
n102.1	Node					1.22		0		1192.086	-632.214		8		
n102	Node					1.21		0		974.358	-632.214		9		
N59	Node					0.625		0		-18.896	-460.106		170		
n101.5	Node					1.2		0		2067.146	-883.12		41		
n101.4	Node					1.2		0		1870.154	-887.267		49		
n101.3	Node					1.2		0		1662.794	-872.752		50		
n101.2	Node					1.2		0		1453.36	-876.899		51		
n101.1	Node					1.2		0		1202.454	-881.046		52		
n101.0	Node					1.2		0		980.579	-866.531		53		
N258	Node					1.2		0		920.445	-1438.43		258		
N7	Node					0.2		0		-413.295	-221.642		196		
n1	Node					2		0		265.187	-115.888		182		
out-hunter	Node					1		0		611.893	198.884		193		
n6	Node					2		0		233.668	-1134.86		241		
out-SWAM	Node					0.8		0		-453.108	-779.025		228		
Out-smithy	Node					1.2		0		621.846	-1403.59		244		
N202	Node					0.6		0		649.218	-1786.8		247		
N267	Node					0.6		0		679.078	-2075.44		250		
N103	Node					2		0		969.116	141.454		276		
N100	Node					4.8		0		728.844	-871.093		320		
N101	Node					5		0		1243.926	-1072.65		328		
N107	Node					6.8		0		1495.247	-1119.93		340		
N110	Node					11.4		0		1761.497	-1147.3		354		
N113	Node					11.4		0		1980.469	-1132.37		361		
N115	Node					5		0		2137.233	-1114.95		385		
N122	Node					10.2		0		2101.401	-277.778		420		
N125	Node					10.2		0		1864.632	-290.248		430		
N128	Node					10.2		0		1627.128	-301.268		438		
N147	Node					2		0		653.796	-1159.24		555		

DETENTION BASIN DETAILS

Name	Elev	Surf. Area	Init Vol. (cu	Outlet Typ	K	Dia(mm)	Centre RL	Pit Family	Pit Type	x	y	HED	Crest RL	Crest Leng	id
Basin2	0.6	6300	0	Culvert	0.5					881.046	-447.664	No			150
	1.2	6830													
	1.3	7500													
n3	0.6	1000	0	Culvert	0.5					248.598	-507.798	No			156
	1	15000													
	1.1	15000													
basin3	0.6	1	0	Culvert	0.5					950.305	-1080.11	No			264
	0.61	6142													
	0.9	6359													
	1.2	6562													
	1.3	7000													
n2	0	1000	0	None						253.575	-291.315	No			198
	0.2	16000													
	1	16500													
wetland 2	1	3000	0	Culvert	0.5					96.811	-793.955	No			216
	2	3000													
	2.1	4000													
Basin1	0.6	1910	0	Culvert	0.5					866.531	-93.078	No			174
	1.2	2187													
	1.3	3000													

SUB-CATCHMENT DETAILS

Name	Pit or Node	Total Area (ha)	Paved Area %	Grass Area %	Supp Area %	Paved Time (min)	Grass Time (min)	Supp Time (min)	Paved Length (m)	Grass Length (m)	Supp Length (m)	Paved Slope(%) %	Grass Slope %	Supp Slope %	Paved Rough	Grass Rough
c102.5	n102.5	2.39	50	50	0	0	0	0	50	50	0	0.5	0.5	0	0.02	0.1
c102.4	n102.4	3.25	50	50	0	0	0	0	50	50	0	0.5	0.5	0	0.02	0.1
c102.3	n102.3	3.45	50	50	0	0	0	0	50	50	0	0.5	0.5	0	0.02	0.1
c102.2	n102.2	3.18	50	50	0	0	0	0	50	50	0	0.5	0.5	0	0.02	0.1
c102.1	n102.1	3.53	50	50	0	0	0	0	50	50	0	0.5	0.5	0	0.02	0.1
c102	n102	3.01	50	50	0	0	0	0	50	50	0	0.5	0.5	0	0.02	0.1
c3	n3	30.5	6	94	0	0	0	0	10	300	0	0.5	0.5	0	0.02	0.1
c101.5	n101.5	1.96	50	50	0	0	0	0	50	50	0	0.5	0.5	0	0.02	0.1
c101.4	n101.4	1.74	50	50	0	0	0	0	50	50	0	0.5	0.5	0	0.02	0.1
c101.3	n101.3	1.8	50	50	0	0	0	0	50	50	0	0.5	0.5	0	0.02	0.1
c101.2	n101.2	1.66	50	50	0	0	0	0	50	50	0	0.5	0.5	0	0.02	0.1
c101.1	n101.1	1.7	50	50	0	0	0	0	50	50	0	0.5	0.5	0	0.02	0.1
c101	n101.0	4.27	50	50	0	0	0	0	50	50	0	0.5	0.5	0	0.02	0.1
c7	N7	280	0	100	0	0	0	0	0	1400	0	0	0.5	0	0.02	0.1
c1	n1	30.3	0	100	0	0	0	0	0	250	0	0	0.5	0	0.02	0.1
c2	n2	22.4	2	98	0	0	0	0	10	500	0	1	0.5	0	0.02	0.1
c5	wetland 2	18.05	6	94	0	0	0	0	178	261	0	0.5	2	0	0.02	0.1
c103	N103	7.7	50	50	0	0	0	0	50	50	0	0.5	0.5	0	0.02	0.1
Cat73	N100	5.58	4	96	0	0	0	0	47	25	0	1	1	0	0.02	0.1
Cat82	N101	1.98	4	96	0	0	0	0	20	234	0	1	1	0	0.02	0.1
Cat88	N107	2.31	4	96	0	0	0	0	25	240	0	1.58	1.58	0	0.02	0.1
Cat91	N110	2.93	4	96	0	0	0	0	25	330	0	2.18	2.18	0	0.02	0.1
Cat93	N113	3.59	4	96	0	0	0	0	25	346	0	2.1	2.1	0	0.02	0.1
Cat97	N115	6.7	4	96	0	0	0	0	20	414	0	2.27	2.27	0	0.02	0.1
Cat117	N122	3.44	4	96	0	0	0	0	20	414	0	2.27	2.27	0	0.02	0.1
Cat119	N125	4.094	4	96	0	0	0	0	20	414	0	2.27	2.27	0	0.02	0.1
Cat124	N128	7.56	4	96	0	0	0	0	20	336	0	2.38	2.38	0	0.02	0.1
C6	N147	18.6	9	91	0	0	0	0	25	360	0	1	1	0	0.02	0.1

PIPE DETAILS

Name	From	To	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Type	Dia (mm)	I.D. (mm)	Rough	Pipe Is	No. Pipes	Chg From	At Chg	Chg (m)	RI (m)
p2.3	Basin2	n3	5	1.01	0.6	8.2	Concrete, r	600	600	0.013	NewFixed	4	Basin2	0		
p3.7	n3	N59	10	0.6	0.59	0.1	Concrete, r	900	900	0.013	NewFixed	2	n3	0		
p3-out	basin3	N258	5	1.01	0.6	8.2	Concrete, r	600	600	0.013	NewFixed	4	basin3	0		
culvert	n1	out-hunter	40	0.4	0	1	Box culver	2.7W x 1.5H		0.013	Existing	1	n1	0		
P5-out	wetland 2	n6	10	1.8	0.9	9	Concrete, r	600	600	0.013	NewFixed	4	wetland 2	0		
p3-1	Basin1	n1	5	1.01	0.6	8.2	Concrete, r	600	600	0.013	NewFixed	4	Basin1	0		

