Nolan Consulting Pty Ltd

Hydrogeological assessment

Proposed Sand Quarry at 5575 South Gippsland Highway, Lang Lang - Work Plan PLN-001536

Lang Lang Sand Resources Pty Ltd

February 2023

226-02

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1 Introduction

This report presents the hydrogeological assessment of Lang Lang Sand Resource's (LLSR) proposed sand quarry at 5575 South Gippsland Highway, Lang Lang 3984. Lang Lang Sand Resources Pty Ltd is a subsidiary of Aurora Construction Materials,

The site is located approximately 5 km south-east of the Lang Lang township, 7 km west of Nyora and 80 km south-east of Melbourne.

1.1 Purpose

The purpose of the assessment is to provide information for Work Plan PLN-001536 of Work Authority WA007541.

1.2 Key assessment elements

This hydrogeological assessment report:

1. Describes the proposed quarry activities
2. Describes the existing conditions
3. Presents
   - field investigation outcomes
   - the conceptual hydrogeological model
4. Presents post closure pit lake water level estimates
5. Presents the impact assessment
6. Proposes the groundwater monitoring program.

1.3 Definitions

For the purposes of this report the terms:

- "property" refers to the land owned by Geoffrey Pate and includes the work authority
- "site" refers to the land within the proposed extraction boundary (Stages 1 to 4)
- "in-pit water storage" refers to the Stage 1A1 pit which will be walled off from the rest of the pit. This storage will manage process water and turbid/acidic runoff before it is directed to the pit lake
- "pit lake" refers to the broader waterbody which occurs in all stages excluding Stage 1A1
- "post-closure" applies to the period after the surrender of the work authority.

1.4 This report

The report has been prepared following:

- property familiarisation visit with LLSR personal and the landowner - 28 March 2019
- inspection of groundwater related infrastructure - 17 June 2019
- an on-site pumping test - 19 September 2019
- installation of groundwater observation bores – late 2020
- gauging of groundwater observation bores – 2020 and 2023
- revision of take and use licence
- prediction of post closure pit lake level including net evaporation modelling

The report has been prepared by Nolan Consulting. Valenza Engineering undertook the field work and groundwater modelling under the direction of Nolan Consulting.

2 Quarrying activities

2.1 Extraction area, depth and staging

The extraction area includes Stages 1 to 4. The maximum extraction depth, including overburden is 30 m below ground surface. The total volume of the excavation is estimated at 14.3 million m^3.

Extraction will occur progressively. The following four stages are proposed:

- Stages 1A1, 1A2 and 1B (North-East)
- Stage 2 (South-east)
- Stage 3 (South-central)
- Stages 4A and 4B (West) - east of 376,750 m east.

The staging is indicative and will be subject to operational and resource quality requirements.

The above-ground ('turkey nest') dam is likely to be removed in either Stage 2 or Stage 3. The final Stage 4B extraction will involve relocation of the processing and stockpiling area and the use of a mobile washing and slimes treatment plant.

Once all extraction stages are complete the walls of the insitu material retained will be removed for processing.

2.2 Production rate

The output is expected to range from 250,000 to 350,000 tonne/yr. of predominantly fine to medium washed sand products for use in concrete and construction. For this hydrogeological assessment a production rate of 300,000 tonne/yr. is assumed.

2.3 Extraction method

The proposed extraction method is:

- dry to about 4 m below ground surface
- wet extraction from the above depth to a maximum of 30 m below the ground surface.

2.3.1 Dry extraction

Dry extraction occur to a depth of about 4 m below the ground level. This is expected to be above the watertable in most areas. A sump will be placed where saturated sediments are intersected. Negligible groundwater will be extracted as minimal abstraction will be required and the shallow sediments are not highly permeable. Any abstracted groundwater will be used for consumptive uses and will not be discharged from the site.

2.3.2 Wet extraction

Wet extraction will be undertaken by floating dredges, grab cranes or drag lines.

Water will not be discharged from the site.

2.4 Water consumption during operations

The consumptive uses during operations will include:

- moisture in the final screened product
- dust suppression.

Net evaporation from the pit lake will also occur.

During the initial dry operations the water lost to the above consumptive uses will be supplied from licenced bore WRK041821 and the sump (to a lesser extent). This is estimated to be up to 30 ML per year. After wet extraction commences this water will be obtained from the in-pit water storage located in the worked out Stage 1A1 area.

These consumptive uses are described below for a sand production rate of 300,000 tonne/yr.

2.4.1 Moisture in the final screened product

18 ML/yr. is estimated to be required in the final product based upon an additional moisture content of 6% by weight (300 by 0.06)

2.4.2 Dust suppression

12 ML/yr. is estimated to be required for dust suppression.

Dust suppression will be required in the dry extraction area, the plant area and access tracks. It will occur on hot and windy days. Water for dust suppression will be supplied via sprinklers from a water cart.

Operating experience suggests that dust suppression will be required on about 60 days per year and that between 50 kL and 200 kL/day will need to be applied.

2.4.3 Evaporation

Net evaporation for the average year is estimated to be between 24 mm (0.24 ML/ha) and 95 mm (0.95 ML/ha) as described in Section 5.2.3.

2.5 Processing

Extracted material will be either trucked or pumped to a sand washing and processing plant which will be established at the western end of the quarry. The processed sand will be stockpiled for sale.

Both dry and wet processing will be employed.

Dry screening will commence immediately and will continue in association with dry extraction for the life of the resource. Dry processing will occur within the processing and stockpiling area.

Wet processing involves introducing water and separating the clay/silt fines to produce a clean washed sand. Dry extracted sand will be fed into the plant and wet via a feed bin at the processing plant. Sand extracted with a grab crane or drag line will be placed in a dewatering and stockpiling area for trucking and/or conveying to the processing plant. Sand extracted using a floating dredge will be either pumped directly to the processing plant or pumped to a dewatering and stockpiling area for trucking and/or conveying to the processing plant.

2.5.1 Overburden

Overburden from the initial extraction area will form a raised base for the processing and stockpiling area, filled and compacted, to maintain drainage away the plant and stockpiles.

Thereafter overburden will be blended with consolidated slimes, interburden and plant oversize for partial backfilling of completed extraction areas with some overburden used in construction of perimeter bunds.

2.5.2 Wet processing plant

The wet processing plant (wash plant) will comprise feed bins, attritioners, pumps, pipelines, classifiers, cyclones, conveyors, blending and stockpiling equipment as well as thickeners, sand dewatering equipment and slimes dewatering equipment. Wash plant processing equipment will be standard industry items and will be updated/replaced as required to maintain plant efficiency, product recovery and slimes treatment (thickening, dewatering and drying).

Wash plant underflow containing slimes will be directed to a thickener, located adjacent to the wash plant. Slimes passing through the thickener will be further treated with appropriate flocculating agents, dewatering and consolidation equipment. Such equipment typically includes slimes buffer tank(s), dewatering equipment (belt press/ plate press/ centrifuges) transportation equipment (conveyors/pipelines/trucks) to produce a dewatered and consolidated waste product.

There will be limited wet slimes storage required during the initial commissioning and evaluation trials to design the most appropriate slimes processing equipment.

Slimes dewatering and consolidation equipment will produce consolidated slimes of a 'spadeable' consistency (typically 50-55%w/w or higher). This recovers a significant proportion of the process water for reuse.

2.5.3 Management of slimes

The consolidated slimes will be temporarily stockpiled in either the processing and stockpiling area or a temporary materials storage and handling area where further water can drain from the material. Any drained water will pass through a sediment / interceptor trap prior to returning to the pit lake.

The consolidated slimes will be blended with overburden / interburden and plant oversize / waste for partial backfilling of completed extraction areas and some used in rehabilitation of terminal extraction batters. The blended material will be deposited at the bottom of the water body.

The blended mix will be transported back to the pit via a conveyor for deposition on the pit floor. This partial backfilling will be distributed by a continually relocated conveyor, either a floating conveyor or a conveyor with an extended boom, so that the material settles to the bottom of the pit lake avoiding tipping of material down the pit terminal batters.

The blended mix will be distributed so that it remains at least 3 m below the seasonal fluctuations of the pit lake's final water level which is estimated to average 19.3 m AHD (see Section 6.5.4). The capacity below this level (approximately 15.5 m AHD) down to the maximum extraction depth of 30 m below ground level is estimated by BCA Consulting to be approximately 9.0 million m^3 using 3D modelling software. This is 3.8 m below the pit lake's estimated final average water level of 19.3 m AHD.

2.5.4 Return water from processing plant

Return water from the processing plant, along with runoff from processing and stockpiling areas via a sediment / interceptor trap, will be managed with an in pit water storage walled off from the remainder of the extraction area.

During Stage 4B mobile wash plant and slimes treatment units will be employed. The mobile plant will be located to the north-west side of the pit, on a prepared hardstand for processing and stockpiling.

2.6 Chemicals, flocculants and hydrocarbons

No hazardous chemicals will be used at the site.

The storage of hydrocarbon and flocculants will be compliant to Australian Standards AS1940 *Storage and Handling of Flammable and Combustible Liquids*, the *Dangerous Goods (Storage and Handling)* Regulations 2022, EPA Publication 1698 *Liquid Storage and Handling Guidelines* of June 2018 and Earth Resources Regulation requirements. MSDS sheets will be maintained in the site office for all dust suppressants, flocculants, neutralising agents, herbicides, pesticides, copper sulphate and any other chemicals used or stored on site.

2.6.1 Flocculants

Biodegradable flocculants will be used to settle and consolidate the slimes.

The flocculants utilised in the slimes treatment will be included in the blended mix that will be deposited in the water filled pit. The water draining from stockpiles of consolidated slimes will pass through a sediment / interceptor trap prior to returning to the in-pit water storage.

2.6.2 Hydrocarbons

The hydrocarbons to be used at the site are limited to diesel fuel, oil, and grease. The proposed controls are:

- fuels will be stored or transported in commercially produced, fully compliant containments or tanks
- a contaminants spill kit available at all times when any minor servicing and/or simple maintenance tasks are undertaken on site
- major servicing / repairs conducted at workshop in appropriately bunded area with workshop fitted with triple interceptor trap and water management structures
- areas where refuelling / minor servicing activities are being undertaken are drained to ensure no water leaves the site without first going through an interceptor trap.

2.7 Waterway

A shallow waterway diversion will be required to move the existing minor drainage line running centrally through the site to a constructed waterway along the northern boundary. This will be constructed and rehabilitated early in the quarry development and will remain in that location.

2.8 Rehabilitation

2.8.1 Overview

The quarry pit will be rehabilitated as a single pit waterbody.

2.8.2 Slimes management

The only potential slimes storage remaining within the rehabilitated landform will be blended with overburden and at least 3 m below the seasonal fluctuations in the pit waterbody at post closure.

When the insitu earthen walls around the in-pit water storage (Stage 1A1) are removed any limited volume of slimes contained at its base will mix with the surrounding backfill material moved into the space, this material having been deposited in the pit waterbody throughout the operation.

2.8.3 Major review

Prior to the completion of Stage 2 and again prior to the completion of Stage 3 major reviews of the rehabilitated waterbody design will be undertaken. This will involve:

- a review of groundwater level monitoring (see Appendix F)
- further hydrogeological investigations which may include the need for additional groundwater observation bores
- reassess the predicted final waterbody surface water level to confirm the level for the original rehabilitation design
- if necessary, review waterbody rehabilitation design in consideration of reassessed water level.

Further details of this major review are provided in the Groundwater Management Plan (Appendix F).

3 Existing conditions

3.1 Property titles, zoning and ownership

3.1.1 Titles

The following titles apply to the 117.8 ha property,

- Lot 1 LP91815 (SPI 1\LP91815)
- Lot 1 PS312674(SPI 1\PS312674)
- Lot 2 PS312674(SPI 2\PS312674)
- Lot 1 TP23467 (SPI 1\TP23467).

The Work Authority is 115 ha in size as it is pulled back at the north-east corner of the property

3.1.2 Zoning

The land within the property is zoned Green Wedge Zone - Schedule 1 (GWZ1) and is subject to an inundation overlay (LSIO).

3.1.3 Land ownership

The property is owned by Geoffrey Pate. LLSR has a sales agreement to purchase the property and the groundwater supply bores.

The current land use within the property is dairy farming with the majority of the land laid out to pasture. The property includes the following features:

- residence off South Gippsland Highway
- dairy sheds (east of the residence)
- winter fill 'turkey nest' dam (south-east of residence)
- groundwater supply bores (see section 3.3.1 and 3.4)
- irrigation system.

The winter fill 'turkey nest' dam has registration licence BEE028511. It has a licenced volume of 90 ML and allows harvesting of runoff, unregulated water way and spring. The water use is for irrigation as well as domestic and stock, dairy and general non-irrigation farm use.

3.2 Land use - surrounding properties

The surrounding properties are listed in Table 3-1.

Table 3-1: Surrounding properties

Direction	Property/feature	Comment
South-west	South Gippsland Highway	
South	Orbital	
East	Railway Sand Supplies	This quarry (WA1004) is about 370 m east of the property
	Beach Energy	Gas plant about 130 m to the north of the north-eastern corner and the land parcel along the eastern boundary
North-east		
North	Huxtable	Work Authority WA1338 is within this property. The landowner advised that shallow quarrying occurs within this work authority

3.3 Groundwater bores

3.3.1 Within property

Details of the three on-site bores installed prior to the observation bores is provided in Table 3-2. Their locations are shown in Figure 1 of Appendix A. The information is sourced from the Water Measurement Information System (WMIS) and inspections.

Table 3-2: On-site bores installed prior to the observation bores

Details	Bores (Works ID)		
	WRK041821	WRK066223	WRK041797
Year completed	1990	2011	1970
Last used	2014	Current	Current
Pump	Removed	Nil	Surface mounted
Depth (m)	39.8	37.4	36.5
Casing type	PVC	NA	PVC
Casing diameter (mm)	200	NA	150
Screen	Stainless steel from 30.0 m to 39.8 m (in coarse sands)	NA	NA

The March 2019 search of the WMIS identified other bores as being within the property. These were not found while undertaking the June 2019 site inspection. This suggests they were decommissioned, failed or are located off-site.

3.3.2 Outside property

A search of the WMIS for groundwater bores within about 3.5 km from the property was undertaken in March 2019. This was followed by a WMIS search for licensed groundwater bores within the same distance from the property undertaken on 24 February 2023. Figure 2 (Appendix A) shows the location of the 14 licensed bores surrounding the property. Information on these bores is presented in Table 3-3.

Table 3-3: Licenced bores within 3.5 km of the property (from WMIS as of 24 February 2023)

Bore ID	In Use	Year	Use	Location with respect to property	Total depth (m)	Screen top (m)	Screen bottom (m)	Screened intervals and lithology	Yield (L/s)
Irrigation									
112605	Used	1992	Irr	1.9 km ENE	105	73	94	73.0-94.0 m: Basalt	1.2
WRK041817	Used	1988	Irr	1.0 km ESE	46.2	39.5	46.2	39.5-46.2 m: Sand	46.2
Irrigation with other uses including stock and domestic									
WRK041785	Used	1997	S, Dairy, Irr	0.9 km S	41.5	33.5	41.5		
WRK041804	Used	1974	S, D, M, Irr	2.8km NW	35.81	28.04	35.81	28.0-35.8 m: Sand	35.81
WRK041810	Used	1976	S, D, M, Irr	3.2 km NW	33.52	26	33.52	25.9-33.5 m: Sand	33.52
Other consumptive uses									
74350	Used	1970	S, Dairy, D	0.2 km N	21.3				

Bore ID	In Use	Year	Use	Location with respect to property	Total depth (m)	Screen top (m)	Screen bottom (m)	Screened intervals and lithology	Yield (L/s)
74410	Used	1975	S, Dairy, D	0.1 km E	70	65.05	70		0.38
WRK041798	Used	1970	Dairy	3.5 km NW	39.6				
WRK041799	Used	1970	S, Dairy, D	1.6 km WNW	25				
WRK041800	Used	1970	S, Dairy, D	1.0 km S	16.4				
WRK041809	Used	1976	S, Dairy, D	2.2km NNW	33.53	23.46	25.29	23.5-25.6 m: Sand 28.7-31.1 m: Sand	31.39
WRK041818	Unused		Ind	Unknown					
WRK041819	Unused		Ind	0.7 km W					
WRK091174	Used	2016	Ind	1.9 km ENE	115	75	85		85
S – Stock, D – Domestic, Irr- irrigation and Ind – Industrial									

Further details on the above irrigation bores are:

112605: shown within WA157 to the north-east.

The bore has not been identified in site inspections and a view of the SRW Hub for bores with licensed allocations. The bore log identified mainly sands to 49 m below ground level, followed by 9 m of coal and 14 m of sandstone, mudstone and clay above basalt at 73 m below ground surface and sequences of sandstone, clay, basalt and coal to 105 m below ground surface.

WRK041817: shown approximately 500 m south of the South Gippsland Highway within the Lang Lang Golf Course.

The bore was installed in 1988, was drilled to 46.2 m and is screened in sand from 39.5 m to 46.2 m. The WMIS lists the yield of this bore as 11.37 L/s with a salinity of 206 mg/L. Eartheon (2015) undertook a two hour pumping and recovery test of this bore in late 2015. The static water level was 15 m below ground surface.

Figure 3 (Appendix A) shows stock, dairy and domestic bores. There are over 50 stock and domestic bores shown as being within 2 km of the property (Figure 3). These are typically screened in sand up to depth of 40 m and have yields of 0.2 L/s to1.3 L/s (with one outlier of up to 7.6 L/s).

Stock and domestic bores 74350 (north) and 74410 (west) of Figure 3 (Appendix A) are shown in the WMIS as being within 1 km of the property. The property owner has not witnessed these bores.

Figure 4 (Appendix A) shows three observation and investigation bores, Figure 5 (Appendix A) shows other 'non-groundwater bores, and Figure 6 (Appendix A) shows the closest State observation bores (SOBN bores).

3.4 Take and use licence - within property

LLSR holds take and use licence BEE077726 with an annual volume of 261.9 ML. The licence and related works licence is provided in Appendix D. Table 3-4 lists information from this licence.

