GatewayWA

Perth Airport and Freight Access Project

Management Plan

Gateway WA Perth Airport and Freight Access Project

Surface and Groundwater Management Plan

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TABLES

FIGURES

ACRONYMS AND ABBREVIATIONS

ASS	Acid Sulphate Soils
CEMP	Construction Environmental Management Plan
DEC	Department of Environment and Conservation
DIWA	Directory of Important Wetlands
GWA	Gateway WA
LAWL	Local Aquifer Water Level
LGA	Local Government Area
PASS	Potential Acid Sulphate Soils
PER	Public Environmental Report
QA/QC	Quality Assurance/Quality Control
SEWPaC	Department of Sustainability, Environment, Water, Population and Communities
SWTC	Scope of Works Technical Criteria
WAC	Westralia Airports Corporation
WTP	Water Treatment Plant

1 INTRODUCTION

1.1 Overview and Proposed Development

The Gateway WA Perth Airport and Freight Access Project (the 'Project') involves the upgrade of road amenity and new construction on Tonkin Highway between Great Eastern and Roe Highways, as well as part of Leach Highway from Orrong Road to Perth Airport. The Project area is located immediately south and west of the existing Perth Airport and includes development within Commonwealth land at Perth Airport. The Project location and significant surface water features are detailed in Appendix A.

The following road and bridge works are proposed as part of the Project:

- Upgrade of Tonkin Highway between Great Eastern Highway and Roe Highway;
- Major freeway to freeway interchange at Leach Highway / Tonkin Highway;
- Planning for a new interchange at Tonkin Highway and Bound Avenue;
- Diamond, grade separated interchange at Tonkin Highway / Horrie Miller Drive / Kewdale Road;
- Upgraded intersection at Roe Highway / Tonkin Highway;
- Intersection upgrade at Leach Highway / Abernethy Road; and
- Upgraded and control of access along Leach Highway between Orrong Road and Tonkin Highway.

The design and construction of the Project will be undertaken by the Gateway WA Alliance (Gateway WA) formed between Main Roads Western Australia (Main Roads), GHD, Aecom, BG&E, Leighton Contractors and Georgiou. Gateway WA is responsible for delivery of the Project and compliance with the Project's environmental conditions and associated management measures detailed in the Project Construction Environment Management Plan (CEMP). This Surface and Groundwater Management Plan has been developed to support the CEMP and detail the water monitoring and management objectives for the Project.

1.2 Project Zones and Timing

The Project has been divided into 6 Areas (Appendix A). The Project will be constructed over a period of three years from April 2013 to June 2016. The proposed timing of construction is as follows:

- Area 4 and 5 – April 2013 to December 2014
- Area 3 – April 2013 - February 2015
- Area 2 – July 2013 to July 2015
- Area 6 – September 2014 to June 2016
- Area 1 – December 2014 to June 2016

Please note this schedule is dependent on approvals timing, awarding of sub-contractors, weather, etc. It is subject to change.

1.3 Purpose and scope

This Surface and Groundwater Management Plan has been prepared to manage the impacts of construction activities on local surface water drainage and wetlands and the local groundwater environment, addressing issues including acid sulfate soils (ASS), dewatering and surface water runoff management.

This plan outlines the potential impacts of project works on local surface- and groundwater environments and details the management strategies, actions and controls that will be used to manage these impacts.

Specifically, it aims to manage any impacts associated with:

- Construction water supply bores (non-potable water); and
- Construction dewatering.

This management plan shall be reviewed by the Environmental Manager if the Project scope changes significantly. Upon review, the document shall be revised and re-issued where appropriate. In addition, continued improvement of the plan will occur in response to environmental incident management reviews and audit findings during the construction of the Project.

If the change is in relation to a Project scope change which results in an environmental impact outside of that originally approved, the revised management plan will be submitted to any regulatory agencies if relevant, in order to obtain the Minister for Environment's approval for that component of work prior to implementation.

1.4 Related Documents

The Surface and Groundwater Management Plan is part of an integrated management program for Gateway WA and should be considered in conjunction with the following management plans related to environmental management:

- Gateway Operating Policy (GWA-PW-PPY-MN-0001)
- Environmental Monitoring Plan (GWA-PW-MNP-EN-0011)
- Spoil and Waste Management Plan (GWA-PW-MNP-EN-0009)
- Construction Environmental Management Plan (GWA-PW-MNP-EN-0001)

A summary table of project environmental commitments made in the above documents is presented in Appendix E.

2 SITE ENVIRONMENTAL CONDITIONS

2.1 Soil and groundwater investigation program

Preliminary site investigations for acid sulfate soils, geotechnical and hydrogeological conditions were completed in 2011 by the Gateway Vision project, a precursor to the current alliance that undertook the majority of the preliminary site investigations. These investigations are being supplemented by a Gateway WA detailed environmental, geotechnical and hydrogeological soil and groundwater investigation program across the whole Project area.

The Gateway WA investigation program will run from October 2012 to approximately July 2013. The program is approximately 50% complete as of April 2013. Factual investigation reports documenting baseline conditions are being prepared for each Project zone prior to disturbance activities commencing. Soil and groundwater investigation locations are included in Appendix B and a summary of results available to date are included in Appendices C and D. The site conditions described include a summary of findings to date.

Table 1 Summary of Gateway Vision and Gateway WA intrusive site investigations

Investigation Method	Gateway Vision (2011)	Gateway WA (2012+)	Total Locations
	Phase A	Phase B	
Cone Penetrometer Test	32	64	**96**
Geotechnical Borehole	3	7	**10**
Geotechnical Borehole and Monitoring Well	8	5	**13**
Geotechnical Borehole and Pumping Well	3	5	**8**
Hand Auger (pavement)	-	25	**25**
Rotary Auger (pavement)	-	15	**15**
Soil Borehole and Monitoring Well (Environmental/ASS)	72	-	**72**
Test Pit	9	10	**19**
Grand Total	**55**	**203**	**258**

In addition to the detailed investigations, one aquifer pump test was completed during Gateway Vision, and up to four pump tests are proposed for the Gateway WA investigations.

The Gateway WA investigation program aims to:

- Provide a detailed understanding of the geological, geotechnical, geochemical, contamination, acid sulfate and hydrogeological conditions for each construction area;
- Provide data to allow 2D and 3D interpretation of subsurface geology, geotechnical and acid sulfate conditions for design and environmental management purposes;

- Provide a network of environmental groundwater monitoring wells, screened in key units of the superficial aquifer to allow for ongoing groundwater level and quality monitoring; and
- Provide pre-construction baseline surface water and groundwater quality information for all areas of the site.

The soil investigation program includes analysis of contamination and ASS indicators. A summary of the completed and planned soil investigation program is included below in Table 2 and standard soil, groundwater and surface water analytical suites in Table 3.

Table 2 Summary of Gateway Vision and Gateway WA soil and water analyses

Analysis suite	Gateway Vision		Gateway WA	
	Analyses	Locations	Analyses	Locations
SOIL				
ASS Field Suite	340	11	1434	42
Soil - Metals			153	42
SPOCAS Suite	151	11	380	42
Chromium reducible sulphur	102	9	166	42
WATER				
Groundwater Field			111	111
Groundwater Lab Quarterly	17	12	111	111
Groundwater Lab Extended			3	111
Surfacewater Lab			10	5
Surfacewater Lab Extended			10	5

Table 3 Gateway WA standard soil, groundwater and surface water analytical suites

Suite	Analytes
SOILS	
ASS Field	pHF; pHFox; Reaction Rate
SPOCAS	ANC/FF; ANCE; CaA; CaKCL; Liming Rate excl. ANC; LR; MgA; MgKCl; MgP; Net Acidity; Net Acidity excl ANC; pHKCl; pHOX; SKCl; SP; SPOS; TAA; TPA; TSA
Chromium Reducable Sulphur	SCr
Metals	Arsenic; Barium; Beryllium; Cadmium; Chromium (III+VI); Cobalt; Copper; Iron; Lead; Manganese; Nickel; Vanadium; Zinc; Mercury
WATER	
Groundwater Field	Dissolved Oxygen (% saturated) (Field); Dissolved Oxygen (Field); Electrical Conductivity (Field); pH (Field); Temp (Field)
Groundwater Quarterly	**Physical Parameters** pH (Lab); Electrical conductivity *(lab); Total Dissolved Solids; TSS; Turbidity
	Major Anions and Cations Hardness as $CaCO_3$; Alkalinity (Bicarbonate as $CaCO_3$); Alkalinity (Carbonate as $CaCO_3$); Alkalinity (Hydroxide) as $CaCO_3$; Alkalinity (total) as $CaCO_3$; Acidity as $CaCO_3$; Sulphate; Chloride; Calcium; Magnesium; Potassium; Sodium; Anions Total; Cations Total; Ionic Balance
	Metals (Total and Dissolved) Aluminium; Arsenic; Cadmium; Chromium (III + VI); Copper; Iron; Lead; Manganese; Mercury; Nickel; Selenium; Zinc

Suite	Analytes
	Nutrients Ammonia as N; Nitrite (as N); Nitrate (as N); Nitrogen (Total Oxidised); Kjedahl Nitrogen Total; Nitrogen (Total); Phosphorus; Reactive Phosphorus as P
	Sulphide
Groundwater Lab Extended	*All of groundwater lab quarterly plus:* Cyanide Total; Herbicides and Pesticides; TRH; BTEX; SVOCs; PAHs
Surface Water Lab	**Physical Parameters** pH (Lab); Electrical conductivity *(lab); Total Dissolved Solids; TSS; Turbidity
	Major Anions and Cations Hardness as $CaCO_3$; Alkalinity (Bicarbonate as $CaCO_3$); Alkalinity (Carbonate as $CaCO_3$); Alkalinity (Hydroxide) as $CaCO_3$; Alkalinity (total) as $CaCO_3$; Acidity as $CaCO_3$; Sulphate; Chloride; Calcium; Magnesium; Potassium; Sodium; Anions Total; Cations Total; Ionic Balance
	Metals (Total and Dissolved) Aluminium; Arsenic; Cadmium; Chromium (III + VI); Copper; Iron; Lead; Manganese; Mercury; Nickel; Selenium; Zinc
	Nutrients Ammonia as N; Nitrite (as N); Nitrate (as N); Nitrogen (Total Oxidised); Kjedahl Nitrogen Total; Nitrogen (Total); Phosphorus; Reactive Phosphorus as P
Surface Water Lab Extended	*All of surface water lab plus:* Sulphide; Dissolved oxygen (% saturated) (field); Dissolved oxygen (field); pH (field); Temp (field); Total coliforms; E. Coli; Enterococci

2.2 Local Geology

The Public Environmental Report (PER) Document written for the Project describes the local geology, as detailed below (Gateway Alliance, 2011):

"The 1:50,000 Environmental Geology Series Map (Perth Sheet) indicates that the Gateway project area (Tonkin Hwy / Boud Ave interchange, Tonkin Hwy / Horrie Miller Dr interchange and Tonkin Hwy / Roe Hwy interchange) is generally located in an area of Bassendean Sand likely to be underlain by the Guildford Formation. The intersection of Tonkin Hwy and Leach Hwy is located in an area of Bassendean Sand. Bassendean Sand is primarily of aeolian (i.e. dune) origin, and comprises sand that is generally uniformly graded, with clean, fine to medium, quartz grains, leached of virtually all carbonates. It is typically very light grey at the surface, becoming yellow with depth. The Guildford Formation is of alluvial origin and typically comprises clayey soils, with variable proportions of clay, silt and sand. Iron cementation of the sand units within the Guildford Formation, colloquially referred to as 'Coffee Rock' may occur in the vicinity of the water table in some areas."

Site investigations have confirmed the local geology, with more detailed descriptions of each unit included in Table 4 below.

Table 4 Gateway WA: Typical Geological Profile

Geologic Unit / Code	Geologic Subunit / Code	Lithological Codes	Typical Lithology / Reported Maximum Unit Thickness
Fill (FILL)		FILL SAND	Variable. Granular fill may include domestic, commercial, construction and other waste. May include re-worked in-situ material and trench backfill. Variable thickness, usually not more than 3m. The only significant fill deposits identified are associated with historical construction activities on former lakes/wetlands in low lying areas.
Lacustrine Deposits (LD)		CLAY SILT SAND	Peaty/organic clay; dark grey and black, with variable sand content. They may include various clay, silt, sand, peat/organic, gypseous and diatomaceous deposits. 12 m thick deposit recorded by Gozzard (1986). At Gateway rarely exceeding 3 m in thickness and found at lakes/wetland areas identifiable in historical aerial photographs. Unit usually contains ASS material.
Bassendean Sand (BS)		SAND	Sand; very light grey at surface, yellow at depth, fine to medium grained, sub-rounded quartz, moderately well sorted; generally poorly graded; mainly frosted quartz sand. Traces of feldspar, heavy minerals and carbonate occur. Davidson (1995) suggests that this unit may be up to 80 m thick. At Gateway, rarely more than 8m. Thicker deposits are associated with locally elevated areas; thickness close to current and former lakes/wetland areas is not more than 2m. Unit often contains ASS material when below the groundwater table.
Pedocrete (P)		SAND SILT	Parts of the Bassendean Sand (BS) and Guildford Formation (GF) and is described as a zone of "densification" which may be attributed to post-depositional geochemical induration of the soil profile (e.g. "coffee rock"). This unit may occur at the Bassendean Sand / Guildford Formation interface and / or in association with the current or recent groundwater table. Where this unit presents as Coffee Rock (brown, black or orange) is considered to be PASS material.

Geologic Unit / Code	Geologic Subunit / Code	Lithological Codes	Typical Lithology / Reported Maximum Unit Thickness
Guildford Formation (GF)	Undifferentiated (u)	SAND SILT CLAY GRAVEL	The Guildford Formation consists of lenticular interbeds of sand, clay, gravel and conglomerate, which are calcareous in places, and characterised by a shelly sand, rich in molluscan fauna, at its base. Davidson (1995) suggests that the Guildford Formation may be up to 35 m thick. Unit often contains ASS material below the groundwater table.
	Sand (s)	SAND	This subunit is characterised by a higher frequency of sandy lenses and/ or thick sand interbeds and/ or coarse sand units which is inferred to possess higher hydraulic conductivities than GFu (and GFf) and is inferred to be hydrogeologically distinct from other Guildford Formation subunits. Unit often contains ASS material below the groundwater table.
	Fines (f)	SILT CLAY SAND	This subunit is characterised by a higher percentage of fines (e.g. clay / silt), relative to GFu and GFs, which is inferred to influence engineering behaviour. GFf has been observed in common association with P and GFf formation may be attributed to similar post-depositional processes in the soil profile (e.g. dissolution and precipitation). Alternatively, the inferred higher fines contents may be associated with environmental conditions during deposition. Unit often contains ASS material below the groundwater table.
Osborne Formation (OF)	Mirrabooka Member (m)	SAND SILT SHALE	The Osborne Formation consists of a basal, weakly consolidated, comparatively thick sandstone section (Henley Sandstone Member), a middle siltstone-shale sequence (Kardinya Shale Member), and an upper sandstone-shale sequence (Mirrabooka Member). The Osborne Formation is characteristically glauconitic, and argillaceous sediments are usually dark grey to black. Pyrite is a common accessory mineral. The sandstone is in part calcareous. Davidson (1995) suggests that this unit may be up to 180 m thick in the Perth Region. OFm consists of sandstone with thin interbeds of siltstone and shale. The sandstone is weakly consolidated, dark-greenish brown, fine to very coarse grained, very poorly sorted, silty and richly glauconitic. The siltstones and shales are moderately consolidated, dark green to black, glauconitic, and contain common spherical, coarse to gravel-sized quartz grains.

2.3 Contaminated and Acid Sulfate Soils

Broad scale ASS characterization was undertaken for the Project in the 2011 PER document (Gateway Vision 2011).

Gateway WA is currently conducting a drilling program for the purposes of soil investigation and borehole construction. Statements made in this management plan reflect the results of the drilling program prior to publishing. Due to project staging, soil investigation works will continue through the Project.

Results to date indicate:

- The presence of Potential Acid Sulfate Soils (PASS) in some geological units, as indicated in Table 4 and summarised in Table 5;
- No actual acid sulphate soils (AASS); and
- No *insitu* soils contaminated with metals above environmental investigation levels.

Preliminary site investigations have not identified any known or suspected contaminated sites within the Project area. However, the potential for unidentified contamination associated with historical site uses, dumping or uncontrolled fill has been recognised. These risks will be managed as part of the construction process.

The presence and distribution of ASS and contaminated soils outside excavation zones are relevant to groundwater management given the potential for ASS to impact groundwater during dewatering operations. Although considered less likely, contaminated soils may impact groundwater under leaching processes (e.g. rainfall infiltration).

A brief description based on the occurrence of ASS material within the geological profile is summarised in Table 5 below, as defined in accordance with the Department of Environment and Conservation (DEC) guidelines. Area specific investigation reports and management plans will detail the precise extent and management of these soils.

Table 5 Occurrence of ASS within the site geological profile

Geologic Unit / Code	Geologic Subunit / Code	Lithological Codes	Typical ASS properties
Fill (FILL)		FILL SAND	No PASS or AASS material identified to date.
Lacustrine Deposits (LD)		CLAY SILT SAND	Unit usually contains ASS material.
Bassendean Sand (BS)		SAND	Unit often contains ASS material when below the groundwater table.
Pedocrete (P)		SAND SILT	Where this unit presents as Coffee Rock (brown, black or orange) is is considered to be PASS material.
Guildford Formation (GF)	Undifferentiated (u) Sand (s) Fines (f)	SAND SILT CLAY GRAVEL	Unit often contains ASS material below the groundwater table

2.4 Local Hydrogeology

2.4.1 Aquifer Units

According to the PER (Gateway Vision 2011):

"*Groundwater is known to occur on the proposed development site with the Bassendean Sands forming the aquifer which overlies the Guildford Formation. The Guildford Formation consists predominantly of clays and silts, of low permeability, such that a perched water table exists on the Guildford Formation, within the Bassendean Sands.*

Groundwater levels in the surficial Bassendean Sands are locally recharged by rainfall and any other surface water bodies to which they are connected such as Swamp drains which run through the area. The regional groundwater water flow is east to west towards the Swan River."

Gateway WA site investigations have confirmed this general view of the local hydrogeology, to which the following can be added:

- There are three main aquifer units in the local superficial aquifer, specifically:
- The "Shallow" aquifer, consisting mainly of saturated BS unit;
- The "Deep" aquifer, consisting mainly of saturated GFs and GFu units; and
- The "Basement" aquifer, consisting of saturated OFm unit.

The Bassendean Sands typically have a saturated thickness of 0-3m, with the higher thicknesses associated with mounding under high infiltration areas away from deep drainage structures, such as the Roe-Tonkin intersection and parts of the Leach-Tonkin intersection.

Table 6 Typical hydrogeological properties of the site geological profile

Geologic Unit / Code	Geologic Subunit / Code	Lithological Codes	Typical expected hydrogeological properties
Fill (FILL)		FILL SAND	Typically unsaturated
Lacustrine Deposits (LD)		CLAY SILT SAND	Typically occur within the phreatic zone. Typically has relatively low vertical permeability, and may temporary perched water tables.Considered part of the “shallow” aquifer where present at Gateway wells.
Bassendean Sand (BS)		SAND	High permeability unit of 0-3m saturated thickness on Gateway WA sites. Where present, this unit is typically well connected to wetlands and surface water bodies or “window” lakes, such as Runway Swamp. It is likely to be an irrigation water source for any old style “spear” garden bores in the area. This unit is the most vulnerable to water level lowering (or raising) due to dewatering and recharge impacts and is the most likely to receive treated dewater after infiltration. Considered part of the “shallow” aquifer where present at Gateway wells.
Pedocrete (P)		SAND SILT	Variable permeability unit of maximum 2m thickness on Gateway WA sites. Mostly high permeability, with localized zones of low permeability possible in highly cemented or chemically altered zones. Considered part of the “shallow” aquifer where present at Gateway wells, but is not a significant hydrogeological unit.
Guildford Formation (GF)	Undifferentiated (u)	SAND SILT CLAY GRAVEL	Variable permeability, moderate horizontal permeability and poor vertical permeability due to sub-horizontal interbedding. Considered part of the “deep” aquifer where present at Gateway wells.
	Sand (s)	SAND	High permeability component of the Guildford. This unit is almost always present on the site with a variable thickness of 2m or greater. It represents the shallowest fully saturated aquifer unit and is expected to provide the majority of the construction water supply for the project as well as most superficial aquifer

			irrigation bores equipped with submersible pumps. If superficial recharge wells are constructed, they are likely to be mostly screened in this unit. Considered part of the “deep” aquifer where present at Gateway wells.
	Fines (f)	SILT CLAY SAND	Low permeability component of the Guildford Formation with low vertical and horizontal permeabilities. This unit is significant as it typically occurs at the top of the Guildford Formation and locally forms a vertical barrier separating the BS and GFs aquifer units or “shallow” and “deep” superficial aquifer units. Gateway WA monitoring wells are typically not screened in this unit.
Osborne Formation (OF)	Mirrabooka Member (m)	SAND SILT SHALE	This is a variable permeability unit, often referred to as “Limestone” in the Gateway Vision investigations. Sandy components are expected to have moderate top high permeability. This unit is considered.

2.4.1.1 Shallow and Deep Aquifer Hydraulic Connectivity

Understanding the hydraulic connectivity between the shallow and the deep aquifer is important given that dewatering from one aquifer (e.g. the Deep Aquifer) may cause drainage of the other (e.g. the Shallow aquifer) and may lead to mobilisation or generation of impacted groundwater.

