Site Water Management Plan

Hanson
HEIDELBERGCEMENT Group
ABN: 90 009 679 734

Calga Sand Quarry

Site Water Management Plan

Compiled by:

R.W. CORKERY & CO. PTY. LIMITED

in conjunction with

Dundon Consulting Pty Ltd

September 2020

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LIST OF ACRONYMS

ANZECC	Australia and New Zealand Environment Conservation Council
CCC	Central Coast Council
DA	Development Application
DEC (EPA)	Department of Environment and Conservation (Environment Protection Authority)
DECC	Department of Environment and Climate Change
DIPNR	Department of Infrastructure, Planning and Natural Resources
DNR	Department of Natural Resources
DoH	Department of Housing
DPIE	Department of Planning, Industry and Environment
EIS	Environmental Impact Statement
EPL	Environment Protection Licence
ESCP	Erosion and Sediment Control Plan
GWMP	Groundwater Monitoring Program
NCEA	National Centre for Engineering in Agriculture
NRAR	Natural Resources Access Regulator
SWMP	Site Water Management Plan
WAL	Water Access Licence

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1. INTRODUCTION

This Site Water Management Plan (SWMP) for the Calga Sand Quarry ("the Quarry"), has been prepared in accordance with *Condition 3(11)* of Development Consent DA 94-4-2004 (DA 24-4-2004) and includes:

- the predicted site water balance (Section 4);
- an Erosion and Sediment Control Plan (Section 5);
- a Surface Water Monitoring Program (Section 6); and
- a Groundwater Monitoring Program (Section 7).

The SWMP has been prepared for Hanson Construction Materials Pty Ltd (Hanson) by R.W. Corkery & Co. Pty Limited in conjunction with Peter Dundon and Associates Pty Ltd. Information previously provided by GSS Environmental regarding surface water management that was included in an earlier version of the SWMP has been retained. The SWMP builds upon and refines the water management concepts presented in the 2004 Environmental Impact Statement (2004 EIS), an amended proposal to extend the quarry following initial reviews of the 2004 EIS by DIPNR (2005 Amendment Report), the ongoing reporting including annual Independent Groundwater Audits and additional documentation prepared for the previously proposed Southern Extension Project, that is no longer proceeding.

For management purposes, the water within the Quarry Site has been divided into three classes.

1. **"Clean" -** surface runoff from rehabilitated catchments and catchments undisturbed or relatively undisturbed by extraction or related activities.
2. **"Dirty" -** surface runoff from disturbed catchments such as the active extraction area, soil and subsoil stockpiles and rehabilitated areas (until stabilised), all of which could contain sediments.
3. **"Contaminated"** - surface runoff which could potentially contain hydrocarbons.

The following definitions are applicable to this document.

- "**Stage 3**" – The area approved for the extension of the quarry under DA 94-4-2004.
- "**Silt Cells**" – The large shallow settling basins that are designed to accumulate sediment/silt, and once dewatered, rehabilitated through the placement of overburden, soil and revegetation over the consolidated sediment.
- "**Water Management System**" – The series of structural controls (including the drains, pipelines, silt cells, storage dams) that are used to manage the "dirty" water and supply water for quarry activities (primarily the wash plant).

2. OBJECTIVES

The principal objectives of site water management are as follows.

i) To ensure sufficient quantities of water can be obtained through the capture of surface water and groundwater to meet the operational and dust suppression requirements of the quarry.

ii) To ensure the segregation of "dirty" water from "clean" water and maximise the retention time of "dirty" water.

iii) Water within storage dams is managed to achieve the following water quality objectives:

– pH 6.0 – 8.0;

– Electrical Conductivity < 350µs/cm;

– Total Grease < 5mg/L; and

– Suspended Solids < 50mg/L.

iv) To minimise the volume of water discharged from the Quarry Site but, should the discharge of water prove necessary, ensure sufficient settlement time is provided prior to discharge such that concentration of suspended sediment within the water meets the objectives identified above in EPL 11295).

v) To minimise erosion and sedimentation from all active and rehabilitated areas of the Quarry Site.

vi) To monitor the effectiveness of surface water controls and ensure all relevant surface and groundwater quality criteria are met.

vii) To monitor the impact of Quarry operations on groundwater level, quality and availability.

viii) To minimise any impacts on the availability of surface water or groundwater to surrounding residents and landholders.

ix) To establish a method of assessing the level of impact on groundwater supply attributable to the quarry.

3. APPROVALS

Hanson is required to operate the approved activities at the Calga Sand Quarry in accordance with the development consent and licences listed in **Table 1**.

It is noted that a variation to Environment Protection Licence (EPL) 11295, issued on 9 January 2018, approved a discharge point and management conditions for the discharge of water as overflow from the Quarry. The management of water discharge including water quality monitoring is discussed in Section 5.4.

A 10ML water licence allocation (WAL 17384) from the Mangrove Creek Water Source (Mangrove Plateau management zone) of the *Water Sharing Plan Central Coast Unregulated Water Sources 2009* accounts for clean water captured from runoff that enters the Quarry Site (discussed in Section 4.3.1) after the Maximum Harvestable Right Capacity of the land owned by Hanson is taken into consideration (estimated annual capture of an average of 19.2ML and Maximum Harvestable Right Capacity of 11.9ML). The records of calculation of the Maximum Harvestable Right Capacity of the land are presented in **Appendix 4**.

Table 1
Calga Sand Quarry – Consents and Licences

Consent/Licence	Category	Entitlement	Notes
Development Consent 94-4-2004	Development Consent	N/A	Commenced :28 October 2005 Expires: 1 July 2030
Environment Protection Licence No 11295	N/A	N/A	Version Dated: 8 January 2018
Water Access Licence 17384	Unregulated River	10 ML	**Water Source:** Mangrove Creek Water Source **Water Sharing Plan:** Central Coast Unregulated Water Sources **Management Zone:** Mangrove Plateau
Water Access Licence 27185	Aquifer	52 ML	**Water Source:** Kulnura Mangrove Mountain Groundwater Source **Water Sharing Plan**: North Coast Fractured and Porous Rock Groundwater Sources.
Water Access Licence 20019	Aquifer	46 ML	**Water Source:** Kulnura Mangrove Mountain Groundwater Source **Water Sharing Plan:** North Coast Fractured and Porous Rock Groundwater Sources.
Water Access Licence 2541	Aquifer	6 ML	**Water Source:** Kulnura Mangrove Mountain Groundwater Source **Water Sharing Plan:** North Coast Fractured and Porous Rock Groundwater Sources.

The water allocation from the Kulnura Mangrove Mountain Groundwater Source of the *Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016* (WAL 27185, WAL 20019 and WAL 2541) accounts for water use for:

- dust suppression;
- evaporation from water storage areas;
- water used in processing and retained in silt (90% of which is recycled); and
- the moisture content of products that leave the Quarry Site.

4. SITE WATER BALANCE

4.1 SUMMARY

The Calga Sand Quarry is situated within the Cabbage Tree Creek catchment, which is a third order stream under the Strahler System (Ref: Strahler, 1957)) that eventually discharges into Kellys Creek, part of the broader Hawkesbury River catchment. Stage 3 of the Quarry represents about 8% of the total catchment area of Cabbage Tree Creek of 385ha.

There are three main sources of water for the Quarry, namely:

- groundwater seepage into the active extraction cell;
- rainfall falling directly into the Quarry Site; and
- off-site runoff that enters the Quarry Site via three man-made drains that carry water from Peats Ridge Road and from a small contributing catchment to the northeast of Stage 3.

Water availability is described in greater detail in Section 4.3.

Water is required at the Quarry for use in the wash plant and for dust suppression. For Stage 1 and 2 operations, water for these activities was drawn from the various storage dams (Dams 1, 6, 7a, 7b, 7c, 10 and 12) within the Quarry. This practice will continue in Stage 3, however given the development of the Quarry, water is now sourced from Dam 7a and Dam 7b/c as well as silt cells. Water is also lost through evaporation from the storage dams and silt cells on site as well as through moisture contained within silts and the moisture in products. Water use is described in greater detail in Section 3.2.

The water use and water sources for the operation are presented in **Figure 1**.

4.2 WATER SOURCES

4.2.1 Maximum Harvestable Rights Capacity

The Maximum Harvestable Right Capacity of the land owned by Hanson is approximately 11.9ML (based on a total landholding of 125.7ha)[1].

4.2.2 Surface Water Rainfall and Offsite Runoff

The footprint of the existing Quarry and Stage 3, combined with a small contributing catchment of approximately 10ha to the northeast of Peats Ridge Road (see **Figure 2**), amounts to a catchment size of approximately 57ha. Given that this catchment consists primarily of a disturbed Quarry area with little vegetation and a sealed road (Peats Ridge Road), the annual runoff rate is estimated to be approximately 45% of rainfall. The annual average rainfall for the area is 854mm and therefore annual runoff collected on site is 219ML/year. This total is comprised of approximately 180.6ML captured within the Quarry directly (and therefore exempt from licence requirements). The remaining 38.4ML falls outside the site on Peats Ridge Road and is diverted around the Quarry. However, 50% of runoff from Peats Ridge Road and the contributing catchment to the northeast of the Quarry Site is diverted around Stage 3 and onto the adjoining land. Therefore approximately 19.2ML/year will be diverted. Thus, the annual runoff available for collection is approximately **199.8ML/year**.

[1] Source: Maximum Harvestable Rights Dam Capacity calculator accessed 27 July 2020.

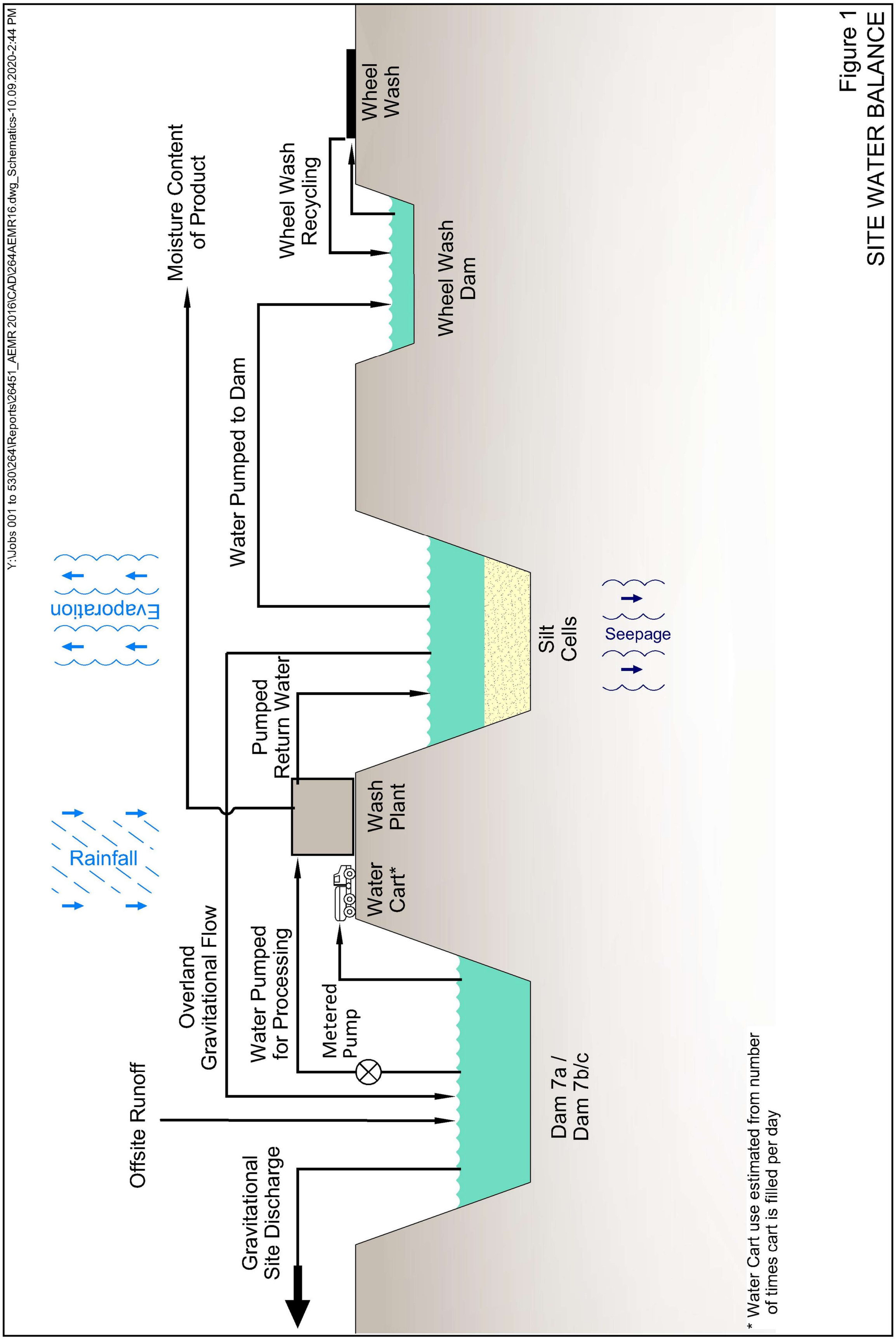

Figure 1
SITE WATER BALANCE

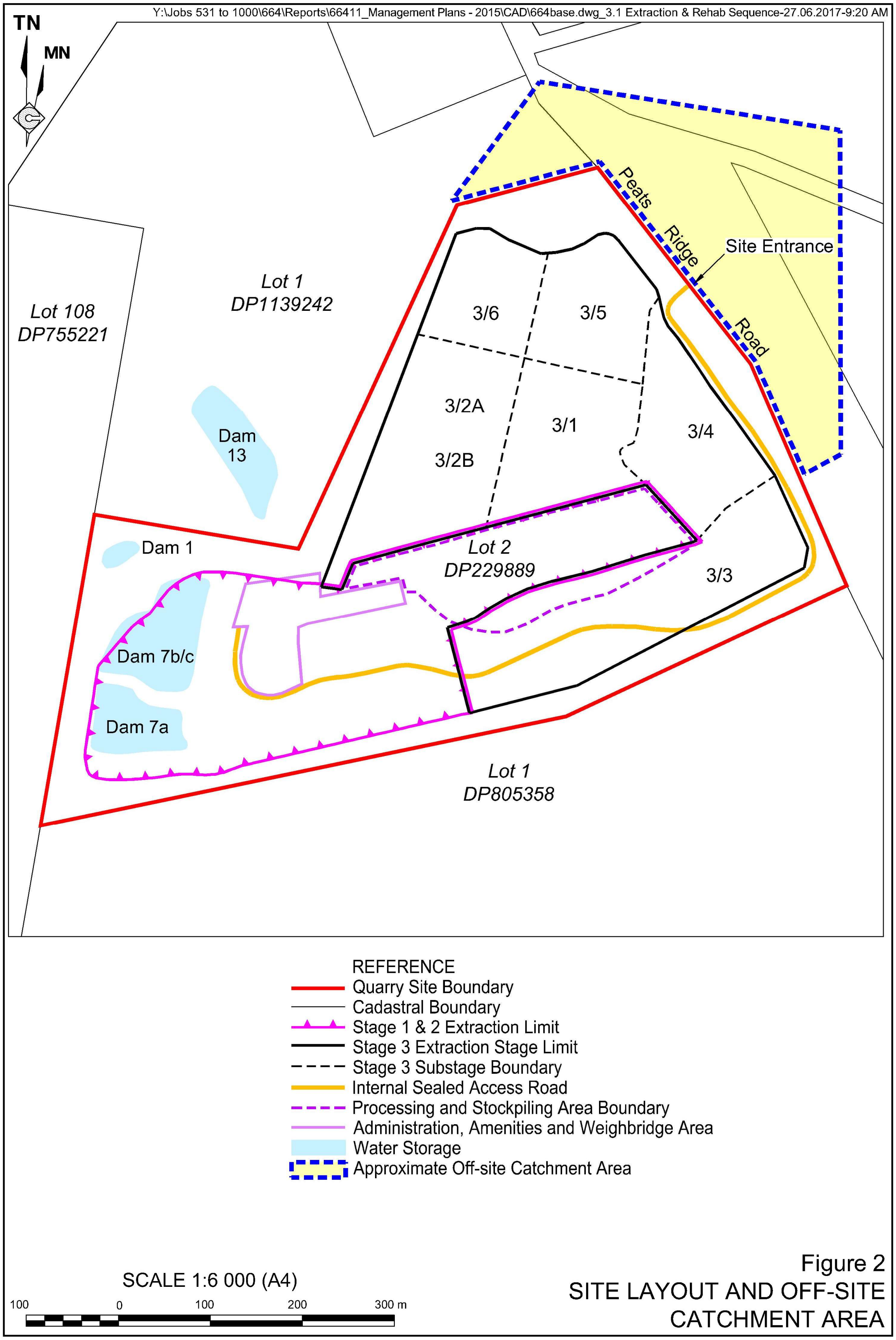

Figure 2
SITE LAYOUT AND OFF-SITE CATCHMENT AREA

4.2.3 Groundwater Seepage

A transient analysis of a three-dimensional groundwater model was carried out to predict the water make in Stage 3 (CM Jewell & Associates, 2004). This analysis suggests the maximum seepage from the Quarry walls and floor will be **49ML/year**. The predicted seepage depends on the timing of the Quarry excavation as well as the model's assessment period, due to the fact that the groundwater seepage rate will change over time. The transient analysis conducted assumes a worst-case scenario, whereby the excavation is considered to be instantaneous and seepage calculated two months after the instantaneous Quarry development, where seepage rates are likely to be at their highest. Therefore, whilst a maximum of 49ML/yr is predicted, the long term seepage rate is likely to be substantially lower than this value.

4.2.4 Total Water Availability

Based on the calculations above, the estimated maximum water availability for the Quarry Site is **248.8ML/year**, based on the following.

- An average of 180.6ML/year of water captured from rainfall and runoff that falls within the Quarry Site.
- An average of 19.2ML/year of water captured from offsite diversion of rainfall and runoff to Dam 7b/c.
- Up to 49ML/year of groundwater seepage. Although it is noted that water inflow in the Quarry walls will generally be less than predicted as explained in Section 4.2.2.

4.3 SITE WATER USE

4.3.1 Sand Washing and Retention of Water in Materials

Approximately 2 200L of water, the majority of which has been recycled from within the Quarry Site is required to produce one tonne of sand product. The Quarry produces predominantly washed sand and therefore, for the purposes of estimating water use, it has been conservatively assumed that 400 000t of washed sand is produced each year. This equates to a total of 1,166ML required to be within the water management system. With the exception of the following, this process water will be continuously recycled and available for reuse.

- The washed sand product will have a moisture content of 7%. As a consequence, up to **28ML/year** will exit the Quarry Site as water retained in the sand products.
- To produce 400 000t of washed sand, approximately 530 000t of raw feed will be washed which has an average silt content of 25%. Therefore, up to 130 000t of silt will be washed from the raw sand each year and deposited in the Quarry silt cells. The silt will bind approximately 1 000L of water per tonne and as a result up to **130ML/year** will be removed from the water cycle and retained in the silt each year.

4.3.2 Dust Suppression

Water is used for dust suppression on the roads, stockpiles and other exposed surfaces around the Quarry Site. Based on existing operational requirements, it is estimated that water used for dust suppression is approximately **5ML/year**.

4.3.3 Evaporation

Based on an evaporation rate of approximately 1 650mm/year calculated using the Monthly Evaporation Calculator developed by the National Centre for Engineering in Agriculture (NCEA)[2] and an average total water surface area of 40 000 m^2, the water loss through evaporation from storage dams and silt cells of the quarry will be up to **66ML/year**.

4.3.4 Total Water Use

Based on the calculations above, the estimated water use for the quarry is up to **229ML/year**, based on the following.

- A maximum of 158ML/year of water lost through the retention of water in silt and sand product.
- 5 ML/year of water used for dust suppression.
- 66ML/year lost as evaporation from storage dams and silt cells on site.

4.4 WATER BALANCE

Assuming, all water not lost through retention in sand and silt, evaporation or used in dust suppression is available for reuse, the total water use for the quarry is estimated to be a maximum of 229ML/year (Refer Section 4.3), and the total maximum water availability is estimated to be 249ML/year (Refer Section 4.2). Subsequently, the site is expected to have a **net water gain of 20ML/year**, based on an average yearly rainfall. It is acknowledged that there is a large variability in the numbers used to calculate this amount and the actual water loss/make is likely to vary significantly from year to year and be dependent on the local meteorological conditions, production rate, process efficiency, and the accuracy of the assumptions. For example, it is likely there will be operational losses of water through the sand washing process that will reduce the volume of water recycled/reused each year and, due to the worst-case scenario used to model the predicted water inflow, the groundwater seepage rate is likely to be much less than 49ML/year.

As a result, the predicted net water gain is likely to be less than 20ML each year. However, while it is likely that the net water gain will be less than 20ML/year, experience at the Quarry over the low rainfall years indicates the Quarry Site has not had a water shortage, i.e. the site has been able to maintain adequate water storages and supply sufficient water for the sand washing process despite drought conditions. The site has a significant water storage capacity, i.e. two dams with 100ML combined capacity, and it is anticipated this capacity would allow continued processing operations during extended periods of low rainfall.

In the event that the water captured in a wet year, or consecutive wet years, exceeds the storage capacity of the water storage dams, treated water will be discharged from the Quarry Site into the tributary of Cabbage Tree Creek, most likely during periods of high rainfall. This discharge

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[2] The Monthly Evaporation Calculator is available from the National Centre for Engineering in Agriculture (NCEA) website at http://kmsi.usq.edu.au/readyreckoner/readyreckoner.aspx

would occur from the outlet of water storage Dam 7b/c, which subsequently, flows to Dam 1, prior to discharge to tributary of Cabbage Tree Creek. Previous water quality monitoring results indicate that there is very little difference between the quality of water discharging from the Quarry Site and that existing in Cabbage Tree Creek. Subsequently, any increased flows leaving the Quarry Site are not expected to have a negative impact on the receiving waters. Any discharge water will be monitored, as described in **Section 6.3**.

4.5 WATER LICENSING

4.5.1 Licence Requirements

Based on the water sources described in Section 4.2, Hanson is required to hold the following water access licences to account for water sourced for operations.

- An average of 7.3ML/year of water captured from offsite diversion of rainfall and runoff to Dam 7b/c. This volume is the difference from estimated water diverted from offsite after the Maximum Harvestable Right Capacity of the land is accounted for (19.2ML minus 11.9ML)
- 49ML per year to account for groundwater seepage into the active extraction area. Although it is noted that water inflow in the Quarry walls will generally be less than predicted as explained in Section 4.2.2.

Rainfall that lands within the Quarry Site and is captured for use on-site is exempt from licence requirements.