Table 3-4: Take and Use licence BEE077726

Item	Licence information
Licence Expiry	30 June 2035
Name of aquifer	UNC-Koo Wee Rup
Groundwater unit	Koo Wee Rup
Related works licence	WLE038316
Works ID (Bores)	WRK041821[1] Industrial or commercial | Extraction point: 376657 (east), 5757487 (north), zone 55 | (Max annual volume – 60 ML WRK125327 Industrial or commercial | Extraction point: 376649 (east), 5757489 (north), zone 55 | Max annual volume – 201.9 ML
Licence volume (ML/yr.)	261.9
Method of taking	Direct extraction from groundwater
Land water to be used on	Volume 8916 Folio 752, Lot 1 of Plan LP091815 Volume 10257 Folio 300, Lot 2 of Plan PS312674E Volume 10257 Folio 299, Lot 1 of Plan PS312674E Volume 10613 Folio 500, Lot 1 of Plan TP023467H
Use of water:	Industrial or commercial use - as well as domestic and stock use

[1] Bore WRK041821 replaced bore 2968/10090 (groundwater licence no. 5378). The former bore was licenced in January 1987 with an annual volume of 257 ML and an irrigated area of 41 ha. This bore was replaced by bore WRK041821 in 1990 (landowner advice).

4 Field investigations and water level gauging

The field investigations undertaken between 2019 and 2020 included:

- installation of groundwater observation bores
- in-situ water quality analyses
- pumping test.

These investigations were preceded by the earlier resource investigation program.

Post installation gauging of groundwater levels was undertaken between 2020 and 2023.

4.1 Earlier resource investigation program

BCA Consulting drilled 26 air cored resource investigation holes to depths of 18 m to 51 m across the property in 2013. The typical profile is:

- topsoil and sandy clay (overburden): 0.0 – 5.0 m below ground level
- silty fine to medium sand, clay silt and fine to medium sand: 5.0 – 20.0 m below ground level
- medium to coarse sand and coarse sand: 20.00 – 40.0 m below ground level.

The depth to the top of the organic sediments varied across the property from 19 m to 28 m below the ground surface. Its thickness ranged from absent at some locations to 8 m. layers of BCA Consulting advised that clay/interburden/organics and peat layers occur within both sand units. First water intersections are presented in Table 4-1.

Table 4-1: Resource investigation bores with recorded water intersections

Bore	Depth to water intersection (m)	Bore	Depth to water intersection (m)	Bore	Depth to water intersection (m)
1	15[2]	10	Not noted[1]	19	Not noted[1]
2	9	11	6-7	20	Not noted[1]
3	Not noted[1]	12	16[2]	21	13[2]
4	7-9	13	12[2]	22	13[2]
5	Not noted[1]	14	Not noted[1]	23	12[2]
6	15[2]	15	Not noted[1]	24	Not noted[1]
7	Not noted[1]	16	Not noted[1]	25	6
8	6	17	Not noted[1]	26	6
9	Not noted[1]	18	Not noted[1]		

[1] Not all first water intersections were recorded on the BCA Consulting bore logs

[2] The deeper intersections are discounted as the speed of drilling is likely to have limited the identification of early intersections].

It is inferred that the base of most of these bores is within the Western Port Group.

Based upon these records the depth to the first groundwater intersection is inferred to be in the order of 6 m below ground surface.

4.2 Installation of groundwater observation bores

Licence to construct works WLE079258 was obtained on 29 September 2020. This was for the installation of four groundwater observation bores (WRK122746 to WRK122749). The purpose of the observation bores was to monitor the depth to groundwater in the shallow sediment across the site. These bores were drilled to depths ranging from 8 m to 10 m below ground level.

The bores were drilled, installed and developed by a licenced driller from Star Drilling from 19 to 20 November 2020. Their locations are shown in Figure 7 (Appendix A). The bore logs including construction details and graphic logs are presented in Appendix B.

The bores were drilled by hollow auger to a diameter of 150 mm.

The bores were installed with 50 mm diameter PVC casing machine slotted over a 3 m length. The bores were gravel packed with 8/16 graded sand to 2 m above the screened interval. A 2 m thick bentonite grout was placed above the gravel pack. The bore was backfilled to the surface and a metal monument was placed over the casing and concreted at the surface.

Soil samples were logged by a Valenza Engineering hydrogeologist (with the exception of MW01). The Valenza Engineering hydrogeologist supervised the bore installation and bore development. Development was conducted with an air compressor until the water was relatively free of sediment.

The generalised profile is:

- 0.0 m– 1.0 m topsoil
- 1.0 m – 4.0 m sandy clay
- 4.0 m – 8.0 m clayey sand
- 8.0 m - >8.0 m sandy clay to clay

All observation bores are screened in the clayey sand. These sediments are inferred to be the clay silt logged in the resource investigation bores (see Section 4.1).

The driller advised that neither sandy clay nor clay was encountered at MW01 below the clayey sand to a depth of 10 m.

4.3 Gauging of groundwater levels

Several groundwater bore level gauging events have been undertaken.

4.3.1 Bores WRK066223 and WRK041821

Water supply bores (bores WRK066223 and WRK041821) were gauged for depth below ground level on 17 June 2019, 19 September 2019 (prior to the pumping test), in 2020 and 24 January 2023. Nearby former production bore WRK041797 was gauged in 2020.

The above bores have been drilled to between 35 m and 40 m from ground surface. The results of the gauging events are presented in Table 5-6.

4.3.2 Observation bores

The four observation bores were gauged for first strike water levels during drilling and as depths to water after development on 26 November 2020, 3 December 2020 and 24 January 2023. The total drilled depth, screened interval and gauged water levels are presented in Table 5-7.

4.4 In situ water quality analyses

The in-situ salinity, temperature, and pH of bores WRK066223 and WRK041821 were recorded on 17 June 2019. The results are presented in Table 4-2.

Table 4-2: Groundwater bore water quality (17 June 2019)

Parameter	Bore	
	WRK066223	WRK041821
EC (µS/cm)	168	2,592
Temperature (°C)	16.45	17.22
pH	5.55	6.87
Comment	During pumping	Stagnant

4.5 Pumping test

A pumping test of bore WRK066223 was undertaken on 19 September 2019 (Appendix C). The pumping test involved a three stage step drawdown test over 80 minute, followed by constant rate pumping at 6.1 L/s for 4 hours and a 100 minute recovery period. Monitoring was undertaken at the pumped bore and at bore WRK041821.Bore WRK066223 is 37.4 m deep and hence is inferred to be screened at depth in the medium to coarse sand (see Section 4.1).

The geometric mean transmissivity and storativity from the pumping test are estimated in Appendix C.

The geometric mean transmissivity was estimated to be 96 m^2/day. Transmissivity is hydraulic conductivity by aquifer thickness. The geometric mean storativity was estimated to be 0.057. Storativity is a dimensionless measure of the volume of water that will be discharged from an aquifer per unit area of the aquifer and per unit reduction in hydraulic head. For an unconfined aquifer it is equal to the drainable porosity.

5 Conceptual hydrogeological model

5.1 Topography

The land slopes from about 23 m AHD along the eastern boundary to about 16 m AHD in the north-west corner.

5.2 Meteorology

5.2.1 Rainfall

Monitoring of the Bureau of Meteorology's Lang Lang station 086063 commenced in 1918. The annual rainfall recorded at this station over the past 22 years is shown in Table 5-1.

Table 5-1: Lang Lang Meteorological Station 086063 - Annual rainfall 2000 to 2019

Year	Rainfall (mm)	Year	Rainfall (mm)
2000	854	2011	980
2001	881	2012	903[1]
2002	669	2013	942
2003	694	2014	768
2004	819	2015	678
2005	764	2016	875
2006	541	2017	871
2007	823	2018	746
2008	681	2019	743
2009	710	2020	991
2010	1 024	2021	868[2]

[1]Uses mean monthly data for March and May 2012

[2] Uses mean monthly data for April 2021

The Bureau of Meteorology's Lang Lang station's 086063 mean monthly rainfall is presented in Table 5-2.

Table 5-2: Lang Lang Meteorological Station 086063 – Mean monthly rainfall

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	48.3	51.4	53.2	73.6	80.9	72.9	77.5	84.9	85.8	83.9	73.3	68.3	859.3

The mean annual rainfall over the past 22 years is 764 mm. This is 95 mm lower than the long term average annual rainfall.

5.2.2 Evaporation

The average annual surface evaporation is estimated to be 887 mm. The mean monthly pan evaporation has been estimated from the Bureau of Meteorology's pan evaporation maps. The estimated evaporation from water surfaces has been estimated as 75% of the pan evaporation (the pan factor).

Morton's CRLE model equations for a deep lake system have been used to estimate surface evaporation from the pit lake. Climate data was obtained from the Bureau of Meteorology Lang Lang and Cranbourne Botanic Gardens meteorological stations with an estimate of monthly mean sunshine hours from the monthly maps obtained at http://www.bom.gov.au/watl/sunshine/. The data was entered into the program WREVAP.

The pit lake evaporation estimates are presented in Table 5-3.

Table 5-3: Dredge pond evaporation estimates

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Pan evaporation (BOM maps)	175	150	125	80	45	36	40	52	80	100	150	150	1183
BOM Pan evaporation with pan factor of 0.75	122	105	88	56	33	25	28	36	56	70	105	105	887
Evaporation from deep lake system (Morton)	124	130	145	119	90	56	36	26	26	40	63	96	952

5.2.3 Conclusions

The net surface evaporation over rainfall for the average year is likely to be between 24 mm/yr. (0.24 ML/ha) and 95 mm (0.95 ML/ha).

Excess rainfall typically occurs from April to October.

5.3 Geology

5.3.1 Regional geology

The primary source of the regional geology description presented in this section is the Geological Survey of Victoria (1980) "*1:100,000 Hydrogeological Map*".

The property is within the eastern part of Western Port basin, on the down-thrown (eastern) side of the Heath Hill Fault (to) and the up-thrown (western) side of the Lang Lang Fault.

The stratigraphic units from youngest to oldest are:

- Quaternary aged sediments consisting of sand, silt and clay
- Tertiary aged Western Port Group comprising:
  - Baxter Formation sands
  - Sherwood Formation sands
  - Yallock Formation sand and gravels
- Tertiary aged Older Volcanic basalt
- Tertiary aged Childers Formation sands and gravels
- Pre Cainozoic bedrock.

The Tertiary and Quaternary sediments infill the basin. They reach a thickness of 300 m in the deepest parts of the basin and about 150 m in the vicinity of the property.

Quaternary sediments were deposited:

- in a low energy phase of swamp, tidal flat and flood plain development are the outcropping geology over the southern part of the property
- by occasional high energy floods from the hills to the east are outcropping geology over the northern part of the property.

The Western Port Group underlying the Quaternary sediments thickens to the west.

The Older Volcanics basalt flows form an extensive sill underlying the Western Port Group.

The Childers Formation is fluviatile in origin. It was formed in a low energy depositional environment associated with swamp, flood plain and tidal flats. The sediments consist of clays, sands, and gravels inter bedded with carbonaceous deposits (Thompson; 1974). The Pre Cainozoic bedrock sediments form the base of the Western Port basin. The sediments outcrop as the Strzelecki Group to the east of the Heath Hill Fault (to the east of the property).

5.3.2 Site

The estimated depths from ground surface of the above stratigraphic units in the vicinity of the property are:

- Quaternary 0 m to 20 m
- Western Port Group 20 m to 90 m
- Older Volcanics 90 m to 120 m
- Childers Formation 120 m to 150 m
- Bedrock > 150 m

5.4 Hydrogeology

The relevant aquifers are the quaternary sands and the Western Port Group.

5.4.1 Aquifer characteristics

The regional aquifer characteristics (salinity, bore yield, horizontal hydraulic conductivity and storage co-efficient are shown in Table 5-4 [sourced from Geological Survey of Victoria (1980) and Geological Survey of Victoria (1981)].

Table 5-4: Regional aquifer characteristics

Aquifer	Salinity (mg/L)	Bore yields (L/s)	Horizontal Hydraulic conductivity (m/day)	Storage Co-efficient
Quaternary				
Sands	*<1,000*	*<2.5*	-	-
Swamp, tidal flat and flood plain	*500 to 1,000*	*<10*	-	-
Western Port Group	300 to 3,000	<25	*1-8.5*	*$2.0*10^{-4}$ to 0.03* with up to 0.35 in the Yallock Formation when unconfined
Older Volcanics	300 to 3,000	<15	2.9-11.7	$5.0*10^{-4}$ to $5.0*10^{-3}$
Childers Formation	<1,000	2.5-25	3.0-3.7	$2.5*10^{-4}$

The transmissivity at depth in the medium to coarse sand and coarse sand is estimated from the pumping test to be 96 m^2/day (see Section 4.5). Assuming a saturated thickness of 50 m, this is equivalent to a hydraulic conductivity of 2.0 m/s. The mean storativity from the pumping test is estimated to be 0.06. This is an unconfined aquifer storativity.

The above aquifer parameters are within the range presented in Table 5-4.

5.4.2 Recharge

The property is within a groundwater recharge zone. Winter rainfall results in aquifer recharge.

Recharge occurs along the Heath Hill Fault to the east as well as vertically by percolation through the Quaternary deposits.

The SKM (1998) "*Permissible Annual Volume Project - Lang Lang GMA*" recommended a Permissible Annual Volume (PAV) of 4,087 ML which over the 265 km^2 area is 15 mm/y and they estimated the available groundwater using the rainfall recharge method as 23 mm/yr. For this assessment the mean annual rainfall contribution to recharge is estimated to be about 18 mm (2% of rainfall).

5.4.3 Water quality

The electrical conductivity (EC), temperature, and pH of on-site groundwater bores WRK066223 and WRK041821 was recorded in-situ on 17 June 2019 (Section 4.4). The results are presented in Table 5-5.

Table 5-5: Groundwater bore water quality (17 June 2019)

Parameter	Bore	
	WRK066223	**WRK041821**
EC (µS/cm)	168	2,592
TDS (mg/L)[1]	109	1,685
Temperature (°C)	16.45	17.22
pH	5.55	6.87
Comment	During pumping	Stagnant

[1] Estimated based upon a TDS to EC ratio of 0.65

The salinity (as TDS) reflect the Western Port Group's range presented in Table 5-4.

5.4.4 Groundwater level

5.4.4.1 Lower sediments of the proposed pit

The maximum depth of the proposed pit is 30 m below ground surface. From 20 m to 40 m below ground surface the coarser sands of the Western Port Group are intersected. The source of groundwater levels in these sediments are the first water strikes in the resource investigation bores and the gauged levels in the on-site production bores.

The first water strikes in the resource investigation bores are presented in Table 4-1.

Table 5-6 presents the gauged water levels of the three on-site bores installed prior to the observation bores. These are WRK0066223, WRK041821 and WRK041797. They have been drilled to between 35 m and 40 m below ground level (bgl) (see Table 3-2).

Table 5-6: Gauged water levels of on-site bores drilled to between 35 m and 40 m bgl

Bore	Date	Gauged water levels		
		m bToC	m bgl	m AHD
WRK066223	17/06/2019	8.47	8.22	10.75
	19/09/ 2019	8.33	8.08	10.89
	2020	6.14	5.89	13.08
	24/01/2023	5.68	5.54	13.54
WRK041821	17/06/2019	NA	5.94	NA
	19/09/ 2019	NA	5.67	NA
WRK041797	2020	5.17	4.91	15.19
m bTOC – m below top of casing				

The water level in these sediments falls from 25.0 m AHD in the south-east corner to about 14 m AHD at the western boundary of Stage 4.

The depth to the water in the coarser sands from 20 m to 40 m below ground level is inferred to be in the order of 6 m below ground level.

5.4.4.2 Upper sediments of proposed pit

From the ground surface to 20 m below ground surface the overburden and silty sand, clay, silt and fine to medium sand are intersected.

The source of groundwater levels in these sediments are the gauged levels in the four observation bores. The total drilled depth, screened intervals and gauged water levels of these bores are presented in Table 5-7. Top of casing and ground surface surveyed levels were provided by BCA Consulting.

Table 5-7: Observation bore installation, water strikes and groundwater levels

Data	Observation bore											
	MW01			MW02			MW03			MW04		
Total depth (m)	10.0			8.0			8.0			10.0		
Screened interval (m bgl)	7.0-10.0			5.0-8.0			5.0-8.0			5.0-8.0		
Top of casing level (m AHD)	15.79			26.14			29.48			21.76		
Water strike during drilling (mbgl)	Unknown			4.6			6.0			3.0		
Level												
Date	**bToC**	**bgl**	**AHD**	**bToC**	**bgl**	**AHD**	**bToC**	**bgl**	**AHD**	**bToC**	**bgl**	**AHD**
26/11/2020	4.9	4.1	10.8	4.2	3.3	21.94	3.9	3.2	25.58	1.4	0.7	20.36
3/12/2020	4.96	4.16	10.83	4.43	3.43	21.81	4.02	3.32	25.46	1.49	0.79	20.27
24/01/2023	5.15	4.33	10.64	4.85	4.00	21.29	3.73	3.00	25.75	1.60	0.89	20.16

The water level in theses bores is relatively uniform over time. The levels fall from about 25.6 m AHD in the east at MW3 to 10.7 m AHD in the north-west at MW01. The water level ranges from 0.7 m below the ground level at MW04 to 4.1 m below the ground level at MW01. The low depth below ground level at MW04 is suspected to be a result of perching or seepage from the turkey nest dam to its north-west.

5.4.5 Flow direction

Groundwater flow within the property is to the west-north-west. As the site is a recharge zone the vertical gradient will be downward. This is confirmed by first strike and gauged water level data (see Section 5.4.4).

5.5 Groundwater dependent ecosystems

The Bureau of Meteorology shows Adams Creek as a High Potential aquatic groundwater dependent ecosystem (national assessment). This creek is at about 630 m north of the property at its closest point.

6 Pit lake water level post closure

6.1 Modelling of change in water level due to net evaporation

A two dimensional finite element steady state groundwater model has been used to predict the post closure (long-term) change in the pit lake level due to net evaporation.

