Mining Proposal Holcim Hawkins Road Sand Quarry, Jandabup – Tenements M70/1248 and M70/1250

Holcim (Australia) Pty Ltd

H04 – J06

30 October 2015

DISCLAIMER, CONFIDENTIALITY AND COPYRIGHT STATEMENT

REPORT DETAILS

Project Number: **H04 – J06**
Report Name: Mining Proposal Holcim Hawkins Road Sand Quarry, Jandabup – Tenements M70/1248 and M70/1250

AUTHORISATION FOR ISSUE

Report Version Date: **30 October 2015**			
Approved for Issue Director	Name: Laura Todd	Signature: 	Date: 30/10/2015

Please Note: This document is considered uncontrolled once printed.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF INSERTED DIAGRAMS

LIST OF APPENDICES

MINING PROPOSAL CHECKLIST

Q No	Mining Proposal checklist	Y/N NA	Page No	Comments
	Public availability			
1	Are you aware that this Mining Proposal is publicly available?	Y	N/A	
2	Is there any information in this mining proposal that should not be publicly available?	N	N/A	
3	If 'No' to Q2, do you have any problems with the information contained within this Mining Proposal being publicly available?	N	N/A	
4	If 'Yes' to Q2, has confidential information been submitted in a separate document / section?	N/A	N/A	
5	Has the Mining Proposal been endorsed? (See last page Checklist.)	Y	ix	
	Mining Proposal Details			
6	Have you included the tenement number(s), site name, proposal overview and date in the title page?	Y	Cover page	
7	Who authored the Mining Proposal?	Holcim Pty Ltd		
8	State who to contact for enquiries about the Mining Proposal?	Jo Russell - Planning & Environment Manager – WA/NT P 9212 2146 M 0429 791 431 Email joanna.russell@holcim.com		
9	How many copies were submitted to DMP?	Electronic = 1 Hard Copies = 0		
10	Is this Mining Proposal to support lease application?	N	N/A	
11	Has a Geological Resource Statement been included (refer section 4.3.2 of Mining Proposal Guidelines)	Y	4	
12	Will more than 10 million tonnes of ore and waste be extracted per year? State total tonnage:	N	4	Up to 1,200,000 tonnes is proposed to be extracted annually. It is estimated approximately 30,000,000 tonnes will be extracted over the 25 year quarry life. Up to 1,000,000 tonnes is proposed to be screened annually.
13	Will more than 2 million tonnes of ore be processed per year? State total throughput.	N	viii	Up to 1,000,000 tonnes is proposed to be screened annually.
14	Is the Mining Proposal located on pre-1899 Crown Grant Land? (not subject to the *Mining Act 1978*)	N	N/A	
15	Is the Mining Proposal located on Reserve Land? If 'Yes' state Reserve types in space below:	Y	N/A	The tenements fall within the Gnangara-Moore River State Forest (State Forest 65). This is a DPaW Managed Land, vested in the Conservation Commission and a listed Environmentally Sensitive Area – it is pine plantation and is an ESA due to groundwater protection issues.
16	Will the Mining Proposal occur within or affect a declared occupied townsite?	N	N/A	
17	Is the Mining Proposal within 2 km of the coastline or a Private Conservation Reserve?	N	16	
18	Is the Mining Proposal wholly or partially within a World Heritage Property, Biosphere Reserve, Heritage Site or Soil Reference Site.	N	N/A	
	Tenement Details			

Q No	Mining Proposal checklist	Y/N NA	Page No	Comments
19	Are all mining operations within granted or applied for tenement boundaries?	Y	1	
20	Are you the tenement holder of all tenements?	Y	1	
21	If 'No' at 20, do you have written authorisation from the tenement holder(s) to undertake the Mining Proposal activities? (Refer to section 4.2.1 of the Mining Proposal Guidelines)	N/A	N/A	
22	Is 'Yes' at 21, then is a copy of the authorisation contained within the Mining Proposal?	N/A	N/A	
23	Have you checked for compliance against tenement conditions?	Y	N/A	
	Location and Site Layout Plans			
24	Have you included location plans showing tenement boundaries and mining operations?	Y	Figures 1,2 3, 4 & 5	
25	Have you included site layout plans showing all mining operations and infrastructure in relation to tenement boundaries?	Y	As above	
26	Have you included "Area of Disturbance Tables" for all tenements impacted by mining operations?	Y	20	No new disturbance – project to be carried out in an area of existing disturbance
	Environmental Protection Act			
27	Does the Mining Proposal require referral under Part IV or the MOU? If 'Yes' describe why in space below:	Y	27	The proposal requires referral given it falls within the Environmental Protection (Gnangra Mound Crown Land) Policy (EPP) (1992). Holcim have submitted a referral.
28	Has the EPA set a level of assessment? If yes state:	N	N/A	
29	Is a clearing permit required? If 'No' then explain why in space below?	Y	N/A	The area has been identified to be within a non-permitted area (defined under Schedule 1, Section 4 of the Environmental Protection (Clearing of Native Vegetation) Regulations 2004). The clearing required to support this program has been approved by Native Vegetation Clearing Permit 6617/1 – granted on 6 August 2015.
30	If 'Yes' at Q29 then has a permit been applied for?	Y	N/A	
31	Is a Works Approval required by the DER (formerly DoE)?	Y	27	A Works Approval application is currently being prepared by Holcim.
32	Has a Works Approval application been submitted to the DER (formerly DoE)?	N	N/A	
33	**Stakeholder Consultation -** Have the following stakeholders been consulted? (use N/A if not applicable)			
	Shire?	Y	28	
	Pastoralist?	N/A	N/A	
	DER?	Will be	28	DER to be consulted as part of Works Approval Requirements
	Main Roads?	N/A	N/A	
	Others? (specify):	Y	28	DMP, FPC, DIA, DoW and DPaW

I hereby certify that to the best of my knowledge the above checklist accurately reflects the information contained within this Mining Proposal.

Name: **Jo Russel** Position: **Planning & Environment Manager – WA/NT**

Signature:  Date: 30 October 2015

EXECUTIVE SUMMARY

Holcim (Australia) Pty Ltd (Holcim) proposes to develop a Sand Quarry on tenements M70/1248 and M70/1250, located in Jandabup north of Perth, approximately 8 km north east of Wanneroo and within the Local Government Area of Wanneroo (Figure 1). The site falls within the Gnangara Pine Plantation, which has been progressively harvested since 2003 until the current time.

The project site is on the Gnangara Mound and is within a Priority 1 Drinking Water Source Protection Area (P1 DWSPA) and an Underground Water Pollution Control Area (UWPCA). Both are managed by the Department of Water (DoW). Water Corporation operates a public drinking water supply scheme that spans the Gnangara Mound. The site is at the south-western edge of this scheme.

As per the Statement of Planning Policy 2.2 *Gnangara Groundwater Protection* (Western Australian Planning Commission, 2005), sand extraction activities above the Gnangara groundwater mounds are permitted, but subject to environmental management detailed in the State-wide Policy No. 1 *Policy and Guidelines for Construction and Silica Sand Mining in Public Drinking Water Source Areas* (Waters and Rivers Commission, 2004). On that basis, Holcim has pro-actively initiated the consultation with the appropriate Governmental Agencies to discuss the key environmental management aspects to take into consideration.

Up to 1,200,000 tonnes is proposed to be extracted annually. It is estimated approximately 30,000,000 tonnes will be extracted over the 25 year quarry life. Up to 1,000,000 tonnes is proposed to be screened annually. The sand will be screened onsite and then trucked offsite Holcim concrete plants and/or customer locations.

A summary of the proposed project components is presented in Table E1.

Table E1: Project Key Characteristics

Project Component	Characteristic
Excavation	
Life of quarry	25 years
Annual material excavated	Up to 1,200,000 tonnes of sand
Total estimated material excavated	Up to 30,000,000 tonnes of sand
Total area of quarry footprint	357.8 ha
Maximum depth of mining above groundwater table	Excavation depth is limited to 3m above maximum groundwater level determined by URS (2015a).
Processing	
Annual material screened	Up to 1,000,000 tonnes of sand
Total material screened	Up to 25,000,000 tonnes of sand
Indicative Machinery List	
Water cart	Either 40000 or 12000 L capacity, used for dust suppression of haul road, pit floor and stockpiles.
Front end loaders	Two Komatsu 470 loaders or similar.
Grader	One CAT 14H grader or similar. For maintaining roads on an as required basis.
Light vehicles	Two for site operators.
Power generation	Western Power Grid supply off Hawkins Road and/or diesel generators
Screening Plant	The screening plant and stockpiling conveyor are track mounted mobile units and move with the quarry faces sand is excavated.

Project Component	Characteristic
Water supply	Bottled water will be supplied to staff as drinking water. Rainwater will be captured and stored onsite. It is currently planned to source water for dust suppression, from a groundwater source being negotiated with DoW. Holcim will obtain necessary approvals for any water supply bores as required.
Transport	
Truck movements and hours	Approximately 150 loaded and return truck movements each per day of operation (depending on truck size).
Workforce	
Operation	4-5 personnel during operation
Hours of operation	0700 to 1700 Monday to Saturday (excluding public holidays)

Commitments

Holcim proposes to undertake the following environmental commitments during the project to minimise potential impacts to the environment (Table E2).

Table E2: Summary of Commitments

Environmental Impact/Issue	Management Commitment
Access	• Holcim commit to reaching agreement with DPaW on roading access routes on an ongoing basis throughout the project. The process will be primarily managed through formal annual reviews with DPaW.
Visual Amenity	• Rehabilitate all disturbed and excavated areas, when work is completed. • Ensure barriers, fences and gates are compatible with the semi-rural style of the area or of a similar colour and texture to the natural landscape. • Locate the screening plant so the quarry pit walls screen it as far as possible. • Locate buildings in areas of low visual impact, and maintain appropriate size. • Operations will be undertaken from 0700–1700 Monday - Saturday (excluding public holidays) only. • A 300 m buffer will be maintained between the proposed quarry and all residents, this includes a 200m strip of vegetation to screen the operation. • Locate product stockpiles to create screening as far as practicable. • Adopt good house-keeping practises, such as orderly storage and removal of disused equipment or waste. • All visual amenity management measures will be incorporated into the Environmental Management Plan.
Surface Water	• Tree stumps will be retained as long as possible to assist soil stabilization. • A buffer zone of 100 m will be maintained between operations and naturally vegetated geomorphic wetlands. • Stockpiles of erodible material will be located away from roads and pavements to minimise sediment transport in runoff. • Each stage will be progressively rehabilitated at completion. • Vegetative cover will be established to minimise erosion. • Holcim will provide spill response equipment at the site. • Bunds will be established along the access road to contain stormwater runoff and settle out sediment. • Hydrocarbon and chemical management measures will ensure surface water contamination does not occur. • All surface water management measures will be incorporated into the Environmental and Water Management Plans.
Groundwater	• Excavation depth is limited to 3m above maximum groundwater level determined by URS (2015a). • Contamination and spills management will be implemented as described below.

Environmental Impact/Issue	Management Commitment
	• Surface water management as described above will ensure that all potentially contaminated surface water runoff will be detained and/or treated before discharge to the environment, minimising the risk of contamination to groundwater via infiltration. • Waste management will ensure that all wastes are disposed of appropriately minimising the risk of groundwater contamination. • All groundwater management measures will be incorporated into the Environmental and Water Management Plans.
Hydrocarbon, Dangerous Goods and Hazardous Substance Management	• The storage, handling and disposal of hazardous materials will be undertaken in a manner that complies with all relevant legal requirements. • Storage of minor quantities of hazardous substances and dangerous goods will only occur in designated areas, which are appropriately signed, bunded or contained. These areas are to be maintained in a clean and tidy state to minimise potential for spills or littering. • All hydrocarbons (grease, fuel, oils and lubricants) will be contained within bunds according to the requirements of Australian Standard 1940. • Hydrocarbons and other hazardous materials shall not be delivered to on site storage areas without appropriate bunding/containment. • Controlled wastes (including waste oil) will be collected and disposed of in accordance with the *Environmental Protection (Controlled Waste) Regulations 2004* which requires: o A licensed contractor to remove, transport and dispose of controlled wastes o Sufficient information be provided to enable categorisation of the waste and selection of an appropriate disposal site o Waste types and packaging to be suitable for transportation prior to collection. • Soil contaminated by hydrocarbons will be segregated into designated sites for storage, then removed from site. • Hydrocarbons and oily wastes (e.g. fuels, greases, de-greaser, emulsified oils and oily waste water) are to be managed using the following practices: o Minimal generation of waste and associated contaminants o Appropriate storage and handling procedures o Segregation of hydrocarbon waste from stormwater and other water o Clean-up procedures for spills. • Regular housekeeping and inspections of dangerous goods and hazardous substances will occur to ensure that storage and handling is appropriate. • Material Safety Data Sheets (MSDS) will maintained and easily accessible/located on-site for all hazardous substances and dangerous goods stored on site. • The workforce will be trained on handling dangerous goods and hazardous substances in line with associated MSDS. • A Spill Response Procedure will be implemented by Holcim. • Hydrocarbon/hazardous material spills will be reported in accordance with Holcim Incident Management Procedures. • Appropriate emergency equipment (including spill kits) will be made available on-site and replenished when required. • All spills will be immediately contained and cleaned up. All wastes from clean-up will be appropriately stored and disposed. • All site personnel will receive training on the Spill Response Procedure. • Copies of the Spill Response Procedure will be available with spill kits and in designated storage areas. • The Site Supervisor shall: o Provide advice in a timely nature as required by personnel regarding the management of hydrocarbons. o Ensure changes to management requirements are communicated to the workforce. o Ensure inspections are done on hydrocarbon storage areas. o Ensure training on Hydrocarbon Management is made available for operational personnel. • All hydrocarbon, dangerous goods and hazardous substance management measures will be incorporated into the Environmental and Water Management Plans.
Flora and Clearing	• Clearing will only occur in previously cleared pine plantation. • 50 m buffers will be maintained to Bush Forever Sites

Environmental Impact/Issue	Management Commitment
	• 100 m buffers will be maintained to naturally vegetated geomorphic wetlands. • 200m vegetation buffer will be maintained on the west boundary to screen the operation. • Vehicles will be restricted to designated access roads and excavation areas. • Areas will be cleared of tree stumps in stages, as they help stabilise the soil. • All flora management measures will be incorporated into the Environmental Management Plan.
Dieback	• All vehicles and equipment will be free of soil and plant material before entering the property. • Training programs and inductions will be conducted for site personnel. • All surface water will be contained onsite. Runoff from the quarry pit, stockpiles, cleaning down and haul roads will be contained, and not released into areas of native vegetation. • Light vehicles and machinery will be restricted to access roads, tracks and the excavation area. • All dieback management measures will be incorporated into the Environmental Management Plan.
Weeds	• All machinery and equipment brought onto site will be clean and free of soil and vegetative material. • Site personnel will be educated on weed risk measures and identification of problem species. • All weed management measures will be incorporated into the Environmental Management Plan.
Fauna	• All disturbance will occur in previously cleared pine plantation. • 50 m buffers will be maintained to the remnant vegetation in Bush Forever Sites • 100 m buffers will be maintained to naturally vegetated geomorphic wetlands. • Vehicles will be restricted to designated access roads and the excavation area. • All fauna management measures will be incorporated into the Environmental Management Plan.
Topsoil /Acid Sulphate Soils (ASS)	• Holcim will avoid disturbance of high ASS risk areas. Holcim commits to the exclusion of mining from a 100 metre buffer around mapped high to moderate risk ASS soils (including 100 metres around all wetlands whether mapped as high to moderate risk or not). • If mining is proposed within the 100 metre buffer, Holcim commits to the provision of a management plan which will include the results of ASS investigations and will incorporate the results into management strategies to be presented with a new mining proposal to be submitted for approval. • Overburden will be stockpiled and used for rehabilitation. • Excavation will not intersect the water table. Excavation depth is limited to 3m above maximum groundwater level determined by URS (2015a). • Based on precedents set by other sand mining operations in the pine plantation (including Rocla's adjacent Hawkins Rd Quarry), the topsoil will not be stripped separately, as the native seed bank will be negligible after growing pines since the 1960's. • Overburden and oversize material stockpiles will be used to recontour and rehabilitate the landscape at quarry closure and are thus temporary. • All topsoil and ASS management measures will be incorporated into the Environmental and Water Management Plans.
Waste	• Hydrocarbons and chemical containers, such as lubricants will be regularly removed from site for disposal at a licensed landfill facility or recycling centre. • Sewage waste will be transported off-site for treatment and disposal by a licensed contractor. No effluent will be released onsite. • Instruction will be provided to site personnel on waste management. • All waste management measures will be incorporated into the Environmental and Water Management Plans.
Noise	• The quarry pit face will be used as far as practicable to provide noise suppression between the nearest dwellings. • Operations will occur between 0700 – 1700 Monday – Saturday (excluding public holidays) to minimise the likelihood of noise nuisance. • All mobile equipment will be maintained, with efficient mufflers and noise shielding.

Environmental Impact/Issue	Management Commitment
	• Any complaints received regarding noise disturbance will be recorded and investigated immediately. • All noise management measures will be incorporated into the Environmental Management Plan.
Dust	• Dust suppression measures, such as water sprays/carts, will be implemented as necessary, in the event that high levels of dust are observed. • Dust will be visually monitored daily during operations and construction to ensure control measures are effective. • Cleared areas will be limited (as many tree stumps will be retained as possible, for as long as possible). • Access roads will be constructed of crushed limestone or other suitable road making material. • Activities with high dust-causing potential, such as stripping, will not be carried out in sensitive areas during adverse wind conditions. • Material drop heights between loaders and trucks and trucks to stockpiles will kept to the minimum practical height. • Any complaints will be investigated immediately. • All dust management measures will be incorporated into the Environmental Management Plan.
Local Community	• In the event of a community complaint, Holcim will investigate and take immediate remedial action. • Operations are limited to 0700 – 1700 Monday - Saturday only. No operations will occur on Sundays or public holidays. • A 300 m buffer will be maintained between the proposed quarry and all residents, this includes a 200m strip of vegetation to screen the operation. • 200m vegetation buffer will be maintained on the west boundary to screen the operation • The noise and dust management measures described above will be used to minimise noise and dust impacts on the community.
Heritage	• Holcim has already undertaken an Aboriginal Heritage survey. • Any identified heritage material will be protected and reported in accordance with relevant legislation. • Should any evidence of early aboriginal occupation be uncovered during works, all activities will be stopped, pending an assessment by a recognised consultant. • All heritage management measures will be incorporated into the Environmental Management Plan.
Rehabilitation/ Closure	• All buildings and infrastructure will be removed. • Any hard stand surfaces will be removed and used to recontour the landscape. • Overburden and oversize screened material will be used as to recontour the landscape. • Area will be seeded and vegetated according to the agreed prescriptions. • A Closure Plan which complies with the DMP 2011 Closure Guideline has been included within this Mining Proposal. • All rehabilitation management measures will be incorporated into the Rehabilitation Management Plan.
Monitoring	• Incorporate the following re-vegetation monitoring: o Short-term monitoring (eg 2nd Spring – 15 months) will focus on establishment success and the need for any short term remedial action including weed control. o Long-term vegetation observations will provide data regarding plant mortality, health, and reproduction to enable analysis of system function, dynamics and resilience. o Monitoring management measure will be incorporated into the Water, Rehabilitation and Environmental Management Plans as relevant. • A pre-quarrying groundwater monitoring programme commenced in May 2015 with the purpose of collecting baseline data. This programme has captured one winter peak to date and comprises both monthly and biannual aspects.' • The operational groundwater monitoring programme will commence following the onset of quarrying operations. The programme focuses on the key risks to the groundwater resource identified in the Water Management Plan (URS, 2015b). The comprehensive suite of analytes will be requested biannually.

1 BACKGROUND INFORMATION

Holcim (Australia) Pty Ltd (Holcim) proposes to develop a Sand Quarry on tenements M70/1248 and M70/1250, located in Jandabup north of Perth, approximately 8 km north east of Wanneroo and within the Local Government Area of Wanneroo (Figure 1). The site falls within the Gnangara Pine Plantation, which has been progressively harvested since 2003 until the current time.

1.1 OWNERSHIP OF LAND TENURE

Tenement numbers M70/1248 and M70/1250 are held by Holcim.

The contact details for the proponent are listed below:

Jo Russell
Planning & Environment Manager – WA/NT
Phone 08 9212 2146
Fax 08 9212 2002
Mobile 0429 791 431
Email joanna.russell@holcim.com
18 Brodie Hall Drive Bentley WA 6102
PO Box 1269 Bentley DC WA 6983

1.2 PROJECT OBJECTIVES

The objective of this project is to extract sand to supply to customers predominantly in the construction industry.

Up to 1,200,000 tonnes is proposed to be extracted annually. It is estimated approximately 30,000,000 tonnes will be extracted over the 25 year quarry life. Up to 1,000,000 tonnes is proposed to be screened annually. The sand will be screened onsite and then trucked offsite Holcim concrete plants and/or customer locations.

1.3 LOCATION AND SITE LAYOUT

The proposed quarry is located within Gnangara-Moore River State Forest in the City of Wanneroo. Tenements M70/1248 and M70/1250 fall within the Gnangara Pine Plantation, which has been progressively harvested since 2003 until the current time. The proposed project is located north of Perth, approximately 8 km north east of Wanneroo, within the Local Government Area of the City of Wanneroo (Figure 1).

The project site is on the Gnangara Mound and is within a Priority 1 Drinking Water Source Protection Area (P1 DWSPA) and an Underground Water Pollution Control Area (UWPCA). Both are managed by the Department of Water (DoW). Water Corporation operates a public drinking water supply scheme that spans the Gnangara Mound. The site is at the south-western edge of this scheme.

Proposed site layout plans are provided within Section 12 (Figures) as follows:

- Figure 1: Location
- Figure 2: Site Layout
- Figure 3: Site Compound Layout
- Figure 4: Quarry Staging Plan
- Figure 5: Site Access Routes.

1.4 HISTORY

The project area is located within the banksia woodland belt of the Swan Coastal Plain (SCP). The native vegetation was cleared approximately 85 years ago to establish the Gnangara Pine Plantation. The pine plantation is being progressively harvested as part of the Gnangara Sustainability Strategy (GSS), which is a joint project between the Department of Water (DoW), Department of Agriculture and Food WA (DAFWA), Department of Parks and Wildlife (DPaW), Department of Planning (DoP), Forest Products Commission (FPC), Water Corporation and CSIRO (Department of Water, 2009b). The GSS is a State Government initiative which aims to provide a framework for a whole of government approach to address land use and water planning issues associated with the Gnangara groundwater system. Three pine plantations have been targeted for harvesting by 2029. The project area has not been previously mined or excavated.

1.5 EXISTING FACILITIES

There are some unsealed roads that transect the project area. These are vested with the Department of Parks and Wildlife. There are also some unsealed tracks, likely used by logging contractors and recreational Four-Wheel Drives (4WDs).

There is no scheme water supply to the site. Bottled water will be supplied to staff as drinking water. Rainwater will be captured and stored onsite. Additional water will be sourced as describe in Section 3.10.

Power will be supplied by either diesel generators or grid connection where possible.

Existing public road infrastructure will be utilised.

2 EXISTING ENVIRONMENT

2.1 REGIONAL SETTING

The Interim Biogeographic Regionalisation for Australia (IBRA) classification system divides Australia into 85 bioregions and 404 subregions. The subregions are defined by major geomorphic features. The bioregions and sub-regions are the reporting unit for assessing the status of native ecosystems, their protection in the national reserve system and for use in the monitoring and evaluation framework in the Australian Government's current Natural Resource Management initiatives (Department of Environment, Water, Heritage and the Arts 2008).

The proposed sand quarry is located within the Swan Coastal Plain 2 (SWA2) Perth subregion, which lies within the Swan Coastal Plain (SCP) Bioregion. The SCP is a low lying coastal plain, mainly covered with woodlands. It is dominated by Banksia or Tuart on sandy soils, *Casuarina obesa* on outwash plains, and paperbark in swampy areas. In the east, the plain rises to duricrusted Mesozoic sediments dominated by Jarrah woodland. The climate is Warm Mediterranean. Three phases of marine sand dune development provide relief. The outwash plains, once dominated by *C. obesa*-marri woodlands and *Melaleuca* shrublands, are extensive only in the south.

The Perth subregion (SWA2) is composed of colluvial and Aeolian sands, alluvial river flats and coastal limestone. Heath and/or Tuart woodlands are present on the limestone, *Banksia* and Jarrah- *Banksia* woodlands on Quaternary marine dunes of various ages, and Marri on colluvial and alluvials. The region includes a complex series of seasonal wetlands and also includes Rottnest, Carnac and Garden Islands. Rainfall ranges between 600 and 1000 mm annually and the climate is Mediterranean. The subregional area is 1,333,901 ha.

2.2 CLIMATE

The proposed quarry is located just outside the Perth metropolitan area. The climate is classified as Mediterranean. The nearest open Climate station is at the Pearce Royal Australian Air Force (RAAF) base. This area experiences hot, dry summers and cool wet winters. Table 1 below displays the average annual climate data for RAAF Pearce Station No. 009053 (Bureau of Meteorology, 2015).

Table 1: Climatic Means from RAAF Pearce Station from 1937 to 2015 (Bureau of Meteorology, 2015)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
Pearce RAAF - BoM# 009053														
Mean Maximum Temperature (°C)	33.5	33.3	30.6	26.4	22.0	18.9	17.8	18.4	20.0	23.4	27.2	30.3	25.2	1940 - 2015
Mean Minimum Temperature (°C)	17.0	17.6	16.0	13.4	10.8	9.4	8.4	8.2	8.8	10.1	12.5	14.5	12.2	1940 - 2015
Mean Rainfall (mm)	7.6	12.2	15.1	34.8	84.9	132.3	133.8	104.2	70.1	36.2	23.7	10.6	679.2	1937 - 2015

2.3 GEOLOGY

The SCP consists of Pliocene to Quaternary sediments (collectively termed 'superficial formations' which comprise aeolian, alluvial, swamp, estuarine and shoreline sediments that were deposited on a gently seaward-sloping unconformity surface on top of Mesozoic sedimentary rocks (Bettenay, McArthur, & Hingston, 1960). The latter rocks include the Leederville Formation (Cretaceous) and the Yarragadee

Formation (Jurassic). Three major dune systems, oriented in a N-S direction, transect the SCP. The Bassendean dunes are the oldest (Pleistocene), lowest and most leached of the series. To the west of the Bassendean dune system are the siliceous Spearwood dunes which overlie limestone, and adjacent to the coast are the calcareous Quindalup dunes, the youngest unit (Bettenay, McArthur, & Hingston, 1960). The superficial formations (i.e. sands, sandstone and limestone) support Perth's two major aquifers: the Gnangara mound north of the Swan River (Department of Water, 2009a), and the Jandakot mound south of the river.

Department of Mines and Petroleum (DMP) surface geology mapping identifies the following surface geology type within the project area Figure 6:

- Most of the tenements are mapped as "S10: Sand – very light grey at surface, yellow at depth, fine to medium-grained, sub-rounded quartz, moderately well sorted of eolian origin."
- Small pockets of the tenement (outside the proposed area of disturbance) are mapped as "CPS: Peaty Clay, dark green and black with variable sand content of lacustrine origin."

2.3.1 RESOURCE STATEMENT

Up to 1,200,000 tonnes is proposed to be extracted annually. It is estimated approximately 30,000,000 tonnes will be extracted over the 25 year quarry life. Up to 1,000,000 tonnes is proposed to be screened annually. The sand will be screened onsite and then trucked offsite Holcim concrete plants and/or customer locations.

The sand will be used predominantly in the construction industry.

2.3.2 WASTE ROCK AND PROCESSING WASTE

Waste material from mining and screening will be mostly organic material leftover from pine stumps, and rocky oversize material. The sand will be screened and the oversize fraction will be stockpiled. This will be returned to the pit during rehabilitation of each stage.

The screening plant and stockpiling conveyor are track mounted mobile units and move with the quarry faces sand is excavated. Other than the screening of sand, there is no processing proposed. Therefore there will be no tailings or other processing wastes produced.

2.4 SOILS AND SOILS PROFILES

The project area overlies Bassendean Sands (Bettenay, McArthur, & Hingston, 1960). The Bassendean Sands have low relief with minor variations in topography, which translate to variable depth to the water table. It consists of low hills of siliceous sand interspersed with poorly drained areas including both seasonal and permanent swamps (Salama, Silberstein, & Pollock, 2005). This dune system originated along a coastline, perhaps as calcareous sand, but leaching has continued for so long that all carbonate has been lost and the steep relief so characteristic of beach dunes has been modified. The Bassendean Sands are characterized by a higher percentage of coarse and medium sands, than the neighboring Spearwood Sands occurring to the west.

Soil mapping by Department of Agriculture and Food WA (Figure 7) classifies soil types across the project area as follows:

- 212Bs_G: Pale deep sands and semi-wet soils
- 212Bs_Ja: Pal deep sands (low gently sloping dunes)
- 212Bs_Ws: Wet soils (often peaty) (Winter wet depressions)

2.4.1 ACID SULPHATE SOILS

Acid sulphate soils (ASS) are naturally occurring soils and sediments containing iron sulfides, most commonly pyrite. When ASS is exposed to air the iron sulfides in the soil react with oxygen and water to produce a variety of iron compounds and sulfuric acid. The resulting acid can release other substances, including heavy metals, from the soil and into the surrounding environment. These materials are characterised by bright yellow or straw coloured mottles of the mineral jarosite and often contain dark reddish coloured streaks. ASS have a soil pH 4 or less (Department of Environment, 2003).

Potential ASS (known as ASS) are soils or sediments which contain iron sulfides and/or other sulfidic minerals that have not been oxidised by exposure to air. The waterlogged layer may be peat, clay, loam or silty sand and is usually dark grey and soft. ASS are not known to be associated with environmental problems in their undisturbed state. While the natural exposure of these soils or sediments to air (e.g. during severe droughts) is associated with the generation of acid, the acidity tends to occur as low frequency, low magnitude, short duration events after drought breaking rains (Department of Environment, 2003).

If disturbed, ASS have the capacity to directly impact upon the basic natural assets of soil, water, biota and air, and thus upon most human endeavours, including agriculture, fishing, aquaculture, recreation, tourism, as well as human health and visual amenity. Impacts can include:

- Soil acidification
- Degradation of water-dependent ecosystems and ecosystem services
- Loss of habitat and biodiversity
- Invasion and dominance of wetlands.

The Department of Environment and Regulation (DER) have compiled ASS risk maps for several regions of Western Australia which provide broad-scale indication of the areas where ASS is most likely to exist. ASS categories within the project area are displayed in Figure 8. Most of the project area is classified as “Low Probability” of ASS occurrence. There are some small pockets which are classified as having a “High Probability” of acid sulphate soils occurrence – however these areas are not within the proposed quarry site disturbance (Figure 8).

As the proposed activities will not disturb the ground below the water table or any areas of high probability of ASS occurrence, it is unlikely that any ASS will be exposed or disturbed.

According to the guideline ‘*Identification and investigation of acid sulfate soils and acidic landscapes*’ (Department of Environment Regulation, 2015), sites should be investigated for ASS if extractive industry works are proposed in any of the areas listed in Table 1 of the guideline, which includes geomorphic wetlands. Accordingly, Holcim commits to the exclusion of mining from a 100 metre buffer around mapped high to moderate risk ASS soils (including 100 metres around all wetlands whether mapped as high to moderate risk or not). If mining is proposed within the 100 metre buffer, Holcim commits to the provision of a management plan which will include the results of ASS investigations and will incorporate the results into management strategies to be presented with a new mining proposal to be submitted for approval. The large sand resource for this project provides sufficient flexibility for forward planning and investigations to occur in a timely manner.

2.4.2 EFFECT OF SOIL CHARACTERISTICS ON REHABILITATION

Given soil in the area is predominantly sandy and acid sulphate soils will not be disturbed, it is unlikely that soil characteristics will affect rehabilitation.

Further information on topsoil management and rehabilitation is contained in Section 5.9.

2.5 TOPOGRAPHY

Topography for the site is shown in Figure 9. Elevation ranges from 50 m Australian Height Datum (AHD) to 80 M AHD.

2.6 HYDROLOGY

2.6.1 SURFACE DRAINAGE

There are no significant surface drainage lines or creeks within the proposed project area (Figure 10). Therefore all runoff is assumed to be via shallow dispersed flow.

The shallow geology of the project area consists predominantly of Bassendean sands. High infiltration is therefore expected. The lack of visible surface channelisation suggests that percolation of rainfall to groundwater is more significant than surface runoff.

2.6.2 WETLANDS

Categorisation of wetlands has been undertaken by Hill *et al.* (1996) for the SCP into a series of "Geomorphic Wetlands" as follows:

- "Conservation Category Wetlands" are those which support high levels of attributes and functions.
- "Resource Enhancement Wetlands" are those that have been partly modified but still support substantial functions and attributes.
- "Multiple Use Wetlands" are classified as those wetlands with few ecological attributes but which still provide important hydrologic functions.

A number of geomorphic wetlands exist within and/or surrounding the proposed project area as shown in Figure 10 including:

- Lake Jandabup to the west
- Hawkins Road Swamp to the northwest
- A dampland area to the east of Mining Tenement M70/1250.

Wetlands, including Lake Jandabup and Hawkins Road Swamp, have formed in the internal swales within the Bassendean Dune System. Lake Jandabup is a groundwater throughflow lake, whereby the water table on the up-gradient side is marginally higher than the lake surface, resulting in a discharge of shallow groundwater to the lake. On the down- gradient side of the lake, the water table is slightly lower than the lake surface, resulting in underflow and seasonal outflows to Superficial Formations to the west (URS, 2015b).

These wetlands are also influenced by direct rainfall, evapotranspiration and local groundwater abstractions by licensed and private bore owners. These influences have historically had a direct impact on the water levels in the lakes and swamps. Lake Jandabup is a regionally-significant wetland that is subject to Ministerial Statement 687 containing the following Ministerial Criteria (WAWA, 1995; DoW, 2008):

- An absolute summer minimum of 44.3 m AHD.
- An absolute spring minimum peak of 44.2 m AHD.
- A preferred spring minimum peak of 44.7 m AHD.
- The water level is only allowed between preferred and absolute minimum at a rate of two in every six years.

An operational and disturbance 100 m buffer is proposed from all naturally vegetated geomorphic wetlands (Figure 10). Appropriate water quality management and contamination prevention measures as described in Section 5 will prevent impacts to Jandabup Lake which is located approximately 500 m to the west of the proposed quarry.

2.6.3 SURFACE WATER QUALITY

Surface water data was requested from the DoW for a 5 km radius of the project area. There are 44 surface water sampling points, mostly in the vicinity of Mariginiup Lake. These points were sampled intermittently between 1962 and 2009. The data is summarised in Table 2. The Electrical Conductivity data classifies the water as at the low end of brackish.

Table 2: Summary of Surface Water Monitoring Data within 5 km radius of Tenements (DoW, 2009)

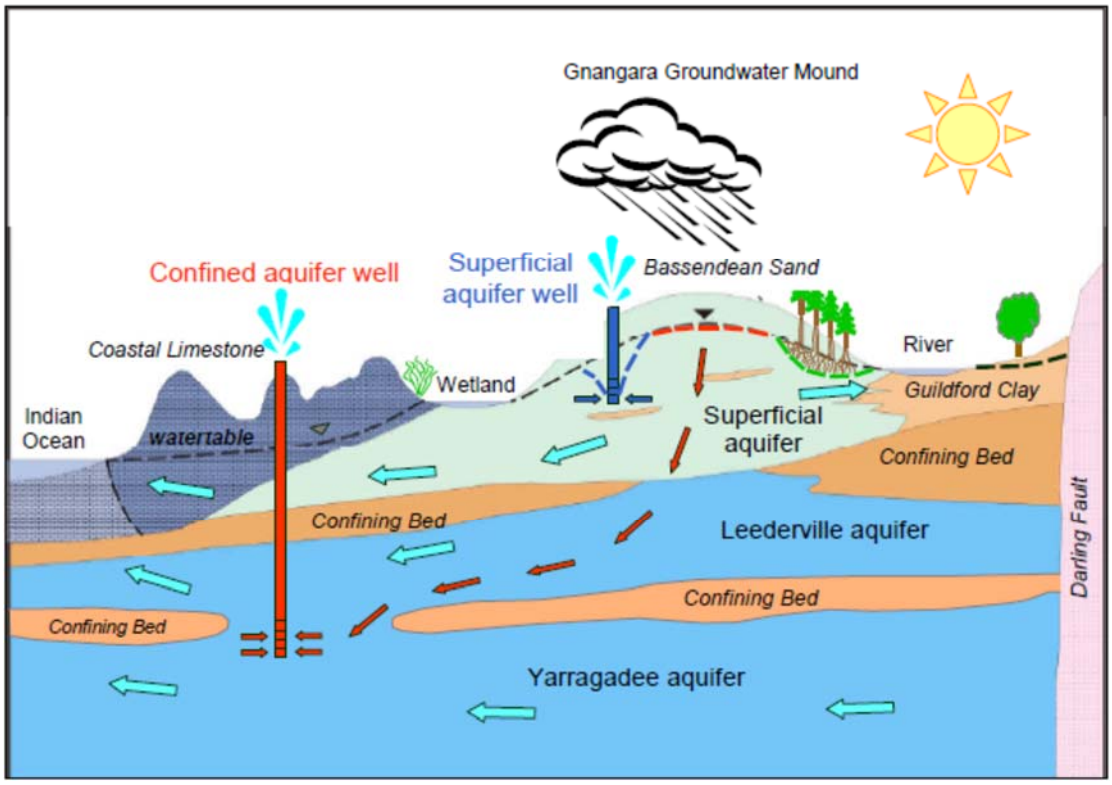
Surface Water Parameters	Minimum	Maximum
pH	3.7	6.4
Total Dissolved Solids (calc @180°C)-HCO_3 (mg/L)	15	3100
Electrical Conductivity (compensated 25ºC in situ) (µS/cm)	1406	1990
Total Nitrogen (mg/L)	0.05	14

2.7 HYDROGEOLOGY

2.7.1 REGIONAL HYDROGEOLOGY

The Perth Basin contains Western Australia's most important groundwater resources. It has extensive aquifers and renewable resources from the relatively high rainfall. Large supplies can be pumped from most parts of the basin, although some areas have high groundwater salinity, and some areas are now fully allocated. The Gnangara Mound is one of the SCP's two major aquifers (Department of Water, 2009a). The two major superficial aquifers in the SCP (the Gnangara mound north of the Swan River, and the Jandakot mound south of the river) are directly recharged by rainwater. The underlying mainly confined Leederville and Yarragadee formations contain vast amounts of water.

Regional groundwater levels in the superficial aquifer are a smoothed replica of the topography of the area. The water level forms a mound at the highest part of the area which discharges eastward and southward into the Swan River, northward toward Gingin River and westward to the ocean. At low points in the landscape, the water table frequently intersects the land surface to form lakes and swamps (Salama, Silberstein, & Pollock, 2005). Under natural conditions, the major outflows from the aquifers are due to evaporation from open water surfaces and transpiration by native vegetation and pine plantations. Other losses occur through groundwater recharge to the deeper aquifers at some localised points. The rate of groundwater flow from north to south on the Gnangara Mound is about 30 m per day beneath the Bassendean Dunes, and about 90 m per day east to west beneath the coastal strip (Salama, Silberstein, & Pollock, 2005). Insert 1 displays the interconnectivity between the wetlands, the superficial aquifer and the underlying aquifers.



Insert 1: Schematic of Water Balance of Gnangara Mound and Swan Coastal Plain (Silberstein, et al., 2007).

Of the two superficial aquifers, the Gnangara mound is by far the more significant in terms of size and public water supply. It stores >20,000 GL of good quality water, with the crest of the 'mound' being 70 m above sea level at maximum saturation. At present it supplies up to 60% of Perth's drinking water as well as supplying irrigation for horticulture and agriculture, and for public open space and garden bores. The aquifer is also important for sustaining numerous groundwater dependent ecosystems such as phreatophytic (groundwater-dependent) terrestrial vegetation, mound springs and caves, besides the wetlands. The increased demand from Perth's growing population, combined with decreasing winter rainfall, has resulted in serious aquifer depletion (nearly 600 GL since 1979), with drawdowns reported to be as much as 6 m at the top of the mound. Water balance studies such as Silberstein *et al.* (2007) show that the watertable has dropped < 6 m from 1975 to 1998. It is declining in storage by 50 GL per year. Consequently, many of the groundwater dependent seasonal wetlands on the mound have been experiencing prolonged and more severe summer drying. The two most common biogeochemical impacts of water table drawdown on the Gnangara mound wetlands are acidification at one extreme, and eutrophication at the other.

2.7.2 LOCAL HYDROGEOLOGY

The project is located within a drinking water source protection area known as the Gnangara Underground Water Pollution Control Area (Figure 11). Analysis of long term groundwater level data for surrounding DoW monitoring bores shows a fairly steady decline in water levels in all of the bores. The length of time for which records are available varies between the bores from 10 to 46 years (with an average of 33 years). This decline is well documented for the Gnangara mound and is caused by a combination of reduced rainfall, groundwater abstraction and evapotranspiration from pine plantations.

A Groundwater Assessment has been prepared for this project – Appendix A (URS, 2015a). To manage the risk of groundwater contamination, it is proposed to limit excavation depth to 3 m above the Maximum Groundwater Level (MGL) determined by URS (2015a) as well as implement contamination prevention measures as described in Section 5.3 and 5.4.

2.7.3 WATER QUALITY

Groundwater data was requested from the DoW for a 5 km radius of the project area. There are 531 bores recorded within this radius, mostly clustered around Jandabup and Mariginup Lakes. These bores have been monitored for a range of water quality variables (metals, nutrients, major ions, organics and microorganisms). The relevant groundwater data is summarised in Table 3. The data reveals some bores show signs of eutrophication (elevated nitrogen), and elevated microorganisms (coliforms), which can be an indicator of faecal contamination.

Table 3: Summary of Groundwater Monitoring Data for Bores within 5 km Radius of the Tenements (DoW, WIN Database Search 2009)

Groundwater Parameters	Minimum	Maximum
Coliforms (CFU/dL)	10	<70
Total Organic Carbon (mg/L)	23	21200
Total Kjedhal Nitrogen (mg/L)	0.17	390

Existing potential impacts to groundwater quality include regional acidic groundwater and the nearby Water Corporation groundwater treatment plant. The water treatment process includes coagulation and mixing, flocculation, sedimentation, filtration, disinfection and fluoridation. The three most common salts used are aluminium sulfate (alum), ferrous sulfate and ferric chloride. Disinfection includes the use of chlorine. The chemical reaction between chlorine and organic material can produce halogenated hydrocarbons such as trihalomethanes which are harmful to human health. Fluoride salts are a by-product of fluoridation.

