24 September 2019

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The Secretary
Department of Planning, Industry & Environment
Planning Assessments
GPO Box 39
SYDNEY NSW 2001

Submission via online portal

Dear Sir,

Stockton Sand Quarry: Windblown Project DA

This correspondence provides a response to submissions made in relation to the proposed modification (Modification 3) to Development Consent DA 140-6-2005 by Boral Resources (Country) Pty Ltd. The modification involves the extending the area of extraction by removing a portion of a 15 metre wide buffer.

The purpose of the correspondence is to consider and respond to agency submissions and where relevant amend the application to avoid or manage the potential for impact.

1.0 PROJECT OVERVIEW

The following section provides an overview of the proposed modification and summary of the assessment report submitted for consideration.

1.1 Project need and summary

To meet short term demand for natural sand, Boral is seeking to modify DA 140-6-2005 to permit a minor expansion to the approved extraction area of the Windblown Project. The proposed expansion of the extraction pit would remove a portion of the 15 metre buffer and add one to two years to the existing sand resource.

The proposed modification does not seek to alter the approved site transportation limits or the depth of extraction as permitted under the existing conditions of consent.

The modification, as submitted, proposed an expanded extraction footprint to take in the northeast, south east and southwestern extents of the 15 metre buffer relocating the 3:1 batter crest to the legal boundary of the site. The modification would cover an area equal to 3.2 hectares and allow for extraction of 475,000 tonnes of sand resource.

1.2 Project assessment

Boral's windblown project area (including the 15 metre buffer sitting between the legal boundary and the active extraction pit) is located on the Stockton Bight located on the transgressive dunes behind Stockton Beach. The current extraction activities occur over an area that was previously dredged by Mineral Deposits Limited (MDL). These former activities went below the water table and extended to the legal boundaries of the site.

The coastal location of the project area renders it exposed to prevailing winds that transport and deposit sand leading to process of, dune deflation and inflation. These process can cover and reveal landscape features and also limit the establishment of dune vegetation.

The Statement of Environmental Effects (SEE) submitted to the Department of Planning, Industry and Environment (DPIE) and referred to agencies for comment, concluded the proposed modification was unlikely to have adverse impact as:

- Previous Aboriginal heritage assessment prepared in support of DA 160-4-2005 had identified that there were no items of significant located within the boundary of the project area due to its highly disturbed condition associated with the MDL operation;
- Due to absence of vegetation on the dune system there would be no adverse impact on the biodiversity; and
- Maintenance of the approved extraction depth limits.

2.0 SUBMISSIONS ANALYSIS

Following submission of the proposed modification, the application was notified and referred to government agencies by the DPIE. A total of five submissions were made in response to notification of the proposed modification. A summary of the submissions received is provided in **Table 1.**

Table 1: Summary of submissions

Position	Community	Organisation	Agency	Total
Comment	0	1	3	4
Objection	0	0	1	1
Support	0	0	0	0
Total	**0**	**1**	**4**	**5**

2.1 Government agency submissions

A total of four government agency submission were received. Comments received are summarised below.

Office of Environment & Heritage: sought further assessment in relation to potential biodiversity and aboriginal heritage impacts. A request was made to retain the approved Rehabilitation and Landscape Management Plan. OEH sought no further assessment of potential flooding impacts.

Port Stephens Council: made a comment of no objection subject to compliance with the existing conditions of consent.

Environmental Protection Authority: The EPA raised no objection, noting that the proposed minor variation would have no significant increase in environmental impact. Recommended conditions of approval were sought, these included:

- the proponent must not extract sand within 0.7 metres of the maximum predicted groundwater level at the premises at any time.
- the proponent must ensure that rehabilitation of final landform levels remain one metre above the maximum predicted groundwater level at the premises.

Department of Industry: has sought confirmation of the potential impact on the existing monitoring network and whether additional bores are required combined with confirmation of the extraction depths. Following the above, DoI has sought to following conditions:

- Any monitoring bores destroyed or damaged due to modification 3 should be immediately replaced.
- Any changes to the monitoring network should be updated in the groundwater monitoring programme and water management plan.
- Monitoring for groundwater impact using groundwater level and quality trigger and trigger action response plan criteria as set out in the accepted water management plan and groundwater monitoring programme is to be continued.

Department of Resources and Geosciences: the resource in the subject area represents an important source of construction sand for the region. GSNSW have no resource concerns to raise with the proposal. However, any amended consent should require the proponent to provide annual production data for the subject site to the DRG.

2.2 Organisation submissions

One submission was made by an organisation, Planning Perceptions on behalf of Coastal Earthmoving Hire Pty Ltd located to the north of the Boral's site on Coxs Lane, Fullerton Cove.

The submission sets out the current status of a planning proposal to rezone adjacent land for residential purposes providing evidence of the DPIE "gateway" approval. The submission acknowledges that sand quarrying operations within proximity to residential properties can operate without undue amenity impacts where appropriate management arrangements are in place.

2.3 Request for a response to submissions

DPIE by email invited the Proponent to prepare and submit a Response to Submissions. The request also sought the following information:

- A statement prepared by an appropriate qualified person to confirm that the area of proposed extraction was not vegetated and consider potential impacts on biodiversity;
- That five sites registered on the Aboriginal Heritage Information Management Systems and noted the be within proximity to Boral's boundary be considered in more detail for potential impact; and
- A survey plan of the approved limits of extraction (as required by Schedule 3 of Condition 1) compared against the current extraction areas.

The matters raised by DPIE, agencies and organisations are considered in section 4.0 of this correspondence.

3.0 PROJECT AMENDMENTS AND CLARIFICATIONS

Following receipt of agency submissions and completion of specialist technical reports the project scope was reviewed to ensure the potential for impact is avoided and where necessary managed.

In accordance with clause 55 of the *Environmental Planning and Assessment Regulations 2000* the proposed modification is amended as follows:

- submission of a corrected layout plan confirming that the proposed expansion of the extraction area would not conflict with areas of established vegetation in the southwest corner of the existing 15 metre buffer;
- reduction in the proposed extraction area expansion; and
- retention of stabilisation methods set out in the adopted Rehabilitation and Landscape Management Plan (2018).

The amended area has reduced the proposed extraction area is approximately 2 hectares and will allow for the extraction of 218,000 tonnes of sand.

The reduced extraction area will avoid those portions of the buffer located to the north and north east of the existing extraction area (or pit) where there are noted encroachments of the protective fencing of archaeological items located on the adjoining beach front.

The archaeological assessment completed by KNC confirms that there are no items of significance located within Boral's holdings and there is no potential for Boral to impact on those items located outside their boundary. However, to provide comfort to OEH Boral has reduced the proposed extraction footprint. By forgoing extraction within the north, north-eastern portions of the buffer, Boral will reduce the available resource.

3.1 Further Information

Based on the submissions received further detailed and technical assessment was undertaken. This includes:

- An Aboriginal Assessment Report prepared by Kelleher Nightingale Consultants Pty Limited **(Attachment A)**;
- A Biodiversity Assessment Report prepared by Niche Environment and Heritage **(Attachment B)**; and
- An amended extraction plan and cross sections **(Attachment C)**; and

- A copy of the boundary survey requested by DPIE compliance unit, previously submitted by email in April 2019 (**Attachment F**).

For the purposes of providing clarity on the location of the existing groundwater monitoring network and Boral's current site management practices the following has been provided for information purposes;

- Survey plan showing monitoring wells and boreholes relative to Boral's boundary and extraction area (**Attachment E**); and
- Groundwater Management Plan **(Attachment F).**

4.0 RESPONSE TO SUBMISSIONS

The following section has sought to address only on those matters requiring resolution or an agreement from Boral.

4.1 Aboriginal archaeology and cultural values

The Office of Environment and Heritage (OEH) requested that a site visit be conducted by a suitably qualified archaeologist and representative Registered Aboriginal Parties (RAPs). Where necessary and based on the outcome of the recommended site visit, an Aboriginal Cultural Heritage Assessment should be prepared.

An Aboriginal heritage assessment (AHA) of the 15 metre wide buffer along the north-eastern, south-eastern and south-western extends of the project area was undertaken by Kelleher Nightingale Consultants (KNC). The AHA has considered the potential for direct and indirect impacts on Aboriginal heritage, within the project area and on land adjacent. The AHA concludes that the proposal is unlikely to have an impact on Aboriginal heritage.

A copy of the AHA is provided in **Appendix A**. The following subsections provide a response to the specific matters raised by agencies.

4.1.1 Site walkovers and consultation

KNC was engaged to undertake an inspection of the project area. KNC inspected the project area on three separate occasion between March and June 2019. These inspections were undertaken to account for the dynamic environment of the dunes, where the process of inflation and deflation could cover or reveal areas of potential significance.

One such walkover included Registered Aboriginal Parties (RAPs), who attended the site on 27 June 2019. A total of 16 RAPs attended the walkover, these parties are identified in section 2 (p.5) of the KNC report, provided at **Attachment A.**

The site inspection with RAPs included a walk over of the project area and a discussion of the site history and existing mining disturbance, further discussion of the project, proposed extraction staging, remediation and archaeological context of the local area including location of nearby previously recorded sites.

No Aboriginal objects were identified and representatives concurred with the assessment of existing severe disturbance within the study area and proposed impact area.

4.1.2 Aboriginal heritage assessment

KNC has undertaken an AHA of the proposed extraction area. The methodology has involved a desktop assessment, consultation with RAPs and visual inspection of the project area (on three separate occasions).

The assessment report in relation to the modification area, concurs with earlier archaeological assessment undertaken to inform the current consent, DA 140-6-2005 that the previous operations of MDL resulted in a highly disturbed and modified environment. The KNC assessment of potential impact concludes:

> *The assessment identified that the Modification 3 proposal will not have an impact on Aboriginal heritage. The impacts of the modification proposal on Aboriginal heritage are consistent with the existing Project Consent. The proposed modification will not result in an increased impact to Aboriginal heritage.*

4.1.3 Aboriginal Heritage Information Management System

DPIE requested that additional information and details regarding adjacent Aboriginal Heritage Information Management System (AHIMs) recorded aboriginal sites be provided. The sites identified included:

- AHIMS #38-4-2068
- AHIMS #38-4-2065
- AHIMS #38-4-2064
- AHIMS #38-4-2063
- AHIMS #38-4-022

KNC as part of the AHA undertook a detailed AHIMS search which identified 75 Aboriginal sites recorded in or near the project area. A total of nine recorded features are located within approximately 50 metres of the extraction area. The general distribution and relationship of these items to Boral's boundary and proposed extraction area extension is shown in **Figure 1** below.

All AHIMS items are located outside Boral's site, two unregistered items, shown as yellow squares in Figure 1 below, have been fenced off and while the items are also outside Boral's site the fence line encroaches into the buffer. All items within proximity to the site were identified as open context midden sites featuring shell and//or artefact.

Archaeological sites located within the dune field will be periodically buried, then re-exposed, with new sites expected to be exposed as the leading edge of the deflation basin slowly moves inland. As a consequence of this process, the visibility of sites is never constant and is related to the dynamic nature of the dune transgression process.

The proposed expansion of the extraction pit is over an area previously dredged for mineral sands. The action of dredging has resulted in a highly disturbed and modified environment. As a consequence of this disturbance the potential for impact is considered unlikely and KNC concludes that the modification would not result in direct impact to Aboriginal Heritage.

Based on the above, there is no requirement to provide protective measures during proposed future works. Despite this, Boral has elected to reduce the extent of the proposed extraction extension to setback the proposed extractive area from the fenced items that encroach over Boral's boundary. This amended extraction footprint is shown in **Attachment C.**

4.2 Biodiversity

OEH sought the preparation and submission of a Biodiversity Development Assessment Report prepared in accordance with the Biodiversity Assessment Method.

DPIE by email on 15 February 2019 clarified that the following would be required,

"Additional information to support the conclusions made for impacts to biodiversity (outlined in the SEE - section 7.2). OEH require further information to understand if the proposal is likely to increase impacts to biodiversity values (under the BC Act 2016) and recommend a survey (walk over) of the modification area by a suitably qualified person to confirm this"

Niche Environment and Heritage undertook a field survey on 4 March 2019 covering the full extent of the buffer area to be included in the modified extraction area. The field survey confirmed that the buffer does not support any native or introduced plant cover or faunal habitat.

Current operations are managed to avoid areas of vegetation, generally located along the landward extent of the extraction area. A minor mapping error included a portion of this area in the original submission, these figures have now been updated to confirm that there will be no extraction in this area.

Based on the assessment of Niche and the clarification on the extant of the active extraction area, to exclude any existing established vegetation, the proposed modification will have no impact on biodiversity values of the site. A copy of the Biodiversity assessment report is provided at **Attachment B**.

Figure 1: location of AHIMS site relative to the 15 metre buffer (source: KNC, 2019)

4.3 Landscape Stabilisation

OEH have requested that the proposed modification be amended to retain the adopted dune stabilisation methods.

Boral has reviewed the proposal to align with the request of OEH. The Rehabilitation and Landscape Management Plan (2018) will be retained as adopted. No amendments are sought to the plan or the conditions as imposed in relation to this aspect.

4.4 Groundwater

As set out in section 7.4 of the submitted SEE, the groundwater table is generally between 1.5 – 1.7 metres Australian Height Datum (AHD). To avoid impacts on groundwater, a maximum extraction depth of 2.5 metres AHD was adopted. This extraction limit is reflected in condition 7 of the existing consolidated consent (as amended).

The EPA and Department of Industry (Water) have sought further information and the inclusion of new conditions in relation to groundwater. These matters are considered in the following subsections.

4.4.1 Groundwater Monitoring

The project area and the site generally, in relation to groundwater, is monitored by a series of bores at various locations around the site and the windblown project area, these area shown in **Figure 2**. A full size copy is provided at **Attachment E.**

Eight of the existing bores are located within the immediate vicinity of the windblown project. The nearest bore, MW1, is located on the landward edge of the operation area clear of the proposed extension. This bore was previously located on the south west boundary but relocated in December 2018 due to ongoing vandalism. The current location of the bore MW1 is shown in **Figure 2** based on this location the proposed modification will not impact on the existing groundwater monitoring network.

As the proposed development alters only the extent of the extraction area and does not alter the method or depth of extraction there is not considered to be any change to the development (as approved) that would trigger a reconsideration of groundwater movement or potential interactions.

A Groundwater Management Plan, prepared by Jacobs (2018) addresses groundwater level and quality trigger and trigger action response plan criteria as set out in the EPA submission. The proposed modification would not require alteration to these requirements and existing conditions of consent would ensure compliance and reporting.

4.4.2 Extraction depth limits

The EPA, while raising no objection to the proposed modification, has recommended additional conditions be included with the aim of protecting the groundwater source. The requested conditions include,

- the proponent must not extract sand within 0.7 metres of the maximum predicted groundwater level at the premises at any time.
- the proponent must ensure that rehabilitation of final landform levels remain one metre above the maximum predicted groundwater level at the premises.

The requested conditions seek to alter aspects of the approved development that are not the subject of the modification. The requested conditions would alter fundamental aspects of the project (as approved) in relation to both active operations and post completion rehabilitation measures.

The modification merely seeks a lateral extension of the extraction pit to permit the use of an otherwise sterilised resource. Extraction of the resource from within the buffer would be unlikely to impact on existing groundwater levels or water quality objectives. Accordingly the modification of this condition is considered to be beyond the scope of matters relevant to the assessment and determination of the proposal.

The requested condition is neither reasonable nor necessary in the context of the modification proposed.

Boral has recently completed a review of the Groundwater Management Plan, implementation of this plan and adherence to the existing conditions of consent is considered suitable to ensure protection of the underlying aquifer. A copy of this plan is provided in **Attachment F**.

Figure 2: location of groundwater monitoring bores/monitoring network

In relation to the proposed condition regarding rehabilitated levels. A Rehabilitation and Landform Management Plan (2018) has been approved for implementation on the site. This plan proposes natural rehabilitation of the pit following completion of extractive activities and sets a completion criteria for the final landform to be a minimum elevation of 2.5 metres AHD.

While Boral acknowledges the intent of the condition proposed in relation to rehabilitation, there are practical limitations associated with a condition that requires *rehabilitation of final landform levels remain one metre above the maximum predicted groundwater level* due to the natural mobility of the dune system in response to prevailing winds causing deflation and inflation of the dune system.

In this regard, Boral believes that the adopted rehabilitation management plan is suitable to manage the potential for exposure of the ground water table. Allowing the dunes to return to a natural state overtime is considered the most appropriate response.

4.5 Context and setting: surrounding land uses

One submission was received in relation to a proposed rezoning of adjacent land located on the opposite side of Nelson Bay Road. The proposal was granted a gateway determination by DPIE on 24 May 2019 and the status of the application is categorised as “pre-exhibition”. In this regard, the proposal is considered neither imminent nor certain in its outcome.

Notwithstanding the above, the nearest point of the submitters land located at No. 21 Cox Lane, Fullerton Cove on the opposite side of Nelson Bay Road to Boral’s holding and approximately 1.24 kilometres northwest of the windblown project.

The nature of the proposed modification, which aims to increase the extraction area to optimise use of the available resource, will not alter the approved method of extraction, hours of operation or transport limits therefore retaining the core features of the operation that could alter amenity of neighbouring properties.

The modification would not result in a changed or diminished amenity for surrounding landholders.

4.6 Extent of extraction area

DPIE has previously sought a survey boundary confirming the location of the legal boundary of Boral’s holdings relative the area of active extractions. These plans were submitted in February 2019. This plan is now submitted for the purposes of completeness, refer to **Attachment D.**

5.0 CONCLUSION

The development, as proposed to be modified, is of a minor nature allowing for a nominal extension of the approved extraction area located on the windblown dunes.

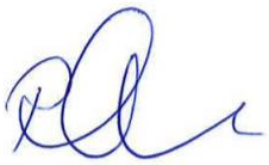
The modification does not *“materially or essentially”* alter the approved development and as such satisfies the test of *“substantially the same”* allowing the proposal to be considered and determined under the provisions of section 4.55 of the EP&A Act 1979.

The modification is needed to ensure the continuation and the extraction of remaining sand within the Stockton Sandpit which supplies the Hunter and Sydney metropolitan regions that have and continue to experience significant demand for sand related products to support numerous commercial and residential projects.

Given the need for the proposed development in meeting existing and likely future demand for sand used to support ongoing construction projects within the identified regions and the minimal environmental impacts likely to result as consequence, we are of the view that the modification is worthy of support.

Should any further additional information or clarification be required in relation to the modification, please contact the undersigned on phone 0401 894 110 or email rachael.snape@boral.com.au

Yours sincerely,



Rachael Snape
Planning and Development Manager (NSW/ACT)

Attachment A: **Aboriginal Assessment Report prepared by Kelleher Nightingale Consultants Pty Limited**

STOCKTON SAND QUARRY – PROPOSED MODIFICATION 3
(DA140-6-2005)

Aboriginal Heritage Assessment

Prepared for Boral Resources (NSW) Pty Limited

September 2019

Ref. 1828

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Document Information

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Recipient	Rachael Snape
Prepared by	Dr Matthew Kelleher; Cristany Milicich; Ben Anderson
Approved by	Dr Matthew Kelleher

Executive Summary

Boral Resources (NSW) Pty Limited ('Boral') currently operates the Stockton sand quarry at Fullerton Cove, in the Port Stephens Local Government Area (LGA) north of Newcastle, NSW. In 2005 Boral lodged a State Significant Development (SSD) application (DA140-6-2005) with the Department of Planning to extract sand from the windblown dunes to the southeast of the central extraction area at the rear of Stockton Beach. This became known as the Windblown Project, and was located in an area previously dredged for mineral sands by Mineral Deposits Limited (MDL) between late 2000 and 2003. The dredge was dismantled in early 2004.

The Windblown Project was subject to a comprehensive environmental assessment process including preparation of an Environmental Impact Statement (EIS) and was subsequently granted consent from the then Minister for Planning on 24/01/2006. Boral is proposing to modify DA 140-6-2005 to permit a minor expansion to the approved extraction area for the Windblown Project which would add one to two years to the existing sand resource. The proposed modification (Modification 3) would not exceed the transportation or depth extraction limits as set out in the existing conditions of consent.

A further EIS was prepared to support the Modification application in January 2019. Following the receipt of agency submissions from the Department of Planning and Environment (DP&E) and the Office of Environment and Heritage (OEH), it was identified that additional Aboriginal heritage assessment would be required. Boral engaged Kelleher Nightingale Consulting Pty Ltd (KNC) to prepare an Aboriginal Heritage Assessment for the Modification 3 area to inform the EIS and response to submissions. This assessment has been prepared in accordance with the recommendations of OEH and DP&E and with reference to relevant OEH guidelines including the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales* (OEH 2010a) and *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (OEH 2010b).

The assessment identified that the Modification 3 proposal will not have an impact on Aboriginal heritage. The impacts of the modification proposal on Aboriginal heritage are consistent with the existing Project Consent. The proposed modification will not result in an increased impact to Aboriginal heritage.

No Aboriginal heritage items, Aboriginal objects or areas of archaeological potential were found to exist within the proposed expansion area, which has been severely disturbed by previous mineral sand extraction.

Recommendations for the proposed Modification area have been developed to be consistent with the existing management measures in the Windblown Project EIS, and include Aboriginal heritage training as part of site inductions, avoidance of recorded sites located in proximity to Boral's property boundary, and adherence to an unexpected finds procedure and procedures for handling human remains.

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Figures

Tables

1 Introduction

1.1 Project background

Boral Resources (NSW) Pty Limited ('Boral') currently operates the Stockton sand quarry at Fullerton Cove, in the Port Stephens Local Government Area (LGA) north of Newcastle, NSW (Figure 1). Boral commenced extraction from the Stockton sand quarry in the early 1990s, under a local level consent (DA2010/94) granted by Port Stephens Council. This consent related to an extraction area located within the central portion of the broader site. This consent has since lapsed and the central extraction area has been successfully rehabilitated to provide a safe and stable landform consistent with the surrounds.

In 2005, while extraction was continuing under the 1994 consent, Boral lodged a State Significant Development (SSD) application (DA140-6-2005) with the Department of Planning to extract sand from the windblown dunes to the southeast of the central extraction area at the rear of Stockton Beach (Figure 2). This became known as the Windblown Project, and was located in an area previously dredged for mineral sands by Mineral Deposits Limited (MDL) between late 2000 and 2003. The dredge was dismantled in early 2004.

The Windblown Project was subject to a comprehensive environmental assessment process including preparation of an Environmental Impact Statement (EIS) (Environmental Resources Management (ERM) 2005a), and was subsequently granted consent from the then Minister for Planning on 24/01/2006. The consent was granted for a period of 20 years from the commencement of operations, being 15/10/2008. Accordingly, extraction of sand from the windblown dunes may continue under this consent until 15/10/2028.

Sand harvested from the Stockton sand quarry is used in many construction related applications across the Hunter and Sydney Metropolitan Regions. Sustained demand for sand related products in response to continued and anticipated growth in the residential and commercial markets has meant that the windblown sand resource will be exhausted sooner than expected. To meet short term demand for sand, Boral is proposing to modify DA 140-6-2005 to permit a minor expansion to the approved extraction area for the Windblown Project which would add one to two years to the existing sand resource. The proposed modification (Modification 3) would not exceed the transportation or depth extraction limits as set out in the existing conditions of consent.

A further EIS was prepared to support the Modification application in January 2019 (Boral 2019). Following the receipt of agency submissions from the Department of Planning and Environment (DP&E) and the Office of Environment and Heritage (OEH), it was identified that additional Aboriginal heritage assessment would be required. Boral engaged Kelleher Nightingale Consulting Pty Ltd (KNC) to prepare an Aboriginal Heritage Assessment for the Modification 3 area to inform the EIS and response to submissions. This assessment has been prepared in accordance with the recommendations of OEH and DP&E and with reference to relevant OEH guidelines including the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales* (OEH 2010a) and *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (OEH 2010b).

1.2 Location of the study area

Boral is seeking approval to expand the active extraction area granted under DA 140-6-2005 to include the 15 metre wide "buffer" that extends along the northeast, southeast and southwest perimeter of Boral's landholding. The area of extension is limited to the southwest and southeast buffer areas and combined with allowing extraction of sand would also relocate the existing batters outward, with the 1:3 crest line repositioned towards Boral's property boundary.

The boundaries around the additional extraction area measure approximately 1,680 metres to the southeast (seaward) and 421 metres to the southwest. The additional area is approximately 3.2 ha and would allow for the capture and use of around 475,000 tonnes of additional sand resource. The proposed Modification 3 expansion area constitutes the 'study area' for the Aboriginal heritage assessment. The study area's location in relation to the existing extraction area and property boundary is shown in Figures 3-4.

1.3 Summary of findings

The assessment identified that the Modification 3 proposal will not have an impact on Aboriginal heritage. No Aboriginal heritage items, Aboriginal objects or areas of archaeological potential were found to exist within the proposed expansion area, which has been severely disturbed by previous mineral sand extraction.

The modification proposal is consistent with the existing Project Consent and will not result in an impact to Aboriginal heritage.

Figure 1. Location of the Stockton sand quarry

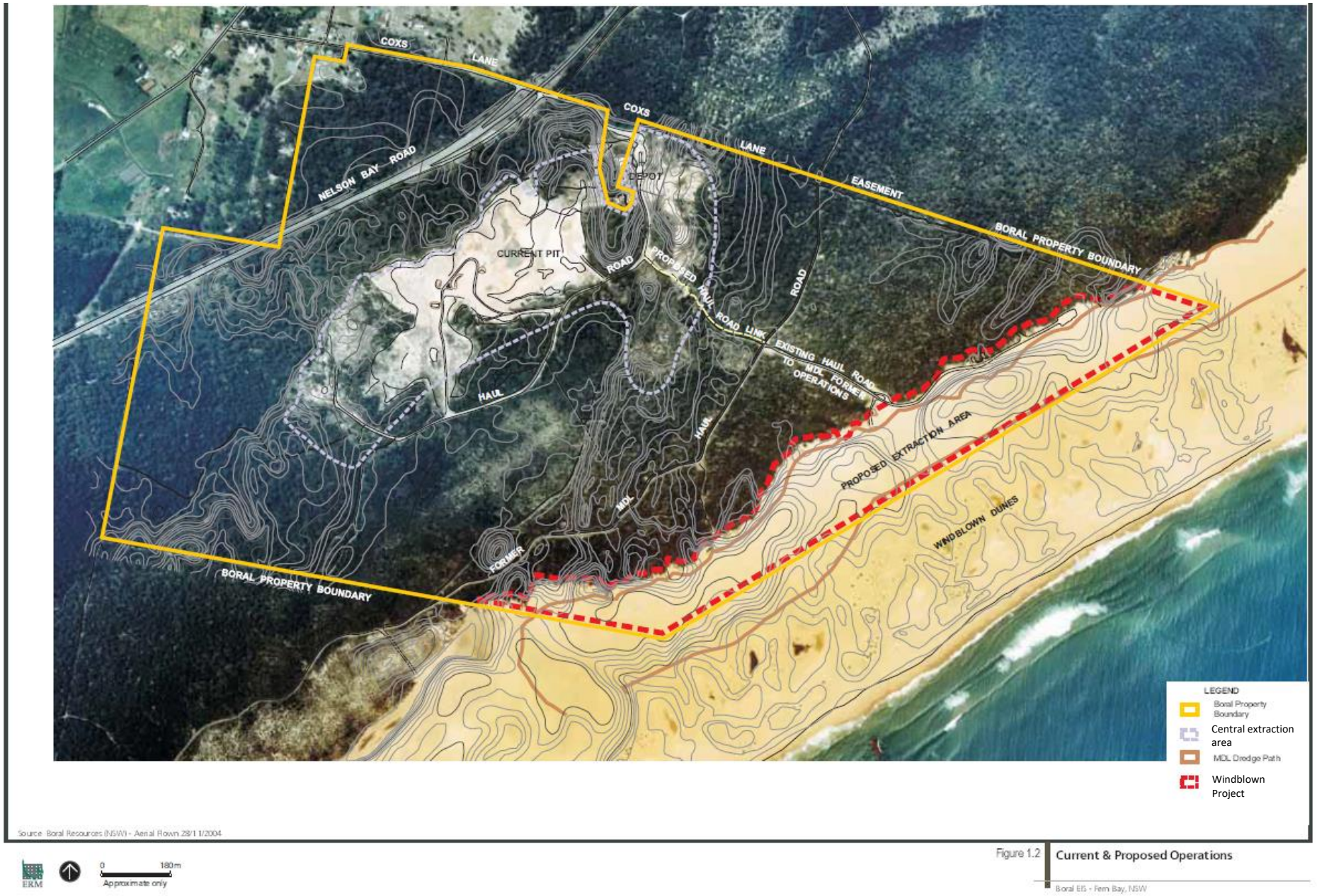

Figure 2. Current and former extraction operations at Stockton sand quarry showing Windblown Project area (ERM 2005a: Figure 1.2)

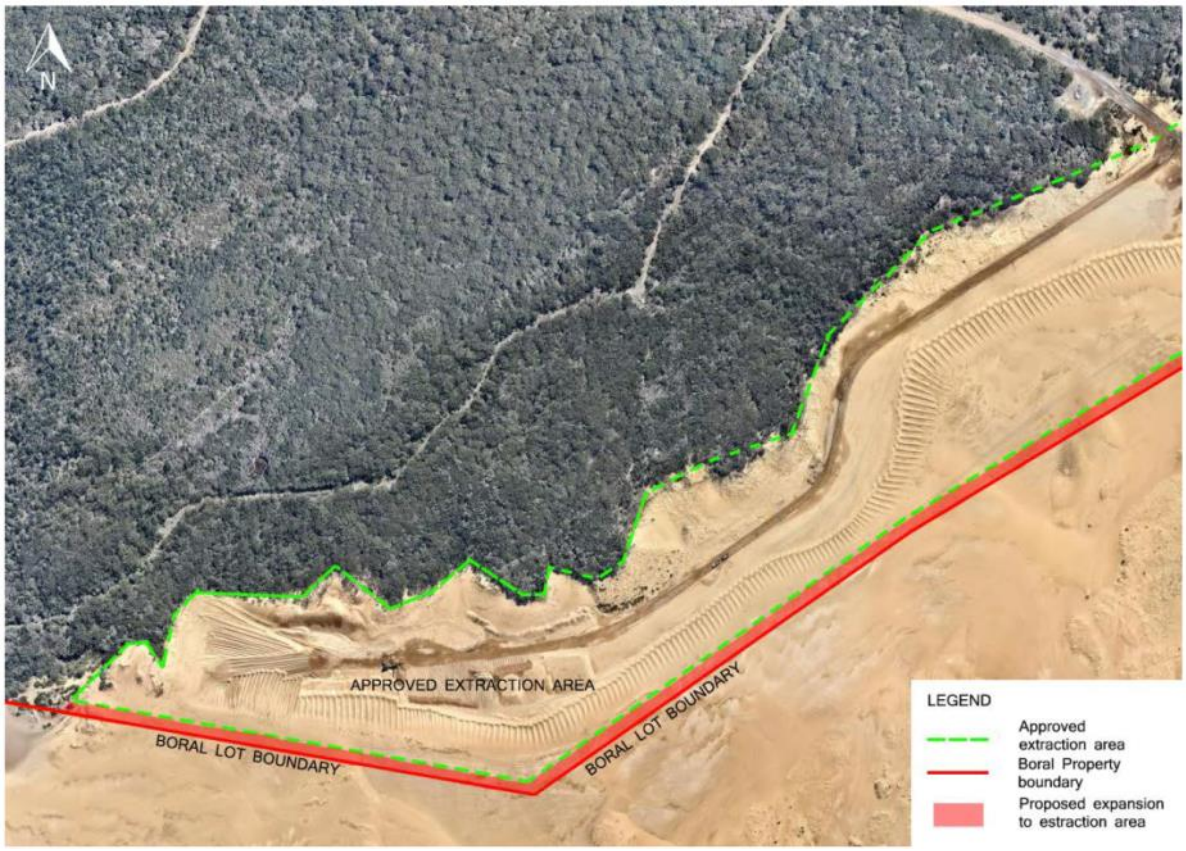

Figure 3. Approved windblown extraction area and the study area shown in red, south west portion (Boral 2019: Figure 4.2)

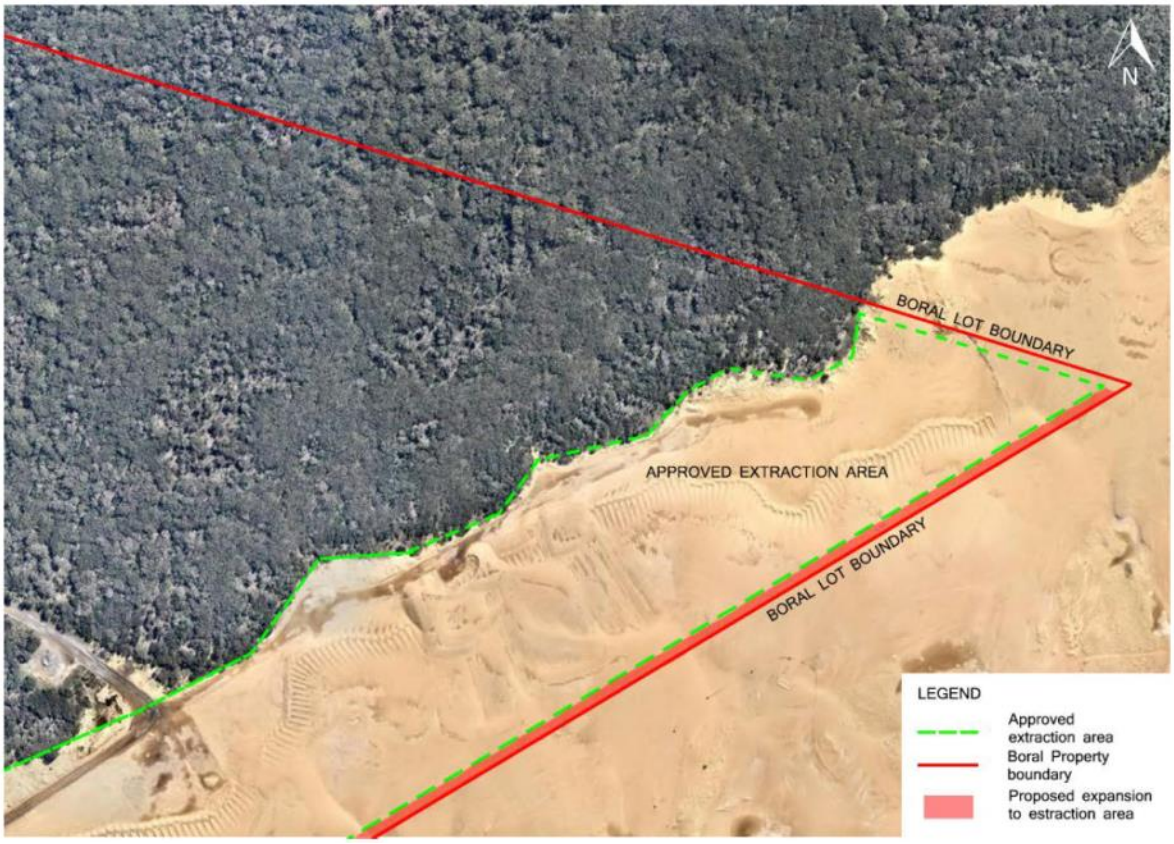

Figure 4. Approved windblown extraction area and the study area shown in red, north east portion (Boral 2019: Figure 4.3)

2 Aboriginal Community Consultation

Boral is currently undertaking an extensive Aboriginal cultural heritage consultation process related to proposed sand quarrying works in the former central extraction area of the property. The consultation process is being conducted in accordance with the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (OEH 2010c).

The process has included compilation of a list of Registered Aboriginal Parties who have an interest in Aboriginal cultural heritage matters for the Stockton sand quarry and local area. Sixteen Aboriginal stakeholders have been identified for the project and are listed in Table 1 below.

Table 1. Registered Aboriginal stakeholders

Registered Aboriginal Stakeholder	Representative and/or Contact Person
Worimi Local Aboriginal Land Council (LALC)	Jamie Merrick
Murra Bidgee Mullangari Aboriginal Corporation	Ryan Johnson
Didge Ngunawal Clan	Paul Boyd and Lilly Carroll
Merrigarn Indigenous Corporation	Shaun Carroll
Muragadi Heritage Indigenous Corporation	Anthony Johnson
Nur-Run-Gee Pty Ltd	Leonard Anderson OAM
Lower Hunter Wonnarua Cultural Services	Tom Miller
Worimi Traditional Owners Indigenous Corporation	Candy Towers
A1 Indigenous Services	Carolyn Hickey
Murrooma Incorporated	Anthony Anderson
Karuah Indigenous Corporation	David Feeney
Widescope Indigenous Group	Steven Hickey
Worimi Conservation Lands (WCL Board of Management c/o Graeme Russell)	Graeme Russell
Amanda Hickey Cultural Services	Amanda Hickey
Aboriginal stakeholder (details withheld)	Aboriginal stakeholder (details withheld)
Aboriginal stakeholder (details withheld)	Aboriginal stakeholder (details withheld)

*Two stakeholders specified they did not want their details released in accordance with item 4.1.5 of the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010*

2.1 Site inspection

A site inspection was undertaken with Aboriginal stakeholder representatives on 27/06/2019. Stakeholders attended across two sessions in the morning and afternoon. Representatives from Worimi LALC, Didge Ngunawal Clan, Nur-Run-Gee Pty Ltd, Murrooma, Worimi Conservation Lands, Karuah Indigenous Corporation, Widescope Indigenous Group and Amanda Hickey Cultural Services attended the inspection and Worimi LALC, Didge Ngunawal Clan, Nur-Run-Gee Pty Ltd, Murrooma, Worimi Conservation Lands and Karuah Indigenous Corporation representatives took part in the site walkover.

Representatives were accompanied by project archaeologist Dr Matthew Kelleher (KNC) and representatives from Boral. The site inspection included a discussion of the site history and existing mining disturbance, further discussion of the project, proposed extraction staging, remediation and archaeological context of the local area including location of nearby previously recorded sites. A site walkover was undertaken of the study area. No Aboriginal objects were identified and representatives concurred with the assessment of existing severe disturbance within the study area and proposed impact area.

3 Landscape Assessment

3.1 Geology and geomorphology

The Stockton sand quarry is located within the Hunter subregion of the Sydney Basin, bordering the Pacific Ocean. The Sydney Basin is a large geological feature stretching from Batemans Bay in the south to Newcastle in the north and Lithgow in the west. The formation of the basin began between 250 to 300 million years ago when river deltas gradually replaced the ocean that had extended as far west as Lithgow (Pickett and Alder 1997). Fluctuating marine advances and regressions deposited sediment onto older basement rocks of the Lachlan Fold Belt and Late Carboniferous volcanoclastic sediments. The Hunter subregion comprises a complex of Permian shales, sandstones, conglomerates, volcanics and coal measures, and is bounded on the north by the Hunter Thrust fault and on the south by cliffs of Narrabeen Sandstone. A Quaternary coastal barrier system is present in the Newcastle/Stockton Bight (National Parks and Wildlife Service (NPWS) 2003:191). The quarry is located within this coastal barrier system in the Stockton Bight.

Stockton Bight (also known as Newcastle Bight) is a wide south facing coastal embayment bordered by Nobbys Head at Newcastle in the south and Birubi Point at Anna Bay in the north. The bedrock of Nobbys Head and the higher relief of Newcastle border the southern side of Stockton Bight, comprising the various Permian age subgroups of the Newcastle Coal Measures (coal, tuff, conglomerate, sandstone and shale) (Gorbert and Chesnut 1975). The Hunter River has been deflected to the south by the Stockton Bight barrier system and enters the sea against Nobbys Head. The Bight sediments abut the sedimentary Permian rocks of the Tomago coal measures (shale, mudstone, sandstone, coal, tuff and clay) and Mulbring siltstone (siltstone, claystone, sandstone, conglomerate and limestone) between Raymond Terrace and Big Swan Bay, and at the northern end of the Bight abut the older Carboniferous Nerong Volcanics at Birubi Point (toscanite, dacite, andesite, ignimbrite, agglomerate, conglomerate, sandstone and siltstone). Between the Stockton training wall of the Hunter River and Birubi Point is the Stockton sand barrier system.

The coastal barrier system consists of a gently curving Quaternary sand dune barrier system that comprises four major components (ERM 2005a:42):

- an inner Pleistocene barrier extending from the Hunter River to Lemon Tree Passage which was deposited as a series of parallel beach ridges and transgressive dunes approximately 120,000 years ago
- a back-barrier depression backs the inner barrier and is occupied by the Hunter River - Raymond Terrace - Grahamstown Reservoir and Port Stephens
- an interbarrier depression occupied by Fullerton Cove - Salt Ash – Tilligerry Creek
- an outer (Holocene) barrier that was deposited after the last post-glacial sea level rise, approximately 6000 years ago.