6.2 Assumptions

6.2.1 Pre-quarrying conditions

The assumed pre-quarry conditions are based upon the conceptual model (Section 5). They are:

- aquifer thickness and depth to base - uniform
- mean aquifer hydraulic conductivity - 2.0 m/day
- aquifer recharge - 18 mm/yr.
- aquifer base below the ground surface – 55 m below the highest estimated point from Data Vic's 10 m Lidar and the 4 known elevations at observation bores
- groundwater flow direction - west-north-west
- groundwater level boundary condition 3 km north-west of property - 3 m AHD.

6.2.2 Post-closure

The assumed post-closure conditions are those presented in Section 6.2.1 as well as:

- extraction has occurred to a depth of 30 m below ground level
- net evaporation from the pit lake is 95 mm/yr.
- groundwater inflows to the pit lake occur into a 3 m zone below the pit lake's surface level.

6.3 Calibration

The model has been calibrated to available observation bore data. The calibrated model results in a hydraulic gradient of 10.0 m across Stage 1 to Stage 4 which is similar to the January 2023 gauged hydraulic gradient.

6.4 Prediction

The model estimates that the pit lake's post closure (long term) net evaporation will result in a water level reduction of 0.2 m.

6.5 Estimate of post closure pit lake water level

6.5.1 Seasonal fluctuations

The pit lake level will fluctuate seasonally due to changes in groundwater ingress and net evaporation. This fluctuation will be less than in an aquifer as the drainable porosity of ponded water is 1.

The groundwater level at the upper tertiary aquifer SOBN bore 145260, 4.2 km to the north, seasonally fluctuates by up to 2 m. For the purpose of estimating the seasonal pit lake level fluctuation a drainable unconfined aquifer porosity of 10% has been assumed as the geometric mean unconfined storativity (drainable porosity) of the proposed pit's lower sediments within the property is estimated to be 5.7% (see Section 4.5). This suggests a mean seasonal fluctuation of 0.2 m.

The peak seasonal fluctuations of the post closure pit lake are conservatively assumed to be less than 0.5 m (0.25 m above and below the long term post closure water level).

6.5.2 Assumptions

The assumptions are:

- the effective transmissivity through the pit lake is equivalent to the existing aquifer (meaning the reduced transmissivity associated with the material placed at the base of the lake is compensated by the water above this material.
- the existing water level of the lower sediments is 6 m below the ground surface (see Section 5.4.4.1)
- the long term net evaporation loss is 0.2 m (see Section 6.4)
- there are no off-site dewatering/recharge influences.

6.5.3 Stages 1 to 2 pit lake

The mean water level within the pit lake once quarrying extends to the western edge of Stage 2 will be below the pre-quarry water level to the east and above the pre-quarry water level to the west. The change in level at the eastern and western boundaries will be less than for Stage 1 to Stage 3 (See Section6.5.4) and hence the minimum depth from the ground surface to the mean water level is likely to be greater than 2.2 m.

6.5.4 Stages 1 to 3 pit lake

The estimated mean water level within the pit lake once quarrying extends to the western edge of Stage 3 is 20.8 m AHD. This is about 2.2 m below the ground level at the western edge of Stage 3 (see figure in Appendix E). This level is below the pre-quarry water level to the east by 4.2 m and above the pre-quarry water level to the west by 3.8 m. The change in level will be less than for Stage 1 to Stage 4. Therefore the long term post closure water level is likely to be well below the existing ground level and hence the quarry pit crest thus the risk of overtopping and significant capillary rise is low.

6.5.5 Stages 1 to 4 pit lake

The estimated mean water level within the pit lake once quarrying extends to the western edge of Stage 4 is 19.3 m AHD. This is about 0.7 m below the ground level at the western edge of Stage 4 (see figure in Appendix E). This level is below the pre-quarry water level to the east by 5.7 m and above the pre-quarry water level to the west by 5.3m.

6.6 Sensitivity study

As there are uncertainties in the assumptions that cannot reasonably be resolved prior to quarrying, a sensitivity study has been conducted to assess the impact of nil net evaporation over the modelling domain. For this scenario the water level within the pit lake is estimated to be about 0.2 m higher than with the net evaporation (see Appendix E).

7 Impact assessment and management plan

7.1 Impact assessment – during operations

The following during operations potential impacts are assessed:

- groundwater level - lower
- groundwater level – higher
- groundwater quality
- soil.

7.1.1 Groundwater level - lower

The maximum fall in groundwater level at the eastern boundary of the pit lake is estimated to be 5.7 m.

The nearest licenced bores to the east are stock, dairy and domestic bore 74410 and irrigation bore WRK041817. Bore 74410 is shown in the WIMS as 0.1km east of the property at depth of 65 m to 70 m below the ground level. Bore WRK041817 is shown in the WIMS as 1.0 km east south east of the property. The maximum fall in water resulting from the pit lake is expected to be less than 2 m at these bores. Annual engagement, from the end of Stage 2, with owners of these bores will be undertaken to determine if their supply bore levels have been adversely impacted by watertable lowering. Mitigation measures will be initiated should adverse impacts be identified.

In addition the current take and use license existed prior to the proposed quarry (groundwater bore 2968/10090 had take and use licence no. 5378 from January 1987). This entitled the property owner to extract 257 ML/yr. The current take and use license BEE077726 with 261.9 ML/yr, to be utilised by the quarry, has replaced this earlier take and use licence.

Hydrogeological reviews will be undertaken during Stage 2 and Stage 3 (See Appendix F)

No springs have been observed within the property.

As the site is sloping the excavation (at completion) will lead to a localised lowering of the groundwater level to the east. Little net impact is expected at the nearest mapped Groundwater Dependent Ecosystem (Adams Creek) is 630 m to the north at its closest point (see Section 5.5).

7.1.2 Groundwater level - higher

As the site is sloping the excavation (at completion) will lead to a localised raising of the groundwater level to the west. Little net impact is expected at the nearest mapped Groundwater Dependent Ecosystem (Adams Creek) is 630 m to the north at its closest point (see Section 5.5).

7.1.3 Water quality

Flocculants should be biodegrade.

Hydrocarbon contamination is unlikely based upon the controls listed in Section 2.6.2.

The pit lake salinity will be similar to the salinity of groundwater seeping into the pit.

7.1.4 Soil

No adverse soil impact is anticipated as the only irrigation proposed in the Work Plan is occasional irrigation of rehabilitated areas, or to respond to excess water in a storm event in the 'turkey nest' farm dam.

7.2 Impact assessment – post closure

7.2.1 Water level

The key post closure water level risks are listed in Table 7-1.

Table 7-1: Key post closure groundwater level risks

Location	Hazard	Consequence	Risk	Comment
West	Water level rise	Waterlogging	Low	Mean level maintained below the ground surface level at the western boundary (see Section 6).
		Overtopping	Very low	Hydrogeological reviews will be undertaken during Stage 2 and Stage 3 (See Appendix F)
East	Water level fall	Reduced yield of water supply bores	Low	At completion of Stage 4 the fall in groundwater level at the eastern boundary of the pit lake is estimated to be 5.7 m. The nearest licenced bores to the east are stock, dairy and domestic bore 74410 and irrigation bore WRK041817. Bore 74410 is shown in the WIMS as 0.1km east of the property at depth of 65 m to 70 m below the ground level. Bore WRK041817 is shown in the WIMS as 1.0 km east south east of the property. The maximum fall in water resulting from the pit lake is expected to be less than 2 m at these bores. Annual engagement, from the end of Stage 2, with owners of these bores will be undertaken to determine if their supply bore levels have been adversely impacted by watertable lowering. Mitigation measures will be initiated should adverse impacts be identified. Hydrogeological reviews will be undertaken during Stage 2 and Stage 3 (See Appendix F)
		Exposure of deposited blend of slimes and overburden in pit lake presenting a public safety hazard	Low	Exposure is unlikely as the upper net evaporation estimate of 95 mm/yr. has been applied which results in a water level lowering of 0.2 m. Hydrogeological reviews will be undertaken during Stage 2 and Stage 3 (See Appendix F)

7.2.2 Water quality

The key post closure pit lake water quality risks are turbidity, salinity, blue-green algae and acidity.

Elevated turbidity is unlikely as surface water inflows into the pit lake are not proposed.

The pit lake water will be sourced from groundwater inflows and rainfall. Losses will be from evaporation. While the salinity of groundwater Western Port Group can range from

300 mg/L to 3,000 mg/L, the salinity of WRK066223 and WRK041821 which have been constructed on site to a depth below ground level of 35 m to 40 m is 168 mg/L to 1,685 mg/L. It is likely that the salinity of groundwater inflows to the pit lake will be within the 168 mg/L to 1,685 mg/L range. As modelling of the impact of net evaporation on the pit lake water levels shows a minor impact on level the increase in the long term salinity of the lake due to net evaporation losses is expected to be minor.

The current groundwater is likely to be neutral to slightly acidic. Acidic waters can occur through exposure of organic layers to air. The proposed operation will manage exposure of such materials and treat any acidification to maintain near neutral conditions in the in-pit water storage and the pit lake.

Blue-green algae is temperature, nitrogen and/or phosphorus dependent. The risk of occurrences increases in the summer months. It is proposed to monitor for blue-green algae and if present treat with copper sulphate.

The Groundwater Management Plan (GWMP) includes turbidity, salinity, pH and blue-green algae monitoring of the pit lake (see Section 7.3 and Appendix F).

7.3 Groundwater management plan

A Groundwater Management Plan (GWMP) for operations and after completion of final rehabilitation work post closure is provided in Appendix F. As extraction progresses more will be learnt about the hydrogeological conditions, and this acquired knowledge will be captured through the implementation of the GWMP.

8 References

Eartheon (2015), "*Bore Yield Assessment, Nyora Quarry*".

Geological Survey of Victoria (1980), "*1:100,000 Hydrogeological Map of Western Port Basin*", R. Lakey & S.J. Tickell.

Geological Survey of Victoria (1981), "*Explanatory Notes on the Western Port Groundwater Basin 1:100,000 Hydrogeological Map*", R. Lakey & S.J. Tickell, Geological Survey Report No. 69, May 1981.

SKM (1998), "*Permissible Annual Volume Project - Lang Lang GMA*"

Thompson B.R. (1974), "*The Geology and Hydrogeology of the Western Port Sunklands*", Geological Survey Report 1974/1.

Appendix A

Figures

Legend:

Site outline

Licenced site bores

Bore Licence/Entitlement

WRK041821 & WRK066223 - WLE038316/BEE022287

WRK041797 - WLE036658/BEE028536

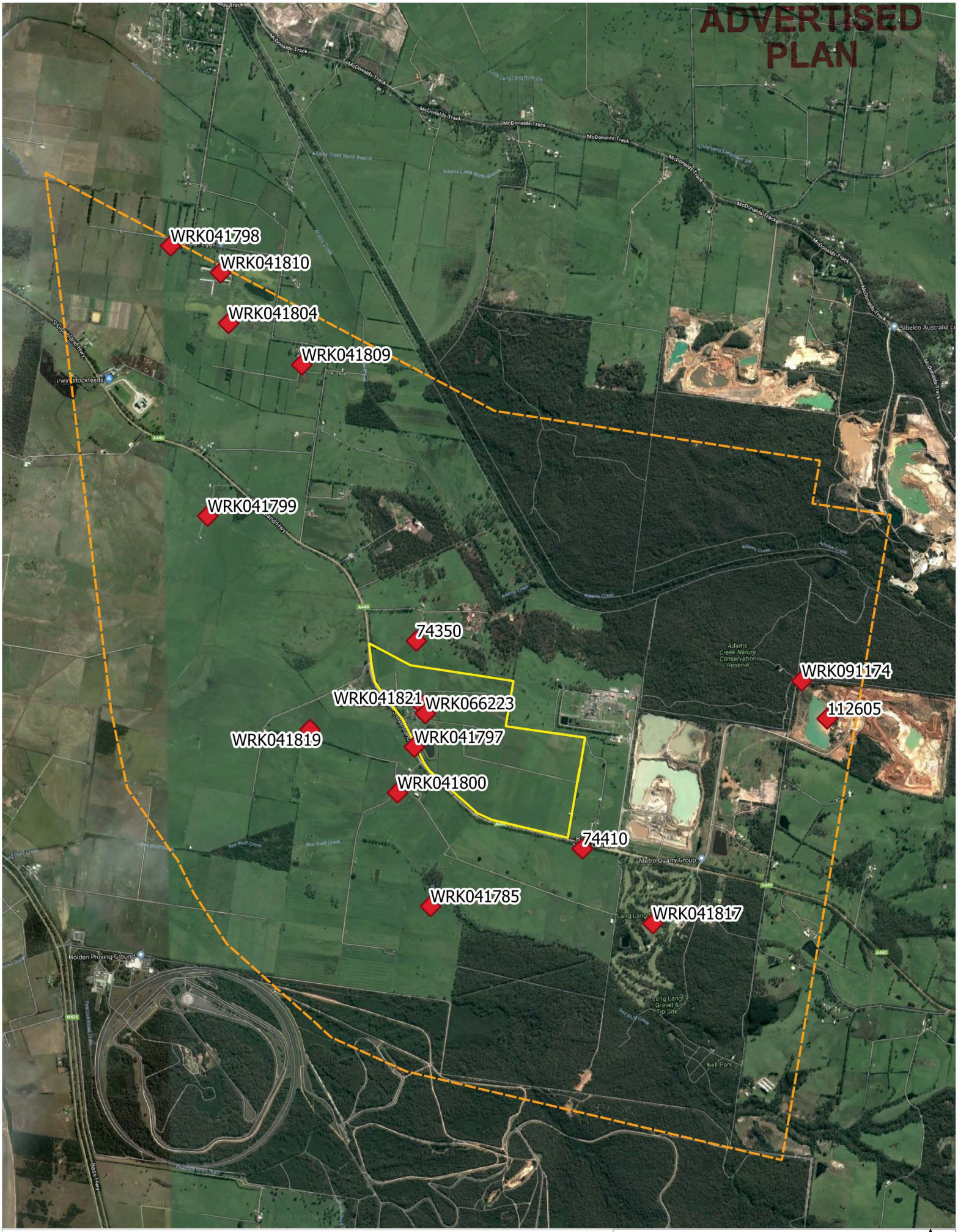
0 100 200 300 m

Drawn: JOC, 02/12/2020
Checked: AV, 02/12/2020
Project: 305
Doc No: 01

References:
Google Maps
Coordinate System: GDA 1994 MGA Zone 55

Valenza Engineering Pty Ltd
Melbourne, Victoria

FIGURE 1: 5575 Sth Gippsland Hwy - Onsite licenced bores



Legend:

Licenced — Site outline — 2km site radius

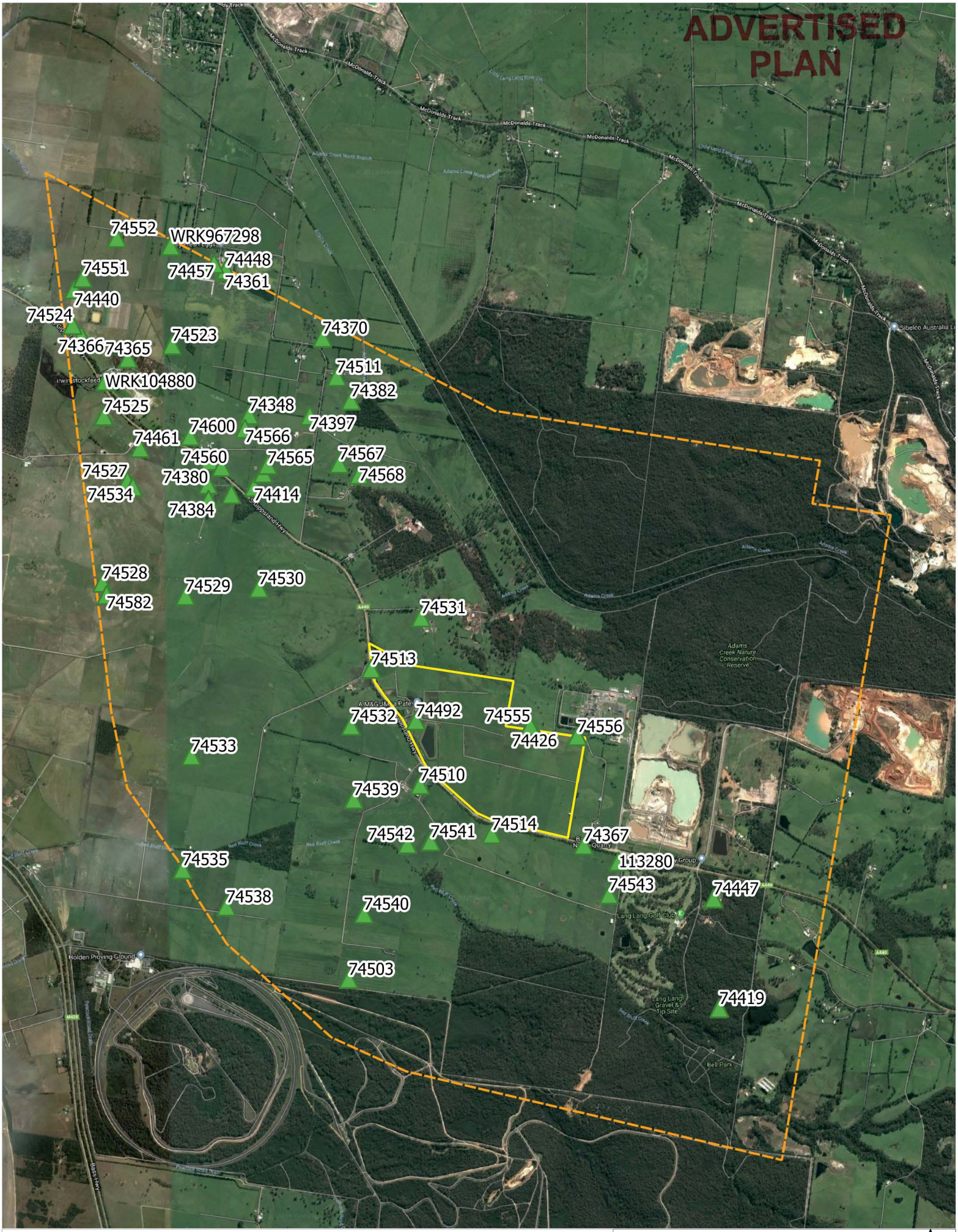
0 500 1000 1500 m

Drawn: JOC, 25/03/2019
Checked: AV, 25/03/2019
Project: 305
Doc No: 02

References:
Google Maps
Coordinate System: GDA 1994 MGA Zone 55

Valenza Engineering Pty Ltd
Melbourne, Victoria

FIGURE 2: 5575 Sth Gippsland Hwy - Surrounding Bores - Licenced



Legend:

Site outline — 2km site radius ▲ Stock and Domestic

0 500 1000 1500 m

Drawn: JOC, 25/03/2019
Checked: AV, 25/03/2019
Project: 305
Doc No: 03

References:
Google Maps
Coordinate System: GDA 1994 MGA Zone 55

Valenza Engineering Pty Ltd
Melbourne, Victoria

FIGURE 3: 5575 Sth Gippsland Hwy - Surrounding Bores - Stock & Domestic

Legend:

Site outline — 2km site radius — Monitoring and Investigation

0 500 1000 1500 m

Drawn: JOC, 25/03/2019
Checked: AV, 25/03/2019
Project: 305
Doc No: 04

References:
Google Maps
Coordinate System: GDA 1994 MGA Zone 55

Valenza Engineering Pty Ltd
Melbourne, Victoria

FIGURE 4: 5575 Sth Gippsland Hwy - Surrounding Bores - Monitoring and Investigation

Legend:

Site outline — 2km site radius — Other

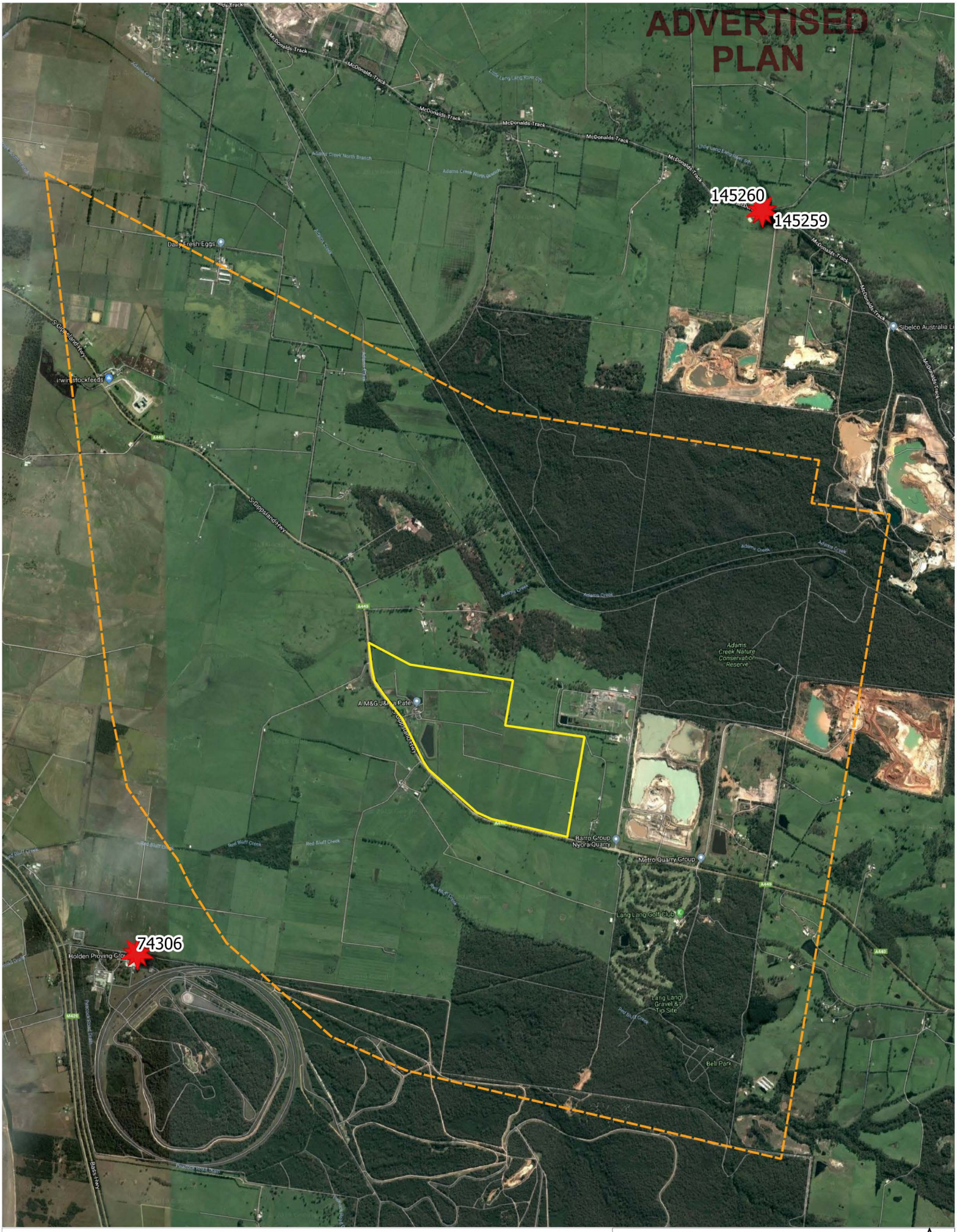
0 500 1000 1500 m

Drawn: JOC, 25/03/2019
Checked: AV, 25/03/2019
Project: 305
Doc No: 05

References:
Google Maps
Coordinate System: GDA 1994 MGA Zone 55

Valenza Engineering Pty Ltd
Melbourne, Victoria

FIGURE 5: 5575 Sth Gippsland Hwy - Surrounding Bores - Other



Legend:

Site outline — 2km site radius — SOBN

0 500 1000 1500 m

Drawn: JOC, 25/03/2019
Checked: AV, 25/03/2019
Project: 305
Doc No: 06

References:
Google Maps
Coordinate System: GDA 1994 MGA Zone 55

Valenza Engineering Pty Ltd
Melbourne, Victoria

FIGURE 6: 5575 Sth Gippsland Hwy - Surrounding Bores - SOBN

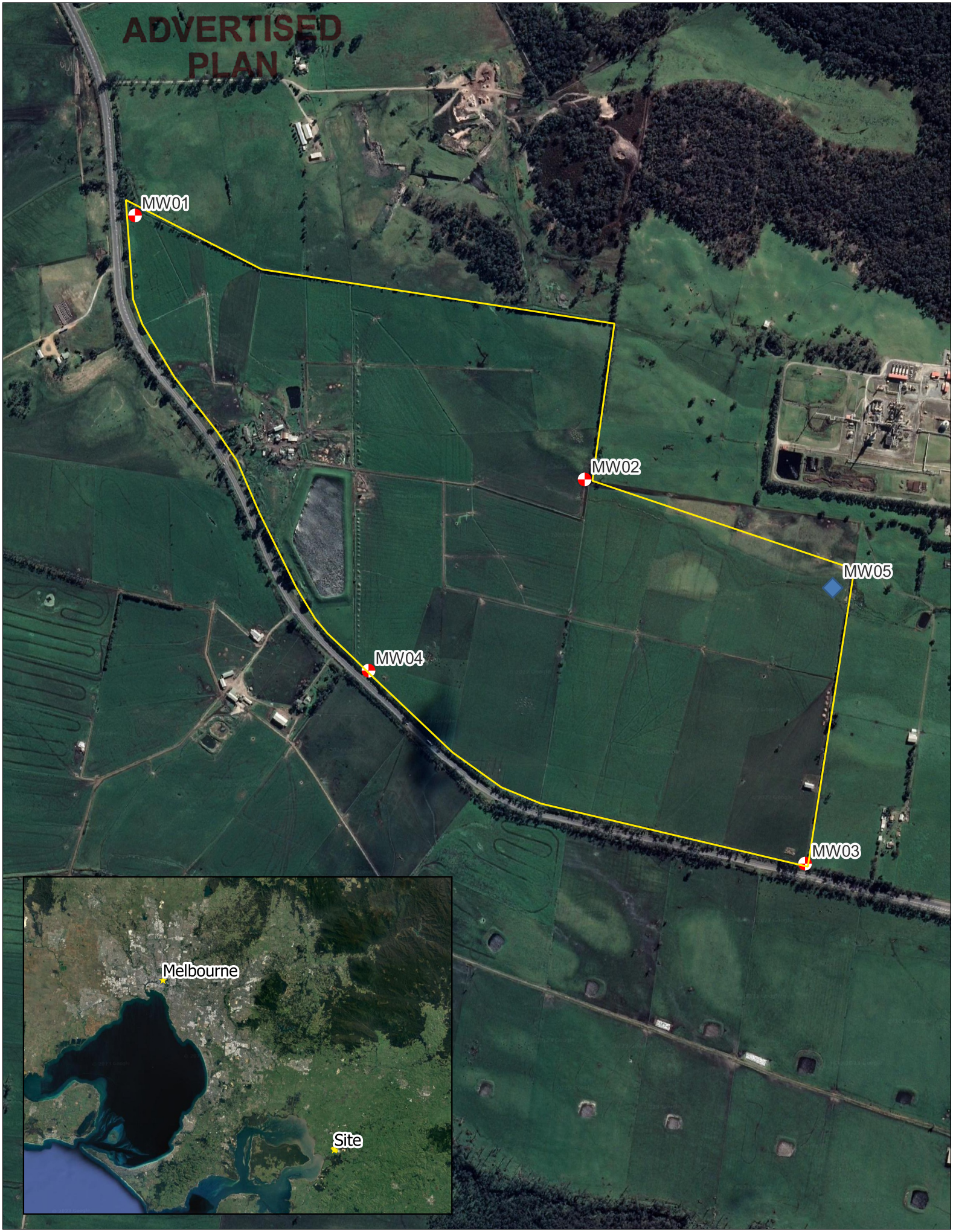


FIGURE 7: Site location and Groundwater Monitoring Locations

Legend:

Work Authority Boundary | Monitoring Bores | Proposed MW05

0 100 200 300 m

GDA 1994 MGA Z55

Drawn: JOC, 23/02/2023
Checked: AV, 23/02/2023
Project: 305
Client: Lang Lang Sand Resources

VALENZA ENGINEERING

Appendix B

Observation bore logs

ENVIRONMENTAL WELL MW01

Valenza Engineering

PROJECT NUMBER 305	**DRILLING COMPANY** Star Drilling Pty Ltd	**COORDINATES** E: 376296; N: 5757930
PROJECT NAME Proposed Sand Quarry	**DRILLER** Mr J. Thomas	**COORD SYS** GDA 94
CLIENT Lang Lang Sand Resources Pty. Ltd.	**DRILL RIG** SDR10	**SURFACE ELEVATION** 14.90 (mAHD)
ADDRESS 5575 Sth Gippsland Hwy, Lang Lang	**DRILLING METHOD** Hollow Auger	**WELL TOC** 15.49 (mAHD)
DRILLING DATE 20/11/2020	**TOTAL DEPTH** 10 m	**LOGGED BY** J. O'Connor-Cooney
LICENCE NO. WLE079258	**DIAMETER** 125 mm	**CHECKED BY** A. Valenza

COMPLETION 0.84 m stick up with monument

CASING 50 mm Class 18 uPVC

SCREEN 3 m x 1 mm at 6 mm interval, machine slotted

COMMENTS Well installed with 3 m screen; 2m bento. grout; 5m of 8/16 graded sand

Depth (m)	Drilling Method	Water	Well Installation	Graphic Log	Material Description	Formation	Elevation (mAHD)
0	Hollow Auger	▽			TOP SOIL: Organic soil, very loose, dark grey to black.	Quaternary	
1					Sandy CLAY: Clay with some sand, moist, dark grey with yellow. High plasticity. Sand is white quartz sand, loosely packed, medium grained and poorly sorted.		
2							
3							
4					Clayey SAND: Sand with minor clay, wet. Sand is white quartz, loosely packed, medium grained and poorly sorted. High plasticity clay.		
5							
6							
7							
8							
9							
10					Termination Depth at 10.0 m SWL on 26/11/20 - 4.06 mbgl Note: Due to inclement weather conditions, drill cuttings and the depths were washed away prior to logging. Log is based upon advice provided by driller		
11							
12							
13							
14							

Disclaimer This bore log is intended for environmental not geotechnical purposes.

produced by ESlog.ESdat.net on 23 Dec 2020

ENVIRONMENTAL WELL MW02

PROJECT NUMBER 305	**DRILLING COMPANY** Star Drilling Pty Ltd	**COORDINATES** E: 377286; N: 5757352
PROJECT NAME Proposed Sand Quarry	**DRILLER** Mr J. Thomas	**COORD SYS** GDA 94
CLIENT Lang Lang Sand Resources Pty. Ltd.	**DRILL RIG** SDR10	**SURFACE ELEVATION** 25.26 (mAHD)
ADDRESS 5575 Sth Gippsland Hwy, Lang Lang	**DRILLING METHOD** Hollow Auger	**WELL TOC** 26.14 (mAHD)
DRILLING DATE 20/11/2020	**TOTAL DEPTH** 8 m	**LOGGED BY** J. O'Connor-Cooney
LICENCE NO. WLE079258	**DIAMETER** 125 mm	**CHECKED BY** A. Valenza
COMPLETION 0.85 m stick up with monument	**CASING** 50 mm Class 18 uPVC	**SCREEN** 3 m x 1 mm at 6 mm interval, machine slotted

COMMENTS Well installed with 3 m screen; 2m bento. grout; 5m of 8/16 graded sand.

Depth (m)	Drilling Method	Water	Well Installation	Graphic Log	Material Description	Formation	Elevation (m)
0	Hollow Auger				TOP SOIL: Organic soil, very loose, dark grey to black.	Quaternary	
1					Sandy CLAY: Moist, dark grey and brown. High plasticity.		
2							
3		▽			Sandy CLAY: Clay with some sand, moist, dark grey with yellow mottling. High plasticity. Sand is white quartz sand, loosely packed, medium grained and poorly sorted.		
4							
5					Clayey SAND: Sand with minor clay, wet and becoming saturated with depth. Sand is white quartz, loosely packed, medium grained and poorly sorted. High plasticity clay.		
6							
7							
8					Sandy CLAY: Clay with minor sand, saturated, grey to black. High plasticity. Sand is white quartz sand, medium grained.		
9					Termination Depth at 8.0 m First Water Strike 4.6m SWL on 26/11/20 - 3.30 mbgl		
10							
11							
12							
13							
14							

Disclaimer This bore log is intended for environmental not geotechnical purposes.

produced by ESlog.ESdat.net on 23 Dec 2020

ENVIRONMENTAL WELL MW03

Valenza Engineering

PROJECT NUMBER 305	**DRILLING COMPANY** Star Drilling Pty Ltd	**COORDINATES** E: 377746; N: 5756505
PROJECT NAME Proposed Sand Quarry	**DRILLER** Mr J. Thomas	**COORD SYS** GDA 94
CLIENT Lang Lang Sand Resources Pty. Ltd.	**DRILL RIG** SDR10	**SURFACE ELEVATION** 28.69 (mAHD)
ADDRESS 5575 Sth Gippsland Hwy, Lang Lang	**DRILLING METHOD** Hollow Auger	**WELL TOC** 29.48 (mAHD)
DRILLING DATE 19/11/2020	**TOTAL DEPTH** 8 m	**LOGGED BY** J. O'Connor-Cooney
LICENCE NO. WLE079258	**DIAMETER** 125 mm	**CHECKED BY** A. Valenza

COMPLETION 0.76 m stick up with monument

CASING 50 mm Class 18 uPVC

SCREEN 3 m x 1 mm at 6 mm interval, machine slotted

COMMENTS Well installed with 3 m screen; 2m bento. grout; 5m of 8/16 graded sand.

Depth (m)	Drilling Method	Water	Well Installation	Graphic Log	Material Description	Formation	Elevation (mAHD)
0	Hollow Auger				TOP SOIL: Clay with organics, moist, dark brown with some yellow mottling. High plasticity.	Quaternary	
1					CLAY: Moist, dark grey with some yellow mottling. High plasticity.		
2					Sandy CLAY: Clay with some sand, moist, dark grey to black with yellow mottling. High plasticity. Sand is white quartz sand, loosely packed, medium grained sand and poorly sorted.		
3		▽			Clayey SAND: Sand with some clay, moist become wetter with depth. Sand is white quartz, loosely packed, medium grained and poorly sorted. High plasticity clay, material becoming more yellow with depth.		
4							
5					Clayey SAND: Sand with some clay, moist becoming saturated with depth, water strike at 6m, light grey. High plasticity.		
6							
7					Sandy CLAY: Clay with very minor sands, saturated, dark grey to black. High plasticity. Sand is white quartz, medium grained and poorly sorted.		
8					Termination Depth at 8.0 m First Water Strike 6m SWL on 26/11/20 - 3.17 mbgl		
9							
10							
11							
12							
13							
14							

Disclaimer This bore log is intended for environmental not geotechnical purposes.

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ENVIRONMENTAL WELL MW04

PROJECT NUMBER 305	**DRILLING COMPANY** Star Drilling Pty Ltd	**COORDINATES** E: 376820; N: 5756906
PROJECT NAME Proposed Sand Quarry	**DRILLER** Mr J. Thomas	**COORD SYS** GDA 94
CLIENT Lang Lang Sand Resources Pty. Ltd.	**DRILL RIG** SDR10	**SURFACE ELEVATION** 21.02 (mAHD)
ADDRESS 5575 Sth Gippsland Hwy, Lang Lang	**DRILLING METHOD** Hollow Auger	**WELL TOC** 21.76 (mAHD)
DRILLING DATE 19/11/2020	**TOTAL DEPTH** 10 m	**LOGGED BY** J. O'Connor-Cooney
LICENCE NO. WLE079258	**DIAMETER** 125 mm	**CHECKED BY** A. Valenza
COMPLETION 0.73 m stick up with monument	**CASING** 50 mm Class 18 uPVC	**SCREEN** 3 m x 1 mm at 6 mm interval, machine slotted

COMMENTS Well installed with 3 m screen; 2m bento. grout; 7m of 8/16 graded sand, including backfill.