DETAILS of SERVICES CROSSING PIPES

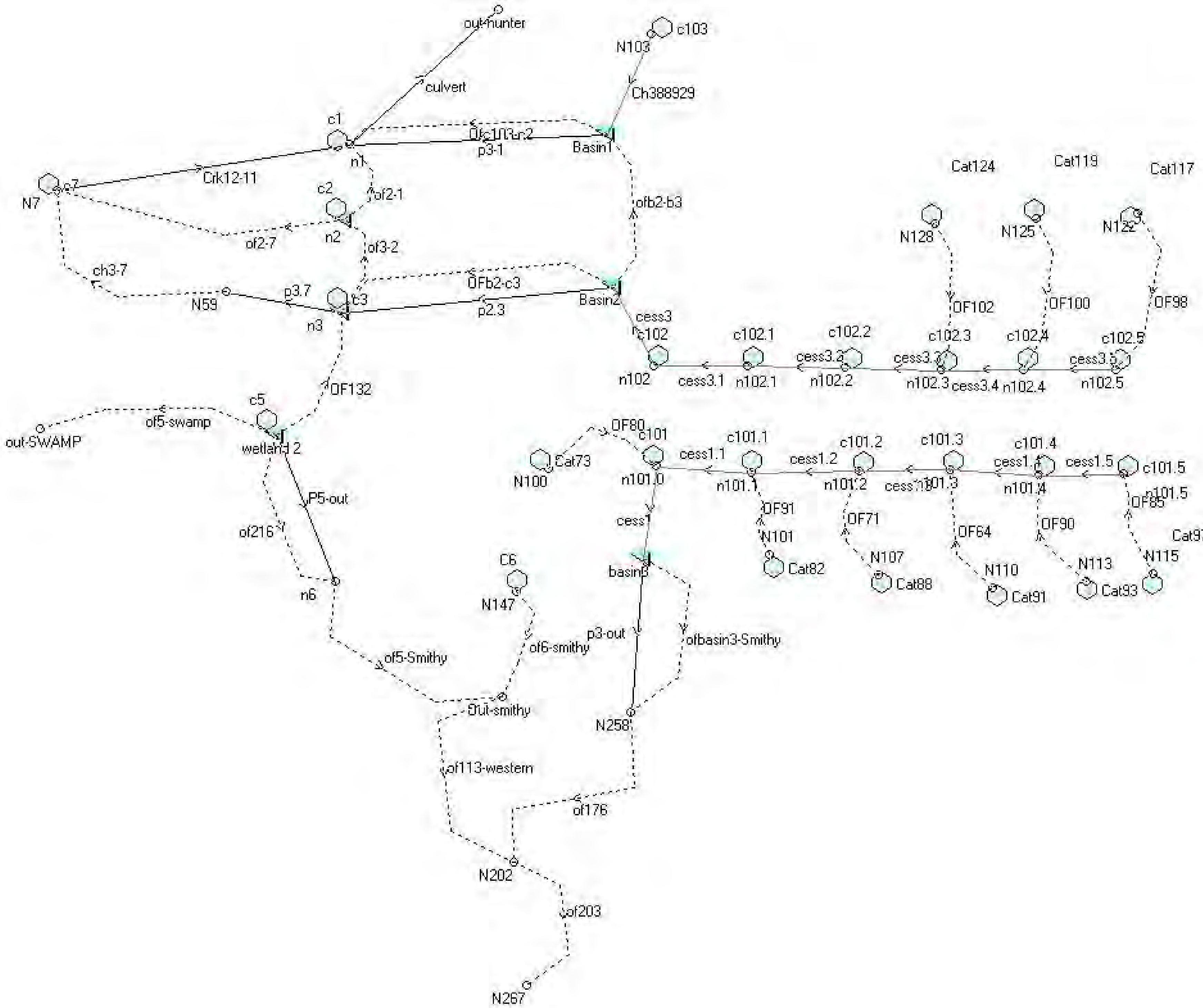
Pipe	Chg (m)	Bottom Elev (m)	Height of S (m)	Chg (m)	Bottom Elev (m)	Height of S (m)	Chg (m)	Bottom Elev (m)	Height of S (m)	etc etc

CHANNEL DETAILS

Name	From	To	Type	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Base Widtl (m)	L.B. Slope (1:?)	R.B. Slope (1:?)	Manning n	Depth (m)	Roofed
cess3.5	n102.5	n102.4	Prismatic	170	1.3	1.25	0.03	2.5	2	2	0.05	1	No
cess3.4	n102.4	n102.3	Prismatic	170	1.25	1.2	0.03	2.5	2	2	0.05	1	No
cess3.3	n102.3	n102.2	Prismatic	170	1.2	1.15	0.03	2.5	2	2	0.05	1	No
cess3.2	n102.2	n102.1	Prismatic	170	1.1	1.15	-0.03	2.5	2	2	0.05	1	No
cess3.1	n102.1	n102	Prismatic	170	1.1	1.05	0.03	2.5	2	2	0.05	1	No
cess3	n102	Basin2	Prismatic	170	1.05	1	0.03	2.5	2	2	0.05	1	No
cess1.5	n101.5	n101.4	Prismatic	130	1.3	1.2	0.08	2.5	2	2	0.05	1	No
cess1.4	n101.4	n101.3	Prismatic	130	1.25	1.2	0.04	2.5	2	2	0.05	1	No
cess1.3	n101.3	n101.2	Prismatic	130	1.2	1.15	0.04	2.5	2	2	0.05	1	No
cess1.2	n101.2	n101.1	Prismatic	130	1.15	1.1	0.04	2.5	2	2	0.05	1	No
cess1.1	n101.1	n101.0	Prismatic	130	1.1	1.05	0.04	2.5	2	2	0.05	1	No
cess1	n101.0	basin3	Prismatic	130	1.05	1	0.04	2.5	2	2	0.05	1	No
Crk12-11	N7	n1	Irregular	600	0.061	0.01							
Ch388929	N103	Basin1	Prismatic	600	1.05	1	0.01	2.5	2	2	0.05	0.35	No

OVERFLOW ROUTE DETAILS

Name	From	To	Travel Time (min)	Spill Level (m)	Crest Length (m)	Weir Coeff. C	Cross Section	Safe Depth Major Stor (m)	SafeDepth Minor Stor (m)	Safe DxV (sq.m/sec)	Bed Slope (%)	D/S Area Contributing %	id
ofb2-b3	Basin2	Basin1	1	1.2	2.5	2	cess drain	0.3	0.3	0.6	0.5	0	177
OFb2-c3	Basin2	n3	10	1.19	20	2	20m spillwa	0.2	0.05	0.6	5	0	155
of3-2	n3	n2	5	0.75	10	2	10m path	0.3	0.3	0.6	0.1	0	202
ch3-7	N59	N7	20				10m path	0.3	0.3	0.6	1	0	210
ofbasin3-S	basin3	N258	5	1.2	20	2	20m spillwa	0.3	0.3	0.6	1	0	269
of176	N258	N202	5				Dummy us	0.3	0.3	0.6	1	0	261
of2-7	n2	N7	1	0.2	4	2	4m path	0.3	0.3	0.6	1	0	212
of2-1	n2	n1	5	0.6	10	2	10m path	0.3	0.3	0.6	0.1	0	205
OF132	wetland 2	n3	10	2	80	2	HWC track	0.3	0.3	0.6	1	0	545
of216	wetland 2	n6	1	1.9	40	2.2	20m spillwa	0.3	0.3	0.6	1	0	240
of5-swamp	wetland 2	out-SWAM	1	1.9	100	2	HWC track	0.3	0.3	0.6	1	0	231
of5-Smithy	n6	Out-smithy	1				10m path	0.3	0.3	0.6	1	0	252
of113-west	Out-smithy	N202	5				10m path	0.3	0.3	0.6	1	0	254
of203	N202	N267	1				HWC track	0.3	0.3	0.6	1	0	256
Ofc103-c2	Basin1	n1	10	1.19	20	2	20m spillwa	0.3	0.3	0.6	1	0	184
OF80	N100	n101.0	10				20m spillwa	0.3	0.3	0.6	1	0	372
OF91	N101	n101.1	10				20m spillwa	0.3	0.3	0.6	1	0	393
OF71	N107	n101.2	10				20m spillwa	0.3	0.3	0.6	1	0	356
OF64	N110	n101.3	10				20m spillwa	0.3	0.3	0.6	1	0	344
OF90	N113	n101.4	10				20m spillwa	0.3	0.3	0.6	1	0	389
OF85	N115	n101.5	10				20m spillwa	0.3	0.3	0.6	1	0	380
OF98	N122	n102.5	10				20m spillwa	0.3	0.3	0.6	1	0	424
OF100	N125	n102.4	10				20m spillwa	0.3	0.3	0.6	1	0	432
OF102	N128	n102.3	10				cess drain	0.3	0.3	0.6	1	0	440
of6-smithy	N147	Out-smithy	1				10m path	0.3	0.3	0.6	1	0	564



