Groundwater Management Plan

Tanilba Northern Dune

Environmental Management

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SIBELCO AUSTRALIA

TABLE OF CONTENTS

1. INTRODUCTION 1
1.1 Background 1
1.2 Groundwater Management Plan 1
1.3 Purpose and Scope 2
1.4 Plan format 2
2. MONITORING PLAN 3
2.1 Groundwater Monitoring 3
2.2 Predicted Maximum Groundwater Elevation - from Baseline level monitoring 3
2.2.1 Derivation of PMGE 3
2.2.2 PMGE Results 4
2.3 Groundwater Quality Trigger Values - from Baseline quality monitoring 4
2.3.1 Derivation of Trigger Values 4
2.3.2 Trigger Value Results 4
2.4 Operational Groundwater Level Monitoring - for compliance with PMGE 4
2.4.1 Groundwater Level Monitoring Schedule 4
2.4.2 Exceedance Investigation 5
2.5 Operational Groundwater Quality Monitoring - for compliance with Trigger Values 5
2.5.1 Groundwater Quality Monitoring Schedule 5
2.5.2 Exceedance Investigation 5
3. OTHER REQUIREMENTS 6
3.1 PMGE derivation 6
3.2 Groundwater Dependent Ecosystems 6
3.3 Acid Sulphate Soil Contingency Plan 6
4 REPORTING AND REVIEW 7
4.1 Exceedance Investigation Reporting 7
4.2 Biannual Groundwater Level and Quality Report 7
4.3 Annual Environmental Management Report 7
4.4 Groundwater Management Plan Review 7
REFERENCES 8
Appendix 1: Northern Dune Extraction Zones 9
Appendix 2: Northern Dune Groundwater Monitoring Network 10
Appendix 3: PMGE surface and piezometer PMGE 11
Appendix 4: Piezometer PMGE Groundwater Level and Groundwater Quality Trigger Values 12
Appendix 5: Northern Dune Extraction Level Plan 13

1. INTRODUCTION

1.1 Background

Sibelco Australia Limited (Sibelco) operate a white silica sand extraction operation on the Tanilba Northern Dune near Oyster Cove on the Tilligerry Peninsula, NSW. See Figure 1.

Figure 1: Location of the Tanilba Northern Dune operation

The operation is subject to the approval granted by the NSW Land and Environment Court and a Court approved Environmental Management Plan, which has been amended and updated as required since project commencement. In addition to the requirements of the conditions of consent relating to groundwater, the Department of Primary Industries (DPI-Water) in conjunction with Hunter Water Corporation (HWC) and the NSW Government Department of Planning and Infrastructure, have specified additional groundwater monitoring requirements.

Sand is extracted at Northern Dune as a rolling west to east cycle in approved zones of clearing native vegetation, extracting sand, reforming a new surface and planting of native vegetation. A site map of extraction zones is provided as Appendix 1.

1.2 Groundwater Management Plan

A Groundwater Management Plan (GMP) has been developed at Northern Dune to ensure compliance with the conditions of consent and licensing requirements stipulated by the relevant regulatory authorities during development and operation at the silica sand site.

The GMP is reviewed prior to commencement of operations in planned zones and updated to incorporate monitoring of additional bores and to respond to current regulatory requirements.

CM Jewel and Associates (2003) developed a GMP prior to the commencement of sand extraction at Northern Dune. In 2011 the GMP was updated for planned extraction at Extraction Zone 4. In 2014 a GMP was developed for planned extraction at Lots 11-13 Extraction Zone. This GMP covers all Northern Dune groundwater management arrangements for sand extraction from Lots 11-13.