Depth (m)	Drilling Method	Water	Well Installation	Graphic Log	Material Description	Formation	Elevation (mAHD)
0	Hollow Auger				TOP SOIL: Clay with organics, moist, dark brown with some yellow mottling. High plasticity.	Quaternary	
1					CLAY: Moist, mustard yellow. High plasticity.		
2					Sandy CLAY: Clay with some sand, moist becoming saturated at about 3m, mustard yellow. High plasticity. Sand is yellow/white quartz sand, loosely packed, fine to medium grained and poorly sorted.		
3							
4							
5					Clayey SAND: Sand with some clay, saturated. Sand is yellow/white quartz, loosely packed, fine to medium grained and poorly sorted. High plasticity clay, mustard yellow.		
6							
7							
8					Sandy CLAY: Clay with very minor sands, saturated, dark grey to black. High plasticity. Driller noted that ground became firmer at 8m.		
9							
10					Termination Depth at 10.0 m Sand backfill to 8m above clay layer First Water Strike 3m SWL on 26/11/20 - 0.68 mbgl		
11							
12							
13							
14							

produced by ESlog.ESdat.net on 23 Dec 2020

Appendix C

Valenza Engineering Pumping test memorandum (26 September 2019)

Valenza Engineering Pty Ltd
ABN 81 147 114 743

info@valenza-engineering.com
www.valenza-engineering.com

MEMORANDUM

Date: 26th of September 2019
Ref: 305_02
From: Sanjeeva Manamperi
To: John Nolan, Nolan Consulting
Subject: **Aquifer Test Summary- ACM Quarry Site, Lang Lang**

Dear John,

1. INTRODUCTION

This memorandum summarises the results of the step test and the constant rate pumping test carried out on the 19th of September 2019, at the proposed sand quarry site at 5575, South Gippsland Freeway, Lang Lang (VIC 3984). According to a database search conducted on the DELWP Water Management Information system (WMIS), there are three licensed groundwater bores at the site, namely WRK066223, WRK041821 and WRK041797 (see Figure 1, in attachment). The bore WRK066223 is currently used as the main water supply for the dairy farm. Pumping test was conducted using WRK066223 (as pumping bore) and WRK041821 (as observation bore) which is located 70m north of the pumping bore (see Figure A-1, Appendix A). The details of the test bores are presented in Table 1. Both of these bores are screened in Western Port Group.

Table 1 Details of Pumping and Observation Bore

Bore ID	Easting MGA Z55	Northing MGA Z55	Bore Depth (in m BGL)	Screen from – to (in m BGL*)	Casing diameter (in mm)
WRK066223	376674	5757424	37.4	31.4-37.4	150
WRK041821	376653	5757484	39.8	21-39	200

* Screen geometry from WMIS

2. METHODOLOGY

The step test and constant rate pumping tests were completed by AGMEK (specialist pumping test contractor) under Valenza Engineering Senior Hydrogeologist's supervision. Due to access restrictions to the irrigation bore WRK041821 fitted (with a 200mm PVC casing), the test was conducted on the dairy bore, fitted with a smaller casing diameter (150mm). Whilst preventing the use of a high capacity pump, the tests were completed successfully and provide a reasonable estimate of the aquifer parameters for the Western Port Group aquifer.

The pumping bore, which is used as the 24-hour water supply bore for the diary operation, was turned off the day prior to the test to allow for full aquifer recovery. It is understood that the yield obtained with the surface pump installed at the bore is about 1.5 L/s. For the duration of the test, the surface pump was dismantled, and a 4" pump was installed at a depth of 34.6 mBGL. Discharge of the pumped water was made to a nearby drain. The standing water levels were measured (pumping bore: 8.5mbtoc; Observation Bore: 5.81mbtoc) prior to the test, and two water levels loggers were installed in the pumping bore (WRK066223) and observation bore (WRK041821). A barometric logger was used for barometric compensation of the level.

A four-stage step test was initiated from 9.00am to 10.30 am to identify the suitable yield for the constant rate test. The 4" pump was set to its maximum yield of 6.1 L/s. The last step was continued for four hours, maintaining a constant pumping rate of 6.1 L/s from 10.30 am to 2.30 pm. Th recovery of the level was recorded from 2:30 pm to 4:00pm. The step duration and the recovery are presented in Table 2.

Table 2 Pumping Test Summary

Bore Hole Number	Testing date and total duration (hr: min)	Duration (min)	Pumping rate (L/sec)
WRK066223 (Pumping Bore) and WRK041821 (Observation Bore)	19/09/2019; 09:10 – 09:30	Step Test: 20 minutes	1.1
	19/09/2019; 09:30 – 09:50	Step Test: 20 minutes	2.1
	19/09/2019; 09:50 – 10:30	Step test: 40 minutes	4.2
	19/09/2019; 10:30 – 14:30	Constant Rate: 4 hours	6.1
	19/09/2019; 14:30 – 16:10	Recovery: 100 minutes	N/A

The results of the step test and constant rate pumping test are provided in Table 3.

3. RESULTS

3.1. AQUIFER TYPE

Based on the analysis of derivatives of drawdown curves, the aquifer type is unconfined. This approach is consistent with the available drill logs (resource drilling) reviewed and considering that the intermediate clayey layer is estimated as partially permeable, due to its sand and silt content. Three analytical solutions were selected for unconfined aquifer conditions (Theis;1935, Neuman;1974, and Moench;1997)) and one solution was for leaky confined aquifer condition (Hantush Jacob;1955).

3.2. STEP TEST

Based on the performance of the step test, it was decided to conduct the constant rate pumping test by continuing the final step test at the maximum pump capacity of 6.1 L/sec. Aquifer test analysis was conducted in Aqtesolv, an aquifer test analysis software.

The results from the four-stage step tests are presented in Figure 1. The step test results were analysed using Hantush Jacob (1955) method (Step Test) for a leaky confined aquifer. The analytical results show a slightly higher storativity values for a leaky confined aquifer solution when compared with unconfined aquifer solutions. The results derived from step results are summarized in Table 3.

Stabilisation of groundwater levels observed after 3-5 minutes of pumping for each step at 1.1 L/s, 2.1 L/s, 4.2 L/s, and 6.1 L/s.

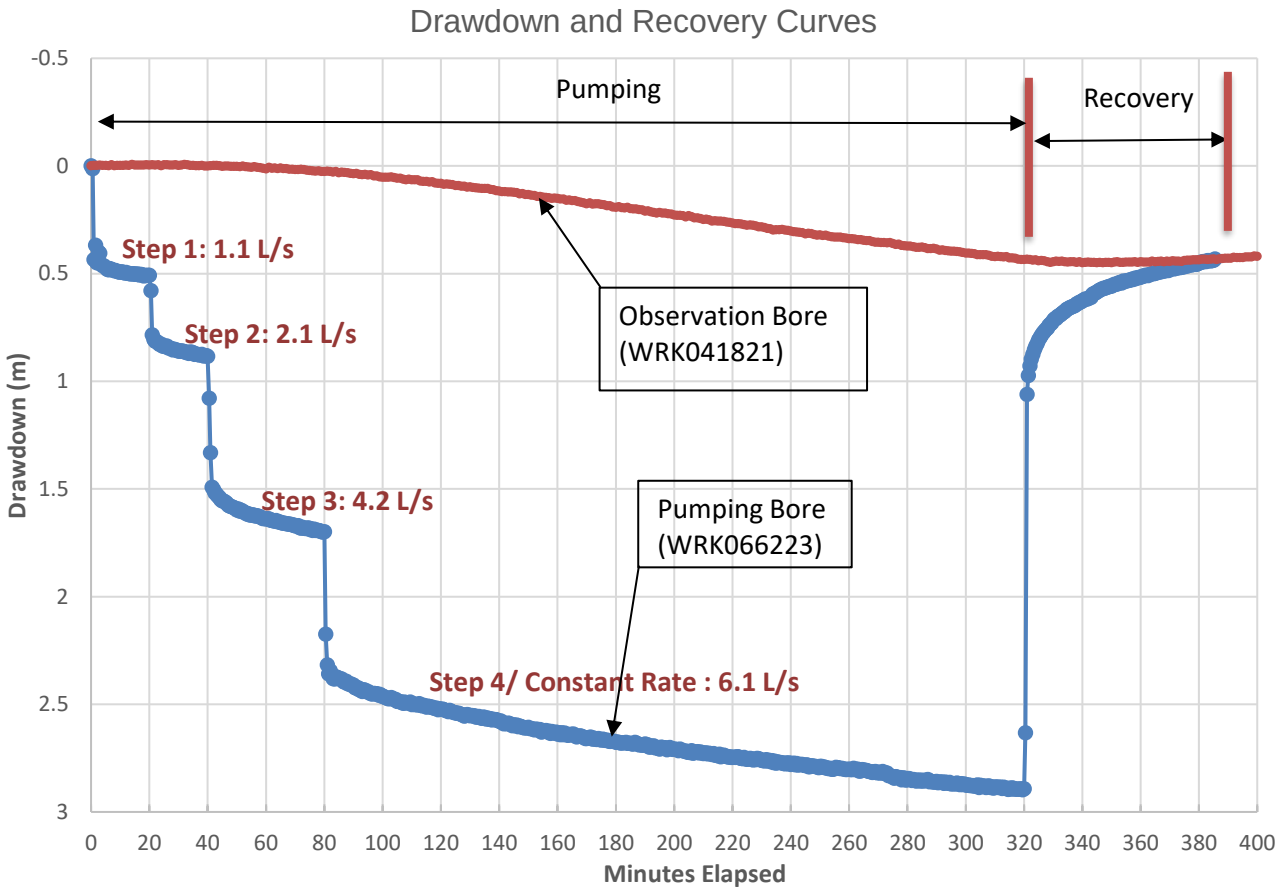


Figure 1 Drawdown and Recovery Curves – Pumping Bore

3.3. CONSTANT RATE

The analysis of the drawdown and recovery data provide an estimate of the transmissivity (T) and storativity (S) of the UTAF aquifer in the vicinity of the pumping bore (WRK066223). Constant rate displacement and recovery data was analysed with the Theis (1935), Neuman (1974), and Moench (1997) methods for unconfined aquifers. All analytical results are summarised in Table 3, and compiled in Appendix A.

Groundwater level chart showing the groundwater levels for the pumping bore (WRK066223) and the observation bore (WRK041821) are presented in Figure 1. The drawdown observed at the pumping bore is about 3 m, over the 320 minutes test period. Drawdown at the observation bore is about 0.45m, 340 minutes after the start of the test.

The recovery of the constant rate test at the end of the pumping period was achieved at 50% after 90 seconds, 75% after 10 minutes and 85% within 60 minutes. Recording was ceased before full recovery.

Table 3 Summary of the Pumping Test Results

BORE ID	Test type	Aquifer type	Test Solution	K (m/day)	T (m^2/day)	S
WRK066223 (Pumping Bore) WRK041821 (Obs Bore)	Constant rate pumping: Analysis based on observation bore drawdown and recovery data	Unconfined	Theis	2.08	83.8	5.5E-03
			Neuman	4.4	77.6	5.5E-03
			Moench	2.48	99.4	6.1E-03
WRK066223 (Pumping Bore only)	Step test: pumping & recovery	Leaky confined	Hantush-Jacob	3.07	122.7	2.13E-01
			Maximum	4.4	122.7	2.13E-01
			Minimum	2.48	77.6	6.1E-03
			Geometric Mean	3.0	95.9	5.7E-02

4. DISCUSSION

The transmissivity value obtained ranged between 77.6 and 122.7 m^2/day (with a geometric mean of 95 .9 m^2/day). This value is consistent with the previously derived values (by Valenza Engineering) for nearby sand quarry located approximately 6km north of the site. However, the T value is one to two orders of magnitude higher than the values derived for the nearest quarry site, located 2kms east of the subject site.

The storativity value derived from the test ranges between 0.21 and 0.0061 (with a geometric mean of 0.057). This is significantly lower than the values derived for nearby sites, possibly due to existence of relatively thick clay rich layer promoting semi-confined conditions.

The Transmissivity derived from the observation bore only is about 83.8 m^2/day, which is aligned with the geometric mean of 95 .9 m^2/day.

Please contact me, should you require additional information or further clarification regarding this memorandum.

Yours sincerely

Dr. Sanjeeva Manamperi
Senior Water Resources Engineer
Tel: +61 (0) 425 619 355
Email: sanjeeva@valenza-engineering.com
Office: 101/620 Collins Street, Melbourne, VIC 3000

Incl: Attachment A, Pumping Test Results

Attachment A
Pumping Test Results

Legend:

Site outline

Alexis Surveyed Bores

ADVERTISED PLAN

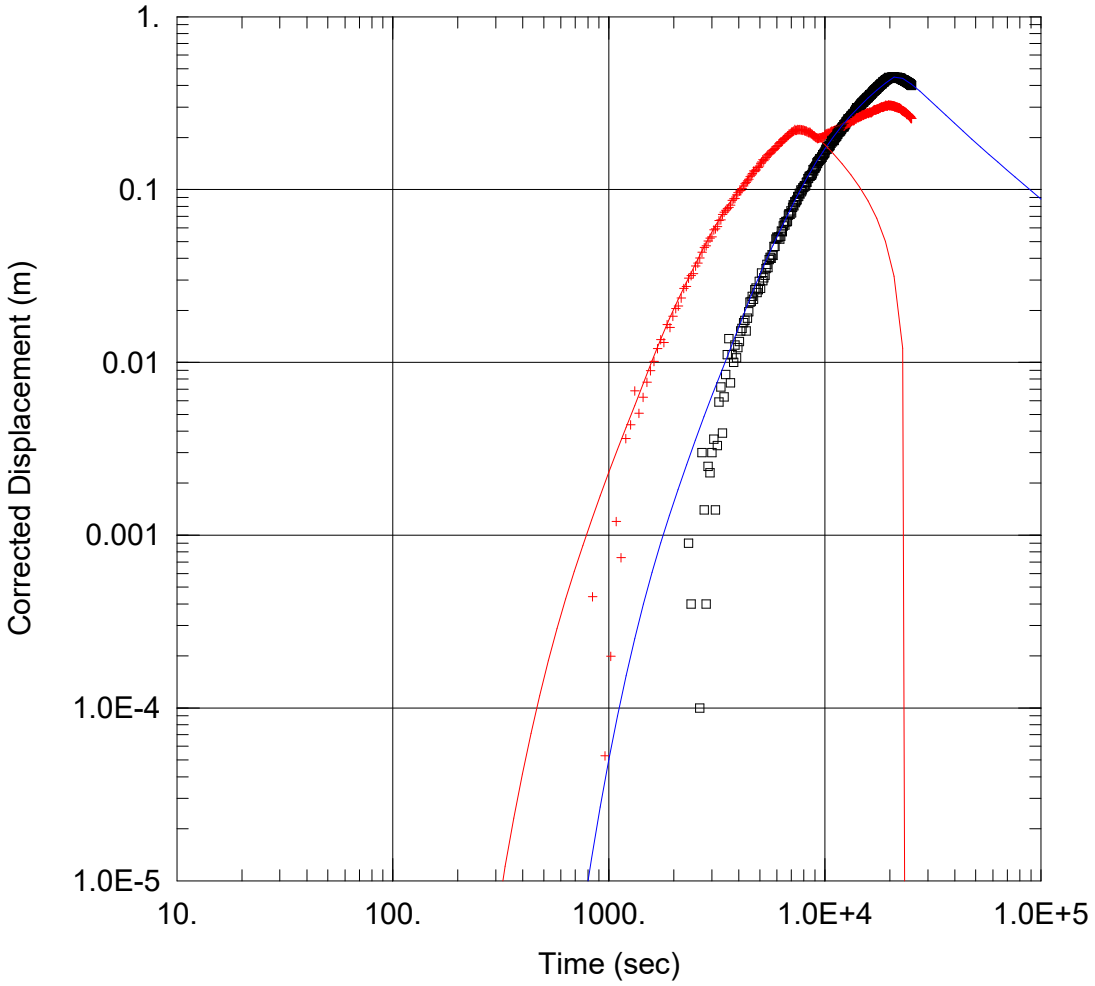
0 100 200 300 m

Drawn: JOC, 14/10/2019
Checked: AV, 14/10/2019
Project: 305
Doc No: 01

References:
Google Maps
Coordinate System: GDA 1994 MGA Zone 55

Valenza Engineering Pty Ltd
Melbourne, Victoria

FIGURE 1: 5575 Sth Gippsland Hwy - Sighted Bores vs WMIS registered Bores



ACM- AQUIFER TEST ANALYSIS

Data Set: W:\...\Test1.aqt
Date: 09/20/19 Time: 13:11:46

PROJECT INFORMATION

Company: Valenza Engineering
Client: Nolan Consulting
Project: 305
Location: ACM- Lang Lang
Test Well: WRK066223
Test Date: 19/09/2019

