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Report on
Preliminary Contamination Assessment

Proposed Train Support Facility
Woodlands Close, Hexham

Prepared for
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Executive Summary

A preliminary contamination assessment (PCA) has been carried out at the proposed Train Support Facility (TSF) off Woodlands Close, Hexham. The assessment was undertaken at the request of QR National and is intended to support the development application for the project. The proposed TSF development over approximately 38 ha of the 255 ha greater Hexham site area includes the construction of additional train tracks, internal vehicle access roads, maintenance facilities, provisioning facilities, wagon storage, wheel Lathe Building and Turntable and administration buildings. The proposed TSF will be located to the west of the proposed ARTC rail sidings (5 rail tracks) adjacent to the Great Northern Railway.

The PCA was undertaken to assess past and present contaminating activities, report on site conditions and provide a preliminary assessment of site contamination. The PCA comprised desktop review, site inspection, soil, groundwater and surface water sampling, laboratory analysis, interpretation and preparation of this report. The PCA report was initially prepared by Douglas Partners Pty Ltd (DP) in 2008. The PCA was updated in August 2011 and incorporated the results of a site assessment by ERM (2010). This PCA has incorporated the results of the previous assessments considering the current proposed development, brief site inspection, a groundwater assessment conducted by DP in late 2011 and the Coffeys assessment for the adjacent Hexham Relief Roads Project (Ref 24).

The desktop review identified that the greater Hexham site has a long history of industrial development, with the construction of the Minmi-Hexham Railway and associated on-site infrastructure commencing in 1853 in the southern portion of the greater Hexham site. The Coal Preparation Plant (CPP) was constructed in 1953 and subsequently closed in 1988. While the majority of infrastructure associated with the former railway and CPP has been removed, the landscape has been significantly altered by the former industrial activities, particularly by substantial placement of coal reject.

The northern portion of the greater Hexham site has a long history of rural landuse including possible cropping and cattle grazing with associated infrastructure (i.e. rural farms). Dairy Farmers constructed a waste water treatment plant (WWTP) on the great Hexham site in the late 1990s and now irrigates treated effluent on the northern and southern portions of the greater Hexham site.

Subsurface investigations conducted in 2008 by DP included a program of drilling (including well installation), test pitting, hand excavation and collection of soil, surface water and groundwater samples. The eastern portion of the greater Hexham site (i.e. proposed Train Support Facility) was targeted as requested by the client.

Subsurface conditions generally comprised fill materials (typically coal reject with intermixed silt and clay) to depths of 0.2 m to greater than 5.5 m, underlain by natural clayey silts, silty clays and sandy clay/clayey sands. Groundwater was encountered at depths ranging from 0.54 m to 2.45 m below the ground surface and is expected to flow to the west, north and east of the site. Contaminant observations during field work generally indicated the absence of gross contamination within soil, groundwater and surface water.

The results of site investigations generally indicated the absence of gross soil contamination associated with the TSF development. Soil exceedences were generally associated with non-volatile medium to heavy chain hydrocarbons.

Based on the site observations and historical information, the potential for widespread soil contamination within the TSF development area is considered to be low.

Minor bonded asbestos containing materials were observed in the immediate vicinity of former site buildings within the TSF development area (i.e. control cabin). Potential asbestos containing materials may also be present in localised dumped piles of filing containing building rubble. The occurrence of asbestos containing materials within the TSF site is therefore not likely to be widespread.

Localised soil remediation is likely to be required for the development of the TSF to remediate hydrocarbon contamination within the fill material in the southern portion of the site and fibro fragments containing asbestos in the former control cabin. This will require preparation of a Remediation Action Plan (RAP), which would assess available remedial options and develop remedial procedures to render the site suitable for the proposed industrial land use.

It is noted that the results generally indicate the absence of gross contamination within the groundwater and surface water samples tested. Widespread elevated levels of nutrients and faecal coliforms were encountered in groundwater and surface water samples taken at the greater Hexham site which indicate that the Hexham Wetland is in a degraded state due to a long history of industrialisation in this area. Based on field observation and laboratory testing, it is considered that the elevated nutrient and faecal coliform concentrations may be attributed to the infiltration of irrigated treated effluent or cattle grazing.

Due to the widespread presence of surface water and groundwater impacts in the vicinity of the TSF development and the greater Hexham site area, together with the degraded nature of the Hexham Wetland, it is not considered practical to remediate surface waters or groundwaters within the TSF site. Potential human health and environmental impacts associated with surface water and groundwater contamination could be managed during and following development through the implementation of a Water Quality Management Plan.

The preliminary contamination assessment conducted at the greater Hexham site has identified soil, surface water and groundwater impacts that will require management to facilitate the development of the TSF.

The following is recommended to address potential impacts in regard to contamination associated with the proposed TSF development:

- Preparation of a site specific Remediation Action Plan (RAP) for contaminated soils, presenting remediation and management options to address localised hydrocarbon impacts and asbestos containing materials. It is understood that GHD have prepared a RAP for the TSF development;
- Additional investigations are recommended to refine remediation requirements. Additional site investigations associated with the TSF development could be conducted during the detailed design phase of the development or in conjunction with the localised site remediation activities;
- Conduct localised remediation and validation of soils impacted by site development (i.e. areas subject to earthworks and ground disturbance);

- Prepare a Water Quality Management Plan (WQMP) to manage surface water and groundwater contamination during and following TSF development. The WQMP would include the following:
  - Mitigation measures to protect human health and the environment;
  - Procedures to minimise the risk of exposure to and potential for migration of impacted waters;
  - An integrated surface water and groundwater monitoring strategy;
  - Contingency measures.

Management of soil, surface water and groundwater impacts will be incorporated with the Construction Environmental Management Plan (CEMP) for the TSF development. The CEMP will address potential impacts through soil and water management (i.e. contaminated soils and waters, acid sulphate soil management, dewatering and drainage etc.). Measures to minimise exposure of impacted soils and waters will be implemented through staged development, monitoring and contingency procedures.
The development area is therefore considered to be suitable for construction of the TSF, subject to appropriate soil remediation and surface water and groundwater management during and following construction.

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Abbreviations

AASS	Actual Acid Sulphate Soil
AHD	Australian Height Datum
Al	Aluminium
ANZECC	Australian and New Zealand Environmental and Conservation Council
As	Arsenic
As (V)	Arsenic with oxidation state V
AS	Australian Standard
ASS	Acid Sulphate Soil
ASSMAC	Acid Sulphate Soil Management Advisory Committee
ASSMP	Acid Sulphate Soil Management Plan
B(a)P	benzo(a)pyrene (a polycyclic aromatic hydrocarbon compound)
bgl	below ground level
BTEX	Benzene, Toluene, Ethylbenzene, total Xylenes (monocyclic aromatic hydrocarbons)
Cd	Cadmium
COC	Chain of Custody
Cr	Chromium
Cr(III)	Chromium with oxidation state III (stable in normal environments)
Cr(VI)	Chromium with oxidation state VI (typically not stable in normal environments)
CT	Contaminant Threshold (screening criteria for waste classification assessment)
Cu	Copper
CWR	Coal Washery Reject
C_6-C_9	Light hydrocarbon chain groups
C_{10}-C_{14}	Light hydrocarbon chain groups
C_{15}-C_{28}	Medium hydrocarbon chain groups
C_{29}-C_{36}	Heavy hydrocarbon chain groups
C_6-C_{36}	Sum of light, medium and heavy hydrocarbon chain groups
DECC	Department of Environment and Climate Change
DECCW	Department of Environment, Climate Change and Water
DIPNR	Department of Infrastructure, Planning and Natural Resources
DNAPL	Dense Non-Aqueous Phase Liquid
DP	Douglas Partners Pty Ltd
DQI	Data Quality Indicator
DQO	Data Quality Objective
EC	Electrical Conductivity
Eh	Redox (oxidation/reduction) potential
EIS	Environmental Impact Statement

Abbreviations (continued)

EPA	Environmental Protection Authority
EPL	Environment Protection Licence
Fe	Iron
GPS	Global Positioning System
GW	Groundwater
ha	hectares
HIL	NSW DEC Contaminated Sites: *Guidelines for the NSW Site Auditors Scheme, 2nd Edition, April 2006*. Health-based Investigation Levels
Hg	Mercury
H_2O_2	Hydrogen Peroxide
KCl	Potassium Chloride
m	metres
mg/kg	milligrams per kilogram (or parts per million)
mg/L	milligrams per litre (or parts per million
ML	megalitre (million litres)
Mn	Manganese
mS/cm	milli-Siemens per cm
NAG	Net Acid Generation
NAPP	Net Acid Production Potential
NATA	National Association of Testing Authorities
NC	No Criteria
ND (nd)	Not Detected (below the PQL)
NEHF	National Environmental Health Forum
Ni	Nickel
NSW	New South Wales
NT	Not Tested
OEH	NSW Office of Environment and Heritage
PAH	Polycyclic Aromatic Hydrocarbons
PASS	Potential Acid Sulphate Soil
Pb	Lead
pH	unit measurement of acidity/alkalinity
pH_f	Soil pH test (1:5 soil/distilled water)
pH_{fox}	Soil peroxide pH test (1:4 soil/distilled water following oxidation of soil with 30% H_2O_2)
PID	Photoionisation Detector
PPE	Personal Protective Equipment
PQL	Practical Quantitation Limit

Abbreviations (continued)

PVC	Polyvinyl Chloride
QA/QC	Quality Assurance / Quality Control
QASSIT	Queensland Acid Sulphate Soil Investigation Team
QASSMAC	Queensland Acid Sulphate Soil Management Advisory Committee
RL	Reduced Level (in metres to a specified datum)
RPD	Relative Percent Difference
S-ANC$_{BT}$	Acid Neutralising Capacity by back titration calculated as equivalent pyrite S%
S-C$_{IN}$	Inorganic Carbon Content by induction furnace as equivalent pyrite S%
SCC	Specific Contaminant Concentration (total concentration for waste classification)
S$_{Cr}$	Chromium reducible sulphur
S$_{KCl}$	KCl extractable sulphur
S$_{NAS}$	Net Acid Soluble Sulphur
s-TAA	Titratable Actual Acidity calculated as equivalent pyrite S%
SPT	Standard Penetration Test
TCLP	Toxicity Characteristic Leaching Potential
TPH	Total Petroleum Hydrocarbons
TRH	Total Recoverable Hydrocarbons
UCL	Upper Confidence Limit
VOC	Volatile Organic Compound
Zn	Zinc

Report on Preliminary Contamination Assessment
Proposed Train Support Facility
Woodlands Close, Hexham

1. Introduction

This report presents the findings of a Preliminary Contamination Assessment (PCA) for a proposed Train Support Facility (TSF) at Woodlands Close, Hexham, NSW. The assessment was carried out at the request of QR National. This report supersedes the PCA report previously prepared for the greater Hexham site (Project 39798.02) dated 4 August 2008 and (Project 39798.04) dated 22 August 2011.

The proposed TSF development is presented in Section 2 of this report.

The PCA was undertaken to assess past and present contaminating activities, report on site condition, and provide a preliminary assessment of site contamination. The assessment was undertaken with reference to NSW EPA "Guidelines for Consultants Reporting on Contaminated Sites" (Ref 3).

The PCA was initially conducted in 2008 and comprised the following tasks:

- Review of available reports to collate previous investigation data relevant to the PCA;
- Review of available site history information;
- Site inspection;
- Soil, groundwater and surface water sampling at systematic and targeted locations over the greater Hexham site;
- Laboratory testing of selected soil, groundwater and surface water samples for a range of potential organic and inorganic contaminants;
- Interpretation of the results of laboratory testing in the context of field observations, local geology and hydrogeology, and history of the greater Hexham site.

The PCA was revised and updated in 2011 to reflect the site conditions present at the time of the assessment. The following additional work was conducted for the revised PCA:

- Review of the ERM 2010 environmental site assessment report;
- Review of aerial photos between 2008 and 2011;
- Site inspection in mid-2011;
- Testing of surface waters for pH and EC;
- Update of the previous PCA report.

Subsequent to the 2011 revision, the following additional work was conducted for the current assessment:

- Discussions with on-site personnel to confirm recent site activities;
- Brief site inspection on 11 April 2012 to assess current site conditions;
- Brief review of the groundwater assessment conducted by DP in late 2011;
- Revision of the PCA report to incorporate the revised proposed development, current site condition and additional information from the groundwater assessment and the Coffeys Contamination Assessment (Ref 24) that was conducted as part of the Hexham Relief Roads EIS (Ref 25).

The results of the 2008 investigation and 2011 revision, together with recent additional works are provided in the following report in relation to the proposed TSF development.

The following drawings were supplied for the purpose of this investigation, which are included in Appendix E:

- Proposed Arrangement (Sheets 1 and 2) – WorleyParsons;
- Areas of Disturbance (Cut and Fill) – GHD;
- Proposed Development Site Plan – Engenicom.

2. Site Description / Proposed Development

The greater Hexham site comprises an irregular shaped area approximately 255 ha and is identified by the following property descriptions:

- Lot 101 DP 1084709;
- Lot 102 DP 1084709;
- Lot 2 DP 735456;
- Lot 10 DP735235;
- Lot 104 DP1084709;
- Part Lot 104 DP 1084709;
- Lot 113 DP 755232;
- Lot 1 DP 155530;
- Lot 12 DP 1075150;
- Lot 1 DP 1062240;
- Lot 311 DP 583724.

The greater Hexham site is located on the western side of the New England Highway and Pacific Highway at Hexham, NSW. The greater Hexham site comprises an irregular shaped area of approximately 255 ha and is bounded to the east by the Great Northern Railway, to the north by Woodland Close and New England Highway, to the west generally by Chichester pipeline and the Hexham Swamp, and to the south by private rural residential property.

The proposed 38 ha TSF development area ("the site") is generally limited to a corridor about 150 m wide adjacent to the Great Northern Railway, due to the linear nature of the development. The TSF site in relation to the greater Hexham site area is shown on GHD Proposed Footprint and Property Descriptions, Lot & Deposited Plan in Appendix E. The ARTC Hexham Relief Roads Project which comprised five new train line (tracks) is located between the proposed TSF and the Great Northern Railway. The development generally only occupies a relatively narrow strip along the eastern side of the overall greater Hexham site, as shown on the WorleyParsons general arrangement figures in Appendix E.

The site boundary and proposed development layout is shown on Drawing 1, Appendix E.

It is understood that the proposed development includes the construction of a rolling stock maintenance facility, located adjacent to the Great Northern Railway Line. The proposed development will include the following aspects:

Stage 1:

- Construction of a connection to the Tarro Interchange and main vehicle access road to the site;
- Construction of earthworks, drainage, circulating roadwork and the construction of one provisioning track, a train examination road, two cut out roads and two wagon maintenance roads;
- Filling and grading of the TSF area (approximately 380,000 m^3 of suitable fill to be imported) so that site levels can match the adjoining rail network;
- Associated signalling and connections to the down coal road on the Great Northern Line;
- Construction of a Provisioning Facility;
- 2 x Provisioning roads and UTM road;
- 2 x Wagon Maintenance roads;
- Wagon storage road;
- Construction of a Wagon Maintenance Building;
- 1 x Wagon storage road;
- Fuel storage area to initially accommodate 2 x 100,000 litre tanks and to be constructed in such a manner as to allow for future expansion of up to 4 x 100,000 litre tanks of diesel fuel.

Stage 2:

- Locomotive Maintenance Building;
- Locomotive Wash Building;
- Locomotive Turntable;
- Locomotive Maintenance roads.

The proposed TSF development is shown in WorleyParsons Proposed Arrangement Figure 2 in Appendix E.

Filling

The majority of filling is proposed to be along the rail formation with the depth of filling in the range 0.2 m to 0.4 m on the southern parts of the site where the site is already filled and from 1.4 m to 1.8 m on the northern parts of the site, where the site is at low lying natural grades.

Localised areas of filling are also proposed as follows:

- 0.3 m high access road on northern parts of site;
- 0.3 m perimeter road around overall southern site, mostly on existing filled areas;
- 0.5 m high temporary construction compound on northern low lying part of site.

Approximate areas of proposed filling are shown on the GHD Areas of Disturbance – Fill plan in Appendix E.

Excavations

Excavations on site are proposed to comprise the following:

- Proposed Basins 1 to 3, with cut ranging from 0.1 m for Basins 1 and 2 on the northern part of the site to 2.6 m for the Basin 3 at the southern part of the site;
- Proposed cess drains leading to the various basins with depths of cut ranging from 1.6 m on the southern site to 1.0 m or less on the northern site;
- Site preparation for proposed access roads and associated culverts with depths of cut typically 0.3 m or less and in places up to 1.5 m;
- Temporary trench excavations for buried services, to depths of up to about 0.8 m.

Approximate areas of proposed cut (excavations) are shown on the GHD Area of Disturbance – Cut plan in Appendix E.

3. Background

3.1 Data Review of Previous Investigations

3.1.1 Overview

A review of available reports conducted by DP and others within or in the vicinity of the TSF site was undertaken. The reports reviewed are listed in Table 1 (DP reports) and Table 2 (reports by others) in chronological order, identified by a letter prefix. It is noted that the previous investigations were generally conducted over the greater Hexham site, and not specifically within the limited TSF site area.

Table 1: Previous Investigations Undertaken on the Site and Surrounding Area by DP

Reference Prefix**	Project Number	Date	Report Title	Field Tests
A	00083	February 1959	Subsoil Investigation, Hexham	3 Bores (location uncertain)
B	02961	March 1971	Foundation Investigation, Ironbark Colliery, Hexham	13 Bores
C	03389	March 1972	Foundation Conditions, Proposed Coal Preparation Plant Hexham	4 Bores
D	06109	June 1978	Foundation Conditions Proposed Road and Rail Interchange Station, Hexham	5 Bores, 2 CPTs
E	16781	August 1993	Geotechnical Investigation, Proposed Depot Redevelopment, Australian Co-Operative Foods Ltd, New England Highway Hexham	4 Bores, 3 CPTs
F	17163, 17163A	August 1995	Geotechnical Investigation and Building Preload, Proposed Service Station Redevelopment, Pacific Highway Hexham	8 Wells*
G	18419, 18419A, 18419B	November 1995	Geotechnical and Acid Sulphate Soil Investigation, Proposed Effluent Ponds, ACF, New England Highway Hexham	6 Test Pits
H	18419C	November 1995	Geotechnical And Acid Sulphate Soil Investigation, Proposed Effluent Ponds, ACF, New England Highway Hexham	2 Bores
I	18457	February 1996	Geotechnical Investigation, Proposed Industrial Development, Lots 1 and 2 Old Maitland Road Hexham	3 CPTs
J	18603	November 1996	Geotechnical Investigation, Proposed Extensions to Club and Car Park, Hexham Bowling Club, Hexham	6 Bores, 2 CPTs

Table 1: Previous Investigations Undertaken on the Site and Surrounding Area by DP (continued)

K	18891	September 1998	Geotechnical Investigation, Proposed Access Road, Hexham	12 Test Pits
L	18891A	January 1999	Geotechnical Investigation, Power Poles, Access Road and Smithy's Crossing, Hexham	5 Bores
M	18944, 18944A, 18944B	February 1999 to November 2000	Groundwater Monitoring, Dairy Farmers, 189 Maitland Road, Hexham	10 Wells*
N	31773	July 2003	Geotechnical Investigation, Augmentation Of Hexham Bowling Club Wastewater Facilities, Hexham Bowling Club, Hexham	2 Bores
O	39033	September 2004	Geotechnical Investigation, Proposed Weighbridge, Sparke Street, Hexham	3 Test Pits, 1 CPT
P	39052	September 2004	Preliminary Site Assessment, Maitland Road, Hexham	Desktop review of geotechnical and geo-environmental data
Q	39159	June 2005	Report on Water Balance Assessment for Disposal of Treated Waste Water	NA
R	39798	October 2007	Preliminary Geotechnical Investigation, Proposed Maintenance Facility, Woodlands Close, Hexham	15 CPTs, 12 Bores, 11 hand augers
S	39798.01	March 2008	Geotechnical Assessment Proposed Rail Siding, Hexham	Desktop review of geotechnical data
T	39798.05	February 2012	Groundwater Assessment, Proposed Hexham Redevelopment, Maitland Road and Woodlands Close, Hexham	12 Wells*

Notes to Table 1:

* Wells – Groundwater monitoring wells

** - Refer Drawing 4 for reference Prefix location

CPT – Cone Penetration Test

NA – Not Applicable

Table 2: Previous Investigations Undertaken on the Site by Others

Reference Prefix*	Company / Project Number	Date	Report Title	Field Tests
U	Garling Mining	October 1997	Unknown (partial report provided)	96 Pits and Bores
V	GHD / 45223	Undated	Rehabilitation of Property and Hexham (Environmental Impact Statement)	NA
W	GHD / 45966	September 2002	Preliminary Contaminated Site Investigation, Rehabilitation of Property at Hexham	NA
X	GHD / 51486	March 2003	Supplementary Information Report, Rehabilitation of Property at Hexham	NA
Y	RCA / 5463-001/0	June 2006	Phase 1 Environmental Site Assessment, 67 Maitland Road, Hexham	NA
Z	RCA / 5463b-002/0	July 2007	Geotech Constraints Report, Hexham Project - 67 Maitland Road, Hexham	NA
Z1	Coffeys GEOTWARA21045AC-A1	July2012	Contamination Assessment, Proposed Hexham Relief Roads	28 Pits 18 Bores 10 Wells

Notes to Table 2:

NA – Not Applicable, no subsurface field work undertaken

*- Refer Drawing 4 for reference Prefix location

It should be noted that the locations of previous tests within the site are approximate in most cases, particularly for the older investigations where site plans were unclear or open to interpretation.

A brief summary of the majority of DP reports, including the work done and principal findings is contained in Reference 1. Relevant information obtained from the review of previous reports is summarised below.

Subsequent to the PCA conducted by DP in 2008, an Environmental Site Assessment was undertaken by Environmental Resources Management Australia Pty Ltd (ERM) in October 2010 (Ref 22). A brief description of the ERM report is provided in Section 3.1.2 below. Information relevant to the TSF development obtained from the ERM report is included within the appropriate sections of this report.

In late 2011 a groundwater assessment was conducted by DP (Ref 23) for the greater Hexham site. A brief outline of the report is provided in Section 3.1.2 below. Information relevant to the TSF development obtained from the report is included within the appropriate sections of this report.

In July 2012 a contamination assessment was conducted by Coffeys (Ref 24) for the Hexham Relief Roads Project which is located between the TSF site and the Great Northern Railway. The results of this recent assessment were used to supplement the results of previous site assessments.

3.1.2 Southern Portion of the Greater Hexham Site

The following presents the pertinent information obtained from a brief review of relevant previous assessments undertaken on the southern portion of the greater Hexham site, namely Lots 311 DP 583724, Lot 1 DP 155530, Lot 12 DP 1075150 and Lot 1 DP 1062240.

Garling Mining Pty Ltd, October 1997 (Ref 4)

DP was provided with a copy of the test locations and a summary of pit and bore logs by the Client. The investigation included drilling/excavation of 96 bores and pits located throughout the coal tailings stockpile. The pits were excavated to depths ranging from 1.5 m to 5.5 m, whilst the bores were augered to depths ranging from 4.9 m to 16 m.

Natural material was encountered at the following depths:

- 6.5 m, north-east portion of the stockpile;
- 9.5 m, central portion of the stockpile;
- 2.1 m to 6.8 m, south-east portion of the stockpile.

Building rubble including furnace bricks, large masonry (brickwork, concrete) was observed in the central eastern portion of the site (i.e. to the east of CWR excavation) to depths ranging up to 2.5 m.

It is noted that the coal tailings stockpiles are generally located to the west of the TSF development. Proposed areas of cut and fill (refer GHD cut/fill drawings in Appendix E) and a proposed effluent disposal area (Drawing 2a, Appendix E), however, are proposed in this area.

Rehabilitation of Property and Hexham (Environmental Impact Statement) and Contaminated Site Investigation, Rehabilitation of Property at Hexham, GHD September 2002 (Ref 5)

An environmental impact statement (EIS) and contaminated site investigation was prepared to assess potential environmental impacts, as part of a development application. The proposed redevelopment comprised the removal of coal washery waste, drying and use at power stations. In addition the majority of the investigation area was proposed to be re-contoured to levels above the 1% AEP flood level (3.9 m AHD).

A limited history review indicated that the investigation area was previously a coal washing and stockpile area, serviced by steam locomotives only (Note: Reference 13 indicates that diesel trains also serviced the site). Tailings dams located in the northern portion of the investigation area were constructed using coarse coal reject. A plan dated 1981 indicates that three above ground storage tanks and two bowsers were formerly located within the investigation area.

The coal washery was closed in 1988 and the associated infrastructure has been subsequently demolished. The identified potential sources of contamination included the former above ground fuel tanks and bowsers, the use of pesticides and importation of fill material throughout the investigation area.

It is noted that the former above ground tanks and bowsers and majority of infrastructure associated with the former coal washery were located within the proposed TSF development footprint.

Preliminary Site Assessment, Maitland Road, Hexham, Douglas Partners Pty Ltd (DP), March 2004 (Ref 6)

The preliminary site assessment comprised a brief site inspection and desktop review, including review of the EIS by GHD to assess geotechnical and contamination properties of the investigation area. Anecdotal information (Dairy Farmers Employee, Mr Neil Alford) indicated that building rubble, understood to originate from demolition operations following the Newcastle Earthquake, was buried sporadically on the site.

