ALS Environmental

Surrogate Control Limits

- No surrogates present on this report.

ALS Environmental

QUALITY CONTROL REPORT

Client	:	**GHD SERVICES PTY LTD**	**Laboratory**	: ALS Environmental Brisbane	**Page**	:	**1 of 6**
Contact	:	MS DANIELLE ROGERS	**Contact**	: Michael Heery			
Address	:	PO BOX 5403 NEWCASTLE WEST NSW AUSTRALIA 2302	**Address**	: 32 Shand Street Stafford QLD Australia 4053	**Work order**	:	**EB0609847**
					Amendment No.	:	
Project	:	221280801 Land Use Strategy	**Quote number**	: EN/005/05	**Date received**	:	5 Oct 2006
Order number	:	2290731			**Date issued**	:	19 Oct 2006
C-O-C number	:	- Not provided -					
Site	:	Williamtown					
E-mail	:	danielle.rogers@ghd.com.au	**E-mail**	: services.brisbane@alsenviro.com	**No. of samples**		
Telephone	:	02 4979 9959	**Telephone**	: +61 (07) 3243 7222	**Received**	:	10
Facsimile	:	02 4979 9988	**Facsimile**	: +61 (07) 3243 7259	**Analysed**	:	10

This final report for the ALSE work order reference EB0609847 supersedes any previous reports with this reference.

Results apply to the samples as submitted. All pages of this report have been checked and approved for release.

This report contains the following information:

- Laboratory Duplicates (DUP); Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Samples (LCS); Recovery and Acceptance Limits
- Matrix Spikes (MS); Recovery and Acceptance Limits

Work order specific comments

Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime (CaCO3) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. Conversion to liming rate in kg/m3 = kg/t x wet bulk density in t/m3.
Retained Acidity not required because pH KCl greater than or equal to 4.5
Excess ANC not required because pH OX less than 6.5.

ALSE - Excellence in Analytical Testing

NATA
WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory - 825

This document is issued in accordance with NATA's accreditation requirements.

Accredited for compliance with ISO/IED 17025

This document has been electronically signed by those names that appear on this report and are the authorised signatories. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatory	Department
Cass Sealby	Inorganics - NATA 825 (818 - Brisbane)

ALS Environmental

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Signatory	Department
Cass Sealby	Inorganics - NATA 825 (818 - Brisbane)

ALS Environmental

Matrix Type: SOIL

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EA029-E: Magnesium Values - continued						
EA029-E: Magnesium Values - (QC Lot: 286298) - continued				% Mg	% Mg	%
EB0609847-001	BH3 0.5-0.6	KCl Extractable Magnesium (23Sm)	0.02 % Mg	<0.02	<0.02	0.0
		Peroxide Magnesium (23Tm)	0.02 % Mg	<0.02	<0.02	0.0
		Acid Reacted Magnesium (23U)	0.02 % Mg	<0.02	<0.02	0.0
		Acidity - Acid Reacted Magnesium (a-23U)	10 mole H+ / t	<10	<10	0.0
		sulfidic - Acid Reacted Magnesium (s-23U)	0.02 % S	<0.02	<0.02	0.0

ALS Environmental

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results		Recovery Limits	
			Spike concentration	Spike Recovery	Dynamic Recovery Limits	
				LCS	Low	High
EA029-E: Magnesium Values - continued						
EA029-E: Magnesium Values - (QC Lot: 286298) - continued		% Mg	% Mg	%	%	%
Peroxide Magnesium (23Tm)	0.02 % Mg	<0.02	----	----	----	----
sulfidic - Acid Reacted Magnesium (s-23U)	0.02 % S	<0.02	----	----	----	----

Chain Of Custody - Record

F.TP6E.1.1

JOB No: 22128080l
Project Name: Land Use Strategy - Stage 2
Location: Williamtown
Lab: ALS - Newcastle

Sampled By: Chris Roach
Project Contact: Danielle Rogers
Results Required By:
(danielle.rogers@ghd.com.au)

Sheet 1 of 1

Laboratory ID No.	LM Sample ID	Matrix: Soil/Sed.	Matrix: Water	Containers: Glass jar	Containers: 1 litre Poly	Containers: 1-litre amber	Containers: VOA	Containers: Plastic Bag	Preservation: None	Preservation: Ice Sampled Frozen	Preservation: Acid	Sampling: Date	Analyses Required: SPOCAS suite
(1)	BH3 0.5-0.6												
(2)	BH5 0.4-0.5												
(3)	BH5 1.1-1.2												
(4)	BH6 1.0-1.1												
(5)	BH7 1.0-1.15												
(6)	BH7 2.0-2.25												
(7)	BH8 0.8-0.9												
(8)	BH8 1.7-1.8												
(9)	BH9 1.2-1.3												
(10)	BH9 1.65-1.75												

ALS Environmental
Brisbane
Work Order
EB0609847
Telephone : +61 (07) 3243 7222

CHAIN OF CUSTODY RECORD

RELEASED BY: (signature)	date/time	RECEIVED BY: (signature)	date/time
A Rogers	3:43 3/10/06	Nichole Jones NJ	3:43 3/10/06
RELEASED BY: (signature)	date/time	RECEIVED BY: (signature)	date/time
Nichole Jones NJ	4:10:06 4pm	Kyle Arthurs	5/10/06
RELEASED BY: (signature)	date/time	RECEIVED BY: (signature)	date/time

Notes-
Samples frozen immediately following fieldwork.

GHD-LONGMAC
57 Herbert St, Artarmon NSW 2064
Locked Bag 2727, St Leonards 1590
pH : 94624700 Fax : 9462 4710

352 King St, Newcastle
Ph: 49799959

Appendix D

Characteristics of ASS

Characteristics of ASS

Soils rich in pyrite or the products of pyrite oxidation are commonly known as ASS. The natural oxidation of these soils can occur when pyrite is exposed to oxygen during declines in relative sea level, prolonged drought, resuspension of reduced sediments, and changes in tidal regimes. Human activities can, however, greatly accelerate pyrite oxidation through the lowering of coastal water tables, reduction of tidal flushing, alterations to surface drainage, dredging and excavation in coastal zones.

The generalised reaction for pyrite oxidation often documented in the literature shows that one mole of oxidised pyrite yields ferric hydroxide and two moles of dissolved sulfuric acid:

$$FeS_{2(s)} + \frac{15}{4} O_{2(g)} + \frac{7}{2} H_2O_{(aq)} \rightarrow Fe(OH)_{3(s)} + 2\ H_2SO_{4(aq)}$$

Several secondary reactions are also known to occur producing further acidity, which can significantly lower soil and water pH, often below pH 3. These low pH conditions readily mobilise toxic metals, such cadmium, arsenic, manganese and aluminium, held within the soil matrix, and can result in the formation of minerals, such as jarosite.

Pyrite typically forms under anaerobic conditions when there is a readily available supply of decomposable organic matter, reducing microbes, sulfate, usually from seawater, and a source of iron, usually derived from sediments. The majority of coastal pyrite was formed in estuarine lowlands and embayments, less than 5 m AHD, between 6000 to 10 000 years ago following the last major sea level rise. ASS are also known to occur in coastal plains where they are often overlain by alluvial deposits.

When left undisturbed, these soils are relatively benign and are indistinguishable from other reduced sedimentary deposits. In this state these soils are generally referred to as Potential Acid Sulfate Soils (PASS). The characteristics of PASS include:

- The presence of waterlogged soils - unripe muds (soft, buttery, blue grey or dark greenish grey) or estuarine silty sands or sands (mid to dark grey);
- Presence of reduced sulphur odours;
- Presence of shells; and
- Soil pH usually neutral but may be acidic.

Once these reduced soils are disturbed and exposed pyrite oxidises to produce enough acidity to exceed the soil's neutralising capacity these soils are termed Actual Acid Sulfate Soils (AASS). The characteristics of AASS include:

- Soil pH less than or equal to 4;
- Presence of shells; and
- Jarosite horizons (pale yellow mineral deposit, product of the incomplete oxidation of pyrite) and/or substantial iron oxide mottling (orange to red secondary mineral deposit, formed from the oxidation and precipitation of mobilised iron).

Major effects of poorly managed AASS include impacts on aquatic ecosystems, disruption of plant physiological processes and health risks for animals and humans. These soils can also negatively impact concrete and steel components of structures, pipelines, and other engineering works.

The characteristics of water that has been affected by acid generated from AASS include:

- A pH of less than 5;
- Low alkalinity concentrations;
- Unusually clear or milky blue-green colour;
- Possible white precipitates (aluminium hydroxides) floating on the surface; and
- Extensive orange to red iron stains, flocculates or bacteria slicks.

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	D Rogers	S Gray		K Blackmore	K. Blackmore	17/08/07

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Department of Planning

Defence and Airport Related Employment Zone Williamtown
Land Use Development Strategy
Hydrology, Flooding and Drainage Assessment

October 2007

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

Contents

Table Index

Figure Index

Appendices

1. Introduction

GHD have been commissioned by the Department of Planning to undertake the RAAF Base Willliamtown/Airport Employment Zone Land Use Development Strategy. Stage 1 of the project was the Site Selection Report, July 2006 (Document Ref. 22/12808/71988). The second stage of the project was the detailed investigations into the Selected Site to determine the land capability and suitability for the use of the subject land as an employment zone. These investigations found there were significant constraints to development in relation to flooding and soil stability and consequently the original study area needed to be reviewed.

This revised report is a technical report on hydrology, flooding and drainage issues in support of the Land Use and Development Strategy Part B – Land Capability and Suitability Assessment. The report involved consultation with the Hunter Water Corporation (HWC), the Department of Water and Energy (DWE) and the Port Stephens Council (PSC). The Hunter Water Corporation (HWC) provided advice in relation to water quality requirements, aquifer interference and protection of water quality. The DWE were approached for advice in respect to the Department's requirements in relation to flooding and stormwater. PSC were consulted for advice in respect to preliminary planning input into the proposed development and for the Council's requirements for the proposed development in relation to both flooding and stormwater management.

2. Existing Flow Characteristics

The flood and drainage behaviour of the Williamtown/Salt Ash catchment was investigated in the WBM Williamtown Salt Ash Flood Study (April 2005). This study examined the Windeyers Creek, Moors drain, Tilligerry Creek, Fullerton Cove and the Hunter River, providing a regional investigation of the flood characteristics of this area. Part of this study generated Design Flood Maps that indicate the extent and level of flooding that would result from a number of scenarios. The various scenarios include local catchment rainfall, tidal effects and flooding from the Hunter River with the break out occurring south of Raymond Terrace. These design flood maps were reviewed to allow for a determination of flow direction over the site.

A variety of available contour data was used to establish a GIS model from which the flow direction and flow paths were determined. The flow paths ascertained from the flood maps and GIS were then compared. This comparison found that both methods produced the same general flow direction and paths.

Figure 1 demonstrates the flow paths and areas mapped as flood prone throughout the site and surrounds. The figure also indicates that flows to the north of Cabbage Tree Road generally traverse from west to east with the area to the north west of Cabbage Tree and Nelson Bay Roads being inundated on a regular basis. Giving consideration specifically to local catchment rainfall, the area of inundation for minor events is only marginally less than that expected for the larger storm event.

To the east of Nelson Bay Road, flows generally traverse in a southerly direction and eventuate at Fullerton Cove. The area of inundation resulting from local catchment rainfall is only marginally less for a minor event than it is for a major event. Examination of the Flood Depth and Water Velocity maps generated as part of the Williamtown Salt Ash Flood Study indicate that for the 100 year storm event the flow velocities generally range from between 0.1m/s and 0.3m/s with some localised areas generating velocities up to 0.6m/s. The corresponding flow depths at these locations range from between 0.25m and approximately 0.5m with a maximum of 0.75m.

Consideration of the worst case of 0.6m/s at 0.75m depth, the velocity/depth product was determined to be 0.45m^2/s. The limit for this product is generally nominated as 0.4m^2/s for safety purposes with an upper limit of 0.6m^2/s also being considered acceptable in 100 year storm events. This implies that under the existing flooding conditions there are no significant safety issues.

The Site is subjected to regular inundation and has a number of flow paths that are not generally well defined. Provided allowance is made for the inclusion of defined flow paths, select placement of fill could be undertaken to create areas for buildings while maintaining flow paths and existing flood conditions.

With consideration given to the above findings, the limitations placed on the development of the site in respect to flooding are minimal. While the area is subjected to regular inundation, the placement of fill required to achieve the desired flood-free floor level, could be done in such a manner as to have negligible impact on the existing flooding conditions.

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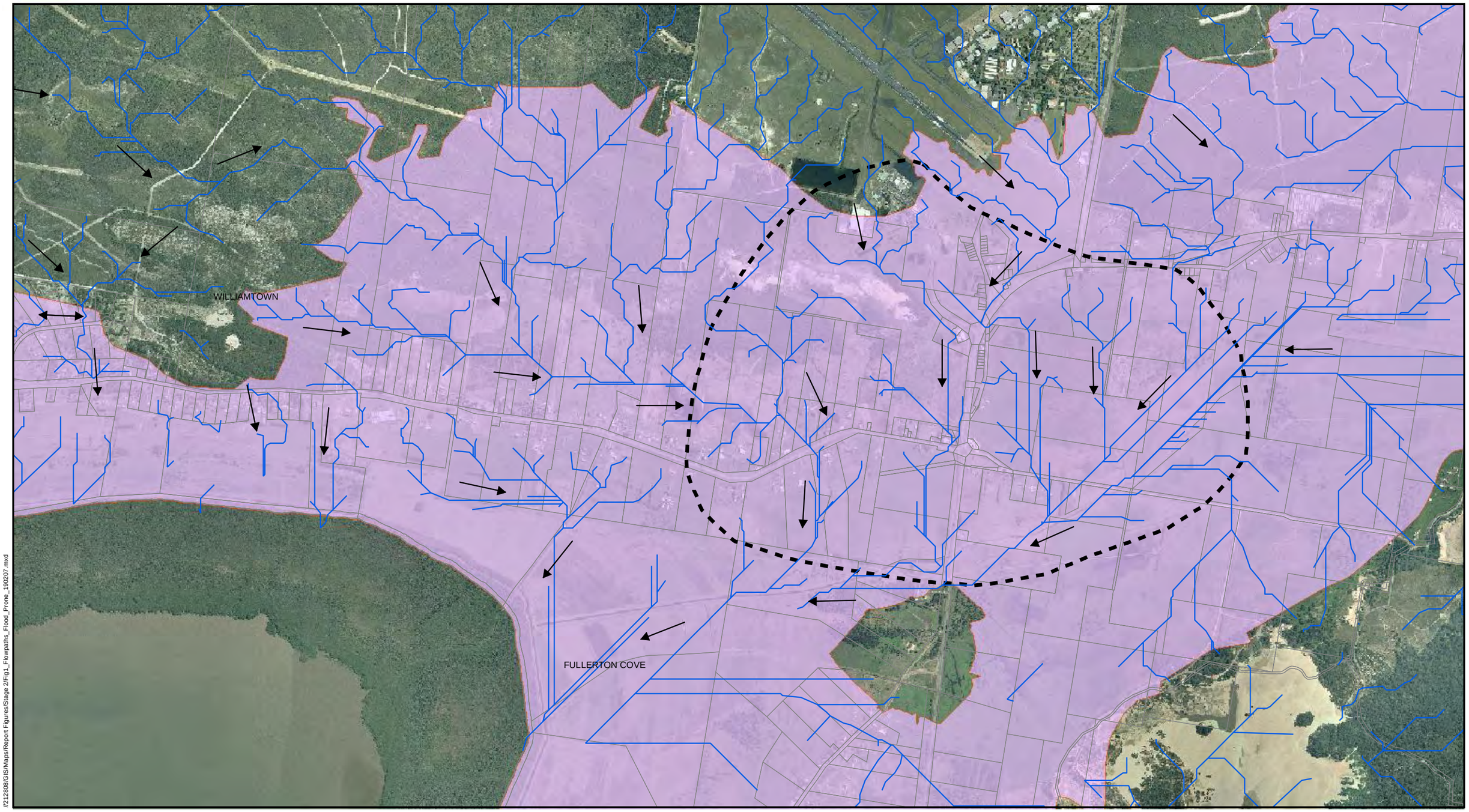

I:\212808\GIS\Maps\Report Figures\Stage 2\Fig1_Flowpaths_Flood_Prone_190207.mxd

1:20,000

0 100 200 400 600 800

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

GRID
N

LEGEND

Study Area **Flow Paths** **Flood Prone Area** Cadastre

Spatial layers courtesy of Department of Lands, Port Stephens Council, DEC

19 February 2007

Flow Paths & Flood Prone Areas

Williamtown Employment Zone - Stage 2

Figure 1

3. Stakeholder Consultation

3.1 Port Stephens Council

GHD provided Port Stephens Council (PSC) with a letter for preliminary planning input into the proposed development. We subsequently followed this letter with a phone call to Wal Mills, Council's representative for this project. From these discussions it was determined that Council's requirements for the proposed development are as follows:

- Undertake a site specific flood investigation that augments the regional flood study performed by WBM. It would be expected that this flood investigation should address:
  - The existing flood conditions for the site and adjacent properties;
  - The proposed flood conditions for the developed site and the potential impacts to the adjacent properties; and
  - The required pad levels and finished floor levels for the development based on PSC's development requirements and the flood study.
- Develop a Stormwater Management Plan that complies with PSC's stormwater code and addresses the requirements of the Department of Water and Energy (DWE) as defined under its jurisdiction.