1.3 Purpose and Scope

The broad primary objectives of the GMP are to develop an implementable approach to manage the potential impact of:

- Sand extraction on groundwater level and quality
- Contaminated groundwater on Groundwater Dependent Ecosystems
- Acid sulphate and potentially acid sulphate soils

The GMP has been developed to provide a formal framework for ongoing monitoring of groundwater at the site. It is intended that this program will provide sufficient data of adequate quality to achieve the following specific objectives:

- Monitor groundwater levels and quality in the vicinity of the site, refine knowledge of the current depth to groundwater and natural fluctuations in groundwater level, and document baseline conditions;
- Demonstrate that sand extraction has not resulted in the release of contaminants that might impact upon groundwater resources
- Demonstrate that sand extraction does not significantly alter the groundwater flow regime within the aquifer
- Demonstrate that sand extraction does not impact on Groundwater Dependent Ecosystems
- Provide a contingency plan to manage any acid sulphate soils and potentially acid sulphate soils encountered during quarrying operations

1.4 Plan format

This plan is structured as follows:

- Section 2 outlines groundwater monitoring management arrangements
- Section 3 outlines other requirements
- Section 4 outlines reporting and review

2. MONITORING PLAN

2.1 Groundwater Monitoring

Groundwater monitoring was initiated at Northern Dune in 2002, prior to the commencement of sand extraction in 2003. The groundwater monitoring network has expanded with the installation of new piezometers into planned zones and is currently twenty one piezometers. See Appendix 2. Groundwater monitoring is required:

- Prior to sand extraction to benchmark (baseline) natural conditions and develop groundwater level and quality trigger values
- During sand extraction (operation) to monitor the potential impact of sand extraction against the groundwater level and quality trigger values
- During Rehabilitation to determine post and extraction conditions for comparison against natural conditions

Baseline groundwater level and quality monitoring is undertaken within a planned zone prior to commencing sand extraction. Baseline groundwater level monitoring is used to create a predicted maximum of groundwater (PMGE) which is then used for determining depth of extraction and final landform. Baseline groundwater quality samples are collected to create Trigger Values for comparison against sample concentrations during extraction operations and post-extraction operations to assist in detecting any changes in groundwater level and quality at the site. Since a GMP is approved prior to the commencement of operations baseline monitoring is incomplete and trigger values determined from the incomplete monitoring are provisional until sand extraction commences. Groundwater monitoring of rehabilitated Extraction Zones is continued until release has been secured from the relevant regulatory authorities. Groundwater monitoring data is collected and analysed by suitably trained personnel in accordance with Sibelco Groundwater Monitoring Guidelines.

2.2 Predicted Maximum Groundwater Elevation - from Baseline level monitoring

Baseline Groundwater level monitoring is used to construct a PMGE surface.

2.2.1 Derivation of PMGE

The original PMGE derived by Jewel (2003) was a purely statistical based prediction of future groundwater behaviour using baseline groundwater. In 2008 the PMGE was exceeded which led to AECOM (2010) developing a similar statistically based estimate for Extraction Zone 4. Sibelco (2011) reviewed the AECOM estimate and identified deficiencies with this approach which led to the development of a more hydrogeological focused methodology. Sibelco developed a PMGE based on an analysis of local and regional groundwater data from 1950 against the 100 year rainfall record. Sibelco concluded that the maximum groundwater elevation at Tanilba Northern Dune operation over the last 100 years in the period 2006-2011 when detailed groundwater levels were being undertaken at Northern Dune. A predicted maximum groundwater elevation was therefore derived from observed groundwater data for Extraction Zone 4. Sibelco (2014) used a similar methodology for deriving the PMGE for Lots 11-13 Extraction Zone based on observed piezometer levels coupled with hand auger testing of groundwater. The Sibelco PMGE is 0.3-0.5 metres more elevated than the Jewel PMGE.

2.2.2 PMGE Results

The PMGE Surface with piezometer PGME is presented in Appendix 3 and the piezometer PMGE are tabled in Appendix 4 with Groundwater Quality Trigger values.

2.3 Groundwater Quality Trigger Values - from Baseline quality monitoring

Baseline groundwater quality monitoring is undertaken prior to conducting any sand extraction within a planned zone. This data is used to create Trigger Values for comparison against sample concentrations during extraction operations and post-extraction operations to assist in detecting any changes in groundwater quality within the zone

2.3.1 Derivation of Trigger Values

Groundwater quality at Northern Dune is driven by the nature of rainfall and properties of the unsaturated zone. Rainfall entering the soil zone undergoes significant changes in chemical composition and pH by processes such as root respiration and decomposition of organic matter via chemical reactions such as sorption and redox. The chemical constituency of infiltrating water in turn modifies groundwater chemistry by processes such as leaching, dilution but not concentration (which is protected against by licence conditions limiting depth to groundwater) as well as dissolution/precipitation. The effect of multiple processes on groundwater quality parameters and therefore setting Trigger Values is that water quality data is often multiple-modal (non-normal distribution) and so simple statistical analysis using mean and standard deviation may not adequately represent processes leading to water quality change.