2.8 VEGETATION AND FLORA

A flora survey and fauna habitat assessment was undertaken – the full survey report is included as Appendix B (EnviroWorks Consulting, 2015a). The potentially significant species and associations of flora expected to occur within the vicinity of the project area were identified and compiled by searching DPaW databases. The on-site floristic survey was undertaken in Autumn and Spring (13th May, 7th, 8th and 10th September) in accordance with Environmental Protection Authority (EPA) Guidance Statement Number 51 (2004) *Guidance for the Assessment of Environmental Factors: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*. Vegetation mapping undertaken as a result of this survey is provided in Figure 12.

2.8.1 LOCAL NATIVE VEGETATION PLANT COMMUNITIES

Two native vegetation community types were identified locally (both outside the proposed quarry disturbance area) (Figure 12):

- The first community (low woodland of *Banksia attenuate, Banksia menziesii* and *Allocasuarina fraseriana*) in uncleared areas.
- The second community (Open Low Woodland of *Eucalyptus rudis – Melaleuca preissiana* over wetland) includes areas of wetland vegetation which occur on seasonally wet sands.

The quarry footprint area was cleared approximately 85 years ago to establish the Gnangara Pine Plantation. The pine planation within the proposed quarry footprint was harvested recently, as part of the Gnangara Sustainability Strategy (GSS).

2.8.2 THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES

A Threatened or Priority Ecological Community (TEC or PEC) is one that has been endorsed by WA's Environment Minister as being subject to processes that threaten to destroy or significantly modify it across

much of its range. A search of the Department of Parks and Wildlife (DPaW) TEC/PEC database for 10 km buffer around the project area indicated 17 TECs / PECs occur within the within the search area as listed below.

However none of these DPaW TEC/PEC records occur within the proposed quarry disturbance area (Figure 13). No TEC's/PEC's were identified within the study through field visits – this is to be expected given the study area is predominantly cleared pine plantation (EnviroWorks Consulting, 2015a). It is highly unlikely that TECs or PECs would exist within the proposed quarry disturbance area which consists of no native vegetation – it occurs exclusively on pine plantation.

DPaW TEC / PEC records occurring within 10 km buffer of proposed project area:

1. Aquatic Root Mat Community Number 1 of Caves of the Swan Coastal Plain, CAVES SCP01, Critically Endangered
2. *Banksia attenuata* woodland over species rich dense shrublands, SCP20a, Endangered
3. *Banksia ilicifolia* woodlands, SCP22, Priority 3
4. Coastal shrublands on shallow sands, SCP29a, Priority 3
5. Communities of Tumulus Springs (Organic Mound Springs, Swan Coastal Plain), Mound Springs SCP, Critically Endangered
6. *Eucalyptus calophylla - Xanthorrhoea preissii* woodlands and shrublands, Swan Coastal Plain, SCP3c, Critically Endangered
7. Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain, SCP15, Vulnerable
8. Herb rich saline shrublands in clay pans, SCP07, Vulnerable
9. Herb rich shrublands in clay pans, SCP08, Vulnerable
10. Low lying *Banksia attenuata* woodlands or shrublands, SCP21c, Priority 3
11. *Melaleuca huegelii - Melaleuca acerosa* (currently M. systena) shrublands on limestone ridges (Gibson et al. 1994 type 26a), Limestone ridges (SCP 26a), Endangered
12. Northern Spearwood shrublands and woodlands, SCP24, Priority 3
13. Shrublands and woodlands on Muchea Limestone, Muchea Limestone, Endangered
14. Shrublands on calcareous silts of the Swan Coastal Plain, SCP18, Vulnerable
15. Shrublands on dry clay flats, SCP10a, Endangered
16. Southern *Eucalyptus gomphocephala - Agonis flexuosa* woodlands, SCP25, Priority 3
17. Swan Coastal Plain *Banksia attenuata - Banksia menziesii* woodlands, SCP23b, Priority 3.

2.8.3 VEGETATION CONDITION

The native vegetation within the study area is in completely degraded to very good ecological condition, according to the rating scale outlined in Keighery (1994). Much of the area has had a long history as a *Pinus pinaster* plantation. Parts of the plantation have been removed within the last 20 years and the native vegetation which is present is re-growth and young rehabilitation. Uncleared native vegetation is generally in good to very good ecological condition apart from localised disturbances and weed invasion associated with tracks and human activities (EnviroWorks Consulting, 2015a).

2.8.4 NATIVE FLORA

155 native plant species representing 110 genera and 39 families were recorded within the study area. The most common native plant families included Proteaceae, Myrtaceae and Fabaceae. Species of Eucalyptus, Banksia, Melaleuca and Nuytsia floribunda dominate the tree and taller shrub flora while Myrtaceae, Ericaceae and Fabaceae species are most common within the lower shrubs. Macrozamia fraseri and Xanthorrhoea preissii plants are common. The native ground flora is species rich with Cyperaceae, Restionaceae, Haemodoraceae and Asteraceae being the most common families (EnviroWorks Consulting, 2015a).

2.8.4.1 CONSERVATION SIGNIFICANT FLORA

A significant flora search requested from DPaW for a 10 km buffer around the project area, showed 37 species of conservation significance recorded previously within the search area as listed below.

None of these DPaW records occur within the proposed project area. The recorded location of *Pimelea calcicola* is from Hepburn Heights and has been incorrectly placed within the Jandabup search area likely due to data entry or recording errors.

No conservation significant flora species were located during field studies. It is unlikely that conservation significant flora species occur within the pine plantation areas, however they could be present within the Bush Forever Sites. Field studies were considered to be optimal in timing for the detection of conservation significant flora – refer to Appendix B (EnviroWorks Consulting, 2015a).

Conservation significant flora species records from DPaW search of 10 km buffer around project area are listed below:

1. *Acacia anomala*, Status: Threatened
2. *Acacia benthamii*, Status: Priority 2
3. *Anigozanthos humilis subsp. Chrysanthus*, Status: Priority 4
4. *Baeckea sp. Limestone (N. Gibson & M.N. Lyons 1425)*, Status: Priority 1
5. *Caladenia huegelii*, Status: Threatened
6. *Calectasia sp. Boundary Road (C. Tauss 557)*, Status: Priority 1
7. *Chamaescilla gibsonii*, Status: Priority 3
8. *Conostylis bracteata*, Status: Priority 3
9. *Cyathochaeta teretifolia*, Status: Priority 3
10. *Dampiera triloba*, Status: Priority 3
11. *Darwinia foetida*, Status: Threatened
12. *Dasymalla axillaris*, Status: Threatened
13. *Drosera occidentalis subsp. occidentalis*, Status: Priority 4
14. *Drosera x sidjamesii*, Status: Priority 1
15. *Eleocharis keigheryi*, Status: Threatened
16. *Eryngium pinnatifidum subsp. Palustre (G.J. Keighery 13459)*, Status: Priority 3
17. *Grevillea curviloba subsp. curviloba*, Status: Threatened
18. *Grevillea curviloba subsp. incurva*, Status: Threatened
19. *Guichenotia tuberculata*, Status: Priority 3
20. *Hibbertia helianthemoides*, Status: Priority 4
21. *Hydrocotyle lemnoides*, Status: Priority 4
22. *Hypolaena robusta*, Status: Priority 4
23. *Jacksonia sericea*, Status: Priority 4
24. *Phlebocarya pilosissima subsp. pilosissima*, Status: Priority 3
25. *Pimelea calcicola*, Status: Priority 3
26. *Pithocarpa corymbulosa*, Status: Priority 3
27. *Platysace ramosissima*, Status: Priority 3
28. *Poranthera moorokatta*, Status: Priority 2
29. *Schoenus griffinianus*, Status: Priority 3
30. *Stenanthemum sublineare*, Status: Priority 2
31. *Stylidium longitubum*, Status: Priority 3
32. *Stylidium trudgenii*, Status: Priority 3
33. *Tetraria sp. Chandala (G.J. Keighery 17055)*, Status: Priority 2
34. *Thelymitra variegata*, Status: Priority 3
35. *Trichocline sp. Treeton (B.J. Keighery & N. Gibson 564)*, Status: Priority 2
36. *Tripterococcus paniculatus*, Status: Priority 4
37. *Verticordia serrata var. linearis*, Status: Priority 3

2.8.5 WEEDS

The Department of Agriculture and Food WA (DAFWA) and the Agriculture Protection Board maintains a list of Declared Weeds for Western Australia. Declared weeds are required to be eradicated by the *Agricultural and Related Resources Protection Act 1976*. If a plant is declared for the whole of the State or for particular Local Government Areas, all landholders are obliged to control that plant on their properties. Declarations specify a category, or categories, for each plant according to the control strategies or objectives which the Agriculture Protection Board believes are appropriate in a particular place.

DAF Declared Plant Priority Classes include:

- P1 - Prohibits movement of plants or their seeds within the State. This prohibits the movement of contaminated machinery and produce including livestock and fodder.
- P2 - Eradicate infestation to destroy and prevent propagation each year until no plants remain. The infested area must be managed in such a way that prevents the spread of seed or plant parts on or in livestock, fodder, grain, vehicles and/or machinery.
- P3 - Control infestation in such a way that prevents the spread of seed or plant parts within and from the property on or in livestock, fodder, grain, vehicles and/or machinery. Treat to destroy and prevent seed set all plants.
- P4 - Prevent the spread of infestation from the property on or in livestock, fodder, grain, vehicles and/or machinery. Treat to destroy and prevent seed set on all plants.
- P5 - Infestations on public lands must be controlled.

During the field survey 61 weed species were recorded. All species are common weeds associated with disturbance and agriculture. One species *Emex australis* (Doublegee) is a Priority 1 Declared Plant within some W.A. local government areas under the Agriculture and Related Resources Act 1976. Weeds were most common within the plantation areas and along tracks. The majority of species are not considered to be serious environmental problems (EnviroWorks Consulting, 2015a).

2.9 FAUNA AND HABITAT

2.9.1 CONSERVATION SIGNFICANT FAUNA

A significant fauna search requested from DPaW for a 10 km buffer around the project area, showed 28 species of conservation significance recorded previously within the search area as listed below.

However none of these DPaW records occur within the proposed quarry disturbance footprint (Figure 15). No threatened fauna were observed during field studies. There was little evidence of fauna presence apart from kangaroos and birds. The project area is not considered significant fauna habitat given it is pine plantation currently under an existing program of clearing by DPaW (EnviroWorks Consulting, 2015a).

Conservation significant fauna species records from DPaW search of 10 km buffer around tenement are listed below:

1. *Botaurus poiciloptilus (Australasian Bittern)*, Status: Threatened
2. *Calidris ferruginea (Curlew Sandpiper)*, Status: Threatened
3. *Calyptorhynchus baudinii (Baudin's Cockatoo (long-billed black-cockatoo), Baudin's Cockatoo)*, Status: Threatened
4. *Calyptorhynchus latirostris (Carnaby's Cockatoo (short-billed black-cockatoo))*, Status: Threatened
5. *Dasyurus geoffroii (Chuditch, Western Quoll)*, Status: Threatened
6. *Falco peregrinus (Peregrine Falcon)* Status: Schedule 4 (Specially Protected)
7. *Falco peregrinus subsp. macropus (Australian Peregrine Falcon)* Status: Schedule 4 (Specially Protected)

8. *Actitis hypoleucos (Common Sandpiper)*, Status: International Agreement (Migratory)
9. *Ardea modesta (Eastern Great Egret)*, Status: International Agreement (Migratory)
10. *Calidris ruficollis (Red-necked Stint)*, Status: International Agreement (Migratory)
11. *Glareola maldivarum (Oriental Pratincole)*, Status: International Agreement (Migratory)
12. *Haliaeetus leucogaster (White-bellied Sea-Eagle)*, Status: International Agreement (Migratory)
13. *Limosa lapponica (Bar-tailed Godwit)*, Status: International Agreement (Migratory)
14. *Merops ornatus (Rainbow Bee-eater)*, Status: International Agreement (Migratory)
15. *Plegadis falcinellus (Glossy Ibis)*, Status: International Agreement (Migratory)
16. *Pluvialis squatarola (Grey Plover)*, Status: International Agreement (Migratory)
17. *Tringa glareola (Wood Sandpiper)*, Status: International Agreement (Migratory)
18. *Tringa nebularia (Common Greenshank)*, Status: International Agreement (Migratory)
19. *Tringa stagnatilis (Marsh Sandpiper)*, Status: International Agreement (Migratory)
20. *Xenus cinereus (Terek Sandpiper)*, Status: International Agreement (Migratory)
21. *Hylaeus globuliferus (bee)*, Status: Priority 3
22. *Leioproctus contrarius (bee)*, Status: Priority 3
23. *Neelaps calonotos (Black-striped Snake)*, Status: Priority 3
24. *Tyto novaehollandiae subsp. novaehollandiae (Masked Owl (southern subsp))*, Status: Priority 3
25. *Ardeotis australis (Australian Bustard)*, Status: Priority 4
26. *Ixobrychus minutus (Little Bittern)*, Status: Priority 4
27. *Macropus irma (Western Brush Wallaby)*, Status: Priority 4
28. *Isoodon obesulus subsp. fusciventer (Quenda, Southern Brown Bandicoot)*, Status: Priority 5

2.9.2 FAUNA HABITAT

The pine plantation vegetation and regrowth areas provide limited shelter and nesting locations and food resources (flowers, fruit, leaves) for terrestrial, arboreal and aerial species.

It should be noted that pine wildings, do represent potential foraging habitat for Carnaby's cockatoo which will feed on pine cones. However, the impact on Carnaby's feeding resources due to pine removal in the area is not likely considered to be an issue as pine removal more broadly is being addressed through the Strategic Assessment of the Perth and Peel Regions (SAPPR) (Department of Premier and Cabinet, Under Development). Public release of the draft SAPPR documents, including a Strategic Conservation Plan (SCP) and Impact Assessment Report, is expected early 2016.

The lack of large trees means the area does not contain habitat for large arboreal or aerial species. There is no breeding habitat for significant bird species (such as tree hollows). The low species richness of the native flora and the sparseness of this vegetation limits the habitat values of these areas (EnviroWorks Consulting, 2015a).

The areas of native vegetation and wetlands may provide fauna habitat. The Banksia woodland communities may provide foraging resources for Carnaby's Cockatoo (EnviroWorks Consulting, 2015a), however these areas are outside the proposed sand quarry footprint.

2.10 DIEBACK

Dieback refers to the introduced plant disease caused by *Phytophthora cinnamomi*. Although there are many species of *Phytophthora*, this is the species that causes the most severe and widespread damage to native plants in Western Australia. Up to 25% of native Western Australian plants are susceptible to *Phytophthora cinnamomi* (Komerek, Shearer, Smith, & Fairman, 1994). It is a microscopic fungus-like pathogen that destroys root systems. It is spread by the movement of water and soil, and management relates to controlling these (Dieback Working Group, 2005). There are no proven eradication methods, and limiting the spread to prevent further damage is the most cost effective measure.

P. cinnamomi is not native to Western Australia. It first arrived in Western Australia on soil around the roots of cultivated plants, shortly after European settlement. It was spread extensively throughout the Southwest when infected gravel was used for road construction. *P. cinnamomi* is now widespread throughout the

Southwest of Western Australia. It is confined to areas with more than 400 mm annual rainfall, and extends between Eneabba and Esperance. It has infested forest, heathland and woodland communities, and is present in much of the bushland around Perth.

The rate of uphill spread via root to root contact amongst host plants has been reported as approximately one metre per annum under ideal environmental conditions. The cross slope and down-slope rate of spread occurs much faster due to the influence of surface and sub-surface water-flows on the dispersal of zoospores. Native animals, feral animals and people act as vectors aiding the wide and rapid spread of dieback, thereby enabling it to establish new centres of infestation in previously un-infested areas.

Dieback is mapped by the presence of dead and dying indicator species which are known to be susceptible to the disease. Dieback has created management issues for road construction, timber harvesting, mining and other industries since land managers realised that the movement of soil is the most important method of transporting and spreading the pathogen.

The project area is considered Un-interpretable. As native vegetation has not been present since the 1960's, there is a lack of indicator species to map the pathogen. Therefore the site will be managed using the precautionary principle in regard to dieback.

2.11 SOCIAL ENVIRONMENT

2.11.1 LOCAL COMMUNITY

The project falls within the City of Wanneroo (Figure 1).

The City of Wanneroo is WA's fastest growing local government authority spanning both urban and rural areas (City of Wanneroo, 2014). The City of Wanneroo covers 686 square kilometres and has a population of approximately 180,000 people (Profile ID, 2014). With an abundance of residential, commercial and industrial land, the City of Wanneroo is undergoing significant development. The City encompasses a wide array of landscapes; from coastal plains to wetlands, from market gardens to residential homes, from thick bushland to urban development and industrial centres (City of Wanneroo, 2014).

2.11.2 LAND USES

The project is located within reserved land (Figure 16). The reserved land is designated as DPaW Managed Land, State Forest Number 65. The area is within the Gnangara Pine Plantation. The pines within the tenements have recently been cleared as part of the Gnangara Sustainability Strategy.

The Wanneroo Groundwater Treatment Plant (GWTP) and Diamond Poultry Farm are located nearby (Figure 16). Bulk dangerous goods are stored onsite at the GWTP; chlorine gas, fluorsocilic acid, hydrochloric acid and sodium hydroxide. Any failure or damage to chlorine equipment which results in a liquid chlorine leak is considered an extremely serious situation. In extreme cases it could be potentially fatal to Water Corporation personnel or members of the public. Concentrations above 37.0 ppm will cause throat irritation, above 74.3 ppm coughing and above 2,460 ppm will almost certainly cause death. Buffers are in place for residential development; these do not apply to mining and industrial premises. If approved, this quarry must be included in the Wanneroo GWTP Contingency Plan.

The tenements fall within the area zoned as State Forest and Water Catchment by the City of Wanneroo (Figure 16). Currently, Perth obtains a large proportion its water supply as groundwater from the Gnangara Mound and the project is within the associated drinking water protection area (Figure 11).

There is some 4WD tourism in the area. The public has 4WD access to most areas managed by the DPaW. The Gnangara Pine Plantation is one of only two metro areas gazetted by the DPAW for Off-Road Vehicle (for motorcycles only) (Department of Environment and Conservation, 2009a; ExploreOz.com, 2009).

2.11.3 NEAREST RESIDENTS

The nearest residents to the tenements are displayed in Figure 17. A 300 m buffer has been allowed for between the proposed quarry and all residents, this includes a 200m strip of vegetation to screen the operation. This complies with the recommended buffer for sand mining within EPA Guidance Statement Number 3 *Separation Distances between Industrial and Sensitive Land Uses* (Environmental Protection Authority, 2005).

The Water Corporation Groundwater Treatment Plant (GWTP) is approximately 500 to the north of the proposed sand quarry Figure 17.

A noise assessment has been conducted by Herring Storer Acoustics (2015) and is attached as Appendix C. Based on the site layout including the 300 m residential buffer, noise levels received at the nearest premises have been calculated to comply with the *Environmental Protection (Noise) Regulations 1997* for the operating times proposed (Monday to Saturday 07:00 to 17:00 hours (excluding Public Holidays)).

2.11.4 SURROUNDING MINING TENEMENTS

There are several other mining and exploration tenements within the surrounding area, including tenements held by Urban Resources and Rocla Quarry Products (Figure 18).

2.12 HERITAGE

2.12.1 ABORIGINAL HERITAGE

Aboriginal sites are places of importance and significance to Aboriginal people and to the cultural heritage of Western Australia. Aboriginal sites include:

- Archaeological - places where material remains associate with past Aboriginal land use.
- Anthropological - places of spiritual importance and significance to Aboriginal people.

The WA *Aboriginal Heritage Act 1972* protects places and objects that may be of importance and significance to Aboriginal people in Western Australia. The Department of Indigenous Affairs maintains a register of Aboriginal sites that are protected under the Aboriginal Heritage Act. It is an offence under this legislation to disturb an Aboriginal site. 'Disturb' is defined as "...excavate, destroy, damage, conceal, or in any way alter any Aboriginal site without prior authorisation of the Registrar of Aboriginal sites and/or consent of the Minister for Indigenous Affairs".

There are several recorded Aboriginal Heritage sites nearby, with the closest mapped site (ID 22160) located approximately 500 m to the north west (Figure 20).

Land clearing (including soil disturbance) for pine establishment commenced in the 1960's. It is highly likely that any heritage sites if present, would have been destroyed during this initial land clearing and pine forest establishment process. Therefore it is considered highly unlikely that any aboriginal heritage sites would remain within the pine plantation due to historical disturbance. In addition recent clearing of pines by the Forest Products Commission has resulted in significant additional disturbance.

Holcim commissioned Australian Heritage Management Services to undertake a heritage study over the project area. No heritage sites were identified during this survey (Australian Heritage Management Solutions, 2015) – refer to Appendix D for the full study report.

The potential for risk of disturbance to aboriginal heritage sites is therefore considered low.

2.12.2 EUROPEAN HERITAGE

There are no known European heritage sites within the tenement boundaries – the closest is Delamare House approximately 3 km to the north west of the tenement (Figure 21).

2.13 DPAW MANAGED LANDS AND CONSERVATION RESERVES

Conservation Reserves are Crown lands to which the *Conservation and Land Management Act 1984* applies (e.g. reserves and State forests). These lands are managed by DPaW. State forests are managed for multiple purposes, including water catchment protection, production on a sustainable yield basis, and conservation (DMP). These areas are afforded special protection and some land uses are not permitted within them.

The tenements fall within the Gnangara-Moore River State Forest (State Forest 65). This is a DPaW Managed Land, vested in the Conservation Commission and a listed Environmentally Sensitive Area (ESA) refer to Section below – it is pine plantation and is an ESA due to groundwater protection issues (Figure 19).

Jandabup Nature Reserve is located approximately 500 m to the west of the proposed quarry, and is a C class nature reserve, also vested in the Conservation Commission. Appropriate water quality management and contamination prevention measures as described in Section 5 will prevent impacts to Jandabup Nature Reserve and Jandabup Lake.

2.14 ENVIRONMENTALLY SENSITIVE AREAS

Environmentally sensitive areas are protected under the *Environmental Protection (Clearing of Native Vegetation) Regulation 2004* and are selected for their environmental values at state or national levels. They include:

- Defined wetlands and riparian vegetation within 50m
- Areas covered by Threatened Ecological Communities
- Area of vegetation within 50 m of Declared Rare Flora
- Bush Forever sites
- Protected wetlands as defined in the *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992*
- Areas of fringing native vegetation in the policy area as defined in *the Environmental Protection (Swan and Canning Rivers) Policy 1998.*

Two ESA's fall within the project area (Figure 19):

- Gnangara Groundwater Protection Area (Figure 11)
- Bush Forever site 326 (Figure 12).

The Bush Forever site will not be disturbed by the proposed quarry, and a minimum buffer of 50 m will be maintained.

2.15 WATER SOURCE PROTECTION AREAS

The Project site occurs within the context of regional DoW water management areas, sub-areas, and Public Drinking Water Source Areas (PDSWAs). The project is located within the Wanneroo Groundwater Area and Jandabup Groundwater Subarea. Groundwater resources in the Project area are managed by the DoW under the:

- Rights in Water and Irrigation Act (resource allocation as PDSWAs); and
- Metropolitan Water Supply, Sewerage and Drainage Act (pollution prevention as Underground Water Pollution Control Areas (UWPCAs)).

The project area is located in a Priority 1 Public Drinking Water Source Protection area (PDWSPA). Extractive industry operations (including sand quarrying) are considered to be an acceptable land use in such areas only if it can be demonstrated that there is sufficient clearance above the water table, and that there is adequate environmental management of the proposed activities i.e. considered a compatible land use with conditions (Waters and Rivers Commission, 2004). As the site is in a P1 PDWSPA, the pit floor and the proposed final surface level needs to remain 3m above the likely future maximum water table (Waters and Rivers Commission, 2004). This can be reduced to 2m in some circumstances, whereby the operator demonstrates that there will be no risk to groundwater resources, through effective management measures during operations. However, after the closure there must be a final 3m clearance to the likely future maximum groundwater level (MGL).

The Project site is also located in the Gnangara Underground Water Pollution Control Area (UWPCA). The Gnangara UWPCA and P1 PDSWA, exclude Lake Jandabup, with the boundaries located close to the eastern edge of the lake, west of the Project area. While extractive industries such as the proposed Jandabup Sand Quarry are compatible with the governing policies for the UWPCA, restrictions apply to the storage of fuels and chemicals, with strict guidelines for rehabilitation (Department of Water, 2013).

2.16 WELLHEAD PROTECTION ZONES

Wellhead protection zones (WHPZ) are used to protect underground sources of drinking water at the bore site-scale. They are circular (unless information is available to determine a different shape), with a radius of 500 metres in P1 areas, and 300 metres in P2 and P3 areas. WHPZs do not extend outside Public Drinking Water Source Area (PDWSA) boundaries (Department of Water, 2013). In accordance with *Water Quality Protection Note No. 15 – Extractive industries near sensitive water resources* (Department of Water, 2013), quarries should not be located in WHPZs. This is to minimise risk to water quality supply infrastructure, limit impact of any petroleum hydrocarbon contamination, and foster retention of natural buffers.

Existing drinking water supply bores (W220, W230 and W240) in the project area are protected by 500m exclusion zones, as they are all within a P1 PDWSA. Recent discussions with the Water Corporation indicate that they are no longer planning to use these bores for potable water supply in the future (*pers. comm.* Bendotti, P., 15 May 2015). However, the DoW has the responsibility of ensuring key drinking water supply infrastructure are protected, and recent advice is that the WHPZs must remain (*pers. comm*. Mackintosh, J., 28 July 2015).

Recent correspondence with both the Water Corporation and the Water Source Protection Branch of the DoW (*pers. comm.* Mackintosh, J., 28 July 2015) indicates that although sand quarrying can take place within the WHPZs, since the bores are no longer active for potable water supply, a buffer of 50m around the infrastructure including bores, pipelines and powerlines not to be disturbed was agreed. An assessment of the suitability of the 50m buffer to protect the water infrastructure was undertaken that considered the quarry depth, potential slope stability and failure mechanisms (AECOM, 2015). It was concluded that 50m was adequate to protect the infrastructure.

3 PROJECT DESCRIPTION

3.1 KEY COMPONENTS

The purposes of this project is to extract sand to supply to customers predominantly in the construction industry.

A summary of the proposed project components is presented in Table 4.

Table 4: Project Key Characteristics

Project Component	Characteristic
Excavation	
Life of quarry	25 years
Annual material excavated	Up to 1,200,000 tonnes of sand
Total estimated material excavated	Up to 30,000,000 tonnes of sand
Total area of quarry footprint	357.8 ha
Maximum depth of mining above groundwater table	Excavation depth is limited to 3m above maximum groundwater level determined by URS (2015a).
Processing	
Annual material screened	Up to 1,000,000 tonnes of sand
Total material screened	Up to 25,000,000 tonnes of sand
Indicative Machinery List	
Water cart	Either 40000 or 12000 L capacity, used for dust suppression of haul road, pit floor and stockpiles.
Front end loaders	Two Komatsu 470 loaders or similar.
Grader	One CAT 14H grader or similar. For maintaining roads on an as required basis.
Light vehicles	Two for site operators.
Power generation	Western Power Grid supply off Hawkins Road and/or diesel generators
Screening Plant	The screening plant and stockpiling conveyor are track mounted mobile units and move with the quarry faces sand is excavated.
Water supply	Bottled water will be supplied to staff as drinking water. Rainwater will be captured and stored onsite. It is currently planned to source water for dust suppression, from a groundwater source being negotiated with DoW. Holcim will obtain necessary approvals for any water supply bores as required.
Transport	
Truck movements and hours	Approximately 150 loaded and return truck movements each per day of operation (depending on truck size).
Workforce	
Operation	4-5 personnel during operation
Hours of operation	0700 to 1700 Monday to Saturday (excluding public holidays)

3.2 SITE LAYOUT

The proposed quarry is located within Gnangara-Moore River State Forest in the City of Wanneroo. Tenements M70/1248 and M70/1250 fall within the Gnangara Pine Plantation, which has been progressively harvested since 2003 until the current time. The proposed project is located approximately 8 km north east of Wanneroo (Figure 1).

Proposed site layout plans are provided with Section 12 (Figures) as follows:

- Figure 1: Location
- Figure 2: Site Layout
- Figure 3: Site Compound Layout
- Figure 4: Quarry Staging Plan
- Figure 5: Site Access Routes.

A buffer of 100 m has been maintained from naturally vegetated geomorphic wetlands, whilst a buffer of 50 m has been maintained from Bush Forever Sites.

A buffer of 300 m has been maintained from residents, this includes a 200m strip of vegetation to screen the operation. This complies with the recommended buffer for sand mining within EPA Guidance Statement Number 3 *Separation Distances between Industrial and Sensitive Land Uses* (Environmental Protection Authority, 2005).

3.2.1 SUPPORTING INFRASTRUCTURE

Supporting infrastructure comprises of

- laydown area;
- maintenance and fuel storage facility;
- site office and carpark;
- lunch room and ablutions;
- weighbridge and wheel wash facility; and
- power and communication lines.

During operations, temporary sand stockpiles are located within the extraction area prior to being loaded on to trucks and removed off site. Sand is either; extracted and directly loaded onto trucks, or undergoes a process of screening and washing. A process of screening is required for concrete sand and some construction sand products. A mobile screening is located at the site along with its own generator.

Once loaded onto trucks, the sand is weighed at the weighbridge facility and transported to customer locations offsite. Trucks are required to drive through a wheel wash bay, prior to leaving site. The wheel wash facility contains one bay with a containment apron and a wheel wash bay with a drive-in sump and an oil water separator. Water is collected in a closed-circuit system before being re-used for wheel washing. The wheel wash facility is lined by concrete. A demountable office will also be located at the weighbridge.

Supporting infrastructure associated with the Project includes lunch room with supporting ablution block, car park, laydown area and fuel storage facility, truck wash out bay and power and communication lines. A fenced laydown area will be used for the storage of heavy equipment and fuel. Diesel will be stored as described in Section 3.2.2 below. A lunch room with ablution facilities will be located alongside the maintenance area.

3.2.2 MAINTENANCE AREA, EQUIPMENT STORAGE AREA AND FUELLING FACILITY

Running repairs will occur on site, however major servicing of machines and equipment will occur off site. A running repairs maintenance area, equipment storage area and fuelling facility will be located within a fenced compound. An equipment storage area for the storage of heavy equipment will be located within the fenced compound. The running repairs maintenance area will contain one bay with a containment apron.

Oils will be stored in the maintenance area for equipment maintenance and will be segregated and bunded in accordance with Australian Standard (AS) 1940 and DMP and DER requirements.

Elevated chemical storage tank systems are prohibited in WHPZs. Elevated chemical tank systems (including fuels) within Underground Water Pollution Control Areas (UWPCA) should have a maximum capacity of 5,000L, unless approved by the Department of Water (Department of Water, 2006).

Diesel will be stored onsite in one self-bunded 20,000L or four 5,000L capacity storage tanks. The risk of diesel storage failure is considered low, as the fuel will be stored in a self-bunded, double skinned tank.

The fuel storage and refilling facility will be managed bunded in accordance with Holcim's Hydrocarbon and Water Management Plans, Australian Standard1940, DMP and DER requirements, with appropriate surface water drainage and collection.

A sump will operate at the site to collect waste water from the washdown bay and maintenance areas that will be covered to minimise the collection of runoff and risks associated with overflow. Water collected in the sump will be regularly removed by a licensed operator and disposed of at an approved waste facility. The sump will be constructed to a DoW approved design.

3.3 AREA OF DISTURBANCE

The total quarry footprint will be approximately 357.8 ha. The table below details the disturbance area. It should be noted that the project will cause no new disturbance as it is proposed in a previously disturbed pine plantation area.

Table 5: Areas of Proposed Disturbance (all within previously cleared pine plantation)

Description	Tenement M70/1248 Proposed Disturbance (ha) – within cleared pine plantation	Tenement M70/1250 Proposed Disturbance (ha) – within cleared pine plantation	Total Disturbance (ha)
Mining Area	135	211.8	346.8
Site and Infrastructure Compounds	1	0	1
Internal Site Roads	5	5	10
Tenement Total Disturbance (ha)	**141**	**216.8**	**357.8**
Tenement Undisturbed Area (ha)	**33.6**	**77.2**	
Tenement TOTAL Area (ha)	**174.6**	**294**	

3.4 CONSTRUCTION

The construction process will be minimal and will involve:

- Accurately marking out the construction areas
- Mobilisation of screen
- Installation of office block, workshop, weighbridge and ablution block
- Construction of the access roads

This process is expected to take four to eight weeks.

3.5 MINING OPERATIONS

Up to 1,200,000 tonnes is proposed to be extracted annually. It is estimated approximately 30,000,000 tonnes will be extracted over the 25 year quarry life. Up to 1,000,000 tonnes is proposed to be screened annually. The sand will be screened onsite and then trucked offsite Holcim concrete plants and/or customer locations. The nominal mining area characteristics are detailed in Table 6.

Table 6: Nominal Mining Operations Characteristics

Project component	Characteristic
Life of quarry	25 years
Annual material excavated	1,200,000 tonnes of sand
Total estimated material excavated	30,000,000 tonnes of sand
Total area of quarry footprint	357.8 ha
Maximum depth of mining above groundwater table	Excavation depth is limited to 3m above maximum groundwater level determined by URS (2015a).

The stockpiles for overburden and oversize screened material will be located in the designated stockpile of the run of quarry pad. Volumes are unknown but overburden depth is expected to be minimal due to the nature of the sand. Oversize material is expected to consist of organic matter and some rock, and is likely to be fairly low, especially if burnt. This location provides maximum screening for aesthetics and noise.

There will be two run of quarry stockpiles located north and south of the mobile screening plant, for screened and unscreened material. Allowance will be made to house the volume of at least seven days of screening. Note that not all material must be screened, only sand destined to be used in cement.

Based on precedents set by other sand mining operations in the pine plantation (including Rocla's adjacent Hawkins Rd Quarry), the topsoil will not be stripped separately, as the native seed bank will be negligible after housing pines since the 1960's. Overburden and oversize material stockpiles will be used to recontour the landscape at quarry closure and are thus temporary.

Excavation will begin on the western-most side of each stage, to allow easy access. A fence/bund will surround each excavation area.

The machinery proposed for the project is listed above in Table 4.

3.6 STAGING AND TIMING

The project will be generally carried out according to the following stages.

- Removal of any remaining pine stumps. Some of the tenements have already been burnt by the DPAW. Any remaining stumps will be dug up, windrowed and burnt or mulched.
- Overburden stripping and stockpiling.
- Establishment of supporting infrastructure (roads, buildings, screen etc).
- Mining of sand from the sides of hills inwards.
- Rehabilitation of to commence progressively where practicable.
- Final rehabilitation and closure to commence at the end of quarry life.

3.6.1 STAGING PLAN

The quarry staging plan is illustrated in Figure 4. Each stage will likely be completed within 1 to 3 years depending on market demand for product. It must be noted that these stages are only indicative and may change once the operation commence.

3.7 PIT DESIGN

Insert 2 shows the proposed excavation within Stage 1 commencing from the north and heading in a southerly direction. In stage 1, the pit floor will be approximately 1 to 6 m below the surrounding topography, thereby assisting with visual and noise buffering. Final batters will be no steeper than 3:1 horizontal to vertical.

Insert 3 shows the pit depth buffer from the groundwater table.

As stated above, stages are only indicative and may change once the operation commence.

3.8 SCREENING

Depending on purpose, some of the material will be screened prior to being trucked off-site. Only sand intended for use in concrete will be screened as required. The screening plant and stockpiling conveyor are track mounted mobile units and will move with the quarry faces sand is excavated. No further processing is required.

3.9 TAILINGS STORAGE

There will not be any tailings produced. The only waste will be oversize screened material, which will consist of organic material (mostly pine tree roots) and any rocky material present. This material will be stockpiled, and returned during rehabilitation of each stage.

3.10 WATER SUPPLY

Holcim have undertaken a review secure a water supply for the site. That review considered a number of potential sources, and followed a pre-defined water supply development strategy.

Discussions with the DoW and arrangements with potential water providers are still ongoing. Holcim will obtain necessary approvals for any water supply bores as required.

3.11 WORKFORCE

Personnel will commute to the site each day. During the construction phase, there will be up to 10 personnel onsite. During operations there will be approximately 4 - 5 personnel. Operating hours will be Monday to Saturday 0700 to 1700 for the duration of the quarry life. The site will not operate on Sundays or public holidays.

3.12 ACCESS AND TRANSPORT

The proposed access route to the site is shown in Figure 5. Access roads have been positioned to utilise existing state forest roads and avoid residential areas as far as practicable. Consultation will occur with DPaW regarding the use and maintenance of State Forest roads and with the City of Wanneroo regarding use of local roads outside the operation where required.

Access roads will be constructed of crushed limestone with a usable running surface width of 7.6 to 10 m, with windrows constructed along each side to prevent any surface water being discharged to adjacent undisturbed areas. Access and internal roads will not be sealed. Dust will be managed via wetting with water

carts when necessary. The width of disturbance is assumed to be up to14 m, allowing for 2 m of bunding on either side. A grader will be used on an as required basis to maintain access roads.

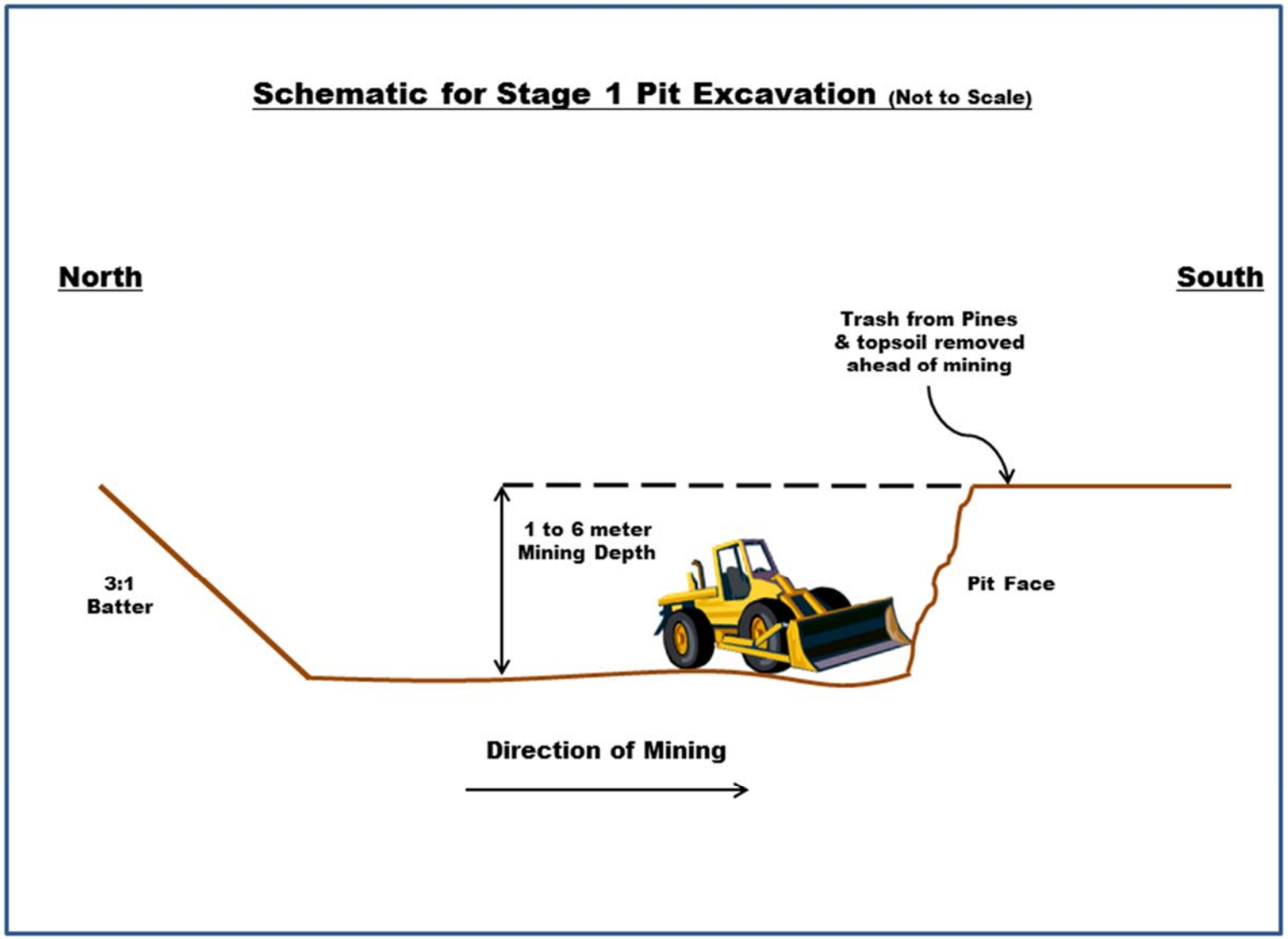
There will be between 30- 150 loaded and return truck movements per day, depending on the size of truck used and customer demand The sand will initially be transported in Semi-trailers (19m long, pay load of 26.5 T) however Holcim plans to use larger vehicles (Pocket Road Trains 27.5m semi-trailer road trains) to meet future demand. An assessment has been undertaken to determine the most appropriate transport route and to identify the impact that haulage operations will have on the road network and surrounding community. All loads leaving the site will be loaded using Loadrite equipped front end loaders. The loads will be covered.

Fencing and secure lockable gates will be installed at access points. These will be kept locked outside of operating hours. Warning signs will be erected to the standard required by the City of Wanneroo and the Department of Mines and Petroleum.