3.2 Department of Water and Energy

Consultation with the DWE, then Department of Natural Resources, lead to advice requesting that a number of issues be considered and addressed as part of the investigation. The areas of interest are summarised below with detailed requirements for flooding and stormwater included.

- Flood Management – The flood management is primarily the responsibility of Local Government and that as part of the State Governments Flood Policy there will be a requirement to demonstrate that the intended use will not exacerbate local flooding and that the proposed development will be designed in expectation of flooding;
- Groundwater Management – The proposal should provide the following details with respect to groundwater management:
  - A description of the existing groundwater system and include geologic details and aquifer systems;
  - Identification of any potential changes to the existing groundwater source and any dependant users including the environment;
  - Management of potential impacts and preparation of contingency measures. Management may include remediation, reduction and management of the groundwater resource with respect to all the users of the resource;
  - Identification of any potential groundwater works including bores, geotechnical testing or monitoring; and
  - Addressing the principals outlined in the NSW State Groundwater Policy Framework.

Where there is a lack of scientific certainty on the impacts of the development on the groundwater regime, DWE will adopt a precautionary principal.

3.3 Hunter Water

Hunter Water provided advice in relation to water quality. The HWC require stormwater and surface runoff from any proposed development be managed in such a way as to ensure it does not impact on the quality of the groundwater. This would include the appropriate interception and treatment of stormwater, including the first flush containment. HWC advise that they would like an opportunity to comment on the Stormwater Management Plan for the proposed employment zone.

4. Flooding and Stormwater Drainage Requirements

The Site is being considered for development as a Defence and Airport Related Employment area. It has been mapped as being flood prone land by Port Stephens Council and has poorly defined drainage paths. The requirements for the proposed development include minimising the potential adverse upstream and downstream flooding impacts resulting from the proposed development.

4.1 Flood Requirements

PSC require a detailed flood investigation for the development area be conducted. Advice from Council has indicated that the WBM study was conducted as a regional assessment and provides Council with a base on which to provide flood advice. Council have advised GHD that a detailed assessment of the area will be required to determine the current flood levels of the development area as well as any potential flooding impacts with respect to the adjoining properties. Under the State Governments Flood Policy, any proponent is required to demonstrate that the proposed development will not exacerbate local flooding.

4.2 Mitigation of Flooding and Drainage Issues

The entire Site is subject to flooding, with low-lying areas that are subject to inundation and ponding of water that can take some time to subside. The Site also has weak drainage paths, which contribute to the issues relating to flooding and drainage. The Council sets flood requirements that include the provision of pad levels and finished floor levels (FFL) to protect property and life from the effects of flood.

4.2.1 Lower Lands Constraints

GHD obtained the WBM TUFLOW flood model previously developed for the Williamtown Salt Ash Flood Study. The proposed Defence and Airport Related Employment Zone (DAREZ) site lies within this area and as such the existing TUFLOW model was amended to determine the potential impacts of the development.

The initial investigation focused on the Stage 1 Selected Site adjacent to Cabbage Tree Road and determined that if this area were to be filled to provide lots above the preliminary 100 year flood level, the natural drainage lines would need to be maintained. It was further noted that these drainage lines could be realigned to suit the proposed development layout.

Despite maintaining the existing drainage lines through the development site there was still an increase in flood level, in the order of 300mm, within the properties to the west of the development. Options for the widening of the existing channel along with the upgrade of the culverts crossing Cabbage Tree Road were then considered. It was found that these upgrades would still result in an increase in flood level of approximately 100mm within the properties to the west of the development.

Subsequently a review of the level of fill within the development was considered and through consultation with PSC, this level was nominated as the 50 year flood level rather than the 100 year level. The amount of flood storage removed from the development area as a direct result of filling is therefore reduced. The impact of this is a flood level increase within the adjacent properties of approximately 70mm in comparison to the original 300mm.

4.2.2 Higher Lands Constraints

With the identification of development limitations for the land fronting Cabbage Tree Road, the potential to develop an extension to the northern portion of the site adjacent to Newcastle Airport was then assessed. A review of the WBM Williamtown Flood Study Design Flood Maps indicated that a large proportion of this area is generally free from inundation for all events up to and including the 100 year storm. However the Design Flood Maps also indicated that the western and eastern extents of this area are inundated for these storms and consist of a combination of floodway, flood storage and flood fringe areas.

With consideration given to the contributing catchments and a review of the flow characteristics, it is considered unlikely that the incorporation of fill in these areas would have a significant impact on the flood levels within the adjacent properties provided sufficient drainage infrastructure is put in place within the development site thereby maintaining the existing flow regimes.

4.3 Sewerage Facilities

Given the sensitivity of the area with regard to the underlying aquifer, Hunter Water stipulate that sewerage facilities provided would need to be such that sewage will be either taken off site (ie pump-out system) or pumped to an existing Hunter Water sewerage system. Our preference would be for the development to be connected to the HWC sewerage system. The developer would need to discuss with Hunter Water, the volume of flows that will be expected from the development and a nominated point of connection could then be provided subject to a capacity review.

The development will need to provide connection to the sewerage system and the Development Control Framework should specifically identify that on-site disposal is not permissible. This is consistent with Hunter Water's approach to new developments within the Special Areas.

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WILLIAMTOWN RAAF BASE

Access Road
Drain
Drain
Drain
Drain
Drain
Access Road
NELSON BAY ROAD
CABBAGE TREE ROAD
Existing Culvert
Existing Culvert
0.5%
4.0
3.0
2.0
1.0

G:\22\12808\GIS\MAPS\Report Figures\Stage 2\FIG2_Lot_Grading_120207.MXD

1:7,000

0 35 70 140 210 280

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

GRID N

Legend

Cadastre
Boundary
Major Contour
Minor Contour
Lot Grading
0.5%

Note: Figure for Illustrative Purposes Only. Lot Grading and Fill Levels Subject to Stage 3 Investigation

12th February 2007

Proposed Lot Levels and Grading

Williamtown Employment Zone - Stage 2

Figure 2

5. Groundwater

5.1 Groundwater

Two major drains pass through the Site, Moors Drain located within the eastern half of the Site and Dawsons Drain located within the western half of the Site. Moors Drain drains most of the stormwater from Newcastle Airport facilities and surrounding land, and parts of the southeastern end of the aircraft runway. Stormwater runoff from this catchment flows via a series of channels and pipes to Medowie Rd, into a culvert under Medowie Rd that flows to Tilligerry Creek. Dawsons Drain drains the southwestern corner of the RAAF Base, which comprises mostly of open grassed areas. Runoff from the catchment discharges into the open drain downstream of Lake Cochran, which flows into Dawson's Drain and then to Fullerton Cove. It is considered that both these drains intercept groundwater during a number of months during the year.

5.1.1 Surface Water

The Department of Defence has been undertaking monthly water quality at Dawsons Drain since 2003 as part of the Surface Water Monitoring Program at RAAF Williamtown (WLM). A summary of water quality data collected from the drain is provided in Table 1.

Table 1 Summary of Dawsons Drain Surface Water Quality Parameters

Parameter	units	Mean ± Standard Deviation
pH	pH	6.37±0.58
Beryllium	µg/L	<1[(a)]
Copper	µg/L	<1[(a)]
Lead	µg/L	<1[(a)]
Manganese	µg/L	14±18
Mercury	µg/L	<1[(a)]
Silver	µg/L	<1[(a)]
Total Petroleum Hydrocarbons C_9-C_{36}	µg/L	<220[(a)]
Benzene, toluene, chlorobenzene, ethylbenzene, xylene	µg/L	<2[(a)]
Phenols	µg/L	<2[(a)]
Polycyclic Aromatic Hydrocarbons	µg/L	<1[(a)]
Organochlorine Pesticides	µg/L	<0.01[(a)]

Parameter	units	Mean ± Standard Deviation
Ammonia as N	µg/L	40±38[(b)]
Nitrate as N	µg/L	19±26[(b)]
Total Nitrogen as N	µg/L	411±167[(b)]
Total Phosphorous as P	µg/L	17±24[(b)]
Biological Oxygen Demand	µg/L	4,538±4,768[(b)]
Suspended Soilds	µg/L	8,905±18,798[(b)]
Faecal Coliforms	CFU/100mL	49±197[(b)]

(a) >80% of reported values were less than the laboratory practical quantifiable limit (PQL).

(b) Where < 80% of results were reported < laboratory PQL, <PQL results were halved for calculating means.

5.1.2 Groundwater Levels

Groundwater levels at the Site are expected to range between 0 and 3 m AHD, with the highest groundwater levels coinciding with the highest period of rainfall between the months of January and June (Wooley et al., 1995; GHD, 2006). Some lowering of the groundwater via drainage channels located within the Site is expected to occur. However the degree to which this occurs has not been yet been determined.

5.1.3 Groundwater Flow

Groundwater flow directions from the Site are to the southeast to southwest towards the lowlands of the Tilligerry Valley (Woolley et al., 1995). The closest Hunter Water Corporation Pump Stations, PS5, PS7, PS9 and PS23, are located a few kilometres to the north of the study Site. Pumping at these stations is not expected to effect groundwater levels at the Site given the distance of these borefields to the Site.

5.1.4 Water Quality

The soils in the northern part of the Site are dominated by permeable sands, which are highly vulnerable to contamination. This part of the site falls within a gazetted HWC Special Area, which is a gazetted area of land that is intended to represent the catchment area of Hunter Water's drinking water sources. The Hunter Water (Special Areas) Regulation 2003 imposes controls on intensive agriculture, sewage disposal, and the bringing of potential pollutants within gazetted Special Areas. Special care will need to be undertaken to ensure groundwater and surface water in this area is not subject to pollution.

The Department of Defence have been monitoring groundwater quality within the northern part of the Site in the vicinity of their Sewage Treatment Facility since 1999. Groundwater in this portion of the Site is fresh (TDS < 500 mg/L) and moderately acidic. A summary of selected groundwater quality parameters for the Northern portion of the Site is provided in Table 2.

Table 2 Summary of Groundwater Quality Parameters for the Northern Section of the Site (Defence Supplied Data)

Parameter	units	Mean ± Standard Deviation
pH	pH units	5.77±0.40
EC	μS/cm	261±113
Aluminium	μg/L	0.6±0.3
Antimony	μg/L	<0.001[(a)]
Arsenic	μg/L	<0.001[(a)]
Beryllium	μg/L	<0.001[(a)]
Cadmium	μg/L	<0.0001[(a)]
Chromium	μg/L	0.003±0.006[(b)]
Copper	μg/L	<0.001[(a)]
Lead	μg/L	<0.001[(a)]
Manganese	μg/L	0.04±0.03[(b)]
Mercury	μg/L	<0.0001[(a)]
Nickel	μg/L	0.001±0.001[(b)]
Silver	μg/L	<0.001[(a)]
Zinc	μg/L	0.03±0.05[(b)]
Total Petroleum Hydrocarbons C_{10}-C_{36}	μg/L	<200[(a)]
Benzene, toluene, chlorobenzene, ethylbenzene, xylene	μg/L	<2[(a)]
Ammonia as N	μg/L	0.80±0.80[(b)]
Total Phosphorous as P	μg/L	0.20±0.33[(b)]

(a) >80% of reported values were less than the laboratory practical quantifiable limit.

(b) Where < 80% of results were reported < laboratory PQL, <PQL results were halved for calculating means.

The southern half of the Site is primarily comprised of poorly-drained waterlogged soils and dark muds with high ASS potential, which are part of the Tilligerry Valley separating the Stockton and Tomago sand ridges. This valley forms part of a remnant tidal waterway that once extended along the Stockton Dune Ridge from Fullerton Cove to Tilligerry Creek (Woolley et al., 1995). Unlike the more northern portions of the site and the rest of the Tomago sandbeds, soils along the Tilligerry Valley are expected to have low infiltration rates, and are less susceptible to contamination.

Groundwater located within this valley is also known to be highly saline (TDS > 5,000 mg/L), unlike the drinking water resources of the Tomago aquifer and the northern sections of the study Site (DLWC, 1996). The lowering of watertables, drainage or excavation of ASS within the southern part of the Site is unlikely to impact the Drinking Water resources as water is expected to discharge to the low-lying Tilligerry Valley, but could impact upon run-off surface water quality.

A summary of groundwater data collected from within the Tilligerry Valley is provided in Table 3.

Table 3 Summary of Groundwater Data for the Tilligerry Valley (NA = Not available).