The original trigger values derived by Jewel (2003) were from double the mean of the baseline concentrations encountered prior to extraction. In 2010 AECOM updated the trigger value calculation to mean plus two standard deviations. Sibelco derived trigger values for Extraction Zone Lots 11-13 based on observed maximum and minimum rather than mean plus two standard deviations because the metals arsenic, manganese and iron demonstrate non-normal distribution and also because the mean plus two standard deviations exceeds the maximum for these water quality parameters.

2.3.2 Trigger Value Results

Groundwater quality Trigger values are tabled in Appendix 4.

2.4 Operational Groundwater Level Monitoring - for compliance with PMGE

2.4.1 Groundwater Level Monitoring Schedule

The NOW and HWC require that groundwater levels in monitoring wells be measured monthly, but that this frequency be increased to weekly for a period of four weeks following any period when rainfall at Williamtown equals or exceeds 100 millimetres over a seven day rolling period, or when water levels are within 100 millimetres of the maximum predicted groundwater levels. Monitoring will continue for the duration of mining, and until the release of the obligation by DPI-Water and HWC. General (visual) observation of currently mined and progressively rehabilitated areas will be carried out regularly to check for the occurrence of surface water ponding or the presence of groundwater windows.

The Northern Dune Extraction Level Plan is provided in Appendix 5.

2.4.2 Exceedance Investigation

If analysis of groundwater level monitoring sample shows anomalous levels above the ***PMGE*** then groundwater in the effected monitoring well will be retested again as soon as possible and in any case within fourteen days to confirm the results. If retesting confirms the anomaly, DPI-Water and HWC will be notified immediately, by telephone and in writing, and within fourteen days of confirmation and an investigation will be initiated and results reported which will:

- Establish the spatial and temporal variability of groundwater level
- Determine whether the anomaly is natural variability (background) or potentially related to a site activity
- Provide an assessment of the potential impact upon the groundwater resource

If observations are made of ***water ponded on the surface*** for more than seven (7) consecutive days then DPI-Water will be notified immediately, by telephone and in writing, and within fourteen days of confirmation and an investigation will be initiated and results reported which will:

- Establish the spatial and temporal variability of surface water level
- Determine whether the anomaly is natural variability (background) or potentially related to a site activity
- Provide an assessment of the potential impact upon the groundwater resource

2.5 Operational Groundwater Quality Monitoring - for compliance with Trigger Values

2.5.1 Groundwater Quality Monitoring Schedule

Operational groundwater quality monitoring is undertaken six monthly once mining commences in a zone, and will continue at a lower frequency for four years after mining ceases or as otherwise determined by DPI-Water and HWC. The monitoring frequency is subject to review in consultation with DPI-Water and HWC.

2.5.2 Exceedance Investigation

If analysis of water quality monitoring sample shows ***anomalous concentrations of any water quality parameter above Trigger Values***, then groundwater in the effected monitoring well will be resampled and tested again as soon as possible and in any case within fourteen days to confirm the results. If resampling confirms the anomaly, DPI-Water and HWC will be notified immediately, by telephone and in writing, and an investigation will be initiated and results reported which will:

- Identify the specific groundwater quality parameters
- Establish the spatial and temporal variability of the water quality parameters
- Determine whether the anomaly is natural variability (background) or potentially related to a site activity
- Provide an assessment of the potential impact upon the groundwater resource

Note: Hydrocarbons pose the greatest potential threat to groundwater. The hydrocarbon risk is reduced by the implemented control measure that no refuelling or mechanical work is undertaken at Northern Dune.