out-hunter
c103
N103
culvert
Ch388929
c1
Ofc103-n2
p3-1
Basin1
n1
N7
c7
Crk12-11
c2
of2-1
ofb2-b3
Cat124
Cat119
Cat117
of2-7
n2
of3-2
N128
N125
N122
ch3-7
OFb2-c3
p3.7
N59
c3
p2.3
Basin2
n3
cess3
c102
OF102
OF100
OF98
c102.1
c102.2
c102.3
c102.4
c102.5
cess3.2
cess3.3
cess3.5
n102
cess3.1
n102.1
n102.2
n102.3
cess3.4
n102.4
n102.5
OF132
c5
of5-swamp
out-SWAMP
wetland 2
OF80
c101
Cat73
N100
n101.0
c101.1
c101.2
c101.3
c101.4
cess1.1
cess1.2
cess1.4
cess1.5
c101.5
n101.1
n101.2
cess1.3
n101.3
n101.4
n101.5
OF85
P5-out
OF91
OF71
OF64
OF90
Cat97
of216
cess1
N101
N107
N110
N113
N115
basin3
Cat82
Cat88
Cat91
Cat93
C6
n6
N147
p3-out
of6-smithy
ofbasin3-Smithy
of5-Smithy
Out-smithy
N258
of113-western
of176
N202
of203
N267

Developed 1yr ARI

PIT / NODE DETAILS				Version 8			
Name	Max HGL	Max Pond HGL	Max Surfac Flow Arrivi (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
n102.5	1.68		0.207				
n102.4	1.68		0.362				
n102.3	1.66		0.399				
n102.2	1.62		0.353				
n102.1	1.57		0.349				
n102	1.48		0.399				
N59	0.72		0				
n101.5	1.61		0.2				
n101.4	1.6		0.27				
n101.3	1.57		0.26				
n101.2	1.54		0.226				
n101.1	1.5		0.262				
n101.0	1.46		0.455				
N258	0.69		0				
N7	0.61		1.01				
n1	0.55		0.799				
out-hunter	0.15		0				
n6	0.9		0				
N103	1.58		0.604				

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
c102.5	0.187	0.187	0	11.08	29.11	0	AR&R 1 year, 2 hours storm, average 16.5 mm/h, Zone 1
c102.4	0.255	0.255	0	11.08	29.11	0	AR&R 1 year, 2 hours storm, average 16.5 mm/h, Zone 1
c102.3	0.271	0.271	0	11.08	29.11	0	AR&R 1 year, 2 hours storm, average 16.5 mm/h, Zone 1
c102.2	0.249	0.249	0	11.08	29.11	0	AR&R 1 year, 2 hours storm, average 16.5 mm/h, Zone 1
c102.1	0.277	0.277	0	11.08	29.11	0	AR&R 1 year, 2 hours storm, average 16.5 mm/h, Zone 1
c102	0.236	0.236	0	11.08	29.11	0	AR&R 1 year, 2 hours storm, average 16.5 mm/h, Zone 1
c3	0.362	0.362	0.006	4.22	85.3	0	AR&R 1 year, 2 hours storm, average 16.5 mm/h, Zone 1
c101.5	0.154	0.154	0	11.08	29.11	0	AR&R 1 year, 2 hours storm, average 16.5 mm/h, Zone 1
c101.4	0.136	0.136	0	11.08	29.11	0	AR&R 1 year, 2 hours storm, average 16.5 mm/h, Zone 1
c101.3	0.141	0.141	0	11.08	29.11	0	AR&R 1 year, 2 hours storm, average 16.5 mm/h, Zone 1
c101.2	0.13	0.13	0	11.08	29.11	0	AR&R 1 year, 2 hours storm, average 16.5 mm/h, Zone 1
c101.1	0.133	0.133	0	11.08	29.11	0	AR&R 1 year, 2 hours storm, average 16.5 mm/h, Zone 1
c101	0.335	0.335	0	11.08	29.11	0	AR&R 1 year, 2 hours storm, average 16.5 mm/h, Zone 1
c7	0.838	0	0.838	0	335.79	0	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
c1	0.254	0	0.254	0	119.44	0	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
c2	0.13	0.027	0.122	5.35	181.04	0	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
c5	0.229	0.061	0.204	37.09	80.86	0	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
c103	0.604	0.604	0.002	11.08	29.11	0	AR&R 1 year, 2 hours storm, average 16.5 mm/h, Zone 1
Cat73	0.158	0.014	0.148	12.62	22.7	0	AR&R 1 year, 9 hours storm, average 6.46 mm/h, Zone 1
Cat82	0.022	0.005	0.02	8.12	93.24	0	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
Cat88	0.028	0.006	0.026	8.09	82.53	0	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
Cat91	0.033	0.007	0.031	7.34	90.71	0	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
Cat93	0.039	0.009	0.036	7.43	94.38	0	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
Cat97	0.067	0.016	0.062	6.35	102.68	0	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
Cat117	0.034	0.008	0.032	6.35	102.68	0	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
Cat119	0.041	0.01	0.038	6.35	102.68	0	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
Cat124	0.086	0.019	0.08	6.26	89.31	0	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
C6	0.326	0.326	0	5.01	65.25	0	AR&R 1 year, 1 hour storm, average 25.2 mm/h, Zone 1

Outflow Volumes for Total Catchment (26.4 impervious + 451 pervious = 478 total ha)

Storm	Total Rainf	Total Runo	Impervious	Pervious Runoff
	cu.m	cu.m (Runo	cu.m (Runo	cu.m (Runoff %)
AR&R 1 ye	120373.8	5537.49 (4	5537.49 (8	0.00 (0.0%)
AR&R 1 ye	157632.4	7613.71 (4	7595.34 (8	18.37 (0.0%)
AR&R 1 ye	183426.8	9020.12 (4	9020.12 (8	0.00 (0.0%)
AR&R 1 ye	238454.8	13697.43 (	12057.85 (	1639.58 (0.7%)
AR&R 1 ye	277719.7	25881.61 (	14230.20 (	11651.40 (4.4%)
AR&R 1 ye	310106	30413.18 (	16020.23 (	14392.94 (4.9%)
AR&R 1 ye	367140.2	28618.85 (	19168.75 (	9450.10 (2.7%)
AR&R 1 ye	412710.3	26956.14 (	21703.77 (	5252.37 (1.3%)

PIPE DETAILS

Name	Max Q	Max V	Max U/S	Max D/S	Due to Storm
	(cu.m/s)	(m/s)	HGL (m)	HGL (m)	
p2.3	0.313	3.13	1.096	0.844	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
p3.7	0.114	0.63	0.807	0.769	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
p3-out	0.32	3.16	1.097	0.687	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
culvert	0.784	1.99	0.546	0.146	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
P5-out	0	0	1.231	0.9	AR&R 1 year, 1 hour storm, average 25.2 mm/h, Zone 1
p3-1	0.171	2.62	1.074	0.668	AR&R 1 year, 9 hours storm, average 6.46 mm/h, Zone 1

CHANNEL DETAILS

Name	Max Q	Max V	Due to Storm
	(cu.m/s)	(m/s)	
cess3.5	0.102	0.09	AR&R 1 year, 2 hours storm, average 16.5 mm/h, Zone 1
cess3.4	0.165	0.13	AR&R 1 year, 2 hours storm, average 16.5 mm/h, Zone 1
cess3.3	0.249	0.16	AR&R 1 year, 9 hours storm, average 6.46 mm/h, Zone 1
cess3.2	0.292	0.21	AR&R 1 year, 9 hours storm, average 6.46 mm/h, Zone 1
cess3.1	0.342	0.24	AR&R 1 year, 9 hours storm, average 6.46 mm/h, Zone 1
cess3	0.391	1.46	AR&R 1 year, 9 hours storm, average 6.46 mm/h, Zone 1
cess1.5	0.129	0.14	AR&R 1 year, 2 hours storm, average 16.5 mm/h, Zone 1
cess1.4	0.155	0.15	AR&R 1 year, 2 hours storm, average 16.5 mm/h, Zone 1
cess1.3	0.184	0.15	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
cess1.2	0.226	0.18	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
cess1.1	0.264	0.21	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
cess1	0.421	1.68	AR&R 1 year, 9 hours storm, average 6.46 mm/h, Zone 1
Crk12-11	0.719	-1.#J	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
Ch388929	0.309	0	AR&R 1 year, 1 hour storm, average 25.2 mm/h, Zone 1