4.5.2 Reporting Water Use

WAL 17384 has a 10ML water use allocation within the Mangrove Creek Water Source (Mangrove Plateau management zone) of the *Water Sharing Plan Central Coast Unregulated Water Sources 2009*. Hanson therefore holds a surplus of 2.7ML for the capture of surface water within the Quarry Site. Hanson will record annual rainfall at the Quarry and use this data to estimate the volume of water that enters the Quarry from the offsite and is subject to this licence. The annual records will be presented in the Annual Review and recorded in a logbook in accordance with the conditional requirements of WAL 17384.

Hanson's water access licences for the Kulnura Mangrove Mountain Groundwater Source of the *Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016* (WAL 27185, WAL 20019 and WAL 2541) provide for a 104ML allocation. Hanson therefore holds a surplus of 55ML for groundwater inflows to the Quarry Site. It is not possible to record annual inflows to active extraction areas as the groundwater inflows have historically evaporated before the water could pool in a sump. Assuming the estimates of seepage are conservative and would not be exceeded for the remaining operations, Hanson will retain the WALs against the assumed inflows. It is not possible for Hanson to maintain a logbook for water use against these access licences.

4.6 WATER BALANCE REVIEW

The following information will be used to estimate ongoing water use within the Quarry so that the water balance can be refined, if necessary.

- Rainfall within the quarry catchment will be recorded by the on-site weather station.
- Evaporation rates will also be estimated using available evaporation data.
- Material produced and despatched from the Quarry on an annual basis will be documented.

An estimate of annual water use will be included in the *Annual Review*. Based upon an analysis of this information, as well as production rates of sand and silt, Hanson will review and update the water balance appropriately.

The majority of water used at the Quarry is through the sand washing process. The water lost is bound to the silt and clay washed out of the raw sandstone as well as evaporation. Whilst the water balance suggests the Quarry has the potential to recover greater than 90% of the water used, any further gains in efficiency could reduce the water consumption at the Quarry. The sand washing process will be monitored over time, and any likely improvements to reduce the water consumption will be investigated and implemented where economically feasible and practical.

5. EROSION AND SEDIMENT CONTROL PLAN

5.1 INTRODUCTION

In accordance with *Condition 3(13)* of DA 24-4-2004, the Erosion and Sediment Control Plan (ESCP) has been prepared consistent with the requirements of the Department of Housing's *Managing Urban Stormwater: Soils and Construction Manual* (DoH, 2004). All erosion and sediment control structures will be constructed or erected in accordance with the recommendations identified in the relevant standard drawing and construction notes of DoH (2004).

The ESCP has been structured as follows.

Section 5.2 identifies activities for the construction and operational phases of the development that could cause soil erosion and generate sediment.

Section 5.3 describes the management principles to be implemented.

Section 5.4 describes the detail on the measures to be employed, including the location, function, and capacity of erosion and sediment control structures.

5.2 SOURCES OF SEDIMENT

5.2.1 Construction

The main potential sources of sediment during construction are:

- clearing and soil stripping activities undertaken to expose the friable sandstone in Stage 3; and
- construction of roads and other infrastructure such as any surface drains and the acoustic bund.

5.2.2 Operations

The main potential sources of sediment during operations are:

- run-off from active extraction areas;
- run-off from roads and drainage areas;
- uncontrolled discharge of sediment-laden water from the silt cells; and
- possible spillages and uncontrolled discharge of sediment-laden water used in, or silt produced by, the sand washing process.

5.3 EROSION AND SEDIMENT MANAGEMENT PRINCIPLES

The principal objective of surface water management for the quarry is to ensure discharge of water from the Quarry Site is minimised, and that the water quality leaving the Quarry Site meets the appropriate quality standards. This objective is intrinsic to erosion and sedimentation designs and controls for the quarry and will be achieved by implementing the following principles.

- Adopting appropriate land clearing procedures for all proposed disturbance areas.
- Separating *undisturbed, "clean water"* runoff from *disturbed, "dirty water"* runoff where possible to minimise and manage "dirty water" runoff.
- Directing sediment-laden runoff into designated sediment control basins.
- Diverting "clean water" runoff unaffected by the operations upstream into natural or constructed drainage features.
- Constructing the haul road and working quarry face with effective surface drainage that flows to sediment control retention ponds.
- Maintaining sediment control infrastructure in a manner that ensures design capacities are maintained for managing sediment-laden water.
- Implementing an effective revegetation and maintenance program for the site.

The principal design aspects of the quarry will be the diversion of "clean water", containment of dirty water and the treatment and recycling of "dirty water" to eliminate the need for any discharge.

5.4 EROSION AND SEDIMENT CONTROLS

5.4.1 Minimal Disturbance

Land disturbance will be minimised by clearing one extraction cell at a time ahead of extraction activities and leaving this disturbed for the shortest possible times. This will be achieved by:

- limiting the cleared width to that required to accommodate excavation within the active Stage 3 and other associated structures; and
- programming the works so that only the areas which are actively being excavated are cleared, therefore limiting the time the areas are exposed and limiting the potential for erosion and sedimentation.

General vegetation clearing and soil stripping will not be undertaken until earthwork operations are ready to commence. All proposed erosion and sediment control measures will be implemented in advance of, or in conjunction with, clearing and stripping operations, where practical. Prior to clearing commencing, the limits of clearing shall be marked and/or supervised by Quarry personnel. All operations will be planned to ensure that there is no damage to any trees outside the limits to be cleared.

5.4.2 Management of Soil Stockpiles

Topsoil stripping within the disturbed area will be undertaken as far as practicable, when the soil is in a slightly moist condition thus reducing damage to soil structure. Stripped soil will be placed directly onto the disturbed areas and spread immediately if excavation sequences, equipment scheduling and weather conditions permit.

If longer term stockpiling, i.e. greater than 6 months, is required, a maximum stockpile height of two (2) metres will be maintained to preserve biological viability and reduce soil deterioration. Soil stockpiles will be sown with the sterile cover crop (annual species).

Where the stockpile is not wholly contained within the quarrying area and associated "dirty" water management system, temporary sediment control measures such as sand bags and silt fences will be used to prevent sediment from leaving the area. Stockpiles will be placed in areas so as to avoid impediment of natural localised drainage lines and minimise the likelihood of water ponding against the stockpile.

Where practical, topsoil will be re-spread in the reverse sequence to its removal, so that the organic layer, containing any seed or vegetation, is placed on the surface. Topsoil will be spread to a minimum depth of 50mm on 3:1 or steeper slopes and to a minimum depth of 100mm on flatter slopes. Re-spreading on the contour will aid runoff control and increases moisture retention for subsequent plant growth.

Re-spread topsoil will be levelled to achieve an even surface, avoiding a compacted or an over-smooth finish.

5.4.3 Clean Water Diversion Works

During periods of heavy rainfall, clean runoff flows onto the Quarry Site via three man-made drains that carry runoff generated on Peats Ridge Road and from the small contributing catchment to the northeast of Stage 3 (approximately 10ha). This runoff will be diverted around Stage 3 to prevent the clean runoff entering the extraction area and compromising silt cell dewatering activities.

A clean water diversion, has been constructed at the base of the earth bund, i.e. the acoustic barriers, required to be constructed around the perimeter of Stage 3. The diversion channel is a permanent mitigation control on the site to minimise erosion and divert run-on water around the disturbed areas for the life of the Stage 3 quarry. The location of the diversion channel is shown on **Figure 3**.

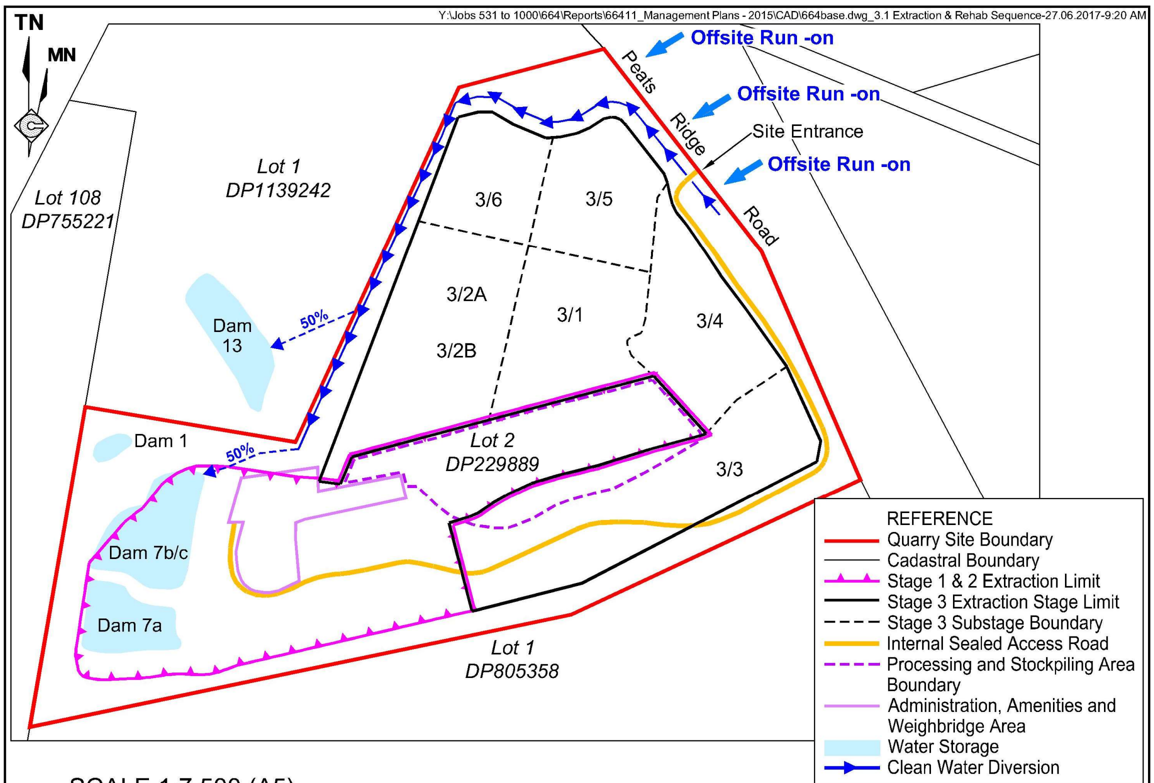

Figure 3
LOCATION OF CLEAN WATER DIVERSION

The channel is trapezoidal in shape with a 3m base width and 3:1 (H:V) batters. The channel has been designed to convey the 100 year ARI, time of concentration (19 min) event, which is a peak flow for the channel of approximately 1.1 m^3/s. All completed banks have been topsoiled and sown with sterile cover crops. **Appendix 1** contains the model input data and hydraulic results for the channel design. A piped culvert is used to convey the channel flows under the Internal Sealed Access Road.

The channel discharges to two locations, as agreed with the affected adjoining land holder. Fifty percent is discharged into a large agricultural dam (Dam 13) on the neighbouring property (see **Figure 3**). Dam 13 is located to the west of Stage 3. It also receives substantial groundwater inflow and is normally close to or at capacity. Overflows from Dam 13 enter a tributary of Cabbage Tree Creek. The remaining fifty percent of the diverted clean water is contained onsite, via a piped discharge from the diversion channel outlet to one of the water storage dams (i.e. 7a or 7b/c). This water is used by Hanson and contained within the quarry water management system. The outlet of the diversion channel has a 50/50 duel pipe culvert to split the flows into the two separate flow paths.

5.4.4 In-pit Water Management and Sediment Removal

The Quarry has been designed so that all “dirty water” is contained within the quarry extraction area and directed to the internal “dirty water” control system throughout all stages of active extraction. “Dirty water” is directed towards the dams of the southwestern section of the quarry (Dams 7a and 7b/c) to allow for the settlement of silt prior to this water being recycled through the wash plant, used for dust suppression purposes.

For Stage 3, the quarry floor will generally be graded so that it drains in a southerly direction towards the existing quarry and “dirty water” control system. However, the active quarry floor may also be locally graded to sump areas which will allow the controlled pumping of dirty water to specific silt cells, depending on the particular stage of quarrying and condition of silt cells. **Figure 3** shows the location of existing silt cells, with new silt cells to be created as quarrying progresses through Stage 3. The capacity of the silt cells will remain relatively constant as consolidated cells are rehabilitated, new cells are constructed following extraction within each of the Stage 3 sub-stages.

The series of silt cells allow for the settling and retention of sediment from the “dirty water” prior to storage in the water storage dams. This system has operated effectively with negligible suspended sediment occurring in the water storage dams. Notwithstanding this, in the event that suspended sediment is observed in the water storage, the use of other options, such as flocculation, will be investigated and implemented.

Dam 7a and Dam 7b/c naturally overflow to Dam 1. Once Dam 1 reaches capacity water overflows at the licenced discharge point to Cabbage Tree Creek. Should water quality in Dam 1 not be suitable for discharge (that is, water samples indicate it does not meet the criteria specified in EPL 11295 – see Section 6.2), water from Dam 7a and Dam 7b/c will be pumped to the active silt cells or to a sump in the extraction stage in order to stop discharge occurring until water quality is ensured. During extreme rainfall events this may not be physically possible. Water pumping from Dam 7a and Dam 7b/c will occur to reinstate a 1m freeboard within the dam to ensure that design capacity is maintained.

5.4.5 Quarry Haul Roads

The internal quarry haul roads within the Quarry Site will be constructed to ensure surface drainage is optimised and stabilised, thereby reducing roadside erosion and sedimentation. Cross-fall drainage structures and mitre drainage will be implemented for the entire length of each haul road. Crowning will generally be implemented on any steeper sections of the haul road. Outfall drainage will be constructed where the road traverses small fill batter areas and in-fall drainage will occur where the road traverses larger fill batter areas.

Mitre drains will be constructed to take water from the shoulders or table drains of the internal haul roads to the internal “dirty water” control system. Road runoff will be intercepted at regular intervals to reduce runoff velocity in each mitre drain. Drain spacing will not exceed 50m.

5.4.6 Additional Erosion and Sediment Controls

Additional control works including, but not limited to, sediment fencing, sand bag sediment filters and revegetation will be employed where suitable. As an example, these controls will be implemented down slope of clearing and soil stripping activities to be undertaken in advance of Stage 3/5.

Sand bag sediment filters will be used "as required" during the construction of drainage and road works, however, the use of sand bags will be limited to situations only where erosion and sediment control is required for a short period (i.e. maximum of three (3) months).

Any batters will be constructed to minimise exposed areas, i.e. minimise the potential surface for erosion. Batters that may require treatment include those on access roads and other construction areas, as these areas may be steep and erodible. Stabilisation, revegetation and rehabilitation works will be undertaken quickly to minimise erosion. These works principally involve hand sowing / planting of indigenous grasses and tubestock.

5.4.7 Maintenance of Erosion Control Structures

The Quarry Manager will undertake regular general environmental inspections and following substantial rainfall events (>20mm in 24 hour period) to ensure that all the water management controls outlined in Sections 5.4.1 to 5.4.6 are functioning as designed and required. The Quarry Manager will also ensure that any contractors on site are operating within the environmental controls as required for their activities. Site drainage and sediment control structures will be inspected regularly after runoff events (>20mm of rain) to check for scouring of diversion drains and accumulation of materials in sediment traps (e.g. sediment fences and sand bags) and storage dams. Inspection will include the following.

i) Haul Roads

The haul roads will be visually inspected to ensure that the appropriate mitigation measures are functioning to convey the surface flows from the road surface and work areas without causing excessive erosion to the road or work areas or the adjacent land. The pipe culverts will also be inspected for any signs of erosion around the culvert or in the drainage line immediately downstream of the culvert. Where controls are observed to be not functioning correctly, the surface will be restored to meet the required standard. Where significant erosion is observed to be occurring on a regular basis, additional controls will be constructed, such as additional mitre drains, scour protection of road drainage, and the re-grading of surface.

ii) Water Diversion Channel

The water diversion channel will be inspected to ensure that it is functioning to divert the surface run-on in accordance with its design. Any signs of erosion along the length of the banks and at the points of discharge will be noted and remedial works undertaken as required. Where significant erosion is observed additional erosion controls will be constructed. Such as establishment of further vegetation cover, armouring of the channel surface and construction of rock scour protection at the entry and discharge locations.

iii) Sediment Controls

Regular visual checks will be made of the silt cells to ensure that there is no noticeable increased discoloration of the water decanted to the "clean water" storages.

iv) Water Storage Dams

Visual checks will be regularly made of all the clean water dams on site to ensure that there is no noticeable increased discoloration in the dams.

v) Additional Sediment Controls

All sediment fencing and sand bag sediment filters will be inspected to ensure that they are functioning adequately.

Where controls are observed not to be functioning correctly, the eroded area will be restored to meet the required standard. Where significant erosion is observed to be occurring on a regular basis, additional controls will be constructed generally in accordance with the guidance contained in *Managing Urban Stormwater: Soils and Construction Manual* (Landcom, 2004) or *Managing Urban Stormwater - Volume 2E Mines and Quarries* (DECC, 2008).

6. SURFACE WATER MONITORING PROGRAM

6.1 INTRODUCTION

This Surface Water Monitoring Program has been prepared in compliance with *Condition 3(14)* of DA 94-4-2004 and includes the following.

a) A detailed baseline data on surface water flows and quality in waterbodies that could potentially be impacted by the Quarry (see Section 6.2).

b) Surface water quality assessment criteria (see Section 6.2).

c) A program to monitor surface water flows and quality (see Section 6.3).

d) A protocol for the investigation, notification and mitigation of identified exceedances of the surface water impact assessment criteria (see Section 6.4).

e) a program to monitor the effectiveness of the Erosion and Sediment Control Plan (see Section 6.5).

A regular program of surface water quality monitoring has historically been conducted for the Calga Quarry, with results compiled and reported in the *Annual Review*. The locations of the monitoring sites for the ongoing monitoring program are displayed in **Figure 4**.

6.2 BASELINE WATER QUALITY DATA FOR RECEIVING WATERS AND ASSESSMENT CRITERIA

The receiving waters that may be potentially affected by quarrying activities include Cabbage Tree Creek and the tributary that directly receives flows from Dam 1. Average monthly surface water monitoring results for the period from 2014 to 2017 are presented in **Table 2**.

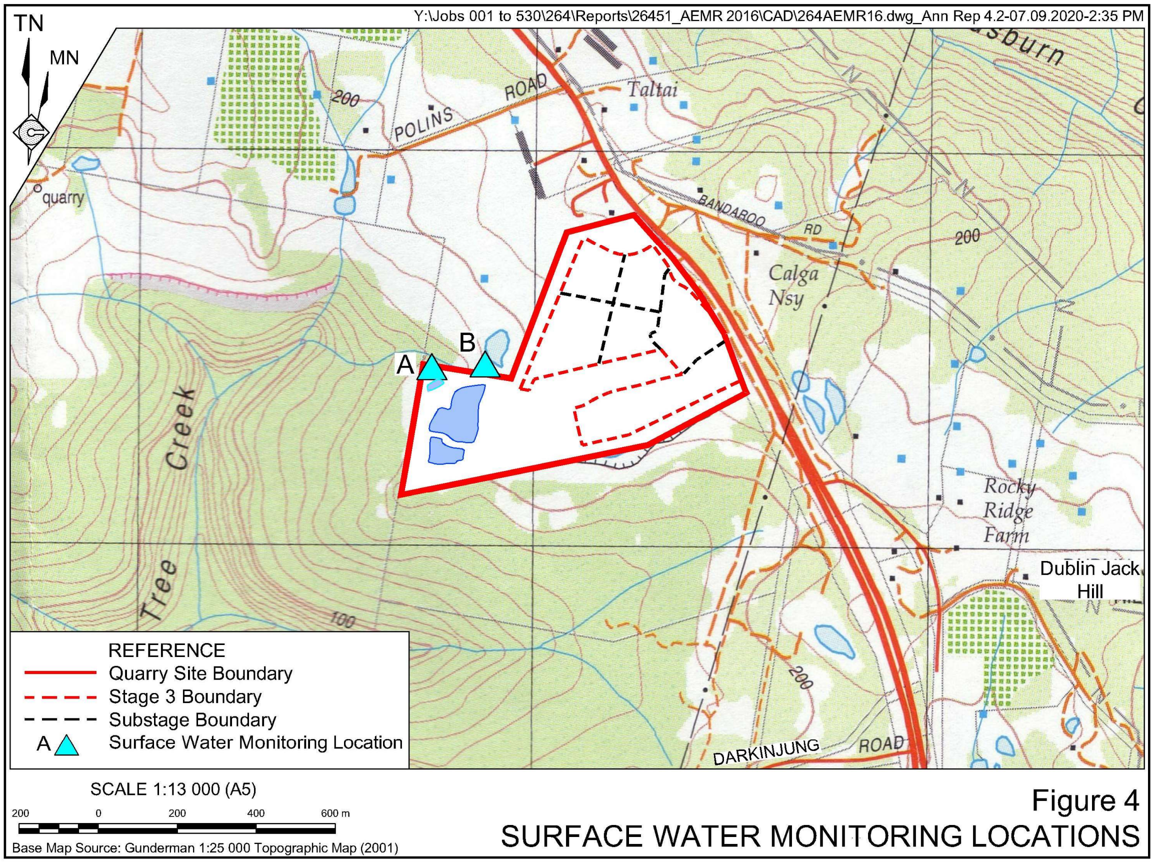

Figure 4
SURFACE WATER MONITORING LOCATIONS

Table 2
Median Monthly Surface Water Monitoring Results 2012 - 2017

Sampling Date #	pH	Electrical Conductivity	Total Grease	Suspended Solids
Units		**µs/cm**	**mg/L**	**mg/L**
Criteria	6.0 – 8.0	350	5	50
Location A@				
2012	5.90	59	<5	8
2013	6.10	64	<5	8
2014	5.97	78	<5	7
2015	5.59	70	<5	9
2016	5.69	68	<5	8
2017	6.44	84	<5	18
Location B@				
2012	6.63	70	<5	10
2013	5.62	81	<5	14
2014	6.72	70	<5	<5
2015	6.69	85	<5	39
2016	6.56	88	<5	17
2017	6.59	109	<5	14
@ For location see **Figure 3**				
Source: Hanson				

The following criteria apply to the Quarry Site in accordance with Condition L2.4 of EPL11295.

- pH – range of 6.0 to 8.0;
- Oil and Grease – < 5mg/L; and
- Suspended Solids, < 50mg/L.

A criteria of 350µs/cm has been adopted for review of electrical conductivity based on the default trigger values for upland streams of southeastern Australian (ANZECC. 2000) guidelines and default trigger values for coastal rivers of NSW.

6.3 WATER QUALITY MONITORING SCHEDULE

In accordance with Condition M2.2 of EPL 11295, Hanson will monitor surface water quality during any discharge event and continue monitoring during discharge. Surface water samples will be taken at monitoring site A and site B to test water quality within the Quarry and at the point of discharge.

Water samples will continue to be taken at locations A and B displayed in **Figure 4** on a monthly basis. Water samples will be analysed for the following key parameters.