Based on the lines of evidence, the hydraulic connectivity between the shallow and deep aquifers is considered spatially variable but is likely to exhibit a moderate to high hydraulic connectivity.

All three aquifer units appear to be substantially connected, with any separation likely to be localised and due to abstraction from the deep or basement aquifers.

2.4.2 Groundwater Levels

Extensive analysis of groundwater level data has been conducted for the purposes of developing design groundwater surfaces which are used to determine the design of major Project features such as road bath structures and pavements.

The site investigation process has also involved the deployment of groundwater level loggers and real-time groundwater level monitoring instruments at each of the construction areas, which will remain operational throughout the Project, to monitor impacts from construction, dewatering and recharge.

Extracts from design report “Project Wide Groundwater Level Determination”, (GWA-PW-REP-00-035-GT-0001- B1, March 2013) are included below:

“*The study area (Figure 1) extends from Swan River on the north and the east to Canning River on the south. The Gateway construction sites will be within or in the vicinity of Perth Airport, Belmont, Cloverdale and Kewdale districts, so these areas were studied in more detail than, for example, Lathlain, Carlisle, Welshpool and other districts adjacent to the Project sites.*

The regional groundwater table (in May of 2003) is illustrated in Figure 1. Groundwater flows from the elevate

d ground in the east to the regional discharge areas at the Swan and the Canning Rivers.

Groundwater levels occur from 20 m AHD (long-term maximum level) on the east to nearly 0 m AHD near Swan River.

The groundwater table rises every year after the first autumn rainfalls in April-May, reaches its maximum in August-October and recedes to its minimum in March (Figure 1).

Groundwater levels change not only seasonally, but also in the long-term. Nearly all Department of Water long-term monitoring boreholes show a decrease in groundwater levels since 1953. This long-term decline of water table is related to both the decrease in rainfall and construction of drains and compensating basins in the study area.”

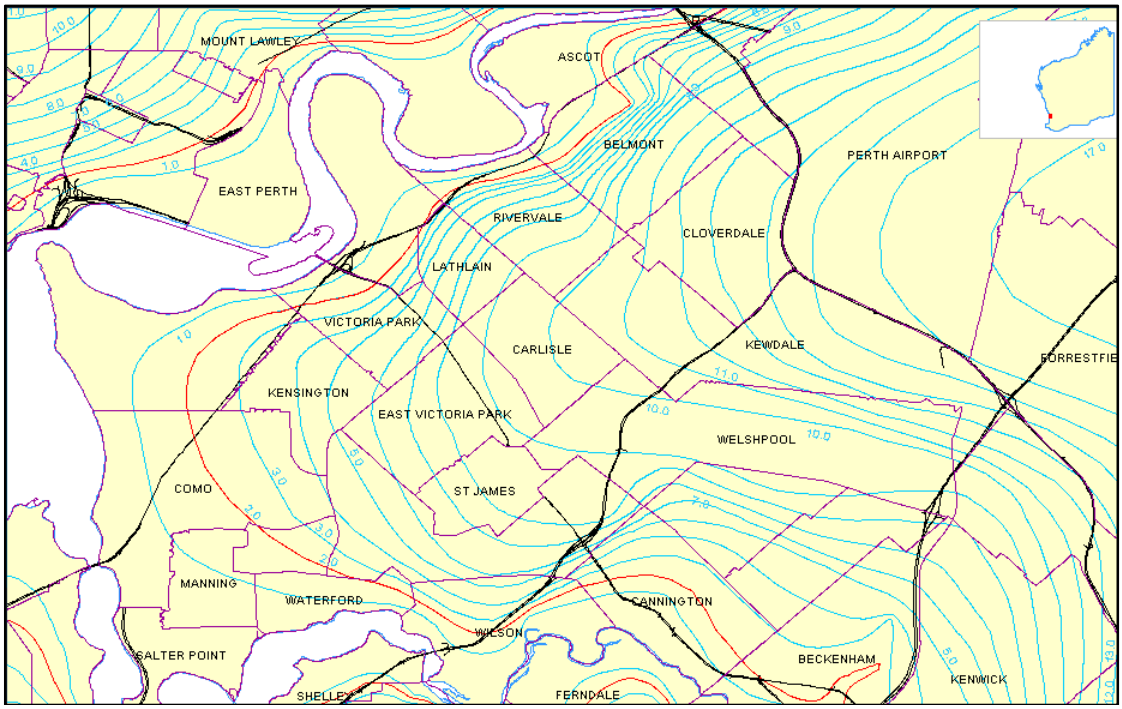

Figure 1 Groundwater Contours in May 2003 (copy from Perth Groundwater Atlas, Department of Water).

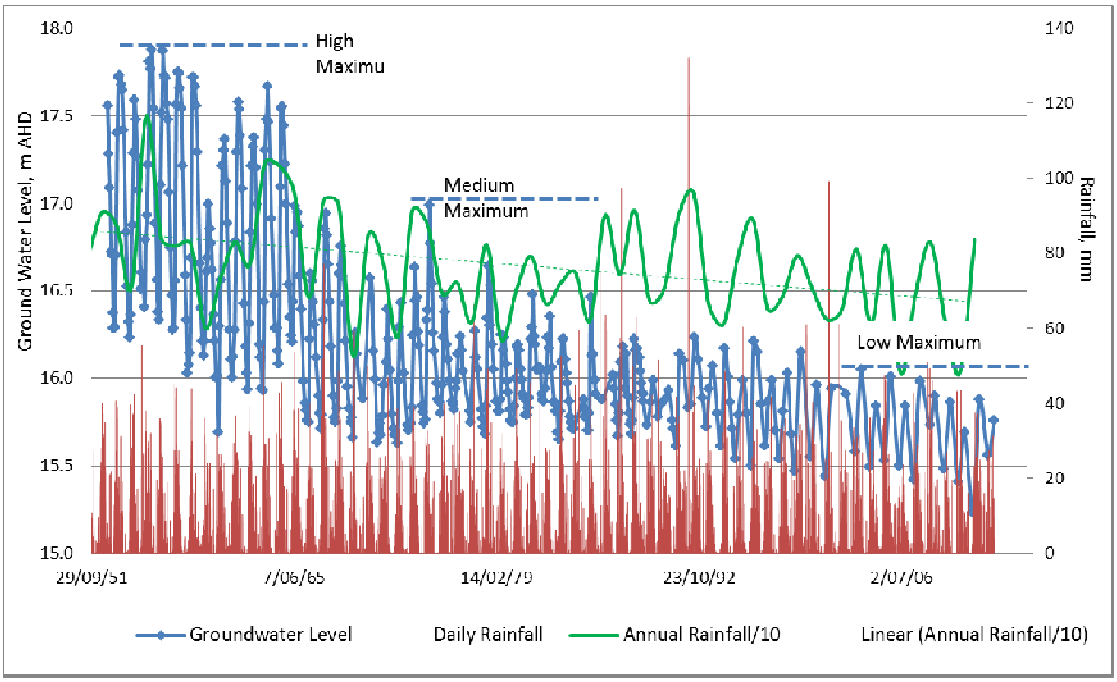

Figure 2 Measured Water Levels at 4883 and Rainfall at Perth Airport Station

2.5 Groundwater Quality Characterisation

A general summary of the current understanding of impacted groundwater is presented in Table 7 below. Full results of the groundwater investigation are presented in Appendix C.

Previous site investigations have been limited in nature. Ongoing site investigations will inform this management plan and results will be updated regularly.

Table 7 Summary of Baseline Groundwater Quality Results

Aquifer	Geologic Unit / Code	Lithological Code	Typical groundwater quality profile
"Shallow"	Fill (FILL)	FILL SAND	• pH is generally neutral, varying between 4.9 and 8.72 • Groundwater is generally of higher alkalinity than acidity, with alkalinity varying between 24 and 340 mg/L as $CaCO_3$ and acidity between 5 and 109 mg/L as $CaCO_3$ • Groundwater contained some elevated total concentrations of iron and aluminium, although dissolved concentrations are significantly lower
	Lacustrine Deposits (LD)	CLAY SILT SAND	
	Bassendean Sand (BS)	SAND	
	Pedocrete (P)	SAND SILT	
"Deep"	Guildford Formation (GFu/s/f)	SAND SILT CLAY GRAVEL	• pH is generally neutral, varying between 4.7 and 7.38 • Groundwater acidity and alkalinity were generally balanced, with alkalinity varying between 34 and 35 mg/L and $CaCO_3$ and acidity varying between 5 and 48 mg/L as $CaCO_3$ • Groundwater contained some elevated total concentrations of iron and aluminium, although dissolved concentrations are significantly lower
"Basement"		SAND SILT CLAY GRAVEL	• No groundwater samples have been retrieved from the basement aquifer to date.
	Osborne Formation (OFm)	SAND SILT SHALE	

2.6 Local Surface Water and Wetlands

There are a number of major constructed drains within the airport land, as well as mapped damp lands and sumps. A significant portion of the area to the east of the existing Tonkin Highway alignment comprises palusplain wetlands which are seasonally inundated or which have a high water table. Approximately three-quarters of wetlands on the Swan Coastal Plain are seasonally waterlogged and are usually interconnected providing an extensive network and mosaic of habitats.

The PER written for the Project detailed surface water along the Project alignment, included below in Sections 2.6.1 through 2.6.4.

2.6.1 Wetlands of International Significance

There are no Wetlands of International Significance within the vicinity of the Project area. The Project is, however, located within the catchments of the Forrestdale and Thomson Lakes, which is a Wetland of International Significance. These wetlands are located 17 km and 26 km from the Project area, respectively.

2.6.2 Nationally Important Wetlands

The Perth Airport Woodland Swamps are classified as a Nationally Important Wetland (DIWA Reference No. WA088). The Perth Airport Woodland Swamps include Munday Swamp and Runway Swamp. Munday Swamp is located approximately 4 km north of the Project area in the northern part of the Perth airport land. Runway Swamp, located to the south-east of the Perth airport runway, was created by historic excavation works and is essentially man-made. Runway Swamp is a small seasonal wetland, with maximum water depths up to 1 m in late winter and no water during the dry summer and autumn months.

2.6.3 State Listed Wetlands

The DEC has developed three management categories for geomorphic wetlands on the Swan Coastal Plain:

- Conservation wetlands – which support high levels of attributes and functions;
- Resource Enhancement wetlands – which have been partly modified but still support substantial functions and attributes; and
- Multiple Use wetlands – which have few attributes but still provide important hydrological functions.

The DEC's Geomorphic Wetlands Swan Coastal Plain dataset identifies 25 wetlands within the vicinity of the Project area. Of these wetlands, 10 are categorized as Conservation wetlands, 6 as Resource Enhancement and 9 as Multiple Use.

2.6.4 Creeks and Drainage Lines

There are no defined creeks or natural drainage lines within, or in proximity to the Project area. Most drainage from the upslope area is captured by the Southern Main Drain, which is managed by Perth Airport and the Water Corporation of WA. This water passes through the Project area in a narrow, deeply incised constructed drain, which intersects groundwater at some locations.

Runway Swamp is the only surface water body within 500 m of the Project area that does not form part of the local stormwater drainage network.

Appendix A shows all of the local surface water bodies and monitoring points, which are potential permanent or temporary connection points between the Project site and the existing drainage or surface water bodies.

3 SURFACE AND GROUNDWATER OBJECTIVES

A Project CEMP has been developed and details the objectives and targets of the Project. According to the CEMP, the overall surface and groundwater objectives for the Project are detailed below (Gateway 2013):

Table 8 Surface and groundwater objectives and performance indicators

Objective	*Target*	*Performance Indicators*
Maintain existing surface water hydrology within the Project area.	*No physical damage to wetlands beyond a maximum of 5 m from the edge of earthworks unless no other means of access or required, or for safety reasons.*	*Occurrence of physical disturbance to wetlands beyond 5 m from the edge of earthworks in Incident Report Register.*
	No significant change in wetland hydrograph including groundwater levels, or the period of inundation of adjacent monitored wetlands, not attributed to rainfall during the construction period.	*Comparison of wetland monitoring during construction with baseline.*
	No evidence of surface water damming against side of highway, during and immediately after construction.	*Site monitoring.*
Prevent deleterious impacts on surface and groundwater quality.	*During construction, no significant change to baseline water quality of adjacent monitored wetlands attributed to construction (parameters to be determined in the Environmental Monitoring Plan).*	*Comparison of wetland monitoring during construction with baseline.*
	No acidification of groundwater or surface water attributed to the construction works.	*Monitoring as per the Groundwater Management Plan and Environmental Monitoring Plan.*
Prevent spillage of hazardous goods to the adjacent environment, particularly wetlands, during operation.	*Detailed design includes roadside drainage with a capacity of 20,000 L in areas adjacent to wetlands or open drains, where possible.*	*Detailed designs include capacity of 20,000 L in areas adjacent to wetlands or open drains.*

4 GROUNDWATER ABSTRACTION MANAGEMENT STRATEGY

Groundwater abstraction will occur on the Project for two purposes:

- Construction water supply abstraction (non-potable construction water); and
- Dewatering for construction purposes.

This plan addresses both types of abstraction.

4.1 Construction water supply scope

Gateway WA will engage a drilling contractor to install a network of groundwater production bores to supply construction water needs over the duration of the Project.

Gateway WA will be responsible for the operation and monitoring of the production bores.

All bores will be metered with a meter reading taken at the end of each month and reported annually to Department of Water.

4.2 Dewatering scope

Dewatering activities aim to lower the water table to accommodate construction as follows:

- Reduce groundwater levels down to minimum of 1m below any construction activity;
- Ensure extracted groundwater is of a quality suitable for recharge, off-site discharge or on-site re-use, and treat where necessary;
- Recharge all extracted groundwater, to the extent site conditions and competing on-site requirements allow; and
- Limit groundwater drawdown outside of the targeted dewatering area.

Dewatering will lower the water table and will be required to support a number of construction activities. Broadly, these will include:

- Soil removal and replacement: Soil replacement works are required in a number of areas to improve local soil profiles' geotechnical properties. In some areas work will be conducted below the groundwater table (e.g. when removing wetland bed sediments) and so supporting dewatering will be required.
- Services relocation: A large number of services (water, power, gas communications, drainage etc) are to be relocated or added during the project. The majority of these will be shallow buried, avoiding groundwater, however in areas with a groundwater level close to surface level, or where underboring from below surface level is required, dewatering may be needed.
- Construction of below water table structures: These include bridge footings and 'bath' structures for sections of road which are required to be lowered due to airport flight path constraints. Dewatering will be required at the time of construction to facilitate construction of these structures, where they are unavoidably located below the groundwater table.

4.3 Dewatering management strategy

Gateway WA's dewatering management strategy aims to achieve the conservation of water through minimising abstraction rates, and treatment and recharge or re-use of dewatering effluent wherever possible.

Dewatering management specifically seeks to:

- Reduce the likelihood of ASS activation;
- Protect nearby surface water features, and associated wetland vegetation;
- Protect nearby structures, if present;
- Reduce mobilisation of contaminated groundwater, if present; and
- Minimise impacts to nearby superficial aquifer groundwater users.

Gateway WA will seek the relevant licences (Section 5C licence) as per the *Rights in Water and Irrigation Act 1914* in regards to dewatering. Due to the large and varied area that the Project covers, that site conditions and therefore dewatering management approach will differ between Project zones. As such, dewatering management plans will be developed as needed per Project zone, and licenses will similarly be sought per Project zone.

Installation, commissioning and operation of dewatering systems (wellpoint or spear vacuum pumps, sump pumps and submersible pumps) will be the responsibility of the appointed dewatering contractor(s). Gateway WA will be responsible for setting management targets and conducting compliance monitoring. Gateway WA will also be responsible for the installation and monitoring of a network of background groundwater monitoring wells.

A schematic of typical dewatering processes is attached as Appendix F.

4.3.1 Dewatering permit

Dewatering activities vary greatly in their scale (flow rate and volume range), duration and associated impacts and environmental risks. Not every dewatering task can be identified at this time. Every dewatering activity will be assessed and planned prior to pumping commencing, to ensure that risks are managed according to this management plan. This is controlled by the use of an internal "Gateway WA Dewatering Permit" which forms part of our Environment Management System. The permit is specific to each dewatering task and details:

- Areas affected and nearest sensitive receptors;
- Expected flow volumes;
- Durations and expected treatment needs; and
- Details of approved effluent disposal/recharge methods to be used.

The Gateway WA Dewatering Permit template is attached as Appendix E.

4.4 Management of construction water abstraction

4.4.1 Monitoring, Trigger Levels and Management Responses

Construction water supply will be monitored for water quality (periodic testing) and quantity.

Quality will be periodically monitored to ensure it:

- Meets the minimum quality requirements for construction use; and
- In acid sulfate soil areas, is not showing indicators of acidification.

Quantity of abstraction will be monitored by flow meter readings and inspections to ensure:

- Abstraction does not exceed Department of Water license quantities; and
- Water is used efficiently for construction purposes, and not being wasted or used for unlicensed purposes.

If monitoring indicates construction water abstraction is not in compliance with license conditions, quality is deteriorating due to acidification or is being used for unlicensed

purposes then abstraction will cease immediately from that location, and an investigation will commence via either a Non-Conformance Report (NCR) or an Incident. Abstraction will not re-commence until the issue is resolved to the satisfaction of the Gateway WA Environment Manager.

4.4.2 Contingency Responses

Each construction zone or area will have multiple (minimum two) potential construction water sources, and each will the capability of supplying sufficient water to meet construction needs. In the event of one source (e.g. the bore) being unavailable, the alternate supply will be used.

It is also possible to transport water by tanker or pipeline from other nearby construction areas, if required to ensure supply for short periods of time.

4.5 Management of dewatering abstraction

4.5.1 Monitoring, Trigger Levels and Management Responses

Abstraction management is critical to ensure target water levels within the construction zone are met, but that over-pumping does not occur.

Target groundwater levels in- and outside excavations will be set individually for each dewatering monitoring well based on location, aquifer and construction requirements, in-line with stated dewatering aims above.

Trigger levels for wells will typically be set 0.5 m above the dewatering target and 1m below the dewatering target to give a 1.5 m target operational zone. These targets may be reviewed and adjusted to decrease size of the operational target zone and increase the factor of safety.

If monitoring indicates that dewatering zone groundwater levels exceed the upper trigger levels (i.e. required drawdown is not being achieved or maintained) management actions are available (in order of preference):

- Adjust automatic pump start and stop water levels;
- Increase pumping rates within the constraints of the system; and/or
- Install additional abstraction capacity (well points, spears or sump pumps).

If monitoring indicates that excavation zone groundwater levels are below the lower trigger levels (i.e. excessive drawdown) management actions available are (in order of preference):

- Adjust automatic pump start and stop water levels; and/or
- Decrease pumping rates; and/or
- Reduce the number of pumps operating.

4.5.2 Contingency Responses

If management responses prove to be insufficient to achieve and maintain the target levels, excavations may be slowed or suspended to enable contingencies to be implemented. Available contingency measures that will be assessed include (in order of preference):

- Construction of additional dewatering wells, spears or sumps;
- Construction of additional drains or groundwater control structures;
- Vertical drains may be used to drain perched water;
- Grout mix cut-off walls or similar could be installed to further restrict the inflow of groundwater to the excavation zone.

Excavation would resume when the required drawdown is able to be reliably obtained.

4.6 Management of dewatering water quality

It is important that pumped water is of a suitable quality for re-use as construction water, or disposal via infiltration or reinjection. The discharge from groundwater pumping in ASS areas may have an acidic pH (typically 5 to 6), it may also have a high total acidity, elevated concentrations of dissolved iron and aluminium and significant quantities of suspended iron flocculent. This may result in adverse environmental impacts if the water is discharged without treatment into sensitive waterways or wetlands.

Water pumped from sumps or some wells/spears in non ASS areas may contain large amounts of suspended solids or dissolved iron which can impede recharge via infiltration or recharge wells.

In some Project areas, it will therefore be necessary to treat extracted groundwater before re-use and/or disposal. Prior to dewatering, an assessment of local groundwater quality will be made, informing the decision of whether treatment is necessary.

Water treatment will occur, where required, using methods consistent with the DEC ASS management guidelines using techniques such as settlement basins, treatment basis, dosing plants, filtration plants or packaged water treatment units which will be detailed in the area specific management plans.

The following water treatment management targets and water level triggers should be considered as guidelines for any dewatering effluent use on-site, regardless of whether a treatment system has been installed.

4.6.1 Dewatering water quality monitoring, trigger levels and management responses

Where treatment of groundwater is necessary, the installation, commissioning and operation of water treatment plants (WTPs) will be the responsibility of the dewatering contractor(s). The dewatering contractor(s) will be responsible for monitoring in- and out-falls of any installed WTPs, reporting results regularly to Gateway WA. Where contractors are unable or unqualified to perform the required monitoring, Gateway WA will resume responsibility for implementing the program.

Gateway WA will be responsible for validating contractor water results and recommending management approaches. The planned monitoring program related to dewatering water treatment is presented in the Environmental Monitoring Plan.

Unless noted otherwise for a specific area, dewatering water will be treated to achieve the following minimum water quality targets (which are consistent with DEC ASS Management guidelines):

- pH in the range 6-8;
- Total Titratable Acidity less than 40 mg/L (as CaCO3);

Treated water quality outside of these levels will trigger a management response.