Aeolian erosion and redeposition have reworked the surfaces of both the inner and outer barriers and in addition the morphology of the beach ridges has been modified by fluvial denudation. The Stockton sand quarry is located in the Holocene outer barrier system and comprises two geomorphological units. The first unit comprises a relict series of vegetated beach parallel dunes and low profile sand sheets, and the second unit comprises the existing beach and unstable high dunes that extend along most of the present coastline (current windblown extraction area). Recent Quaternary coastal geology mapping (Figure 5; Hashimoto and Troedson 2008) shows the two geological units which underlie the Stockton sand quarry. The majority of the property is located atop Holocene dunes of marine sand (Qhbd), corresponding to the stable, vegetated beach parallel dunes and intervening sand sheets in the western part of the quarry property. Small areas to the west and north are mapped as Holocene beach ridge swales and dune deflation hollows (Qhbw) comprising marine sand, organic mud and peat. The Windblown Project and the current Modification 3 study area is located atop Holocene age mobile dunes comprised of marine sand (Qhbdm), corresponding to the geomorphological unit of existing beach and unstable high dunes.

The transverse dune system within the study area is the product of strong winds and fine to medium bare sand. The study area is located on the active hind dunes of the third and most recent phase of dune transgression, commencing 300-500 years before present (BP) (Short 2005:10). Earlier Phase 1 and 2 transgressions formed the stable, vegetated dunes at the rear of the beach and date to around 5200-4000 BP and 2000 BP respectively (Short 2017). The current Phase 3 dune transgression is represented by the presently mobile bare dunes that dominate the outer section of the barrier and extend most of the length of the beach. Prevailing winds from the southwest are contributing to migration of the dunes in a northeast direction (parallel to the beach). The western crests of the dunes also migrate to the northwest at rates between 3 to 5 metres per year driven by the onshore southeast winds. An approximately 20 year period has been established for dune cycling (i.e. surfaces are repeatedly covered by advancing dune crests then exposed by the following dune swales) (Short 2017:20). The northwest movement of the dune is moving sands into the Windblown extraction area and the current study area. The dunes are being replenished by sand blown from the bare beach foredune located outside the boundary of Boral's landholdings. This movement of sand into the extraction area is exacerbated by significant 4 wheel drive (4WD) disturbance along the beach. The current study area has also been modified by previous mineral sand extraction (see section 3.3).

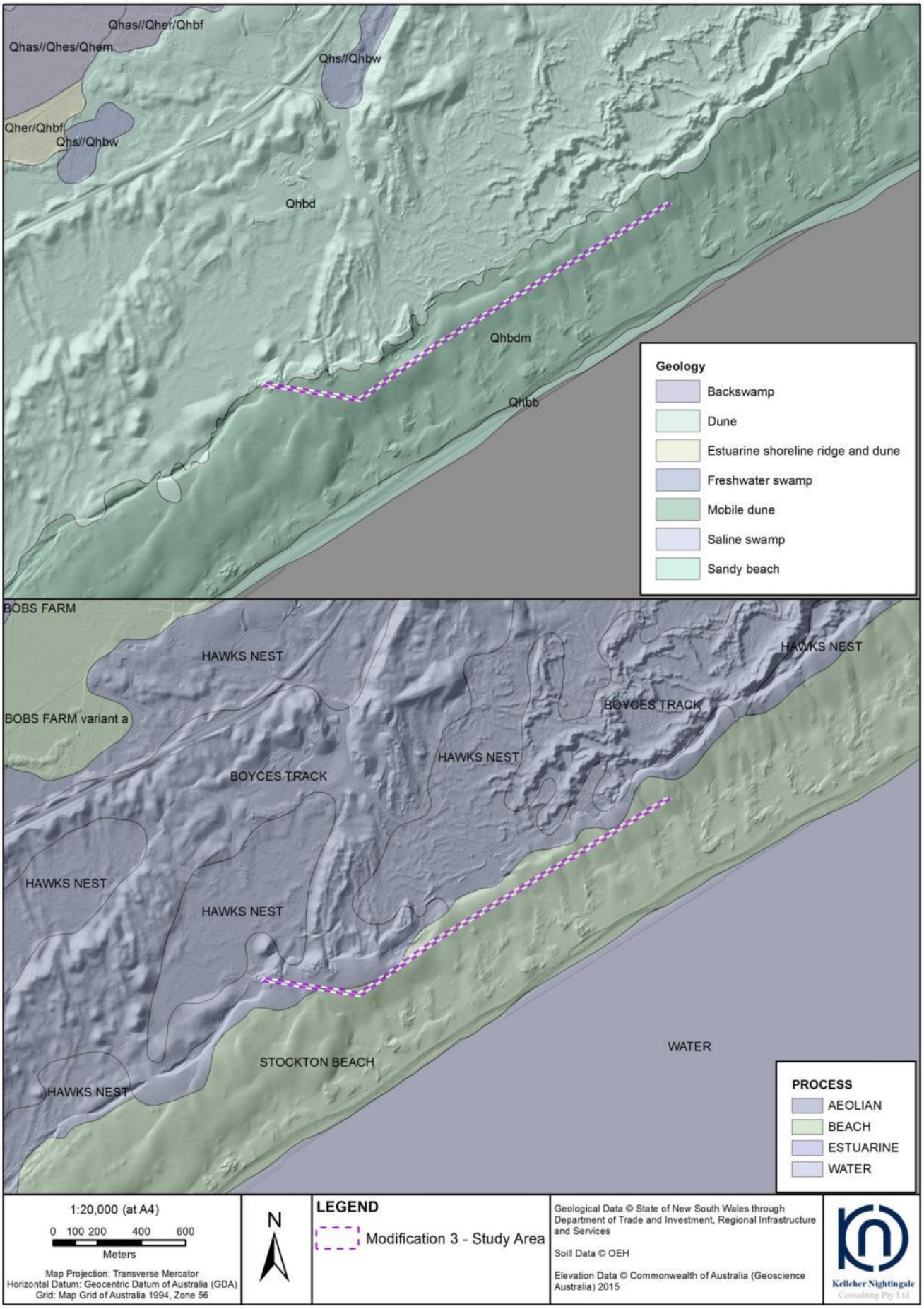

Figure 5. Geology and soils of the study area

3.2 Soils and hydrology

There are three soil landscapes occurring across the Stockton quarry property. The study area and proposed Modification 3 extraction area intersects two of these. The majority of the area is located atop the Stockton Beach soil landscape, occurring on the beaches and unstable sand dunes of the Tomago Coastal Plain. Stockton Beach soils comprise deep (>200 cm), well to poorly drained Solonchaks/Calcareous Sands on beaches, with deep (>200 cm), very well-drained Calcareous Sands on dunes (Matthei 1995). Materials comprise Quaternary Holocene quartz sand, shell fragments and flotsam. This landscape is highly dynamic, constantly being modified by wind and waves, and is particularly susceptible to aeolian erosion and movement. The Stockton Beach soil landscape active transgressive Phase 3 dune is gradually engulfing the Boyces Track soil landscape and Hawks Nest soil landscape which occur to the west on the more stable, vegetated Phase ½ parallel dunes and sand sheets.

The south western portion of the study area intersects the mapped extent of the Boyces Track soil landscape. Boyces Track soils occur on the high, steep, Quaternary Holocene transgressive aeolian dunes of the Tomago Coastal Plain. Soils comprise deep (>300 cm), well-drained weakly developed Podzols under native vegetation with loose, loamy sand topsoils. The low Holocene sandsheets, swales and low transgressive dunes are occupied by Hawks Nest soils. These comprise deep (>300 cm), well-drained Podzols and Siliceous Sands/Podzols on dunes and deep (>200 cm), poorly drained Humus Podzols on sandsheets (Matthei 1995:215). Both landscapes are non-cohesive and susceptible to wind erosion. The proposed extraction area is devoid of vegetation and topsoil coverage.

No springs or permanent streams are present within the study area or the larger Boral property. Several small semi-permanent waterholes are present around the stable, vegetated dunes and shallow water pools form in the inter-dunal swales after periods of rain, persisting when deflation reaches the water table. Groundwater in the proposed extraction area is shallow, between 1.52 metres to 1.67 metres Australian Height Datum (AHD). Surface runoff is negligible and groundwater recharge is high (ERM 2005a:49).

3.3 Land use and existing disturbance

The current study area has been modified by previous mineral sand extraction activity and is highly disturbed. Mineral Deposits Limited (MDL) dredged mineral sands from the unvegetated windblown dunes within Boral's land in accordance with an EIS prepared in April 2000. Mining commenced in October 2002, with the dredge moving progressively from southwest to northeast through Boral's property. MDL's dredging within Boral's property was completed in July 2003 and the dredge was removed the following year.

Dredging involved suctioning, screening, separating the heavy mineral fraction and reinstating the bulk of the dune mass. All the sand within the dredge path, to a level at least four metres below the groundwater table has been processed. Heavy mineral sand dredging normally deposits most of the oversized material such as sticks and roots and shell into the bottom of the dredge pond, which in this case would be approximately minus three metres AHD. Some shell and gravel is however mixed through the sand mass, and is often observed as a lag deposit on the dune surface (ERM 2005a:81). The dredge path runs through the current study area, parallel to the Boral property boundary.

The mining destroyed the original dune morphology, with the remaining sand replaced on the site to recreate the approximate pre-mining dune morphology. However while the overall gross dune morphology (height, width and volume) was retained the detailed meso-scale dune shape was not, meaning the active transverse dunes were not reconstructed in the area south of Boral's landholding (Short 2005:17). Boral's Windblown extraction project commenced in 2008 and has progressively quarried sand from the approved extraction area, bordered by a 1:3 gradient batter. The current proposal to extract within the buffer would also move the batters outwards and reposition their crests. This movement would be into an area previously directly disturbed by the dredge path.

3.4 Summary

The study area is located in a geomorphically active and highly dynamic environment. The Phase 3 transgressive dune system is a mobile and travelling system, with dune migration periodically exposing and burying surfaces on a cycle of approximately 20 years (Short 2017:20). Dunes are being replenished by sand blown in from the foredune and seaward deflation basin, and are migrating to the north east and northwest at approximately 7 metres/year and 3-5 metres/year respectively. Soils comprise deep, unconsolidated mobile beach sands, with no topsoil development or vegetation cover within the study area. The active Phase 3 dunes overlie the earlier Holocene foredune ridge plain dating to c. 6000 BP, and the Phase 1 and 2 dune remnants, which are being reworked and periodically exposed as darker remnant soil horizons on the dune faces.

The study area contains landforms that are considered archaeologically sensitive under the *Due Diligence Code of Practice*, as it is located within a sand dune system and within 200 metres of waters, however, given its previous history of extensive disturbance, the study area meets the definition of 'disturbed land' under the OEH *Due Diligence Code of Practice.*

4 Archaeological Context

4.1 Database searches and known information sources

4.1.1 AHIMS web services

The Aboriginal Heritage Information Management System (AHIMS) is a database operated by the Office of Environment and Heritage (OEH) and regulated under section 90Q of the *National Parks and Wildlife Act 1974*. AHIMS contains information and records pertaining to registered Aboriginal archaeological sites (Aboriginal objects, as defined under the Act) and declared Aboriginal places in NSW. A search of AHIMS was conducted on 9 May 2019 and 25 July 2019 to identify registered (known) Aboriginal sites or declared Aboriginal places within or adjacent to the study area (Appendix A).

The AHIMS Web Service database search was conducted within the following coordinates (GDA, Zone 56):

Eastings:	388850 - 393800
Northings:	6363000 - 6366500
Buffer:	0 metres (search coordinates included a buffer around the study area)

The AHIMS search results showed 75 Aboriginal sites recorded in or near the above location. No Aboriginal places had been declared in or near the above location. The locations of registered Aboriginal sites in the search area are shown on Figure 6. The frequencies of site types ('site features') are listed in Table 2.

Table 2. Frequency of site features from AHIMS database search

Site Context	Site Features	Frequency	(%)
Open Site	Aboriginal Resource and Gathering; Artefact	2	*2.7*
	Artefact	18	*24.0*
	Artefact; Shell	24	*32.0*
	Shell	24	*32.0*
	Restricted*	7	*9.6*
Total		*75*	*100*

*Seven restricted sites were present within the AHIMS search area, meaning no further information is available regarding site type, location or condition. Consultation with the AHIMS registrar confirmed that none of these were located within the study area and would not be impacted by any works within the proposed modification area.

As well as determining if there are any registered (known) sites within a given area, an AHIMS search also helps to characterise local archaeology by illustrating the distribution of known sites within the local landscape. Search results for the current project indicated the predominance of open context occurrences of artefacts and shell (middens) around the study area. According to the data retrieved from AHIMS, these are the most common manifestations of archaeological material in the local area. Sites displaying solely shell (n=24) or solely artefacts (n=18) have also been recorded. Artefacts may be identified in isolation ('isolated finds') or in association with others in an artefact scatter (open camp site). Two artefact sites have also been recorded in associated with areas of Aboriginal Resource and Gathering.

The presence of numerous recorded sites in the vicinity of the study area demonstrates physically that the local landscape was used by Aboriginal people in the past and that material traces of this landscape use have survived in the form of Aboriginal objects and archaeological deposit. Nine previously registered AHIMS sites are located within approximately 50 metres of the proposed Modification 3 extraction area. All are open context midden sites featuring shell and/or artefacts. These recordings are discussed further in section 4.2.

4.1.2 Other heritage registers and databases

A search was also undertaken of the following statutory and non-statutory heritage registers for Aboriginal heritage items within or adjacent to the study area:

- Port Stephens Local Environmental Plan (LEP) 2013
- State Heritage Register and State Heritage Inventory
- Section 170 Heritage and Conservation Registers
- Commonwealth Heritage List
- National Heritage List
- Australian Heritage Database
- Australian Heritage Places Inventory
- Register of the National Estate (N.B. the Register was closed in 2007 and is no longer a statutory list. It is maintained on a non-statutory basis as a publicly available archive and educational resource).

Figure 6. AHIMS extensive search results

Three heritage items were identified on these registers. The Port Stephens LEP 2013 lists the 'Stockton Beach Dune System' within Lots 224–227 and 230 DP 1097995, Lots 216 and 218 DP 1044608, Lot 592 DP 1097992 and Lot 7033 DP 1053720. The item borders the Boral property to the east and north. The item is listed as a natural landscape. The listing includes 'Aboriginal site and shell middens, ship wrecks, WWII ramparts, tank traps, proofing range, rifle range and tin huts' within the Stockton Beach Dune System. The item is listed as 'I34' on Schedule 5 of the Port Stephens LEP 2013 as displaying local heritage significance. The item is located outside of the current study area.

The Register of the National Estate, a non-statutory archive which closed in 2007, lists two further recordings in the Fern Bay area. 'Newcastle Bight Coastal Area' is listed as an Indicative Place (i.e. was not accessioned onto the register prior to its closing) and was nominated for its Natural value. The statement of significance includes Aboriginal heritage values in its description, particularly "some of the largest Midden sites in NSW as well as burial and educational sites". The recording is not a listed heritage item and has no legal status as a statutory heritage item.

A second Indicative Place described only as 'Indigenous Place' is listed for the suburb of Fern Bay, with no further information available. This recording is also not a listed heritage item and has no legal status as a statutory heritage item.

No other Aboriginal heritage items or items of Aboriginal heritage significance were listed on these databases within or in the vicinity of the study area.

4.2 Previously recorded archaeological sites

Nine previously registered AHIMS sites are located within approximately 85 metres of Boral's property boundary and the proposed Modification 3 extraction area. All are open context midden sites. These site recordings are discussed below and shown in Figure 7.

Fern Bay 6 (AHIMS 38-4-0262)

The site comprises an open context midden recorded during the *Newcastle Bight Aboriginal Sites Study* in 1990. The site was one of a series of midden sites recorded along the base of the 10 metre contour running parallel to the beach, southeast of Boral's property boundary. The site was located in a highly deflated dune surface with exposures of the old land surface (Holocene foredune ridge plain) in the dune face. Archaeological material was located at the base of the dune (i.e. not associated with the former land surface). A small scatter of pipi across a 6 metre x 4 metre area was located at the base of the active transgressive dune front at the rear of the swale, at the same level as the swale surface. Shell density was estimated at 130 shells/0.25m^2. While the AHIMS extensive search lists this site as featuring both shell and artefacts, the site card notes that no stone artefacts were identified. The site had a south-east aspect and was located approximately 50 metres from intermittent rain pools in the swale. The registered site location is approximately 85 metres from the current study area boundary.

Fern Bay 7 (AHIMS 38-4-0263)

Fern Bay 7 comprises another open context midden site recorded during the *Newcastle Bight Aboriginal Sites Study* in 1990, approximately 140 metres north east of Fern Bay 6. The site comprised a small pipi midden remnant measuring 4 metres x 3 metres, with an average shell density of 100/0.25m^2. All shells were single valves and the site card also noted the presence of highly fragmented pipi scattered around it, some of which appeared burnt. No stone was identified, with the AHIMS extensive search mistakenly listing 'artefact' as a site feature. The midden material was identified on a highly deflated ground surface at the landward margin of the swale, at the base of the active transgressive dune to the north west. The registered site location is approximately 60 metres from the current study area boundary.

Fern Bay 8 (AHIMS 38-4-0264)

The site comprises an open context midden recorded during the *Newcastle Bight Aboriginal Sites Study* in 1990. This site was located approximately 200 metres east and 100 metres north of Fern Bay 7, south east of the current study area. The site comprised two flakes of Nobbys tuff and an associated scatter of possible pipi midden. The flakes were located on the active transgressive dune face in a deflated, narrow exposure of the underlying old dune surface (Holocene foredune ridge plain). The associated shell material was located at a lower elevation, on the landward edge of the adjoining swale. Both flakes were relatively large (>5cm length) and had flaked platforms. Neither retained any cortex. The registered site location is approximately 83 metres from the current study area boundary.

Figure 7. Previously recorded AHIMS sites in proximity to the study area

Fern Bay 9 (AHIMS 38-4-0265)

Fern Bay 9 comprises an open context midden site recorded during the *Newcastle Bight Aboriginal Sites Study* in 1990. Te site was located approximately 100 metres east and 100 metres north of Fern Bay 8. The site comprised three clusters of shell midden material located on/within old land surface exposures along the base of the active transgressive dune, at the landward margin of the swale. The clusters measured 10 metres x 5 metres, 2 metres x 2 metres, and 6 metres x 5 metres, with loose, scattered surface shell between them. In the densest part of the midden exposure, shell density was estimated at >100/0.25m^2. Species was predominantly pipi (>95%) with occasional other species. Site condition was described as heavily deflated and fragmented, although the top of the three mounds retained some shell packing. One stone artefact was also identified, being a cone split flake of Nobbys tuff with no cortex. The registered site location is approximately 47 metres from the current study area boundary.

Fern Bay 12 (AHIMS 38-4-0268)

The site comprises an open context midden site recorded during the *Newcastle Bight Aboriginal Sites Study* in 1990. Fern Bay 12 was recorded approximately 445 metres north east of Fern Bay 9 and 85 metres south west of Worimi RVA 024/025. The site comprised two main shell clusters with scattered fragmentary shell and stone in between. Clusters were located on the landward side of the swale, at the base of a transgressive dune blowout, and measured 8 metres x 5 metres and 8 metres x 3 metres spaced 10 metres apart. Density ranged from 50-100+ shells/0.25m^2, predominantly pipi. The deposit was heavily deflated at the base of the swale. Six flakes of Nobbys Tuff were recorded at the site.

Worimi RVA 029 (AHIMS 38-4-1869), Worimi RVA 028 (AHIMS 38-4-1868), Worimi RVA027 (AHIMS 38-4-1867), Worimi RVA 024 (AHIMS 38-4-1864) and Worimi RVA 025 (AHIMS 38-4-1865)

Five further sites have been recorded within approximately 85 metres of the current study area boundary. The five sites were all recorded in 2016 by NPWS staff and comprise open context sites featuring shell material. The sites are located at varying distances from Boral's property boundary. Worimi RVA 029 is located near the base of the transgressive dune on the landward edge of the swale, in a similar landscape context as Fern Bay 6 and Fern Bay 7. Worimi RVA 024, 025, 027 and 028 are located on the seaward face of the transgressive dune and appear to be associated with exposures of the old Holocene foredune ridge plain similar to Fern Bay 8 and Fern Bay 9. Site cards for these recordings were not available from AHIMS and no further information regarding site contents was available.

4.3 Previous archaeological investigations

The Modification 3 study area and adjacent areas have been subject to a number of detailed archaeological investigations conducted as part of the planning and approval process for previous sand extraction activities, as well as larger scale regional studies of the Newcastle Bight.

Newcastle Bight Aboriginal Sites Study

The Newcastle Bight Aboriginal Sites Study was a comprehensive and large scale assessment undertaken in the late 1980s to inform the region's future development planning (Dean-Jones 1990). The assessment area encompassed the whole of the Bight and a range of environmental and geomorphological contexts. A detailed analysis of environmental change and landscape processes through the Late Pleistocene and Holocene was formulated in order to better understand the Aboriginal archaeological record. The study also included a review of previously recorded sites and relevant ethnographical data. Prior to this study, approximately 70 Aboriginal archaeological sites had been formally recorded within the Bight's dual barrier system, primarily midden sites. While some of these were spatially extensive, including dense concentrations of stone artefacts and packed, stratified shell, the majority of middens were smaller deposits exhibiting high levels of disturbance from a combination of natural (aeolian, fluvial) factors and modern landscape use. The dynamic geomorphic context of the Bight was highlighted as a particular factor in site taphonomy, detection and distribution patterning.

A field survey was undertaken as part of the assessment and recorded over 100 archaeological sites, with a further 40-50 additional middens noted in the modern foredune/swale but not recorded in details. Midden sites predominated, with three quarters (74%) of the newly recorded sites including at least a sparse scatter of estuarine or marine shell material. Most of these were thin and disturbed deposits, with only 12% displaying dense concentrations or lenses of packed shell. Stone artefacts were relatively rare, with fewer than five recorded at most sites where these were present. Denser concentrations of stone artefacts were associated with two particular types of site: midden complexes associated with late Holocene stable dune surfaces overlooking the deflation basin at the rear of the beach, and open campsites on Pleistocene dunes associated with Pleistocene freshwater wetlands or Holocene estuarine wetlands. It was noted that despite the presence of sites on Pleistocene dune surfaces of the inner barrier, there was no evidence that these were of an age with the substrate, and were generally similar in stone tool technology to more recent sites from the Holocene barrier. Site differences appeared to relate to differing environmental contexts and exploitation of the attendant resource zones rather than differences in site age.

An analysis of site distribution patterning was undertaken based on the results of the background research and the field survey. For the most part, newly identified sites recorded during the survey were located on the deflation basin and outer margin of active transgressive dunes. Almost all were middens. This was considered to represent intensive occupation of the deflation basin/dune area over the last 1000 years but with several caveats; namely, the very active geomorphological processes. In particular, dune cycling and the movement of transgressive dunes leads to constant exposure, deflation and reburial of archaeological material. Freshwater pools in the swales and deflation basin also deflate and rework middens around their margins. Large and complex middens may only be exposed as discontinuous, disturbed scatters or recorded as several smaller sites and archaeological context was hard to ascertain where no direct association with a recognisable land surface existed.

Within this geomorphic context, almost all of the definitive archaeological sites were located either at the interface between the deflation basin and the seaward base of the transgressive dune, or in close association with linear exposures of the older Holocene land surface (wherever this occurred). The Fern Bay sites recorded during this assessment near the current study area are located within these contexts. Disturbed shell scatters around the margins of the freshwater soaks were considered to be lag deposits in the deflating floor of the swales and blowouts. Given the high number of sites recorded within these areas, the active transgressive dune/deflation basin margin was ascribed with high archaeological sensitivity, although it was noted that apart from the current beach/foredune, this was also the area with the greatest geomorphic instability. It was also noted that 4WD activity was impacting on numerous sites. It was recommended that this activity be better managed to minimise archaeological impact, and that the NPWS explore the possibility of increasing their landholdings in the Bight in order to capture a sample of the aeolian surfaces which dominate its complex geomorphology.

Stockton Rifle Range

An Aboriginal cultural heritage and archaeological assessment was undertaken for a proposed residential development at the Stockton Rifle Range approximately 3.4 kilometres to the south west of the current study area (Umwelt 2017). The assessment comprised a review of background information including landscape factors and archaeological context, an Aboriginal community consultation process and a field survey. The assessment focused on the proposed development lands within the vegetated stable dune system east of Fern Bay. The part of the property containing the active transgressive (vegetated) dune field and beach front was to be rezoned as E2 Environmental Conservation land and not developed.

A review of landscape factors identified the complex geomorphology of the Stockton Bight dual barrier system and dune transgression sequence as a key factor in understanding archaeological site occurrence, visibility and preservation. In particular, it was noted that the Holocene beach ridge, strand plain and dune sequence present along the outer barrier had a maximum age of approximately 6000 BP. Within this sequence, the three phases of dune transgression have been dated to 4500 - 4000BP for Phase 1, 2300 - 1200BP for Phase 2, and the currently active Phase 3 approximately 300BP. The current study area is located within the active Phase 3 dune.

The environmental context of the local area would have provided a wide range of resources to Aboriginal people. Flora and fauna from terrestrial, saltmarsh, estuarine and marine environments would have provided raw materials for food, medicine, and material culture. Stone resources suitable for tool-making do not occur in the immediate area but were available from outcrops at Nobbys Head to the south and various coal measures at Shortland and Tomago to the west and northwest. Coastal woodland would have been present across the earlier Phase 1 and Phase 2 stable transgressive dunes, supporting range of mammal, reptile and bird species that provided food and other resources for Aboriginal people.

Review of archaeological context confirmed that shell middens were the most commonly recorded site type in the area. A previous analysis of archaeological patterning by Umwelt (2003) identified that sites recorded within the vegetated dune field (stable Phase 1 and 2 transgressive dunes) were primarily small scatters of stone artefacts or small (likely single event) pipi middens. Sites within the vegetated dunes tended to be buried and only visible in disturbed areas, resulting from a combination of bioturbation, occupation processes (e.g. trampling) and natural slope movement processes. Sites within the deflation basin between the foredune and the active, un-vegetated Phase 3 dunes included both small scatters and middens along with more complex sites, with identification and exposure of archaeological material "at least partially dictated by the history of deposition and deflation in the location and the destructive forces of aeolian abrasion" (Umwelt 2003). It was also noted that most sites in the Outer Barrier had not been subject to dating, and that while sites were known to occur on the buried soil surfaces of the Holocene foredune ridge plain, the archaeological material was not necessarily of the same age.

Field survey was undertaken of the proposed residential development area located within the western vegetated area. Eleven previously unrecorded sites were identified and the locations of two previously recorded sites within the area were revisited. Site comprised artefact scatters with shell midden material. Artefact raw material was primarily Nobbys tuff with occasional silcrete. Shell material was generally in poor condition, weathered and highly fragmented.

Sites were identified in areas of exposure and disturbance associated with the decommissioning and remediation of the former rifle range and Defence lands, or along recreational vehicle tracks. The location of four further registered sites (presumed but unconfirmed burials registered as a result of anomalous results on a Ground Penetrating Radar survey) were confirmed to be outside the proposed development area, along the Popplewell Road reserve to the west. The cultural values assessment conducted by the Aboriginal community identified that the more intact, vegetated stable dunes north of the access road displayed very high significance, along with known site locations.

Stockton Sandpit Windblown Sand Extraction Archaeological Assessment

Aboriginal heritage assessment formed part of the EIS prepared for the existing Windblown Project (ERM 2005b). The entirety of the current study area was assessed as part of this investigation, which concentrated on the proposed Windblown extraction area (primarily on the active transgressive dune previously dredged for mineral sands by MDL). The assessment included background research to provide an assessment of the potential for the study area to contain cultural material, a site inspection to assess Aboriginal cultural heritage and areas of potential cultural heritage, and consultation with the Aboriginal community (Worimi LALC and Maaiangal Aboriginal Heritage Incorporation).

Environmental assessment confirmed that the proposed Windblown extraction area was located in a geomorphically complex and dynamic context. Three periods of dune transgression have been recorded for the outer barrier, described by ERM as follows: the first occurred approximately 4000 years ago, the second approximately 1200 years ago and the third, which is still active and is overriding the 1200 year old outer transgressive dune, began approximately 300 years ago. The entirety of the current modification study area is located on the active, 300 year old transgressive dune and within the dredge path of the previous MDL operations. It was considered that Aboriginal sites on the stabilised dune immediately behind the active transgressive dune may be as old as 1200 years, while those on the active transgressive dune, if present, were likely to be quite recent. Identified soil landscapes within the current study area comprised Stockton Beach sands (unstratified fine to medium-grained loose aeolian sand) with shell fragments.

Analysis and discussion of the previous MDL mineral sand extraction operation concluded that the entirety of the previously dredged area had been subject to severe disturbance to a level several metres below the water table. It was noted that shell and gravel material occurred throughout the processed sands and were occasionally left as lag deposits on the 'dune' surfaces. Ongoing disturbance from recreational 4WD activity along the active dunes was also considered likely to have impacted on cultural material.

Review of background archaeological information indicated that the majority of the sites recorded along the Stockton Bight were located on or near the deflation basin between the frontal dune and the main transgressive dune mass; however it was noted that this patterning may have been the result of better visibility and exposure in comparison to the stable, vegetated Phase 1 and 2 dunes. This accorded with the findings of the Newcastle Bight Aboriginal Sites Study, which identified this as a particularly archaeologically sensitive part of the outer barrier. Previous assessment had recorded few sites on the active Phase 3 transgressive dune mass landward of the deflation basin.

It was identified during background information review that several previously recorded AHIMS sites near Boral's property boundary were likely located slightly further seaward than their registered coordinates. This includes the Fern Bay sites located within 85 metres of the current study area that were recorded during the Newcastle Bight Aboriginal Sites Study. Mapping on the site cards indicates these were primarily located along the landward margin of the deflation basin, at the base of the active transgressive dune along the 10 metre contour. There were no recorded sites within the proposed Windblown extraction area, and recent dredging meant there was considered to be almost no archaeological potential (ERM 2005a:82). There was considered to be low to moderate archaeological potential in the corridor between the dredge path and native vegetation on the Phase 1/2 dunes, and one new site (named BFB 1) was recorded here during the subsequent field survey. The site comprised a shell midden of moderate density, highly fragmented pipi on an exposure of the darker old Holocene land surface. No artefacts were recorded. The proposed Windblown project impact area was changed in order to avoid the site.

The Aboriginal cultural assessment found that the overall landscape, native vegetation, waterholes, and archaeological sites were all significant to the Aboriginal community. Significance assessment for BFB 1 found the site to have low archaeological significance. Following modification of the proposed extraction area to avoid BFB 1, impact assessment considered that the Windblown project would not impact on any Aboriginal cultural heritage. In particular, the potential for Aboriginal cultural material to occur in the area previously subject to dredging was assessed as minimal given the severe levels of disturbance: "the dredge path has been thoroughly disturbed and all archaeological sites in this section have been destroyed or significantly disturbed to the point that any archaeological material present would have very low archaeological significance" (ERM 2005b:18). The current proposed Modification 3 study area falls within the previous dredge path, in an area classed as severely disturbed by the existing EIS for the Windblown project. No further archaeological work was recommended and the project was granted consent from the then Minister for Planning in 2006.

5 Summary and Predictions

Desktop review and assessment combined results of heritage register searches, previous investigations and landscape assessment. The desktop assessment identified the potential for Aboriginal sites in the form of midden sites containing shell material or stone artefacts and isolated artefacts or potential archaeological deposits to occur within the local area.

Sites have most commonly been recorded across the deflation basin and margin of the active transgressive dunes, and are often associated with exposures of the old Holocene land surface. Site integrity is highly varied and is often affected by erosion, deflation and sand movement as well as direct disturbance from recreational 4WD use. The majority of recorded sites are highly fragmented shell scatters of low-moderate density with occasional stone artefacts.

The Aeolian Stockton Beach soil landscape is associated with the most recent Phase 3 transgressive dune (300-500 years old) and is a highly dynamic, shifting landscape. Sites are more often associated with the older buried soil surfaces of the Holocene foredune ridge plain or the stable, vegetated Phase 1 and 2 dune masses at the rear of the open beach.

Given the history of severe disturbance within the current study area due to previous heavy mineral mining, archaeological potential has repeatedly been assessed as minimal to non-existent along the former dredge path. Scattered shell material occurs as lag deposits on the landward active dune surface but is not cultural in nature, instead being the result of the sand treatment and screening associated with the dredging process. The dune mass present along Boral's property boundary is not an entirely natural formation, being partially the result of sand replacement following mineral extraction and sand spraying over the crest. However, given the movement of the transgressive dune since the cessation of dredging, it is possible that cultural material along the crest and seaward slope has been exposed in the intervening years. This is likely to be scattered and fragmented shell midden material (predominantly pipi) with a low to nil frequency of stone artefacts. Any cultural material is likely to be associated with exposures of the older Holocene land surface.

6 Site Inspection

The study area was inspected and assessed on three occasions over a five month period between March-July 2019. Multiple inspections were undertaken given the dynamic geomorphology and changeable conditions of the active transgressive dune. Inspections were undertaken by Dr Matthew Kelleher, Mark Rawson and Tristram Miller (KNC), accompanied by Neil Gascoyne (Boral) and Registered Aboriginal Stakeholders for the Stockton Sandpit property. Aboriginal community participation in the site inspections is detailed in Section 2.

The site inspections aimed to identify Aboriginal objects or sites (if present) and assess the archaeological potential and sensitivity of the proposed Modification 3 study area. Adjacent areas on the deflation basin margin and seaward dune face (outside of the study area and proposed impact area) and the locations of previously recorded sites were also inspected. The site inspections were undertaken on foot with access via 4WD.

Inspection along the southern property boundary confirmed the extent of previous disturbance and the encroachment of sand from the former dredge pond area. The sand mass to the south of Boral's property is unusually large with low relief, the result of the large mound left after the cessation of the MDL project. This sand mass is slowly being reworked and reshaped by the natural aeolian processes into a transverse dune system and has affected the rate of both inflation and deflation across this section of the beach (Short 2017). In particular, the deflation basin has been inflated and thus provides more sand to the developing transverse dune system at the rear, leading to encroachment of the sand mass into Boral's property.

Pan-like gravel lag surfaces were evident during a subsequent site visit. These were not visible during the initial site visit, having previously been covered over by loose windblown sand. No Aboriginal objects, sites, or areas of potential were identified within the proposed Modification extraction area along the southern boundary. Archaeological sensitivity and potential are minimal given the extent of previous disturbance.

Plate 1. View to east along southern property boundary across Modification area showing large encroaching dune at right

Plate 2. Same view as Plate 1 on subsequent site visit

Plate 3. View east along southern property boundary showing gravel/shell lag surface from MDL mining

Plate 4. Isolated shell fragment on lag surface

Conditions were similar along the southern part of the eastern property boundary (south of the haul road), with low visibility and no archaeological exposure. Fine shell and gravel lag surfaces were present in many areas and were particularly evident in the swales between the incipient transverse dunes. A later inspection identified occasional, isolated fragments of heavily weathered shell on the surface. These appeared to be isolated, natural shell occurrences and were not associated with cultural material or archaeological deposit. No exposures of the older Holocene land surface were evident along the portion of the study area south of the haul road, with a soft, windblown sand surface present between and overlying the gravel lag surfaces.

In some areas, exposure of the old Holocene land surface was evident to the east of the boundary fence, but these were truncated and did not continue into the study area, the result of previous dredging disturbance (Plate 8). North of the haul road, some organic material was identified scattered across the surface of the southern transverse dune slope just inside the Boral fenceline. This included shell, scattered clumps of darker organic soil material, driftwood and recent bird bone. This material was not present during the first site inspection, and appeared to be a recent, disturbed deposit atop the windblown sand (i.e. it was not an in situ deposit revealed by deflation).

The eastern (seaward) face of the same dune contains two previously registered midden sites (Worimi RVA 024 and Worimi RVA 025), approximately 60 metres from the Boral boundary. Both are associated with a long, linear exposure of the old Holocene land surface. Aerial imagery and visual inspection indicates that this exposure is truncated at the Boral fenceline and the former dredge path and does not extend within the study area, which is highly disturbed. 4WD disturbance along this section of Boral's fenceline is also extensive and is likely to have contributed to the disturbance and movement of recent surface material.

Plate 5. View to south west along Boral boundary

Plate 6. Isolated occurrence of fragmented shell on dune surface (50mm scale)

Plate 7. Small, isolated shell scatter on mobile dune slope surface

Plate 8. View north east along Boral fenceline showing exposure of Holocene land surface at right and truncation in midground at former dredge path

Plate 9. View north west up dune slope showing recent surface disturbance

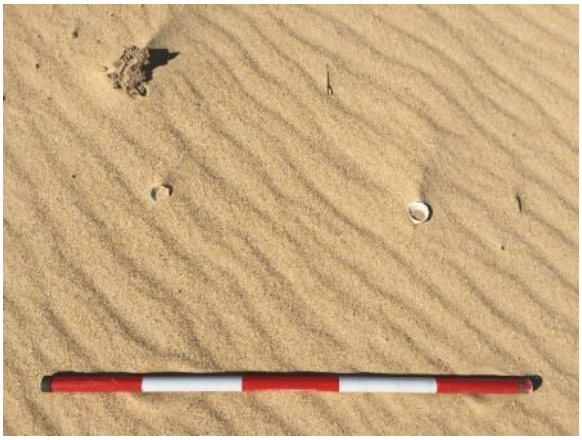

Plate 10. Detail of shell and clumped organic material on windblown surface

Plate 11. View north west across proposed Modification area from Boral property boundary to current sand extraction operation

Plate 12. View south west along Boral property boundary across proposed Modification area

The section of the beach surrounding the Boral property forms part of the Worimi Conservation Lands and is managed by the NPWS. Numerous midden sites (both registered and unregistered) occur in this area, particularly along the margin of the deflation basin, and these have been fenced to discourage public access and 4WD incursion. Fencing includes both wooden posts or star pickets with nylon rope. A number of middens have been covered over with hessian sacking in an attempt to conserve them, however constant aeolian deflation and redeposition of sand is occurring in the area. This can result in the hessian and shell middens being left as 'pedestals' as the surrounding sand deflates, leaving them elevated above the deflation basin and prone to collapse. Many of these sites are associated with exposures of the old Holocene land surface, visible as dark organic striations in the sand. Visible cultural material was predominantly pipi shell, with no stone artefacts observed during the site visits.

Two of these fenced areas are in proximity to the Boral property boundary and the proposed Modification 3 study area. Both were visited on multiple occasions during the site visits to assess their position and condition in the changing landscape. The southern of the two fenced areas is located at approximately 392275E 6364595N (GDA 94) and contains a partially exposed deposit of shell midden. This site is not registered on AHIMS. The fenced exclusion area around the site partially overlaps the temporary fenceline marking the Boral property boundary, with the south western corner of the fence extending into the study area.

It is understood that no impact will occur to the fenced areas along Boral's boundary.

The fenced area contains several exposures of the old Holocene land surface, visible as dark, organic-rich striations through the sand. A small hummock is present on the eastern side of the area with small spinifex plants. This hummock is an exposure of a former crest landform on the old land surface, which is being eroded by aeolian action. A scatter of fragmented pipi shell material is present on the surface to the west of and in the lee of the hummock, near the centre of the fenced area. Linear exposures of the old land surface extend to the north east and to the west. The site is located in a swale between two transverse dunes.

Plate 13. Views north east along Boral boundary showing overlap with fenced exclusion area around shell midden (arrowed). Grey sand in foreground and midground displays fine gravel lag from dredging activity. Midden deposit is unlikely to extend into study area.

Plate 14. Pipi shell midden exposure in centre of fenced area

Plate 15. View to west across swale from boundary showing gravel lag surface

No cultural material was observed in the portion of the fenced area that overlaps the study area. Shell material and exposures of the old land surface do not extend into the current study area. Immediately west of the fence, the swale landform extends into the Boral property and this area has been severely disturbed by the former MDL dredge. A lag deposit of fine gravels extends across the study area to the west, in contrast to the fine sands present to the east of the fenceline. It is considered unlikely that any cultural deposit associated with the site extends into the study area due to the high levels of disturbance.