3. OTHER REQUIREMENTS

At the request of the Department of Planning this section of the GMP outlines how the PMGE surface was derived; demonstrates that sand extraction does not impact on Groundwater Dependent Ecosystems, and provides a contingency plan to manage acid-sulphate soils.

3.1 PMGE derivation

Planned sand extraction is based on a PMGE. The PMGE surface has been constructed from the predicted maximum groundwater elevations of piezometers, which at Northern Dune are the observed maximum groundwater elevations, complimented by auger testing of groundwater. The PMGE surface was created in MAPINFO using an Inverse Distance Weighting method with a 3rd Power weight model, 50m cell size and the maximum calculated value of coincident points. The PMGE surface does not represent an actual surface but is an artificial surface created from groundwater levels at different dates. The prediction is therefore cautionary because it overstates actual maximum groundwater elevation which occurred from other sample points at the time of peak measurement. See Appendix 3.

3.2 Groundwater Dependent Ecosystems

Groundwater Dependent Ecosystems (GDE) are “any system that uses groundwater at any time for any duration in order to maintain its composition and condition” (SKM, 2012). Non-dependent ecosystems occur mostly in recharge areas and have no connection to groundwater. The risk of impacting on a GDE at Lots 11-13 is low because:

- Planned sand extraction is of a sand dune where depth to groundwater may be in excess of 10 metres and it is unlikely that vegetation is dependent on groundwater, but instead relies on soil moisture (ie. no connection)
- The sand dune is a recharge area
- A study by SKM in 2012 for the NSW Office of Water (NOW) on NSW Coastal GDE’s did not identify a GDE at the site (NOW, 2012) and the site is not listed in the National Atlas of GDE’s

3.3 Acid Sulphate Soil Contingency Plan

Acid sulphate soils are naturally occurring soils, sediments or organic substrates that are formed under waterlogged conditions. These soils contain iron sulphide minerals which are benign in groundwater (saturated zone) but react with oxygen to form sulphuric acid in the unsaturated zone. The risk of encountering an acid sulphate soil at Lots 1-13 is low because:

- Sand extraction is of a clean white sand which has no potential for forming acid sulphate soils
- The underlying Coffee rock has potential for forming acid sulphate soils but because sand extraction is limited to 1 metre above the predicted maximum groundwater elevation of groundwater in this sand aquifer sand extraction will be at least 1 metre above the Coffee rock

If an acid-sulphate soil was unearthed, work will immediately cease and an Acid Sulphate Soil Contingency Plan be prepared to the satisfaction of DPI-Water and HWC which appropriately outlines how groundwater resources will be protected, and if required, will outline a method to remediate impacted groundwater.

4 REPORTING AND REVIEW

4.1 Exceedance Investigation Reporting

Confirmed groundwater level and quality exceedances will be compiled in a summary report that will be submitted to DPI-Water and HWC.

4.2 Biannual Groundwater Level and Quality Report

The results of the groundwater level and quality monitoring will be compiled in a summary report which will be submitted to DPI-Water and HWC on a six-monthly basis.

4.3 Annual Environmental Management Report

The results of the measured groundwater levels and quality analysis will be submitted to DPI-Water and HWC as part of the Annual Environmental Management Report (AEMR). Data will be validated against monitoring program QA objectives, and interpreted with reference to the overall monitoring program objectives. The AEMR will also include rainfall data from Williamtown and descriptions of any environmental incidents.

4.4 Groundwater Management Plan Review

The GMP will be reviewed at the completion of sand extraction in a zone and/or prior to commencement of operations in each new zone. If this review indicates a need to change programs or procedures, then a submission outlining the proposed changes and the need for them will be made to DPI-Water and HWC.

REFERENCES

AECOM (2009) Literature Review on Groundwater Conditions Underlying the Northern Dune and the Potential Impacts of the White Sand Mining Operation. Unpublished report

AECOM (2010) Development of New Trigger Levels and a Data Analysis Protocol. Unpublished Report

C M JEWEL & ASSOCIATES (2003) Tanilba Northern Dune Groundwater Management Plan

NSW Office of Water (2012) Risk Assessment guidelines for groundwater dependent ecosystems. Volume 2 – Worked examples for seven pilot coastal aquifers in NSW. Published by the Department of Primary Industries.