Additional trigger levels may be appropriate in areas where background groundwater quality is poor (e.g. exceeds health or environmental guidelines), as identified by baseline groundwater quality monitoring, or where water is being discharged to the natural environment (e.g. vegetated areas). In these cases, criteria will be developed on an area by area basis, based on baseline monitoring. In all cases discharged water quality will be treated and monitored to be either as good as, or better quality than, baseline water quality or below relevant environmental water quality guidelines.

It is impractical to document all potential causes of a water quality trigger level exceedance and response. After commissioning of the WTP, the most likely causes of water treatment water quality exceedances are:

- Malfunction of the water treatment plant; or

- Significant change in the water quality of the untreated water.

In either case, dewatering contractor(s) will be notified immediately and the adjustments to the WTP will be made to bring the treated water quality below trigger levels.

An exceedance of a trigger level will result in the following:

- Confirmation of water quality results through review of supporting laboratory analysis, review of QA/QC and possibly additional sampling;
- Assessment of the exceedance against trends and variation in inflow water quality (graphs of time verses concentrations);
- Investigation as to the likely cause of the exceedances, and rectification where possible (see below);
- If the exceedance is a recurring (or possibly recurring) problem, an environmental and health risk assessment will be undertaken; and
- If the risk is deemed unacceptable, contingency responses will be considered as mitigation responses.

Short term management responses available, to mitigate the risks of any trigger level exceedances while WTP adjustments are made, include (in order of preference):

- Store untreated groundwater in buffer storage ponds (several hours storage at least will typically be available);
- Temporary reduction of dewatering flow rates;
    - This may be possible for hours or days without affecting construction activities.
- Use of recharge/infiltration system with untreated or partially treated groundwater;
    - This may be possible days, weeks or even months, however prolonged recharge of poorly treated water will likely result in clogging of the recharge system

4.6.2 Contingency Responses

Where required, the water treatment system will be critical in maintaining the dewatering system operational capacity and construction schedule. It is anticipated that WTPs will normally operate at a capacity that is lower than its design capacity to allow for unexpected increase in dewatering flows. The WTPs will also be designed such that routine maintenance can be undertaken without disrupting the treatment process.

However, if the plant is not able to reliably treat water to the required standards, the WTPs will be capable of upgrade and modification to increase flow rate, or treatment parameters by modular expansion at short notice.

4.7 Management of dewatering effluent disposal

Extracted water that is not used for construction purposes will be reinjected into the superficial aquifer to minimise the environmental impact of Project extraction.

Management of dewatering effluent will prioritize maintaining existing local groundwater levels, surface water levels and quality to within baseline levels.

When water level and quality targets are being met in local aquifers, dewatering effluent may be used on-site to support construction activities.

4.7.1 Dewatering effluent disposal monitoring, trigger levels and management responses

In order to conserve groundwater and reduce the area affected by groundwater drawdown, dewatering operations will locally recharge as much dewatering effluent as possible.

The preferred option for disposal of dewatering effluent is to re-infiltrate on-site via earthen basins or trenches (infiltration basins). These infiltration structures may be placed strategically as part of groundwater flow management (e.g. to mound groundwater), and limit off-site impacts, particularly near protected or sensitive wetlands. Typically recharge areas will be separated from the dewatering zones by at least 50 m.

Where infiltration basins are not practical (e.g. due to space constraints), groundwater recharge wells may be installed, or discharge to vegetated depressions or wetlands may be considered.

Clearing of native vegetation will not occur for the sole purpose of installing temporary infiltration basins or recharge wells. In most cases, recharge will occur within the planned Project clearing footprint. In some cases, it may be possible (and preferable) to infiltrate treated dewatering water in naturally vegetated depressions or directly to surface water bodies. Water can then be resupplied directly to areas at most risk of ecological stress due to temporary lowered groundwater levels. This will only occur if water quality is consistently below trigger levels for discharge to the natural environment.

Local recharge of dewatering effluent will be controlled at all times within dedicated recharge basis or wells and will not overflow to the piped stormwater drainage system under normal conditions.

If the recharge system is not able to dispose of all the dewatering effluent in a controlled manner (i.e. without overflowing and entering the stormwater system or natural environment, or without causing detrimental flooding of native vegetation), management actions will be triggered such as:

- Investigation of the main cause of the loss of recharge capacity (e.g. poor water quality or high sediment loads);
- Increase the frequency of cleaning of infiltration basins (sludge removal) or redevelopment of recharge wells;
- If the problems is with recharge wells, consider chemical dosing to prevent or manage clogging due to scale or biological fouling; and
- Adjust/improve the water treatment plant to provide better quality water for infiltration (e.g. lower iron and sediment content).

During and immediately after periods of high rainfall, it is possible some unavoidable mixing of stormwater and treated dewatering effluent may occur due to short-term localised flooding. At these times, monitoring of the construction site runoff will occur as per the surface water management plan outlined in Section 7.

4.7.2 Contingency Responses

In most cases, it is expected that sufficient space will be available within the construction footprint for the reliable infiltration or recharge of dewatering effluent. However, if during dewatering it is evident that the planned infiltration or recharge capacity is not sufficient, several contingency responses are available to prevent dewatering discharge entering the piped stormwater system.

Contingency disposal options include:

- Reduce the rate of dewatering (e.g. by reducing the area under dewatering management);
- Construction of additional infiltration basins, trenches or recharge wells;

- Infiltration via additional vegetated areas or wetlands, if water quality is acceptable;
- Disposal to sewer (if a connection is available in the vicinity).

Water will not be disposed of to the stormwater system unless it is an emergency situation and all other contingency options have been exhausted. This would be done on a temporary basis only, following notification of the asset owner and relevant regulatory/advisory bodies.

5 MANAGEMENT OF LOCAL AQUIFER WATER LEVELS

5.1 Overview

Impacts of dewatering and construction water abstraction on local aquifer water levels (LAWL) will be managed by:

- Prioritising reinjection of all dewatering effluent into the superficial aquifer close to where abstraction occurred;
- Utilisation of surface infiltration ponds, trenches or galleries, in areas deemed high risk of shallow ASS (e.g. peat areas);
- Use of supplementary shallow recharge wells where space restrictions limit the installation of infiltration galleries; and
- Minimise any unavoidable exposure of PASS materials (e.g. beneath the base of the excavation) by minimising the duration of drawdown.

5.2 Monitoring, trigger levels and management responses

Groundwater level monitoring will be undertaken as per the detailed procedures contained within the Environmental Monitoring Plan. Three groups of groundwater wells will be considered for management purposes:

- Excavation zone monitoring wells
    - Wells inside or very close to the active excavation zones - these are not part of the LAWL monitoring, as water levels inside excavation zones are managed in accordance with dewatering abstraction requirements (Section 4.3)
- Near-field monitoring wells
    - The sub-set of LAWL wells located closest (typically within 50 m) to active dewatering areas and are most likely to show operational impacts, should they occur - these wells are monitored most frequently and are expected to show measureable impacts due to dewatering within trigger levels.
- Far-field monitoring wells
    - These are the remaining LAWL wells not included as Near-field wells. They are away from active dewatering areas and are less likely to show measurable impacts due to dewatering.

Groundwater level trigger levels (both high and low) will be set individually for each monitoring well based on the location and screened aquifer. These will typically be set at 1 m above the seasonal high and 1 m below the seasonal low.

Under normal operations an exceedance of the trigger levels will result in the following actions:

- Confirmation of water results through assessment of nearby wells and possibly additional gauging;
- Assessment of the exceedance against groundwater level trends, gradients and variations pumping, recharge and rainfall (graphs of water level and flow rates verses time);
- Investigation as to the likely cause of the exceedances, and rectification where possible (see below);
- If the exceedance is a recurring (or possibly recurring) problem, a formal assessment of the risk (consequence and likelihood of recurrence) resulting from the exceedances will be undertaken.

- If the risk is deemed unacceptable, contingency responses will be considered (see Section 4).

Examples of likely causes of trigger level exceedances able to be easily rectified include:

- Under or over pumping due to equipment malfunction or power failure;
- Clogging of pipe work; and
- Incorrect balancing of disposal network.

5.3 Contingency responses

If local aquifer water levels/pressures are not able to be managed within trigger levels through normal management responses, the use of contingency options may be required. These would typically only be considered where compliance with environmental approval conditions could not be achieved using the planned management. Contingency options that will be assessed include (in order of preference):

- Installation of additional capacity near areas affected; and
- Installation of additional groundwater control structures such as soil grout mix cut-off walls or similar.

6 MANAGEMENT OF LOCAL AQUIFER WATER QUALITY

6.1 Overview

Local aquifer water quality is at risk of degradation as a result of Gateway WA activities through:

- Re-distribution of existing contamination as a result of pumping and recharge or construction of groundwater control structures; and
- Generation of new contamination as a result of activation of ASS, or spills derived from on-site handling activities.

The existing contaminants of concern, which are considered to be above background concentrations, comprise the following:

- Nitrogen
- Metals
- Acidity
- Hydrocarbons

Baseline monitoring has indicated the presence of some metals and nitrogen-related contamination above health and environmental guideline levels (see Appendix C).

The Gateway WA CEMP provides procedures and measures to minimise the risks to groundwater through spills or other loss of containment due to the Project activities.

The primary control to minimise the risk of ASS activation and associated degradation of groundwater quality involves the reinjection of abstracted waters to maintain groundwater levels within the shallow and deep aquifer (refer Section 5 above). However, additional controls include:

- pH adjustment of re-injected waters to a target of pH 8 to help neutralise any acidity generated close to the recharge points; and
- Altering the WTP to improve water quality prior to recharge.

6.2 Monitoring, trigger levels and management responses

Groundwater quality monitoring will be undertaken as per the Environmental Monitoring Plan. Three groups of wells will be considered for management purposes:

- Excavation zone monitoring wells
- Near-field monitoring wells (shallow and deep)
- Far-field monitoring wells (shallow and deep)

Assessment Trigger Levels are derived from a combination of published guidelines and site specific assessment levels developed based on background water quality. Refer to Environmental Monitoring Plan for details.

All groundwater water quality data will be compared to the relevant baseline levels. Exceedance of a trigger level will result the following management responses as a minimum:

- Confirmation of exceedances through review of supporting laboratory analyses, review of QA/QC, and possibly additional sampling;
- Assessment of the exceedance against trends and variation in water quality (graphs of time verses concentrations);
- Investigation as to the likely cause of the exceedances (e.g. groundwater level reduction in areas of ASS), and rectification if possible (see below);

- If the exceedance is a recurring (or possibly recurring) problem, a formal assessment of the risk (consequence and likelihood of recurrence) resulting from the exceedances will be undertaken;
- If the risk is deemed unacceptable, contingency responses will be assessed.

It is impractical to document all potential causes of a water quality trigger level exceedances and responses. However, once the likely cause of the exceedances is known, actions available to address the exceedance include (in order of preference):

- Increase monitoring frequency to better discern trends and variation in the data, and hence improve management;
- Cease or limit the groundwater abstraction or recharge in areas where contaminated waters are known to occur; and
- Increase aquifer recharge in areas to control or drive the contaminated groundwater flow away from groundwater abstraction system (if possible).

6.3 Contingency responses

If local aquifer water quality is not able to be managed within trigger levels through the above standard management responses, the use of contingency options may be required. Contingency options include (in order of preference):

- Installation of additional monitoring wells to help refine and understand the extent of the groundwater quality risks;
- Management of ASS impacts though pH correction of recharge waters via strategically placed recharge wells or infiltration galleries;
- Upgrade or amend the water treatment plant process to treat contaminated groundwater to a higher quality before re-injection; and
- Use of contingency disposal methods.

7 MANAGEMENT OF SURFACE WATER AND WETLANDS

7.1 Overview

For the purpose of this management plan, based on discussions with State and Federal regulators, an area is considered to be a wetland requiring management or protection if it is mapped as a Resource Enhancement or Conservation category wetland by the DEC or mapped as a Nationally Important Wetland by SEWPaC. Runway Swamp is the only area to fall into the latter category, and has not previously been totally cleared (i.e. contains native vegetation). All listed wetlands in the vicinity of the Project are shown in Appendix A.

Runway Swamp is the only permanent or semi-permanent surface water body within 500 m of the Gateway WA construction zone which is not directly connected to the Water Corporation or Perth Airport surface water drainage scheme.

All wetlands and surface water bodies (basins and drains) present within, or close to, the Project area will require monitoring and management to prevent impacts from this Project. Those wetlands within the approved Project footprint which are entirely removed or permanently impacted by the Project will not be monitored. This plan addresses management of project construction phase and temporary works in relation to surface water and wetlands. The impact of permanent works on surface water and wetlands has been addressed as part of the overall Project environmental approval process.

Gateway WA will carry out project activities in a manner designed to minimize direct and indirect impacts on potentially affected wetlands and surface water features.

7.2 Potential impacts

Potential impacts on local surface water and wetlands as a result of this Project may include:

- Changes to hydrogeological regimes:
    - Dewatering operations may impact surface water expressions, water availability to deep rooted vegetation or groundwater entering drainage systems; and
    - Temporary (construction phase) stormwater management measures may alter local recharge, drainage or flooding regimes.
- Changes to water quality:
    - Chemical spills;
    - Erosion from construction areas; and
    - ASS disturbance.

These potential changes in hydrogeological regimes and water quality may lead to the following impacts:

- Alteration of wetland systems ecology;
- Spread of weeds and/or dieback;
- Alteration or loss of wetland flora and fauna communities; and
- Flooding or damage to the drainage network.

Impacts associated with stormwater management and drainage design for temporary and permanent works are addressed through the drainage design report being prepared for all aspects of the Project. Drainage designs will comply with the requirements of the Project Scope of Works Technical Criteria (SWTC – Project

contract between Main Roads and Gateway WA), and wherever possible meet the Department of Water's guidelines for Water Sensitive Urban Design.

7.3 Monitoring and management responses

Gateway WA will be responsible for setting monitoring locations, frequencies and analytes detailed in the Environmental Monitoring Plan. Gateway WA will also be responsible for the implementation of the plan and all surface water and wetland monitoring activities.

Monitoring activities will include baseline and on-going:

- Visual inspections of identified wetland areas for evidence of disturbance and indirect impact;
- Monitoring surface water levels at identified surface water features;
- Field and laboratory analysis of water quality from identified surface water features;
- Visual inspection of project embankments during construction for evidence of erosion or surface water damming;
- Flow rate and water quality monitoring at any point where project water discharges off-site or to a recognised wetland (e.g. project stormwater runoff, dewatering effluent disposal); and
- Visual inspections of existing drainage paths and channels to ensure they are not unnecessarily blocked or restricted.

In addition to the above monitoring practices, Gateway WA will introduce a number of management controls to reduce the likelihood of Project activities impacting surface water and wetlands:

- Wash down bay water will be discharged at least 50 m from Conservation Category or Resource Enhancement wetlands, Airport Precinct 5 and IOCZ, and areas of threatened flora or communities;
- No physical damage to wetlands beyond a maximum of 5 m from the edge of earthworks unless no other means of access is possible or for safety reasons;
- No refuelling will take place within 50 m of a wetland or drainage line;
- A 'no-go' map will be provided for each construction zone. These will indicate all sensitive environmental areas;
- Road verges and batters will be temporarily stabilised where necessary and then revegetated to minimised runoff and erosion;
- No more than 16 ha of wetlands will be permanently impacted on Perth Airport land;
- Wash down bays will be managed to prevent environmental impacts. Vehicles and plant will only wash down in wash down bays. No concrete trucks, apart from the truck chute, will be washed down on site. Concrete water from the chute wash down will be confined onsite and removed once hardened and will not be released into vegetated areas;
- Stockpiles which shall be left onsite for more than a day during May – September and more than five days during October – March, will be bunded where necessary to minimise the amount of run-off entering environmentally sensitive areas; and
- Stockpiles will not be placed within 15 m of a drainage pit.

7.4 Contingency Responses

Stormwater management will include the use of low bunds, silt fencing, bales or other erosion and siltation prevention equipment where necessary. The diversion of any open drains will be avoided during construction wherever possible.

8 OPERATION RISK MANAGEMENT

8.1 Overview

As part of the Alliance design process, risk workshops have been conducted to identify the most significant project risks and identify where additional management and risk mitigation effort may be required. Risks are assessed for intrinsic risk (no management), and after normal or existing management controls are applied. Risks are then assessed for consequence and likelihood before being assigned a risk rating.

8.2 Approvals Risk Mitigation

A key risk identified to be managed was identified as the timely obtaining of the required approvals for dewatering and groundwater management. There are numerous agencies with an interest in the groundwater management for the project including Department of Water, Department of Environment and Conservation, WA Planning Commission and Main Roads. The strategies employed to minimise any delays associated with approvals included:

- Early engagement with all key regulators; and
- Close integration of the environmental approvals team with design and construction teams.

8.3 Dewatering Design Risk Mitigation

Dewatering management specifically seeks to:

- Reduce the likelihood of Acid Sulphate Soils activation;
- Protect nearby surface water features, and associated wetland vegetation;
- Protect nearby structures, if present;
- Reduce mobilisation of contaminated groundwater, if present; and
- Minimise impacts to nearby superficial aquifer groundwater users.

Key design aspects to achieve the above aims are listed below.

- Groundwater modeling (Visual Modflow) for large dewatering operations:
    - Uses 3D site geology modelled from site investigative works;
    - Includes numerous sensitivity analyses;
    - Is subject to peer review by an independent design verifier;
    - Uses site specific aquifer properties, to be confirmed using additional Alliance pump tests;
    - Optimise well spacing, screen design and placement of groundwater control structures (soil grout mix walls);
    - Allows estimation and management of geotechnical risk factors such as subsidence, heave and piping failures.
- Use of collection and recharge ring mains:
    - enable prompt attachment of additional recharge wells;
    - allow for isolation of pipe sections for online maintenance or repair;
    - provide spare capacity when required.
- Inclusion of redundancy and spare capacity:
    - Water Treatment Plants will have spare capacity, ability to be extended or upgraded and able to have routine maintenance while in continuous operation;

- Design of all system components is based on upper modelling flow estimates;
- Additional recharge capacity will always be available, over and above what is modelled as required. This is made possible due to the staging of the works, maintenance of the recharge ring main and use of recharge wells further away from active dewatering zones if required.

8.4 Monitoring and Geotechnical Risk Mitigation

It is not the intention of this document to describe the management of geotechnical risks associated with groundwater levels, pressures and flows. These are well described in Alliance geotechnical reports. Similarly the details of groundwater monitoring are described in the Environmental Monitoring Plan.

However, the Alliance has taken the view that groundwater monitoring and management will be integrated and to that end all groundwater related monitoring and reporting will be completed centrally by the Alliance, with data made available for use by all construction, environmental and safety management personnel.

8.5 Groundwater Disposal Risk Mitigation

A primary requirement of the dewatering system design was to recharge almost all abstracted groundwater. The Alliance believes this goal is achievable, however, previous projects have shown that it is critical to the smooth running of the project to have contingency options. As a result, the Alliance is ensuring the following water disposal contingency measures will be available at short notice, in the event that the groundwater recharge network is not able to dispose of some or all of the abstracted water.

8.5.1 Option 1: Surface Infiltration

The Alliance will maintain a surface and near surface infiltration network of Infiltration trenches, galleries or swales. These will be used normally to distribute water evenly to PASS areas of the site immediately adjacent to the dewatering zones, which are most likely to be affected by dewatering drawdown.

This option will have a limited capacity which will depend on the seasonal shallow groundwater levels and the quality of the water to be infiltrated (high iron or fines content will block the infiltration zones).

Where infiltration basins are not practical (e.g. due to space constraints), groundwater recharge wells may be installed, or discharge vegetated depressions or wetlands may be considered.

8.5.2 Option 2: Discharge to Sewer

Where it is not possible to fully infiltrate all dewatering effluent (e.g. due to onsite space constraints) the Alliance will negotiate with the Water Corporation to temporarily discharge dewatering flow to sewer, provided a connection point can be found locally.

8.5.3 Option 3: Emergency Discharge to Storm water

Planned discharge of water from the site to the off-site stormwater system will not occur. The only circumstance where stormwater discharge is possible is in the unlikely event of an emergency release or overflow where all other disposal options are unavailable or at capacity and it were unsafe to cease dewatering.

Any stormwater discharge would be accompanied by immediate notification of the regulators, increased monitoring and an emergency response plan to ensure discharge flows and duration were minimised.

9 RESPONSABILITIES AND REPORTING

9.1 Reporting

Regular monitoring will be undertaken and records will be kept. Reporting will be undertaken on an as-needs basis.

9.2 Responsibilities

Primary responsibilities for implementation of this management plan fall with the key groups shown in Figure 3. General areas of responsibility are outlined below.