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
WRK041821	376674	5757424

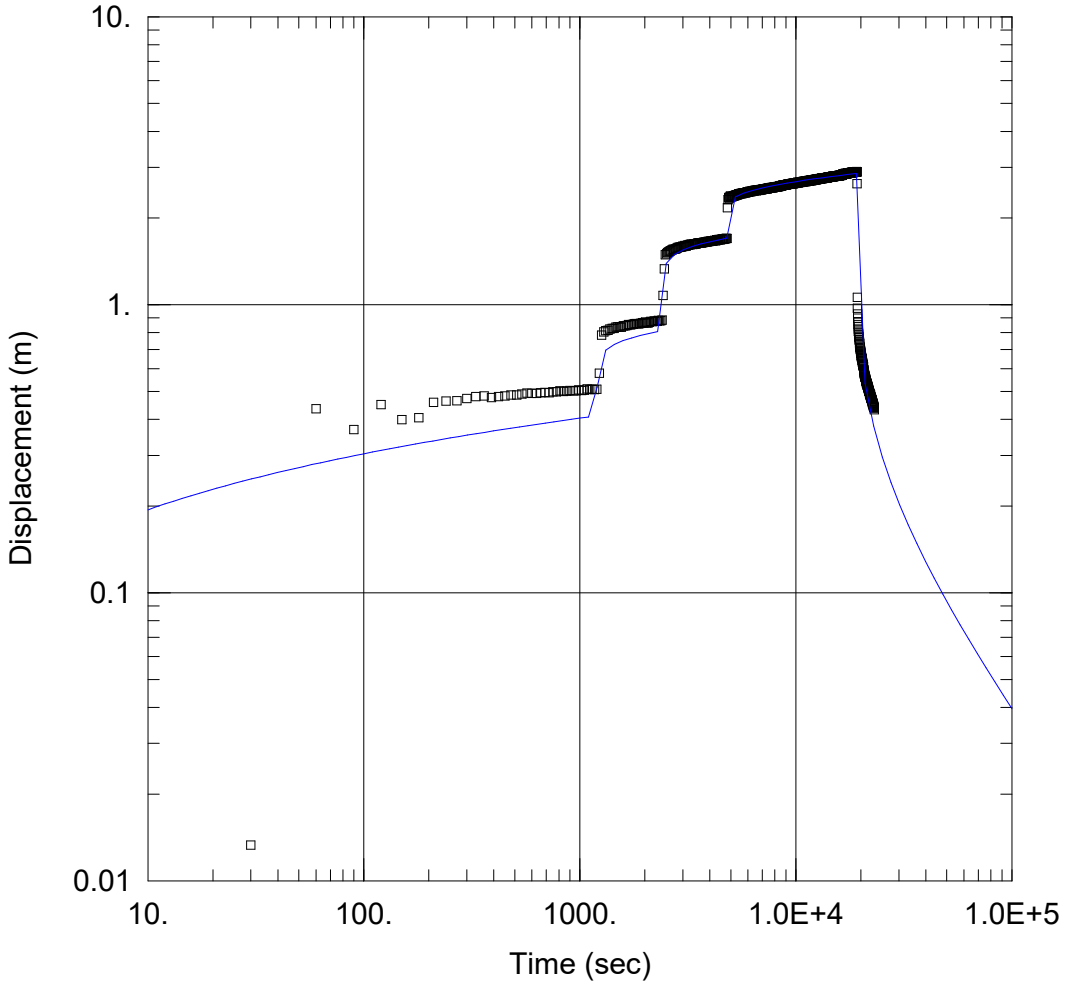
Observation Wells

Well Name	X (m)	Y (m)
▫ WRK041821	376653	5757484

SOLUTION

Aquifer Model: Unconfined
Solution Method: Theis

T = 83.72 m^2/day
S = 0.0055
Kz/Kr = 0.0955
b = 40. m



ACM- AQUIFER TEST ANALYSIS

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Date: 09/20/19 Time: 13:42:18

PROJECT INFORMATION

Company: Valenza Engineering
Client: Nolan Consulting
Project: 305
Location: ACM- Lang Lang
Test Well: WRK066223
Test Date: 19/09/2019

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
WRK066223	376674	5757424

Observation Wells

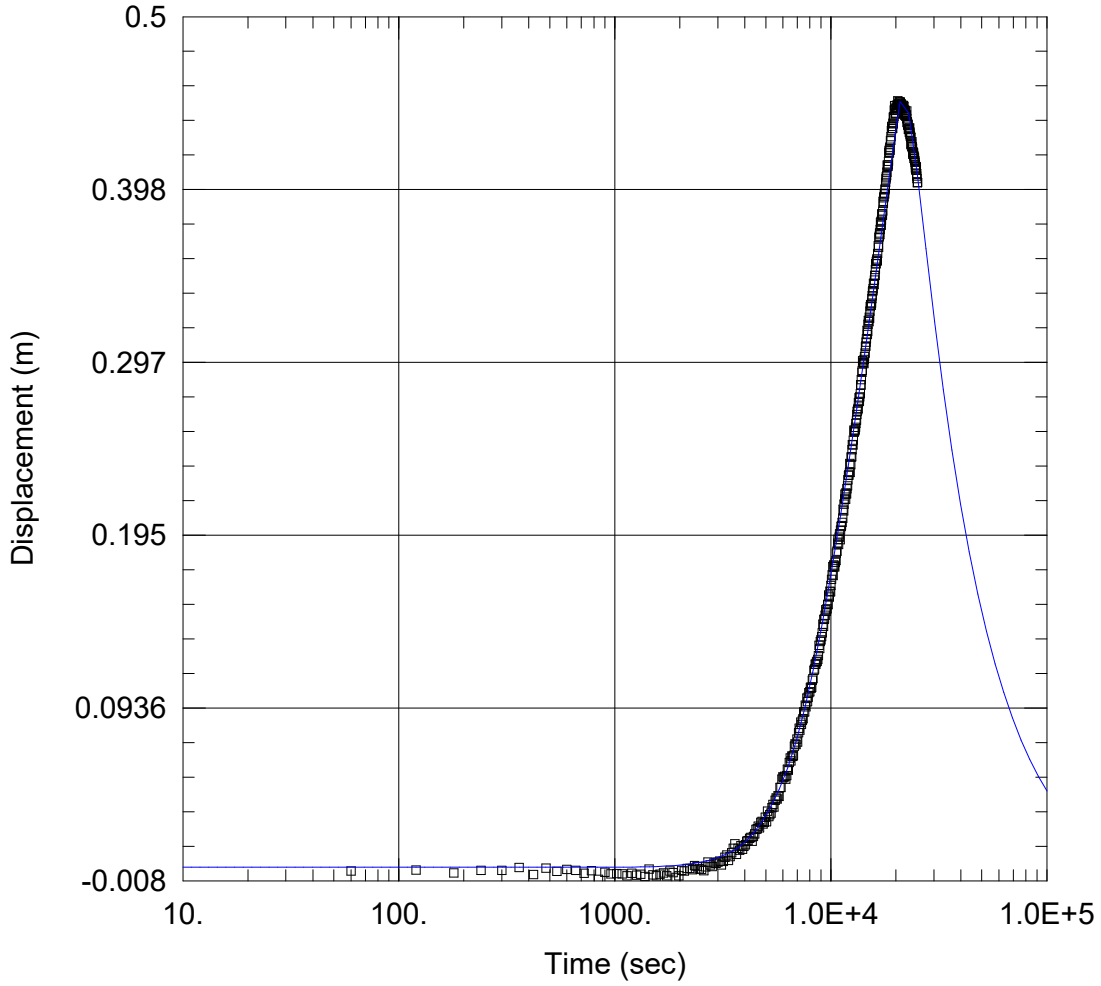
Well Name	X (m)	Y (m)
▫ WRK066223	376674	5757424

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush

T = 122.7 m^2/day
ß = 0.1209
b = 40. m

S = 0.2127
Kz/Kr = 2.844



ACM- AQUIFER TEST ANALYSIS

Data Set: W:\...\Test1.aqt
Date: 09/20/19 Time: 13:58:03

PROJECT INFORMATION

Company: Valenza Engineering
Client: Nolan Consulting
Project: 305
Location: ACM- Lang Lang
Test Well: WRK066223
Test Date: 19/09/2019

AQUIFER DATA

Saturated Thickness: 40. m

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
WRK041821	376674	5757424

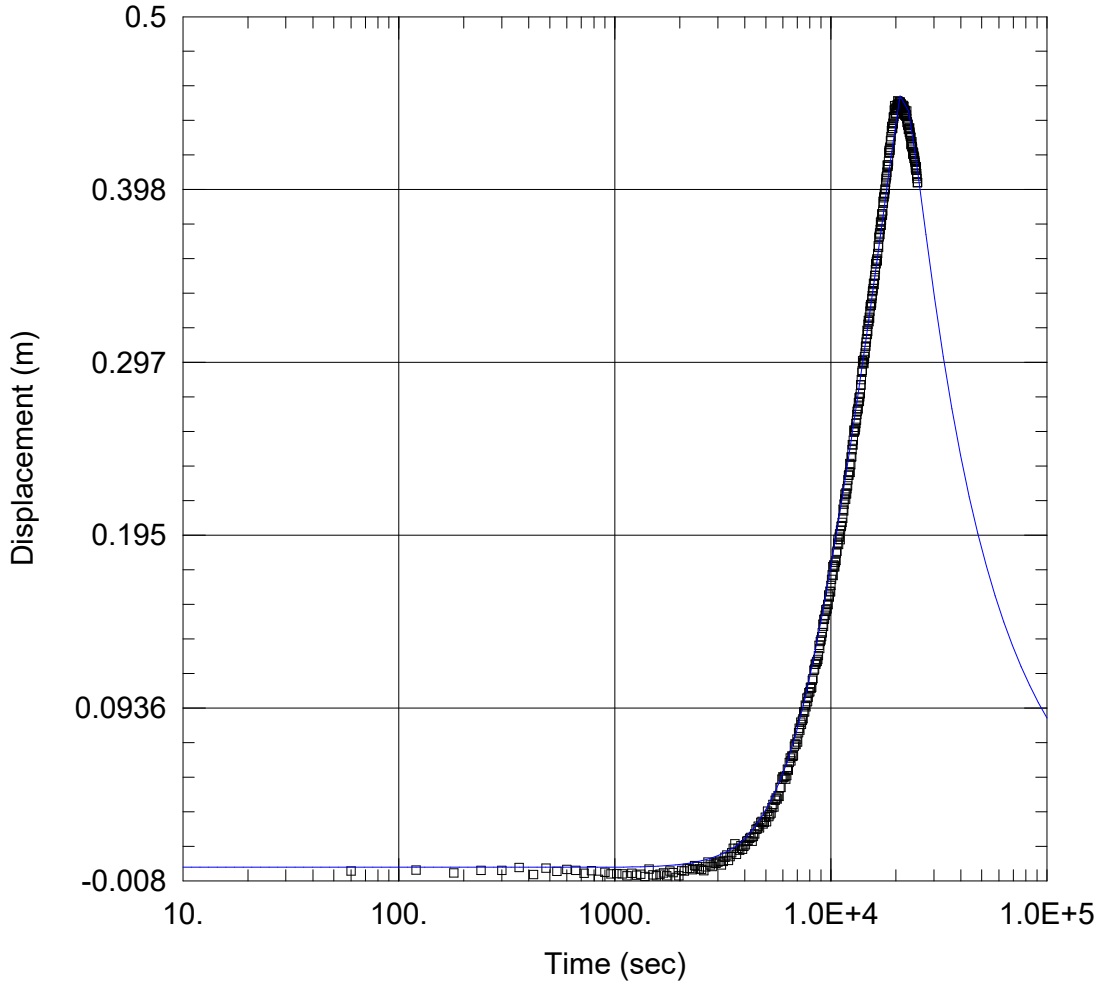
Observation Wells

Well Name	X (m)	Y (m)
▫ WRK041821	376653	5757484

SOLUTION

Aquifer Model: Unconfined
Solution Method: Neuman

T = 77.55 m^2/day
Sy = 0.5
S = 0.005524
ß = 0.09416



ACM- AQUIFER TEST ANALYSIS

Data Set: W:\...\Test1.aqt
Date: 09/20/19 Time: 14:02:08

PROJECT INFORMATION

Company: Valenza Engineering
Client: Nolan Consulting
Project: 305
Location: ACM- Lang Lang
Test Well: WRK066223
Test Date: 19/09/2019

AQUIFER DATA

Saturated Thickness: 40. m Anisotropy Ratio (Kz/Kr): 3.959E-6

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
WRK041821	376674	5757424

Observation Wells

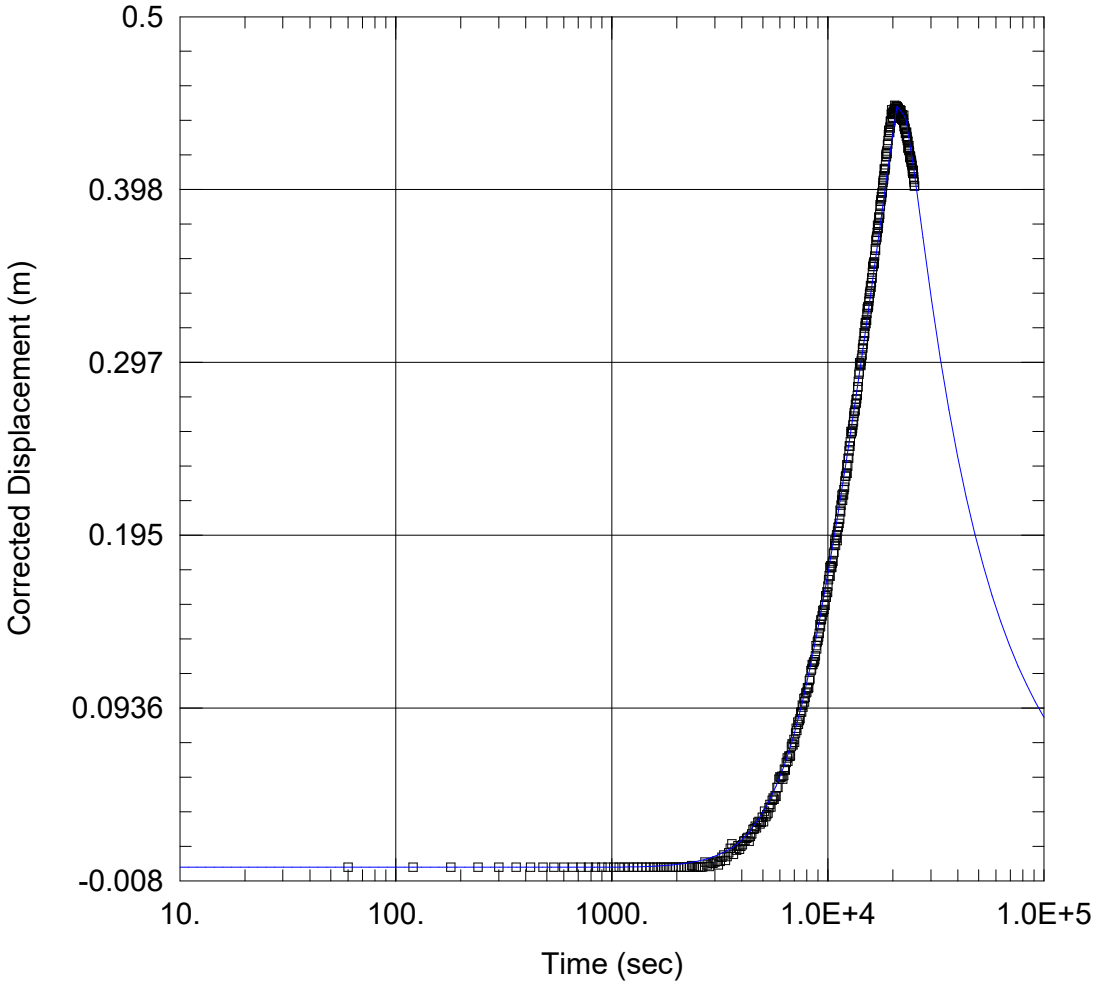
Well Name	X (m)	Y (m)
▫ WRK041821	376653	5757484

SOLUTION

Aquifer Model: Unconfined Solution Method: Moench

T = 99.39 m^2/day
Sy = 0.001
Sw = 0.
r(c) = 0.0625 m

S = 0.00611
ß = 1.0E-5
r(w) = 0.075 m
alpha = 1.0E+30 sec^{-1}



ACM- AQUIFER TEST ANALYSIS

Data Set: W:\...\Test1.aqt
Date: 09/20/19 Time: 13:53:03

PROJECT INFORMATION

Company: Valenza Engineering
Client: Nolan Consulting
Project: 305
Location: ACM- Lang Lang
Test Well: WRK066223
Test Date: 19/09/2019

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
WRK041821	376674	5757424

Observation Wells

Well Name	X (m)	Y (m)
▫ WRK041821	376653	5757484

SOLUTION

Aquifer Model: Unconfined
Solution Method: Theis

T = 83.72 m^2/day
S = 0.0055
Kz/Kr = 0.0955
b = 40. m

Appendix D

Groundwater take and use licence

Entitlement ID:
BEE077726

Printed on: 09 Mar 2021 9:15:10 am

COPY OF RECORD IN THE VICTORIAN WATER REGISTER

TAKE AND USE LICENCE

under Section 51 of the Water Act 1989

The information in this copy of record is as recorded at the time of printing. Current information should be obtained by a search of the register. The State of Victoria does not warrant the accuracy or completeness of this information and accepts no responsibility for any subsequent release, publication or reproduction of this information.

This licence does not remove the need to apply for any authorisation or permission necessary under any other Act of Parliament with respect to anything authorised by the take and use licence.

Water used under this entitlement is not fit for any use that may involve human consumption, directly or indirectly, without first being properly treated.

The Authority does not guarantee, by the granting of the licence, that the licensee will obtain any specific quantity or quality of water. The Authority is not liable for any loss or damage suffered by the licensee as a result of the quantity of water being insufficient or the quality of the water being unsuitable for use by the licensee at any particular time or for any particular purpose.

This take and use licence entitles its holders to take and use water as set out under the licence description, subject to the conditions that are specified.

Licence Holder(s)

LANG LANG SAND RESOURCES PTY LTD of SUITE 2
LEVEL 1
20 ENGLISH STREET ESSENDON FIELDS VIC 3041

Licence Contact Details

LANG LANG SAND RESOURCES PTY LTD	SUITE 2 LEVEL 1 20 ENGLISH STREET ESSENDON FIELDS VIC 3041

Licence Description

Expiry date	30 Jun 2035
Status	Active
Authority	Southern Rural Water
Name of waterway, aquifer or works	UNC-Koo Wee Rup
Water system type	Groundwater (Westernport catchment)
River basin or groundwater unit	Koo Wee Rup (GMU)
Licence volume	261.9 megalitres
Licence volume adjusted for temporary trade	261.9 megalitres
Method of taking	Direct extraction from Groundwater
Period during which water can be taken	01 Jul - 30 Jun inclusive

Use of water	Industrial or commercial use - as well as domestic and stock use
Trading Zone	Koo Wee Rup 7 QA

Licence Volume Details

Licence volume	261.9 megalitres
Licence volume adjusted for temporary trade	261.9 megalitres

Temporary volume transaction details

Approval date	*Volume traded (ML)*	*Expiry date*
Nil		

Extraction Point Details

Easting	*Northing*	*Zone MGA*	*Location description*
376650	5757490	Zone 55	WRK125327
376657	5757487	Zone 55	WRK041821

Land on which the Water is to be Used

Land description

Volume 8916 Folio 752
Lot 1 of Plan LP091815

Volume 10257 Folio 300
Lot 2 of Plan PS312674E

Volume 10257 Folio 299
Lot 1 of Plan PS312674E

Volume 10613 Folio 500
Lot 1 of Plan TP023467H

Property address

5575 SOUTH GIPPSLAND HIGHWAY, LANG LANG, VIC 3984

Related Instruments

Related entitlements	Nil
Related works licences	WLE038316
Other related entities	Nil

Application History

Reference	*Type*	*Status*	*Lodged date*	*Approved date*	*Recorded date*
BER048759	Modify	Approved	09 Mar 2021	09 Mar 2021	
BEX004261	Subdivide or amalgamate	Approved	04 Mar 2021	04 Mar 2021	

Conditions

This take and use licence is subject to the following conditions:

Method of taking

1 Water may only be taken under this licence if it is taken by the method specified in this licence.

2 The licence holder must at all times provide the Authority with safe access to inspect all works and appliances used to take water under this licence.