SIBELCO (2011a) Tanilba Northern Dune Groundwater Management Plan. Unpublished report

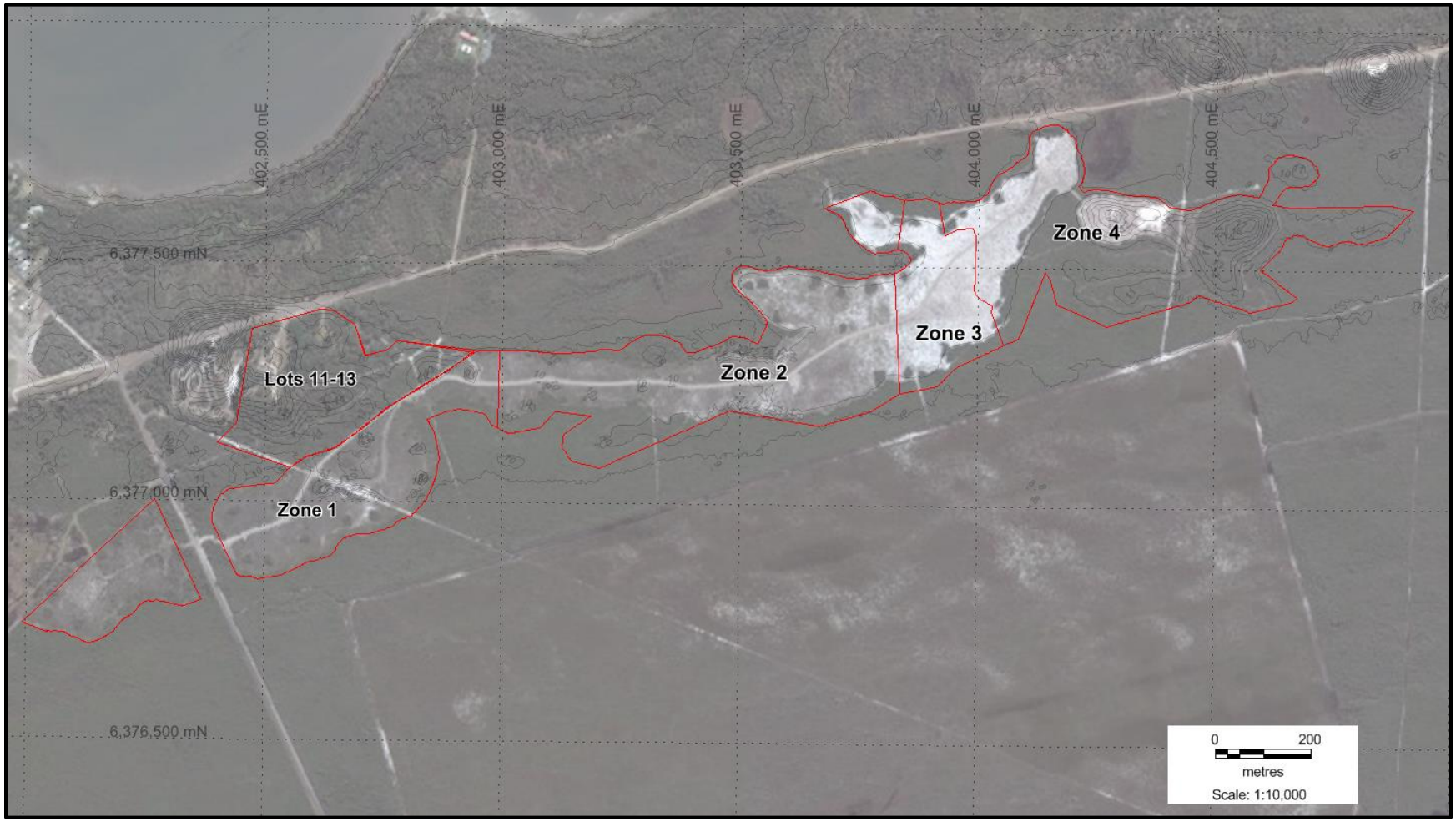
SIBELCO (2011b) Maximum groundwater elevation prediction at Tanilba Northern Dune operation. Unpublished report

SIBELCO (2013) Groundwater Monitoring Guidelines. Unpublished Report.