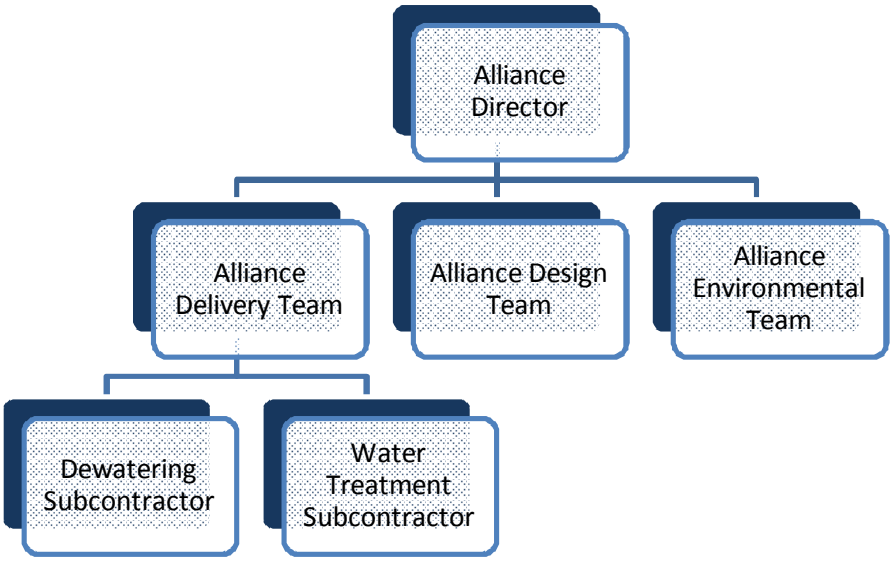

Figure 3 Groundwater Management Relationship Diagram

9.2.1 Alliance Environmental Team

With regards to groundwater management, the Alliance Environmental team will be responsible for:

- Coordinating groundwater and dewatering approvals;
- All groundwater quality monitoring, other than field testing conducted by Subcontractors;
- All groundwater level monitoring, other than that undertaken by the Dewatering Subcontractor;
- Assessment of data against trigger levels, reporting and provision of monitoring data to relevant parties;
- Reporting to the regulators;
- Coordination of investigations into trigger level exceedances and expediting any decisions regarding any contingency measures; and
- Provision of advice to the Delivery Team regarding operational changes to improve environmental outcomes.

9.2.2 Alliance Delivery Team

The Alliance Delivery Team is responsible for managing the Subcontractors performance, informing them of construction requirements, any design changes and day to day site constraints.

The Delivery Team is responsible for addressing any monitoring exceedances and implementing contingency measures.

9.2.3 Alliance Design Team

The Alliance Design Team is responsible for providing adequate design detail where required to allow the Delivery Team and Subcontractors to undertake their work.

9.2.4 Dewatering Contractor

When engaged, the Dewatering Subcontractor will have professional and practical working knowledge of dewatering systems in comparable projects and will be responsible for the installation, operation and decommissioning of the dewatering system, other than the Water Treatment Plant.

With regards to groundwater management, the Dewatering Subcontractor will undertake and report to Gateway WA:

- All monitoring of pumping and recharge pressures, flow rates and metered flow;
- All monitoring of water levels within the excavation zones;
- All maintenance of the pumping wells, recharge wells, monitoring wells within the excavation zone, pipes and pumps of the dewatering system;
- Any adjustments to the of pumping quantities to maintain the drawdown for construction requirements, considering safety issues (e.g. heave, boiling);
- Any adjustments to the recharge system (pressures, flow rates, locations) in accordance with Delivery Team instructions; and
- Routine operation and checking of the water treatment plant.

Where dewatering works are carried out directly by Gateway WA, the Project delivery team will assume these responsibilities.

9.2.5 Water Treatment Contractor

The Water Treatment Subcontractor will have professional and practical working knowledge of the water treatment systems in comparable projects and will be responsible for the installation, operation and decommissioning of the Water Treatment Plant. It is anticipated the water treatment plant will be substantially automatic, such that daily operation and checks can be performed by the Dewatering contractor, with less frequent maintenance and monitoring by the Water Treatment Contractor.

With regards to groundwater management, the Water Treatment Subcontractor will undertake:

- All monitoring and maintenance of the water treatment process; and
- Any adjustments to treatment process.

Where water treatment works are carried out directly by Gateway WA, the Project delivery team will assume these responsibilities.

APPENDIX A: PROJECT LAYOUT AND ENVIRONMENTAL CONSTRAINTS

AREA 1

0 100 200 300

Metres

GDA 1994 Perth Coastal Grid 1994

1:8,150 (A3)

LEGEND

GHD Cockatoo Tree Locations

Potential breeding trees

Fence

Permanent Fence

Directory of Important Wetlands

DEC Geomorphic Wetlands

Conservation

Resource Enhancement

Core black cockatoo feeding habitat

Airport Land

Maximum Project Area

Environmental Constraints in Work Areas

WORK AREA 1

GatewayWA

Perth Airport and Freight Access Project

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Last Printed: 26/02/13

AREA 2

0 120 240 360

Metres

GDA 1994 Perth Coastal Grid 1994

1:9,190 (A3)

LEGEND

GHD Cockatoo Tree Locations

- Possible roosting site
- Potential breeding trees
- *Macarthuria keigheryi*

Fence

- Fauna Fence
- Permanent Fence
- Directory of Important Wetlands
- Runway Swamp

DEC Geomorphic Wetlands

- Conservation
- Resource Enhancement
- Core black cockatoo feeding habitat
- Airport Land
- Maximum Project Area

Environmental Constraints in Work Areas

WORK AREA 2

GatewayWA

Perth Airport and Freight Access Project

Last Modified 1/03/2013 at 03:52 PM by vdinh
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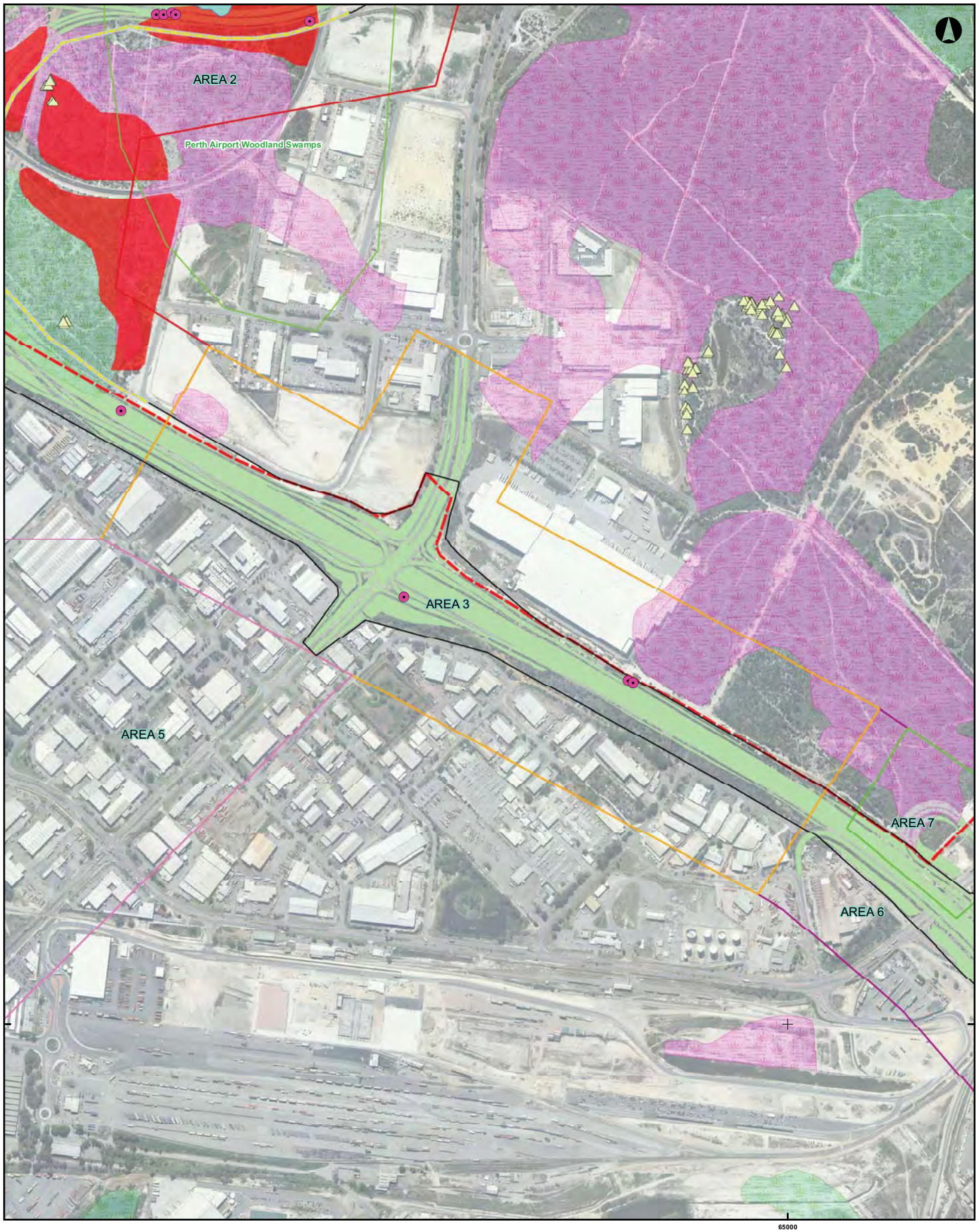

AREA 3

0 100 200 300

Metres

GDA 1994 Perth Coastal Grid 1994

1:7,790 (A3)

LEGEND

GHD Cockatoo Tree Locations

- Potential breeding trees
- *Macarthuria keigheryi*

Fence

- Fauna Fence

- Directory of Important Wetlands
- Runway Swamp

DEC Geomorphic Wetlands

- Conservation
- Resource Enhancement
- Core black cockatoo feeding habitat
- Airport Land
- Maximum Project Area

Environmental Constraints in Work Areas

WORK AREA 3

GatewayWA

Perth Airport and Freight Access Project

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Last Printed: 26/02/13

AREA 4

0 100 200 300

Metres

GDA 1994 Perth Coastal Grid 1994

1:7,420 (A3)

LEGEND

GHD Cockatoo Tree Locations

- Potential breeding trees

DEC Geomorphic Wetlands

- Conservation
- Core black cockatoo feeding habitat
- Airport Land
- Maximum Project Area

Environmental Constraints in Work Areas

WORK AREA 4

GatewayWA

Perth Airport and Freight Access Project

AREA 5

0 170 340 510

Metres

GDA 1994 Perth Coastal Grid 1994

1:12,840 (A3)

LEGEND

GHD Cockatoo Tree Locations

- Potential breeding trees
- *Macarthuria keigheryi*

Fence

- Fauna Fence
- Directory of Important Wetlands
- Runway Swamp

DEC Geomorphic Wetlands

- Conservation
- Resource Enhancement
- Core black cockatoo feeding habitat
- Airport Land
- Maximum Project Area

Environmental Constraints in Work Areas

WORK AREA 5

GatewayWA

Perth Airport and Freight Access Project

Last Modified 1/03/2013 at 03:52 PM by vdinh
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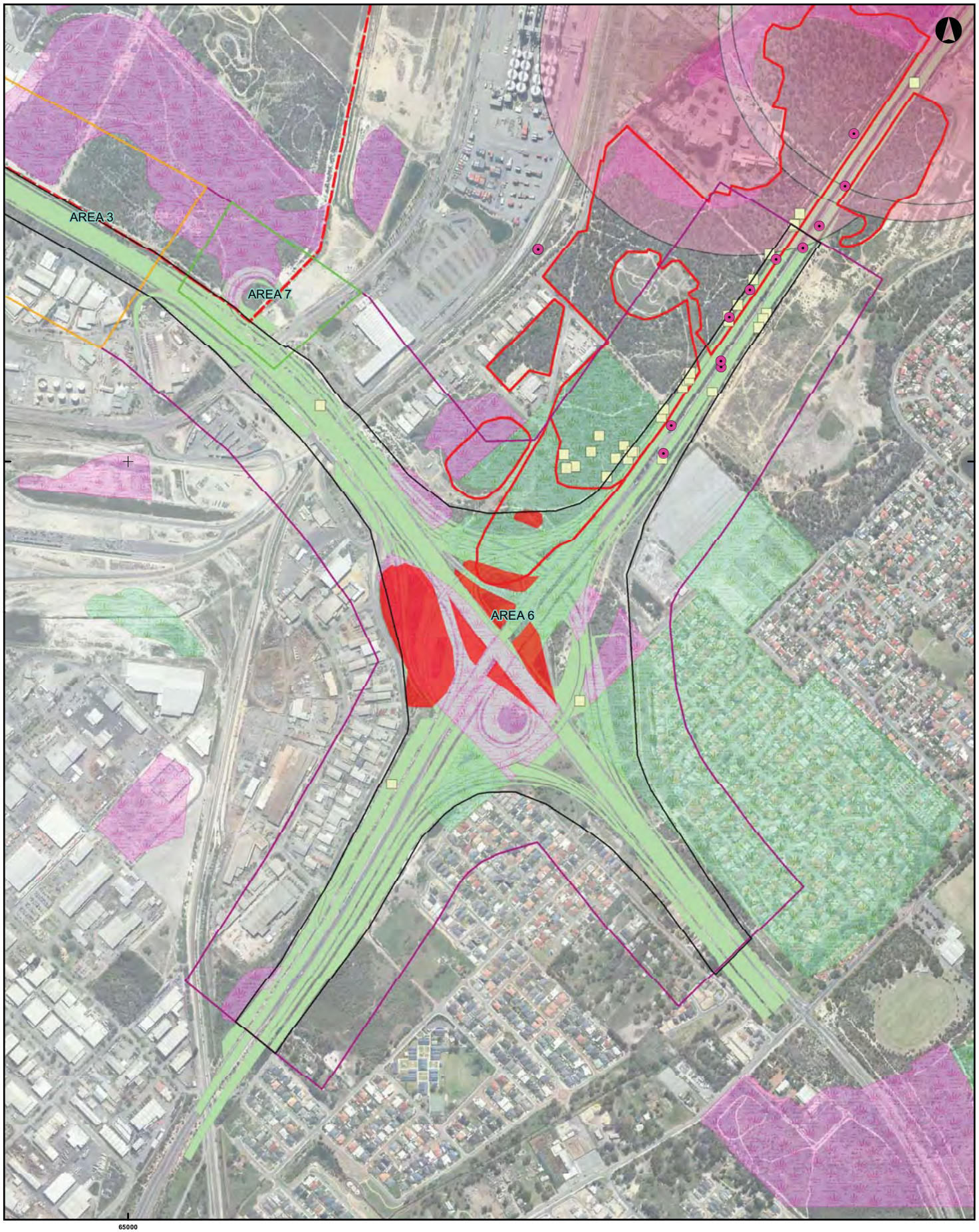

AREA 6

0 120 240 360

Metres

GDA 1994 Perth Coastal Grid 1994

1:8,920 (A3)

LEGEND

GHD Cockatoo Tree Locations

- Potential breeding trees
- *Conospermum undulatum*

- DEC Threatened Ecological Community Boundary
- Threatened Ecological Communities

DEC Geomorphic Wetlands

- Conservation
- Resource Enhancement
- Core black cockatoo feeding habitat
- Airport Land
- Maximum Project Area

Environmental Constraints in Work Areas

WORK AREA 6

GatewayWA

Perth Airport and Freight Access Project

Last Modified 1/03/2013 at 03:52 PM by vdinh
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Last Printed: 26/02/13

APPENDIX B: SOIL AND GROUNDWATER INVESTIGATION LOCATIONS

Geotechnical Investigations

Existing and Planned Testing Locations

Area 1-1

Date Printed: 3/04/2013

0 10 20 30 40

Metres

1:1,125 (A3)

Coordinate System: Perth Coastal Grid 94 (PCG94)

Design (26 March 2013)

TESTING LOCATIONS

Phase A (Gateway Vision, 2011)

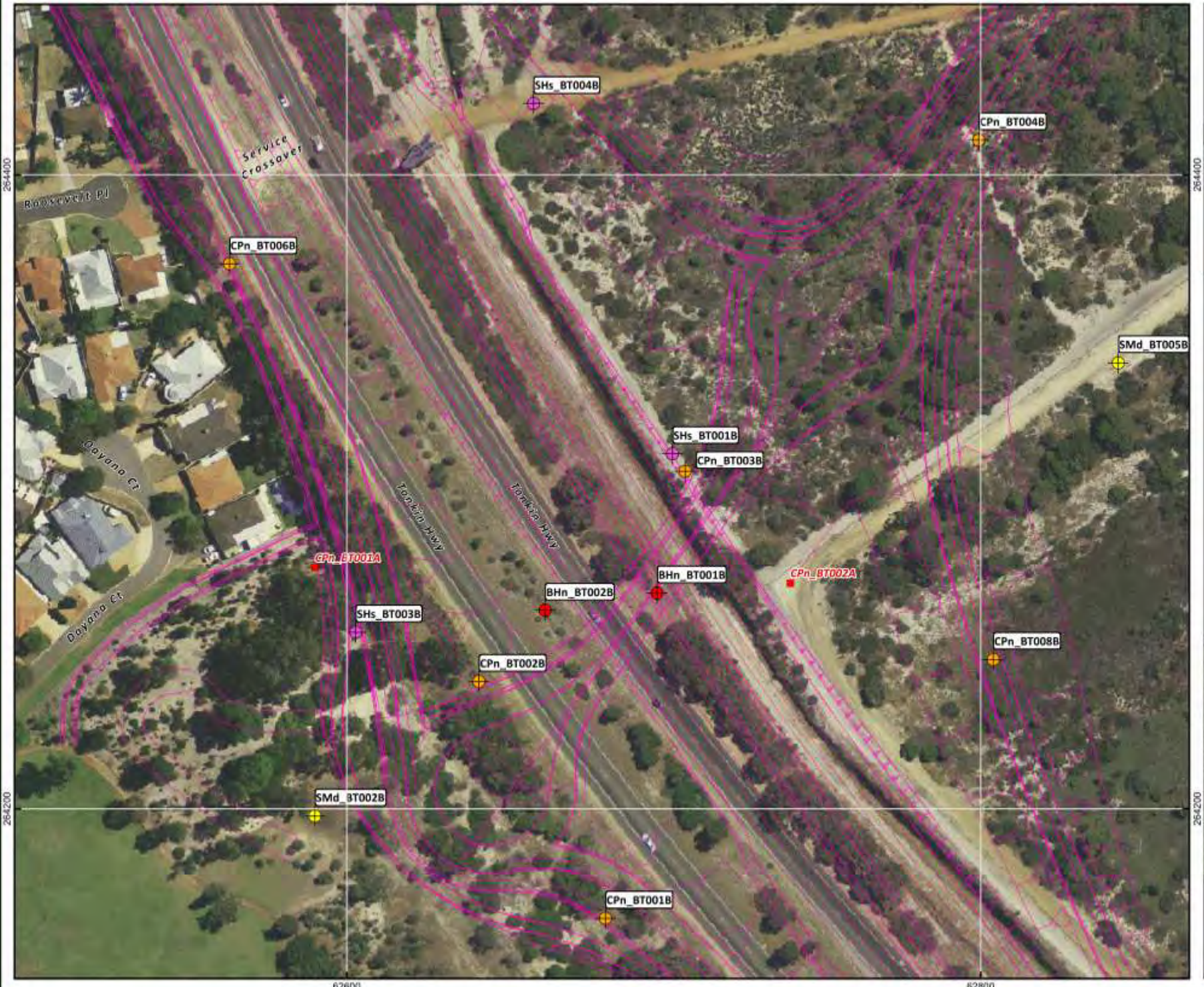
Phase B (Gateway WA Alliance, 2013)

- BH - Geotechnical Borehole
- BM - Geotechnical Borehole & Monitoring Well
- BP - Geotechnical Borehole & Pumping Well
- CP - Cone Penetrometer Test
- HA - Hand Auger (pavement)
- RA - Rotary Auger (pavement)
- SH - Soil Borehole (Environmental/ASS)
- SM - Soil Borehole Monitoring Well (Environmental/ASS)

GLIDE Surfaces	*OLS Surfaces*
4.4m	OLS 4.4m
4.6m	OLS 4.6m
8.0m	OLS 8.0m
9.0m	OLS 9.0m

GatewayWA

Perth Airport and Freight Access Project



Geotechnical Investigations

Existing and Planned Testing Locations

Area 1-2

Date Printed: 3/04/2013

0 10 20 30 40

Metres

1:1,125 (A3)

Coordinate System: Perth Coastal Grid 94 (PCG94)

Design (26 March 2013)

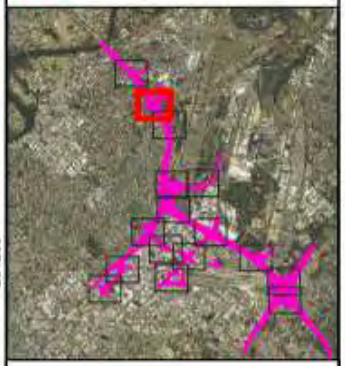
TESTING LOCATIONS

Phase A (Gateway Vision, 2011)

Phase B (Gateway WA Alliance, 2013)

- BH - Geotechnical Borehole
- BM - Geotechnical Borehole & Monitoring Well
- BP - Geotechnical Borehole & Pumping Well
- CP - Cone Penetrometer Test
- HA - Hand Auger (pavement)
- RA - Rotary Auger (pavement)
- SH - Soil Borehole (Environmental/ASS)
- SM - Soil Borehole Monitoring Well (Environmental/ASS)

GLIDE Surfaces	*OLS Surfaces*
4.4m	OLS 4.4m
4.6m	OLS 4.6m
8.0m	OLS 8.0m
9.0m	OLS 9.0m



GatewayWA

Perth Airport and Freight Access Project

Geotechnical Investigations

Existing and Planned Testing Locations

Area 1-3

Date Printed: 3/04/2013

0 10 20 30 40

Metres

1:1,125 (A3)

Coordinate System: Perth Coastal Grid 94 (PCG94)

Design (26 March 2013)

TESTING LOCATIONS

Phase A (Gateway Vision, 2011)