- pH
- Electrical Conductivity
- Total Grease
- Suspended Solids

Opportunistic grab samples may also be taken periodically from the other dams or the tributary of Cabbage Tree Creek system during significant rainfall events. These samples will be analysed for the same parameters as above.

6.4 EROSION AND SEDIMENT CONTROL MONITORING

The measurement of concentrations of suspended solids over time will establish the effectiveness of the various erosion and sediment controls. The water quality monitoring results will be reviewed in conjunction with the visual observations undertaken as part of the routine maintenance (refer Section 5.4.7).

6.5 INVESTIGATION AND REPORTING OF EXCEEDANCES

For each sampling event, water quality results will be compared against the assessment criteria in the plan (refer Section 6.2). Any exceedance of criteria will trigger an immediate investigation to determine the cause of the exceedance and preparation of a corrective action plan to re-establish or introduce additional appropriate controls as necessary. Initially, however, whenever possible, the water would be re-sampled to verify the result recording an exceedance. Mitigation measures to be implemented in response to an incident are presented in the trigger action response plan (Section 6.6).

The reporting of all monitoring and measurement data will be undertaken in accordance with the requirements of the development consent, including notification of monitoring/investigation results to external organisations if required. All results will be reported in the *Annual Review.*

Hanson will also notify DPIE, NRAR and EPA, as soon as practically possible after any incident, where an incident is a set of circumstances that:

- causes or threatens to cause material harm to the environment; and/or
- breaches or exceeds the nominated assessment criteria.

A report would be submitted to DPIE regarding the incident within 7 days of the incident occurring.

6.6 TRIGGER ACTION RESPONSE PLAN

The triggers and actions / responses to be implemented in response to these triggers are presented in **Table 3**.

Table 3
Trigger Action Response Plan

Page 1 of 2

Trigger	Action / Response
Erosion or sediment control structure identified during routine inspection to be not performing as designed. For example: • Drainage line failure or scouring. • Dam overflow or dam wall failure. • Excessive sediment visible in Dam 7a or 7b/c. • Failure of vegetative cover on terminal areas or other areas revegetated for temporary stabilisation.	Quarry Manager advised of issue. Remedial maintenance works scheduled as soon as practically possible. If issues identified again, a certified (or appropriately qualified) practitioner or erosion and sediment control to be commissioned to provide recommendations for further improvements.
Erosion and sedimentation identified beyond Quarry Site boundary.	Quarry Manager to be advised of the issue. Where material harm to the environment is considered to have occurred (e.g. through sedimentation of the surrounding environment) NRAR, EPA and DPIE are to be notified as soon as practicable. Identify flow paths within the relevant catchment and install upslope diversions where possible. Complete remedial earthworks, e.g. cross-ripping, scarification, over eroding surface. Install additional downslope (secondary) sedimentation controls, e.g. sediment fencing.

Table 3 (Cont'd)
Trigger Action Response Plan

Page 2 of 2

Trigger	Action / Response
Overflow or breach of storage dams or silt cells	Quarry Manager to be advised of the issue. Where material harm to the environment is considered to have occurred (e.g. through sedimentation of the surrounding environment) the NRAR, EPA and DPIE are to be notified as soon as practicable. Further flow of water to or through these structures redirected, where practical. Remedial works completed to repair the breach. Should the capacity of structure be the cause of the incident, review meteorological conditions and capacity requirements and commission a specialist consultant as required.
Hydrocarbon or chemical reagent spill to sediment dam.	Refer to procedures provide in the Pollution Incident Response Management Plan (PIRMP).
Water quality exceeds the assessment criteria.	Arrange for further sampling to be undertaken to confirm the initial monitoring result. Notify NRAR, EPA and DRE of the exceedance. Investigate method for correcting non-compliant result, e.g. flocculent for TSS, neutralising agent for pH. Commission specialist consultant as required. Prepare a corrective action plan to re-establish or introduce additional appropriate controls as necessary. Contact the EPA and others, as required, in accordance with the PIRMP and Section 6.5.

7. GROUNDWATER MONITORING PROGRAM

7.1 BACKGROUND

The Groundwater Monitoring Program (GWMP) has been prepared to meet part of the requirements of *Condition 3(11)* of DA 24-4-2004, which requires Hanson "*… prior to carrying out any development, … to prepare and subsequently implement a Water Management Plan for the development, in consultation with the DPI Water, and to the satisfaction of the Secretary. This plan … shall include …a Groundwater Monitoring Program."*

The requirements of the GWMP are detailed in *Condition 3(15)* of DA 24-4-2004, viz:

"a) a program to collect detailed baseline data, based on sound statistical analysis, to benchmark the pre-quarrying natural variation in groundwater levels, yield and quality in groundwater bores within the predicted drawdown impact zone identified in the Amendment Report;

b) groundwater impact assessment criteria for monitoring bores and privately-owned bores;

c) a program to monitor impacts on the groundwater supply of potentially affected landowners, groundwater dependent ecosystems, and on vegetation; and

d) a protocol for the investigation, notification and mitigation of exceedances of the groundwater impact assessment criteria."

Condition 3(11) of DA 24-4-2004 notes that the *"... Groundwater Monitoring Program must be prepared in accordance with the recommendations of the independent groundwater assessment reports ... prepared by Mackie Environmental Research[3] ... unless otherwise authorised by the Secretary."*

Condition 3(17) of DA 24-4-2004requires that Hanson must undertake an independent audit of groundwater impacts of the development to determine compliance with the groundwater impact assessment criteria. The independent groundwater audit has been undertaken each year with data from the previous five years used for consideration of groundwater quality, while hydrographs of groundwater levels in each bore in the monitoring network are provided as **Appendix 2**.

7.2 SCOPE OF GROUNDWATER MONITORING PROGRAM

7.2.1 Yield Characteristics of Existing Bores/Wells on Neighbouring Properties

Hydraulic testing of privately owned stock and domestic and industrial production bores/wells located on neighbouring properties within a distance of 500m from the approved limit of extraction was completed in 2008 for all bores to which access was granted. Further testing of bore CP13 was undertaken in February 2014 and testing in bore CP15 was undertaken in December 2019. Access to the remaining bore (CP14) has not been possible and it is understood the bore is now sealed. Where land owner approval was received, bores were subjected to hydraulic testing, comprising a pumping test of at least 6 hours duration.

Additional hydraulic testing of stock and domestic and industrial production bores/wells located on neighbouring properties within a distance of 500m from the approved limit of extraction would occur following a substantiated complaint of reduced water availability at any of these bores and subject to approval from the land owner.

7.2.2 The Groundwater Monitoring Network

The groundwater monitoring network comprises all stock and domestic or industrial production bores/wells located on neighbouring properties within a distance of 500m from the approved limit of extraction for which access approval has been granted, as well as monitoring bores constructed within the Quarry Site and on adjoining properties. The location of bores within the monitoring network is displayed in **Figure 5.**

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[3] Mackie Environmental Research Pty Ltd, 2004. *Review of Additional Groundwater Modelling of Calga Sand Quarry*, dated December 2004.
Mackie Environmental Research Pty Ltd, 2005. Letter report entitled *Calga Sand Quarry, Amendment to DA 94-4-2004*, dated 21 July 2005.

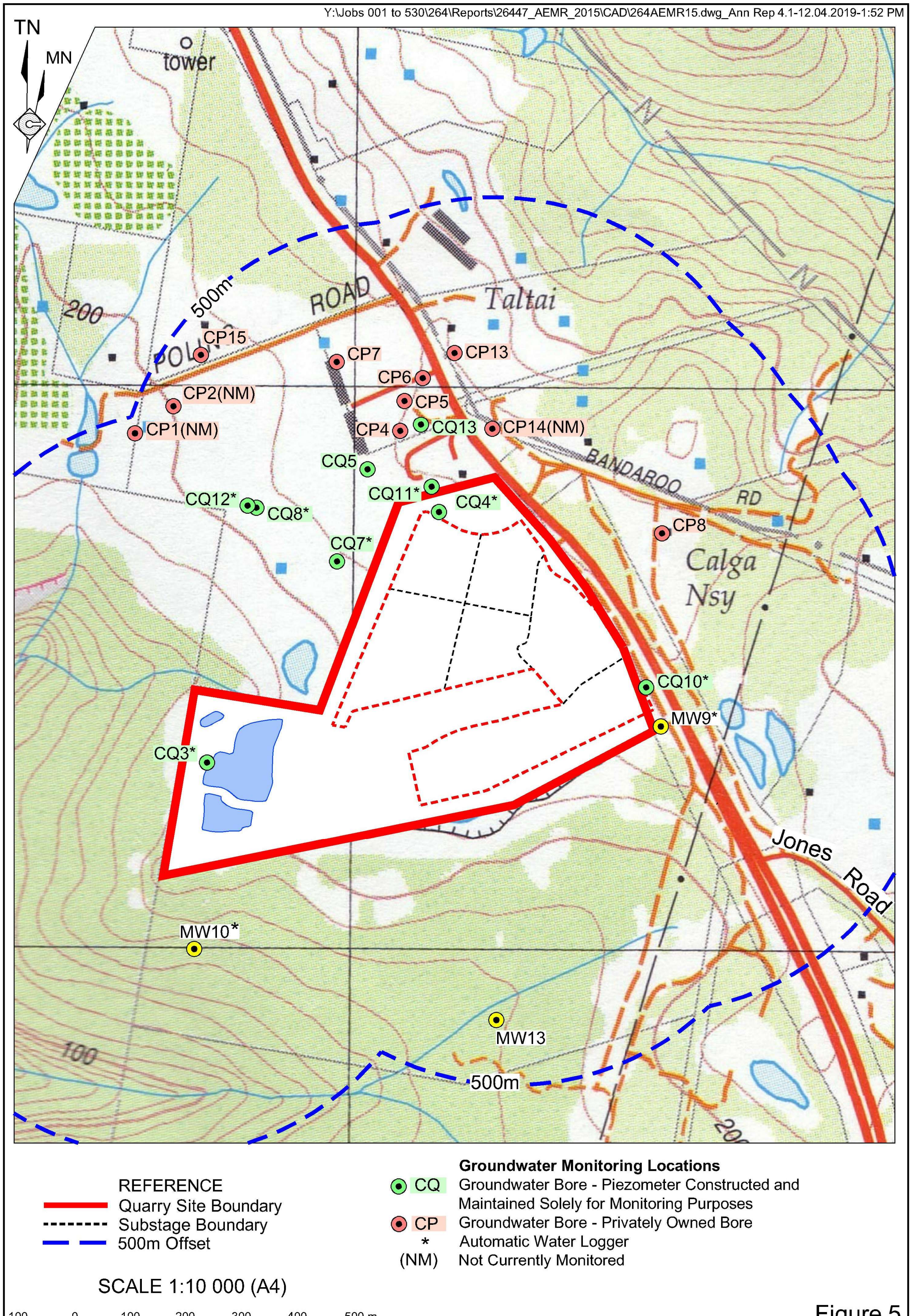

Figure 5
GROUNDWATER MONITORING BORES

Figure 5 includes the locations of bores that are to form part of the ongoing monitoring network. It is noted that bores that are no longer accessible due to the progression of extraction activities, that have been removed by the landowner or that are no longer necessary have been removed. **Table 4** presents available data for each bore within the groundwater monitoring network. On that basis, the following bores that were previously included in the monitoring network are no longer part of the network.

- CQ1 and CQ2– removed through extraction.
- CQ9 – damaged by the landowner.
- CQ6 and CP3 – removed by the landowner.
- MW7, MW8, MW16 and MW17 – these bores no longer provide useful information as they were previously installed for groundwater investigations concerning the proposed Southern Extension that is not proceeding at this time.

The objective of the monitoring program is to monitor for changes in groundwater levels and/or quality over time, so that potential impacts from the sand extraction operations can be detected and can be distinguished from climatic effects or other effects not related to sand extraction.

7.2.3 Groundwater Levels

The monitoring of groundwater levels will be undertaken in all monitoring bores located within the Quarry Site and on adjoining properties, and (subject to landholder approval) in all privately-owned bores on neighbouring properties within a distance of 500m from the approved limit of extraction. Monitoring of Hanson's monitoring bores CQ3, CQ4, CQ7, CQ8, CQ10, CQ11S, CQ11D CQ12,CQ13, MW9 and MW10 will be undertaken using automatic recorders, with a nominal 6-hourly recording frequency. Monitoring of water levels in the remaining Hanson monitoring bores and privately-owned bores will be undertaken manually using a water level device on a quarterly basis. The location of monitoring bores within the monitoring network including the monitoring bores added since receipt of development consent is displayed in **Figure 5**.

7.2.4 Groundwater Quality

Water samples will be collected quarterly from all monitoring bores and existing production bores displayed in **Figure 5**, for on-site determination of pH and EC.

Laboratory analysis of groundwater samples from all monitoring bores and existing production bores displayed in **Figure 5** will be undertaken on an annual basis and will include:

- major cations (Ca, Mg, Na, K) and anions (CO_3, HCO_3, SO_4, Cl, F and NO_3); and
- dissolved metals (Al, Cd, Cr, Cu, Fe, Mn, Ni, Pb, Zn).

Monitoring results are reported in the annual independent groundwater audit and the Annual Review. Previous records have failed to detect arsenic, boron, selenium and mercury in the groundwater quality analysis and it is considered unnecessary to continue monitoring these parameters. These parameters have therefore been removed from the analysis list. The list of analytes and frequency of testing will be reviewed periodically throughout the life of the quarry.

Table 4
Groundwater Monitoring Network

Page 1 of 2

Bore	Old Name	Registered Bore No	Licence Number	Location (MGA)		Ground Level	Stick-up	Bore Depth	Groundwater Production Interval		Screen Interval	
				Easting	Northing	(mAHD)	(m)		(mBGL)	(mAHD)	(mBGL)	(mAHD)
CP1	PB1	GW101409	20WA100239	333592.3	6301899.8	193.51	0.02	60.9	NR			
CP2	PB2	GW104887	20WA204164	333662.0	6301950.9	190.75	0.12	40.0	11–13	178–180		
CP4		GW066908	20WA100239	334118.0	6301917.3	218.00	0.27	44.0	13.9–14.1 27.3–27.7	204 191	Open hole	
CP5	Kashouli	GW067408	20WA100223	334083.3	6301972.1	215.92	0.40	76.0	10.1–10.2 20.4–20.5 38.3–38.6 61.2–61.3	206 195 177 155	Open hole	
CP6		GW101316		334120.7	6302011.4	217.27	0.75	92.0	16.5–16.8 62.7–63.0 76.2–76.5	201 154 141	Open hole	
CP7		GW037925		333964.3	6302049.2	210.54	0.36	76.2	4.8–39.5	171-206	Open hole	
CP8	Rozmanec	GW066907	10BL143533	334549.9	6301715.0	223.33	0.25	42.7	20.6–20.7 44.3–44.6	203 179	Open hole	
CP13	White	NK	NK	334183.9	6302039.1	218.38	0.38	>50	NK	NK	NK	
CP14	King	NK	NK	334244.9	6301922.7	~220	NK	NK	NK			
CP15	Glenworth Valley	GW104887	20WA100659	333723.9	6302052.2	~203	NK	40	3.1	NK	NK	
CQ3		GW104245		333718.4	6301299.8	180.437	0.57	21.8			18.3–21.3	159.2–162.2
CQ5	G31	NK	NK	334003.3	6301838.4	212.697	0.83	23.7	-	-	20.7-23.7	189.0-192.0
CQ4		GW104246		334147.85	6301797.3	214.821	0.68	20.0			18.3-21.3	159.2-162.2

Table 4
Groundwater Monitoring Network

Page 2 of 2

Bore	Old Name	Registered Bore No	Licence Number	Location (MGA) Easting	Location (MGA) Northing	Ground Level (mAHD)	Stick-up (m)	Bore Depth	Groundwater Production Interval (mBGL)	Groundwater Production Interval (mAHD)	Screen Interval (mBGL)	Screen Interval (mAHD)
CQ7	G33	*NK*	*NK*	333949.5	6301683.3	204.303	0.85	29.7	17.4 18.9 20.1	186.9 185.4 184.2	20.7–26.7	177.6–183.6
CQ8	G34	*NK*	*NK*	333786.4	6301778.8	200.904	0.86	26.6	19.6	181.3	17.7–23.7	177.2–183.2
CQ10		GW202214	20BL170313	334520.7	6301453.3	223.13	0.85	57	28-31	195-192	51–57	166–172
CQ11S		GW202191	20BL170191	334170.5	6301822.7	216.34	0.78	38	22.4-26.5	194-190	32–38	178–184
CQ11D		GW202192		334162.6	6301820.7	216.30	0.78	65	16-24 25.3-42.4	200-192 191-174	59–65	151–157
CQ12		GW202193		333794.2	6301802.3	202.61	0.02	15			9–15	188–194
CQ13		GW202215	20BL170190	334128.1	6301923.3	218.30	0.82	65	18-21 44-44.5	200-197 174	59–65	153–159
MW9		GW201800		*334543*	*6301387*	223.56	0.88	27.0			24-30	194–200
MW10		GW201801		*333716*	*6300992*	163.14	0.87	30.0			24-30	133–139
MW13		GW201802		*334236*	*6300819*	178.42	0.89	45.0			39-45	133–139

7.2.5 Rainfall and Evaporation

Hanson will maintain its weather station on the site and will maintain daily records of rainfall and evapotranspiration throughout the life of the project. A summary of annual rainfall and evaporation will be provided in the *Annual Review*.

7.2.6 Periodic Review of Performance

In accordance with *Condition 3(17)* of DA 94-4-2004*,* it is proposed that an independent groundwater audit will be carried out every 12 months throughout the life of the Quarry. These reviews will assess groundwater elevation trends and impacts and consider other collected monitoring data.

Should it be determined at any review that there is a declining baseline trend, and the component of drawdown attributable to the sand extraction operations exceeds 1.0m at any off-site monitored bore monitored bores (**Figure 5**), then an investigation would be commenced to determine whether there has been a loss of yield at any of the existing production bores within the 500m zone, subject to landholder approval. This will be determined by carrying out an identical pumping test to that conducted prior to commencement, as proposed above in Section 6.2.1.

At each review, the frequency and extent of monitoring will be reviewed, and if considered appropriate, a reduction in either the breadth or frequency of monitoring may be recommended for approval by the Secretary in consultation with NRAR.

The independent annual groundwater audit would be included in the relevant *Annual Review*.

7.2.7 Groundwater Dependent Ecosystems and Vegetation

The groundwater dependent ecosystems and vegetation beyond the Quarry Site are to be inspected on an annual basis as part of the overall vegetation management and rehabilitation review. This inspection will form part of the overall vegetation management of the Quarry Site and will be documented in the *Annual Review*.

A total of five 20m square monitoring plots were established approximately 500m south of the Quarry Site by Cumberland Ecology in January 2016. Three plots were established within Sandstone Hanging Swamps (Groundwater Dependent Wetlands) and two plots were established in Sandstone Ranges Gully Rainforest (baseflow stream). **Figure 6** displays the location of the GDE monitoring plots.

The existing condition of vegetation within the monitoring plots was recorded by Cumberland Ecology to establish a baseline for future monitoring. The initial (baseline) monitoring confirmed that all vegetation was considered to be in good condition, with no evidence of nutrient enrichment or weed invasion. All species recorded were native species. Several native bird species were observed during the survey as well as freshwater shrimp within one monitoring plot. Cumberland Ecology noted that freshwater shrimp are generally intolerant of pollutants, indicating that water quality is high in that location.

Annual review of GDE Condition will be compared to baseline data to ensure any changes are monitored.

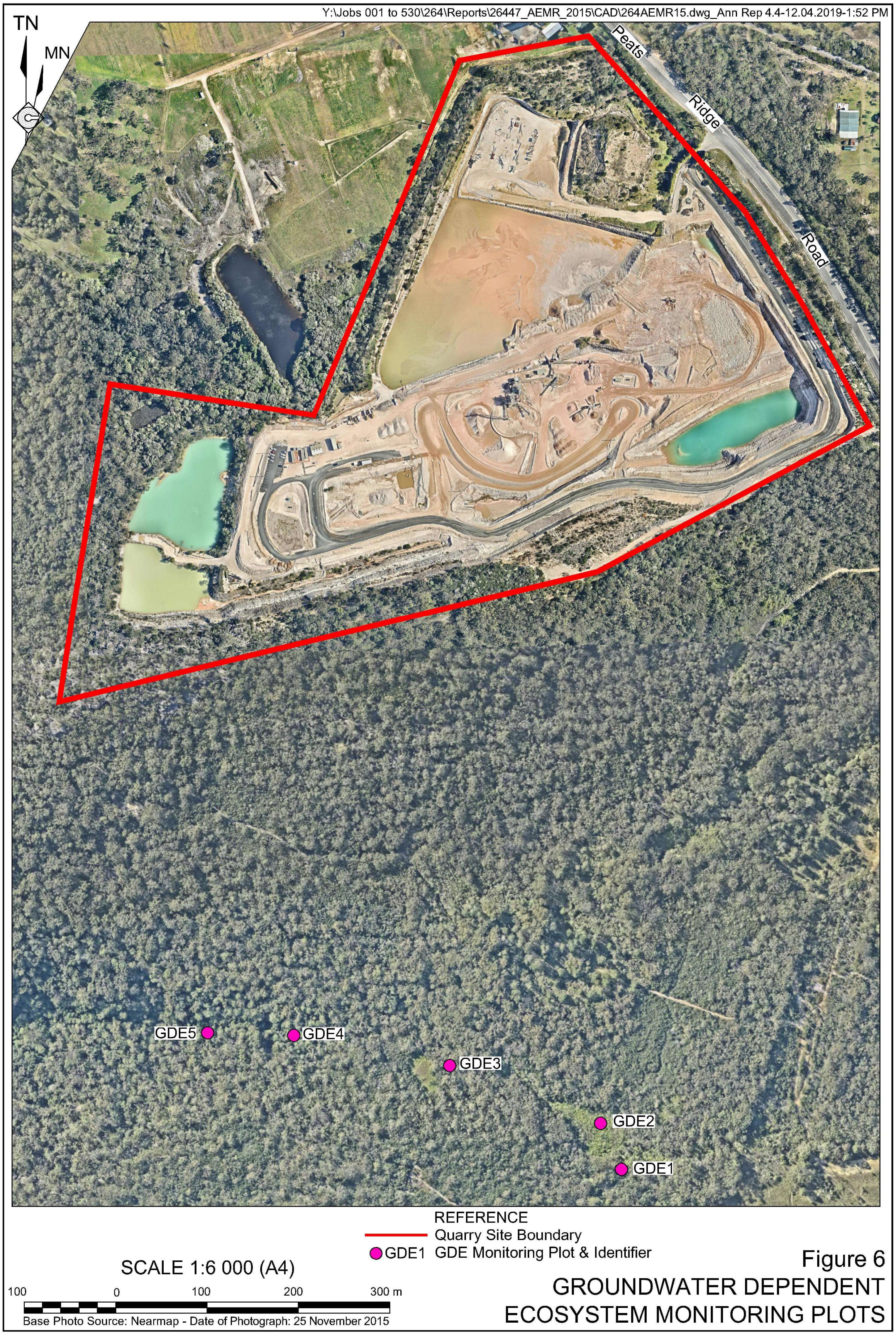

Figure 6
GROUNDWATER DEPENDENT ECOSYSTEM MONITORING PLOTS

7.3 BASELINE MONITORING DATA

7.3.1 Groundwater Levels

Table 5 provides a summary of historic groundwater level monitoring records. Groundwater levels have been reported in successive *Annual Reviews* with the results recorded using continuous water level recorders, supplemented by quarterly manual measurements. Hydrographs for all monitored bores are provided as **Appendix 2**.