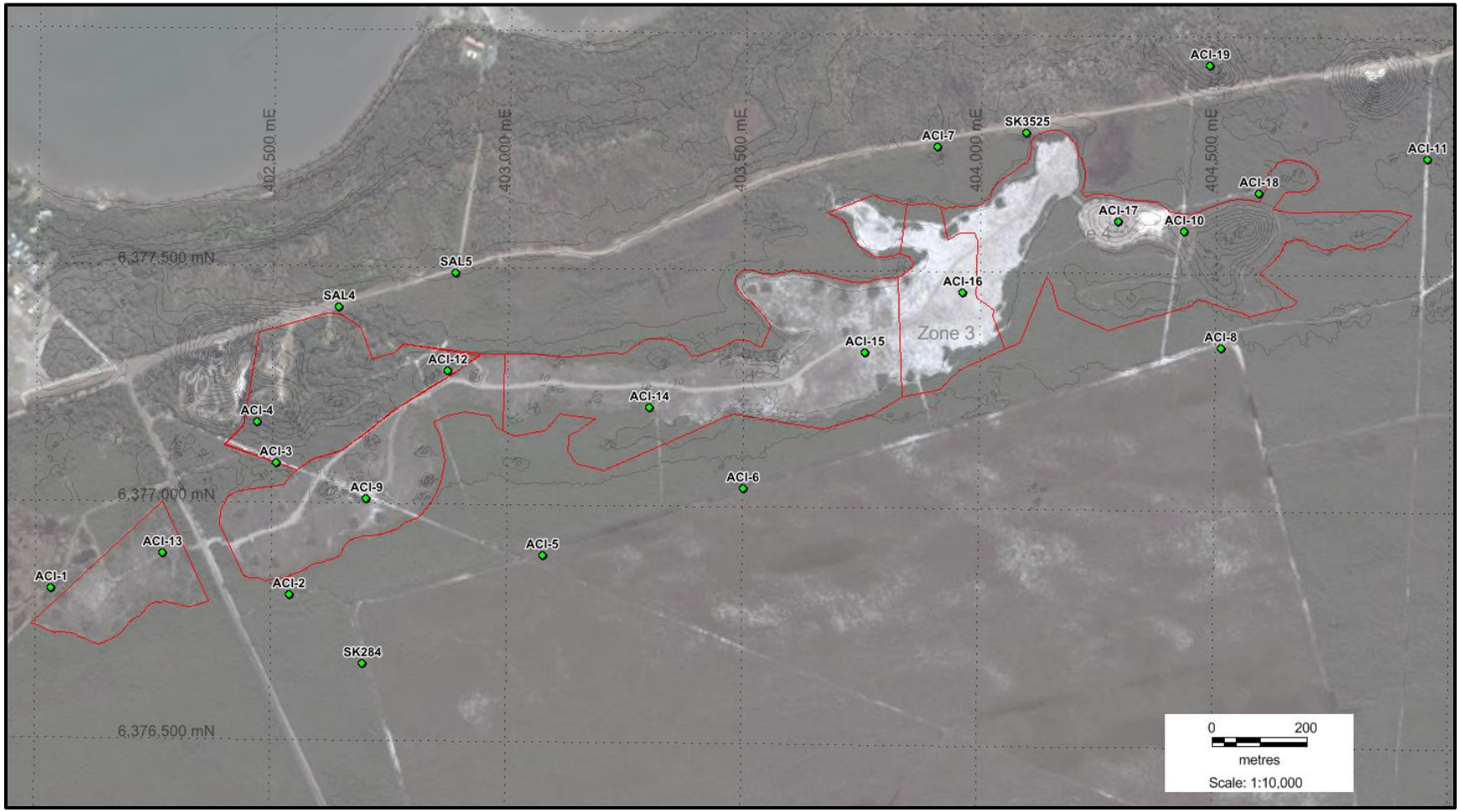
SIBELCO (2014) Groundwater Management Plan Tanilba Northern Dune Lots 11-13 Extraction Zone. Unpublished Report.