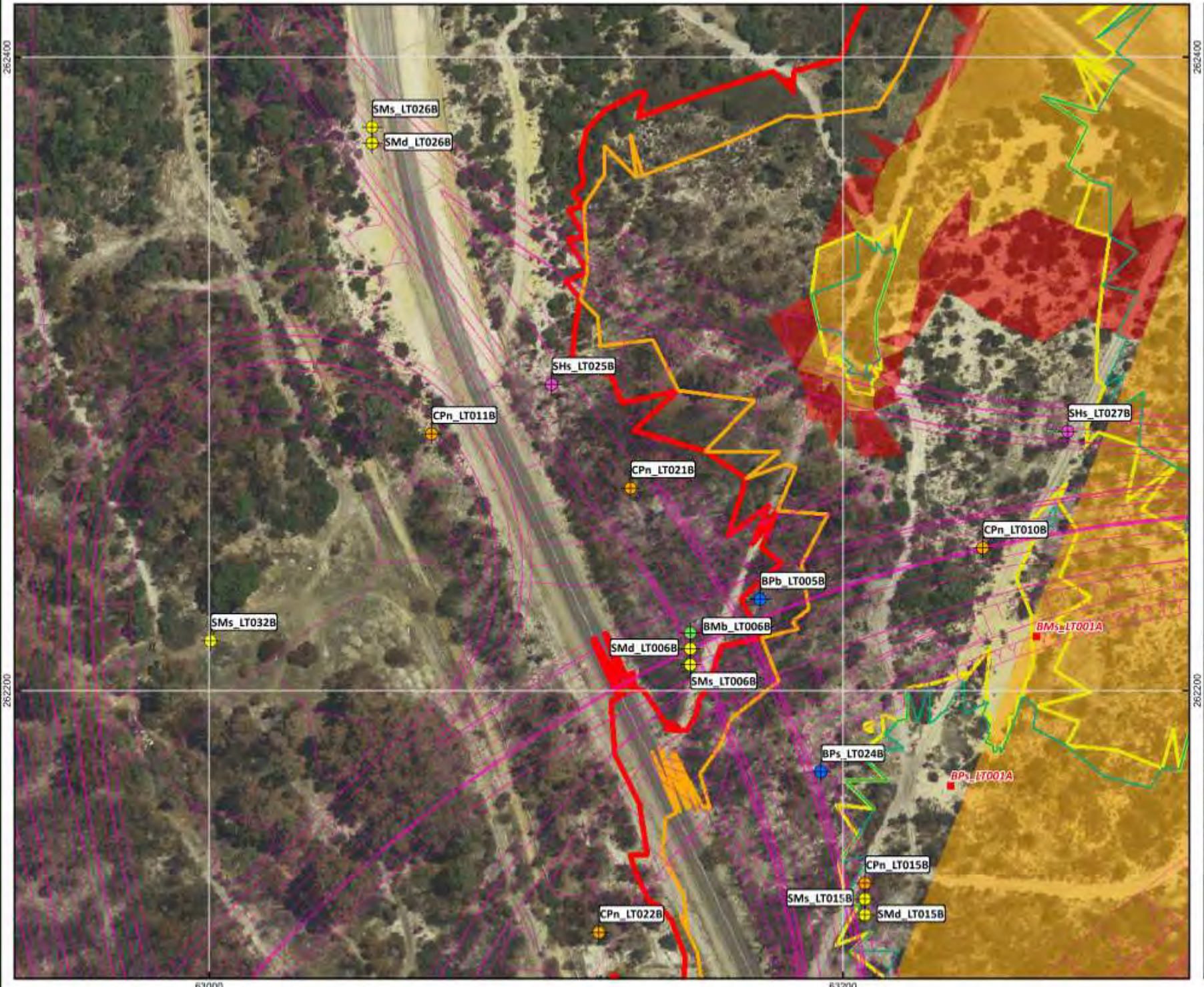
Phase B (Gateway WA Alliance, 2013)

- BH - Geotechnical Borehole
- BM - Geotechnical Borehole & Monitoring Well
- BP - Geotechnical Borehole & Pumping Well
- CP - Cone Penetrometer Test
- HA - Hand Auger (pavement)
- RA - Rotary Auger (pavement)
- SH - Soil Borehole (Environmental/ASS)
- SM - Soil Borehole Monitoring Well (Environmental/ASS)

GLIDE Surfaces	*OLS Surfaces*
4.4m	OLS 4.4m
4.6m	OLS 4.6m
8.0m	OLS 8.0m
9.0m	OLS 9.0m

GatewayWA

Perth Airport and Freight Access Project



Geotechnical Investigations

Existing and Planned Testing Locations

Area 2-1

Date Printed: 3/04/2013

0 10 20 30 40

Metres

1:1,125 (A3)

Coordinate System: Perth Coastal Grid 94 (PCG94)

Design (26 March 2013)

TESTING LOCATIONS

Phase A (Gateway Vision, 2011)

Phase B (Gateway WA Alliance, 2013)

- BH - Geotechnical Borehole
- BM - Geotechnical Borehole & Monitoring Well
- BP - Geotechnical Borehole & Pumping Well
- CP - Cone Penetrometer Test
- HA - Hand Auger (pavement)
- RA - Rotary Auger (pavement)
- SH - Soil Borehole (Environmental/ASS)
- SM - Soil Borehole Monitoring Well (Environmental/ASS)

GLIDE Surfaces	*OLS Surfaces*
4.4m	OLS 4.4m
4.6m	OLS 4.6m
8.0m	OLS 8.0m
9.0m	OLS 9.0m

GatewayWA

Perth Airport and Freight Access Project

Geotechnical Investigations

Existing and Planned Testing Locations

Area 2-2

Date Printed: 3/04/2013

0 10 20 30 40

Metres

1:1,125 (A3)

Coordinate System: Perth Coastal Grid 94 (PCG94)

Design (26 March 2013)

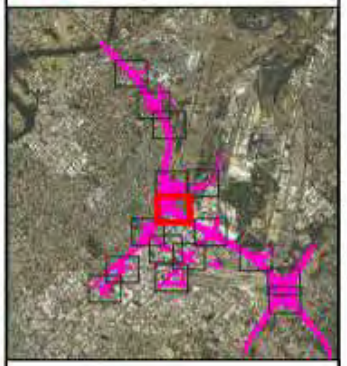
TESTING LOCATIONS

Phase A (Gateway Vision, 2011)

Phase B (Gateway WA Alliance, 2013)

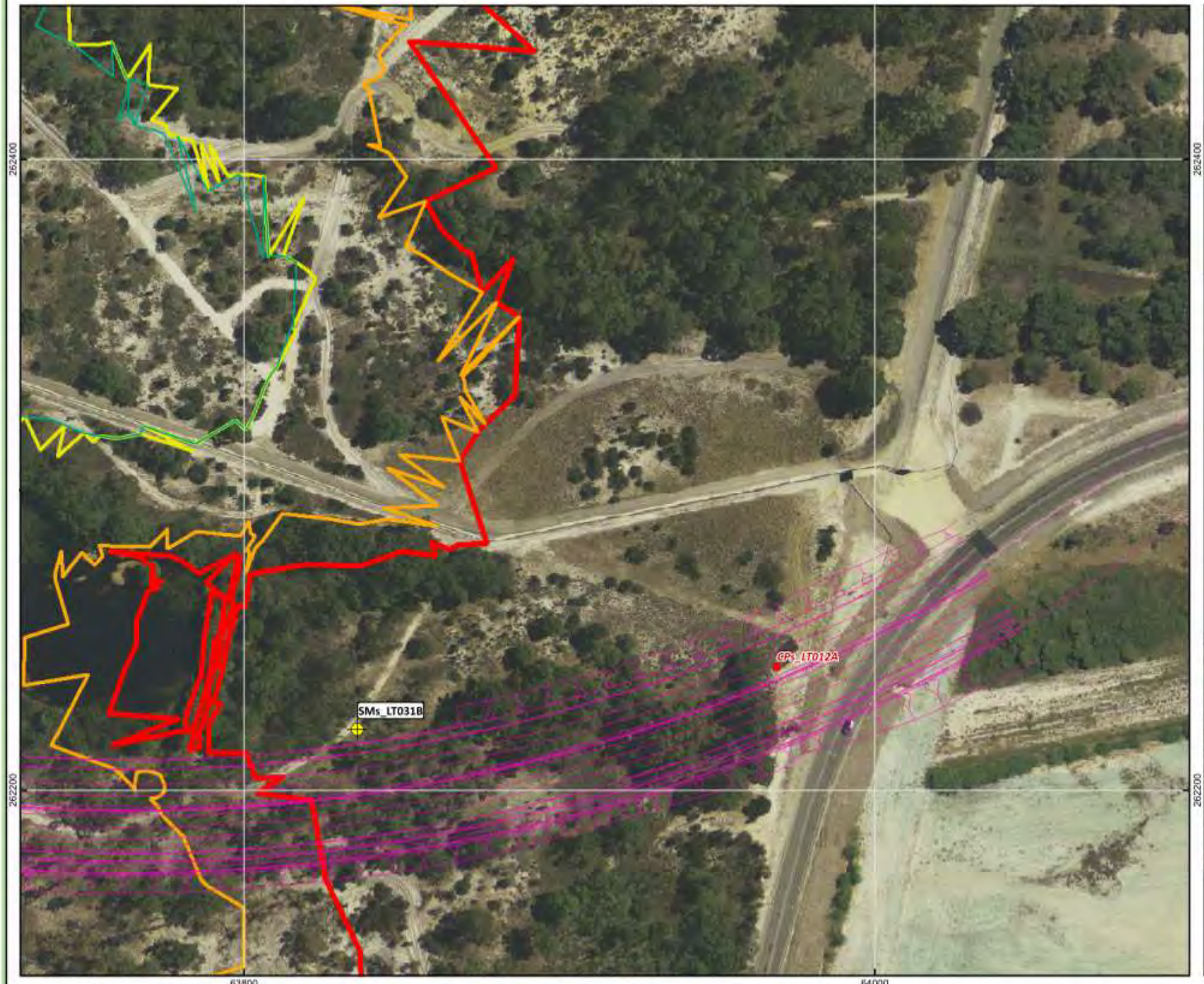
- BH - Geotechnical Borehole
- BM - Geotechnical Borehole & Monitoring Well
- BP - Geotechnical Borehole & Pumping Well
- CP - Cone Penetrometer Test
- HA - Hand Auger (pavement)
- RA - Rotary Auger (pavement)
- SH - Soil Borehole (Environmental/ASS)
- SM - Soil Borehole Monitoring Well (Environmental/ASS)

GLIDE Surfaces	*OLS Surfaces*
4.4m	OLS 4.4m
4.6m	OLS 4.6m
8.0m	OLS 8.0m
9.0m	OLS 9.0m



GatewayWA

Perth Airport and Freight Access Project



Geotechnical Investigations

Existing and Planned Testing Locations

Area 2-3

Date Printed: 3/04/2013

0 10 20 30 40

Metres

1:1,125 (A3)

Coordinate System: Perth Coastal Grid 94 (PCG94)

Design (26 March 2013)

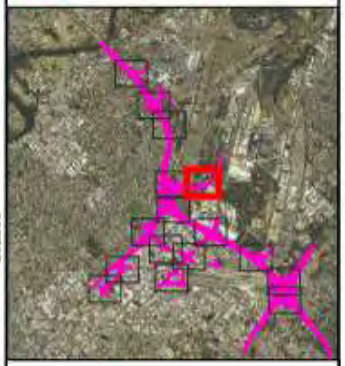
TESTING LOCATIONS

Phase A (Gateway Vision, 2011)

Phase B (Gateway WA Alliance, 2013)

- BH - Geotechnical Borehole
- BM - Geotechnical Borehole & Monitoring Well
- BP - Geotechnical Borehole & Pumping Well
- CP - Cone Penetrometer Test
- HA - Hand Auger (pavement)
- RA - Rotary Auger (pavement)
- SH - Soil Borehole (Environmental/ASS)
- SM - Soil Borehole Monitoring Well (Environmental/ASS)

GLIDE Surfaces	*OLS Surfaces*
4.4m	OLS 4.4m
4.6m	OLS 4.6m
8.0m	OLS 8.0m
9.0m	OLS 9.0m



GatewayWA

Perth Airport and Freight Access Project

Geotechnical Investigations

Existing and Planned Testing Locations

Area 3

Date Printed: 3/04/2013

0 10 20 30 40

Metres

1:1,125 (A3)

Coordinate System: Perth Coastal Grid 94 (PCG94)

Design (26 March 2013)

TESTING LOCATIONS

Phase A (Gateway Vision, 2011)

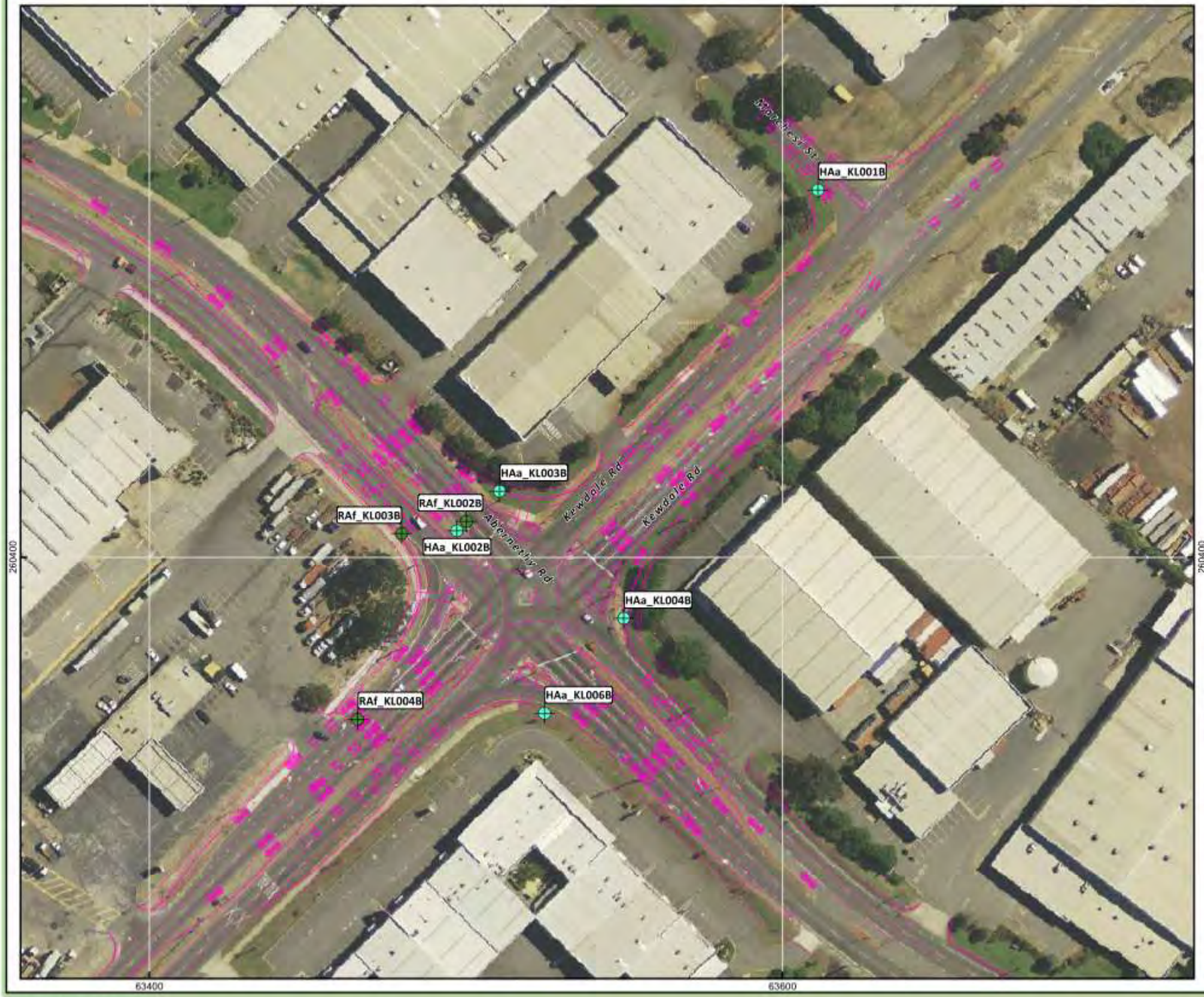
Phase B (Gateway WA Alliance, 2013)

- BH - Geotechnical Borehole
- BM - Geotechnical Borehole & Monitoring Well
- BP - Geotechnical Borehole & Pumping Well
- CP - Cone Penetrometer Test
- HA - Hand Auger (pavement)
- RA - Rotary Auger (pavement)
- SH - Soil Borehole (Environmental/ASS)
- SM - Soil Borehole Monitoring Well (Environmental/ASS)

GLIDE Surfaces	*OLS Surfaces*
4.4m	OLS 4.4m
4.6m	OLS 4.6m
8.0m	OLS 8.0m
9.0m	OLS 9.0m

GatewayWA

Perth Airport and Freight Access Project



Geotechnical Investigations

Existing and Planned Testing Locations

Area 3a-1

Date Printed: 3/04/2013

0 10 20 30 40

Metres

1:1,125 (A3)

Coordinate System: Perth Coastal Grid 94 (PCG94)

Design (26 March 2013)

TESTING LOCATIONS

Phase A (Gateway Vision, 2011)

Phase B (Gateway WA Alliance, 2013)

- BH - Geotechnical Borehole
- BM - Geotechnical Borehole & Monitoring Well
- BP - Geotechnical Borehole & Pumping Well
- CP - Cone Penetrometer Test
- HA - Hand Auger (pavement)
- RA - Rotary Auger (pavement)
- SH - Soil Borehole (Environmental/ASS)
- SM - Soil Borehole Monitoring Well (Environmental/ASS)

GLIDE Surfaces	*OLS Surfaces*
4.4m	OLS 4.4m
4.6m	OLS 4.6m
8.0m	OLS 8.0m
9.0m	OLS 9.0m

GatewayWA

Perth Airport and Freight Access Project

Geotechnical Investigations

Existing and Planned Testing Locations

Area 3a-2

Date Printed: 3/04/2013

0 10 20 30 40

Metres

1:1,125 (A3)

Coordinate System: Perth Coastal Grid 94 (PCG94)

Design (26 March 2013)

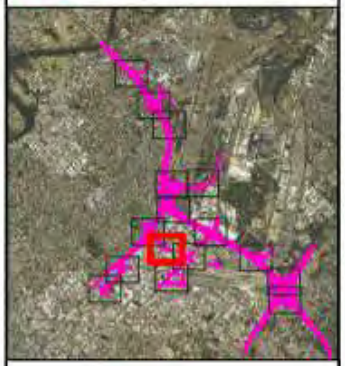
TESTING LOCATIONS

Phase A (Gateway Vision, 2011)

Phase B (Gateway WA Alliance, 2013)

- BH - Geotechnical Borehole
- BM - Geotechnical Borehole & Monitoring Well
- BP - Geotechnical Borehole & Pumping Well
- CP - Cone Penetrometer Test
- HA - Hand Auger (pavement)
- RA - Rotary Auger (pavement)
- SH - Soil Borehole (Environmental/ASS)
- SM - Soil Borehole Monitoring Well (Environmental/ASS)

GLIDE Surfaces	*OLS Surfaces*
4.4m	OLS 4.4m
4.6m	OLS 4.6m
8.0m	OLS 8.0m
9.0m	OLS 9.0m



GatewayWA

Perth Airport and Freight Access Project

Geotechnical Investigations

Existing and Planned Testing Locations

Area 3a-3

Date Printed: 3/04/2013

0 10 20 30 40

Metres

1:1,125 (A3)

Coordinate System: Perth Coastal Grid 94 (PCG94)

Design (26 March 2013)

TESTING LOCATIONS

Phase A (Gateway Vision, 2011)

Phase B (Gateway WA Alliance, 2013)

- BH - Geotechnical Borehole
- BM - Geotechnical Borehole & Monitoring Well
- BP - Geotechnical Borehole & Pumping Well
- CP - Cone Penetrometer Test
- HA - Hand Auger (pavement)
- RA - Rotary Auger (pavement)
- SH - Soil Borehole (Environmental/ASS)
- SM - Soil Borehole Monitoring Well (Environmental/ASS)

GLIDE Surfaces	*OLS Surfaces*
4.4m	OLS 4.4m
4.6m	OLS 4.6m
8.0m	OLS 8.0m
9.0m	OLS 9.0m

GatewayWA

Perth Airport and Freight Access Project

Geotechnical Investigations

Existing and Planned Testing Locations

Area 3a-4

Date Printed: 3/04/2013

0 10 20 30 40

Metres

1:1,125 (A3)

Coordinate System: Perth Coastal Grid 94 (PCG94)

Design (26 March 2013)

TESTING LOCATIONS

Phase A (Gateway Vision, 2011)

Phase B (Gateway WA Alliance, 2013)

- BH - Geotechnical Borehole
- BM - Geotechnical Borehole & Monitoring Well
- BP - Geotechnical Borehole & Pumping Well
- CP - Cone Penetrometer Test
- HA - Hand Auger (pavement)
- RA - Rotary Auger (pavement)
- SH - Soil Borehole (Environmental/ASS)
- SM - Soil Borehole Monitoring Well (Environmental/ASS)

GLIDE Surfaces	*OLS Surfaces*
4.4m	OLS 4.4m
4.6m	OLS 4.6m
8.0m	OLS 8.0m
9.0m	OLS 9.0m

GatewayWA

Perth Airport and Freight Access Project

Geotechnical Investigations

Existing and Planned Testing Locations

Area 3a-5

Date Printed: 3/04/2013

0 10 20 30 40

Metres

1:1,125 (A3)

Coordinate System: Perth Coastal Grid 94 (PCG94)

Design (26 March 2013)