OVERFLOW ROUTE DETAILS

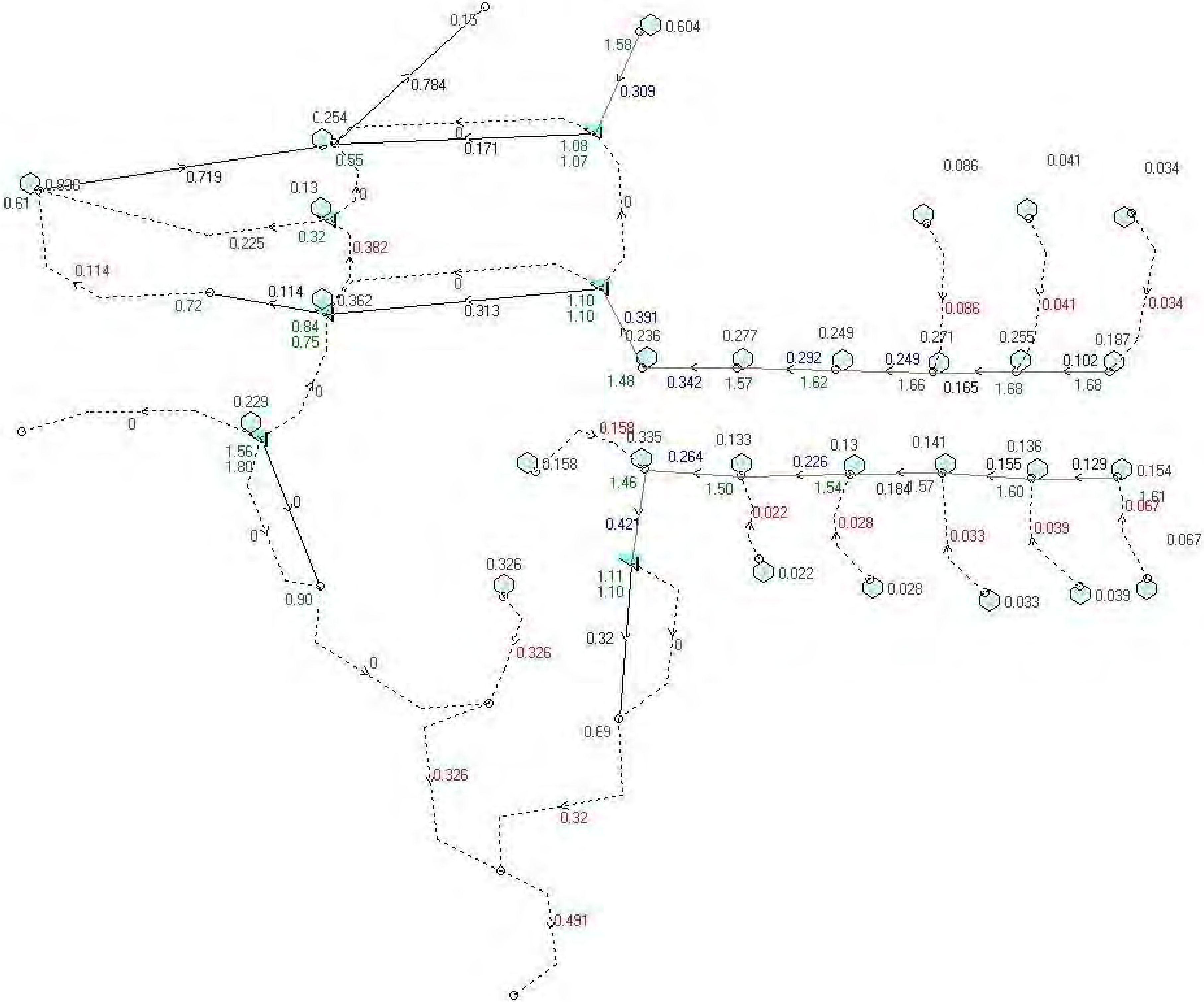
Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
ofb2-b3	0	0	0.085	0	0	0	0	
OFb2-c3	0	0	0.101	0	0	0	0	
of3-2	0.382	0.382	0.136	0.568	0.04	10	0.07	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
ch3-7	0.114	0.114	0.431	0.133	0.01	10	0.09	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
ofbasin3-S	0	0	0.879	0	0	0	0	
of176	0.32	0.32	21.732	0.048	0.03	20.15	0.62	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
of2-7	0.225	0.225	0.163	0.368	0.06	4	0.15	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
of2-1	0	0	0.136	0	0	0	0	
OF132	0	0	44.636	0	0	0	0	
of216	0	0	0.879	0	0	0	0	
of5-swamp	0	0	44.636	0	0	0	0	
of5-Smithy	0	0	0.431	0	0	0	0	
of113-west	0.326	0.326	0.431	0.252	0.03	10	0.13	AR&R 1 year, 1 hour storm, average 25.2 mm/h, Zone 1
of203	0.491	0.491	44.636	0.02	0	100	0.25	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
Ofc103-c2	0	0	0.879	0	0	0	0	
OF80	0.158	0.158	0.879	0.106	0.01	20	0.07	AR&R 1 year, 9 hours storm, average 6.46 mm/h, Zone 1
OF91	0.022	0.022	0.879	0.032	0	20	0.03	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
OF71	0.028	0.028	0.879	0.037	0	20	0.04	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
OF64	0.033	0.033	0.879	0.041	0	20	0.04	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
OF90	0.039	0.039	0.879	0.045	0	20	0.04	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
OF85	0.067	0.067	0.879	0.064	0	20	0.05	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
OF98	0.034	0.034	0.879	0.043	0	20	0.04	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
OF100	0.041	0.041	0.879	0.047	0	20	0.04	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
OF102	0.086	0.086	0.12	0.247	0.03	3.49	0.12	AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1
of6-smithy	0.326	0.326	0.431	0.252	0.03	10	0.13	AR&R 1 year, 1 hour storm, average 25.2 mm/h, Zone 1

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
Basin2	1.1	3288.7	0.313	0.313	0
n3	0.84	923.7	0.496	0.114	0.382
basin3	1.11	3155	0.32	0.32	0
n2	0.32	3255.8	0.225	0	0.225
wetland 2	1.56	1687.3	0	0	0
Basin1	1.08	963.4	0.171	0.171	0

CONTINUITY CHECK for AR&R 1 year, 12 hours storm, average 5.41 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Ch (cu.m)	Difference %
n102.5	986.14	976.79	0	0.9
n102.4	2271.81	2245.96	0	1.1
n102.3	3890.66	3855.53	0	0.9
n102.2	4808.23	4751.19	0	1.2
n102.1	5808.74	5758.64	0	0.9
n102	6661	6608.17	0	0.8
Basin2	6608.17	3835.81	2739.69	0.5
n3	6412.92	6227.46	184.95	0
N59	2457.32	2457.3	0	0
n101.5	1113.26	1110.6	0	0.2
n101.4	1919.09	1902.37	0	0.9
n101.3	2677.72	2662	0	0.6
n101.2	3348.41	3328.74	0	0.6
n101.1	3996.94	3975.18	0	0.5
n101.0	5773.11	5754.26	0	0.3
basin3	5754.26	3132.03	2596.68	0.4
N258	3132.03	3132.02	0	0
N7	11892.23	8901.05	0	25.2
n1	12207.87	9012.03	0	26.2
out-hunter	9012.03	9012.03	0	0
n2	4935.61	3331.1	1604.51	0
wetland 2	1687.31	0	1687.31	0
n6	0	0	0	0
out-SWAM	0	0	0	0
Out-smithy	1927.6	1927.6	0	0
N202	5058.47	5058.39	0	0
N267	5058.16	5058.16	0	0
N103	2640.45	2608.42	0	1.2
Basin1	2608.42	1704.63	835.53	2.6
N100	518.64	518.64	0	0
N101	158.8	158.8	0	0
N107	189.46	189.46	0	0
N110	236.27	236.27	0	0
N113	287.2	287.2	0	0
N115	526.04	526.04	0	0
N122	270.09	270.09	0	0
N125	321.43	321.43	0	0
N128	611.43	611.43	0	0
N147	1927.6	1927.6	0	0