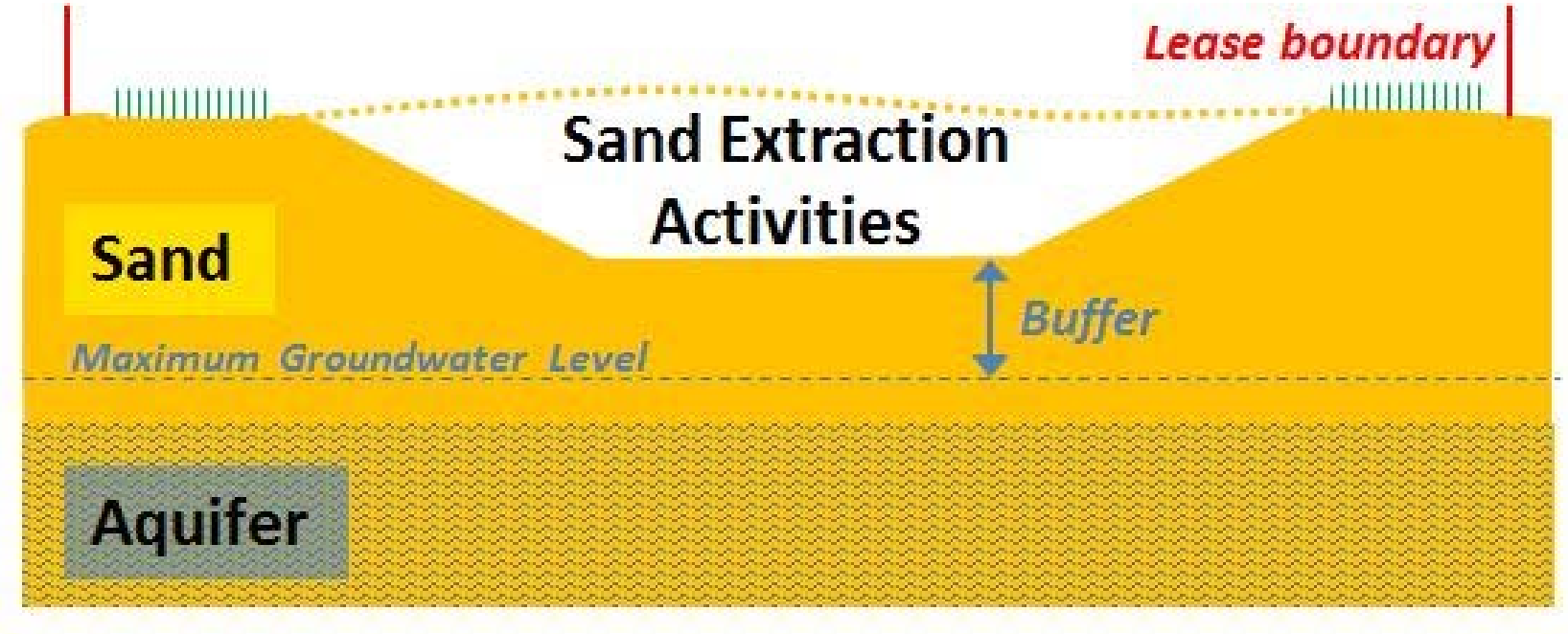
It is acknowledged that DPaW requires continued access to roads in the area. Therefore, if Holcim propose mining through roads alternatives are to be agreed with DPaW prior to proceeding. Holcim commit to reaching agreement with DPaW on roading access routes on an ongoing basis throughout the project. The process will be primarily managed through formal annual reviews with DPaW. Holcim also commit to resolving a final roading plan with DPaW upon decommissioning of the site.

3.13 RESIDENTIAL BUFFER

A buffer of 300 m has been maintained from residents, this includes a 200m strip of vegetation to screen the operation (Figure 17). This complies with the recommended buffer for sand mining within EPA Guidance Statement Number 3 *Separation Distances between Industrial and Sensitive Land Uses* (Environmental Protection Authority, 2005).



Insert 2: Schematic for Stage 1 Pit Excavation



Insert 3: Pit Depth Buffer from Groundwater Table

3.14 RESOURCE REQUIREMENTS

Bottled water will be supplied to staff as drinking water. Rainwater will also be captured and stored on site. Additional water will sourced as described in Section 3.10.

Diesel generators and/or grid connection if possible will provide power to the site and screening plant. Diesel, oil, lubricant, coolant and so on will be brought onsite as required.

3.15 COMPLIANCE WITH LEGISLATION AND OTHER APPROVALS

As per the Statement of Planning Policy 2.2 *Gnangara Groundwater Protection* (Western Australian Planning Commission, 2005), sand extraction activities above the Gnangara groundwater mounds are permitted, but subject to environmental management detailed in the State-wide Policy No. 1 *Policy and Guidelines for Construction and Silica Sand Mining in Public Drinking Water Source Areas* (Waters and Rivers Commission, 2004). On that basis, Holcim has pro-actively initiated the consultation with the appropriate Governmental Agencies to discuss the key environmental management aspects to take into consideration.

The proposal triggers criteria for referral under Pt IV of the Environmental Protection Act given if falls within the *Environmental Protection (Gnangra Mound Crown Land) Policy (EPP) (1992)*. Holcim have submitted a referral to the EPA.

In relation to groundwater, Holcim's tenement conditions state that:

- All proposed exploration activities within the Public Drinking Water Source Areas (PDWSA's) comply with the DoW water quality protection note land use capability in public drinking water areas.
- All Quarrying Act tenement activities are prohibited within a 300m radius of any observation well in a P2 area unless DoW approval is first obtained.
- All Quarrying Act tenement activities are prohibited within a 500m radius of any production well in a P1 area unless DoW approval is first obtained.
- Quarrying operations in PDWSA's must use dry soil extraction methods and leave an undisturbed soil profile above maximum groundwater levels as follows; P1 – 3 metres.

The project does not currently require any clearing of remnant native vegetation, as the project occurs within cleared pine plantation. However, the area has been identified to be within a non-permitted area (defined under Schedule 1, Section 4 of the Environmental Protection (Clearing of Native Vegetation) Regulations 2004). A Native Vegetation Clearing Permit is required to support the clearing for this program; an application is currently under assessment with the DMP.

Water supply will be obtained as outlined in Section 3.10. Necessary approvals will be obtained as required.

Part V of the EP Act covers Works Approvals and Licences. These are the key statutory tools the Department of Environment Regulation (DER) use to regulate industry in WA. They are intended to prevent pollution during both the construction and operational phases. All Prescribed premises (premises that are likely to cause pollution of the air, land or water), described in Schedule 1 of the WA *Environmental Protection Regulations 1987* require a Works Approval for construction and a Licence to commence and continue operations.

The proposed quarry will be classified as a Prescribed Premise under Category 12 where more than 50,000 tonnes per year of sand is screened. The Works Approval and Licencing Requirements will be discussed with the DER as required in due course. A mobile screening plant will be used.

The key Commonwealth and State legislation relevant to this project has been summarised in Table 7.

Table 7: Key Commonwealth and State Legislation

Legislation	Relevance	Regulatory Authority
Environmental Protection Act 1986 (WA)	Prevention, control and abatement of pollution, including dust, and conservation protection and enhancement of the environment. Regulates vegetation clearing and the screening licence.	DER
Wildlife Conservation Act 1950 (WA)	Provides for the conservation and protection of wildlife (flora and fauna). Special provisions and schedules cover protection and management of gazetted rare flora and fauna.	DPaW
Conservation and Land Management Act 1984	Administers all reserved land vested in the Conservation Commission, collectively referred to as DPAW Managed lands.	DPaW
Environmental Protection (Clearing of Native Vegetation) Regulations 2004 (WA)	Covers clearing of native vegetation. A clearing permit must be sought under these regulations.	DPaW
Environmental Protection (Noise) Regulations 1997 (WA)	Covers noise limits for certain premises listed.	DER
Agriculture and Related Resources Protection Act 1976 (WA)	Covers management of weeds with potential to impact agricultural production.	Department of Agriculture and Food WA (DAFWA)
Road Traffic (Vehicle Standards) Regulations 2002 and the Road Traffic (Vehicle Standards)	The Department of Transport administers all heavy vehicle legislation and manages all areas of vehicle and driver licensing.	The Department of Transport

3.15.1 ENVIRONMENTAL BONDS

Almost all mining proposals involving ground disturbance require the tenement holder to submit environmental bonds prior to approval. The purpose of Environmental Bonds is to ensure that the State is not exposed to unacceptable cost should quarry operators fail to meet the rehabilitation requirements of the tenements. Alternatively contribution to the Mining Rehabilitation Fund can be undertaken.

Holcim will meet these requirements.

4 CONSULTATION

4.1 CONSULTATION REGISTER

To date the proponent (Holcim) have made a number of contacts with stakeholders and plans to build on this platform of communication through ongoing consultation. The details of stakeholder consultation undertaken to date is outlined in Table 8.

Table 8: Consultation Register

Stakeholder	Who Was Consulted	Date	Method	Topics Discussed	Issues Raised by Stakeholder	Outcome / Response
DoW	Amy Evangelista Natural Resource Manager	25/11/15	Meeting	Overview given of proposed project and proposed groundwater studies	DoW nominated initial contact points for further discussions. DoW provided advice on: - Methodology for determination of MGL – level needs to be carefully considered given changing land use and rainfall patters. - Management of wellhead protection zones (WHPZ's) for existing water corp bores in the area discussed - Baseline water quality monitoring - Water Source Planning – Holcim should plan for a water source for dust suppression - Hydrogeological assessment – Holcim should use the "composite scenario" when assessing future water table elevations.	Holcim made note of designated contact points and other DoW advice. DoW advice was incorporated into planning groundwater assessment and management for the project.
DoW	Amy Evangelista Natural Resource Manager	3/12/15	Email	Memo emailed to DoW covering the drilling and monitoring bore construction activities planned by Holcim at their Jandabup Project site	DoW agreed that the monitoring program should proceed and indicated the bores construction could commence	Holcim commenced construction of monitoring bores
DoW	Amy Evangelista Natural Resource Manager	16/1/15	Email	DoW advised that: - Extractive industry is permissible in P1 Drinking Water Source Area if there is sufficient clearance above water table and sufficient environmental management. - DoW recommended a Water Management Plan be developed - The quarry should not be located in a WHPZ	Holcim noted DoW advice and committed to development of a Water Management Plan	N/A

Stakeholder	Who Was Consulted	Date	Method	Topics Discussed	Issues Raised by Stakeholder	Outcome / Response
DoW	Amy Evangelista Natural Resource Manager	23/2/15	Email	Holcim provided two reports to DoW: - Phase 1 Desktop Study and Recommendations - Phase 3 Monitoring Bore Completion Report	DoW indicated it was generally happy with the proposed monitoring program, however sought clarification on the duration of monitoring.	Holcim clarified that monitoring would be ongoing for the life of the project.
DoW	Amy Evangelista Natural Resource Manager	4/6/15	Email	Holcim provided DoW with correspondence from Water Corporation showing that the watercorp bores within the project are no longer used and proposed removal of the WHPZ.	DoW confirmed that the WHPZ's could be removed and indicated it would investigate the process to do so.	N/A
DoW	Bree Lyons Natural Resource Management Officer	16/7/15	Email	Well head protection zone (WHPZ), separation to MGL and determination of MGL.	DoW advised that: -It would investigate removal of WHPZ -3m separation to MGL will be required. DoW provided advice on how MGL should be determined.	Holcim requested further clarification on the methodology to determine MGL
DoW	Bree Lyons Natural Resource Management Officer	16/7/15	Email	Holcim requested further clarification on determination of MGL. Based on discussions with DoW hydrogeologists Holcim propose determination of MGL using long term data to establish a future predicted MGL based on a set of pre-defined criteria using an agreed model.	N/A. Holcim requested a meeting to discuss further.	Meeting arranged for 28/7/15
DoW	James Mackintosh Program Manager Land Use Planning Swan Avon Region	28/7/15	Meeting	DoW advised that contrary to previous advice, the WHPZs will remain, irrespective of any discussions and correspondence that have been had with the Water Corporation. Discussion was held regarding the methodology for determination of MGL.	Although the WHPZs will remain, this will not preclude mining by Holcim as no activities are planned to extent below the water table provide appropriate management is in place.	Holcim committed to provide DoW with proposed MGL assessment methodology for review after the meeting.
DoW	James Mackintosh Program Manager Land Use Planning Swan Avon Region	5/8/15	Email	Memo provided to Water Protection Branch outlining proposed approach for ongoing groundwater assessment and determination of MGL.	DoW responded indicating that the proposed approach for ongoing groundwater assessment and determination of MGL was acceptable, and that DoW will do PRAMS modelling to verify the results.	Holcim commenced the ongoing groundwater assessment and determination of MGL via modelling.

Stakeholder	Who Was Consulted	Date	Method	Topics Discussed	Issues Raised by Stakeholder	Outcome / Response
DoW	James Mackintosh Program Manager Land Use Planning Swan Avon Region	17/9/15	Meeting	DoW advised that they are close to completing their latest update to the PRAMS model and that this will provide the foundation for the determination of an MGL for the Holcim Jandabup Project.	The Holcim groundwater assessment will be submitted in November with the Mining Proposal. DoW advised that the Project's groundwater assessment and adopted model would be reviewed by the DoW with a view to resolve differences relating to regional changes predicted by PRAMS once those results were available	N/A
DoW	Carlie Slodecki Land Use Planning – Swan Avon Region	22/10/15	Phone Email	Fuel Storage	5000 litres is the total volume (of all tanks) permitted in a P1 area, which is substantiated by the following statement (highlighted below) in *Water Quality Protection Note No. 56 - Tanks for elevated chemical storage* (DoW, 2006). Therefore if Holcim are proposing to store greater than 5,000 L, in accordance with the policy, justification of special circumstances warranting additional storage and assessment of environmental risk and mitigation measures must be submitted by the proponent to the DoW for approval (which can be addressed in the required Water Management Plan).	Additional fuel storage will be requested in the Water Management Plan.
City of Wanneroo	Josh Coppola Planning Advisor: Extractive Industries	22/10/15	Meeting	• Drilling program • Project update • Traffic management • Environmental impacts • Community engagement, door knocking local residents	Assess the Traffic Impact will be assessed once the assessment is finalised. The City of Wanneroo believes a Development Approval is required, Holcim have received conflicting advice. A community information brochure will be sent out to neighbouring residents and City of Wanneroo Councillors in early November.	Holcim will send a copy of the community information sheet to the Planning department and Councillors
City of Wanneroo	Josh Coppola Planning Advisor: Extractive Industries	13/4/15	Meeting	• Project Background • Traffic management • Environmental impacts • Community engagement	The City recommends that Holcim: • Assess the Traffic Impact as required.	Holcim have conducted a traffic study which will be provided to the City for review.
EPASU	Mark Jefferies Manager Mining and Industrial Assessments	25/5/15	Email	Requested a meeting to discuss proposed Jandabup Quarry	Agreed to meet	Meeting set for 10/6/15

Stakeholder	Who Was Consulted	Date	Method	Topics Discussed	Issues Raised by Stakeholder	Outcome / Response
EPASU	Mark Jefferies Manager Mining and Industrial Assessments	9/6/15	Email	Emailed briefing note, intended for discussion at meeting the following day	N/A	N/A
EPASU	Mark Jefferies Manager Mining and Industrial Assessments	10/6/15	Meeting	Discussed Briefing Note on Proposed Jandabup Sand Quarry. Discussed Perth to Peel Strategic Assessment and likely end land use.	Indicated briefing note contained useful information on project key characteristics and environmental factors. Confirmed it was Holcim's decision on whether to refer the project to the EPA. Indicated that if Holcim chose not to refer the project, DMP would discuss the Mining Proposal and need for referral with EPA.	Holcim indicated it would consider the need for referral to the EPA. If Holcim decides not to refer to the EPA, it understands that DMP will discuss this with EPA on receipt of the Mining Proposal.
EPASU	Richard Sutherland Principal Environmental Officer, Mining and Industrial Assessments (South)	23/9/15	Meeting	Discussed whether the project required referral to the EPA under Section 38 of the EP Act because the tenements fall within the *Environmental Protection (Gnangra Mound Crown Land) Policy (EPP) (1992).*	Project does require referral due to the EPP.	Holcim committed to refer the project to EPA.
DPaW	Dan Coffey Area Manager South, Environmental Management Branch	13/5/15	Phone Call	Requested meeting to discuss proposed Jandabup Quarry	Agreed to meet	Meeting set for 12/6/15
DPaW	Dan Coffey Area Manager South, Environmental Management Branch	11/6/15	email	Emailed briefing note, intended for discussion at meeting the following day	N/A	N/A
DPaW	Dan Coffey Area Manager South, Environmental Management Branch	12/6/15	Meeting	Discussed briefing note and intended end land use. Discussed proposed rehabilitation methods.	DPaW suggested that Holcim prepare a Rehabilitation Plan and provide to DPaW for comment, prior to submission of Mining Proposal. DPaW also suggested that Holcim collaborate regarding rehabilitation research with other companies operating in the area.	Holcim agreed to provide rehabilitation plan to DPaW prior to submission of Mining Proposal. Holcim also indicated it would collaborate with other companies in area on rehabilitation research.
DPaW	Dan Coffey Area Manager South, Environmental Management Branch	22/7/15	Email	Provided a copy of the Draft Rehabilitation Plan for comment by DPaW	Verbal feedback provided on plan by phone. DPaW enquired about additional completion criteria.	Feedback incorporated into plan. Holcim responded that additional completion criteria will be provided to DPaW for comment within the Closure Plan.

Stakeholder	Who Was Consulted	Date	Method	Topics Discussed	Issues Raised by Stakeholder	Outcome / Response
DPaW	Dan Coffey Area Manager South, Environmental Management Branch	22/7/15	Email	Draft Rehabilitation Plan	• Additional completion criteria required. • Rehabilitation Plan should be incorporated into Mine Closure Plan	Feedback incorporated into plan. Holcim responded that additional completion criteria will be provided to DPaW for comment within the Closure Plan.
DMP	Clare Grosser Team Leader, Operations Environment	10/6/15	Email	Requested meeting to discuss proposed Jandabup Quarry	Agreed to meet	Meeting set for 15/6/15
DMP	Clare Grosser Team Leader, Operations Environment	10/6/15	email	Emailed briefing note, intended for discussion at meeting the following day	N/A	N/A
DMP	Clare Grosser Team Leader, Operations Environment	15/6/15	Meeting	Discussed briefing note and intended end land use. Discussed proposed rehabilitation methods. Discussed consultation that has occurred with other regulatory stakeholders. Discussed proposed environmental management.	DMP indicated that Holcims regulatory consultation and proposed environmental management seemed adequate to date. DMP indicated it would discuss the need for referral with EPA once the Mining Proposal was received. DMP indicated Holcim should consider submitting clearing permit application ASAP to ensure this is in the system early.	Holcim indicated it was planning on submitting the Mining Proposal in the next few months and it would submit the clearing permit application in the next few weeks.
DMP	Clare Grosser Team Leader, Operations Environment	25/9/15	Meeting	Discussed whether the project required referral to the EPA under Section 38 of the EP Act because the tenements fall within the *Environmental Protection (Gnangra Mound Crown Land) Policy (EPP) (1992).*	Project does require referral due to the EPP.	Holcim committed to refer the project to EPA.
FPC	Andrew Milne FPC	17/6/15	Meeting	Advised FPC of Holcim Proposed Jandabup Quarry	No issues raised, but asked to be kept informed of planned access routes.	Holcim indicated it would keep FPC informed of planned access routes.
DIA	Cesar Rodriguez, Manager Advice and Approvals	16/6/15	Meeting	Advised DIA of Proposed Jandabup Quarry	No issues raised, but indicated consultation with relevant indigenous representatives should take place.	Holcim plan to undertake a Heritage Study which will include consultation with relevant indigenous representatives.

Stakeholder	Who Was Consulted	Date	Method	Topics Discussed	Issues Raised by Stakeholder	Outcome / Response
Neighboring Residents	Residents on Townsend Road, Hawkins Road, Wirrega Road, Panini Way.	October	Door knocking	Summary of the Proposed Jandabup Quarry	Residents mainly raised concerns over the visual amenity, dust, noise, hours of operation and truck routes. 3 residents mentioned that they had not been consultant when the neighbouring operation was approved. 2 residents mentioned the drying of Lake Jandabup from the pine plantation. 5 residents raised concerns over illegal dumping and off road vehicle use in the area. 3 residents asked questions regarding the end land use of the area.	Truck movements are limited by mine pit opening time at 7am. Operations will be undertaken from 0700–1700 Monday - Saturday (excluding public holidays) only. A 300 m buffer will be maintained between the proposed quarry and all residents, this includes a 200m strip of vegetation to screen the operation HAUS has water trucks and sprinklers to reduce dust levels (Section 4.9). A noise assessment determined that the operation will operate within the Australia Noise Limits. A hotline will be established for residents to call if they have complaints during operations. A community information brochure will be sent out to neighbouring residents and City of Wanneroo Councillors in early November.

5 ENVIRONMENTAL IMPACTS AND MANAGEMENT

Holcim have developed a number of management plans for this project which are appended to this mining proposal as follows:

- Environmental Management Plan (EnviroWorks Consulting, 2015b) (Appendix E)
- Water Management Plan (URS, 2015b) (Appendix F)
- Closure Plan (EnviroWorks Consulting, 2015c) (Appendix G)
- Hydrocarbon Management Plan (Holcim, 2015) (Appendix H).

The management measures within the above plans are summarised in the sub-sections below.

5.1 VISUAL AMENITY

Visual impact can occur when the operation is visible from neighbouring properties or roads, caused by being too high in the landscape, too close to neighbours, or having insufficient visual screening.

The nearest residents to the tenements are displayed in Figure 17. There is a significant buffer of at least 300 m between the proposed quarry site and all residents, this includes a 200m strip of vegetation to screen the operation. This complies with the recommended buffer for sand mining within EPA Guidance Statement Number 3 *Separation Distances between Industrial and Sensitive Land Uses* (Environmental Protection Authority, 2005).

The Water Corporation Groundwater Treatment Plant (GWTP) is approximately 500 m to the north of the proposed sand quarry Figure 11.

Based on the buffer distance of 300 m from residential areas, it is unlikely visual amenity will be a problem.

5.1.1 MANAGEMENT STRATEGIES:

Visual amenity management measures include:

- Rehabilitate all disturbed and excavated areas, when work is completed.
- Ensure barriers, fences and gates are compatible with the semi-rural style of the area or of a similar colour and texture to the natural landscape.
- Locate the screening plant so the quarry pit walls screen it as far as possible.
- Locate buildings in areas of low visual impact, and maintain appropriate size.
- Operations will be undertaken from 0700–1700 Monday - Saturday only (excluding public holidays).
- Locate product stockpiles to create screening as far as practicable.
- A 300 m buffer will be maintained between the proposed quarry and all residents, this includes a 200m strip of vegetation to screen the operation.
- Adopt good house-keeping practises, such as orderly storage and removal of disused equipment or waste.
- All visual amenity management measures will be incorporated into the Environmental Management Plan (Appendix E).

5.2 SURFACE WATER MANAGEMENT

Flooding is not considered an issue in the areas that operations will be occurring. The Bassendean Sands in the area have a high hydraulic conductivity and rainfall infiltrates rapidly.

Considering the high infiltration rate, potential impacts to nearby surface water bodies such as Hawkins Road Swamp are considered low.

5.2.1 MANAGEMENT STRATEGIES

The project site will be designed, constructed and operated to avoid disruption of surface water flows and ensure that potential contaminants are not released into Wetlands or Bush Forever Sites. Operational areas will be located 100 m and 50 m from naturally vegetated geomorphic wetlands and Bush Forever Sites respectively.

To manage the potential effects on water quality from the discharge of storm water with elevated sediment levels or any other contaminants, the following practices will be employed:

- Tree stumps will be retained as long as possible to assist soil stabilization.
- A buffer zone of 100 m will be maintained between operations and naturally vegetated geomorphic wetlands.
- Stockpiles of erodible material will be located away from roads and pavements to minimise sediment transport in runoff.
- Each stage will be progressively rehabilitated at completion.
- Vegetative cover will be established to minimise erosion.
- Holcim will provide spill response equipment at the site.
- Bunds will be established along the access road to contain stormwater runoff and settle out sediment.
- Hydrocarbon and chemical management measures will ensure surface water contamination does not occur.
- Annual surface water monitoring will be undertaken when surface water is present.
- All surface water management measures will be incorporated into the Environmental and Water Management Plans (Appendices E and F).

5.3 GROUNDWATER MANAGEMENT

Given that neither pit dewatering or groundwater abstraction for water supply are proposed as part of this project, impact to groundwater is unlikely.

The only potential source of impact to groundwater is contamination via hydrocarbons and sewerage. There are minimal hydrocarbons and chemicals to be stored on site, reducing the likelihood of any major groundwater contamination.

A Groundwater Assessment has been prepared for this project – Appendix A (URS, 2015a). To manage the risk of groundwater contamination, it is proposed to limit excavation depth to 3 m above the MGL determined by URS (2015a) as well as implement contamination prevention measures as described in Section 5.3 and 5.4.

The Wanneroo Water treatment plant is located at the top northeast corner of the proposed site. The treatment plant is fed via a network of production bores and pipelines. The Water Corporation infrastructure mainly consists of bore headworks and collector mains. Major collector mains of DN600 AC, DN900 and DN1200 steel mains are located along Amaranted Rd. Bore 240 head works and bore compound as well as a 450/375 AC collector main is located along Hawking Rd. Bore 230 and bore 220 together with associated compounds and collector mains (DN375/DN300 AC) are located north of Wirrega Rd. No recorded water assets are located in close proximity to the western boundary of proposed site. A formal risk assessment determined that a 50m excavation buffer distance is considered to be adequate for the proposed excavation site expansion.

5.3.1 MANAGEMENT STRATEGIES

Management practices to minimise the potential for impact to groundwater quality and quantity include:

- Excavation depth is limited to 3m above maximum groundwater level determined by URS (2015a).
- Contamination and spills management will be implemented as described below.
- Surface water management as described above will ensure that all potentially contaminated surface water runoff will be detained and/or treated before discharge to the environment, minimising the risk of contamination to groundwater via infiltration.
- Waste management will ensure that all wastes are disposed of appropriately minimising the risk of groundwater contamination.
- All groundwater management measures will be incorporated into the Environmental and Water Management Plans (Appendices E and F).

5.4 HYDROCARBON, DANGEROUS GOODS AND HAZARDOUS SUBSTANCE MANAGEMENT

The types of hydrocarbons, dangerous good and hazardous materials proposed to be stored and used at the quarry, with the potential to cause contamination include:

- Hydrocarbons (oils, greases, fuels and degreasers)
- Solvents
- Detergents
- Glues
- Paints
- Hazardous wastes (such as sewage, used hydrocarbons and chemicals etc).

Hazardous materials, such as fuels, lubricants, solvents, detergents and paints have the potential to cause atmospheric, soil or water contamination and human health issues if incorrectly stored, used or disposed of. Appropriate management of these substances is required to prevent such impacts.

5.4.1 MANAGEMENT STRATEGIES

Holcim will transport, store and use dangerous goods and hazardous materials in accordance with the following legislation and standards:

- *Dangerous Goods Safety Act, 2004*
- *Dangerous Goods (Explosives) Regulations, 2007*
- *Dangerous Goods (General) Regulations, 2007*
- *Dangerous Goods (Road and Rail Transport of Non-explosives) Regulations, 2007*
- *Dangerous Goods (Storage and Handling of Non-explosives) Regulations, 2007*
- *Australian Code for the Transport of Dangerous Goods by Road and Rail, (7th Ed.)*
- *Road Traffic Act, 1974*
- *Australian Standard AS 1940-2004: The storage and handling of flammable and combustible liquids*
- *Quarry Safety and Inspections Act, 1994.*

The following management measures will be used to effectively manage dangerous goods and hazardous materials:

- The storage, handling and disposal of hazardous materials will be undertaken in a manner that complies with all relevant legal requirements.

- Storage of minor quantities of hazardous substances and dangerous goods will only occur in designated areas, which are appropriately signed, bunded or contained. These areas are to be maintained in a clean and tidy state to minimise potential for spills or littering.
- All hydrocarbons (grease, fuel, oils and lubricants) will be contained within bunds according to the requirements of Australian Standard 1940.
- Hydrocarbons and other hazardous materials shall not be delivered to on site storage areas without appropriate bunding/containment.
- Controlled wastes (including waste oil) will be collected and disposed of in accordance with the *Environmental Protection (Controlled Waste) Regulations 2004* which requires*:*
  - A licensed contractor to remove, transport and dispose of controlled wastes
  - Sufficient information be provided to enable categorisation of the waste and selection of an appropriate disposal site
  - Waste types and packaging to be suitable for transportation prior to collection.
- Soil contaminated by hydrocarbons will be segregated into designated sites for storage, then removed from site.
- Hydrocarbons and oily wastes (e.g. fuels, greases, de-greaser, emulsified oils and oily waste water) are to be managed using the following practices:
  - Minimal generation of waste and associated contaminants
  - Appropriate storage and handling procedures
  - Segregation of hydrocarbon waste from stormwater and other water
  - Clean-up procedures for spills.
- Regular housekeeping and inspections of dangerous goods and hazardous substances will occur to ensure that storage and handling is appropriate.
- Material Safety Data Sheets (MSDS) will maintained and easily accessible/located on-site for all hazardous substances and dangerous goods stored on site.
- The workforce will be trained on handling dangerous goods and hazardous substances in line with associated MSDS.
- A Spill Response Procedure will be implemented by Holcim.
- Hydrocarbon/hazardous material spills will be reported in accordance with Holcim Incident Management Procedures.
- Appropriate emergency equipment (including spill kits) will be made available on-site and replenished when required.
- All spills will be immediately contained and cleaned up. All wastes from clean-up will be appropriately stored and disposed.
- All site personnel will receive training on the Spill Response Procedure.
- Copies of the Spill Response Procedure will be available with spill kits and in designated storage areas.
- All hydrocarbon, dangerous goods and hazardous substance management measures will be incorporated into the Environmental and Water Management Plans (Appendices E and F).
- The Site Supervisor shall:
  - Provide advice in a timely nature as required by personnel regarding the management of hydrocarbons.
  - Ensure changes to management requirements are communicated to the workforce.
  - Ensure inspections are done on hydrocarbon storage areas.
  - Ensure training on Hydrocarbon Management is made available for operational personnel.

Holcim have developed a separate Hydrocarbon Management Plan for the operation which is attached as Appendix H.

5.5 FLORA AND CLEARING

The proposed quarry footprint is located exclusively on harvested pine plantation. Therefore there will be no clearing of remnant native vegetation or flora. However, the area has been identified to be within a non-permitted area (defined under Schedule 1, Section 4 of *the Environmental Protection (Clearing of Native Vegetation) Regulations 2004*). The clearing required to support this program has been approved by Native Vegetation Clearing Permit 6617/1 – granted on 6 August 2015.

5.5.1 MANAGEMENT STRATEGIES

Flora and clearing management strategies include:

- Clearing will only occur in previously cleared pine plantation.
- 50 m buffers will be maintained to Bush Forever Sites
- 100 m buffers will be maintained to naturally vegetated geomorphic wetlands.
- Vehicles will be restricted to designated access roads and excavation areas.
- Areas will be cleared of tree stumps in stages, as they help stabilise the soil.
- All flora management measures will be incorporated into the Environmental Management Plan (Appendix E).

5.6 DIEBACK MANAGEMENT

Due to the removal of native vegetation in the 1960's to establish the pine plantation, the absence of indicator species mean the site is considered Un-interpretable. Therefore the site will be managed using the precautionary principle, and as such hygiene guidelines will be implemented in accordance with the Dieback Management Protocol,

The aim of dieback management during excavation is to minimise the risk of entry of dieback to the site. This is achieved by preventing the import of any soil or plant material on mobile equipment and vehicles. As vehicles will be travelling on sealed surfaces prior to entering the quarry site, the risk is low. Holcim will ensure that all plant and equipment is clean prior to entering the site.

As the proposed quarry footprint is within cleared land, the second objective is to prevent the spread of dieback from this disturbed area into neighbouring areas of native vegetation; in particular, Wetlands and the Bush Forever site.

5.6.1 MANAGEMENT STRATEGIES

In many ways, the management strategies for dieback control are very similar to that of weed control, and the two management practices should be considered together. Many of the below strategies are recommended for Un-interpretable sites in the Management of *Phytophthora* Dieback in Extractive Industries document (Dieback Working Group, 2005).

Broadly the following principles of dieback management will be applied to this project:

- All vehicles and equipment will be free of soil and plant material before entering the property.
- Training programs and inductions will be conducted for site personnel.
- All surface water will be contained onsite. Runoff from the quarry pit, stockpiles, cleaning down and haul roads will be contained, and not released into areas of native vegetation.
- Light vehicles and machinery will be restricted to access roads, tracks and the excavation area.
- All dieback management measures will be incorporated into the Environmental Management Plan (Appendix E).

5.7 WEED MANAGEMENT

Earthworks, topsoil and overburden transportation, vehicle movement and other factors have the potential to introduce additional weeds to the area and to spread existing populations of introduced flora within the proposed quarry site. A weed is a plant that is non-native to an area or region and is considered to be a nuisance due to excessive growth and/or disturbance to the local eco-system. The principles of weed management are similar to that of plant diseases. Generally if the actions taken to prevent Dieback spread are applied, weeds will also be controlled.

During the field survey 61 weed species were recorded. All species are common weeds associated with disturbance and agriculture. One species *Emex australis* (Doublegee) is a Priority 1 Declared Plant within some W.A. local government areas under the Agriculture and Related Resources Act 1976. Weeds were most common within the plantation areas and along tracks. The majority of species are not considered to be serious environmental problems (EnviroWorks Consulting, 2015a).

5.7.1 MANAGEMENT STRATEGIES

Holcim Weed Management approach includes:

- Identification of type of weeds being targeted.
- Appropriate timing of spraying / other management measures.
- Appropriate type of spray and/or weed control measures being used.
- Planning for ongoing management of weeds.

Broadly the following principles of weed management will be applied to this project:

- All machinery and equipment brought onto site will be clean and free of soil and vegetative material.
- Site personnel will be educated on weed risk measures and identification of problem species.
- All weed management measures will be incorporated into the Environmental Management Plan (Appendix E).

Weed management will need to take into account the status of the P1 PDWSA as only certain chemcials can be used in these areas. Any weed sprays will need to be approved by DoW.

5.8 FAUNA

The proposed site layout has been planned to eliminate any clearing of native vegetation. As the quarry footprint is cleared pine plantation, it is unlikely significant fauna species of habitat will be directly disturbed by the project. There will likely be some localised loss of individual fauna due to direct mortality arising from the additional traffic between the proposed quarry and customer locations. It is unlikely, however, that the loss of individuals associated with these events would be significant enough to affect the conservation status of any of the species recorded from the region.

The proposed quarry may have the following potential impacts on native fauna:

- Loss of fauna habitat through vegetation clearing (unlikely to be significant);
- Ecological impacts such as changes to fire frequency and feral species numbers;
- Fauna deaths through clearing and road kill from traffic and
- Loss of fauna by contamination of water source or direct contact with hazardous substances.

It should be noted that pine wildings, do represent potential foraging habitat for Carnaby's cockatoo which will feed on pine cones. However, the impact on Carnaby's feeding resources due to pine removal in the area is not likely considered to be an issue as pine removal more broadly is being addressed through the Strategic Assessment of the Perth and Peel Regions (Department of Premier and Cabinet, Under Development)

5.8.1 MANAGEMENT STRATEGIES

Holcim will employ management precautions with regard to fauna. These will include:

- All disturbance will occur in previously cleared pine plantation;
- 50 m buffers will be maintained to the remnant vegetation in Bush Forever Sites;
- 100 m buffers will be maintained to naturally vegetated geomorphic wetlands;
- Vehicles will be restricted to designated access roads and the excavation area; and
- All fauna management measures will be incorporated into the Environmental Management Plan (Appendix E).

5.9 TOPSOIL AND ACID SULPHATE SOIL

There is no native topsoil available for rehabilitation at the site. *Pinus pinaster* plantation has been in place since the 1960's, and the native seed bank would be negligible. Depending on topsoil viability, the site will be single stripped as overburden, which will be stockpiled for use in future rehabilitation activities.

Overburden will be stripped from the clearing footprint, and will be stockpiled on the edge of the run of quarry pad in appropriate windrows. Stripping of overburden will occur in calm wind conditions. The overburden stockpiles will be located along the western edge of the run of quarry pad to provide maximum screening from neighbours.

As the proposed activities will not disturb the ground below the water table or any areas of high probability of ASS occurrence, it is unlikely that any ASS will be exposed or disturbed.

DMP has advised that '*according to the DEC guideline 'Identification and investigation of acid sulphate soils and acidic landscapes', sites should be investigated for ASS if extractive industry works are proposed in any of the areas listed in Table 1, which includes wetlands as found in the proposed tenement*.' Accordingly, Holcim commits to the exclusion of mining from a 100 metre buffer around mapped high to moderate risk ASS soils (including 100 metres around all wetlands whether mapped as high to moderate risk or not). If mining is proposed within the 100 metre buffer, Holcim commits to the provision of a management plan which will include the results of ASS investigations and will incorporate the results into management strategies to be presented with a new mining proposal to be submitted for approval. The large sand resource in this tenement provides sufficient flexibility for forward planning and investigations to occur in a timely manner

5.9.1 MANAGEMENT STRATEGIES

Holcim plan to manage ASS and overburden/topsoil in the following manner:

- Holcim will avoid disturbance of high ASS risk areas. Holcim commits to the exclusion of mining from a 100 metre buffer around mapped high to moderate risk ASS soils (including 100 metres around all wetlands whether mapped as high to moderate risk or not).
- If mining is proposed within the 100 metre buffer, Holcim commits to the provision of a management plan which will include the results of ASS investigations and will incorporate the results into management strategies to be presented with a new mining proposal to be submitted for approval.
- Overburden will be stockpiled and used for rehabilitation.

- Excavation will not intersect the water table. Excavation depth is limited to 3m above maximum groundwater level determined by URS (2015a).
- Based on precedents set by other sand mining operations in the pine plantation (including Rocla's adjacent Hawkins Rd Quarry), the topsoil will not be stripped separately, as the native seed bank will be negligible after growing pines since the 1960's.
- Overburden and oversize material stockpiles will be used to recontour the landscape and rehabilitate the excavation at quarry closure and are thus temporary.
- All topsoil / ASS management measures will be incorporated into the Environmental and Water Management Plan.
- All topsoil and ASS management measures will be incorporated into the Environmental and Water Management Plans (Appendices E and F).

5.10 WASTE MANAGEMENT

Wastes must be managed in order to prevent visual impacts, contamination of groundwater, soil and surface water, and human health issues. Holcim apply the waste management principles of reduce, re-use and recycle. The following wastes may potentially be produced by the proposed project:

- Hydrocarbon and chemical contaminated wastes (such as used oil, empty drums and containers, spill absorbent materials etc).
- General waste (such as kitchen waste, paper, cardboard etc).
- Sewage and domestic wastewater.

5.10.1 MANAGEMENT STRATEGIES

Holcim plan to manage wastes in the following manner:

- Hydrocarbons and chemical containers, such as lubricants will be regularly removed from site for disposal at a licensed landfill facility or recycling facility.
- Sewage waste will be transported off-site for treatment and disposal by a licensed contractor. No effluent will be released onsite.
- Instruction will be provided to site personnel on waste management.
- All waste management measures will be incorporated into the Environmental and Water Management Plans (Appendices E and F).

5.11 NOISE

Noise generated by the proposed quarry is expected to be localised and due to:

- Operation of earthmoving equipment throughout the construction and operational phases.
- Traffic along the transport routes.
- Noise generated by the screening machinery.

Occupational noise associated with mining falls under the *Mines Safety and Inspection Act 1994* and *Regulations 1995*. It is usually managed by providing all necessary hearing protection, and conducting inductions and educational programs for all staff.

Research into the impact of noise on fauna is relatively scarce however it is known that a large number of animals are quick to adapt to man-made noises if other threats are absent. The expected operational and transport noise generated by this quarry is unlikely to have an adverse effect on local wildlife.

A noise assessment was completed for this project by Herring Storer Acoustics (2015) – refer to Appendix C. The Herring Storer study predicted that noise levels received at the nearest premises will comply with the Environmental Protection (Noise) Regulations 1997 for the operating times proposed - 0700 – 1700 Monday – Saturday (excluding public holidays).

5.11.1 MANAGEMENT STRATEGIES

Sound travels mostly by line-of-sight, so many noise management strategies involve locating equipment and processing plant in a depression, on the pit floor or behind stockpiles or bunds, to reflect the noise. Holcim will implement the following management strategies to minimise off site noise:

- The quarry pit face will be used as far as practicable to provide noise suppression between the nearest dwellings.
- Operations will occur between 0700 – 1700 Monday – Saturday (excluding public holidays) to minimise the likelihood of noise nuisance.
- All mobile equipment will be maintained, with efficient mufflers and noise shielding.
- Any complaints received regarding noise disturbance will be recorded and investigated immediately.
- All noise management measures will be incorporated into the Environmental Management Plan (Appendix E).

5.12 DUST

Excessive dust can have adverse impacts on both workers and health of surrounding vegetation. Dust generated from the proposed quarries is expected to be minor and localised. Dust may be generated by:

- Earthworks during the construction and operational phase
- Clearing and stripping
- Excavation
- Screening
- Loading and transport
- Movement of vehicles
- Wind erosion of exposed surfaces.

A dust management for the proposed operation, based on the DER publication "*A guideline for managing the impacts of dust and associated contaminants from land development sites, contaminated sites remediation and other related activities"* (Department of Environment and Conservation, 2011). All dust management measures have been incorporated into the Environmental Management Plan (Appendix E).

5.12.1 MANAGEMENT STRATEGIES

Holcim have made allowance for water cart operation, and ensuring the disturbed area exposed is kept to a minimum at all times. To satisfy the requirements of the *Mines Safety and Inspection Act 1994 and Regulations 1995* in regard to occupational health risks from dust, Holcim will ensure that all personnel will have access to efficient dust masks and that a water cart is available during mining operations.

Access roads and internal road will be constructed of compacted crushed limestone (they will not be sealed). Dust will be managed via the use of water carts where necessary to prevent dust generation.

Standard dust suppression measures will be implemented during construction and operation to minimise impacts on surrounding vegetation. Management strategies to be undertaken are as follows:

- Dust suppression measures, such as water sprays/carts, will be implemented as necessary, in the event that high levels of dust are observed.
- Dust will be visually monitored daily during operations and construction to ensure control measures are effective.
- Cleared areas will be limited (as many tree stumps will be retained as possible, for as long as possible).
- Access roads will be constructed of crushed limestone or other suitable road making material.
- Activities with high dust-causing potential, such as stripping, will not be carried out in sensitive areas during adverse wind conditions.
- Material drop heights between loaders and trucks and trucks to stockpiles will kept to the minimum practical height.
- Any complaints will be investigated immediately.
- All dust management measures will be incorporated into the Environmental Management Plan.