TESTING LOCATIONS

Phase A (Gateway Vision, 2011)

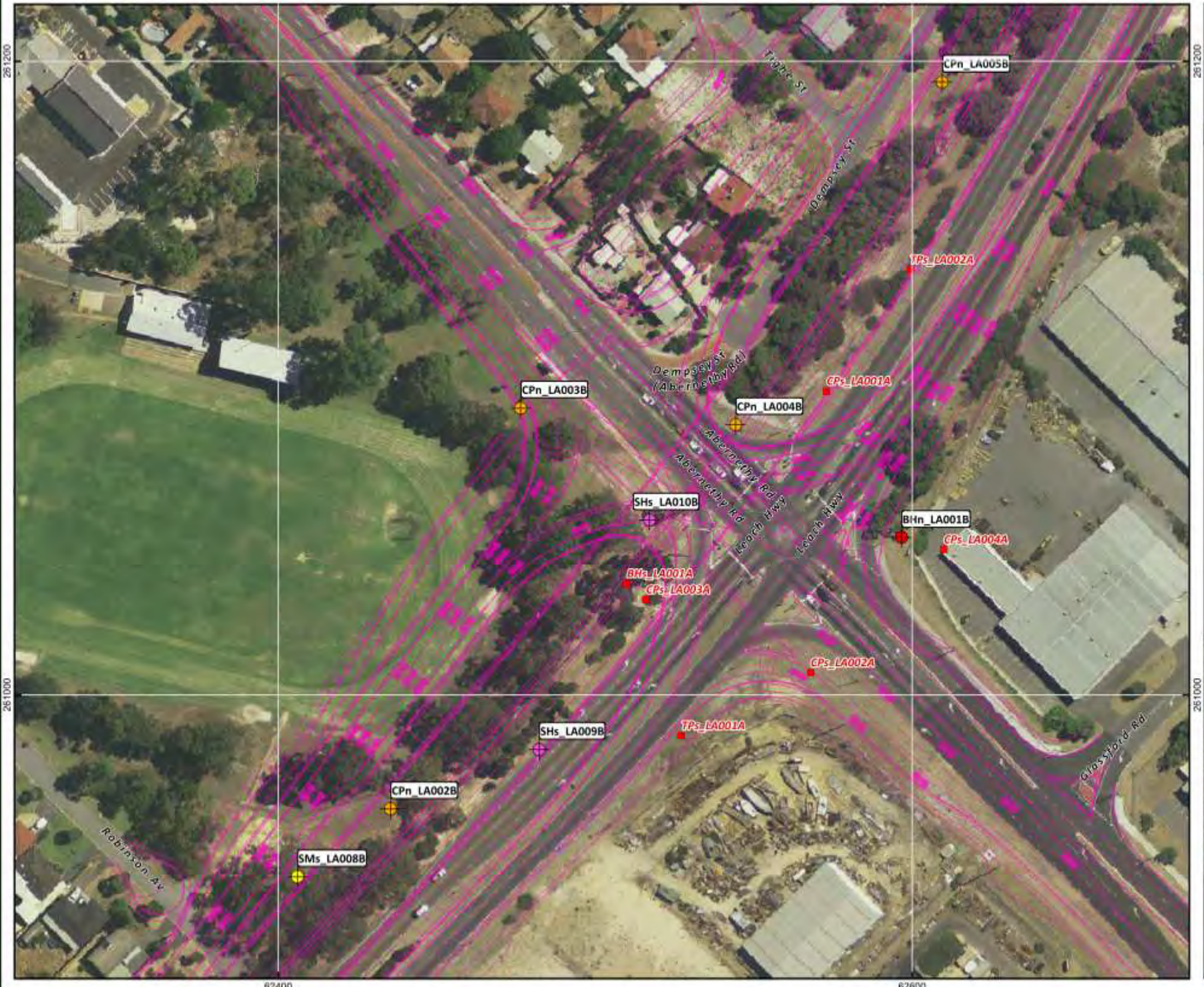
Phase B (Gateway WA Alliance, 2013)

- BH - Geotechnical Borehole
- BM - Geotechnical Borehole & Monitoring Well
- BP - Geotechnical Borehole & Pumping Well
- CP - Cone Penetrometer Test
- HA - Hand Auger (pavement)
- RA - Rotary Auger (pavement)
- SH - Soil Borehole (Environmental/ASS)
- SM - Soil Borehole Monitoring Well (Environmental/ASS)

GLIDE Surfaces	*OLS Surfaces*
4.4m	OLS 4.4m
4.6m	OLS 4.6m
8.0m	OLS 8.0m
9.0m	OLS 9.0m

GatewayWA

Perth Airport and Freight Access Project



Geotechnical Investigations

Existing and Planned Testing Locations

Area 4

Date Printed: 3/04/2013

0 10 20 30 40

Metres

1:1,125 (A3)

Coordinate System: Perth Coastal Grid 94 (PCG94)

Design (26 March 2013)

TESTING LOCATIONS

Phase A (Gateway Vision, 2011)

Phase B (Gateway WA Alliance, 2013)

- BH - Geotechnical Borehole
- BM - Geotechnical Borehole & Monitoring Well
- BP - Geotechnical Borehole & Pumping Well
- CP - Cone Penetrometer Test
- HA - Hand Auger (pavement)
- RA - Rotary Auger (pavement)
- SH - Soil Borehole (Environmental/ASS)
- SM - Soil Borehole Monitoring Well (Environmental/ASS)

GLIDE Surfaces	*OLS Surfaces*
4.4m	OLS 4.4m
4.6m	OLS 4.6m
8.0m	OLS 8.0m
9.0m	OLS 9.0m

GatewayWA

Perth Airport and Freight Access Project

Geotechnical Investigations

Existing and Planned Testing Locations

Area 5

Date Printed: 3/04/2013

0 10 20 30 40

Metres

1:1,125 (A3)

Coordinate System: Perth Coastal Grid 94 (PCG94)

Design (26 March 2013)

TESTING LOCATIONS

Phase A (Gateway Vision, 2011)

Phase B (Gateway WA Alliance, 2013)

- BH - Geotechnical Borehole
- BM - Geotechnical Borehole & Monitoring Well
- BP - Geotechnical Borehole & Pumping Well
- CP - Cone Penetrometer Test
- HA - Hand Auger (pavement)
- RA - Rotary Auger (pavement)
- SH - Soil Borehole (Environmental/ASS)
- SM - Soil Borehole Monitoring Well (Environmental/ASS)

GLIDE Surfaces	*OLS Surfaces*
4.4m	OLS 4.4m
4.6m	OLS 4.6m
8.0m	OLS 8.0m
9.0m	OLS 9.0m

GatewayWA

Perth Airport and Freight Access Project

Geotechnical Investigations

Existing and Planned Testing Locations

Area 6-1

Date Printed: 3/04/2013

0 10 20 30 40

Metres

1:1,125 (A3)

Coordinate System: Perth Coastal Grid 94 (PCG94)

Design (26 March 2013)

TESTING LOCATIONS

Phase A (Gateway Vision, 2011)

Phase B (Gateway WA Alliance, 2013)

- BH - Geotechnical Borehole
- BM - Geotechnical Borehole & Monitoring Well
- BP - Geotechnical Borehole & Pumping Well
- CP - Cone Penetrometer Test
- HA - Hand Auger (pavement)
- RA - Rotary Auger (pavement)
- SH - Soil Borehole (Environmental/ASS)
- SM - Soil Borehole Monitoring Well (Environmental/ASS)

GLIDE Surfaces	*OLS Surfaces*
4.4m	OLS 4.4m
4.6m	OLS 4.6m
8.0m	OLS 8.0m
9.0m	OLS 9.0m

GatewayWA

Perth Airport and Freight Access Project

Geotechnical Investigations

Existing and Planned Testing Locations

Area 6-2

Date Printed: 3/04/2013

0 10 20 30 40

Metres

1:1,125 (A3)

Coordinate System: Perth Coastal Grid 94 (PCG94)

Design (26 March 2013)

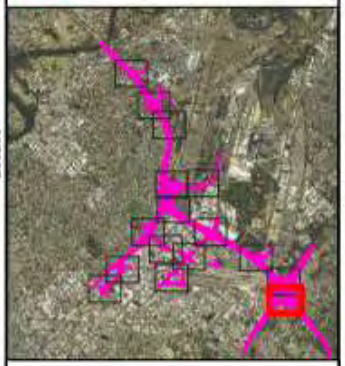
TESTING LOCATIONS

Phase A (Gateway Vision, 2011)

Phase B (Gateway WA Alliance, 2013)

- BH - Geotechnical Borehole
- BM - Geotechnical Borehole & Monitoring Well
- BP - Geotechnical Borehole & Pumping Well
- CP - Cone Penetrometer Test
- HA - Hand Auger (pavement)
- RA - Rotary Auger (pavement)
- SH - Soil Borehole (Environmental/ASS)
- SM - Soil Borehole Monitoring Well (Environmental/ASS)

GLIDE Surfaces	*OLS Surfaces*
4.4m	OLS 4.4m
4.6m	OLS 4.6m
8.0m	OLS 8.0m
9.0m	OLS 9.0m



GatewayWA

Perth Airport and Freight Access Project

APPENDIX C: GROUNDWATER BASELINE INVESTIGATION RESULTS

Area	BT	BT	HT	HT	HT	HT	LA	LA	LA	LA	LT	LT	LT	LT	LT	RT	RT
LocCode	SMd_BT003B	SMd_BT003B	BMd_HT001A	BMd_HT001A	BMd_HT001A	BMd_HT001A	BMd_LA001A	BMd_LA001A	BMd_LA001A	SMd_LA006B	BMd_LT001A	BMd_LT002A	BMd_LT002A	BMd_LT002A	BMd_LT002B	BMd_RT001A	BMd_RT001A
Sampled_Date-Time	21/02/2013	21/02/2013	7/02/2011	11/02/2011	20/02/2013	20/02/2013	7/02/2011	15/02/2011	19/02/2013	19/02/2013	1/03/2013	7/02/2011	11/02/2011	22/02/2013	20/02/2013	7/02/2011	15/02/2011

Chem_Group	ChemName	Units	EQL	DEC Fresh Waters															
	Alkalinity (M)	mg/L	1		35	34	-	-	-	-	-	-	-	-	-	-	-	-	-
	Acidity as CaCO3	mg/L	1		40	48	-	<1	32	30	-	8	45	32	20	-	11	24	25	-	5
Field	Electrical Conductivity (Field)	µS/cm			-	0.49	-	-	-	0.262	-	-	0.447	0.216	0.93	-	-	0.7	0.98	-	-
	Dissolved Oxygen (Field)	mg/L			-	0.15	-	-	-	0.43	-	-	1.1	0.33	3.98	-	-	0.12	0.2	-	-
	Temp (Field)	oC			-	19.3	-	-	-	22	-	-	22.9	20.8	20.1	-	-	20.7	23.1	-	-
	pH (Field)	pH Unit			-	5.52	-	-	-	4.7	-	-	5.47	4.9	7.38	-	-	6.05	6.88	-	-
Inorganics	Ionic Balance	%	0.01		2.39	3.59	-	0.06	4.41	5.83	-	5.62	6.03	-	5.77	-	3.33	1.06	3.98	-	10.2
	sulphide (as H2S)	µg/L	50		1500	-	-	-	<50	-	-	-	-	-	-	-	-	-	-	-	-
	Electrical conductivity *(lab)	µS/cm	1		484	483	221	228	239	238	472	501	411	184	1060	774	786	686	968	369	428
	Anions Total	meq/L	0.01		4.43	4.54	-	2.1	1.95	2.05	-	4.18	3.29	1.59	11.8	-	8.2	6.48	9.69	-	3.93
	Cations Total	meq/L	0.01		4.22	4.22	-	2.1	2.13	2.3	-	4.68	3.71	1.68	10.5	-	7.67	6.34	10.5	-	3.21
	Carbon Dioxide	mg/L	5		46	-	-	-	130	-	-	-	-	-	-	-	-	-	-	-	-
	Chloride	mg/L	1		116 - 120	122	38	41	44	44	60	64	51	30	172	154	155	168	173	48	59
	Kjeldahl Nitrogen Total	mg/L	0.1		3.1 - 4.9	3.2	-	2.7	<0.2 - 0.2	0.1	-	4.4	2.7	<0.1	1.4	-	0.4	0.4	0.4	-	0.1
	Sulphide	mg/L	0.1		0.7	<0.1	-	<0.1	<0.1	<0.1	-	<0.1	0.2	<0.1	<0.1	-	<0.1	0.9	<0.1	-	<0.1
	Total Dissolved Solids	mg/L	5		2300 - 7340	9980	-	710	220 - 352	355	-	349	277	365	628	-	496	456	617	-	260
	TSS	mg/L	1		2350 - 6600	2050	-	2060	8 - 47	8	-	20	<5	912	636	-	<5	<5	6	-	<5
	Turbidity	NTU	0.1		9200 - 9960	9200	-	-	198 - 230	203	-	-	0.7	713	582	-	-	3.9	20.3	-	-
	pH (Lab)	pH Unit	0.01		6.28 - 6.3	6.18	6.32	6.3	5.4 - 5.84	6.03	6.53	6.35	6.38	5.84	7.62	8.05	7.96	6.8	7.62	6.79	6.89
Nutrients	Ammonia as N	µg/L	10		540 - 760	700	20	30	<10 - 50	20	70	80	50	20	310	60	40	180	130	20	20
	Nitrogen (Total)	µg/L	100		3100 - 4900	3200	-	4000	1700 - 1800	1600	-	10,400	7800	<100	1400	-	1300	400	800	-	100
	Nitrate (as N)	mg/L	0.01	0.7[#1]	<0.01	0.01	-	-	1.55 - 1.7	1.51	-	-	5.12	<0.01	<0.01	-	-	0.01	0.37	-	-
	Nitrite (as N)	mg/L	0.01		<0.01	<0.01	-	-	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	-	-	<0.01	0.02	-	-
	Nitrogen (Total Oxidised)	mg/L	0.01		<0.01	0.01	-	1.29	1.55 - 1.7	1.51	-	6.02	5.12	<0.01	<0.01	-	0.94	0.01	0.39	-	0.01
	Phosphate total (P)	mg/L	0.05		0.16	-	-	-	<0.05	-	-	-	-	-	-	-	-	-	-	-	-
	Reactive Phosphorus as P	mg/L	0.01		<0.01 - 0.06	<0.01	-	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	0.12	-	2.18	0.03	5.55	-	<0.01
	Sulphate	mg/L	1		-	-	32	33	-	-	86	82	-	-	-	29	29	-	-	83	84
	Sulphate (Filtered)	mg/L	1		22	20	-	-	30	32	-	-	63	29	47	-	-	22	46	-	-
	Sulphate as S	mg/L	5		5.5	-	-	-	9.7	-	-	-	-	-	-	-	-	-	-	-	-
Alkalinity	Alkalinity (Bicarbonate as CaCO3)	mg/L	1		35 - 42	34	19	13	<20 - 4	7	37	34	27	7	298	160	161	64	193	24	27
	Alkalinity (Carbonate as CaCO3)	mg/L	1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Alkalinity (Hydroxide) as CaCO3	mg/L	1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Alkalinity (total) as CaCO3	mg/L	1		35 - 42	34	19	13	<20 - 4	7	37	34	27	7	298	160	161	64	193	24	27
	Hardness as CaCO3	mg/L	1		44 - 49	49	-	-	49 - 50	57	-	-	61	17	270	-	-	94	165	-	-
Metals	Aluminium	mg/L	0.01	0.055[#1]	172 - 190	182	-	110	1.8 - 3.46	2.16	-	0.21	0.02	7.12	3.91	-	1.1	0.1	0.22	-	<0.1
	Aluminium (Filtered)	mg/L	0.01	0.055[#1]	0.24 - 0.35	0.22	-	0.11	<0.01	<0.01	-	0.08	<0.01	0.02	0.03	-	0.02	0.04	0.03	-	<0.01
	Arsenic	mg/L	0.001	0.013[#1]	0.013 - 0.027	0.028	-	-	<0.001	<0.001	-	-	<0.001	<0.001	0.037	-	-	<0.001	0.003	-	-
	Arsenic (Filtered)	mg/L	0.001	0.013[#1]	<0.005 - 0.001	0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	0.002	-	0.001	<0.001	0.003	-	0.033
	Cadmium	mg/L	0.0001	0.0002[#1]	<0.001 - 0.0002	0.0002	-	-	<0.0001	<0.0001	-	-	<0.0001	<0.0001	0.0003	-	-	<0.0001	<0.0001	-	-
	Cadmium (Filtered)	mg/L	0.0001	0.0002[#1]	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001	-	0.0005
	Calcium	mg/L	0.5		4	-	-	-	2.2	-	-	-	-	-	-	-	-	-	-	-	-
	Calcium (Filtered)	mg/L	1		3	3	5	4	2	3	8	7	3	2	85	54	51	21	48	2	2
	Chromium (III+VI)	mg/L	0.001	0.01[#1]	0.51 - 0.578	0.613	-	-	0.002 - 0.004	0.002	-	-	<0.001	0.014	0.049	-	-	0.001	0.002	-	-
	Chromium (III+VI) (Filtered)	mg/L	0.001	0.01[#1]	<0.005 - 0.004	0.004	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	0.001	-	0.001	0.001	0.002	-	<0.001
	Copper	mg/L	0.001	0.0014[#1]	<0.005 - 0.006	0.006	-	-	<0.001	<0.001	-	-	<0.001	<0.001	0.05	-	-	<0.001	0.001	-	-
	Copper (Filtered)	mg/L	0.001	0.0014[#1]	<0.001	<0.001	-	-	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	-	-
	Iron	mg/L	0.05		30.3 - 31	33	-	4.7	0.14 - 0.27	0.18	-	0.84	0.77	2.71	13.9	-	0.68	1.46	2.95	-	1.84
	Iron (Filtered)	mg/L	0.05		0.46 - 0.56	0.55	-	0.09	<0.05	<0.05	-	0.63	0.62	0.1	1.21	-	0.3	1.37	2.96	-	1.49
	Lead	mg/L	0.001	0.0034[#1]	0.19 - 0.202	0.186	-	-	0.005 - 0.006	0.006	-	-	<0.001	0.006	0.027	-	-	<0.001	<0.001	-	-
	Lead (Filtered)	mg/L	0.001	0.0034[#1]	<0.001	<0.001	-	-	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	-	-
	Magnesium	mg/L	0.5		8.2	-	-	-	11	-	-	-	-	-	-	-	-	-	-	-	-
	Magnesium (Filtered)	mg/L	1		10	10	9	8	11	12	16	14	13	3	14	12	12	10	11	6	6
	Manganese	mg/L	0.001	1.9[#1]	0.03 - 0.034	0.037	-	-	0.007	0.007	-	-	0.023	0.004	0.704	-	-	0.265	0.66	-	-
	Manganese (Filtered)	mg/L	0.001	1.9[#1]	<0.025 - 0.008	0.008	-	0.03	0.007 - 0.008	0.007	-	0.145	0.02	0.013	0.437	-	0.138	0.262	0.674	-	0.07
	Mercury (Filtered)	mg/L	0.0001	0.00006[#1]	<0.0001	<0.0001	-	-	<0.0001	<0.0001	-	-	<0.0001	<0.0001	<0.0001	-	-	<0.0001	<0.0001	-	-
	Nickel	mg/L	0.001	0.011[#1]	0.036 - 0.046	0.042	-	-	<0.001	<0.001	-	-	<0.001	0.002	0.02	-	-	0.003	0.002	-	-
	Nickel (Filtered)	mg/L	0.001	0.011[#1]	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	0.002	<0.001	<0.001	0.005	-	0.002	0.003	0.002	-	0.001
	Phosphorus	mg/L	0.01		3.69	3.91	-	0.87	<0.01	<0.01	-	0.04	0.09	0.07	0.89	-	2.43	0.04	7.49	-	0.02
	Potassium	mg/L	0.5		2.2	-	-	-	2.5	-	-	-	-	-	-	-	-	-	-	-	-
	Potassium (Filtered)	mg/L	1		3	3	-	3	3	3	-	5	4	3	4	-	5	3	6	-	3
	Selenium	mg/L	0.001	0.005[#1]	<0.005 - 0.02	0.02	-	-	<0.01 - 0.001	<0.01	-	-	<0.01	<0.01	<0.01	-	-	<0.01	<0.01	-	-
	Selenium (Filtered)	mg/L	0.001	0.005[#1]	<0.005	<0.01	-	<0.01	<0.001	<0.01	-	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	-	<0.01
	Sodium	mg/L	0.5		65	-	-	-	22	-	-	-	-	-	-	-	-	-	-	-	-
	Sodium (Filtered)	mg/L	1		73	73	29	28	24	25	76	69	55	29	115	97	93	101	162	66	58
	Zinc	mg/L	0.001	0.008[#1]	0.02 - 0.069	0.072	-	-	<0.005 - 0.004	<0.005	-	-	0.008	0.014	0.116	-	-	<0.005	<0.005	-	-
	Zinc (Filtered)	mg/L	0.001	0.008[#1]	<0.005 - 0.013	<0.005	-	0.006	<0.005 - 0.003	<0.005	-	0.069	0.006	0.014	0.008	-	0.008	<0.005	0.007	-	0.026
ASS - Acidity Trail	TAA	µg/L	10000		55,000	-	-	-	50,000	-	-	-	-	-	-	-	-	-	-	-	-