During subsequent visits, the midden material was found to be less exposed, having been partially covered over by windblown sands. The shell material previously visible in the centre of the area was no longer evident. This cycle of exposure and reburial is typical for deposits on the edge of the transverse dune system and deflation basin, and confirms the necessity of multiple site visits.

Plate 16. Typical linear exposure of old Holocene land surface

Plate 17. Subsequent site visit showing lower levels of exposure/visibility due to sand encroachment

The second fenced area is located near the north eastern extent of Boral's property at approximately 392672E 6364855N (GDA 94), approximately 13 metres to the east of the temporary fence line marking the lot boundary. The area is located wholly on the seaward side of Boral's temporary fenceline, however when considered against the cadastral boundary the fenced area partially overlaps the study area. No registered AHIMS site exists at this location. No shell or other cultural material was visible within this area on any of the site visits, with the area being covered by soft, windblown sand drifts. No exposures of the old Holocene land surface were identified. Examination of older aerial photos (as recently as 2017) indicate that a linear exposure of the old Holocene land surface was present at this location and is truncated at the Boral boundary, similar to observed current conditions further to the south. The site appears to be associated with this former exposure, now covered over by windblown sands. As with the first fenced area, the portion of the study area abutting the fence has been subject to previous dredging. It is considered unlikely any deposit associated with this fenced area extends into the current study area. The occasional scattered surface shell material present on the surface elsewhere along the boundary was less frequent at the northern extent of the study area due to increased aeolian sand transport into this part of the property.

Plate 18. View to east showing northernmost fenced area outside of Boral fenceline

Plate 19. Detail of fenced area showing deflation basin beyond

6.1 Summary of results

No Aboriginal objects or areas of archaeological potential were identified within the study area during the site inspections. The study area has been significantly disturbed by previous dredging activities. Due to this significant land modification, no potential for intact subsurface archaeological deposit was identified within the study area. The locations of previously recorded sites in proximity to the study area boundary were confirmed. A number of these have been surrounded by protective fencing. Figure 8 shows the identified locations. It is understood that no impact will occur to the fenced areas along the boundary. No cultural material associated with these recordings was found to extend within the proposed Modification 3 area.

Figure 8. Previously recorded sites and fenced areas along study area boundary

7 Discussion and Impact Assessment

Based on results of desktop assessment, consultation and visual inspection of the study area, the assessment has identified that the Modification 3 proposal is unlikely to have an impact on Aboriginal heritage. This assessment concurs with the findings of previous Aboriginal archaeological assessment undertaken to inform the EIS for the existing Windblown Project, which included the current study area in its investigation. The study area and proposed expansion to the existing extraction area is located along the previous MDL dredge path and is a highly disturbed, modified environment.

The modification proposal is consistent with the existing Project Consent and will not result in direct impact to Aboriginal heritage.

Indirect impacts have also been considered as part of this assessment. While the proposed extraction area is located within a highly modified environment, neighbouring sections of the transgressive dune and deflation basin contain known Aboriginal archaeological sites. These were assessed during the site inspections and confirmed that cultural material associated with these recordings is not within the proposed Modification 3 impact area. Changes to the dune morphology west of Boral's property line as a result of the proposed modification would be located downwind of these recorded site locations. The proposal is unlikely to interfere with the geomorphological processes currently acting on the sites, which are primarily aeolian and driven by the movement of sand from the deflation basin onto the transgressive dune. This cycling of sand from the front to the rear of the beach results in periodic covering and uncovering of recorded cultural material. Deflation and exposure of midden material is a natural consequence of the dune transgression process.

Recent assessment of the geomorphology and dune dynamics along the Boral property boundary identified a number of key points relevant to assessing potential archaeological impact of the modification proposal (Short 2017:23). The Stockton dune field is a natural dune system that has evolved over the last c. 6000 years with three episodes of dune migration. The most recent commenced between 300-500 years ago and forms the active, bare transgressive dunes where the study area is located. In recent decades this natural dune movement has been adversely impacted by 4WD traffic that has led to a more unstable foredune and deflation basin seaward of the study area and along the beach. This has increased sand mobility, with the net result being an increase in the amount of deflation and an expansion of the deflation basin.

This lowering and expansion of the deflation basin is occurring throughout the dunes between Lavis Lane and the former MDL dredge site, with the highest levels of deflation in the northern section towards Lavis Lane. Comparison and analysis of survey data collected by Boral over a 15 year period between 2001 and 2016 indicated that there was less deflation in front of the Boral site (Short 2017:16-17) than along other sections of the beach. This time period encompasses the duration of the current Windblown project sand extraction and indicates that existing quarrying across the rear of the active transgressive dune system has not increased deflation which might have affected Aboriginal archaeological sites located seaward of the operations.

The transverse dunes are migrating to the northeast at a rate of 6-10 metres per year. This migration cycle creates a very unstable bare surface that is periodically buried by the advancing dune crest then exposed by the following dune swale, on an average cycle of 20 years. Recently reported deflation in parts of the Worimi Conservation Lands can be attributed to this natural dune migration, aggravated by 4WD activity, leading to the ongoing deflation and northwest expansion of the deflation basin (Short 2017). Ongoing 4WD activity in the basin destroys vegetation and disturbs the shelly lag, exposing more fine sand to wind transport than would otherwise be the case (Short 2017:20). Archaeological sites located within the dune field will be periodically buried, then re-exposed, with new sites expected to be exposed as the leading edge of the deflation basin slowly moves inland.

Aboriginal archaeological sites located east of Boral's site boundary are being impacted by various natural and anthropomorphic processes. A base line survey of the condition of archaeological sites within the Stockton dune field, followed by annual updates would be required to determine if Boral's proposed activities would result in indirect impacts. A baseline condition assessment for the dune field does not currently exist. The systematic monitoring of archaeological sites within the Stockton dune combined with geomorphic observations and documentation of anthropogenic factors will yield an increased understanding of any potential indirect impact on Aboriginal heritage. Existing geomorphological reports (Short 2017) suggest that Boral's activities do not result in an increased erosion of Aboriginal sites located seaward of the operations.

8 Conclusions and Recommendations

No Aboriginal heritage was identified within the study area. Aboriginal archaeological assessment and repeated site inspections of the study area did not identify any Aboriginal objects. In addition, no areas of potential for subsurface Aboriginal objects were identified.

It is understood that no impact will occur to the fenced areas along Boral's boundary.

The study area was found to be heavily disturbed by previous heavy mineral sand mining and dredging. The modification proposal is consistent with the existing Project Consent and will not result in an impact to Aboriginal heritage.

8.1 Management recommendations

Recommendations for the proposed Modification area have been developed to be consistent with the existing management measures in the Windblown Project EIS (ERM 2005a).

8.1.1 Heritage Training and Induction Process

- **Aboriginal heritage management procedures will be included in construction personnel training and induction processes.**

Aboriginal heritage management procedures and responsibilities for compliance will form part of the project induction for construction/extraction personnel (employees, contractors, subcontractors and/or agents). This will include site identification (including Aboriginal heritage site map) to ensure all personnel are aware of Aboriginal heritage management responsibilities, issues affecting their activities and procedures for dealing with unexpected finds including human remains.

8.1.2 Avoiding Impact to Adjacent Areas

All works associated with the proposed Modification 3 should be contained within the study area as defined in this report. Additional archaeological or Aboriginal heritage assessment would be required for any proposed impacts outside the current study area.

Aboriginal objects and recorded sites are known to occur in adjacent landforms and these must be avoided by all proposed extraction activities. Management measures to be implemented should include clear fencing of the boundary of the approved impact zone and the inclusion of Aboriginal heritage in the Environmental Management Plan (EMP). Documented toolbox talks should also be held to ensure all on-site staff and contractors are aware of obligations and requirements regarding the protection of Aboriginal heritage.

8.1.3 Unexpected Finds Procedure

- **Any unexpected Aboriginal heritage items (Aboriginal objects) will be managed appropriately.**

In the event that an unexpected find (Aboriginal object) is encountered the following procedure will apply:

1. Stop work and protect find area and report to environmental manager
2. Contact heritage advisor for identification
    a. No further action if the find is not an Aboriginal object
    b. If the find is an Aboriginal object proceed to next step
3. Undertake relevant regulatory requirements and contact regulator
4. Implement conservation or mitigation strategy
5. Obtain approval if required and comply with conditions
6. Recommence work

8.1.4 Procedures for Handling Human Remains

- **Note that Project or Modification Approvals do not include the destruction of Aboriginal remains.**
- **Any potential human remains encountered will be protected and managed appropriately.**

This section outlines the procedure for handling human remains in accordance with the *Skeletal Remains – Guidelines for the Management of Human Skeletal Remains* under the *Heritage Act 1977* (NSW Heritage Office 1998) and the *Aboriginal Cultural Heritage Standards and Guidelines Kit* (NPWS 1997). In the event that extraction activity reveals possible human skeletal material (remains), the following procedure is to be followed:

1. as soon as remains are exposed, all work is to halt at that location immediately and the Project environmental manager on site is to be immediately notified to allow assessment and management;
    i. stop all activities;
    ii. secure the site; and
    iii. not further harm the remains.
2. contact police: the discovery of human remains triggers a process which assumes that they are associated with a crime. The NSW Police retain carriage of the process until such time as the remains are confirmed to be Aboriginal or historic;
3. Notify the approval authority when human remains are found;
4. once the police process is complete and if remains are not associated with a contemporary crime DP&E will determine the process, in consultation with OEH and/or the Heritage Office as appropriate;
    i. if the remains are identified as Aboriginal, the site is to be secured and DP&E and all Aboriginal stakeholders are to be notified in writing. DP&E will act in consultation with OEH as appropriate. OEH will be notified in writing according to DP&E instructions; or
    ii. if the remains are identified as non-Aboriginal (historical) remains, the site is to be secured and the DP&E is to be contacted. DP&E will act in consultation with the Heritage Division as appropriate. The Heritage Division will be notified in writing according to DP&E instructions;
5. once the police process is complete and if the remains are identified as not being human work can recommence once the appropriate clearances have been given.

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Appendix A AHIMS Extensive Search Results

Office of Environment & Heritage

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 1828 Stockton

Client Service ID : 437444

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
38-4-1645	Fullerton Cove Midden 2	GDA	56	390179	6365560	Open site	Valid	Artefact : -, Shell : -		
	Contact	Recorders	Ms.Erin Mein					Permits	4398	
38-4-2011	George St 1	GDA	56	390796	6366074	Open site	Valid	Artefact : -		
	Contact	Recorders	Umwelt (Australia) Pty Limited,Miss.Nicola Roche					Permits	4398	
38-4-1872	Worimi RVA 032	GDA	56	391356	6363899	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1871	Worimi RVA 031	GDA	56	391731	6364059	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1869	Worimi RVA 029	GDA	56	391857	6364253	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1870	Worimi RVA 030	GDA	56	391926	6364193	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1867	Worimi RVA027	GDA	56	391965	6364382	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers,Mr.Matthew Kelleher,Kelleher Nightingale Consulting Pty Ltd ((					Permits		
38-4-1868	Worimi RVA 028	GDA	56	391971	6364367	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1864	Worimi RVA 024	GDA	56	392464	6364646	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1865	Worimi RVA 025	GDA	56	392464	6364646	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1873	Worimi RVA 033	GDA	56	392600	6364679	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1863	Worimi RVA 023	GDA	56	392876	6364757	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1807	RVA site 1	GDA	56	393021	6364846	Open site	Valid	Shell : -, Artefact : -		
	Contact	Recorders	NPWS - Hunter District					Permits		
38-4-1861	Worimi RVA 021	GDA	56	393027	6364869	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1860	Worimi RVA 020	GDA	56	393069	6365020	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1858	Restriction applied. Please contact ahims@environment.nsw.gov.au.					Open site	Valid			
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1857	Restriction applied. Please contact ahims@environment.nsw.gov.au.					Open site	Valid			

Report generated by AHIMS Web Service on 25/07/2019 for Cristany Milicich for the following area at Datum :GDA, Zone : 56, Eastings : 388850 - 393800, Northings : 6363000 - 6366500 with a Buffer of 0 meters. Additional Info : Archaeological assessment. Number of Aboriginal sites and Aboriginal objects found is 75

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Page 1 of 5

Office of Environment & Heritage

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 1828 Stockton

Client Service ID : 437444

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1856	Restriction applied. Please contact ahims@environment.nsw.gov.au.					Open site	Valid			
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1859	Restriction applied. Please contact ahims@environment.nsw.gov.au.					Open site	Valid			
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1855	Restriction applied. Please contact ahims@environment.nsw.gov.au.					Open site	Valid			
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1854	Restriction applied. Please contact ahims@environment.nsw.gov.au.					Open site	Valid			
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1853	Restriction applied. Please contact ahims@environment.nsw.gov.au.					Open site	Valid			
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-0791	Fern Bay Estate 8	AGD	56	388750	6363700	Open site	Valid	Artefact : -, Shell : -		
	Contact	Recorders	Pam Dean-Jones					Permits		
38-4-0787	Fern Bay Estate 9	AGD	56	388790	6363344	Open site	Valid	Artefact : -		
	Contact	Recorders	Jim Wheeler					Permits	2026	
38-4-0861	Fern Bay Estaet 9	AGD	56	388790	6363440	Open site	Valid	Shell : 1		
	Contact T Russell	Recorders	Jim Wheeler					Permits		
38-4-0789	Fern bay Estate 11	AGD	56	388850	6363850	Open site	Valid	Artefact : -		
	Contact	Recorders	Pam Dean-Jones					Permits		
38-4-0131	NBR5;	AGD	56	388920	6364080	Open site	Valid	Artefact : -	Open Camp Site	1269
	Contact	Recorders	Margrit Koettig,Rex Silcox					Permits		
38-4-0788	Fern Bay Estate 10	AGD	56	388950	6363900	Open site	Valid	Shell : -		
	Contact	Recorders	Pam Dean-Jones					Permits	2355	
38-4-0951	Fern Bay Estate 18	AGD	56	389035	6364110	Open site	Valid	Shell : 2, Artefact : 81		
	Contact T Russell	Recorders	ERM Australia Pty Ltd- Sydney CBD					Permits		
38-4-0130	NBR6;	AGD	56	389260	6364220	Open site	Valid	Shell : -, Artefact : -	Midden	1269,101086
	Contact	Recorders	Margrit Koettig,Rex Silcox					Permits		
38-4-0127	NBR9;	AGD	56	389360	6364400	Open site	Valid	Shell : -, Artefact : -	Midden	1269,101086
	Contact	Recorders	Margrit Koettig,Rex Silcox					Permits		
38-4-0949	Fern Bay Estate 16	AGD	56	389772	6364185	Open site	Valid	Artefact : 4		
	Contact T Russell	Recorders	ERM Australia Pty Ltd- Sydney CBD					Permits		

Report generated by AHIMS Web Service on 25/07/2019 for Cristany Milicich for the following area at Datum :GDA, Zone : 56, Eastings : 388850 - 393800, Northings : 6363000 - 6366500 with a Buffer of 0 meters. Additional Info : Archaeological assessment. Number of Aboriginal sites and Aboriginal objects found is 75

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AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 1828 Stockton

Client Service ID : 437444

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
38-4-0950	Fern Bay Estate 17	AGD	56	389785	6364535	Open site	Valid	Artefact : -, Shell : -		
	Contact T Russell	Recorders	ERM Australia Pty Ltd- Sydney CBD					Permits		
38-4-0948	Fern Bay Estate 15	AGD	56	389847	6364460	Open site	Valid	Artefact : 1		
	Contact T Russell	Recorders	ERM Australia Pty Ltd- Sydney CBD					Permits		
38-4-0129	NBR7;	AGD	56	389850	6364380	Open site	Valid	Artefact : -	Open Camp Site	1269,101086
	Contact	Recorders	Margrit Koettig,Rex Silcox					Permits		
38-5-0157	Fullerton Site 1;Newcastle Bight;	AGD	56	389930	6362840	Open site	Valid	Shell : -, Artefact : -	Midden,Open Camp Site	
	Contact	Recorders	Liam Dagg					Permits	845,916	
38-4-0321	Newcastle Bight 2;	AGD	56	390050	6364760	Open site	Valid	Artefact : -	Open Camp Site	2250,101086
	Contact	Recorders	Mr.Matthew Barber					Permits		
38-5-0161	Fullerton Site 5;Newcastle Bight;	AGD	56	390090	6363090	Open site	Valid	Shell : -, Artefact : -	Midden,Open Camp Site	
	Contact	Recorders	Liam Dagg					Permits	916	
38-5-0158	Fullerton Site 2;Newcastle Bight;	AGD	56	390260	6363040	Open site	Valid	Shell : -, Artefact : -	Midden,Open Camp Site	
	Contact	Recorders	Liam Dagg,Liam Dagg					Permits	845,916	
38-4-0706	FC 1	AGD	56	390580	6365650	Open site	Valid	Artefact : 9		
	Contact	Recorders	Mary Dallas Consulting Archaeologists (MDCA)					Permits		
38-5-0159	Fullerton Site 3;Newcastle Bight;	AGD	56	390640	6363260	Open site	Valid	Shell : -, Artefact : -	Midden,Open Camp Site	
	Contact	Recorders	Liam Dagg,Liam Dagg					Permits	845,916	
38-5-0160	Fullerton Site 4;Newcastle Bight;	AGD	56	390960	6363500	Open site	Valid	Shell : -, Artefact : -	Midden,Open Camp Site	
	Contact	Recorders	Liam Dagg					Permits	916	
38-4-0260	Fern Bay_4;	AGD	56	391000	6363500	Open site	Valid	Artefact : -	Open Camp Site	1845
	Contact	Recorders	Pam Dean-Jones,Mr.Luke Godwin,M Heath					Permits		
38-5-0162	Fullerton Site 6;Newcastle Bight;	AGD	56	391040	6363460	Open site	Valid	Shell : -, Artefact : -	Midden	
	Contact	Recorders	Liam Dagg					Permits	916	
38-4-0340	Williamtown 1;WT-1;	AGD	56	391100	6365500	Open site	Valid	Artefact : -	Open Camp Site	
	Contact	Recorders	Giles Hamm Archaeology					Permits		
38-4-1035	Fullerton Cove Extraction 1	AGD	56	391149	6366046	Open site	Valid	Artefact : 100		
	Contact Searle	Recorders	Ms.Penny Mccardle					Permits	3033	
38-4-0261	Fern Bay_5;	AGD	56	391200	6363700	Open site	Valid	Shell : -, Artefact : -	Midden	1845
	Contact	Recorders	Pam Dean-Jones,Mr.Luke Godwin,M Heath					Permits		
38-4-0563	Fullerton 1	AGD	56	391352	6363717	Open site	Valid	Shell : -		

Report generated by AHIMS Web Service on 25/07/2019 for Cristany Milicich for the following area at Datum :GDA, Zone : 56, Eastings : 388850 - 393800, Northings : 6363000 - 6366500 with a Buffer of 0 meters. Additional Info : Archaeological assessment. Number of Aboriginal sites and Aboriginal objects found is 75

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AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 1828 Stockton

Client Service ID : 437444

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		
38-4-0644	Fullerton Site 36	AGD	56	391496	6363762	Open site	Valid	Artefact : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		
38-4-0262	Fern Bay_6;	AGD	56	391500	6363900	Open site	Valid	Shell : -, Artefact : -	Midden	1845
	Contact	Recorders	Pam Dean-Jones,Mr.Luke Godwin,M Heath					Permits		
38-4-0263	Fern Bay_7;	AGD	56	391600	6364000	Open site	Valid	Shell : -, Artefact : -	Midden	1845
	Contact	Recorders	Pam Dean-Jones,Mr.Luke Godwin,M Heath					Permits		
38-4-0322	Newcastle Bight 1;	AGD	56	391670	6364600	Open site	Valid	Shell : -, Artefact : -	Midden	2250
	Contact	Recorders	Mr.Matthew Barber					Permits		
38-4-0264	Fern Bay_8;	AGD	56	391800	6364100	Open site	Valid	Shell : -, Artefact : -	Midden	1845
	Contact	Recorders	Pam Dean-Jones,Mr.Luke Godwin,M Heath					Permits		
38-4-0564	Fullerton 3	AGD	56	391828	6364079	Open site	Valid	Shell : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		
38-4-0265	Fern Bay_9;	AGD	56	391900	6364200	Open site	Valid	Shell : -, Artefact : -	Midden	1845
	Contact	Recorders	Pam Dean-Jones,Mr.Luke Godwin,M Heath					Permits		
38-4-0565	Fullerton 4	AGD	56	391904	6364081	Open site	Valid	Shell : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		
38-4-0566	Fullerton 5	AGD	56	392065	6364201	Open site	Valid	Shell : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		
38-4-0266	Fern Bay_10;	AGD	56	392100	6364200	Open site	Valid	Shell : -, Artefact : -	Midden	1845
	Contact	Recorders	Pam Dean-Jones,Mr.Luke Godwin,M Heath					Permits		
38-4-0267	Fern Bay_11;	AGD	56	392200	6364300	Open site	Valid	Shell : -, Artefact : -	Midden	1845
	Contact	Recorders	Pam Dean-Jones,Mr.Luke Godwin,M Heath					Permits		
38-4-0567	Fullerton 7	AGD	56	392285	6364371	Open site	Valid	Shell : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		
38-4-0268	Fern Bay_12;	AGD	56	392300	6364400	Open site	Valid	Shell : -, Artefact : -	Midden	1845
	Contact	Recorders	Pam Dean-Jones,Mr.Luke Godwin,M Heath					Permits		
38-4-0054	Newcastle Bight;	AGD	56	392377	6364161	Open site	Valid	Artefact : -	Open Camp Site	
	Contact	Recorders	J.A Starling					Permits		
38-4-0269	Fern Bay_13;	AGD	56	392400	6364400	Open site	Valid	Shell : -, Artefact : -	Midden	1845
	Contact	Recorders	Pam Dean-Jones,Mr.Luke Godwin,M Heath					Permits		
38-4-0568	Fullerton 8	AGD	56	392465	6364420	Open site	Valid	Shell : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		
38-4-0569	Fullerton 9	AGD	56	392710	6364583	Open site	Valid	Artefact : 19, Shell : 1		

Report generated by AHIMS Web Service on 25/07/2019 for Cristany Milicich for the following area at Datum :GDA, Zone : 56, Eastings : 388850 - 393800, Northings : 6363000 - 6366500 with a Buffer of 0 meters. Additional Info : Archaeological assessment. Number of Aboriginal sites and Aboriginal objects found is 75

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AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 1828 Stockton

Client Service ID : 437444

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		
38-4-0068	Newcastle Bight;3;	AGD	56	392795	6366181	Open site	Valid	Artefact : -	Open Camp Site	
	Contact	Recorders	M Dodkin					Permits		
38-4-0570	Fullerton 10	AGD	56	393049	6364716	Open site	Valid	Shell : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		
38-4-0645	Fullerton Site 37	AGD	56	393117	6364880	Open site	Valid	Shell : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		
38-4-0571	Fullerton 11	AGD	56	393188	6364916	Open site	Valid	Shell : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		
38-4-1030	Lagoons 4	AGD	56	393233	6366293	Open site	Valid	Aboriginal Resource and Gathering : 1, Artefact : 3000		
	Contact Searle	Recorders	Mr.Peter Anderson					Permits		
38-4-1032	Lagoons 3	AGD	56	393250	6366153	Open site	Valid	Artefact : 2		
	Contact Searle	Recorders	Mr.Peter Anderson					Permits		
38-4-1034	Lagoons 2	AGD	56	393271	6365983	Open site	Valid	Artefact : 3		
	Contact Searle	Recorders	Mr.Peter Anderson					Permits		
38-4-1033	Lagoons 1	AGD	56	393272	6365983	Open site	Valid	Artefact : 2100, Aboriginal Resource and Gathering : 1		
	Contact Searle	Recorders	Mr.Peter Anderson					Permits		
38-4-0056	Freshwater Lagoons;	AGD	56	393351	6365825	Open site	Valid	Artefact : -	Open Camp Site	315,703
	Contact	Recorders	ASRSYS					Permits		
38-4-0572	Fullerton 12	AGD	56	393525	6366116	Open site	Valid	Shell : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		

Report generated by AHIMS Web Service on 25/07/2019 for Cristany Milicich for the following area at Datum :GDA, Zone : 56, Eastings : 388850 - 393800, Northings : 6363000 - 6366500 with a Buffer of 0 meters. Additional Info : Archaeological assessment. Number of Aboriginal sites and Aboriginal objects found is 75

Attachment B: Biodiversity Assessment Report prepared by Niche Environment and Heritage

Excellence in your environment

niche Environment and Heritage

Stockton Sandpit (DA140-6-2005) – Proposed Modification 3
Biodiversity Assessment

Prepared for Boral Resources Pty Limited | 16 September 2019

niche-eh.com

Excellence in your environment

Document control

Project number	Client	Project manager	LGA
4880	Boral Resources	Luke Baker	Port Stephens

Version	Author	Review	Status	Date
D1	Luke Baker	Amanda Griffith	Draft	21/03/2019
Rev0	Luke Baker	Rachael Snape (Boral Resources)	Final	16/09/2019

Enquiries should be addressed to:

Sydney Head Office
Niche Environment and Heritage
02 9630 5658
info@niche-eh.com
PO Box 2443 North Parramatta
NSW 1750 Australia

Executive summary

Context

Boral Resources (NSW) Pty Limited ('Boral') currently operates the Stockton Sandpit, a sand quarry located on the windblown dunes at Fullerton Cove in the Local Government Area (LGA) of Port Stephens, known as the "Windblown Project" (Figure 1). The extraction activity is undertaken in accordance with development consent DA140-6-2005.

To meet short term demand for sand, Boral is proposing to modify DA140-6-2005 to permit a minor expansion to the approved extraction area for the Windblown Project which would add one to two years to the existing sand resource. Boral is seeking approval to expand the active extraction area granted under DA140-6-2005 to include a portion of the 15 metre wide "buffer" that extends along the north-east, south-east and south-west perimeter of Boral's landholding.

Aims

Niche Environment and Heritage (Niche) were commissioned by Boral to provide a biodiversity impact assessment for the project to assess the impacts on threatened biodiversity and habitat under both the NSW *Biodiversity Conservation Act 2016* (BC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This assessment has utilised the OEH (2016) Biodiversity Assessment Methodology (BAM), and has been completed by an Accredited Assessor.

Study area

The Study Area includes the area currently occupied by a 15 metre wide buffer located between the active extraction area (quarry pit) and the adjacent beach, encompassing 3.2 hectares immediately adjacent to the current operations (Figure 2).

The Study Area is located on the transverse dune system that is the product of strong winds and made up of fine to medium bare sand. Owing to the dynamic nature of sand dunes, influenced by prevailing winds, the area of the Windblown Project (subject of this modification) is currently devoid of vegetation.

Survey overview

A field survey was undertaken by Luke Baker (Senior Ecologist and Accredited Assessor) on the 4th of March 2019. Given the relatively small area considered in this assessment, and the accessibility of the site, the entire study area was traversed by foot and vehicle (Figure 3). No flora plots/transects or targeted fauna surveys were undertaken given the Study Area was devoid of any vegetation.

Native vegetation assessment

The field survey confirmed that the area to be directly disturbed consisted of bare sand which did not contain any native or introduced plant cover.

The closest patch of native vegetation occurs approximately 50 metres to the south of the Study Area and includes a small patch (approximately 0.3 ha) of native vegetation consisting of sparse Old Man Banksia (*Banksia serrata*) and Spinifex (*Spinifex sericeus*). This patch is likely to align with the Plant Community Type - Coast Tea Tree/Old Man Banksia coastal shrubland on fore dunes of the Central and lower North Coast.

To ensure that this patch would not be impacted, the Study Area was amended to allow for a set back from the native vegetation to safeguard it from potential impacts (Figure 3). Boral have already demarcated this area to ensure no access from Boral/contractor vehicles or by contractor/employee foot traffic.

Threatened flora

During the field survey, no BC Act or EPBC Act listed threatened flora were recorded. Many of the threatened flora that have potential to occur within the locality are relatively conspicuous and are unlikely to remain undetected during the survey. Furthermore, the Study Area consisted of bare sand dunes with no vegetation present. As such, it is highly unlikely that any threatened flora would occur within the Study Area.

Threatened fauna

No threatened fauna were recorded within the Study Area, however a White-bellied Sea Eagle (*Haliaeetus leucogaster*) (listed as Vulnerable under the BC Act) was observed outside of the Study Area during the field survey.

Given the presence of bare sand cover within the area to be disturbed, no important threatened fauna habitat such as hollow trees, logs, native vegetation, water features, etc. would be impacted by the project. As such, it is highly unlikely that any threatened fauna would rely on the habitat of the Study Area.

SEPP 44. Koala habitat

No SEPP 44 Koala habitat would be impacted by the Project. The Study Area consists of bare sand cover.

Avoidance and minimisation

The location of the Study Area occurs immediately adjacent to the existing approved Extraction Area, within an area of land that does not comprise any vegetation cover or fauna habitat.

The location of the project area has been positioned away from patches of native vegetation to the south , in order to prevent impacts to biodiversity.

As such, Boral have demonstrated avoidance of impacts to biodiversity associated with the modification.

Impacts

Direct impacts associated with the proposed modification are limited to the removal of sand. No direct impacts to native vegetation and fauna habitat are likely to occur.

The proposal is not anticipated to further contribute to indirect impacts associated with noise, air quality, dust, traffic, and waste management currently controlled for within the approved extraction operation. Furthermore, as discussed in the Boral (2019) EIS, the proposal is anticipated to have minimal impact on groundwater given the extraction would not occur below a maximum extraction depth of 2.5 metres AHD, which is part of the existing conditions of consent.

The current extraction operations are managed in accordance with an Environmental Management Strategy (Environmental Compliance Strategy, September 2016). It is recommended that this current Plan be implemented for the Study Area to further safeguard from potential indirect impacts to biodiversity.

Offset

No biodiversity offsetting is required, as native vegetation and flora and fauna habitat will not be impacted by the proposal.

Table of Contents

List of Figures

1. Introduction

1.1 Introduction

Boral Resources (NSW) Pty Limited (hereafter referred to as 'Boral') currently operates the Stockton Sandpit, a sand quarry, known as the "Windblown Project", located on the windblown dunes at Fullerton Cove in the Local Government Area (LGA) of Port Stephens (**Error! Reference source not found.**). The extraction activity is undertaken in accordance with development consent DA140-6-2005.

Sand harvested from the Stockton Sandpit is used in many construction related applications across the local Hunter and Sydney Metropolitan Regions. Sustained demand for sand related products in response to continued and anticipated growth in the residential and commercial markets has meant that the windblown sand resource will be exhausted sooner than expected. To meet short term demand for sand, Boral is proposing to modify DA140-6-2005 to include a minor expansion to the approved extraction area for the Windblown Project which would add one to two years to the existing sand resource. The proposed modification would not exceed the transportation or depth extraction limits as set out in the existing conditions of consent.

Niche Environment and Heritage (Niche) were commissioned by Boral to provide a biodiversity impact assessment for the project to assess the impacts on threatened biodiversity and habitat under both the NSW Biodiversity Conservation Act 2016 (BC Act) and Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

1.2 Proposed modification

Boral is seeking approval to expand the active extraction area granted under DA140-6-2005 to include a portion of the 15 metre wide "buffer" that extends along the north-east, south-east and south-west perimeter of Boral's landholding.

The area of extension will be limited to the south-west and south-east buffer areas and combined with allowing extraction of sand would also relocate the existing batters outward, with the 1:3 crest line repositioned towards Boral's property boundary allowing for the capture and use of the additional sand (Figure 1, Figure 2).

The boundaries around the additional extraction area, to the south-east (seaward) and south-west boundaries measure approximately 1,680 metres and 421 metres respectively. The total area of the 15 metre buffer is approximately 3.2 hectares and has a total resource volume of around 475,000 tonnes of sand.

1.3 Study area

The Study Area includes the area currently occupied by a 15 metre wide buffer located between the active extraction area (quarry pit) and the adjacent beach, encompassing the 3.2 hectares immediately adjacent to the current operations (Figure 2).

The Study Area is located on the transverse dune system that is the product of strong winds and is made up of fine to medium bare sand. Owing to the dynamic nature of sand dunes, influenced by prevailing winds, the area of the Windblown Project (subject of this modification) is currently devoid of vegetation.

The Study Area is located within the NSW North Coast IBRA Regions, Karuah Manning IBRA Subregion and Sydney-Newcastle Barriers and Beaches Mitchell Landscape.

1.4 Assessment objectives and format

The primary objective of this assessment is to use the guidelines and methodology provided in the BAM to determine the impact the Project would have on biodiversity.

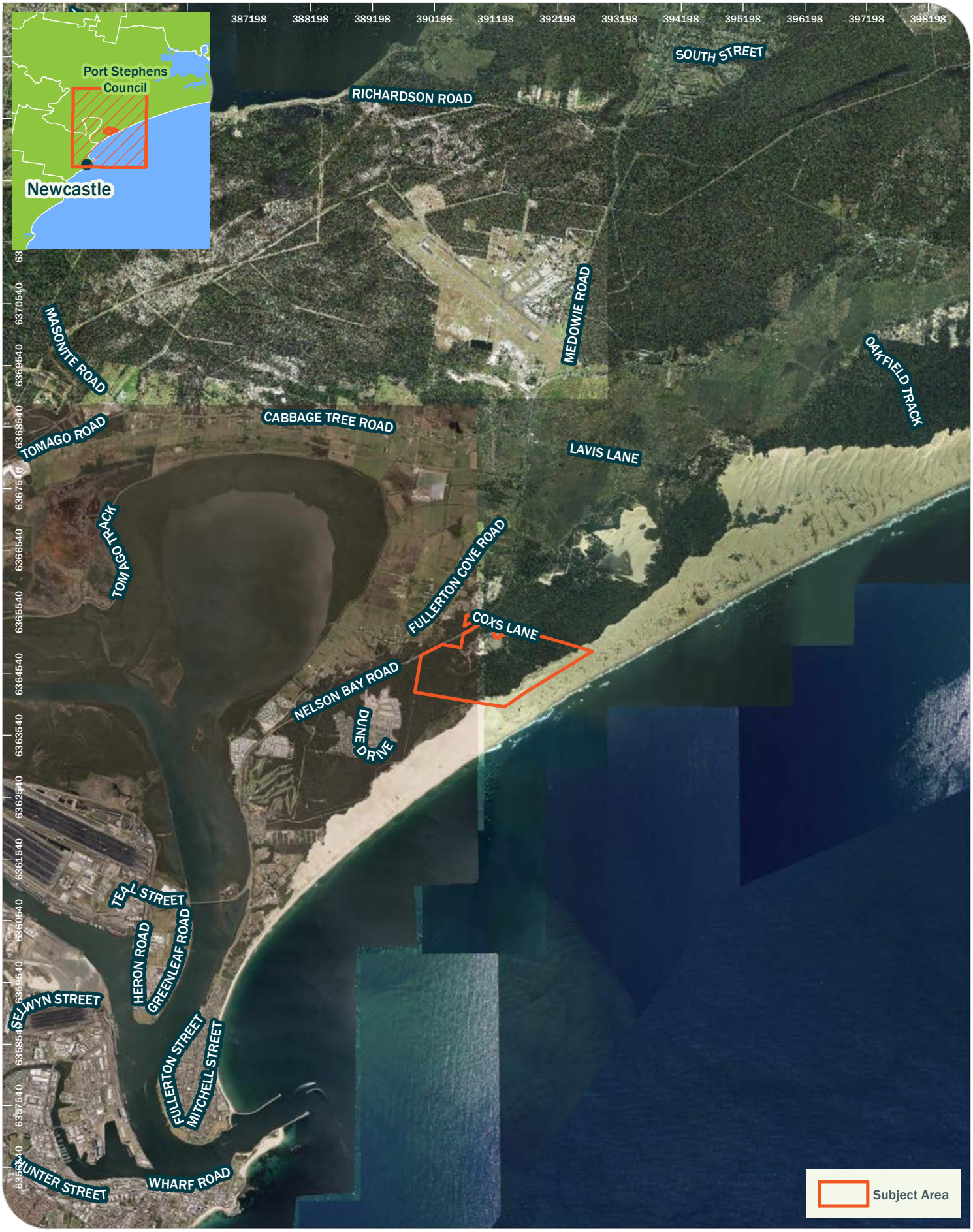
As discussed throughout this report, no native vegetation or threatened biodiversity habitat is present at the site or would be impacted by the Project. As such, a Biodiversity Development Assessment Report (BDAR) and subsequent biodiversity offsetting is not proposed. Niche therefore has approached this biodiversity assessment by undertaking the following components:

- Assessment of native vegetation
- Assessment of threatened species and populations.
- Avoid and minimise impacts on biodiversity values.

1.5 Assessment resources and assessor qualifications

This assessment has been prepared by the following accredited assessors:

- Luke Baker – Senior Ecologist/Ecology Team Leader/Accredited Biodiversity Assessor: flora and fauna field survey, data management, report preparation.
- Amanda Griffith (Accredited Biodiversity Assessor) – internal review.



niche Environment and Heritage

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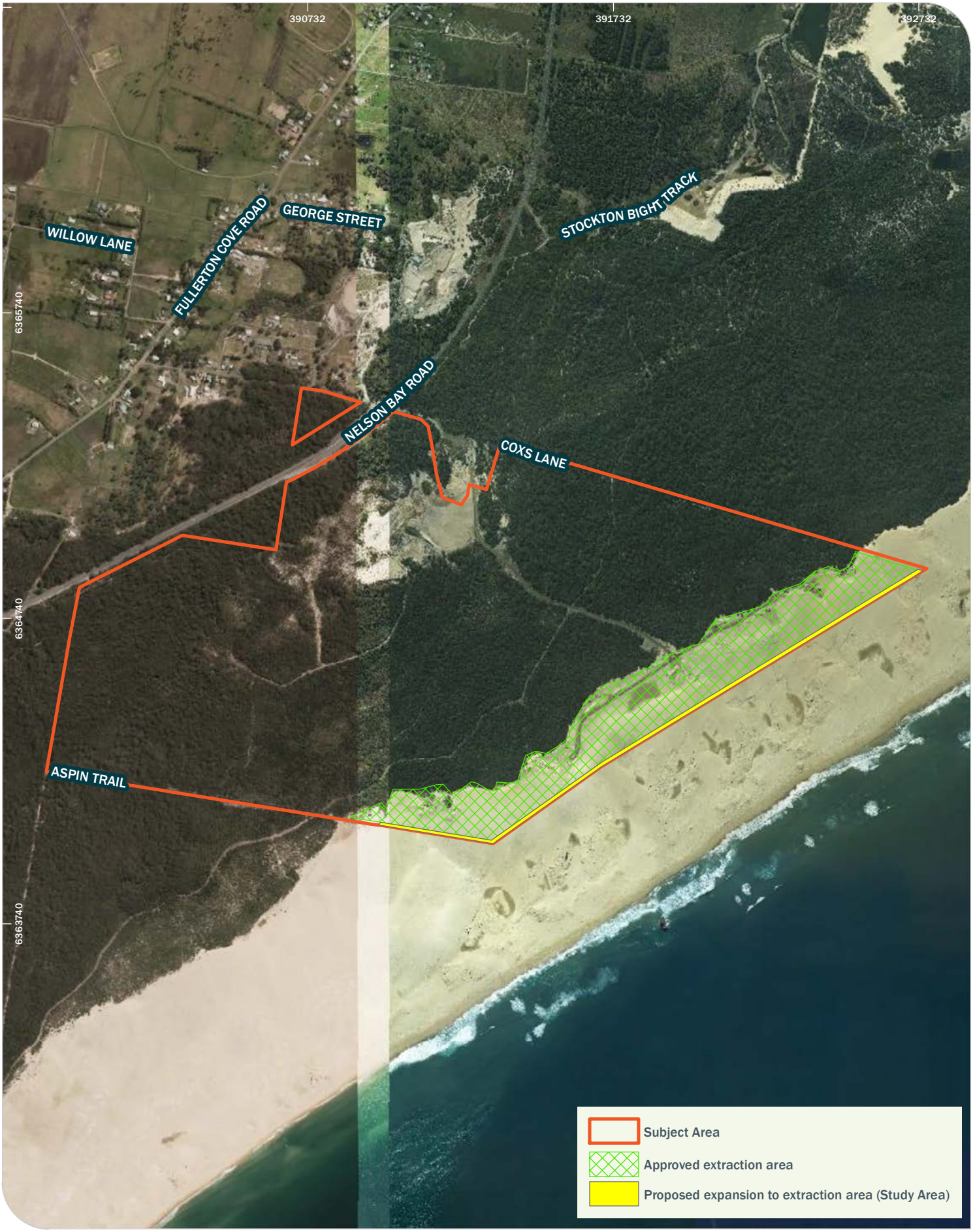
GDA 1994 MGA Zone 56

Location Map

Stockton Sandpit (DA140-6-2005) – Proposed Modification 3

Niche PM: Luke Baker
Niche Proj. #: 4880
Client: Boral Resources

Figure 1



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GDA 1994 MGA Zone 56

Proposed modification (Study Area)

Stockton Sandpit (DA140-6-2005) – Proposed Modification 3

Niche PM: Luke Baker
Niche Proj. #: 4880
Client: Boral Resources

Figure 2

2. Native vegetation and flora assessment

2.1 Data review

2.1.1 Atlas of NSW Wildlife Database

A review of spatial records of threatened flora within a 10 kilometres radius of the Study Area was undertaken using data obtained from the Atlas of NSW Wildlife. Records were obtained prior to field survey. Results were considered during field survey planning and the likelihood of occurrence analysis, performed prior to field survey and updated post field survey. The results of the search are provided in Appendix 1.