Table 5
Summary of Historic Groundwater Level Monitoring Data

Bore	Date Range	Water levels (expressed as mAHD)			
		Range	5th Percentile	10th Percentile	50th Percentile
CQ3	2002 – 2020	168.24-171.17	169.59	169.91	170.6
CQ4	2002 – 2020	203.54-210.22	204.32	204.49	206.45
CQ5	2004 – 2020	203.05-209.29	204.60	205.09	206.91
CQ7	2004 – 2020	197.48-199.81	198.05	198.17	198.81
CQ8	2004 – 2020	190.37-196.76	191.41	192.43	195.53
CQ10	2006 – 2020	196.68-202.99	197.38	198.31	201.25
CQ11S	2006 – 2020	204.44-210.86	205.01	205.40	207.25
CQ11D	2006 – 2020	203.37-209.46	203.87	204.25	206.01
CQ12	2006 – 2020	194.12-200.02	195.37	196.64	198.38
CQ13	2006 – 2020	200.50-208.48	202.86	203.74	205.81
CP4	2006 – 2020	194.45-216.86	204.58	205.23	208.47
CP5	2006 – 2020	189.89-212.02	200.87	202.80	207.81
CP6	2006 – 2020	193.18-210.71	202.44	204.01	207.47
CP7	2006 – 2020	201.36-210.23	202.86	205.37	208.29
CP8	2006 – 2020	199.78-204.42	200.11	200.70	202.91
CP13	2014 – 2020	200.42-206.90	202.24	204.07	206.46
CP15	2016 – 2020	199.92-201.06	199.95	199.97	200.20
MW7	2006 – 2020	192.04-196.94	193.12	193.83	195.03
MW8	2006 – 2020	181.34-186.24	181.72	183.02	184.41
MW9	2006 – 2020	199.83-203.53	200.27	200.55	202.54
MW10	2006 – 2020	148.17-153.64	148.57	149.19	151.10
MW13	2006 – 2020	169.27-171.38	169.87	170.11	170.68
MW16	2006 – 2020	164.49-165.79	164.63	164.78	165.34
MW17	2014 – 2020	161.66-162.69	161.76	161.86	162.28

7.3.2 Groundwater Quality

Graphs of historic groundwater quality monitoring of pH and electrical conductivity are provided in **Appendix 2**. Laboratory assessed groundwater quality data recorded between 2013 and 2017 is provided in **Appendix 3**. Ongoing results will be reported in successive *Annual Reviews*. The water quality results are compared with the ANZECC (2000) default trigger values for freshwater ecosystem protection and, with the exception of electrical conductivity (75th percentile), the 95th percentile of results recorded between 2012 to 2017, where sufficient data is available.

It should be noted that historic results indicate exceedances for dissolved metals, however the ANZECC (2000) default trigger values are for surface water and do not reflect the natural variation in groundwater quality and are not related to the Quarry operations. For example, exceedances of nitrate are believed to be due to the agricultural activities on the neighbouring properties and result either from fertilizer application or possibly from chicken farming.

7.3.3 Rainfall

Table 6 records the rainfall recorded on the Quarry Site between January 2008 and December 2017. For completeness, the average rainfall recorded at the nearby Peats Ridge meteorological station has been included for reference. A summary of annual rainfall is presented in the *Annual Review*.

Table 6
Rainfall Recorded at Calga Sand Quarry (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	148.4	179.2	103.4	185.2	11.0	153.8	65.6	40.6	143.6	77.6	15.2	51.4
2009	86.6	225.0	71.4	146.2	148.2	68.4	30.6	3.6	9.2	156.2	40.2	50.0
2010	44.6	143.4	127.8	54.6	122.4	111.0	47.4	32.8	36.4	94.6	180.2	117.6
2011	60.0	53.6	134.4	206.6	146.6	106.8	161.2	75.0	104.6	92.6	193.0	151.8
2012	153.2	227.8	134.4	154.4	22.6	140.0	22.8	11.2	29.8	16.6	58.2	89.8
2013	29.8	280.6	150.0	116.2	82.2	120.2	8.8	12.2	16.8	48.0	154.6	14.4
2014	29.6	106.6	145.8	53.4	31.1	90.8	23.3	202.7	70.2	57.5	48.5	139.6
2015	193.7	61.0	92.2	377.4	119.6	80.1	37.0	34.4	38.9	50.0	129.6	146.1
2016	244.8	27.0	71.6	34.8	11.0	158.2	54.6	75.6	35.0	30.4	39	42.6
2017	20.6	2.2[1]	412.2	48.0	17.6	95.8	3.4	9.6	4.8[1]	50.4	36.2	12.6[1]
Mean	**101.1**	**130.6**	**144.3**	**137.7**	**71.2**	**112.5**	**45.5**	**49.8**	**48.9**	**67.4**	**89.5**	**81.6**
Bureau of Meteorology Peats Ridge Station (No. 61351) - 1981 – 2015												
Mean[2]	**113.3**	**154.3**	**135.9**	**123.0**	**89.7**	**99.5**	**62.7**	**74.0**	**69.1**	**85.3**	**100.7**	**92.4**
Note 1: Data not based on complete records for this month												
Note 2: Mean for Rainfall recorded at Peats Ridge for all available years (1981 to 2015)												

7.4 IMPACT ASSESSMENT CRITERIA

7.4.1 Groundwater Levels

Triggers for investigation of groundwater levels (proposed impact assessment criteria) are presented in **Table 7**. The trigger for investigation is 1m below the 5th percentile lowest historical records. This level has been set to allow for seasonal fluctuations that are not indicative of the loss of groundwater that might be caused by the Quarry operation. The trigger level for each bore has been included in hydrographs presented in **Appendix 2**.

Table 7
Summary of Historic Groundwater Level Monitoring Data

Bore	**Water levels (expressed as mAHD)**	
	5th Percentile	**Trigger Level (1m below 5th Percentile)**
CQ3	169.59	168.59
CQ4	204.32	203.32
CQ5	204.60	203.60
CQ7	198.05	197.05
CQ8	191.41	190.41
CQ10	197.38	196.38
CQ11S	205.01	204.01
CQ11D	203.87	202.87
CQ12	195.37	194.37
CQ13	202.86	201.86
CP4	204.58	203.58
CP5	200.87	199.87
CP6	202.44	201.44
CP7	202.86	201.86
CP8	200.11	199.11
CP13	202.24	201.24
CP15	199.95	198.95
MW7	193.12	192.12
MW8	181.72	180.72
MW9	200.27	199.27
MW10	148.57	147.57
MW13	169.87	168.87
MW16	164.63	163.63
MW17	161.76	160.76

The proposed response actions are as follows.

- If monthly groundwater monitoring identifies groundwater levels fall below the trigger levels nominated in **Table 7**, an investigation of the cause of the change would be commenced.
- If at any annual independent audit review, there is a declining trend in groundwater levels which is not attributable to climatic conditions or other factors not related to the sand extraction activities, and if the groundwater level decline at monitoring bores CQ10 or CQ11 deemed due to sand extraction impacts exceeds 1.0m, then the adjoining landholders will be approached to arrange re-testing of their existing production bore(s). The test results will be compared to pre-extraction tests, and if it is determined that any bore has suffered a reduction

in its pumping yield of greater than 10% (in accordance with *Condition 3(10)* of DA 94-4-2004), then arrangements will be made with the affected landholder to restore water supply potential, by one of the following means.

1. Supply of an equivalent water supply by pumping from a production bore on Hanson's property.
2. Deepening of the affected bore (if feasible).
3. Drilling a deeper replacement bore.
4. Another arrangement mutually acceptable to the landholder and Hanson.

- If at any annual independent audit review, it is assessed that a drawdown in excess of 1m has occurred as a result of quarrying activity at any other off-site monitoring bore, the drawdowns will be investigated to determine if any neighbouring private bore has suffered an adverse impact on bore yield. This may include consideration of drawdowns and drawdown trends, and if necessary re-testing of the private bore as detailed above.
- If at any other time, a landholder's bore within 500m of the quarry suffers a reported loss of yield >10% due to declining groundwater levels, the loss of yield would be notified to both the Secretary and the affected landholders (in accordance with *Condition 4(1)*) of DA 94-4-2004. The Company would also commission an independent hydrogeologist to conduct an investigation regarding the loss of yield. The investigation would include a review of all monitoring data, and if necessary a re-testing of the bore to allow comparison of performance with previous tests. If the investigation reveals that the loss of yield is attributable to the sand extraction activities, then arrangements would be made with the landholder to restore the supply by one of the means described above.

7.4.2 Groundwater Quality

Groundwater quality will continue to be assessed against the ANZECC (2000) guideline values for freshwater ecosystem protection, where available, and the 95^{th} percentile of records recorded between 2012 to 2017. Both the ANZECC (2000) default trigger values and adopted trigger values are presented in **Table 8**. Both trigger values are provided in **Appendix 3** for each bore in the monitoring network (see **Appendix 2** for trend information on pH and electrical conductivity). Any exceedances will continue to be considered against historic results and in the context of local land use.

If any private bore within 500m of the quarry experiences a salinity increase (20% increase in EC or TDS based on the last five years of data – see **Appendix 3**), the following response actions would be implemented.

- Re-sample the bore to verify the quality.
- If the salinity increase is confirmed, immediately notify the Secretary and affected landholder and refer the data to an independent hydrogeologist for investigation.
- If the investigation confirms the sand extraction activities as the likely cause, then arrangements would be made with the landholder to restore the supply by one of the means described above.

Table 8
Groundwater Quality Trigger Values

Parameter	Units	ANZECC Guideline	Assumed Trigger Values (based on 95th Percentile Value for Records 2012 – 2017 – see Appendix 3)									
			CQ3	CQ5	CQ4	CQ7	CQ8	CQ10	CQ11S	CQ11D	CQ12	CQ13
pH	pH unit	N/A	6.64	4.99	5.84	5.65	5.64	5.02	5.24	5.04	4.937	5.095
Conductivity @ 25ºC*	µS/cm	N/A	187	197	132.2	121	156	187	175	178	149	240
Hydroxide Alkalinity as $CaCO_3$	mg/L	N/A	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbonate Alkalinity as $CaCO_3$	mg/L	N/A	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bicarbonate Alkalinity as $CaCO_3$	mg/L	N/A	52	NA	6	3	20	2	8	2	1	NA
Sulphate	mg/L	N/A	6	30	8	4	10	35	36	42	29.1	2
Chloride	mg/L	N/A	29	31	27.1	28	25	30	26	25	23.1	40
Calcium	mg/L	N/A	2	4	NA	1	NA	3	NA	NA	NA	NA
Magnesium	mg/L	N/A	5	6	2	2	5	4	5	5	6	8
Sodium	mg/L	N/A	18	19	20.1	16	18	21	22	22	13	27
Potassium	mg/L	N/A	2	3	NA	1	1	NA	4	2	1	2
Aluminium – total	mg/L	0.055	0.22	2.27	0.46	1.41	0.582	2.359	1.02	1.63	1.1485	1.113
Arsenic – total	mg/L	0.013	0.003	0.002	NA	NA	NA	0.001	NA	0.001	NA	NA
Cadmium – total	mg/L	0.0002	0.0006	NA	NA	NA	NA	0.0002	NA	0.0002	NA	NA
Chromium – total	mg/L	ID	0.003	0.001	0.001	0.003	0.002	0.0155	0.001	0.004	0.001	0.002
Copper – total	mg/L	0.0014	0.010	0.014	0.007	0.0096	0.003	0.048	0.006	0.007	0.004	0.004
Lead – total	mg/L	0.0034	0.0028	0.003	0.007	0.0055	0.003	0.011	0.009	0.098	0.005	0.008
Manganese – total	mg/L	1.9	1.8935	0.023	0.028	0.02065	0.006	0.039	0.017	0.022	0.006	0.006
Nickel – total	mg/L	0.011	0.016	0.004	0.004	0.001	0.003	0.005	0.002	0.003	0.001	0.001
Selenium – total	mg/L	0.005	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc – total	mg/L	0.008	0.097	0.136	0.102	0.088	0.060	0.17	0.1059	0.236	0.135	0.050
Boron – total	mg/L	0.37	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron – total	mg/L	ID	18.6	0.778	0.396	0.96	0.11	0.72	0.35	0.45	0.16	0.32
Mercury	mg/L	0.00006	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluoride	mg/L	N/A	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.1
Nitrite as N	mg/L	N/A	0.05	0.06	0.08	0.02	0.02	NA	NA	NA	0.01	0.02
Nitrate as N	mg/L	0.7	0.555	3.34	2.85	2.14	7.208	0.99	0.35	0.282	1.08	12.11
Nitrite + Nitrate as N	mg/L	N/A	0.59	3.34	2.85	2.15	7.208	0.99	0.35	0.282	1.08	12.11
Total Anions	meq/L	N/A	1.9	1.38	0.93	0.82	1.22	1.53	1.43	1.50	1.19	1.95
Total Cations	meq/L	N/A	1.51	1.36	1.04	0.90	1.19	1.37	1.37	1.424	1.04	1.87
NA – No records above the limit of recording have occurred for this parameter and therefore the ANZECC guideline will be used as a reference trigger value.												

Table 8 (Cont'd)
Groundwater Quality Trigger Values

Page 2 of 2

Parameter	Units	ANZECC Guideline	Assumed Trigger Values (based on 95th Percentile Value for Records 2012 – 2017 – see Appendix 3)							
			CP4	CP5	CP6	CP7	CP8	MW9	MW10	MW13
pH	pH unit	N/A	5.41	4.76	4.78	6.00	4.77	5.32	4.89	5.36
Conductivity @ 25ºC*	µS/cm	N/A	219	248	197	163	159.6	100.3	139	113
Hydroxide Alkalinity as $CaCO_3$	mg/L	N/A	NA	NA	NA	NA	NA	NA	NA	NA
Carbonate Alkalinity as $CaCO_3$	mg/L	N/A	NA	NA	NA	NA	NA	NA	NA	NA
Bicarbonate Alkalinity as $CaCO_3$	mg/L	N/A	2	NA	NA	9	NA	NA	NA	1
Sulphate	mg/L	N/A	23	4	9	27	10	4	6	3
Chloride	mg/L	N/A	39	25	30	16	35	27.1	35	29
Calcium	mg/L	N/A	4	2	NA	8	NA	NA	NA	NA
Magnesium	mg/L	N/A	6	16	8	5	3	1	2	2
Sodium	mg/L	N/A	20	14	19	8	22	14	16	15
Potassium	mg/L	N/A	4	3	1	11	NA	NA	NA	NA
Aluminium – total	mg/L	0.055	0.98	0.91	1.01	0.56	1.01	6.32	1.08	0.17
Arsenic – total	mg/L	0.013	NA	NA	NA	NA	NA	0.009	NA	NA
Cadmium – total	mg/L	0.0002	0.0002	0.0002	NA	NA	NA	NA	NA	NA
Chromium – total	mg/L	ID	0.0048	0.002	0.007	NA	0.002	0.0202	NA	NA
Copper – total	mg/L	0.0014	0.026	0.057	0.028	0.014	0.005	0.016	0.004	0.007
Lead – total	mg/L	0.0034	0.020	0.009	0.005	0.002	0.0029	0.012	0.003	0.002
Manganese – total	mg/L	1.9	0.022	0.003	0.009	0.292	0.011	0.013	0.0145	0.040
Nickel – total	mg/L	0.011	0.091	0.008	0.007	0.001	NA	0.003	0.002	0.003
Selenium – total	mg/L	0.005	NA	NA	NA	NA	NA	NA	NA	NA
Zinc – total	mg/L	0.008	0.314	0.371	0.289	0.117	0.04	0.050	0.079	0.088
Boron – total	mg/L	0.37	NA	NA	NA	NA	NA	NA	NA	NA
Iron – total	mg/L	ID	0.99	NA	0.09	5.67	0.19	7.63	0.06	0.13
Mercury	mg/L	0.00006	NA	NA	NA	NA	NA	NA	NA	NA
Fluoride	mg/L	N/A	NA	NA	NA	NA	NA	0.2	NA	NA
Nitrite as N	mg/L	N/A	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate as N	mg/L	0.7	5.31	20.17	10.21	5.22	2.27	0.34	0.37	0.67
Nitrite + Nitrate as N	mg/L	N/A	5.31	20.17	10.21	5.22	2.27	0.34	0.37	0.67
Total Anions	meq/L	N/A	1.45	2.07	1.64	1.01	1.11	0.82	1.08	0.87
Total Cations	meq/L	N/A	1.57	2.00	1.45	1.35	1.18	0.69	0.86	0.8
NA – No records above the limit of recording have occurred for this parameter and therefore the ANZECC guideline will be used as a reference trigger value.										

7.5 INVESTIGATION AND REPORTING OF EXCEEDANCES

The results of groundwater level monitoring and groundwater quality sampling will be compared against the relevant assessment criteria and any other relevant criteria that may be defined by the EPA. Any exceedance of criteria will trigger an immediate investigation to determine the cause of the exceedance and preparation of a corrective action plan to re-establish or introduce additional appropriate controls as necessary. Whenever possible, re-sampling would occur to verify the result recording an exceedance. Immediately after identification of an exceedance:

- DPIE, NRAR and EPA would be notified of any exceedance; and
- where the exceedance is identified in a privately-owned bore, the landowner would be notified.

The triggers for an investigation are defined in Section 7.4. In these instances, an investigation may include the following.

- Review of meteorological conditions to establish relevant patterns.
- Inspection of the bore and context of local land uses.
- Review of results upgradient of the affected bore to establish a possible source of contamination.
- Retesting of water levels or groundwater quality, whichever is relevant.

Hanson will also report the results of investigation to DPIE, NRAR and EPA, as soon as practicable after any incident, where an incident is a set of circumstances that:

- causes or threatens to cause material harm to the environment; and/or
- breaches or exceeds the nominated assessment criteria.

A report would be submitted to DPIE regarding the incident within 7 days of the incident occurring.

8. COMPLAINTS HANDLING AND RESPONSE

Complaints may be received via one of the following methods.

- Directly via an email, telephone call or text message.
- Indirectly via the relevant government agencies.

It remains Hanson's preference that all complaints are directed to the Quarry Manager (or his nominee) rather than via a government agency. This direct contact has proven effective in the past as the cause of the complaint can be quickly identified and the solutions adopted.

All complaints are referred to the Quarry Manager (or his nominee), thoroughly investigated and documented in the Quarry *Complaints Register* with the following information recorded.

- Date of the complaint
- Time of the complaint

- Name of complainant (if available).
- How the complaint was received.
- Detailed description of the complaint.
- Person who received the complaint.

Once the Quarry Manager is satisfied that the complaint is substantiated, an investigation of the location, sources and causes of the complaint will be undertaken. Following investigation of the issue, the Quarry Manager will provide feedback to the complainant that details the investigations undertaken, the results of the investigation and measures implemented to ensure that operations remain compliant. A description of any follow-up investigations and the response provided to the complainant will also be recorded in the *Complaints Register* upon satisfactory closure of the issue.

All complaints received are summarised in the *Annual Review*, which is made publicly available via the Hanson website. Complaints are also summarised in the *Annual Return* document to the EPA.

9. REPORTING AND PUBLICATION OF MONITORING RESULTS

Hanson will include all monitoring results within the appendices to the *Annual Review*. That document, once approved by the relevant government agencies, will be published on the Company's website.

In accordance with the requirements of Section 66(6) of the *Protection of the Environment Operations Act 1997*, the *Requirements for Publishing Pollution Monitoring Data*" (NSW EPA, 2012), and the *Wed-based Reporting Guideline* (DPE, 2015), Hanson will publish a meaningful summary of all pollution monitoring data on the Hanson website within 14 days of the monitoring results being received. In addition, Hanson will provide a copy of obtained data (the value of each individual monitoring sample) at no cost to any member of the public, when requested**.** The data will be published in a format that summarises raw data, is comprehensible by the general public and also includes all accompanying necessary information.

The following documents will also be available on the Hanson website in accordance with the *Wed-based Reporting Guideline* (DPE, 2015).

- All statutory environmental, planning and cultural heritage approvals.
- Hanson's environmental management strategy documents relevant to the Calga Quarry.
- Compliance related documents including independent audits, *Annual Review* documents and a register of any incidents notified to DPIE.
- The community complaints register (updated monthly).
- Minutes of the Community Consultative Committee meetings.

10. PERSONNEL MANAGEMENT

10.1 ROLES AND RESPONSIBILITY

Table 9 outlines the roles and responsibilities of personnel with reference to management of water.

Table 9
Roles and Responsibilities of Personnel with Respect to Management of Water

Role	Responsibilities
Environmental Planning and Compliance Coordinator	Ensure compliance with the Site Water Management Plan Ensure adequate resources are available to implement the Site Water Management Plan. Ensure suitably trained personnel are available to implement the responsibilities of the Quarry Manager during any time of the Quarry Manager's absence from site. Coordinate the review of the Plan (see Section 13).
Quarry Manager, or his/her nominee	Ensure the implementation of the Site Water Management Plan. Ensure monitoring results are regularly reviewed/evaluated and entered into the environmental database. Ensure reviews of meteorological forecasts are undertaken on a daily basis prior to the commencement of operations. Implementation of the Erosion and Sediment Control Plan. Provide primary contact for complaints and supply follow-up information to any complainant. Initiate investigations of complaints as received from the public or government agency. Prepare a report to government agencies or neighbours following an incident (see Section 11). Ensure employees are competent through training and awareness programs.
All On-site Personnel	Operate in a manner that minimises risks of incidents to themselves, fellow workers or the surrounding environment. Fully implement the relevant control measures within the Site Water Management Plan. Report any extraordinary events to the Quarry Manager. Follow any instructions provided by the Quarry Manager.

10.2 COMPETENCE TRAINING AND AWARENESS

All personnel and contractors working at the Quarry undergo an induction. This induction includes information on environmental responsibilities while working on site.

After completing the induction, workers will sign a statement of attendance and records of this are kept in the administration office.

Regular toolbox meetings are held to discuss whole-of-site production, management, safety and environmental issues. Matters relating to water management are raised during these meetings, when necessary.