The potential sources of contamination identified included the former above ground fuel storage tanks, truck wash bay, railway lines (pesticides, herbicides), ash, fill material of unknown origin, irrigation of treated effluent, potential acid drainage and leaching of salts from the stockpile area.

It is noted that these potential sources of contamination are associated with or have the potential to impact on the TSF development footprint.

Phase 1 Environmental Site Assessment, 67 Maitland Road, RCA Australia, June 2006 (Ref 7)

The assessment comprised a review of available site history, and a site walkover. No subsurface sampling or analysis was undertaken. The site history search indicated that the Minmi-Hexham railway and Hunter Valley Company Railway (Great Northern Railway) commenced operation in 1856. From the 1950's the site was reclaimed and developed as a coal preparation plant, stockpiling and despatch terminal.

RCA identified a number of areas of potential contamination as follows:

Former Minmi-Hexham Railway and Rail Yard:

- Bathhouse and Signal Box (Control Cabin) were present on the site. Anecdotal evidence indicated that the Control Cabin may have exploded. The cabin was burnt-out, with ash and building rubble (including fibre cement sheeting/fragments) in the base of the building;
- Vegetated stockpiles, approximately 20 m to the north of the bathhouse were identified;
- Minmi-Hexham Railway embankment is visible, some sleepers and concrete foundations remain. The embankment appeared to comprise coal reject.

It is noted that the Bathhouse and signal box (control cabin), vegetation stockpiles and part of the railway embankment are situated within the TSF development site.

Former Tailings Pond / Coal Reject Stockpile:

- Former Coal washery tailings dam;
- The area to the south of the large CWR excavation, was understood to contain building rubble from the Newcastle Earthquake (Anecdotal information suggests the tailings dams were capped with coal reject and clay material. The clay material was understood to have been sourced from a road cutting in Jesmond);
- The area to the north-east of the large CWR excavation is reported to contain refractory bricks, concrete and steel reinforcing;

It is noted that some areas of cut/fill are proposed within this area for the TSF development.

Site Stormwater and Discharge Points:

- Off-site migration of effluent irrigation water.

Former Coal Washery and Rail Loop:

- RCA reported indiscriminate dumping of waste, including steel and possibly asbestos.

The associated contaminants of concern include Heavy Metals, Total Petroleum Hydrocarbons (TPHs), Polyaromatic Hydrocarbons (PAHs), solvents, faecal coliforms and asbestos. RCA recommended further work, comprising both soil and groundwater sampling, be undertaken to assess the extent and nature of potential contamination at the site.

It is noted that the majority of infrastructure associated with the former coal washery is located within the proposed TSF development area, however, the coal reject stockpiles are generally located to the west of the TSF with the exception of the localised areas of cut/fill and the proposed effluent disposal area.

Project Thomas II, Stage 2 Environmental Site Assessment by ERM, October 2010 (Ref 22)

An assessment on the southern portion of the greater Hexham site was undertaken by ERM in October 2010. The assessment comprised subsurface sampling and analysis from nineteen test pits and 21 bores (refer to ERM Figure 2, Appendix E). The pits were excavated to depths ranging from 0.8 m to 3.0 m, whilst the bores were augured to depths ranging from 1.3 m to 7.5 m. Groundwater monitoring wells were installed in 10 of the 21 bores to depths ranging from 2.0 m to 7.5 m.

A total of 82 soil samples and ten water samples were tested for BTEX, heavy metals (As, Cd, Cr, Cu, Hg, Pb, Ni, Zn), TPH and PAH. Two fragments of fibro sheeting were also analysed for asbestos.

The results of the ERM investigation have been incorporated into this report and outlined below.

Contamination Assessment, Proposed Hexham Relief Roads Project Hexham, Coffey Environments, July 2012 (Ref 24)

The contamination assessment was conducted as part of the EIS for the proposed Relief Roads Project, located immediately adjacent to the north east boundary of the subject site (i.e. between the subject site and the Great Northern Railway).

The assessment comprised a review of background information, subsurface investigation (28 test pits, 18 bores, 10 groundwater wells), and collection and analysis of soil, surface water and groundwater samples.

A number of areas of environmental concern were identified in the assessment (i.e. rail ballast, imported fill materials, former and existing building areas, former abandoned fuel tanks, historical rail use, adjacent industrial land, groundwater, effluent irrigation, illegal dumping of waste).

The assessment indicated that the potential for widespread soil contamination within the project area was considered to be low.

Some soil contamination (hydrocarbon) was identified, that would require remediation/management. Widespread contamination of surface water (faecal coliforms, E. Coli, nutrients and metals) and groundwater (metals and nutrients) was identified. It was considered impractical to remediate the surface water and groundwater impact within the project area due to the widespread nature of contamination and the already degraded state of this portion of Hexham Wetland.

The following general recommendations were made in the report:

- Prepare and implement a Remediation Action Plan to remediate/manage the identified contamination;
- Prepare a Construction Environmental Management Plan (CEMP) to protect workers during construction;
- Prepare a Water Quality Management Plan as part of the CEMP to manage surface water and groundwater contamination.

It is noted that the Coffeys report generally related to the narrow strip of land between the subject site (Train Support Facility) and the existing Great Northern Railway, which is proposed for the construction of five new train lines (tracks) for the Relief Roads.

3.1.3 Central Portion of the Greater Hexham Site

The following presents a brief review of relevant previous assessments undertaken on the central portion of the greater Hexham site, namely Lot 113 DP 755232, Lot 104 DP 1084709.

Groundwater Monitoring, Dairy Farmers, 189 Maitland Road Hexham, by DP, June 1999 (Ref 8), September 1999 (Ref 9) and October 2000 (Ref 10)

The groundwater monitoring assessment was undertaken to address EPA licence requirements for spray irrigation of treated effluent from the Dairy Farmers Factory, restaurant and service station located to the east of the investigation area. The effluent was treated to secondary level and spray irrigated on about 44 hectares to the north and north-west of the treatment plant.

Subsurface conditions generally comprised topsoil or fill to depths of 0.2 m to 0.5 m underlain by silty clays to 0.5 m to 2.8 m depth, underlain by sandy clays to termination depths between 2.8 m and 4.3 m.

Groundwater contours indicated the presence of a shallow groundwater ridge near the eastern boundary of the investigation area. Groundwater within the effluent irrigation area generally flowed north and north-west. The estimated hydraulic conductivity of underlying sandy clays/clayey sands were relatively low, ranging between 2 x 10^{-6} m/s and 7 x 10^{-6} m/s. The seepage velocity was estimated to be 0.5 m to 2 m/year in the effluent irrigation area migrating to the tidal drain to the north of the site. Piezometric data loggers indicated that there was minimal tidal influence on groundwater from the nearby Hunter River.

DP undertook three rounds of groundwater monitoring between June 1999 and October 2000. The laboratory results for each of the wells were found to be relatively consistent between monitoring rounds. Elevated concentrations of faecal coliforms, and Total Kjeldahl Nitrogen (TKN) were detected at some locations. Where relevant, the results of the assessment have been referenced in the current assessment.

It is noted that the TSF footprint encroaches within the spray irrigation area in the northern section of the site (refer to Drawing 2A, Appendix E). The TSF is also down-gradient of the broader spray irrigation area (i.e. potential receptor).

Water Balance Assessment for Disposal of Treated Wastewater, Dairy Farmers, 189 Maitland Road, Hexham, by DP, June 2005 (Ref 11)

The report provides the results of a water balance assessment for the disposal of treated wastewater. The work was conducted to assess treated wastewater irrigation activities for the estimation of wet weather storage requirements based on water balance estimates. In 2004, the irrigation rate for treated wastewater averaged 3.8 ML per week and was irrigated over an approximately 60.1 ha area. It is understood that the irrigation area was increased to approximately 64.6 ha. The approximate irrigation area is shown on Drawing 2A, Appendix E.

The results of the assessment indicated that both the irrigation area and wet weather storage volume should be adequate for the hydraulic loading from Dairy Farmers Operations.

Irrigation of Milk Factory Effluent, Hexham, Soil Monitoring Report, by NSW Department of Primary Industries, November 2007 (Ref 12)

The report describes the impact irrigated treated effluent has had on the soil and water properties of irrigated areas. The assessment forms part of approximately annual monitoring at the greater Hexham site. The main impact of the effluent irrigation is the build-up of phosphorous and fluctuating surface salinity. Nitrate levels in the soil were recorded as low. The estimated nutrient and organic loading rates for 2005 are presented in Table 3 below.

Table 3: Estimated Nutrient and Organic Loading Rate for 2005[1]

	Mean Concentration (mg/L)	Loading Applied (kg/ha)	
		Pastures	Coalwash
Total Suspended Solids	2628	3992	7256
Oil / Grease	480	729	1375
Biological Oxygen Demand	2376	3609	6804
Total Phosphorous	48	72.9	137.5
Total Nitrogen	0.42	0.64	1.2

Notes to Table 3:

1. Sourced from Ref 12.

Groundwater Assessment, Proposed Hexham Redevelopment, Maitland Road and Woodlands Close, Hexham, February 2012 (Ref 23)

The groundwater assessment was undertaken to further assess groundwater conditions and provide recommendations for groundwater management at the greater Hexham site. The assessment included drilling and installation of 12 additional wells (at eight locations) including four paired wells to improve the groundwater monitoring network, sampling of 35 groundwater monitoring wells (new and existing), laboratory testing of soil and groundwater samples and mapping of groundwater contours (refer to DP Drawing 2, Appendix E). The new wells were installed adjacent to site boundaries to assess groundwater quality potentially migrating from the greater Hexham site.

Laboratory analysis comprised 14 soil samples for TRH, BTEX, PAH & Metals (8), five soil samples for TPH via silica-gel clean up analysis; 39 groundwater samples for TRH, BTEX, PAH, Metals (9), pH and EC; and 10 groundwater samples for Faecal coliforms, TKN, TN, TP and BOD.

A summary of pertinent results from this assessment have been incorporated with this report.

4. Geology and Hydrogeology

The 1:100,000 scale Newcastle Coalfield Regional Geology map (Sheet 9321), published by the Department of Mineral Resources, indicates that the site is underlain by Quaternary Alluvium. The alluvium typically comprises unconsolidated sediments deposited in a fluvial or estuarine environment, and includes gravel, sand, silt and clay.

Reference to the Acid Sulphate Soil Risk Map for Beresfield (Sheet 9232 N3), published by the Department of Land and Water Conservation, indicates the entire site has a high probability of acid sulphate soils within one metre of the (natural) ground surface.

An online records search of registered groundwater with the Department of Water and Energy (DWE-currently NSW Office of Water) indicated that there are nine registered groundwater wells located around the perimeter of the greater Hexham site and are used for monitoring purposes. The monitoring bores were registered in October 2011 and were installed as part of the current investigations associated with the proposed TSF development.

Reference to the Department of Natural Resources, Natural Resource Atlas indicates that the south-eastern portion of Lot 113 DP 755232 is identified as a SEPP 14 Wetlands. SEPP 14 places planning and development controls under the Environmental Planning and Assessment Act 1979.

Based on previous investigations (Ref 8) and site conditions, the regional groundwater is understood to be shallow, relative to the natural ground surface. Effluent irrigation is likely to cause either a perched water table in filling or a localised raised water table within natural soils.

The regional groundwater flow regime is expected to be to both the west of the greater Hexham site towards Hexham Nature Reserve, located along the western boundary of the greater Hexham site and to the east of the greater Hexham site toward the Hunter River, located less than 200 m from the central portion of the eastern boundary. Groundwater in the central northern portion of the greater Hexham site is likely to flow towards two unlined drainage channels that drain across the greater Hexham site in an approximate west-east and south-west to north east direction, which drain to Purgatory Creek then the Hunter River.

Previous investigations (Ref 8) undertaken in the central portion of the greater Hexham site estimated hydraulic conductivity of underlying sandy clays/clayey sands to be relatively low, ranging between 2×10^{-6} m/s and 7×10^{-6} m/s. The seepage velocity in the effluent irrigation area migrating to the tidal drain to the north of the site was estimated to be 0.5 m to 2 m/year.

It should be noted that groundwater levels are affected by climatic conditions and soil permeability and will therefore vary with time.

Reference to the 1:25,000 topographical map for Beresfield, the 1:4000 orthophoto map for Hexham U63657 and a contour plan provided by WorleyParsons Pty Ltd indicates that the site is relatively flat with the exception of large filled areas in the southern portion of the site (associated with former railway lines, coal tailings stockpile and former coal preparation plant area).

The northern and central portion of the greater Hexham site typically ranges in elevation from RL 0.2 to 1.2 AHD, with the exception of scattered stockpiles which range up to RL 6.8 AHD. Site drainage would drain toward four drainage channels located in the northern and central portion of the greater Hexham site. The northern drainage channel is orientated in a south-west to north-east and west to east direction. Two small drainage channels in the central portion of the site fall in an approximately north-west direction. The two drainage channels converge and flow to the western boundary. To the west of the site the drainage channel flows to the north and converges with a larger drainage channel which passes through the site in a west-east direction.

The coal tailings stockpiles generally located immediately west of the TSF development area form a large elevated platform of RL 8 to 10 AHD, ranging up to RL 13 AHD in the central portion. The coal stockpile has relatively steep embankments, with a drainage channel around the perimeter, which drains in a westerly direction. A number of drainage channels and low lying swampy areas are present throughout the southern portion of the site including:

- A drainage channel orientated in an east-west direction, which is located in the southern portion of the site;
- A drainage channel along the base of former railway embankment, which is located in the south-east portion of the site orientated in a north-south direction;
- A drainage channel to the west of the gravel access road along the eastern boundary at approximately Ch 174.5 km to 174.6 km.

Site levels to the east and south of the coal tailings stockpile have been modified by the placement of fill and range between RL 1.8 and 4.8 AHD. The southern portion of the site is low-lying and ranges between RL 0.6 m to 0.8 AHD.

Site contours and drainage channels are shown on Drawing 2A, Appendix E.

Further information on site hydrology is presented in the DP report on the Assessment of Potential Groundwater Level Impacts for the TSF development (Ref 26).

5. Site History

5.1 Extent of Site History Review

The preliminary contamination assessment was conducted with reference to NSW EPA Guidelines (Ref 3), and comprised the following:

- Searches with Newcastle City Council (NCC);
- Review of Literature and former site survey plans;
- Review of historical aerial photos;
- Searches with NSW Department of Environment & Climate Change (DECC – currently NSW EPA);
- Search of nearby registered groundwater bores through NSW Office of Water;
- WorkCover Dangerous Goods Register Search;
- Discussions with Dairy Farmers Employee (Mr Paul Alford).

Details are presented in the following sections.

The site history review was generally conducted for the greater Hexham site area. Historical information relevant to the TSF site was utilised for the preliminary contamination assessment.

5.2 Searches with Newcastle City Council

Correspondence in 2008 with Newcastle City Council (NCC) identified the following Building Applications (BA) and Development Applications (DA) had been submitted:

Lot 311 DP 583724 and Lot 1 DP 155530 and Lot 12 DP 1075150

- 1964 BA: Factory Building;
- 1965 BA: Alterations and Additions to Factory;
- 1967 BA: Alterations and Additions;
- 1969 BA: Amenities;
- 1972 BA: Materials Handling Plant;
- 1973 BA (2): Amenities; Alterations and Additions;
- 1974 BA (2): Storage Shed; Alterations and Additions;
- 1979 BA: Truck Washing Facility (Wheel Wash);
- 1980 BA: Amenities;
- 1983 DA/BA: Amenities Building;
- 1984 DA/BA: Warehouse;
- 1986 DA/BA: Alterations and Additions;
- 1987 DA/BA (2): Switch Room; Alterations and Additions;
- 2002 DA: Site Rehabilitation.

Lot 1 DP 1062240

- Nil on record.

Lot 113 DP 755232

- 1962 BA (3): Boat cover; Garage; Alterations and Additions;
- 1963;1966(2);1967;1969;1971;1972(4);1973;1980;1983;1984;1991;1993(2);1994(3);1996(4) BA's: All Alterations and Additions;
- 1970 BA (5): Offices; Milk Silos; Amenities; 2 x Alterations and Additions;
- 1985 BA (2): Boiler House; Alterations and Additions;
- 1989 BA (2): Milk Bar & Fast Food; Petrol and Convenience Store;
- 1991 DA: Recycle Waste Water for Irrigation;
- 1992 BA: Pump House and Dam;
- 1995 BA (2): Upgrade Effluent Treatment System; Alterations and Additions;
- 1998 BA (2): New Shed; Fire Sprinkler System;
- 2000 DA: Subdivision.

Based on the above BA/DA information, Lot 113 DP 755232 appears to have been previously included in a larger allotment which incorporated the Dairy Farmers Factory located to the east of the site. It is considered likely that the BA/DAs from 1962 to 1989 are associated with development to the east of the subject site.

Lot 104 DP 1084709

- 2004 DA: Subdivision.

Lot 2 DP 735456 and Lot 1 DP 735456 and Lot 10 DP 735235

- Nil on record.

Lot 101 DP 1084709 and Lot 6 DP 735235

- 1999 DA: Floodlighting Over Sign;
- 2004 DA: Subdivision.

Lot 102 DP 1084709

- 2004 DA: Subdivision.

Review of individual Section 149 Planning Certificates for the site, indicated the following:

- The property is, or contains, flood prone land as defined in the Floodplain Development Manual;
- The property is zoned 4(b) Port and industry Zone, 5(a) Special uses Zone –Transport, 7(b) Environmental Protection Zone;
- The land is not within a proclaimed Mine Subsidence District under the Mine Subsidence Compensation Act 1961;
- The land is not affected by matters required to be disclosed under section 59(2) of the Contaminated Land Management Act 1997;
- The site is affected by a notice by the Minister for Planning for receipt of a proposal for amendment of Schedule 3 of the State Environment Planning Policy (Major Developments) 2005 to include the site identified as "Hexham Redevelopment", gazetted on 14 December 2007.

In addition, the following information for individual properties was provided:

Lot 311 DP 583724, Lot 1 DP 155530, and Lot 12 DP 1075150

- The Minmi – Hexham Railway Line is situated on the land;
- Land development records indicate that the land may have been used for a waste emplacement facility in association with coal washery operations;
- The land is affected by a property agreement between Coal and Allied Operations Pty Limited with NCC indemnifying Council from any claim in the event of proposed additions being damaged by floodwaters.

Lot 113 DP 755232

- Land use history indicates that the land was previously used for effluent treatment purpose.

Lot 100 DP 1084709

- Land use development records indicate the site may have previously been used for coal loading purposes.

5.3 Review of Literature

Coal, Railways and Mines, The Story of the Railways and Collieries of J & A Brown by Brian Robert Andrews, Iron Horse Press, 2004, 2nd edition 2007 (Ref 13)

The following presents a brief summary of the historical information relating to the site:

- Minmi-Hexham Railway construction commenced in 1853;
- Construction required large amounts of fill to make embankments across the swamp. The fill was sourced from the side of a hill about two miles from Minmi, a location now known as the 'Sand Cutting';
- The railway was constructed by laying bushes and logs on the swamp then covered with suitable material for the formation of the Railway;

- A signal man was stationed at the Minmi-Hexham and Hunter River Company Railway crossing (currently the Great Northern Railway);
- In the mid-1850's a coke works was constructed in Minmi, producing approximately 10 tonnes (approximately 10.16 tonnes) of coke per week, which was transported to Hexham for shipment;
- In 1859, the Great Northern Railway and the Minmi-Hexham Railway were connected with two sidings and a run-around loop. By 1900 Colliery Siding consisted of seven sidings and one loop. The Hexham Staithe and Workshop area (to the east of the site) consisted of engineers and carpenters workshops and two loading shoots;
- A plan dated 1890 indicates that there were cottages between the rail siding and Minmi-Hexham Railway;
- In 1909, an second rail line between Hexham and Minmi was constructed;
- A ninth siding was constructed in 1949, and was used to access the Hexham Coal Preparation Plant;
- During the 1960's three sidings were constructed (No 9 to 11) to store trains of unwashed coal in transit to the Coal Preparation Plant;
- In 1942, work commenced on a locomotive shed to the west of the Great Northern Railway. The locomotive sheds included ash pits;
- Bathhouse constructed adjacent to control cabin in 1949;
- A crushing and sizing plant was constructed on the northern side of the sidings and operated between 1936 and 1955. A dump hopper below rail level on the first loop. The coal was fed by a plate feeder to a crusher and then onto a conveyor belt through to an overhead building that spanned three rail lines to facilitate loading onto rail wagons. A schematic site plan of the sidings is presented in Appendix B.

Coal Preparation Plant

- Construction of the Coal Preparation Plant commenced in 1953 and began operation in 1955. The site was filled with stone and shale from collieries and from Richmond Vale Colliery for the formation of the rail sidings associated with the plant;
- Wagons of unwashed coal were dumped into a below rail level hopper, taken to the plant for washing. The washing consisted of passing coal over a 'medium bath denser than coal but lighter than the stone and shale'. The stone and shale falls to the bottom and is collected as reject;
- Between 1957 and 1962, a stacking and reclaim system was constructed, comprising an elevated conveyor belt and an conveyor belt fitted in an underground tunnel below the stockpile;
- A rail crossing was constructed on the Up-side of Hexham Signal box (i.e. North of Hexham Station) in 1963;
- In 1972, the Coal and Allied Balloon Loop Siding was constructed. The area was filled with reject from the Coal Preparation Plant. A schematic site plan of the site is presented in Appendix B;
- A loading bin and conveyor were constructed along the railway as depicted in a 1988 site photograph presented in Appendix B;

- A schematic site plan presented in Appendix B, depicts the site layout in 1978 with the Balloon Siding, the Coal Preparation Plant, the Coal & Allied Siding and Browns Siding (former Colliery Siding, adjacent to former Minmi Hexham Railway);
- In the mid-1980's a conveyor system was constructed from the Coal Preparation Plant to allow coal to be road-hauled and fed into the plant using loaders. A site photo of the Coal Preparation Plant is presented in Appendix B;
- Hexham Coal Preparation Plant closed in May 1988.

5.4 Review of Historical Aerial Photographs

The following historical aerial photos and orthophotos were reviewed for the assessment:

Table 4: Aerial Photo Review

Year	Approximate Scale	Black & White/Colour
1944	1: 4,000	B & W
1954	1: 30,000 and Enlargement	B & W
1961	1:16,000	B & W
1965	1:16,000	B & W
1966	1: 30,000	B & W
1971	1:16,000	B & W
1974	1: 16 000 and Enlargement	B & W
1986	1:4,000 Orthophoto	B & W
1990	1:16,000	Colour
1992	1: 25,000 and Enlargement	Colour
2004	1:10,000	Colour
June 2010	Near Map Digital Image	Colour
November 2010	Near Map Digital Image	Colour
June 2011	Near Map Digital Image	Colour

1944 Aerial Photograph (not including northern or southern part of greater Hexham site)

- The Minmi-Hexham Railway runs parallel and to the west of the Main Northern railway along the southern part of the site before heading west about midway along the site at about chainage 175.7 km to 175.9 km (south of Dairy Farmers boundary);
- The locomotive shed, bathhouse, control cabin and crushing plant are evident along the Minmi-Hexham railway;
- A number of Minmi-Hexham rail lines crossed the Main Northern Railway and extended to the east of the site toward a rail yard along the bank of the Hunter River;

- Hexham Station had been constructed at this time. A small building appears to be present to the west of Hexham Station (to the east of the site);
- Old Maitland Road, the Great Northern Railway and Hexham Station are present to the east of the site;
- Woodlands close formed part of the New England Highway at this time and crossed the railway line at about Ch 177 km;
- An overhead conveyor (or similar) extended from the Hunter River over the rail line (at about Ch 176.8 km) to a rail siding parallel to the Main Northern Railway land extending to the west of Woodlands Close. A small to medium sized building was located to the south of the rail siding;
- A rural/residential style building and sheds were located in the central portion of the greater Hexham site (Lot 113 DP 755232) and the surrounding area appears to have been fenced into ploughed or tilled paddocks. Clumps of scatted trees remained in the south-eastern and north western portion of Lot 113 DP 755232;
- To the south of the Minmi-Hexham Railway the site and surrounding land to the west is undeveloped low-lying swamp land;
- A pipeline is evident along the western boundary of the greater Hexham site, a rural residential dwelling is located to north-west of the Minmi-Hexham rail line;
- Factory style buildings had been constructed on the adjacent Dairy Farmers site to the east of the site.

1954 Aerial Photograph

- Similar to the 1944 aerial photograph;
- Construction had commenced for a rail line running parallel approximately 100 m to the west of the eastern greater Hexham site boundary between the southern boundary of the property and the Minmi-Hexham rail line;
- A large factory style building (coal preparation plant) had been constructed along the rail line about Ch 177.7 km to 177.9 km;
- Some clearing of vegetation to the south of the Minmi-Hexham rail line had been undertaken, possibly associated with the rail line construction;
- The southern portion of the site was undeveloped low-lying swamp-land and grass-land;
- The low-lying swamp in the south-east portion of Lot 113 DP 755232 appears to have contained ponded surface water;
- An excavated drainage channel has been constructed, directing water around the rail-siding to a drainage culvert to the east of the site toward Purgatory Creek, which flows to the Hunter River;
- Ponded/dammed water is present to the west of the conveyor and rail-siding;
- The northern portion of the site was grassed and appears to have been ploughed/tilled (possibly cropped);
- The surrounding land use appears to have been predominantly rural and residential with some light industry (dairy farmers) to the east of the site and swamp land to the south and south-west. In addition, Hexham Bridge to the east of the site had been constructed at this time.