Comments
#1 P.Chau

Area	RT
LocCode	SMd_RT009B
Sampled_Date-Time	20/02/2013

Chem_Group	ChemName	Units	EQL	DEC Fresh Waters	
	Alkalinity (M)	mg/L	1		-
	Acidity as CaCO3	mg/L	1		12
Field	Electrical Conductivity (Field)	µS/cm			0.398
	Dissolved Oxygen (Field)	mg/L			0.18
	Temp (Field)	oC			20.5
	pH (Field)	pH Unit			5.74
Inorganics	Ionic Balance	%	0.01		2.01
	sulphide (as H2S)	µg/L	50		-
	Electrical conductivity *(lab)	µS/cm	1		372
	Anions Total	meq/L	0.01		3.41
	Cations Total	meq/L	0.01		3.28
	Carbon Dioxide	mg/L	5		-
	Chloride	mg/L	1		70
	Kjeldahl Nitrogen Total	mg/L	0.1		<0.1
	Sulphide	mg/L	0.1		<0.1
	Total Dissolved Solids	mg/L	5		289
	TSS	mg/L	1		330
	Turbidity	NTU	0.1		195
	pH (Lab)	pH Unit	0.01		6.68
Nutrients	Ammonia as N	µg/L	10		50
	Nitrogen (Total)	µg/L	100		<100
	Nitrate (as N)	mg/L	0.01	0.7[#1]	<0.01
	Nitrite (as N)	mg/L	0.01		<0.01
	Nitrogen (Total Oxidised)	mg/L	0.01		<0.01
	Phosphate total (P)	mg/L	0.05		-
	Reactive Phosphorus as P	mg/L	0.01		<0.01
	Sulphate	mg/L	1		-
	Sulphate (Filtered)	mg/L	1		48
	Sulphate as S	mg/L	5		-
Alkalinity	Alkalinity (Bicarbonate as CaCO3)	mg/L	1		22
	Alkalinity (Carbonate as CaCO3)	mg/L	1		<1
	Alkalinity (Hydroxide) as CaCO3	mg/L	1		<1
	Alkalinity (total) as CaCO3	mg/L	1		22
	Hardness as CaCO3	mg/L	1		40
Metals	Aluminium	mg/L	0.01	0.055[#1]	3.6
	Aluminium (Filtered)	mg/L	0.01	0.055[#1]	<0.01
	Arsenic	mg/L	0.001	0.013[#1]	<0.001
	Arsenic (Filtered)	mg/L	0.001	0.013[#1]	<0.001
	Cadmium	mg/L	0.0001	0.0002[#1]	<0.0001
	Cadmium (Filtered)	mg/L	0.0001	0.0002[#1]	<0.0001
	Calcium	mg/L	0.5		-
	Calcium (Filtered)	mg/L	1		6
	Chromium (III+VI)	mg/L	0.001	0.01[#1]	0.012
	Chromium (III+VI) (Filtered)	mg/L	0.001	0.01[#1]	<0.001
	Copper	mg/L	0.001	0.0014[#1]	0.001
	Copper (Filtered)	mg/L	0.001	0.0014[#1]	<0.001
	Iron	mg/L	0.05		1.25
	Iron (Filtered)	mg/L	0.05		0.67
	Lead	mg/L	0.001	0.0034[#1]	0.028
	Lead (Filtered)	mg/L	0.001	0.0034[#1]	<0.001
	Magnesium	mg/L	0.5		-
	Magnesium (Filtered)	mg/L	1		6
	Manganese	mg/L	0.001	1.9[#1]	0.022
	Manganese (Filtered)	mg/L	0.001	1.9[#1]	0.02
	Mercury (Filtered)	mg/L	0.0001	0.00006[#1]	<0.0001
	Nickel	mg/L	0.001	0.011[#1]	0.002
	Nickel (Filtered)	mg/L	0.001	0.011[#1]	<0.001
	Phosphorus	mg/L	0.01		0.08
	Potassium	mg/L	0.5		-
	Potassium (Filtered)	mg/L	1		2
	Selenium	mg/L	0.001	0.005[#1]	<0.01
	Selenium (Filtered)	mg/L	0.001	0.005[#1]	<0.01
	Sodium	mg/L	0.5		-
	Sodium (Filtered)	mg/L	1		56
	Zinc	mg/L	0.001	0.008[#1]	0.015
	Zinc (Filtered)	mg/L	0.001	0.008[#1]	<0.005
ASS - Acidity Trail	TAA	ug/L	10000		-

Comments
#1 P.Chau

Area	AT	AT	AT	AT	BT	BT	BT	BT	HT	HT	HT	HT	HT	HT	LA	LA	LA	LA	LA
LocCode	SMs_AT003A	SMs_AT004B	SMs_AT005B	SMs_AT005B	SMd_BT003B	SMd_BT003B	SMs_BT002B	SMs_HT007B	SMs_HT009B	SMs_HT010B	SMs_HT011B	SMs_HT012B	SMs_HT013B	SMd_LA006B	SMs_LA004B	SMs_LA005B	SMs_LA007B	SMs_LA008B	
Sampled_Date-Time	11/02/2011	20/02/2013	19/02/2013	19/02/2013	21/02/2013	21/02/2013	21/02/2013	21/02/2013	20/02/2013	21/02/2013	20/02/2013	21/02/2013	20/02/2013	19/02/2013	20/02/2013	19/02/2013	19/02/2013	19/02/2013	

Chem_Group	ChemName	Units	EQL	DEC Fresh Waters																
	Alkalinity (M)	mg/L	1		-	-	-	-	35	34	24	340	-	225	-	61	-	-	-	-	-	-
	Acidity as CaCO3	mg/L	1		36 - 40	24	25	23	40	48	13	25	24	13	20	52	8	32	29	31	65	109
	N-Nitrosodiphenyl & Diphenylamine	µg/L	4		-	-	-	-	-	-	-	-	-	-	<4	-	-	-	-	-	-	-
	Pronamide	µg/L	2		-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-
Field	Electrical Conductivity (Field)	µS/cm			-	0.72	-	0.74	-	0.49	0.101	1.05	1.19	0.93	0.457	0.349	0.195	0.216	1.66	0.219	0.82	1.64
	Dissolved Oxygen (Field)	mg/L			-	10.25	-	0.25	-	0.15	0.16	3.08	6.37	11.11	7.48	0.21	4.59	0.33	3.29	2.65	0.17	0.15
	Temp (Field)	oC			-	12.3	-	22.4	-	19.3	24	17.9	14.4	15.9	26.3	23.7	21.7	20.8	23.1	21.9	23.3	22.3
	pH (Field)	pH Unit			-	6.84	-	7.24	-	5.52	5.83	7.01	7.44	7.35	6.4	5.99	5.65	4.9	6.86	5.94	6.1	6.24
Inorganics	Ionic Balance	%	0.01		1.1 - 3.22	2.83	2.87	1.31	2.39	3.59	-	0.47	0.51	0.44	2.2	1.74	-	-	4.68	-	1.36	2.08
	sulphide (as H2S)	µg/L	50		-	-	<50	-	1500	-	-	-	-	-	-	-	-	-	-	-	-	-
	Electrical conductivity *(lab)	µS/cm	1		380 - 385	534	683	676	484	483	85	976	971	816	426	322	172	184	1710	165	762	1580
	Anions Total	meq/L	0.01		3.57 - 4.07	5.56	7.31	7.04	4.43	4.54	0.87	10.3	11.4	8.42	3.98	3.39	1.29	1.59	18.3	1.46	7.52	17.1
	Cations Total	meq/L	0.01		3.49 - 3.82	5.88	6.91	6.86	4.22	4.22	0.91	10.2	11.3	8.35	4.16	3.27	1.62	1.68	16.6	1.65	7.31	16.4
	Carbon Dioxide	mg/L	5		-	-	26	-	46	-	-	-	-	-	-	-	-	-	-	-	-	-
	Chloride	mg/L	1		66 - 69	25	34 - 36	35	116 - 120	122	11	87	100	106	67	43	29	30	375	19	121	298
	Cyanide Total	mg/L	0.004	0.007[#1]	-	-	-	-	-	-	-	-	-	-	<0.004	-	-	-	-	-	-	-
	Kjeldahl Nitrogen Total	mg/L	0.1		3.9 - 4	2.6	<0.2 - 0.2	0.1	3.1 - 4.9	3.2	0.3	0.4	0.7	0.9	0.4	2.1	<0.5	<0.1	0.5	<0.1	0.7	1.1
	Sulphide	mg/L	0.1		<0.1	<0.1	<0.1	<0.1	0.7	<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
	Total Dissolved Solids	mg/L	5		1930 - 1950	383	380 - 488	508	2300 - 7340	9980	279	603	708	650	350	394	222	365	1080	112	628	1130
	TSS	mg/L	1		590 - 715	1800	67 - 100	580	2350 - 6600	2050	102	174	18	538	292	620	80	912	1150	726	350	142
	Turbidity	NTU	0.1		-	5410	79.2 - 140	876	9200 - 9960	9200	367	62.4	12.7	299	366	501	128	713	1360	361	1800	173
	pH (Lab)	pH Unit	0.01		6.93 - 7.17	7.68	7.3 - 7.73	7.6	6.28 - 6.3	6.18	6.68	7.56	7.97	7.79	7.07	6.54	6.55	5.84	7.55	6.48	6.55	6.84
Nutrients	Ammonia as N	µg/L	10		510 - 540	50	130 - 160	160	540 - 760	700	100	260	150	250	120	610	30	20	30	20	470	810
	Nitrogen (Total)	µg/L	100		3900 - 4000	10,500	<200 - 200	100	3100 - 4900	3200	300	400	700	900	800	2100	4000	<100	600	200	700	1100
	Nitrate (as N)	mg/L	0.01	0.7[#1]	-	7.93	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	0.01	0.36	<0.02	4	<0.01	0.13	0.18	0.02	0.02
	Nitrite (as N)	mg/L	0.01		-	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Nitrogen (Total Oxidised)	mg/L	0.01		0.01	7.94	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	0.01	0.38	<0.02	4	<0.01	0.13	0.18	0.02	0.02
	Phosphate total (P)	mg/L	0.05		-	-	<0.05	-	0.16	-	-	-	-	-	-	-	-	-	-	-	-	-
	Reactive Phosphorus as P	mg/L	0.01		<0.01	<0.01	<0.01	<0.01	<0.01 - 0.06	<0.01	0.08	<0.01	0.09	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.04	0.08
	Sulphate	mg/L	1		19 - 22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Sulphate (Filtered)	mg/L	1		-	40	50	45	22	20	4	51	60	45	35	46	18	29	160	32	126	116
	Sulphate as S	mg/L	5		-	-	14	-	5.5	-	-	-	-	-	-	-	-	-	-	-	-	-
Alkalinity	Alkalinity (Bicarbonate as CaCO3)	mg/L	1		66 - 82	173	260 - 266	256	35 - 42	34	24	340	368	225	68	61	5	7	218	13	74	316
	Alkalinity (Carbonate as CaCO3)	mg/L	1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Alkalinity (Hydroxide) as CaCO3	mg/L	1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Alkalinity (total) as CaCO3	mg/L	1		66 - 82	173	260 - 266	256	35 - 42	34	24	340	368	225	68	61	5	7	218	13	74	316
	Hardness as CaCO3	mg/L	1		-	226	227 - 240	225	44 - 49	49	23	325	411	174	106	97	32	17	342	43	192	365
Metals	Aluminium	mg/L	0.01	0.055[#1]	45.2 - 48.7	65.6	2.1 - 2.16	2.86	172 - 190	182	6.39	3.08	0.25	4.42	2.4	8.01	1.99	7.12	36.6	5.65	10.5	1.86
	Aluminium (Filtered)	mg/L	0.01	0.055[#1]	0.13 - 0.17	0.02	<0.05 - 0.1	<0.01	0.24 - 0.35	0.22	0.27	0.02	<0.01	0.04	<0.01	0.53	<0.01	0.02	<0.01	<0.01	1.15	0.03
	Arsenic	mg/L	0.001	0.013[#1]	-	0.008	0.001 - 0.002	0.001	0.013 - 0.027	0.028	0.001	<0.001	0.004	0.005	0.006	0.002	<0.001	<0.001	0.001	<0.001	0.003	0.015
	Arsenic (Filtered)	mg/L	0.001	0.013[#1]	0.002	<0.001	<0.001 - 0.001	0.001	<0.005 - 0.001	0.001	0.001	<0.001	0.005	0.005	0.004	0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.017
	Cadmium	mg/L	0.0001	0.0002[#1]	-	<0.0001	<0.0001	<0.0001	<0.001 - 0.0002	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Cadmium (Filtered)	mg/L	0.0001	0.0002[#1]	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Calcium	mg/L	0.5		-	-	70	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-
	Calcium (Filtered)	mg/L	1		15 - 17	74	63	62	3	3	6	56	79	35	16	19	3	2	99	4	54	100
	Chromium (III+VI)	mg/L	0.001	0.01[#1]	-	0.077	0.005	0.006	0.51 - 0.578	0.613	0.007	0.01	<0.001	0.024	0.003	0.009	0.003	0.014	0.045	0.009	0.022	0.003
	Chromium (III+VI) (Filtered)	mg/L	0.001	0.01[#1]	0.002	<0.001	<0.001	<0.001	<0.005 - 0.004	0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001
	Copper	mg/L	0.001	0.0014[#1]	-	0.018	<0.001	<0.001	<0.005 - 0.006	0.006	<0.001	0.001	<0.001	0.006	0.003	0.001	<0.001	<0.001	0.004	<0.001	0.001	<0.001
	Copper (Filtered)	mg/L	0.001	0.0014[#1]	-	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001
	Iron	mg/L	0.05		13.3 - 14.2	11.8	2.62 - 4.4	2.68	30.3 - 31	33	1.35	2.84	0.56	5.99	4.65	2.67	0.54	2.71	4.51	0.92	3.31	9.46
	Iron (Filtered)	mg/L	0.05		0.59 - 0.72	<0.05	1.86 - 2.3	1.95	0.46 - 0.56	0.55	1.12	0.4	0.16	1.15	1.94	1.56	<0.05	0.1	<0.05	0.41	0.65	8.38
	Lead	mg/L	0.001	0.0034[#1]	-	0.114	0.002	0.002	0.19 - 0.202	0.186	0.011	0.008	<0.001	0.021	0.005	0.025	0.002	0.006	0.017	0.01	0.081	0.003
	Lead (Filtered)	mg/L	0.001	0.0034[#1]	-	<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	0.002	<0.001
	Magnesium	mg/L	0.5		-	-	16	-	8.2	-	-	-	-	-	-	-	-	-	-	-	-	-
	Magnesium (Filtered)	mg/L	1		10	10	17	17	10	10	2	45	52	21	16	12	6	3	23	8	14	28
	Manganese	mg/L	0.001	1.9[#1]	-	0.017	0.024	0.023	0.03 - 0.034	0.037	0.005	0.015	0.015	0.046	0.026	0.008	0.011	0.004	0.012	0.012	0.044	0.085
	Manganese (Filtered)	mg/L	0.001	1.9[#1]	0.267 - 0.276	0.007	0.022 - 0.024	0.022	<0.025 - 0.008	0.008	0.004	0.012	0.013	0.038	0.021	0.007	0.008	0.013	0.007	0.011	0.025	0.082
	Mercury (Filtered)	mg/L	0.0001	0.00006[#1]	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Nickel	mg/L	0.001	0.011[#1]	-	0.021	<0.001	<0.001	0.036 - 0.046	0.042	0.001	0.003	0.003	0.008	0.002	0.002	0.002	0.002	0.011	0.002	0.016	0.001
	Nickel (Filtered)	mg/L	0.001	0.011[#1]	0.012	0.002	<0.001 - 0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.003	0.005	0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.011	<0.001
	Phosphorus	mg/L	0.01		0.45 - 0.51	3.55	0.04	0.04	3.69	3.91	0.14	0.03	0.09	0.08	0.07	0.09	0.4	0.07	0.67	0.09	0.33	0.71
	Potassium	mg/L	0.5		-	-	3	-	2.2	-	-	-	-	-	-	-	-	-	-	-	-	-
	Potassium (Filtered)	mg/L	1		5 - 6	4	4	4	3	3	2	11	5	7	5	3	6	3	9	2	13	19
	Selenium	mg/L	0.001	0.005[#1]	-	<0.01	<0.001	<0.01	<0.005 - 0.02	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Selenium (Filtered)	mg/L	0.001	0.005[#1]	<0.01	<0.01	<0.001	<0.01	<0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Sodium	mg/L	0.5		-	-	46	-	65	-	-	-	-	-	-	-	-	-	-	-	-	-
	Sodium (Filtered)	mg/L	1		42 - 45	29	52	52	73	73	9	79	68	108	44	29	19	29	220	17	72	199
	Zinc	mg/L	0.001	0.008[#1]	-	0.103	0.005 - 0.006	0.006	0.02 - 0.069	0.072	<0.005	<0.005	<0.005	<0.005	0.022	0.01	0.009	0.014	0.032	0.019	0.014	8.23
	Zinc (Filtered)	mg/L	0.001	0.008[#1]	<0.005	0.018	0.003 - 0.008	<0.005	<0.005 - 0.013	<0.005	<0.005	0.006	0.011	0.014	0.012	0.009	0.008	0.014	0.009	0.026	0.005	<0.005
ASS - Acidity Trail	TAA	µg/L	10000		-	-	30,000	-	55,000	-	-	-	-	-	-	-	-	-	-	-	-	-

Comments
#1 P.Chau

Area	LA	LA	LT	LT	LT	RT	RT	RT	RT			
LocCode	SMs_LA009B	SMs_LA010B	BMs_LT001B	BMs_LT003A	SMs_LT002B	SMd_RT009B	SMs_RT008B	SMs_RT015B	SMs_RT016B	SWB_DubsCloseBasin	SWB_HudswellRdTN	SWB_RunwaySwamp
Sampled_Date-Time	19/02/2013	19/02/2013	20/02/2013	22/02/2013	19/02/2013	20/02/2013	20/02/2013	1/03/2013	20/02/2013	15/02/2013	15/02/2013	26/02/2013