11. PLAN REVIEW AND CONTINUAL IMPROVEMENT PROTOCOL

This Plan was presented in draft form to DPIE and DPIE Water / Natural Resource Access Regulator and comments from each agency addressed in finalising the document. A summary of the comments and response / amendments made to the plan are presented in **Appendix 5**.

The Plan will be reviewed annually from the date of approval or (in accordance with *Condition 5(4)* of DA 94-4-2004) within three months of submission of an *Annual Review*, an incident report resulting from a notifiable incident, each independent environmental audit and any modification to DA 94-4-2004. This will ensure the adequacy of the Plan and allow for opportunities of adaptive management and continual improvement. This will include a review of monitoring and updating of trigger levels, as necessary, as the Quarry development progresses. Each review will also evaluate the effectiveness of the overall monitoring program and whether it should be modified or scaled back.

Continuous improvement of this Plan will be achieved by the ongoing evaluation of the monitoring results against relevant criteria for the purpose of identifying opportunities for improvement. The continuous improvement process will be designed to:

- identify areas of opportunity for improvement of environmental management and performance;
- determine the cause or causes of non-compliance by reviewing the trigger conditions against any observed events or complaints that may be received. Triggers and responses may be refined where lessons from experience and feedback from stakeholders can inform changes to the Plan;
- develop and implement a plan of corrective and preventative action to address any non-compliance;
- verify the effectiveness of the corrective and preventative actions;
- document any changes in procedures resulting from process improvement; and
- make comparisons with objectives and targets.

12. REFERENCES

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Strahler, A. N. 1957. Quantitative analysis of watershed geomorphology. Transactions of the American Geophysical Union (38):913-920.

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Appendices

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Appendix 1

Baseline Surface Water Flow Calculations (GSS Environmental Services)

(Total No. of pages including blank pages = 4)

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GSS Environmental
Environmental & Land Management Consultants

PROJECT: Calga Sand Quarry – Northern Extension

COMPUTED BY: Rod Masters

DRAINAGE AREA: 10 ha

DESIGN EVENT: ARI - 1%, DURATION – Tc

TABLE A1
Data Input

Parameter	Unit	Output
Discharge	m^3/sec	1.1
Peak Flow Period	hrs	0.32
Channel Slope	%	1
Channel Bottom Width	m	3
Batter Grade	h:v	3
Material Type	dimensionless	unreinforced vegetation
Retardance	cm	15
Vegetation Type	dimensionless	mixed (sod & bunched)
Vegetation Density	%	50 - 75
Soil Type	dimensionless	Sandy Loam
Manning's Roughness Coefficient	dimensionless	0.05

TABLE A2
Hydraulic Results

Parameter	Unit	Output
Flow Velocity	m/sec	0.82
Flow Area	m^2	1.34
Hydraulic Radius	m	0.26
Flow Depth	m	0.34
Permissible Shear Stress	Pa	1.68
Calculated Shear Stress	Pa	1.28
Safety Factor	dimensionless	1.31
RESULT	dimensionless	**STABLE**

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Appendix 2

Historic Groundwater Bore Hydrographs and Water Quality Results (Dundon Consulting Pty Ltd)

(Total No. of pages including blank pages = 14)

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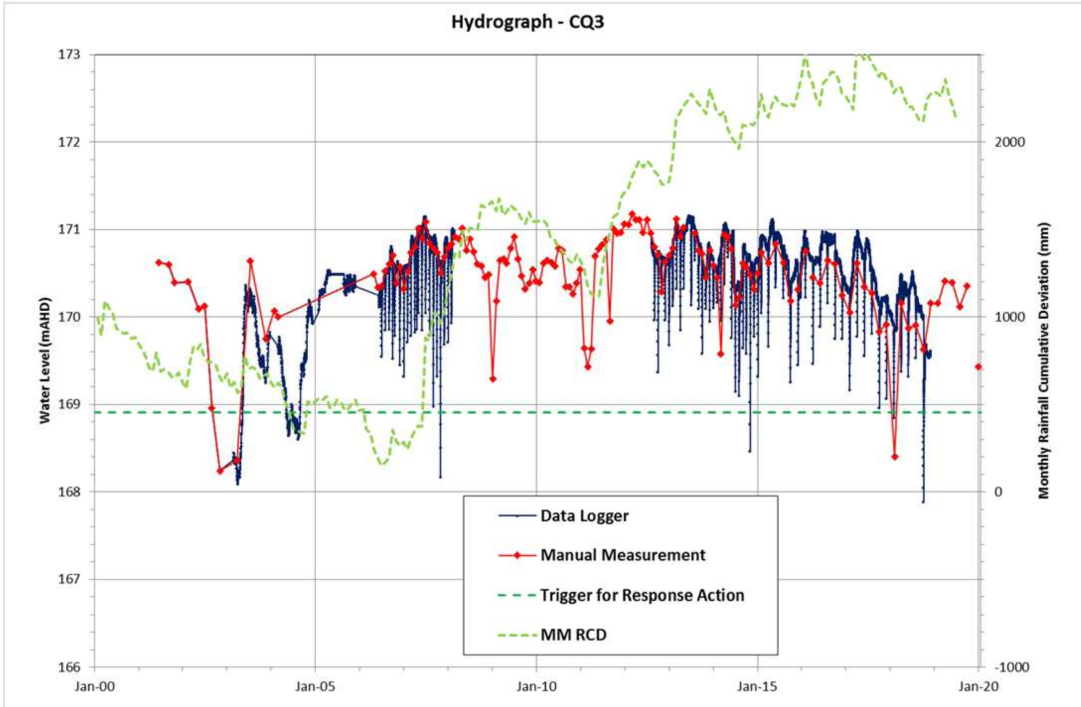
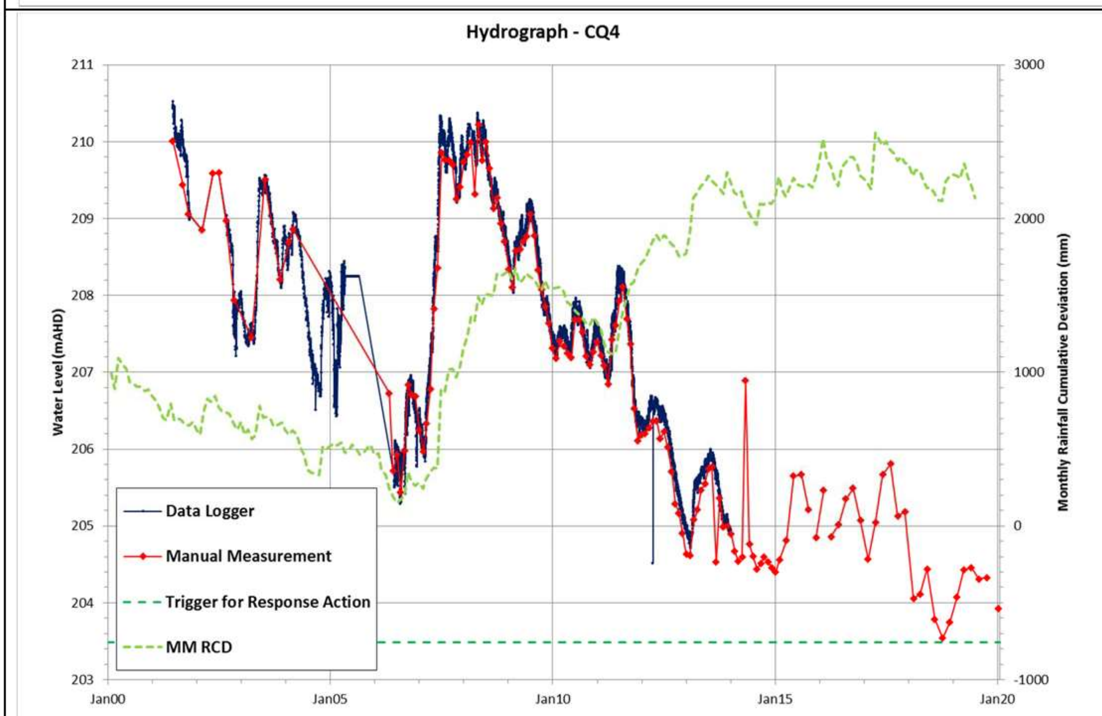
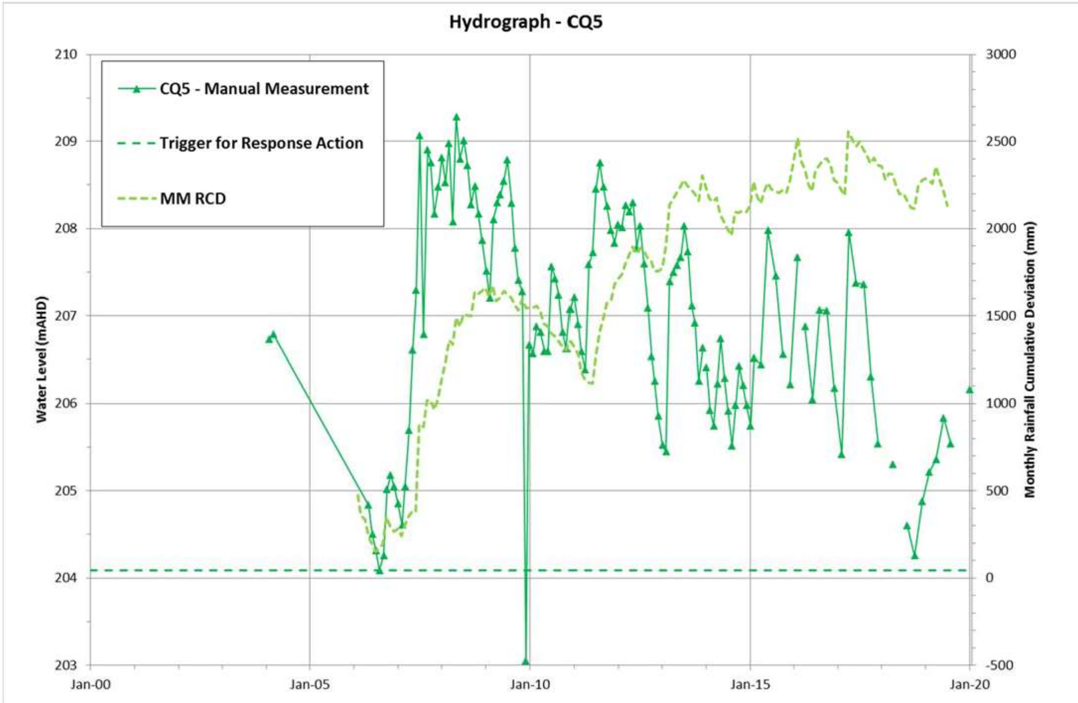
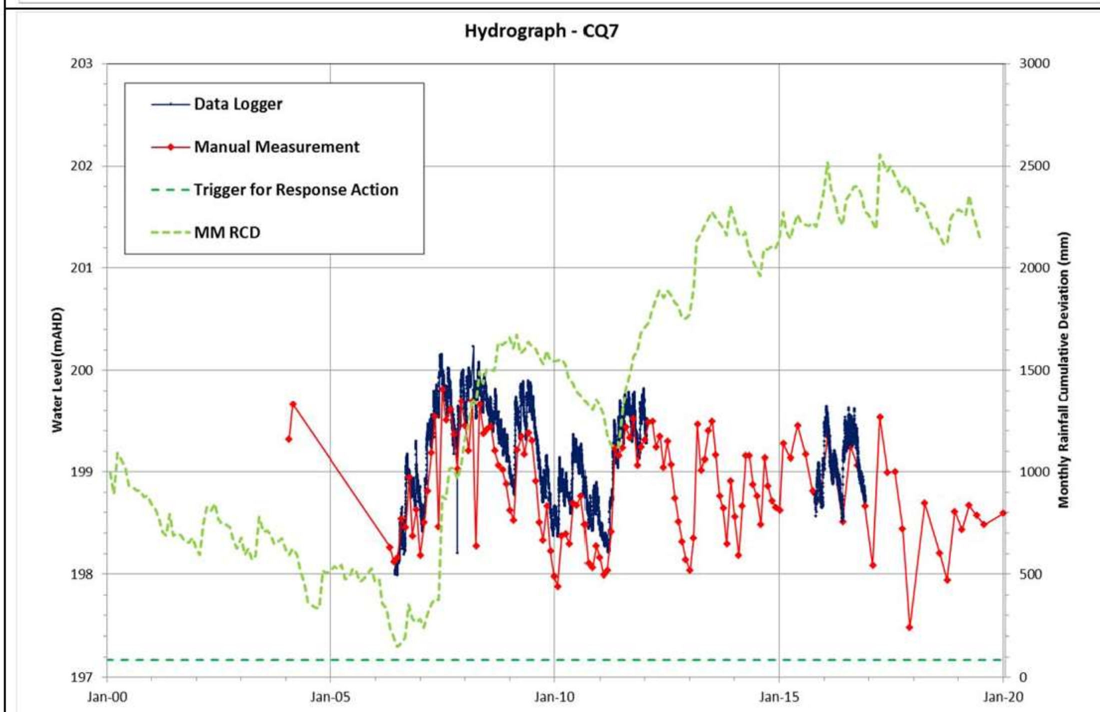


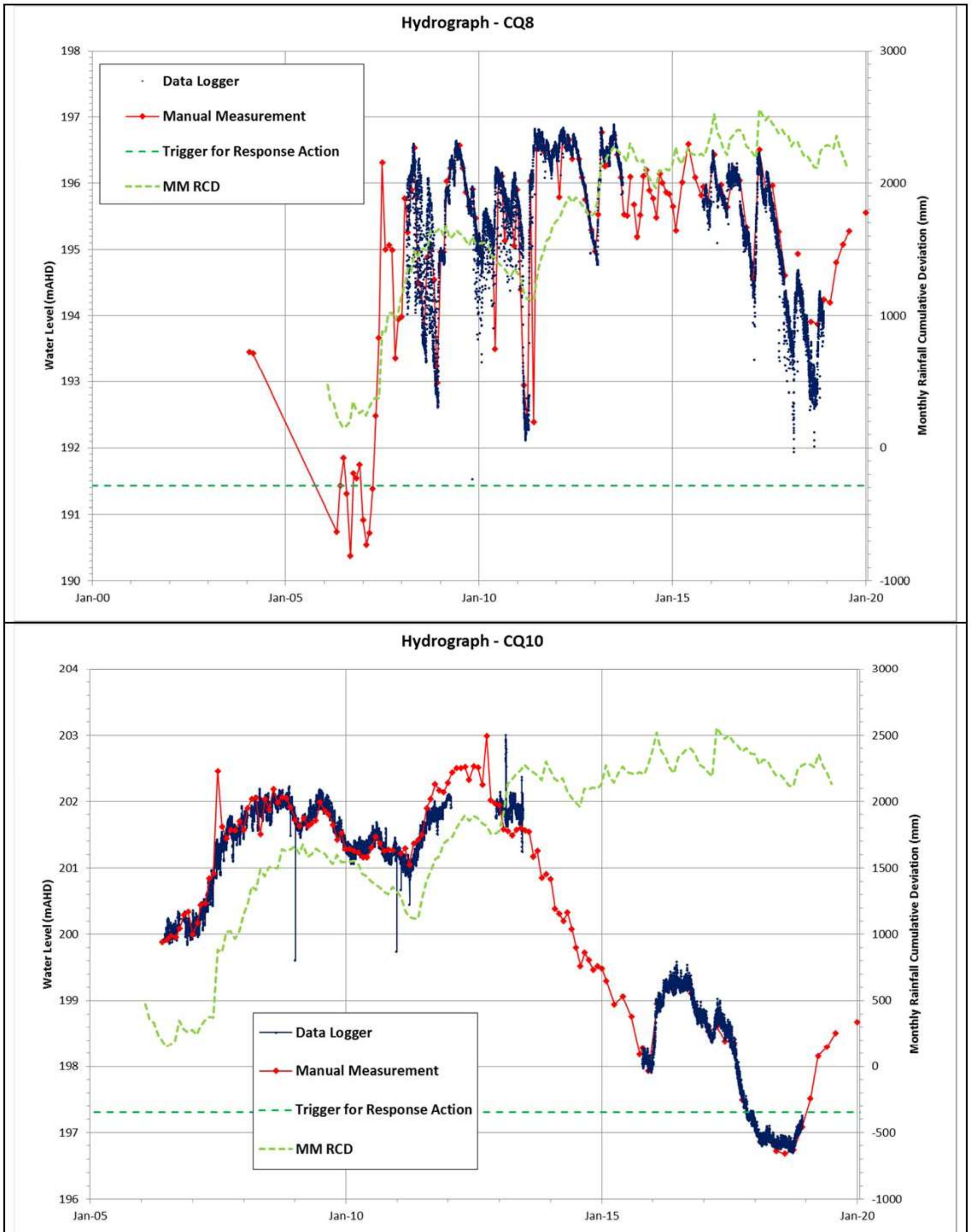


Date: 5 August 2020		Scale: as shown	**Hanson**
Author: PD	Checked: PD	Project No: 19-0362	**Calga Sand Quarry Water Level Hydrographs and Triggers Bores CQ3 and CQ4**
Dwg No: 0362-001		Revision:	
Dundon Consulting Pty Ltd			**Figure 1**

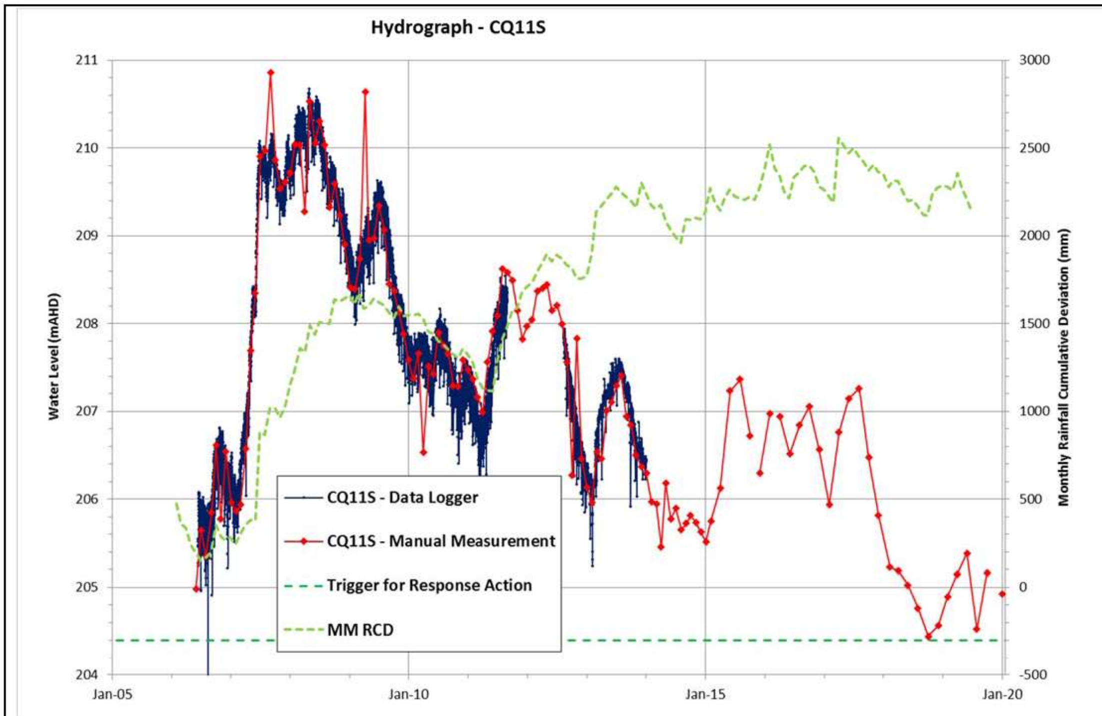


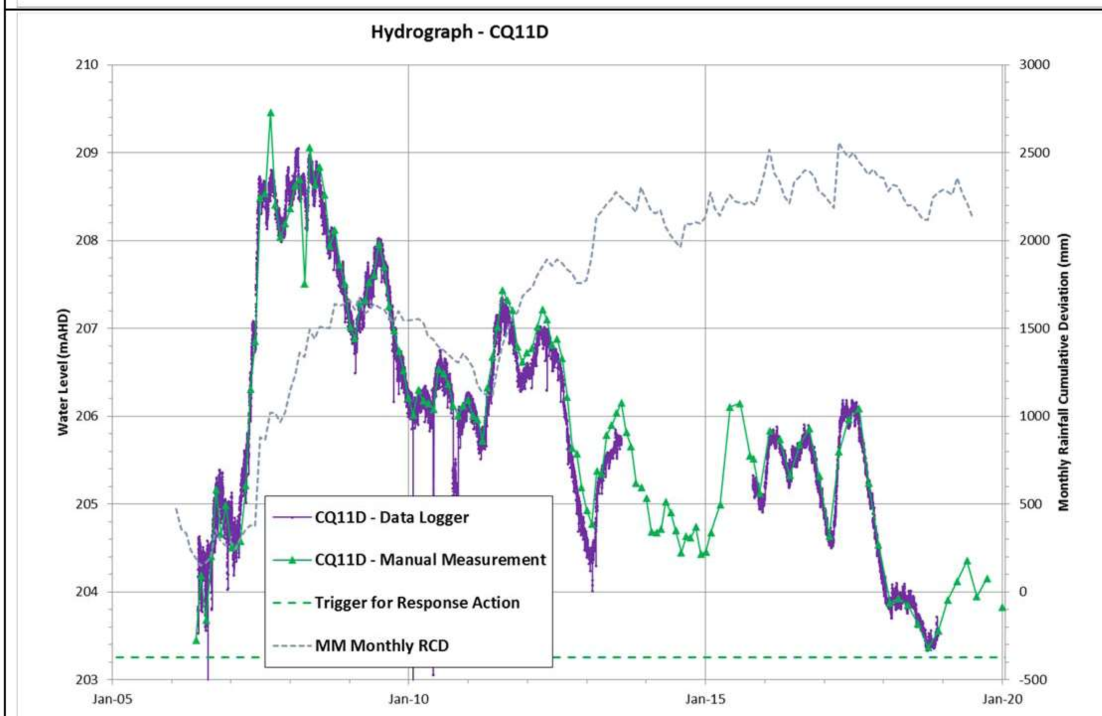


Date: 5 August 2020		Scale: as shown	**Hanson**
Author: PD	Checked: PD	Project No: 19-0362	**Calga Sand Quarry Water Level Hydrographs and Triggers Bores CQ5 and CQ7**
Dwg No: 0362-002		Revision:	
Dundon Consulting Pty Ltd			**Figure 2**