1961 Aerial Photograph (Southern portion of great Hexham site only)

- Similar to the 1954 aerial photograph;
- Additional infrastructure has been constructed near the coal preparation plant. A coal stockpile to the south-west of the preparation plant and a tailings area for coal fines to the north west are also evident;
- Rail crossing on southern part of the site at about Ch 174.1 km;
- A number of residential dwellings had been constructed along Old Maitland Road to the east of the site.

1965 Aerial Photograph

- Similar to the 1961 aerial photograph;
- An additional rail crossing is located at about Ch 175.4 km;
- The northern portion of the site remained unchanged predominantly rural agricultural land use, with signs of ploughing/tilling and possibly cropping in some areas;
- Re-alignment of the New England Highway to the north of the site, creating a Tarro by-pass.

1966 Aerial Photograph

- Similar to the 1965 aerial photograph.

1971 Aerial Photograph

- Similar to the 1966 aerial photograph. Tailings dams have been constructed to the north west of the coal preparation plant, and coal stockpiles are located to the south-west of the plant;
- The remaining portion of the site appeared unchanged with the exception of, an unpaved access road to the rural residential property in the central portion of Lot 113 DP 755232, which is now evident.

1974 Aerial Photograph (not including northern portion of greater Hexham site)

- Rail Loop and associated conveyor had been constructed at this time. The area to the south of the rail loop appears to have remained low-lying swamp land;
- Additional infrastructure surrounding the coal preparation plant had been constructed. The area to the north-west and south-west of the preparation plant appears to be coal stockpiles, and the coal tailings dams appear to be located to west of the coal stockpiles and to the north and rail loop;
- The railway lines associated with the former rail siding located to the south-west of Woodlands Close appear to have been removed. The conveyor and associated buildings remain on the site.

1986 Orthophotomap

- Coal Preparation Plant buildings, stockpiles, tailings ponds, conveyors and the rail loop are present, and in operation. The coal stockpiles and tailings dam area have expanded to the north to the Minmi-Hexham rail line;
- Rail carriages appear to be present on rail loop and the Minmi-Hexham rail line;
- A large silo, or similar, has been constructed on the site to the north of the rail crossing at about Ch 175 km 300 m to 400 m;
- A small building is present near the rail crossing at about Ch 175 km 300 m to 400 m, possibly a gatehouse. A wheel wash is located to west of the building, and a small dam was located to the south-west of the building;
- Minmi-Hexham rail crossing to Hunter River appears to have been decommissioned, along with the rail line to the west of the greater Hexham site;
- The conveyor and adjacent buildings associated with the former rail-siding to the south-west of Woodlands Close has been decommissioned;
- The rural-residential property in the central portion of Lot 113 appears to have been demolished;
- The electrical transmission line traversing the northern portion of the greater Hexham site has been constructed. The northern portion of the greater Hexham site appears to have been used for rural activities. Ponded water is evident in the low-lying sections;
- The second arm of the Hexham Bridge has been constructed along with several commercial/industrial developments to the east of the site.

1990 Aerial Photograph (excludes northern portion of greater Hexham site)

- The coal tailings dams are evident however the majority of coal stockpiles are vegetated with grass, indicating that site operations had ceased;
- The coal conveyors appear to have been decommissioned, however the remaining buildings and infrastructure are present on the greater Hexham site, including a number of rail carriages on the Minmi-Hexham rail line.

1992 Aerial Photograph

- The former tailings dams appear to have been filled and are vegetated with grass;
- The buildings associated with the coal preparation plant have been decommissioned. Only the concrete slabs appear to remain;
- Trees are present within the rail loop and adjacent to the former rail lines.

2004 Aerial Photograph

- The Dairy Farmers effluent treatment plant has been constructed. Ponded/dammed water is present along the edges of the coal stockpile, indicating that effluent irrigation may have commenced;
- An excavation approximately 100 m by 150 m has been excavated within the central portion of the coal stockpile;
- The remaining portion of the greater Hexham site and the surrounding area remained relatively unchanged.

June 2010 Aerial Photograph

- Stockpiles of dumped material/rubbish are located in the central portion of the site, approximately 70 m east of the Bathhouse;
- A large number of stockpiles of imported fill are located directly to the east of the CWR excavation;
- A fenced compound associated with the Chichester pipeline upgrade is present at the south eastern portion of the site, adjacent to the balloon rail loop. The compound contains a significant amount of piping, large soil stockpiles, construction materials and equipment;
- Ground works and stockpiling located at the north western portion of the WWTP site.

November 2010 Aerial Photograph

- An excavation approximately 2.95 km in length has been undertaken along the western edge of the greater Hexham site for the Chichester pipeline upgrade;
- Earthworks have been undertaken on fill stockpiles located directly east of the CWR excavation to form a possible bike (motor-cross) track;
- The fenced compound associated with the Chichester pipeline now contains site sheds and an increased amount of construction equipment around the perimeter of the compound. Soil stockpiles and piping have reduced in size and number. A trenched and bunded area has been constructed directly south of the compound;
- An excavated channel relating to the Chichester pipeline upgrade, approximately 475 m long by up to 25 m wide (tapering off slightly towards the east) is located south-west of the fenced compound. Orange staining is present within areas of surface water;
- Site offices associated with the Chichester pipeline upgrade are located at the north western portion of the WWTP site;
- A fenced stockpile of material, possibly excavated during the construction of the new Chichester pipeline, is located in the far northern portion of the greater Hexham site.

June 2011 Aerial Photograph

- Chichester pipeline upgrade works appear to be continuing;
- Fill stockpiles located directly east of the CWR excavation used to form a possible bike (motor-cross) track appear to have been levelled and spread out;
- The fenced compound associated with the Chichester pipeline contains less piping and only smaller stockpiles. The trenched and bunded area constructed directly south of the compound contains some stockpiled soils and possible lime;
- The orange staining present within areas of surface water located south-west of the fenced compound associated with the Chichester pipeline upgrade has reduced in size, however has appeared to have migrated to the south;
- The fenced stockpile of material, possibly excavated during the construction of the new Chichester pipeline, located in the far northern portion of greater Hexham site is still evident. Some drums are also present adjacent to the stockpile.

It is noted that data obtained from aerial photos was limited due to the relatively small scale and poor resolutions. Historical aerial photos reviewed for this assessment are shown in Appendix B.

5.5 Review of Historical Site Plan

A topographic site plan entitled “Coal and Allied Operation Pty Limited, Hexham Coal Preparation Plant”, dated March 1981 was reviewed. The site plan was adapted from aerial photography (dated November 1980) and presents topography and site infrastructure for the southern portion of the greater Hexham site.

The site layout is generally consistent with the 1974 aerial photograph. Site infrastructure included:

- The Coal Preparation Plant with a number of buildings to the east and south including an Electrical Installation Building;
- An overhead conveyor from the Coal Preparation Plant to the Coal Stockpile area (west);
- A Refuelling area, with three fuel storage tanks and two bowsers;
- The Balloon Railway Loop with conveyor;
- A loader, which is depicted to the east of the bathhouse.

It is noted the above-mentioned infrastructure is within or partly within the TSF development area.

5.6 NSW Department of Environment and Climate Change

A review of the NSW DECC (currently NSW EPA) public register in 2008 indicated the site has no statutory notices issued under the provision of the Contaminated Land and Management Act.

5.7 NSW WorkCover Dangerous Goods Register Search

A search of the Stored Chemical Information Database (SCID) and microfiche records by NSW WorkCover regarding licences to keep dangerous goods was undertaken in 2008 for the following lots:

- 67 Maitland Road, Hexham (Lot 311 DP583724, Lot 1 DP 155530, and Lot 12 DP 1075150);
- 65A Maitland Road, Hexham (Lot 1 DP 1062240);
- 179 Maitland Road, Hexham (Lot 113 DP 755232).

The search did not identify any records for these properties.

5.8 Discussions with Dairy Farmers Employee (Paul Alford)

The following information was obtained from discussions in 2008 with Mr Paul Alford, an employee of Dairy Farmers (now owned by Brancourts Pty Ltd) who oversees the waste water treatment plant and effluent irrigation:

- The dam wall embankments for the waste water treatment plant were constructed using site clays sourced from an area to the west and north-east of the treatment plant. These areas have subsequently been filled with fill material from varying sources;
- The waste water treatment plant treats approximately 500,000 L/day;
- A concrete bunded 1000 L above ground diesel storage tank is located within the waste water treatment plant and is used for refuelling;
- No large quantities of chemicals are stored on site;
- Pesticides (i.e. Round-up) are periodically applied within the effluent irrigation area;
- According to Mr Alford building rubble is present within the coal tailings stockpile in sporadic areas. He considers that the building rubble may have originated from the Newcastle Earthquake.

Discussions in 2012 with Mr Paul Alford indicated the following:

- A significant reduction in irrigation volumes since Brancourts Pty Ltd takeover due to reduction in dairy production;
- Bike (motocross) track has since been levelled using machinery used to construct the HWC pipeline;
- Mr Alford has been engaged to erect fencing and lockable gates along the HWC pipeline to keep livestock away from the area.

6. Site Condition

6.1 Site Features Observed During 2008 Investigation

The 2008 investigation was conducted over the greater Hexham site area. The site was divided into three main areas for descriptive purposes. The features relevant to the TSF site are described below.

Southern Portion (Ch 174 km to 175.9 km)

The southern portion of the greater Hexham site comprised Lots 311 DP 583724, Lot 1 DP 155530, Lot 12 DP 1075150 and Lot 1 DP 1062240.

The greater Hexham site contains the remains of a former Coal Preparation Plant and associated facilities, former tailings ponds (stockpiles) and part of the disused Minmi-Hexham Railway and Colliery Sidings. The remains of the former Coal & Allied Balloon Loop were present on the south-western part of the greater Hexham site, which the proposed TSF developments effluent disposal area encroaches upon. The area to the south of the Balloon Rail Loop appeared to be low-lying swamp land.

An unsealed access road is situated along the eastern boundary of the greater Hexham site, immediately adjacent to the Great Northern Railway. The access road was used to gain access to Lot 312 DP 583724 located further to the south of the site. It is understood that the access road was constructed in 1999. It is noted this road is situated to the east of the TSF footprint in the southern portion of the site (i.e. ARTC Hexham Reliefs Road Project).

Site levels have been modified by the placement of filling, generally associated with the former Coal Preparation Plant facilities, including rail sidings. The site levels along the eastern portion of the site vary from RL 0.4 AHD to 3.7 AHD. Surface observations indicated that coal washery reject was the predominant fill type (refer Figure 1). Site vegetation comprised grass, reeds (low lying parts), together with scattered trees.

Figure 1: Filled area in central-eastern portion of the greater Hexham site. Coal reject and fines evident in the surface material (looking south)

The former tailings pond in the north-western portion of the greater Hexham site had been filled with coal fines and coal reject forming an elevated platform (stockpile) approximately 6 m (RL 8 AHD) above the surrounding area. An area in the central portion of the stockpile has been raised above the surrounding platform and has an elevation ranging up to RL 13 AHD. At the time of field work, the stockpile was spray irrigated with treated effluent by Dairy Farmers and was densely vegetated with grass (Figure 2). Anecdotal information indicates that building rubble (understood to originate from demolition operations following the 1989 Newcastle Earthquake) had been buried sporadically on the area (see Section 5).

Figure 2: Densely vegetated grass on surface of stockpile, looking north-east

An excavation approximately 100 m by 150 m was present in the central portion of the stockpile. It is understood that the excavation was undertaken in about 2001-2002 as part of a trial to reclaim, dry and beneficially use the coal fines. The walls of the excavation were observed to range up to 8 m and comprised coal reject. Figure 3, below depicts the northern wall of the excavation vegetated with grass. Leached salts are evident in sporadic locations at the base of the excavation.

Figure 3: Looking west along the northern wall of the excavation.
Leached salts are evident in sporadic locations at the base of the excavation

The former Balloon Rail Loop and the Rail Sidings were typically evident due to fill embankments. The Balloon Rail Loop appears to have been connected to the Great Northern Railway at approximately Ch 174.2 km.

Rail sleepers, signals and scattered 44-gallon drums were observed along the former Balloon Rail Loop. Dense vegetation, predominantly comprising semi-mature trees were present in the internal portion of the Rail Loop. Concrete footings associated with the coal loading conveyors were observed in the north-east portion of the Rail Loop.

Concrete slabs and piers, associated with the former Coal Preparation Plant, the conveyors and associated buildings were observed on the site predominantly between about Ch 174.6 km and 174.95 km. The remains of a former rail crossing and wheel wash were located between about Ch 175.3 km and 175.4 km.

During the initial site inspection on the 18 March 2008, an abandoned former underground storage tank was located adjacent to a concrete platform (about Ch 174.8 km) (Figure 4). However, during field work (2 April 2008), DP observed that the tank had been removed from the site and residual tank contents were present on the ground surface. It is noted that Pit 128 was located at the footprint of the former tank.

Figure 4: Abandoned former Underground Storage Tank located adjacent to a concrete platform in the south-eastern portion of the site

A derelict brick bathhouse and control cabin (signal box) remains on the site at approximately Ch 174.85 km. The buildings were constructed of brick. The roof of the bathhouse had been removed, whilst the roof of the control cabin was constructed of corrugated metal and was partially demolished (Figure 5). The walls of the control cabin are stained black, indicating fire damage. It is noted a previous report indicates that the cabin may have exploded (Ref 7). Fragments of fibre cement sheeting (possible containing asbestos) were observed on the floor of the bathhouse and control cabin. A small area to the west of the control cabin is bitumen sealed. A number of scattered stockpiles covered in thick vegetation were observed approximately 20 m to the north of the Bath house and also surrounding the former locomotive shed (Figure 6).

Figure 5: Bathhouse and Control Cabin located adjacent to the former Minmi-Hexham Railway

Figure 6: Stockpile covered in dense vegetation near concrete slab of Locomotive Shed, Bathhouse and Control Cabin in background (right)

Concrete slabs associated with the locomotive shed and crushing plant remain on the site to the east and west of the buildings respectively. Two small corrugated metal sheds are located in the vicinity of the former crushing plant. The former Minmi-Hexham Railway line and Colliery Siding had been dismantled. However, an elevated fill embankment indicated the approximate former location of the railway and siding.

In addition, scattered stockpiles of material were present throughout the southern portion of the site. Visual observations indicate that the stockpiles typically comprised coal reject or rail ballast. However, occasional stockpiles of building rubble, including terracotta roof tiles, fibro sheeting and timber rail sleepers, were also observed (see Drawing 2, Appendix E for approximate locations). It is noted that these stockpiles were not assessed in detail as part of the current investigation.

Central Portion of the Site (Ch 175.9 to 177.2 km)

The central portion of the greater Hexham site is identified as Lot 113 DP 755232 and Lot 104 DP 1084709, with the TSF footprint largely located within the eastern portion of these lots.

The area is generally low lying with dense grass cover and scattered trees. Surface levels typically range from RL 0.5 to 1.5 AHD. The area was predominantly vegetated with grass and scattered trees. A SEPP 14 wetland is located in the south-east corner of the Lot 113. At the time of field work the area was observed to be vegetated with grasses, with ponded surface water approximately 0.1 m to 0.3 m deep in parts.

The Dairy Farmers waste water treatment plant (WWTP) was in operation in the central-southern portion of Lot 113 DP 7555232 to the west of the SEPP 14 wetland. It is understood that approximately 500,000 L of effluent from the Dairy Farmers Factory located to the east of the site, is treated at the plant daily. The treatment plant comprised a large corrugated metal shed with an unpaved floor and a series of treatment ponds. The ponds are raised above the surrounding ground level.

It is understood from discussions with Mr Paul Alford, Dairy Farmers Employee that site clays were used to form the walls of the ponds. The clays were typically sourced from an area to the west and north-east (Ref 8) of the treatment plant and to the north-east. This area has subsequently been filled with imported fill from varying sources.

The effluent is treated to a secondary level and spray irrigated, via a network of irrigation pipelines on the western and northern portions of Lot 113 and on the former coal tailings stockpile to the south of the WWTP as shown on Drawing 2a, Appendix E. The effluent irrigation area was vegetated with dense grass and cattle were grazing throughout Lot 113 during field work. Shallow excavated drainage channels were present throughout the greater Hexham site. The predominant surface water flow would be toward the western boundary of Lot 113.

A gravel access road provides access from Woodlands Close, along the eastern portion of the site, to the WWTP and to a rural residential property located to the west of the site. A second gravel access road commences in the central eastern portion of Lot 113 and is orientated in a north-west direction passing through Lot 104, Lot 2 and Lot 10 in the northern portion of the site. This access road was observed to be elevated by up to 1 m above the surrounding ground level.

A cattle holding yard with a loading ramp was observed in the central portion of the site. The area to the north-east of the cattle yard, near Bore 3, appeared to be elevated above the surrounding ground level with approximately 0.5 m of fill material (Drawing 2, Appendix E). It is understood that a former rural residential dwelling was formerly located in this area.

A concrete slab, with fragments of fibre cement sheeting was located to the south of the gravel access road in the central-western portion of Lot 113. It is understood that this building was a former baling shed (Figure 7).

Figure 7: Concrete slab of former baling shed, located within the effluent irrigated paddock vegetated with dense grass

A roughly triangular shaped area along the eastern boundary of Lot 113 was fenced. It is understood this area, which extends approximately 500 m along the eastern boundary, adjacent to the Great Northern Railway is currently owned by the Australian Rail Track Corporation (ARTC). Large stockpiles of rail ballast were present within the northern portion of the fenced area. A number of the stockpiles were vegetated suggesting that the stockpiles have been on the site for a substantial period of time.

Two large silos and the derelict remains of buildings were present in the central-eastern portion of the fenced area. This portion of the site was vegetated with overgrown weedy vegetation, which precluded a thorough visual assessment of this area. It is noted that the weedy vegetation may indicate disturbed ground or stockpiles in this area (Figure 8). To the west of the silos, the site was densely vegetated with semi-mature trees. Whilst the southern portion of the fenced area was observed to be low lying swamp land vegetated with reeds (Figure 9).

Figure 8: Two silos and derelict remains of buildings covered in dense weedy vegetation

Figure 9: Southern low lying swampy portion of fenced ARTC area, looking north-west towards the silos

Lot 104 DP 108709 located to the north of the Dairy Farmers site (Lot 113) predominately comprises low-lying grassed paddocks. At the time of field work for the 2008 assessment, the site was boggy with ponded surface water in portions of the site and cattle were grazing over the area. An un-named creek/drain traverses the site in a roughly west-east orientation. The creek/drain appears to have been excavated below former ground levels and has been diverted around an elevated fill platform in the eastern portion of the site. The drain flows to the east and joins into Purgatory Creek before discharging into the Hunter River. It is understood that a rail siding was formerly located on the elevated fill platform. Scattered vegetated stockpiles were located along the bank of the diverted drainage channel (Figure 10).

Figure 10: Scattered stockpiles on northern portion of elevated fill platform along bank of diverted drainage channel

A dam covered with surface algae was located in the south-east corner of Lot 104. It is considered that the dam was associated with the former rail siding.

Northern and Western Portion of the site (Ch 177.200 to 177.960 km)

The northern and western portion of the site comprised Lot 101 DP 1084709, Lot 102 DP 1084709, Lot 104 DP 1084709, Lot 2 DP 735456 and Lot 10 DP735235.

The northern and western portion of the site was observed to be low-lying grassland, with elevated unpaved access roads (Figure 11). At the time of field work, the site was observed to be boggy with ponded surface water in scattered locations.

Figure 11: Elevated unpaved access road in northern portion of the site, looking north. Chichester pipeline to left

An un-lined drainage channel in the northern portion of the site has been excavated below the ground level. The channel is orientated in an approximately east-west orientation to the west of the Chichester pipeline and turns toward the north-west to the west of the pipeline.

An electrical transmission easement traverses the site in an east-west orientation. The transmission towers were observed to be constructed on fill platforms approximately 1 m to 1.5 m above the surrounding ground level.

6.2 Site Features Observed During 2011 Site inspection

Subsequent to the 2008 assessment, a site inspection was conducted in March 2011 to assess site conditions. The majority of the site features remained unchanged from the 2008 investigation, as detailed in Section 6.1 above, with the following exceptions.

Chichester Trunk Gravity Main Pipeline Upgrade

Hunter Water Corporation (HWC) commissioned Diona Pty Ltd (Diona) to replace the above ground Chichester trunk gravity main pipeline with a new underground pipeline. Construction commenced in May 2010 and comprised trenching, installation of a 900 mm diameter pipe, backfilling with natural material, as well as imported sand and the removal of the current above ground pipe. Pipeline installation and backfilling was complete in the northern and central portions of the greater Hexham site, and predominantly complete in the southern portion at the time of the inspection in March 2011. Excavation work associated with the pipeline installation was observed adjacent to the gravel access track in the north western corner of Lot 1 DP155530 and west of the northern side of the balloon rail loop. Evidence of excavation and backfilling was observed along the entire alignment of the new pipeline.

Pipeline construction has predominantly occurred inside the HWC pipeline easement, directly adjacent to the current Chichester pipeline. The new pipeline alignment, however, diverges from the existing pipeline easement and crosses directly through the southern portion of the QR site. This part of the new pipeline alignment runs parallel to the southern side of the former balloon rail loop, orientated in a south-east direction. Recently disturbed soil and ponded surface water were evident along an area of approximately 450 m by 20 m in the pipeline installation area (Figure 12). The ground surface is approximately 1.5 m below the fill platform and comprises batter slopes of approximately 2V:1H. Orange staining (possible iron staining) was observed in areas of disturbed soils and ponded surface water (Figures 13 and 14).

Figure 12: Ponded surface water within disturbed soil along alignment of HWC pipeline (looking west)

Figure 13: Orange staining within ponded surface water adjacent to former balloon rail loop

Figure 14: Orange staining of soil adjacent to former balloon rail loop

A stockpile of material likely to have been excavated during the recent pipeline construction was observed in the far northern portion of the site. The stockpile was partially vegetated, encompassed an area of approximately 20 m by 6 m by 2 m high and generally comprised grey/brown gravelly clayey sand at the surface.

Another stockpile of material likely to have been excavated during the recent pipeline construction, as well as a stockpile of sand, were observed directly adjacent to the north western corner of the coal tailings stockpile (Figure 15). It should be noted that these stockpiles were located in the vicinity of the site boundary and could possibly be off-site. The stockpile of excavated material generally comprised dark grey clayey sandy gravel with some coal and siltstone gravel. The sand stockpile generally comprised light grey fine to medium grained sand possibly used to backfill trenches around the new pipeline.

Figure 15: Stockpiles adjacent to Chichester pipeline upgrade (looking south). Note - this material has since been removed

The alignment of the pipeline and the location of stockpiles are shown on Drawing 2A, Appendix E.

Diona Pty Ltd Compound

A temporary, fenced, compound had been set up by Diona within Lot 311 DP 583724 in the southern portion of the greater Hexham site, adjacent to the balloon rail loop. The compound covers an area of approximately 2.5 ha and had been set up to facilitate the construction of the new HWC trunk main.

The Diona compound consisted of site offices, machinery and construction materials necessary for the HWC pipeline upgrade (Figure 16). Machinery and construction materials stored within the compound included excavators, polycarbonate concrete lined pipes, 1000 L water tanks, large water filtration tanks, shipping containers, concrete barriers and several 1 tonne bags of lime. Four separate stockpiles of materials were stored within the compound and were observed to comprise sand, coarse gravel/ballast and bunded material thought to be lime. A large stockpile of torn garbage bags containing woodchips/straw was also observed in the northern portion of the compound.

Figure 16: Diona compound situated at the southern portion of the site (looking south to south west from the western section of the compound)

Figure 17: Sand stockpile at the western section of the compound (looking north). Note - this material has since been removed

A trenched and bunded area, of approximately 1750m^2, has been constructed directly to the south of the fenced Diona compound. Trenching has been excavated to approximately 0.4 m and bunds were constructed from coal spoil material excavated from the trench (Figure 18).

Figure 18: Trench and bunded stockpile area directly adjacent to Diona compound (looking south west). Note - this material has since been removed.

Three stockpiles were located within the bunded area and comprised the following:

- Dark grey silty/clayey sand with trace shell, cobbles and organic material, moist;
- Grey / Brown gravelly sand with trace silt, cobbles, timber, concrete and coal, moist;
- Stockpiled powdered lime.

The lime stockpile was partially contained using concrete barriers (Figure 19). Employees of Diona indicated the area was used for the treatment of acid sulphate soils.

Figure 19: Stockpile of lime material within bunded area adjacent to Diona compound (looking west). Note - this material has since been removed

Bike (motor-cross) Track Constructed in Central Portion of Coal Tailings Stockpile

Large quantities of imported fill material had been deposited approximately 20 m to the east of the CWR excavation area, within Lot 311 DP 583724 (Refer to Drawing 1, Appendix E). A motocross track comprising approximately 20 ramps/jumps had been formed over an area of approximately 1.1 ha using the deposited fill material (Figure 20).