6 SOCIAL IMPACTS AND MANAGEMENT

The impacts of the proposal on the socio-economic environment would be largely positive given the maintenance of employment, the local production of construction products with reduced delivery costs (and therefore potentially reduced costs in general), and the flow-on effects to subsidiary and associated industries and businesses of the proposal.

The operation would ensure the employment of 4 to 5 full-time personnel with a range of other contractors also be engaged from time to time. The maintenance of ongoing full-time employment would also stimulate employment in ancillary businesses, as well as those benefiting from the increased economic activities within the City of Wanneroo.

6.1 LOCAL COMMUNITY

The closest residents are located 300 m from the proposed quarry. Potential impacts will be managed through detailed project and operational designs to avoid or minimise these impacts. Key focus areas for the assessments include groundwater, surface water, air quality, noise and traffic.

6.1.1 MANAGEMENT STRATEGIES

Management measures to minimize impacts to the local community include:

- In the event of a community complaint, Holcim will investigate and take immediate remedial action.
- Operations are limited to 0700 – 1700 Monday – Saturday only. No operations will occur on Sundays or public holidays.
- A 300 m buffer will be maintained between the proposed quarry and all residents, this includes a 200m strip of vegetation to screen the operation.
- The noise and dust management measures described above will be used to minimise noise and dust impacts on the community.

6.2 HERITAGE

There are several recorded Aboriginal Heritage sites nearby, with the closest mapped site (ID 22160) located approximately 500 m to the north west (Figure 20).

Land clearing (including soil disturbance) for pine establishment commenced in the 1960's. It is highly likely that any heritage sites if present, would have been destroyed during this initial land clearing and pine forest establishment process. Therefore it is considered highly unlikely that any aboriginal heritage sites would remain within the pine plantation due to historical disturbance. In addition recent clearing of pines by the Forest Products Commission has resulted in significant additional disturbance.

Holcim commissioned Australian Heritage Management Solutions to undertake a heritage study over the project area. No heritage sites were identified during this survey (Australian Heritage Management Solutions, 2015) – refer to Appendix D for the summary report.

The potential for risk of disturbance to aboriginal heritage sites is therefore considered low.

There are no known European heritage sites within the tenement boundaries – the closest is Delamare House approximately 700 m to the North West of the tenement (Figure 21).

Mineral extraction and associated works have the potential to disturb Aboriginal artefacts if they are likely to exist in the proposed disturbance footprint.

6.2.1 ABORIGINAL HERITAGE DUE DILIGENCE

In 2013, Department of Indigenous Affairs (DIA) and Department of the Premier and Cabinet (DPC) released the *Aboriginal Heritage Due Diligence Guidelines* (DIA and DPC, 2013). The purpose of these Guidelines is to assist land users to be more aware of how their activities could adversely impact an Aboriginal site. Due diligence may involve one or all of the following actions:

(a) assessing the landscape where an activity is to take place;
(b) assessing the proposed activity and the potential impact on the landscape;
(c) searching the Register of Aboriginal Sites and the Aboriginal Heritage Inquiry System;
(d) consulting with the relevant Aboriginal people;
(e) agreeing to an Aboriginal heritage survey; or
(f) other heritage management strategies.

The section below presents the due diligence risk assessment conducted for this project.

6.2.1.1 RISK ASSESSMENT

The risk matrix from the *Aboriginal Heritage Due Diligence Guidelines* (DIA and DPC, 2013) has been completed – refer to Table 9 below with selected risk categories highlighted in green.

The disturbance to be undertaken by Holcim is moderate as mining will be carried out on land which is already disturbed and is progressively being re-cleared of pine plantation by DPaW. Therefore no clearing will be conducted by Holcim – this clearing will be done by DPaW prior to mining occurring. The Aboriginal Heritage risk is deemed low.

Table 9: Aboriginal Heritage Risk Assessment
Due Diligence Guidelines (DIA and DPC, 2013)

	1. Negligible disturbance	2. Minimal disturbance	3. Moderate disturbance	4. Significant disturbance	5. Major disturbance
Built Environment - e.g. urban environment, towns, metropolitan region.	Low	Low	Low	Low	Medium
Significantly Altered Environment - e.g. cultivated and cleared land.	Low	Low	Low	Medium	High
Moderately Altered Environment - e.g. partially cleared lands, re-vegetated landscape.	Low	Low	Medium	Medium	High
Minimally Altered Environment - e.g. urban bush land, regrowth areas	Low	Medium	Medium	High	High
Unaltered Environment - e.g. protected areas or pristine environment.	Low	Medium	High	High	High

6.2.2 MANAGEMENT STRATEGIES

Heritage management measures include:

- Holcim has already undertaken an Aboriginal Heritage survey (refer to Appendix C).
- Any identified heritage material will be protected and reported in accordance with relevant legislation.
- Should any evidence of early aboriginal occupation be uncovered during works, all activities will be stopped, pending an assessment by a recognised consultant.
- All heritage management measures will be incorporated into the Environmental Management Plan.
- Holcim commit to develop a Cultural Heritage Management Plan with the Whadjuk representatives to ensure they are informed and involved in Holcim's future developments and to ensure any potential heritage places are managed appropriately, including during development of rehabilitation and decommissioning plans.

6.3 LAND USE

Land uses in the surrounding area include pine plantation, recreational four-wheel-driving, and housing (zoned General Rural). Many of these properties are used for horse breeding and training. The pine plantations surrounding the tenements are covered by mining tenement applications, mostly by raw material extractors. This project is not likely to have any impact on the surrounding land uses.

6.4 WORKFORCE INDUCTION AND TRAINING

Holcim will develop an environmental induction that all personnel must complete prior to work commencing onsite. It will summarise the potential issues and environmental management strategies detailed in Sections 3 and 5. Personnel will complete refresher training annually.

7 QUARRY CLOSURE

7.1 POST MINING LAND USE

The pine plantation is being progressively harvested as part of the Gnangara Sustainability Strategy, which is a joint project between the Department of Water, Department of Agriculture and Food WA, Department of Parks and Wildlife, Department for Planning and Infrastructure, Forest Products Commission, Water Corporation and CSIRO (Department of Water, 2009b). The Gnangara Sustainability Strategy is a State Government initiative which aims to provide a framework for a whole of government approach to address land use and water planning issues associated with the Gnangara groundwater system. Three pine plantations have been targeted for harvesting by 2029.

The Gnangara Sustainability Strategy (Department of Water, 2009b) and the East Wanneroo Structure Plan (Western Australian Planning Commission, 2011) indicate that tenement M70/1248 and the eastern edge of tenement M70/1250 remaining subject to further planning (Figure 22). Whilst the remainder of tenement M70/1250 is designated for post pine banksia rehabilitation or state forests (Figure 22).

Consultation with the current land manager DPaW has indicated DPaW's preference for the land to be rehabilitated to native vegetation. Therefore, in the absence of any changes to end use it has been determined that the whole site is to be rehabilitated to native woodland. In the event that the proposed end use changes, this approach will need to be revised.

The proposed quarry is expected to have a life of 30 years. The land will be rehabilitated progressively in accordance with a rehabilitation plan agreed upon with DPaW. Local Government and other relevant stakeholders.

Therefore, Holcim will:

- Establish a safe and stable land surface which supports native vegetation growth focussing on providing food resource for Carnaby's Cockatoo.
- Revegetate the quarry landforms to establish vegetation appropriate for the area and final land use.

7.2 DECOMISSIONING AND CLOSURE

7.2.1 DECOMMISIONING

At the end of the quarries life Holcim will undertake the following actions to decommission the site:

- All buildings and infrastructure will be removed.
- Any contaminated sites as a result of the projects operations are registered and appropriately decommissioned.
- Roads will be rehabilitated or access retained in accordance DPaW requirements.
- Any hard stand surfaces will be removed and used to recontour the landscape.
- Overburden and scalps (oversize screened material) will be used as recontour the landscape.
- All remaining open areas rehabilitated.

7.2.2 CLOSURE PLAN

A closure plan has been prepared for this operation (EnviroWorks Consulting, 2015) in accordance with the DMP Quarry Closure Guideline (Department of Mines and Petroleum, 2011b) and is provided in Appendix G.

Holcim commit to rehabilitating the excavation areas, the run of quarry pad (including screening site, stockpile pads, transportable buildings) and access roads, and decommissioning all infrastructure.

8 MONITORING AND REPORTING

Quarry activities and potential environmental impacts require ongoing monitoring to ensure legislation, policies, standards and guidelines are being met.

8.1 ENVIRONMENTAL MONITORING PROGRAMME

8.1.1 REVEGETATION MONITORING

The rehabilitation monitoring program will be largely driven by the requirements of the related research trials. Subject to the design and requirements of research trials the monitoring program should constitute the following elements:

- Short-term monitoring (eg 2nd Spring – 15 months) will focus on establishment success and the need for any short term remedial action including weed control.
- Long-term vegetation observations will provide data regarding plant mortality, health, and reproduction to enable analysis of system function, dynamics and resilience. Long-term observations will include:
    - Native seedling recruitment (derived from the topsoil, from seed broadcasting, and tubestock) following each Spring for years 3 & 5, following rehabilitation operations;
    - Plant reproductive and regenerative capability over time;
    - Recruitment and persistence of weeds with subsequent management, which may include spraying for removal if necessary; and
    - The need for supplementary planting of tubestock.

8.1.2 GROUNDWATER MONITORING

A pre-quarrying groundwater monitoring programme commenced in May 2015 with the purpose of collecting baseline data. This programme has captured one winter peak to date and comprises both monthly and biannual aspects (Table 10).

The operational groundwater monitoring programme (Table 11) will commence following the onset of quarrying operations, currently scheduled for early 2016. The operational programme focuses on the key risks to the groundwater resource identified in the Water Management Plan (URS, 2015b). The comprehensive suite of analytes will be requested biannually and comprises:

General water suite *(chloride, sulphate, alkalinity, acidity, pH, electrical conductivity, total dissolved solids, calcium, magnesium, sodium, potassium, iron, manganese and aluminium, carbonate, bicarbonate, total hardness),* ***Nutrients*** *(TKN, Total P, ammonia, NO_3),* ***Organic suite*** *(TPH/TRH(C6-C36 or 40)/BTEX).*

Table 10: Pre-operational Groundwater Monitoring Program

Frequency	Bore Locations	Parameters	Methodology and QA/QC
Monthly	On-site – HMB01, HMB02, HMB03, HMB04, HMB05, HMB06, HMB07B, HMB08	Groundwater levels Groundwater quality (EC, pH, temperature)	Groundwater levels to be measured to the nearest cm using a water level meter. Field groundwater quality readings to be taken using a water quality meter
	Off-site – JB10B, JB12A*, JB9C, W230, W240, WCM Redrill, WE1B, WE2C*, WM24, WM35, WM23.	Groundwater levels	Collected from the DoW and Water Corporation bores near the project footprint.
Biannually	On-site – HMB01, HMB02, HMB03, HMB04, HMB05, HMB06, HMB07B, HMB08	Groundwater quality (comprehensive suite including hydrocarbon screening, pesticides and herbicides)	Groundwater sampling to be undertaken using low-flow sampling (peristaltic). *In situ* analysis of groundwater to be conducted using a calibrated water quality meter. QA/QC samples to be taken; Duplicates and triplicates (1 in 20 primary samples) Field and rinsate blanks (1 per day of sampling) Samples to be analysed by a NATA accredited laboratory.
	Off-site – JB10B, JB12A*, JB9C, W230, W240, WCM Redrill, WE1B, WE2C*, WM24, WM35, WM23.	Groundwater levels Groundwater quality (EC, pH, temperature, DO)	Collected from the DoW and Water Corporation bores near the project footprint.

Table 11: Operational Groundwater Monitoring Programme

Frequency	Bore Locations	Parameters	Methodology and QA/QC	Rationale
Monthly	WHPZ bores: HMB07B, W230, JB10B, W240	Groundwater levels	Groundwater levels to be measured to the nearest cm using a water level meter.	Monthly measurements to ensure seasonal variations and short-term trends are captured. These levels will be assessed against assigned trigger values. Monthly data will improve the understanding of the effects climate change and land use are having on the local water table, and will identify any project attributable impacts to the water table.
Quarterly	JB12B, JB9C, WCM Redrill, WE1B, WE2B, WM24, WM35, WM23. HMB01, HMB02, HMB03, HMB04, HMB05, HMB06, HMB08	Groundwater levels	Groundwater levels to be measured to the nearest cm using a water level meter.	Quarterly measurements to capture seasonal trends. These levels will be assessed against assigned trigger values. This data will support the on-site monitoring data and to provide a greater spatial representation of groundwater levels in the shallow water table zone.
	WHPZ bores: HMB07B, W230, JB10B, W240	Groundwater quality (EC, pH, temperature)	Field groundwater quality readings to be taken using a calibrated water quality meter.	There is a minor risk to local groundwater resources from the application of water containing low concentrations of salt, which may accumulate at the water table.
Annually	WHPZ bores: HMB07B, W230, JB10B, W240 On-site bores: HMB01, HMB02, HMB03, HMB04, HMB05, HMB06, HMB08	Groundwater quality (comprehensive suite)	Groundwater sampling to be undertaken using low-flow sampling (peristaltic). *In situ* analysis of groundwater to be conducted using a calibrated water quality meter. QA/QC samples to be taken at the following frequency; • Duplicates and triplicates (1 in 20 primary samples) • Field and rinsate blanks (1 per day of sampling) Samples to be analysed by a NATA accredited laboratory.	Potential identified risk for the contamination of groundwater at the water table if there is a significant unplanned leak or unmanaged spill. Hydrocarbons and nutrients were detected above assessment levels (NH&MRC, 2015) in samples taken during the pre-quarrying programme detected. Potential unplanned release of these substances includes on-site hydrocarbons and ablution facilities. The laboratory results will be assessed against appropriate assessment levels.
	Off-site bores: JB12B, JB9C, WCM Redrill, WE1B, WE2B, WM24, WM35, WM23.	Groundwater levels Groundwater quality (EC, pH, temperature)	Groundwater levels to be measured to the nearest cm using a water level meter. Field groundwater quality readings to be taken using a calibrated water quality meter.	There is a potential for water table mounding beneath cleared quarry areas. The monitoring will aim to identify any changes in water levels before r nearby water-sensitive features. There is a minor risk to local groundwater resources from the application of water containing low concentrations of salt, which may accumulate at the water table.
It is recognised that some of the proposed monitoring bores to be installed within the mine footprint may be destroyed as quarrying operations commence.				

8.2 INSPECTIONS AND AUDITS

Monthly Environmental, Health and Safety (EHS) inspections will be undertaken by the Site Supervisor, using a checklist. All corrective actions will be logged and must be completed.

8.3 ANNUAL REPORTING

Under the *Mining Act 1978*, mining lease holders are required to submit an Annual Environmental Report (AER) to the DMP each year. An AER will also be submitted to the DER as required by the Environmental Licence. The AER will include the following:

- Progress of excavation, including the volume/tonnage removed
- Volume screened
- Contingency actions and outcomes
- Environmental incidents
- Community complaints and responses.

8.4 INCIDENTS AND COMPLAINTS

Holcim commit to reporting all environmental incidents which may occur onsite. An environmental incident is any event that could or does result in environmental impact, including the following:

- Contamination of water
- Contamination of soil
- Incorrect waste disposal
- Illegal clearing of native vegetation
- Death of wildlife
- Spills by hazardous materials, chemicals, or hydrocarbons
- Unauthorised land disturbance, including clearing or disturbance of heritage sites
- Fumes or spills from waste
- Waste that is available to native fauna or will attract feral wildlife
- Community complaints
- Other environmental harm.

Holcim will systematically investigate incidents, identify root causes and implement preventative measures.

9 SUMMARY OF COMMITTMENTS

The proposed quarry will be constructed and operated in such a way to ensure environmental impacts are minimised wherever possible. Holcim has made a number of commitments to minimise the environmental impacts. These are summarised in Table 12.

Table 12: Summary of Commitments

Environmental Impact/Issue	Management Commitment
Access	• Holcim commit to reaching agreement with DPaW on roading access routes on an ongoing basis throughout the project. The process will be primarily managed through formal annual reviews with DPaW.
Visual Amenity	• Rehabilitate all disturbed and excavated areas, when work is completed. • Ensure barriers, fences and gates are compatible with the semi-rural style of the area or of a similar colour and texture to the natural landscape. • Locate the screening plant so the quarry pit walls screen it as far as possible. • Locate buildings in areas of low visual impact, and maintain appropriate size. • Operations will be undertaken from 0700–1700 Monday - Saturday (excluding public holidays) only. • A 300 m buffer will be maintained between the proposed quarry and all residents, this includes a 200m strip of vegetation to screen the operation. • Locate product stockpiles to create screening as far as practicable. • Adopt good house-keeping practises, such as orderly storage and removal of disused equipment or waste. • All visual amenity management measures will be incorporated into the Environmental Management Plan.
Surface Water	• Tree stumps will be retained as long as possible to assist soil stabilization. • A buffer zone of 100 m will be maintained between operations and naturally vegetated geomorphic wetlands. • Stockpiles of erodible material will be located away from roads and pavements to minimise sediment transport in runoff. • Each stage will be progressively rehabilitated at completion. • Vegetative cover will be established to minimise erosion. • Holcim will provide spill response equipment at the site. • Bunds will be established along the access road to contain stormwater runoff and settle out sediment. • Hydrocarbon and chemical management measures will ensure surface water contamination does not occur. • All surface water management measures will be incorporated into the Environmental and Water Management Plans.
Groundwater	• Excavation depth is limited to 3m above maximum groundwater level determined by URS (2015a). • Contamination and spills management will be implemented as described below. • Surface water management as described above will ensure that all potentially contaminated surface water runoff will be detained and/or treated before discharge to the environment, minimising the risk of contamination to groundwater via infiltration. • Waste management will ensure that all wastes are disposed of appropriately minimising the risk of groundwater contamination. • All groundwater management measures will be incorporated into the Environmental and Water Management Plans.
Hydrocarbon, Dangerous Goods and Hazardous Substance Management	• The storage, handling and disposal of hazardous materials will be undertaken in a manner that complies with all relevant legal requirements. • Storage of minor quantities of hazardous substances and dangerous goods will only occur in designated areas, which are appropriately signed, bunded or contained. These areas are to be maintained in a clean and tidy state to minimise potential for spills or littering.

Environmental Impact/Issue	Management Commitment
	• All hydrocarbons (grease, fuel, oils and lubricants) will be contained within bunds according to the requirements of Australian Standard 1940. • Hydrocarbons and other hazardous materials shall not be delivered to on site storage areas without appropriate bunding/containment. • Controlled wastes (including waste oil) will be collected and disposed of in accordance with the *Environmental Protection (Controlled Waste) Regulations 2004* which requires: o A licensed contractor to remove, transport and dispose of controlled wastes o Sufficient information be provided to enable categorisation of the waste and selection of an appropriate disposal site o Waste types and packaging to be suitable for transportation prior to collection. • Soil contaminated by hydrocarbons will be segregated into designated sites for storage, then removed from site. • Hydrocarbons and oily wastes (e.g. fuels, greases, de-greaser, emulsified oils and oily waste water) are to be managed using the following practices: o Minimal generation of waste and associated contaminants o Appropriate storage and handling procedures o Segregation of hydrocarbon waste from stormwater and other water o Clean-up procedures for spills. • Regular housekeeping and inspections of dangerous goods and hazardous substances will occur to ensure that storage and handling is appropriate. • Material Safety Data Sheets (MSDS) will maintained and easily accessible/located on-site for all hazardous substances and dangerous goods stored on site. • The workforce will be trained on handling dangerous goods and hazardous substances in line with associated MSDS. • A Spill Response Procedure will be implemented by Holcim. • Hydrocarbon/hazardous material spills will be reported in accordance with Holcim Incident Management Procedures. • Appropriate emergency equipment (including spill kits) will be made available on-site and replenished when required. • All spills will be immediately contained and cleaned up. All wastes from clean-up will be appropriately stored and disposed. • All site personnel will receive training on the Spill Response Procedure. • Copies of the Spill Response Procedure will be available with spill kits and in designated storage areas. • The Site Supervisor shall: o Provide advice in a timely nature as required by personnel regarding the management of hydrocarbons. o Ensure changes to management requirements are communicated to the workforce. o Ensure inspections are done on hydrocarbon storage areas. o Ensure training on Hydrocarbon Management is made available for operational personnel. • All hydrocarbon, dangerous goods and hazardous substance management measures will be incorporated into the Environmental and Water Management Plans.
Flora and Clearing	• Clearing will only occur in previously cleared pine plantation. • 50 m buffers will be maintained to Bush Forever Sites • 100 m buffers will be maintained to naturally vegetated geomorphic wetlands. • 200m vegetation buffer will be maintained on the west boundary to screen the operation. • Vehicles will be restricted to designated access roads and excavation areas. • Areas will be cleared of tree stumps in stages, as they help stabilise the soil. • All flora management measures will be incorporated into the Environmental Management Plan.
Dieback	• All vehicles and equipment will be free of soil and plant material before entering the property. • Training programs and inductions will be conducted for site personnel. • All surface water will be contained onsite. Runoff from the quarry pit, stockpiles, cleaning down and haul roads will be contained, and not released into areas of native vegetation. • Light vehicles and machinery will be restricted to access roads, tracks and the excavation

Environmental Impact/Issue	Management Commitment
	area. • All dieback management measures will be incorporated into the Environmental Management Plan.
Weeds	• All machinery and equipment brought onto site will be clean and free of soil and vegetative material. • Site personnel will be educated on weed risk measures and identification of problem species. • All weed management measures will be incorporated into the Environmental Management Plan.
Fauna	• All disturbance will occur in previously cleared pine plantation. • 50 m buffers will be maintained to the remnant vegetation in Bush Forever Sites • 100 m buffers will be maintained to naturally vegetated geomorphic wetlands. • Vehicles will be restricted to designated access roads and the excavation area. • All fauna management measures will be incorporated into the Environmental Management Plan.
Topsoil /Acid Sulphate Soils (ASS)	• Holcim will avoid disturbance of high ASS risk areas. Holcim commits to the exclusion of mining from a 100 metre buffer around mapped high to moderate risk ASS soils (including 100 metres around all wetlands whether mapped as high to moderate risk or not). • If mining is proposed within the 100 metre buffer, Holcim commits to the provision of a management plan which will include the results of ASS investigations and will incorporate the results into management strategies to be presented with a new mining proposal to be submitted for approval. • Overburden will be stockpiled and used for rehabilitation. • Excavation will not intersect the water table. Excavation depth is limited to 3m above maximum groundwater level determined by URS (2015a). • Based on precedents set by other sand mining operations in the pine plantation (including Rocla's adjacent Hawkins Rd Quarry), the topsoil will not be stripped separately, as the native seed bank will be negligible after growing pines since the 1960's. • Overburden and oversize material stockpiles will be used to recontour and rehabilitate the landscape at quarry closure and are thus temporary. • . • All topsoil and ASS management measures will be incorporated into the Environmental and Water Management Plans.
Waste	• Hydrocarbons and chemical containers, such as lubricants will be regularly removed from site for disposal at a licensed landfill facility or recycling centre. • Sewage waste will be transported off-site for treatment and disposal by a licensed contractor. No effluent will be released onsite. • Instruction will be provided to site personnel on waste management. • All waste management measures will be incorporated into the Environmental and Water Management Plans.
Noise	• The quarry pit face will be used as far as practicable to provide noise suppression between the nearest dwellings. • Operations will occur between 0700 – 1700 Monday – Saturday (excluding public holidays) to minimise the likelihood of noise nuisance. • All mobile equipment will be maintained, with efficient mufflers and noise shielding. • Any complaints received regarding noise disturbance will be recorded and investigated immediately. • All noise management measures will be incorporated into the Environmental Management Plan.
Dust	• Dust suppression measures, such as water sprays/carts, will be implemented as necessary, in the event that high levels of dust are observed. • Dust will be visually monitored daily during operations and construction to ensure control measures are effective. • Cleared areas will be limited (as many tree stumps will be retained as possible, for as long as possible). • Access roads will be constructed of crushed limestone or other suitable road making

Environmental Impact/Issue	Management Commitment
	material. • Activities with high dust-causing potential, such as stripping, will not be carried out in sensitive areas during adverse wind conditions. • Material drop heights between loaders and trucks and trucks to stockpiles will kept to the minimum practical height. • Any complaints will be investigated immediately. • All dust management measures will be incorporated into the Environmental Management Plan.
Local Community	• In the event of a community complaint, Holcim will investigate and take immediate remedial action. • Operations are limited to 0700 – 1700 Monday - Saturday only. No operations will occur on Sundays or public holidays. • A 300 m buffer will be maintained between the proposed quarry and all residents, this includes a 200m strip of vegetation to screen the operation. • 200m vegetation buffer will be maintained on the west boundary to screen the operation • The noise and dust management measures described above will be used to minimise noise and dust impacts on the community.
Heritage	• Holcim has already undertaken an Aboriginal Heritage survey. • Any identified heritage material will be protected and reported in accordance with relevant legislation. • Should any evidence of early aboriginal occupation be uncovered during works, all activities will be stopped, pending an assessment by a recognised consultant. • All heritage management measures will be incorporated into the Environmental Management Plan.
Rehabilitation/ Closure	• All buildings and infrastructure will be removed. • Any hard stand surfaces will be removed and used to recontour the landscape. • Overburden and oversize screened material will be used as to recontour the landscape. • Area will be seeded and vegetated according to the agreed prescriptions. • A Closure Plan which complies with the DMP 2011 Closure Guideline has been included within this Mining Proposal. • All rehabilitation management measures will be incorporated into the Rehabilitation Management Plan.
Monitoring	• Incorporate the following re-vegetation monitoring: o Short-term monitoring (eg 2nd Spring – 15 months) will focus on establishment success and the need for any short term remedial action including weed control. o Long-term vegetation observations will provide data regarding plant mortality, health, and reproduction to enable analysis of system function, dynamics and resilience. o Monitoring management measure will be incorporated into the Water, Rehabilitation and Environmental Management Plans as relevant. • A pre-quarrying groundwater monitoring programme commenced in May 2015 with the purpose of collecting baseline data. This programme has captured one winter peak to date and comprises both monthly and biannual aspects. • The operational groundwater monitoring programme will commence following the onset of quarrying operations. The programme focuses on the key risks to the groundwater resource identified in the Water Management Plan (URS, 2015b). The comprehensive suite of analytes will be requested biannually.

10 REFERENCES

AECOM. (2015). *Jandabup Sand Quarry Expansion Assessment on Proximity of Water Corporation Infrastructure. .* Perth: Memorandum dated 20th October 2015. File Ref. 42908863-007.

Australian Heritage Management Solutions. (2015). *Heritage Study - Holcim Jandabup Quarry.* Perth: Unpublished Study Prepared for Holcim Pty Ltd.

Bettenay, E., McArthur, W. M., & Hingston, F. J. (1960). *The soil associations of part of the Swan Coastal plain, Western Australia.* Melbourne, Australia: Division of Soils, Commonwealth Scientific and Industrial Research Organisation.

Bureau of Meteorology. (2015). *Climate Statistics for Pearce RAAF (Station No. 009053)*. Retrieved May 2012, from Bureau of Meteorology: http://www.bom.gov.au/climate/averages/tables/cw_009053.shtml.

City of Wanneroo. (2014). *Welcome to the City of Wanneroo.* http://www.wanneroo.wa.gov.au/Home.

Department of Environment. (2003). *General Guidance on Managing Acid Sulfate Soils.* Retrieved October 2009, from Department of Environment: http://portal.environment.wa.gov.au/pls/portal/docs/PAGE/DOE_ADMIN/GUIDELINE_REPOSITORY/ASSMP%20_FINAL_.PDF.

Department of Environment and Conservation. (2009a). Retrieved September 2009, from http://www.dec.wa.gov.au/parks-and-recreation/visitor-information/4wd-on-calm-managed-lands/where-can-you-go.html.

Department of Environment and Conservation. (2011). *A guideline for managing the impacts of dust and associated contaminants from land development sites, contaminated sites remediation and other related activities.* Perth: Government of Western Australia.

Department of Environment Regulation. (2015). *Identification and investigation of acid sulfate soils and acidic landscapes.* Perth: Government of Western Australia.

Department of Mines and Petroleum. (2011b). *Guidelines for Preparing Mine Closure Plans.* Western Australia.

Department of Premier and Cabinet. (Under Development). *Strategic Assessment of the Perth and Peel Regions.* Perth: Government of Western Australia.

Department of Water. (2006). *Water Quality Protection Note No. 56 - Tanks for elevated chemical storage .* Perth: Government of Western Australia.

Department of Water. (2009a). *Gnangara Mound - A Unique Water Source*. Retrieved from Department of Water: http://www.water.wa.gov.au/Waterways+health/Groundwater/Gnangara+Mound/default.aspx.

Department of Water. (2009b). *Gnangara Sustainability Strategy.* Retrieved October 2009, from http://portal.water.wa.gov.au/portal/page/portal/gss/GnangaraSustainabilityStrategy.

Department of Water. (2013). *Water Quality Protection Note No. 15 – Extractive industries near sensitive water resources.* Perth: Government of Western Australia.

DIA and DPC. (2013). *Aboriginal Heritage Due Diligence Guidelines.* Perth: Department of Indigenous Affairs and Department of Premier and Cabinet.

Dieback Working Group. (2005). *Best Practice Guidelines: Management of Phytophthora Dieback in Extractive Industries.* Retrieved 5 January, 2012, from http://www.dieback.org.au/go/managing-dieback/manuals-and-guidelines.

Environmental Protection Authority. (2005). *Separation Distances between Industrial and Sensitive Land Uses.* Perth: Government of Western Australia.

EnviroWorks Consulting. (2015). *Holcim Hawkins Road Jandabup Mine Closure Plan.* Perth: Unpublished Report Prepared for Holcim Pty Ltd.

EnviroWorks Consulting. (2015a). *Flora Survey and Fauna Habitat Assessment, Proposed Sand Quarry, Hawkins Rd.* Perth: Unpublished report prepared for Holcim Pty Ltd.

EnviroWorks Consulting. (2015b). *Environmental Management Plan Holcim Sand Quarry - Tenements M70/1258 and M70/1250.* Perth: Unpublished Report Prepared for Holcim (Australia) Pty Ltd.

EnviroWorks Consulting. (2015c). *Closure Plan Holcim Hawkins Road Sand Quarry - Tenements M70/1248 and M70/1250.* Perth: Unpublished Report Prepared for Holcim (Australia) Pty Ltd.

ExploreOz.com. (2009). Retrieved from ExploreOz.com: ExploreOz.com

Herring Storer Accoustics. (2015). *Noise Assessment Holcim Hawkins Road Quarry Jandabup.* Perth: Unpublished Report Prepared for Holcim Pty Ltd.

Hill, A. L., Semeniuk, C. A., Seeniuk, V., & del Marco, A. (1996). *Wetlands of the Swan Coastal Plain. Volume 2: Wetland Mapping, Classification and Evaluation - Wetland Atlas.* Perth, Western Australia: Prepared for the Water and Rivers Commission and the Department of Environmental Protection.

Holcim. (2015). *Hydrocarbon Management Plan Jandabup.* Perth: Internal Holcim Report.

Komerek, B., Shearer, B. L., Smith, B., & Fairman, R. (1994). *Phosphonate offers a practical method for the control of Phytophthora cinnamomi in native plant communities. Symposium on Plant Diseases in Ecosystems (Eds R.T. Wills & W.A. Cowling).* Perth, WA: Royal Society of Western Australia and the Ecological Society of Australia.

NH&MRC. (2015). *Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy.* Canberra: National Health and Medical Research Council, National Resource Management Ministerial Council.

Profile ID. (2014). *City of Wanneroo Community Profile.* http://profile.id.com.au/wanneroo.

Salama, R., Silberstein, R., & Pollock, D. (2005). Soil characteristics of the Bassendean and Spearwood Sands of the Gnagara Mound (WA) and their controls on recharge, water level patterns and solutes of the superficial aquifer. *Water, Air, and Soil Pollution: Focus*, 5: 3-26.

Silberstein, R., Walker, S., Hick, W., Higginson, S., Bumbrell, I., Canci, M., & Hodgeson, G. (2007). *Water balance of the pine plantations on Gnangara Mound a CSIRO Land and Water and Water Corporation presentation.* Retrieved September 2009, from http://www.clw.csiro.au/division/perth/seminars/2007/documents/Silberstein_May2007.pdf.

URS. (2015a). *Groundwater Impact Assessment Jandabup Sand Quarry Project, Tenemetns M70/1248 and M70/1250.* Perth: Unpublished report prepared for Holcim (Australia) Pty Ltd.

URS. (2015b). *Water Management Plan Jandabup Sand Quarry Project, Tenements M70/1248 and M70/1250.* Perth: Unpublished Report Prepared for Holcim (Australia) Pty Ltd.

Waters and Rivers Commission. (2004). *Policy and Guidelines for Construction and Silica Sand Mining in Public Drinking Water Source Areas .* Perth: State Government of Western Australia.

Western Australian Planning Commission. (2005). *Statement of Planning Policy 2.2 Gnangara Groundwater Protection .* Perth: Government of Western Australia.

Western Australian Planning Commission. (2011). *East Wanneroo Structure Plan.* Western Australia.

11 GLOSSARY

11.1 UNITS, SYMBOLS AND PREFIXES

11.1.1 UNITS

g	Gram; a unit used to express weight
L	Litre; a unit used to express volume
m	Metre; a unit used to express length
bcm	Bank cubic meters; a unit used to describe the volume of in-situ rock
dB	Decibel; unit used to express sound intensity
h	Hour; a unit used to express time
ha	Hectare; a unit used to express area
m2	Square metre; a unit used to express area
m3	Cubic metre; unit used to express volume.
V	Volt; a unit used to express the potential difference across a conductor
VA	Volt-amp; a unit used to express apparent power; is equal to voltage applied multiplied by current drawn
VPD	Vehicles per day
yr	Year
s	Second; a unit used to express time
ppm	Parts per million; a unit used to express concentration
ppt	Parts per thousand; a unit used to express concentration
T	Tonne

11.1.2 SYMBOLS

%	percentage (proportion out of one hundred)
/	Per
p	per
$	Australian dollars
a	annum; year
°C	degree Celsius

11.1.3 PREFIXES

G	10^{9}
M	10^{6}
k	10^{3}
d	10^{-1}
c	10^{-2}
m	10^{-3}.
µ	10^{-6}
N	10^{-9}

11.2 WORDS AND ABBREVIATIONS

Term	Definition/Expansion
acid	Substance with a pH less than 7.0; the lower the pH the higher the corrosive ability of the substance.

Term	Definition/Expansion
acidic	Having a pH less than 7.0.
AHD	Australian Height Datum
ALARP	As low as reasonably practicable.
amenity	The desirability of an area.
amphibians	Animals (such as frogs) adapted to live both on land and in water.
ARI	Average recurrence interval; a measure of the rarity of a rainfall event.
artefact	Anything made by human workmanship, particularly by previous cultures (such as chipped and modified stones used as tools).
background	The conditions (e.g., noise levels, bird populations) already present in an area before the commencement of a specific activity (e.g., a mining operation).
best practice	A best practice is a process, technique, or use of technology, equipment or resource that has a proven record of success.
bioregion	A complex land area composed of a cluster of interacting ecosystems that are repeated in similar form. It describes the dominant landscape scale attributes of climate, lithology, geology, landforms and vegetation. It is based on the Interim Biogeographic Regionalisation for Australia (see IBRA).
biodiversity	The diversity of different species of plants, animals and microorganisms, including the genes they contain, in the ecosystem of which they are part.
bore	A well, usually of less than 20 cm diameter, sunk into the ground and from which water is pumped.
bund	An earth, rock, or concrete embankment constructed to prevent the inflow or outflow of liquids or the transmission of noise.
catchment	The entire land area from which water (e.g., rainfall) drains to a specific water course or waterbody.
clay	A discrete mineral species, belonging to the layered silicate group of less than 2 microns in diameter.
compaction	The process of close packing of individual grains in a soil or sediment as a response to pressure.
concentration	The amount of a substance per unit of mass or volume of the medium in which it occurs.
conservative	A prediction, assumption, or measurement that errs on the side of safety.
contractor	Specialist brought in to perform a specific task, such as the construction of quarry infrastructure or the excavation (mining) of the open pit.
DER	Department of Environment and Regulation (WA)
DoE	Department of Environment (Federal)
DPaW	Department of Parks and Wildlife (WA)
density	The mass of a substance divided by its volume.
DIA	Department of Indigenous Affairs (WA)
DoCEP	Department of Consumer and Employment Protection (WA)
DoW	Department of Water (WA)
DRF	Declared Rare Flora.
DSP	District Structure Plan
ecosystem	An interacting system of animals, plants, other organisms and non-living parts of the environment.
emission	A discharge of a substance (e.g., dust) into the environment.
endemic	Native to, or restricted to, a certain country or area.
environment	A general term for all the conditions (physical, chemical, biological and social) in which an organism or group of organisms (including human beings) exists.
EPA	Environmental Protection Authority.
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)

Term	Definition/Expansion
erosion	The wearing away of the land surface (whether natural or artificial) by the action of water, wind and ice.
fauna	A general term for animals (birds, reptiles, marsupials, fish etc.), particularly in a defined area or over a defined time period.
feed	Material being fed into a process.
flora	A general term for plants, particularly those found in a defined area or characteristic of a defined time period.
foraging	Searching for food over a wide area.
grade	The concentration of metal, e.g., iron either in an individual rock sample or averaged over a specified volume of rock.
gradient	Rate of change of a given variable (such as temperature or elevation) with distance.
greenhouse gases	Carbon dioxide, methane, nitrous oxide, perfluorocarbons, hydrofluorocarbons and sulfur hexafluoride.
ground vibration	Vibration transmitted through the ground following blasting.
groundwater	All waters occurring below the land surface; the upper surface of the soils saturated by groundwater in any particular area is called the water table.
habitat	The particular local environment occupied by an organism.
hydrology	The study of water, particularly its movement in streams, rivers, or underground.
infrastructure	The supporting installations and services that supply the needs of a project.
introduced	Introduced to a particular environment; exotic.
invertebrates	Commonly, animals without a backbone (jellyfish, worms, molluscs, etc.).
irrigation	The artificial flooding of agricultural land to promote cultivation.
landform	A specific feature of a landscape (such as a hill) or the general shape of the land.
load	The amount of a substance discharged into a body of water (e.g., salt or sediment); usually expressed as mass over a specified time (e.g., tonnes per year).
MBGL	Meters Below Ground Level
model	A mathematical simulation of a natural system (such as the variation of particulate levels within a lake) used to predict how the system will change with time, particularly where external changes have been imposed upon it (such as from mining operations).
monitoring	Systematic sampling and, if appropriate, sample analysis to record changes over time caused by impacts such as mining.
native	Belonging to, or found naturally, in a particular environment.
natural	Existing in, or formed by, nature (generally excludes anything obviously modified by human beings).
neutral	Neither acidic nor basic (e.g., a pH equal to 7.0).
nutrients	Generally refers to nitrogen and phosphorus, which are essential for biological growth.
operations	Mining and ore processing activities.
ORV	Off Road Vehicles.
passive	Performing a function without electrical or mechanical action or movement.
PER	Public environmental review.
pH	Percentage hydrogen; a measure of the degree of acidity or alkalinity of a solution; expressed numerically (logarithmically) on a scale of 1 to 14, on which 1 is most acid, 7 is neutral and 14 is most basic (alkaline).
Prescribed Premise	A premise that falls into the categories prescribed in Schedule 1 of the Environmental Protection Regulations 1987.
project area	the total area covered by the project, including pit, processing plant, stockpiles, haul road, rail siding, port facilities etc.
quadrat	A square measuring area used in ecological studies such as the distribution of plants or animals in an area. Quadrats can vary in size depending largely on the focus of the

Term	Definition/Expansion
	study.
receptor	A designated place at which an impact may occur (e.g., a dwelling).
recharge	The addition of water to an aquifer, directly from the surface, indirectly from the unsaturated zone, or by discharge from overlying or underlying aquifer systems.
rehabilitation	The restoration of a landscape and especially the vegetation following its disturbance.
reptiles	Cold-blooded vertebrates, including lizards, snakes, turtles, and crocodiles.
reserve	The calculated tonnage and grade of ore which can be extracted profitably from a mineral deposit; classified according to the level of confidence that can be placed in the data.
residual impacts	Impacts from an activity (e.g., mining) that remain after mitigation measures.
resource	The calculated amount of material in a mineral deposit, based on exploration drilling information.
richness (of fauna or flora)	A measure of the number of species in a given area or assemblage.
runoff	That portion of precipitation (rain, hail and snow) that flows from a specific area as water.
ore	Siliceous group of particles within the size range 63 microns to 2 millimetres.
silt	Sediment with particles finer than ore and coarser than clay, i.e., 2 to 63 microns.
species	A taxonomic grouping of organisms that is able to interbreed with each other but not with members of other species.
stockpile	A pile used to store material (such as low-grade ore) for future use.
stockpiled	Stored in a stockpile.
stripping	Removal of vegetation and topsoil.
surface water	Water flowing over, or contained on, a landscape (e.g., runoff, streams, lakes, etc.).
taxa	Plural of taxon.
taxon	A group or category, at any level, in a system for classifying plants or animals. Animal or plant group having natural relations.
TEC	Threatened Ecological Community.
topography	Physical relief and contour of a region.
topsoil	Upper layer of soil, usually containing more organic material and nutrients than the subsoil beneath it.
TPS	Town Planning Scheme
variable	Not constant, subject to change.
vibration	Oscillating movement.
WAPC	Western Australian Planning Commission
WAWC Act	WA Wildlife Conservation Act, 1950
water balance	The sum of the inputs and outputs and changes in storage levels of water in a given locality.
water quality	Degree of the lack of contamination of water.
watertable	The surface of the groundwater, below which soil and rock are saturated.
watercourse	Stream or river, running water.
weed	Any plant (in particular an herbaceous one) that survives in an area where it is harmful or troublesome to the desired land use.
wetland	A low-lying area regularly inundated or permanently covered by shallow water.