Take location

3 Water may only be taken under this licence if it is taken at the location specified in the licence under "extraction point details".

Take volume and rate

4 The volume of water taken under this licence in any twelve-month period from 1 July to 30 June must not exceed the licence volume, less any volume that has been temporarily transferred to another person or location.

5 The maximum volume that may be taken under this licence in any one day is 5.00 megalitres per day.

Temporary transfers to the licence holder

6 If there has been a temporary transfer of another licence to take water at the location, and use water on the land, specified in this licence:

a) the extra volume of water taken must not exceed the volume transferred, and

b) all the conditions of this licence apply to the taking and using of water consequential to the transfer.

Water allocations

7 The Authority may determine water allocations at 1 July or during the course of the subsequent twelve-month period that are less than 100% of the licence volume, in which case the licence volume is correspondingly reduced for that twelve-month period.

Take period

8 Unless otherwise directed by the Authority, water may be taken at any time between 1 July and 30 June.

Rosters and restrictions

9 When directed by the Authority, water must be taken in accordance with the rosters and restrictions determined by the Authority, and advised to the licence holder.

Metering of water taken and used

10 Water may only be taken under this licence if it is taken through a meter approved by the Authority.

11 Meters must be installed, in accordance with the specifications set by the Authority, at the licence holder's expense.

12 Meters used for the purpose of this licence are deemed to be the property of the Authority.

13 The licence holder must at all times provide the Authority with safe access to meters for the purpose of reading, calibration or maintenance.

14 The licence holder must notify the Authority within one business day if the meter ceases to function or operate properly.

15 The licence holder must, if required by the Authority, keep an accurate record of the quantity of water taken under this licence and allow the Authority to inspect this record at all reasonable times, and provide a copy of the record when requested.

16 The licence holder must not, without the consent of the Authority, interfere with, disconnect or remove any meter used for the purposes of the licence.

17 The Authority may, if it deems necessary, make an estimate of the total volume of water taken

under this licence.

Use of water

18 Water taken under this licence may only be used on the land, and for the purposes, specified in the licence.

19 The licence holder must at all times provide the Authority with safe access to inspect the land on which water is licensed to be used.

Managing drainage disposal

20 Where water use results in drainage from the land specified in the licence, that drainage water must be disposed in ways that meet with the standards, terms and conditions adopted from time to time by the Authority.

Particular conditions

21 The licence holder must undertake monitoring of groundwater levels and water quality around the site perimeter and report on this annually.

22 The licence holder must submit the report to SRW by 30 September each year.

Fees and charges

23 The licence holder must, when requested by the Authority, pay all fees, costs and other charges under the Water Act 1989 in respect of this licence.

END OF COPY OF RECORD

Works Licence ID:

WLE038316

Printed on: 09 Mar 2021 9:15:10 am

COPY OF RECORD IN THE VICTORIAN WATER REGISTER

LICENCE TO OPERATE WORKS

under Section 67 of the Water Act 1989

The information in this copy of record is as recorded at the time of printing. Current information should be obtained by a search of the register. The State of Victoria does not warrant the accuracy or completeness of this information and accepts no responsibility for any subsequent release, publication or reproduction of this information.

This licence does not remove the need to apply for any authorisation or permission necessary under any other Act of Parliament with respect to anything authorised by the works licence.

Water used under this licence is not fit for any use that may involve human consumption, directly or indirectly, without first being properly treated.

This licence is not to be interpreted as an endorsement of the design and/or construction of any works (including dams). The Authority does not accept any responsibility or liability for any suits or actions arising from injury, loss, damage or death to person or property which may arise from the maintenance, existence or use of the works.

Each person named as a licence holder is responsible for ensuring all the conditions of this licence are complied with.

This licence authorises its holders to operate the described works, subject to the conditions.

Licence Holder(s)

LANG LANG SAND RESOURCES PTY LTD of SUITE 2
LEVEL 1
20 ENGLISH STREET ESSENDON FIELDS VIC 3041

Licence Contact Details

LANG LANG SAND
RESOURCES PTY LTD

SUITE 2
LEVEL 1
20 ENGLISH STREET
ESSENDON FIELDS VIC 3041

Licence Details

Expiry date	30 Jun 2035
Status	Active
Authority	Southern Rural Water
Name of waterway or aquifer	UNC-Koo Wee Rup
Water system	Koo Wee Rup (GMU)

Summary of Licensed Works

The details in this section are a summary only. They are subject to the conditions specified in this licence.

Works ID	*Works type*	*Use of water*
WRK041821	Bore	Industrial or commercial
WRK125327	Bore	Industrial or commercial

Description of Licensed Works

WORKS ID WRK041821

Works type	Bore
Constructed depth	39.790 metres

Extraction Details

Service point/s	SP075496 KWR.74595
Maximum extraction rate	1.300 megalitres per day (The physical capacity of the works)
Maximum daily volume	0.450 megalitres (The volume authorised to be extracted via the works)
Maximum annual volume	60.000 megalitres
Use of water	Industrial or commercial use - as well as domestic and stock use

Works location

Easting	*Northing*	*Zone MGA*
376657	5757487	Zone 55

Land description

Volume 10613 Folio 500
Lot 1 of Plan TP023467H

Property address

5575 SOUTH GIPPSLAND HIGHWAY, LANG LANG, VIC 3984

Description of Licensed Works

WORKS ID WRK125327

Works type	Bore
Works subtype	Dragline hole
Maximum depth	30.000 metres
Constructed depth	30.000 metres

Extraction Details

Service point/s	SP132623 WRK125327
Maximum extraction rate	5.000 megalitres per day (The physical capacity of the works)
Maximum daily volume	1.500 megalitres (The volume authorised to be extracted via the works)
Maximum annual volume	201.900 megalitres
Use of water	Industrial or commercial use - as well as domestic and stock use

Works location

Easting	*Northing*	*Zone MGA*
376649.412	5757489.332	Zone 55

Land description

Volume 10613 Folio 500
Lot 1 of Plan TP023467H

Property address

5575 SOUTH GIPPSLAND HIGHWAY, LANG LANG, VIC 3984

Related Instruments

Related entitlements BEE077726

Related water-use entities Nil

Application History

Reference	*Type*	*Status*	*Lodged date*	*Approved date*	*Recorded date*
WLV906521	Modify	Approved	04 Mar 2021	04 Mar 2021	
WLV712668	Modify	Approved	22 Dec 2020	22 Dec 2020	
WLR004204	Modify	Approved	16 Jun 2020	16 Jun 2020	
WLV704020	Modify	Approved	17 Mar 2017	17 Mar 2017	
WLV701648	Modify	Approved	02 Sep 2015	30 Nov 2015	
WLV037216	Modify	Approved	30 Nov 2011	02 Dec 2011	
WLI556725	Issue	Approved	29 Aug 2009	29 Aug 2009	

Conditions

Licence WLE038316 is subject to the following conditions:

Preventing pollution

1 Water must not be taken through the works if the Authority reasonably believes fuel, or lubricant, or any other matter used in connection with works and appliances associated with this licence, is at risk of contaminating a waterway, or aquifer, or the riparian or riverine environment.

2 The licence holder must construct and maintain bund walls around any hydrocarbon-fuel-driven engine, motor, fuel storage, or chemical storage used in connection with this licence, in accordance with the timeframe, specifications, guidelines and standards prescribed by the Authority.

Rosters and restrictions

3 When directed by the Authority, water must be taken in accordance with the rosters and restrictions determined by the Authority, and advised to the licence holder.

Metering of water taken and used

4 Water may only be taken under this licence if it is taken through a meter approved by the Authority.

5 Meters must be installed, in accordance with the specifications set by the Authority, at the licence holder's expense.

6 Meters used for the purpose of this licence are deemed to be the property of the Authority.

7 The licence holder must at all times provide the Authority with safe access to meters for the purpose of reading, calibration or maintenance.

8 The licence holder must notify the Authority within one business day if the meter ceases to function or operate properly.

9 The licence holder must, if required by the Authority, keep an accurate record of the quantity of water taken under this licence and allow the Authority to inspect this record at all reasonable times, and provide a copy of the record when requested.

10 The licence holder must not, without the consent of the Authority, interfere with, disconnect or remove any meter used for the purposes of the licence.

11 The Authority may, if it deems necessary, make an estimate of the total volume of water taken under this licence.

Protecting other water users

12 The licence holder must, if required by the Authority, monitor and record water levels in the bore(s) before and after pumping; the licence holder must also provide this information in writing as directed by the Authority.

13 The licence holder must, at the licence-holder’s expense, if required by the Authority, conduct a pumping test and obtain a hydrogeological report, to the Authority's specification, on the potential for bore operation to interfere with any bore, aquifer, groundwater dependent ecosystem or waterway.

14 The licence holder must, if required by the Authority, provide the Authority with the results of water quality tests on samples of water pumped from the bore.

15 The licence holder must provide the Authority with safe access to the licensed bore and works for the purposes of obtaining water level measurements, water samples and any other information or data pertaining to the operation of the bore, the works and the aquifer.

16 The licence holder must, if required by the Authority, cease taking water entirely, or cease taking water for a given period, or reduce the quantity of water taken during any period if, the Authority reasonably believes, or in accordance with the assessment in a Groundwater Management Plan, the use or disposal of water under this licence may injure or adversely affect any other person or an aquifer or the environment.

17 The licence holder must, if required by the Authority, enter into a formal agreement to supply

water to any party affected by interference from bore operation.

18 The bore(s) must not be altered or decommissioned without a works licence that authorises alteration, or decommissioning.

Operation and maintenance

19 Water may only be taken through the works at the specified location.

20 The licence holder must keep all works, appliances and dams associated with this licence, including outlet pipes and valves, in a safe and operable condition, and free from obstacles and vegetation that might hinder access to works.

21 Water may only be taken through the works if the works are sited, constructed, operated and maintained to the satisfaction of the Authority.

22 The licence holder must at all times provide the Authority with safe access to inspect all works and appliances used to take water under this licence.

Protecting biodiversity

23 Water must not be taken through the works if the Authority reasonably believes that the taking of water, through the works and appliances associated with this licence, is at risk of causing damage to the environment.

24 The licence holder must, if required by the Authority, remedy any damage to the environment that in the opinion of the Authority is a result of the installation, operation or maintenance of the works.

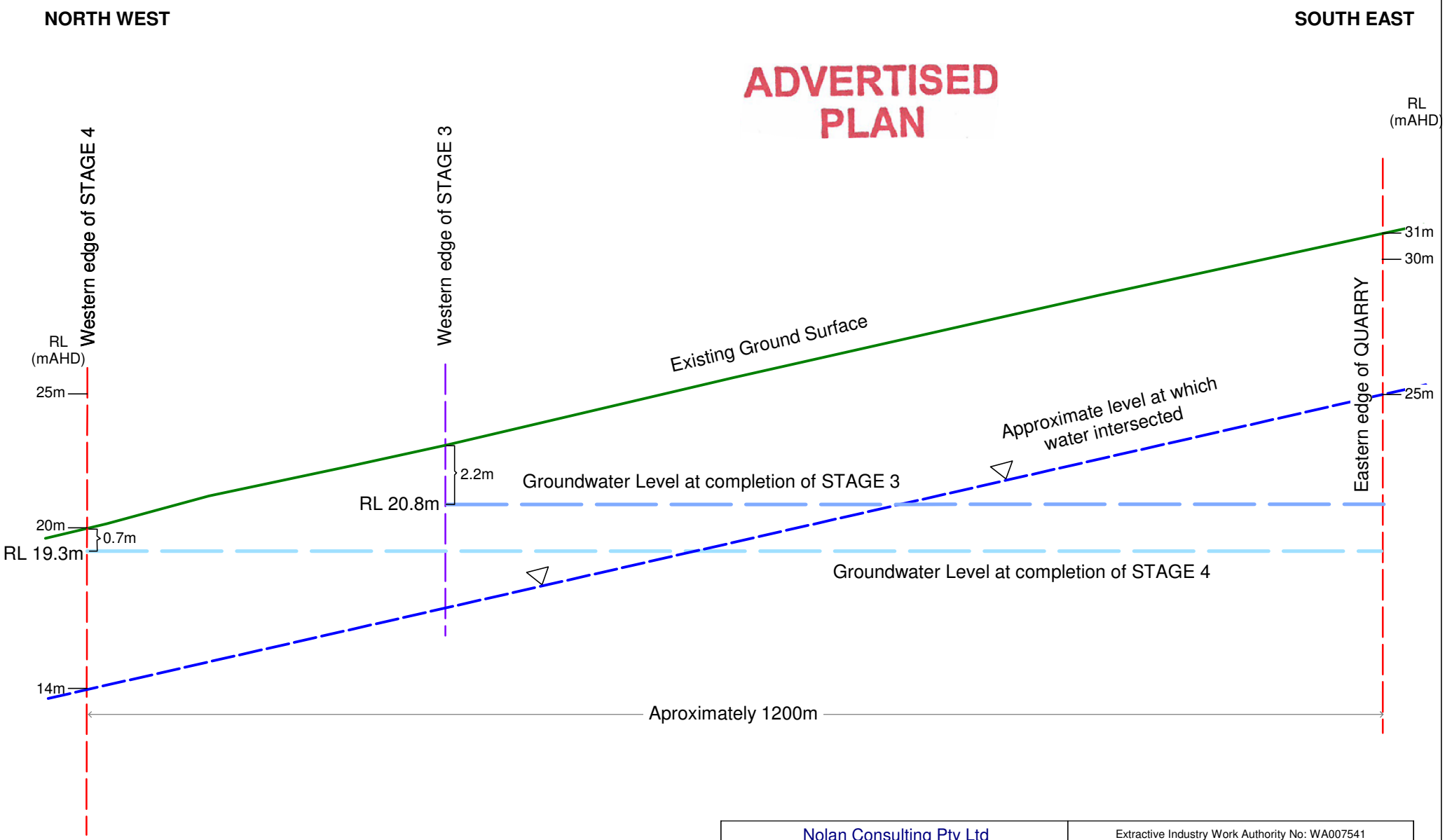
Fees and charges

25 The licence holder must, when requested by the Authority, pay all fees, costs and other charges under the Water Act 1989 in respect of this licence.

END OF COPY OF RECORD

Appendix E

Estimated mean groundwater level post closure



Note : Diagrammatic only
Approx. 1 Vertical : 27 Horizontal

Nolan Consulting Pty Ltd For **LANG LANG RESOURCES P/L**	Extractive Industry Work Authority No: WA007541 Lang Lang Sand Pit, LANG LANG **ESTIMATED MEAN GROUNDWATER LEVELS AT POST CLOSURE**
Drawing: BCA A4-2237 Revision: 0 Author: J.N. FigF.1_RegionalPlan_0223.WOR Date: 28/02/2023	LLSR Hydrogeological Report **Appendix : E**

Appendix F

Groundwater Management Plan

Nolan Consulting Pty Ltd

Hydrogeological assessment

Proposed Sand Quarry at 5575 South Gippsland Highway, Lang Lang - Work Plan PLN-001536

Appendix F – Groundwater Management Plan

Lang Lang Sand Resources Pty Ltd

February 2023

226-02

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1 Introduction

Lang Lang Sand Resources Pty Ltd (LLSR) proposes to establish a sand quarry within Work Authority 7541 (WA 007541). This land, at 5575 South Gippsland Highway, Lang Lang, is about 5 km south-east of Lang Lang township, 7 km west of Nyora and 80 km south-east of Melbourne (Figure F.1).

1.1 Background

Nolan Consulting has been engaged by LLSR to prepare this Groundwater Management Plan as Appendix F to the hydrogeological assessment report.

1.2 Key elements

This Groundwater Management Plan (GWMP):

- identifies monitoring sites and water quality parameters
- specifies monitoring methods, frequency and duration
- identifies triggers with actions/mitigation measures
- proposes review and reporting arrangements.

1.3 Definitions

For the purposes of this report the terms:

- "property" refers to the land owned by Geoffrey Pate and includes the work authority
- "site" refers to the land within the proposed extraction boundary (Stages 1 to 4)
- "in-pit water storage" refers to the Stage 1A1 pit which will be walled off from the rest of the pit. This storage will manage process water and turbid/acidic runoff before it is directed to the pit lake
- "pit lake" refers to the broader waterbody which occurs in all stages excluding Stage 1A1.

The property and site are shown in Figure F.2.

2 Monitoring sites and parameters

2.1 Sites

The monitoring sites are:

- groundwater observation bores
  - MW01, MW02, MW03 and MW04 (existing)
  - MW05 in the north-east – east of MW02 and north of MW03 (additional bore to be installed)
- water supply bores under Licence to Operate Works WLE038316
- surface waters
  - in-pit water storage (Stage 1A1)
  - pit lake
  - quarry pit sump (dry conditions)
- on-site rain gauge.

They are all on-site. The locations of the groundwater observation bore sites are shown in Figure F.3.

LLSR has advised it will install observation bore MW05 and formally commence the monitoring program prior to commencing extraction. Observation bore MW05 is to be drilled to a depth of between 20 m and 30 m below ground surface.

2.2 Parameters

2.2.1 Water level

All groundwater observation bores will be gauged for level. The in-pit water storage, pit lake and any quarry pit sump will be monitored for level.

Reduced water levels for the groundwater observation bores will be computed from depth to water from top of casing gauging information. Reduced water levels for the in-pit water storage, pit lake and any quarry pit sump will be surveyed.