Imported filling used to construct the motocross track generally comprised light grey/brown clay filling with trace fibro sheet fragments at some locations (possibly containing bonded asbestos materials), tile, brick, plastic sheeting, concrete, timber, terracotta, metal and slag (Figure 21). Dark grey/black clayey sandy gravel with some coal and siltstone was also utilised in the construction of the ramps. This dark grey material is likely to have been excavated from the nearby CWR excavation area, as there is evidence of recently excavated material. It is noted that approximately 800 mm of cut is proposed through this area (refer to GHD Fig C0002, Appendix E)

A water tank is located adjacent to the northern corner of the CWR excavation. A network of black polyethylene irrigation line runs from the water tank around the northern and western sides of the track and several hoses running to the middle of the track. Small areas of ponded surface water, up to 0.2 m deep, were observed at several locations within the bike track area.

Figure 20: Bike track constructed from filling material and associated water tank (looking south east from edge of CWR excavation)

Figure 21: Fibro fragment within soil in south western corner of bike track. Note – fill materials within this are were subsequently levelled

Dumping of Filling and Deleterious Material

Stockpiles of dumped filling and deleterious material are located within Lot 12 DP 1075150, in the central portion of the greater Hexham site, approximately 70 m east of the Bathhouse (Figure 22). The dumped filling comprised light grey clayey sand (weathered sandstone), sandstone gravel, cobbles and boulders. The deleterious material included, bricks, concrete, terracotta pipe, sediment fencing, plastic sheeting, green waste and an empty 44 gallon drum.

Figure 22: Dumped material in the central portion of site, north-east of the Bathhouse / Control room (looking south)

ARTC Compound

A roughly triangular shaped area along the eastern boundary of Lot 113 was fenced. It is understood this area, which extends approximately 500 m along the eastern boundary adjacent to the Great Northern Railway, is currently used by the Australian Rail Track Corporation (ARTC). Large stockpiles of rail ballast, excavators and site sheds were present within the fenced area.

6.3 Site Features Observed During 2012 Site inspection

Subsequent to the 2011 inspection, a site inspection was conducted on 11 April 2012 to assess current site conditions. The majority of the site features remained unchanged from the 2011 inspection, as detailed in Section 6.2 above, with the following exceptions.

Diona Pty Ltd – Watermain Upgrade Works

Gravel access tracks have been constructed along the new watermain pipeline routes, with former above ground pipework now removed. Fill materials used to construct the tracks were observed to comprise crushed rock/railway ballast (Figures 23, 24 and 25).

Figure 23: Gravel access track in south eastern portion of the greater Hexham site associated with the new watermain pipeline

Figure 24: Gravel access track in southern portion of the greater Hexham site adjacent to new watermain pipeline

Figure 25: Gravel access track in south western portion of the greater Hexham site adjacent to new watermain pipeline

The Diona storage compound still remains, however, the area largely comprises stored piping and some machinery now (Figure 26). Stockpiles of lime outside the compound are no longer evident (Figure 18 and 19) and the ground surface in the area around the compound appears to have been graded (Figure 26).

Figure 26: Diona Compound looking north-west

A number of fill stockpiles dumped on-site which had previously been observed, where no longer present (i.e. only remnant surface impact evident). These include fill stockpiles shown in Figure 15 (Location on Drawing 2a).

Additional areas comprising dumped general waste were observed in some areas including the former truck wash area in the central eastern portion of the greater Hexham site which comprised a mixture of household wastes. A new stockpile of demolition waste was also observed which included fibro sheeting (possibly containing asbestos) located adjacent to the main entrance road to the east of the WWTP (Figure 27). Near surface impact was also observed in the vicinity of the stockpile. It is understood that this stockpile was removed by a third party following the DP inspection.

Figure 27: Dumped demolition waste in central eastern portion of site

Bike (motocross) Track Constructed in Central Portion of Coal Tailings Stockpile

The stockpiled filling observed in 2011 which was utilised as a bike track (Figures 20 and 21) appears to have been levelled and spread (Figure 28), which was evidenced by the hummocky ground surface. Filling consistent with that initially observed within the bike track area was present at the surface where vegetation was absent.

Figure 28: Former Bike track looking south west from the CWR excavation area

6.4 Drainage

The following presents a brief summary of site drainage, based on site observations and review of a topographic plan provided by WorleyParsons.

Southern Portion of the Greater Hexham Site

Site contours indicate that surface water on the coal tailings stockpile would drain toward the edge of the stockpile. A number of small dams are evident along the top boundary of stockpile. Drains are situated along the base of the northern portion of the eastern boundary, the northern boundary and the western boundary of the stockpile. Water collected from this drain flows west to Hexham Nature Reserve via a drainage culvert, which passes under the Chichester pipeline. A drain to the south of the stockpile was observed, however the direction of drainage was not clear.

Surface water on the south east portion of the coal tailings stockpile would drain to the east toward a low-lying swampy area which feeds to a small dam/drain to the south of the former wheel wash. A stormwater pipe was observed leading to/from the small dam /drain, however the direction of flow was not clear.

Apart from the coal tailings stockpile, a number of drainage channels and low lying swampy areas are present throughout the southern portion of the greater Hexham site. It is considered likely that the drains were constructed to divert surface water away from former infrastructure. The direction of flow along the channels and off-site discharge points was not established at a number of locations. The following presents a brief summary of site drainage:

- An unlined drainage channel orientated in an east west direction is located in the southern portion of the greater Hexham site. Drainage pipelines pass under the eastern arm of the former Balloon Loop Railway, however a drainage channel or pipe work was not observed along the western arm of the Balloon Loop Railway;
- A drainage channel along the base of former railway embankment is located in the south-east portion of the greater Hexham site orientated in a north-south direction. The direction of surface flow, and off-site migration (if any) was not determined;
- A low lying swampy area is located in the south-eastern portion of the greater Hexham site. It was not clear if this area drains to the low-lying swampy area to the south of the Balloon Loop Railway;
- A drainage channel to the west of the gravel access road along the eastern boundary at approximately Ch 174.500 to Ch 174.600 km. A small drainage pipeline was observed draining to the east boundary of the greater Hexham site.

Central Portion of Site

The area to the west of the Dairy Farmers WWTP is a low-lying swamp/wetland, with no observed drainage routes. Two shallow unlined drainage channels have been excavated in the effluent irrigation area to the west and north-west of the Dairy Farmers WWTP. The drainage channels converge to the north of the old baling shed and drains to the west of the greater Hexham site. To the west of the site the drainage channel flows to the north and converges with a larger un-lined drainage channel which passes through the site in a west-east direction.

The area to the north of the effluent irrigation area is low lying land with a number of small drainage channels that drain in a northerly direction to the west-east orientated drainage channel.

Northern Portion of the Site

The northern portion of the greater Hexham site is low-lying with an unlined drainage channel flowing in a south-east to north-west direction.

Further information on site drainage and hydrology is presented in Reference 26.

7. Potential Contaminants

7.1 Potential Contaminants - 2008 Investigation

Based on the available site history information and observations made during the site inspection, the principal sources of potential contamination associated with the TSF development (i.e. within the TSF area of potential to impact on the TSF area) are considered to be:

- Fuel storage within the former coal preparation plant, comprising three above ground tanks and two bowsers (hydrocarbons and heavy metals);
- Above ground diesel tank within the WWTP (hydrocarbons and heavy metals);
- Former wheel wash bay/truck wash (hydrocarbons, heavy metals);
- Railway lines: Balloon Rail Loop, Minmi-Hexham Railway, Colliery Sidings, Coal Preparation Plant and Coal and Allied Siding (pesticides, heavy metals, hydrocarbons, asbestos);
- Coal reject fill across the site (predominantly in the southern portion of the site) including the former coal tailings stockpile (range of contaminants including hydrocarbons, heavy metals and potential for acidic or saline leachate);
- Fill materials of unknown origin deposited on or within the coal tailings stockpile – topsoil capping material and building rubble (potentially associated with Newcastle Earthquake) (range of contaminants including heavy metals, hydrocarbons, pesticides, asbestos, PCBs etc.);
- Fill stockpiles of unknown origin located at various locations throughout the site (range of contaminants including heavy metals, hydrocarbons, pesticides, asbestos, PCBs etc.);
- Fibre cement sheeting fragments (possibly containing asbestos) on ground surface of former control cabin and baling shed and in scattered locations near former buildings;
- Surficial contamination around former infrastructure due to spills of oils, solvents and hydrocarbons due to maintenance of machinery and locomotives, and a potential for asbestos associated with former building materials;
- Former cropping activities (pesticides, heavy metals, hydrocarbons);
- WWTP and associated irrigation (hydrocarbons, nutrients, microbiological contaminants).

The main sources of contamination associated with adjacent site land uses, which may have resulted in impact to the site, include the Great Northern Railway to the east of the site (similar contaminants as those listed above) and the operating service stations to the east of the site (heavy metals and hydrocarbons). The impact of these sources on the site (if any) would generally be associated with groundwater impact and would be dependent on the local groundwater regime.

7.2 Additional Potential Contaminants – 2011 Assessment

Based on a review of the additional report review of aerial photographs taken between 2008 to 2011 and observations made during the 2011 site inspection, the principal sources of potential contamination associated with the TSF site, supplementary to those mentioned in Section 7.1 above, are considered to be:

- Fill stockpiles of unknown origin associated with the bike (motor-cross) track construction (range of contaminants including heavy metals, hydrocarbons, pesticides, asbestos, PCBs etc.);
- Orange stained soils within areas of ponded surface waters adjacent to the Diona compound (possible iron precipitate associated with acid sulphate soil exposure, possible acidic conditions);
- Fill stockpiles located within the bunded area directly adjacent to the Diona compound (range of contaminants including heavy metals, hydrocarbons, pesticides, asbestos, PCBs and low pH soils (i.e. Acid Sulphate Soil);
- Stockpile of lime located within bunded area directly adjacent to the Diona compound (potential for impact on underlying soils – high pH);
- Fill stockpiles possibly associated with construction of the new HWC pipeline, located in the central portion of the site (range of contaminants including heavy metals, hydrocarbons, pesticides, asbestos, PCBs and low pH soils (i.e. acid sulphate soil);
- Fill stockpiles located approximately 70 m east of the Bathhouse (range of contaminants including heavy metals, hydrocarbons, pesticides, asbestos, PCBs etc.);
- Potential acid generation and associated impacts from exposure of ASS during construction of the HWC pipeline (potential acidic conditions).

The additional potential sources of contamination observed at the site (subsequent to the 2008 assessment) were generally limited to imported fill stockpiles that may contain various contaminants (depending on the source of the fill materials), and potential acidic conditions associated with soil disturbance during HWC pipeline installation works.

It is noted that the Hunter Water Corporation's Chichester pipeline easement has not been investigated as part of this assessment. Potential contaminants which may be associated with the easement include possible lead impact to surface soils from lead jointing material. In addition, imported fill materials may be present within the easement (i.e. source unknown), which may contain contamination.

7.3 Additional Potential Contaminants – 2012 Assessment

Based on observations made during the 2012 site inspection and brief discussions with site personnel, no additional sources of potential contamination were identified on-site other than the additional localised imported fill stockpiles and general refuse observed.

8. Field Work

8.1 Sampling Rationale

A combination of a systematic and judgemental sampling procedure was conducted for the preliminary assessment to investigate the potential sources of contamination identified in 2008 (described above). The sampling procedure was designed to target areas of potential contamination and to provide broad coverage of the eastern portion of the greater Hexham site, i.e. the proposed area of development. On this basis only, limited sampling was undertaken on the western portion of the greater Hexham site.

A total of 66 test pits and nine bore locations (including nine hand augers) were sampled and analysed within the greater Hexham site. It is noted that the OEH does not provide direct guidance of the minimum number of sampling points for sites larger than 5 ha, however 55 sampling points are suggested for characterisation a 5 ha site, and if extrapolated over 1,300 sampling points would be required for characterisation of the 260 ha site. It is considered, however, that the sampling density undertaken is sufficient for the purposes of this preliminary assessment based on the available site history information and site observations.

Samples were selected for analysis on the basis of the likely presence of contamination, based on material type, visual or olfactory evidence of possible contamination (i.e. odour or staining), proximity to a known source of contamination, and whether generally representative of soil/fill conditions.

8.2 Methods

The field work was carried out between 1 and 9 April 2008, and comprised soil sampling at 59 pit locations and nine bore locations in areas of potential contamination and across the eastern portion of the greater Hexham site. The bores were drilled to a maximum depth of 5 m using a specialised bobcat mounted drill rig. The test pits were excavated to depths up to 3 m by backhoe, with the exception of Pits 110 to 118 and Pit 160, which were excavated to depths up to 5.5 m using an excavator, and Pits 154 to 156, 158 and Pits 165 to 169 which were excavated using hand tools to a maximum depth of 0.9 m.

The test locations were set out by an environmental scientist and geo-environmental engineer from DP. They also logged the subsurface profile in the bores and pits and collected samples for identification purposes. The approximate test locations are shown on Drawing 2, Appendix E.

A number of test locations were selected to further assess identified areas of potential contamination, as summarised below:

Table 5: Areas of Potential Contamination associated with the TSF site

Area of Potential Contamination	Test Location
Former Fuel Storage Area	Bore 102, Pit 129 and Pit 128
A/G diesel tank in WWTP	Pit 165
Former Wheel Wash Bay	Pit 142
Former Railway Lines	Pits 121, 124, 127, 157, Bore 103, 105, 106, 108, 109
Coal Reject Fill	Pits 120, 123, 130 130A
Coal Tailings Stockpile	Pits 110 to 118, 115A and 160
Acidic/Saline Leachate	Bores 101 to 108
Imported Fill	Pits 150 to 152, 158, 159
Former buildings infrastructure	Pits 125, 126, 128, 131 to 136, 136A, 139, 142 to 144, 146 to 149, 153
Fibre cement fragments	Surface samples 148A/0.0 and 153A/0.0
Former cropping activities	Pit 153
Dairy Farmers WWTP and associated irrigation	Bores 101 to 108 and SW201 to SW211
Filling identified by RCA	Not Tested
Fill stockpiles associated with the bike track construction	Not Tested[1]
Fill stockpiles within bunded area directly adjacent to the Diona compound	
Fill stockpiles possibly associated with construction of the new HWC pipeline	
Orange stained soils parallel to south side of former balloon rail loop	
Potential acid generation from trenching along the alignment of the new trunk main pipeline	

Notes to Table 5:

1. Potential for contamination observed during the March 2011 site inspection. No subsequent sampling and testing has been undertaken to date.

Samples for environmental purposes were generally collected from the near surface, and at regular depth intervals or changes in strata within each bore or pit. At bore locations, the soil samples were collected directly from the solid flight augers using stainless steel sampling equipment. Augers were screwed into the ground at discrete depths and retracted without rotation to minimise sample disturbance. Care was taken to remove any extraneous material deposited on the outer auger flights as the auger was withdrawn from the borehole. At test pit locations, the soil samples were collected directly from the side walls of the test pits or from the backhoe bucket using disposable sampling equipment. Care was taken to remove any extraneous material deposited on the sample.

All sampling data was recorded on DP chain of custody sheets, and the general sampling procedure comprised:

- Decontamination of sampling equipment using a 3% solution of phosphate free detergent (Decon 90) and tap water prior to collecting each sample;
- The use of disposable gloves for each sampling event;
- Transfer of samples into laboratory-prepared glass jars, and capping immediately;
- Collection of 10% replicate samples for QA/QC purposes;
- Collection of replicate soil samples in zip-lock plastic bags at each depth for PID screening;
- Labelling of sample containers with individual and unique identification, including project number, sample location and sample depth;
- Placement of the sample jars and replicate sample bags into a cooled, insulated and sealed container for transport to the laboratory;
- Use of chain of custody (C-O-C) documentation ensuring that sample tracking and custody could be cross-checked at any point in the transfer of samples from the field to the laboratory. Copies of completed forms are contained in Appendix D.

Following each test bore, drilling equipment was decontaminated using pressurised tap water and phosphate free detergent (Decon 90) to minimise the risk of cross-contamination.

Replicate samples for each sample were screened for the presence of volatile organic compounds (VOC's), using a Microtip HL-2000 photo-ionisation detector (PID) with a 10.6 eV lamp, calibrated to 100 ppm Isobutylene. The PID is capable of detecting over 300 VOC's but is reported on a total VOC basis.

Information on quality assurance and quality control, including analysis of replicate samples, is found in Appendix D.

8.3 Well Design and Installation

Nine groundwater wells constructed of 50 mm diameter flush threaded Class 18 PVC were installed in Bores 101 to 109 in accordance with current industry standards, using solid flight augers from the 4WD mounted drilling rig.

A 3 m machine slotted PVC screen with an end cap was installed from a depth of about 1 m above the observed water table, to up to 2 m below the water table (i.e. to intercept possible floating product). A filter pack was installed in the bore annulus consisting of 5/2 graded and washed gravel above the slotted PVC screen. A bentonite seal (150 mm to 400 mm thick) was placed above the filter pack within the annulus.

The wells were completed with approximately 0.5 m to 0.7 m of PVC casing above the ground surface. A lockable stainless steel well monument was installed over the PVC. Mounded concrete was placed around the base of the well monument and within the annulus above the bentonite. Details of well design and construction are shown on Borehole Logs 101 to 109, Appendix A.

Drilling and well installation was undertaken under QA/QC protocol to minimise the risk of cross contamination.

The groundwater wells were surveyed for location and elevation (top of casing) by Monteath & Powys Pty Ltd.

8.4 Well Development / Purging and Sampling

Following installation, the wells were developed on 7 April 2008 by removing a minimum five bore volumes of groundwater using single check valve clear view disposable bailers to ensure an efficient hydraulic connection between the well and the formation. Regular pH, electrical conductivity (EC), dissolved oxygen (DO), Oxidation Reduction Potential (ORP), and turbidity measurements were undertaken on groundwater during development using calibrated portable meters until steady readings were achieved.

Prior to sampling, the wells were purged until steady pH, EC, DO, ORP and turbidity readings were achieved by removing a minimum of three bore volumes of groundwater using single check valve clear view disposable bailers.

Groundwater samples from the wells were collected on 16 April 2008 using a single check valve clear view disposable bailers and filtered (as required) and preserved in laboratory prepared containers for analysis. The samples were delivered to the laboratory within the recommended holding times for analysis. The groundwater level was allowed to recover from the effects of purging prior to sampling. Samples were collected under strict QA/QC protocols.

The headspace of groundwater collected from each well was also screened for the presence of volatile organic compounds (VOC's) using a calibrated PID following purging. Following development, an oil-water interface meter was used to assess the possible presence of a floating product within each well.

The process of obtaining samples and their transportation, storage and delivery to laboratories for analysis was documented on a DP standard chain-of-custody form. Copies of completed forms are contained in Appendix D.

The depth to groundwater was measured prior to purging and sampling in each well to assist in determining groundwater flow direction.

8.5 Surface Water Sampling

A total of 11 water samples were collected from surface water bodies across the greater Hexham site on 14 April 2008. A calibrated multi-parameter Troll 9500 was used to monitor surface water conditions prior to sampling.

The samples were collected using disposable sampling containers and filtered (as required) and preserved in laboratory prepared containers for analysis. The samples were delivered to the laboratory within the recommended holding times for analysis. Samples were collected under strict QA/QC protocols.

The process of obtaining samples and their transportation, storage and delivery to laboratories for analysis was documented on a DP standard chain-of-custody form. Copies of completed forms are contained in Appendix D.

An additional ten surface water samples were tested for pH and EC using handheld calibrated meters during the site inspection on 16 March 2011.

8.6 Data Quality Objectives

Table 6 summarises data quality objectives (DQOs) and the procedures designed to enable achievement of the DQOs.

Table 6: Data Quality Objectives

DQO	Achievement Evaluation Procedure
Documentation completeness	Completion of field and laboratory chain of custody documentation, completion of borehole logs.
Data completeness	Sampling density comparison with Table A, NSW EPA's Sampling Design Guidelines 1996, and analysis of appropriate determinants based on site history and on-site observation.
Data comparability	Use of NATA certified laboratory, use of consistent sampling technique.
Precision and accuracy for sampling and analysis	Achievement of 50% RPD for replicate analysis, acceptable levels for laboratory QC criteria.

8.7 Results

8.7.1 DP 2008 Investigation

The subsurface conditions are presented in detail in the borehole and test pit logs, Appendix A. These should be read in conjunction with the general notes preceding them, which explain definitions of the classification methods and descriptive terms used.

The following is a summary of the subsurface conditions encountered in the bores and pits together with previous investigations undertaken by DP on the greater Hexham site:

Filling – encountered in all pits/bores, predominantly comprising coarse gravel sized coal reject, intermixed with silt and clay, to depths between 0.2 m greater than 5.5 m (generally <2 m with the exception of the coal tailing stockpile).

The coal tailings stockpile was found to comprise gravel to cobble sized coal reject with intermixed carbonaceous siltstone and clay and sand, underlain by silty clay fill predominantly comprising coal fines. Building rubble, comprising bricks, concrete and ceramic fragments was encountered in Pit 115 and 115A to depths of 1.5 m and 1.2 m, respectively.

Note: Fill materials were predominantly encountered in the southern portion of the site in the former Coal Preparation Plant and Coal stockpile area.

Fill material including trace bricks, ash and cobbles were identified within the fill material at a number of test locations, refer to borehole and test pit logs for detailed subsurface conditions.

Clayey Silt – encountered from 1.5 m to 2.9 m, generally comprising an approximately 0.1 m to 0.3 m thick layer of soft to stiff, dark brown or dark grey clayey silt, with some fine grained sand.

Silty Clay – encountered from 1.8 m to 2.8 m to test pit completion between 2.0 m and 3.2 m and generally comprising soft to stiff grey mottled orange silty clay, with trace fine grained sand at some locations.

Sandy Clay/Clayey Sand – encountered in the central and northern portion of the greater Hexham site predominantly underlying the silty clay, and generally comprising grey mottled orange fine to medium grained sandy clay/clayey sand (Pits 151, 152, 153, 163 and 164).

Natural materials were typically encountered at depths ranging between RL -0.2 AHD and 1.7 AHD.

The observed subsurface conditions were generally found to be consistent with previous investigations undertaken on the greater Hexham site and surrounding area by DP. The following presents a brief summary of subsurface conditions encountered in previous investigations.

Table 7: Summary of Subsurface Conditions Encountered in Previous Investigations

Stratum	Description
Fill	Predominantly comprising coarse coal reject (chitter), and intermixed with sand and clays where spread elsewhere particularly on the southern half of the greater Hexham site in the area of a former Coal Handling Preparation Plant. Over the southern half of the greater Hexham site the fill depth is typically 0.5 m to 1.5 m depth, but up to about 2 m. Note – No investigation was previously conducted by DP within the coal tailings stockpile.
Clay (alluvial)	Soft to firm silty clays/clays and clayey silts are present beneath the fill at all CPT test locations. The clay layer is typically 15 m to 17 m thick but up to 25 m thick at the southern end of the greater Hexham site. It is this layer which presents issues of poor bearing capacity for footings and pavements, as well as potential long term settlements under load due to its compressibility. The clay profile is interbedded by silty sand/clayey sand, particularly in the upper profile of the unit.
Sand	Sand, clayey sand or silty sand, with occasional gravel, usually loose to medium dense, becoming dense with depth. The thickness and distribution of this layer is quite variable and it is not always present.
Clay (residual)	The deeper clays are generally stiff to very stiff sandy clay, grading to hard clays and weathered rock although weathered rock was not encountered during the current investigation.

Groundwater was encountered in a number of the bores and pits during drilling and excavation at depths ranging between 0.5 m to 2.45 m below ground level. Perched groundwater was observed in the coal tailings stockpile at depths ranging between 0.4 m and 2.9 m below the ground surface. The perched groundwater in the coal tailings stockpile would be affected by the application of effluent irrigation.

8.7.2 ERM 2010 Investigation

Pits and bores excavated during the ERM 2010 investigation south of the coal tailings stockpile area (elevated platform) generally comprised brown, black and grey gravelly clay, coal and sand filling to an approximate depth of 1.0 m, underlain by black coal dust and coal tailings filling to an approximate depth of 2.2 m, underlain by stiff grey mottled brown clay or gravelly clay.

Pits and bores excavated within the coal tailings stockpile area (elevated platform) generally comprised dark brown/black gravelly silt with abundant rootlets and frequent coal inclusions to an approximate depth of 0.2 m underlain by coal tailings and coal dust to a depth of 2.3 m, underlain by highly elastic coal dust with coal chips throughout.

Pits and bores within the coal tailings stockpile area were excavated to a maximum depth of 7.5 m and were all terminated before reaching natural material.

8.8 Groundwater Conditions

8.8.1 DP 2008 Investigation

Nine groundwater monitoring wells (Bores 101 to 109) were installed as part of the 2008 investigation. In addition, four existing groundwater wells (Bores 2, 3, 5 and 7) installed by DP as part of a previous investigation (Ref 8) were utilised.

Groundwater piezometric levels were measured in each of the wells prior to purging on the 15 April 2008 and are summarised in Table 8 below.