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0.69
0.326
0.32
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Developed 10 yr ARI

PIT / NODE DETAILS Version 8

Name	Max HGL	Max Pond HGL	Max Surfac Flow Arrivir (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
n102.5	2.3		0.56				
n102.4	2.29		0.928				
n102.3	2.27		1.662				
n102.2	2.2		1.757				
n102.1	2.1		1.914				
n102	1.94		2.045				
N59	0.96		0				
n101.5	2.22		0.671				
n101.4	2.21		1.004				
n101.3	2.18		1.286				
n101.2	2.13		1.524				
n101.1	2.06		1.77				
n101.0	1.94		2.363				
N258	0.78		1.045				
N7	1.47		10.236				
n1	1.24		11.893				
out-hunter	0.84		0				
n6	1.01		0.356				
N103	1.94		1.609				

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
c102.5	0.389	0.389	0.061	8.59	22.56	0	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
c102.4	0.529	0.529	0.084	8.59	22.56	0	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
c102.3	0.562	0.562	0.089	8.59	22.56	0	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
c102.2	0.518	0.518	0.082	8.59	22.56	0	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
c102.1	0.575	0.575	0.091	8.59	22.56	0	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
c102	0.49	0.49	0.077	8.59	22.56	0	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
c3	1.97	0.214	1.835	4.73	95.63	0	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
c101.5	0.319	0.319	0.05	8.59	22.56	0	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
c101.4	0.283	0.283	0.045	8.59	22.56	0	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
c101.3	0.293	0.293	0.046	8.59	22.56	0	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
c101.2	0.27	0.27	0.043	8.59	22.56	0	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
c101.1	0.277	0.277	0.044	8.59	22.56	0	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
c101	0.695	0.695	0.11	8.59	22.56	0	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
c7	8.804	0	8.804	0	258.54	0	AR&R 10 year, 12 hours storm, average 10.4 mm/h, Zone 1
c1	2.18	0	2.18	0	59.26	0	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
c2	1.173	0.052	1.158	3.84	129.92	0	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
c5	1.698	0.258	1.621	18.4	40.12	0	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
c103	1.609	1.254	0.523	8.59	22.56	0	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
Cat73	1.21	0.077	1.167	6.72	12.09	0	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
Cat82	0.17	0.03	0.166	4.03	46.26	0	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
Cat88	0.213	0.035	0.209	4.01	40.95	0	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
Cat91	0.254	0.044	0.248	3.64	45.01	0	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
Cat93	0.308	0.054	0.298	3.68	46.82	0	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
Cat97	0.544	0.1	0.529	3.15	50.94	0	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
Cat117	0.279	0.052	0.272	3.15	50.94	0	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
Cat119	0.332	0.061	0.323	3.15	50.94	0	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
Cat124	0.659	0.113	0.644	3.1	44.31	0	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
C6	1.293	0.196	1.15	6.66	86.65	0	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1

Outflow Volumes for Total Catchment (26.4 impervious + 451 pervious = 478 total ha)

Storm	Total Rainf cu.m	Total Runo cu.m (Runc	Impervious cu.m (Runc	Pervious Runoff cu.m (Runoff %)
AR&R 10 y	298068.6	122054.21	15351.71 (	106702.50 (37.9%)
AR&R 10 y	349657.4	151156.64	18199.93 (	132956.70 (40.2%)
AR&R 10 y	408411.3	175433.89	21445.93 (	153987.97 (39.9%)
AR&R 10 y	533084.1	218291.67	28330.32 (	189961.34 (37.7%)
AR&R 10 y	596137.2	237566.56	31813.67 (	205752.89 (36.5%)
AR&R 10 y	711925.4	266499.00	38214.43 (	228284.58 (33.9%)
AR&R 10 y	804785.3	267240.06	43375.01 (	223865.05 (29.4%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
p2.3	1.154	2.15	1.298	1.298	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
p3.7	0.837	1.06	1.212	1.126	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
p3-out	1.31	4.76	1.185	0.775	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
culvert	11.343	4.97	1.245	0.845	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
P5-out	0.528	3.78	1.909	1.009	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
p3-1	0.703	1.72	1.245	1.245	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm
cess3.5	0.37	0.08	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
cess3.4	0.843	0.19	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
cess3.3	1.591	0.33	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
cess3.2	1.735	0.41	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
cess3.1	1.894	0.5	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
cess3	2.029	2.2	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
cess1.5	0.624	0.16	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
cess1.4	0.96	0.24	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
cess1.3	1.277	0.29	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
cess1.2	1.547	0.37	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
cess1.1	1.799	0.47	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
cess1	2.382	2.69	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
Crk12-11	9.882	-1.#J	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
Ch388929	1.105	2.58	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
ofb2-b3	0.153	0.153	0.085	0.417	0.05	4.17	0.11	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
OFb2-c3	1.415	1.415	1.006	0.246	0.07	20	0.29	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
of3-2	1.906	1.906	0.136	1	0.19	10	0.19	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
ch3-7	0.837	0.837	0.431	0.452	0.08	10	0.19	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
ofbasin3-S	1.045	1.045	0.879	0.333	0.05	20	0.16	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
of176	2.351	2.351	21.732	0.104	0.12	33.91	1.11	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
of2-7	0.896	0.896	0.163	0.916	0.22	4	0.24	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
of2-1	1.817	1.817	0.136	1	0.18	10	0.18	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
OF132	0	0	44.636	0	0	0	0	
of216	0.356	0.356	0.879	0.173	0.02	20	0.1	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
of5-swamp	0.81	0.81	44.636	0.027	0.01	100	0.3	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
of5-Smithy	0.882	0.882	0.431	0.467	0.09	10	0.19	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
of113-west	2.118	2.118	0.431	0.809	0.21	10	0.26	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
of203	4.252	4.252	44.636	0.073	0.04	100	0.58	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
Ofc103-c2	0.266	0.266	0.879	0.145	0.01	20	0.09	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1
OF80	1.21	1.21	0.879	0.365	0.06	20	0.17	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
OF91	0.17	0.17	0.879	0.111	0.01	20	0.08	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
OF71	0.213	0.213	0.879	0.127	0.01	20	0.08	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
OF64	0.254	0.254	0.879	0.141	0.01	20	0.09	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
OF90	0.308	0.308	0.879	0.159	0.02	20	0.1	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
OF85	0.544	0.544	0.879	0.225	0.03	20	0.12	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
OF98	0.279	0.279	0.879	0.15	0.01	20	0.09	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
OF100	0.332	0.332	0.879	0.166	0.02	20	0.1	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
OF102	0.659	0.659	0.12	0.761	0.16	5.54	0.22	AR&R 10 year, 2 hours storm, average 31.2 mm/h, Zone 1
of6-smithy	1.293	1.293	0.431	0.592	0.13	10	0.22	AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1