2.1.2 EPBC Act Protected Matters Search

A Protected Matters Search (EPBC Act) was carried out for a 10 kilometre radius of the Study Area. Results were considered during field survey planning and the likelihood of occurrence analysis, performed prior to field survey and updated post field survey. The results of the search are provided in Appendix 1.

2.2 Plant community delineation and mapping

A field survey was undertaken by Luke Baker (Senior Ecologist and Accredited Assessor) on the 4th of March 2019. Given the relatively small area considered in this assessment, and the ease of access to the site, the entire study area was traversed by foot and vehicle (Figure 3).
The field survey confirmed that the area to be directly disturbed consisted of bare sand cover which did not support any native or introduced plant cover. This is clearly evident in Photo 1 below and through aerial photography interpretation of the site.

The nearest patch of native vegetation to the Study Area consisted of a small patch (approximately 0.3 hectares) of sparse Old Man Banksia (*Banksia serrata*) and Spinifex (*Spinifex sericeus*). This patch is likely to align with the Plant Community Type - Coast Tea Tree/Old Man Banksia coastal shrubland on fore dunes of the Central and lower North Coast.

To ensure that this patch of vegetation would not be impacted by the Project, the proposed project footprint was amended to allow for a set back from the native vegetation to safeguard it from potential impacts (see insert in Figure 3). Boral have already demarcated this area to ensure there will be no access from Boral/contractor vehicles or by contractor/employee foot traffic.

Photo 1. Bare sand occupying the Study Area

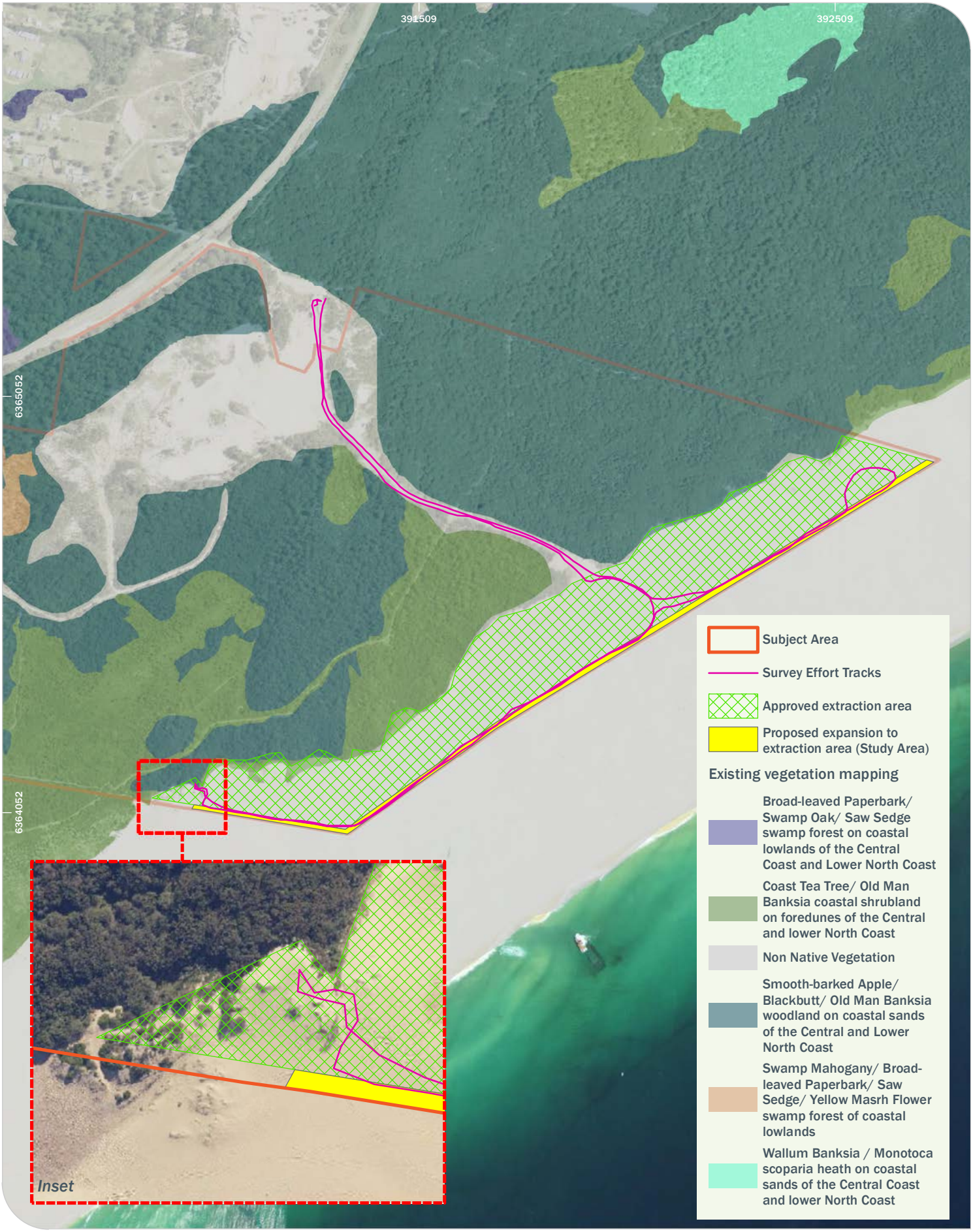
2.3 Threatened ecological communities

Based on the results of the site inspection, no TECs occur within the Study Area given the Study Area consisted of bare sand cover only.

2.4 Threatened flora

Threatened flora with the potential to occur, as generated by the BAM Calculator and database searches are provided in Appendix 1.

During the field survey, no BC Act or EPBC Act listed threatened flora were recorded. Many of the threatened flora that have potential to occur are relatively conspicuous and are unlikely to remain undetected during the survey. Furthermore, the Study Area consisted of bare sand with no vegetation present. As such, it is highly unlikely that any threatened flora would occur within the Study Area.



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GDA 1994 MGA Zone 56

Survey Effort and Vegetation Mapping

Stockton Sandpit (DA140-6-2005) – Proposed Modification 3

Niche PM: Luke Baker
Niche Proj. #: 4880
Client: Boral Resources

Figure 3

3. Assessment of fauna and habitat

3.1 Bionet Atlas & EPBC Act Protected Matters Search

Similar to the assessment undertaken in section 2.1, a review of spatial records of threatened fauna within a 10 kilometre radius of the Study Area was undertaken using data obtained from the Bionet Atlas, and predicted threatened biodiversity were generated from an EPBC Act Protected Matters Search.

Eighty-seven threatened fauna have been previously recorded or have modelled habitat within a 10 kilometre radius of the Study Area (Appendix 1) according to the database searches. The potential for these species to occur within the Study Area is discussed in section 3.5 and Appendix 1.

3.2 Methods – field survey

Given the nature of the works and the fact that the Study Area comprises bare sand dunes only, no targeted fauna surveys were considered necessary. A habitat-based assessment was completed by Luke Baker (Senior Ecologist and Accredited Assessor) on the 4th of March 2019, which provided sufficient detail to determine the type and condition of habitats for fauna species.

3.3 Fauna habitat

The Study Area consisted of open, bare sand dunes and did not contain any limiting habitat features such as hollows, logs, woody debris, leaf litter, watercourses or vegetation cover. Such habitat features are likely to be present throughout the shrub and woodland vegetation types to the west of the Study Area. The Study Area does not provide any connectively linkages to such habitat.

3.4 Fauna recorded during field surveys

No fauna were recorded within the Study Area, however a total of 11 birds were recorded during field surveys adjacent to the Study Area. All of the bird species recorded are locally common species and included: Silver Gull (*Chroicocephalus novaehollandiae*), Galah (*Eolophus roseicapillus*), White-bellied Sea-Eagle (*Haliaeetus leucogaster*), Crimson Rosella (P*latycercus elegans*), Rainbow Lorikeet (*Trichoglossus haematodus)*, Superb Fairy-wren (*Malurus cyaneus*), Noisy Miner (*Manorina melanocephala*), New Holland Honeyeater (*Phylidonyris novaehollandiae*), Australian Magpie (*Cracticus tibicen*), Australian Raven (*Corvus coronoides*), Sulphur-crested cockatoo (*Cacatua galerita*).

3.5 Threatened fauna and migratory fauna

No threatened fauna were recorded within the Study Area, however a White-bellied Sea Eagle (*Haliaeetus leucogaster*) (listed as Vulnerable under the BC Act) was observed flying outside of the Study Area during the field survey.

Given the lack of resources for threatened fauna within the Study Area, the majority of threatened fauna with the potential to occur are considered unlikely to occur or be impacted by the Project.

Five migratory species (Red Knot, Ruddy Turnstone, Red-necked Stint, Great Knot and Pacific Golden Plover) were considered to have a low likelihood of occurrence based on their habit of roosting on open beaches. These species are migratory, spending the summer in Australia, migrating to the northern hemisphere in winter to breed. Given the extent of suitable roosting habitat adjacent to the Project (the sand dune system is extensive along Stockton Beach) and the fact that the birds roost at night, when sand

mining activity does not occur, it is considered unlikely that these species would be impacted by the Project.

3.6 State Environment Planning Policy 44 – Koala Habitat

No State Environment Planning Policy 44 (SEPP 44) Koala habitat would be impacted by the Project. No Koala habitat trees or corridors occur within the Study Area.

4. Impact Assessment

4.1 Avoid and minimise impacts

In accordance with the BAM, proponents must demonstrate measures employed to avoid, mitigate and offset impacts of a project on biodiversity values. This section of the report outlines the avoidance planning, management and mitigation measures that Boral has incorporated into the project design or will employ during construction, operation or completion of the project to reduce impacts on biodiversity values.

4.2 Avoidance

The location of the Study Area occurs immediately adjacent to the existing approved Extraction Area, within an area of land that does not comprise any vegetation cover or fauna habitat.

The location of the Study Area has been positioned away from nearby patches of native vegetation to the south (approximately 50 metres away), in order to prevent impacts to biodiversity.

As such, Boral have demonstrated avoidance of impacts to biodiversity associated with the modification.

4.2.1 Mitigation measures

Impacts arising from the proposal will primarily relate to vehicle movements along existing haul roads, and dredging activities that are already in operation.

Boral currently have an Environmental Management Strategy (Environmental Compliance Services, 2016) in place which provides mitigation measures for their existing operations.

The Environmental Management Strategy encompasses the following core area, which would be updated as required to reflect the current project:

- Environmental Management System (EMS)
- Rehabilitation & Landscape Management Plan (RLMS)
- Erosion & Sediment Management Plan (ESMP)
- Ground Water Management Plan (GWMP).

Mitigation measures included in the Environmental Management Strategy and relevant to the Project include the following:

- Fencing and signposting – Use of fencing and/or highly visible rope or tape to delineate the boundary of site and prevent access into adjacent areas of native vegetation.
- Employee Education and General Environmental Controls - Employees and contractors will be educated on controls, to avoid or at least minimise potential environmental impacts associated with activities.
- Minimisation of dust generation by appropriate dust suppression.
- Procedures for the management of hydrocarbon and/or chemical spills including the requirement for vehicles to carry spill kits.
- Ensuring vehicles remain on designated roads and tracks and abide by site speed limits.
- Management and removal of all rubbish from the Study Area.

The current Environmental Management Strategy would be amended to incorporate the Study Area.

4.2.2 Rehabilitation

The existing operation would be rehabilitated in accordance with the R.W Corkery and Associates Pty Limited Landscape and Rehabilitation Management Plan (2018). This Plan would be updated to include the Study Area.

4.3 Impact Assessment

4.3.1 Direct Impacts

Direct impacts associated with the proposed modification are limited to the removal of sand. No direct impacts to native vegetation and fauna habitat are likely to occur.

4.3.2 Indirect impacts

The potential for indirect impacts to biodiversity associated with the modification are likely to be minimal, given the Study Area is located at least 50 metres away from the nearest patch of native vegetation and fauna habitat.

As discussed in the Boral (2019) EIS, the proposed modification is not anticipated to further substantially contribute to indirect impacts associated with noise, air quality, dust, traffic, and waste management currently addressed and controlled for within the approved extraction operation and Environmental Management Plan. Furthermore, as discussed in the Boral (2019) EIS, the modification is anticipated to have minimal impact on groundwater given the extraction would not occur below a maximum extraction depth of 2.5 metres AHD, which is part of the existing conditions of consent.

The current extraction operations are managed in accordance with an Environmental Management Strategy (Environmental Compliance Services, 2016). It is recommended that this current Plan be extended and implemented to include the Study Area to further safeguard biodiversity from potential indirect impacts from the Project

Given the Study Area is essentially a 15 metre expansion of the approved extraction boundary, and would be subject to the same operations, mitigation measures and controls as detailed in the current Environmental Management Plan, it is considered unlikely that indirect impacts would increase substantially beyond the level of that currently operating. Given the current operations to date have not resulted in an impact to native vegetation within the locality due to any groundwater change, it seems unlikely that this would occur as a result of this modification.

4.4 Biodiversity offsetting

No Biodiversity offsetting is required, as native vegetation and habitat are unlikely to be impacted by the proposal.

5. Conclusion

This report assesses the potential impacts associated with the Stockton Sandpit (DA140-6-2005) – Proposed Modification 3.

During the field survey, no native vegetation was recorded within the Study Area.

No threatened flora are likely to be impacted by the Project given the lack of habitat and absence of threatened flora during the field survey.

No threatened fauna are likely to be impacted by the Project given the lack of habitat features within the Study Area.

The modification avoids direct impacts to native vegetation and habitat as the Study Area consisted of bare sand cover, and indirect impacts are unlikely to increase above that currently operating.

Mitigation measures associated with indirect impacts have been proposed through the revision and implementation of the existing Environmental Management Plan to include the Study Area

Given biodiversity impacts are unlikely, no biodiversity offsets are required for the proposal.

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Annex 1. Likelihood of occurrence

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
Amphibians						
Crinia tinnula	Wallum Froglet	V	-	Wallum Froglets are found in paperbark swamps and sedge swamps of the coastal 'wallum' country. Their tadpoles are adapted to acid conditions and may be outcompeted by the Common Froglet. Males call from the base of vegetation in and around the breeding site and are almost impossible to locate. Calling occurs from Autumn to Spring, being most strongly associated with flooding following rainfall. Its range extends from SE QLD to the Kurnell Peninsular of Sydney.	None	Species
Heleioporus australiacus	Giant Burrowing Frog	V	V	The Giant Burrowing Frog has been recorded breeding in a range of water bodies associated with sandy environments of the coast and adjacent ranges from the Sydney Basin south the eastern Victoria. It breeds in hanging swamps, perennial non-flooding creeks and occasionally permanent pools, but permanent water must be present to allow its large tadpoles time to reach metamorphosis.	None	Species
Litoria aurea	Green and Golden Bell Frog	E	V	Inhabits a very wide range of water bodies including marshes, dams and streams, particularly those containing emergent vegetation such as bullrushes or spikerushes. It also inhabits numerous types of man-made water bodies including quarries and sand extraction sites. Optimum habitat includes water-bodies that are un-shaded, free of predatory fish such as Plague Minnow, have a grassy area nearby and diurnal sheltering sites available.	None	Species
Mixophyes balbus	Stuttering Frog	E	V	Associated with streams in dry sclerophyll and wet sclerophyll forests and rainforests of more upland areas of the Great Dividing Range of NSW and down into Victoria. Breeding occurs along forest streams with permanent water where eggs are deposited within nests excavated in riffle zones by the females and the tadpoles swim free into the stream when large enough to do so. Outside of breeding, individuals range widely across the forest floor and can be found hundreds of metres from water.	None	Species
Birds						
Actitis hypoleucos	Common Sandpiper	-	M, MA	Utilises a wide range of coastal wetlands and some inland wetlands, mostly found around muddy margins or rocky shores. Forages in shallow water and on soft mud, roosts on rocks or vegetation such as mangroves. Northern hemisphere breeding.	Low	N/A
Anthochaera phrygia	Regent Honeyeater	CE	CE	The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. Birds are also found in drier coastal woodlands and forests in some years. There are only three known key breeding regions remaining: north-	None	Species

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
				east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region. In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands. In some years flocks converge on flowering coastal woodlands and forests.		
Apus pacificus	Fork-tailed Swift	-	M	The Fork-tailed Swift is almost exclusively aerial, flying from less than one metre to at least 300 m above ground and probably much higher.	Low	N/A
Arenaria interpres	Ruddy Turnstone	-	M	Mainly found in coastal regions with exposed rock coast lines or coral reefs. Also found on rock platforms with shallow tidal pools, and occasionally beaches and estuaries. Northern hemisphere breeding.	Low	N/A
Artamus cyanopterus cyanopterus	Dusky Woodswallow	V	-	Often reported in woodlands and dry open sclerophyll forests, usually dominated by eucalypts, including mallee associations. It has also been recorded in shrublands and heathlands and various modified habitats, including regenerating forests; very occasionally in moist forests or rainforests.	None	N/A
Botaurus poiciloptilus	Australasian Bittern	E	E	The Australasian Bittern is widespread but uncommon over south-eastern Australia. In NSW they may be found over most of the state except for the far north-west. Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes and spikerushes.	None	Species
Burhinus grallarius	Bush Stone-curlew	E	-	The Bush Stone-curlew is found throughout Australia except for the central southern coast and inland, the far south-east corner, and Tasmania. Only in northern Australia is it still common however and in the south-east it is either rare or extinct throughout its former range. Inhabits open forests and woodlands with a sparse grassy ground layer and fallen timber. Largely nocturnal, being especially active on moonlit nights.	None	Ecosystem
Calidris acuminata	Sharp-tailed Sandpiper	-	M	Prefers muddy edges of shallow or brackish wetlands, with inundated or emergent sedges, saltmarsh or other low vegetation. Also found foraging in sewage ponds and flooded paddocks. Northern hemisphere breeding.	None	N/A
Calidris canutus	Red Knot	-	M, E	Usually found foraging in soft substrate near the edge of the water on intertidal mudflats. Also have been recorded at nearby lakes, sewage ponds and floodwaters. Roosts on sandy beaches, spits and islands. Northern hemisphere breeding.	Low	N/A
Calidris ferruginea	Curlew Sandpiper	E	CE, M	It occurs along the entire coast of NSW, particularly in the Hunter Estuary, and sometimes in freshwater wetlands in the Murray-Darling Basin. It generally occupies littoral and estuarine habitats, and in New South Wales is mainly found in intertidal mudflats of sheltered coasts. It also occurs in non-tidal swamps, lakes and lagoons on the coast and sometimes the inland. Northern hemisphere breeding.	None	N/A

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
Calidris melanotos	Pectoral Sandpiper	-	M	Prefers shallow fresh to saline wetlands, found at coastal lagoons, estuaries, bays, swamps, inundated grasslands, saltmarshes and artificial wetlands. Northern hemisphere breeding.	None	N/A
Calidris ruficollis	Red-necked Stint	-	M	Mostly found in coastal areas including inlets, bays, lagoons and estuaries with intertidal mudflats. Occasionally on exposed ocean beaches and sometimes rocky shores and reefs. Northern hemisphere breeding.	Low	N/A
Calidris tenuirostris	Great Knot	V	M, CE	In NSW, this species has been recorded at scattered sites along the coast to about Narooma. It has also been observed inland at Tullakool, Armidale, Gilgandra and Griffith. Occurs within sheltered, coastal habitats containing large, intertidal mudflats or sand flats, including inlets, bays, harbours, estuaries and lagoons. Often recorded on sandy beaches with mudflats nearby, sandy spits and islets and sometimes on exposed reefs or rock platforms. Northern hemisphere breeding.	Low	N/A
Charadrius bicinctus	Double-banded Plover	-	M	Found on littoral, estuarine and fresh or saline terrestrial wetlands, rocky beaches, bays and inlets. Sometimes found on exposed reefs and rock platforms. Migrates to breed in New Zealand.	None	N/A
Charadrius leschenaultii	Greater Sand Plover	V	M, V	Occur on sheltered sandy, shelly or muddy beaches with large intertidal mudflats or sandbanks, as well as sandy estuarine lagoons. Non-breeding in Australia.	None	N/A
Charadrius mongolus	Lesser Sand Plover	V	M, E	Inhabits large intertidal sand flats or mudflats in sheltered bays, harbours and estuaries, and occasionally sandy ocean beaches, coral reefs, wave-cut rock platforms and rocky outcrops. Non-breeding in Australia.	None	N/A
Cuculus optatus, Cuculus saturatus	Oriental Cuckoo	-	M, MA	Mainly inhabits coniferous, deciduous and mixed forests. Breeds in northern hemisphere. Brood parasite, laying eggs in nests of other birds.	None	N/A
Dasyornis brachypterus	Eastern Bristlebird	E	E	Found in coastal woodlands, dense scrub and heathlands, particularly where it borders taller woodlands.	None	Species
Diomedea antipodensis	Antipodean Albatross	V	V, M, MA	The species ranges across the southern Pacific Ocean, east to the coast of Chile and west to eastern Australia. The Antipodean Albatross breeds biennially in colonies on ridges, slopes and plateaus of isolated subantarctic islands, usually in vegetation such as grass tussocks. This species regularly occurs in small numbers off the NSW south coast from Green Cape to Newcastle during winter where they feed on cuttlefish.	None	N/A
Diomedea exulans	Wandering Albatross	E	V, M, MA	The Wandering Albatross is marine, pelagic and aerial. The Wandering Albatross visits Australian waters from Fremantle, Western Australia to northern New South Wales between June and September each year.	None	N/A

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
Diomedea gibsoni, Diomedea antipodensis gibsoni	Gibson's Albatross	V	V, M, MA	The species is regularly encountered on trans-Tasman shipping routes and at seas off Sydney, and regularly occurs off the NSW coast usually between Green Cape and Newcastle. This species is known only to breed on the Adams, Disappointment and Auckland Islands in the subantarctic Auckland Island group. Potential forage in NSW waters during the winter is considered significant for the species.	None	N/A
Ephippiorhynchus asiaticus	Black-necked Stork	E	-	Mainly found on shallow, permanent, freshwater terrestrial wetlands, and surrounding marginal vegetation, including swamps, floodplains, watercourses and billabongs, freshwater meadows, wet heathland, farm dams and shallow floodwaters, as well as extending into adjacent grasslands, paddocks and open savannah woodlands. They also forage within or around estuaries and along intertidal shorelines, such as saltmarshes, mudflats and sand flats, and mangrove vegetation.	None	Species
Epthianura albifrons	White-fronted Chat	V	-	Low vegetation in salty coastal and inland areas and crops. Runs along ground and is found in local flocks in Winter.	None	Ecosystem
Erythrotriorchis radiatus	Red Goshawk	CE	V	Distributed sparsely through northern and eastern Australia, from the western Kimberley Division of northern Western Australia to north-eastern Queensland and south to far north-eastern NSW, and with scattered records in central Australia. In NSW, preferred habitats include mixed subtropical rainforest, Melaleuca swamp forest and riparian Eucalyptus forest of coastal rivers. Very rare in NSW.	None	Species
Gallinago hardwickii	Latham's Snipe	-	M	Latham's Snipe is a non-breeding migrant to the south east of Australia including Tasmania, passing through the north and New Guinea on passage. Latham's Snipe breed in Japan and on the east Asian mainland. Seen in small groups or singly in freshwater wetlands on or near the coast, generally among dense cover. They are found in any vegetation around wetlands, in sedges, grasses, lignum, reeds and rushes and also in saltmarsh and creek edges on migration.	None	N/A
Gallinago megala	Swinhoe's Snipe	-	M	Occurs at edges of wetlands, swamps and freshwater streams. Also known to occur in grasslands, sewage ponds and drying claypans. Northern hemisphere breeding.	None	N/A
Gallinago stenura	Pin-tailed Snipe	-	M	Occurs at edges of shallow freshwater swamps, ponds and lakes with emergent, sparse to dense cover of grass/sedge or other vegetation. Also found on more open wetlands, claypans and sewage ponds. Breeds in the northern hemisphere.	None	N/A
Glossopsitta pusilla	Little Lorikeet	V	-	Distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range in NSW, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri. Mostly occur in dry, open eucalypt forests and woodlands. They feed primarily on nectar and pollen in the tree canopy. Nest hollows are located at heights of between 2 m	None	Ecosystem

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
				and 15 m, mostly in living, smooth-barked eucalypts. Most breeding records come from the western slopes.		
Grantiella picta	Painted Honeyeater	V	V	The Painted Honeyeater is nomadic and occurs at low densities throughout its range. The greatest concentrations of the bird and almost all breeding occurs on the inland slopes of the Great Dividing Range in NSW, Victoria and southern Queensland. During the winter it is more likely to be found in the north of its distribution. Inhabits boree, brigalow and box-gum woodlands and box-ironbark forests.	None	Ecosystem
Haematopus fuliginosus	Sooty Oystercatcher	V	-	In NSW the Sooty Oystercatcher occupies rocky headlands, reefs and offshore islands along the entire coast, apparently as a single continuous population.	None	Species
Haematopus longirostris	Pied Oystercatcher	E	-	The Pied Oystercatcher inhabits marine littoral habitats, including islands. It occupies muddy, sandy, stony or rocky estuaries, inlets and beaches, particularly intertidal mudflats and sandbanks in large marine bays.	None	Species
Haliaeetus leucogaster	White-bellied Sea-Eagle	V	MA	Inhabits coastal and near coastal areas, building large stick nests, and feeding mostly on marine and estuarine fish and aquatic fauna.	None	N/A
Hieraaetus morphnoides	Little Eagle	V	-	Most abundant in lightly timbered areas with open areas nearby. Often recorded foraging in grasslands, crops, treeless dune fields, and recently logged areas. May nest in farmland, woodland and forest in tall trees.	None	Ecosystem
Hirundapus caudacutus	White-throated Needletail	-	M, MA	An aerial species found in feeding concentrations over cities, hilltops and timbered ranges.	None	N/A
Lathamus discolor	Swift Parrot	E	CE	The Swift Parrot occurs in woodlands and forests of NSW from May to August, where it feeds on eucalypt nectar, pollen and associated insects. The Swift Parrot is dependent on flowering resources across a wide range of habitats in its wintering grounds in NSW. This species is migratory, breeding in Tasmania and also nomadic, moving about in response to changing food availability.	None	Ecosystem
Limicola falcinellus	Broad-billed Sandpiper	V	M	Favours sheltered parts of the coast such as estuarine sand flats and mudflats, harbours, embayments, lagoons, saltmarshes and reefs as feeding and roosting habitat. Occasionally, individuals may be recorded in sewage farms or within shallow freshwater lagoons. Broad-billed Sandpipers roost on banks on sheltered sand, shell or shingle beaches. Breeds in the northern hemisphere.	None	Species
Limosa lapponica baueri	Bar-tailed Godwit	-	M, V	Bar-tailed Godwit (spp baueri) is the eastern Australian / New Zealand sub species. Mainly found in coastal habitats such as intertidal sand flats, mudflats, estuaries, inlets, coastal	None	N/A

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
				lagoons and bays. Often found around beds of seagrass and saltmarsh. Northern hemisphere breeding.		
Limosa lapponica menzbieri	Bar-tailed godwit	-	M, CE	Bar-tailed Godwit (spp menzbieri) is the western Australian sub species. Mainly found in coastal habitats such as intertidal sand flats, mudflats, estuaries, inlets, coastal lagoons and bays. Often found around beds of seagrass and saltmarsh. Northern hemisphere breeding.	None	N/A
Limosa limosa	Black-tailed Godwit	V	M	Primarily a coastal species. Usually found in sheltered bays, estuaries and lagoons with large intertidal mudflats and/or sand flats. Further inland, it can also be found on mudflats and in water less than 10 cm deep, around muddy lakes and swamps. Northern hemisphere breeding.	None	Ecosystem
Macronectes giganteus	Southern Giant Petrel	E	E	The Southern Giant Petrel has a circumpolar pelagic range from Antarctica to approximately 20 S and is a common visitor off the coast of NSW. Over summer, the species nests in small colonies amongst open vegetation on antarctic and subantarctic islands, including Macquarie and Heard Islands and in Australian Antarctic territory.	None	EEC/Marine
Macronectes halli	Northern Giant-petrel	V	V	Breeding in Australian territory is limited to Macquarie Island and occurs during spring and summer.	None	EEC/Marine
Monarcha melanopsis	Black-faced Monarch	-	M	Found along the coast of eastern Australia, becoming less common further south. Inhabits rainforests, eucalypt woodlands, coastal scrub and damp gullies. It may be found in more open woodland when migrating.	None	N/A
Monarcha trivirgatus	Spectacled Monarch	-	M	Coastal north-eastern and eastern Australia, including coastal islands, from Cape York, Queensland to Port Stephens, New South Wales. Prefers thick understorey in rainforests, wet gullies and waterside vegetation, as well as mangroves.	None	N/A
Motacilla flava	Yellow Wagtail	-	M	Breeds in temperate Europe and Asia. The Yellow Wagtail is a regular wet season visitor to northern Australia. Increasing records in NSW suggest this species is an occasional but regular summer visitor to the Hunter River region. The species is considered a vagrant to Victoria, South Australia and southern Western Australia. Habitat requirements for the Yellow Wagtail are highly variable, but typically include open grassy flats near water. Habitats include open areas with low vegetation such as grasslands, airstrips, pastures, sports fields; damp open areas such as muddy or grassy edges of wetlands, rivers, irrigated farmland, dams, waterholes; sewage farms, sometimes utilise tidal mudflats and edges of mangroves.	None	N/A

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
Myiagra cyanoleuca	Satin Flycatcher	-	M	The Satin Flycatcher is found along the east coast of Australia from far northern Queensland to Tasmania, including south-eastern South Australia. Found in tall forests, preferring wetter habitats such as heavily forested gullies, but not rainforests.	None	N/A
Neophema pulchella	Turquoise Parrot	V	-	The Turquoise Parrot's range extends from southern Queensland through to northern Victoria, from the coastal plains to the western slopes of the Great Dividing Range. Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. Nests in tree hollows, logs or posts, from August to December. It lays four or five white, rounded eggs on a nest of decayed wood dust.	None	Ecosystem
Ninox strenua	Powerful Owl	V	-	Occupies wet and dry eucalypt forests and rainforests. Can occupy both un-logged and lightly logged forests as well as undisturbed forests where it usually roosts on the limbs of dense trees in gully areas. It is most commonly recorded within turpentine tall open forests and black she-oak within open forests. Large mature trees with hollows at least 0.5 m deep are required for nesting. Tree hollows are particularly important for the Powerful Owl because a large proportion of the diet is made up of hollow-dependent arboreal marsupials. Nest trees for this species are usually emergent with a diameter at breast height of at least 100 cm.	None	Ecosystem
Numenius madagascariensis	Eastern Curlew	-	CE, MA, M	A primarily coastal distribution. Found in all states, particularly the north, east, and south-east regions including Tasmania. Rarely recorded inland. Mainly forages on soft sheltered intertidal sand flats or mudflats, open and without vegetation or cover. Breeds in the northern hemisphere.	None	Ecosystem
Numenius minutus	Little Curlew	-	M	Feeds in short, dry grassland and sedgeland, including dry floodplains and black soil plains, which have scattered, shallow freshwater pools. Northern hemisphere breeding.	None	N/A
Numenius phaeopus	Whimbrel	-	M	Usually found on intertidal mudflats of sheltered coasts. Also found in harbours, lagoons, estuaries and river deltas, often those with mangroves. Northern hemisphere breeding.	None	N/A
Pandion cristatus, Pandion haliaetus	Eastern Osprey	V	M, MA	Ospreys are found right around the Australian coast line, except for Victoria and Tasmania. They are common around the northern coast, especially on rocky shorelines, islands and reefs. The species is uncommon to rare or absent from closely settled parts of south-eastern Australia. Favour coastal areas, especially the mouths of large rivers, lagoons and lakes. Feed on fish over clear, open water.	None	Species
Philomachus pugnax	Ruff	-	M	Generally found in fresh, brackish to saline wetlands with exposed mudflats at the edges. Breeds in northern hemisphere.	None	N/A

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
Phoebetria fusca	Sooty Albatross	V	-	In Australian waters, this species is generally recorded in winter off the south coast from Tasmania to Western Australia, while there are occasional sightings off the NSW coast, north of Grafton. This pelagic or ocean-going species inhabits subantarctic and subtropical marine waters, spending the majority of its time at sea, and rarely occurs in continental shelf waters.	None	EEC/Marine
Pluvialis fulva	Pacific Golden Plover	-	M	Coastal habitats such as beaches, mudflats, sand flats, estuaries, lagoons and evaporation ponds in salt works. Northern hemisphere breeding.	Low	N/A
Pluvialis squatarola	Grey Plover	-	M	Almost entirely in coastal areas including sheltered embayment's, estuaries and lagoons with mudflats and sand flats, and occasionally on rocky coasts with platforms or reef flats. Breeds in northern hemisphere.	None	N/A
Pterodroma neglecta neglecta	Kermadec Petrel (west Pacific subspecies)	V	V	Typically nests on the surface in loose colonies among rocks and vegetation. On Ball's Pyramid it nests only on steep cliffs above 400 m. On Phillip I. it nests under stands of African Olive. This species is marine and highly pelagic, rarely approaching land except at colonies.	None	EEC/Marine
Rhipidura rufifrons	Rufous Fantail	-	M	Found along the east coast of Australia from far northern Queensland to Tasmania, including south-eastern South Australia. Inhabits tall forests, preferring wetter habitats such as heavily forested gullies, but not rainforests.	None	Species
Rostratula australis	Australian Painted Snipe	E	E, MA	In NSW, this species has been recorded at the Paroo wetlands, Lake Cowell, Macquarie Marshes and Hexham Swamp. Most common in the Murray-Darling Basin. Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds.	None	Ecosystem
Sternula albifrons	Little Tern	E	M	In Australia, Little Terns inhabit sheltered coastal environments, including lagoons, estuaries, river mouths and deltas, lakes, bays, harbours and inlets, especially those with exposed sandbanks or sand-spits, and also on exposed ocean beaches.	None	Species
Thalassarche cauta (sensu stricto), Thalassarche cauta cauta	Shy Albatross, Tasmanian Shy Albatross	V	V, M, MA	The Shy Albatross is a marine species occurring in subantarctic and subtropical waters, reaching the tropics in the cool Humboldt Current off South America.	None	EEC/Marine
Thalassarche melanophris	Black-browed Albatross	V	V, M, MA	The Black-browed Albatross has a circumpolar range over the southern oceans, and are seen off the southern Australian coast mainly during winter. Inhabits antarctic, subantarctic, subtropical marine and coastal waters over upwellings and boundaries of currents.	None	N/A

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
Tringa brevipes, Heteroscelus brevipes	Grey-tailed Tattler	-	M, MA	Found on sheltered coasts with reefs and rock platforms, intertidal mudflats, estuaries and coastal lagoons, especially fringed with mangroves. Northern hemisphere breeding.	None	N/A
Tringa nebularia	Common Greenshank	-	M	Variety of inland wetlands and sheltered coastal habitats of varying salinity. Found on mudflats, saltmarsh, mangroves in embayments, harbours, deltas and lagoons. Breeds in northern hemisphere.	None	N/A
Tringa stagnatilis	Marsh Sandpiper	-	M	Permanent or ephemeral wetlands of varying salinity, including swamps, lagoons, billabongs, saltpans, saltmarshes, estuaries, sewage farms and salt works. Northern hemisphere breeding.	None	N/A
Tyto novaehollandiae	Masked Owl	V	-	Inhabits a diverse range of wooded habitat that provide tall or dense mature trees with hollows suitable for nesting and roosting. Mostly recorded in open forest and woodlands adjacent to cleared lands. Nest in hollows, in trunks and in near vertical spouts or large trees, usually living but sometimes dead. Nest hollows are usually located within dense forests or woodlands. Masked Owls prey upon hollow-dependent arboreal marsupials, but terrestrial mammals make up the largest proportion of the diet.	None	Ecosystem
Xenus cinereus	Terek Sandpiper	V	M, MA	The Terek Sandpiper mostly forages in the open, on soft wet intertidal mudflats or in sheltered estuaries, embayments, harbours or lagoons. Northern hemisphere breeding.	None	Ecosystem
Mammals						
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Located in a variety of drier habitats, including the dry sclerophyll forests and woodlands to the east and west of the Great Dividing Range. Can also be found on the edges of rainforests and in wet sclerophyll forests. This species roosts in caves and mines in groups of between 3 and 37 individuals.	None	Ecosystem and species
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	Inhabit sclerophyll forests, preferring wet habitats where trees are more than 20 m high. Two observations have been made of roosts in stem holes of living eucalypts. There is debate about whether or not this species moves to lower altitudes during winter, or whether they remain sedentary but enter torpor. This species also appears to be highly mobile and records showing movements of up to 12 km between roosting and foraging sites.	None	Ecosystem
Miniopterus australis	Little Bentwing-bat	V	-	Coastal north-eastern NSW and eastern Queensland. The Little Bentwing-bat is an insectivorous bat that roost in caves, in old mines, in tunnels, under bridges, or in similar structures. They breed in large aggregations in a small number of known caves and may travel hundreds of kilometres from feeding home ranges to breeding sites. They have a	None	Ecosystem and species

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
				preference for moist eucalypt forest, rainforest or dense coastal banksia scrub where it forages below the canopy for insects.		
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	-	Eastern Bentwing-bats occur along the east and north-west coasts of Australia. Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. Form discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young.	None	Ecosystem and species
Mormopterus norfolkensis	Eastern Freetail-bat	V	-	Most records are from dry eucalypt forests and woodlands to the east of the Great Dividing Range. Appears to roost in trees, but little is known of this species' habits.	None	Ecosystem
Myotis macropus	Southern Myotis	V	-	The Southern Myotis is found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria. Generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, stormwater channels, buildings, under bridges and in dense foliage.	None	Ecosystem and species
Petauroides volans	Greater Glider	-	V	The Greater Glider is restricted to eastern Australia, occurring from the Windsor Tableland in north Queensland through to central Victoria. It is typically found in highest abundance in taller, montane, moist eucalypt forests with relatively old trees and abundant hollows.	None	Species
Petaurus norfolcensis	Squirrel Glider	V	-	Generally occurs in dry sclerophyll forests and woodlands but is absent from dense coastal ranges in the southern part of its range. Requires abundant hollow bearing trees and a mix of eucalypts, banksias and acacias. There is only limited information available on den tree use by Squirrel gliders, but it has been observed using both living and dead trees as well as hollow stumps. Within a suitable vegetation community at least one species should flower heavily in winter and one species of eucalypt should be smooth barked. Endangered population in the Wagga Wagga LGA.	None	Species
Phascogale tapoatafa	Brush-tailed Phascogale	V	-	The Brush-tailed Phascogale has a patchy distribution around the coast of Australia. In NSW it is mainly found east of the Great Dividing Range although there are occasional records west of the divide. Prefer dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs or leaf litter. Also inhabit heath, swamps, rainforest and wet sclerophyll forest.	None	Species
Phascolarctos cinereus	Koala	V	V	Inhabits eucalypt forests and woodlands. The suitability of these forests for habitation depends on the size and species of trees present, soil nutrients, climate and rainfall.	None	Species
Phascolarctos cinereus	Koala, Hawks Nest and Tea	EP	-	Inhabits eucalypt forests and woodlands. The suitability of these forests for habitation depends on the size and species of trees present, soil nutrients, climate and rainfall.	None	N/A