12 FIGURES

Holcim

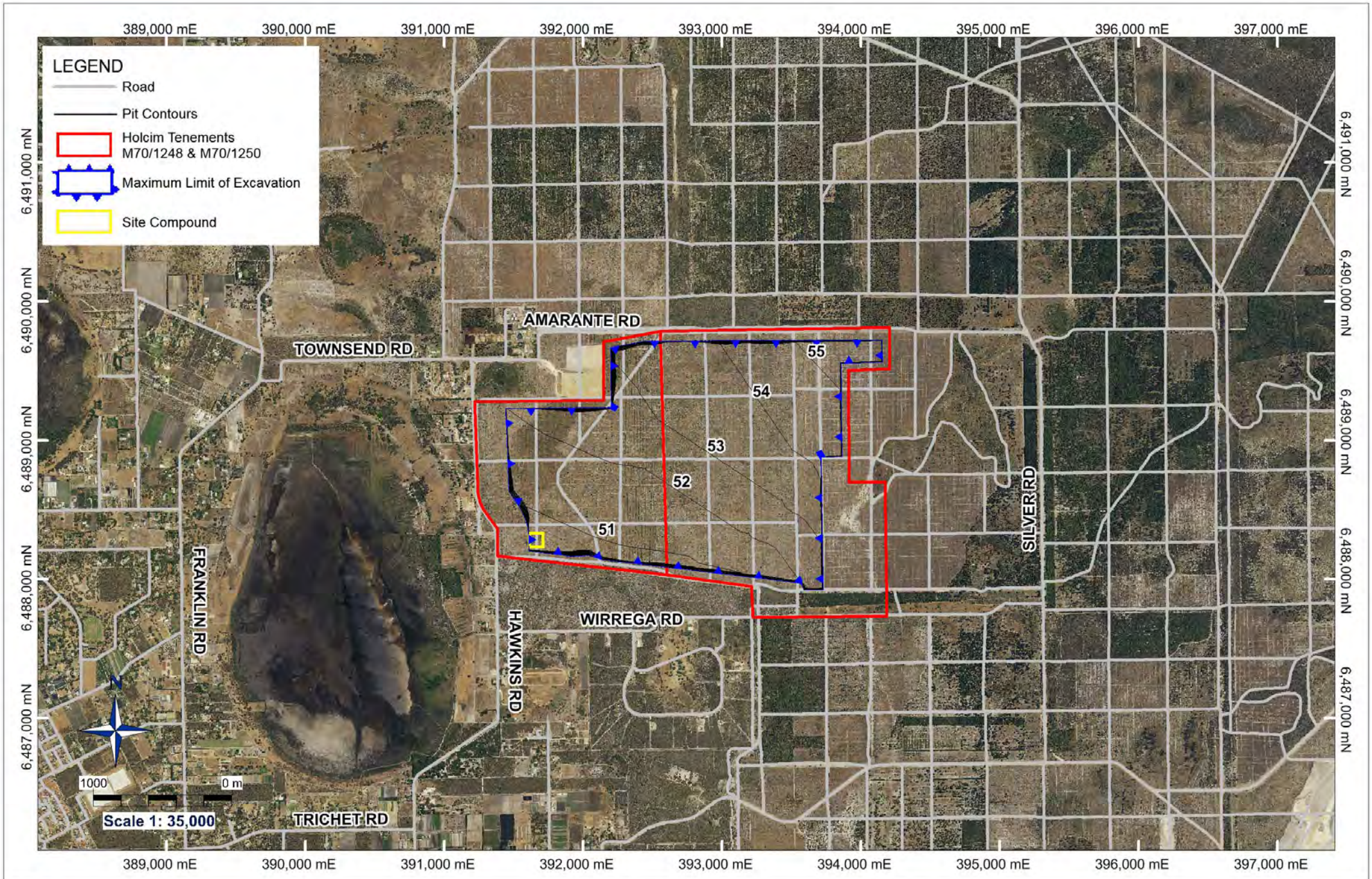
EnviroWorks CONSULTING

Figure No. 1
Location Map

Date: 2/10/2015 Paper: A4 P GDA94, MGA50

Data Source: 4K, 13A, 15I, 17A

File Info: H04_J06_Base_Map_V2

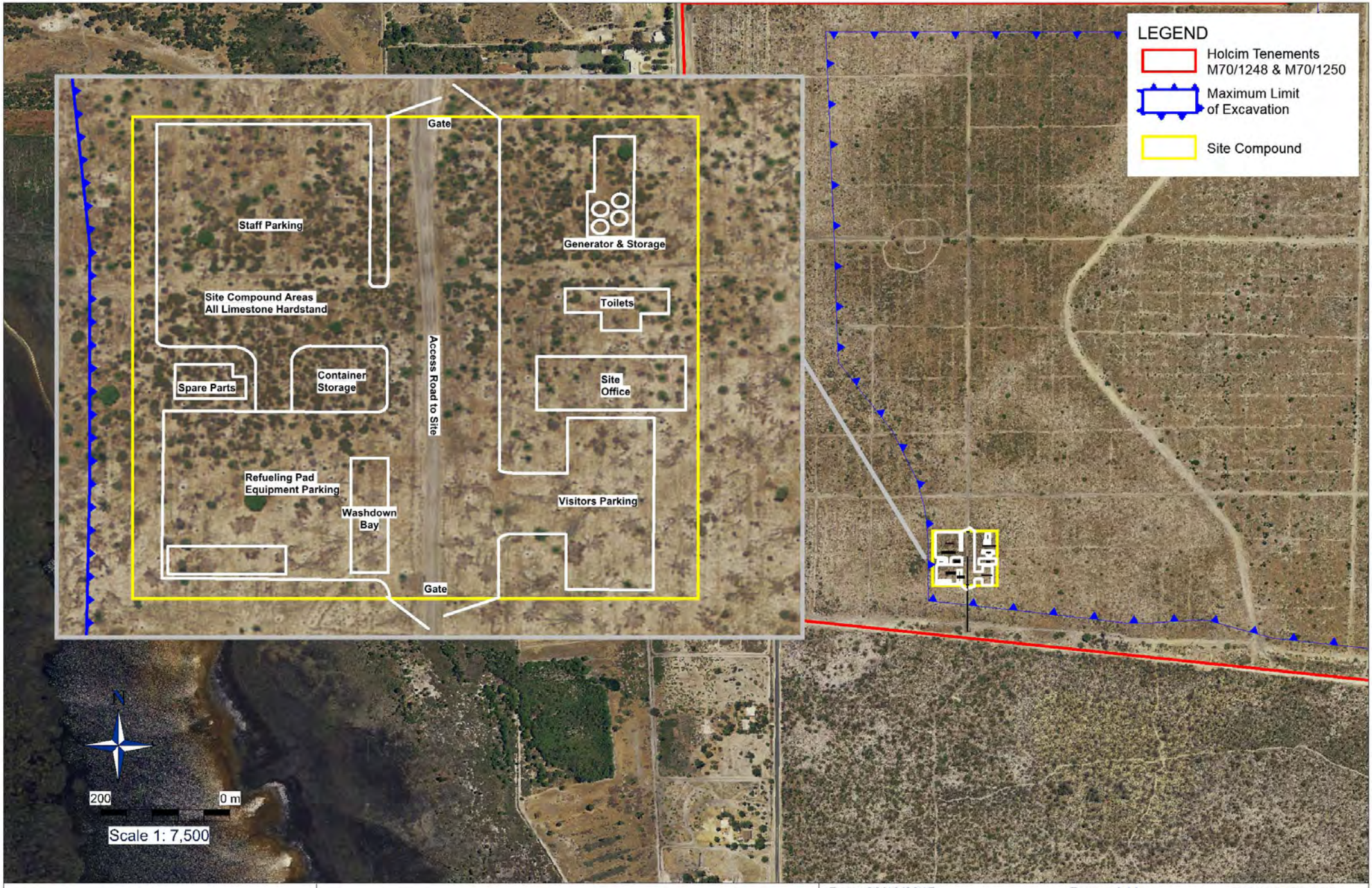


Holcim

EnviroWorks CONSULTING

Fig No. 2
Site Layout

Date: 26/10/2015	Paper: A4 L	GDA94, MGA50
Data Source: 7A, 13A		
File Info: U04_J06_Site_Layout_Area_20.08.2015		

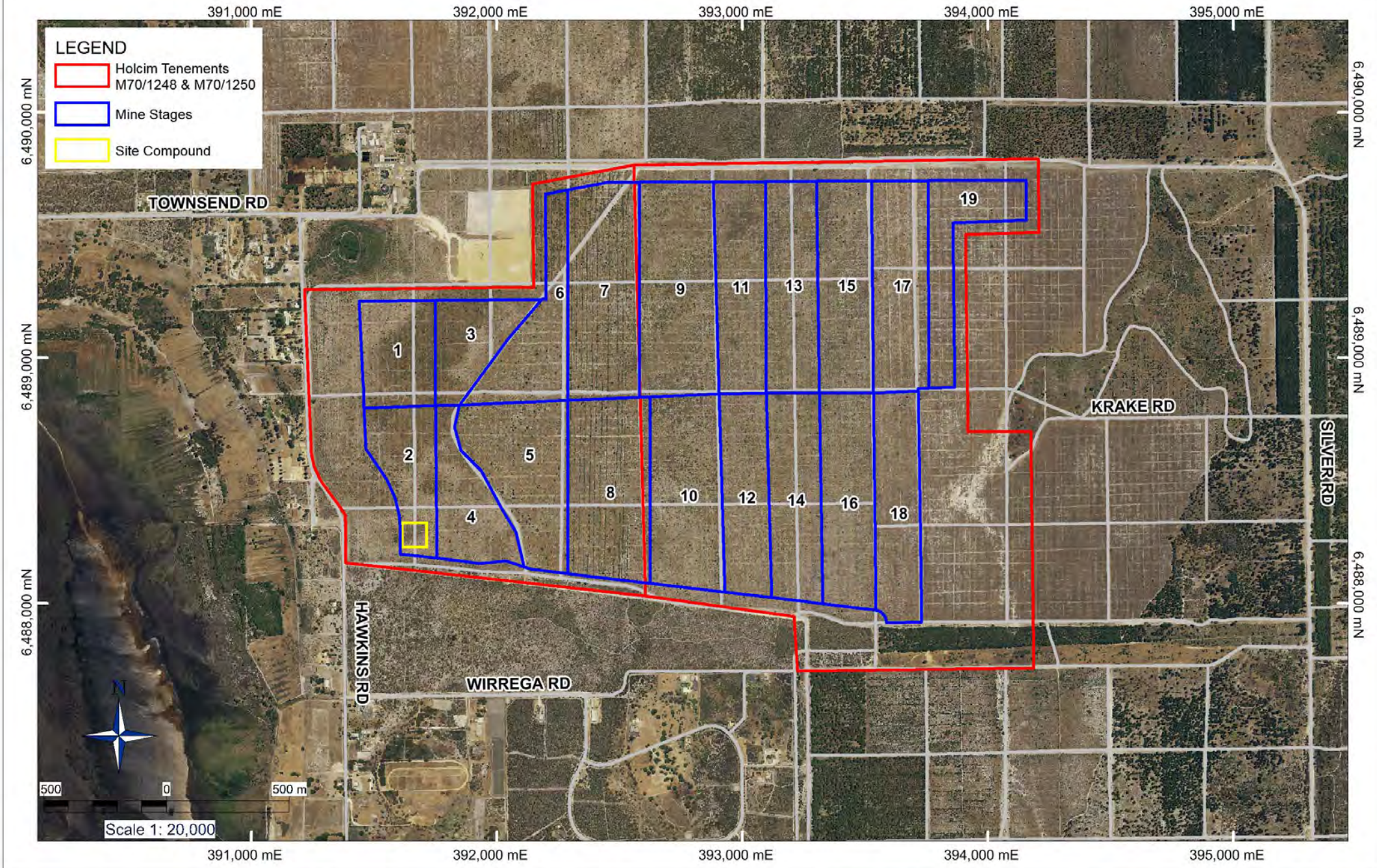


Holcim

EnviroWorks CONSULTING

Figure No. 3
Site Compound Layout

Date: 26/10/2015	Paper: A4 L	GDA94, MGA50
Data Source: 13A, 15I		
File Info: H04_J06_Site_Compound_Layout_20.08.2015		

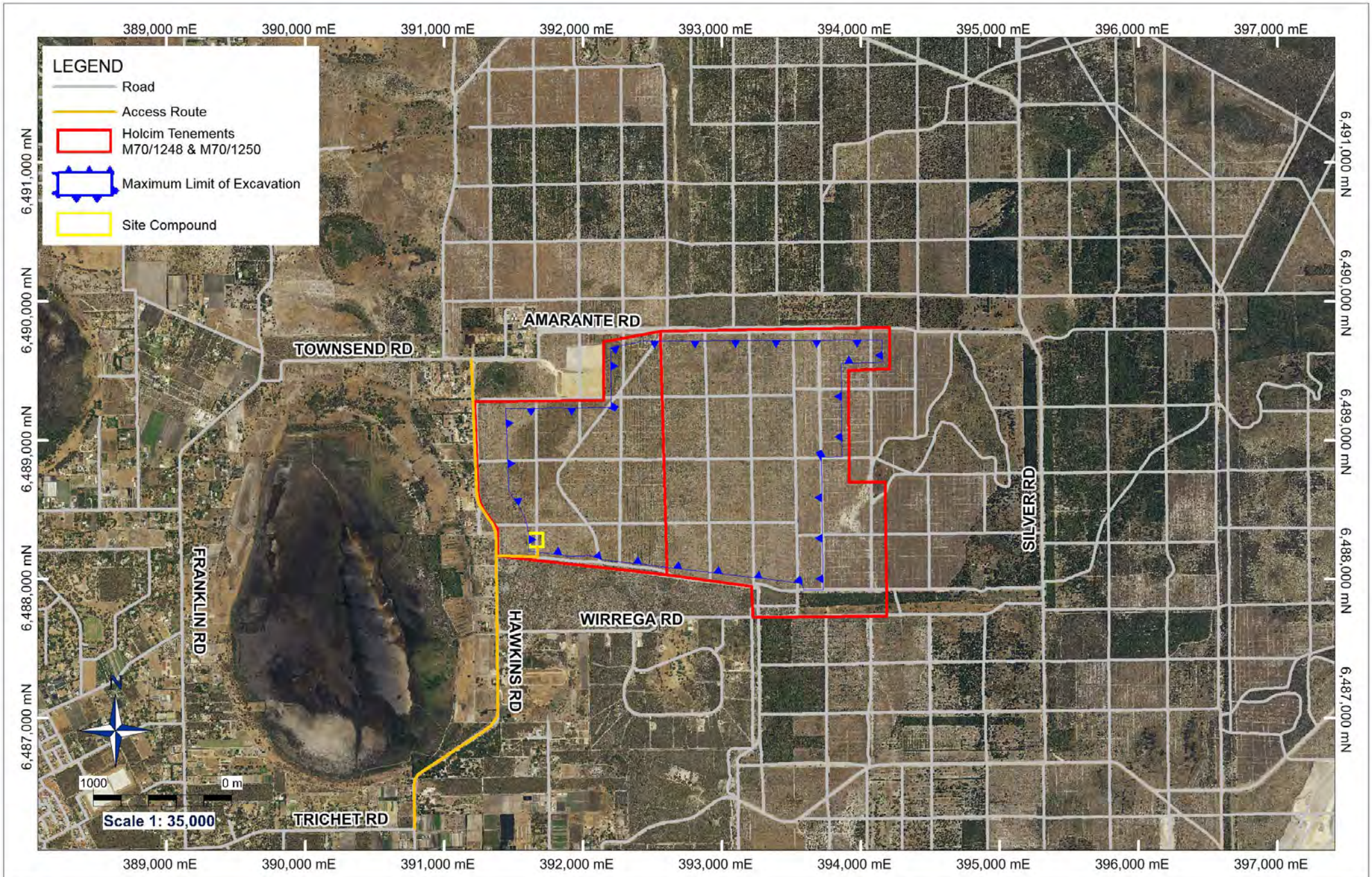


Holcim

EnviroWorks CONSULTING

Figure No. 4
Mining Staging Plan

Date: 26/10/2015	Paper: A4 L	GDA94, MGA50
Data Source: 8A, 13A		
File Info: H04_J06_Mine_Staging_26.08.2015		

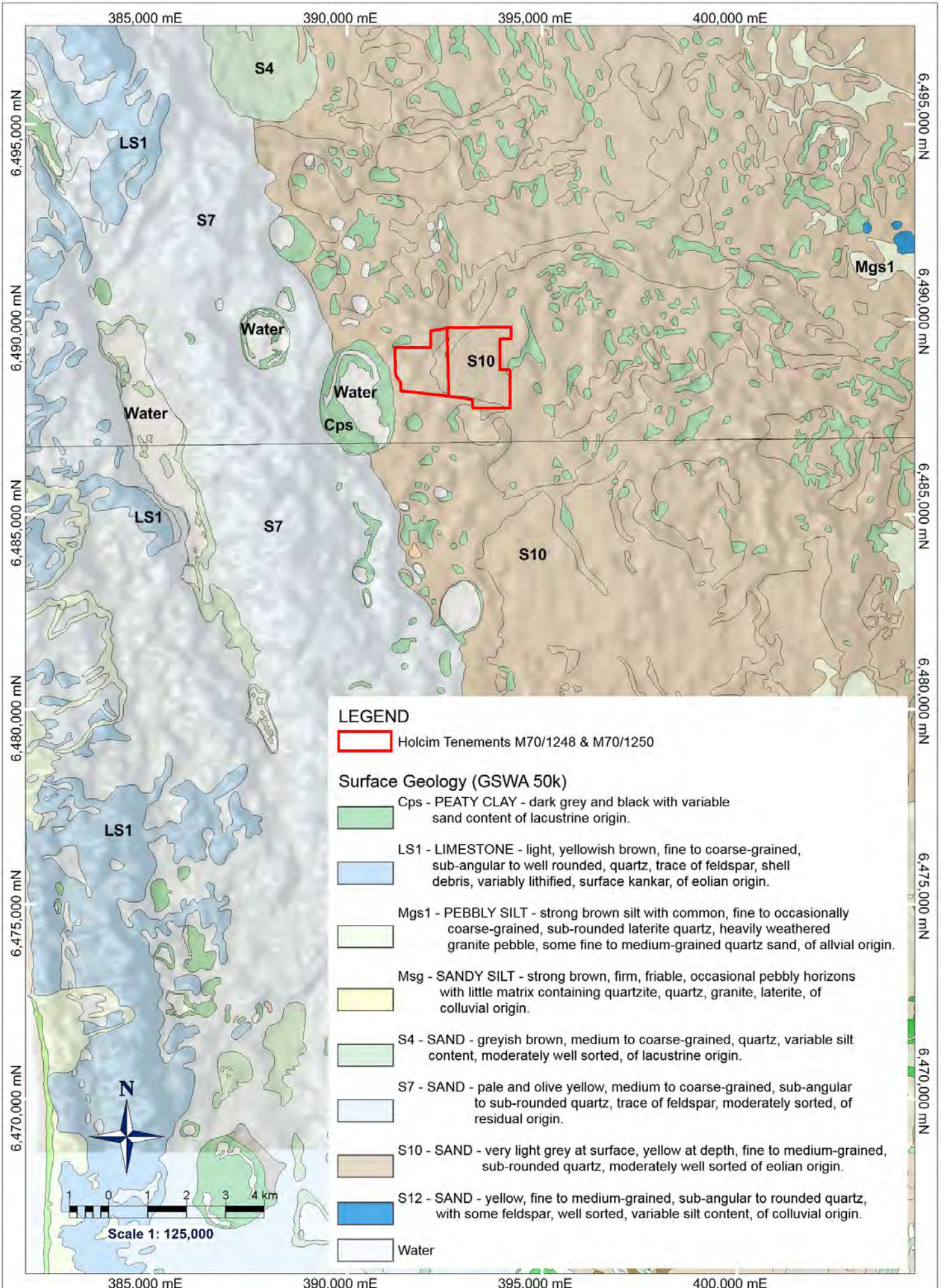


Holcim

EnviroWorks CONSULTING

Fig No. 5
Site Access Routes

Date: 26/10/2015	Paper: A4 L	GDA94, MGA50
Data Source: 7A, 13A		
File Info: H04_J06_Site_Access_Route_20.08.2015		