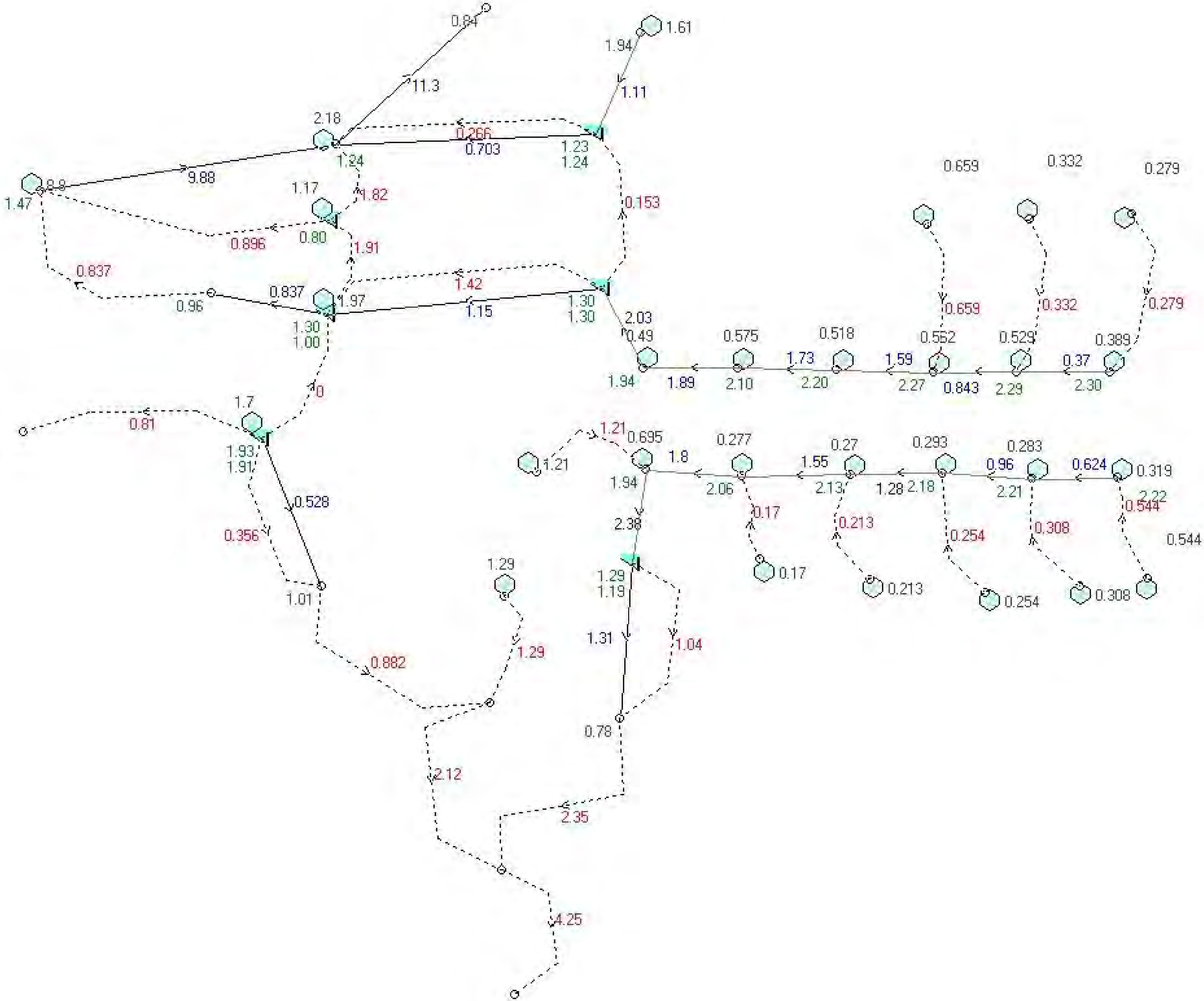
DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
Basin2	1.3	4637.4	2.722	1.154	1.568
n3	1.3	7116.2	2.743	0.837	1.906
basin3	1.29	4365.9	2.355	1.31	1.045
n2	0.8	11145.8	2.713	0	2.713
wetland 2	1.93	2776.2	1.694	0.528	1.166
Basin1	1.23	1286	0.969	0.703	0.266

CONTINUITY CHECK for AR&R 10 year, 9 hours storm, average 12.4 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Ch (cu.m)	Difference %
n102.5	3225.02	3191.96	0	1
n102.4	7305.95	7229.52	0	1
n102.3	13096.45	13007.93	0	0.7
n102.2	15165.24	15054.73	0	0.7
n102.1	17451.53	17350.1	0	0.6
n102	19394.54	19294.82	0	0.5
Basin2	19294.82	16453.1	2771.43	0.4
n3	30318.91	30061.28	256.64	0
N59	9234.04	9234.01	0	0
n101.5	4450.75	4434.31	0	0.4
n101.4	7288.96	7241.85	0	0.6
n101.3	9830.27	9784.16	0	0.5
n101.2	11988.57	11938.21	0	0.4
n101.1	14014.2	13963.53	0	0.4
n101.0	19478.51	19433.09	0	0.2
basin3	19433.09	16762.97	2619.38	0.3
N258	16762.96	16762.98	0	0
N7	143418.8	136126.7	0	5.1
n1	166322.9	159416.6	0	4.2
out-hunter	159416.6	159416.6	0	0
n2	30879.43	28408.4	2469.15	0
wetland 2	8654.56	6248.01	2406.54	0
n6	4266.66	4266.66	0	0
out-SWAM	1981.36	1981.36	0	0
Out-smithy	13518.67	13518.73	0	0
N202	30279.25	30279.63	0	0
N267	30279.23	30279.23	0	0
N103	5883.17	5834.71	0	0.8
Basin1	6535.63	5597.28	841.66	1.5
N100	2614.53	2614.53	0	0
N101	922.81	922.81	0	0
N107	1077.64	1077.64	0	0
N110	1365.94	1365.94	0	0
N113	1673.12	1673.12	0	0
N115	3120.28	3120.28	0	0
N122	1602.24	1602.24	0	0
N125	1906.77	1906.77	0	0
N128	3524.54	3524.54	0	0
N147	9252	9252	0	0

Run Log for QR Hexham A developed1.drn run at 11:36:04 on 30/5/2012



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Appendix B MUSIC Modelling Result Files

Existing Site: Source Nodes

Node Type	AgriculturalSourceNode	AgriculturalSourc	AgriculturalSourceNode	ForestSourceNode
Node Name	C101	102	103	surrounding catchments:
Node ID	5	8	9	7
Coordinates				
General - Location	C101	102	103	surrounding catchments:
General - Notes				C5, C6(partial),c7
General - Fluxes - Daily				
General - Fluxes - Sub-Daily				
Areas - Total Area (ha)	40.84	83.2	23.09	310.13
Areas - Impervious (%)	4	4	4	4
Areas - Pervious (%)	96	96	96	96
Rainfall-Runoff - Impervious Area - Rainfall Threshold (mm/day)	1	1	1	1.5
Rainfall-Runoff - Pervious Area - Soil Storage Capacity (mm)	120	120	120	100
Rainfall-Runoff - Pervious Area - Initial Storage (% of Capacity)	36	36	36	30
Rainfall-Runoff - Pervious Area - Field Capacity (mm)	80	80	80	30
Rainfall-Runoff - Pervious Area - Infiltration Capacity Coefficient - a	200	200	200	400
Rainfall-Runoff - Pervious Area - Infiltration Capacity Exponent - b	1	1	1	1
Rainfall-Runoff - Groundwater Properties - Initial Depth (mm)	10	10	10	0
Rainfall-Runoff - Groundwater Properties - Daily Recharge Rate (%)	25	25	25	25
Rainfall-Runoff - Groundwater Properties - Daily Baseflow Rate (%)	5	5	5	50
Rainfall-Runoff - Groundwater Properties - Daily Deep Seepage Rate (%)	0	0	0	0
Total Suspended Solids - Base Flow Concentration - Mean (log mg/L)	1.74	1.74	1.74	1.74
Total Suspended Solids - Base Flow Concentration - Std Dev (log mg/L)	0.13	0.32	0.13	0.32
Total Suspended Solids - Base Flow Concentration - Estimation Method	0	0	0	0
Total Suspended Solids - Base Flow Concentration - Serial Correlation (R squared)	0	0	0	0
Total Suspended Solids - Storm Flow Concentration - Mean (log mg/L)	2.279	2.279	2.279	2.004
Total Suspended Solids - Storm Flow Concentration - Std Dev (log mg/L)	0.46	0.46	0.46	0.598
Total Suspended Solids - Storm Flow Concentration - Estimation Method	0	0	0	0
Total Suspended Solids - Storm Flow Concentration - Serial Correlation (R squared)	0	0	0	0
Total Phosphorus - Base Flow Concentration - Mean (log mg/L)	-0.14	-0.14	-0.14	-0.14
Total Phosphorus - Base Flow Concentration - Std Dev (log mg/L)	1.368	1.368	1.368	1.368
Total Phosphorus - Base Flow Concentration - Estimation Method	0	0	0	0
Total Phosphorus - Base Flow Concentration - Serial Correlation (R squared)	0	0	0	0
Total Phosphorus - Storm Flow Concentration - Mean (log mg/L)	-0.14	-0.267	-0.14	-0.658
Total Phosphorus - Storm Flow Concentration - Std Dev (log mg/L)	0.47	0.47	0.47	0.503
Total Phosphorus - Storm Flow Concentration - Estimation Method	0	0	0	0
Total Phosphorus - Storm Flow Concentration - Serial Correlation (R squared)	0	0	0	0
Total Nitrogen - Base Flow Concentration - Mean (log mg/L)	0.24	0.24	0.24	0.24
Total Nitrogen - Base Flow Concentration - Std Dev (log mg/L)	0.339	0.339	0.339	0.339
Total Nitrogen - Base Flow Concentration - Estimation Method	0	0	0	0
Total Nitrogen - Base Flow Concentration - Serial Correlation (R squared)	0	0	0	0
Total Nitrogen - Storm Flow Concentration - Mean (log mg/L)	0.6	0.602	0.6	0.322
Total Nitrogen - Storm Flow Concentration - Std Dev (log mg/L)	0.376	0.376	0.376	0.418
Total Nitrogen - Storm Flow Concentration - Estimation Method	0	0	0	0
Total Nitrogen - Storm Flow Concentration - Serial Correlation (R squared)	0	0	0	0