Bore ID	AMG Northing	AMG Easting	RL Surface (m AHD)	Base of Aquifer (m AHD)	Aquifer Thickness (m)	Water Level (m AHD)	Date Sampled	Sample Depth (m)	pH	Fe (mg/L)	Cl (mg/L)	EC (µs/cm)	Source
SK6348	6367886	392966	2.09	-39.4	41.5	0.82	4/03/80	10	6.2	38.50	3800	NA	Viswanathan, 1983; GHD, 1995
								25	6.0	58.00	4400	NA	
								40	6.1	33.00	5400	NA	
						1.59	29/10/03	2 to 40	NA	NA	NA	>18 850	HWC
SK6438	6370703	397184	0.63	-24.9	25.6	-0.77	4/03/08	6.5	6.6	20.50	7000	NA	Viswanathan, 1983; GHD, 1995
								15.5	6.6	20.50	10 000	NA	
								26	6.6	21.50	10 300	NA	
						0.00	29/10/03	6 to 26	NA	NA	NA	>1730	HWC
SK6439	6369220	395156	1.20	-27.0	28.2	-0.64	4/03/80	7	6.8	15.50	6100	NA	Viswanathan, 1983; GHD, 1995
								27	6.8	17.00	6300	NA	
								53	6.8	17.00	6300	NA	

6. Development and Potential Adverse Impacts

The site selected for development in the first stage of this project, required a significant amount of fill along with realignment and better definition of the existing drainage paths. This area may still be developed in the future, however the revised study area is not anticipated to require fill to such a significant extent. To assist in the stormwater management of the development it will be necessary to ensure each lot retains stormwater on site for water quality and quantity management. The Development Control Framework will need to clarify what stormwater requirements each developer will need to adhere to. This is to be carried out in the subsequent stage of this project.

The potential adverse impacts relate to the quality, quantity and speed of water arriving onto and leaving from the site. Effects to be considered are also any impacts on the flood characteristics of the site and on the adjoining lands.

The quality of drainage water leaving the site is to be controlled through on-site drainage detention basins. The quantity of water arriving onto and leaving the site will also be controlled through this method.

The limitations placed on the development of the site in respect to flooding are minimal. While the area is subjected to regular inundation, the placement of fill required to achieve the desired flood–free floor level, could be done in such a manner as to have nil impacts on the existing flooding conditions.

7. Stormwater Quantity Requirements

Based on previous Port Stephens Council industrial developments within the Tomago Aquifer, it is expected that individual allotments will be required to provide on-lot water quantity management. The common areas of the development, including the road reserves would be treated within a regional facility. The type of treatment requirements for both the on lot and regional facilities are detailed below.

7.1 Allotment Stormwater Quantity Requirements

To minimise the impacts of the proposal on adjacent lands, it is important that the:

- Annual stormwater volume discharged from the site is comparable to the equivalent existing values; and
- Peak flow rate for all peak ARI storm events is comparable to the equivalent existing flows from the site.

Based on this the allotment strategy would involve two separate components, one to maintain the volume of stormwater and one to reduce the peak flows from the site.

7.1.1 Maintain Annual Volume

Development within the area would increase the area of imperviousness of the existing catchment. This increase subsequently reduces the infiltration capacity of the area, increasing the amount of rainfall that would run off the site. To prevent this increase in volume, allotment strategies could include capture and on-site reuse in accordance with the Department of Environment and Climate Change (DECC) stormwater reuse guidelines or infiltration back into the groundwater after suitable treatment.

The sizing of such structures will be strongly dependant on the type of development and the area of imperviousness for each site and would be subject to individual allotment assessments.

7.1.2 Maintain Peak Flows

The development of each lot would be required to maintain the effective 10 to 100 year ARI peak flow rates from the site. This could be achieved through an underground or aboveground detention system that limits flow off the site. The configuration of this system would be subject to the lot size and the percentage of imperviousness of each lot.

7.2 Road Reserve Stormwater Quantity Requirements

The road reserve stormwater quantity could be attenuated through roadside infiltration tanks and end of line structures where the waterways discharge from the site. These structures could act as both an infiltration area and a means for peak flow detention. This would treat both the annual quantity and peak flow rates from the road reserve. The general size of these devices could be minimised and located within the road reserve reducing land take, as it would be treating only a minor portion of the catchment.

7.3 Stormwater and Surface Runoff Management

HWC expects that appropriate stormwater planning measures be undertaken to ensure any runoff into the surrounding sandbeds does not impact upon the quality of the groundwater. This would include appropriate interception and treatment of stormwater, including first flush containment. Any release of stormwater into the sandbeds should be treated to meet the protected waters criteria identified in clause 8 of the *NSW Clean Waters Regulation 1972.* In the event that these regulations are repealed the appropriate water quality criteria shall be identified in the ANZECC water quality guidelines for fresh and marine waters.

8. Stormwater Quality Requirements

8.1 Allotment Stormwater Quality Requirements

It is assumed that each allotment would be required to treat stormwater so that it does not adversely impact on the quality of the groundwater and it achieves the discharge criteria set out by DWE and HWC. This could involve each lot providing structures to remove and collect litter, sediments, nutrients and hydrocarbons.

8.2 Road Reserve Stormwater Quality Requirements

The road reserve stormwater quality measures would be of a similar fashion to that of the allotment strategy with the road reserve treatment consisting of measures to remove common road pollutants. These measures could include source controls like swales and bioretention running parallel with the road or end of line controls including gross pollutant traps, bioretention areas and sand filters. The final configuration of the stormwater quality measures would be determined on the development of a road and lot layout.

8.3 Aquifer Interference

The HWC would be concerned about any construction or operational activities that could interfere with the aquifer. Any such activities should be made clear as part of the development application and be appropriately regulated via the inclusion of provisions into the development consent conditions. The developer should also be reminded that any works that interfere with the groundwater would need to be approved by DWE under the provisions of the Water Management Act, 2000.

8.4 Safe Storage and Handling of Fuels and Chemicals

Any chemical spills could result in contamination of the groundwater and hence HWC would stipulate that any storage and handling of chemicals and fuels must be done strictly in accordance with the appropriate Australian Standards (eg. AS 1940-1993 for *The storage and handling of flammable and combustible liquids,* AS/NZS 4452-1 997 for *The storage and handling of toxic substances).* Contingency response plans that outline emergency procedures for chemical spills need to be incorporated into both the construction and operational aspects of the development HWC would expect these requirements be incorporated into the development conditions of consent.

9. Conclusion

Based on the stormwater and flooding requirements of the site the following would be required to advance the concept:

- A more detailed hydraulic assessment of the site with the final fill levels to provide nil flooding impact on adjacent lands. This would require a detailed site survey with sufficient resolution to generate contours with a 100 mm resolution;
- Geotechnical investigation to determine the ground conditions and the suitability of the site for filling; and
- Lot layout and road layout to determine the configuration of the stormwater layout and the areas recommended for trunk drainage stormwater treatment.

These requirements are to be carried out in the third and final stage of the project.

Appendix A

References

References

1. Department of Land and Water Conservation (DLWC) (1996) Tomago-Tomaree-Stockton Draft Groundwater Management Plan;
2. GHD (1995) Hunter Water Corporation, Tomago and North Stockton Sandbeds Hydrogeological Assessment, Volume 1 and Volume 2;
3. GHD (2006) RAAF Base Williamtown and SAWR Groundwater Monitoring Program – Quarterly Monitoring Report (September 2006);
4. WBM for Port Stephens Council and Department of Infrastructure Planning and natural Resources, 2005. "Williamtown Salt Ash Flood Study";
5. Woolley, D., Mount, T. and Gill J. (1995) NSW Department of Water Resources, Tomago Tomaree Stockton Groundwater – Technical Review; and
6. Viswanathan, M. (1983) North Stockton Sandbeds Study – A Preliminary Report.

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0	J Bernardi	MJ Piggott	*MJ Piggott*	MJ Piggott	*MJ Piggott*	13/03/07
1	MJ Piggott	K Blackmore	K. Blackmore	K Blackmore	K. Blackmore	24/10/07

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Department of Planning

Report on RAAF Base Williamtown/Newcastle Airport Employment Zone Land Use Development Strategy

Revised Water and Wastewater Strategy

October 2007

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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Table Index

Appendices

1. Introduction

The Department of Planning commissioned GHD Pty Ltd (GHD) to carry out the Defence and Airport Related Employment Zone Land Use Strategy at the RAAF Base Williamtown/NAL in May 2006. Stage 1 of the project was a 'desktop' study undertaken as part of the site selection process (Document Ref: 22/12808/71988). The location of the site is at Williamtown, NSW. It follows on from the previous report, the *Airport Related Employment Zone; Stage 1 – Site Selection Report July 2006* which identified a Selected Site for the more detailed investigations. Thus the original Water and Wastewater Strategy related to that original Selected Site.

The Stage 2 investigations identified development constraints on the lower land fronting Cabbage Tree Road which consequently lead to the inclusion of some additional lands to the west of the north western boundary. This necessitated revisiting the original technical reports and thus revising the Water and Wastewater Report. This report presents the outcome of investigations, analysis and consultation in relation to the required strategy for water and wastewater that would be required to support a specialised employment zone and comment on the implications for the revised area.

The report provides information on the requirements and options for the supply of water and wastewater services that would be needed for an employment zone of approximately 100ha, the site selected at Williamtown. It also considers the potential requirements for an expansion of the RAAF Base and Newcastle Airport Limited (NAL). The Williamtown area has an existing water supply system served by Hunter Water, however the area is not currently serviced with wastewater services.

GHD have calculated the likely loading requirements for the specialised employment zone proposed, the expansion of the existing Base facilities and the expansion of the Newcastle Airport. The use of this data and the subsequent consultation with the Hunter Water Corporation (HWC) lead to the advice provided by the HWC. At this stage, information on water and wastewater sizing and costs are indicative and any changes due to the revised study area are within the order of accuracy of the original estimates. Further investigation and assessment would be for actual costing.

2. Consultation

GHD sought advice from with the HWC on the requirements for the water and wastewater provision. Part of that consultation required GHD to calculate and provide expected loadings for the proposed airport related employment zone. This report is based on those costings, the outcomes of the consultation with the HWC and the advice later provided to GHD in the form of a letter that detailed the HWC requirements for a water and wastewater strategy. Appendix A provides the letter of advice from the HWC to GHD detailing these requirements.

It was not considered necessary to obtain additional advice from Hunter Water on the matter after consideration of the implications of the revised area.

3. Wastewater Transportation

The Williamtown area has an existing water supply system served by Hunter Water Corporation (HWC). HWC undertake periodic reviews of its water supply systems. These reviews identify future potential development and infrastructure required to service those developments. The most recent review identified the Williamtown employment area as having potential for future development. The review found that the area could be adequately serviced with a water supply system with appropriate augmentations.

3.1 Estimated Loads

GHD provided current and projected loadings for the RAAF Base, the NAL and the potential development of a defence and airport related employment zone to enable the calculations to be used by HWC for advice on the available options. The loadings used for this assessment are summarised below in Table 1. The calculated loadings are indicative and are not expected to change significantly due to the change to the study area.

Table 1 Wastewater Loadings

	2011 LOADS[1]			2026 LOADS[1]		
	ET	**ADWF (L/s)**	**PWWF (L/s)**	**ET**	**ADWF (L/s)**	**PWWF (L/s)**
RAAF Base	711	8	60	1085	12	80
Newcastle Airport	135	3	12	280	8	25
Employment Zone (100 ha Medium Scenario)	250	3	22	1000	11	83
TOTAL	1096	13.3	94.6	2365	31.0	187.9

1. Wastewater loadings provide for the proposed airport related employment zone, RAAF Base and the Newcastle Airport.

3.2 Employment Zone Reticulation

The wastewater reticulation requirements for the development of the proposed employment zone need to be determined (usually this would be by the developer of the site). This would be provided to HWC to enable the wastewater reticulation design standards to be in accordance with Hunter Water's requirements.

This report provides estimates based on an indicative wastewater reticulation requirement for a developed area of approximately 100 ha. Based on the relatively flat nature of the site, it is assumed that two local pump stations will be required; this is in addition to a transfer pump station. The provision of actual requirements and the cost of those requirements would require further investigation. The developer would confirm the results later at such time as the development configuration is more clearly defined. An indicative reticulation layout is shown in Figure 1 and summarised in Table 2 below.

The revised area is more elongated in shape and consequently the length of piping required may potentially be increased. However, the reticulation requirements and area used for these estimates are approximate and consequently remain applicable to the revised area as whilst reticulation costs may vary due to a minor increase in pipe length, this would still be considered to be within the accuracy of the estimates previously made.

Table 2 Indicative Wastewater Reticulation Details

Infrastructure for Ultimate Loadings

Catchment	PS	Rising Main	Gravity Sewer Mains
1	1.8m Dia, 9m depth with two 4.5 kW pumps	DN150 Rising Main (80DN)	DN225
2	2.4m Dia, 9m depth with two 20 kW pumps	ONiSO Rising Main (50DN)	3000m DN150 2000m DN225
Transfer PS	See Table 3 Option 1	See Table 3 Option 1	2000m DN150 2000m DN225

Note that this report has not attempted to quantify any potential additional internal wastewater reticulation/lead in works that may be required by NAL for future expansion of their site.

3.3 Transfer Options to Raymond Terrace Wastewater Treatment Plant

The closest wastewater treatment plant to the Williamtown area is located at Raymond Terrace, approximately 13 km from the Site. Based on the loadings calculated by GHD and the subsequent consultation between HWC and GHD, there were three transfer options investigated to pump flows to this plant provided HWC. These options are summarised below:

3.3.1 Option 1

Option 1 is to construct a series Transfer Pump Station at Williamtown and a 13.5km long 450mm diameter rising main to Raymond Terrace WWTW. See Figure 2a for a schematic diagram of this option.

3.3.2 Option 2

Option 2 involves the construction of a series Transfer Pump Station at Williamtown and a 13.5km long 375mm diameter rising main to Raymond Terrace WWTW. Construct a series booster pump station approximately mid way along the rising main route once flows exceed 157L/s. A pump upgrade will also be required at the Transfer Pump Station at this time. See Figure 2b for a schematic diagram of Option 2.

3.3.3 Option 3

Option 3 is to construct a series Transfer Pump Station at Williamtown and a 13.5km long 375mm diameter rising main to Raymond Terrace WWTW. Construct a parallel 13.5km 300mm diameter rising main once flows exceed 157LIs. This option will also require a pump upgrade at the Transfer Pump Station at this time. See Figure 2c for a schematic diagram of Option 3.

For each of the three options, the indicative pumping capacities for the Transfer System and the rising main dimensions have been provided. These are summarised in Table 3 below.

Table 3 Indicative Transfer System Pumping Capacities and Rising Main Dimensions

Option	Initial Infrastructure (2011)		Future Upgrades (2021)	
	Transfer PS	Rising Main	Transfer PS	Rising Main
1	Series Station, 5.0m wet well, with four 91 kW pumps	DN450 Rising Main (13.5km)	N/A	N/A
2	Series Station, 5.0m wet well, with four 110 kW pumps	DN375 Rising Main (13.5km)	Upgrade pumps to four 101kW pumps. Construct Series Booster PS (5.0m wet well, with four 95kW pumps)	N/A
3	Series Station, 5.0m wet well, with four 110kW pumps	0N375 Rising Main (13.5km)	Upgrade pumps to four 98kW pumps	Construct parallel 0N300 Rising Main (13.5km)

The three options discussed above remain relevant for the revised area. The location of the proposed transfer pump station was indicative only. Any relocation would be accessed via the road reserve and would require a similar length of trunk main. The potential for the main to be slightly shorter is due to the possibility of locating the station further west of the original location. This would be possible if an internal road were constructed to the west of the original intersection on Cabbage Tree Road and if it was found desirable to locate the station in a more central location within this revised area.

3.3.4 Economic Analysis of Options 1-3

The economic analysis undertaken compares Options 1-3. It takes into account both the capital and ongoing operational, management and processing costs. Option I as shown in Figure 2a was found to have the lowest present value life cycle cost. It is the preferred Transfer System.