Table 8: Groundwater Piezometric Levels

Bore	RL Ground Surface[1] (AHD)	RL Top Of Casing (AHD)	15 April 2008	
			Depth to Ground Water[2]	RL Ground Water
101	2.60	3.09	1.70	1.40
102	2.55	3.18	1.23	1.95
103	3.07	3.72	1.45	2.27
104	1.48	2.12	0.99	1.13
105	4.10	4.83	2.64	2.19
106	1.96	2.47	1.09	1.38
107	1.84	2.50	1.25	1.25
108	3.29	3.97	1.09	2.88
109	1.48	2.15	1.97	0.18
2	1.06	1.66	0.55	1.11
3	1.08	1.59	0.64	0.95
5	1.51	1.85	1.01	0.84
7	0.36	0.57	0.27	0.30

Notes to Table 8:

1. Relative Level, were provided by Monteath and Powys
2. Depth below Top of PVC Casing

Due to local mounding of the groundwater table, the regional groundwater flow is multi-directional, being to the west of the greater Hexham site towards Hexham Nature Reserve (located along the western boundary of the greater Hexham site), to the east of the site toward the Hunter River, located less than 200 m from the central portion of the eastern boundary and to the north/north-west of the greater Hexham site. Groundwater in the central northern portion of the greater Hexham site is likely to flow towards two unlined drainage channels that drain across the site in an approximate west-east and south-west to north-east direction, which drain to Purgatory Creek then the Hunter River.

It is noted that elevated groundwater levels were identified to the south (Bore 103) and within the south-east portion (Bore 105) of the coal tailings stockpile, which is considered to be associated with effluent irrigation and the presence of filling material (i.e. perched groundwater).

It is noted, that the fill material and natural silty clay and clayey sands beneath the site do not form a continuous layer and this may result in localised groundwater flow variations along variable filling horizons and along any residual bedding planes or other lineaments within the clay substrate. Furthermore, groundwater levels are affected by climatic conditions and soil permeability and will therefore vary with time.

Groundwater parameters measured in the field during purging and sampling are presented in Table 9 below.

Table 9: DP Measured Groundwater Parameters – 2008 Investigation

Sample Location	pH	EC µS/cm	ORP (Mv)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%)	Temperature (°C)	Turbidity (NTU)	Comments (Purging)
2	6.3	7278	-15	3.3	36	20	447	Slightly to moderately turbid, yellow brown
3	6.3	16170	-47	5.1	56	19	532	Moderately turbid, slight sewage odour
5	6.6	2637	-35	3.4	37	20	1084	Moderately turbid, brown
7	6.5	29010	-100	3.0	37	20	169	Moderately turbid, brown
101	6.4	10650	-97	1.4	17	23	580	Very turbid, grey, slight PAH odour
102	5.9	1819	-22	2.4	28	22	862	Very turbid, dark grey
103	6.1	3550	-53	2.5	27	20	1288	Very turbid, dark grey, slight PAH odour
104	6.8	4578	-96	1.9	20	19	1621	Very turbid, dark grey, slight PAH odour
105	5.3	6261	24	4.0	45	21	NT	Very turbid, grey, slight PAH odour
106	6.2	8816	-27	3.1	34	20	1856	Very turbid, dark grey, slight PAH odour
107	6.5	4423	-72	2.7	30	22	2008	Very turbid, grey brown
108	6.4	3187	-23	1.7	16	19	NT	Very turbid, grey, slight PAH odour
109	7.1	5065	-83	2.0	22	20	1402	Very turbid, dark grey

Notes to Table 9:

EC – Electrical Conductivity

ORP – Oxidation Reduction Potential

NTU – Nephelometric Turbidity Units

The measured results suggest that the water is slightly acidic to neutral, and brackish, with the exception of Bore 3 and Bore 7 which are saline. The water was reducing with low dissolved oxygen content. The groundwater samples were moderately to very turbid.

Daily weather observations for Newcastle University (approximately 6 km to the south-east of the site) were accessed through the Bureau of Meteorology (Ref 14) to assess rainfall prior to sampling. The rainfall data indicates that 36.9 mm of rain fell at Newcastle University between 1 April and 15 April 2008. With 9 mm of rainfall on 15 April 2008, the day prior to sampling, and 5 mm on 16 April 2008, the day of sampling.

8.8.2 ERM 2010 Investigation

Ten groundwater monitoring wells (MW01 to MW10) were installed as part of the ERM 2010 investigation. Groundwater piezometric levels were measured in each of the wells prior to purging on 30 September 2010, however no surveyed levels of monitoring wells were included in the report or appendices.

Groundwater parameters measured in the field by ERM during purging and sampling are presented in Table 10 below.

Table 10: ERM Measured Groundwater Parameters

Sample Location	pH	EC (EC (µS/cm)	ORP (Mv)	Dissolved Oxygen (mg/L)	Temperature (°c)	Turbidity (NTU)	Comments
MW01	6.1	3800	22	6.35	18.4	NT	Dark brown / black
MW02	5.6	1800	57	5.01	17.7	NT	Dark brown / black
MW03	6.3	3500	39	3.01	16.5	NT	Dark brown / black
MW04	6.8	3500	-66	6.5	17.1	NT	Dark brown / black
MW05	7.0	3100	-23	7.89	16.9	NT	Dark brown / black
MW06	5.9	2600	80	3.26	17.6	NT	Dark brown / black
MW07	6.4	3500	12	4.11	17.7	NT	Dark brown / black
MW08	7.2	1900	28	5.17	17.0	NT	Dark brown / black
MW09	7.4	2400	14	5.5	15.2	NT	Dark brown / black
MW10	6.7	6500	-56	5.42	19.1	NT	Dark brown / black

Notes to Table 10:
EC – Electrical Conductivity
ORP – Oxidation Reduction Potential
NTU – Nephelometric Turbidity Units

The measured results suggest that the water is slightly acidic to neutral, and brackish. The colour of groundwater, recorded on ERM ground water monitoring reports, indicate the groundwater samples were very turbid.

ERM bore and test pit locations are shown on ERM Figure 2 in Appendix E.

8.9 Surface Water Conditions

8.9.1 DP 2008 Investigation

Surface water samples were collected from 11 locations across the greater Hexham site. The surface water sampling was undertaken in general accordance with the Hexham Train Servicing Facility – Surface Water Quality Monitoring Brief, by WorleyParsons, dated 2 April 2008 (Ref 15). Eight sampling locations (201 to 208) were set out by an Environmental Scientist from DP and an Environmental Engineer from WorleyParsons. It is understood that further surface water monitoring shall be undertaken at sample locations 201 to 208 to provide an assessment of water quality conditions during both construction and operation of the proposed development.

An additional three sampling locations (209 to 211) were set out as part of the 2008 preliminary contamination assessment to assess potential areas of contamination across the greater Hexham site.

A calibrated multi-parameter Troll 9500 was used to monitor surface water conditions prior to sampling, with results presented in Table 11 below.

Table 11: Measured Surface Water Parameters - 2008 Investigation

Sample Location	pH	EC us/cm	ORP (Mv)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%)	Temperature (°c)	Turbidity (NTU)	Comments
201	6.9	2041	142	7.9	57	20	20.8	Brown, slightly turbid
202	6.9	3693	-186	2.8	60	18	48.8	Brown, moderately turbid , slight sewage odour, green algae on surface
203	6.5	1736	-34	6.9	73	20	4.8	Slightly turbid, slight sewage odour
204	6.9	1368	12	6.9	86	19	28.8	Brown, slightly turbid
205	6.9	977	-62	5.1	77	17	57.5	Brown, slightly turbid, reeds and green algae on surface of water
206	7.3	2623	14	4.1	39	16	12.6	Brown slightly turbid, reeds and green algae on surface of water
207	7.3	10610	47	8.7	37	18	20	Trace turbidity
208	6.7	1124	-69	3.8	36	17	53.5	Slightly turbid, algae on surface of water
209	6.3	375	9	4.5	80	17	9.9	Trace turbidity, reeds in drainage channel
210	8.4	2193	35	NT	92	21	12	Amber, moderately turbid
211	6.8	2191	-141	2.4	24	17	2610	Brown, turbid, slight sewage odour, reeds in water body, suspended organic matter in water column

Notes to Table 11:
EC – Electrical Conductivity
ORP – Oxidation Reduction Potential
NTU – Nephelometric Turbidity Units

The measured results suggest that the water is slightly acidic to neutral, with the exception of Sample 210, which was found to be alkaline. The electrical conductivity was generally low indicating fresh water to slightly brackish conditions, with the exception of sample 207 which was found to be saline. ORP measurements ranged from reducing to oxidative conditions and DO levels indicate low to moderate dissolved oxygen content.

Daily weather observations for Newcastle University (approximately 6 km to the south-east of the site) were accessed through the Bureau of Meteorology (Ref 14) to assess rainfall prior to sampling. No rainfall was recorded for the 72 hours prior to surface water sampling on 14 April 2008 (Note: No data was provided for 14 April 2008).

8.9.2 DP 2011 – Surface Water pH and EC Testing

Ponded surface waters were screened for pH and EC at ten additional locations during the 2011 site inspection. Sample locations generally targeted areas which had been disturbed since the DP 2008 investigation. A calibrated Horiba D-54 pH / EC meter was used to undertake the screening with the results presented in Table 12 below:

Table 12: Measured Surface Water pH and EC - 2011 Inspection

Surface Water Location	Surface Water ID	pH	EC (mS/cm)
West of former baling 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 - directly east of CWR excavation	SW 303	9.5	1.2
	SW 304	8.1	1.1
CWR 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

The measured results suggest that surface waters were moderately alkaline to neutral and fresh to slightly brackish across the majority of the site with the exception of the disturbed area along the southern side of the former balloon rail loop which was found to be slightly to moderately acidic.

The approximate screening locations can be found on Drawing 2A, Appendix E.

8.10 Contaminant Observations

8.10.1 DP 2008 Investigation

The southern portion of the greater Hexham site was found to be underlain with coal reject fill. Coal reject fill material typically ranged in depths from 1.1 m to greater than 3.0/5.5 m (i.e. test pit/excavator termination). Visual or olfactory (i.e. odour or staining) observations during field work generally indicate the absence of gross contamination within the coal reject.

The following observations of potential contamination were observed within the test bores and pits.

Table 13: Contaminant Observations within Test Bores/Pits

Potential Contaminant Observation	Test Bore / Pit / Depth
Building Rubble / fill inclusions	Pit 113, from surface to 1.2 m, trace bricks and metal. Pits 115 and 115A, from 0.2 m to 1.5 m, inclusions of bricks, concrete and ceramic and metal. Pit 127, 0.9 m to 1.2 m, trace brick fragments. Pit 132A, surface to 0.2 m, fill with trace terracotta tiles. Pit 136 and 136A from surface to 0.2 m and 0.6 m respectively, trace scrap metal. Pit 142 from 0.15 to 0.3, large concrete fragment. Pit 145, form 0.6m to 0.9 m trace bricks. Pit 148, from surface to 0.25 m, trace porcelain. Pit 149, from 0.9 m to 0.95 m, trace timber and brick fragments. Pit 150, from 0.5 to 1.5 m, trace scrap metal. Pit 151 and 151A, from surface to 0.45 m, trace timber and plastic. Pit 157, at 0.4 m, scrap metal.
Slight Hydrocarbon Odour	Pit 128, from surface to 1.5 m, hydrocarbon odour (located within footprint of former abandoned UST). Pit 129 from 0.4 m to 2.8 m, hydrocarbon odour (located adjacent to former refuelling area). Pit 131, from 0.7 m to 0.9 m, hydrocarbon odour around broken terracotta pipe. Pit 165, surface hydrocarbon staining.
Rail Infrastructure	Pit 127, from surface to 0.5 m, rail sleepers. Pit 146, from surface to 0.15 m, rail sleepers. Pit 147, from surface to 0.2 m, rail sleepers and scrap metal.
Ash materials	Pit 140, from surface to 1.2 m, fill some ash. Pit 150, from surface to 0.4 m, fill predominantly ash. Pit 155, surface to 0.25 m, fill with ash. Pit 157, 0.65 to 0.85 m, fill with some ash. Pit 163, from surface to 0.5 m, fill with trace ash. Pit 164, from 0.35 m to 0.45 m, frill with some ash.
Staining	Pit 126 at 0.7 m, fill material stained green.
Potential Asbestos materials	Surface sample 148A/0.0 and 153A/0.0.

The results of PID screening on soil samples are shown on the test pit/borehole logs in Appendix A, and generally suggest the absence of gross volatile hydrocarbon impact.

There was no visual or olfactory evidence (i.e. staining or odours) to suggest the presence of gross contamination within seepage water and ground water within pits, with the exception of Pit 128 and 131. Field observations indicate that the residual contents of the abandoned UST were spread on the ground surface around Pit 128. Ponded surface water was observed to exhibit a hydrocarbon odour and sheen. Whilst in Pit 131, leaking water from the broken terracotta pipe was observed to have a moderate hydrocarbon odour with a green surface sheen.

There was no visual or olfactory evidence (i.e. staining or odours) to suggest the presence of gross contamination with the groundwater in the majority of bores. A slight hydrocarbon odour was detected in Bores 101, 103, 105 and 108. Measurement by an oil/water interface meter did not identify any floating product and the PID screening of the groundwater headspace suggested the absence of gross volatile hydrocarbon impact.

There was no visual or olfactory evidence (i.e. staining or odours) to suggest the presence of gross contamination with the surface water in the majority of sample locations. A slight sewage odour was noted at sample locations 202, 203 and 211, and water at sample location 210 was observed to be amber. PID screening of the surface water headspace suggested the absence of gross volatile hydrocarbon impact.

8.10.2 DP 2011 Investigation

There was no visual or olfactory evidence (i.e. staining or odours) to suggest the presence of gross contamination with the surface water in the majority of sample locations. A slight sewage odour was noted at sample locations 202, 203 and 211, and water at sample location 210 was observed to be amber. PID screening of the surface water headspace suggested the absence of gross volatile hydrocarbon impact.

9. Laboratory Testing

9.1 Analytical Programme

9.1.1 DP 2008 Investigation

Laboratory testing was undertaken by SGS Australia Pty Ltd (SGS), with the exception of faecal coliforms which were analysed at Ecowise Environmental. Both laboratories are registered with the National Association of Testing Authorities, Australia (NATA).

A total of 75 soil samples (including seven QA/QC samples), 14 groundwater samples (including one QA/QC), 12 surface water samples (including one QA/QC sample) and two fibro sheeting samples were selected to provide a preliminary assessment of soil, groundwater and surface water conditions across the greater Hexham site.

The samples were selected to target the potential sources of contamination identified in 2008 (Section 7).

The soil samples were analysed for a combination of the following potential contaminants:

- Total Recoverable Hydrocarbons (TRH);
- Benzene, Toluene, Ethyl Benzene, Xylene (BTEX);
- Polycyclic Aromatic Hydrocarbons (PAH);
- Organochlorine Pesticides (OCP);
- Organophosphorus Pesticides (OPP);
- Polychlorinated Biphenyls (PCB);
- Metals: Arsenic (As); Cadmium (Cd); Chromium (Cr); Copper (Cu); Lead (Pb); Mercury (Hg); Nickel (Ni); Zinc (Zn);
- Faecal Coliforms;
- Asbestos.

In addition, a total of 21 soil samples were analysed for aggressiveness to concrete and steel (sulphate, chloride, pH and EC).

The groundwater and surface water samples were analysed for a combination of the following potential contaminants:

- Total Recoverable Hydrocarbons (TRH);
- Benzene, Toluene, Ethyl Benzene, Xylene (BTEX);
- Polycyclic Aromatic Hydrocarbons (PAH);
- Organochlorine Pesticides (OCP);
- Organophosphorus Pesticides (OPP);
- Polychlorinated Biphenyls (PCB);
- Metals: Arsenic (As); Cadmium (Cd); Chromium (Cr); Copper (Cu); Lead (Pb); Mercury (Hg); Nickel (Ni); Zinc (Zn): Iron (Fe);
- Faecal Coliforms;
- Total Kjeldahl Nitrogen – TKN;
- Total Nitrogen – TN;
- Total Phosphorous – TP;
- Biological Oxygen Demand – BOD;
- pH and Electrical Conductivity - EC;
- Chemical Oxygen Demand - COD (surface water only);
- Total Dissolved Solids - TDS (surface water only).

9.1.2 ERM 2010 Investigation

A total of eighty two (82) soil samples and ten (10) groundwater samples were selected by ERM for analysis. The soil and groundwater samples were analysed for a combination of the following potential contaminants:

- Total Recoverable Hydrocarbons (TRH);
- Benzene, Toluene, Ethyl Benzene, Xylene (BTEX);
- Polycyclic Aromatic Hydrocarbons (PAH);
- Metals: Arsenic (As); Cadmium (Cd); Chromium (Cr); Copper (Cu); Lead (Pb); Mercury (Hg); Nickel (Ni); Zinc (Zn).

Two fragments of fibro sheeting were also analysed for asbestos.

9.2 Analytical Results - DP 2008 Investigation

The results of chemical analysis of soil, groundwater and surface water samples are presented in the laboratory report sheets (Appendix C), and are summarised in Tables 14 to 18 below. Analytical results of previous assessments (Ref 1) have been included.

Table 14: Results of Chemical Analysis on Soil – Heavy Metals

Bore/Pit	Depth (m)	PID (ppm)	Metal							
			As	Cd	Cr	Cu	Pb	Hg	Ni	Zn
Previous Assessment, DP (Ref 1)										
TP14	0.8	<1	<3	<0.1	2.1	5.9	15	<0.05	3.5	24
TP18	1.0	<1	20	0.3	2.2	17	16	0.13	3.5	33
TP28	0.1	<1	7	0.3	8	18	20	0.06	13	140
D1	0.1	<1	4	0.1	14	11	9	0.05	13	36
TP28	1.0	<1	<3	<0.1	3.5	5	5	<0.05	3.8	110
TP29	0.4	<1	<3	0.2	4	6.7	23	<0.05	8	81
2008 Assessment										
BH101	0.8-1.0	<1	28	<0.3	2.1	13	14	0.54	3	15
BH102	0.3-0.5	<1	8	<0.3	4.4	11	11	0.08	7.9	42
BH103	0.0-0.1	<1	35	0.3	4.5	16	27	0.21	7.1	58
BH104	0.8-1.0	<1	9	0.6	2.5	19	20	0.11	2.3	39
BH105	1.8-2.0	<1	4	<0.3	5.2	27	9.8	0.23	26	55
BH106	0.0-0.1	<1	10	0.5	8.7	21	21	0.09	13	120
BH107	0.8-1.0	<1	20	0.7	8.3	77	120	0.3	19	170
BD103	0.8-1.0	<1	25	1	12	110	160	0.12	33	370
BH108	0.3-0.5	<1	29	0.6	2	15	24	0.11	3.8	70
BH109	0.0-0.1	<1	7	0.4	1.8	13	21	0.11	3.6	74
BD105	0.0-0.1	<1	8	0.4	1.9	14	26	0.09	3.8	77
TP110	0.2	<1	5	<0.3	6.7	9.7	9	<0.05	6.6	30
TP111	0.8	<1	5	<0.3	6.7	9.7	9	<0.05	6.6	30
TP112	1.8	<1	18	0.7	4.4	21	14	0.54	49	79
TP113	0.5	<1	5	<0.3	5.4	8	7	<0.05	7.4	32
TP114	0.2	<1	4	0.3	13	23	18	0.07	36	84
TP115	1.0	<1	3	0.7	27	17	180	0.06	11	340
TP115A	0.6	<1	14	0.4	2.5	17	31	0.23	3.7	180
TP116	1.5	<1	<3	<0.3	2.4	8.8	8	0.27	5.4	36
TP117	2.0	<1	<3	<0.3	2.3	11	11	0.06	2.8	46
TP118	3.5	<1	20	0.3	2.8	22	21	0.2	5.7	42
TP119	1.0	<1	12	0.6	1.2	16	20	0.07	1.4	76
TP160	4.0	<1	<3	<0.3	2.1	6.9	9	0.07	3	160
TP120	0.0-0.05	<1	29	<0.3	4.6	24	33	0.08	12	38
TP121	0.3	<1	<3	<0.3	3.2	3.8	7	<0.05	2.5	38
TP122	0.5	<1	8	<0.3	1.4	15	20	0.5	3.3	29
TP124	0.0-0.05	<1	27	0.5	6.2	15	29	0.18	7.8	100
BD106	0.0-0.05	<1	19	0.6	11	17	32	0.13	29	130
TP125	0.3	<1	8	<0.3	9.3	13	10	0.08	15	37
TP126	0.7	<1	15	1.1	27	36	68	0.21	67	410
TP127	0.0-0.05	<1	20	1.3	32	150	34	0.05	29	79
TP128	0.0-0.05	<1	<3	<0.3	0.8	0.8	6	<0.05	0.6	22
BD108	0.0-0.05	<1	<3	<0.3	0.7	0.7	7	<0.05	0.6	26
TP128	1.6	<1	10	0.6	32	51	32	<0.05	43	87
TP129	1.0	<1	8	<0.3	1.8	10	15	0.15	3.9	23
TP130	0.5	<1	7	<0.3	1	13	23	0.19	6.7	46
TP131	0.9	<1	8	0.3	1.9	18	26	0.09	5.8	80
TP131	1.3	<1	4	0.4	37	34	12	<0.05	61	68
TP132	0.0-0.05	<1	9	0.3	2.3	17	24	0.2	4.1	59
TP134	0.1	<1	10	0.3	17	20	11	<0.05	20	70
TP135	0.0-0.05	<1	8	0.5	17	16	25	0.07	12	160

Notes to Table 14:
All results in mg/kg on a dry weight basis
PQL - Practical Quantitation Limits
PID - Photoionisation Detector
1 - Health Based Criteria for Industrial/Commercial Land Use
D1 - Replicate sample of TP28/0.1
BD103 - Replicate sample of BH107/0.8-1.0
BD105 - Replicate sample of BH109/0.0-0.1
BD106 - Replicate sample of TP124/0.0-0.05
BD108 - Replicate sample of TP128/0.0-0.05
BD116 - Replicate sample of TP140/0.1
BD117 - Replicate sample of TP148/0.0-0.05
BD121 - Replicate sample of TP168/0.0-0.02
BH – Bore
TP – Pit

Table 14: Results of Chemical Analysis on Soil – Heavy Metals (continued)

Bore/Pit	Depth (m)	PID (ppm)	Metal	Bore/Pit	Depth (m)	PID (ppm)	Metal	Bore/Pit	Depth (m)	PID (ppm)
2008 Assessment										
TP138	0.0-0.05	<1	14	0.5	2.8	18	46	0.16	4.5	140
TP139	2.3	<1	8	<0.3	4.1	11	19	0.14	8	32
TP140	0.1	<1	<3	<0.3	2.5	11	9.5	<0.05	6.1	30
BD116	0.1	<1	<3	<0.3	1.9	12	8	<0.05	4.9	110
TP141	1.9	<1	17	<0.3	0.9	15	30	0.11	4.7	38
TP142	0.1	<1	8	0.4	15	28	15	<0.05	29	84
TP143	0.65	<1	5	<0.3	1.1	13	22	0.15	2	43
TP145	0.6	<1	<3	<0.3	6.2	13	9.8	0.11	9.4	16
TP146	0.0	<1	11	0.5	6.1	100	85	0.15	10	60
TP147	0.9	<1	9	0.3	4.2	41	26	0.09	15	57
TP148	0.0-0.05	<1	25	0.9	9.1	890	88	0.05	22	160
BD117	0.0-0.05	<1	19	0.7	7.6	740	100	0.07	19	120
TP149	0.95	<1	27	0.3	2.4	32	27	0.56	3.4	47
TP150	0.1	<1	15	0.8	10	150	170	<0.05	20	69
TP150	0.5	<1	11	0.7	13	130	82	0.08	20	400
TP151	0.0-0.05	<1	4	<0.3	13	26	10	<0.05	18	63
TP152	0.6	<1	6	0.8	25	49	60	0.12	59	380
TP153	0.0-0.05	<1	4	0.7	28	66	140	<0.05	41	430
TP154	0.0-0.05	<1	6	0.4	8.9	27	28	0.07	7.6	96
TP155	0.1	<1	4	2.6	23	33	81	0.05	26	1500
TP156	0.0-0.05	<1	5	0.4	10	27	46	0.07	6.6	110
TP157	0.7	<1	120	1.1	17	61	35	<0.05	35	95
TP158	0.2	<1	8	<0.3	7.3	11	7	0.05	9.1	86
TP159	0.5	<1	5	<0.3	2.7	11	14	0.05	2.7	49
TP162	1.3	<1	5	<0.3	10	66	54	0.07	13	42
TP163	0.1	<1	17	0.6	15	47	58	0.31	11	93
TP164	0.4	<1	5	<0.3	5.9	35	26	<0.05	10	32
TP164	1.0	<1	34	0.9	32	18	20	<0.05	6.6	46
TP165	0.1	<1	<3	<0.3	4.7	6.6	9.9	<0.05	2.6	59
TP166	0.0-0.02	<1	9	0.3	6.9	20	48	<0.05	11	94
TP168	0.0-0.02	<1	6	<0.3	6.3	17	15	<0.05	9.6	88
BD121	0.0-0.02	<1	9	0.4	7	19	17	<0.05	11	94
TP169	0.0-0.02	<1	7	0.3	8.2	22	18	<0.05	10	88
Laboratory PQL			3	0.3	0.3	0.5	1	0.05	0.5	0.5
NSW EPA - NEHF F 1 (Ref 6)			500	100	500	5000	1500	75	3000	35000