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
	Gardens population					
Potorous tridactylus tridactylus	Long-nosed Potoroo	V	V	Inhabits coastal heath and wet and dry sclerophyll forests. Generally found in areas with rainfall greater than 760 mm. Requires relatively thick ground cover where the soil is light and sandy.	None	Ecosystem
Pseudomys novaehollandiae	New Holland Mouse	-	V	The New Holland Mouse currently has a disjunct, fragmented distribution across Tasmania, Victoria, New South Wales and Queensland. Across the species' range the New Holland Mouse is known to inhabit open heathlands, open woodlands with a heathland understorey, and vegetated sand dunes.	None	Ecosystem
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, melaleuca swamps and banksia woodlands. Bats commute daily to foraging areas, usually within 15 km of the day roost although some individuals may travel up to 70 km.	None	Ecosystem and species
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. When foraging for insects, flies high and fast over the forest canopy, but lower in more open country. Forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory.	None	Ecosystem
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	Prefer moist gullies in mature coastal forests and rainforests, between the Great Dividing Range and the coast. They are only found at low altitudes below 500 m. In dense environments they utilise natural and human-made opening in the forest for flight paths. Creeks and small rivers are favoured foraging habitat. This species roosts in hollow tree trunks and branches.	None	Ecosystem
Flora						
Angophora inopina	Charmhaven Apple	V	V	Endemic to the Central Coast region of NSW. The known northern limit is near Karuah where a disjunct population occurs; to the south populations extend from Toronto to Charmhaven with the main population occurring between Charmhaven and Morisset. Occurs most frequently in Red Bloodwood Scribbly Gum woodland, wet heath, Red Mahogany Paperbark Sedge woodland and Stringybark Red Bloodwood forest.	None	Species
Commersonia prostrata	Dwarf Kerrawang	E	E	Occurs on sandy, sometimes peaty soils in a wide variety of habitats: snow gum woodland at Rose Lagoon; Blue-leaved Stringybark open forest at Tallong; and in Brittle Gum low open woodland at Penrose; Scribbly Gum - Swamp Mahogany ecotonal forest at Tomago.	None	Species

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
Cryptostylis hunteriana	Leafless Tongue-orchid	V	V	Does not appear to have well defined habitat preferences and is known from a range of communities, including swamp-heath and woodland. The larger populations typically occur in woodland dominated by Scribbly Gum, Silvertop Ash, Red Bloodwood and Black She-oak and appears to prefer open areas in the understorey of this community.	None	Species
Diuris arenaria	Sand Doubletail	E	-	Known from the Tomaree Peninsula near Newcastle. This species occurs in coastal heath and dry grassy eucalypt forest on sandy flats. Grows in gently undulating country in eucalypt forest with a grassy understorey on clay soil.	None	Species
Diuris praecox	Rough Doubletail	V	V	Occurs between Ourimbah and Nelson Bay. Grows on hills and slopes of near-coastal districts in open forests which have a grassy to fairly dense understorey. Exists as subterranean tubers most of the year. It produces leaves and flowering stems in winter.	None	Species
Eucalyptus camfieldii	Heart-leaved Stringybark	V	V	Restricted distribution in a narrow band with the most northerly records in the Raymond Terrace Area south to Waterfall. Poor coastal country in shallow sandy soils overlying Hawkesbury sandstone. Coastal heath mostly on exposed sandy ridges. Occurs mostly in small scattered stands near the boundary of tall coastal heaths and low open woodland of the slightly more fertile inland areas.	None	Species
Eucalyptus parramattensis subsp. decadens		V	V	Generally occupies deep, low-nutrient sands, often those subject to periodic inundation or where water tables are relatively high. It occurs in dry sclerophyll woodland with dry heath understorey. It also occurs as an emergent in dry or wet heathland. Often where this species occurs, it is a community dominant.		None
Grevillea parviflora subsp. parviflora	Small-flowered Grevillea	V	V	Grows in sandy or light clay soils usually over thin shales. Occurs in a range of vegetation types from heath and shrubby woodland to open forest. Found over a range of altitudes from flat, low-lying areas to upper slopes and ridge crests. Often occurs in open, slightly disturbed sites such as along tracks.	None	Species
Maundia triglochinoides		V	-	Grows in swamps, creeks or shallow freshwater 30 - 60 cm deep on heavy clay, low nutrients. Flowering occurs during warmer months. Diaspore is the seed and root tubers, which are probably dispersed by water.		None
Melaleuca biconvexa	Biconvex Paperbark	V	V	Grows in damp places, often near streams or low-lying areas on alluvial soils of low slopes or sheltered aspects. Scattered and dispersed populations found in the Jervis Bay area in the south and the Gosford-Wyong area in the north.	None	Species
Persicaria elatior	Tall Knotweed	V	V	This species normally grows in damp places, especially beside streams and lakes. Occasionally in swamp forest or associated with disturbance.	None	Species

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
Phaius australis	Southern Swamp Orchid	E	E	Swampy grassland or swampy forest including rainforest, eucalypt or paperbark forest, mostly in coastal areas.	None	Species
Senecio spathulatus	Coast Groundsel	E	-	Coast Groundsel occurs in Nadgee Nature Reserve (Cape Howe) and between Kurnell in Sydney and Myall Lakes National Park (with a possible occurrence at Cudmirrah). In Victoria there are scattered populations from Wilsons Promontory to the NSW border. Coast Groundsel grows on primary dunes.	None	Species
Syzygium paniculatum	Magenta Lilly Pilly	E	V	Found only in NSW, in a narrow, linear coastal strip from Bulahdelah to Conjola State forest. On the south coast the species occurs on grey soils over sandstone, restricted mainly to remnant stands of littoral rainforest. On the central coast it occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities.	None	Species
Tetratheca juncea	Black-eyed Susan	V	V	Confined to the northern portion of the Sydney Basin bioregion and the southern portion of the North Coast bioregion in the local government areas of Wyong, Lake Macquarie, Newcastle, Port Stephens, Great Lakes and Cessnock. It is usually found in low open forest-woodland with a mixed shrub understorey and grassy groundcover. The majority of populations occur on low nutrient soils associated with the Awaba Soil Landscape. Cryptic species that requires survey in September-October.	None	Species

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Sydney
Illawarra
Central Coast
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Our services

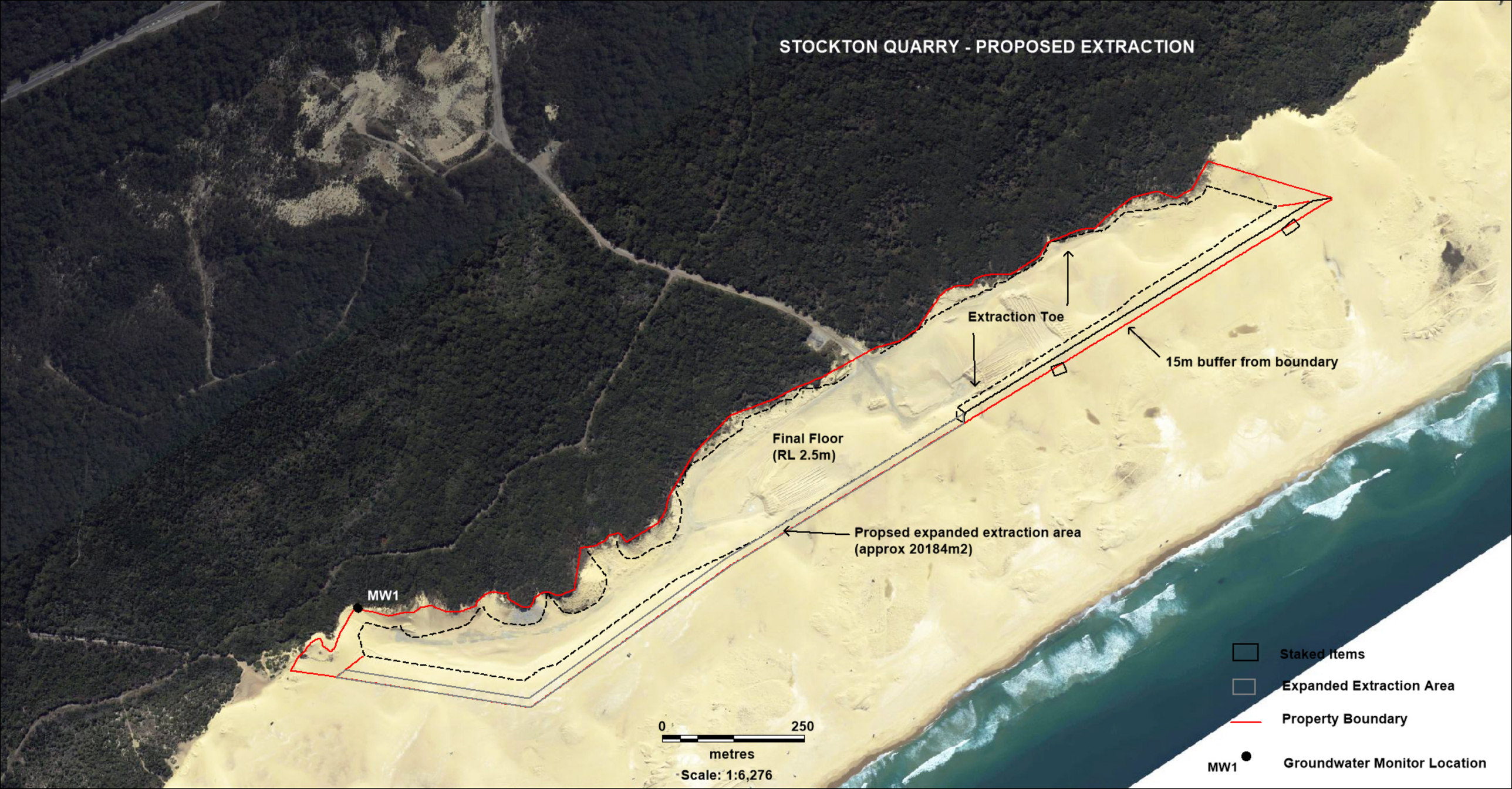
Ecology and biodiversity
Terrestrial
Freshwater
Marine and coastal
Research and monitoring
Wildlife Schools and training

Heritage management
Aboriginal heritage
Historical heritage
Conservation management
Community consultation
Archaeological, built and landscape values

Environmental management and approvals
Impact assessments
Development and activity approvals
Rehabilitation
Stakeholder consultation and facilitation
Project management

Environmental offsetting
Offset strategy and assessment (NSW, QLD, Commonwealth)
Accredited BAM assessors (NSW)
Biodiversity Stewardship Site Agreements (NSW)
Offset site establishment and management
Offset brokerage
Advanced Offset establishment (QLD)

Attachment C: Amended extraction plan and cross sections


STOCKTON QUARRY - PROPOSED EXTRACTION
Extraction Toe
15m buffer from boundary
Final Floor
(RL 2.5m)
Propsed expanded extraction area
(approx 20184m2)
MW1
0
250
metres
Scale: 1:6,276
Staked Items
Expanded Extraction Area
Property Boundary
MW1
Groundwater Monitor Location

Boral Quarries
Build something great ™

Figure 1
SECTION LOCATIONS
Stockton Sand Quarry Dredging

Source: Photomapping (2018), Boral (2018), Cambium Group (2019).

Boral Quarries
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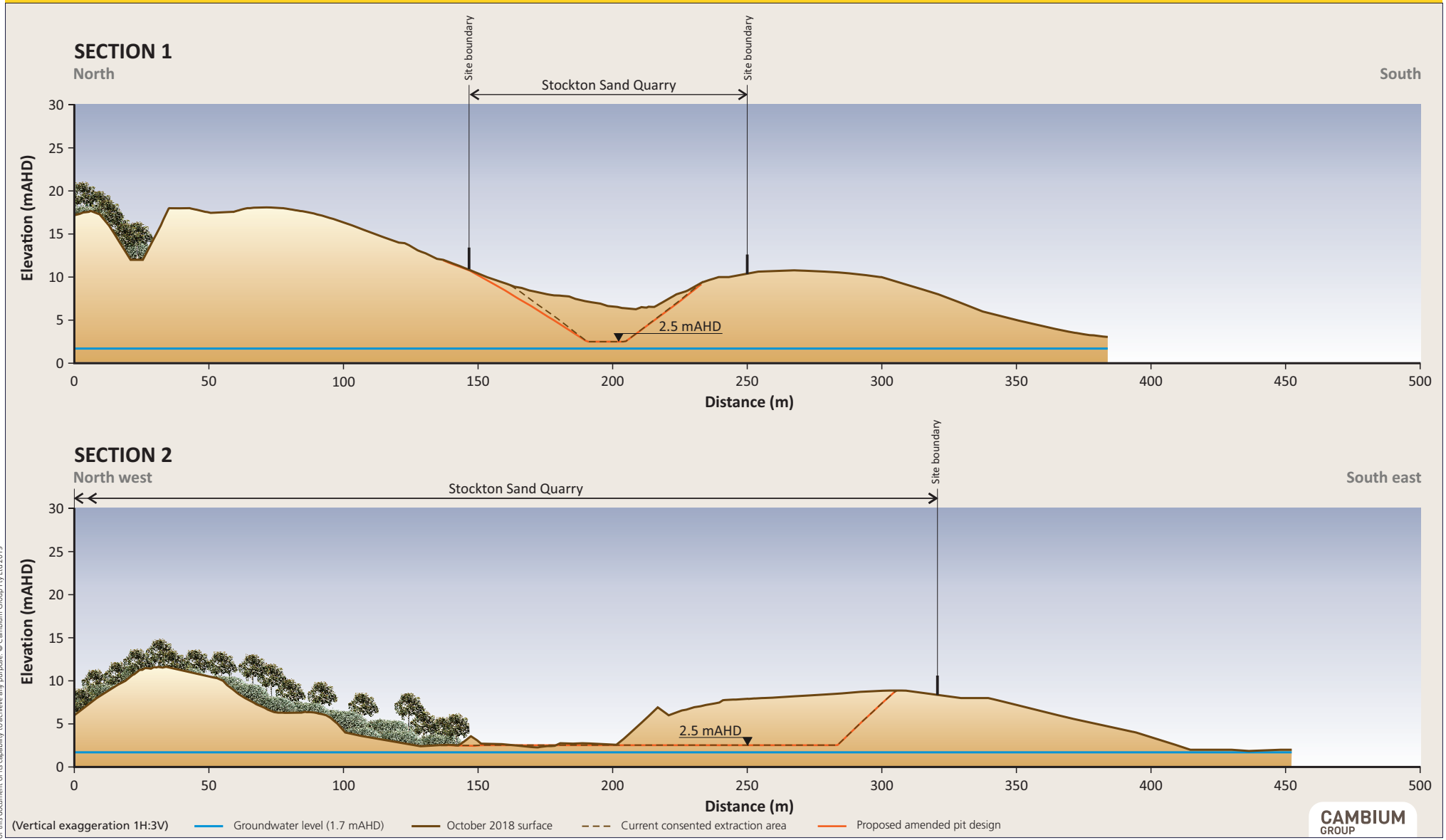
Figure 2
SECTIONS
Stockton Sand Quarry Dredging



Source: Photomapping (2018), Boral (2018), Cambium Group (2019).

CAMBIUM GROUP

Boral Quarries
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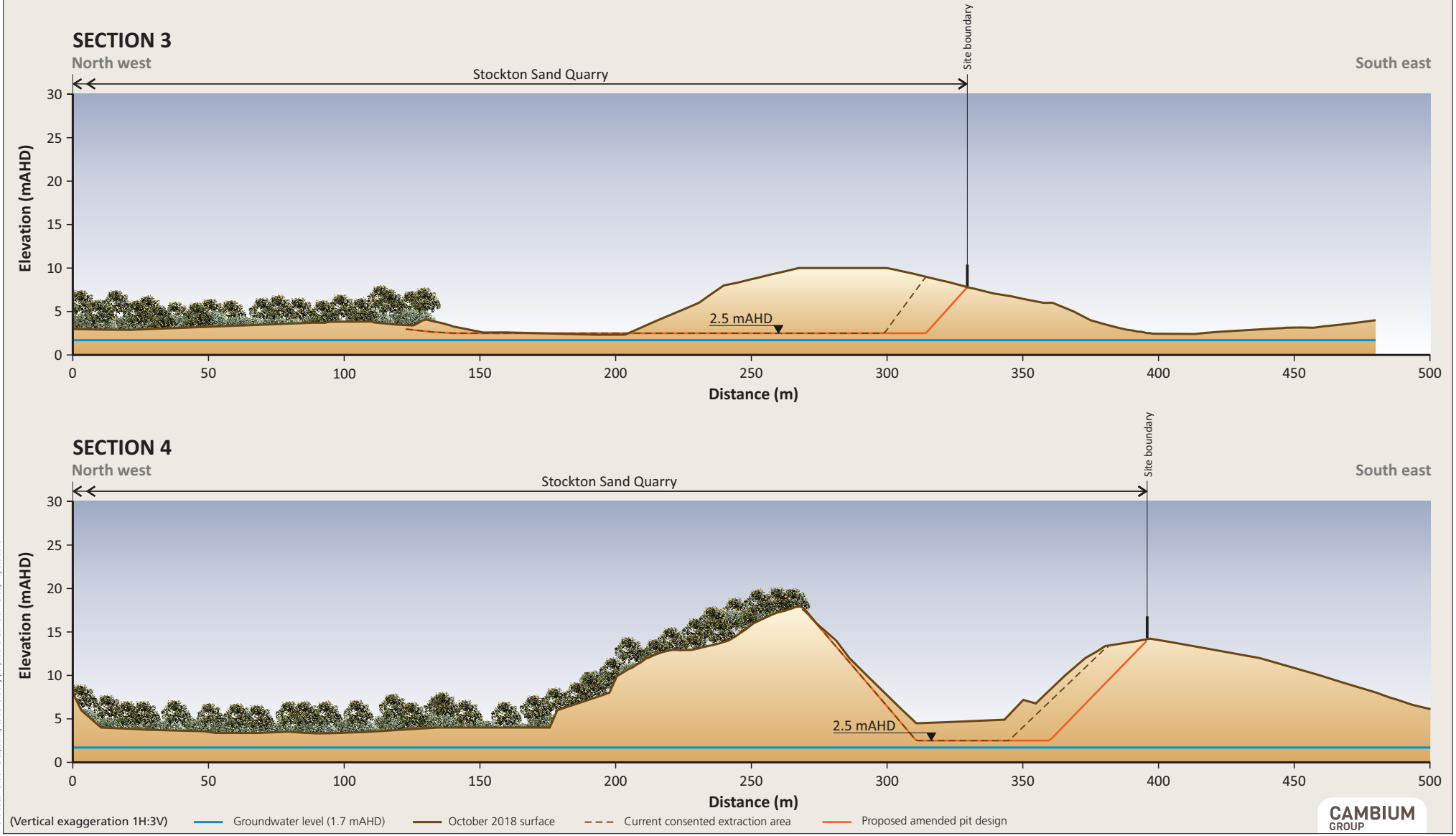
Figure 3
SECTIONS
Stockton Sand Quarry Dredging

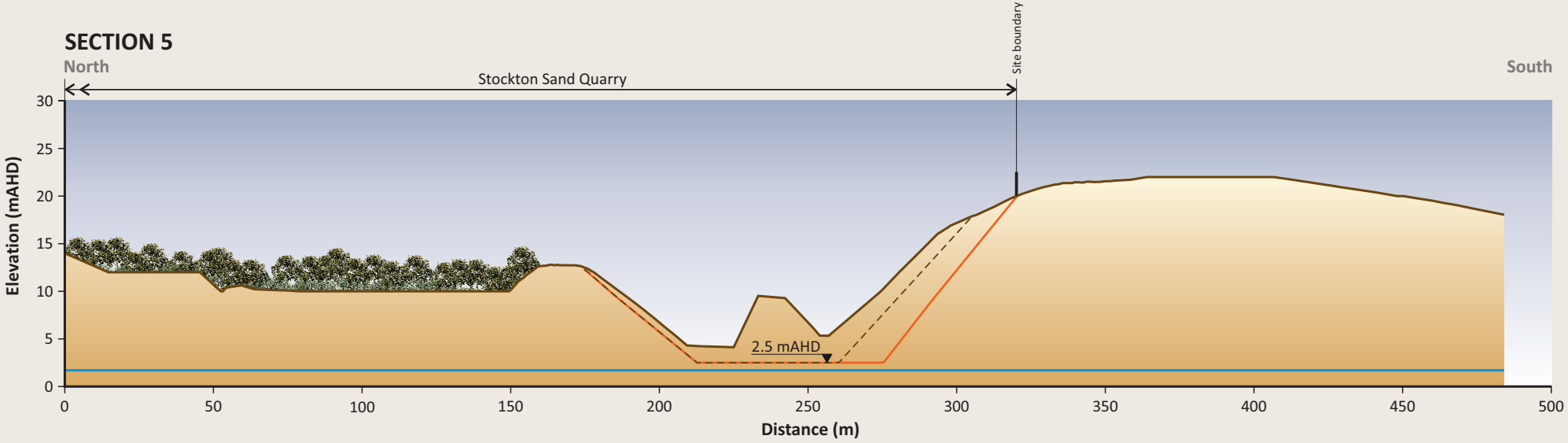


Source: Photomapping (2018), Boral (2018), Cambium Group (2019).

CAMBIUM GROUP

Boral Quarries
Build something great ™

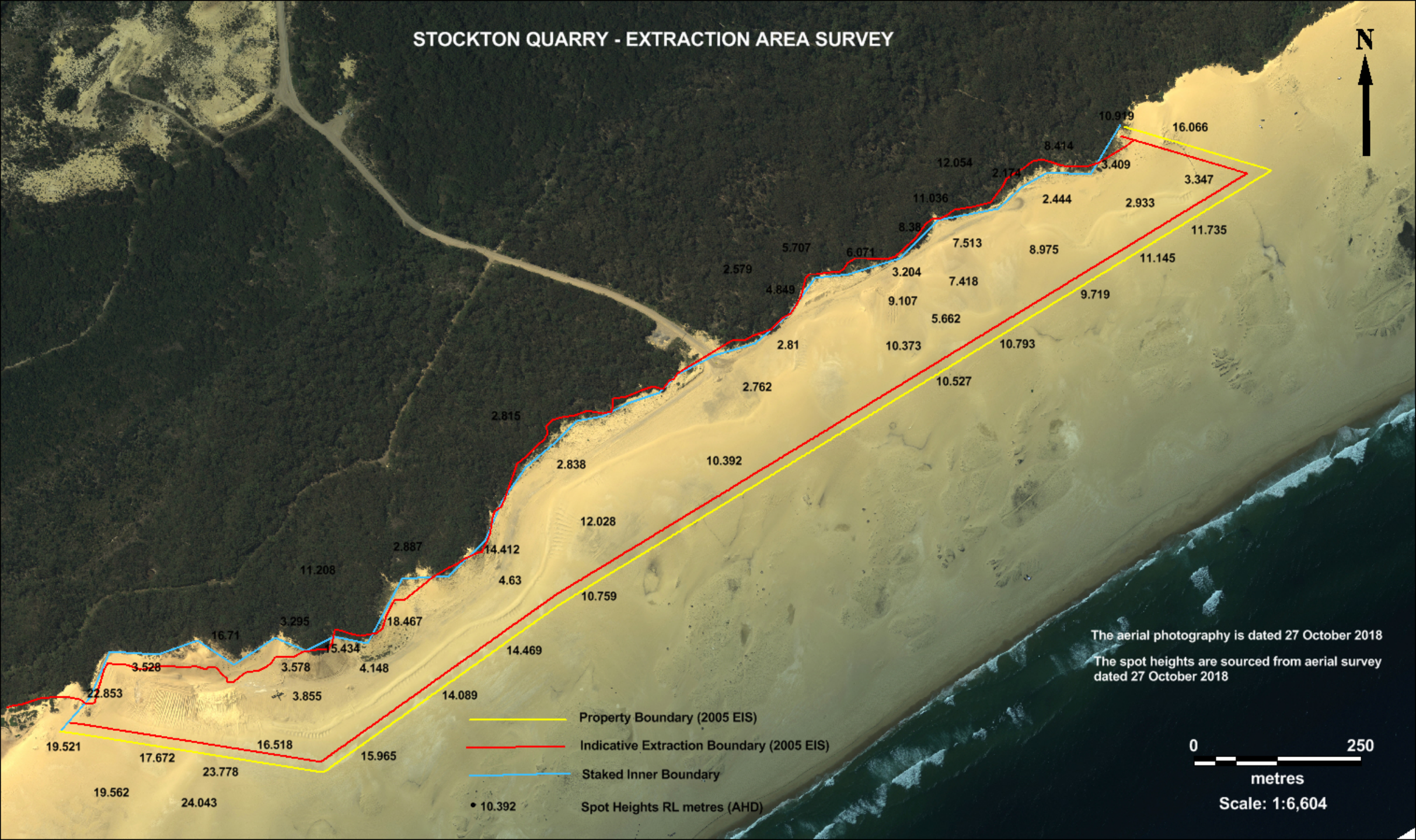
Figure 4
SECTIONS
Stockton Sand Quarry Dredging



(Vertical exaggeration 1H:3V) — Groundwater level (1.7 mAHD) — October 2018 surface - - - Current consented extraction area — Proposed amended pit design

Source: Photomapping (2018), Boral (2018), Cambium Group (2019).

Attachment D: Boundary and extraction area surveys


STOCKTON QUARRY - EXTRACTION AREA SURVEY
N
10.919
16.066
8.414
12.054
2.174
3.409
3.347
11.036
2.444
2.933
8.38
11.735
5.707
6.071
7.513
8.975
11.145
2.579
3.204
7.418
4.849
9.107
9.719
5.662
2.81
10.373
10.793
10.527
2.762
2.815
2.838
10.392
12.028
2.887
14.412
11.208
4.63
10.759
3.295
18.467
16.71
5.434
14.469
3.528
3.578
4.148
22.853
3.855
14.089
19.521
16.518
17.672
15.965
23.778
19.562
24.043
Property Boundary (2005 EIS)
Indicative Extraction Boundary (2005 EIS)
Staked Inner Boundary
10.392
Spot Heights RL metres (AHD)
The aerial photography is dated 27 October 2018
The spot heights are sourced from aerial survey dated 27 October 2018
0
250
metres
Scale: 1:6,604

Attachment E: Survey plan showing the location of monitoring wells and boreholes (DeWitt Surveying, 2019)

NOTES:

1. THE SURVEY IS ON TRUE MAP GRID OF AUSTRALIA (MGA). BASED ON STN400 - E391874.589 N6364649.279.
2. ALL REDUCED LEVELS ARE BASED ON AUSTRALIAN HEIGHT DATUM (AHD).
3. ORIGIN OF LEVELS STN400 R.L.3.117 (AHD)
6. THE BOUNDARIES SHOWN ARE APPROXIMATE ONLY. THE BOUNDARIES SHOWN HAVE BEEN COMPILED FROM THE RELEVANT DEPOSITED PLANS.

M.G.A. COORDINATES

NAME	EASTING	NORTHING	REDUCED LEVEL	DATE OF SURVEY
MW1	391032.68	6364177.29	4.41	20/06/2019
MW2	391351.81	6363950.74	9.86	20/06/2019
MW5	391588.87	6364388.10	4.98	20/06/2019
MW6	391781.34	6364527.27	3.51	20/06/2019
MW7	392042.03	6364700.52	4.03	20/06/2019
MW8	392242.74	6364807.46	2.98	20/06/2019
MW9	392413.75	6364895.09	5.50	20/06/2019
GW2	392028.71	6365103.30	2.99	20/06/2019
GW3	391884.98	6364614.76	4.00	20/06/2019
GW4	390446.05	6364167.18	3.86	20/06/2019

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TITLE

PLAN SHOWING LOCATION OF

MONITORING WELLS & BOREHOLES

Ed.	Date	Amendment
H		
G		
F		
E		
D		
C		
B		
A	11.07.19	INITIAL ISSUE

JOB ADDRESS: COX'S LANE, FULLERTON COVE

CLIENT: BORAL

PLAN No 001

JOB REF: 5848

SCALE: A1 1:4000 A3 1:8000

SURVEY DATE: 20.06.19

PLAN DATE: 11.07.19

DATUM: AHD

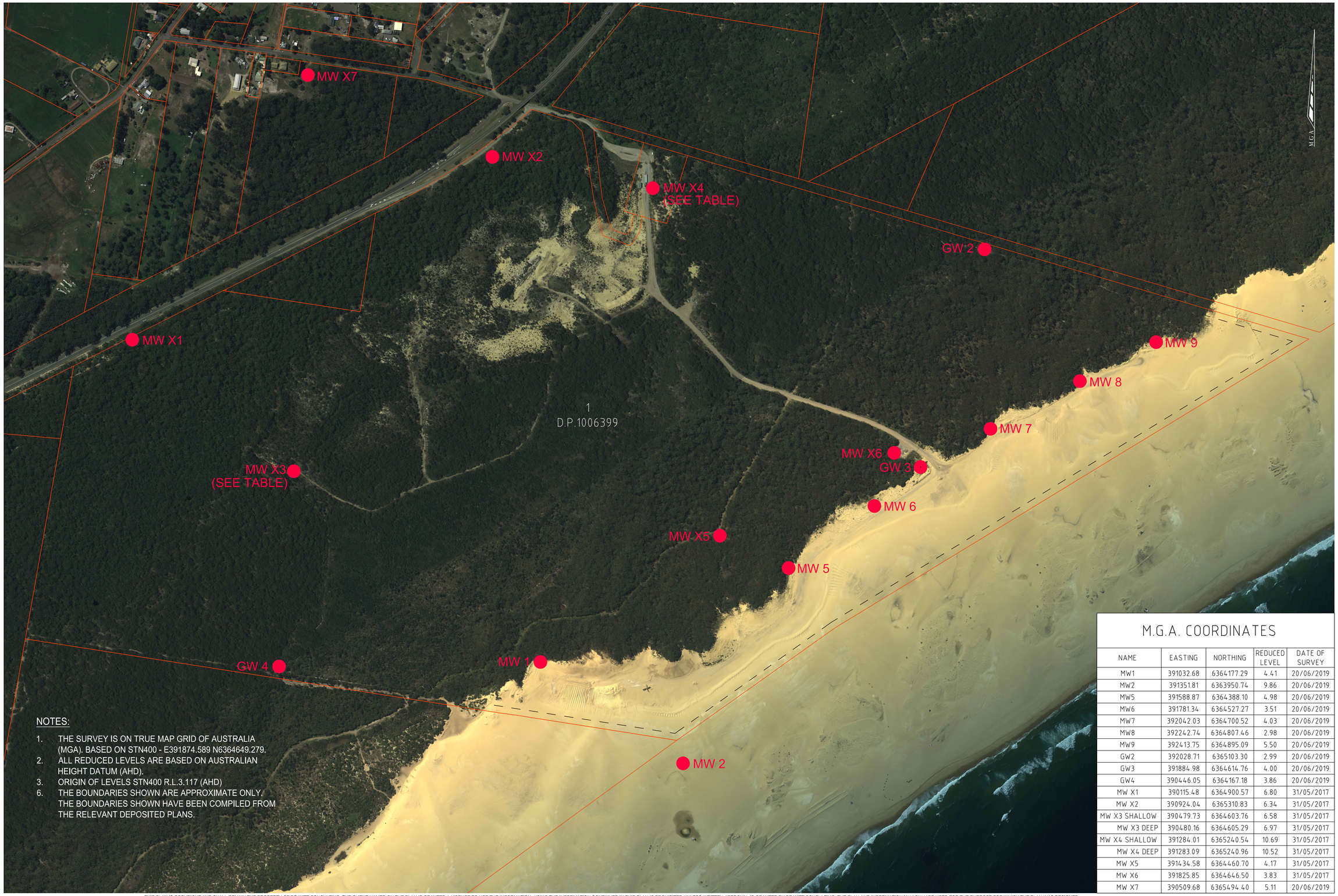
CAD REF: 5848PU190621 - GRID.MJO

ORIGIN OF LEVELS STN400 RL 3.117

DRAWN JG
SURVEYOR CM
CHECKED MH
APPROVED MH

SHEET No 1/2

DRAWING REF: 5848-BOREHOLE & MONITORING WELLS-11.07.19



NOTES:

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2. ALL REDUCED LEVELS ARE BASED ON AUSTRALIAN HEIGHT DATUM (AHD).
3. ORIGIN OF LEVELS STN400 R.L.3.117 (AHD)
6. THE BOUNDARIES SHOWN ARE APPROXIMATE ONLY. THE BOUNDARIES SHOWN HAVE BEEN COMPILED FROM THE RELEVANT DEPOSITED PLANS.

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MW9	392413.75	6364895.09	5.50	20/06/2019
GW2	392028.71	6365103.30	2.99	20/06/2019
GW3	391884.98	6364614.76	4.00	20/06/2019
GW4	390446.05	6364167.18	3.86	20/06/2019
MW X1	390115.48	6364900.57	6.80	31/05/2017
MW X2	390924.04	6365310.83	6.34	31/05/2017
MW X3 SHALLOW	390479.73	6364603.76	6.58	31/05/2017
MW X3 DEEP	390480.16	6364605.29	6.97	31/05/2017
MW X4 SHALLOW	391284.01	6365240.54	10.69	31/05/2017
MW X4 DEEP	391283.09	6365240.96	10.52	31/05/2017
MW X5	391434.58	6364460.70	4.17	31/05/2017
MW X6	391825.85	6364646.50	3.83	31/05/2017
MW X7	390509.68	6365494.40	5.11	20/06/2019

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ORIGIN OF LEVELS STN400 RL 3.117

DRAWN JG
SURVEYOR CM
CHECKED MH
APPROVED MH

SHEET No 2/2

DRAWING REF: 5848-BOREHOLE & MONITORING WELLS-11.07.19

Attachment F: Groundwater Management Plan prepared (Jacobs, 2018)

Stockton Sand Quarry

Boral Pty Ltd

Stockton Sand Quarry Groundwater Management Plan

IA147700_001e | E

16 February 2018

Stockton Sand Quarry

Project no:	IA147700
Document title:	Stockton Sand Quarry Groundwater Management Plan
Document No.:	IA147700_001e
Revision:	E
Date:	16 February 2018
Client name:	Boral Pty Ltd
Client no:	-
Project manager:	Greg Sheppard
Author:	Jonathon Tait
File name:	J:\IE\Projects\04_Eastern\IA147700\21 - Deliverables\IA147700_001e_GWMP.docx

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Document history and status

Revision	Date	Description	By	Review	Approved
A	15 May 2017	Draft for Client Review	JT	GS	
B	19 May 2017	Incorporation of Client Review Comments	GS	GS	
C	30 November 2017	Incorporation of DPI Water Comments	JT	GS	
D	6 December 2017	Include reference to Development Consent Schedule 4, Condition 3	JT	GS	
E	15 February 2018	Incorporation of client comments	JT	GS	

Contents

1. Introduction

Jacobs has been engaged by R. W. Corkery and Co Pty Limited (RWC) on behalf of Boral Resources (NSW) Pty Ltd (Boral) to assess and update the existing groundwater monitoring program (GWMP) for the Stockton Dune Sand Quarry (the Quarry).

1.1 Background

The Quarry, located on Lots 1 and 2 (DP 1006399) and Lot 3 (DP 664552), is adjacent to and provided access to by Coxs Lane in Fullerton Cove, New South Wales. Boral commenced extraction operations at the Quarry on 15 October 2008 as approved by Development Consent 140-6-2005 ("DA 140-6-2005"). A location plan of the Quarry, groundwater monitoring network and immediately surrounding areas is presented in **Figure 1**. Locations of historical groundwater monitoring bores that have been destroyed or decommissioned are presented in **Figure 2**.

DA 140-6-2005 was issued under the *Environmental Planning and Assessment Act 1979* on 24 January 2006, with modifications approved on 10 May 2006 and June 2011. Activities outlined within DA 140-6-2005 are approved to continue to 15 October 2028.

Quarry operations involve the extraction of dune and windblown sand with a front end loader and direct transfer to product trucks with no on-site processing occurring. Progressive rehabilitation is undertaken in areas within the Quarry Site, however, it is noted that due to the nature of the resource and its location (i.e. ongoing replenishment of resource into the extraction areas from windblown sand), rehabilitation activities are limited in these active areas.

In accordance with DA 140-6-2005 and to ensure no direct impact on the groundwater resources, sand is extracted from the unsaturated zone above the unconfined aquifer. A maximum extraction depth of 2.5 m AHD is outlined within DA 140-6-2005 to ensure that no aquifer interference activities occur.

The quarry currently operates under a GWMP approved by DP&E in 2008 (ERM, 2008).

1.2 Purpose of this Report

This report presents an update of the groundwater monitoring program for the Quarry based upon Development Consent DA 140-6-2005 conditional requirements, following alterations to the existing groundwater monitoring network first established in 2007, and the inclusion of additional data into the trigger level assessment.

The program has been revised following a review and analysis of the monitoring completed since 2007 and in accordance with DA 140-6-2005. Table 1 details the relevant consent conditions applicable to this GWMP and the sections these conditions are satisfied.

Table 1 : Report details and relevance to consent conditions.

Consent Conditions (DA 140-6-2005)	
Schedule 3	
12 (a) – detailed baseline data on groundwater levels, flows and quality based on statistical analysis, to benchmark pre-quarrying natural variation in groundwater levels and quality.	Section 3
12 (b) – Groundwater impact assessment criteria.	Section 4
12 (c) – A program to monitoring groundwater levels and quality.	Sections 5 & 6
Schedule 4	
3 – Each year following the date this consent, the applicant shall prepare and submit an Annual Environmental Management Report (AEMR) to the Director-General and relevant agencies.	Section 7

The updated groundwater monitoring program ensures the collection of relevant groundwater data and provides updated impact identification measures to facilitate efficient and effective management practices.

The revised GWMP also reflects changes in the groundwater monitoring network due to the installation of new monitoring bores and the loss of a number of monitoring bores since the 2008 GWMP was prepared.

1.3 Regulatory Consultation

A draft of this report has been provided to DPI Water for review and comment. DPI Water provided review comments on 07 September 2017. The comments provided by DPI water have been considered and the GWMP has been revised accordingly. A copy of DPI Water review is provided in Appendix A.

2. Environmental Setting

The Quarry is located on the coastal sand dunes of Stockton Beach, which are accumulations of windblown (aeolian) sand. Sand is extracted from the un-vegetated dunes located immediately behind the beachfront.

2.1 Climate

The Quarry is situated approximately 10 km north-west of Newcastle, within the Hunter Valley region which has a varied climate depending on proximity to the coast. The coastal areas tend to be subtropical with warm summers and generally mild winters.

The nearest Bureau of Meteorology rain gauging station to the Quarry (approximately 4km north) is Williamtown RAAF, station number 061078. Long-term rainfall data are provided on Table 2. Rainfall is heaviest in late autumn and early winter with the average annual rainfall in the Quarry area is 1,125.3 mm/year.

Table 2 : Long term rainfall

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean (mm)	99.9	118.3	119.8	111.8	110.8	123.0	71.9	73.6	59.7	73.0	82.4	79.0
Median (mm)	77.0	94.6	107.7	97.6	95.5	102.9	63.2	55.8	49.8	56.2	80.2	62.3

Data source - Bureau of Meteorology Station Number 061078; accessed 15/02/2018.

2.2 Hydrogeology

Groundwater within and surrounding the Quarry occurs within the coastal sand aquifers of the Stockton Sandbeds Groundwater Source.

Coastal sand aquifers typically have significant connection with surface water. There is minimal surface water runoff as the dunes have a high infiltration capacity.

Typically, groundwater residence time in these aquifers is generally short, ranging from days to months. Using available groundwater level data from existing and historical monitoring bores, **Figure 3** shows the average groundwater level contours for each quarter (i.e. January, February, March etc.) since monitoring commenced, and indicates little seasonal variation in groundwater levels and/or flows. Using this information, groundwater flow, in the seaward portion of the tenement, is to the southeast towards the ocean.

Based on recommendations from a gap analysis study completed by RPS (2016), several new monitoring bores were installed in May 2017, toward the west of the tenement, to further understand groundwater movement. In combination with currently monitored data, groundwater level data collected from the recently installed bores shows a groundwater divide that coincides with elevated dune areas (**Figure 4**). Groundwater flow is to the southeast towards the ocean and also inland towards Fullerton Cove.

Bore logs indicate all monitoring bores were installed into sand with a general increase in grain size with depth. No monitoring bores have intercepted bedrock. **Figure 5** shows geological cross sections through the quarry and show the extraction limit of 2.5 mAHD, inferred groundwater levels and relative position of monitoring bores. From the cross section it can be seen that the inferred water table is close to ground level in the low lying area previously extracted to the northwest of the tenement. In the current dune extraction area, the inferred water table is below the 2.5 mAHD extraction limit.