SKM (2012) Summary Report for NWC NSW Coastal Groundwater Dependent Ecosystem and Groundwater Quality Project Unpublished Report

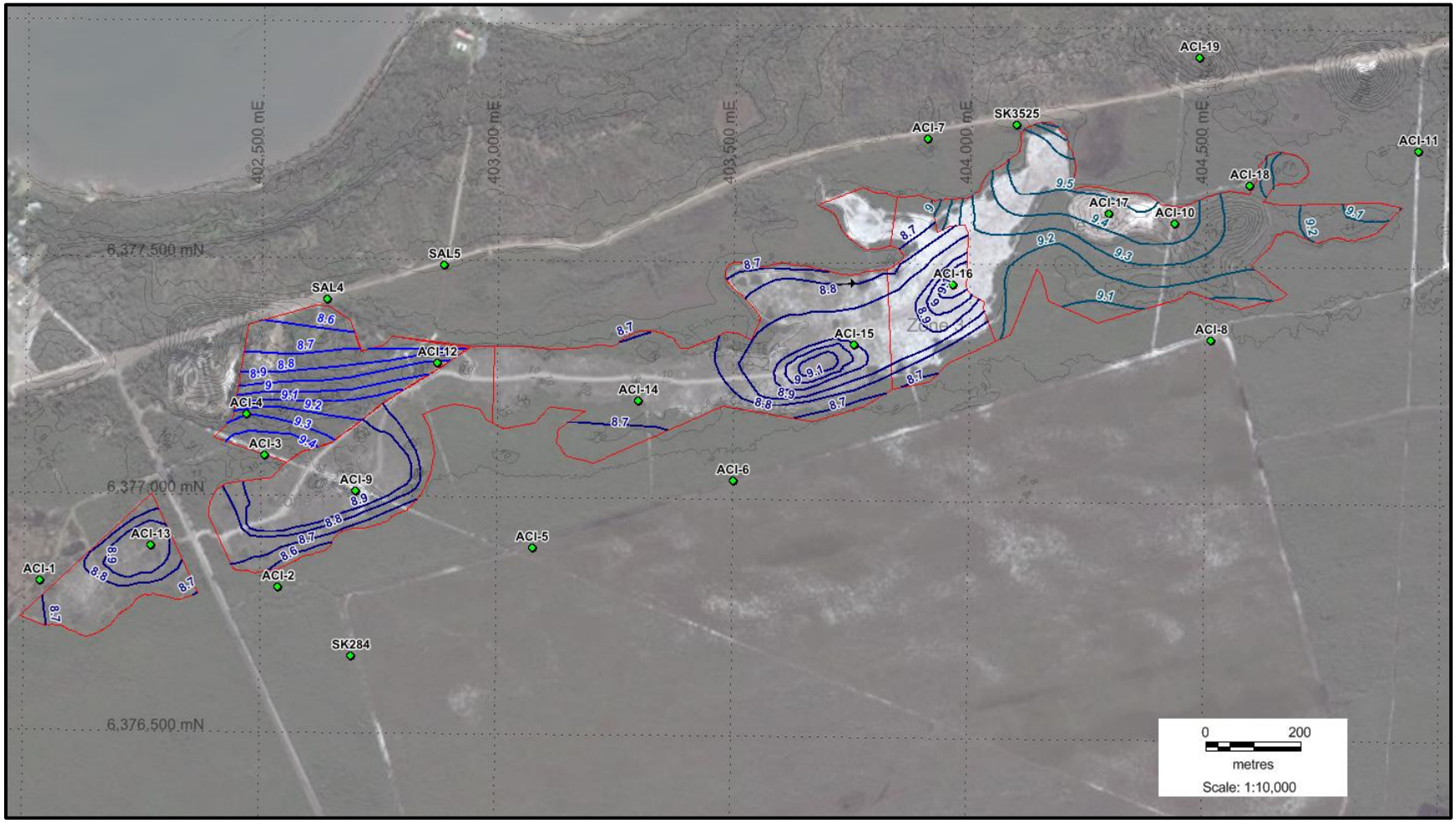
Appendix 1: Northern Dune Extraction Zones