Notes to Table 14:
All results in mg/kg on a dry weight basis
PQL - Practical Quantitation Limits
PID - Photoionisation Detector
1 - Health Based Criteria for Industrial/Commercial Land Use
D1 - Replicate sample of TP28/0.1
BD103 - Replicate sample of BH107/0.8-1.0
BD105 - Replicate sample of BH109/0.0-0.1
BD106 - Replicate sample of TP124/0.0-0.05
BD108 - Replicate sample of TP128/0.0-0.05
BD116 - Replicate sample of TP140/0.1
BD117 - Replicate sample of TP148/0.0-0.05
BD121 - Replicate sample of TP168/0.0-0.02
BH – Bore
TP – Pit

Table 15: Results of Chemical Analysis on Soil - TRH and BTEX

Bore / Pit	Depth (m)	PID (ppm)	Analyte							
			TRH				BTEX			
			C_6 - C_9	C_{10} - C_{14}	C_{15} - C_{28}	C_{29} - C_{36}	Benzene	Toluene	Ethyl Benzene	Xylene
Previous Assessment, DP (Ref 1)										
TP14	0.8	<1	<20	<20	<50	<50	<0.5	<0.5	<0.5	<1.5
TP18	1.0	<1	<21	<20	100	<50	<0.5	<0.5	<0.5	<1.5
TP28	0.1	<1	<22	23	290	170	<0.5	<0.5	<0.5	<1.5
D1	0.1	<1	<24	<20	250	170	<0.5	<0.5	<0.5	<1.5
TP28	1.0	<1	<23	<50	<50	<50	<0.5	<0.5	<0.5	<1.5
TP29	0.4	<1	<25	**110**	**2600**	**1900**	<0.5	<0.5	<0.5	<1.5
2008 Assessment										
BH101	0.8-1.0	<1	<20	**79**	**780**	**310**	<0.5	<0.5	<0.5	<1.5
BH102	0.3-0.5	<1	<20	**150**	**1400**	**440**	<0.5	<0.5	<0.5	<1.5
BH103	0.0-0.1	<1	<20	60	610	300	<0.5	<0.5	<0.5	<1.5
BH104	0.8-1.0	<1	<20	<20	340	150	<0.5	<0.5	<0.5	<1.5
BH105	1.8-2.0	<1	<20	41	600	340	<0.5	<0.5	<0.5	<1.5
BH106	0.0-0.1	<1	<20	<20	200	120	<0.5	<0.5	<0.5	<1.5
BH107	0.8-1.0	<1	<20	26	430	200	<0.5	<0.5	<0.5	<1.5
BD103	0.8-1.0	<1	<20	21	390	300	<0.5	<0.5	<0.5	<1.5
BH108	0.3-0.5	<1	<20	33	480	230	<0.5	<0.5	<0.5	<1.5
BH109	0.0-0.1	<1	<20	**90**	**1100**	**500**	<0.5	<0.5	<0.5	<1.5
BD105	0.0-0.1	<1	<20	39	520	300	<0.5	<0.5	<0.5	<1.5
TP110	0.2	<1	<20	<20	110	<50	<0.5	<0.5	<0.5	<1.5
TP111	0.8	<1	<20	<20	110	<50	<0.5	<0.5	<0.5	<1.5
TP112	1.8	<1	<20	<20	330	190	<0.5	<0.5	<0.5	<1.5
TP113	0.5	<1	<20	<20	<50	<50	<0.5	<0.5	<0.5	<1.5
TP114	0.2	<1	<20	<20	<50	<50	<0.5	<0.5	<0.5	<1.5
TP115	1.0	<1	<20	<20	320	180	<0.5	<0.5	<0.5	<1.5
TP115A	0.6	<1	<20	<20	<50	<50	<0.5	<0.5	<0.5	<1.5
TP116	1.5	<1	<20	**130**	**2400**	**1900**	<0.5	<0.5	<0.5	<1.5
TP117	2.0	<1	<20	**180**	**2700**	**1700**	<0.5	<0.5	<0.5	<1.5
TP118	3.5	<1	<20	<20	170	120	<0.5	<0.5	<0.5	<1.5
TP119	1.0	<1	<20	<20	230	140	<0.5	<0.5	<0.5	<1.5
TP160	4.0	<1	<20	**180**	**2000**	**1200**	<0.5	<0.5	<0.5	<1.5
TP120	0.0-0.05	<1	<20	31	390	170	<0.5	<0.5	<0.5	<1.5
TP121	0.3	<1	<20	<20	<50	<50	<0.5	<0.5	<0.5	<1.5
TP122	0.5	<1	<20	<20	150	51	<0.5	<0.5	<0.5	<1.5
TP124	0.0-0.05	<1	<20	<20	140	71	<0.5	<0.5	<0.5	<1.5
BD106	0.0-0.05	<1	<20	<20	190	76	<0.5	<0.5	<0.5	<1.5
TP125	0.3	<1	<20	<20	<50	<50	<0.5	<0.5	<0.5	<1.5
TP126	0.7	<1	<20	<20	430	300	<0.5	<0.5	<0.5	<1.5
TP127	0.0-0.05	<1	<20	21	370	340	<0.5	<0.5	<0.5	<1.5
TP128	0.0-0.05	<1	<20	**<200**	**8700**	**8200**	<0.5	<0.5	<0.5	<1.5
BD108	0.0-0.05	<1	<20	**<200**	**10000**	**11000**	<0.5	<0.5	<0.5	<1.5
TP128	1.6	<1	<20	<20	<50	<50	<0.5	<0.5	<0.5	<1.5
TP129	1.0	<1	<20	28	300	130	<0.5	<0.5	<0.5	<1.5
TP130	0.5	<1	<20	**63**	**680**	**290**	<0.5	<0.5	<0.5	<1.5
TP131	0.9	<1	<20	**61**	**750**	**360**	<0.5	<0.5	<0.5	<1.5
TP131	1.3	<1	<20	<20	<50	<50	<0.5	<0.5	<0.5	<1.5
TP132	0.0-0.05	<1	<20	<20	230	66	<0.5	<0.5	<0.5	<1.5
TP134	0.1	<1	<20	<20	<50	<50	<0.5	<0.5	<0.5	<1.5

Notes to Table 15:

All results in mg/kg on a dry weight basis
PQL - Practical Quantitation Limits
PID - Photoionisation Detector
1 - Threshold Concentration for Sensitive Land Use (Ref 17)
Bold results indicate exceedence of Service Station Guidelines (Ref 17)
D1 - Replicate sample of TP28/0.1
BD103 - Replicate sample of BH107/0.8-1.0
BD105 - Replicate sample of BH109/0.0-0.1
BD106 - Replicate sample of TP124/0.0-0.05
BD108 - Replicate sample of TP128/0.0-0.05
BD116 - Replicate sample of TP140/0.1
BD117 - Replicate sample of TP148/0.0-0.05
BD121 - Replicate sample of TP168/0.0-0.02
BH - Bore
TP – Pit

Table 15: Results of Chemical Analysis on Soil - TRH and BTEX (continued)

Bore / Pit	Depth (m)	PID (ppm)	Analyte							
			TRH				BTEX			
			C_6 - C_9	C_{10} - C_{14}	C_{15} - C_{28}	C_{29} - C_{36}	Benzene	Toluene	Ethyl Benzene	Xylene
2008 Assessment										
TP135	0.0-0.05	<1	<20	23	300	110	<0.5	<0.5	<0.5	<1.5
TP136A	0.0-0.05	<1	<20	22	290	110	<0.5	<0.5	<0.5	<1.5
TP138	0.0-0.05	<1	<20	34	380	170	<0.5	<0.5	<0.5	<1.5
TP139	2.3	<1	<20	<20	<50	<50	<0.5	<0.5	<0.5	<1.5
TP140	0.1	<1	<20	<20	54	<50	<0.5	<0.5	<0.5	<1.5
BD116	0.1	<1	<20	<20	110	70	<0.5	<0.5	<0.5	<1.5
TP141	1.9	<1	<20	<20	120	<50	<0.5	<0.5	<0.5	<1.5
TP142	0.1	<1	<20	<20	<50	<50	<0.5	<0.5	<0.5	<1.5
TP143	0.65	<1	<20	<20	230	110	<0.5	<0.5	<0.5	<1.5
TP145	0.6	<1	<20	<20	180	110	<0.5	<0.5	<0.5	<1.5
TP146	0.0	<1	<20	**67**	**870**	**880**	<0.5	<0.5	<0.5	<1.5
TP147	0.9	<1	<20	<20	140	72	<0.5	<0.5	<0.5	<1.5
TP148	0.0-0.05	<1	<20	**<200**	**650**	**1600**	<0.5	<0.5	<0.5	<1.5
BD117	0.0-0.05	<1	<20	**43**	**600**	**790**	<0.5	<0.5	<0.5	<1.5
TP149	0.95	<1	<20	<20	180	69	<0.5	<0.5	<0.5	<1.5
TP150	0.1	<1	<20	**<200**	**860**	**2000**	<0.5	<0.5	<0.5	<1.5
TP150	0.5	<1	<20	26	430	440	<0.5	<0.5	<0.5	<1.5
TP151	0.0-0.05	<1	<20	<20	<50	<50	<0.5	<0.5	<0.5	<1.5
TP152	0.6	<1	<20	<20	110	130	<0.5	<0.5	<0.5	<1.5
TP153	0.0-0.05	<1	<20	<20	<50	<50	<0.5	<0.5	<0.5	<1.5
TP154	0.0-0.05	<1	<20	<20	59	<50	<0.5	<0.5	<0.5	<1.5
TP155	0.1	<1	<20	<20	<50	<50	<0.5	<0.5	<0.5	<1.5
TP156	0.0-0.05	<1	<20	<20	180	150	<0.5	<0.5	<0.5	<1.5
TP157	0.7	<1	<20	<20	52	<50	<0.5	<0.5	<0.5	<1.5
TP158	0.2	<1	<20	<20	<50	<50	<0.5	<0.5	<0.5	<1.5
TP159	0.5	<1	<20	<20	<50	<50	<0.5	<0.5	<0.5	<1.5
TP162	1.3	<1	<20	<20	65	<50	<0.5	<0.5	<0.5	<1.5
TP163	0.1	<1	<20	<20	160	130	<0.5	<0.5	<0.5	<1.5
TP164	0.4	<1	<20	<20	89	66	<0.5	<0.5	<0.5	<1.5
TP164	1.0	<1	<20	<20	<50	<50	<0.5	<0.5	<0.5	<1.5
TP165	0.1	<1	<20	<20	270	150	<0.5	<0.5	<0.5	<1.5
TP166	0.0-0.02	<1	<20	<20	<50	64	<0.5	<0.5	<0.5	<1.5
TP168	0.0-0.02	<1	<20	<20	<50	58	<0.5	<0.5	<0.5	<1.5
BD121	0.0-0.02	<1	<20	<20	<50	<50	<0.5	<0.5	<0.5	<1.5
TP169	0.0-0.02	<1	<20	<20	110	170	<0.5	<0.5	<0.5	<1.5
Laboratory PQL			20	20	50	50	0.5	0.5	0.5	1.5
NSW EPA Criteria for			65		1000		1	1.4/130[1]	3.1/50[1]	14/25[1]
Service Station Sites [1] (Ref 17)					total					

Notes to Table 15:

All results in mg/kg on a dry weight basis
PQL - Practical Quantitation Limits
PID - Photoionisation Detector
1 - Threshold Concentration for Sensitive Land Use (Ref 17)
Bold results indicate exceedence of Service Station Guidelines (Ref 17)
D1 - Replicate sample of TP28/0.1
BD103 - Replicate sample of BH107/0.8-1.0
BD105 - Replicate sample of BH109/0.0-0.1
BD106 - Replicate sample of TP124/0.0-0.05
BD108 - Replicate sample of TP128/0.0-0.05
BD116 - Replicate sample of TP140/0.1
BD117 - Replicate sample of TP148/0.0-0.05
BD121 - Replicate sample of TP168/0.0-0.02
BH - Bore
TP – Pit

Table 16: Results of Chemical Analysis on Soil - PAH, PCB, OPP, OCP and Asbestos

Bore / Pit	Depth (m)	PID (ppm)	Total PAH	Benzo(a) Pyrene	PCB	Total OPP	Total OCP	Asbestos
Previous Assessment, DP (Ref 1)								
TP14	0.8	<1	<1.77	0.07	all <0.1	all <0.1	all <0.1	NT
TP18	1.0	<1	<1.96	0.06	all <0.1	all <0.1	all <0.1	NT
TP28	0.1	<1	<2.69	0.09	all <0.1	all <0.1	all <0.1	NT
D1	0.1	<1	<2.69	0.08	all <0.1	all <0.1	all <0.1	NT
TP28	1.0	<1	<1.55	<0.05	all <0.1	all <0.1	all <0.1	NT
TP29	0.4	<1	<14.02	0.62	all <0.1	all <0.1	all <0.1	NT
2008 Assessment								
BH101	0.8-1.0	<1	<4.37	0.12	all <0.1	all <0.1	all <0.1	ND
BH102	0.3-0.5	<1	<5.50	0.14	all <0.1	all <0.1	all <0.1	ND
BH103	0.0-0.1	<1	<3.74	<0.05	all <0.1	all <0.1	all <0.1	ND
BH104	0.8-1.0	<1	<1.89	<0.05	all <0.1	all <0.1	all <0.1	NT
BH105	1.8-2.0	<1	<2.65	0.08	all <0.1	all <0.1	all <0.1	NT
BH106	0.0-0.1	<1	<4.26	0.16	all <0.1	all <0.1	all <0.1	ND
BH107	0.8-1.0	<1	<7.63	0.4	all <0.1	all <0.1	all <0.1	ND
BD103	0.8-1.0	<1	<7.95	0.46	all <0.1	all <0.1	all <0.1	NT
BH108	0.3-0.5	<1	<2.74	<0.05	all <0.1	all <0.1	all <0.1	ND
BH109	0.0-0.1	<1	<3.06	0.15	all <0.1	all <0.1	all <0.1	ND
BD105	0.0-0.1	<1	<3.38	0.13	all <0.1	all <0.1	all <0.1	NT
TP110	0.2	<1	<1.99	<0.05	all <0.1	all <0.1	all <0.1	ND
TP111	0.8	<1	<1.99	<0.05	all <0.1	all <0.1	all <0.1	ND
TP112	1.8	<1	<1.75	<0.05	all <0.1	all <0.1	all <0.1	ND
TP113	0.5	<1	<1.61	<0.05	all <0.1	all <0.1	all <0.1	ND
TP114	0.2	<1	<1.55	<0.05	all <0.1	all <0.1	all <0.1	ND
TP115	1.0	<1	<3.60	0.2	all <0.1	all <0.1	all <0.1	ND
TP115A	0.6	<1	<1.85	<0.05	all <0.1	all <0.1	all <0.1	ND
TP116	1.5	<1	<3.02	0.12	all <0.1	all <0.1	all <0.1	ND
TP117	2.0	<1	<4.39	0.19	all <0.1	all <0.1	all <0.1	ND
TP118	3.5	<1	<2.75	<0.05	all <0.1	all <0.1	all <0.1	ND
TP119	1.0	<1	<1.85	<0.05	all <0.1	all <0.1	all <0.1	ND
TP160	4.0	<1	<4.91	0.21	all <0.1	all <0.1	all <0.1	ND
TP120	0.0-0.05	<1	<3.98	0.08	all <0.1	all <0.1	all <0.1	ND
TP121	0.3	<1	<1.55	<0.05	all <0.1	all <0.1	all <0.1	ND
TP122	0.5	<1	<2.38	0.08	all <0.1	all <0.1	all <0.1	ND
TP124	0.0-0.05	<1	<2.15	<0.05	all <0.1	all <0.1	all <0.1	ND
BD106	0.0-0.05	<1	<2.49	0.05	all <0.1	all <0.1	all <0.1	NT
TP125	0.3	<1	<1.55	<0.05	all <0.1	all <0.1	all <0.1	ND
TP126	0.7	<1	<7.00	0.2	all <0.1	all <0.1	all <0.1	ND
TP127	0.0-0.05	<1	<2.88	0.08	all <0.1	all <0.1	all <0.1	ND
TP128	0.0-0.05	<1	<1.85	<0.05	all <1	all <1	all <1	ND
BD108	0.0-0.05	<1	<2.06	<0.05	all <1	all <1	all <1	NT
TP128	1.6	<1	<1.55	<0.05	all <0.1	all <0.1	all <0.1	NT
TP129	1.0	<1	<2.45	<0.05	all <0.1	all <0.1	all <0.1	ND
TP130	0.5	<1	<2.25	0.05	all <0.1	all <0.1	all <0.1	ND
TP131	0.9	<1	<1.75	<0.05	all <0.1	all <0.1	all <0.1	ND
TP131	1.3	<1	<1.55	<0.05	all <0.1	all <0.1	all <0.1	NT
TP132	0.0-0.05	<1	<3.25	0.05	all <0.1	all <0.1	all <0.1	ND
TP134	0.1	<1	<1.55	<0.05	all <0.1	all <0.1	all <0.1	ND
TP135	0.0-0.05	<1	<3.73	0.13	all <0.1	all <0.1	all <0.1	ND
TP136A	0.0-0.05	<1	<3.25	0.05	all <0.1	all <0.1	all <0.1	ND

Notes to Table 16:

All results in mg/kg on a dry weight basis
NC - No Criteria
ND - Not Detected
1 - Health Based Criteria for Industrial/Commercial Land Use
2 - Correspondence from NSW EPA Director of Contaminated Sites to Accredited Site Auditors
3 – Fibre cement sheeting
D1 - Replicate sample of TP28/0.1
BD105 - Replicate sample of BH109/0.0-0.1
BD108 - Replicate sample of TP128/0.0-0.05
BD117 - Replicate sample of TP148/0.0-0.05
BH – Bore
PQL - Practical Quantitation Limits
NT - Not Tested
PID - Photoionisation Detector
BD103 - Replicate sample of BH107/0.8-1.0
BD106 - Replicate sample of TP124/0.0-0.05
BD116 - Replicate sample of TP140/0.1
BD121 - Replicate sample of TP168/0.0-0.02
TP – Pit

Table 16: Results of Chemical Analysis on Soil - PAH, PCB, OPP, OCP and Asbestos (continued)

Bore / Pit	Depth (m)	PID (ppm)	Total PAH	Benzo(a) Pyrene	PCB	Total OPP	Total OCP	Asbestos
2008 Assessment								
TP138	0.0-0.05	<1	<3.79	0.09	all <0.1	all <0.1	all <0.1	ND
TP139	2.3	<1	<1.55	<0.05	all <0.1	all <0.1	all <0.1	ND
TP140	0.1	<1	<1.75	<0.05	all <0.1	all <0.1	all <0.1	ND
BD116	0.1	<1	<1.59	<0.05	all <0.1	all <0.1	all <0.1	NT
TP141	1.9	<1	<2.25	<0.05	all <0.1	all <0.1	all <0.1	ND
TP142	0.1	<1	<1.55	<0.05	all <0.1	all <0.1	all <0.1	ND
TP143	0.65	<1	<2.86	0.06	all <0.1	all <0.1	all <0.1	ND
TP145	0.6	<1	<2.12	<0.05	all <0.1	all <0.1	all <0.1	ND
TP146	0.0	<1	<4.63	0.13	all <0.1	all <0.1	all <0.1	ND
TP147	0.9	<1	<3.35	0.15	all <0.1	all <0.1	all <0.1	ND
TP148	0.0-0.05	<1	<3.24	0.14	all <0.1	all <0.1	all <0.1	ND
BD117	0.0-0.05	<1	<3.82	0.12	all <0.1	all <0.1	all <0.1	NT
148A[3]	0.0	NT	NT	NT	NT	NT	NT	Asbestos Detected
TP149	0.95	<1	<2.71	<0.05	all <0.1	all <0.1	all <0.1	ND
TP150	0.1	<1	<2.78	0.11	all <0.1	all <0.1	all <0.1	ND
TP150	0.5	<1	<3.66	0.09	all <0.1	all <0.1	all <0.1	ND
TP151	0.0-0.05	<1	<1.55	<0.05	all <0.1	all <0.1	all <0.1	ND
TP152	0.6	<1	<3.27	0.17	all <0.1	all <0.1	all <0.1	ND
TP153	0.0-0.05	<1	<1.56	0.06	all <0.1	all <0.1	all <0.1	ND
153A[3]	0.0	NT	NT	NT	NT	NT	NT	Asbestos Detected
TP154	0.0-0.05	<1	<1.85	<0.05	all <0.1	all <0.1	all <0.1	ND
TP155	0.1	<1	<1.79	0.09	all <0.1	all <0.1	all <0.1	ND
TP156	0.0-0.05	<1	<2.93	0.13	all <0.1	all <0.1	all <0.1	ND
TP157	0.7	<1	<1.79	0.09	all <0.1	all <0.1	all <0.1	ND
TP158	0.2	<1	<1.55	<0.05	all <0.1	all <0.1	all <0.1	ND
TP159	0.5	<1	<1.55	<0.05	all <0.1	all <0.1	all <0.1	ND
TP162	1.3	<1	<1.65	<0.05	all <0.1	all <0.1	all <0.1	ND
TP163	0.1	<1	<2.80	0.12	all <0.1	all <0.1	all <0.1	ND
TP164	0.4	<1	<1.68	<0.05	all <0.1	all <0.1	all <0.1	ND
TP164	1.0	<1	<1.55	<0.05	all <0.1	all <0.1	all <0.1	NT
TP165	0.1	<1	<1.55	<0.05	all <0.1	all <0.1	all <0.1	ND
TP166	0.0-0.02	<1	<1.55	<0.05	all <0.1	all <0.1	all <0.1	NT
TP168	0.0-0.02	<1	<1.61	0.05	all <0.1	all <0.1	all <0.1	NT
BD121	0.0-0.02	<1	<1.56	0.05	all <0.1	all <0.1	all <0.1	NT
TP169	0.0-0.02	<1	<1.59	0.05	all <0.1	all <0.1	all <0.1	ND
Laboratory PQL			1.55 total	0.05	0.1/each	0.1/each	0.1/each	
NSW EPA - NEHF F [1] (Ref 16)			100	5	50	NC	NC	No Asbestos present on the surface [2]

Notes to Table 16:

All results in mg/kg on a dry weight basis

PQL - Practical Quantitation Limits

NC - No Criteria

NT - Not Tested

ND - Not Detected

PID - Photoionisation Detector

1 - Health Based Criteria for Industrial/Commercial Land Use

2 - Correspondence from NSW EPA Director of Contaminated Sites to Accredited Site Auditors

3 – Fibre cement sheeting

D1 - Replicate sample of TP28/0.1

BD103 - Replicate sample of BH107/0.8-1.0

BD105 - Replicate sample of BH109/0.0-0.1

BD106 - Replicate sample of TP124/0.0-0.05

BD108 - Replicate sample of TP128/0.0-0.05

BD116 - Replicate sample of TP140/0.1

BD117 - Replicate sample of TP148/0.0-0.05

BD121 - Replicate sample of TP168/0.0-0.02

BH – Bore

TP – Pit

Table 17: Results of Chemical Analysis on Soil - pH, EC, Chloride and Sulphate

Bore / Pit	Depth (m)	PID (ppm)	pH	EC (µs/cm)	Chloride (mg/kg)	Sulphate (mg/kg)
Previous Assessment, DP (Ref 1)						
TP14	0.8	<1	6.9	NT	98	270
TP18	1.0	<1	9.4	NT	12	210
TP28	0.1	<1	6.1	NT	81	21
D1	0.1	<1	7.1	NT	580	200
TP28	1.0	<1	6.4	NT	65	27
TP29	0.4	<1	6.2	NT	11	250
2008 Assessment						
BH104	0.8-1.0	<1	7.6	380	10	47
BH105	1.8-2.0	<1	4.7	160	4.7	550
TP110	0.2	<1	8.3	88	46	74
TP111	0.8	<1	7.1	130	3.1	28
TP112	1.8	<1	5.5	1400	3.8	2200
TP113	0.5	<1	8.3	220	5.8	5
TP114	0.2	<1	7.6	460	57	77
TP115	1.0	<1	7.6	24	0.7	3
TP115A	0.6	<1	7.9	230	6.3	17
TP116	1.5	<1	7.9	850	9.6	54
TP117	2.0	<1	7.6	700	12	47
TP118	3.5	<1	5.8	270	0.9	60
TP119	1.0	<1	8.9	530	4.6	89
TP160	4.0	<1	8.8	610	17	36
TP121	0.3	<1	6.8	36	3.7	4
TP129	1.0	<1	6.7	1100	5.3	390
TP143	0.65	<1	5.4	97	<0.5	12
TP145	0.6	<1	5.5	65	1.4	8
TP147	0.9	<1	6.0	12	14	30
TP150	0.5	<1	5.7	68	4.1	13
TP162	1.3	<1	6.8	94	7.9	2
Laboratory PQL			NA	<1	<0.5	<2

Notes to Table 17:
PQL - Practical Quantitation Limits
NT - Not Tested
NA - Not Applicable
D1 - Replicate sample of TP28/0.1