2.3 Potential Groundwater Impacts

No significant groundwater related impacts are anticipated arising from the current quarry operation. Key arguments for the minimal risk to groundwater are summarised as follows:

- No foreign material is introduced into the Quarry.
- All extraction of windblown sand is from the unsaturated zone of the dune surface adjoining the vegetation cover.
- Extracted sand is in an unsaturated and oxidised state. Extraction therefore presents no risk to acid sulphate soil generation. This view is supported by the baseline pH data in the extraction area which is neutral to alkaline.

- Groundwater is not intercepted or extracted and water levels are not impacted. This leads to a negligible risk of saltwater intrusion from the surrounding ocean as a result of quarrying activities.

The area inland of the current dune sand extraction area has historically been subjected to mineral sand extraction, which posed a significantly greater risk of groundwater impact than the current operations. Notwithstanding, no significant legacy water quality issues are apparent in the data.

2.3.1 Groundwater Dependent Ecosystems

The closest potential GDEs are located to south-east (seaward) and north-west (inland) of the extraction area.

The seaward GDEs comprise small ephemeral and mobile shallow deflation basin lakes vegetated with a variety of grasses, sedges and reeds. These lakes provide an ephemeral habitat for a number of invertebrates and other species (ERM, 2008).

The inland GDEs are primarily the swamp forests in the dune swales and the low lying heath. These systems are up gradient (inland) of the current dune extraction area, a previous groundwater assessment (ERMA, 2010) noted that the risk of impacting these GDEs is very low given the sand extraction depth restrictions and low evaporation in times of high groundwater.

3. Baseline Monitoring Data

Groundwater data has been collected at the Quarry across Boral's groundwater monitoring network over a period of ten years (2007 to 2017).

The current groundwater monitoring network includes 12 monitoring bores located in the Quarry property (**Figure 1**). All bores are licensed under monitoring license 20BL171772.

The monitoring network includes groundwater monitoring bores (MW series bores) that have been installed as part of the Stockton Sand Quarry monitoring network, as well as four pre-existing groundwater monitoring bores (GW series bores). Bore construction details are provided on Table 3.

The groundwater monitoring bores are monitored for water level, field water quality parameters and comprehensive chemistry, while the GDE monitoring bores are monitored for water level only.

Since the 2008 GWMP, the majority of the historical bores referred to in the 2008 GWMP have been destroyed and an additional eight (8) replacement monitoring bores were installed during 2013. Three of these replacement bores (MW3, MW4 and MW10) have also been destroyed.

In 2013 the monitoring bore network was renumbered to simplify the monitoring procedure. This groundwater monitoring program refers to the monitoring network by the updated nomenclature which numbers the groundwater bores sequentially from south to north (**Figure 1**). The GW series bores have retained their original nomenclature. Destroyed and decommissioned bore locations are provided on **Figure 2**.

It is noted that groundwater monitoring data is not available during the periods October 2008 to October 2009 and April 2010 to May 2013. These gaps in monitoring coverage were the result of an internal restructure at the monitoring company providing the monitoring services causing a lapse in routine monitoring. Monitoring has been completed consistently from 2013 to present.

Monitoring data were collected monthly for the period 2007 to 2011 and quarterly from 2011 onwards.

No groundwater impacts have been identified to date as a result of the Quarry operations. This is expected as sand extraction has remained in excess of 2.5 metre above the groundwater table (the groundwater table fluctuates seasonally). It is therefore considered that groundwater data collected to date is representative of baseline conditions.

Monitored groundwater data includes:

- Groundwater levels (all monitoring bores)
- Field water quality parameters electrical conductivity (EC) and pH (MW series monitoring locations only).
- Laboratory chemical analysis (MW series monitoring locations only).

Table 3 : Stockton Sand Quarry Monitoring Network

Location ID	Easting (MGA94)	Northing (MGA94)	Elevation (m AHD)	Depth (mBGL)	Screened Interval (mBGL)	Status
Current Groundwater Monitoring Network – Figure 1						
MW1	390940	6364059	19	25	19 – 25	Groundwater monitoring program
MW2	391352	6363951	12	25	19 – 25	Groundwater monitoring program
MW5	391589	6364389	5	8	2 – 8	Groundwater monitoring program
MW6	391781	6364527	3	8	2 – 8	Groundwater monitoring program
MW7	392042	6364700	4	8	2 – 8	Groundwater monitoring program
MW8	392243	6364808	3	8	2 – 8	Groundwater monitoring program
MW9	392414	6364895	5.5	8	2 – 8	Groundwater monitoring program
MW11	392600	6364951	15.5	18	12 – 18	Groundwater monitoring program
GW1	391421	6364854	12*	N/A	N/A	Groundwater monitoring program
GW2	392129	6365071	8*	N/A	N/A	Groundwater monitoring program
GW3	391690	6364528	6*	N/A	N/A	Groundwater monitoring program
GW4	390434	6364177	8*	N/A	N/A	Groundwater monitoring program
Historical Groundwater Monitoring Network - Figure 2						

Location ID	Easting (MGA94)	Northing (MGA94)	Elevation (m AHD)	Depth (mBGL)	Screened Interval (mBGL)	Status
MW1	391128	6364095	21.7	22.7	19.7 – 22.7	Destroyed
MW2	391331	6364058	23.8	25	22 – 25	Destroyed
MW3 (old)	391457	6364185	21.0	23.5	20.5 – 23	Destroyed
MW3	391428	6364225	19.5	25	19 – 25	Destroyed
MW4	391699	6364229	9.5	10	7 – 10	Destroyed
MW5 (old)	391670	6364404	14.2	NA	NA	Destroyed
MW5A	391677	3634494	6.0	15.8	12.8 – 15.8	Destroyed
MW6	391864	6364375	11.8	14.7	11.7 – 14.7	Destroyed
MW7	392080	6364628	14.1	17.5	14.5 – 17.5	Destroyed
MW8	392274	6364633	14.2	17.5	14.5 – 17.5	Destroyed
MW9	392338	6364846	2.6	5	2-5 – 0	Destroyed
MW10 (old)	392629	6364845	9.4	11.5	8.5 – 11.5	Destroyed
MW10	392604	6364757	11	21	15 – 21	Destroyed
GW5	390705	6365182	na	na	na	Destroyed

* Monitoring location not surveyed, elevations are estimates from google earth.
na: information not available
m AHD: metres above Australian height datum
mBGL: metres below ground level

3.1 Monitoring Results

A brief discussion of groundwater monitoring data to date, for the current monitoring network, is provided in the following sections.

3.1.1 Groundwater levels

Groundwater level hydrographs are provided on **Figure 6.** Groundwater levels for the monitoring bores are presented as elevations in m AHD (Australian Height Datum). It is noted however that ground elevations for the GW series monitoring bores are inferred from topographic data.

The monitoring bores generally display relatively uniform water level response across the site. The MW series bores typically range from 1.4 to 2.7 mAHD. MW1 peaked at 3.6 mAHD in 2007 in response to significant rainfall totalling 414.2 mm in June 2007. Higher rainfall occurred in January 2016 (422.4 mm), although monitoring did not capture the peak groundwater elevation. In response to above average rainfalls in June 2017 (236.6mm) groundwater levels peaked. Aside from immediately following extreme rainfall event, groundwater levels generally remain below the limit of sand extraction at 2.5 mAHD.

The GW series monitoring bores show similar magnitude fluctuations in water levels, although actual groundwater elevations are higher with the bores located further from the coast.

3.1.2 Water Quality

Figure 7 present the field groundwater quality monitoring results. **Figures 8 to 19** present the groundwater quality analytical results.

3.1.2.1 Salinity (Figure 7)

Groundwater salinity is typically in the range 180 to 1000 µS/cm. A number of bores display significant spikes in salinity following large rainfall events, this is attributed to infiltrating rainfall mobilising salt spray from the dune surface. No significant trends in salinity are apparent over the period of monitoring.

3.1.2.2 pH (Figure 7)

Groundwater pH is typically in the range 6 to 8 pH units. Individual monitoring locations display considerable variability however there are no overriding long term trends. Monitoring bore MW9 shows the greatest variability ranging from 8.3 in July 2007 to 5.5 in October 2009.

3.1.2.3 Aluminium (Figure 8)

MW1, MW5 and MW7 display variable concentrations of aluminium since 2013/2014. The remainder of monitoring location display low aluminium concentrations typically below 0.15 mg/L. Levels at MW2 are often below the laboratory limit of reporting of 0.01 mg/L.

3.1.2.4 Arsenic (Figure 8)

Arsenic concentrations are typically below 0.03 mg/L. MW1, MW6, MW9, and MW11 display slightly elevated and more variable concentrations, and level at MW9 have historically been much higher (up to 0.11 mg/L).

MW2, MW5, MW7 and MW8 remain close to or below the limit of reporting of 0.001 mg/L.

3.1.2.5 Boron (Figure 9)

Concentrations of boron are typically very stable and below 0.05 mg/L, with the exception of two spurious data points for MW2. Pre-2014 results suggest that the laboratory detection at the time may not have been sufficiently accurate.

3.1.2.6 Cadmium (Figure 9)

Results for cadmium are typically at or below the limit of reporting.

3.1.2.7 Calcium (Figure 10)

Calcium concentrations are typically less than 100 mg/L and relatively stable. MW11 shows concentrations that are elevated above the rest of the monitoring network. Historical data typically show considerably greater variability than data collected since 2013.

3.1.2.8 Chromium (Figure 10)

Chromium concentrations are generally fairly low and below 0.005 mg/L with the majority of monitoring bore close to or below the limit of reporting (usually 0.001 mg/L). MW7 and MW9 display a slight declining trend since 2013.

3.1.2.9 Copper (Figure 11)

Concentrations of copper are typically at or below the limit of reporting (0.001 mg/L). Minor spikes are observed at MW1, MW2 and MW5 in early 2017.

3.1.2.10 Iron (Figure 11)

Elevated iron concentrations are observed at MW7, MW8, MW11, these monitoring locations also show variable concentrations. All other monitoring locations show relatively stable concentrations below 2 mg/L.

3.1.2.11 Lead (Figure 12)

Concentrations of lead are typically at or below the limit of reporting (0.001 mg/L). Historical data show low but more variable concentrations.

3.1.2.12 Magnesium (Figure 12)

MW5, MW7, MW8 and MW9 show fluctuating magnesium concentrations, the remaining monitoring locations are relatively stable in the range 1 to 8 mg/L.

3.1.2.13 Manganese (Figure 13)

Concentrations of manganese are relatively stable and below 0.1 mg/L. Historical data show much greater variability and fluctuations.

3.1.2.14 Mercury (Figure 13)

Results for mercury are typically at or below the limit of reporting (0.0001 mg/L). Historical data have a limit of reporting of 0.001 mg/L, as do two more recent analyses from MW1.

3.1.2.15 Nickel (Figure 14)

Concentrations of nickel are typically at or below the limit of reporting (0.001 mg/L). Historical data show more variability with an anomalous spike at MW5, MW6 and MW8 in July and September 2010.

3.1.2.16 Potassium (Figure 14)

Potassium results are generally in the range 0.8 to 6 mg/L.

3.1.2.17 Selenium (Figure 15)

Results for selenium are typically at or below the laboratory limit of reporting (0.001 mg/L). It is inferred that elevated results for July and November 2013 represent a higher limit of reporting (0.1 mg/L) for those analyses given the consistency for all samples.

3.1.2.18 Sodium (Figure 15)

MW5, MW7 and MW8 show fluctuating sodium concentrations peaking at 200 mg/L at MW5, the remaining monitoring locations are relatively stable in the range 9 to 51 mg/L.

3.1.2.19 Zinc (Figure 16)

Concentrations of zinc are generally fairly low and below 0.03 mg/L. MW1 displayed elevated zinc levels up to 0.26 mg/L.

3.1.2.20 Alkalinity (Figure 16)

Alkalinity is typically in the range 50 to 200 mg/L as Ca CO3. MW11 shows slightly higher levels of 300 to 380 mg/L. Water in this range generally has a good buffering potential.

3.1.2.21 Chloride (Figure 17)

MW5, MW7 and MW8 show fluctuating chloride concentrations peaking at 290 mg/L at MW5, the remaining monitoring locations are relatively stable in the range 18 to 83 mg/L.

3.1.2.22 Hardness (Figure 17)

Hardness as CaCO3 has not been monitored since 2010. Historical data show variable and fluctuating levels generally in the range 100 to 500 mg/L as equivalent CaCO3. Water in this range is classified as hard to very hard.

3.1.2.23 Nitrate (Figure 18)

Nitrate has not been monitored since 2010 but was resumed in late 2017. Historical monitoring data shows low background concentrations, with nitrate typically below 4 mg/L. MW1 displayed elevated but declining concentrations, peaking at 12.5 mg/L. Recent data typically shows nitrates below detectable limits.

3.1.2.24 Phosphorous (Figure 18)

Phosphorous has not been monitored since 2010 but was resumed in late 2017. Historical monitoring data show relatively low background concentrations, with phosphorous typically below 0.1 mg/L. Recent data shows spikes in MW6 and MW8 up to 0.70 mg/L.

3.1.2.25 Sulphate (Figure 19)

Concentrations of sulphate are generally relatively stable and below 50 mg/L. Historical data shows greater variability with MW7 and MW8 peaking at 238 and 223 mg/L respectively.

3.1.2.26 Turbidity (Figure 19)

Turbidity has been inconsistently monitored on since 2010. Turbidity results are generally low as is expected from groundwater monitoring bores. Historical data show some fluctuation and spikes, possibly related to bore construction and ongoing development with purging.

Turbidity in relation to groundwater is typically measured as an indicator of purging adequacy and is indicative of the condition of the monitoring bore as opposed to the aquifer. Presentation of turbidity for determining trigger thresholds is therefore not considered appropriate. A turbidity concentration of 10 NTU or less is generally considered to indicate adequate purging in conjunction with stabilisation of other physical parameters.

3.2 Monitoring Coverage

The current and proposed groundwater and surface water monitoring network, as presented on **Figure 1** and in Table 3, provides comprehensive coverage of groundwater levels and quality in the area of current quarry extractions. Future monitoring bore losses will be assessed on an individual basis to determine whether a replacement bore is deemed necessary.

4. Trigger Level Review

4.1 Methodology

The methodology used to update the trigger thresholds for this revised GWMP is the same as applied to the original GWMP completed by ERM in April 2008. Threshold limits are calculated by adding or subtracting two standard deviations from the mean and forming an upper and lower threshold limit.

The subtraction of two standard deviations from the mean will often result in lower threshold limits that are either negative or lower than laboratory limits of detection. The following points describe the procedure for assigning trigger thresholds where subtracting two standard deviations results in un-usable lower limits:

- If the analyte was not detected above the laboratory quantification limit during the groundwater sampling rounds, the upper trigger level for those analytes will be set to the laboratory limit of reporting.
- If the calculation of the lower trigger value resulted in a negative value or a value below the laboratory quantification limit, no lower trigger has been applied.

Laboratory limits of reporting (LOR) have been retained in the data set as a numeric value equal to the limit of reporting for the purposes of statistical analyses.

Where current monitoring bore locations are replacements for historical monitoring bores, and where the replacement bore has been installed in close proximity to the original, the water quality record for the historical monitoring bore has been incorporated into the baseline dataset for the original monitoring bore. Due to differences in ground elevations this has not been undertaken for water levels.

4.2 Groundwater Levels

Groundwater level threshold limits are presented in Table 5. MW series monitoring bore limits have been calculated in mAHD (metres Australian Height Datum) and GW series monitoring bores have been calculated in mBGL (metres below ground level).

Table 4 : Groundwater level threshold limits

Monitoring Location	Units	Upper Limit	Lower Limit	Observation Count
MW1	mAHD	2.92	0.98	35
MW2	mAHD	2.33	1.09	17
MW5	mAHD	2.51	0.77	13
MW6	mAHD	2.66	0.60	17
MW7	mAHD	2.52	1.17	31
MW8	mAHD	2.57	1.23	31
MW9	mAHD	2.56	1.22	30
MW11	mAHD	2.72	1.21	17
GW1	mBGL	7.42	9.04	17
GW2	mBGL	0.27	2.00	27
GW3	mBGL	1.40	2.87	26
GW4	mBGL	1.58	2.86	32

Data encompasses current monitoring bore network and historical in a similar monitoring location

m AHD – meters above Australian Height Datum; mBGL – meters below ground level

tba – to be announced

4.3 Groundwater Quality

Upper and lower thresholds for water quality indicators are presented in Table 6 to Table 8.

Table 5 : Electrical Conductivity Upper Limits

Monitoring Location	Upper Threshold Limit (µS/cm)	Lower Threshold Limit (µS/cm)	Count
MW1	444.4	195.0	35
MW2	719.0	286.6	21
MW5	1015.3	104.8	41
MW6	583.5	115.2	41
MW7	1036.5	469.9	31
MW8	1021.4	453.2	35
MW9	964.7	155.2	32
MW11	915.0	691.4	10

µS/cm : Micro Siemens per centimetre

Table 6 : pH upper and lower limits

Monitoring Location	Upper Threshold Limit (pH Units)	Lower Threshold Limit (pH Units)	Count
MW1	7.47	5.67	25
MW2	7.86	7.05	8
MW5	7.68	5.88	29
MW6	7.65	6.60	28
MW7	7.53	6.64	25
MW8	7.59	6.71	29
MW9	8.33	4.93	26
MW11	6.96	6.72	4

Table 7 : Upper and lower threshold limits for laboratory analytes

Analyte	MW1		MW2		MW5		MW6		MW7		MW8		MW9		MW11	
	Upper Limit	Lower Limit	Upper Limit	Lower Limit	Upper Limit	Lower Limit	Upper Limit	Lower Limit	Upper Limit	Lower Limit	Upper Limit	Lower Limit	Upper Limit	Lower Limit	Upper Limit	Lower Limit
Turbidity (NTU)	145.4	na	103.0	na	39.4	na	33.2	na	187.0	na	25.7	na	74.7	na	nd	nd
Chloride (mg/L)	47.0	15.8	42.0	13.8	200.5	na	44.0	3.8	134.0	na	190.2	na	136.3	na	59.9	8.0
Sulphate as SO4	48.8	na	60.9	0.12	76.18	na	56.6	na	191.7	na	196.0	na	41.7	na	61.5	na
Aluminium (mg/l)	0.251	na	0.074	na	1.861	na	0.158	na	0.391	na	0.077	na	1.515	na	0.213	na
Arsenic (mg/L)	0.020	na	0.018	na	0.024	na	0.026	na	0.067	na	0.029	na	0.111	na	0.023	0.002
Boron (mg/L)	0.089	na	0.182	na	0.090	na	0.078	na	0.091	na	0.085	na	0.095	na	0.068	0.003
Calcium (mg/L)	76.2	na	121.0	28.4	141.1	na	102.9	1.86	196.5	5.1	197.2	18.7	140.2	na	162.6	116.5
Cadmium (mg/L)	0.003	na	0.002	na	0.003	na	0.002	na	0.002	na	0.002	na	0.004	na	0.0001	na
Chromium (mg/L)	0.009	na	0.002	na	0.010	na	0.006	na	0.005	na	0.006	na	0.007	na	0.002	0.001
Copper (mg/L)	0.011	na	0.008	na	0.011	na	0.012	na	0.007	na	0.010	na	0.004	na	0.001	na
Iron (mg/L)	1.78	na	1.81	na	2.68	na	3.44	na	8.23	na	10.69	na	7.21	na	3.56	na
Potassium (mg/L)	4.6	na	3.0	na	5.7	na	2.8	na	5.2	0.4	4.6	0.3	7.1	na	4.4	1.1
Magnesium (mg/L)	9.7	na	8.5	5.3	20.0	na	7.6	na	14.3	1.8	14.1	1.1	12.1	2.8	7.2	2.3
Manganese (mg/L)	0.03	na	0.43	na	0.32	na	0.06	na	0.82	na	0.32	na	1.32	na	0.07	na
Nitrogen (mg/L)	0.001	na	0.001	na	0.001	na	0.001	na	0.001	na	0.001	na	0.0010	na	0.0010	na
Sodium (mg/L)	38.6	na	24.9	5.2	173.3	na	26.8	na	99.2	na	127.4	na	78.7	na	39.0	4.9
Nickel (mg/L)	0.026	na	0.010	na	0.076	na	0.074	na	0.012	na	0.064	na	0.022	na	0.0010	na
Lead (mg/L)	0.008	na	0.0028	na	0.022	na	0.010	na	0.009	na	0.014	na	0.008	na	0.0010	na

Analyte	MW1		MW2		MW5		MW6		MW7		MW8		MW9		MW11	
	Upper Limit	Lower Limit	Upper Limit	Lower Limit	Upper Limit	Lower Limit	Upper Limit	Lower Limit	Upper Limit	Lower Limit	Upper Limit	Lower Limit	Upper Limit	Lower Limit	Upper Limit	Lower Limit
Selenium (mg/L)	0.009	na	0.010	na	0.011	na	0.011	na	0.009	na	0.009	na	0.009	na	0.011	na
Zinc (mg/L)	0.124	na	0.032	na	0.030	na	0.027	na	0.028	na	0.022	na	0.061	na	0.030	0.002
Filterable Reactive P (mg/L)	0.03	na	0.09	na	0.07	na	0.37	na	0.21	na	0.38	na	0.30	na	0.09	0.06
Nitrate -N (mg/L)	10.57	na	2.11	0.75	4.74	na	2.38	0.01	1.36	na	0.91	na	1.04	na	0.01	0.01
Alkalinity (mg CaCO3/L)	157.4	6.2	294.1	47.4	293.3	18.0	246.0	22.8	313.3	74.6	317.8	71.7	360.32	na	396.6	291.0
Hardness as CaCO3	170.5	66.4	374.46	278.6	431.2	117.7	274.4	144.2	487.1	274.8	501.1	283.8	484.7	11.1	nd	nd
Mercury (mg/L)	0.0016	na	0.0012	na	0.0016	na	0.0015	na	0.0016	na	0.0016	na	0.0016	na	0.0001	na
Fluoride (mg/L)	0.755	0.002	0.183	0.042	0.753	na	0.726	na	0.732	na	0.746	na	0.736	na	0.100	0.100

Note: na – method results in negative value or value below limit of reporting.

nd – insufficient data

Limit of reporting (LOR) for upper threshold limit indicated by “<”

5. Monitoring Program

5.1 Groundwater Monitoring

The current groundwater monitoring network is provided in Table 3 and **Figure 1**. The ongoing groundwater monitoring program is provided in Table 8 below.

Table 8 : Groundwater Monitoring Program

Parameter	Frequency	Location
Water level	Monthly	All groundwater monitoring bores
Field water Quality Parameters · pH · EC	Quarterly	MW Series Groundwater Monitoring Bores
Laboratory Chemical Analysis · Na, K, Ca, Mg, HCO3, CO3, Cl, SO4 · Al, As, B, Cd, Cr, Cu, F, Fe, Hg, Mn, Ni, Pb, Se, Zn · Alkalinity, Hardness, Phosphorous, Nitrate-N, Sulphate	Quarterly	MW Series Groundwater Monitoring Bores

6. RESPONSE PLAN

6.1 Contingency Measures

In the event of any adverse impacts, or water quality degradation beyond assigned trigger levels, Boral Resources (NSW) Pty Ltd has a responsibility to undertake the following:

- Commission an investigation into the identified impact.
- Develop a staged response program sufficient to mitigate the adverse impact.
- Attempt to establish and implement measures to limit further impact.

The identification process and response protocols to potential adverse outcomes are provided in the Trigger Action Response Plan (TARP) outlined in Table 9. The responses proposed incorporate a staged assessment and development of management measures deemed appropriate for each individual event.

The baseline monitoring data provides the basis for assigned trigger levels and takes into account historical natural variations. Specific key indicators for monitoring have been designed to facilitate the early identification of any changes to groundwater quality outside of normal variation or where parameters do not follow the trends predicted in the 2005 EIS (ERM, 2005).

6.2 Trigger Action Response Plan (TARP)

The TARP sets appropriate triggers levels and a subsequent response for the prevention or mitigation of impacts to natural groundwater conditions in a response to the Quarry activities.

The monitoring program outlined in Section 4 has been designed to detect changes in groundwater levels and groundwater quality using assigned trigger level threshold values.

The first objective of the TARP is to benchmark the natural variation in groundwater levels and quality to the existing groundwater monitoring network and baseline data.

Aspects assessed to be at risk are summarised in Section 2.3 of this report. No adverse impacts to groundwater are anticipated in response to the quarry operations however, groundwater quality and levels will continue to be monitored to support this assumption.

Table 9: Trigger Action Response Plan (TARP)

Aspect	Parameter	Frequency	Purpose	Trigger	Trigger Action	Purpose	Trigger Response Action	Responsibility
Groundwater level monitoring	Groundwater level	Monthly	To identify any impacts to the groundwater level due to quarry operations.	Two consecutive monthly observations indicating a steady decline in groundwater levels below the designated lower trigger level threshold (**Table 5**)	Repeat water level monitoring to confirm exceedance. Review data for accuracy. Refer the matter to an independent hydrogeologist / environmental scientist (or similar) to review.	Identify, investigate and report on impacts to groundwater levels. Inform agencies of baseline assessment and monitoring.	Inform relative agencies within 7 days of being notified of the exceedance with an exceedance notification letter. Exceedance investigation report to be issued within 60-days of initial notification to authorities.	Boral Resources (NSW) Pty Limited Environmental Officer
Groundwater quality in monitoring bores	EC	Quarterly	To identify any impacts to the groundwater level due to quarry operations.	Two consecutive quarterly EC observations above the designated upper trigger level threshold values (**Table 6**).	Repeat sampling of monitoring bore exceeding trigger. Review data for accuracy. Refer the matter to an independent hydrogeologist / environmental scientist (or similar) to review.	Identify, investigate and report on impacts to groundwater quality. Potentially prompt further investigation and sampling for analytes. Confirm and review trigger levels.		
	pH			Two consecutive quarterly pH observations outside of the designated trigger level threshold values (**Table 7**).				
	Major Ions and Metals			Two consecutive quarterly observations above the designated upper trigger level threshold values (**Table 8**).				

6.3 Response Action

The below response program would be carried out in consultation with regulatory departments such as NSW Department of Planning and Environment, NSW Office of Water, Environment Protection Authority etc.

In the event of any exceedance of the assigned trigger levels, the following response plan will be initiated:

- When aware of the exceedance, review the circumstances leading to the exceedance event.
  - Repeat the monitoring event to confirm the exceedance. If still in exceedance, issue a notification letter briefly detailing the exceedance to the relevant authorities within 7 days.
- When the trigger notification has been issued, initiate an investigation into the exceedance. The investigation report is to be issued within 60-days from the notification to authorities and be completed by an external consultant such as a hydrogeologist and/or environmental scientist (or similar). The investigation report should consider the following to determine potential causes:
  - Is the data accurate?
  - Similar triggers at other monitoring locations?
  - Anthropogenic / natural impacts responsible?
  - Abnormal weather conditions?
  - Active quarrying within the vicinity?

6.4 Roles and Responsibilities

All employees and contractors of the Quarry are responsible for the ongoing environmental management. Positions within the organisation have roles, responsibility and authority for managing environmental aspects, action plans, programs and controls.

The key responsibilities are provided below:

- Overall responsibility for environmental compliance with Environmental Protection License 10132 and DA 140-6-2005 conditions – Regional Environmental Manager.
- Implementation and adherence to this Groundwater Monitoring Plan – Quarry Manager.
- Delegating tasks associated with this groundwater monitoring Plan in order to achieve compliance – Quarry Manager.

7. Annual Environmental Management Report

Boral currently undertakes an Annual Environmental Management Report (AEMR) for groundwater monitoring completed during the 12-month reporting period in accordance with DA 140-6-2005 (Schedule 4, Condition 3).

The AEMR should report on monitoring locations and requirements detailed in this GWMP. The groundwater monitoring review is to include the following:

- A summary of the monitoring completed over the 12-month reporting period.
- A comparison of the monitoring results with the trigger levels detailed in Section 4, including the identification of any trigger level exceedance.
- Analysis of any non-compliance against trigger levels.
- A description of all management / mitigation measures taken following an identified non-compliance.

Development consent DA 140-6-2005 (Schedule 4, Condition 3) also specifies that, with reference to the groundwater monitoring bores, the report must:

- identify the standards and performance measures that apply to the development;
- describe the works carried out in the last 12 months;
- describe the works that will be carried out in the next 12 months;
- include a summary of the complaints received during the past year, and compare this to the complaints received in previous years;
- include a summary of the monitoring results for the development during the past year;
- include an analysis of these monitoring results against the relevant:
  - impact assessment criteria;
  - monitoring results from previous years; and
  - predictions in the EIS.
- identify any trends in the monitoring results over the life of the development;
- identify any non-compliance during the previous year; and
- describe what actions were, or are being taken to ensure compliance.

8. References

ANZECC, 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Australian and New Zealand Environmental and Conservational Council, and Agriculture and Resource Management Council of Australia and New Zealand.

ADWG, 2011. Australian Drinking Water Guidelines 6. National Health and Medical Research Council, National Resource Management Ministerial Council, Commonwealth of Australia, Canberra.

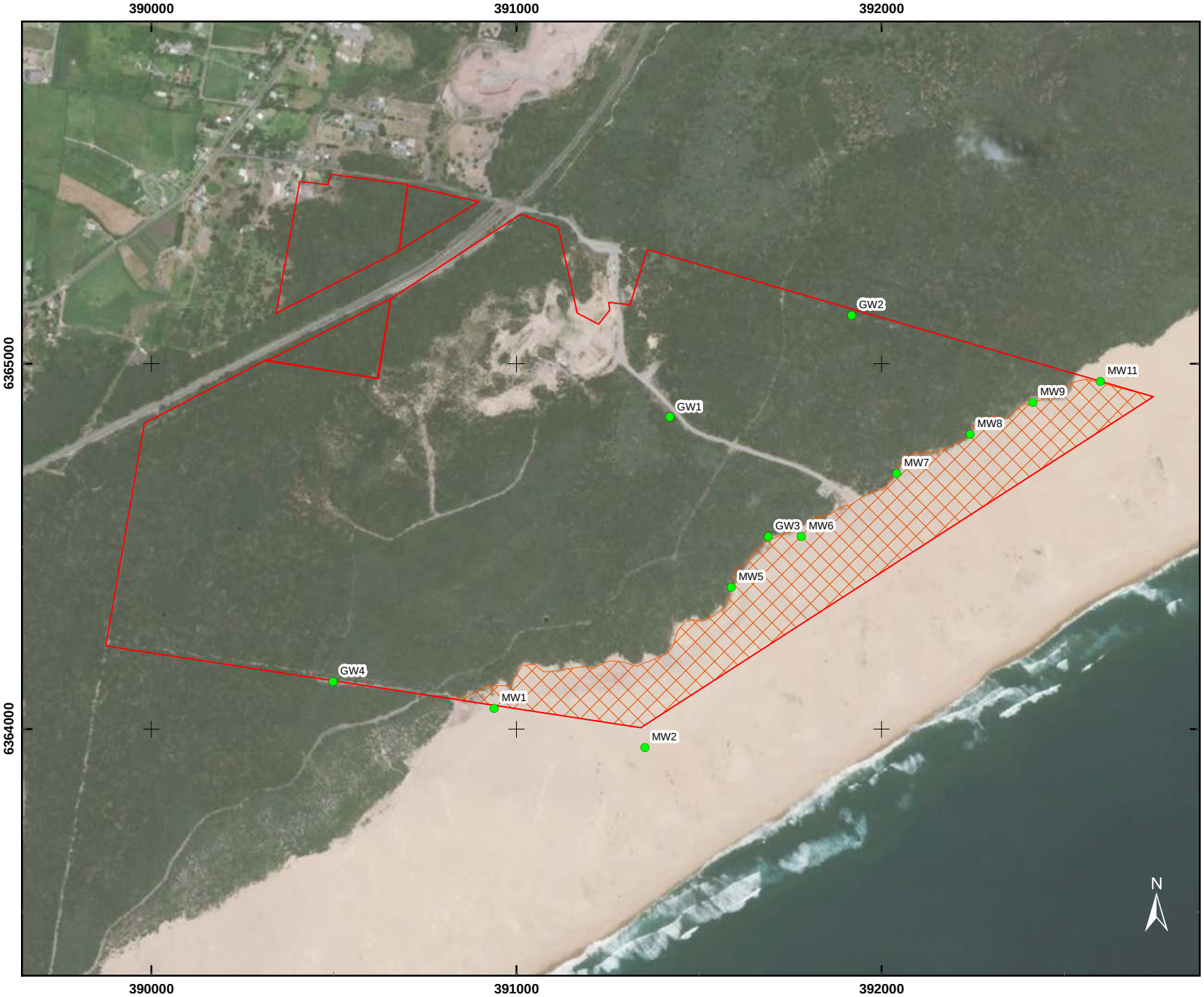
ERM, 2005. *Environmental Impact Statement Stockton Sandpit Windblown Sand Extraction, for Boral Resources (Country) Pty Limited*. Environmental Resources Management Australia Pty Ltd

ERM, 2008. Stockton Transgressive Dune Quarry, Groundwater Monitoring Program and Baseline Data. Environmental Resources Management Australia Pty Ltd, Reference 00640400GWMP Final 2, April 2008.

RPS Water, 2016, *Boral Stockton Quarry – Groundwater Gap Analysis.* Consultant report provided for Boral Resources (NSW) Pty Ltd. Reference WS00256B/003a, 26 July 2016.

RPS Aquaterra 2011, *Stockton Sand Quarry Groundwater Monitoring Program*, *Revision 3.*

FIGURES



LEGEND

- Active Tenement
- Current Extraction Area
- Existing Piezometers

0 125 250 375 500

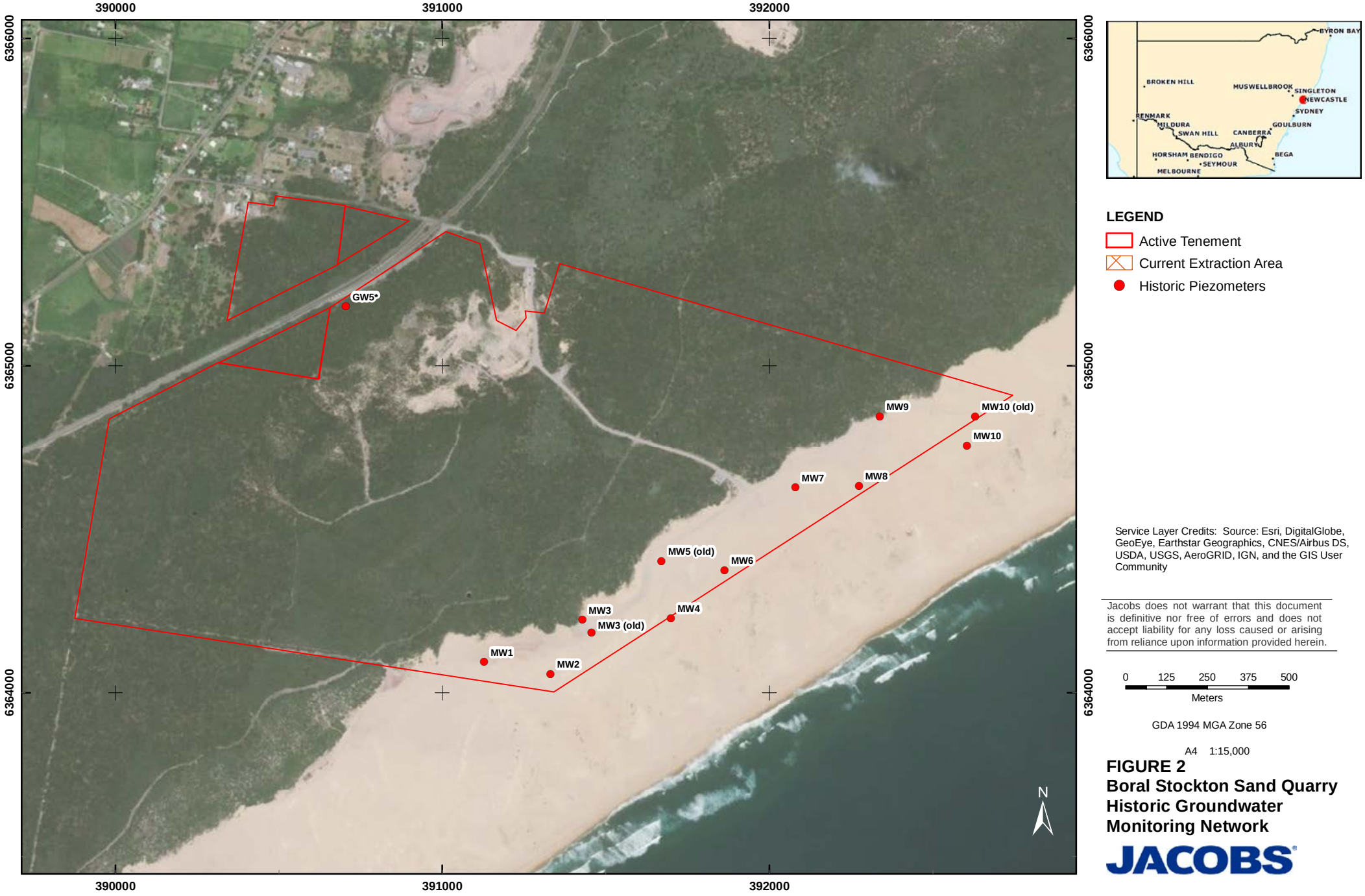
Meters

GDA 1994 MGA Zone 56

A4 1:15,000

FIGURE1
Boral Stockton Sand Quarry
Existing Groundwater Monitoring Network

JACOBS



LEGEND

- Active Tenement
- Current Extraction Area
- Historic Piezometers

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

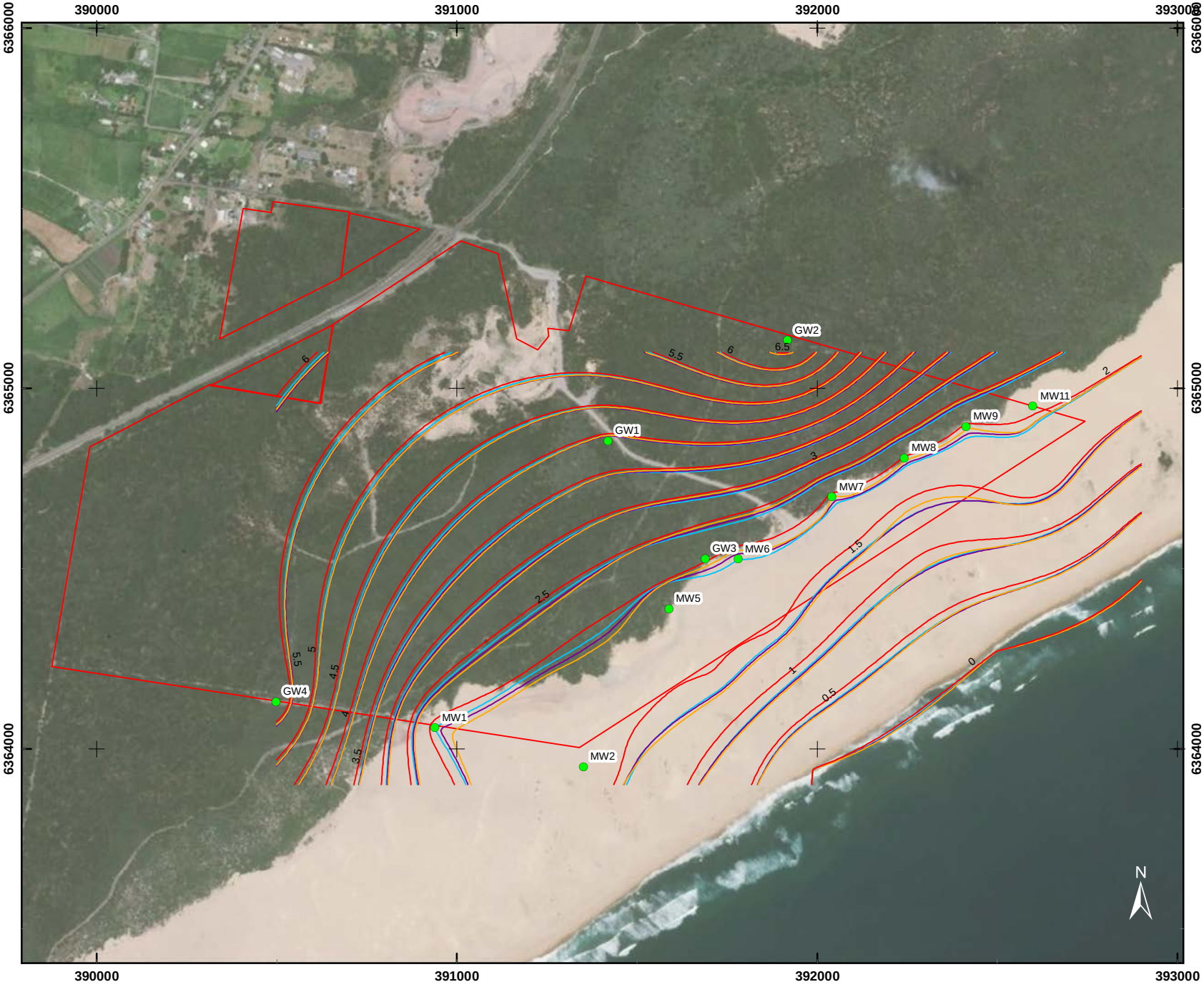
0 125 250 375 500
Meters

GDA 1994 MGA Zone 56

A4 1:15,000

FIGURE 2
Boral Stockton Sand Quarry Historic Groundwater Monitoring Network

JACOBS



LEGEND

- Active Tenement
- Existing Piezometers
- Quarter 1 Contours
- Quarter 2 Contours
- Quarter 3 Contours
- Quarter 4 Contours