Option 1 provides the greatest flexibility, this would enable this option to cope with higher flows should the employment zone ever be expanded beyond the 100 ha area on which the estimates have been based. Option 1 could potentially be increased to cater for approximately 360L/s with an additional series booster pump station constructed half way along the transfer main. On the other hand, both Options 2 and 3 a parallel rising main in addition to pump station upgrades would be required to achieve the equivalent flow rate at a much higher capital cost.

Funding and procurement arrangements of the Transfer System would need to be the subject of further consultation between Hunter Water and the main parties that would be serviced including the landowners and developers of the airport related employment zone, the Department of Defence and the NAL. A summary of the capital costs for the Transfer System as described in section 2.3.1 Option 1 above and including the costs to meet the reticulation requirements in the employment zone site are presented in Table 4 below.

There is no reason to anticipate any significant increase in cost due to the revised area.

Table 4 Capital Cost Estimates - Transfer System & Employment Zone Reticulation

	Capital Costs
1 Transfer System to Raymond Terrace WWTW	$14,934,000
2 Employment Zone Development Reticulation	$9,367,000
TOTAL	$24,301,000 as $24.3m

1. Cost shared on a user pays basis; and
2. Cost met by Developer of the Employment Zone.

4. Water Supply

Williamtown (including the RAAF base and NAL) and Medowie are currently supplied with potable water from Hunter Water. Trunk water distribution infrastructure extends from Hunter Water's Tomago pump station along Cabbage Tree Road through Williamtown to Medowie.

4.1 Trunk System Augmentation

A water distribution strategy study has recently been completed for this system that has determined augmentation requirements for the trunk system to cater for future growth. The growth includes potential increased demand from the RAAF base, NAL, the employment zone development at Williamtown, and further residential development at Medowie. Approximately $3.1 m of system augmentation works are planned over the next 20 years to cater for this growth. These works would be funded and constructed by Hunter Water, and the cost recovered over time from development through the Medowie Water System Developer Charge (discussed further below).

4.2 Employment Zone Reticulation

Water reticulation requirements within the employment zone development would need to be determined by the developer of the site and designed in accordance with Hunter Water's design standards. The design and construction of these works would be funded by the developer.

For the purposes of this report, indicative water reticulation for the employment zone development has been estimated. This comprises of approximately 1km of 150mm diameter mains and 2.3km of 200mm diameter mains at a total capital cost of approximately $850,000. There is no reason to anticipate any significant increase in cost as a result of the revised area.

Actual requirements and capital cost will need to be further investigated and confirmed by the developer further down the track once the development configuration becomes better defined.

Note that this report has not attempted to quantify any potential additional internal water reticulation/lead in works that may be required and funded by NAL for future expansion of their site.

5. Water and Wastewater Developer Charges

The future use of the land as a Defence and Airport related employment zone would attract Developer Charges levied by HWC. Hunter Water levy new development to recover the cost of capacity provided to service growth. These charges are calculated in accordance with the Independent Pricing and Regulatory Tribunal (IPART) determination issued on the 21 September 2000. IPART do not set the actual charges, however they do specify the methodology that is to be used to calculated them. The charges are indexed annually for inflation and revised by Hunter Water once every 5 years. This is in accordance with IPART requirements.

HWC updated the Developer Charges on l July 2006. The Charges would apply to the future development of the employment zone and to any expansion of the RAAF Base and NAL. The current Developer Charges are given below:

Raymond Terrace Wastewater Treatment Plant	$3,137[1]
Medowie Water System (including water headworks)	$136[1]

1. These costings are based on an equivalent tenancy (ET) for commercial/industrial development.

Using the above developer charges, and the estimates given in Table 1 regarding the equivalent tenancy, the approximate costs can be estimated.

Employment Zone Development (1000 ET)	$3.27m
NAL (future expansion of 145 ET)	$0.47m
RAAF Base (future expansion of 374 ET)	$1.22m

No significant changes to these costs are expected as a result of the revised study area as discussed in this report. Whilst reticulation piping required may be marginally longer due to the generally more elongated shape of the developable land this may well be offset by the slightly shorter trunk gravity main. In addition, these relatively minor variations are considered to be within the order of accuracy of the original cost estimates.

Appendix A

Letter from HWC

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36 HONEYSUCKLE DRIVE NEWCASTLE . ABN 46 228 513 446 . HUNTERWATER.COM.AU

25 October 2006

Reference: HW2006-2332/1
Telephone: 4979 9522
Facsimile: 4979 9468

Mr Glen McDiarmid
GHD
PO Box 5403
Hunter Region Mail Centre
NSW 2310

Dear Glen,

RE: WILLIAMTOWN LAND USE STRATEGY STUDY - WATER AND WASTEWATER SERVICING

Further to our meeting on 27 September 2006, please find attached a summary of Hunter Water's assessment of the water and wastewater servicing requirements for the RAAF Base, Newcastle Airport Limited (NAL) and the potential 100ha employment zone development at Williamtown.

Should you have any queries, please contact Michelle White on phone 4979 9548.

Yours sincerely,

Greg Bone.

Greg Bone
Manager Network Planning

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WILLIAMTOWN LAND USE STRATEGY STUDY - WATER AND WASTEWATER SERVICING

INTRODUCTION

The purpose of this document is to provide information to GHD (who have been engaged by the Department of Planning to prepare the Williamtown Land Use Strategy Study) on water supply and wastewater servicing to a potential 100ha employment zone development at Williamtown, and potential expansion of the RAAF Base and Newcastle Airport Limited (NAL).

At this stage, information on water and wastewater sizing and costs are only indicative and are subject to further investigation and assessment. This report does not constitute a commitment by Hunter Water to the funding of new capital works.

WASTEWATER TRANSPORTATION

The Williamtown area is not currently serviced with wastewater services from Hunter Water.

Estimated Loads

GHD provided current and projected loadings for the RAAF Base, NAL and the employment zone development (17/08/06 GMcD email). The loadings used for this assessment are summarised below in **Table 1**:

Table 1: Wastewater loadings for the RAAF Base, NAL and the employment zone.

	2011 LOADS			2026 LOADS		
	ET	ADWF (L/s)	PWWF (L/s)	ET	ADWF (L/s)	PWWF (L/s)
RAAF BASE	711	8	60	1085	12	80
NEWCASTLE AIRPORT	135	3	12	280	8	25
EMPLOYMENT ZONE (100 ha Medium Scenario)	250	3	22	1000	11	83
TOTAL	**1096**	**13.3**	**94.6**	**2365**	**31.0**	**187.9**

Employment Zone Reticulation

Wastewater reticulation requirements within the employment zone development would need to be determined by the developer of the site and designed in accordance with Hunter Water's design standards. These works would be funded by the developer of the site.

For the purposes of this report, indicative wastewater reticulation for the 100ha medium development area has been estimated. Based on the relatively flat nature of the site, two local pump stations (in addition to a transfer pump station) have been assumed. Actual requirements and cost will need to be further investigated and confirmed by the developer once the development configuration becomes better defined. An indicative reticulation layout is shown in **Figure 1** and summarised in **Table 2** below.

Table 2: Indicative wastewater reticulation details for the 100 ha employment zone.

INFRASTRUCTURE FOR ULIMATE LOADINGS			
Catchment	**PS**	**RISING MAIN**	**GRAVITY SEWER MAINS**
1	1.8m DIA, 9m depth with two 4.5 kW pumps	DN150 Rising Main (800m)	1000m DN150 1000m DN225
2	2.4m DIA, 9m depth with two 20 kW pumps	DN150 Rising Main (500m)	3000m DN150 2000m DN225
Transfer PS	See Table 3 Option 1	See Table 3 Option 1	2000m DN150 2000m DN225

Note that this report has not attempted to quantify any potential additional internal wastewater reticulation/lead in works that may be required by NAL for future expansion of their site.

Transfer Options to Raymond Terrace Wastewater Treatment Plant

The closest wastewater treatment plant to the Williamtown area is at Raymond Terrace. Three transfer options were investigated to pump flows to this plant:

- Option 1: Construct a series Transfer Pump Station at Williamtown and a 13.5km long 450mm diameter rising main to Raymond Terrace WWTW.
- Option 2: Construct a series Transfer Pump Station at Williamtown and a 13.5km long 375mm diameter rising main to Raymond Terrace WWTW. Construct a series booster pump station approximately mid way along the rising main route once flows exceed 157L/s. A pump upgrade will also be required at the Transfer Pump Station at this time.
- Option 3: Construct a series Transfer Pump Station at Williamtown and a 13.5km long 375mm diameter rising main to Raymond Terrace WWTW. Construct a parallel 13.5km 300mm diameter rising main once flows exceed 157L/s. A pump upgrade will also be required at the Transfer Pump Station at this time.

Schematic diagrams of the above options are shown in **Figures 2a** to **2c**. The indicative pumping capacities and rising main dimensions are summarised in **Table 3** below.

Table 3: Indicative Transfer System pumping capacities and rising main dimensions

OPTION	INITIAL INFRASTRUCTURE (2011)		FUTURE UPGRADES (2021)	
	Transfer PS	RISING MAIN	Transfer PS	RISING MAIN
1	Series Station, 5.0m wet well, with four 91 kW pumps	DN450 Rising Main (13.5km)	N/A	N/A
2	Series Station, 5.0m wet well, with four 110 kW pumps	DN375 Rising Main (13.5km)	Upgrade pumps to four 101kW pumps. Construct Series Booster PS (5.0m wet well, with four 95 kW pumps)	N/A
3	Series Station, 5.0m wet well, with four 110 kW pumps	DN375 Rising Main (13.5km)	Upgrade pumps to four 98kW pumps	Construct parallel DN300 Rising Main (13.5km)

An economic analysis was undertaken to compare the three options taking into account capital and ongoing OM&A costs. Option 1 (as shown in Figure 2a) was identified as having the lowest present value life cycle cost and is the preferred Transfer System. Additionally, Option 1 provides the greatest flexibility to cope with higher flows should the employment zone be potentially expanded beyond 100 ha in the future (after 2026). Option 1 can be increased to approximately 360L/s with an additional series booster pump station constructed half way along the transfer main. For both Options 2 and 3 a parallel rising main in addition to pump station upgrades would be required to achieve the equivalent flow rate at a much higher capital cost.

Funding and procurement arrangements of the Transfer System are subject to further discussion between Hunter Water and the main parties that would be serviced (RAAF, NAL and the Employment Zone Development). Ultimately, however, the capital cost of the Transfer System is shared on a user pays basis.

A summary of the capital costs for the Transfer System (Option 1) and the reticulation within the employment zone development are presented in **Table 5.**

Table 5: Capital Cost Estimates - Transfer System & Employment Zone Reticulation

	Capital Costs
Transfer System to Ray Terrace WWTW [1]	$14,934,000
Emp. Zone Dev. Reticulation [2]	$9,367,000
TOTAL	$24,301,000 (say $24.3m)

1 Cost shared on a user pays basis
2 Cost met by Developer of the Employment Zone

WATER SUPPLY

Williamtown (including the RAAF base and NAL) and Medowie is currently supplied with potable water from Hunter Water. Trunk water distribution infrastructure extends from Hunter Water's Tomago pump station along Cabbage Tree Road through Williamtown to Medowie.

Trunk System Augmentation

A water distribution strategy study has recently been completed for this system that has determined augmentation requirements for the trunk system to cater for future growth. The growth includes potential increased demand from the RAAF base, NAL, the employment zone development at Williamtown, and further residential development at Medowie. Approximately $3.1m of system augmentation works are planned over the next 20 years to cater for this growth. These works would be funded and constructed by Hunter Water, and the cost recovered over time from development through the Medowie Water System Developer Charge (discussed further below).

Employment Zone Reticulation

Water reticulation requirements within the employment zone development would need to be determined by the developer of the site and designed in accordance with Hunter Water's design standards. The design and construction of these works is funded by the developer.

For the purposes of this report, indicative water reticulation for the employment zone development has been estimated. This comprises of approximately 1km of 150mm diameter mains and 2.3km of 200mm diameter mains at a total capital cost of approximately $850,000. Actual requirements and capital cost will need to be further investigated and confirmed by the developer further down the track once the development configuration becomes better defined.

Note that this report has not attempted to quantify any potential additional internal water reticulation/lead in works that may be required and funded by NAL for future expansion of their site.

WATER & WASTEWATER DEVELOPER CHARGES

Hunter Water levies Developer Charges on new development to recover the cost of capacity that Hunter Water provides to service growth. Hunter Water's Developer Charges are calculated in accordance with the Independent Pricing and Regulatory Tribunal (IPART) determination issued on the 21st September 2000. IPART do not set the actual charges but they specify the calculation methodology to be used. The charges are indexed annually for inflation and revised by Hunter Water once every 5 years in accordance with IPART requirements.

Hunter recently updated its Developer Charges on 1st July 2006 and further information is available on Hunter Water's web site. Developer Charges would apply to the employment zone development and to the expansion of the RAAF Base and NAL. As an indication, the current Developer Charges are as follows :-

Raymond Terrace Wastewater Treatment Plant	$3,137 per ET (Commercial/Industrial)
Medowie Water System (including water headworks)	$136 per ET (Commercial/Industrial)

Accordingly, this would equate to the following approximate costs that would need to be met by the three main parties based on ETs outlined in Table 1 and current Developer Charges :-

Employment Zone Development (1000 ET)	$3.27m
NAL (future expansion of 145 ET)	$0.47m
RAAF Base (future expansion of 374 ET)	$1.22m