Table 18: Results of Chemical Analysis on Groundwater and Surface Water

Sample Type	Groundwater														Surface Water												Laboratory PQL	Australian Drinking Water Guidelines - Health Based (Ref 18)	ANZECC (2000) - Trigger Values (Ref 19)		
																													Slightly to Moderately disturbed systems		
Sample Identification	2	3	5	BD130	7	101	102	103	104	105	106	107	108	109	SW201	BD201	SW202	SW203	SW204	SW205	SW206	SW207	SW208	SW209	SW210	SW211			Fresh	Marine	Irrigation Waters
PID (ppm)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1					
pH	6.4	6	6.7	6.7	5.8	5.7	5.9	5.7	6.9	4.9	6.4	6.6	6.3	7.2	7.3	7.3	7	6.9	7.4	7.3	7.6	7.6	7.1	6.4	8.5	7	0	6.5-8.5 [8]	6.5-8.5 [1]	8.0-8.4 [1]	>6 [5]
Electrical Conductivity (µS/cm)	5100	9700	2600	2500	25000	5200	1700	3600	4900	6300	8900	5300	3400	5200	2300	2300	4100	1800	1500	2700	3100	11000	1200	450	2300	2600	1	NC	NC	NC	1000 - 7500 [3]
Total Dissolved Solids	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	1200000	1200000	2300000	1000000	820000	1700000	2000000	7400000	770000	290000	1600000	1600000	5000	NC	2000000 [13]	NC	NC
Biochemical Oxygen Demand	<2000	<2000	<2000	<2000	5600	<5000	<5000	<5000	<5000	46000	<5000	<5000	<5000	7200	5000	7000	27000	8000	5000	7000	6000	7000	22000	8000	10000	28000	2000	NC	15000 [12]	NC	NC
Chemical Oxygen Demand	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	130000	85000	140000	94000	120000	120000	79000	150000	70000	49000	340000	150000	5000	NC	40000 [12]	NC	NC
Total Kjeldahl Nitrogen	<200	500	<200	<200	10000	1400	4300	300	700	3000	1800	1400	9800	1400	2600	2100	2900	2400	400	1000	1900	900	900	1100	4700	2800	200	NC	NC	NC	NC
Total Nitrogen	<200	490	<200	<200	10000	1400	4300	320	720	3000	1800	1500	9800	1400	2600	2100	2900	2400	360	1000	2000	920	940	1100	4700	2800	200	NC	350 [1]	120 [1]	5000 [4]
Total Phosphorus	130	140	60	80	2800	1200	1500	450	810	3000	330	370	4700	4700	530	330	630	740	1400	1800	2000	90	900	180	270	270	50	NC	350 [1]	120 [1]	5000 [4]
Anions																															
Ammonia (NH_3) as N	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	330	320	1200	50	20	120	300	20	40	30	90	60	10	500 [18]	900	910	NC
Nitrite (NO_2^-) as N	<5	10	9	<5	20	20	9	20	<5	<5	<5	30	<5	<5	10	10	<5	9	<5	<5	20	<5	<5	<5	20	8	5	3000	NC	NC	NC
Nitrate (NO_3^-) as N	50	8	10	10	<5	20	<5	<5	30	<5	20	30	10	<5	10	20	<5	<5	<5	<5	40	<5	6	6	20	<5	5	50000	700	NC	NC
NO_x (NO_2^- + NO_3^-)	<57	<10	<10	<17	<28	<10	<14	<27	<30	<10	<25	<10	<17	<10	24	36	<10	<14	<10	<10	58	<10	<11	<11	46	<13	10	NC	40 [1][2]	5 [1]	NC
Metal																															
As	1.6	8.2	1	<1	6.1	1.5	7.1	6.3	4	8.5	3.1	8.4	1.8	1.3	1.2	1.6	2.6	1.2	2	1.8	1.8	1.3	1.2	<1	16	1.1	1	7	13 [9]	NC	100 [4]
Cd	<0.1	<0.1	<0.1	<0.1	<0.1	0.42	<0.1	<0.1	<0.1	1.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	2	0.2	0.7	10 [4]
Cr	1.1	1.2	<1	<1	2.3	<1	<1	<1	<1	<1	1	<1	<1	2.7	<1	<1	<1	1.2	<1	<1	1.8	1.4	<1	<1	<1	<1	1	50 [7]	1 [7]	4.4 [7]	100 [4]
Cu	5.2	2.5	1.3	1.7	1	1.6	1.7	1.8	1.7	5.4	1.7	1.3	1.2	2.1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	7.3	<1	1	2000	1.4	1.3	200 [4]
Fe^{2+}	480	20000	100	130	28000	13000	16000	28000	4800	480000	5400	12000	4400	190	1100	950	190	1200	520	630	190	33	260	270	1400	190	5	300 [8]	NC	NC	200 [4]
Ni	20	44	9.6	9.5	210	17	24	18	10	1100	31	6.5	16	1.6	9.6	10	3	2.5	4	8.2	9.1	7.4	5.3	2.4	6	5.5	1	20	11	7	200 [4]
Pb	<1	<1	<1	<1	1	1.7	<1	<1	<1	<1	<1	<1	<1	2.6	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.8	<1	1	10	3.4	4.4	2000 [4]
Zn	82	63	34	29	120	120	51	29	18	1500	26	38	28	23	5.3	7.3	1.4	4.3	1.8	3.4	4	5.9	1.7	20	22	2.2	1	NC	8	15	2000 [4]
Hg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	1	0.06 [10]	0.1 [10]	2 [4]
TRH																															
C_6 - C_9	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40	40	NC	NC		NC
C_{10} - C_{14}	<40	<40	<40	<40	<40	<40	45	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40	40	NC	NC	nc	NC
C_{15} - C_{28}	<100	<100	<100	<100	<100	<100	698	<100	<100	<100	<100	<100	823	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	100	NC	NC		NC
C_{29} - C_{36}	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	416	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	100	NC	NC		NC
BTEX																															
Benzene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	1	950	500	NC
Toluene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	800	NC	180 [L]	NC
Ethyl Benzene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	300	NC	80 [L]	NC
Xylene	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	3	600	200 [11]	NC	NC
PAHs																															
Total PAHs	<1.60	<1.60	<1.60	<1.60	<1.60	<1.60	<1.90	<1.60	<1.60	<1.60	<1.60	<1.60	<5.60	<1.60	<4.10	<1.50	<1.90	<1.90	<1.80	<1.70	<1.70	<1.50	<1.50	<1.50	<1.50	<1.50	1.5/1.9	NC	NC	NC	NC
Benzo(a)pyrene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.01	0.1 [L]	0.1 [L]	NC
OPPs	all <0.001	all <0.001	all <0.001	all <0.001	all <0.001	all <0.001	all <0.001	all <0.001	all <0.001	all <0.001	all <0.001	all <0.001	all <0.001	all <0.001	all <0.001	all <0.01	all <0.01	all <0.1	all <0.01	all <0.1	all <0.01	all <0.01	all <0.01	all <0.01	all <0.01	all <0.1	0.1	Species Dependent	Species Dependent	Species Dependent	NC
OCPs																															
Total OCPs	all <0.01	all <0.01	all <0.01	all <0.01	all <0.01	all <0.01	all <0.01	all <0.01	all <0.01	all <0.01	all <0.01	all <0.01	all <0.01	all <0.01	all <0.01	all <0.1	all <0.1	all <1	all <0.1	all <0.1	all <0.1	all <0.1	all <0.1	all <0.1	all <0.1	all <0.1	0.01/0.1	NC	NC	NC	NC
Aldrin + Dieldrin	all <0.001	all <0.001	all <0.001	all <0.001	all <0.001	all <0.001	all <0.001	all <0.001	all <0.001	all <0.001	all <0.001	all <0.001	all <0.001	all <0.001	all <0.001	all <0.01	all <0.01	all <0.1	all <0.1	all <0.01	all <0.01	all <0.01	all <0.01	all <0.01	all <0.01	all <0.01	0.01/0.1	0.3	NC	NC	NC
Chlordane	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.01	<0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	0.01/0.1	1	0.03	NC	NC
DDT	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.01	<0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	0.01/0.1	20	0.006	NC	NC
Heptachlor	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.01	<0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	0.01/0.2	0.3	0.01	NC	NC
PCBs	all <0.01	all <0.01	all <0.01	all <0.01	all <0.01	all <0.01	all <0.01	all <0.01	all <0.01	all <0.01	all <0.01	all <0.01	all <0.01	all <0.01	all <0.01	all <0.1	all <0.1	all <1	all <0.1	all <0.1	all <0.1	all <0.1	all <0.1	all <0.1	all <0.1	all <1	0.1/1	NC	NC	NC	NC
Faecal Coliforms (cfu/100 mL)	30	<1	<1	NT	700	<1	<1	10	100	<1	<1	<1	240	~9300	550	NT	30	1090	260	420	60	NT	NT	NT	~2150	860	1	NIL	NC	NC	<100 [6]

Notes to Table 18:

Results expressed in µg/L unless otherwise stated

PQL - Practical Quantitation Limits

(1) - Trigger Values for physical and chemical stressors for south-east Australia for Slightly Disturbed Ecosystems (Table 3.3.2)

(2) - For Freshwater Lakes and Reservoirs (Conservative)

(3) - Tolerance value of Clover (Conservative Value for Pastures)

(4) - Long Term Trigger Values (up to 100 yrs)

(5) - Trigger Values for assessing corrosiveness of water

(6) - Drinking water criteria for Livestock

(7) - Chromium (VI)

(8) - Aesthetic Guideline Value

(9) - Arsenic (V) (conservative)

(10) - Mercury (Inorganic)

(11) - p-xylene (conservative)

(12) - Netherlands Environmental Quality Objectives - Intervention values for mineral oil in groundwater

(13) - Trigger value based on Tsvetnenko (1998) in absence of specific hydrocarbon species data (ANZECC 2000 Table 8.3.2.4)

(14) - Trigger value based on physico-chemcial stressor guidelines for the protection of aquaculture species

(15) - Trigger value based on tolerance of livestock to dissolved soilds - poultry (conservative)

(L) - 95% Low Reliability Trigger Values (99% protection level applied where recommended (ie benzo(a)pyrene))

NT - Not Tested

NC - No Criteria

NA - Not Applicable

BD130 - Replicate sample of Groundwater Sample 5

BD201 - Replicate sample of Surface Water Sample SW201

Exceeds ANZECC 2000 Guidelines for Fresh Slightly to Moderately disturbed systems

Exceeds ANZECC 2000 Guidelines for Marine Slightly to Moderately disturbed systems

Exceeds ANZECC 2000 Guidelines for both Fresh and Marine Slightly to Moderately disturbed systems

Exceeds ANZECC 2000 Guidelines - Irrigation Waters in absence of ANZECC 2000 Guidelines for Fresh and Marine Slightly to Moderately disturbed systems

The results of chemical analysis of soil and groundwater samples from the ERM 2010 investigation can be found within the ERM report (Ref 22), and are discussed below in Section 10.2.2.

10. Assessment of Contamination

10.1 Assessment Criteria

Results of the chemical analyses were compared to the following NSW EPA recommended guidelines:

- NSW EPA (1998). Contaminated Sites - Guidelines for the Site Auditor Scheme 2nd Edition, April 2006 (Ref 16);
- NSW EPA (1994). Contaminated Sites - Guidelines for Assessing Service Station Sites, December 1994, (Ref 17);
- National Water Quality Management Strategy (2004), "Australian Drinking Water Guidelines", (Ref 18);
- ANZECC (2000) Fresh and Marine Water Quality Guidelines (Ref 19).

The NSW EPA Guidelines for the NSW Site Auditor Scheme contain National Environmental Health Forum (NEHF) levels for various beneficial use scenarios including: low density residential (A), high density residential (D), recreational (E) and commercial/industrial (F). These criteria are applicable where aesthetic and ecological concerns are not an issue. Health based criteria for commercial/industrial use (NEHF F), are considered to be appropriate for the proposed development.

The NSW EPA Guidelines for Assessing Service Station Sites (Ref 17) were used to assess total TRH and BTEX contamination across the site. The criteria used are threshold concentrations for sensitive land use.

The ANZECC (2000) Guidelines for Fresh and Marine Water Quality (Ref 19) were used to assess groundwater quality. The protection of aquatic ecosystem guidelines are considered to be relevant due to the proximity of the site to Hexham Nature Reserve and the Hunter River. The receiving waters are considered to be a "slightly to moderately disturbed system".

It is noted that the groundwater flow at the site is multi-directional, as shown on the Groundwater Contour Plan in Appendix E. Groundwater from the TSF development area predominantly flows east towards the Hunter River, which is brackish to saline. Groundwater over the western portion of the greater Hexham site (i.e. generally west of the TSF development) generally flows towards Hexham Swamp to the west, which is generally fresh to brackish. Due to the multi-direction groundwater flow direction and the variable quality of recovering waters, the results of groundwater and surface water analysis were compared to both fresh water and marine water trigger values (as shown in Table 18 above).

ANZECC (2000) states that there is currently insufficient data to derive high reliability trigger values for various contaminants. For these contaminants, low reliability trigger values have been considered.

ANZECC (2000) states that there is currently insufficient data to derive a high reliability trigger value for TPH, however propose a low reliability trigger value for TPH of 7 µg/L. This guideline is generally considered to be overly conservative and is also well below the TPH detection limit which most laboratories can achieve. No guideline concentration has therefore been adopted for TPH in groundwater at this site.

10.2 Assessment of Contamination

10.2.1 DP 2008 Investigation

Soil/Fill

Soil chemical analysis results were generally within the health based criteria for commercial/industrial land use (i.e. NEHF F), and NSW EPA sensitive land use criteria for TRH and BTEX with the following exceptions:

- Elevated TRH (C_{10}-C_{36}) in BH101/0.8-1.0 m, BH 102/0.3-0.5 m, BH109/0.0-0.1 m, TP116/1.5 m, TP117/2.0 m, TP160/4.0 m, TP128/0.0-0.05 m (and associated replicate BD108), TP130/0.5 m, TP131/0.9 m, TP146/0.0 m, TP148/0.0-0.05 m (and associated replicate BD117) and TP150/0.1 m;
- Two samples of fibre cement collected from the ground surface of the former Control Cabin (148A) and Old Baling Shed (153A) were found to contain asbestos.

The following presents a brief summary of the TRH (C10-C36) exceedances in relation to sampling location:

- BH101/0.8-1.0 was collected from the south-eastern portion of the site and was observed to comprise gravelly silty sand fill with some coal reject;
- BH102/0.3-0.5 was located near the former fuelling area of the Coal Preparation Plant, and comprised silty sand fill with some coal reject;
- BH109/0.0-0.1 was collected from the near surface of an elevated fill platform associated with the former rail siding in the northern portion of the site, and comprised gravelly sandy fill with trace coal reject;
- TP116/1.5, TP117/2.0, TP160/4.0; were located within the coal tailings stockpile, the samples predominantly comprised coal fines;
- TP128/0.0-0.05 (and associated replicate BD108) collected from the near surface filling within the footprint of the former abandoned fuel tanks. Silty sand fill with hydrocarbon staining and odour was observed from the surface to about 1.5 m. Note: the underlying sample TP128/1.6 m had no detected concentrations of TRH (C_{10}-C_{36});
- TP130/0.5 m was collected from the former coal stockpile area, and was observed to comprise fill material clayey silty gravel (predominantly coal reject);
- TP131/0.9 m was collected adjacent to a broken terracotta pipe adjacent to former Coal Preparation Plant buildings, and comprised silty sandy gravely coal reject;

- TP146/0.0 m, was located adjacent to former infrastructure (possibly the former crushing plant) near the former Hexham-Minmi railway (west of the TSF footprint), and comprised silty sand fill with trace gravel sized coal reject;
- TP148/0.0-0.05 m (and associated replicate BD117) was located adjacent to the former Control Cabin, and comprised sand sized coal reject;
- TP150/0.1 m was collected from a fill stockpile to the north of the former bathhouse, and comprised gravelly silty sand, predominantly ash and coal reject.

Based on the above summary, it is evident that the majority of exceedances are located in the vicinity of former infrastructure (i.e. crushing plant, control cabin, bathhouse, coal preparation plant buildings, rail sidings etc.) or fuel storage areas in the proposed TSF Area (generally southern portion of the site). The remainder of the detected exceedances were generally associated with fill materials in both the proposed TSF area and broader site area.

In addition to the above TRH (C_{10}-C_{36}) exceedances, it is noted that detected concentrations of TRH (C_{10}-C_{36}), within the adopted criteria, were found within the majority of fill samples selected for analysis. Detected concentrations of PAH including benzo(a)pyrene within the adopted criteria were also found in a number of samples.

The source and extent of TRH (C_{10}-C_{36}) contamination within the fill samples (excluding TP128/0.0-0.05) from the southern portion of the site has not been determined. The samples were collected adjacent to former infrastructure, with the former coal tailings stockpile and filled areas predominantly comprising coal reject. TRH (C_{10}-C_{36}) impact in fill could be a result of former site operations, or naturally occurring hydrocarbons from coal reject and coal fines. In addition, areas that have been irrigated with treated effluent could also contain hydrocarbons due to effluent properties (refer to groundwater discussion below). Hydrocarbons associated with irrigations waters may not be petroleum based. Additional laboratory testing would be required to assess the source/type of hydrocarbons within soil samples.

The results of pH, EC, chloride and sulphate testing were found to be generally low, indicating generally non-aggressive and mild exposure classifications when compared to the requirements for steel/concrete piles presented in AS 2159-2009 (Ref 21). It is recommended, however, to provide sufficient concrete cover and appropriate strength to accommodate for the environment and any changes in conditions. It is noted that the results of pH and EC testing within the fill materials indicated moderately acidic to moderately basic and non-saline to highly saline (typically non-saline to moderately saline) soil conditions. Soil acidity and salinity will affect plant growth.

Groundwater

Groundwater chemical analysis results were generally within the ANZECC (2000) trigger values (fresh and marine) for the protection of aquatic ecosystems with the following exceptions:

- Elevated heavy metals (including chromium, copper, iron, nickel, and zinc) above the adopted criteria were found in all groundwater samples except SW202;
- Elevated TRH (C_{10}-C_{36}) were found in Bore 102 and Bore 108 (739 µg/L and 1239 µg/L respectively);
- Elevated benzo(a)pyrene above the adopted criteria in Bore 108;

- Faecal coliforms above the adopted criteria in Bore 7, Bore 104, Bore 108 and Bore 109 (above the adopted criteria (100 cfu). Note: Bore 109 was found to contain faecal coliforms approximately 9300 cfu, significantly above the adopted criteria;
- pH levels were found to be outside the acceptable range for freshwater in a number of samples;
- Elevated EC was detected in Bore 7 indicating saline water;
- Elevated BOD was observed in Bore 7, Bore 105, Bore 109;
- Elevated TKN, TON and TP were found in Bore 7, Bore 102, Bore 105 and Bore 108.

The groundwater results for Bore 2, 3, 5 and 7 were compared to previous analytical results (Appendix C, Ref 10). A comparison of the results generally indicate the following:

- The pH was comparable to previous monitoring with a decrease in Bore 7 from 6.6 to 5.8;
- Electrical conductivity was comparable to previous monitoring in Bore 5 and 7, whilst an increase was observed in Bore 2 and a decrease in Bore 3;
- Total Kjeldahl Nitrogen (TKN) was observed to decrease;
- Total Oxidisable Nitrogen (TON) was observed to decrease in Bore 2 and Bore 5, while an increase was observed in Bore 3 and Bore 7;
- Total Phosphorous was generally observed to decrease;
- Increase in Faecal Coliforms in Bore 7.

The laboratory results are generally comparable to groundwater monitoring undertaken by others prior to 2008 (Ref 12).

The groundwater was found to be neutral to slightly acidic (pH ranging between 4.9 and 7.2), and brackish, with the exception of sample Bore 7 which was found to be saline.

It is considered that the elevated Faecal Coliforms, TKN, TON, TP, observed in selected samples may be attributed to infiltration of treated effluent into the groundwater. It is noted, however that elevated Faecal Coliforms were only detected in the vicinity of the effluent irrigation areas, while elevated nutrients and heavy metals were detected in the majority of groundwater samples tested.

Elevated concentrations of heavy metals were found in all groundwater samples and may be attributed to a combination of infiltration of the irrigated treated effluent and leaching from the fill located throughout the greater Hexham site. In addition, based on DP's experience elevated concentrations of heavy metals are common in developed areas and comparable heavy metal concentrations have previously been recorded by DP in the surrounding area.

It is considered that elevated TRH (C_{10}-C_{36}) in Bore 102 may be attributed to hydrocarbon impact associated with the adjacent former fuelling facility. Whilst the source of elevated TRH (C_{10}-C_{36}) in Bore 108 has not been determined, the potential sources include leaching of hydrocarbon contaminated fill material within the coal tailing stockpile or hydrocarbons within the treated effluent. It is noted that Bore 108 was located on the north-western embankment of the coal tailings stockpile, which is irrigated with treated effluent. The estimated mean concentration of oil and grease within the treated effluent is 480,000 µg/L (Ref 12). Given the elevated nutrient and organic concentrations detected in Bore 108, it is considered likely that the detected TRH (C_{10}-C_{36}) exceedance in Bore 108 is associated with the treated effluent. Hydrocarbons associated with irrigations waters may not be petroleum based. Additional sampling and laboratory analysis would be required to confirm the source/type of hydrocarbons within the above wells.

A significantly elevated faecal coliform concentration of ~9300 cfu was detected in Bore 109, in comparison to the remaining groundwater results which recorded faecal coliforms ranging between <1 cfu and 700 cfu. Bore 109 was located well north of the effluent irrigation area and appears to represent a spurious faecal coliform result, which may possibly be a result of cattle grazing. It is noted that elevated faecal coliform results up to 33000 cfu have been detected in groundwater samples (Bore 3) in previous assessments (Ref 10).

Surface Water

Surface water chemical analysis results were generally within the ANZECC (2000) trigger values (fresh and marine) for the protection of aquatic ecosystems with the following exceptions:

- Heavy metal exceedances were detected in sample 201 (and BD 201 - Fe, Ni), 203 (Cr, Fe), 204 (Fe), 205 (Fe, Ni), 206 (Cr, Ni), 207 (Cr, Ni), 208 (Fe), 209 (Fe, Zn), 210 (As, Cu, Fe, Zn) and 211 (Zn);
- pH was found to be marginally below the lower acceptable limit for freshwater in sample 209;
- TDS exceedances were found in samples 202, 206 and 207;
- BOD exceedances were found in samples 202, 208 and 211;
- COD and Total Nitrogen exceedances were found in all samples;
- Total Phosphorous exceedances were found in all samples, except samples 207, 209, 210, and 211;
- An ammonia exceedance was found in sample 202;
- Faecal Coliform exceedances were found in samples 201, 203, 204, 205, 210 and 211.

Chemical analysis of surface water samples indicates elevated heavy metals, nutrients and organics in comparison to the adopted guideline. The elevated results are considered likely to be attributed to the seepage and or surface infiltration of the Dairy Farmers effluent irrigation on the southern and central portion of the greater Hexham site or associated with leaching of contaminants from fill materials. It is noted for comparative purposes that the estimated nutrient and organic loading rates of the treated effluent (see Table 3) are significantly higher than the detected concentrations.

Comparison of groundwater and surface water contaminant levels indicates the following:

- pH levels are generally lower in groundwater (i.e. more acidic);
- EC levels are generally commensurate or slightly higher in groundwater (i.e. more saline);
- BOD levels are higher in surface waters;
- TKN and TN levels are generally commensurate;
- Total Phosphorous levels are generally commensurate or higher in groundwater;
- Heavy Metals levels in particular Copper, Iron, Nickel and Zinc are generally higher in groundwater.

10.2.2 ERM 2010 Investigation

Soil / Fill

Twenty seven (27) soil samples, from nineteen (19) different locations out of the eighty two (82) soil samples tested for TPH were identified to contain TPH concentrations exceeding the adopted criteria. The majority of exceedances were in fill material located within the coal tailings stockpile area, with the exception of BH01 and BH03 located south of the coal tailings stockpile in the former balloon rail loop and former refuelling area, respectively. Table 19 provides a summary of samples reported to exceed the adopted criteria for TPH.

Table 19: Summary of TPH Exceedances Identified by ERM

Bore/Well/Pit	Depth (m)	Analyte				Total
		TPH				
		C_6 - C_9	C_{10} - C_{14}	C_{15} - C_{28}	C_{29} - C_{36}	C_{10} - C_{36}
BH01	2	<10	60	760	340	1160
BH03	1.3	<10	150	1530	630	2310
BH06	0.2	<10	110	1250	640	2000
BH06	3	<10	80	1180	600	1860
BH09	1	<10	80	1020	580	1680
BH09	3	<10	100	1610	1440	3150
MW03	1	<10	100	740	320	1160
MW03	3	<10	70	770	360	1200
MW06	0.5	<10	80	830	360	1270
MW07	0.5	<10	100	1070	480	1650
MW08	0.5	<10	160	1940	980	3080
MW09	2	<10	160	1830	1040	3030
MW09	3	<10	60	770	580	1410
MW10	7.5	<10	60	110	640	1800
TP01	2.8	<10	60	1000	880	1940
TP02	0.2	<10	90	920	410	1420
TP02	2.2	<10	<50	680	580	1260
TP03	3.1	<10	60	860	460	1380
TP04	0.2	<10	80	940	480	1500
TP04	3	<10	100	1920	1010	3030
TP05	0.3	<10	140	1440	850	2430
TP06	2.1	<10	<50	780	580	1360
TP06	3.1	<10	90	1290	790	2170
TP07	0.2	<10	60	710	420	1190
TP18	0.2	<10	100	890	460	1450
TP18	0.8	<10	140	1010	510	1660
TP19	1.4	<10	170	1230	500	1900
Laboratory PQL		10	50	100	100	50
NSW EPA - NEHF F [1] (Ref 16)		NC		NC		NC
NSW EPA Criteria for Service Station Sites [2] (Ref 17)		65	1000 total			1000

Notes to Table 19:

All results in mg/kg on a dry weight basis

PQL - Practical Quantitation Limits

1 - Health Based Criteria for Industrial/Commercial Land Use

2 - Threshold Concentration for Sensitive Land Use (Ref 17)

Shaded results indicate exceedence of Service Station Guidelines (Ref 17)

BH – Bore

TP – Pit

MW – Monitoring Well

Sample BH09/1.0 m located in the north-western portion of the coal tailings stockpile was found to contain elevated Total PAHs.