Chem_Group	ChemName	Units	EQL	DEC Fresh Waters											
	Alkalinity (M)	mg/L	1		-	-	-	-	-	-	-	-	-	-	-	-
	Acidity as CaCO3	mg/L	1		19	25	17	16 - 22	28	12	31	-	25	5	7	<1
	N-Nitrosodiphenyl & Diphenylamine	µg/L	4		-	-	-	-	-	-	-	-	-	-	-	-
	Pronamide	µg/L	2		-	-	-	-	-	-	-	-	-	-	-	-
Field	Electrical Conductivity (Field)	µS/cm			0.6	0.85	0.79	0.71	0.55	0.398	0.448	0.81	1.19	-	-	10.94
	Dissolved Oxygen (Field)	mg/L			3.26	4.15	0.1	1.08	2.57	0.18	6.89	2.78	7.48	-	-	0.13
	Temp (Field)	oC			22.1	23.3	22.6	20.7	21.4	20.5	22.4	22.2	26.9	-	-	22.9
	pH (Field)	pH Unit			6.21	5.69	7.29	6.54	5.73	5.74	5.62	7.94	6.68	-	-	8.72
Inorganics	Ionic Balance	%	0.01		1.54	1.08	1.56	0.53 - 0.75	0.12	2.01	2.93	-	1.71	1.87	3.64	3.77
	sulphide (as H2S)	µg/L	50		-	-	-	-	-	-	-	-	-	-	-	-
	Electrical conductivity *(lab)	µS/cm	1		557	807	772	721 - 729	524	372	420	-	1160	700	1750	13,700
	Anions Total	meq/L	0.01		5.12	7.63	7.63	6.51	4.7	3.41	3.87	-	11.6	6.79	16.7	144
	Cations Total	meq/L	0.01		5.28	7.47	7.87	6.58 - 6.61	4.68	3.28	4.1	-	12	7.05	18	134
	Carbon Dioxide	mg/L	5		-	-	-	-	-	-	-	-	-	-	-	-
	Chloride	mg/L	1		98	226	116	141 - 144	110	70	64	-	181	105	440	4160
	Cyanide Total	mg/L	0.004	0.007[#1]	-	-	-	-	-	-	-	-	-	-	-	-
	Kjeldahl Nitrogen Total	mg/L	0.1		0.2	0.1	0.3	0.6 - 1	0.6	<0.1	<0.1	-	0.7	3	1.3	13.2
	Sulphide	mg/L	0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.1	-	-	<0.1
	Total Dissolved Solids	mg/L	5		384	496	500	430 - 453	463	289	279	-	735	470	1100	9100
	TSS	mg/L	1		1020	436	<5	22	280	330	14	-	460	28	<5	130
	Turbidity	NTU	0.1		424	279	5.8	13.4 - 15.3	1540	195	10.3	-	1320	16.6	5.2	75
	pH (Lab)	pH Unit	0.01		6.87	6.39	7.87	7.12 - 7.26	6.43	6.68	6.66	-	7.49	8.23	8.09	8.52
Nutrients	Ammonia as N	µg/L	10		80	20	180	10	40	50	80	-	90	160	100	70
	Nitrogen (Total)	µg/L	100		1700	2000	300	4200 - 4800	2300	<100	<100	-	2200	3000	1300	13,200
	Nitrate (as N)	mg/L	0.01	0.7[#1]	1.46	1.94	<0.01	3.64 - 3.77	1.67	<0.01	0.01	-	1.48	<0.01	<0.01	<0.01
	Nitrite (as N)	mg/L	0.01		0.08	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	-	0.04	<0.01	<0.01	<0.01
	Nitrogen (Total Oxidised)	mg/L	0.01		1.54	1.94	<0.01	3.65 - 3.78	1.67	<0.01	0.01	-	1.52	<0.01	<0.01	<0.01
	Phosphate total (P)	mg/L	0.05		-	-	-	-	-	-	-	-	-	-	-	-
	Reactive Phosphorus as P	mg/L	0.01		<0.01	<0.01	0.15	0.05	<0.01	<0.01	<0.01	-	<0.01	0.37	0.15	<0.01
	Sulphate	mg/L	1		-	-	-	-	-	-	-	-	-	-	-	-
	Sulphate (Filtered)	mg/L	1		72	40	<5	16 - 18	40	48	76	-	190	19	32	596
	Sulphate as S	mg/L	5		-	-	-	-	-	-	-	-	-	-	-	-
Alkalinity	Alkalinity (Bicarbonate as CaCO3)	mg/L	1		43	21	218	106 - 108	38	22	24	-	129	172	183	660
	Alkalinity (Carbonate as CaCO3)	mg/L	1		<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	77
	Alkalinity (Hydroxide) as CaCO3	mg/L	1		<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	<1
	Alkalinity (total) as CaCO3	mg/L	1		43	21	218	106 - 108	38	22	24	-	129	172	183	738
	Hardness as CaCO3	mg/L	1		83	106	233	165	101	40	142	-	326	166	278	1720
Metals	Aluminium	mg/L	0.01	0.055[#1]	6.34	5.35	0.02	0.04 - 0.06	6.83	3.6	0.23	-	4.14	0.04	<0.01	1.72
	Aluminium (Filtered)	mg/L	0.01	0.055[#1]	0.03	<0.01	0.02	<0.01	0.04	<0.01	<0.01	-	0.1	0.02	<0.01	0.7
	Arsenic	mg/L	0.001	0.013[#1]	<0.001	<0.001	0.001	<0.001 - 0.001	<0.001	<0.001	<0.001	-	0.002	<0.001	0.003	0.011
	Arsenic (Filtered)	mg/L	0.001	0.013[#1]	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	0.002	0.011
	Cadmium	mg/L	0.0001	0.0002[#1]	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001	<0.0001
	Cadmium (Filtered)	mg/L	0.0001	0.0002[#1]	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001	<0.0001
	Calcium	mg/L	0.5		-	-	-	-	-	-	-	-	-	-	-	-
	Calcium (Filtered)	mg/L	1		10	8	80	53	14	6	4	-	73	50	57	186
	Chromium (III+VI)	mg/L	0.001	0.01[#1]	0.031	0.012	<0.001	<0.001	0.012	0.012	<0.001	-	0.012	<0.001	<0.001	0.006
	Chromium (III+VI) (Filtered)	mg/L	0.001	0.01[#1]	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	0.006
	Copper	mg/L	0.001	0.0014[#1]	0.002	<0.001	<0.001	<0.001 - 0.001	<0.001	0.001	<0.001	-	0.003	0.002	<0.001	0.008
	Copper (Filtered)	mg/L	0.001	0.0014[#1]	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	0.002	0.002	<0.001	0.006
	Iron	mg/L	0.05		1.11	0.69	4.96	0.1 - 0.16	0.65	1.25	2.58	-	1.59	0.59	1.1	1.8
	Iron (Filtered)	mg/L	0.05		0.13	0.07	4.77	<0.05	0.73	0.67	2.52	-	0.46	0.06	0.26	1.26
	Lead	mg/L	0.001	0.0034[#1]	0.006	0.002	<0.001	<0.001	0.006	0.028	<0.001	-	0.036	<0.001	<0.001	0.006
	Lead (Filtered)	mg/L	0.001	0.0034[#1]	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	0.006
	Magnesium	mg/L	0.5		-	-	-	-	-	-	-	-	-	-	-	-
	Magnesium (Filtered)	mg/L	1		14	21	8	8	16	6	32	-	35	10	33	305
	Manganese	mg/L	0.001	1.9[#1]	0.013	0.016	0.487	0.016	0.013	0.022	0.012	-	0.03	0.035	0.039	0.06
	Manganese (Filtered)	mg/L	0.001	1.9[#1]	0.008	0.017	0.49	0.013	0.003	0.02	0.012	-	0.026	0.001	<0.001	0.059
	Mercury (Filtered)	mg/L	0.0001	0.00006[#1]	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001	<0.0001
	Nickel	mg/L	0.001	0.011[#1]	0.002	0.002	<0.001	<0.001 - 0.005	0.002	0.002	0.002	-	0.008	0.002	<0.001	0.011
	Nickel (Filtered)	mg/L	0.001	0.011[#1]	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	0.002	-	0.008	0.001	<0.001	0.008
	Phosphorus	mg/L	0.01		0.06	0.06	0.15	0.08	0.39	0.08	<0.01	-	0.1	0.9	0.3	0.33
	Potassium	mg/L	0.5		-	-	-	-	-	-	-	-	-	-	-	-
	Potassium (Filtered)	mg/L	1		6	3	5	4 - 5	4	2	2	-	5	32	12	70
	Selenium	mg/L	0.001	0.005[#1]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01
	Selenium (Filtered)	mg/L	0.001	0.005[#1]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01
	Sodium	mg/L	0.5		-	-	-	-	-	-	-	-	-	-	-	-
	Sodium (Filtered)	mg/L	1		80	121	71	73	59	56	28	-	124	67	279	2250
	Zinc	mg/L	0.001	0.008[#1]	0.033	0.039	<0.005	0.016 - 0.018	0.016	0.015	<0.005	-	0.027	0.018	0.007	0.02
	Zinc (Filtered)	mg/L	0.001	0.008[#1]	0.011	0.046	0.018	0.019	<0.005	<0.005	0.006	-	0.017	0.006	<0.005	0.021
ASS - Acidity Trail	TAA	µg/L	10000		-	-	-	-	-	-	-	-	-	-	-	-

Comments
#1 P.Chau

APPENDIX D: PROJECT SURFACE WATER AND GROUNDWATER COMPLIANCE TABLE

Aspect	Document	Commitment	Section
Surface Water and Wetlands	Public Environmental Review Document	A Hydrology and Wetlands Management Plan will be developed.	This Document
		Direct Impacts to Wetlands will be minimised as far as possible.	Sections 7.2-7.4
		Main Roads WA will work with Westralia Airports Corporation to provide opportunities for the successful implementation of the 'Living Stream' plans for WAC land in the Project area.	Not addressed in this document
		The road design will incorporate drainage structures to ensure no direct discharge of road run-off to wetlands or to a 50 m wetland buffer area.	Section 7.3
		Water quality monitoring will be undertaken to determine baseline water quality of Runway Swamp.	Section 7.3
		Existing natural drainage paths and drainage channels will not be unnecessarily blocked or restricted. Any material that is found to block drainage will be removed immediately.	Section 7.3
		Hydrocarbons will not be stored within 50 m of a wetland or drainage line.	Section 7.3
		No refuelling will take place within 50 m of a wetland or drainage line.	Section 7.3
		Road verges and batters will be revegetated to minimised runoff and erosion.	Section 7.3
	Construction Environmental Management Plan	No physical damage to wetlands beyond a maximum of 5 m from the edge of earthworks unless no other means of access or required, or for safety reasons.	Section 7.3
		No significant change in wetland hydrography including groundwater levels, or the period of inundation of adjacent monitored wetlands, not attributed to rainfall during the construction period.	Section 5.2 and Section 7.3

Aspect	Document	Commitment	Section
		During construction, no significant change to baseline water quality of adjacent monitored wetlands attributed to construction (parameters determined in the Environmental Monitoring Plan).	Section 7.3
		Generally, detailed drainage includes the capacity of retaining 20,000 L in areas adjacent to wetlands in order to prevent contamination of wetlands during a traffic incident involving large volumes of hazardous goods. The design will also allow for the first 16 mm of rainfall to be collected for infiltration in drainage basins/swales or for treatment within a pollution treatment device.	Section 3
		Baseline information will be collected at nominated wetlands adjacent to the works, including Runway Swamp. Baseline information may also be collected at reference sites situated further away from the works. Baseline information will include both water quality and wetland levels.	Section 7.3
		No more than 16 ha of wetlands will be permanently impacted on Perth Airport land.	Section 7.3
		There shall be no direct discharge of road run-off into permanently protected wetlands (those outside the Project impact footprint). This could be achieved by: - Kerbing or constructing swales - Draining road run-off to median and roadside swales or detention/infiltration basins - Installing terminal drainage blocks at end of swales to ensure retention/infiltration prior to overland sheet flow - Ensuring no direct drainage connection between the median and adjacent wetland areas - Vegetating roadside swales (will slow water flow and provide for biological	Section 7.4

Aspect	Document	Commitment	Section
		infiltration).	
		A ‘no-go’ map will be provided for each construction zone. These will indicate all sensitive environmental areas.	Section 7.3
		Construction shall be undertaken in accordance with detailed design plans, including: - installing of fences to minimise risk of accidental impact on all permanently protected (adjacent) wetlands - installing erosion/scour control measures - minimise native vegetation clearing. Such controls should be installed in conjunction with surrounding drainage works, and should not be installed at a later date, potentially leading to impacts during this period.	Section 7.3
		The diversion of any open drains will be avoided during construction wherever possible.	Section 7.4
		No evidence of surface water damming against side of highway, during and immediately after construction.	Section 7.3
		Road run-off shall be infiltrated at source where possible.	Section 7.4
		No acidification of groundwater or surface water attributed to the construction works.	Section 6.2
		Erosion controls shall be applied at permanent discharge points.	Section 7.4
		The taking of other water, such as that from nearby evaporation ponds, will only be undertaken on the advice of the Environmental Manager.	Section 4.7
		Stormwater management shall be designed and implemented wherever relevant on road construction areas, within lay down areas and at offices with the aim to prevent	Section 7.4

Aspect	Document	Commitment	Section
		direct run-off into nearby permanently protected wetlands as well as other sensitive areas (Precinct 5, IOCZ, and threatened flora, communities and fauna habitats). Stormwater management will include the use of low bunds, silt fencing, bales or other erosion and siltation prevention equipment where necessary.	
		Stockpiles which shall be left onsite for more than a day during May – September and more than five days during October – March, will be bunded where necessary to minimise the amount of run-off entering environmentally sensitive areas. Stockpiles will not be placed within 15 m of a drainage pit.	Section 7.3
		Wash down bay water will be discharged at least 50 m from Conservation Category or Resource Enhancement wetlands, Precinct 5, IOCZ, areas of threatened flora or communities.	Section 7.3
		Wash down of vehicles and plant will not occur except in designated areas such as the wash down bays.	Section 7.3
		Wash down of concrete trucks, apart from the truck chute, will not be washed down on site. Concrete water from the chute wash down will be confined onsite and removed once hardened. It will not be released into vegetated areas.	Section 7.3
		Existing natural drainage paths and drainage channels will not be unnecessarily blocked or restricted. Any material that is found to block drainage will be removed immediately	Section 7.3
		Soft landscaping works shall occur as soon as practicable in the sequence of works.	Not addressed in this document
	Surface and Groundwater Management Plan	Water will not be disposed of to the stormwater system unless it is an emergency situation.	Section 7.4

Aspect	Document	Commitment	Section
Dewatering	Public Environmental Review Document	Should groundwater extraction be required for road construction, groundwater levels and water quality will be monitored to determine impacts associated with ASS or groundwater draws down.	Section 5 and Section 6
	Construction Environmental Management Plan	A Dewatering Management Plan will be developed and implemented. This shall include the management and monitoring (quality and groundwater levels) requirements during all dewatering works onsite and shall be approved by the Department of Water.	This document
		Dewatering (taking groundwater), including bore abstraction, will be undertaken in accordance with a Licence to Take water as approved by the Department of Water as required under the *Rights in Water and Irrigation Act 1914.*	Section 4
	Surface and Groundwater Management Plan	Recharge water will be treated prior to reinjection.	Section 4.6
		Groundwater level monitoring will be completed using manually dipped open hole piezometers and pressure sensor piezometers (e.g. vibrating wire piezometers) which automatically record water levels or activate alarms in the event of high or low water levels.	Section 5.2
		Extracted water will be treated to prevent environmental impacts and to make it suitable for site use.	Section 4.6
		Water flow rates and pressures will be measured at well heads during start-up of the recharge bore(s) to provide baseline readings. The baseline readings will be compared to subsequent readings (trends) during groundwater recharge to evaluate well and aquifer efficiencies (clogging).	Section 5.2
		Quality of recharge water will be monitored to prevent contamination of aquifers.	Section 6
		Under normal operations, the water treatment system will remove iron, TSS and adjust pH to reduce the risk of aquifer and well clogging. Should monitoring of	Section 4.6

Aspect	Document	Commitment	Section
		nuisance parameters (iron, TSS and pH) exceed the above trigger levels, management responses will be adopted.	
ASS	Construction Environmental Management Plan	Investigations of the project area will be undertaken to determine if an ASS Management Plan will need to be developed. If so, it shall be approved by DEC and implemented during construction.	Not covered in this document
Induction	Construction Environmental Management Plan	The induction program shall include information regarding the conservation of wetlands, potential impacts to surface and groundwater quality as well as the management actions outlined in this table.	Not covered in this document

APPENDIX E: GATEWAY WA DEWATERING PERMIT

DEWATERING PERMIT

Number:	GWA-
Revision:	A
Date:	10/04/2013

Permit number:	

Project engineer:		**Date of submission:**	
Project zone:		**Proposed start date:**	

Proposed works

Dewatering is to be carried out in accordance with the project zone's Dewatering Management Plan and Surface & Groundwater Management Plan. **Append to this permit a map** showing (most data are available on GWA Web Viewer):

- Area to be dewatered;
- Location of treatment tanks/ponds and of disposal/infiltration points/ponds;
- Nearby stormwater drainage lines and conservation category wetlands;
- Nearby groundwater bores (Department of Water, private, GWA monitoring & production)

Current GWL:		**Target GWL:**		**Estimated flow rate[m^3/day]:**	
Treatment methods:	*e.g. "dewatering effluent will be stored in an overhead tank where it will be neutralised at a rate of..."*				
Disposal methods:	*e.g. "an infiltration basin will be constructed..."*				
Additional comments					

Comments and approval

Environment representative comments

Approved by:		**Signature:**		**Date:**	

Construction representative comments

Approved by:		**Signature:**		**Date:**	

Monitoring Supervisor

When required, the appointed dewatering contractor should report water level and quality data weekly to Gateway WA:

- Daily monitoring of field-measured pH and Total Titratable Acidity of dewatering effluent prior to disposal/infiltration;
- Daily monitoring of field-measured pH and Total Titratable Acidity of minimum two closest GWA monitoring wells;
- Ongoing monitoring of groundwater levels in dewatering area and surrounds.

A full list of contractor responsibilities and monitoring guidelines is contained in the project area's Dewatering Management Plan.

Supervisor/Sponsor:		**Phone:**	

DEWATERING PERMIT

Monitoring requirement during dewatering operations	Daily Results							
	Day:	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**
	Date:							
Dewatering discharge rate	*[L/s]*							
Dewatered volume	*[kL]*							
Dewatering effluent (inlet to treatment system)	*TTA [mg/L $CaCO_3$]*							
	pH							
Dewatering effluent (outlet from treatment system)	*TTA [mg/L $CaCO_3$]*							
	pH							
Quantity of neutralising agent used	*[L] or[kL] or [bags]*							
Comment on integrity of infiltration ponds	-							
Groundwater Monitoring Location 1	Groundwater level [mBTOC]							
Bore ID:	*TTA [mg/L $CaCO_3$]*							
	pH							
Groundwater Monitoring Location 2	Groundwater level [mBTOC]							
Bore ID:	*TTA [mg/L $CaCO_3$]*							
	pH							

DEWATERING EFFLUENT MANAGEMENT FLOWCHART

Responsibilities | **Actions, triggers and responses**

DEWATERING CONTRACTOR / GATEWAY WA CONSTRUCTION

Complete Gateway WA dewatering permit and submit to Gateway WA Environment who will determine whether monitoring is required, generally if:

- **Dewatering schedule longer than 7 days; and/or**
- **Expected radius of influence greater than 50 m; and/or**
- **Site presents ASS, soil or groundwater contamination risk**

No monitoring required

Proceed with dewatering. Advise Gateway WA Environment of any changes to dewatering scope/schedule.

DEWATERING CONTRACTOR / GATEWAY WA CONSTRUCTION

Dewatering monitoring required

GATEWAY WA ENVIRONMENT

Daily field measurements on effluent and minimum two nearby groundwater wells:

- Discharge rate and volume
- Groundwater levels
- pH, TTA and EC

Record and report results to Gateway WA Environment on a weekly basis who will advise the necessary actions as follows:

pH > 6 and TTA < 40 mg/L

DEWATERING CONTRACTOR / GATEWAY WA CONSTRUCTION

Continue daily monitoring

GATEWAY WA ENVIRONMENT

Fortnightly lab analysis:

- pH
- Total Acidity
- Total Alkalinity

4 < pH < 6 and TTA < 40 mg/L

DEWATERING CONTRACTOR / GATEWAY WA CONSTRUCTION

Effluent to be treated via:

1. a lime dosing unit;
2. settlement tank/pond (with geofabric);
3. infiltration pond

Continue daily monitoring

GATEWAY WA ENVIRONMENT

Fortnightly lab analysis:

- pH
- Total Acidity
- Total Alkalinity

pH > 6 and 40 < TTA < 100 mg/L

DEWATERING CONTRACTOR / GATEWAY WA CONSTRUCTION

Effluent to be treated via:

1. a lime dosing unit;
2. settlement tank/pond (with geofabric);
3. infiltration pond

Continue daily monitoring

GATEWAY WA ENVIRONMENT

Weekly laboratory analysis:

- pH
- Total Acidity
- Total Alkalinity

Detailed fortnightly field and laboratory analyses required on dewater effluent

pH < 4 and/or TTA > 100 mg/L

Advise DEC immediately as dewatering may be required to stop

DEWATERING CONTRACTOR / GATEWAY WA CONSTRUCTION

Effluent to be treated via:

1. a lime dosing unit;
2. settlement tank/pond (with geofabric);
3. infiltration pond

Increase liming rate

Continue daily monitoring

GATEWAY WA ENVIRONMENT

Detailed weekly laboratory analyses and fortnightly field measurements required on dewater effluent:

- pH
- Total Acidity
- Total Alkalinity
- DO
- ORP

GATEWAY WA ENVIRONMENT

Sampling, analysis, classification & disposal of settlement tank/pond sediments

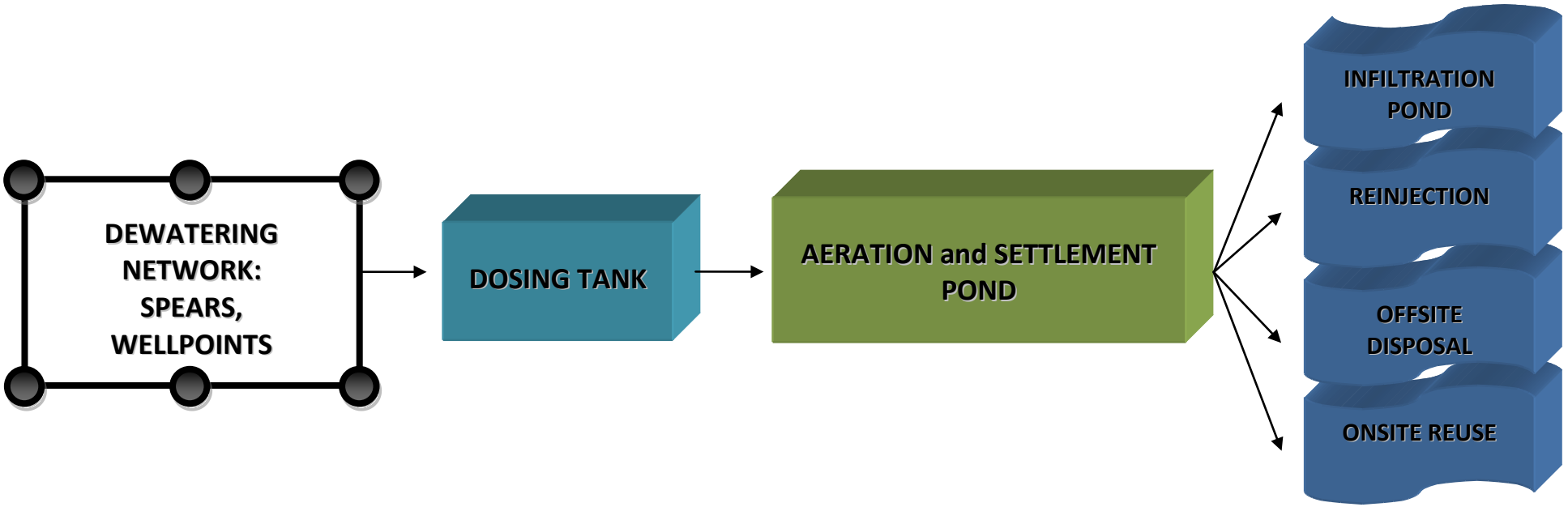
Completion of dewatering program

Post dewatering groundwater monitoring

GATEWAY WA ENVIRONMENT

Closure reporting

APPENDIX F: TYPICAL DEWATERING EFFLUENT TREATMENT AND DISPOSAL SCHEMATIC


DEWATERING NETWORK: SPEARS, WELLPOINTS
DOSING TANK
AERATION and SETTLEMENT POND
INFILTRATION POND
REINJECTION
OFFSITE DISPOSAL
ONSITE REUSE