Appendix B

Figures

FIGURE 1- INDICATIVE GRAVITY MAIN ALIGNMENTS - MED DEVELOPMENT SCENARIO

PS1

PS2

RAAF and Airport to discharge direct to Regional WWPS

PROPOSED TRANSFER PUMP STATION

INDICATIVE GRAVITY MAIN ALIGNMENT

INDICATIVE RISING MAIN ALIGNMENT

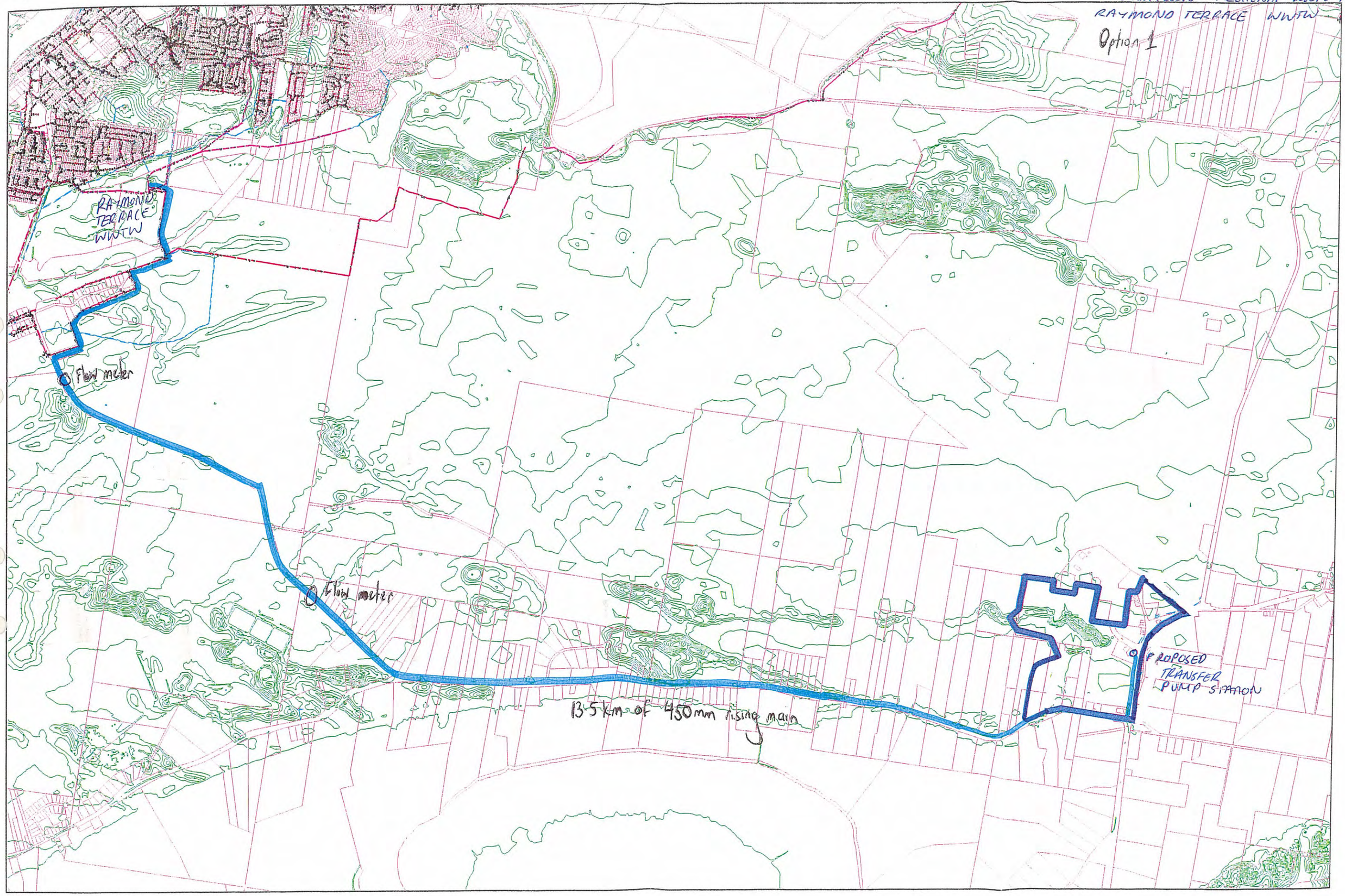
INDICATIVE PUMP STATION

GRAVITY CATCHMENT BOUNDARY

HWC

FIGURE 2a - RISING MAIN TRANSFERRING FR
WILLIAMTOWN REGIONAL WWPS T
RAYMOND TERRACE WWTW

Option 1



HWC

FIGURE 2b RISING MAIN TRANSFERRING FR
WILLIAMTOWN REGIONAL WWPS
RAYMOND TERRACE WWTW
Option 2

RAYMOND TERRACE WWTW

Flow meter

Flow meter

Proposed booster pump station

13.5km of 375mm rising main

PROPOSED TRANSFER PUMP STATION

HWC

FIGURE 2c - RISING MAIN TRANSFERRING FRO
WILLIAMTOWN REGIONAL WWPS T
RAYMOND TERRACE WWTW

Option 3

RAYMOND TERRACE WWTW

Flow meters

Flow meters

13.5km of 375mm rising main

13.5km of 300mm rising main

PROPOSED TRANSFER PUMP STATION

HWC

GHD Pty Ltd ABN 39 008 488 373

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		Name	Signature	Name	Signature	Date
0	S Cahill	G McDiarmid		K Blackmore		24/10/07

FIGURE 2b RISING MAIN TRANSFERRING FR
WILLIAMTOWN REGIONAL WWPS
RAYMOND TERRACE WWTW
Option 2

RAYMOND TERRACE WWTW

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Department of Planning, Port Stephens Shire Council

Williamtown Employment Zone

Bushfire Constraints Assessment

August 2006

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1. Introduction

1.1 Purpose

GHD Pty Ltd (GHD) was commissioned by the Department of Planning (DoP) to undertake an analysis of the possible bushfire constraints as part of a Land Use Capability / Suitability Investigation.

This report is the bushfire constraints analysis that has been conducted as part of the initial assessment of land use capabilities associated with the Williamtown Employment Zone. This report can be used only for its intended purpose, being preliminary indications, for planning purposes, related to the potential bushfire constraints at the Williamtown Employment Zone.

It should be noted that any draft Local Environment Plan would require consultation with the Commissioner of the NSW Rural Fire Service, and take account of any comments made on behalf of the NSW Rural Fire Service.

1.1.1 Development Stage

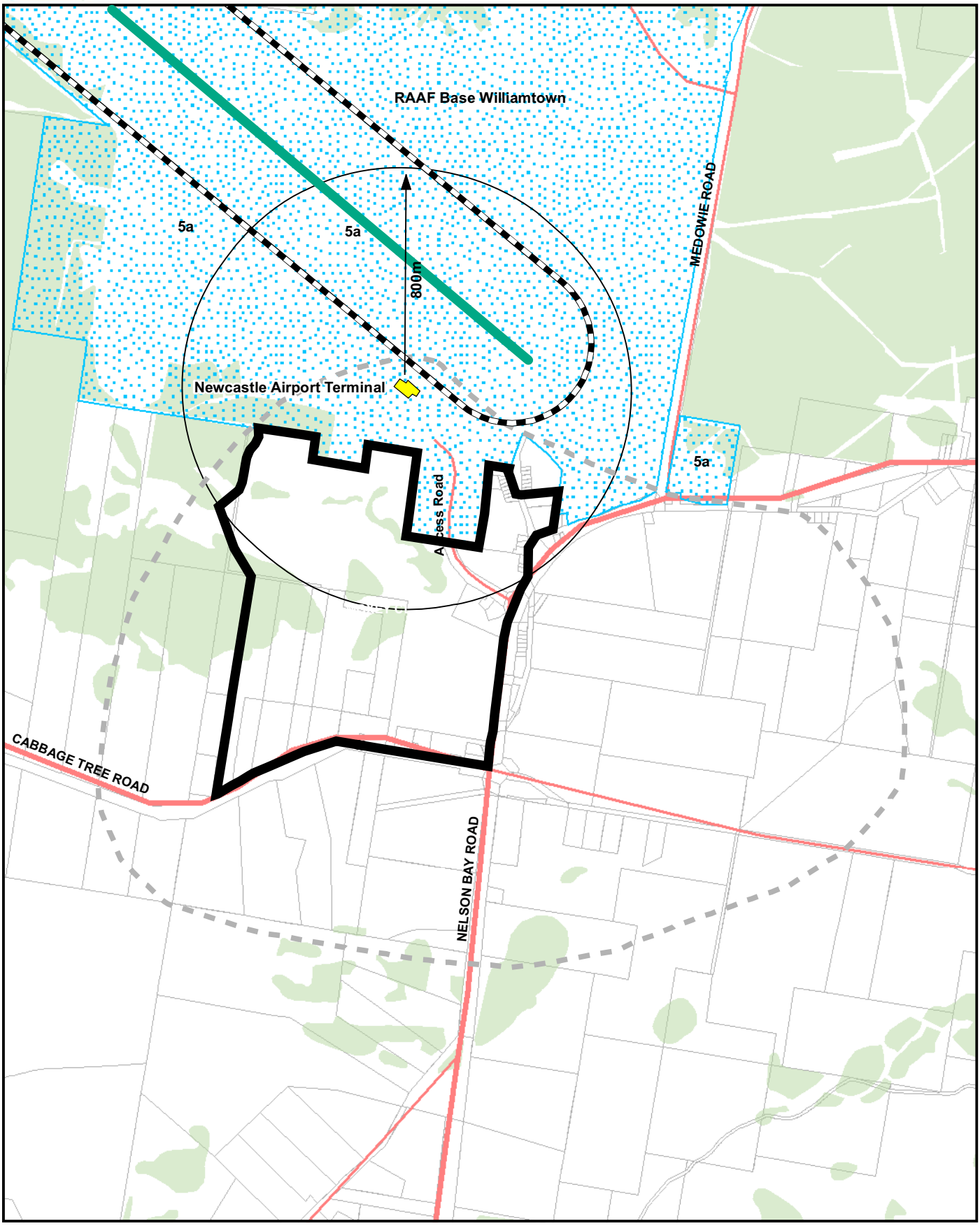
The proposed development at the Williamtown Employment Zone is for commercial and industrial premises. There is no residential, rural residential or special purpose buildings proposed.

Land use capability and suitability assessment is being considered in the current stage of the development. No draft or potential layout for buildings, roads or potential infrastructure has been available for this assessment. A more detailed bushfire hazard assessment will be required once a draft layout of building footprints is developed in consideration of this constraints assessment.

1.2 Site Location

The study area is located adjacent to RAAF Base Williamtown due south of the existing Newcastle Airport. The site is bounded to the south by Cabbage Tree Rd and the east by Nelson Bay Rd. The study area is approximately 110 ha comprised of blocks of land with multiple tenure and ownership. Figure 1 provides an overview of the study area.

Figure 1 - Site Location



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LEGEND

- Study Area
- LHCCREMS Vegetation
- Cadastre
- Employment Zone - Investigation Area
- (5a) Special Uses - Defence
- Newcastle Airport Terminal
- Exsiting Runway
- Existing Runway Buffer (300m)
- Roads

Spatial layers courtesy of Port Stephens Council

//2212808/GIS_Cadd/Worpaces/Figure1

2. Site Context

2.1 Physical Description

The site is predominantly flat with substantial areas of lower lying wetlands and a smaller area of coastal sand dune rising and falling sharply over short distances within the flatter landscape. The landscape surrounding the site is of similar character.

Vegetation within the study site is predominantly cleared, some remnant patches remain (Figure 1) and cleared areas do have some sparsely scattered overstorey trees. Remnant vegetation has been under scrubbed to remove the understorey in some cases, largely confined to the vegetated areas not inundated by water. The larger patches of remnant vegetation have a denser more intact understorey and tend to coincide with the 'Blind Harry Swamp Soil Landscape' (Figure 1).

The landuse across the majority of the study site is a combination of grazing and small farms with residences. Within the site boundary there is also a petrol station and school.

2.2 Bushfire Prone Land

From the Port Stephens Shire Council web site the site is predominantly classified as bushfire prone land, the exceptions being the small parcels to the North East within the study site (Figure 2).

If bushfire prone land touches the edge or corner of a single parcel of land then the entire parcel is deemed to be bushfire prone according to the NSW Rural Fire Service, and requires bushfire assessment.

Pursuant to Section 117 of the Environmental Planning and Assessment Act 1979 the Ministers Direction Number 19, the council must consider bushfire in preparation of a draft Local Environment Plan, having regard to *Planning for Bushfire Protection 2001* .

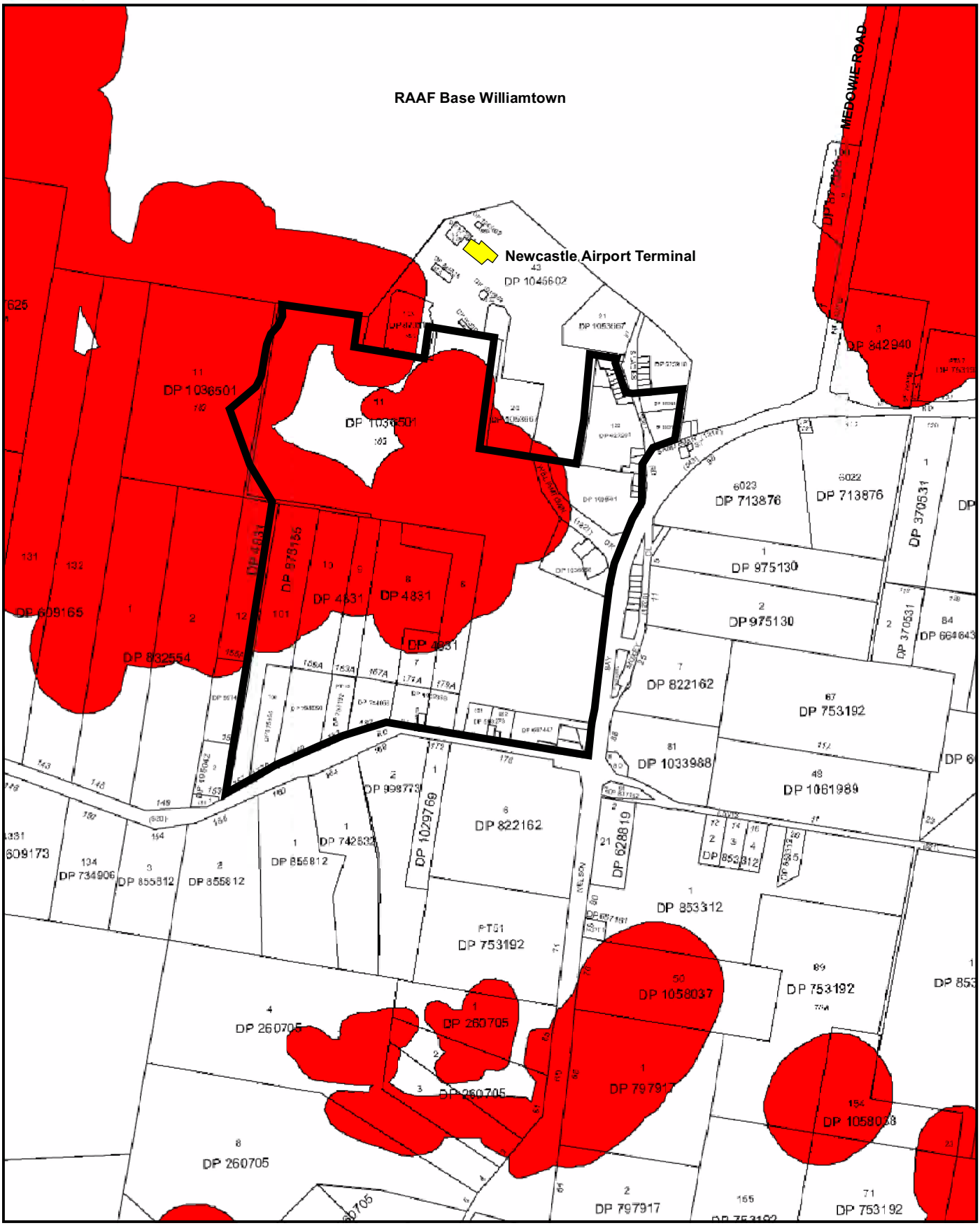
2.3 Bushfire History

Discussion with the NSW Rural Fire Service advise that ignition sources in the local vicinity to the site include burning for agricultural activities and burning of stolen cars dumped in the Hunter Water land to the west of the site.

Fire behaviour in the forested areas is described by the Rural Fire Service and having a high difficulty of suppression during the summer very high to extreme fire danger days.

It was suggested by the Rural Fire Service that access between any buildings and the vegetation would be a valuable component to fire management.

Figure 2 - Bushfire Prone Land



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Spatial layers courtesy of Port Stephens Council

3. Methods

3.1 Desktop Assessment

The desktop assessment included collation and analysis of:

- Bushfire prone mapping
- Aerial photography
- Vegetation classification mapping
- Physical relief, tenure, roads, and other descriptive feature mapping.