Appendix 2: Northern Dune Groundwater Monitoring Network



Appendix 3: PMGE surface and piezometer PMGE



Jewel PMGE Extraction Zones 1 -13 (dark blue), Sibelco PMGE Extraction Zone 4 (green) and Sibelco PMGE Lots 11-13 (bright blue)

Appendix 4: Piezometer PMGE Groundwater Level and Groundwater Quality Trigger Values

Extraction Zone	Bore	PMGE	GROUNDWATER QUALITY TRIGGER VALUES											
			pH	EC	Iron mg/L		Arsenic mg/L		Manganese mg/L		TPH mg/L			
					Dissolved	*Total*	*Dissolved*	*Total*	*Dissolved*	*Total*	*C6-C9*	*C10-C14*	*C15-C28*	*C29-C40*
1	ACI-1	8.82	x	x	x	x	x	x	x	x	x	x	x	x
	ACI-12	9.28	x	x	x	x	x	x	x	x	x	x	x	x
	ACI-13	**9.20**	x	x	1.547	6.428	0.001	0.012	0.061	0.056	0.02	0.05	1.00	1.00
	ACI-2	**8.44**	x	x	3.058	3.623	0.001	0.010	0.015	0.014	0.02	0.05	1.00	1.00
	ACI-3	9.47	x	x	x	x	x	x	x	x	x	x	x	x
	ACI-4	9.31	x	x	x	x	x	x	x	x	x	x	x	x
	ACI-5	**8.16**	x	x	2.048	3.286	0.001	0.015	0.014	0.036	0.02	0.05	1.00	1.00
	ACI-9	9.31	x	x	x	x	x	x	x	x	x	x	x	x
2	**ACI-14**	**9.02**	x	x	1.532	2.262	0.001	0.008	0.070	0.082	0.02	0.05	1.00	1.00
	ACI-15	9.26	x	x	x	x	x	x	x	x	x	x	x	x
	ACI-6	**8.29**	x	x	0.493	0.935	0.001	0.001	0.006	0.006	0.02	0.05	1.00	1.00
3	**ACI-16**	**9.26**	x	x	0.188	11.419	0.001	0.002	0.061	0.104	0.02	0.05	1.00	1.00
	ACI-7	8.92	x	x	x	x	x	x	x	x	x	x	x	x
4	ACI-10	9.49	x	x	x	x	x	x	x	x	x	x	x	x
	ACI-17	9.47	x	x	x	x	x	x	x	x	x	x	x	x
	ACI-8	**8.86**	x	x	1.108	1.410	0.002	0.002	0.006	0.006	0.02	0.05	1.00	1.00
	ACI-18	**9.12**	x	x	7.590	10.870	0.002	0.003	0.262	0.378	0.02	0.05	1.00	1.00
n/a	**ACI-11**	**9.54**	x	x	4.344	5.116	0.002	0.002	0.028	0.030	0.02	0.05	1.00	1.00
Lots 11-13	**SAL4**	**8.65**	4.44-6.63	213	3.210	3.640	0.001	0.002	0.093	0.116	0.02	0.05	1.00	1.00
-	ACI-19	9.06	x	x	x	x	x	x	x	x	x	x	x	x
	SAL5	x	x	x	x	x	x	x	x	x	x	x	x	x
	SK284	8.49	x	x	x	x	x	x	x	x	x	x	x	x
	SK3525	9.55	x	x	x	x	x	x	x	x	x	x	x	x
	SK3530	9.25	x	x	x	x	x	x	x	x	x	x	x	x

Trigger levels for Extraction Zones 1-4 calculated by AECOM have been retained which includes spurious data eg. ACI-13 Total Mn > Dissolved Mn and is based on a methodology. Lots 11-13 baseline data is simply maxiumum observed.

Appendix 5: Northern Dune Extraction Level Plan