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

0 125 250 375 500

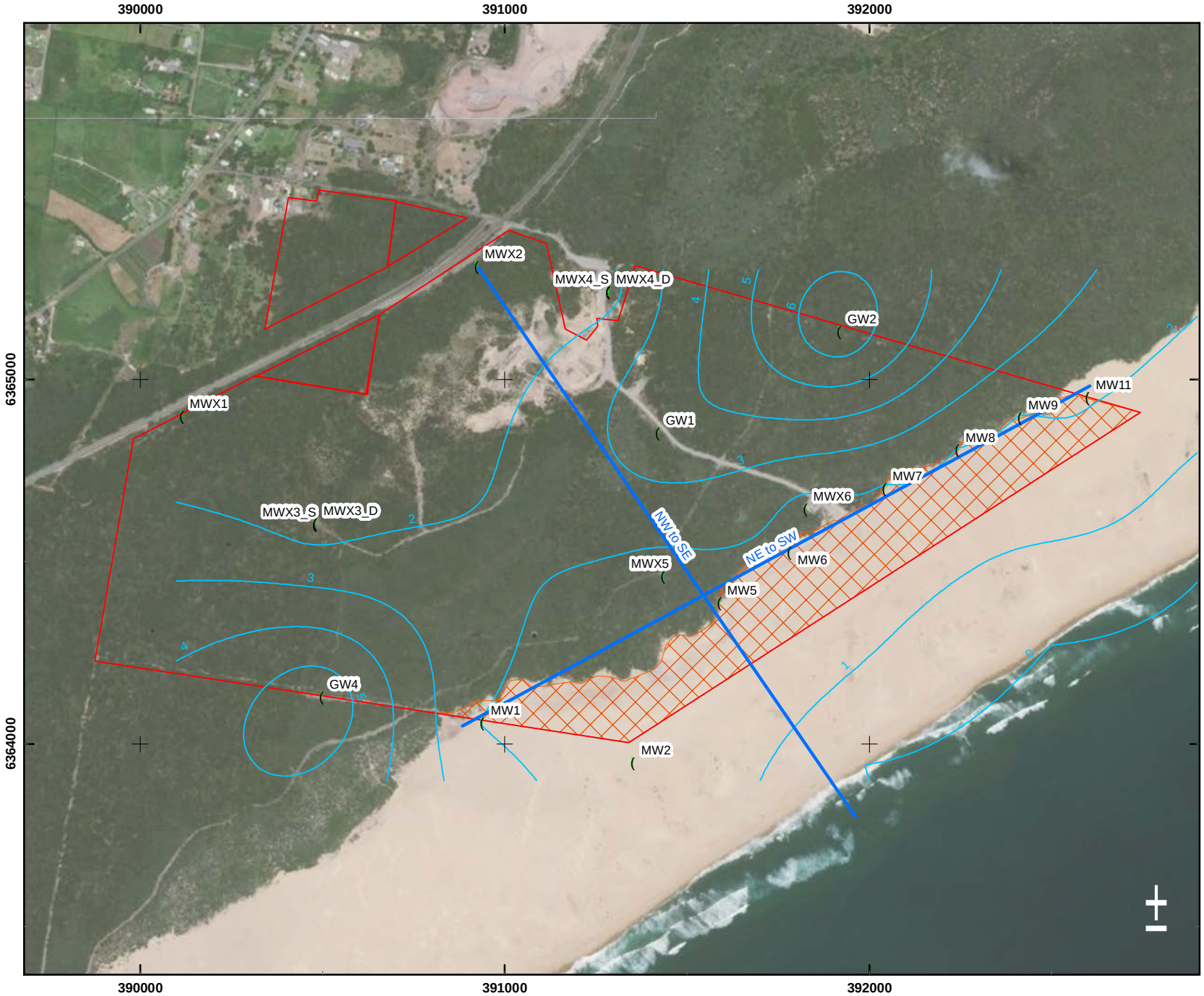
Meters

GDA 1994 MGA Zone 56

A4 1:15,000

FIGURE 3
Boral Stockton Sand Quarry
Average Seasonal Groundwater Level Contours

JACOBS



LEGEND

- Active Tenement
- Current Extraction Area
- Groundwater Contours With New Piezos (mAHD)
- Line of Section (approx..) refer to Figure 5

0 125 250 375 500

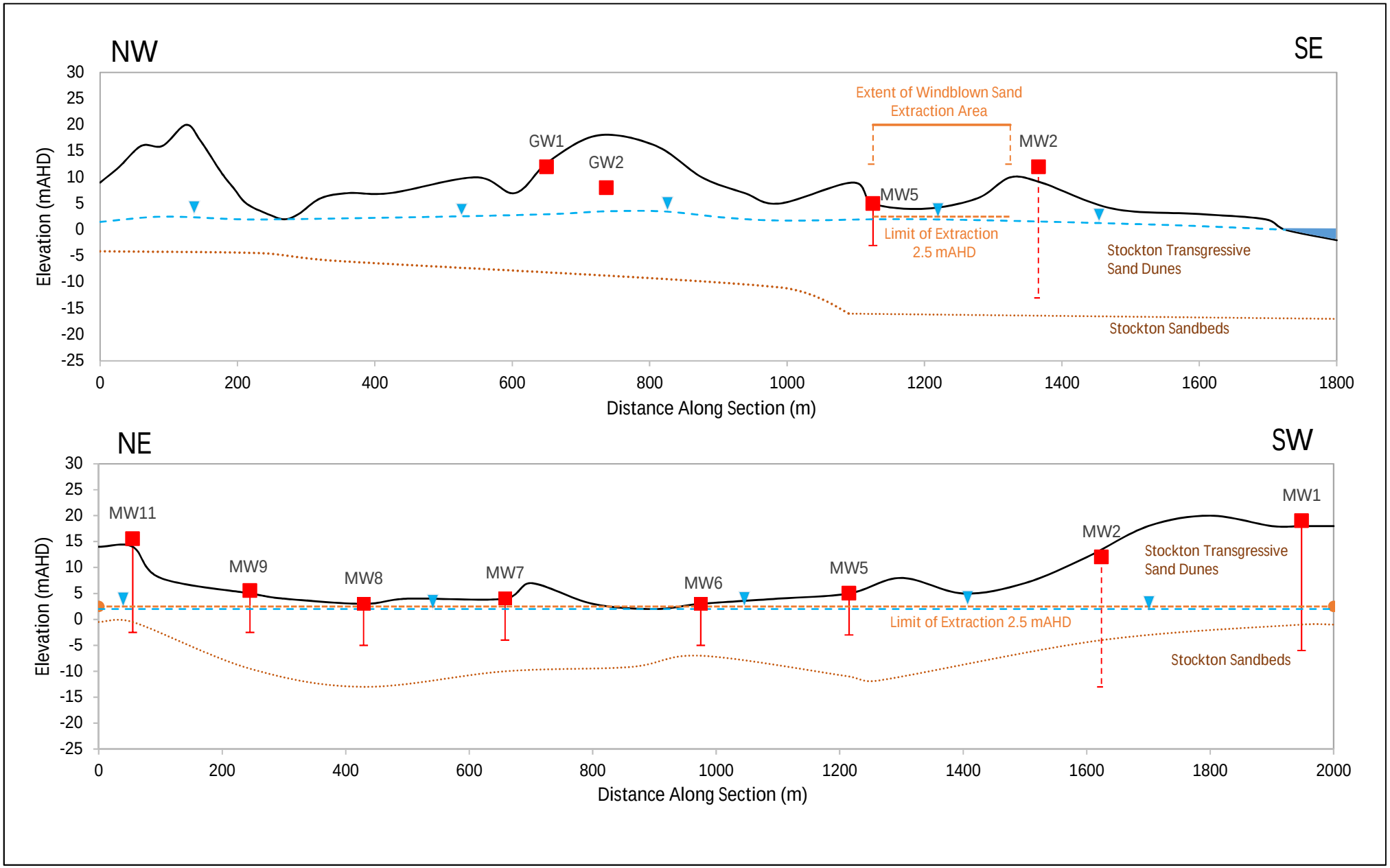
Meters

GDA 1994 MGA Zone 56

A4 1:15,000

FIGURE 4
Boral Stockton Sand Quarry
Average Groundwater Level Contours with Newly Installed Piezometers

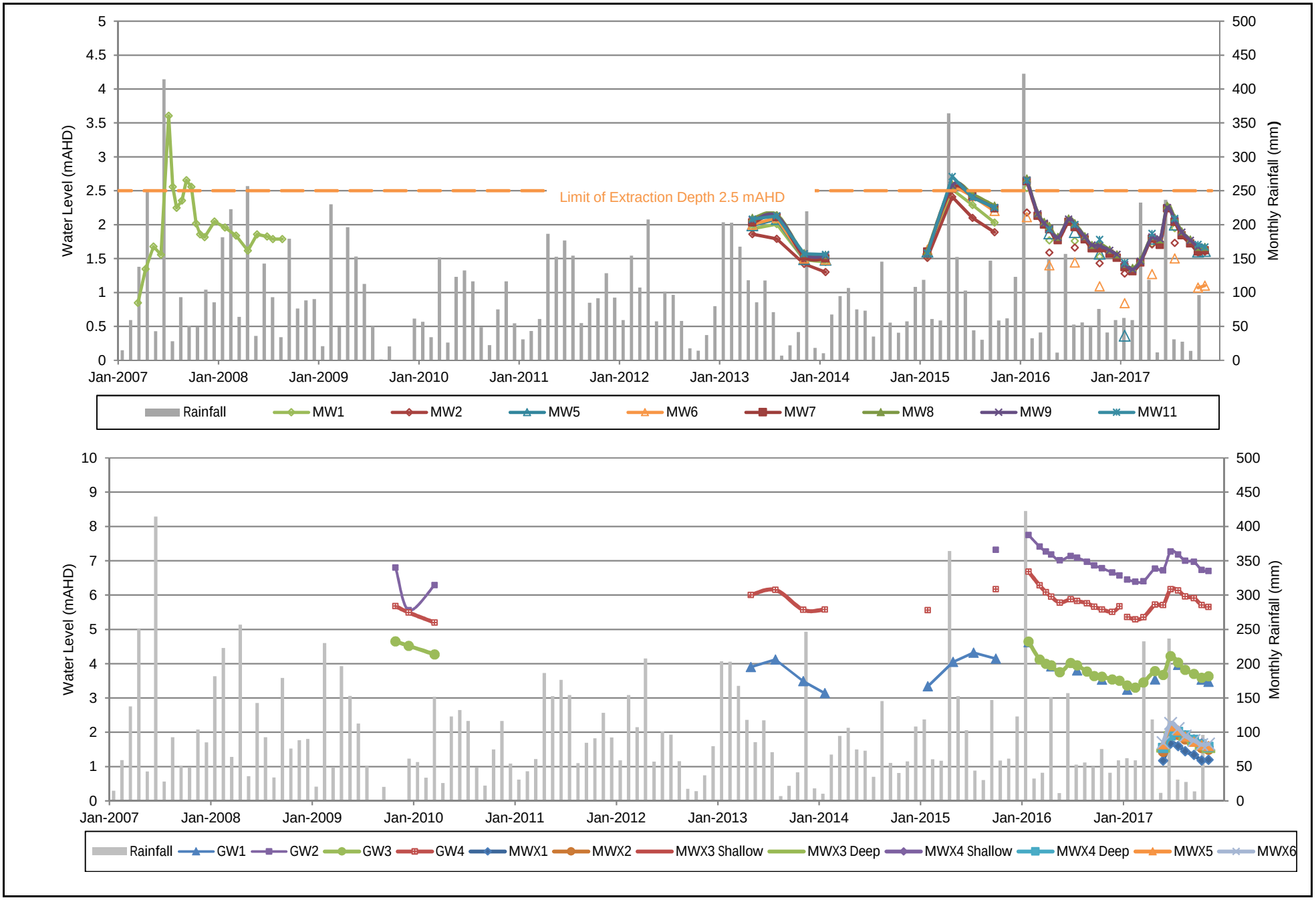
JACOBS



JACOBS

GEOLOGICAL CROSS SECTION FIGURE 5

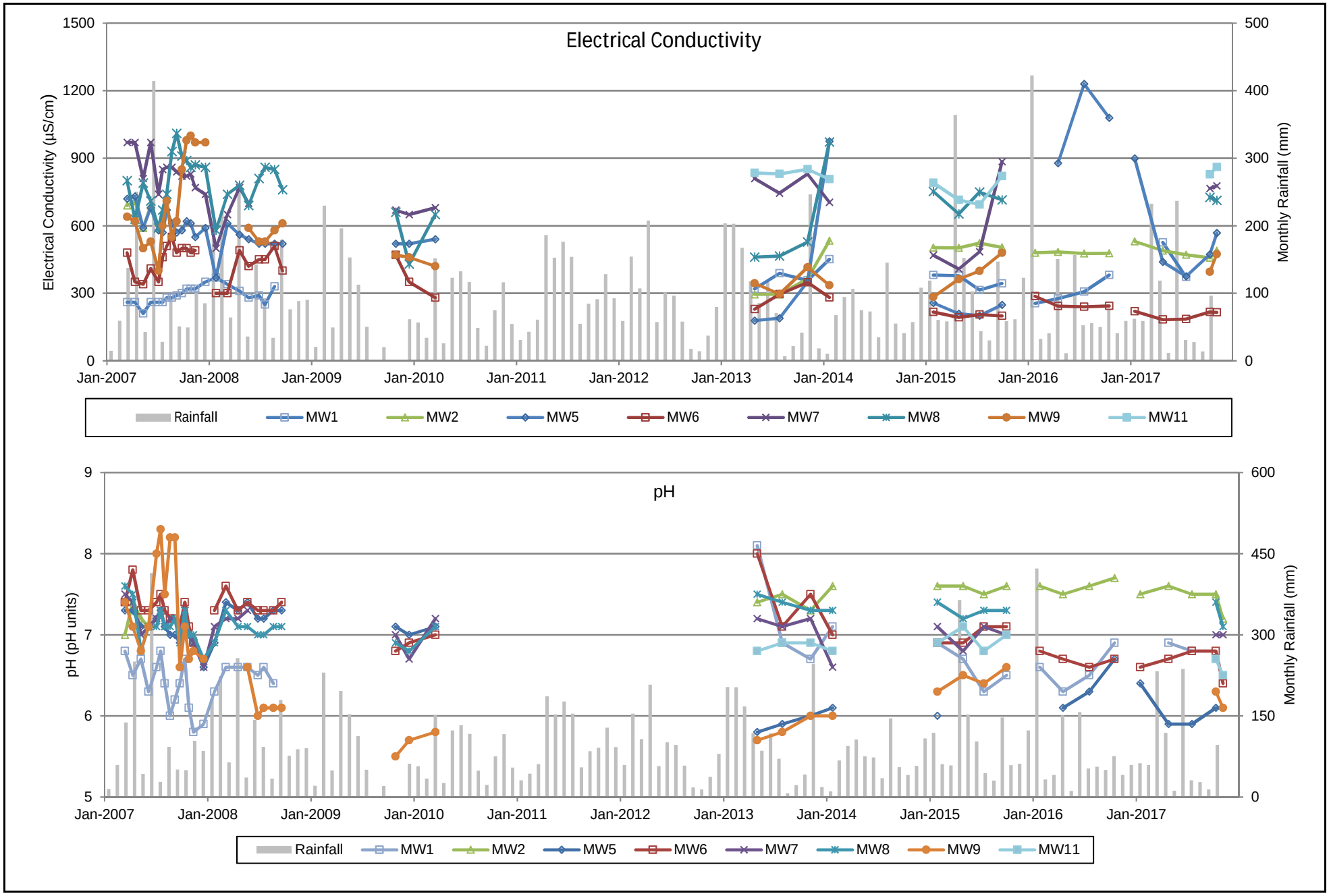
J:\IE\Projects\04_Eastern\IA147700\02 - Documents\Groundwater Analysis\[Cross Section Stockton - final.xlsx]Figure 5 cross section



JACOBS

GROUNDWATER LEVELS FIGURE 6

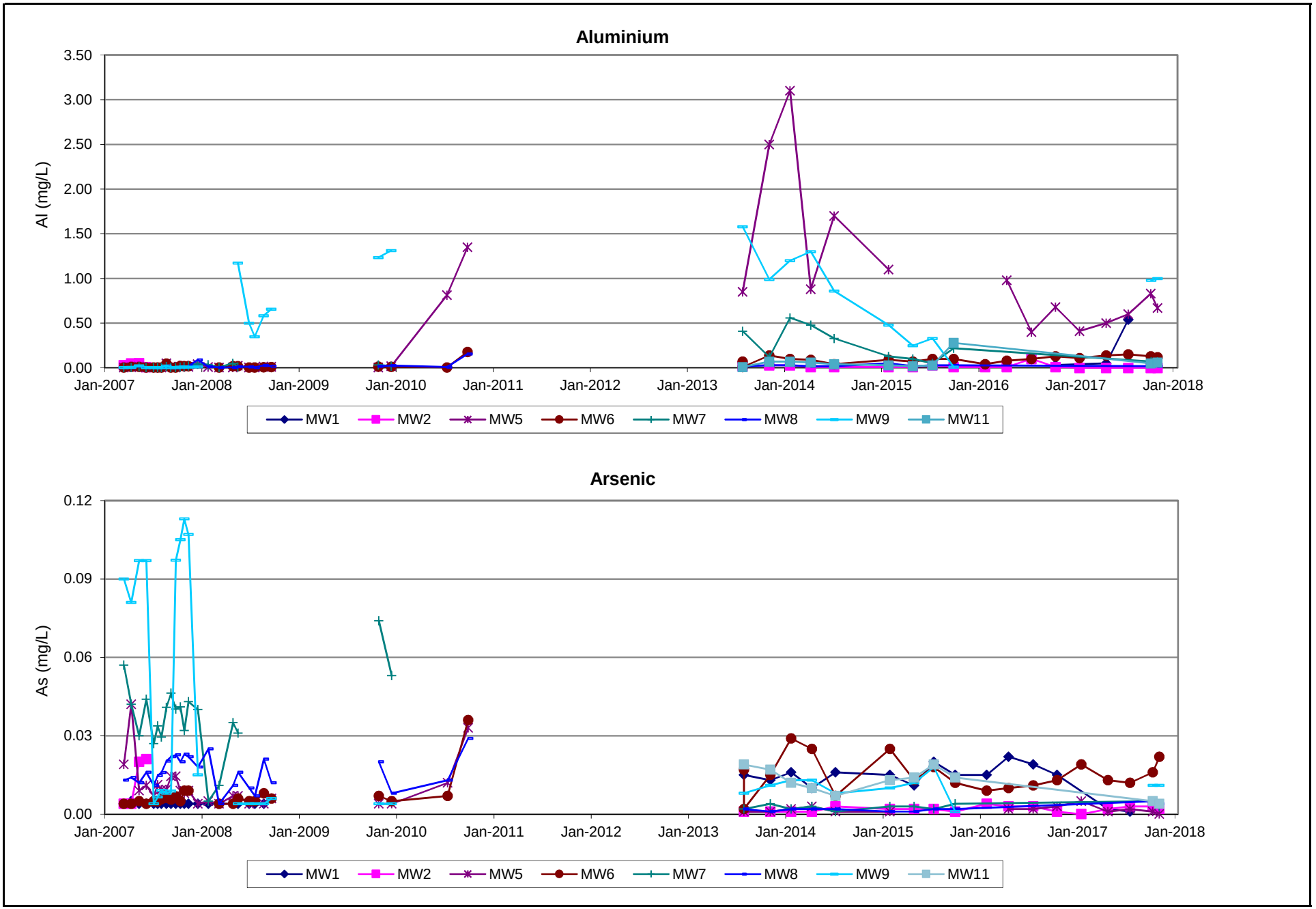
J:\IE\Projects\04_Eastern\IA147700\02 - Documents\Groundwater Analysis\001c qb\[001c_Groundwater Levels and Field Chem figs.xlsx]Fig 6 GW levels



JACOBS

BASELINE FIELD GROUNDWATER QUALITY FIGURE 7

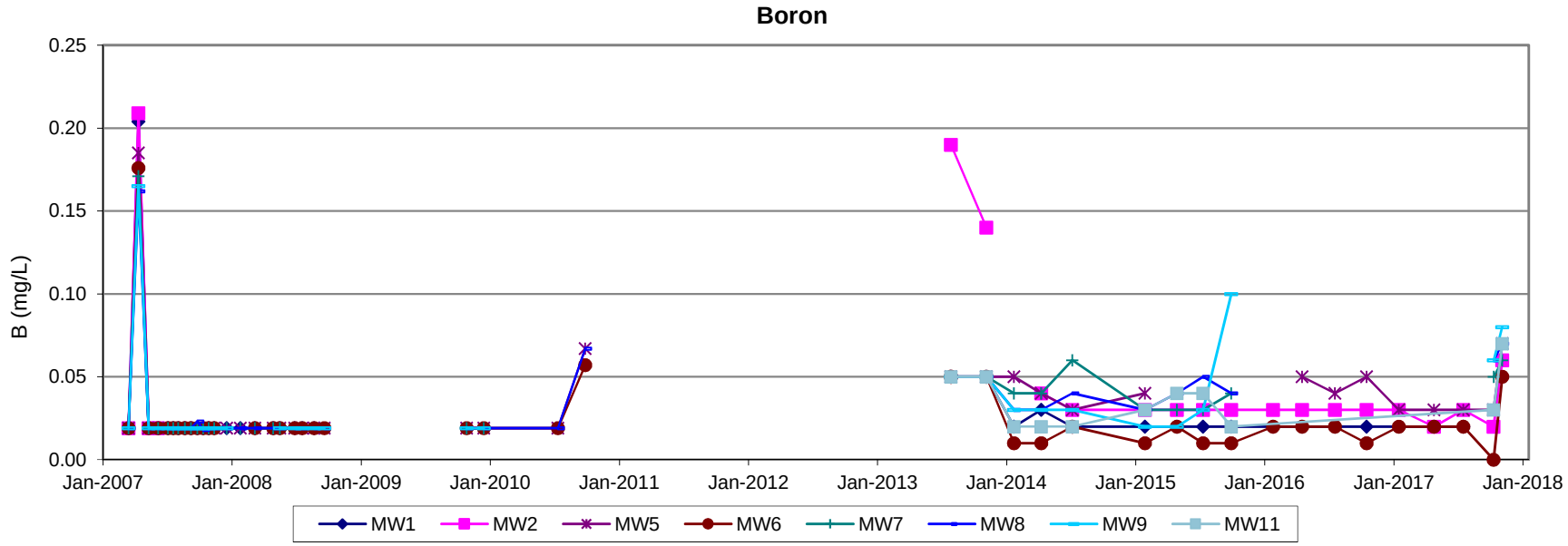
J:\IE\Projects\04_Eastern\IA147700\02 - Documents\Groundwater Analysis\001c qb\[001c_Groundwater Levels and Field Chem.xlsx]Fig 7 EC pH

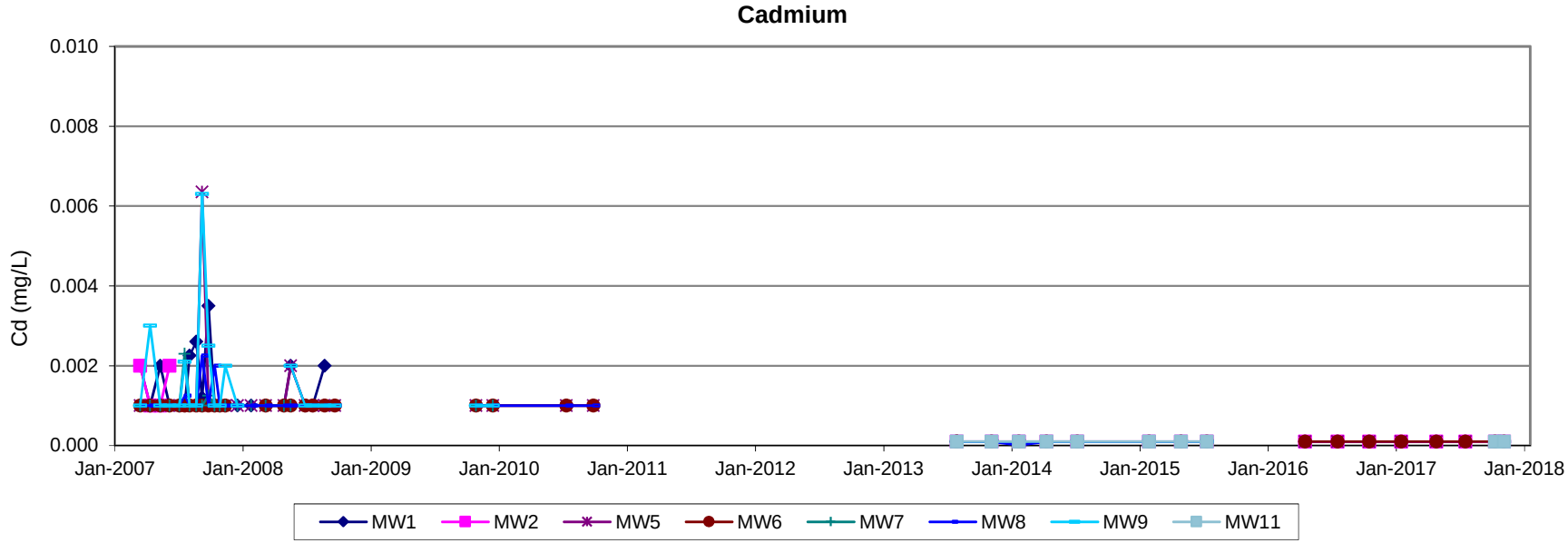


JACOBS

BASELINE GROUNDWATER QUALITY [ALUMINIUM ARSENIC] FIGURE 8

J:\IE\Projects\04_Eastern\IA147700\02 - Documents\Groundwater Analysis\001c qb\[001c_Comprehensive Water Quality.xlsx]Al As

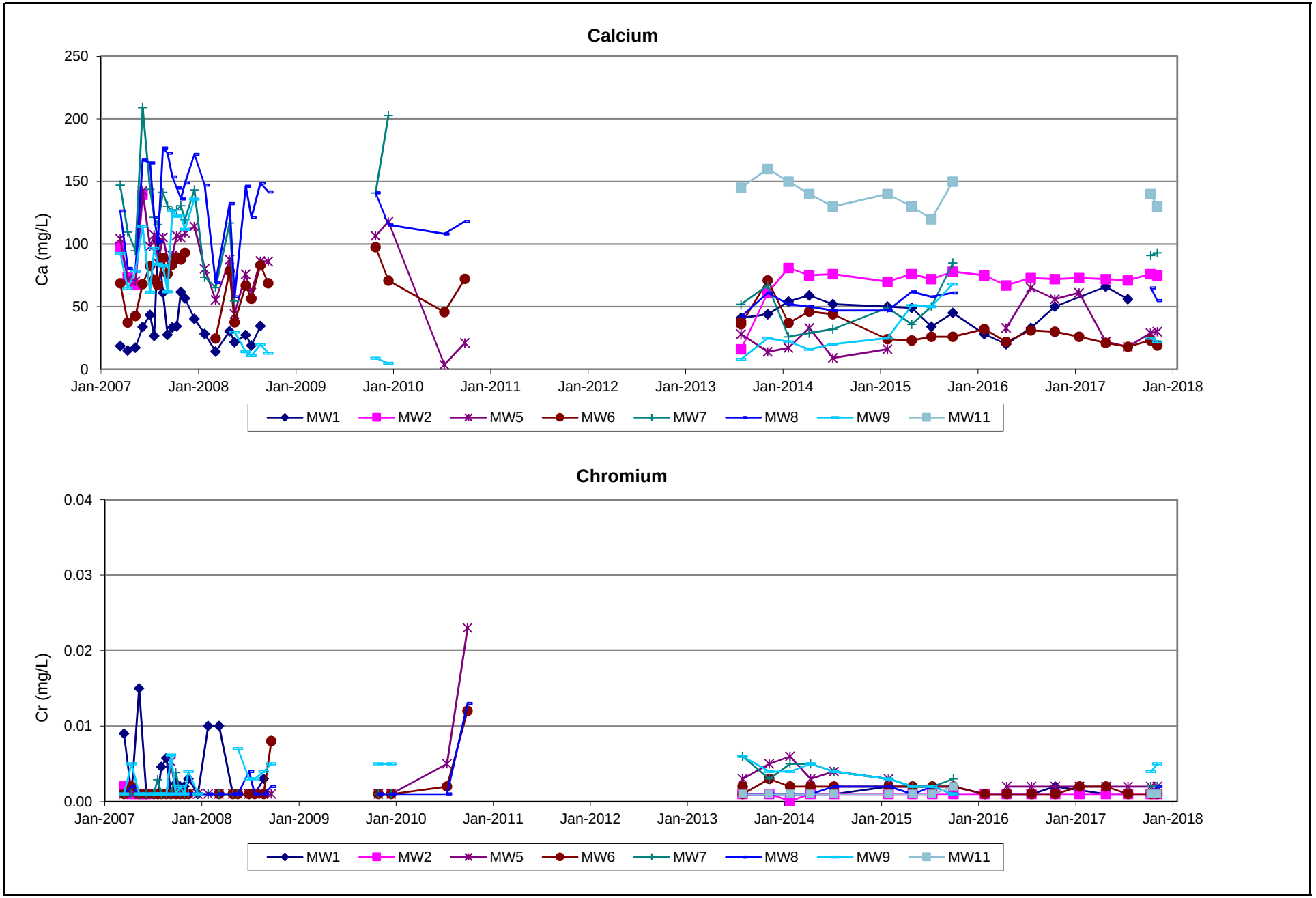


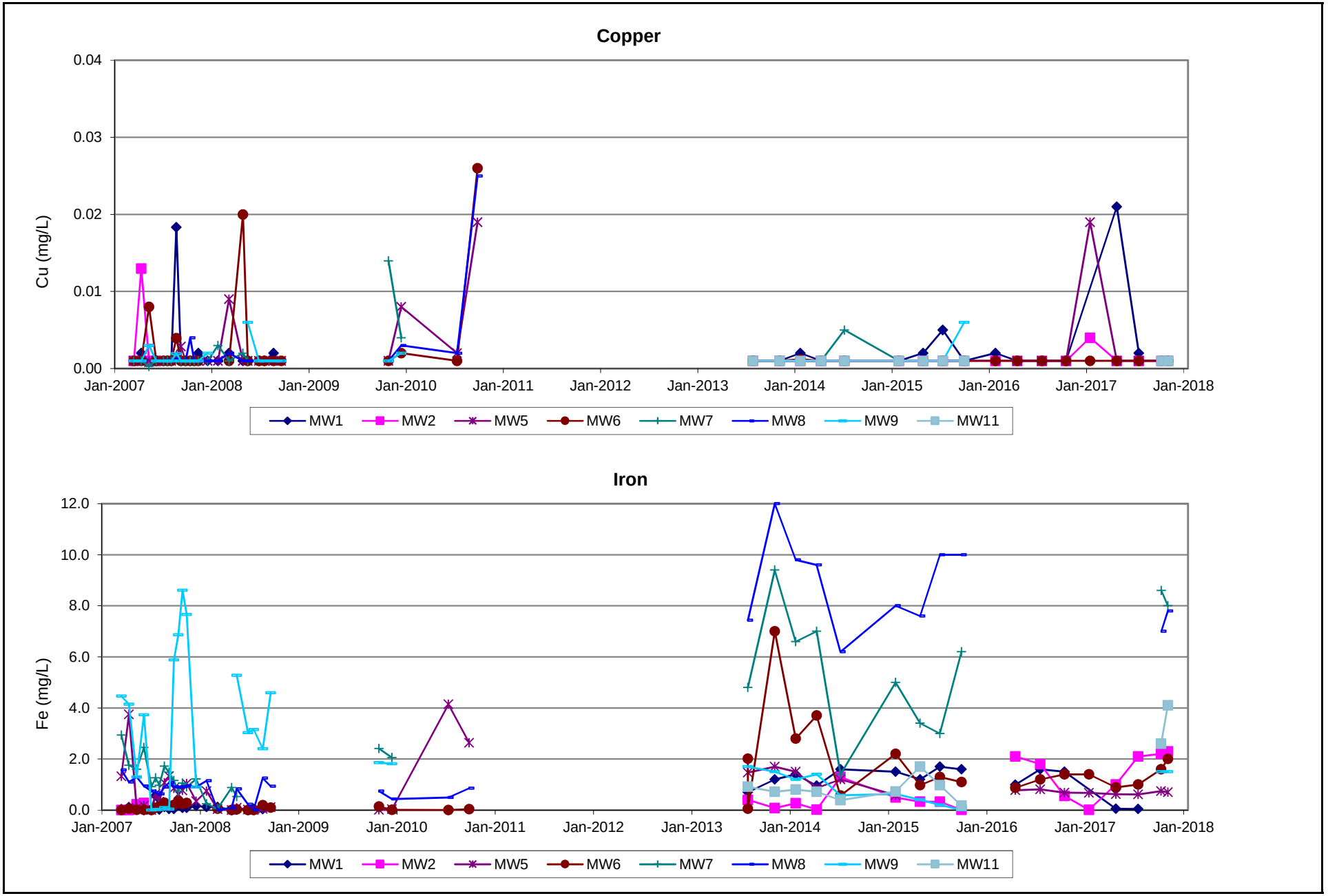


JACOBS

BASELINE GROUNDWATER QUALITY [BORON CADMIUM] FIGURE 9

J:\IE\Projects\04_Eastern\IA147700\02 - Documents\Groundwater Analysis\001c qb\[001c_Comprehensive Water Quality.xlsx]B Cd

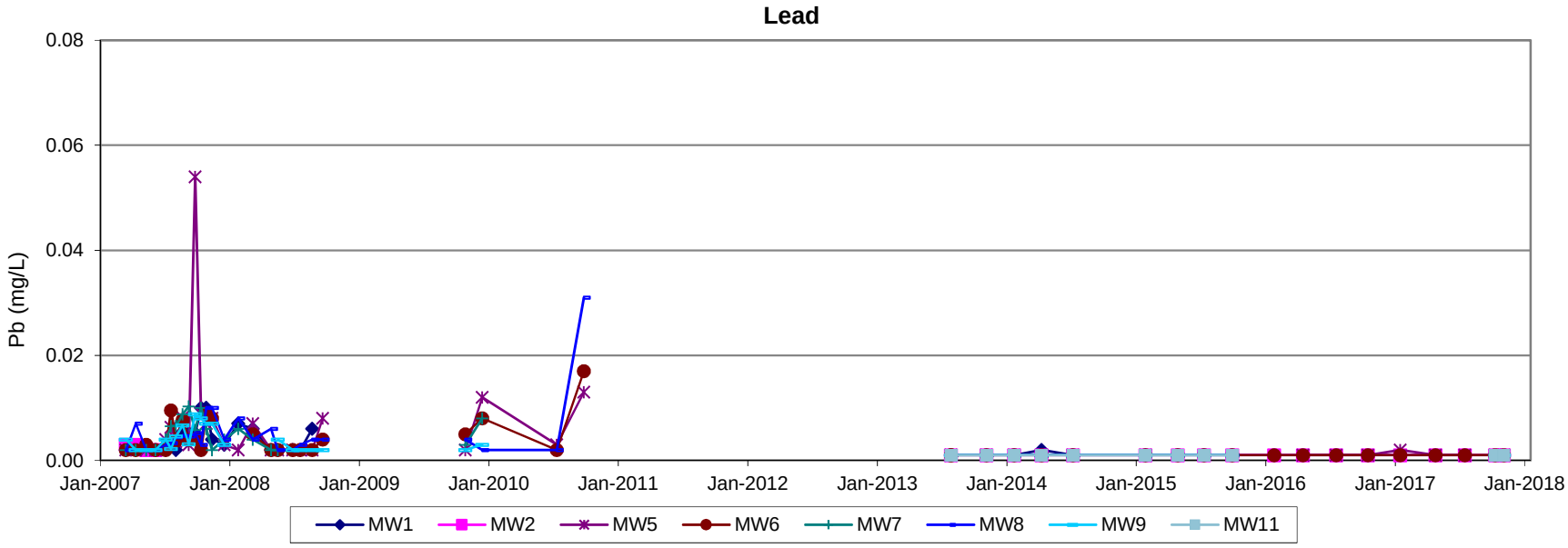

Calcium
Ca (mg/L)
250
200
150
100
50
0
Jan-2007
Jan-2008
Jan-2009
Jan-2010
Jan-2011
Jan-2012
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
MW1
MW2
MW5
MW6
MW7
MW8
MW9
MW11
Chromium
Cr (mg/L)
0.04
0.03
0.02
0.01
0.00
Jan-2007
Jan-2008
Jan-2009
Jan-2010
Jan-2011
Jan-2012
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
MW1
MW2
MW5
MW6
MW7
MW8
MW9
MW11

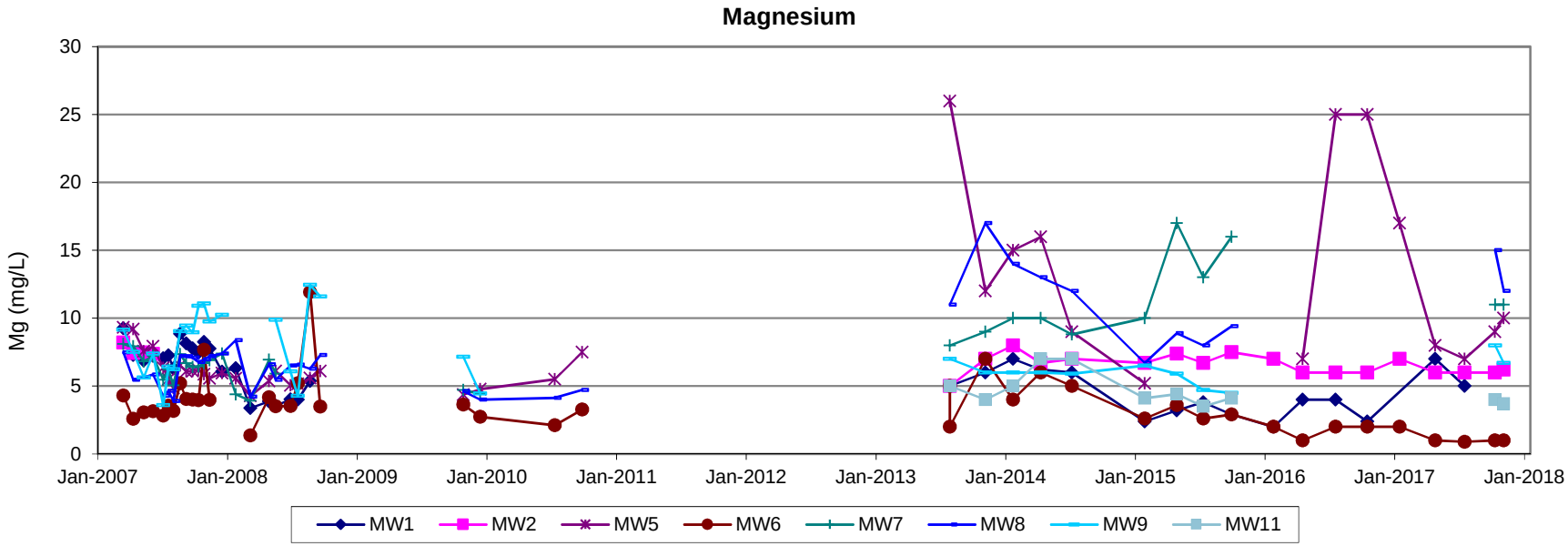


JACOBS

BASELINE GROUNDWATER QUALITY [COPPER IRON] FIGURE 11

J:\IE\Projects\04_Eastern\IA147700\02 - Documents\Groundwater Analysis\001c qb\[001c_Comprehensive Water Quality.xlsx]Fe Cu