Development Site With Treatment

Node Type	AgriculturalSourceN	AgriculturalSource	UserDefinedSour	UserDefinedSourc	UserDefinedSo	UserDefinedSourc
Node Name	**C4**	**C6 (partial) cess drain**	**C101-A**	**C102**	**c103**	**C101-B**
Node ID	23	24	1	2	3	22
Coordinates						
General - Location	C4	C6 (partial) cess drain	C101-A	C102	c103	C101-B
General - Notes						
General - Fluxes - Daily						
General - Fluxes - Sub-Daily						
Areas - Total Area (ha)	30.62	7.56	7.571	24.146	3.014	6.108
Areas - Impervious (%)	4	4	50	50	50	50
Areas - Pervious (%)	96	96	50	50	50	50
Rainfall-Runoff - Impervious Area - Rainfall Threshold (mm/day)	1	1	1.5	1.5	1.5	1.5
Rainfall-Runoff - Pervious Area - Soil Storage Capacity (mm)	120	120	100	100	100	100
Rainfall-Runoff - Pervious Area - Initial Storage (% of Capacity)	36	36	30	30	30	30
Rainfall-Runoff - Pervious Area - Field Capacity (mm)	80	80	30	30	30	30
Rainfall-Runoff - Pervious Area - Infiltration Capacity Coefficient - a	200	200	400	400	400	400
Rainfall-Runoff - Pervious Area - Infiltration Capacity Exponent - b	1	1	1	1	1	1
Rainfall-Runoff - Groundwater Properties - Initial Depth (mm)	10	10	0	0	0	0
Rainfall-Runoff - Groundwater Properties - Daily Recharge Rate (%)	25	25	25	25	25	25
Rainfall-Runoff - Groundwater Properties - Daily Baseflow Rate (%)	5	5	50	50	50	50
Rainfall-Runoff - Groundwater Properties - Daily Deep Seepage Rate (%)	0	0	0	0	0	0
Total Suspended Solids - Base Flow Concentration - Mean (log mg/L)	1.74	1.74	1.74	1.74	1.74	1.74
Total Suspended Solids - Base Flow Concentration - Std Dev (log mg/L)	0.13	0.13	0.497	0.5	0.497	0.497
Total Suspended Solids - Base Flow Concentration - Estimation Method	0	0	0	0	0	0
Total Suspended Solids - Base Flow Concentration - Serial Correlation (R squared)	0	0	0	0	0	0
Total Suspended Solids - Storm Flow Concentration - Mean (log mg/L)	2.279	2.279	2.6	2.6	2.6	2.6
Total Suspended Solids - Storm Flow Concentration - Std Dev (log mg/L)	0.46	0.46	0.495	0.495	0.495	0.495
Total Suspended Solids - Storm Flow Concentration - Estimation Method	0	0	0	0	0	0
Total Suspended Solids - Storm Flow Concentration - Serial Correlation (R squared)	0	0	0	0	0	0
Total Phosphorus - Base Flow Concentration - Mean (log mg/L)	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14
Total Phosphorus - Base Flow Concentration - Std Dev (log mg/L)	1.368	1.368	0.533	0.533	0.533	0.533
Total Phosphorus - Base Flow Concentration - Estimation Method	0	0	0	0	0	0
Total Phosphorus - Base Flow Concentration - Serial Correlation (R squared)	0	0	0	0	0	0
Total Phosphorus - Storm Flow Concentration - Mean (log mg/L)	-0.14	-0.14	-0.523	-0.523	-0.523	-0.523
Total Phosphorus - Storm Flow Concentration - Std Dev (log mg/L)	0.47	0.47	0.27	0.271	0.271	0.271
Total Phosphorus - Storm Flow Concentration - Estimation Method	0	0	0	0	0	0
Total Phosphorus - Storm Flow Concentration - Serial Correlation (R squared)	0	0	0	0	0	0
Total Nitrogen - Base Flow Concentration - Mean (log mg/L)	0.24	0.24	0.24	0.24	0.24	0.24
Total Nitrogen - Base Flow Concentration - Std Dev (log mg/L)	0.339	0.339	0.258	0.258	0.258	0.258
Total Nitrogen - Base Flow Concentration - Estimation Method	0	0	0	0	0	0
Total Nitrogen - Base Flow Concentration - Serial Correlation (R squared)	0	0	0	0	0	0
Total Nitrogen - Storm Flow Concentration - Mean (log mg/L)	0.6	0.6	0.398	0.398	0.398	0.398
Total Nitrogen - Storm Flow Concentration - Std Dev (log mg/L)	0.376	0.376	0.3	0.3	0.3	0.3
Total Nitrogen - Storm Flow Concentration - Estimation Method	0	0	0	0	0	0
Total Nitrogen - Storm Flow Concentration - Serial Correlation (R squared)	0	0	0	0	0	0

Treatment Nodes - Wetlands

Node Type	WetlandNode	WetlandNode	WetlandNode
Node Name	**Basin 3**	**Basin 2**	**Basin 1**
Node ID	7	8	12
Coordinates			
General - Location	Basin 3	Basin 2	Basin 1
General - Notes			
General - Fluxes			
Stormwater Re-use - Use stored water for irrigation or other purpose	1	1	1
Stormwater Re-use - Annual Demand (kL/yr) Scaled by Daily: PET	-9999	-9999	-9999
Stormwater Re-use - Annual Demand (kk/yr) Scaled by Daily: PET - Rain	-9999	-9999	-9999
Stormwater Re-use - Daily Demand (kL/day)	-9999000	-9999000	-9999000
Stormwater Re-use - User-defined distribution of Annual Demand (ML/yr)	-9999	-9999	-9999
Stormwater Re-use - User-defined time series			
Inlet Properties - Low Flow By-pass (cubic metres per sec)	0	0	0
Inlet Properties - High Flow By-pass (cubic metres per sec)	100	100	100
Inlet Properties - Inlet Pond Volume (cubic metres)	0	0	0
Storage Properties - Surface Area (square metres)	6562	6675	2187
Storage Properties - Extended Detention Depth (metres)	0.6	0.6	0.6
Storage Properties - Permanent Pool Volume (cubic metres)	2500	2404	793
Storage Properties - Exfiltration Rate (mm/hr)	3.6	3.6	3.6
Storage Properties - Evaporative Loss as % of PET	125	125	125
Outlet Properties - Equivalent Pipe Diameter (mm)	300	300	300
Outlet Properties - Overflow Weir Width (metres)	4	4	4
Outlet Properties - Notional Detention Time (hrs)	6.733035744	6.848981041	2.244003226
Advanced Properties - Orifice Discharge Coefficient	0.6	0.6	0.6
Advanced Properties - Weir Coefficient	1.7	1.7	1.7
Advanced Properties - Number of CSTR Cells	5	5	5
Advanced Properties - Total Suspended Solids - k (m/yr)	1500	1500	1500
Advanced Properties - Total Suspended Solids - C* (mg/L)	6	6	6
Advanced Properties - Total Suspended Solids - C** (mg/L)	6	6	6
Advanced Properties - Total Phosphorus - k (m/yr)	1000	1000	1000
Advanced Properties - Total Phosphorus - C* (mg/L)	0.06	0.06	0.06
Advanced Properties - Total Phosphorus - C** (mg/L)	0.06	0.06	0.06
Advanced Properties - Total Nitrogen - k (m/yr)	150	150	150
Advanced Properties - Total Nitrogen - C* (mg/L)	1	1	1
Advanced Properties - Total Nitrogen - C** (mg/L)	1	1	1
Advanced Properties - Threshold Hydraulic Loading for C** (m/yr)	3500	3500	3500
Advanced Properties - User Defined Storage-Discharge-Height			