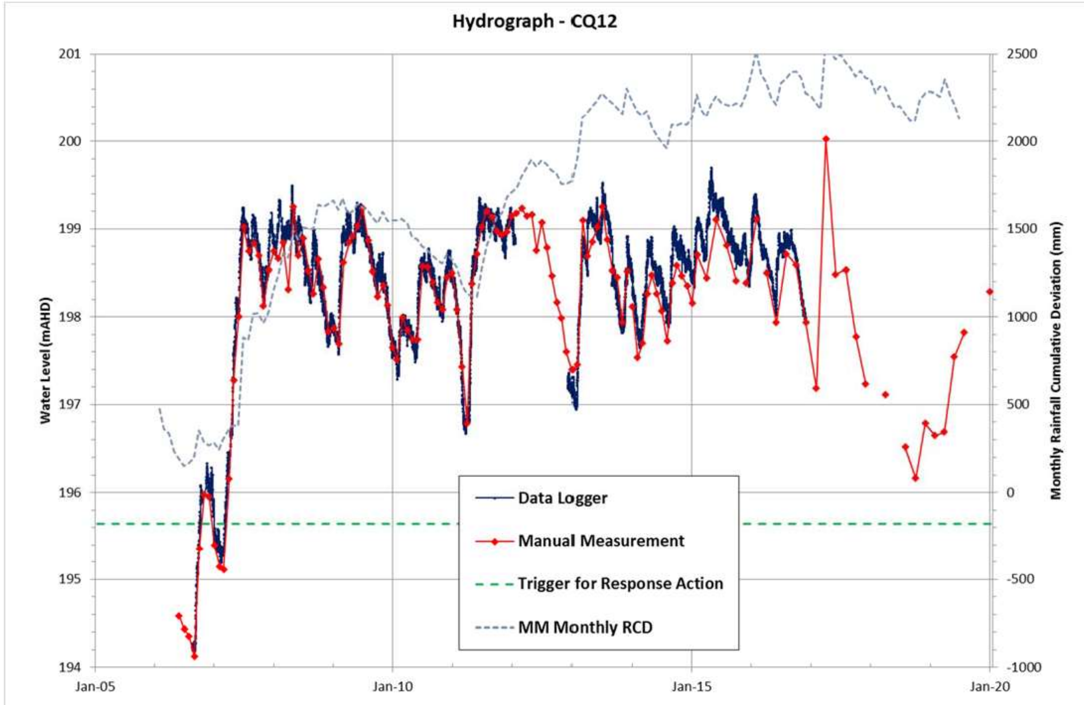


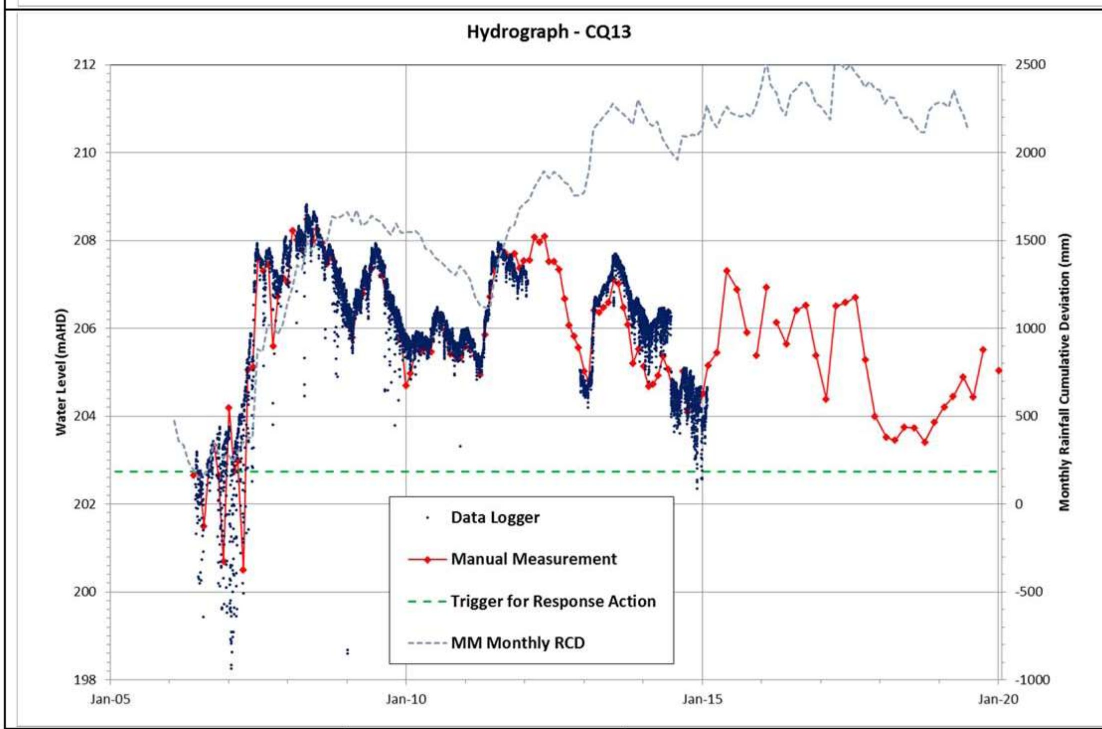
Date: 5 August 2020		Scale: as shown	**Hanson**
Author: PD	Checked: PD	Project No: 19-0362	**Calga Sand Quarry Water Level Hydrographs and Triggers Bores CQ8 and CQ10**
Dwg No: 0362-003		Revision:	
Dundon Consulting Pty Ltd			**Figure 3**



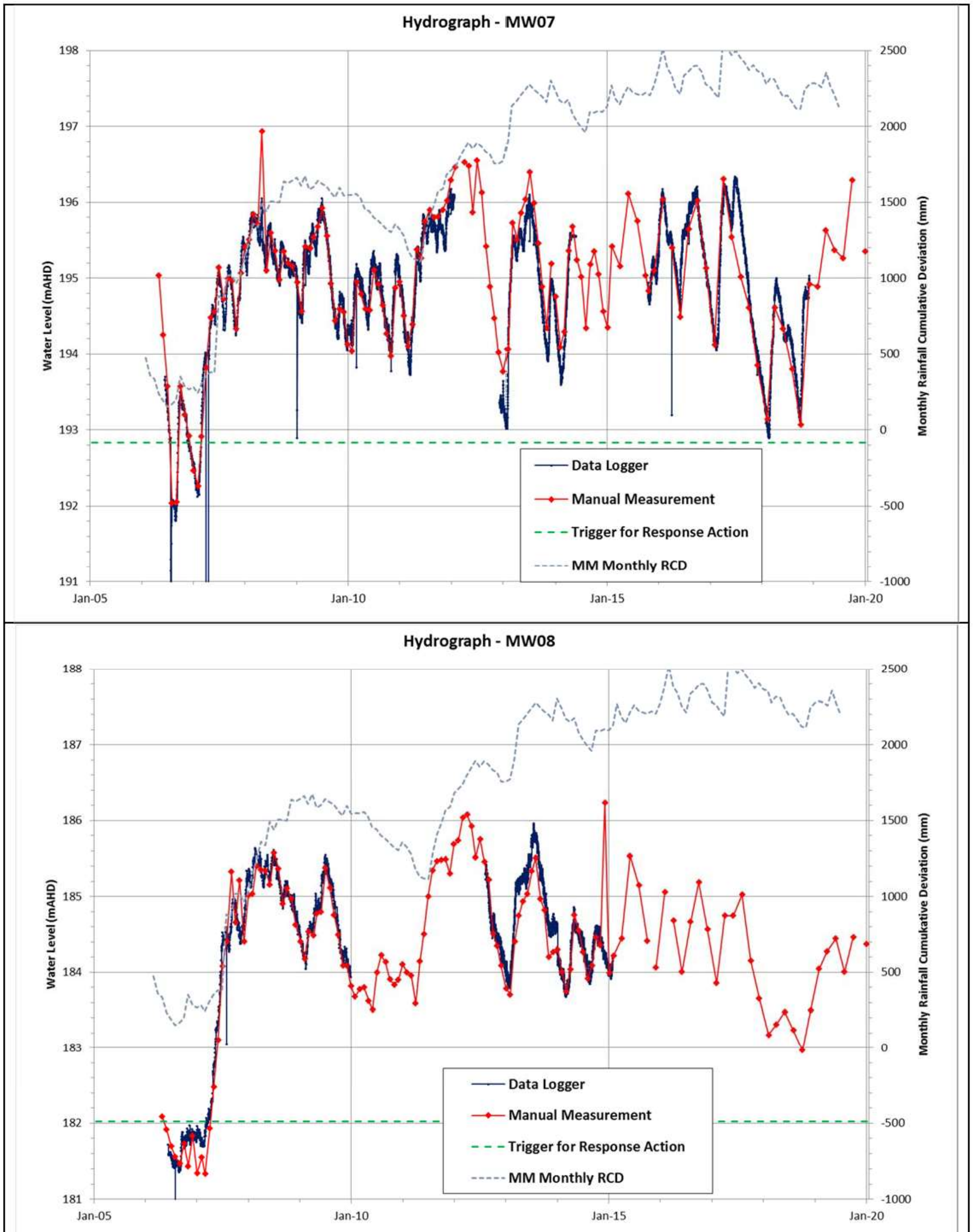


Date: 5 August 2020		Scale: as shown	**Hanson**
Author: PD	Checked: PD	Project No: 19-0362	**Calga Sand Quarry** **Water Level Hydrographs and Triggers** **Bores CQ11S and CQ11D**
Dwg No: 0362-004		Revision:	
Dundon Consulting Pty Ltd			**Figure 4**

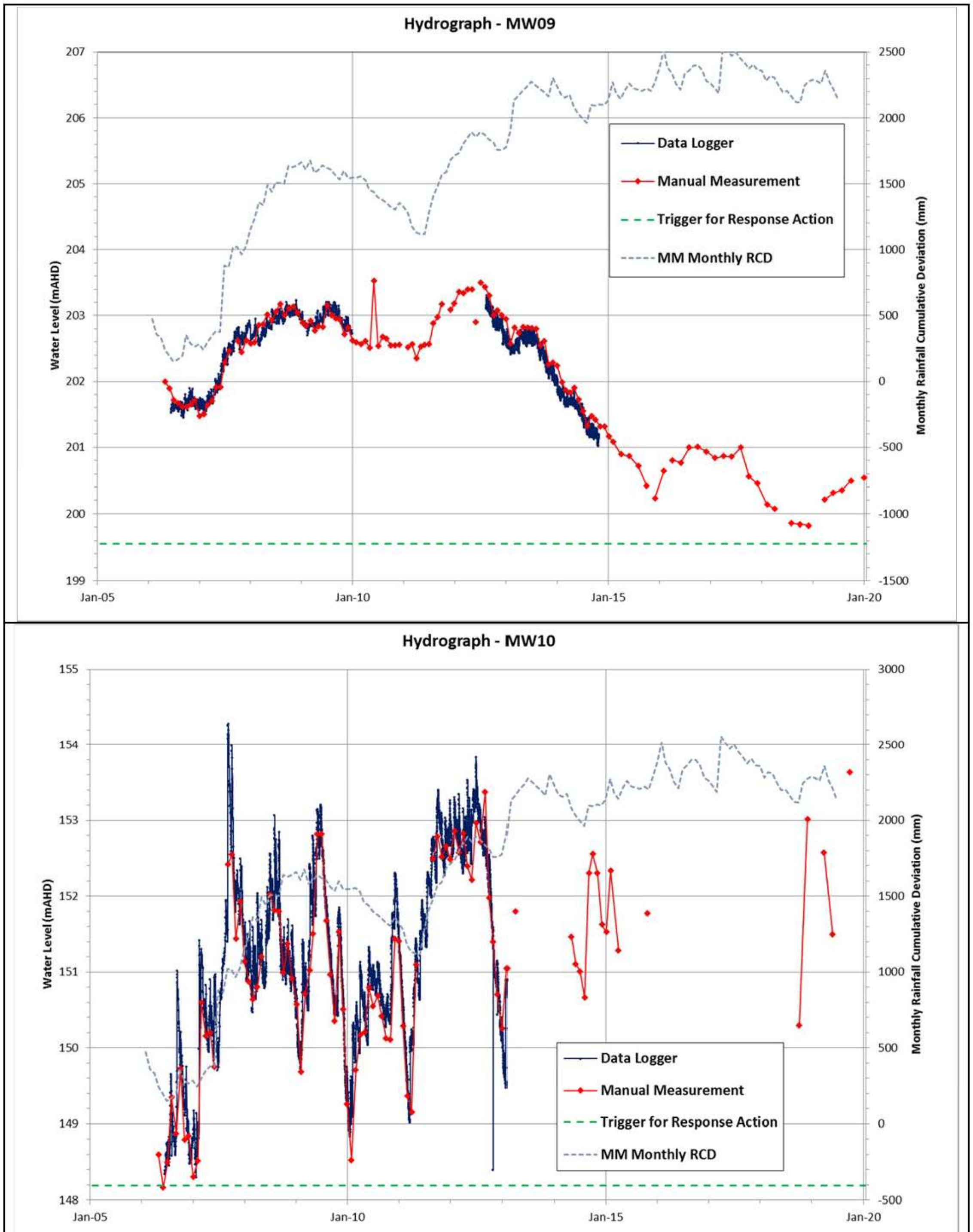




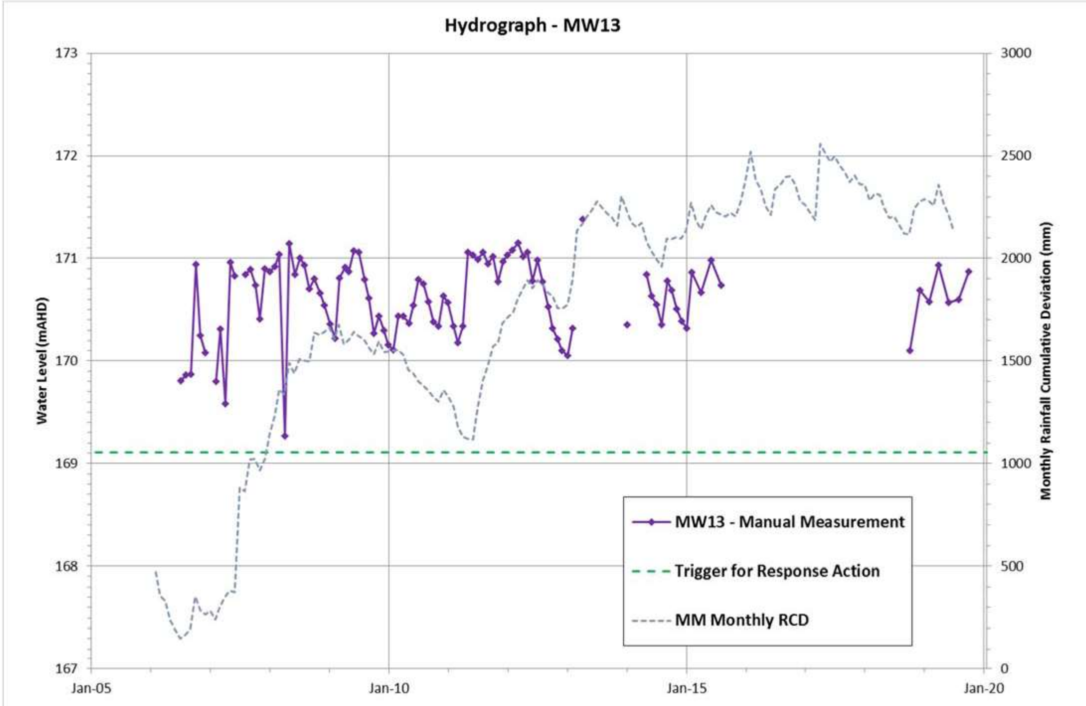
Date: 5 August 2020		Scale: as shown	**Hanson**
Author: PD	Checked: PD	Project No: 19-0362	**Calga Sand Quarry** **Water Level Hydrographs and Triggers** **Bores CQ12 and CQ13**
Dwg No: 0362-005		Revision:	
Dundon Consulting Pty Ltd			**Figure 5**

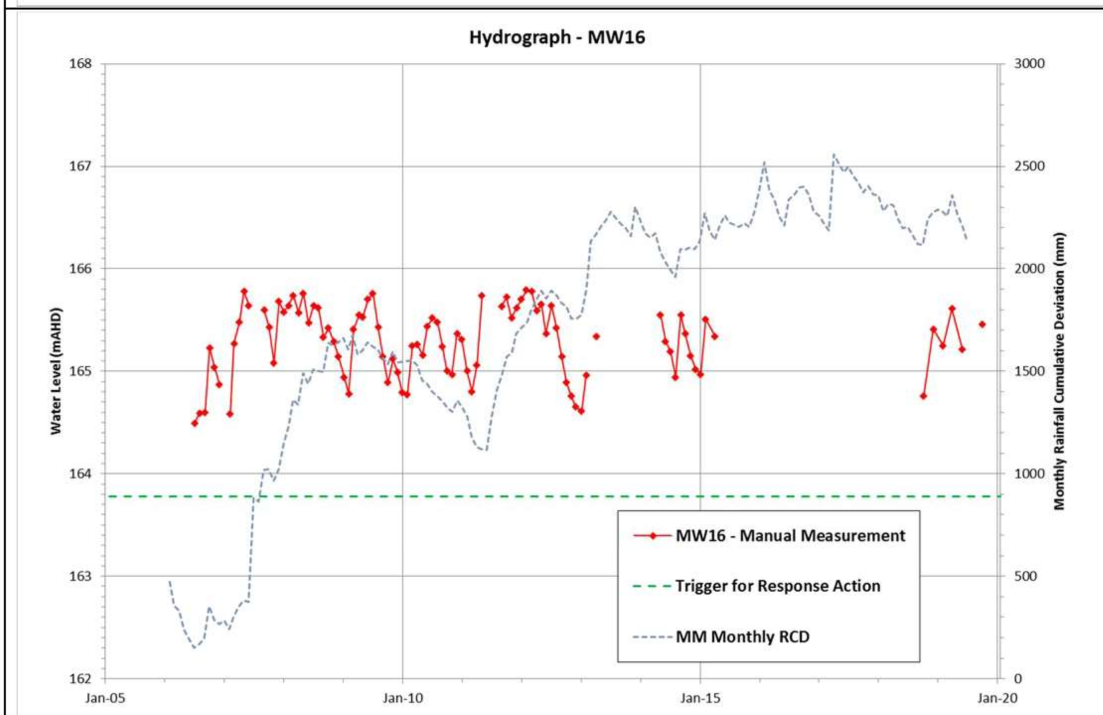


Date: 5 August 2020		Scale: as shown	**Hanson**
Author: PD	Checked: PD	Project No: 19-0362	**Calga Sand Quarry Water Level Hydrographs and Triggers Bores MW7 and MW8**
Dwg No: 0362-006		Revision:	
Dundon Consulting Pty Ltd			**Figure 6**

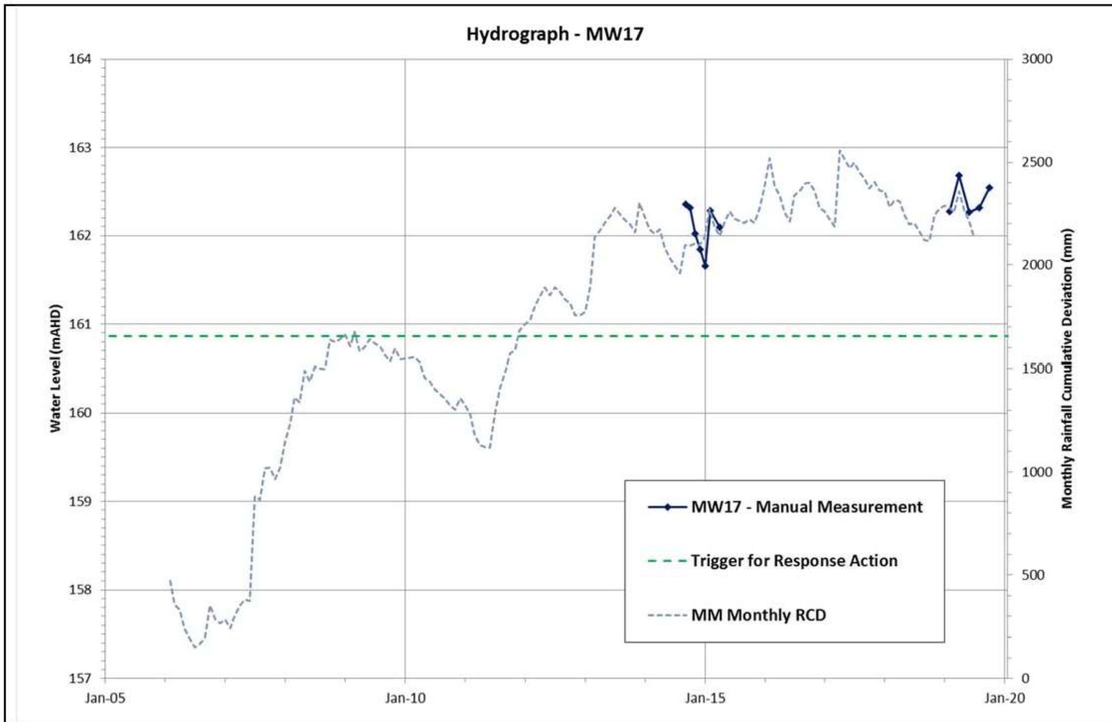


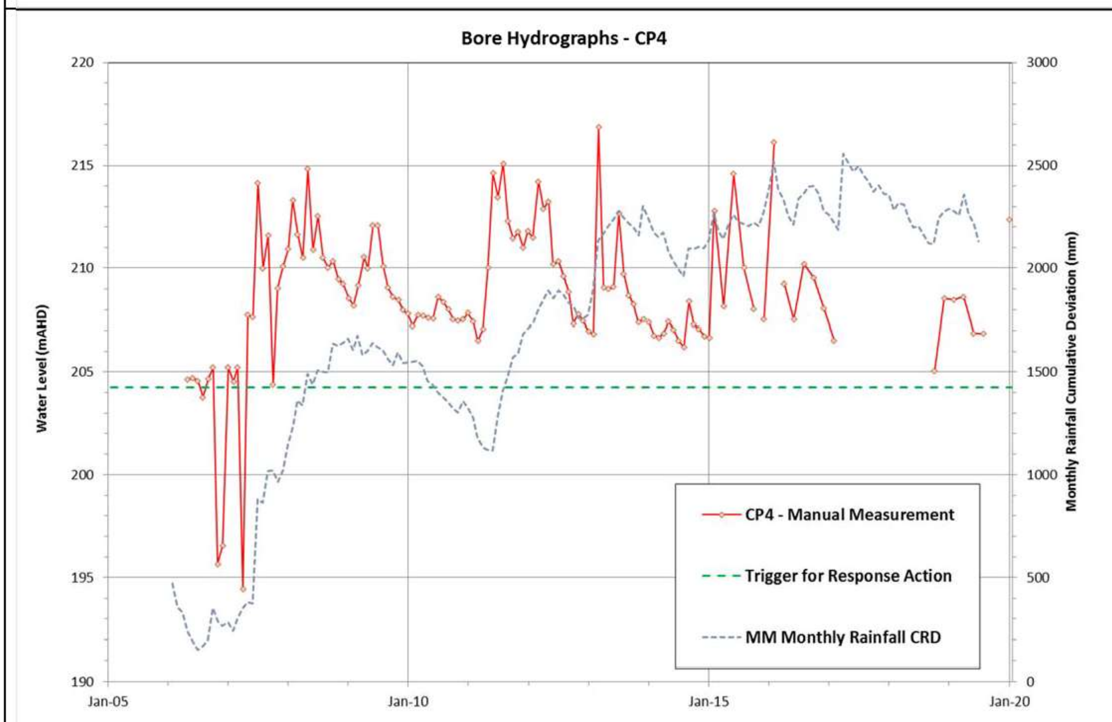
Date: 5 August 2020		Scale: as shown	**Hanson**
Author: PD	Checked: PD	Project No: 19-0362	**Calga Sand Quarry** **Water Level Hydrographs and Triggers** **Bores MW9 and MW10**
Dwg No: 0362-007		Revision:	
Dundon Consulting Pty Ltd			**Figure 7**