Holcim

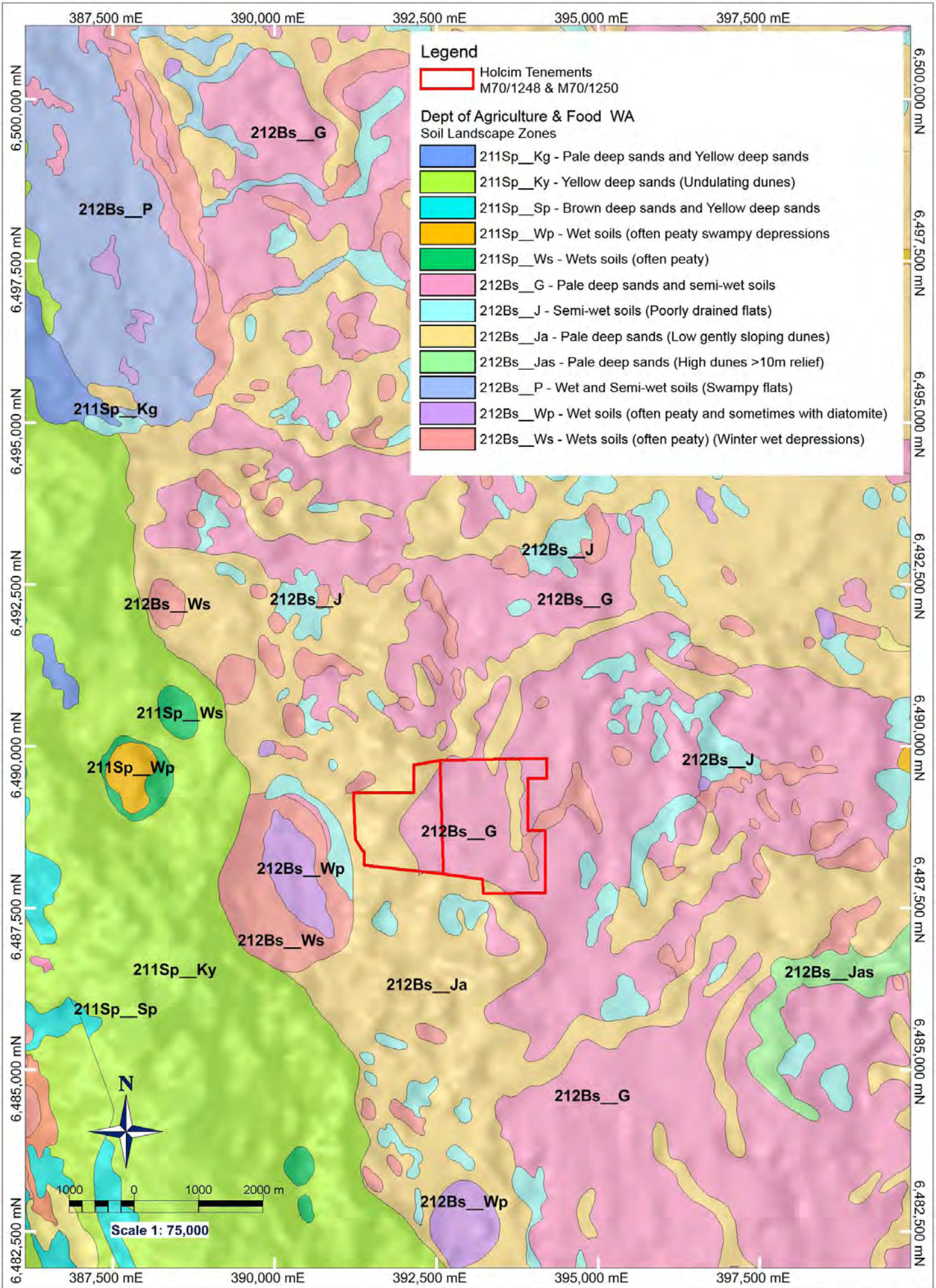
EnviroWorks CONSULTING

Figure No. 6
Surface Geology

Date: 20/08/2015 Paper: A4 P GDA94, MGA50

Data Source: 9A, 11B

File Info: U04_J06_Surface_Geology_20.08.2015



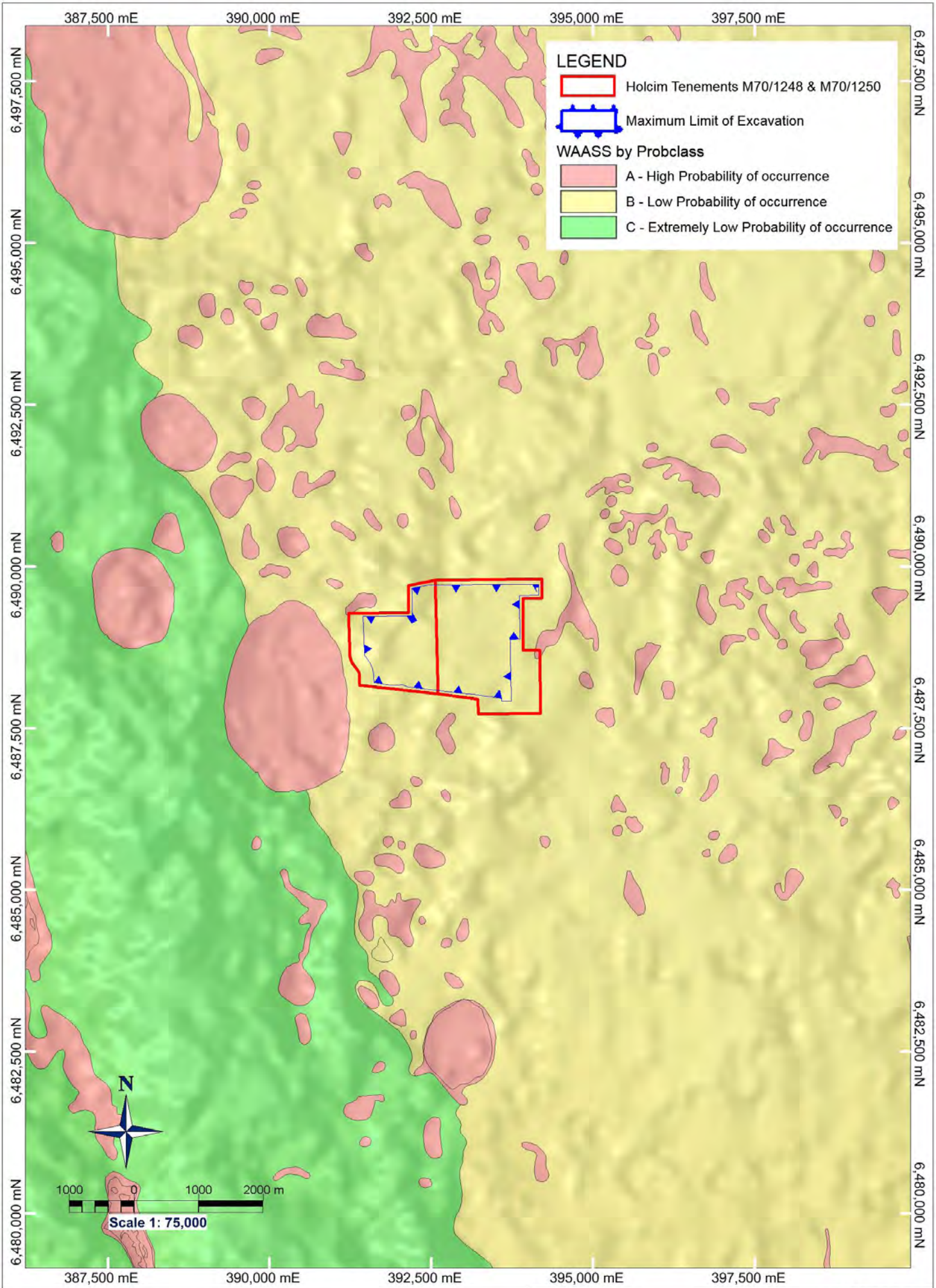
Holcim | EnviroWorks CONSULTING

Figure No. 7
Soil Types

Date: 20/08/2015 Paper: A4 P GDA94, MGA50

Data Source: 9A, 18C

File Info: U04_J06_Soil_Type_20.08.2015



Holcim

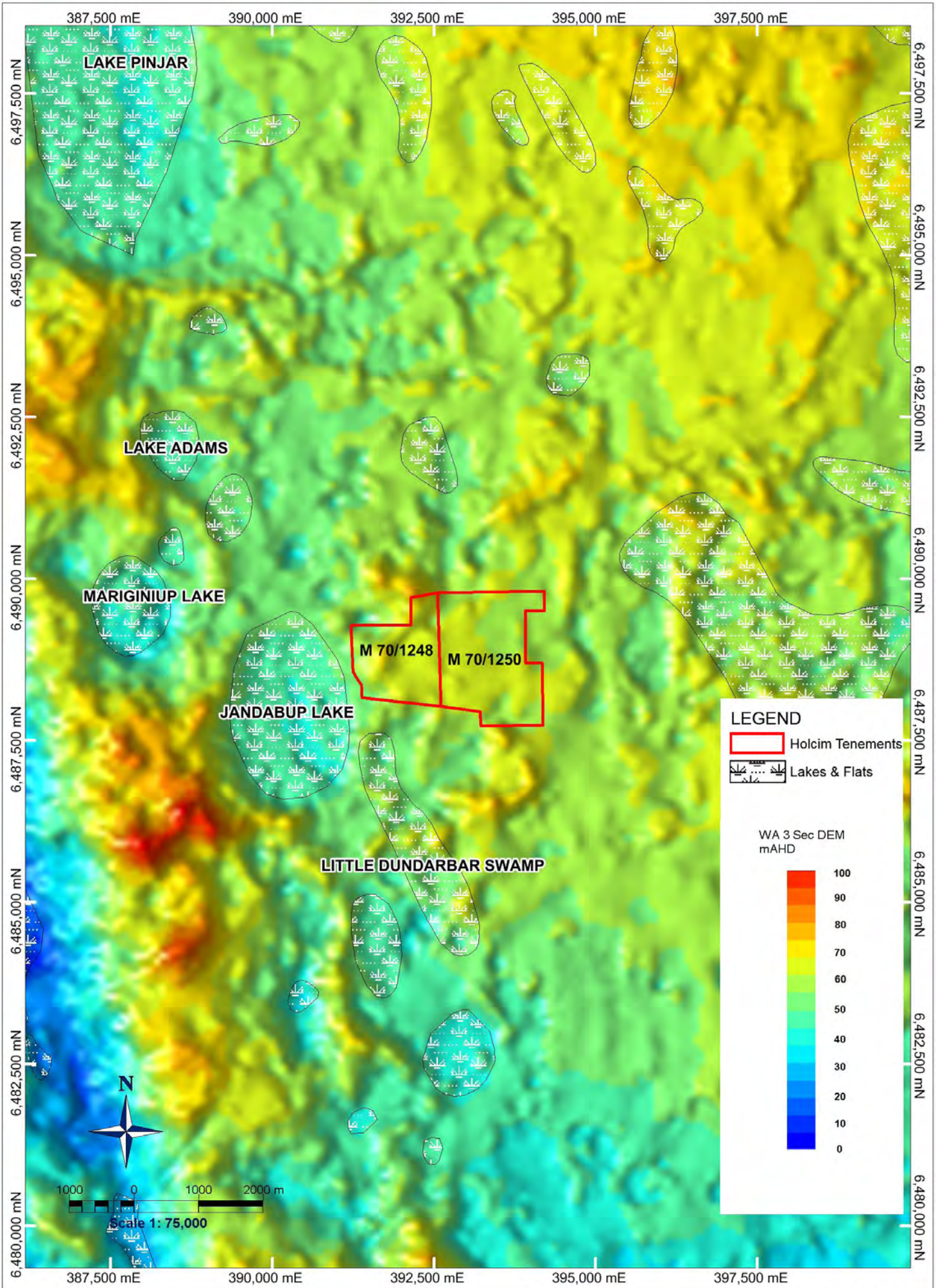
EnviroWorks CONSULTING

Figure No. 8
Acid Sulphate Soils

Date: 26/10/2015 Paper: A4 P GDA94, MGA50

Data Source: 9A, 18A

File Info: U04_J06_Acid_Sulphate_20.08.2015



Holcim

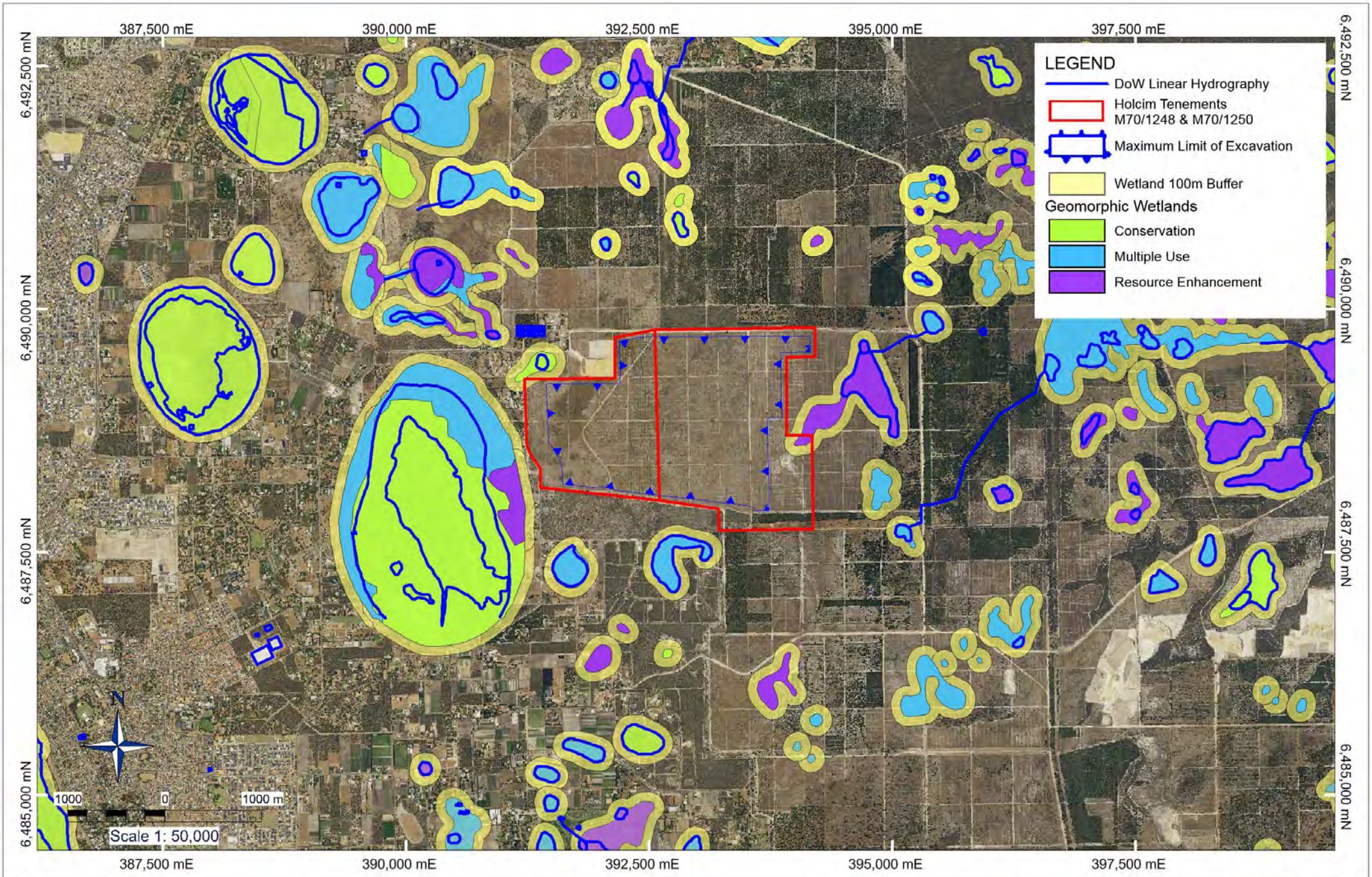
EnviroWorks CONSULTING

Figure No.9
Elevation

Date: 26/08/2015 Paper: A4 P GDA94, MGA50

Data Source: 9A

File Info: H04_J06_Elevation_26.08.2015



Holcim

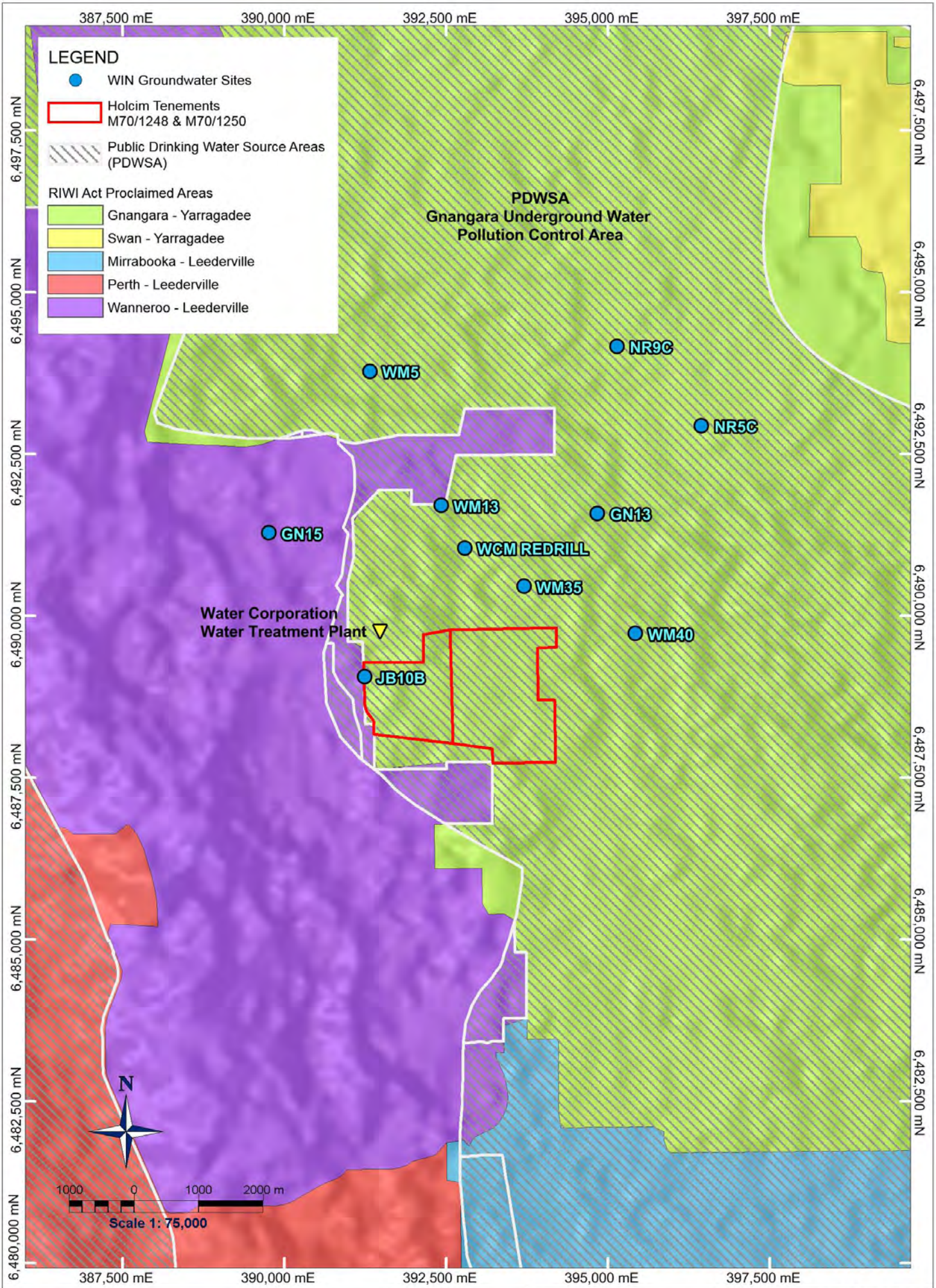
EnviroWorks CONSULTING

Figure No. 10
Surface Water

Date: 26/10/2015 | Paper: A4 L | GDA94, MGA50

Data Source: 9A, 21AB, 21AF

File Info: H04_J06_Surface_Water_20.08.2015



Holcim

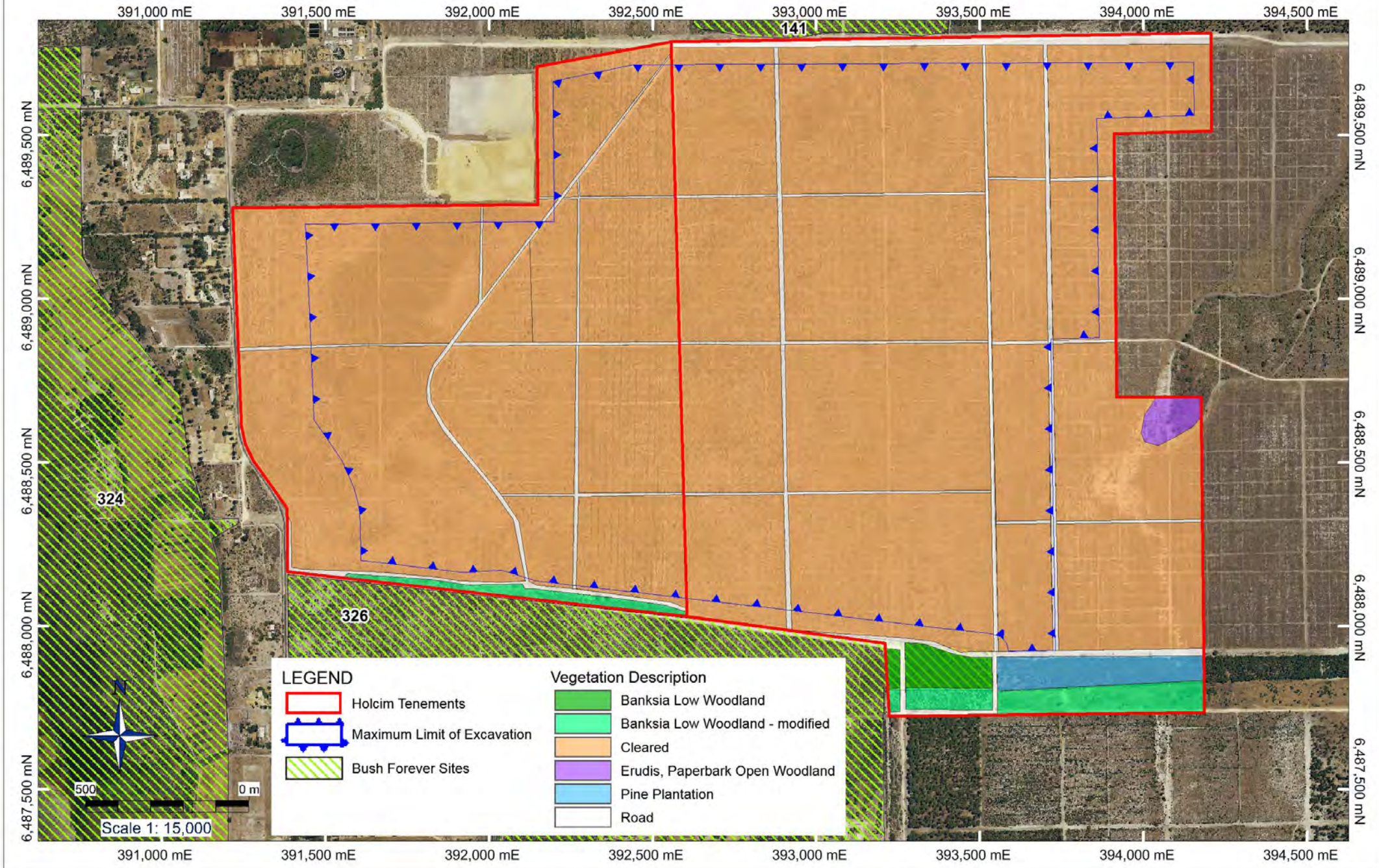
EnviroWorks CONSULTING

Figure No. 11
Ground Water

Date: 21/08/2015 Paper: A4 P GDA94, MGA50

Data Source: 9A, 21A, 21B, 21G

File Info: H04_J06_Ground_Water_21.08.2015



Holcim

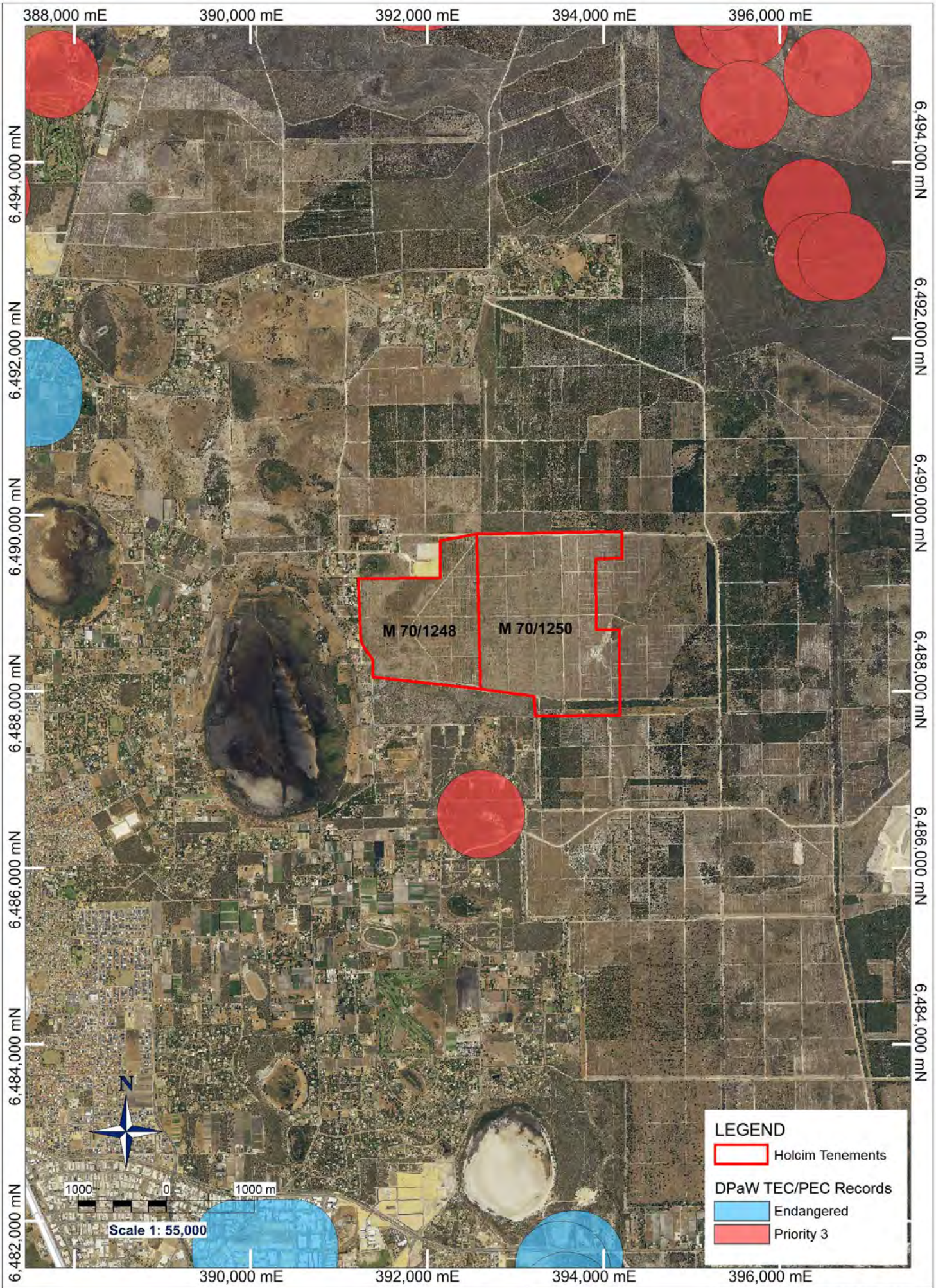
EnviroWorks CONSULTING

Figure No. 12
Vegetation

Date: 26/10/2015 | Paper: A4 L | GDA94, MGA50

Data Source: 7A, 13A, 23A

File Info: H04_J06_Vegetation_21.08.2015



Holcim

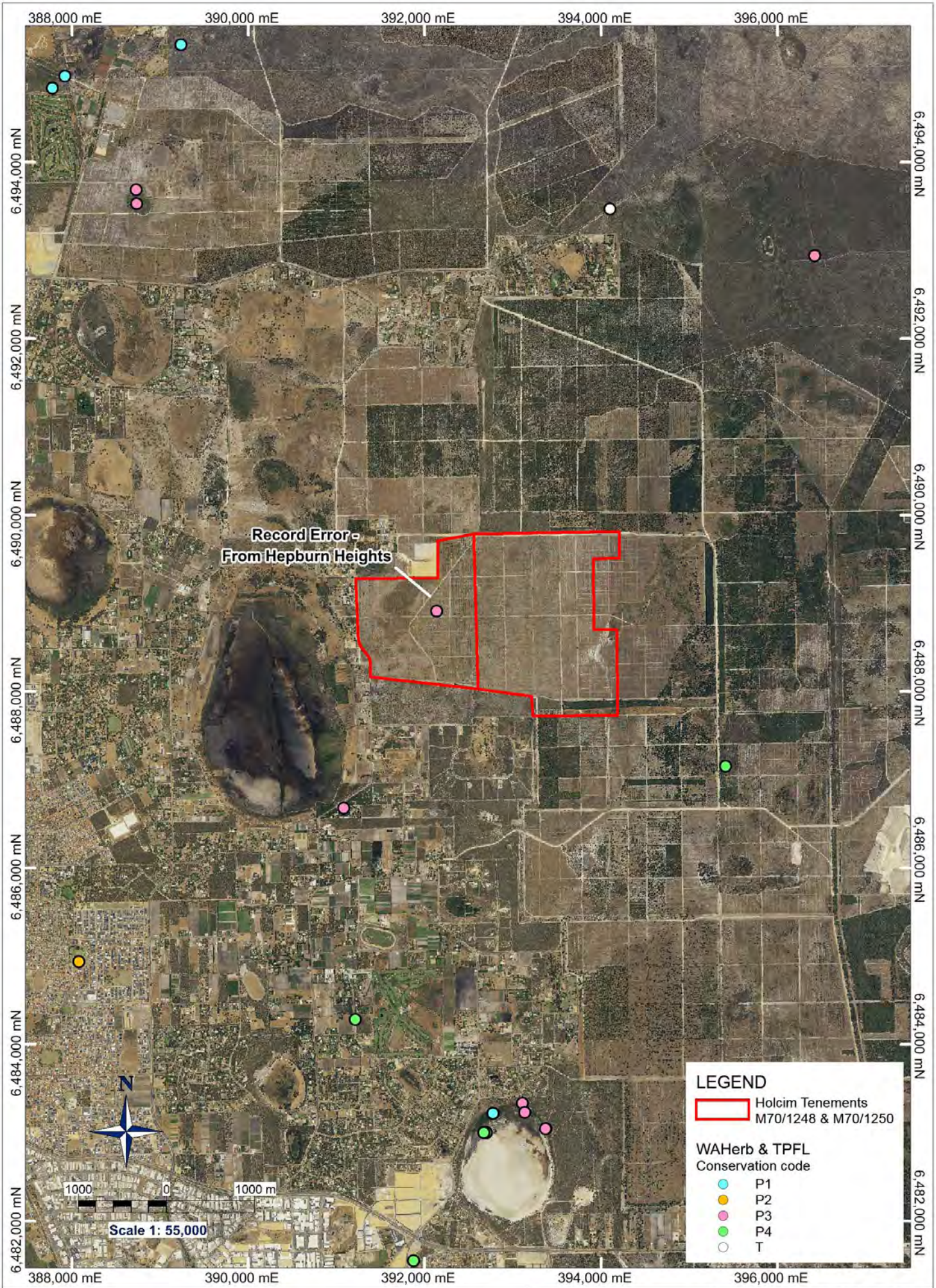
EnviroWorks CONSULTING

Figure No. 13
DPaW TEC/PEC Records

Date: 20/08/2015 Paper: A4 P GDA94, MGA50

Data Source: 10H, 10I, 10J, 13A, 15I,

File Info: H04_J06_TECPEC_21.08.2015



Holcim

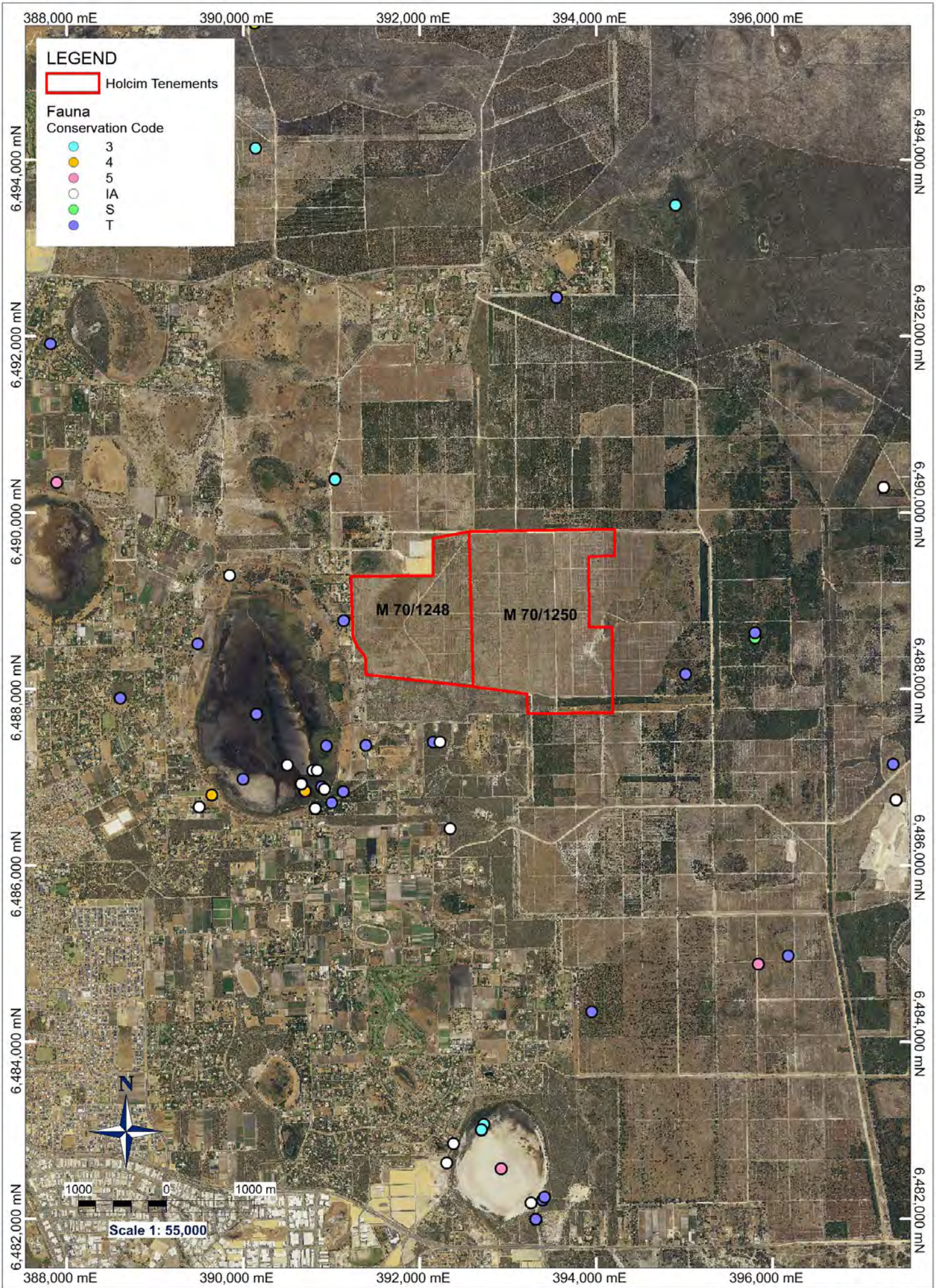
EnviroWorks CONSULTING

Figure No. 14
DPaW Significant Flora Records

Date: 21/08/2015 Paper: A4 P GDA94, MGA50

Data Source: 10H, 10I, 10J, 13A, 15I,

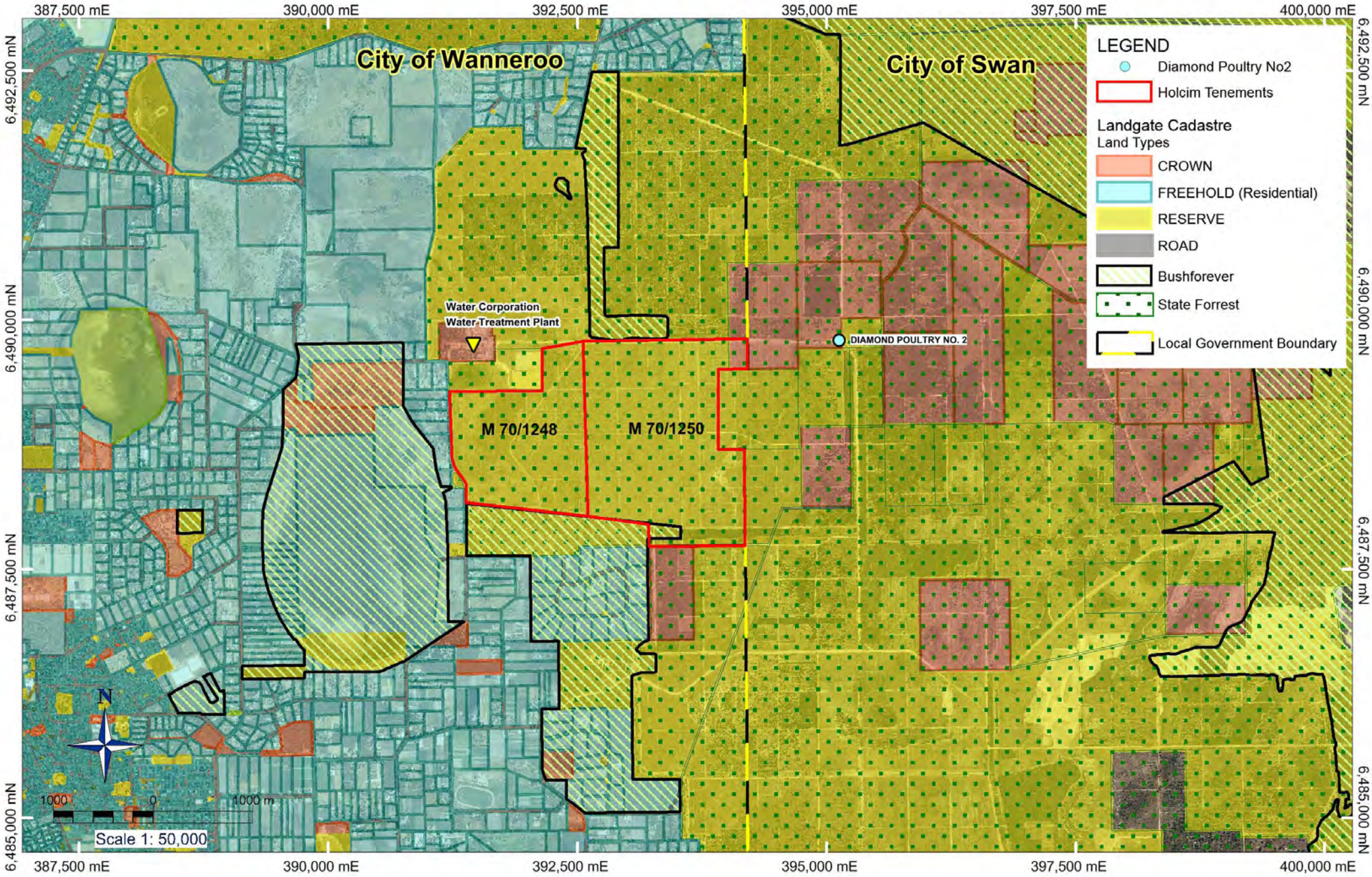
File Info: H04_J06_Sig_Flora_21.08.2015



Holcim | EnviroWorks CONSULTING

Figure No. 15
Fauna

Date: 21/08/2015 Paper: A4 P GDA94, MGA50
Data Source: 10H, 10I, 10J, 13A, 15I,
File Info: H04_J06_Fauna_21.08.2015



Holcim

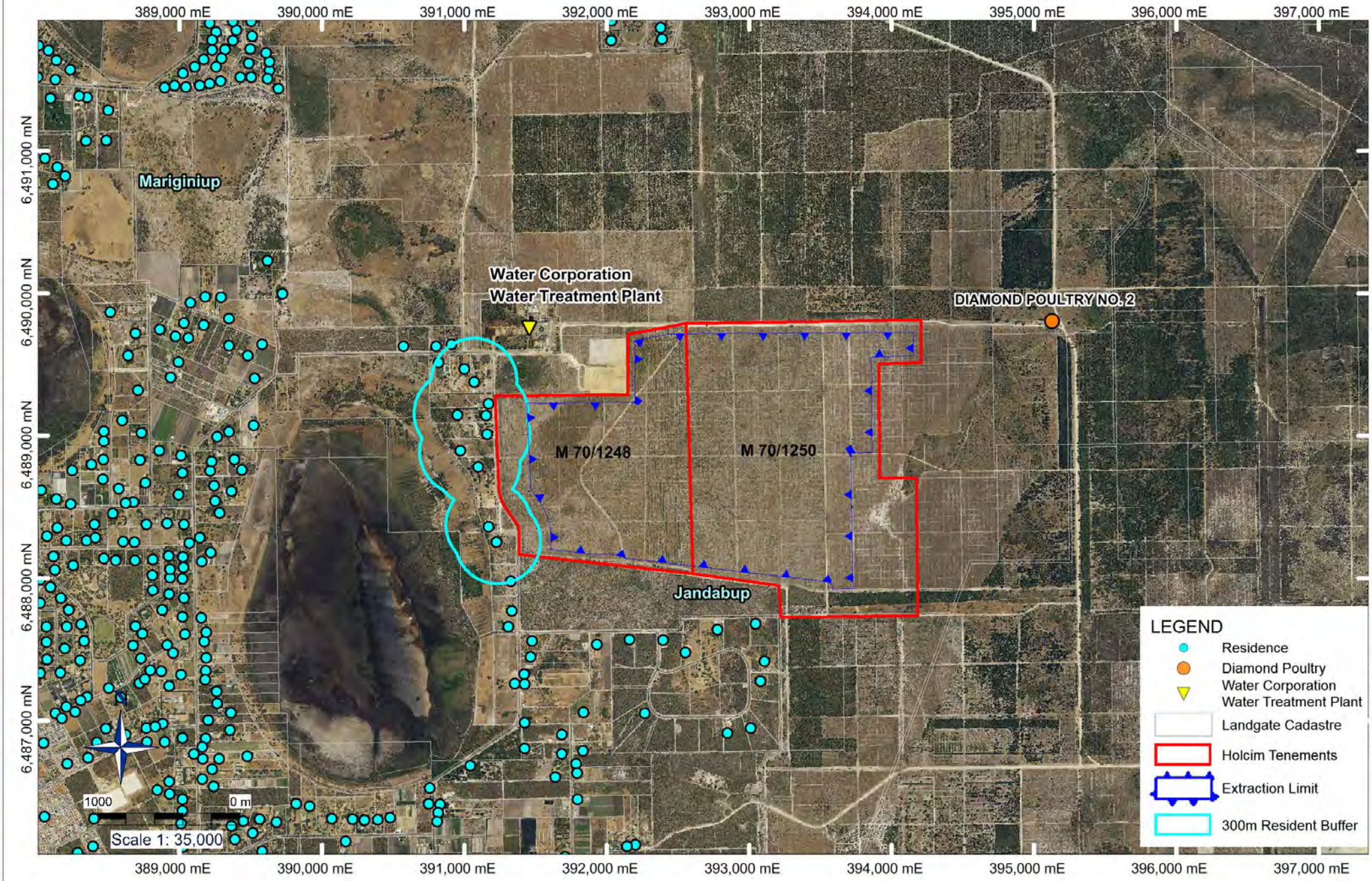
EnviroWorks CONSULTING

Figure No. 16
Land Use

Date: 20/08/2015 | Paper: A4 L | GDA94, MGA50

Data Source: 8A, 13A, 15I

File Info: H04_J06_Land_Use_21.08.2015



Holcim

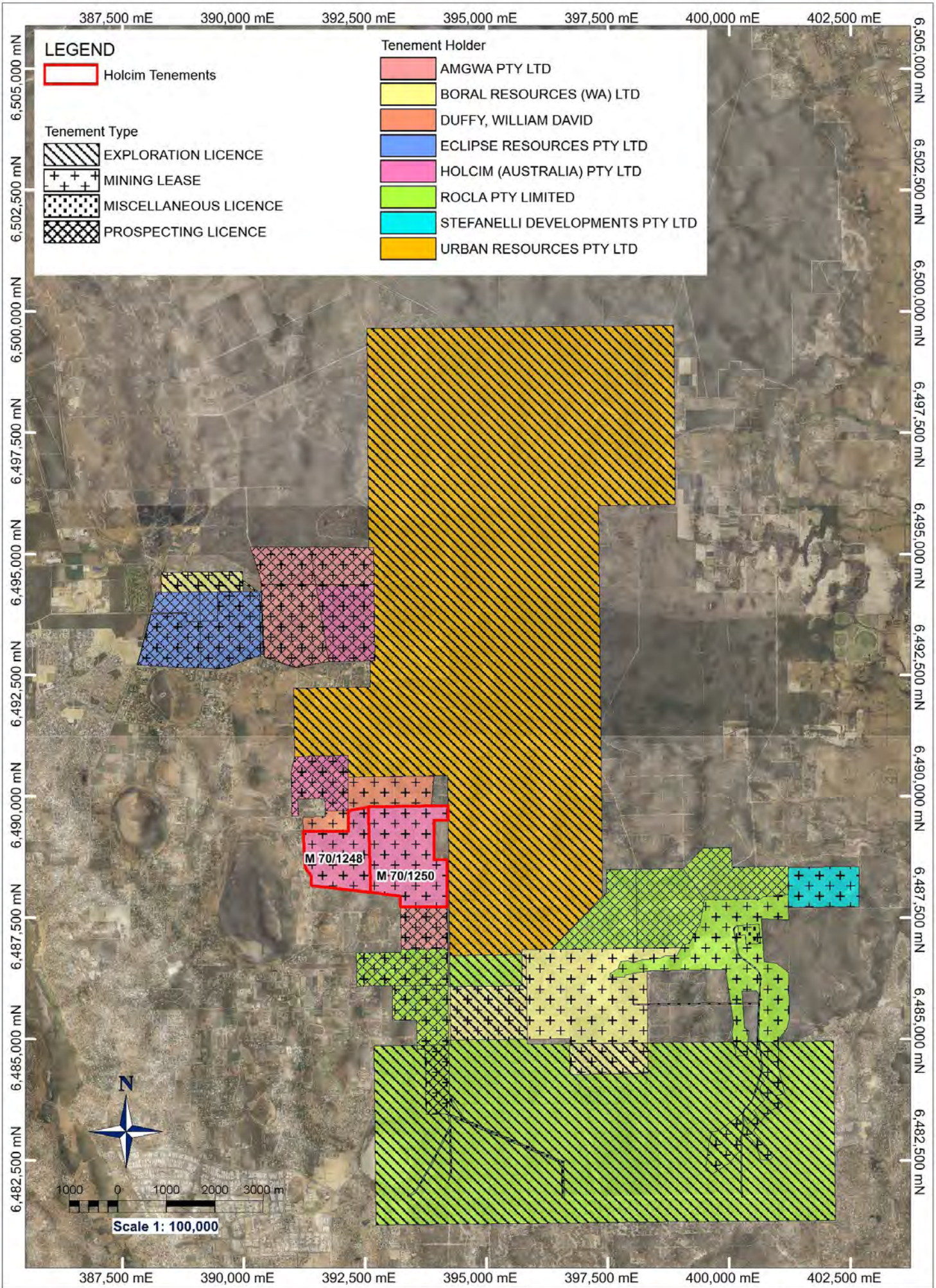
EnviroWorks CONSULTING

Figure No. 17
Nearest Residents

Date: 26/10/2015 Paper: A4 L GDA94, MGA50

Data Source: 8A, 13A

File Info: H04_J06_Nearest_Resident_21.08.15



Holcim

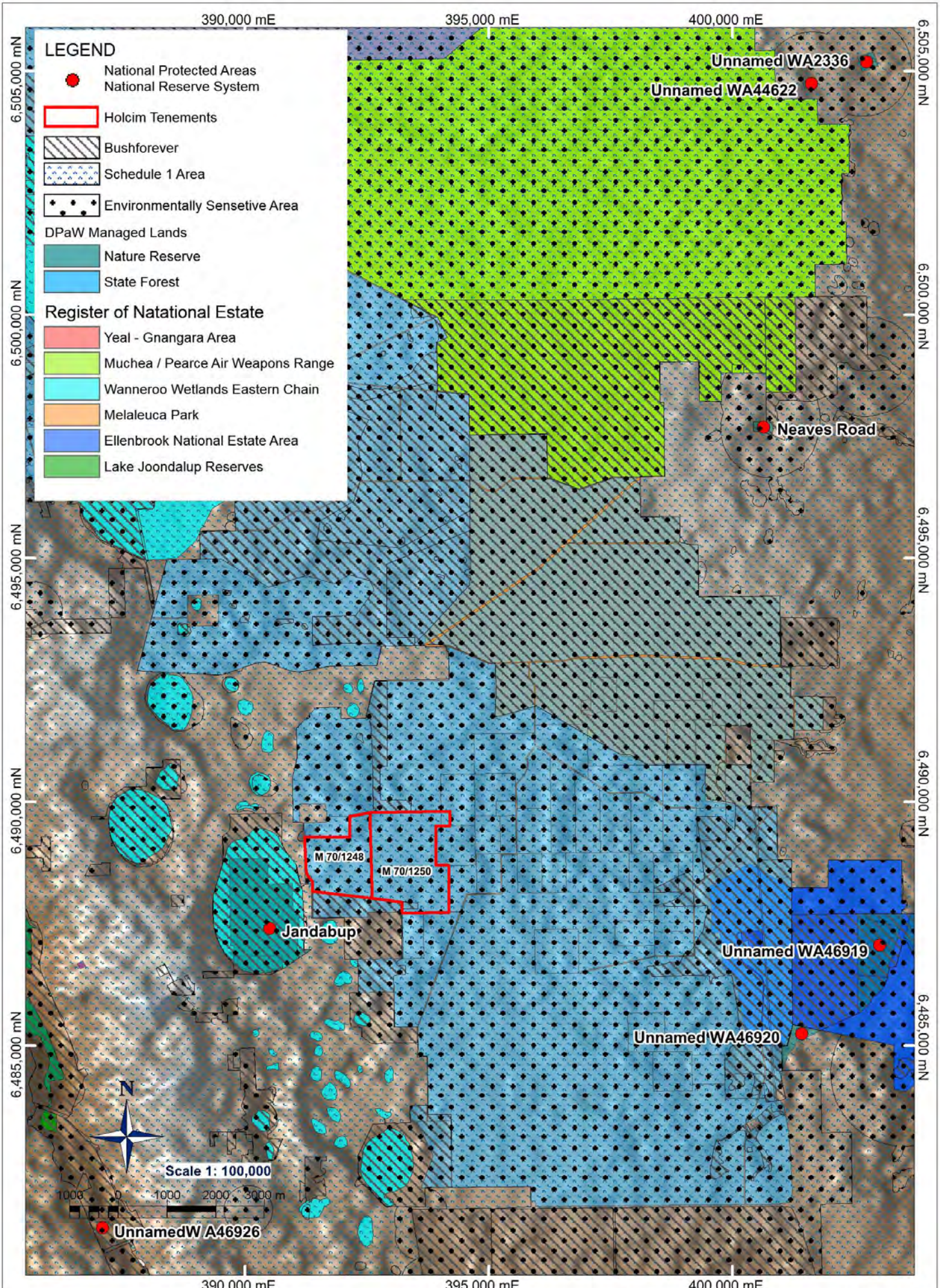
EnviroWorks CONSULTING

Figure No. 18
Surrounding Tenements

Date: 24/08/2015 Paper: A4 P GDA94, MGA50

Data Source: 9A, 15I

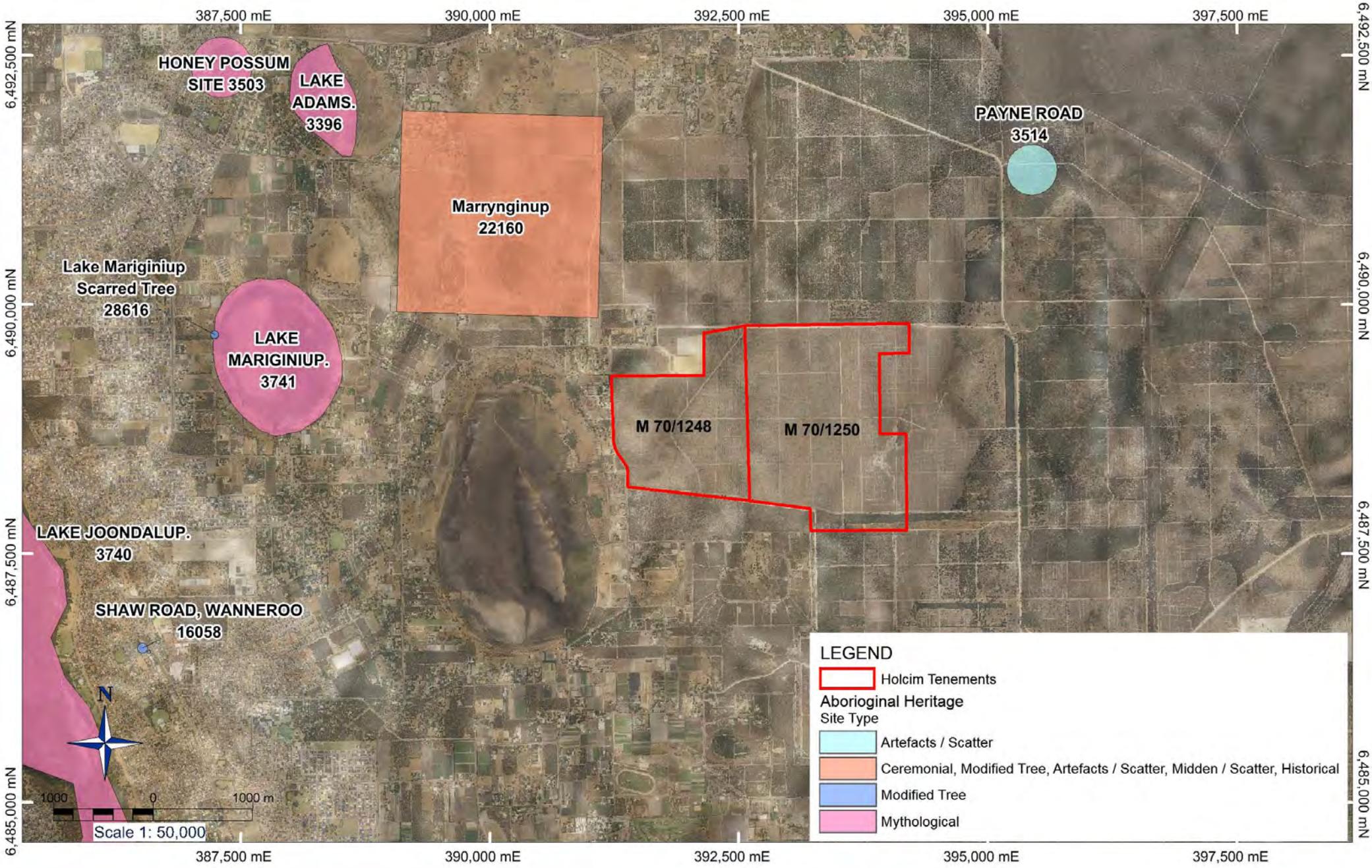
File Info: H04_J06_Tenements_24.08.2015



Holcim | EnviroWorks CONSULTING

Figure No. 19
Conservation Areas

Date: 24/08/2015 Paper: A4 P GDA94, MGA50
Data Source: 9A, 10A, 10F, 10M, 10N, 15I
File Info: H04_J06_Conservation_24.08.2015

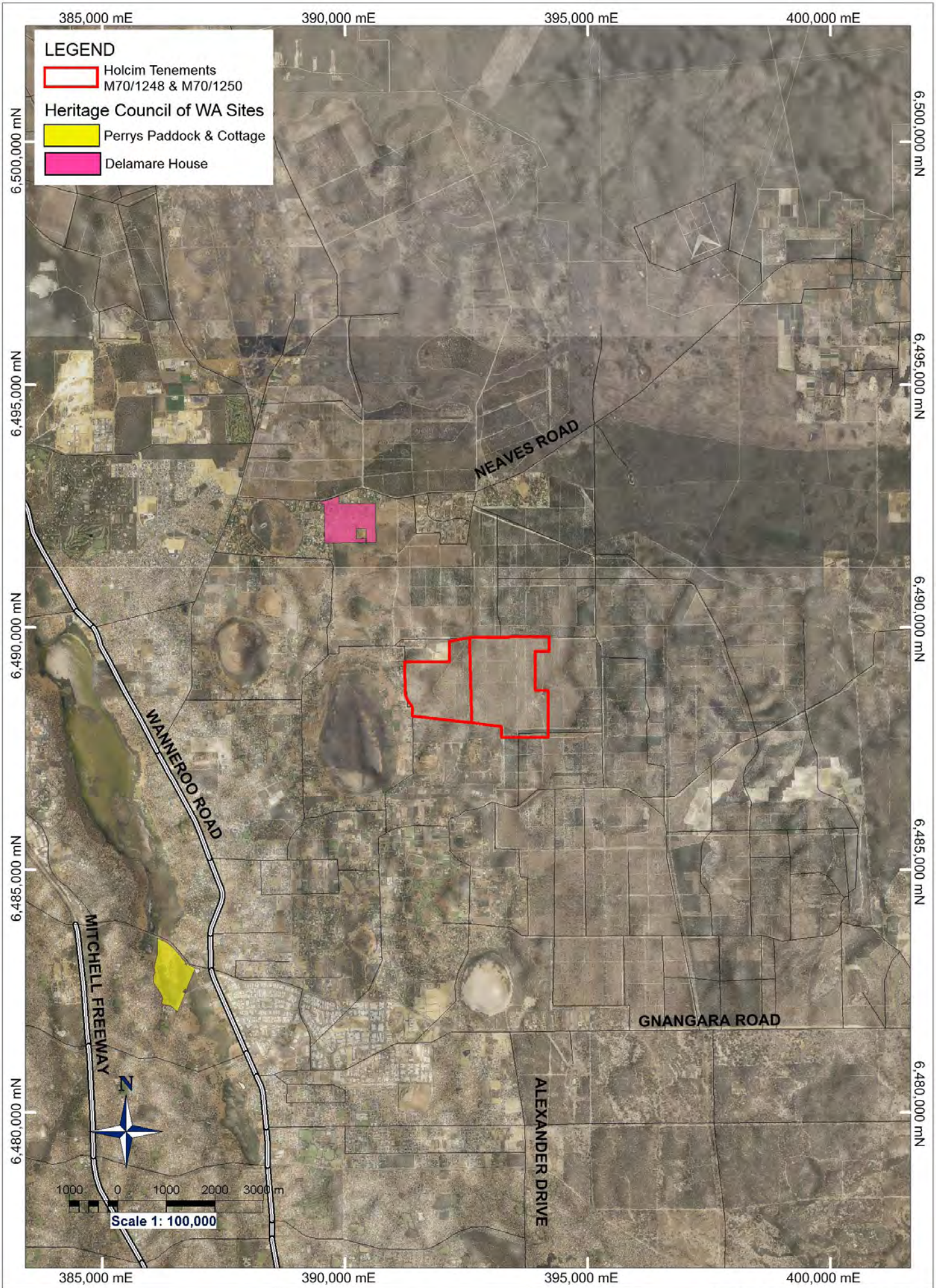


Holcim

EnviroWorks CONSULTING

Figure No. 20
Aboriginal Heritage

Date: 24/08/2015	Paper: A4 L	GDA94, MGA50
Data Source: 2H, 9A, 15I		
File Info: H04_J06_Aboriginal_Heritage_24.08.2015		



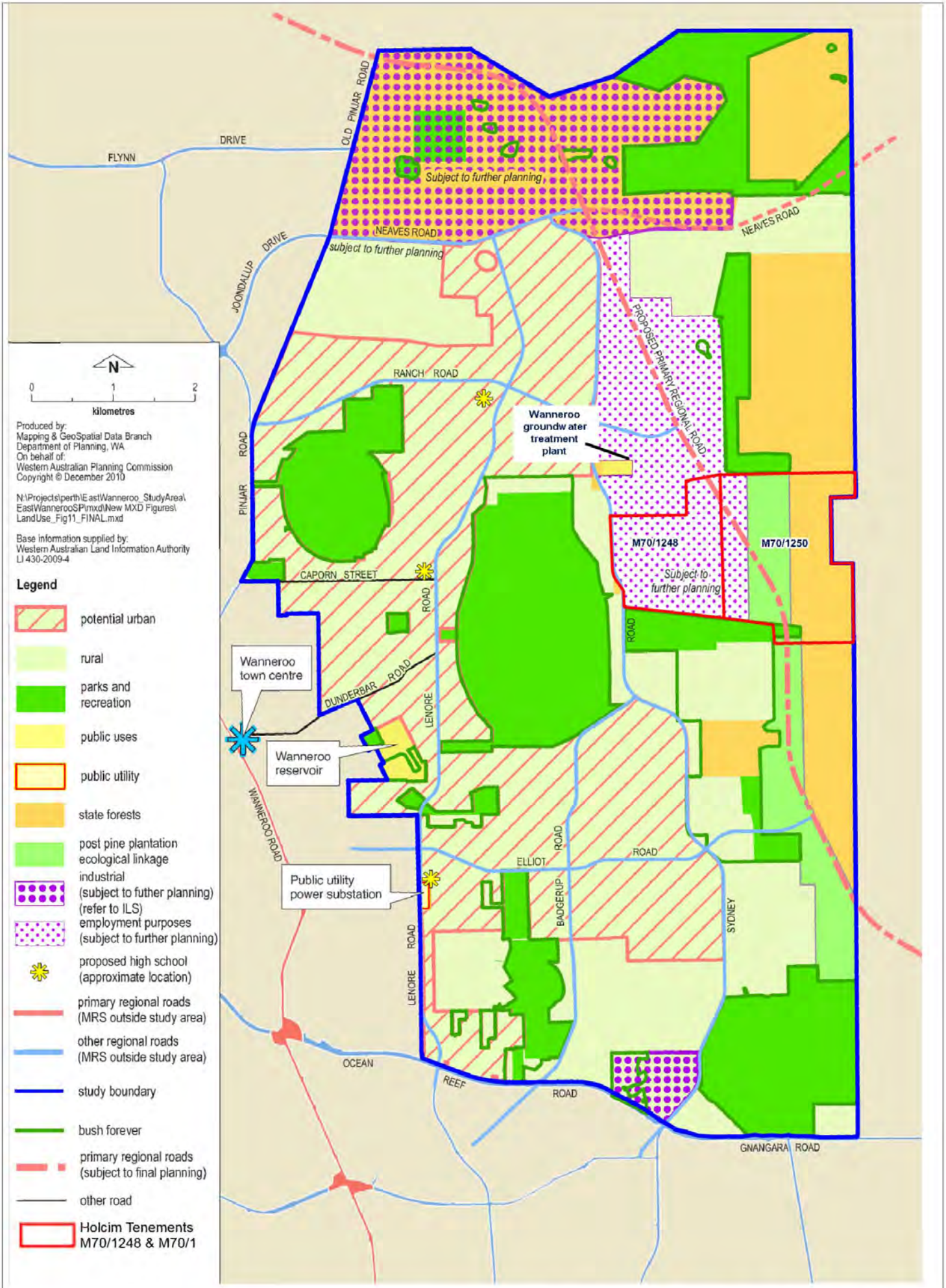
Holcim | EnviroWorks CONSULTING

Figure No. 21
European Heritage

Date: 24/08/2015 Paper: A4 P GDA94, MGA50

Data Source: 9A, 10Q, 12A, 15I

File Info: H04_J06_European_Heritage_24.08.2015



Holcim

EnviroWorks CONSULTING

Figure No. 22
East Wanneroo Structure Plan

Date: 24/08/2015 Paper: A4 P GDA94, MGA50

Data Source: 15l, Western Australian Planning Commission, 2011

File Info: H04_J06_Wanneroo_Structure_Plan_24.08.2015

APPENDIX A. GROUNDWATER IMPACT ASSESSMENT (URS, 2015A)

URS

Report

Groundwater Impact Assessment

AUSTRALIA

Jandabup Sand Quarry Project, Tenements M70/1248 and M70/1250

29 October 2015
42908863/RF/Wat/0204/0

Prepared for:
Holcim (Australia) Pty Ltd

Prepared by URS Australia Pty Ltd

URS

DOCUMENT PRODUCTION / APPROVAL RECORD				
Issue No.	**Name**	**Signature**	**Date**	**Position Title**
Prepared by	Rebekah Farrant Wen Yu		29/10/2015	Senior Project Hydrogeologist Principal Hydrogeologist/Groundwater Modeller
Checked by	Rob Wallis		29/10/2015	Senior Principal Hydrogeologist
Approved by	Rob Wallis		29/10/2015	Senior Principal Hydrogeologist

Report Name:
Groundwater Impact Assessment

Sub Title:
Jandabup Sand Quarry Project,
Tenements M70/1248 and M70/1250

Report No.
42908863/RF/Wat/0204/0

Status:
Final

DOCUMENT REVISION RECORD		
Issue No.	**Date**	**Details of Revisions**
A	18/09/2015	First Draft Submitted to Client
B	26/10/2015	Second draft for client review
C	28/10/2015	Final draft report to client
0	29/10/2015	Final report to client

Client Contact Details:
Joanna Russell
Holcim (Australia) Pty Ltd
18 Brodie Hall Drive
Bentley WA 6102

Issued by:
URS Australia Pty Ltd
Level 3, 3 Forrest Place
Perth WA 6000
PO Box 6004, East Perth 6892
Australia
T: +61 8 9326 0100
F: +61 8 9326 0296

URS

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

FIGURES

ABBREVIATIONS

Abbreviation	Description
AER	Annual Environmental Report
bgl	below ground level
BoM	Bureau of Meteorology
DER	Department of Environment Regulation
DO	Dissolved Oxygen
DoW	Department of Water
EC	Electrical Conductivity
kg/kL	Kilograms per kilolitre
kL	Kilolitres
kL/day	Kilolitres per day
kL/year	Kilolitres per year
kL/m^2	Kilolitres per square metres
kL/yr	Kilolitre per year
L/m^2	Litres per square metre
m AHD	Metres above the Australian Height Datum
m	metres
m^2	Square metres
mm	Millimetres
MGL	Maximum Groundwater Level
mg/L	Milligrams per litre
mg/m^2	Milligrams per square metre
FPC	Forest Products Commission
LOR	Limit of Reporting
P1 DWSPA	Priority 1 Drinking Water Source Protection Area
PRAMS	Perth Regional Aquifer Management System
SCP	Swan Coastal Plain
TDS	Total dissolved solids
TRH	Total Recoverable Hydrocarbons
UWPCA	Underground Water Pollution Control Area
WHPZs	Wellhead Protection Zones
WIR	Water Information Reporting
WMP	Water Management Plan

EXECUTIVE SUMMARY

This assessment considers a silica sand quarry, which Holcim (Australia) Pty Ltd is planning to operate onwards from 2016, at a site to the east of Lake Jandabup in the northern districts of Perth. The proposed quarry is expected to operate for about 25 years, and comprise a simple excavate-and-truck process that does not involve washing. The following is a summary of aspects that are significant to the groundwater environment near the proposed Project.