3.2 Field Investigation

A site inspection was conducted by GHD on 21st August 2006. The site inspection assessed slope and vegetation types to determine likely constraints.

Nine points were surveyed, located as shown in Figure 3.

A summary of field records from each transect is provided in Section 4.

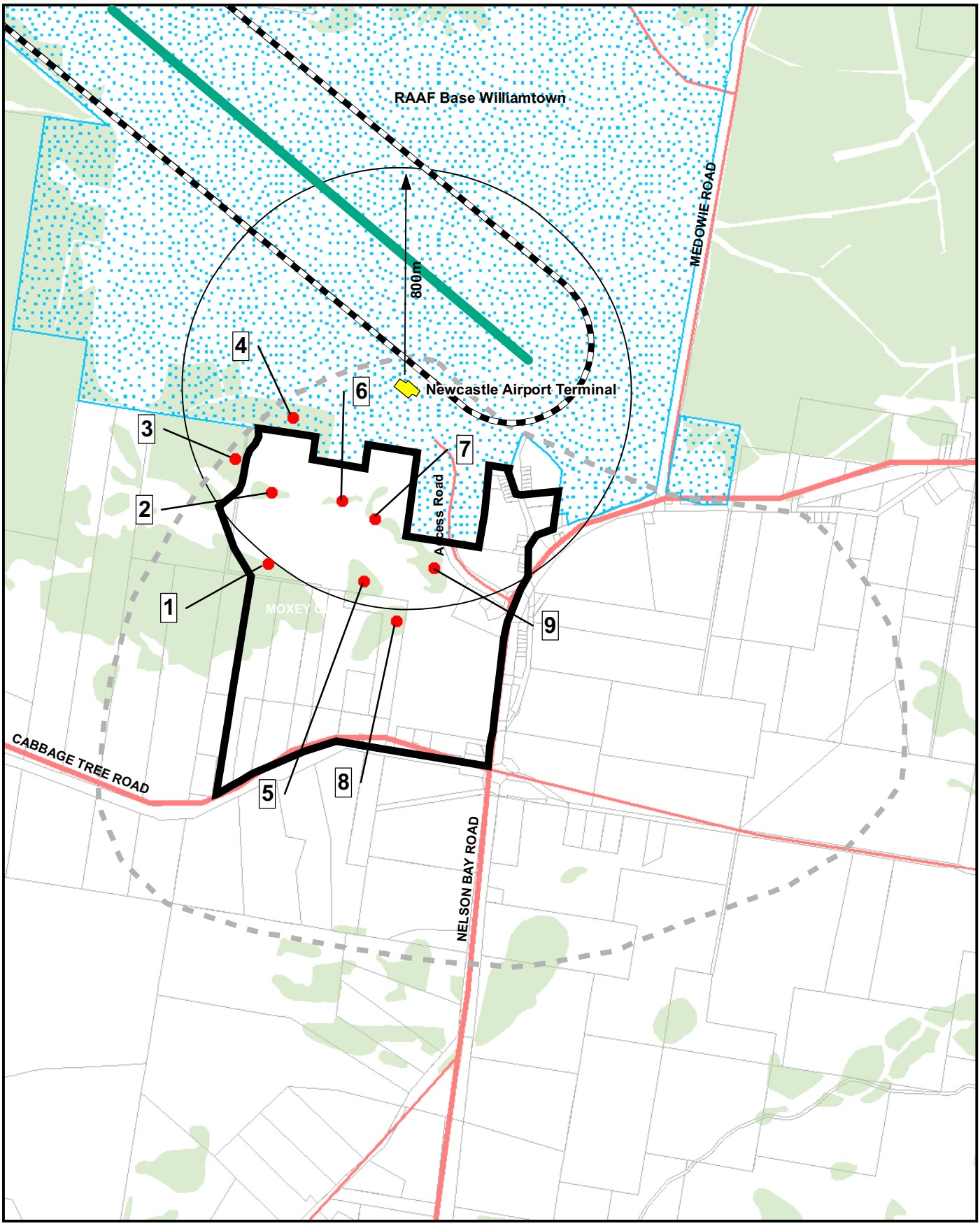
3.3 Analysis

The proposed development will be commercial and industrial not residential or special purpose development and is not required to comply with Planning for Bushfire Protection (PBP), the guidelines prepared by NSW Planning. However it is possible and likely that it will be referred to the NSW Rural Fire Service and consideration of the implications against the NSW guidelines *Planning for Bushfire Protection* (Planning NSW, 2001) is recommended.

The constraints analysis of this site will indicate preliminary assessment of:

- Asset Protection Zones
- Building Construction standards
- Access and Egress to the site
- Water source for the site
- Site Layout

Figure 3 - Survey Points



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- Survey Points

Spatial layers courtesy of Port Stephens Council

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4. Summary of Field Survey Results

The predominant vegetation group and general slope for each point surveyed is shown in Table 1.

Table 1 Summary of Fire Hazard Constraints

Point location	Vegetation Group	Slope
1	Group 1	Flat, localised sand hill
2	Group 3	Flat
3	Group 2	Flat
4	Group 1	Flat
5	Group 2	Flat
6	Group 3	Flat
7	Group 2	Flat
8	Group 2	Flat
9	Group 3	Flat, localised sand hill

5. Site Considerations

5.1 Asset Protection Zones

Asset Protection Zones (APZs) act as a buffer between the proposed development and the hazard and are the principal bushfire protection mechanism. APZs reduce the vulnerability to fires through construction and maintenance of an Outer Protection Area (OPA) and an Inner Protection Area (IPA).

There are not established standards for commercial or industrial facilities within the NSW guidelines. The NSW Rural Fire Service has informally advised GHD that in the past it has used a 20m separation of commercial and industrial buildings from the bushfire hazard (vegetation). The 20m separation is intended to be maintained as an Inner Protection Area, (Section 5.1.1 below).

Figure 4 indicates the potential location and extent of APZ's that may constrain building development close to vegetation. Several of the smaller vegetation patches separated from the larger tracts do not have APZ's surrounding them. These smaller remnant patches of vegetation are either less than 1 hectare in size, and therefore do not register as fire prone, else are under scrubbed with wide crown separations and are unlikely to require an APZ separation as they are in a condition equal to that prescribed as an Inner Protection Area. Confirmation of this must be obtained from the NSW Rural Fire Service.

5.1.1 Inner Protection Area (IPA)

The purpose of the IPA is to minimise the impact of direct flame contact and radiant heat on the development.

The performance of the IPA should be such that:

- there is minimal fine fuel that could be set alight by a bushfire; and
- tree crowns are discontinuous (i.e. separated by approximately 2 m).

Trees and shrubs are permitted within the IPA provided they do not form a continuous canopy, are not species that retain dead material or deposit excessive quantities of ground fuel in a short period or in the fire danger period and are located so that they will not ignite the asset through direct flame contact or radiant heat.

A fire trail can be incorporated into the IPA. This will provide:

- easier access for firefighters allowing more efficient use of fire fighting resources;
- a safe retreat for fire fighters; and
- a clear control line from which to conduct back-burning operations if necessary.

A fire trail will need to have the following attributes.

- located within a minimum 6 m wide reserve (4 m wide trail and 1 m wide cleared area each side of trail);
- constructed in accordance with design criteria outlined in the PBP;
- be trafficable by firefighting vehicles under all weather conditions;
- appropriate drainage and erosion controls;

- not traverse any wetlands or other land potentially subject to periodic inundation;
- be maintained in a serviceable and accessible condition at all times; and
- have passing bays at regular intervals of 200 m.

The IPA should be kept free of fuel through regular mowing with less than three tonnes per hectare of fine fuel present at any time.

5.2 Construction Standard

The NSW guideline (PBP) does not specify a standard of building construction for commercial or industrial buildings within bushfire prone lands. The standards established within the guidelines for residential developments incorporate a building standard equivalent to Level 3 construction (AS 3959) which is linked to the Building Code of Australia (BCA). It is likely that a commercial building will equate to or supersede a Level 3 construction standard for residential buildings. It is possible that the NSW Rural Fire Service will stipulate a Level 3 construction standard for a commercial building at this site.

5.3 Site Access

The access surrounding and between the buildings should be developed as two way and accessible for heavy vehicle use and be connected to form a circular or through road route leading to and from public roads.

A perimeter fire trail or suitable vehicle access around the building envelopes or site boundary to the site should be established and maintained. This would need to be located entirely within the site and include the following attributes:

- a minimum trafficable width of 4 m with an additional 1m wide strip on each side of the road kept clear of bushes and long grass;
- the road should have a passing bay about every 200 m where possible, which should be 20 m long by 3 m wide, making a minimum trafficable width of 7 m at the passing bay;
- the capacity of road should be sufficient to carry fully loaded firefighting vehicles (approximately 28 tonnes or 9 tonnes per axle);
- a minimum vertical clearance of 6 m to any overhanging obstructions, including tree branches;
- curves should have a minimum inner radius of 6 m and be minimal in number to allow for rapid access and escape;
- the minimum distance between inner and outer curves should be 6 m;
- maximum grades should not exceed 15º and preferably not more than 10º;
- roads should provide sufficient width to allow firefighting vehicle crews to work with firefighting equipment around the vehicle.

5.4 Water

The proposed development is planned to have access to mains water supply. Fire hydrant and water supply should be included in accordance with AS 2419.1 – 1994.

5.5 Site Layout

When planning building envelopes, parking, roads and open spaces at the site consideration should be given to placing buildings away from the retained vegetation, bushfire hazard, as far as practicable or minimising the perimeter of the development exposed on the bushfire hazard sides of the site. This can be achieved through steps including planning open space adjacent to the vegetation, car parks between the vegetation and buildings and perimeter road design.

5.6 Additional Recommendations

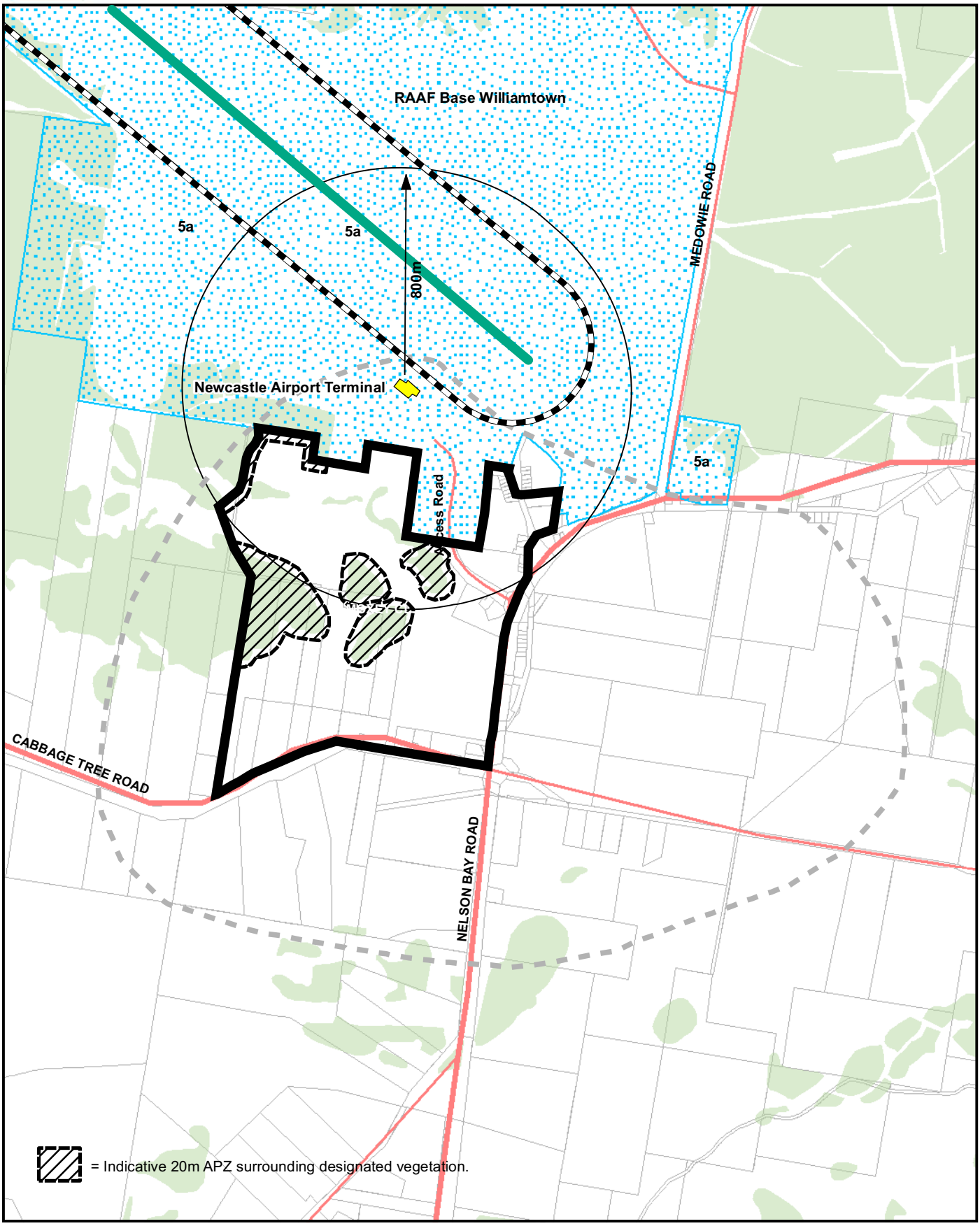
The draft Local Environment Plan should further consider:

- Introduction of controls which avoid placing inappropriate developments in hazardous situations;
- Introduction of controls on the placement of combustible materials in the Inner Protection Area; and
- Ensure that bushfire hazard reduction is not prohibited within the Asset Protection Zone.

A number of additional recommendations are suggested for bushfire protection during construction and operation of the development. They include:

- Preparation of a site management plan that details bushfire prevention measures to be implemented during construction and later for the operation of the facility including but not limited to:
    - Work involving risk of ignition should not be carried out during total fire bans;
    - Bushfire suppression equipment should be available on site;
    - Appropriate storage and maintenance of fuels and other flammable materials.
- Emergency procedures should be detailed for any persons located at the site during the bushfire season; and
- Local Rural Fire Service Control Centre should be notified of the dates during which construction is to be undertaken and any dates during which 'hot works' are to be conducted should be highlighted. This would enable the Rural Fire Service to advise when weather conditions are not appropriate to carry out the works proposed.

Figure 4 - Bushfire Constraints



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Spatial layers courtesy of Port Stephens Council

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NSW Department of Plannning

Williamtown Employment Zone

Report for Supplementary Ecological Investigations

December 2007

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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1. Introduction

1.1 Purpose of Current Study

In early 2007, GHD Pty Ltd (GHD) undertook a preliminary assessment of ecological values across approximately 100 ha of land identified for an aviation industry employment zone at Williamtown (GHD 2007). Whilst much of the study area was identified as having 'high' ecological value, the Lower Hunter Regional Strategy allows for development to proceed in these areas provided an adequate level of offsetting is undertaken. An investigation into flooding issues, however, resulted in a developable area considered by the Project Group to be insufficient to meet the objectives of the Employment Zone. An area of approximately 50 ha adjoining the northwest corner of the area investigated by GHD (2007) was subsequently identified as a potentially developable area. This area constitutes the study area for the current supplementary investigations.