2.2.2 Volumes

Pumping from the two licensed water supply bores, the inflow to the in-pit water storage, any inflows to the pit lake and any quarry pit sump will be metered for cumulative flow.

2.2.3 Water quality

The water quality of the monitoring sites will be tested in-situ and will be analysed by a NATA certified laboratory.

2.2.3.1 In-situ

All samples will be tested in-situ for:

- pH
- electrical conductivity
- dissolved oxygen
- redox
- temperature.

2.2.3.2 Laboratory

Groundwater samples will be analysed by a NATA certified laboratory for:

- pH
- bicarbonate alkalinity as $CaCO_3$,
- sulphate as SO_4
- total dissolved solids (salinity)
- major cations and anions
- nitrite (as N), nitrate (as N) and total kjeldahl nitrogen (as N)
- total phosphorus
- iron
- manganese
- turbidity.

Surface water samples will be analysed for the above parameters as well as dissolved oxygen and blue green algae.

Groundwater sampling will be conducted in accordance with the EPA (2022) "*Groundwater Sampling Guidelines*" and surface water sampling will be conducted in accordance with the EPA (2009) "*Sampling and Analysis of Waters, Wastewaters, Soils and Wastes*".

2.2.4 Rainfall

Daily rainfall will be recorded at an on-site rain gauge.

3 Monitoring

3.1 Water level

The water level will be monitored at all groundwater observation bores, water supply bores and the water storage.

3.2 Volumes

The volume of water pumped from the monitoring points listed in Section 2.2.2 will be monitored by cumulative flow meters.

3.3 Water quality

3.3.1 Sampling methods

Samples will be collected, stored in containers provided by the testing laboratory and submitted for testing to a NATA certified laboratory within the required holding times and under chain-of-custody procedures.

Groundwater sampling will be conducted in accordance with the EPA (2022) *"Groundwater Sampling Guidelines",* EPA Publication 669.1, February 2022.

Surface waters will be sampled using a grab sampler. Samples will be obtained in accordance with EPA (2009) *"Sampling and Analysis of Water, Wastewaters, Soils and Wastes"*, Publication IWRG701.

For all collected samples the following will be undertaken:

- decontaminating sampling equipment with Decon 90 prior to site visit
- rinsing equipment with demineralised water between samples
- field filtering using SteriCups (0.22 µm) for dissolved metals
- storing samples immediately after collection in an ice filled esky
- transporting of samples to laboratory under chain of custody (COC) arrangements.

3.4 Recording of results

3.4.1 In-situ

In-situ water quality parameters will be recorded. The records will be entered on field monitoring data sheets.

3.4.2 Laboratory

Samples will be analysed by a NATA accredited laboratory.

3.4.2.1 Sampling frequency and duration

The sampling frequency is presented in Table 3-1.

Table 3-1: Monitoring program sampling frequency

Site	Category	Frequency
Groundwater observation bores	Level	Monthly
	Water quality (on-site)	Quarterly
	Water quality (lab)	Annual
Water supply bores	Cumulative flow	Monthly
	Water quality (on-site)	Quarterly
Surface waters	Level	Quarterly
	Cumulative flow	Monthly
	Water quality (on-site)	Quarterly
Rain gauge	Rain	Daily

Monitoring will occur 12 months prior to quarrying, the duration of the quarrying activity and after completion of final rehabilitation works until the mean pit water level stabilises.

4 Triggers and contingency plan

4.1 Operational triggers

Table 4-1 lists operational triggers.

Table 4-1: Operational triggers

No	Description
A.1	Groundwater observation bore MW02 level reduces to less than 1.5 m from ground surface and/or groundwater observation bore MW04 level reduces to less than 0.5 m from ground surface. The 'level' to be the mean recorded during the preceding year at these bores.
A.2	Annual engagement, from end of Stage 2, with owners of the following bores to determine if their supply bore levels have been adversely impacted by watertable lowering:: • S&D bores within 1 km east and south east of site and/or • licensed bore 744100 and/or • licensed bore WRK041817
A.3	Exceedance of water environmental values as per the Environmental Protection Act 2017's Environmental Reference Standard and a 20% change in concentration/value from base concentration/value at observation bores.

4.2 Post rehabilitation triggers

Table 4-2 lists post rehabilitation triggers, i.e. after completion of final rehabilitation works.

Table 4-2: Post rehabilitation triggers

No	Description
B.1	Pit waterbody mean stabilised water level is 0.5 m below or above levels presented in Appendix E, or revision of these levels following subsequent hydrogeological assessment.
B.2	Exceedance of water environmental values as per the Environmental Protection Act 2017's Environmental Reference Standard and a 20% change in concentration/value from base concentration/value at observation bores.

4.3 Contingency plan

The objective of the contingency plan is to allow for mitigation measures to be implemented prior to adverse impacts occurring. Table 4-3 lists contingency plan mitigation measure.

Table 4-3: Contingency plan mitigation measures

No	Description of mitigation measures
Operations	
A.1	Cease westerly migration of extraction and undertake HA to determine cause of trigger exceedance including if due quarrying activities. If cause of trigger exceedance found to be due to quarrying activities establish a partition wall and adopt HA recommendations.
A.2	Undertake HA to determine cause of trigger exceedance including if due to quarrying activities. If cause of trigger exceedance found to be due to quarrying activities adopt HA recommendations.

No	Description of mitigation measures
A.3	To be specific to the environmental value's indicator. Example measures are: • salinity: utilise waterway diversion water during peak flows • low pH: lime dosing of drainage waters from organic sand stockpiles • aesthetics: copper sulphate dosing to limit the incidence of blue-green algae.
Post rehabilitation	
B.1	Undertake HA to determine cause of trigger exceedance, including if due to quarrying activities, and adopt HA recommendations if accepted by ERR. These recommendations may include: • increasing bund height and/or restriction of inflows if *Pit waterbody mean stabilised water level of 0.5 m below* trigger is met • capture of peak waterway flows to raise level if *Pit waterbody mean stabilised water level of 0.5 m below if stabilised level* trigger is met. Relevant agency authorisations would be required prior to implementing any of these measures.
B.2	As per A.3.

5 Major review

Prior to the completion of Stage 2 and again prior to the completion of Stage 3 major reviews of the rehabilitated pit lake design will be undertaken. This will involve:

- a review of groundwater level monitoring (see Section 3.1)
- further hydrogeological investigations which may include the need for additional groundwater observation bores
- reassess the predicted final waterbody surface water level to confirm the level for the original rehabilitation design
- if necessary, review waterbody rehabilitation design in consideration of reassessed water level.

The timing of these reviews provides a point in the extraction staging where the entire quarry pit crest will be above the predicted final water level and there will be ample water retained over the pit backfill. Prior to these points, it is expected that enough information will be available to undertake the major reviews of the final water level in the rehabilitated waterbody.

The review will reassess the proposed design for the final waterbody based on the gained hydrogeological knowledge and reassessment of the final water level through groundwater modelling which will consider evapotranspiration from the ground surface. This will include review of the current designed beaching zones which are based on the current understanding of the likely final waterbody level.

If the review confirms that the current design is likely to remain safe, stable and sustainable, and the beaching zones are at the likely final waterbody level, then the rehabilitation of terminal batters will proceed as designed. However, if the final water level of the pit lake is revised, then the implications for the current rehabilitation design for the waterbody will be considered.

A potential future Stage 5 will be subject to further approvals, based in part on these reviews.

6 Review and reporting

6.1 Review and update

The GWMP will be reviewed and updated:

- at any time, as agreed, should the understanding of the impacts change as a result of the monitoring outcomes.
- after mitigation measures are implemented
- every 5 years in the absence of earlier modifications.

6.2 Reporting

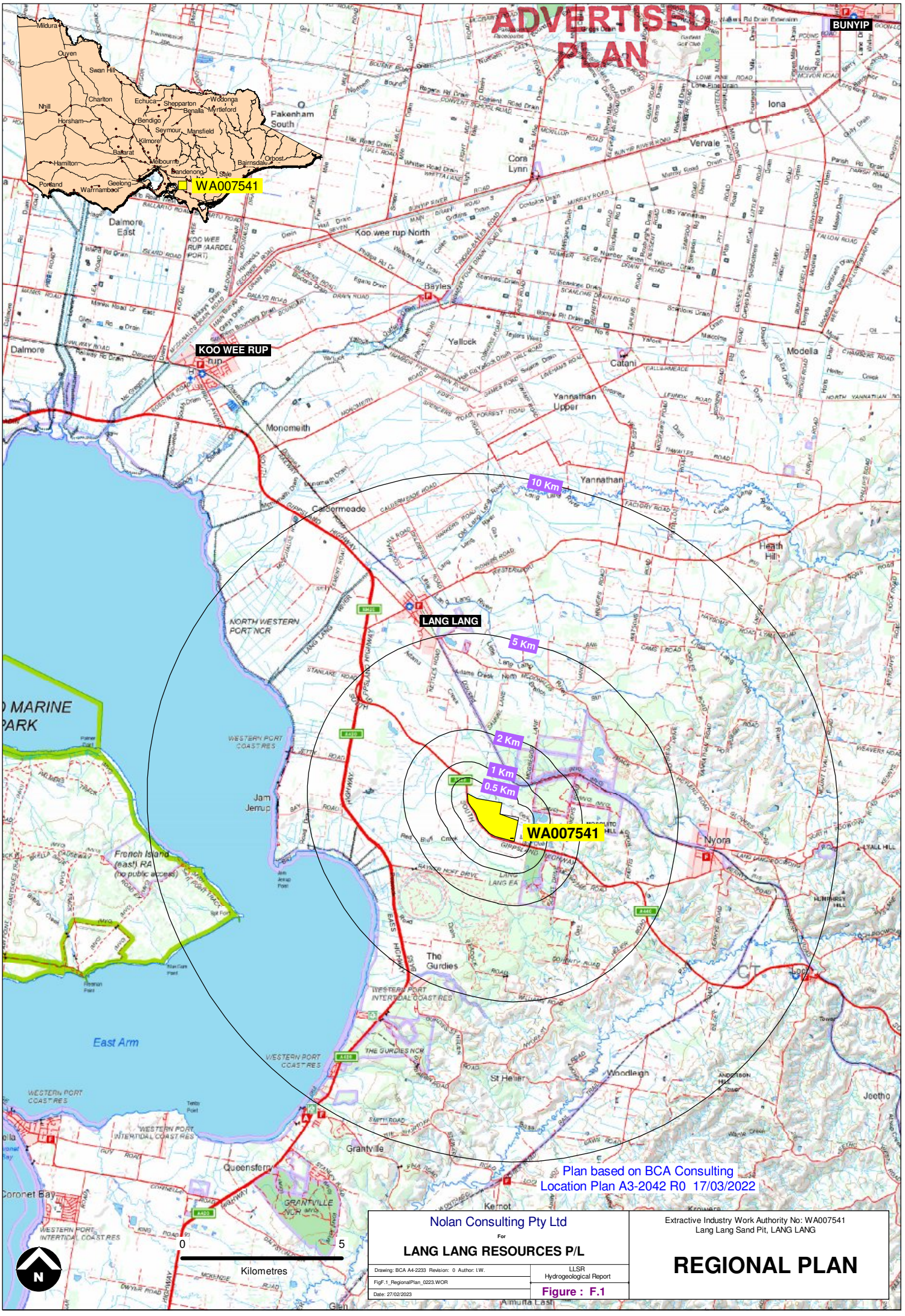
Annual groundwater monitoring reports will be prepared.

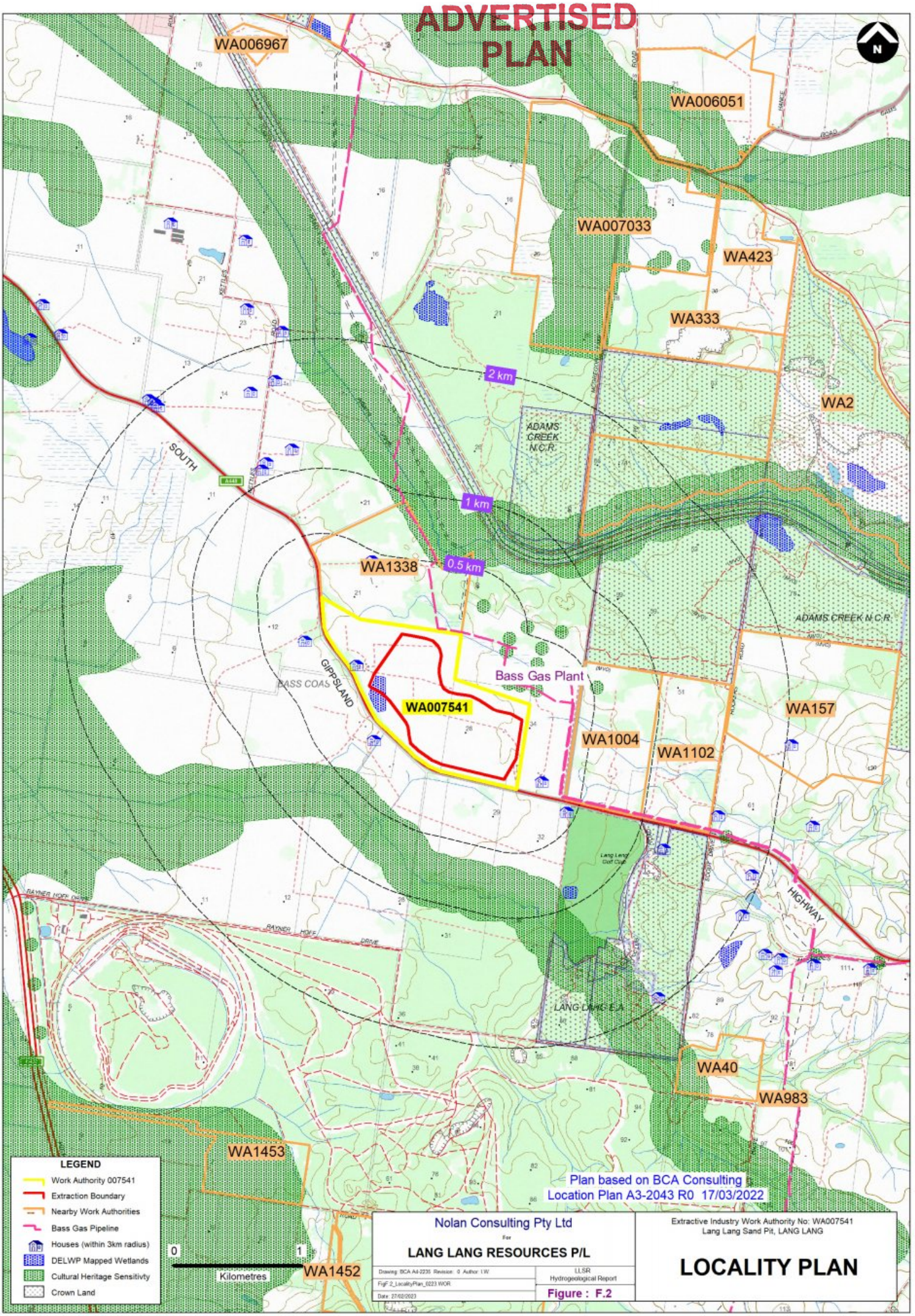
7 References

EPA (2022), "*Groundwater Sampling Guidelines*", EPA Publication 669.1, February 2022.

EPA (2009), "*Sampling and Analysis of Water, Wastewaters, Soils and Wastes*", EPA Publication IWRG701, June 2009.

Figures


ADVERTISED PLAN
WA007541
BUNYIP
KOO WEE RUP
LANG LANG
10 Km
5 Km
2 Km
1 Km
0.5 Km
WA007541
Plan based on BCA Consulting
Location Plan A3-2042 R0 17/03/2022
0
5
Kilometres
N
Nolan Consulting Pty Ltd
For
LANG LANG RESOURCES P/L
Drawing: BCA A4-2233 Revision: 0 Author: I.W.
FigF.1_RegionalPlan_0223.WOR
Date: 27/02/2023
LLSR
Hydrogeological Report
Figure : F.1
Extractive Industry Work Authority No: WA007541
Lang Lang Sand Pit, LANG LANG
REGIONAL PLAN


ADVERTISED PLAN
WA006967
WA006051
WA007033
WA423
WA333
WA2
2 km
1 km
0.5 km
ADAMS CREEK N.C.R.
SOUTH GIPPSLAND
WA1338
Bass Gas Plant
WA007541
WA157
WA1004
WA1102
HIGHWAY
LANG LANG E.A.
WA40
WA983
WA1453
WA1452
LEGEND
Work Authority 007541
Extraction Boundary
Nearby Work Authorities
Bass Gas Pipeline
Houses (within 3km radius)
DELWP Mapped Wetlands
Cultural Heritage Sensitivty
Crown Land
0
1
Kilometres
Plan based on BCA Consulting
Location Plan A3-2043 R0 17/03/2022
Nolan Consulting Pty Ltd
For
LANG LANG RESOURCES P/L
Drawing: BCA A4-2235 Revision: 0 Author: I.W
FigF 2_LocalityPlan_0223.WOR
Date: 27/02/2023
LLSR
Hydrogeological Report
Figure : F.2
Extractive Industry Work Authority No: WA007541
Lang Lang Sand Pit, LANG LANG
LOCALITY PLAN


MW01
MW02
MW03
MW04
MW05
Additional Bore;
Exact location to be finalised
SOUTH
GIPPSLAND
HIGHWAY
WA007541
0
200
Metres
N
LEGEND
WORK AUTHORITY BOUNDARY
EXTRACTION BOUNDARY
GROUNDWATER MONITORING BORE
ADDITIONAL GROUNDWATER MONITORING BORE
Aerial Photography Nearmap December 2019
ADVERTISED PLAN
Nolan Consulting Pty Ltd
For
LANG LANG RESOURCES P/L
Drawing: BCA A4-2236 Revision: 0 Author: LW.
FigF.3_GW MonitoringLoc_0223.WOR
Date: 27/02/2023
LLSR Hydrogeological Report
Figure : F.3
Extractive Industry Work Authority No: WA007541
Lang Lang Sand Pit, LANG LANG
GROUNDWATER MONITORING LOCATION