Significance of the Site to State Water Resources

The project site is within a Priority 1 Drinking Water Source Protection Area (P1 DWSPA) and an Underground Water Pollution Control Area (UWPCA). Both are managed by the Department of Water (DoW). Water Corporation operates a public drinking water supply scheme that spans the Gnangara Mound. The site is at the south-western edge of this scheme. Lake Jandabup is a regionally-significant wetland that is subject to a Ministerial Condition that is to maintain a level of 44.3 m AHD (absolute summer minimum). The project site is up-gradient of Lake Jandabup and therefore within the recharge source area for the lake.

The site has also been used to source drinking water by the Water Corporation. Water supply bores (W210 – W240) established in the 1970s operated for about ten years before being decommissioned in the mid-1980s. Bores W210 and W220 are still operated by the Water Corporation for the DoW to supply supplementation water to Lake Jandabup. Security of supply from this infrastructure is managed by the Department of Water (DoW).

Climate Aspects

Long-term climate data in the Perth Region indicates that the climate has been becoming drier over the past 15 to 20 years. Data for this assessment was derived from synthetic BoM SILO stations to the north and south of the site with data representing the past 16 years.

Land-use Change

Land-uses in the Jandabup area have changed twice since the mid-1960s when the project site was covered with pine plantation forest. This forest has been steadily removed over the past 10 years. While the Project site has been cleared since 2010, adjacent areas are still being cleared. The Forest Products Commission plan to harvest all remaining pine forests in the area, however, the actual timing is still uncertain.

Over the past few decades, urbanisation of the Jandabup area has progressed. Areas not under pine plantation have steadily been converted to semi-rural, lifestyle blocks. Department of Planning maps of the area indicate the spread and density of urbanisation are expected to continue. Again, the timing for this transformation is uncertain, but changes to the water environment are expected.

Holcim Groundwater Investigations

The field investigation undertaken for this study indicates that the Bassendean Sand in the Project area is not homogeneous. The Bassendean Sand contains variable amounts of silt and organic matter depending on proximity to sand dunes, or swamps and damplands. Higher

amounts of these components were observed in soils at the eastern side of the Project. Hydraulic properties, regional-scaled groundwater flow, and responses to recharge and abstraction are all therefore, expected to be locally variable. Mapped groundwater levels indicate there are local-scaled influences on the water table in the order of 1m to 2m.

Groundwater quality in the project site is also variable. Salinities are low, but evidence of influence from acid-sulphate soils in the east is present with low pH values and elevated sulphate concentrations. The groundwater in this area is not of potable standard with respect to aesthetic limits for pH and for ammonia in some cases. Dissolved phase hydrocarbons were detected at low concentrations in three bores, however, given the spatial distribution and previous land use, it is unlikely that these are of human origin.

Holcim Monitoring Programme

Groundwater level monitoring by Holcim has captured most of one seasonal cycle. The Holcim data align with long term levels monitored by the DoW at their regional sites. Groundwater level data from the Holcim bores indicate variable rates of seasonal rises, suggesting local variability in rates of recharge and/or aquifer storage.

Groundwater levels across the Bassendean Sand aquifer indicate very weak vertical gradients suggesting the aquifer is essentially responding as a single unconfined unit. Small influences from local groundwater abstraction from W220 are suggested by HMB07B.

Review of Historical Groundwater Levels

Groundwater levels fell in the 1970s and 1980s as a result of:

- pine plantation establishment in the 1960s
- groundwater abstraction by the Water Corp in the 1970s and 1980s

Levels began to stabilise in the 1990s and early 2000s as a result of cessation of pumping by the Water Corporation from nearby bores. Groundwater levels near Lake Jandabup have stabilised in the past ten years as a result of water being pumped to the lake under the direction of the DoW. However, further to the east, the levels are still following a falling trend.

The stabilisation of levels in some areas indicates that present conditions are approaching a steady-state balance due to the removal of the pine trees and drying climate. The effects of Water Corporation abstraction cessation was a feature of earlier decades, although supplementation pumping is likely affecting groundwater levels near bores W210 and W220.

The slow stabilisation of groundwater levels indicates the positive effects of the pine tree removal programme are mostly offset by the drying climate. If the climate has dried by 10-15% in the past 20 years, then the approaching balance suggests the loss of recharge from the pine trees prior to 2005 was of a similar amount in some areas, and less in others.

Holcim Change Assessment

This assessment combines observed groundwater levels with predicted changes to recharge due to climate, regional land-use and quarrying. The change assessment employed outputs from the DoW Perth Regional Aquifer Modelling System (PRAMS) model as well as a local-scaled DoW model that captures all of these variables. The local-scaled groundwater model is

a refined extract from PRAMS. Local refinements include land-use distributions and changes since 2001. It includes averaged rainfall data provided by the DoW from Zones 5 and 6 in the PRAMS model.

The model predictions indicate that changes to the recharge conditions take about 10 to 15 years to equilibrate to a new water table elevation. Short term changes resulting from an above-average rainfall year are generally small. Groundwater abstraction influences near the project site are also apparent, particularly near bore W220.

The local-scaled model was used to characterise impacts on the water environment due to quarrying. Changes to the water table were estimated by adjusting the groundwater recharge rate for conceptual annualised quarry blocks, followed by a one-year rehabilitation phase. Differences between the same model with, and without the quarrying influences were calculated. Impacts to the water table elevation are expected to include a rise of between 0.05m to 0.15m within the site and rise of 0.01m at Lake Jandabup.

The maximum groundwater level across the site was determined by adding the DoW-predicted changes between 2013 and 2030 to current winter groundwater levels. This approach incorporates a range of changes to the groundwater balance due to long term land use changes including pine clearing, urbanisation, climate change, and groundwater abstraction by the Water Corporation and other nearby users (licensed and unlicensed).

To ensure adequate clearance above the water table, the MGL map requires ongoing refinement to account for local variances in the groundwater balance due to land use changes and medium to long term changes to rainfall.

With the aid of the Department of Water Holcim is investigating a number of options to source water for dust-suppression requirements at the project.

Sensitivity and Uncertainty in this Assessment

The change assessment assumed that recharge rates within the project area will be very high. It was assumed that recharge rates will be similar to previously adopted rates for urban and industrial areas (45% of annual rainfall). The actual rates of recharge in quarry areas is as-yet unknown. The outcomes of sensitivity to this uncertainty were tested using the groundwater flow model. An increase in net recharge by a further 10% is predicted to result in a further water table rise in the order of 0.01m. The net effect on the groundwater levels from the actual rate of recharge will be regularly monitored and assessed by Holcim.

Conclusions

Quarrying at Jandabup is expected to have a positive effect on the water resource due to the increased rate of net recharge to the water table. This change is, however, not expected to be permanent as the recharge rates after rehabilitation are likely to be similar to current conditions (post-pine plantation woodland). Quarry-related changes will not contribute to regionally downward trends at the water table. Quarrying-related changes are expected to be mostly confined to the mining tenements. No detectable changes are expected at Lake Jandabup.

A source for the Project's water supply is still under negotiation with the DoW, and with their assistance, a range of potential sources are being considered.

Some influence from a dampland area to the east of the site suggests that previous land-uses in this area combined with reduced rainfall recharge from climate change may have influenced the quality of local groundwater. This change is the result of lowered water table due to the establishment of pine plantations and possibly groundwater abstraction by the Water Corporation, and oxidation of sulphide minerals in organic-rich and typically waterlogged areas. These influences have resulted in groundwater that is of variable quality ranging from potable to non-potable.

A water management plan has been developed to minimise adverse influences from Holcim's quarrying activities. This plan includes protocols for managing risks to existing water supply infrastructure and groundwater quality, as well as monitoring the overall effect that quarrying will have on the groundwater level and Lake Jandabup. Incorporated in this plan is a review cycle that will allow Holcim to identify changes to the groundwater environment. It will also allow Holcim to maintain an acceptable separation from the water table, while also maximise the benefits of this basic raw materials resource.

1 INTRODUCTION

1.1 Background

Holcim (Australia) Pty Ltd (Holcim) is proposing to quarry silica sand within Quarrying Tenements M70/1248 and M70/1250, located at Jandabup (Figure 1-1). Hydrogeological aspects of the site including a desktop study, monitoring bore drilling programme and monitoring programme definition have previously been undertaken by URS (2014, 2015a, 2015b).

As a result of these studies, key issues that have been considered in this assessment include:

- Recent assessments by the Department of Water (DoW) indicate that groundwater levels could rise in the future depending on whether management of the regional water balance is successful. This will affect the final pit floor elevation above the water table, considering there also needs to be a 3m buffer clearance.
- Groundwater resources in the Project area are managed by the DoW under the
  - Rights in Water and Irrigation Act (resource allocation as PDSWAs); and
  - Metropolitan Water Supply, Sewerage and Drainage Act (pollution prevention as Underground Water Pollution Control Area – UWPCAs).
- Ministerial conditions have been set with regards to the performance of water resource management measures in place for Lake Jandabup by the DoW and Water Corporation. Recent reviews by the Office of the Environmental Protection Authority (OEPA) indicate there have been breaches of these conditions in recent years.
- Existing drinking water supply bores in the project area are protected by the DoW by a 500m exclusion zone for any groundwater disturbing activities around such bores within a Priority 1 Drinking Water Source Protection Area (P1 DWSPA).
- As the site is in a P1 DWSPA, the quarry floor needs to remain 3m above the water table during and after quarrying. DoW policy allows this to be reduced to 2m in some circumstances.
- Changes to the water table in the Project area, that may influence closure-based decisions, are the result of several factors that have prevailed over the past 30 to 40 years including:
  - pine plantation establishment and recent removal;
  - drinking water supply abstraction by the Water Corporation and recent cessation;
  - local groundwater abstraction by licensed and unlicensed bore owners;
  - climate change; and
  - changes to groundwater recharge rates due to urbanisation and direct urban drainage.

To support a Mining Proposal, Holcim is required to assess water related risks and develop a management plan to address these risks. The Water Management Plan (WMP) has been prepared under a separate cover (URS, 2015b). Recent consultation with the DoW, indicates

that ensuring an adequate buffer between the quarry floor and the water table is to be maintained during both the operation and closure phases.

Additionally, changes to nearby groundwater-sensitive ecology's and existing groundwater users need to be identified and managed, to minimise cumulative impacts from the Project.

The Project will require a water supply for dust suppression only, as product processing (sand washing) will not be undertaken on this site. Holcim is planning to acquire a water supply for the project from an external source i.e. not from the water table within the quarry area. Discussions with the DoW regarding the location of the source are ongoing.

1.2 Objectives

The main objectives of this groundwater impact assessment are to:

1. determine the future Maximum Groundwater Level (MGL)
2. determine the likely changes to groundwater environment at Lake Jandabup due to the Project.

1.3 Scope of Work

The scope of work of this assessment includes the following:

1. Document the results of baseline monitoring to establish seasonal groundwater levels and quality variability within and downstream of the site;
2. Identify the risks the Project poses to the groundwater environment and existing users.
3. Undertake a change assessment including:
   - Characterise the future net change to the local groundwater levels resulting from internal and external influences;
   - Characterise the future change to the local groundwater quality resulting from internal and external influences;
4. Undertake an impact assessment including:
   - Develop an MGL map across the proposed quarry site;
   - Assess groundwater level changes to local wetlands including Lake Jandabup (west) and a dampland area that is characterised as a high risk acid-sulphate soil area (east) from the proposed quarry;
   - Assess impacts to local, existing groundwater users from the proposed quarry;
5. Identify and assess mitigation strategies, if appropriate;
6. Prepare an operational-phase monitoring programme; and
7. Prepare a technical report to support the Mining Proposal.

This report details the results of groundwater assessments undertaken since November 2014 to meet the above objectives and scope.

2 PHYSICAL ENVIRONMENT

2.1 Climate

The proposed sand quarry is located approximately 23 km north of Perth. The area is in a Mediterranean climatic region that is characterised by hot, dry summers and mild, wet winters. Rainfall has been recorded by the Bureau of Meteorology (BoM) at weather stations across the Perth Region since 1907 (Wanneroo - BoM, 2015). Climate change in Perth is reflected by the difference between the 20-year average annual rainfall of 692.9 mm (1995 – 2015) and the 5-year average annual rainfall recorded at Perth Airport, 654.5 mm (2010 – 2015). This indicates that the climate is becoming drier in this area which is consistent with recent findings in *State of the Climate 2014* (BoM and CSIRO 2015).

For this assessment, rainfall data sourced from the Perth Regional Aquifer Modelling System (PRAMS) model that defines eight climatic zones across the Perth Region (*pers. comm.*, Yesertener, C, DoW, 28th August 2015). The project area lies on the boundary of two of these climatic zones, Zone 5 to the north and Zone 6 to the south. Both of these sites have been represented by interpolated datasets, which were originally sourced from the BoM SILO database. These datasets comprise interpolated measurements spanning a 36 year period (1978 - 2014). The locations of the data drills are presented on Figure 1-1. Like the Perth Airport data, these datasets also indicate drying trends over the past 20 years.

Evaporation rates in the Perth area are typically 1,800mm/year (BoM, 2015).

Rainfall records for three stations in the Perth Region between 1944 and 2015 are presented graphically in Figure 2-1.

2.2 Geology, Soils and Landforms

The project area lies on the Quaternary, Bassendean Dune system within the Swan Coastal Plain (SCP), which is bounded to the east by the Darling Scarp (Davidson 1995). The Bassendean Dune system forms an undulating eolian sand plain that unconformably overlies Cretaceous and Tertiary strata (Davidson 1995). Locally, the Bassendean Sand contains variable amounts of silt and organic matter.

The topography near the project area ranges between 25 and 75 m AHD (Davidson 1995, Davidson and Yu 2006 extracts – Appendix A). Generally, the ground surface falls to the west, although locally, the sand dunes have formed swales and valleys in which rich soils have developed. Prior to the establishment of the Gnangara Pine Forest, these areas supported dense stands of Banskia Woodland vegetation.

2.3 Land-use

The current land uses of the project area and surrounds have been obtained from the Department of Planning (Appendix B). Key land use types in the area include:

- Pine forest – including the Gnangara State Forest.
- Parks and recreation – including Lake Jandabup and Bush Forever sites.
- General rural – including rural and semi-rural properties.
- Public purposes - including the Water Corporation Jandabup Treatment Plant.

The Gnangara State Forest pine plantation was established in the Project area during the 1960s. Quarrying Tenements M70/1248 and M70/1250 are located on State Forrest 65, which is managed by the Forrest Product Commission (FPC). Based on historical air-photo imagery, (Landgate, 2015), the Project site appears to have been deforested between 2005 and 2010, with the exception of a small area in the southern part of M70/1250. During this time, and to the present day, pine tree blocks around the Project site have also been incrementally removed. There are now only remnant pine plantation forest areas near the Project site. These land-use changes within the Project area, between 2001 and 2015, are visible from the historical aerial imagery presented in Figure 2-2.

The other significant changes in land-use near the Project site are the establishment of the Jandabup Water Corporation Treatment Plant in the 1970s, and the urbanisation of adjacent areas in the late-1990s and early-2000s. The historical imagery also indicates that areas surrounding Lake Jandabup have become increasingly urbanised since the 1970s.

2.3.1 Water Dependent Features

Surface water features and wetlands located in the vicinity of the Project area are presented on Figure 2-3. The key local surface water features include;

- Lake Jandabup to the west
- Hawkins Road Swamp to the northwest
- a dampland area to the east of Quarrying Tenement M70/1250.

Wetlands, including Lake Jandabup and Hawkins Road Swamp, have formed in the internal swales within the Bassendean Dune system. Lake Jandabup is a groundwater throughflow lake, whereby the water table on the up-gradient side is marginally higher than the lake surface, resulting in a discharge of shallow groundwater to the lake. On the down- gradient side of the lake, the water table is slightly lower than the lake surface, resulting in underflow and seasonal outflows to Superficial Formations to the west (Davidson 1995).

These wetlands are also influenced by direct rainfall, evapotranspiration and local groundwater abstractions by licensed and private bore owners. These influences have historically, had a direct impact on the water levels in the lakes and swamps.

Lake Jandabup is a regionally-significant wetland that is subject to Ministerial Statement 687 containing the following Ministerial Criteria (WAWA, 1995; DoW, 2008):

- An absolute summer minimum of 44.3m AHD.
- An absolute spring minimum peak of 44.2m AHD.
- A preferred spring minimum peak of 44.7m AHD.
- The water level is only allowed between preferred and absolute minimum at a rate of two in every six years.

2.3.2 Acid Sulphate Soils

Wetlands and damplands in the region are highly susceptible to changes in water balance and seasonal water levels. These changes can lead to the acidification of local groundwater and surface water due to the oxidation of sulphide minerals that have accumulated in a typically

reducing, organic-rich environment. Oxidation occurs when the water table remains below the typical seasonal range, often as a result of changes to groundwater recharge and discharge rates.

Soil mapping in the Project area (DER/DPI, 2015) has identified a moderate to high risk of occurrence of acid-sulphate soils occurring in wetland areas including Lake Jandabup, Hawkins Road Swamp and an unnamed dampland area on the Project's eastern boundary (Figure 2-3). However, for the majority of the Project area, the risk is moderate to low as the water table does not occur within 3m of natural soil surface.

2.3.3 Groundwater Use

A search of the Department of Water (DoW) Water Information Reporting (WIR) database, (DoW, 2015) indicated that there are 25 licensed superficial aquifer drawpoints located within 1 km of the site. The locations of these groundwater users in the vicinity of the Project area are illustrated on Figure 2-4.

Of the identified licensed drawpoints, five are controlled by the Water Corporation. Three of these drawpoints (W220, W230 and W240) are located along the boundary of Quarrying Tenements M70/1248 and M70/1250. These three drawpoints were originally part of the Gnangara Drinking Water Supply Scheme. However, available data, and discussions with the Water Corporation, indicate that these have not been used to supply drinking water since the mid- to late-1980s. Production bores, W220 and W210 (900m to the south) are still operated by the Water Corporation under the direction of the DoW to supply supplementation water to Lake Jandabup (*pers. comm*. Bendotti, P., Water Corp., 15 May 2015).

The closest licenced, off-site drawpoints are located along the western side of the Project site. These bores (as close as 125m) are hydraulically, down-gradient of the site. They are used for private rural abstraction purposes.

2.3.4 Contaminated Sites

A search of the DER contaminated sites database shows no known contaminating land-uses in the Jandabup area that could affect the local groundwater resources.

3 GROUNDWATER MANAGEMENT SCHEMES

3.1 Regional Groundwater Management Schemes

Figure 3-1 shows the Project site within the context of regional DoW water management areas, sub-areas, and Public Drinking Water Source Areas (PDSWAs). The project is located within the Wanneroo Groundwater Area and Jandabup Groundwater Subarea.

Groundwater resources in the Project area are managed by the DoW under the:

- Rights in Water and Irrigation Act (resource allocation as PDSWAs); and
- Metropolitan Water Supply, Sewerage and Drainage Act (pollution prevention as Underground Water Pollution Control Areas (UWPCAs)).

The project area is located in a Priority 1 Public Drinking Water Source Protection area (PDWSPA - DoE 2004). Extractive industry operations (including sand quarrying) are considered to be an acceptable land use in such areas only if it can be demonstrated that there is sufficient clearance above the water table, and that there is adequate environmental management of the proposed activities i.e. considered a compatible land use with conditions (WRC 1999).

As the site is in a P1 PDWSPA, the pit floor and the proposed final surface level needs to remain 3m above the likely future maximum water table (WRC, 1999). This can be reduced to 2m in some circumstances, whereby the operator demonstrates that there will be no risk to groundwater resources, through effective management measures during operations. However, after the closure there must be a final 3m clearance to the likely future maximum groundwater level (MGL).

The Project site is also located in the Gnangara Underground Water Pollution Control Area (UWPCA – DoW 2007). The Gnangara UWPCA and P1 PDSWA, exclude Lake Jandabup, with the boundaries located close to the eastern edge of the lake, west of the Project area. While extractive industries such as the proposed Jandabup Sand Quarry are compatible with the governing policies for the UWPCA, restrictions apply to the storage of fuels and chemicals, with strict guidelines for rehabilitation (DoW, 2013; WAPC, 2001; WAPC, 2003; WAPC, 2005).

3.2 DMP Tenement Conditions

In relation to groundwater, Holcim's tenement conditions state that;

- All proposed exploration activities within the Public Drinking Water Source Areas (PDWSA's) comply with the DoW water quality protection note land use capability in public drinking water areas.
- All Quarrying Act tenement activities are prohibited within a 300m radius of any observation well in a P2 area unless DoW approval is first obtained.
- All Quarrying Act tenement activities are prohibited within a 500m radius of any production well in a P1 area unless DoW approval is first obtained.
- Quarrying operations in PDWSA's must use dry soil extraction methods and leave an undisturbed soil profile above maximum groundwater levels as follows; P1 – 3 metres.

3.2.1 Wellhead Protection Zones

Wellhead protection zones (WHPZ) are used to protect underground sources of drinking water at the bore site-scale. They are circular (unless information is available to determine a different shape), with a radius of 500 metres in P1 areas, and 300 metres in P2 and P3 areas. WHPZs do not extend outside PDWSA boundaries (WRC, 1999; DoE 2004, DoW 2013).

In accordance with *Water Quality Protection Note No. 15 – Extractive industries near sensitive water resources* (DoW, 2013), quarries should not be located in WHPZs. This is to minimise risk to water quality supply infrastructure, limit impact of any petroleum hydrocarbon contamination, and foster retention of natural buffers.

Existing drinking water supply bores (W220, W230 and W240) in the project area are protected by 500m exclusion zones, as they are all within a P1 DWSPA. A local-scaled map delineating the WHPZs in the vicinity of the Project area is presented on Figure 3-2. Recent discussions with the Water Corporation indicate that they are no longer planning to use these bores for potable water supply in the future (*pers. comm.* Bendotti, P., 15 May 2015). However, the DoW has the responsibility of ensuring key drinking water supply infrastructure are protected, and recent advice is that the WHPZs must remain (*pers. comm*. Mackintosh, J., 28 July 2015).

Recent correspondence with both the Water Corporation and the Water Source Protection Branch of the DoW (*pers. comm.* Mackintosh, J., 28 July 2015) indicates that although sand quarrying can take place within the WHPZs, since the bores are no longer active for potable water supply, a buffer of 50m around the infrastructure including bores, pipelines and powerlines not to be disturbed was agreed. An assessment of the suitability of the 50m buffer to protect the water infrastructure was undertaken that considered the quarry depth, potential slope stability and failure mechanisms (AECOM, 2015). It was concluded that 50m was adequate to protect the infrastructure.

4 HYDROGEOLOGY

4.1 Existing Information

The hydrogeology described in this section has been derived primarily from a definitive study "*Hydrogeology and Groundwater Resources of the Perth Region Western Australia*" (Davidson, 1995). The stratigraphic sequence of the Cainozoic and Mesozoic formations in the project area is as follows (Davidson, 1995, Davidson and Yu 2006 extracts - Appendix A):

- 0 – 50m – Superficial Formations
- 50 – 250m –Osborne Formation
- 250 – 560m – Leederville Formation
- 560 – 810m – South Perth Shale

The Superficial Formations are the focus of this report as there is no likelihood that the Project will influence the deeper formations.

The Superficial Formations (comprising mainly sand and silty sand) form an extensive unconfined aquifer system on the Swan Coastal Plain. The superficial aquifer associated with these formations is inhomogeneous, ranging from predominantly clayey sediments (Guildford Clay) to the east, adjacent to the Darling Fault, a sandy succession (Bassendean Sand and Gnangara Sand) in the central coastal plain, to sand and limestone (Tamala Limestone) closer to the coast.

The water table elevation in these formations is dependent on topography, aquifer permeability and local recharge and discharge rates and locations. Groundwater levels generally fluctuate by about 1m seasonally in the central sandy and coastal plain areas. The water table is dominated by two regionally-significant groundwater mounds, the Gnangara Mound and the Jandakot Mound.

Groundwater quality in the Superficial Formations is variable across the system, with the salinity ranging from 130 to 12,000mg/L total dissolved solids (TDS). However, salinity concentrations rarely exceed 1,000mg/L TDS. The groundwater quality type in the Bassendean Sand is described as sodium chloride rich (Davidson 1995).

4.2 Groundwater Information from the Jandabup Area

Because of the area's significance to supplying public drinking water, the Water Corporation have established a monitoring network that spans the Holcim site. Along with abstraction data, groundwater levels have been recorded from bores screened across the Superficial Formations and locally, across the water table. In addition, the DoW has installed monitoring bores across the Jandabup area to record changes to groundwater levels within the Superficial Formations. Data from these monitoring bores are collected regularly by the DoW and stored on their database. These data are publically-available, and have been accessed through the online Water Information Reporting portal (DoW, 2015).

In addition to groundwater monitoring, the DoW also monitor the levels and quality of surface water in lakes and wetlands in the region. Of importance to this study are the data collected from the southern end of Lake Jandabup (Station 1944). The DoW undertake regular reviews of these data to report on the state of water resources and influences from users including the

Water Corporation, local licensed groundwater bore owners, and private, unlicensed bore owners, as well as external influences from long term changes to the climate.

To aid this assessment, Holcim installed eight monitoring bores in December 2014, and January 2015 (URS, 2015a). During this programme, it was observed that across the water table, sand was the dominant lithology across the site with higher amounts of organic matter present in the samples from bores in the eastern sector of the site. Hydraulic properties are, therefore, expected to be locally variable.

In May 2015, a groundwater monitoring programme commenced, comprising monthly groundwater level and quality measurements, and biannual water quality sampling. Further details on the monitoring programme are provided in Appendix C. The locations of Holcim's bores and off-site regional monitoring bores are presented Figure 4-1.

4.2.1 Groundwater Levels

Hydrographs for all suitable monitoring bores representing the eastern and western areas of the site are shown on Figure 4-2 and Figure 4-3 respectively. Historical DoW monitoring results from nearby regional bores are shown in Figure 4-4 and Figure 4-5. Rainfall data are presented alongside all hydrographs for comparative purposes. Water levels recorded at the DoW Lake Jandabup (Station 1944) site are provided in Figure 4-6.

Current groundwater level distributions have been mapped using the monitoring bore data from the months of May 2015 (Figure 4-7) and August 2015 (Figure 4-8). Groundwater level data collected by Holcim since December 2014 is presented in Appendix D.

4.2.2 Groundwater Quality

Existing chemical and physicochemical properties of local groundwater have been monitored by Holcim. This includes sampling and laboratory analysis, and in-situ field measurements such as downhole salinity readings from all nominated monitoring bores. Graduated profiling of the Holcim bores was also undertaken in September 2015 to determine if the water table is stratified with respect to salinity.

Field quality measurement data collected between December 2014 and September 2015 are presented in Appendix E. The major ion chemistry of groundwater sampled in May and September 2015 is plotted on a Piper Diagram in Figure 4-9. The results of laboratory analyses on these samples are presented in Appendix F.

4.3 Monitoring Data Review

4.3.1 Review of Groundwater Level Data

Temporal Groundwater Level Changes

The following observations are made from recent monitoring data collected by Holcim between December 2014 and August 2015 (Figure 4-2 and Figure 4-3) within, and adjacent to the Project site:

- Most bores show declining groundwater levels between December 2014 and July 2015 followed by a slight (seasonal) rise in August 2015.

- Two bores, HMB04 and HMB05, had not started the seasonal rise by August 2015.
- Bore HMB07B shows the largest seasonal change and steepest rise between July and August 2015.
- Subtle differences in the seasonal responses indicate the recharge rate and/or aquifer storage is spatially variable across the site.

The following observations are made on long-term monitoring data collected by the DoW since 1975 (Figure 4-4 to Figure 4-6):

- Groundwater levels fell between the mid-1970s and late-1980s, in response to the earlier establishment of the pine plantations and then, the abstraction of groundwater by the Water Corporation.
- Between the late-1980s and late 1990s, groundwater levels stabilised after abstraction from the Water Corporation bores ceased.
- Since the late-1990s, groundwater levels continued to fall in some bores including: JB12A, WM35, WCM Redrill, WM24, W230 and W240. Groundwater levels in other bores are closer to Lake Jandabup including: JB9C, JB10B, and WM23, remained stable.
- Although difficult to identify, it is likely that falling groundwater levels observed since the late 1990s are partly due to the declining rainfall rate observed since then.
- The available data do not yet indicate that groundwater elevations are rising, as previously predicted, from the removal of the pine plantation. Apart from bores close to Lake Jandabup, groundwater level data from other regional bores indicate the water table is still slowly falling. If this trend continues, it suggests that the declining rainfall, and corresponding reduced recharge, will be countering the expected increasing rates of recharge from the removal of the pine plantations.
- The long-term data indicate that seasonal fluctuations vary across the Jandabup area suggesting recharge rates and/or aquifer storage varies spatially. In addition, some bores show more subdued seasonal rises during the 1990s suggesting that less recharge was reaching the water table each year during this time than in earlier and more recent years.
- Surface water levels in Lake Jandabup have fluctuated annually since 2001 over a more-or-less stable range (44m to 45mAHD). A generally similar seasonal response is observed from data collected between 1975 and 1988. However, between 1889 and 2001, these fluctuations appear to have been two-yearly. In the 1980s, the long-term trend indicates the level was falling, possibly as a result of abstraction and reduced recharge rates due to the presence of the pine plantation. The rate of decline slowed in the early-1990s to the relatively stable trend, with the aid of supplementation pumping, that we see today.

Spatial Groundwater Level Trends

Groundwater level contours representing summer and winter in May and August 2015 respectively indicate that groundwater levels and gradients vary slightly over the site (Figure 4-7 and Figure 4-8). As suggested by the hydrographs and bore logs, subtle variations in recharge and aquifer hydraulic properties are reflected in the hydraulic gradients. Generally, the hydraulic gradient beneath the eastern half of the site is steeper than in the west. Relatively flat gradients are present to the southwest across Snake Swamp, Little Dunbar

Swamp and Lake Jandabup, suggesting these features represent interconnected groundwater discharge areas. It is also likely that abstraction from Water Corporation bores W210 and W220 is also affecting groundwater levels in the southern area. Steeper gradients in the northwest indicate that the Hawkins Road Swamp does not significantly influence groundwater flow and discharge in that area.

4.3.2 Review of Groundwater Quality Data

Observations in relation to the groundwater quality at Jandabup are as follows:

- Groundwater quality in the project site is spatially variable with respect to salinity ranging from 88 mg/L TDS to 559 mg/L TDS and pH ranging from 4.3 to 7.5. These results indicate that while the groundwater is fresh, it ranges from acidic to neutral. The only bores that do not show acidic conditions are WE1b and WE2b, which are up-gradient of local damplands.
- The major ion analysis for May and September 2015 are presented in Figure 4-9. These results are consistent with Davidson (1995) indicating that the groundwater is of the sodium-chloride type. Influences on the local groundwater quality from acid-sulphate soils are seen as higher ionic proportions of sulphate in bores HMB06 and HMB08. This is attributed to acid-sulphate soil degradation in up-gradient (eastern) damplands.
- Total petroleum hydrocarbons (C29-C36) were above the LOR at two monitoring bores tested in May 2015, and three bores tested in September 2015. The samples where Total Recoverable Hydrocarbons (TRH) were identified in September 2015 were subjected to a silica gel clean-up, and analysed by gas chromatography/flame ionisation detection (FID) to assist with the identification and origin of any petroleum detected. This analysis indicates the detected hydrocarbons are at relatively low concentrations, and although they are in the normal range for oils and grease, their origin is unclear. Given the observed presence of organic soils in the eastern area, it is possible that compounds of this type have been generated by the decomposition of the organic components within the soils. Given the spatial distribution of these detections and previous land use (forestry), it is unlikely that these are of human origin. Dissolved phase petroleum hydrocarbons were detected (after silica gel clean-up) in the following September 2015 samples: HMB03 (450ug/L in the C29-C36 fraction), HMB06 (330ug/L in the C29-C36 fraction) and HMB08 (560ug/L in the C29-C36 fraction).
- The salinity profiles across the water table from the eight on-site monitoring bores are presented in Appendix E. With the exception of the profiles at HMB06 and HMB08 the groundwater salinity across the site is not appreciably stratified suggesting recharge mixes with local groundwater and that evapotranspiration influences on the groundwater quality are not significant. However, bores HMB06 and HMB08 both show the electrical conductivity (and salinity) increase with depth; more so at HMB08 than HMB06. These observations suggest that recharge in these areas is mixing and dispersing salts from the damplands to the east.
- The baseline Jandabup Project groundwater quality results exceeded the current Australian Drinking Water Guidelines, aesthetic (NH&MRC, 2015) in the following cases:
  - All samples taken in May and September 2015 were below the lower limit for pH, with the exception of HMB02 samples, which were within the guideline range. The minimum pH value of 4.4 (HMB05) was recorded in September 2015.

  - Ammonia concentrations in May 2015 samples from HMB03 (0.61 mg/L), HMB06 (0.58 mg/L) and HMB08 (0.69 mg/L) exceeded the guideline value of 0.5 mg/L. Ammonia concentrations in samples taken in September 2015 from HMB03 (0.51 mg/L), and HMB08 (0.67 mg/L) also exceeded the guideline value.

- The sample results did not exceed any Australian Drinking Water Guideline health criteria (NH&MRC, 2015).
- The Environmental Protection (Gnangara Mound Crown Land) Policy Approval Order 1992 (Government Gazette, 1992) details the environmental quality objectives to be achieved and maintained in respect of groundwater in the Project area. The baseline Jandabup Project groundwater quality results exceeded the environmental quality objectives in the following cases:
  - The environmental quality objective for manganese is 0.02 mg/L. Manganese concentrations at HMB06 were above this value in May and September 2015. Manganese concentrations at HMB08 were above this value in September 2015.
  - For pH, a range is given as the environmental quality objective of 6.5 to 8.5. All samples taken in May and September 2015 were below the lower limit for pH, with the exception of HMB02 samples which were within the policy's range.
  - The majority of TDS, sodium, sulphate, nitrate and chloride concentrations are above the respective environmental quality objectives.
  - The environmental quality objectives for ammonia and phosphorus in groundwater are 0.01 mg/L and 0.02 mg/L respectively. Ammonia concentrations were above the respective objective at HMB03, HMB06 and HMB08 during May and September 2015. Ammonia concentrations were above the respective objective at HMB01 and HMB04 during May 2015. Concentrations of Total Phosphorus were above the quality objective at HMB01, HMB05, HMB06 and HMB08 during May 2015. Concentrations did not exceed the objective in September 2015.
  - The environmental quality objective for hydrocarbons (total) in groundwater is 0.5 µg/L. Hydrocarbons were detected above this value at three bores during 2015 at: HMB03, HMB06 and HMB08.

5 PROJECT DESCRIPTION

5.1 Quarrying Method

The expected duration of the Holcim Jandabup Sand Quarry Project is currently estimated to be 25 years. This may vary depending on the adopted maximum groundwater level (MGL), market conditions, and raw material quality.

Holcim plan to extract the silica sand by simple excavate and truck techniques. Topsoil and vegetation will be stockpiled for later use in rehabilitation. The high quality silica sand will be excavated with a front end loader, and transported to its destination using dedicated haulage trucks.

On-site infrastructure is expected to comprise perimeter fencing, an unsealed access road and quarry ramp, active quarry area, progressive rehabilitation area, excavator and haulage trucks, water storage tank, refuelling area and storage tanks, and on-site ablution facilities. No washing of the sand is planned, so no fines or slimes will be generated.

5.2 Quarry Schedule/Extent

At this stage, the quarry schedule is still being finalised. However, for this assessment, it has been assumed that quarrying will be continuous with an active quarry area that is led by topsoil and vegetation clearing and quarrying, followed by short term stabilisation and long-term rehabilitation activities.

As depicted on Figure 5-1, the quarry will remain within Quarrying tenements M70/1248 and M70/1250, and stand back from the boundaries to create a buffer to keep safe the water infrastructure (bores, pipelines and power reticulation systems) that are present along the southern and western boundaries, as well as to manage noise and visual issues. The size and rational of the buffer is described in the Jandabup Sand Quarry Quarrying Proposal (Enviroworks, 2015).

5.3 Proposed Water Supply

Discussions with the DoW and arrangements with potential water providers are still ongoing.

5.4 Potential Risks to the Groundwater Environment

As described in Section 3, the Project is situated within a Priority 1 Drinking Water Source Protection Area (P1 DWSPA) that is managed by the DoW to ensure the resource utilised for drinking water by the Water Corporation, is secure. In addition to this, there are three existing water bores and associated infrastructure present along the southern and western perimeters of the Holcim quarrying tenements. As they are located within a P1 DWSPA, each is surrounded by a well head protection zone of 500m radius (Figure 5-1).

Bordering the Project site are three other water-sensitive features:

- Lake Jandabup (west) that is subject to a Ministerial Condition in managing the level;
- Hawkins Road Swamp (northwest); and
- A dampland area to the east of Mining Tenement M70/1250.

Based on the proposed Project activities and proximity of water-sensitive features nearby, the following potential risks have been identified:

- Water table mounding beneath cleared quarry areas. While this may actually supplement the local groundwater resource, it presents a risk to the quarrying operation in maintaining sufficient clearance to avoid interaction with local groundwater either during or after quarrying. These changes are unlikely to present a significant risk to the groundwater quality, given the source is rainwater and the pathway is barren silica sand. The receptor in this case is the local groundwater resource.
- There is a potential for the contamination of groundwater at the water table if there is a significant unplanned leak or unmanaged spill. Leaks or spills could potentially arise from refuelling of on-site excavators. Haulage trucks will be refuelled off-site and on-site machinery will also be serviced off-site, thereby minimising the risk of releases of oils and lubricants. Releases of hydrocarbons (hydraulic oils and lubricants) are still possible due to unexpected failure of hoses or lubricant delivery systems on board the excavator or trucks. Managing this risk is the primary purpose of a DoW requirement for maintaining a 3m clearance above the MGL during operations.
- Changes to local groundwater quality due to dust suppression across the quarry floor, ramps and un-rehabilitated areas. There is a minor risk to local groundwater resources from the application of water containing low concentrations of salt, which may accumulate at the water table.
- Drawdown associated with water supply abstraction. Long-term drawdown in the Jandabup area, as with other areas across the Gnangara Mound, is managed by the DoW, Water Corporation and Forest Products Commission. In this case, the Project water supply is planned to be derived from an established local Water Corporation bore using a small portion of an existing DoW allocation used for supplementation of Lake Jandabup. The receptor in this case is the local water resource and potentially nearby groundwater users.