Two fibro fragments (samples A1 and A2) collected from the surface were reported to contain asbestos. Sample A1 was collected from a dumping site located adjacent to the former balloon rail loop and was reported to contain chrysotile and crocidolite asbestos. Sample A2 was collected from materials located within the former control cabin and was reported to contain chrysotile asbestos.

Heavy metal and BTEX concentrations within the samples tested were all within the adopted criteria.

Groundwater

A total of ten (10) water samples were analysed for BTEX, heavy metals (As, Cd, Cr, Cu, Hg, Pb, Ni, Zn), TPH and PAH. For the purpose of their investigation, ERM classified groundwater samples as suitable for industrial/commercial or residential land uses under the following guidelines:

- NSW EPA (1994) Guidelines for Assessing Service Station Sites - Threshold concentrations for Sensitive Land Use. (Residential and Industrial Land Uses);
- NEPC (1999) NEPM Schedule B (1) Guideline on Investigation Levels for Soil and Groundwater (1999) – (HIL-A for Residential land use, HIL-F for Industrial Land use);
- NHMRC and NRMMC (2004) Guidelines for Drinking Water Quality in Australia (Residential Land use);
- WHO (2008) Petroleum Products in Drinking-Water (Residential Land use);
- ANZECC (2000) Guidelines for Fresh and Marine Water Quality (Industrial Land use).

Fresh water quality thresholds were used to evaluate the site for industrial land use and drinking water quality thresholds were used to evaluate the site for residential land use.

The following Drinking Water Quality (residential land use) exceedances for heavy metals were reported:

- Arsenic – in MW01 (0.007 mg/L), MW02 (0.014 mg/L) and MW09 (0.028 mg/L);
- Nickel – all wells except MW04, ranging from 0.12 mg/L in MW08 to 0.834 mg/L in MW10.

The following Fresh Water Quality (industrial/commercial land use) exceedances for heavy metals were reported:

- Zinc - in all wells, ranging from 0.008 mg/L in MW07 to 0.822 mg/L in MW10;
- Copper - in all wells, ranging from 0.002 mg/L in MW01, MW03, MW04 and MW06 to 0.088; mg/L in MW09;
- Nickel - in all wells except MW04, ranging from 0.12 mg/L in MW08 to 0.834 mg/L in MW10;
- Cadmium - in MW08 (0.0002 mg/L) and in MW09 (0.0003 mg/L).

Guideline exceedances of TPH and PAH (industrial/commercial and residential land use) were reported as follows:

- TPH – in wells MW01, MW03 and MW09. Results reported ranged from 160µg/L for TPH in the C_{10}-C_{14} fraction to 8430 µg /L in the C_{15}-C_{28} fraction;
- PAH – detectible levels of PAH were found in MW01, MW03 and MW09. However MW09 was the only one to exceed the nominated guideline with a Benzo(a)Pyrene concentration of 3.7 µg/L.

10.2.3 DP 2012 Groundwater Assessment

Soil / Fill

A total of 14 soil samples (including 1 QA/QC sample) collected from the newly installed well boreholes within the greater Hexham site were selected and analysed for TRH, BTEX, PAH and heavy metals (8).

Soil chemical analysis results were all within the health based criteria for commercial/industrial land use (i.e. NEHF F), and NSW EPA sensitive land use criteria for TRH and BTEX.

Five soil samples (Bores 303/0.25 m, 303/1.2 m – 1.4 m, 304/0.25 m, 306/0.05 m and 308/0.05 m) with slightly elevated TRH were selected and analysed for TPH following silica gel cleanup to assess 'Petroleum Hydrocarbon' concentrations. The results of the laboratory analysis indicate that soil samples from Bores 303/1.2 m – 1.4 m and 304/0.25 m contained petroleum hydrocarbons.

Groundwater

A total of 39 groundwater samples (including 4 QA/QC samples) were analysed for TRH, BTEX, PAH, Metals (9), pH and EC. Ten of these groundwater samples were also analysed for Faecal coliforms, TKN, TN, TP and BOD.

The location of the groundwater wells and groundwater contours for the 17 October 2011 gauging event are shown on DP Drawing 2, Appendix E. The results of groundwater analysis are presented in Table 10, Appendix C.

Groundwater chemical analysis results were generally within the ANZECC (2000) trigger values (fresh and marine) for the protection of aquatic ecosystems with the following exceptions:

- pH values, which were outside the adopted trigger values for the majority of samples;
- Elevated heavy metals (arsenic (one well), cadmium (one well), chromium (two wells), copper (17 wells), nickel (all wells) and zinc (34 wells));
- Elevated TP (with the exception of Bore 106) and TN were found in all groundwater samples tested;
- Faecal coliforms above the adopted criteria in Bores MW09 and 307.

It is noted that no detectable concentrations of TRH, BTEX or PAH were found in any of the groundwater samples analysed.

The groundwater was found to be acidic to slightly alkaline (pH ranging between 3.5 and 7.6, typically >6). Low pH values of 3.5 and 3.8 were detected in samples from Wells MW01 and MW02, respectively. pH levels of 5.7 and 5.6, respectively, were measured for these wells during purging.

The groundwater was found to be brackish, with the exception of samples 4, 7, 305 and 306AL (south to north western greater Hexham boundary) which were found to be saline, and samples 5 and 301 (north to central eastern boundary) which were found to be fresh. The highest salinity levels were detected within wells located within the farm irrigation area (Bore 7).

Elevated heavy metals were detected in the majority of wells. It is noted that:

- Elevated Arsenic and Cadmium concentrations were only detected in Bore 302AL (lower clay aquifer) and elevated Chromium levels were only detected in Bore 306AL and Bore 308AL (both lower clay aquifer wells);
- Elevated Copper was detected in approximately half the samples with no apparent spatial trend;
- Elevated Ni and Zn concentrations were detected in majority of wells with higher concentration generally observed within / downgradient of the coal tailing stockpile irrigation area.

Elevated Faecal Coliforms were detected in Bore 307 (south-western site greater Hexham site boundary) and Bore MW09 (within coal tailing effluent irrigation area) and Bore 108 (north-west corner of coal tailing stockpile). The remaining samples tested had results less than the lab PQL.

Elevated TN and TP concentrations were detected in all samples tested (with the exception of Bore 106 for TP). The highest concentrations were detected within the farm/coal tailings irrigation area.

Comparison of the results of monitoring in well pairs screened in the upper filling and underlying days (i.e. Wells 302U, 302AL, 303U, 303AL, 306U, 306AL, 308U and 308AL) indicate the following:

- pH levels are generally slightly higher in the wells screened in lower clay aquifer;
- EC levels were significantly higher in the wells screened in the lower clay aquifer;
- Metal concentrations were generally higher in the wells screened in the lower clay aquifer.

10.2.4 Coffeys 2012 Contamination Assessment

The following presents a summary of the results of the Coffeys assessment which was conducted for the narrow strip of land between the subject site (Proposed TSF) and the existing Great Northern Railway.

Soil / Fill

The potential for widespread contamination within filling and natural materials in the Project Area was considered to be low. Hydrocarbon impacts greater than 2.5 times the identified criteria (heavy chain petroleum hydrocarbons TPH (C_{10} – C_{36}) and PAH) was identified within some ballast and coal reject fill materials. Assessment within the former fuel tank area indicated the following:

- Possible presence of a backfilled excavation;
- No evidence of fuel tanks to a depth of 1.1 m below the existing ground surface;
- Elevated hydrocarbon (TPH C_{10} – C_{36} (47/mg/kg to 995 mg/kg)).

Preliminary Waste Classification

The results of testing indicated that fill materials were generally classified as General Soil Waste. Some areas of Restricted Soil Waste and hazardous waste were also identified.

A localised stockpile of illegally dumped waste containing fibre-board (asbestos) was observed, which was subsequently removed. The potential for future dumping of waste was identified due to public access to the site. If this occurs, appropriate waste classification and removal would be required. Natural soils at the site are classified general solid waste due to acid sulphate soils conditions.

Surface Water and Groundwater Contamination

Widespread contamination of surface water comprising faecal coliforms, E. Coli, nutrients and metals was identified both on-site and immediately off-site. Widespread contamination of groundwater in the form of metals and nutrients has also been identified.

The source of surface water impact is likely to be associated with the grazing of cattle or effluent irrigation that occurs west of the Relief Roads Project Area. The Hexham Wetland is in a degraded state due to a long history of industrialisation.

Given the widespread nature of surface water and groundwater impacts and the degraded state of the Hexham Wetland, remediation was not considered to be practical.

Requirements for appropriate management of potential risks to human health and the environment were identified in regard to surface water and groundwater impacts.

Recommendations – Hexham Relief Roads Project

Preparation of a site specific Remediation Action Plan (RAP) was recommended to address soil contamination identified at the site.

Rules to human health and the environment would be managed during and following construction via a Construction Environmental Management Plan (CEMP) and Water Quality Management Plan.

Remediation Action Plan

A Remediation Action Plan (RAP) was prepared by Coffeys for the proposed relief road construction.

The RAP provided options for remediation, and the preferred option was as follows:

- Excavation and landfill disposal of localised soil contamination;
- Administration controls via the CEMP to manage possible exposure to contaminated soils that have been identified outside the proposed relief road project area.

Surface Water and Groundwater Contamination would be managed via the Water Quality Management Plan to protect worker health and prevent exacerbation of the contamination.

11. Discussion

11.1 Summary of Results – TSF Development Area

The results of the above assessments indicated the following with respect to potential soil, groundwater and surface water contamination associated with the TSF development area:

- Presence of soil hydrocarbon impact (TRH C_{10}-C_{36}) in Pit 128 from the surface to about 1.5 m, considered likely to be associated with a former abandoned UST;
- Presence of localised soil and groundwater hydrocarbon impact (TRH C_{10}-C_{36}) possibly associated with the former fuelling area (Bore 102/0.3-0.5 and BH03/1.3);
- Presence of soil TRH (C_{10}-C_{36}) soil contamination adjacent to former infrastructure;
- Presence of TRH (C_{10}-C_{36}) soil contamination within fill material generally containing coal reject located within the southern portion of the site (DP Bore 101/0.8-1.0, BH03);
- Presence of fibre cement fragments containing asbestos within the former control cabin;
- Presence of localised dumped filling, building rubble, concrete, bricks, etc. (including the potential for asbestos contamination);
- Presence of groundwater heavy metal and nutrient impact in all bores;
- Presence of groundwater faecal coliform impact in Bore 109, possibly associated with upslope effluent irrigation;
- Presence of surface water heavy metal and nutrient impact at all surface water sampling locations;
- Presence of surface water faecal coliform impact at SW201, SW202, SW203, SW205, SW210 and SW211, possibly associated with effluent irrigation or cattle grazing.

11.2 Proposed Site Disturbance

The available results of previous and current contamination assessments have been collated by GHD and are presented in the GHD Contamination Drawings in Appendix D. The approximate extent of contamination has also been interpreted by GHD. The proposed TSF development is shown on the WorleyParsons Proposed Arrangement Figures in Appendix E. Areas of ground disturbance (excavation) are shown on the GHD "Areas of Disturbance Drawing also in Appendix E.

Excavations on site are expected to include:

- Proposed Basins 1 to 3;
- Proposed cess drains;
- Site preparation for proposed access roads and associated culverts;
- Temporary trench excavations for buried services.

Based on the shallow groundwater levels at site it is anticipated that most excavations will intersect groundwater (Refer to GHD Areas of Disturbance Plan in Appendix E). Temporary dewatering may be required to allow construction activities, especially for the access road, culvert and buried service excavations. For the proposed cess drains and detention ponds it may be possible to excavate these without dewatering.

Excavations on the southern parts of the site will be predominantly through existing filling which is typically granular and can be expected to be relatively permeable. Dewatering is likely to be achieved by a combination of sump and pump methods for localised excavations with the possibility of spear point dewatering in some areas.

On the northern parts of the site excavations will be through the natural clay soils, which are generally of low permeability with the exception of local sandy or silty layers. Sump and pump dewatering is expected to be used and due to the low permeability of these soils flow rates are expected to be relatively low if they are not under surface water.

The results of the preliminary contamination assessment have identified soil, groundwater and surface water impacts that will require management due to disturbance (i.e. excavation / dewatering) associated with the development of the TSF.

11.3 Soil Contamination

The results of site investigations generally indicated the absence of gross soil contamination associated with the TSF development. Soil exceedences were generally associated with non-volatile medium to heavy chain hydrocarbons. Due to the non-volatile nature of the localised impacts observed within fill materials during the site investigations, it is unlikely that significant odours will be generated if such materials are excavated or disturbed during TSF development.

Based on the site observations and historical information, the potential for widespread soil contamination within the TSF development area is considered to be low.

Minor bonded asbestos containing materials were observed in the immediate vicinity of former site buildings (i.e. control cabin). Potential asbestos containing materials may also be present in localised dumped piles of filing containing building rubble. The occurrence of asbestos containing materials within the TSF site is therefore not likely to be widespread.

It is understood that the TSF development will not impact significantly on the adjacent coal washery reject stockpiles immediately west of the TSF site.

11.4 Groundwater and Surface Water Contamination

It is noted that the results generally indicate the absence of gross contamination within the groundwater and surface water samples tested. Widespread elevated levels of nutrients and faecal coliforms were encountered in groundwater and surface water samples taken at the site which indicate that the Hexham Wetland is in a degraded state due to a long history of industrialisation in this area. Based on field observation and laboratory testing, it is considered that the elevated nutrient and faecal coliform concentrations may be attributed to the infiltration of irrigated treated effluent or cattle grazing. It is noted that the detected concentration of nutrients are significantly lower than the estimated nutrient and organic loading rates of the treated effluent (see Table 3 – Section 3.1.3).

In addition, slightly elevated levels of heavy metal contamination were encountered in groundwater and surface water samples taken at the site. Based on field observations and laboratory testing in soils, no apparent impact was observed on the site to suggest gross heavy metal contamination within soils. It therefore is possible that the slightly elevated heavy metal concentrations in groundwater and surface water are consistent with regional groundwater and surface water quality.

Site observations and measurements indicated that the groundwater flow within the site is multi-directional as shown on the groundwater contour plan in Appendix E. Groundwater within the TSF development area (i.e. generally eastern portion of the greater Hexham site) flows east towards the Hunter River. Groundwater within the western portion of the greater Hexham site (including the coal handling stockpiles) predominantly flows west towards the Hexham Swamp. Groundwater within the northern portion of the greater Hexham site flows north towards the unlined drainage channels and wetland to the north of the site. Surface water drains in the northern portion of the greater Hexham site flow towards two shallow drainage channels that flow to Purgatory Creek then the Hunter River. A drainage channel around the perimeter of the coal tailings stockpile in the central portion of the greater Hexham site, drains in a westerly direction towards Hexham Nature Reserve. Further information on the site hydrology is presented in Reference 26.

Due to the widespread presence of surface water and groundwater impacts in the vicinity of the TSF development and the greater Hexham site area, together with the degraded nature of the Hexham Wetland, it is not considered practical to remediate surface waters or groundwaters within the TSF site. Potential human health and environmental impacts associated with surface water and groundwater contamination could be managed during and following development through the implementation of a Water Quality Management Plan. An integrated surface water and groundwater monitoring program is recommended to establish existing groundwater and surface water conditions at the site. The assessment should consider the potential source of impacts on waters, background quality, potential for off-site migration and significance of elevated contaminant concentrations in waters.

11.5 Dewatering

As discussed in Section 11.2, localised dewatering will be required for the TSF development due to the relatively low groundwater table which is present at the site.

The results of surface water and groundwater monitoring indicated widespread elevated levels of metals, nutrients, faecal coliforms and E.Coli. Appropriate management of groundwater quality will be required during dewatering activities.

General procedures to minimise the potential impacts associated with dewatering were presented in the Acid Sulphate Soil Management Plan (ASSMP) for the TSF project, which included:

- Minimise the dewatering depth required for construction (i.e. as close as practicable to the invert level of the excavation);
- Minimise the time and volume of exposed soils (i.e. Stage excavation and dewatering);
- Collection of extracted groundwater in a multi stage sedimentation tank or similar and treat as necessary prior to appropriate disposal / discharge;
- The extracted groundwater could then be discharged to a bunded area away from the dewatering site (i.e. evaporation/infiltration), or appropriately disposed, subject to regulatory requirements;
- Water quality should be monitored prior to discharge.

In addition, site activities including dewatering should be conducted in accordance with a Water Quality Management Plan to manage potential human health and environmental impacts as discussed in Section 11.4 above.

Notwithstanding regulatory requirements, it is suggested that the ANZECC Guidelines for Fresh and Marine Water Quality, 2000 (Ref 3) for “slightly to moderately disturbed ecosystems” are considered before discharging any waters or leachate to the environment.

It is noted that current water quality on-site (surface water and groundwater) and off-site (Hexham Swamp and Hunter River) do not meet ANZECC guidelines, and as such indicate a degraded ecosystem. Discharge of waters from site dewatering activities should also consider background water quality and potential for controlled on-site infiltration in order to manage possible impacts, subject to regulatory approvals.

Appropriate management of discharge waters will also be required to address potential OHS and Environmental impacts in accordance with statutory and regulatory requirements.

Potential adverse impacts associated with excavations and dewatering should be mitigated through the implementation of an appropriate Soil and Water Management Plan (i.e. erosion and sediment controls, stormwater/drainage management) and Water Quality Management Plan (surface water and groundwater).

An integrated surface water and groundwater monitoring program should be formulated to manage surface water and groundwater quality during and following development.

The above plans would form part of the Construction Environmental Management Plan (CEMP) for the proposed TSF development.

As stated in Section 4, there are currently nine groundwater wells registered with the NSW Office of Water for monitoring purposes at the greater Hexham site. These wells were installed as part of the current investigations for the TSF development at the perimeter of the greater Hexham site.

It is understood that the proposed TSF Project Area is covered by an existing Water Sharing Plan (WSP), namely the Hunter unregulated and alluvial groundwater sources WSP. Within this WSP, the TSF Project Area forms part of Groundwater Management Area (GMA) 17.

A license under Part 5 of the Water Act 1912 will be required for all activities with the potential to intercept groundwater, including excavations, dewatering works and the installation and operation of monitoring bores prior to the commencement of construction.

Site development should be conducted with due regard to statutory and regulatory requirements.

11.6 Potential Off-Site Impacts

Based on the above field and analytical observations, it is considered that there is a potential for off-site migration of groundwater and surface water containing elevated heavy metals, nutrients and faecal coliforms. In addition, there is a potential for migration of hydrocarbons via groundwater from the former refuelling area (Bore 102). Effluent irrigation activities and cattle grazing at the site could be contributing to the impacts on waters at the site. It is understood that effluent irrigation is proposed to continue under NSW EPA licence (No 816) for the interim.

Measures to manage potential impacts to human health and the environment as a result of potential off-site impacts will be required. As discussed in Section 11.4 above, this could be achieved through appropriate management via a Water Quality Management Plan as part of the Construction Environmental Management Plan (CEMP) for the TSF development.

It is understood that the TSF development will not include bulk excavation of coal washery reject materials present within the stockpiles adjacent to the proposed TSF. In addition, localised excavations and dewatering for TSF development will be conducted in a staged manner to minimise the extent and duration of localised disturbance. This will minimise potential impacts associated with localised excavations within acid sulphate soils (in accordance with the Acid Sulphate Soil Management Plan for the development). The potential for adverse impacts due to leachate generation will also be minimised through controlled / staged development and appropriate soil and water management during and following site development in accordance with the CEMP.

11.7 Additional Investigation

Based on the above, additional investigation is recommended to further assess identified areas of contamination and areas that are likely to be disturbed during TSF development. It is understood that the requirements for specific investigations will be outlined in the RAP, and will be further developed for implementation as the design of the TSF is progressed.

The additional assessment for the TSF development should include:

- Further assessment of the lateral extent and depth of identified soil TRH (C_{10}-C_{36}) contamination and areas that are likely to be disturbed during TSF development. This should include additional laboratory testing to confirm the type/source of hydrocarbons (i.e. confirm whether petroleum or naturally occurring hydrocarbons), and allow further comparison with relevant guidelines;
- The extent of hydrocarbon contamination associated with the former refuelling areas (i.e. Bore 102, Pit 129 and Pit 128);
- Where elevated concentrations of contamination are present in soil or fill, leachability testing of fill materials to assist in assessing groundwater and surface water contamination and suitability of fill materials to remain on-site;
- Assessment of localised fill stockpiles not currently assessed as part of this assessment;
- Additional sampling and analysis to increase sampling density for site characterisation;
- Integrated groundwater and surface water sampling program to further assess water quality, source of impacts, background quality, potential for off-site migration and significance of elevated levels;
- Assessment of potential acid sulphate soil impacts and acidic conditions associated with the installation of the HWC pipeline (southern end of TSF).

Additional site investigations associated with the TSF development could be conducted during the detailed design phase of the development or in conjunction with the localised site remediation activities presented in Section 11.8 below.

11.8 Site Remediation - Soil

Localised soil remediation is likely to be required for the development of the TSF to remediate detected hydrocarbon contamination within the fill material in the southern portion of the site and fibro fragments containing asbestos in the former control cabin. This will require preparation of a Remediation Action Plan (RAP), which would assess available remedial options and develop remedial procedures to render the site suitable for the proposed industrial land use. The relevant additional investigations recommended above should be conducted prior to site remediation to confirm remediation requirements.

The remedial works likely to be required to render the site suitable for the proposed development may include:

- Localised excavation to remove hydrocarbon impacted soil associated with former fuel tank (Pit 128) and the former refuelling area (Bore 102 and Pit 128);
- Appropriate removal and validation or on-site management of asbestos impacted materials associated with the former control cabin;
- Assessment and classification of numerous fill stockpiles (many of which were not assessed as part of the current assessment) and subsequent re-use or off-site disposal to landfill (as required);
- Preparation of management procedures to minimise impacts of contaminated groundwater/surface water on the proposed development.

With regard to the TRH (C_{10}-C_{36}) impacted fill material within the southern portion of the site, further testing is recommended to confirm the source/type of hydrocarbon impact to assess whether remediation (if any) is required. If required, remedial works may include the "chasing out" of material, disposal of materials to a licensed landfill and subsequent validation testing and analysis. Alternatively, on-site remediation or management of contaminated soils could be considered. This would require further investigation of the leachability characteristics of the contaminated soils and capping/containment requirements, and would be subject to regulatory approvals. Leaving the material on-site would attract a notice on the Section 149 Certificate for the site, and require a long term Environmental Management Plan for construction, excavation and future site use.

It is understood that a Remediation Action Plan (RAP) will be prepared by GHD for the TSF development. The RAP will incorporate the relevant additional investigations required to facilitate appropriate site remediation.

12. Recommendations

The preliminary contamination assessment conducted at the site has identified soil, surface water and groundwater impacts that will require management to facilitate the development of the TSF.

The following is recommended to address potential impacts in regard to contamination associated with the proposed TSF development:

- Preparation of a site specific Remediation Action Plan (RAP) for contaminated soils, presenting remediation and management options to address localised hydrocarbon impacts and asbestos containing materials. It is understood that GHD have prepared a RAP for the TSF development;
- Additional investigations are recommended to refine remediation requirements. Additional site investigations associated with the TSF development could be conducted during the detailed design phase of the development or in conjunction with the localised site remediation activities;
- Conduct localised remediation and validation of soils impacted by site development (i.e. areas subject to earthworks and ground disturbance);
- Prepare a Water Quality Management Plan (WQMP) to manage surface water and groundwater contamination during and following TSF development. The WQMP would include the following:
    - Mitigation measures to protect human health and the environment;
    - Procedures to minimise the risk of exposure to and potential for migration of impacted waters;
    - An integrated surface water and groundwater monitoring strategy;
    - Contingency measures.

Management of soil, surface water and groundwater impacts will be incorporated with the Construction Environmental Management Plan (CEMP) for the TSF development. The CEMP will address potential impacts through soil and water management (i.e. contaminated soils and waters, acid sulphate soil management, dewatering and drainage etc.). Measures to minimise exposure of impacted soils and waters will be implemented through staged development, monitoring and contingency procedures.

The development area is therefore considered to be suitable for construction of the TSF, subject to appropriate soil remediation and surface water and groundwater management during and following construction.

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14. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for this project at Maitland Road and Woodlands Close, Hexham, NSW in accordance with DP's proposal NCL120095 dated 19 March 2012 and subsequent proposal NCL120293 dated 19 June 2012 and acceptance received from QR National. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of QR National for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

Douglas Partners Pty Ltd