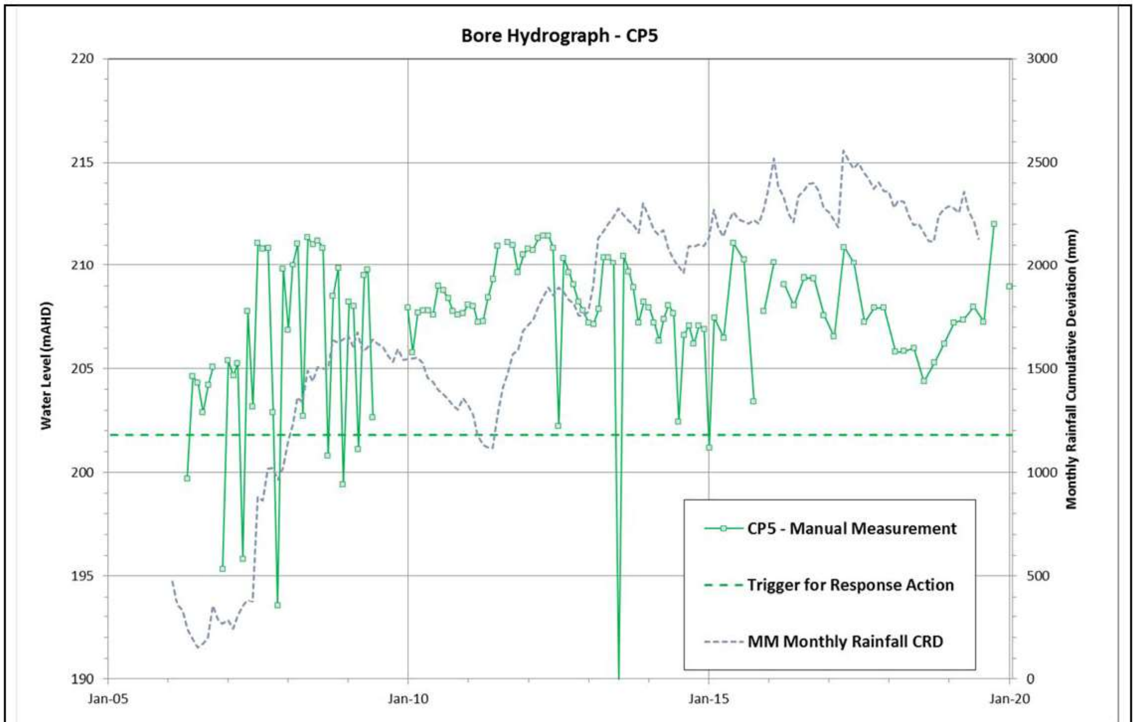


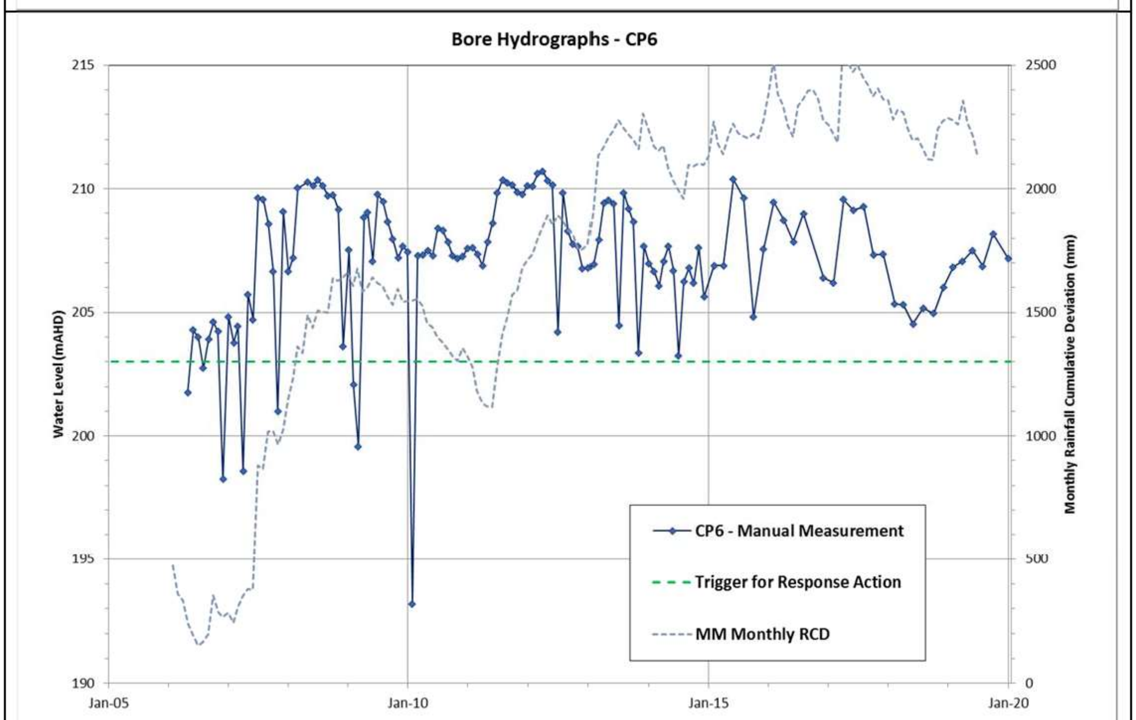
Date: 5 August 2020		Scale: as shown	**Hanson**	
Author: PD	Checked: PD	Project No: 19-0362	**Calga Sand Quarry** **Water Level Hydrographs and Triggers** **Bores MW13 and MW16**	
Dwg No: 0362-008		Revision:		
Dundon Consulting Pty Ltd				**Figure 8**



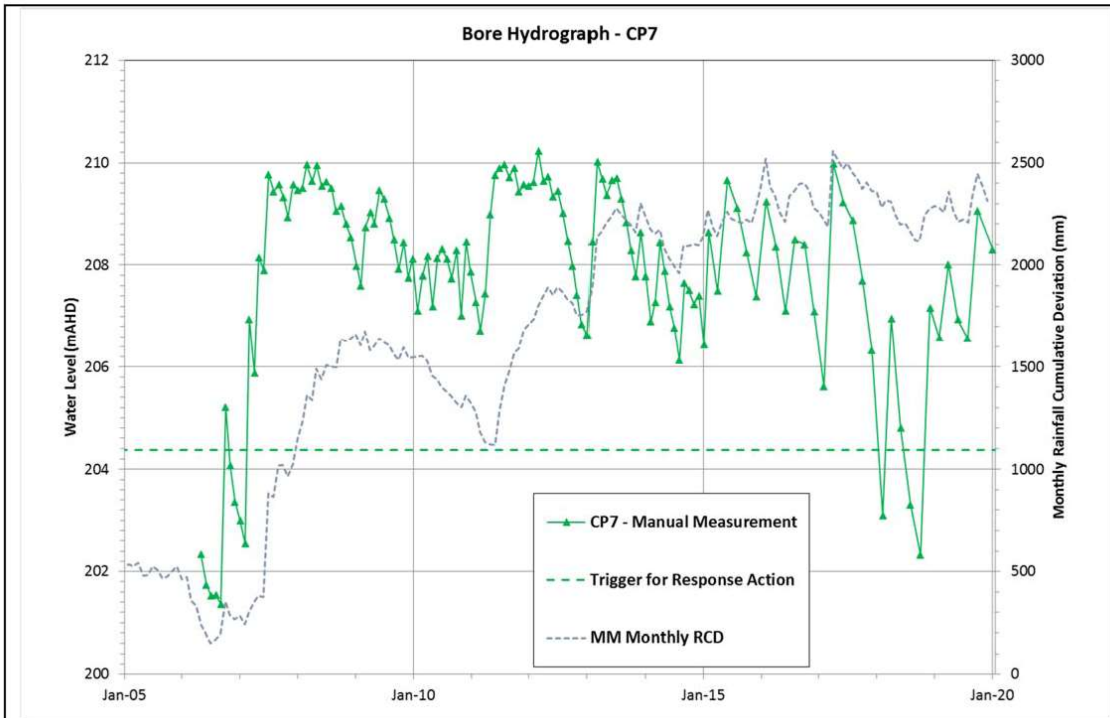


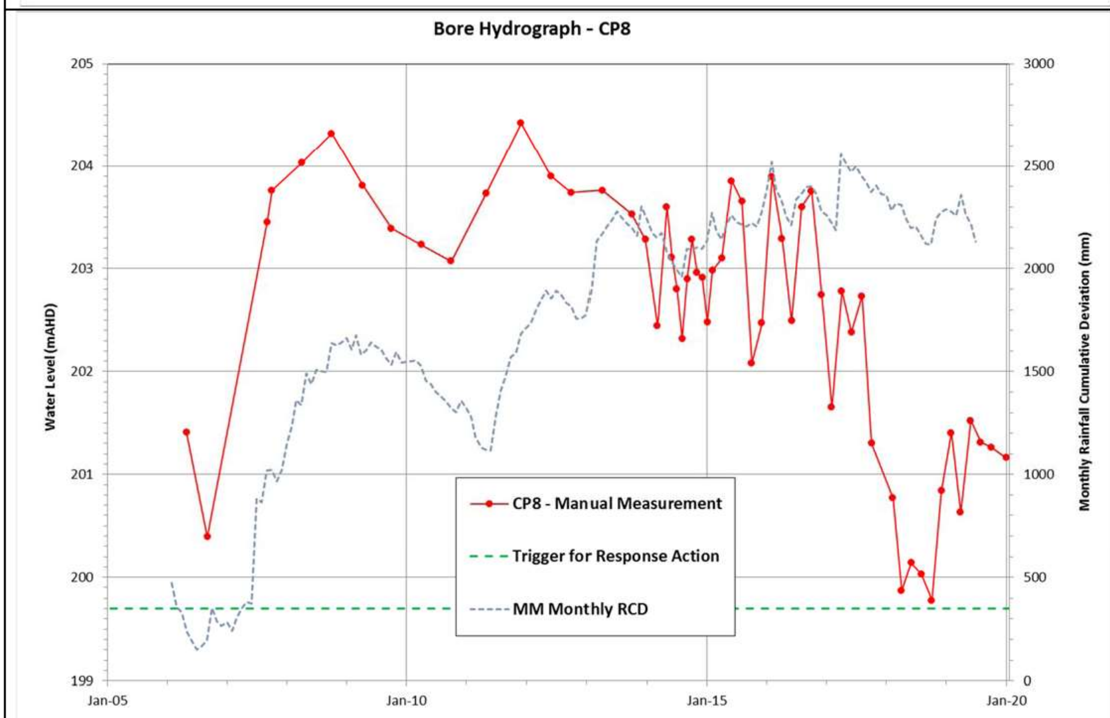
Date: 5 August 2020		Scale: as shown	**Hanson**
Author: PD	Checked: PD	Project No: 19-0362	**Calga Sand Quarry** **Water Level Hydrographs and Triggers** **Bores MW17 and CP4**
Dwg No: 0362-009		Revision:	
Dundon Consulting Pty Ltd			**Figure 9**



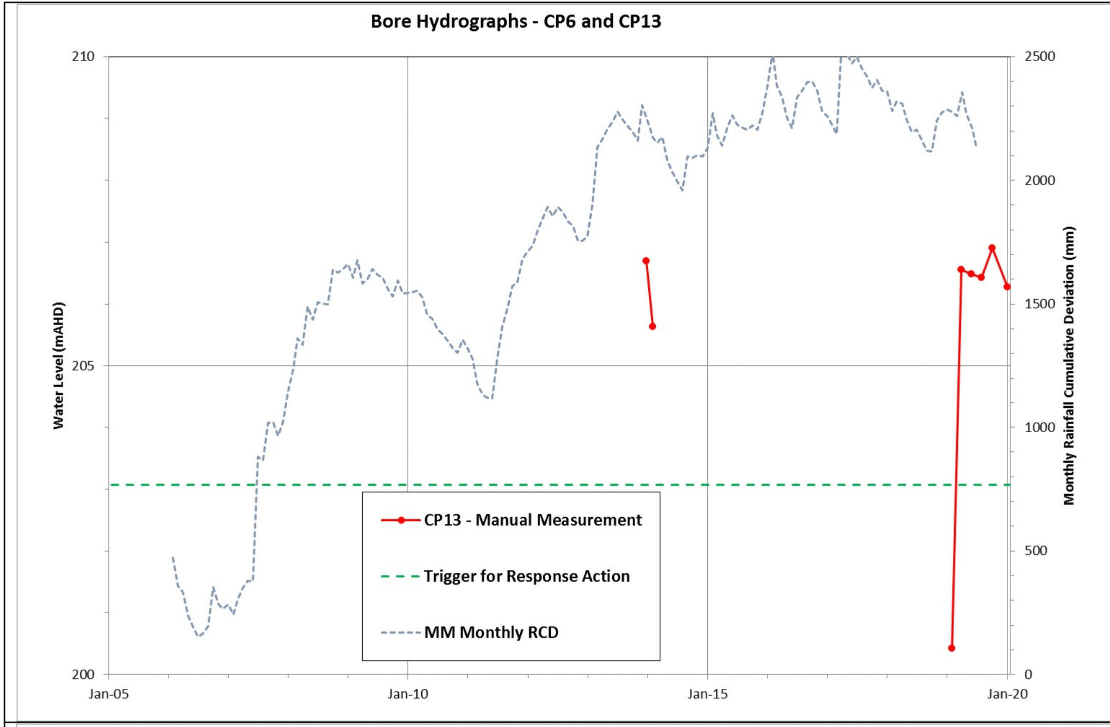


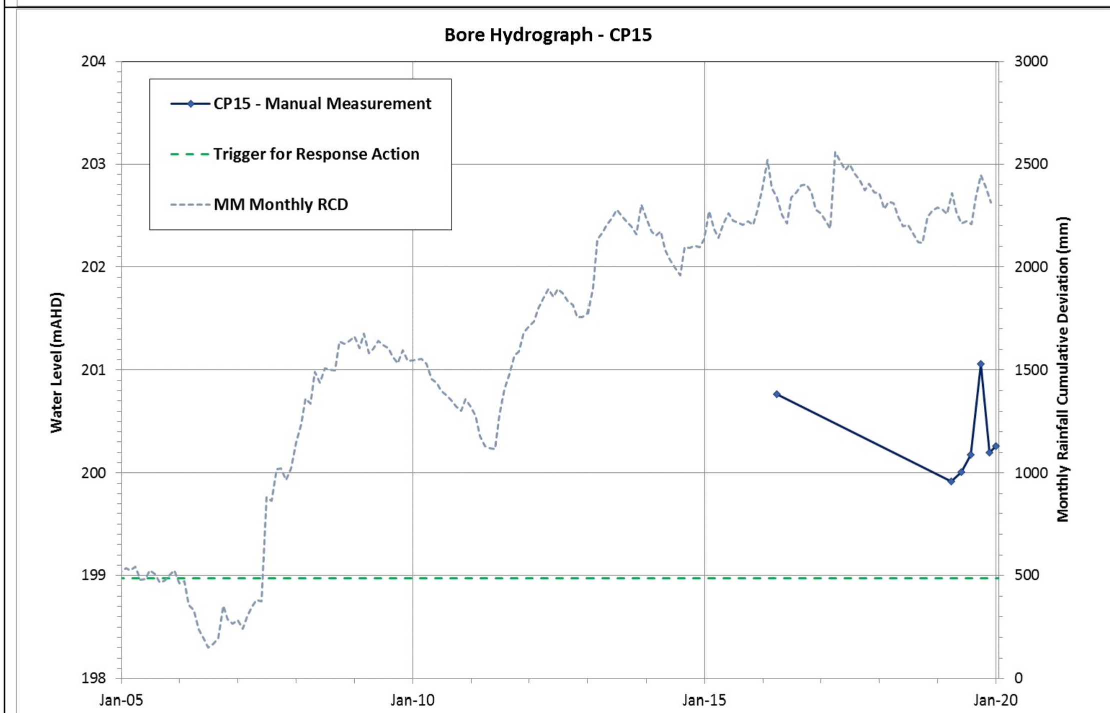
Date: 5 August 2020		Scale: as shown	**Hanson**
Author: PD	Checked: PD	Project No: 19-0362	**Calga Sand Quarry** **Water Level Hydrographs and Triggers** **Bores CP5 and CP6**
Dwg No: 0362-010		Revision:	
Dundon Consulting Pty Ltd			**Figure 10**





Date: 5 August 2020		Scale: as shown	**Hanson**
Author: PD	Checked: PD	Project No: 19-0362	**Calga Sand Quarry**
Dwg No: 0362-011		Revision:	**Water Level Hydrographs and Triggers Bores CP7 and CP8**
Dundon Consulting Pty Ltd			**Figure 11**





Date: 5 August 2020		Scale: as shown	**Hanson**
Author: PD	Checked: PD	Project No: 19-0362	**Calga Sand Quarry Water Level Hydrographs and Triggers Bores CP13 and CP15**
Dwg No: 0362-012		Revision:	
Dundon Consulting Pty Ltd			**Figure 12**

Appendix 3

Laboratory Assessed Groundwater Quality Results (April 2013 to 2 October 2017)

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Groundwater Quality – Bore CQ3 – 2013 to 2017

Parameter	Units	LOR	ANZECC (2000) Guideline	Date Sampled 5/04/13	2/10/13	4/04/14	2/10/14	2/04/15	2/10/15	5/04/16	4/10/16	3/04/17	3/10/17	Statistical Analysis Records Below LOR	% Below LOR	Average	Minimum	Max	95th %ile
pH	pH unit	0.01	N/A	6.44	6.06	6.41	6.54	6.61	6.01	6.66	6.47	6.28	6.06	0	0%	6.35	6.01	6.66	6.64
Conductivity @ 25ºC	µS/cm	1	N/A	144	118	128	138	177	106	192	152	181	129	0	0%	147	106	192	187
Hydroxide Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Carbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	34	21	26	28	46	17	53	38	51	22	0	0%	34	17	53	52
Sulphate	mg/L	1	N/A	<1	<1	<1	2	5	3	4	3	1	6	3	30%	3	1	6	6
Chloride	mg/L	1	N/A	22	24	27	20	24	22	30	22	23	23	0	0%	24	20	30	29
Calcium	mg/L	1	N/A	2	2	2	1	2	2	2	2	2	1	0	0%	2	1	2	2
Magnesium	mg/L	1	N/A	4	4	4	3	4	4	4	4	5	3	0	0%	4	3	5	5
Sodium	mg/L	1	N/A	13	13	15	12	16	13	19	13	15	15	0	0%	14	12	19	18
Potassium	mg/L	1	N/A	2	1	2	1	2	1	2	1	2	1	0	0%	2	1	2	2
Aluminium – total	mg/L	0.01	0.055	0.27	0.14	0.1	0.15	0.14	0.08	0.13	0.03	0.03	0.14	0	0%	0.12	0.03	0.27	0.22
Arsenic – total	mg/L	0.001	0.013	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	0.003	<0.001	8	80%	0.002	0.001	0.003	0.003
Cadmium – total	mg/L	1E-04	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0006	<0.0001	9	90%	0.0006	0.0006	0.000 6	0.0006
Chromium – total	mg/L	0.001	ID	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	<0.001	9	90%	0.003	0.003	0.003	0.003
Copper – total	mg/L	0.001	0.0014	<0.001	0.002	0.007	0.002	0.004	<0.001	0.011	<0.001	0.003	0.004	3	30%	0.005	0.002	0.011	0.010
Lead – total	mg/L	0.001	0.0034	0.001	0.002	0.003	<0.001	0.002	<0.001	0.001	<0.001	<0.001	0.002	4	40%	0.002	0.001	0.003	0.0028
Manganese – total	mg/L	0.001	1.9	1.59	1.47	1.69	1.31	2.06	1.36	1.19	1.48	1.42	0.514	0	0%	1.408	0.514	2.06	1.8935
Nickel – total	mg/L	0.001	0.011	0.009	0.014	0.011	0.013	0.003	0.015	0.012	0.01	0.007	0.017	0	0%	0.011	0.003	0.017	0.016
Selenium – total	mg/L	0.01	0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	10	100%	NA	NA	NA	NA
Zinc – total	mg/L	0.005	0.008	0.043	0.032	0.103	0.015	0.034	0.014	0.044	0.009	0.019	0.088	0	0%	0.040	0.009	0.103	0.097
Boron – total	mg/L	0.05	0.37	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	10	100%	NA	NA	NA	NA
Iron – total	mg/L	0.05	ID	19.3	17.5	16.5	14.2	9.86	12	6.97	12.7	13.5	5.54	0	0%	12.81	5.54	19.3	18.6
Mercury	mg/L	1E-04	0.00006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	10	100%	NA	NA	NA	NA
Fluoride	mg/L	0.1	N/A	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	10	100%	NA	NA	NA	NA
Nitrite as N	mg/L	0.01	N/A	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	9	90%	0.05	0.05	0.05	0.05
Nitrate as N	mg/L	0.01	0.7	0.66	<0.01	0.01	0.01	<0.01	0.03	<0.01	0.04	<0.01	0.24	4	40%	0.17	0.01	0.66	0.555
Nitrite + Nitrate as N	mg/L	0.01	N/A	0.71	<0.01	0.01	0.01	<0.01	0.03	<0.01	0.04	<0.01	0.24	4	40%	0.17	0.01	0.71	0.5925
Total Anions	meq/L	0.01	N/A	1.3	1.1	1.28	1.16	1.7	1.02	1.99	1.44	1.71	1.21	0	0%	1.39	1.02	1.99	1.9
Total Cations	meq/L	0.01	N/A	1.05	1.02	1.13	0.84	1.18	1.02	1.7	1.02	1.21	1.27	0	0%	1.14	0.84	1.7	1.51