6 CHANGE ASSESSMENT

6.1 Methodology

As described in Section 1.2, the objectives of this assessment were to:

1. Determine the MGL across the site; and
2. Determine the net change from quarrying, on Lake Jandabup.

The maximum groundwater level (MGL) for the project is a key constraint for Holcim in that, with an acceptable clearance buffer, it determines the lowest level the quarry floor can be excavated to. The MGL can be based on historical or current observations, or it can be based on extrapolations of available data using a predictive tool that includes changes due to local and regional groundwater trends and external influences such as climate change. In lieu of an established methodology to determine the MGL that is applicable to this assessment, a best-fit approach was developed that included the following components:

- Assess historical groundwater levels and trends:
  - Prepare hydrographs of groundwater bores within and near the Project site.
  - Align long-term monitoring data in the area with current short-term data from Holcim-monitored bores.
  - Analyse the hydrographs to define, where possible, external influences on the groundwater environment relevant to the Project site.
  - Based on recent trends, define and map the current MGL for each monitoring bore.
- Predict quarry-related changes to the groundwater environment:
  - Acquire a copy of the existing local-scaled groundwater flow model from the DoW (DoW, 2009a).
  - Reconfigure the model to realign recharge domains within and nearby the quarry site to the additional observed conditions between 2009 and 2015.
  - For the duration of quarrying, reconfigure the model to include yearly blocks to reflect higher recharge rates for disturbed areas during quarrying and transitional rates during rehabilitation.
  - Extend the model to predict post-quarrying groundwater level recoveries / changes.
- Determine the regional significance of the changes:
  - Extract hydrographs from mine blocks within the quarry site and at Lake Jandabup to determine water elevation trends during and after quarrying to define Project-specific changes.
  - Compare the above changes to historical trends to characterise the regional significance of the expected changes.
  - Compare the predicted water level elevations from Lake Jandabup with and without quarrying to determine the net change due to the quarrying operations.
- Develop an MGL map:
  - From a predicted change map supplied by the DoW, extract the predicted future water table change data.

- Extract groundwater levels from July 2013 (the DoW change calculation benchmark), or nearest equivalent from the available local dataset.
- Calculate the predicted MGL for all available sites and prepare a contour map across the site.

6.2 Assumptions

Details of the local-scaled model setup and modifications are provided in Appendix G. The following changes to the existing local-scaled DoW model and additional assumptions have been made that potentially influence the net change to the water level at Lake Jandabup:

- Adoption of the established DoW model.
  - Predicted groundwater levels from the model were initially checked against current observed readings to determine the status of the model's calibration.
  - Land-uses that describe the local groundwater recharge rate were modified to reflect the removal of the local pine plantation between 2006 and 2015. Areas where the pine trees were cleared were characterised with a compatible recharge rate based on existing land-use types (see below).
  - The primary purpose of the above changes was to establish the model's functionality (and suitability) to predict change at a local scale across the Project site. While the differences between predicted and observed groundwater levels were reduced (by adopting the modified land-uses as well as a revised rainfall dataset provided by the DoW - see below), the model was not used to predict absolute groundwater elevations.
  - Other than the above changes, it was assumed that the setup and underlying calibration of the DoW local model for the Jandabup area is adequate for the purpose of this assessment. It is possible that long term, future external influences beyond the extent of the model may influence local outcomes. These will be incorporated in future revisions of the MGL when sufficient data become available.
- The adopted method of simulation and sequence of quarrying.
  - As the recharge rate is assumed to be higher during quarrying (see below), the water table beneath the site is expected to become slightly mounded compared to undisturbed areas. This approach simulates quarrying in blocks assuming that as one block is finished and undergoes rehabilitation, the next block starts. An implication of this approach is that changes to the water table from one block may cumulatively influence the next. In reality, quarrying will be continuous and active areas will be more remote from each other for each mine strip. As a result, the predicted cumulative change may not occur.
- Modified rates of recharge.
  - For the purpose of this assessment, the adopted rate of recharge after the pine plantation was removed was based on its transition back to bushland. On the basis of discussions between Holcim and the Department for Parks and Wildlife (*pers. com*. Daniel Coffey, Area Manager South, Environmental Management Branch), it was assumed that a recharge rate, across the Project area, aligned to the Banksia Woodland land-use was appropriate to represent native regrowth, as is currently occurring. The same assumption was made for cleared pine plantation blocks outside of the Project site.

  - During quarrying, after the vegetation has been removed, the rate of recharge is expected to increase as the depth to water will be smaller, and there will be virtually no losses due to evapotranspiration. For this assessment, it was assumed that the highest recharge rate used in the existing model, one used to characterise industrial conditions, was a reasonable proxy for active quarrying conditions.
  - During the rehabilitation stage, recharge rates are expected to transition back to Banksia Woodland-type conditions. For these simulations, it has been assumed that rehabilitation will take one year and that over this period, recharge rates will approximate about half-way between the higher industrial rate and lower banksia woodland rate. The actual rate for each block may vary depending on the success of the rehabilitation programme and timing within the seasonal cycle.

- The adopted rainfall rate.
  - The previous DoW simulations assumed a rainfall sequence comprising measured data from the Wanneroo Meteorological Station. Observed monthly rainfall totals from 2001 to 2009 were used for calibration, and a repeated, synthetic annual dataset was used for the predictive years from 2009 to 2031.
  - For this simulation, rainfall data were sourced from the DoW PRAMS model (*pers. comm.* Yesertener, Cahit, 28 August 2015). These data include rainfall data from two nearby synthetic stations that through a data drill process on the BoM SILO database characterises two hydrological zones that span the project site. Data from these sites were then averaged to describe observed conditions between 2001 and 2015, and repeated annually, to describe future monthly rainfalls from 2016 onwards. The future data are synthetic monthly totals derived by the DoW to characterise “medium” rainfall conditions in PRAMS. These data were adopted at the request of the DoW (*pers. comm.* Mackintosh, James, 28 August 2015).

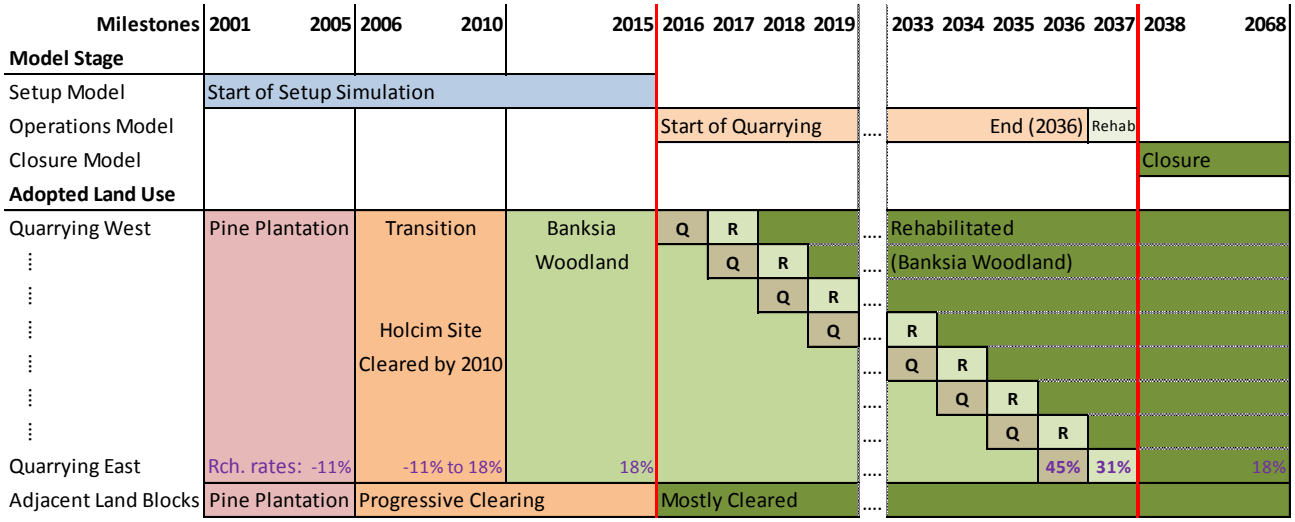
6.3 Predicted Changes to Groundwater Levels

6.3.1 Local-scaled Model Setup

As described above, the Jandabup Local Model (DoW, 2009a) was updated to include the observed removal of the Gnangara Pine Forest over the Project site and adjacent areas. The timing of the pine forest removal was based on Landgate historical imagery (Landgate, 2015). Figure 6-1 depicts the timeline covering the transition from pine plantation to bushland within the Project site between 2006 and 2010, and in adjacent areas between 2006 and 2015. For this assessment, it was assumed that the existing land-use arrangement remains static after 2013 for the duration of the simulations.

Also shown on Figure 6-1, is the sequencing of quarrying and rehabilitation between 2016 and 2036, based on a nominal 20-year project life. Adopted net recharge rates (rainfall less evapotranspiration) were drawn from the existing model setup (see above assumptions). Mine closure was simulated for the period after the final block is rehabilitated.

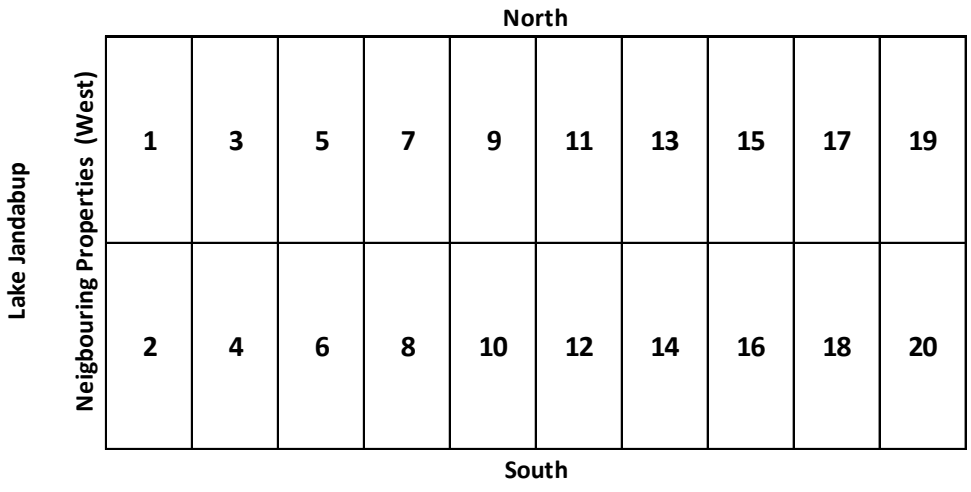
Figure 6-1 Model Setup Timeline



Notes: Clearing timeline adopted from Landgate imagery (see Figure 2-2)
Percentages shown above are recharge rates as a percentage of the rainfall scenario provided by DoW
Recharge rates for Pine Plantation and Banksia Woodland adopted from DoW (2009)
Recharge rate for quarrying land use type (**Q above**) assumed to be 45% based on the highest rate in DoW (2009)
Progressive clearing characterised as a simplified change in landuse type
Rehabilitation recharge (**R above**) assumed to be 31% based on half the difference between Quarrying and Banksia Woodland types

The DoW local-scaled model was reconfigured to broadly represent the quarrying operations on an annual basis for 20 years. Conservatism in this approach (see Section 7.6) means that outcomes should not be significantly different should operations extend across the same footprint, but for 25 years as is currently estimated. The layout of discrete conceptual "annual quarry blocks" is shown in Figure 6-2. The actual locations and sequencing are nominal and subject to change. In all cases, the predicted changes were calculated by comparing outputs from models that are otherwise identical, except for the addition of the "annual quarry blocks".

Figure 6-2 Conceptual Quarrying Sequence



6.3.2 Predicted Temporal Changes

The results of model simulations are presented as follows:

Figure 6-3 Predicted Groundwater Levels - Quarry Blocks

Figure 6-4 Predicted Background Groundwater Levels – 2001-2044

Key features indicated by these results include:

- Predicted long term background groundwater level changes:
  - Groundwater levels in all bores decline and stabilise in the early 2000s. The decline is a residual response to the pine plantations that covered the site prior to 2005.
  - From about 2005, groundwater levels stabilise in response to increased recharge from the removal of pine trees.
  - From about 2010, the levels begin to rise in response to the increased clearance of pine trees across the Project site.
  - Between 2010 and 2022, groundwater levels continue to rise and stabilise at levels in response to the new balance between recharge (new land-use conditions) and discharge (towards Lake Jandabup and coastal aquifers.
  - The rates and timing of the above changes are linked to the proximity to:
    - Lake Jandabup
    - local swamps and damplands
    - areas of more or less intense local pine clearing.
  - While the predicted response to pine clearing is within about 5 years of the land-use change, re-stabilisation to the new levels is expected to take 10 to 15 years.
  - Changes due to urbanisation were not captured in this simulation, but are not expected to influence changes to the water table from quarrying operations.
- Local changes associated with increased recharge rates in active quarry areas:
  - Groundwater levels beneath each quarry block are predicted to rise as a result of the increased rate of groundwater recharge from the removal of vegetation and dry sand above the water table.
  - Residual mounding from earlier quarry blocks may accumulate depending on the rate of mining and pattern of sand removal of adjacent blocks.
  - The predicted annual rises are a feature of the model set-up. In reality the mound is expected to grow, then migrate with the quarry floor. Beneath rehabilitated areas, the mound will dissipate.
  - Groundwater mounding beneath cleared areas is predicted to be small, in the order of 0.05m to 0.15m.

6.3.3 Predicted Spatial Changes

It is apparent from the simulations that changes to the groundwater environment due to quarrying should be localised. A composite change map representing sum of all of the predicted changes due to quarrying is presented in Figure 6-5.

The largest recharge mounding is predicted to occur within the central portion of the Project site. With the exception of a small area to the east, changes in the order of 0.1m are expected to remain within the Holcim tenements. Changes outside of this area are unlikely to be detectable within the range of background variability (Figure 4-4 and Figure 4-5). The accumulation of mounding between successive quarried areas is probably an artefact of the nominal mine schedule and adoption of annual quarry blocks. Higher recharge rates across smaller, but more mobile areas, is more likely to result in smaller mound heights and extents. This presentation is, however, considered to represent worst case conditions. Given the magnitude of the expected changes, outcome sensitivities associated changes to the operational life are expected to be low.

6.4 Potential Changes to Groundwater Quality

One of the potential risks to groundwater quality is from dust suppression due to the application of water sourced from local groundwater. Based on the variables described in Table 6-1 below, it is estimated, that on average, the groundwater salinity near the water table will increase by about 39mg/L as a result of the dust suppression activity.

Table 6-1 Estimated Salinity Change Calculations

Estimated Salinity of Groundwater Source	190	mg/L
	0.190	kg/kL
Annual Dust Suppression Application Volume:	50,000	kL/yr
Total Proposed Quarry Footprint:	3,958,892	m^2
Average Annual Area Under Dust Suppression:	197,945	m^2
Average Annual Dust Suppression Application Rate:	0.253	kL/m^2
Potential Salt Loading:	0.048	kg/m^2
	47,993	mg/m^2
Average Annual Rainfall at Site (SILO):	681	mm
Quarry Area Annualised Recharge (45%):	307	mm
Average Recharge Volume:	307	L/m^2
Potential Salinity Change in Water Table Mixing Zone (4m)	**39**	**mg/L**

Notes: The adopted salinity was derived from the maximum salinity observed at HMB07B. The average rainfall totals were derived from a SILO Data Drill extract averaged across two synthetic data stations used by the PRAMS model (*pers. comm*. Yesertener, C., DoW, 28 August 2015)

7 IMPACT ASSESSMENT

The impact assessment has considered:

- The future Maximum Groundwater Level (MGL) distribution across the proposed quarry site.
- The influence that the Project may have on Lake Jandabup water levels.
- The influence that the Project may have on nearby existing groundwater users.
- Changes to local groundwater quality from the proposed quarry.
- Cumulative impacts from the proposed quarry activities.
- Sensitivity and uncertainty assessment on predictions.

7.1 Impacts to Groundwater Levels

7.1.1 Maximum Groundwater Level

An MGL map was derived using observed groundwater levels from August 2015 (equivalent to July 2013) and predicted changes adopted from recent PRAMS simulations (*pers. com.* J Mackintosh (DoW), 22nd October 2015). For comparison purposes, available data from July 2013 (+/- one month) are shown alongside the observed readings from August 2015.

Observed and predicted groundwater levels used in this assessment are shown in Table 7-1 and as contours on Figure 7-1. Significant features of these MGLs include.

- Flow patterns inferred from these contours mimic the contours based on current winter groundwater levels (Figure 4-8). This indicates that groundwater flow is expected to remain towards Lake Jandabup and local wetlands such as Snake Swamp and Little Dunbar Swamp.
- Differences between current levels and the MGLs range from 0.9m (bore WM24) to 2.1m (bore WMC Redrill). As described in Section 6.3, quarrying-related changes are small, representing between 2% and 9% of the total predicted future change on–site and 0.5% to 4.5% offsite.

7.1.2 Impacts to Lake Jandabup

As indicated in Table 7-1 and on Figure 6-5, water levels in Lake Jandabup are not expected to be impacted by changes to the water table due to quarrying. Underlying the future level of Lake Jandabup is the local water balance that is driven by the regional groundwater balance that affects upstream and downstream groundwater gradients, and rainfall. Details of the model setup are presented in Appendix G

Table 7-1 Calculated Maximum Groundwater Levels

Site Name	Easting	Northing	Observed Elevation +/- July 2013 (m AHD)	Observed Elevation on 14/08/2015 (m AHD)	PRAMS Predicted) Change 2013-2030 (m)	Adopted MGL (m AHD)
HMB01	391655.4	6489269.8		47.82	2.00	49.82
HMB02	392720.8	6489758.5		48.96	1.88	50.84
HMB03	394065.2	6489771.1		51.45	1.56	53.01
HMB04	391986.0	6488859.1		47.38	1.76	49.14
HMB05	392742.2	6488858.9		47.91	1.53	49.44
HMB06	393721.1	6488881.5		49.88	1.40	51.28
HMB07B	392911.7	6488005.2		46.72	1.04	47.76
HMB08	394085.3	6487938.1		49.04	1.07	50.11
JB10B	391237.9	6489076.0	46.20	46.53	1.99	48.52
JB12A	391160.4	6486837.5	44.27	44.37	1.70	46.07
JB9C	391368.6	6488072.0	45.21	45.50	1.66	47.16
W230	391998.9	6488106.1		45.56	1.50	47.06
W240	391240.1	6488853.8		46.38	1.91	48.29
WE1B	395292.4	6488277.9		49.70	1.34	51.04
WE2B	395292.3	6488326.6		49.95	1.35	51.30
WM23	391378.9	6487113.7	44.59	44.97	1.58	46.55
WM24	394050.0	6486531.2	46.39	46.06	0.88	46.94
WM35	393715.2	6490465.5		52.15	1.81	53.96
WMC REDRILL	392790.7	6491031.0	50.78	50.36	2.08	52.44
Jandabup-Lake	390321.2	6487095.1	44.50	44.52	1.84	46.36

7.2 Impacts to Existing Users

The nearest known groundwater users are located along the southern and western site boundaries (Figure 2-4). This includes bores operated by private owners and the Water Corporation. Potential impacts to these owners include a change in groundwater level, and physical disturbance.

Groundwater level changes include minor water table mounding (Figure 6-5). These changes are not expected to represent a significant impact. It is likely that neither will be detectable against background variability.

Given the private bores are located off-site, only the Water Corporation bores are potentially susceptible to physical influence from the Project. As detailed in the Water Management Plan, Holcim are planning to mitigate risks by establishing and maintaining a non-disturbance buffer between the quarry and the existing water supply infrastructure (URS, 2015b).

7.3 Impacts to Groundwater Quality

On the basis that the observed water table salinity across the Project site ranges from 110 to 500 mg/L TDS, with the estimated change in salinity (Section 6.4), local groundwater is expected to remain well-within the range of natural variation observed across the site. With

these projected increases, the groundwater within the Project site should remain well within the drinking water limit of 600 mg/L TDS (NH&MRC, 2015).

As there are no sand washing or processing activities planned for this site, no other changes to the local groundwater quality are expected. Potentially-contaminating events such as a spill or leak from on-site machinery will be managed according to the approved containment and recovery procedures outlined in the Holcim Jandabup Water Management Plan (URS, 2015b).

7.4 Cumulative Impacts

Cumulative impacts at the Jandabup Project site may arise from a combination of several factors including:

- pine tree removal
- nearby urbanisation
- nearby quarrying operations

All of these influences have the potential to influence groundwater levels at the Project site. On the basis of analyses conducted for this assessment, cumulative impacts may arise if, as planned the pine trees are all removed in addition the establishment of denser, more proximal urbanisation to the Project. Results of an assessment of the sensitivity to the adopted MGL are discussed in Section 7-5.

The potential for cumulative impacts arising from nearby quarries is considered to be insignificant. The largest predicted changes due to increased recharge within the Project are about 0.15m. These changes are localised and transient i.e., they are expected to dissipate within a few years of operations. This scenario may occur when Holcim's quarry is located along the northern boundary, either next to the existing Rocla Quarry, or planned future Urban Resources quarry. Under these conditions, should quarrying in adjacent operations actually occur, the available data indicate there is a potential for only a minor cumulative change (mounding) to the water table. Assuming the other operation was located adjacent to Holcim's planned quarry, a rise in the order of 0.1m to 0.2m is possible, depending on the duration that the two operations are co-located.

7.5 Sensitivity and Uncertainty Assessment on Predictions

The models used to characterise changes to the groundwater environment are expected to be most susceptible to uncertainties including the assumed fully-cleared recharge rate, adopted rainfall totals, and expansion of urbanisation and contraction of pine forests. To test these assumptions and uncertainties, three sensitivity scenarios were simulated:

1. Varying the rate of recharge in disturbed areas.
2. Varying the future rainfall, and hence, recharge rates.
3. Testing the influence of regional changes due to future urbanisation and pine forest removal.

All of these simulations were undertaken using the local-scaled model that includes all of the water balance stressors that feature in the scenarios conducted in 2009, with the exception that rainfall now includes the medium case rainfall rates, and the removal of pine trees within close proximity of the Project area. For Sensitivity Run 1, the simulation also included the nominal quarrying sequence and adjusted recharge rates.

7.5.1 *Sensitivity Scenario 1 - Disturbed Area Recharge Rate*

Disturbed areas that have no vegetation have been characterised by adopting a high rate of recharge, based on the established urban and industrial land-use in the DoW model. To test the sensitivity of the predicted changes, the DoW model was reconfigured to increase the "disturbed area" recharge from 45% to 50%. Based on the predicted changes (Table 7-2) is concluded that the mounding-related outcomes are not sensitive to this parameter.

Table 7-2 Predicted Change due to Higher Recharge rate for Disturbed Areas (m)

Bore	Predicted No Quarrying MGL (18%)	Predicted Quarrying MGL (45%)	Predicted Change (18% to 45%)	Predicted Quarrying MGL (50%)	Predicted Change (45% to 50%)
HMB01	48.00	48.02	0.02	48.02	0.00
HMB02	50.24	50.27	0.03	50.28	0.01
HMB03	52.46	52.50	0.04	52.50	0.00
HMB04	48.08	48.10	0.02	48.11	0.01
HMB05	49.09	49.13	0.04	49.14	0.01
HMB06	50.47	50.55	0.08	50.56	0.01
HMB07B	48.02	48.05	0.03	48.06	0.01
HMB08	49.30	49.35	0.05	49.36	0.01

7.5.2 *Sensitivity Scenario 2 - Sensitivity to Climate Change*

The local-scaled DoW model includes rainfall data from two synthetic sites north and south of Jandabup that is being used in PRAMS to characterise a "medium scenario". The DoW also run wet and dry scenario's when assessing potential regional changes with PRAMS. To test the sensitivity of outcomes at Jandabup, the adopted climate scenario was revised to include rainfall within a +/- 10% range. The net change associated with this range is depicted in Table 7-3. Based on these simulation results, predicted future MGL outcomes are expected to be sensitive (+/-0.5m) to these assumptions.

Table 7-3 Predicted Change due to Higher and Lower Rates of Rainfall

Bore	Predicted MGL Base-case (m)	Predicted MGL Sensitivity No Quarrying +10 % Rainfall	Predicted Change (m)	Predicted MGL Sensitivity No Quarrying -10 % Rainfall	Predicted Change (m)
HMB01	48.00	48.35	0.35	47.69	-0.31
HMB02	50.25	50.65	0.40	49.90	-0.35
HMB03	52.46	52.87	0.41	52.12	-0.34
HMB04	48.09	48.46	0.37	47.76	-0.33
HMB05	49.10	49.54	0.44	48.73	-0.37
HMB06	50.48	50.99	0.51	50.09	-0.39
HMB07B	48.02	48.51	0.49	47.58	-0.44
HMB08	49.31	49.86	0.55	48.83	-0.48

7.5.3 Sensitivity Scenario 3 - Regional Influences

The 2009 study included an assessment of the influence that continued groundwater abstraction from the confined Leederville Aquifer may have on the Superficial Aquifer at the Project site. The model does not include confined aquifers, or vertical leakage across the Osborne Formation. It was recognised that while downward leakage from the Superficial to Leederville aquifers is likely, it was considered to be at a rate that that is unlikely to significantly affect the water balance in the Superficial Formations (DoW, 2009a).

While the PRAMS model has predicted future changes that have guided the adopted MGL estimate, it is noted that the hydrographs showing observed data are still yet to show a significant response to any of the predicted water balance stressors. To understand the potential impact of adopting the PRAMS model results, a sensitivity analysis was undertaken whereby the water balance stressors present prior to 2015 are allowed to stabilise. The analysis included the following conditions:

Rainfall – the medium case containing synthetic data looped for the duration of the scenario.

Pine trees – no further pine clearing influences were to take place within the model domain.

Urbanisation – urbanisation and industrial land uses as modelled in 2009 remains static.

The results shown in Table 7-4 indicate that significant differences between the PRAMS and local-scaled models as a result of different assumptions behind the extent of urbanisation. The largest differences are apparent in the northwest near HMB01 (1.52m); the smallest are in the southeast near HMB08 (0.06m). This distribution of change differences indicates that assumptions associated with urbanisation affects a significant proportion of the site (north and western sectors), while changes arising from future pine clearing (south and southeast) are minimal.

Table 7-4 Predicted Sensitivity due to Land-Use Assumptions

Bore	PRAMS Predicted Rise (m)	Local Model Predicted Rise (m)	Difference (m)
HMB01	2.00	0.48	1.52
HMB02	1.88	0.84	1.04
HMB03	1.56	0.88	0.68
HMB04	1.76	0.92	0.84
HMB05	1.53	1.07	0.46
HMB06	1.40	1.08	0.32
HMB07B	1.04	0.68	0.36
HMB08	1.07	1.01	0.06

7.6 Assessment Conservatism

The adopted climate input data assumes rainfall patterns will not change significantly in the future. In reality, climate change is likely to continue to some degree. Rainfall data adopted in this assessment, sourced from the DoWs PRAMS model, results in stable groundwater level trends. Should future rainfall patterns see further decreases there will be further reductions in recharge, hence falling water table. While the adopted rainfall data are for a medium case, they are considered to be conservative to a reasonable degree because they do not decrease with time.

For this assessment, a nominal 20-year quarrying schedule has, for simplicity, been adopted whereby, the extent and duration of quarrying across the site is roughly the same. After the resource is fully defined, it is possible that the quarrying schedule may extend over a longer period – 25 years as is currently estimated. The adopted approach is considered to represent a reasonable worst case in that each block is assumed to be fully cleared for one year, followed by a rehabilitation phase for the following year. In reality, the rate and extent of quarrying and rehabilitation will be smaller and mounding should be more subdued and localised. The actual rate of advancement across the site will vary according to local resource thicknesses and market access constraints. Assuming a constant rate of delivery, areas with thicker resources will be quarried at a slower rate than areas where it is thinner.

It has been assumed from investigations by the DoW that net recharge equals the measured rainfall, less evapotranspiration. In reality, the net recharge rate should also account for losses within the soil water balance. In effect, small rainfall events that have been assumed to contribute to recharge, will not. Rainfall from small rainfall events will be retained in the unsaturated zone and consumed by evapotranspiration processes. This has to some degree been taken into account by the absence of evapotranspiration in some domains in the derivation of recharge by the DoW in 2009. This assumption will therefore, tend to over-predict the rate of recharge.

8 IMPACT MANAGEMENT

8.1 Potential Impact Sources

Four potential impact sources have been identified:

- Salt accumulation near the water table due from dust suppression.
- Water table mounding due to increased rates of groundwater recharge in quarry areas.
- Unplanned groundwater quality impacts

8.1.1 Operational

Dust Suppression

As described in Section 6.4 it is expected that natural salt in groundwater used for dust suppression may accumulate near the water table. The rate of accumulation is linked to the salt loading defined by the rate of dust suppression water application. Given that the water table will be no less than three metres depth, salt accumulation from the evaporation of groundwater is not expected to be significant. All groundwater level simulations assume a three metre extinction depth.

Groundwater Mounding Beneath Quarry Areas

While a smaller depth to the water table, due to quarrying, may result from a slightly higher recharge rates across the site, the net effect is expected to be negligible. The analysis behind this has taken into account all of the operational and post-closure variables from which a 3m buffer between the quarry floor and MGL can be derived.

Mounding is predicted to be transient in that areas subjected to higher rates of recharge will recover within several years. Cumulative changes are predicted to occur to a small degree where quarrying of adjacent mine blocks occurs.

Evidence from sand quarrying at the Holcim Baldivis site (also accessing Bassendean Sand) indicates that the effect of increased recharge on the water table in a similar environment is small. Long-term groundwater level monitoring at that site (Golder, 2015) indicates that the water table adjacent to cleared and quarried land has not appreciably responded to land-use changes over the past seven years. For the Jandabup site, the implication of this information is that the assumed rate of recharge is possibly overly-conservative.

In order to establish an effective future MGL i.e. one that protects the groundwater resource and maximises the benefit to the community, local-scaled groundwater level monitoring during the first three years should be undertaken. As quarrying is planned to start in the north-west sector, this monitoring will also provide useful data on groundwater level changes near the Hawkins Road Swamp, a potentially sensitive groundwater feature. The results of this monitoring should be assessed with a view to revising the future MGL on the basis of observed recharge responses.

Unplanned Changes to the Groundwater Quality

Other than the potential for a minor change to local salinity due to dust suppression activities, the proposed quarrying method does not involve any substances that are expected to impact the groundwater quality.

It is still possible, however, that the groundwater quality could be affected by spills or leaks of hydrocarbons such as diesel and lubricating oils and greases. These are unplanned events that are ultimately, the driver behind maintaining a 3m separation between the quarry and the water table during operations.

8.1.2 Closure

On the basis that the Holcim proposal is only to remove sand and rehabilitate afterwards without introducing any wastes, there are no identified impact sources after closure.

8.2 Impact Mitigation

The potential impacts identified in Section 7.1 are, by and large, small to insignificant. Some mitigation aspects have been considered that may either further minimise the potential impacts, or clarify the need for additional actions.

8.2.1 Salt accumulation

As described in Section 6.4, the accumulation of salt from dust suppression across the quarry during the 20-year operational period could, theoretically, result in an increase in salinity at the water table of up to about 40mg/L TDS. In reality, the salt will not migrate to the water table instantly, as some will remain in the unsaturated zone. However, assuming the salt did reach the water table instantly, the indicative increase is considered insignificant in the context of local groundwater quality variability. As such, no adverse impact is expected, and mitigation is therefore, not required.

8.2.2 Mounding Due to Increased Recharge

As described in Section 7.1, groundwater mounding may occur beneath the active quarry area, but that the mound will dissipate quickly after the quarry moves to other areas within the resource footprint. Due to its localised and transient nature, mounding is not expected to lead to any adverse impacts. It may locally supplement small and localised drawdowns near bore W220, and overall, add to the local groundwater resource. As a result, no mounding-specific mitigation is considered necessary.

8.2.3 Unplanned Changes to the Groundwater Quality

Management of unplanned events such as leaks and spills is detailed in the Jandabup Water Management Plan (summarised below).

8.3 Water Management Plan Summary

Separate to this assessment, URS has prepared the Jandabup Water Management Plan (URS, 2015b). That document details the actions, responses and responsibilities to potential impacts associated with the planned quarrying processes. The key actions that Holcim propose to manage the potential groundwater impacts are summarised in Table 7-1.

Table 8-1 Key Water Management Commitments and Actions

Aspect	Management Commitment
Operational Groundwater Management	• Excavation depth will limited to 3m above maximum groundwater level.
	• Contamination and spills management will be implemented according to the emergency response plan
	• All potentially contaminated surface water runoff will be detained and/or treated before discharge to the environment, minimising the risk of contamination to groundwater via infiltration.
	• Waste management will ensure that all wastes are disposed of appropriately minimising the risk of groundwater contamination.
Monitoring	• A groundwater monitoring programme will be implemented including eight dedicated groundwater monitoring bores installed by Holcim and selected monitoring bores installed by the DoW and Water Corporation.
	• Monitoring includes a pre-quarrying programme to establish baseline groundwater levels and quality across the site. This will continue until December 2016, completing a two year baseline phase.
	• An operational phase programme will commence in 2017 that will include the same monitoring bores but with slightly different frequencies and parameters. This programme will collect operational data at sites near the active quarry area, near rehabilitated areas, and ongoing background data from undisturbed areas.
	• Groundwater monitoring data will be collated annually and presented in the Annual Environmental Review. A summary of trends and significant events affecting the groundwater environment will be included in this review.
	• Every three years, the data will be subjected to a detailed review in sync with the WMP and Closure Plan reviews. This review will include a re-assessment of all available data and validate predictions used to characterise impacts and the MGL.
	• The water management plan will be reviewed every three years in line with regular reviews of the closure plan.
Administration	• The Jandabup Quarry Manager is nominated as the responsible person to ensure all aspects of the Water Management Plan are undertaken.
Closure Groundwater Management	• A closure monitoring programme will be finalised during the operational phase. Monitoring will continue for 5 years after closure.

9 CONCLUSIONS

Quarrying at Jandabup is expected to have a positive effect on the water resource due to the increased rate of net recharge to the water table. This change is, however, not expected to be permanent as the recharge rates after rehabilitation are likely to be similar to current conditions (post-pine plantation woodland). Quarry-related changes will not contribute to regionally downward trends currently observed at the water table. Quarrying-related changes are expected to be mostly confined to the mining tenements. No detectable changes are expected at Lake Jandabup.

A source for the Project's water supply is still under negotiation with the DoW, and with their assistance, a range of potential sources are being considered. Based on recent discussions with the DoW, obtaining a long term source within the Project area is unlikely. However, other potential options that are under consideration include establishing a source from within the Project area for the next 5 to 10 years, or securing a source from a nearby groundwater sub-area (probably involving trucking the water to site) through a an entitlement trading arrangement with another user, or installing dedicated facilities at a new site. Once the location of the source has been determined a separate impact assessment may be required as part of the DoW groundwater licensing process

Some influence from a dampland area to the east of the site suggests that previous land-uses in this area combined with reduced rainfall recharge from climate change may have influenced the quality of local groundwater. This change is the result of lowered water table due to the establishment of pine plantations and possibly groundwater abstraction by the Water Corporation, and oxidation of sulphide minerals in organic-rich and typically waterlogged areas. These influences have resulted in groundwater that is of variable quality ranging from potable to non-potable.

A water management plan has been developed to minimise adverse influences from Holcim's quarrying activities. This plan includes protocols for managing risks to existing water supply infrastructure and groundwater contamination, as well as monitoring the overall effect that quarrying will have on the groundwater level and Lake Jandabup. Incorporated in this plan is a review cycle that will allow Holcim to identify changes to the groundwater environment. It will also allow Holcim to maintain an acceptable separation from the water table, while also maximise the benefits of this basic raw materials resource.

10 REFERENCES

AECOM, 2015. Jandabup Sand Quarry Expansion Assessment on Proximity of Water Corporation Infrastructure. Memorandum dated 20th October 2015. File Ref. 42908863-007.

BoM, 2015. Bureau of Meteorology climate data online. http://www.bom.gov.au/climate/data/, Accessed 3 September 2015.

BoM and CSIRO 2015. State of the Climate 2014. Government of Western Australia in collaboration with CSIRO, Perth.

Davidson 1995, Hydrogeology and groundwater resources of the Perth Region, Western Australia, Western Australian Department of Mines, Perth.

Davidson, W.A. and Yu, X. 2006. Perth regional aquifer modelling system (PRAMS) model development: Hydrogeological and groundwater modelling. Department of Water, Western Australia, Hydrogeological record series HG20.

DER/DPI, 2015. Acid sulphate soil risk maps prepared by the Department of Environment Regulation (DER) and Department for Planning and Infrastructure (DPI). http://www.der.wa.gov.au/your-environment/acid-sulfate-soils, accessed 10 September 2015.

DoE, 2004. Department of Environment Water Quality Protection Note: Land use compatibility in Public Drinking Water Source Areas. Government of Western Australia, Western Australia.

DoW, 2007. Gnangara Underground Water Pollution Control Area Drinking Water Source Protection Review – Integrated Water Supply Scheme. Infrastructure Planning Branch, Government of Western Australia, Perth.

DoW, 2008. Review of Ministerial Conditions on the Groundwater Resources of the Gnangara Mound. Water Allocation Planning Branch, Government of Western Australia, Perth.

DoW 2009a. East Wanneroo Integrated Groundwater-Lake Flow Modelling: Predictive scenario modelling to support the Gnangara Sustainability Strategy. Hydrogeological Record Series, Report HG35, dated August 2009.

DoW, 2009b. Operational policy no. 5.12 – Hydrogeological reporting associated with a groundwater well licence, November 2008. Government of Western Australia, Western Australia.

DoW, 2013. Water Quality Protection Note No. 15. Extractive industries near sensitive water resources. Government of Western Australia, Perth.

DoW, 2015. Department of Water Water Information Reporting (WIR) database search undertaken on 4th September 2015 from http://wir.water.wa.gov.au/SitePages/SiteExplorer.aspx

Enviroworks, 2015. Mining Proposal Holcim Hawkins Road Sand Quarry Jandabup – Tenements M70/1248 and M70/1250, Unpublished Report Prepared by EnviroWorks Consulting for Holcim (Australia) Pty Ltd

Golder, 2015. Baldivis Sand Quarry triennial Aquifer Monitoring review 2014. Unpublished report prepared for Holcim (Australia) Pty Ltd. dated March 2015. report reference: 1521617-001-R-Rev0

Government Gazette, 1992. Environmental Protection (Gnangara Mound Crown Land) Policy Approval Order 1992. Published 24 December 1992.

Landgate, 2015. Historical aerial imagery sourced from Landgate web portal at: https://www.landgate.wa.gov.au/bmvf/app/mapviewer/?shutterId=ap#. Accessed on 1 September 2015.

NH&MRC, 2015. Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy. National Health and Medical Research Council, National Resource Management Ministerial Council, Commonwealth of Australia, Canberra. Version 3.1 Updated March 2015.

URS, 2014. Phase 1 Desktop Study and Recommendations – Holcim Jandabup Project. Unpublished report prepared for Holcim (Australia) Pty Ltd. Document No. 42908743-RF-Geo-1044_0.

URS, 2015a. Monitoring Bore Completion Report – Holcim Jandabup Project. Unpublished report prepared for Holcim (Australia) Pty Ltd. Document No. 42908743-RF-Geo-1083_1.

URS. 2015b. Jandabup Sand Quarry Project, Tenements M70/1248 and M70/1250 – Water Management Plan. Unpublished report prepared for Holcim (Australia) Pty Ltd. Document No. 42908863/RF/Wat/0205/A.

WRC, 1999. Water and Rivers Commission Policy and Guidelines for Construction and Silica Sand Quarrying in Public Drinking Water Source Areas, Water and Rivers Commission, Statewide Policy No. 1.

WAPC, 2001. Western Australian Planning Commission Gnangara Land Use and Water Management Strategy. WAPC in conjunction with Water and Rivers Commission, Western Australia.

WAPC, 2003. Statement of planning policy 2.7: Public drinking water source policy, prepared under section 5AA of the Town Planning and Development Act 1928, special Government Gazette No. 92.

WAPC. 2005. Statement of Planning Policy No 2.2 Gnangara Groundwater Protection. Prepared under section 5AA of the Town Planning and Development Act 1928 (as amended)., special Government Gazette No. 150., Western Australia.

WAWA, 1995. Water Authority of Western Australia Review of Proposed Changes to Environmental Conditions, Gnangara Mound Groundwater Resources, Chapter 46. Government of Western Australia, Perth.

11 LIMITATIONS

11.1 Geotechnical & Hydro Geological Report

URS Australia Pty Ltd (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Holcim (Australia) Pty Ltd and only those third parties who have been authorised in writing by URS to rely on the report.

It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the contract dated 1 January 2014.

The methodology adopted and sources of information used by URS are outlined in this the Report.

Where this report indicates that information has been provided to URS by third parties, URS has made no independent verification of this information unless required as part of the agreed scope of work. URS assumes no liability for any inaccuracies in or omissions to that information.

This Report was prepared between March and October 2015.The information in this report is considered to be accurate at the date of issue and is in accordance with conditions at the site at the dates sampled. Opinions and recommendations presented herein apply to the site existing at the time of our investigation and cannot necessarily apply to site changes of which URS is not aware and has not had the opportunity to evaluate. This document and the information contained herein should only be regarded as validly representing the site conditions at the time of the investigation unless otherwise explicitly stated in a preceding section of this report. URS disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

This report contains information obtained by inspection, sampling, testing or other means of investigation. This information is directly relevant only to the points in the ground where they were obtained at the time of the assessment. The borehole logs indicate the inferred ground conditions only at the specific locations tested. The precision with which conditions are indicated depends largely on the uniformity of conditions and on the frequency and method of sampling as constrained by the project budget limitations. The behaviour of groundwater and some aspects of contaminants in soil and groundwater are complex. Our conclusions are based upon the analytical data presented in this report and our experience. Future advances in regard to the understanding of chemicals and their behaviour, and changes in regulations affecting their management, could impact on our conclusions and recommendations regarding their potential presence on this site.

Where conditions encountered at the site are subsequently found to differ significantly from those anticipated in this report, URS must be notified of any such findings and be provided with an opportunity to review the recommendations of this report.

Whilst to the best of our knowledge information contained in this report is accurate at the date of issue, subsurface conditions, including groundwater levels can change in a limited time.

Therefore this document and the information contained herein should only be regarded as valid at the time of the investigation unless otherwise explicitly stated in this report.

Except as required by law, no third party may use or rely on, this Report unless otherwise agreed by URS in writing. Where such agreement is provided, URS will provide a letter of reliance to the agreed third party in the form required by URS.

To the extent permitted by law, URS expressly disclaims and excludes liability for any loss, damage, cost or expenses suffered by any third party relating to or resulting from the use of, or reliance on, any information contained in this Report. URS does not admit that any action, liability or claim may exist or be available to any third party.

URS does not represent that this Report is suitable for use by any third party.

Except as specifically stated in this section, URS does not authorise the use of this Report by any third party.

It is the responsibility of third parties to independently make inquiries or seek advice in relation to their particular requirements and proposed use of the relevant property.

Any estimates of potential costs which have been provided are presented as estimates only as at the date of the Report. Any cost estimates that have been provided may therefore vary from actual costs at the time of expenditure.