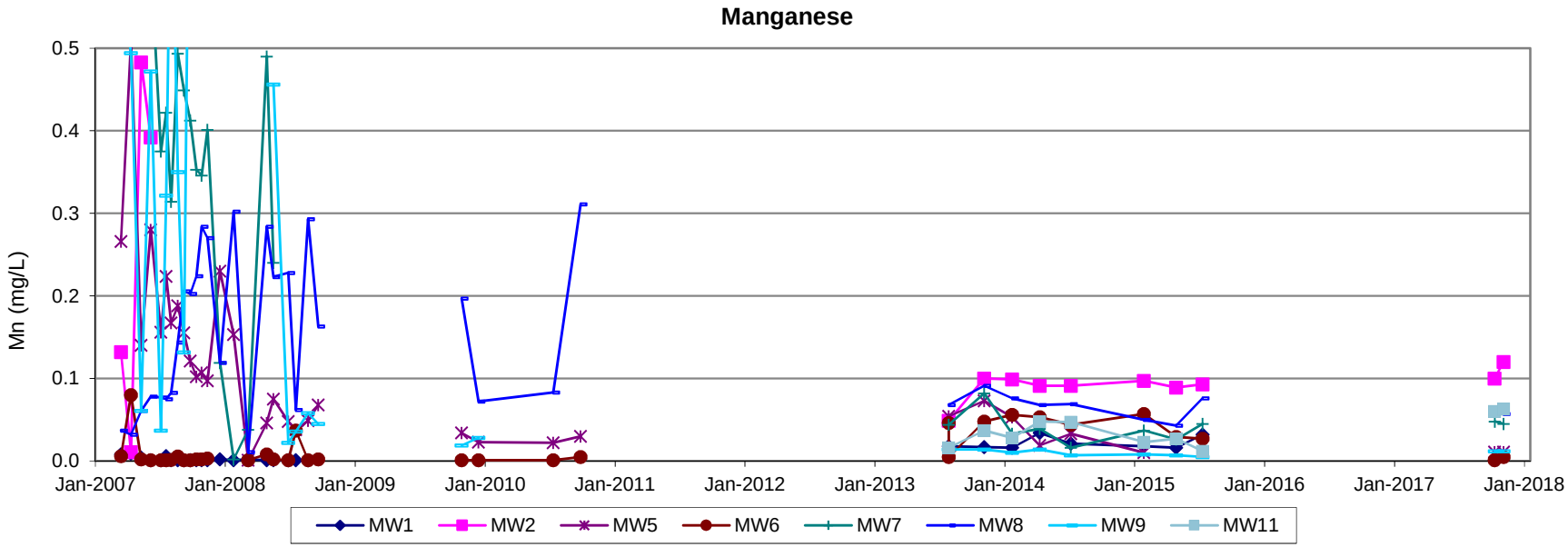


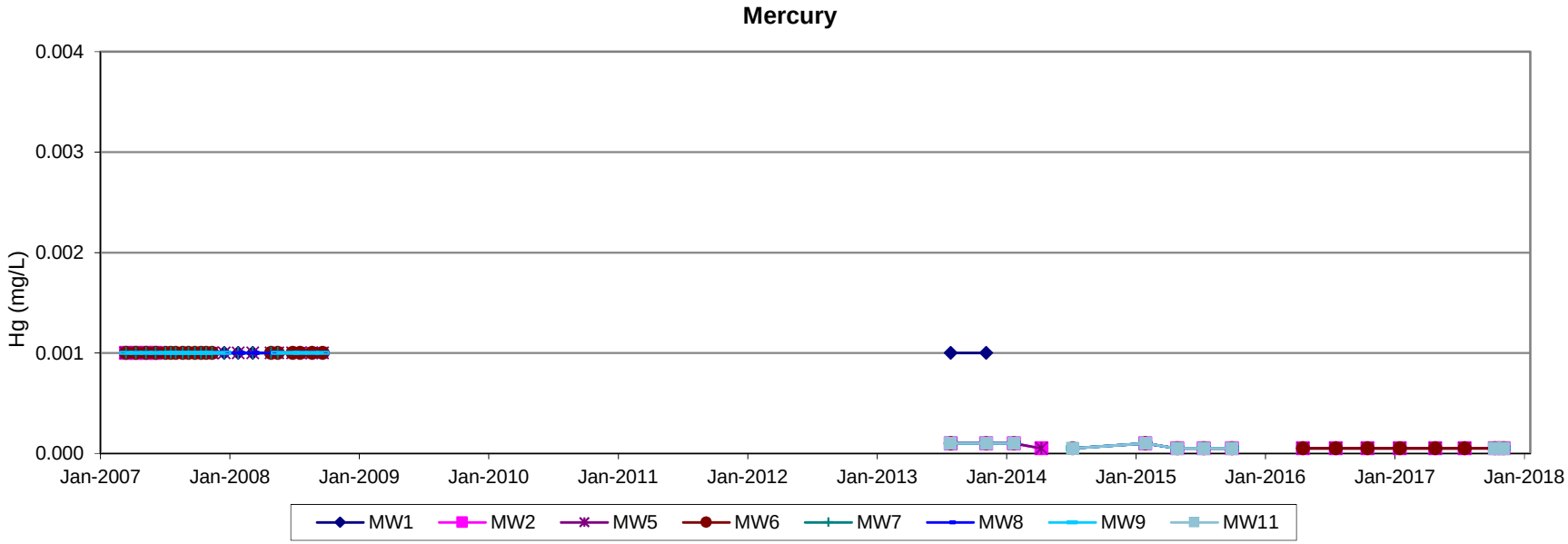


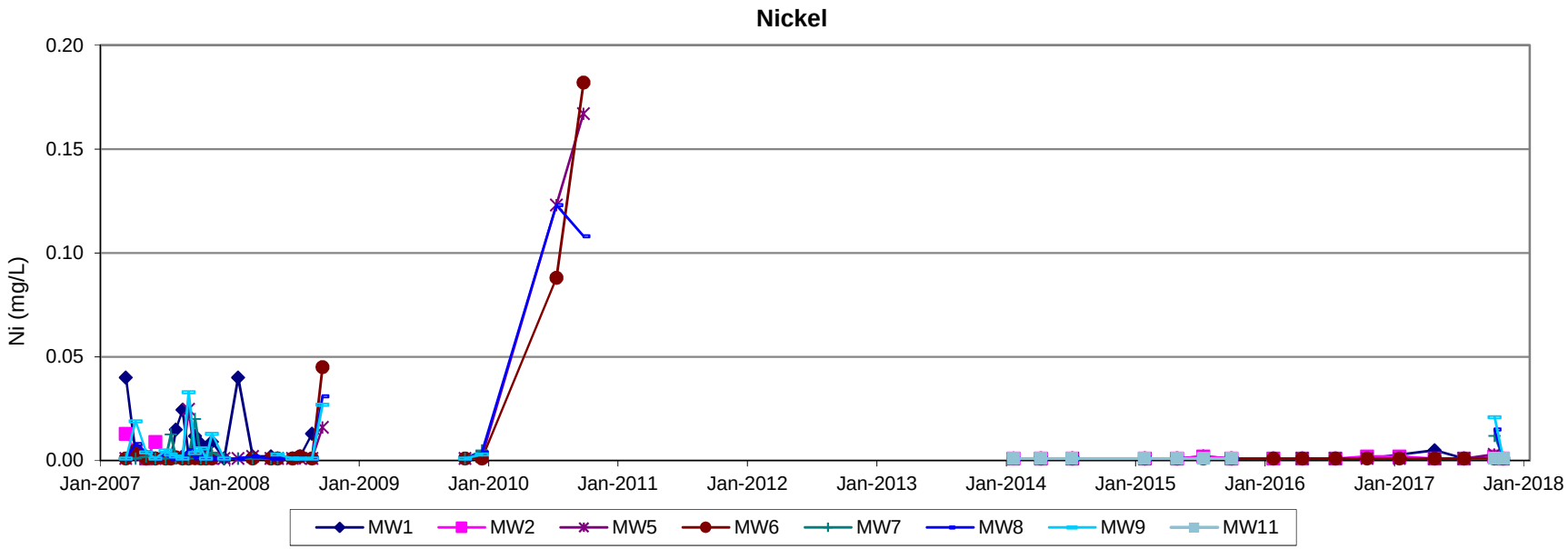
JACOBS

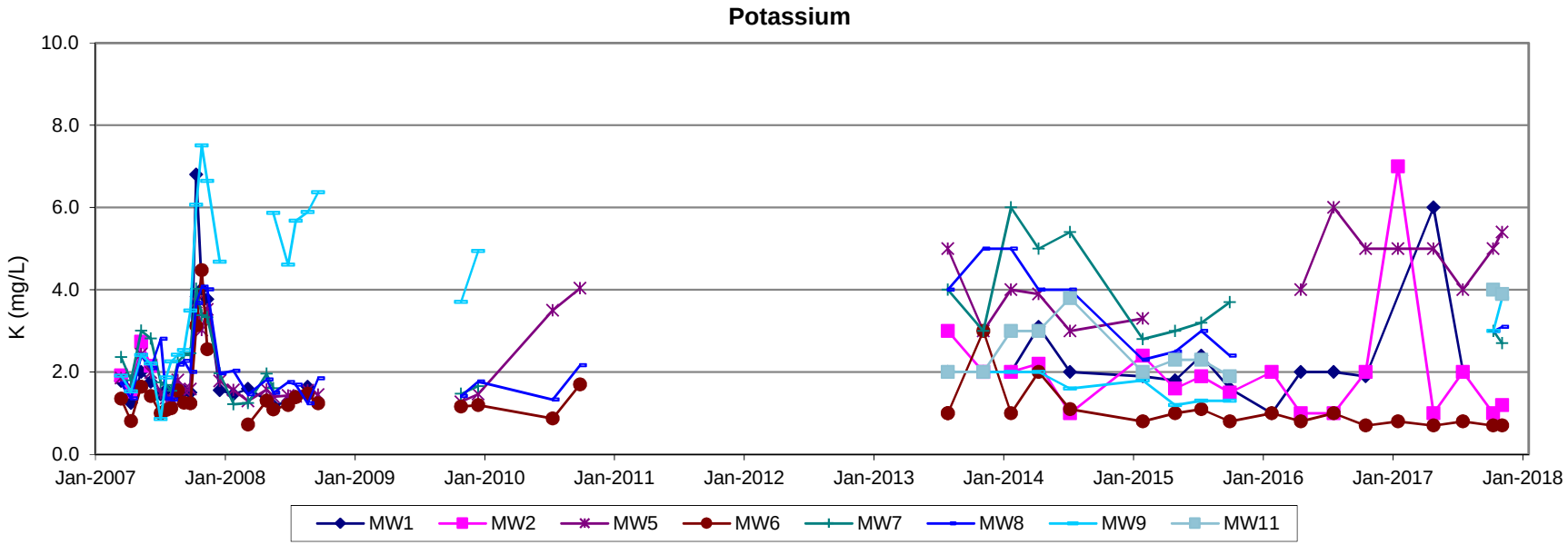
BASELINE GROUNDWATER QUALITY [LEAD MAGNESIUM] FIGURE 12

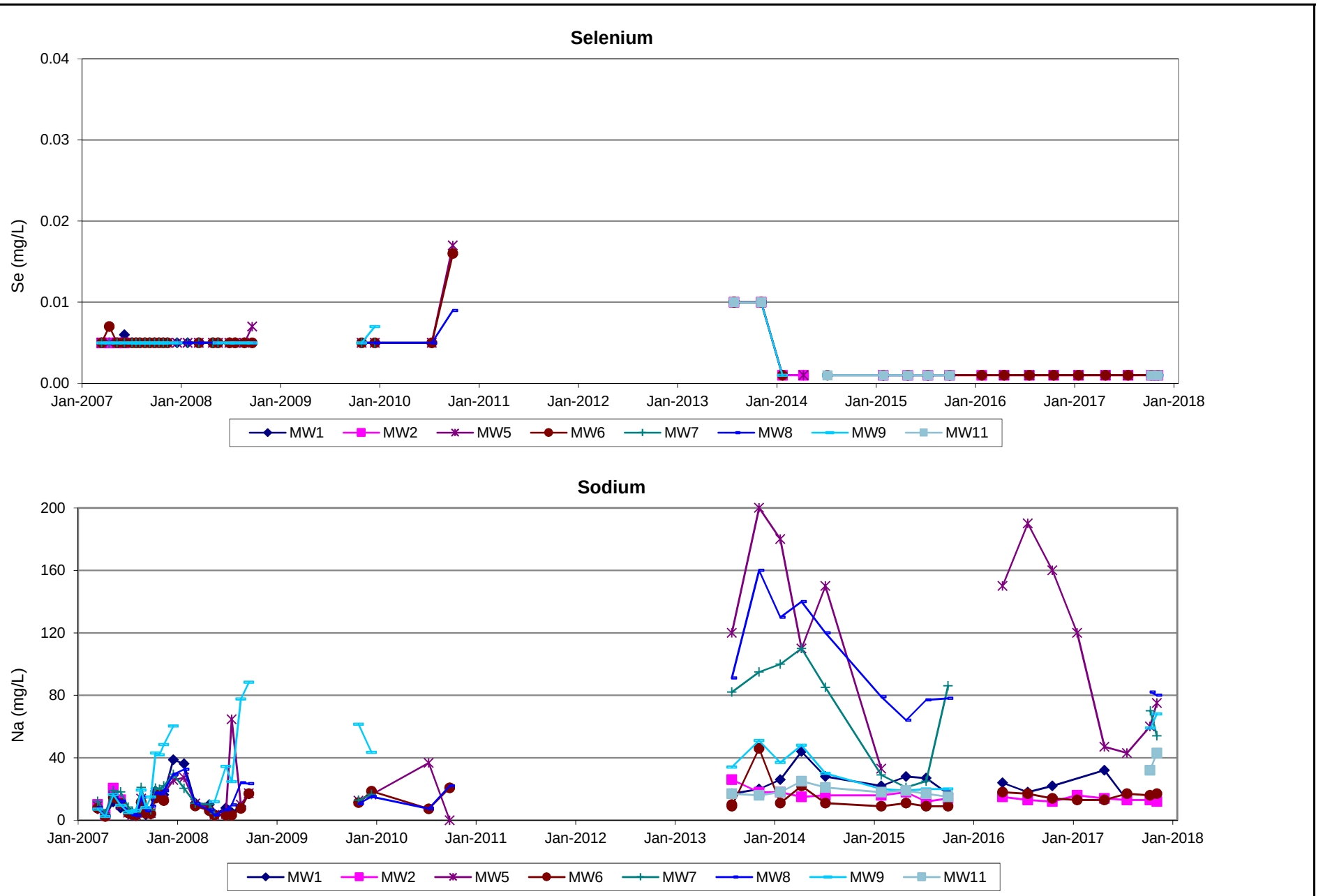
J:\IE\Projects\04_Eastern\IA147700\02 - Documents\Groundwater Analysis\001c qb\[001c_Comprehensive Water Quality.xlsx]Mg Pb


Manganese
Mn (mg/L)
0.5
0.4
0.3
0.2
0.1
0.0
Jan-2007
Jan-2008
Jan-2009
Jan-2010
Jan-2011
Jan-2012
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
MW1
MW2
MW5
MW6
MW7
MW8
MW9
MW11


Mercury
Hg (mg/L)
0.004
0.003
0.002
0.001
0.000
Jan-2007
Jan-2008
Jan-2009
Jan-2010
Jan-2011
Jan-2012
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
MW1
MW2
MW5
MW6
MW7
MW8
MW9
MW11


Nickel
0.20
0.15
0.10
0.05
0.00
Ni (mg/L)
Jan-2007
Jan-2008
Jan-2009
Jan-2010
Jan-2011
Jan-2012
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
MW1
MW2
MW5
MW6
MW7
MW8
MW9
MW11

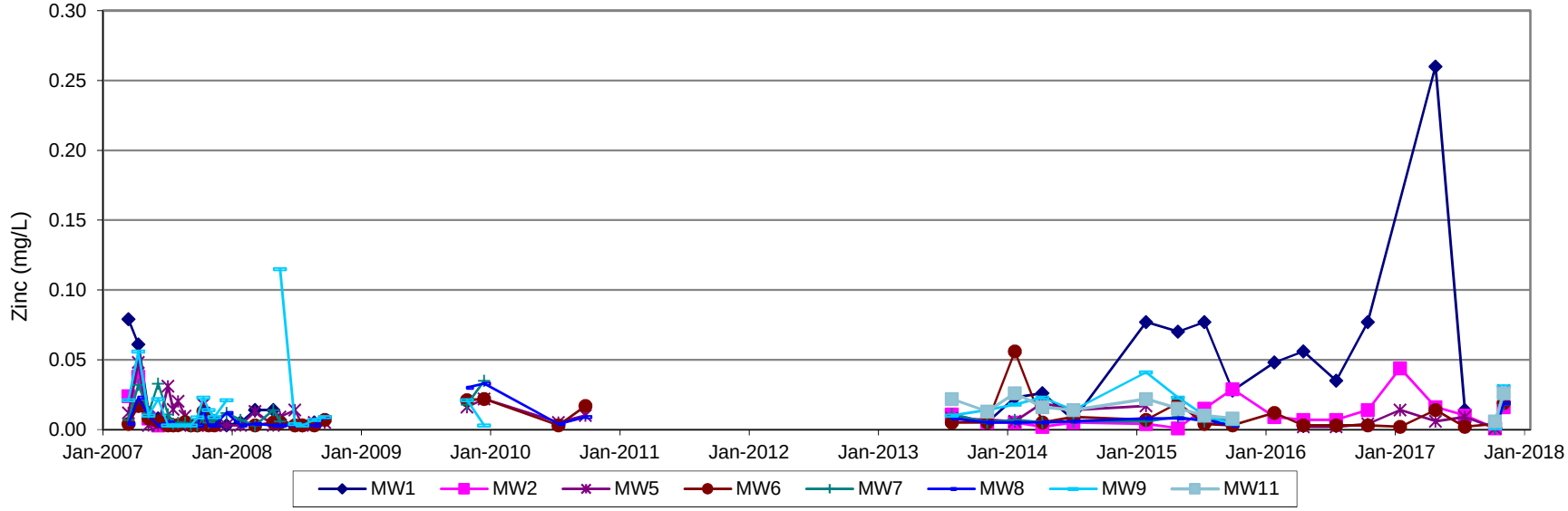

Potassium
10.0
8.0
6.0
4.0
2.0
0.0
K (mg/L)
Jan-2007
Jan-2008
Jan-2009
Jan-2010
Jan-2011
Jan-2012
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
MW1
MW2
MW5
MW6
MW7
MW8
MW9
MW11

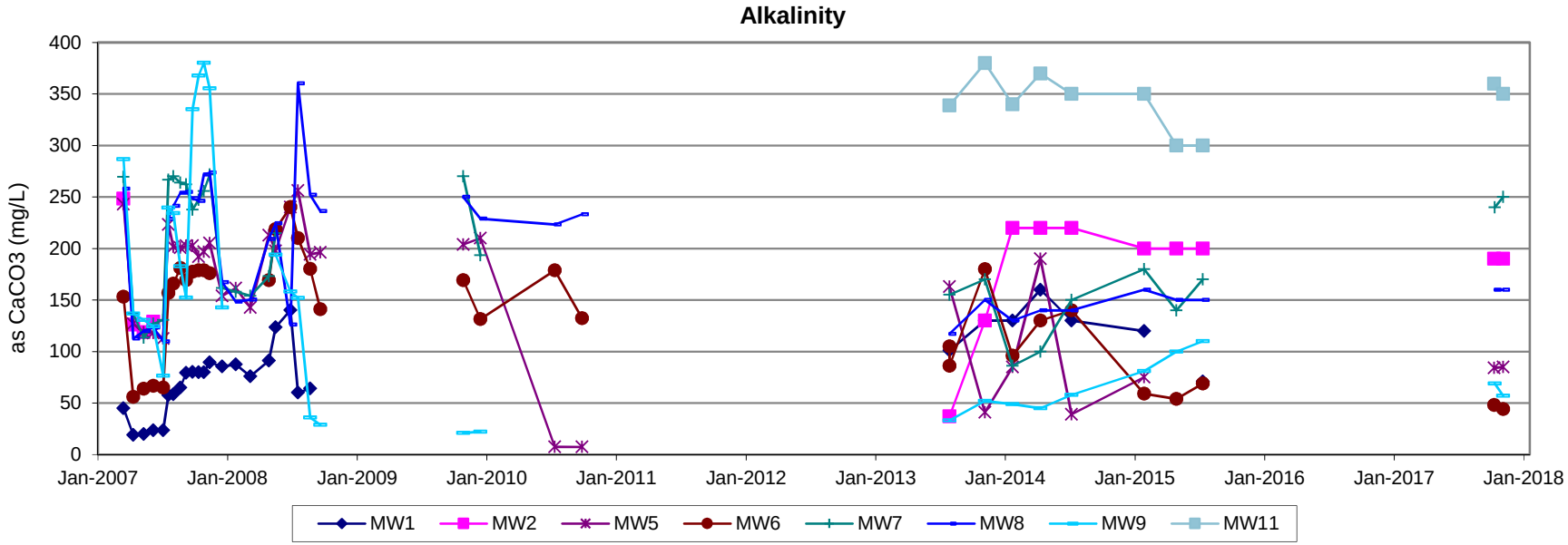


JACOBS

BASELINE GROUNDWATER QUALITY [SELENIUM SODIUM] FIGURE 15

J:\IE\Projects\04_Eastern\IA147700\02 - Documents\Groundwater Analysis\001c qb\[001c_Comprehensive Water Quality.xlsx]Na Se

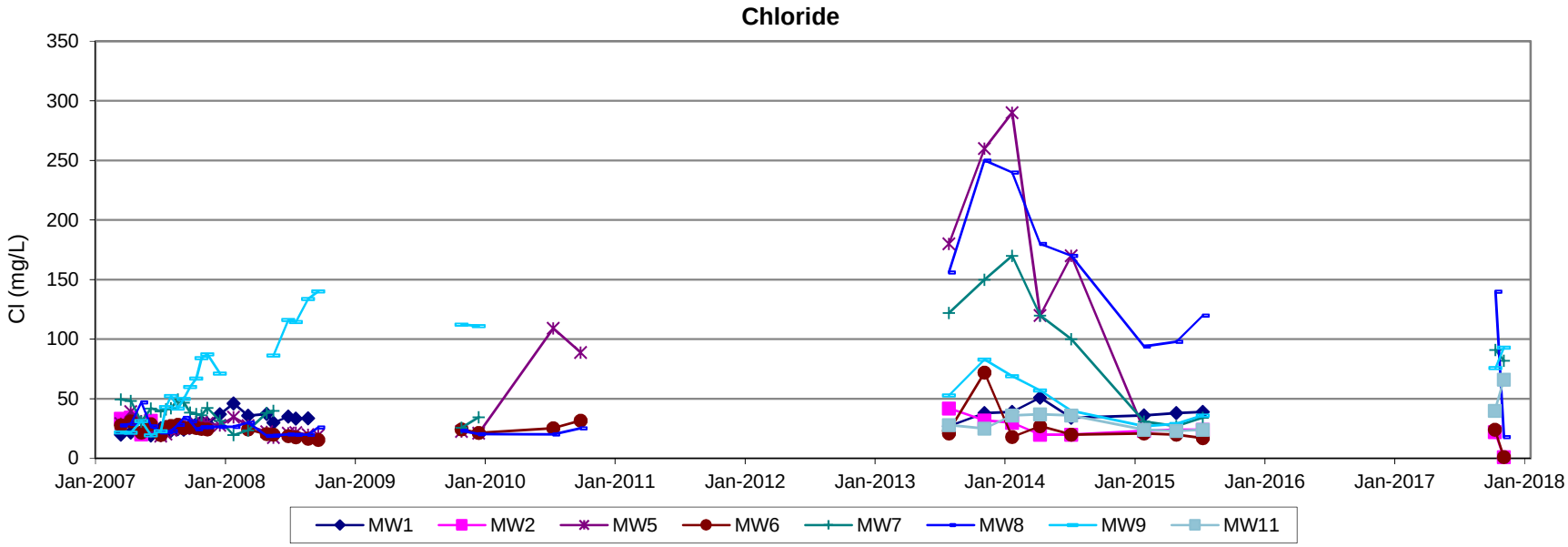


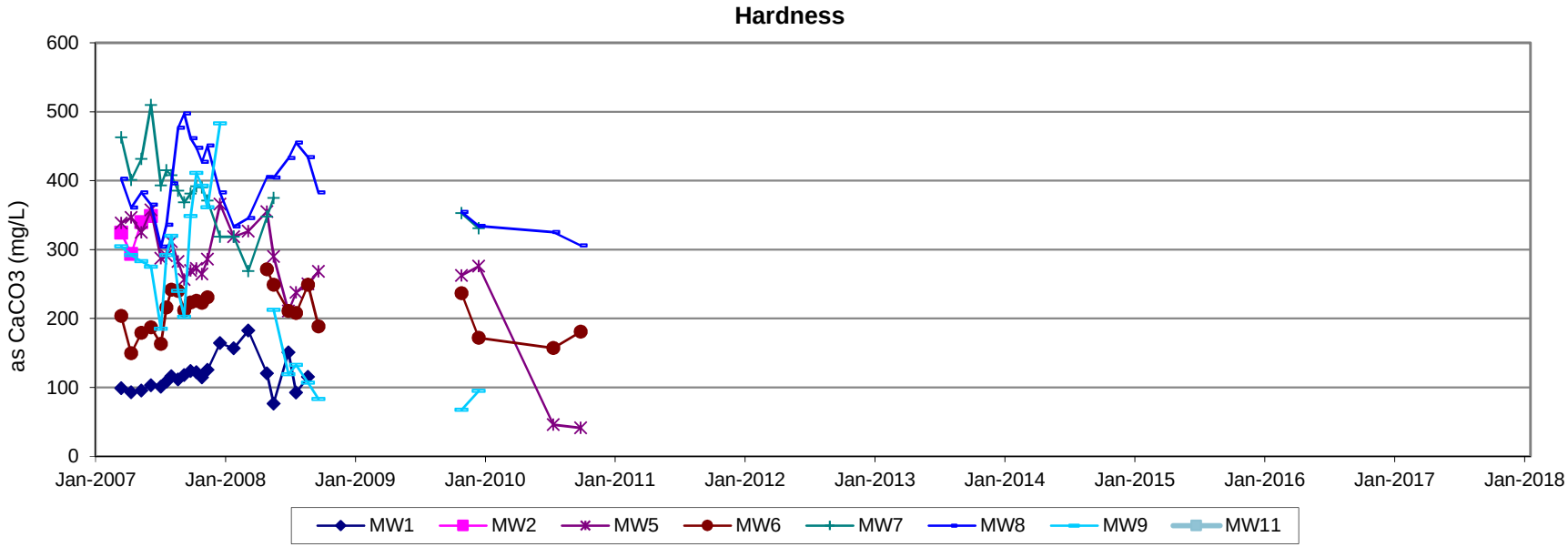


JACOBS

BASELINE GROUNDWATER QUALITY [ZINC ALKALINITY] FIGURE 16

J:\IE\Projects\04_Eastern\IA147700\02 - Documents\Groundwater Analysis\001c qb\[001c_Comprehensive Water Quality.xlsx]CaCO3 Zn


Chloride
Cl (mg/L)
350
300
250
200
150
100
50
0
Jan-2007
Jan-2008
Jan-2009
Jan-2010
Jan-2011
Jan-2012
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
MW1
MW2
MW5
MW6
MW7
MW8
MW9
MW11


Hardness
as CaCO3 (mg/L)
600
500
400
300
200
100
0
Jan-2007
Jan-2008
Jan-2009
Jan-2010
Jan-2011
Jan-2012
Jan-2013
Jan-2014
Jan-2015
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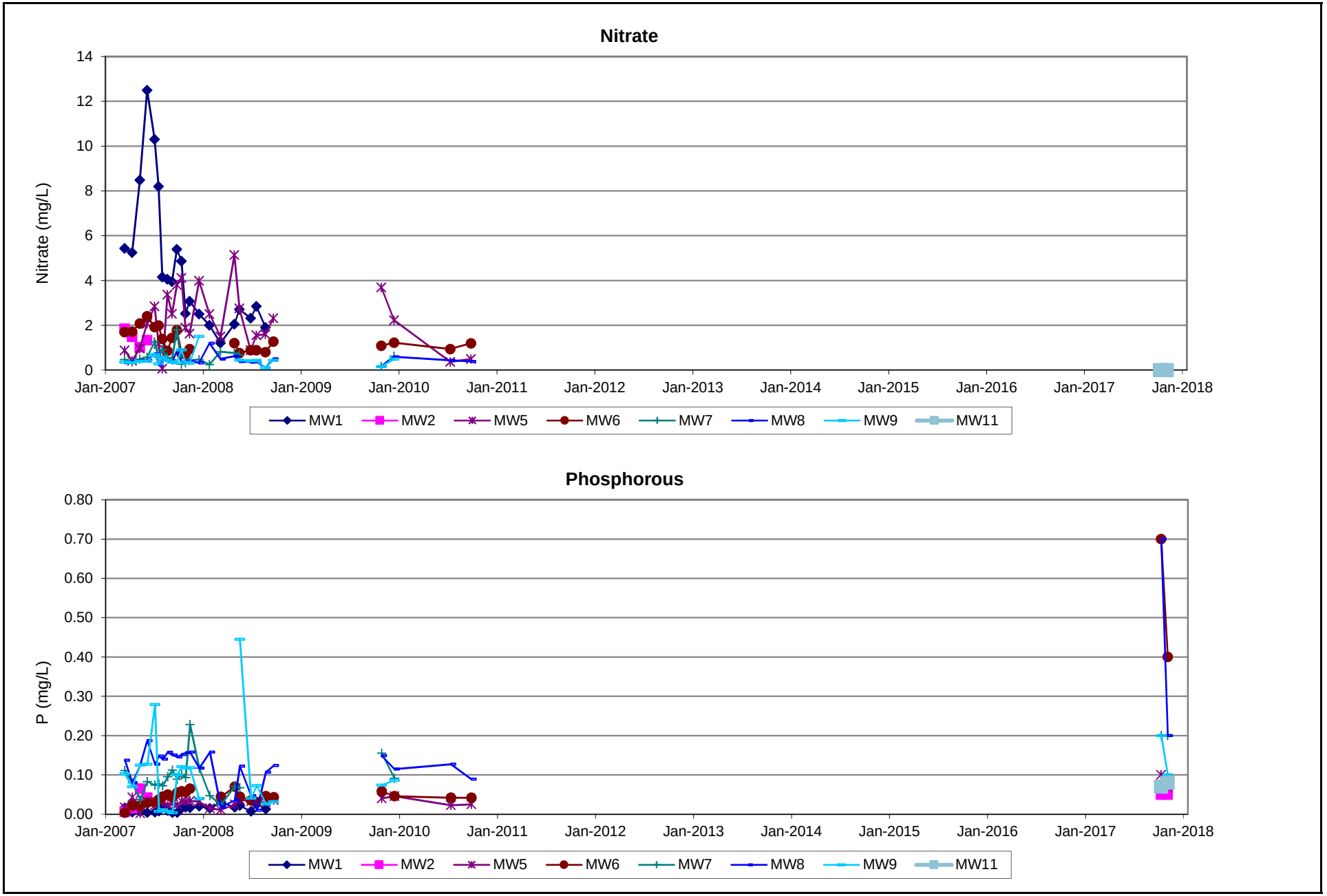
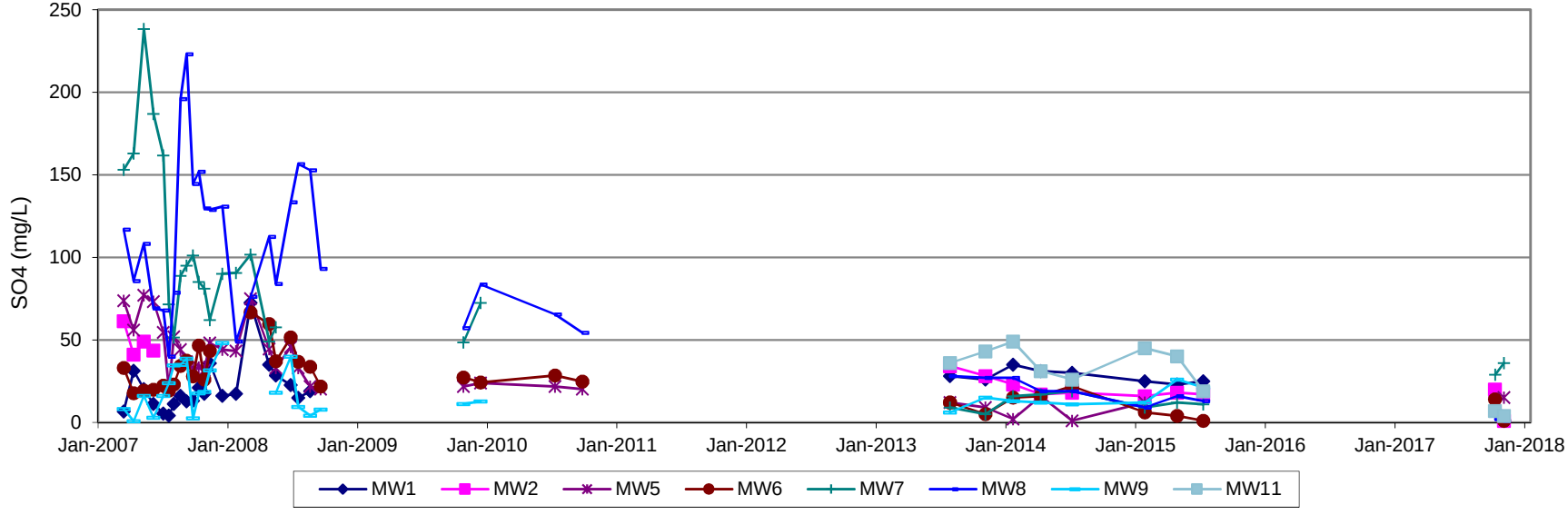
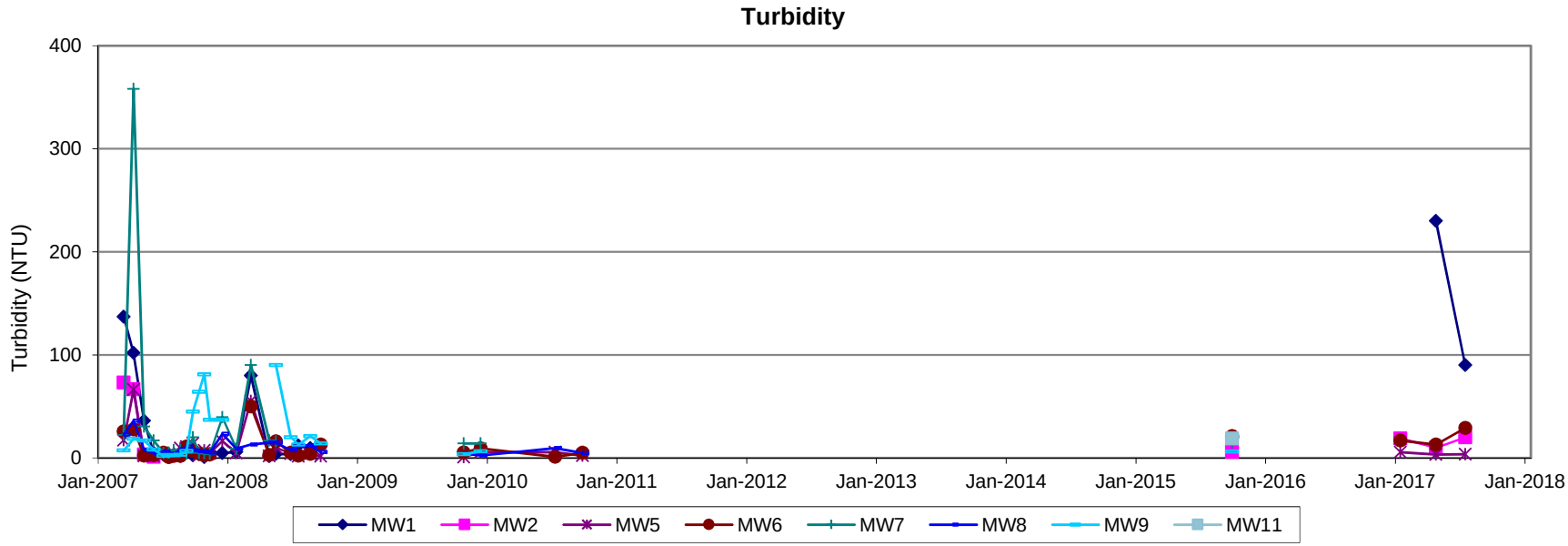
Jan-2018
MW1
MW2
MW5
MW6
MW7
MW8
MW9
MW11


Nitrate
Nitrate (mg/L)
14
12
10
8
6
4
2
0
Jan-2007
Jan-2008
Jan-2009
Jan-2010
Jan-2011
Jan-2012
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
MW1
MW2
MW5
MW6
MW7
MW8
MW9
MW11
Phosphorous
P (mg/L)
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Jan-2007
Jan-2008
Jan-2009
Jan-2010
Jan-2011
Jan-2012
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
MW1
MW2
MW5
MW6
MW7
MW8
MW9
MW11


Sulphate
SO4 (mg/L)
250
200
150
100
50
0
Jan-2007
Jan-2008
Jan-2009
Jan-2010
Jan-2011
Jan-2012
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
MW1
MW2
MW5
MW6
MW7
MW8
MW9
MW11


Turbidity
Turbidity (NTU)
400
300
200
100
0
Jan-2007
Jan-2008
Jan-2009
Jan-2010
Jan-2011
Jan-2012
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
MW1
MW2
MW5
MW6
MW7
MW8
MW9
MW11

Appendix A. DPI Water Review Comments

Department of Primary Industries
Water

Contact Ryan Shepherd
Phone (02) 4904 2650
Email ryan.shepherd@dpi.nsw.gov.au
Our ref OUT17/37203

Rod Johnson
Environmental Operations Manager
Boral
Greystanes House
Lot 107, Clunies Ross Street, Prospect NSW 2148, NSW

via email: Rod.Johnson@boral.com.au

Dear Mr Johnson,

Stockton Sand Quarry- Groundwater Monitoring and Modelling Plan Review

I am writing in reference to your correspondence sent to DPI Water on 27 June 2017, requesting a review of Boral's Stockton Sand Quarry Groundwater Monitoring and Modelling Plan (GMMP). DPI Water has reviewed the GMMP and provides the following comment and recommendations.

The GMMP is lacking in detail for a stand-alone independent document. DPI Water recommends the inclusion of the following.

- A table of the development consent condition which applies to this GMMP and the relevant section in the GMMP with the details outlined and discussed.
- Clearly identify all of the 12 listed monitoring bores on the location figure. It is noted that the current figure only shows 8 new monitoring bores. The older 'GW series' bores are not shown.
- A figure showing the location of the defunct historical monitoring bores.
- Groundwater level, height (m AHD) contour plans or flow nets drawn from the recorded groundwater levels over a series of months or quarters.
- Include cross sections (E-W and N-S) showing groundwater levels, monitoring bores relative position in the section line and levels of extraction.
- Include monitoring of the closest occurrence of both the inland GDE's and the seaward shallow deflation basin lakes GDE's in the water quality monitoring programme.
- Update the Trigger Action Response Plans (TARP) table with timeframes for the actions proposed.
- Note the applicable condition within Schedule 4, Condition 3 which applies to annual reporting. All the points within Condition 3 need to be outlined as required to be addressed with reference to the groundwater monitoring wells.

- Include a note pertaining to the required Independent Environmental Audit in accordance with Schedule 4 Condition 4 of DA 14-6-2005, as a component of reporting in the GMMP.

A DPI Water hydrogeologist can be made available should a meeting be required.

Please contact Ryan Shepherd, Water Regulation Officer (Newcastle) on (02) 4904 2650 or ryan.shepherd@dpi.nsw.gov.au if you have further enquiries regarding this matter.

Yours sincerely

Irene Zinger
Manager
Regulatory Operations - Metro
DPI Water

07 September 2017