A description of the overall study area, including regional context, is provided in GHD (2007).

1.2 Approach to Study

The supplementary investigations followed the approach adopted by GHD (2007).

The key ecological issues requiring clarification through field investigations included:

- Whether the study area contains potential habitat for species, populations or ecological communities listed under the NSW Threatened Species Conservation Act 1995 (TSC Act) or the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act);
- Confirmation of the conservation significance of areas of Koala habitat identified in the Port Stephens Council Comprehensive Koala Plan of Management (Port Stephens Council 2002); and
- The distribution of ecological values across the study area, which can then be used to inform the strategy for net improvement of biodiversity assets in the local area.

Data from the above was used to identify areas that:

- Are potentially constrained by high ecological values (while at the same time offering opportunities for on-site conservation);
- Offer opportunities for offsetting any biodiversity impacts to ensure net improvement of biodiversity assets in the study area; and
- Offer opportunities for development without compromising local biodiversity, particularly threatened species, populations and ecological communities.

This report documents findings relating to the above.

2. Description of Study Area

2.1 Description of Study Area

2.1.1 Location

The study area, which comprises approximately 50 ha, is located at Williamtown, approximately 16 km northeast of Newcastle in the Port Stephens Local Government Area (LGA) and is located to the southwest of the RAAF base Williamtown.

2.1.2 Soils and Geology

The 1:100 000 Soil Landscape Sheet indicates that the study area falls on the Blind Harrys Swamp Soil Landscape within the south-eastern portion and on the Shoal Bay and Tea Gardens Soil Landscapes within the remainder (Matthei 1995).

Blind Harrys Soil Landscape is a swamp landscape associated with waterlogged swales and deflation areas on sands of the Tomago Coastal Plain. The underlying geology consists of unconsolidated Quaternary sandy peats, peats and mud (Matthei 1995). This soil landscape underlies the Swamp Sclerophyll Forest in the south-eastern portion of the study area.

The Shoal Bay and Tea Gardens Soil Landscapes are aeolian landscapes. The Shoal Bay landscape consists of Pleistocene sandsheets and low dunes on the Tomago Coastal Plain. This landscape has been extensively cleared (through sand extraction), although uncleared open-forest and woodland with a tall shrub understorey still remain in some areas. On poorly drained sandsheets, cleared to uncleared closed Paperbark (*Melaleuca* spp.) swamp forest occurs (Matthei 1995). This soil landscape occurs within the central eastern portion of the study area and has been heavily impacted by sand extraction.

The Tea Gardens Soil Landscape comprises Pleistocence beach ridges and sandsheets consisting of marine and Aeolian quartz sands. Vegetation is typically generally uncleared wet heath forest communities in poorly drained swales and deflation basins (Matthei 1995). This soil landscape occurs across the northern half of the study area.

2.1.3 Climate

The study area has a warm temperate climate with warm wet summers and mild dry winters. The average annual rainfall in the area is 1000 to 1,200 mm. During summer the temperatures range from between an average maximum of 26 - 29oC and an average minimum of 17 - 20oC. In winter the average maximum drops to 16 - 19oC and the average minimum to 6 - 9 oC (Bureau of Meteorology 2006).

2.1.4 Land Use

The study area comprises privately owned rural land. The central part of the study area exhibits evidence of past sand extraction activities. There appears to be no regular agricultural activity being undertaken on the land, with extensive regeneration of woodland vegetation in previously cleared areas, particularly in the north-western portion of the study area.

3. Methodology

3.1 Approach to Study

The supplementary investigations incorporated the following project tasks:

- Review of LHCCREMS (House 2003) vegetation mapping;
- Review of Port Stephens Comprehensive Koala Plan of Management;
- Field Investigations; and
- Identification and mapping of ecological values across the study area.

LHCCREMS vegetation mapping was broadly ground-verified over two days. Broad-scale habitat assessment was also undertaken to determine the potential for threatened species and communities to occur within the study area. Nocturnal surveys involving stagwatching and spotlighting were undertaken on four separate nights. Two ecologists undertook surveys over two days and four nights during September and October 2007.

3.2 Flora Surveys

3.2.1 Vegetation Mapping

Broad-scale vegetation mapping, including ground-verification of existing vegetation mapping (LHCCREMS 2003), was undertaken across the study area involving a general walk through the study area and accessible vegetation stands. Vegetation communities were identified based on the dominant canopy species and structural characteristics and the boundaries marked using a Global Positioning System (GPS).

The likelihood of vegetation communities to qualify as an Endangered Ecological Community (EEC) listed under the TSC Act and/or the EPBC Act was assessed and boundaries were broadly mapped. Accurate survey of community boundaries was not undertaken, as this was not part of the brief. Boundary mapping was primarily based on air photo interpretation and collection of point data in the field using handheld GPS.

3.2.2 Threatened Flora

The likelihood of threatened or rare flora species occurring within the study area was assessed through analyses of their habitat requirements and availability of suitable habitat within the study area. Random meander searches for threatened plants, such as the Leafless Tongue Orchid (*Cryptostylis hunteriana*) were also undertaken.

3.3 Fauna Surveys

The study area provides habitat for a range of fauna, with certain areas providing potential habitat for threatened species. The fauna fieldwork focussed on habitat assessment and was aimed at ascertaining the potential importance of these areas for native fauna, and in particular threatened species. This then facilitated the assignment of ecological value ratings across the study area.

3.3.1 Habitat Assessment

A broad scale fauna habitat assessment to determine current habitat value's across the site was undertaken and focussed on the requirements of threatened species with the potential to occur on the site. Specific resources such as shelter, basking, roosting, nesting and foraging sites for amphibians, birds, bats, arboreal mammals, ground-dwelling mammals and reptiles were noted. Any other important physical features such as areas supporting hollow-bearing trees were noted.

3.3.2 Habitat Searches

Searches for evidence of the presence of fauna, such as scats, diggings, scratches on smooth-barked trees, etc, were undertaken. Bare substrate, such as sand, was examined for animal tracks. Searches of groundcover habitat for sheltering reptiles and frogs, such as under debris and logs, were undertaken.

3.3.3 Opportunistic Records

Incidental records of bird, amphibian, reptile and mammal species were collected during the entire survey period.

3.3.4 Frog Surveys

Prior to commencement of the frog surveys, an assessment of habitat suitability across the study area was undertaken. Habitat searches and spotlighting were subsequently conducted at all waterbodies within the study area, including ephemeral water bodies in the regenerating wet heath forest and the permanent freshwater wetland in the western portion of the study area. The Wallum Froglet, which is listed as 'vulnerable' on the TSC Act, was specifically targeted during the frog surveys.

The Wallum Froglet is a small frog that breeds in late winter when males call after heavy rain from within sedge tussocks or at the water's edge. This species is best identified during the breeding season during the day and after heavy rain (DEC 2006a). The field surveys for this assessment were undertaken outside the breeding season of the Wallum Froglet. Furthermore, significant rainfall had fallen in the region for several weeks, resulting in most of the ephemeral ponds being dry. Despite these limitations, the field surveys were successful in recording Wallum Froglet in the study area (see Section 4.2.5).

3.3.5 Koala Habitat Assessment

The study area falls within the Port Stephens LGA, consequently State Environmental Planning Policy No. 44 – Koala Habitat (SEPP 44) applies. PSC has prepared a Comprehensive Koala Plan of Management (CKPoM) (Port Stephens Council 2002), which supersedes the requirements of SEPP 44. As is the case with SEPP 44, the CKPoM aims to encourage conservation and management of areas of natural vegetation that provide habitat for Koalas to ensure a permanent population over their present range and to reverse the current trend of Koala population decline.

Vegetation surveys undertaken within the study area assessed the likelihood of areas constituting Preferred Koala Habitat by noting dominant canopy species and determining the presence of preferred and important food trees (as defined by the CKPoM). The Koala Habitat Planning Map presented in the CKPOM was used as a background reference, with the field surveys designed to identify inconsistencies in the CKPOM mapping.

3.3.6 Weather Conditions and Survey Limitations

The weather during the field survey was generally fine and warm. Daytime temperatures were around 23 to 27°C. During the nocturnal surveys, conditions were cool to mild, calm, with partially overcast skies.

The absence of significant rainfall during the survey period and the timing of the field surveys (ie outside the breeding season of the Wallum Froglet) did not allow for full assessment of the distribution of the Wallum Froglet across the study area. It is assumed therefore that all low-lying areas within the study area, including intact swamp woodland / forest vegetation as well as regenerating vegetation, provides suitable habitat for the species.

The field surveys undertaken for this assessment were not designed to enable all species, either resident or transitory to the study area, to be detected. Some fauna species are highly mobile and transient in their use of resources.

Surveys were undertaken outside the optimal survey period for some cryptic species, such as the orchid species Sand Double Tail (*Diuris arenaria*) and Rough Double Tail (*Diuris praecox*). Hence it is possible that if such species do occupy the study area they would have gone undetected.

The field surveys were aimed at providing an overall assessment of the ecological values of the site and study area with particular emphasis on threatened species to allow an assessment of the impacts of the proposal. For those species of conservation significance that were not detected but with the potential to occur on the site, an assessment of the likelihood of their occurrence was made based on known habitat requirements.

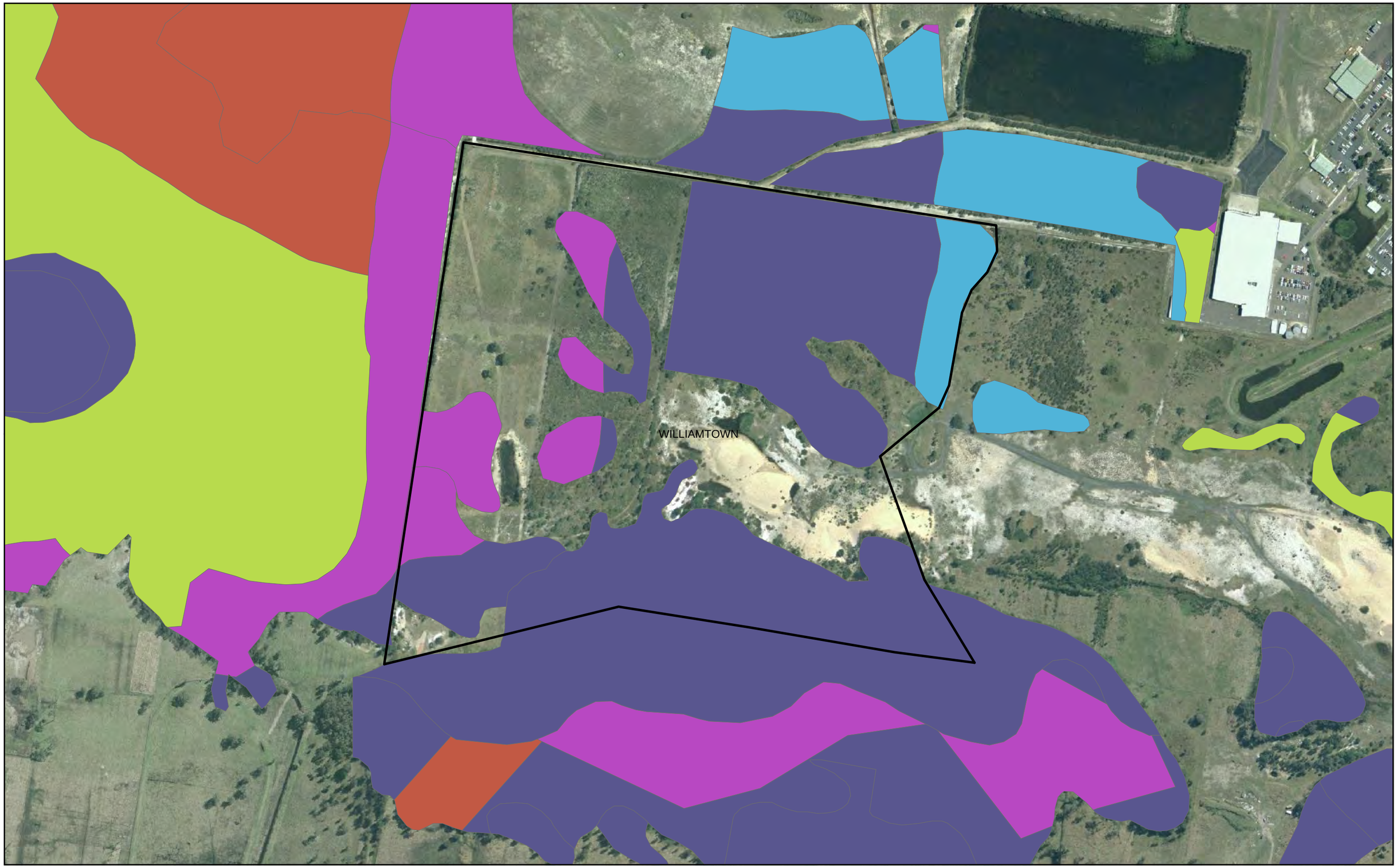
4. Results

4.1 Review of LHCCREMS Vegetation Mapping

LHCCREMS (2003) vegetation mapping, as illustrated in Figure 4-1, indicates the following three vegetation communities as occurring across the study area:

- Coastal Sand Wallum Woodland / Heath;
- Swamp Mahogany Paperbark Forest; and
- Tomago Sand Swamp Woodland.

Canopy species characterising each of the above communities are provided in Table 4-1. The *Port Stephens Council 2004 Comprehensive State of the Environment Report* (PSC 2004) lists which LHCCREMS map units are likely to correspond with State and Commonwealth listed Endangered Ecological Communities (EECs). Based on LHCCREMS vegetation mapping and a review of PSC (2004), it was determined that at least one vegetation community mapped within the study area, ie Swamp Mahogany Paperbark Forest, may correspond to the EEC: Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions. Ground verification of the LHCCREMS vegetation mapping confirmed the occurrence of Swamp Sclerophyll Forest EEC within the study area, as well as the regionally vulnerable and regionally specialised Tomago Sand Swamp Woodland.



1:4,500 for A3

0 25 50 100 150 200

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

LEGEND

- Additional Land for Investigation
- Coastal Sand Apple - Blackbutt orest
- Coastal Sand Wallum Woodland - Heath
- Swamp Mahogany - Paperbark Forest
- Swamp Oak Rushland Forest
- Tomago Sand Swamp Woodland

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LHCCREMS Vegetation Mapping for Study Area

23 | October 2007

Figure 4.1

GIS Filename: \22\12808\GIS\MAPS\Ecology\Report Figs(Oct07)\Fig1_LHCCREMS_231007.mxd

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Table 4-1 Description and Significance of LHCCREMS Vegetation Communities Potentially Occurring within the Study Area

LHCCREMS Map Unit	Map Unit Name	Canopy Species	Possible Endangered Ecological Community	Regionally Vulnerable Vegetation Communities	Regionally Specialised Vegetation Communities	NPWS Significant Vegetation Communities
34	Coastal Sand Wallum Woodland / Heath	*Banksia aemula / Corymbia gummifera / Angophora costata*				
37	Swamp Mahogany Paperbark Forest	*Melaleuca quinquenervia / Eucalyptus robusta / Casuarina glauca*	Swamp Sclerophyll Forest on Coastal Floodplains	X		X
33	Coastal Sand Apple Blackbutt Forest	*Angophora costata / Eucalyptus pilularis*				
36	Tomago Sand Swamp Woodland	*E. parramattensis subsp decadens*[1] */ Leptospermum polygalifolium*		X	X	

1: *Eucalyptus parramattensis subsp. decadens* is also listed as 'vulnerable' under the TSC Act and EPBC Act.