Swale Treatment Nodes

Node Type	SwaleNode	SwaleNode	SwaleNode	SwaleNode
Node Name	Swale 101-A	Swale 101-B	Swale 102	Swale 103
Node ID	4	5	10	11
Coordinates				
General - Location	Swale 101-A	Swale 101-B	Swale 102	Swale 103
General - Notes				
General - Fluxes				
Inlet Properties - Low Flow By-pass (cubic metres per sec)	0	0	0	0
Storage Properties - Length (metres)	524	258	981.8	256
Storage Properties - Bed Slope (%)	0.01	0.01	0.05	0.05
Storage Properties - Base Width (metres)	2.5	2.5	2.5	5
Storage Properties - Top Width (metres)	4.9	4.9	4.9	12.8
Storage Properties - Depth (metres)	0.6	0.6	0.6	0.6
Storage Properties - Vegetation Height (metres)	0.1	0.1	0.1	0.1
Storage Properties - Exfiltration Rate (mm/hr)	0	0	0	0
Advanced Properties - Number of CSTR Cells	10	10	10	10
Advanced Properties - Total Suspended Solids - k (m/yr)	8000	8000	8000	8000
Advanced Properties - Total Suspended Solids - C* (mg/L)	20	20	20	20
Advanced Properties - Total Suspended Solids - C** (mg/L)	14	14	14	14
Advanced Properties - Total Phosphorus - k (m/yr)	6000	6000	6000	6000
Advanced Properties - Total Phosphorus - C* (mg/L)	0.13	0.13	0.13	0.13
Advanced Properties - Total Phosphorus - C** (mg/L)	0.13	0.13	0.13	0.13
Advanced Properties - Total Nitrogen - k (m/yr)	500	500	500	500
Advanced Properties - Total Nitrogen - C* (mg/L)	1.4	1.4	1.4	1.4
Advanced Properties - Total Nitrogen - C** (mg/L)	1.4	1.4	1.4	1.4
Advanced Properties - Threshold Hydraulic Loading for C** (m/yr)	3500	3500	3500	3500

GPT Treatment Node

Node Type	**GPTNode**
Node Name	Gross Pollutant Trap
Node ID	Gross Pollutant Trap
Coordinates	
Lo-flow bypass rate (cum/sec)	0
High Flow By-pass (cubic metres per sec)	0.1
Flow Transfer Function - Input #2	10
Flow Transfer Function - Output #2	10
GP Transfer Function - Input #2	15
GP Transfer Function - Output #2	15
TN Transfer Function - Input #2	50
TN Transfer Function - Output #2	50
TP Transfer Function - Input #2	50
TP Transfer Function - Output #2	50
TSS Transfer Function - Input #2	1000
TSS Transfer Function - Output #2	300

Appendix C Inspection and Test Plans

Issue	**SEDIMENT AND EROSION CONTROLS – ESTABLISHMENT AND MAINTENANCE**
Purpose	Monitor and maintain Sediment and Erosion controls to minimise pollutant export from the site.
Responsibility	Site Foreman
Criteria	• Sediment traps, check dams – clean out when 30% of design capacity • Basins – remove sediment within 1 week of reaching 100% of design capacity • Truck shakedown – clean out when 90% of design capacity • All controls to be cleaned when construction stops for periods >2 weeks.
Monitoring	Inspect controls: • Daily for first week; • Fortnightly thereafter; • after rainfall events >25mm/day • Prior to shut downs >2 weeks.
Corrective Actions	• Increase frequency of maintenance; • Improve sediment and erosion controls • Modify site practices
Reporting	• Record inspect results; • Store 1 copy on site for inspection by authorities; • Provide monthly copies to Superintendent
Notification	For Breach of Criteria; • Notify Superintendent by phone and Fax on same day, or within 12 hours. Detail rectification measures undertaken/proposed.

Issue	BASIN WATER QUALITY AND LEVELS
Purpose	Monitor water quality in basins to maintain within an accep**table** range in case of overflow. Maintain adequate buffer in the basin in the event of wet weather.
Responsibility	Site Foreman
Criteria	• pH – 6 to 8.5 (or ±0.5 of receiving waters) • Suspended Solids - <50mg/L[1] • Water level <90%
Monitoring	Inspect: • Daily for first week; • Weekly thereafter; • Prior to rainfall, if possible • After rainfall events >25mm/day • Prior to shut downs >2 weeks.
Corrective Actions	• pH – add Hydrated Lime or Acid to modify pH accordingly; • Suspended Solids – add Gypsum. Other flocculants require approval due to possibly impacts on aquatic species. • Modify site practices; • Pump water from pond, clear out discharge pipes.
Reporting	• Record inspect results; • Store 1 copy on site for inspection by authorities; • Provide monthly copies to Superintendent
Notification	For Breach of Criteria and discharge from site; • Notify Superintendent by phone and Fax on same day, or within 12 hours. Detail rectification measures undertaken/proposed. When water quality is unsatisfactory for > 2weeks; • Notify Superintendent to determine rectification measures.

Issue	DUST CONTROL
Purpose	Control dust on the site to prevent adverse impacts on adjacent properties.
Responsibility	Site Foreman

[1] If a relationship can be established between Turbidity and TSS then turbidity readings may be adopted for the monitoring criteria.

Criteria	• Less than 1 complaint per week, and less than 3 in total
Monitoring	Inspect: • Continuously monitor site conditions and weather; • If >3 complaints are received set up dust monitoring stations with data loggers.
Corrective Actions	• Water cart; • Install wind breaks in accordance with Blue Book. • Stop work on windy days. • Revegetate exposed areas (e.g. hydro-mulch); • Install dust monitoring;
Reporting	• Record wind speed and direction, water truck usage (number, times) and wind breaks (install date, details); • Review dust monitoring results and collate weekly, or upon receipt of complaints. • Store 1 copy on site for inspection by authorities; • Provide monthly summaries to Superintendent.
Notification	For Breach of Criteria; • Notify Superintendent by phone and Fax on same day, or within 12 hours. Detail rectification measures undertaken/proposed.

Issue	**WATER RELEASES**
Purpose	Protect receiving waters during planned discharges.
Responsibility	Site Foreman
Criteria	• pH – 6 to 8.5 (or ±0.5 of receiving waters) • Suspended Solids - <50mg/L
Monitoring	• Record pH and TSS in receiving waters daily and following rainfall events >25mm/day • Record pH and TSS in receiving waters prior to release; • Record ph and TSS in pond water.
Corrective Actions	• pH – add Hydrated Lime or Acid to modify pH accordingly; • Suspended Solids – add Gypsum. Other flocculants require approval due to possibly impacts on aquatic species. • Modify site practices;
Reporting	• Report all monitoring results. • Store 1 copy on site for inspection by authorities; • Provide monthly summaries to Superintendent.
Notification	For Breach of Criteria; • Notify Superintendent by phone and Fax on same day, or within 12 hours. Detail rectification measures undertaken/proposed.