4.2 Field Surveys

4.2.1 Vegetation Communities

The study area contains a range of vegetation communities exhibiting ‘within community’ variation. The range of vegetation communities is likely to be largely a result of the underlying soil landscapes, with both swamp and aeolian landscapes occurring.

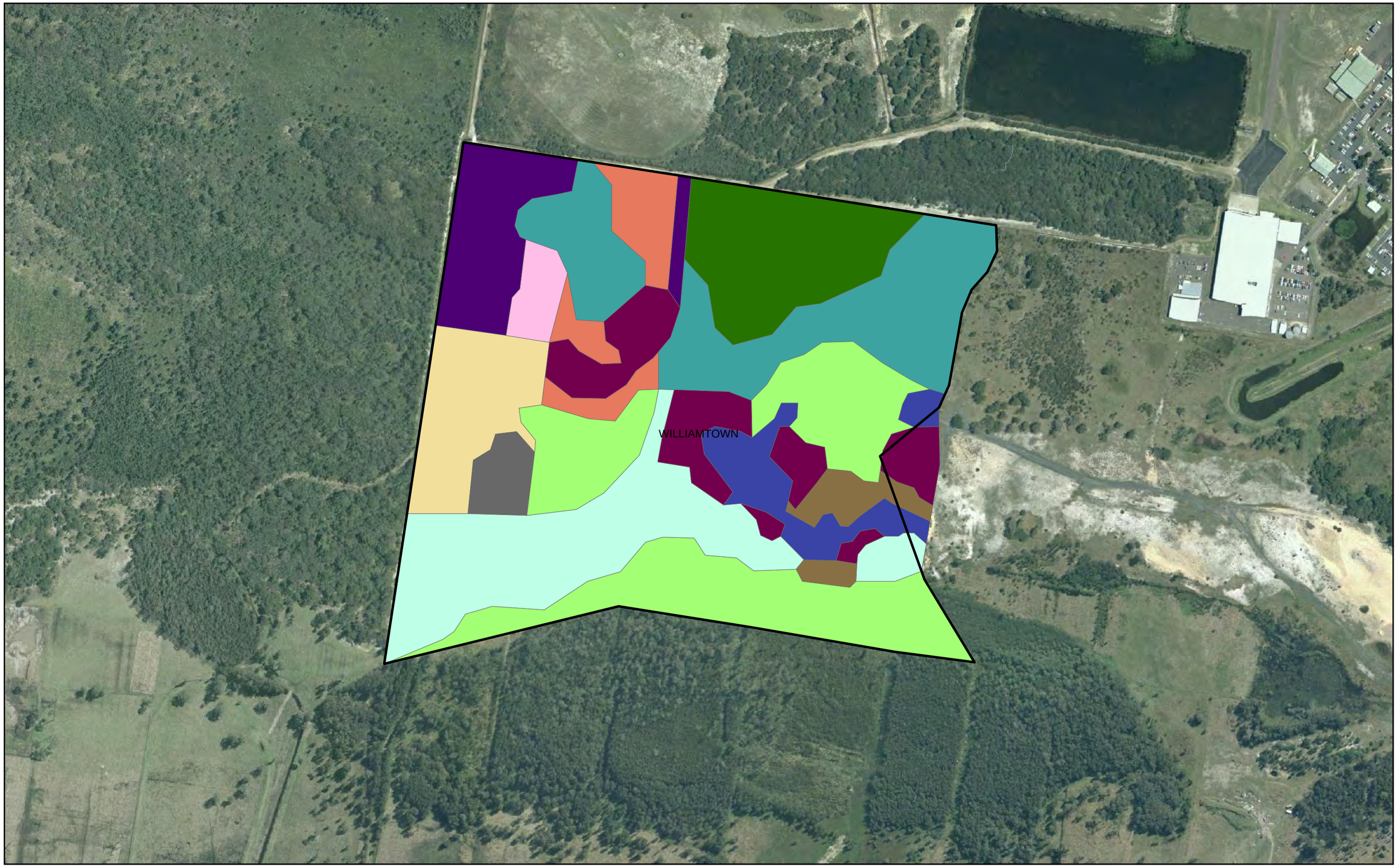
The ‘within community’ variation is presumably the result of subtle variations in topography (and hence proximity to the underlying water table) as well as disturbance history, such as fire frequency and length of time since clearing, where such practices have occurred.

The field surveys determined the following native vegetation communities occur within the study area:

- Scribbly Gum / Smooth-barked Apple Woodland;
- Swamp Mahogany / Paperbark Forest;
- Smooth-barked Apple Woodland;
- Heathland;
- Heathland – disturbed;
- Wet Heath Forest – Swamp Mahogany dominant;
- Wet Heath Forest – Broad-leaved Paperbark dominant;
- Red Gum Woodland*;*
- Regenerating wet heath forest with ephemeral waterbodies;
- Shrubland; and
- Freshwater Wetland.

Areas of high disturbance resulting from past land use practices (such as sand extraction) also occur, and have been mapped as ‘Weeds / Cleared / Bare Sand’.

A brief description of each vegetation community recorded within the study area is provided below. The location of communities within the study area is shown in Figure 4-2.



1:4,500 for A3

0 25 50 100 150 200

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

LEGEND

- Additional Land for Investigation
- Freshwater wetland
- Heathland
- Heathland - disturbed
- Red Gum Woodland
- Regenerating wet heath forest with ephemeral waterbodies
- Scribbly Gum/Smooth-barked Apple Woodland
- Shrubland
- Smooth-barked Apple Woodland
- Swamp mahogany/paerbark forest
- Weeds/cleared/bare sand
- Wet Heath Forest - Broad-leaved Paperbrk dominant
- Wet Heath Forest - Swamp Mahogany dominant

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Vegetation Communities Occuring within Study Area

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Figure 4.2

GIS Filename: \22\12808\GIS\MAPS\Ecology\Report Figs(Oct07)\Fig2_VegComm_231007.mxd

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- Scribbly Gum / Smooth-barked Apple Woodland:

Scribbly Gum / Smooth-barked Apple Woodland occurs on better drained soils within the study area, where the watertable does not appears to be as elevated, as evidenced by the absence of sedges and the predominance of bracken and blady grass. The canopy attains a height of 15 to 20 metres and approximately 50 to 60 per cent foliage cover. The dominant canopy species are Scribbly Gum (*Eucalyptus signata*) and Smooth-barked Apple (*Angophora costata*), with the latter species becoming less abundant in the north-eastern corner of the study area. A dense layer of shrubs common to moist sandy soils, including *Leptospermum polygalifolium*, *Melaleuca nodosa*, *Persoonia lanceolata*, *Hakea teretifolia* and *Melaleuca sieberi* dominates the mid-storey. The understorey comprises rushes, small shrubs, grasses and herbs. Rushes include *Leptocarpus tenax*, *Baloskion tetraphyllum subsp meiostachyum* and *Schoenus brevifolius*. Small shrubs include *Baeckea ramosissima subsp ramosissima, Leucopogon ericoides* and *Petrophile pulchella* while the dominant herb is Pomax (*Pomax umbellata*). Blady Grass and Bracken dominate the groundcover where the community adjoins the area of bare sand in the centre of the study area. Various species of terrestrial orchid and native lily also occur.

This community appears to correlate with LHCCREMS map unit: Tomago Sand Swamp Woodland (MU 36). Tomago Sand Swamp Woodland occurs on Quaternary sands of the Tomago Sandbeds, in areas where the sand is poorly drained. Structurally, this community ranges from a low open forest to a wet heath or sedgeland (House 2003). Variation in this community is dependent on soil drainage, with changes in structures occurring repeatedly over several hectares (House 2003). *Eucalyptus parramattensis subsp decadens* is the most common tree with local abundance of *Eucalyptus signata* in the western end of the sandbeds (House 2003).

Smooth-barked Apple is not listed within the map unit profile for Tomago Sand Swamp Woodland as a diagnostic species. However, the areas in which Smooth-barked Apple co-dominates with Scribbly Gum coincides with areas where the community merges with other communities in which Smooth-barked Apple is diagnostic, such as Coastal Wet Sand Cyperoid Heath and Coastal Plains Angophora Woodland.

- Red Gum Woodland:

Structurally, this community is a very a low open forest. Earp's Red Gum (*Eucalyptus parramattensis subsp decadens*) is the dominant tree species within the canopy, with Swamp Mahogany (*Eucalyptus robusta*) also occurring. Earp's Red Gum is listed as 'vulnerable' on both the TSC Act and EPBC Act.

The understorey comprises rushes and small shrubs, grasses and herbs. Rushes include *Leptocarpus tenax*, and *Schoenus brevifolius*. Small shrubs *include Melaleuca thymifolia, Baeckea ramosissima subsp ramosissima, Aotus ericoides, Leucopogon ericoides* and *Petrophile pulchella*, while the more commonly occuring grasses and herbs include *Entolasia stricta, Dampiera stricta* and *Hibbertia fasciculata*.

This community correlates with LHCCREMS map unit 36: Tomago Sand Swamp Woodland, which occurs on Quaternary sands of the Tomago Sandbeds in areas where the sand is poorly drained (House 2003). Tomago Sand Swamp Woodland is considered to be a regionally vulnerable and regionally specialised vegetation community.

- Swamp Mahogany / Paperbark Swamp Forest:

Swamp Mahogany / Paperbark Swamp Forest occurs as several sub-communities in areas of impeded drainage on Quaternary Sands across the study area. The first sub-community is typified by an open forest of Swamp Mahogany (*Eucalyptus robusta*) and Broad-leaved Paperbark (*Melaleuca quinquinervia*) with a predominance of Bracken (*Pteridium esculentum*) and Blady Grass (*Imperata cylindrica*) in the understorey, suggesting recent and/or frequent fire. *Acacia longifolia* dominates the understorey. Smooth-barked Apple (*Angophora costata*) occurs as a sub-dominant. This sub-community occurs in the northeast of the study area.

The second sub-community is a wet form with a high abundance of ferns in the lowest stratum (such as *Blechnum indicum* and *Hypolepis muelleri*), a form in which Swamp Mahogany / Paperbark Forest typically occurs on the coastal sands at Tomago (House 2003). Tall Saw Sedge (*Gahnia clarkeii*) is also common within in the understorey.

The third sub-community consists of regenerating stands of Swamp Mahogany / Paperbark Forest in disturbed areas where broad-scale clearing appears to have taken place in the last 10 to 15 years. This sub-community generally occurs in close proximity to the sand extraction area in the centre of the study area and is largely dominated by juvenile Broad-leaved Paperbark, with shrubs such as *Leptospermum polygalifolium*, *Banksia oblongifolia* and *Melaleuca nodosa* also occurring.

This community is considered to correlate with Swamp Sclerophyll Forest on Coastal Floodplains, an endangered ecological community listed under the TSC Act.

- Heathland:

Heathland occurs within the study area as a dense, short (less than two metres) complex of shrubs such as *Hakea teretifolia*, *Callistemon pachyphyllus*, *Acacia longifolia*, *Melaleuca nodosa, Monotoca scoparia,* in combination with sedges such as Tall Saw Sedge (*Gahnia seeberi, Leptocarpus tenax*, *Schoenus brevifolius* and *Lepyrodia scariosa.* This dense layer is interspersed with taller shrubs such as *Melaleuca seeberi*, *Callistemon citrinus* and *Banksia robur*. Small shrubs include *Melaleuca thymifolia, Baeckea ramosissima subsp ramosissima, Aotus ericoides, Leucopogon ericoides* and *Petrophile pulchella*, while the more commonly occurring groundcover species include *Entolasia stricta, Selaginella uliginosa* and *Hibbertia fasciculata*. *Cassytha glabella* forma *glabella* is also common.

Variation in this community is dependent on soil drainage and disturbance history, with structural changes occurring repeatedly throughout the study area. The heathland appears to be in the process of regenerating following past clearing, and is likely to have occurred as low open forest prior to clearing, as suggested by the sporadic emergence of juvenile eucalypts throughout the heathland.

Heathland within the study area correlates with the LHCCREMS map units 'Coastal Wet Sand Cyperoid Heath' (MU44), 'Tomago Sand Swamp Woodland' (MU36) and transitional vegetation where the two communities merge.

Coastal Wet Sand Cyperoid Heath is a wet heath community found on coastal sandy soils with permanently high water tables. A significant part of its distribution is found on the Tomago sand plain. Its most distinctive feature is an abundance of water tolerant sedges. Structurally, this community is variable between heathland and low open forest (House 2003). Where MU44 occurs in the study area as low open forest, it has been classified as 'Wet Heath Forest' (as described below).

Disturbed heathland within the study area is characterised by a predominance of Whisky Grass and Bracken Fern (the latter suggesting a high frequency of fire), as well as localised occurrences of opportunistic species such as *Acacia longifolia*.

- Wet Heath Forest:

Where Coastal Wet Sand Cyperoid Heath occurs within the study area as open forest or woodland, the canopy comprises *Melaleuca quinquinervia*, *Eucalyptus robusta* and *Angophora costata*, with a dense ground layer of sedges such as *Gahnia clarkei* and *Lepyrodia scariosa.* Floristic composition varies across the study area, with some areas supporting dense stands of Broad-leaved Paperbark. Elsewhere, the wet heath forest is dominated by Swamp Mahogany, with Broad-leaved Paperbark and Smooth-barked Apple occurring as co-dominants.

The understorey is dominated by shrubs such as Hakea *teretifolia* and *Callistemon pachyphyllus* and *Melaleuca sieberi.*

- Smooth-barked Apple Woodland:

Smooth-barked Apple Woodland is a dry shrubby community occurring on free-draining soils associated with sandy ridges and slopes within the study area. Mature Smooth-barked Apple, attaining a height of 20 to 25 metres, dominates the canopy. Red Bloodwood is present as an occasional occurrence, with a localized occurrence of Rough-barked Apple (*Angophora floribunda)* in the western portion of the study area. The dry shrubby mid-story comprises *Leptospermum polygalifolium, Dillwynia* retorta and Acacia *longifolia.* Juvenile Smooth-barked Apple dominates the mid-storey in areas where broad-scale clearing has occurred in the past. The ground layer is dominated by grasses such as *Entolasia stricta*, Bracken (*Pteridium esculentum*) and *Themeda australis*. Other common species found among the lower stratum include *Lomandra obliqua*, *Imperata cylindrica var major*, *Gonocarpus tetragynus, Lepidosperma laterale* and *Mirbelia rubiifolia*.

The Smooth-barked Apple Woodland in the western portion of the study area is highly disturbed, with low tree recruitment and dominance of the groundcover by Bracken Fern and Blady Grass. A well developed mid-storey is absent and shrub species only occur sporadically within the understorey.

- Freshwater Wetland:

A dam approximately 0.3 ha in size has been excavated in the western portion of the wetland resulting in a permanent freshwater wetland dominated by rushes and sedges such as Tall Spike Rush *Eleocharis sphacelata* and *Leptocarpus tenax*.