Groundwater Quality – Bore CQ4 – 2013 to 2017

Parameter	Units	LOR	ANZECC (2000) Guideline	Date Sampled										Statistical Analysis					
				5/04/13	2/10/13	4/04/14	2/10/14	2/04/15	2/10/15	5/04/16	4/10/16	3/04/17	3/10/17	Records Below LOR	% Below LOR	Average	Minimum	Max	95th %ile
pH	pH unit	0.01	N/A	4.87	5.30	6.28	5.31	5.19	4.90	5.01	5.22	5.25	5.25	0	0%	5.26	4.87	6.28	5.84
Conductivity @ 25ºC	µS/cm	1	N/A	104	106	118	124	130	105	122	130	134	126	0	0%	119.9	104	134	132.2
Hydroxide Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Carbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	1	<1	<1	<1	2	1	3	7	3	4	40%	2.8	1	7	6
Sulphate	mg/L	1	N/A	7	6	7	8	6	6	8	6	5	6	0	0%	6.5	5	8	8
Chloride	mg/L	1	N/A	22	25	28	22	26	23	26	22	23	23	0	0%	24	22	28	27.1
Calcium	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Magnesium	mg/L	1	N/A	1	1	1	2	2	2	2	2	2	1	0	0%	1.6	1	2	2
Sodium	mg/L	1	N/A	15	17	19	18	19	17	19	18	21	19	0	0%	18.2	15	21	20.1
Potassium	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Aluminium – total	mg/L	0.01	0.055	0.17	0.31	0.47	0.2	0.45	0.14	0.38	0.33	0.15	0.16	0	0%	0.28	0.14	0.47	0.46
Arsenic – total	mg/L	0.001	0.013	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	10	100%	NA	NA	NA	NA
Cadmium – total	mg/L	1E-04	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	10	100%	NA	NA	NA	NA
Chromium – total	mg/L	0.001	ID	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.001	<0.001	<0.001	<0.001	8	80%	0.001	0.001	0.001	0.001
Copper – total	mg/L	0.001	0.0014	<0.001	0.003	0.007	0.002	0.007	0.002	0.007	0.005	0.002	0.001	1	10%	0.004	0.001	0.007	0.007
Lead – total	mg/L	0.001	0.0034	0.002	0.002	0.004	0.002	0.009	0.002	0.004	0.005	0.002	0.002	0	0%	0.003	0.002	0.009	0.007
Manganese – total	mg/L	0.001	1.9	0.034	0.006	0.02	0.004	0.012	0.017	0.018	0.018	0.011	0.008	0	0%	0.015	0.004	0.034	0.028
Nickel – total	mg/L	0.001	0.011	<0.001	0.002	0.005	<0.001	0.001	0.001	0.003	0.002	0.001	<0.001	3	30%	0.002	0.001	0.005	0.004
Selenium – total	mg/L	0.01	0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	10	100%	NA	NA	NA	NA
Zinc – total	mg/L	0.005	0.008	0.012	0.064	0.119	0.029	0.072	0.058	0.075	0.081	0.027	0.031	0	0%	0.057	0.012	0.119	0.102
Boron – total	mg/L	0.05	0.37	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	10	100%	NA	NA	NA	NA
Iron – total	mg/L	0.05	ID	0.41	0.23	0.37	<0.05	0.24	0.37	0.33	0.28	0.15	<0.05	2	20%	0.30	0.15	0.41	0.396
Mercury	mg/L	1E-04	0.00006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	10	100%	NA	NA	NA	NA
Fluoride	mg/L	0.1	N/A	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	10	100%	NA	NA	NA	NA
Nitrite as N	mg/L	0.01	N/A	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.01	0.09	7	70%	0.04	0.01	0.09	0.08
Nitrate as N	mg/L	0.01	0.7	0.6	0.88	1.74	2.35	2.7	2.19	2.97	2.47	1.53	2.19	0	0%	1.96	0.60	2.97	2.85
Nitrite + Nitrate as N	mg/L	0.01	N/A	0.6	0.88	1.74	2.35	2.7	2.19	2.97	2.49	1.54	2.28	0	0%	1.97	0.60	2.97	2.85
Total Anions	meq/L	0.01	N/A	0.77	0.85	0.94	0.79	0.86	0.81	0.92	0.8	0.89	0.83	0	0%	0.85	0.77	0.94	0.93
Total Cations	meq/L	0.01	N/A	0.73	0.82	0.91	0.95	0.99	0.9	0.99	0.95	1.08	0.91	0	0%	0.92	0.73	1.08	1.04

Groundwater Quality – Bore CQ5 – 2013 to 2017

Parameter	Units	LOR	ANZECC (2000) Guideline	Date Sampled 5/04/13	2/10/13	4/04/14	2/10/14	2/04/15	2/10/15	5/04/16	4/10/16	3/04/17	3/10/17	Statistical Analysis Records Below LOR	% Below LOR	Average	Minimum	Max	95th %ile
pH	pH unit	0.01	N/A	3.81	4.57	4.71	4.9	4.65	4.1	4.31	4.19	4.66	5.06	0	0%	4.50	3.81	5.06	4.99
Conductivity @ 25ºC	µS/cm	1	N/A	194	200	184	174	171	164	160	188	169	185	0	0%	179	160	200	197
Hydroxide Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Carbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Sulphate	mg/L	1	N/A	25	25	25	30	26	27	29	27	24	27	0	0%	27	24	30	30
Chloride	mg/L	1	N/A	22	32	29	22	25	26	23	21	20	25	0	0%	25	20	32	31
Calcium	mg/L	1	N/A	3	1	2	2	2	<1	2	2	4	<1	2	20%	2	1	4	4
Magnesium	mg/L	1	N/A	4	6	5	4	4	5	4	5	5	4	0	0%	5	4	6	6
Sodium	mg/L	1	N/A	14	20	17	16	14	17	15	15	14	17	0	0%	16	14	20	19
Potassium	mg/L	1	N/A	2	<1	1	1	1	<1	1	1	3	<1	3	30%	1	1	3	3
Aluminium – total	mg/L	0.01	0.055	1.07	1.81	1.9	1.41	1.12	1.66	1.32	1.68	1.59	2.57	0	0%	1.61	1.07	2.57	2.27
Arsenic – total	mg/L	0.001	0.013	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	9	90%	0.002	0.002	0.002	0.002
Cadmium – total	mg/L	1E-04	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	10	100%	NA	NA	NA	NA
Chromium – total	mg/L	0.001	ID	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	9	90%	0.001	0.001	0.001	0.001
Copper – total	mg/L	0.001	0.0014	0.001	<0.001	0.016	<0.001	4.65	4.1	<0.001	0.003	0.005	0.002	3	30%	1.254	0.001	4.65	0.014
Lead – total	mg/L	0.001	0.0034	0.002	0.001	0.003	0.001	171	164	0.001	<0.001	0.003	0.003	1	10%	37.224	0.001	171	0.003
Manganese – total	mg/L	0.001	1.9	0.008	0.005	0.021	0.004	<1	<1	0.005	0.006	0.023	0.023	2	20%	0.012	0.004	0.023	0.023
Nickel – total	mg/L	0.001	0.011	<0.001	<0.001	0.004	<0.001	<1	<1	<0.001	<0.001	<0.001	0.001	8	80%	0.003	0.001	0.004	0.004
Selenium – total	mg/L	0.01	0.005	<0.01	<0.01	<0.01	<0.01	<1	<1	<0.01	<0.01	<0.01	<0.01	10	100%	NA	NA	NA	NA
Zinc – total	mg/L	0.005	0.008	0.049	0.024	0.111	0.006	26	27	0.013	0.012	0.156	0.023	0	0%	5.339	0.006	27	0.136
Boron – total	mg/L	0.05	0.37	<0.05	<0.05	<0.05	<0.05	25	26	<0.05	<0.05	<0.05	<0.05	8	80%	25.50	25	26	NA
Iron – total	mg/L	0.05	ID	0.08	0.16	0.45	<0.05	2	<1	<0.05	<0.05	0.4	0.86	4	40%	0.66	0.08	2	0.778
Mercury	mg/L	1E-04	0.00006	<0.0001	<0.0001	<0.0001	<0.0001	4	5	<0.0001	<0.0001	<0.0001	<0.0001	8	80%	4.5000	4	5	NA
Fluoride	mg/L	0.1	N/A	<0.1	<0.1	<0.1	<0.1	14	17	<0.1	<0.1	<0.1	<0.1	8	80%	15.5	14	17	NA
Nitrite as N	mg/L	0.01	N/A	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.06	<0.01	9	90%	0.06	0.06	0.06	0.06
Nitrate as N	mg/L	0.01	0.7	3.78	2.58	2.45	1.73	1.81	2.13	1.85	2.55	2.58	2.81	0	0%	2.43	1.73	3.78	3.34
Nitrite + Nitrate as N	mg/L	0.01	N/A	3.78	2.58	2.48	1.73	1.81	2.13	1.85	2.55	2.64	2.81	0	0%	2.436	1.73	3.78	3.3435
Total Anions	meq/L	0.01	N/A	1.14	1.42	1.34	1.24	1.25	1.3	1.25	1.15	1.06	1.27	0	0%	1.24	1.06	1.42	1.38
Total Cations	meq/L	0.01	N/A	1.14	1.41	1.28	1.15	1.06	1.15	1.11	1.19	1.3	1.07	0	0%	1.19	1.06	1.41	1.36

Groundwater Quality – Bore CQ7 – 2013 to 2017

Parameter	Units	LOR	ANZECC (2000) Guideline	Date Sampled										Statistical Analysis					
				5/04/13	2/10/13	4/04/14	2/10/14	2/04/15	2/10/15	5/04/16	4/10/16	3/04/17	3/10/17	Records Below LOR	% Below LOR	Average	Minimum	Max	95th %ile
pH	pH unit	0.01	N/A	5.69	4.99	5.01	5.59	4.7	4.5	4.82	4.67	4.58	5.41	0	0%	5.00	4.5	5.69	5.65
Conductivity @ 25ºC	µS/cm	1	N/A	112	116	103	110	119	92	102	112	123	112	0	0%	110	92	123	121
Hydroxide Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Carbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	3	<1	<1	<1	<1	<1	<1	<1	<1	<1	9	90%	3	3	3	3
Sulphate	mg/L	1	N/A	3	1	3	3	3	2	4	3	3	4	0	0%	3	1	4	4
Chloride	mg/L	1	N/A	23	28	26	22	27	23	26	22	24	24	0	0%	25	22	28	28
Calcium	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	1	<1	9	90%	1	1	1	1
Magnesium	mg/L	1	N/A	2	2	1	2	1	2	2	2	2	1	0	0%	2	1	2	2
Sodium	mg/L	1	N/A	14	15	15	15	15	14	16	14	16	15	0	0%	15	14	16	16
Potassium	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	1	<1	9	90%	1	1	1	1
Aluminium – total	mg/L	0.01	0.055	0.11	0.19	0.19	0.26	0.38	0.24	0.33	0.54	0.21	2.13	0	0%	0.46	0.11	2.13	1.41
Arsenic – total	mg/L	0.001	0.013	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	10	100%	NA	NA	NA	NA
Cadmium – total	mg/L	1E-04	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	10	100%	NA	NA	NA	NA
Chromium – total	mg/L	0.001	ID	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	0.003	8	80%	0.002	0.001	0.003	0.003
Copper – total	mg/L	0.001	0.0014	0.001	<0.001	0.002	<0.001	0.004	<0.001	0.004	0.003	0.002	0.012	3	30%	0.004	0.001	0.012	0.0096
Lead – total	mg/L	0.001	0.0034	0.002	<0.001	<0.001	<0.001	0.001	0.001	0.002	0.001	0.001	0.007	3	30%	0.002	0.001	0.007	0.0055
Manganese – total	mg/L	0.001	1.9	0.008	0.001	0.005	0.004	0.004	0.004	0.008	0.005	0.006	0.031	0	0%	0.008	0.001	0.031	0.02065
Nickel – total	mg/L	0.001	0.011	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	0.001	8	80%	0.001	0.001	0.001	0.001
Selenium – total	mg/L	0.01	0.005	<0.01	<0.01	<0.01	<0.01	<0.001	<0.01	<0.01	<0.01	<0.01	<0.01	10	100%	NA	NA	NA	NA
Zinc – total	mg/L	0.005	0.008	0.049	0.006	0.022	0.012	0.031	0.011	0.035	0.017	0.046	0.12	0	0%	0.035	0.006	0.12	0.088
Boron – total	mg/L	0.05	0.37	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	10	100%	NA	NA	NA	NA
Iron – total	mg/L	0.05	ID	0.08	<0.05	<0.05	0.1	0.11	0.08	0.22	0.24	0.08	1.34	2	20%	0.28	0.08	1.34	0.96
Mercury	mg/L	1E-04	0.00006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	10	100%	NA	NA	NA	NA
Fluoride	mg/L	0.1	N/A	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	10	100%	NA	NA	NA	NA
Nitrite as N	mg/L	0.01	N/A	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	9	90%	0.02	0.02	0.02	0.02
Nitrate as N	mg/L	0.01	0.7	1.44	1.58	1.71	1.72	2.25	1.52	1.34	1.29	2.01	1.39	0	0%	1.63	1.29	2.25	2.14
Nitrite + Nitrate as N	mg/L	0.01	N/A	1.44	1.58	1.71	1.72	2.25	1.52	1.34	1.29	2.03	1.39	0	0%	1.63	1.29	2.25	2.15
Total Anions	meq/L	0.01	N/A	0.77	0.81	0.8	0.68	0.82	0.69	0.82	0.68	0.74	0.76	0	0%	0.76	0.68	0.82	0.82
Total Cations	meq/L	0.01	N/A	0.77	0.82	0.73	0.82	0.73	0.77	0.86	0.77	0.94	0.73	0	0%	0.79	0.73	0.94	0.90

Groundwater Quality – Bore CQ8 – 2013 to 2017

				Date Sampled										Statistical Analysis					
Parameter	**Units**	**LOR**	**ANZECC (2000) Guideline**	**5/04/13**	**2/10/13**	**4/04/14**	**2/10/14**	**2/04/15**	**2/10/15**	**5/04/16**	**4/10/16**	**3/04/17**	**3/10/17**	**Records Below LOR**	**% Below LOR**	**Average**	**Minimum**	**Maxi mum**	**95th %ile**
pH	pH unit	0.01	N/A	4.37	4.83	5.18	4.97	4.79	4.32	4.50	4.39	6.01	4.39	0	0%	4.78	4.32	6.01	5.64
Conductivity @ 25ºC	µS/cm	1	N/A	156	156	136	148	148	119	133	152	155	138	0	0%	144	119	156	156
Hydroxide Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Carbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	2	<1	<1	<1	<1	<1	21	<1	8	80%	12	2	21	20
Sulphate	mg/L	1	N/A	5	4	6	7	6	6	10	8	8	10	0	0%	7	4	10	10
Chloride	mg/L	1	N/A	21	25	21	19	24	18	21	18	20	19	0	0%	21	18	25	25
Calcium	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Magnesium	mg/L	1	N/A	4	5	4	4	4	4	4	4	5	3	0	0%	4	3	5	5
Sodium	mg/L	1	N/A	17	18	17	14	16	14	16	14	17	15	0	0%	16	14	18	18
Potassium	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	1	<1	9	90%	1	1	1	1
Aluminium – total	mg/L	0.01	0.055	0.56	0.56	0.54	0.51	0.49	0.43	0.51	0.52	0.11	0.6	0	0%	0.48	0.11	0.6	0.582
Arsenic – total	mg/L	0.001	0.013	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	10	100%	NA	NA	NA	NA
Cadmium – total	mg/L	1E-04	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	10	100%	NA	NA	NA	NA
Chromium – total	mg/L	0.001	ID	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	9	90%	0.002	0.002	0.002	0.002
Copper – total	mg/L	0.001	0.0014	0.002	0.003	0.003	<0.001	<0.001	<0.001	<0.001	0.001	0.002	<0.001	5	50%	0.002	0.001	0.003	0.003
Lead – total	mg/L	0.001	0.0034	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	8	80%	0.003	0.002	0.003	0.003
Manganese – total	mg/L	0.001	1.9	0.005	0.002	0.004	0.001	<0.001	<0.001	0.001	0.001	0.007	0.004	2	20%	0.003	0.001	0.007	0.006
Nickel – total	mg/L	0.001	0.011	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	8	80%	0.002	0.001	0.003	0.003
Selenium – total	mg/L	0.01	0.005	<0.01	<0.01	<0.01	<0.01	<0.001	<0.01	<0.01	<0.01	<0.01	<0.01	10	100%	NA	NA	NA	NA
Zinc – total	mg/L	0.005	0.008	0.071	0.022	0.027	0.011	0.012	0.006	0.018	0.016	0.044	0.046	0	0%	0.027	0.006	0.071	0.060
Boron – total	mg/L	0.05	0.37	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	10	100%	NA	NA	NA	NA
Iron – total	mg/L	0.05	ID	0.11	0.06	0.07	<0.05	<0.05	<0.05	0.09	<0.05	0.04	0.05	4	40%	0.07	0.04	0.11	0.11
Mercury	mg/L	1E-04	0.00006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	10	100%	NA	NA	NA	NA
Fluoride	mg/L	0.1	N/A	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	10	100%	NA	NA	NA	NA
Nitrite as N	mg/L	0.01	N/A	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	9	90%	0.02	0.02	0.02	0.02
Nitrate as N	mg/L	0.01	0.7	7.28	7.12	6.12	6.37	6.09	5.81	5.56	5.46	1.3	4.91	0	0%	5.60	1.3	7.28	7.208
Nitrite + Nitrate as N	mg/L	0.01	N/A	7.28	7.12	6.14	6.37	6.09	5.81	5.56	5.46	1.3	4.91	0	0%	5.60	1.3	7.28	7.208
Total Anions	meq/L	0.01	N/A	0.7	0.79	1.27	0.68	0.8	1.01	0.8	0.67	1.15	0.74	0	0%	0.86	0.67	1.27	1.22
Total Cations	meq/L	0.01	N/A	1.07	1.19	1.07	0.94	1.03	0.94	1.02	0.94	1.18	0.9	0	0%	1.03	0.9	1.19	1.19

Groundwater Quality – Bore CQ10 – 2013 to 2017

Parameter	Units	LOR	ANZECC (2000) Guideline	Date Sampled										Statistical Analysis					
				5/04/13	2/10/13	4/04/14	2/10/14	2/04/15	2/10/15	5/04/16	4/10/16	3/04/17	3/10/17	Records Below LOR	% Below LOR	Average	Minimum	Max	95th %ile
pH	pH unit	0.01	N/A	4.8	4.96	4.6	4.49	4.6	4.2	5.07	4.76	4.35	4.74	0	0%	4.66	4.2	5.07	5.02
Conductivity @ 25ºC	µS/cm	1	N/A	178	182	188	185	179	138	140	149	167	151	0	0%	166	138	188	187
Hydroxide Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Carbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	2	<1	<1	<1	9	90%	2	2	2	2
Sulphate	mg/L	1	N/A	29	31	34	36	30	22	24	21	18	20	0	0%	27	18	36	35
Chloride	mg/L	1	N/A	29	31	29	21	28	24	27	23	25	25	0	0%	26	21	31	30
Calcium	mg/L	1	N/A	3	3	3	2	2	1	1	1	2	<1	1	10%	2	1	3	3
Magnesium	mg/L	1	N/A	4	4	4	4	4	3	3	3	4	2	0	0%	4	2	4	4
Sodium	mg/L	1	N/A	20	21	19	15	17	17	18	16	19	18	0	0%	18	15	21	21
Potassium	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Aluminium – total	mg/L	0.01	0.055	1.36	1.61	2.62	2.04	1.94	1.18	0.97	0.9	1.11	1.02	0	0%	1.48	0.9	2.62	2.359
Arsenic – total	mg/L	0.001	0.013	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	9	90%	0.001	0.001	0.001	0.001
Cadmium – total	mg/L	1E-04	0.0002	0.0002	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	8	80%	0.0002	0.0001	0.0002	0.0002
Chromium – total	mg/L	0.001	ID	0.002	<0.001	0.017	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	7	70%	0.007	0.001	0.017	0.0155
Copper – total	mg/L	0.001	0.0014	0.02	0.014	0.04	0.048	0.048	0.03	0.031	0.024	0.038	0.029	0	0%	0.032	0.014	0.048	0.048
Lead – total	mg/L	0.001	0.0034	0.014	0.006	0.004	0.002	0.002	<0.001	0.003	0.002	0.004	0.001	1	10%	0.004	0.001	0.014	0.011
Manganese – total	mg/L	0.001	1.9	0.038	0.031	0.04	0.018	0.025	0.017	0.033	0.028	0.035	0.016	0	0%	0.028	0.016	0.04	0.039
Nickel – total	mg/L	0.001	0.011	0.005	0.004	0.005	0.001	0.002	0.001	0.002	0.003	0.002	0.002	0	0%	0.003	0.001	0.005	0.005
Selenium – total	mg/L	0.01	0.005	<0.01	<0.01	<0.01	<0.01	<0.001	<0.01	<0.01	<0.01	<0.01	<0.01	10	100%	NA	NA	NA	NA
Zinc – total	mg/L	0.005	0.008	0.205	0.137	0.051	0.017	0.052	0.013	0.051	0.049	0.064	0.02	0	0%	0.07	0.013	0.205	0.17
Boron – total	mg/L	0.05	0.37	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	10	100%	NA	NA	NA	NA
Iron – total	mg/L	0.05	ID	0.5	0.13	0.9	0.2	0.44	0.15	0.3	0.12	0.45	0.16	0	0%	0.34	0.12	0.9	0.72
Mercury	mg/L	1E-04	0.00006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	10	100%	NA	NA	NA	NA
Fluoride	mg/L	0.1	N/A	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	10	100%	NA	NA	NA	NA
Nitrite as N	mg/L	0.01	N/A	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	10	100%	NA	NA	NA	NA
Nitrate as N	mg/L	0.01	0.7	0.69	0.55	0.95	0.92	1.03	0.87	0.04	0.02	0.83	0.76	0	0%	0.67	0.02	1.03	0.99
Nitrite + Nitrate as N	mg/L	0.01	N/A	0.69	0.55	0.95	0.92	1.03	0.87	0.04	0.02	0.83	0.76	0	0%	0.67	0.02	1.03	0.99
Total Anions	meq/L	0.01	N/A	1.42	1.52	1.53	1.34	1.41	1.14	1.3	1.09	1.08	1.12	0	0%	1.30	1.08	1.53	1.53
Total Cations	meq/L	0.01	N/A	1.35	1.39	1.31	1.08	1.17	1.04	1.08	0.99	1.26	0.95	0	0%	1.16	0.95	1.39	1.37

Groundwater Quality – Bore CQ11S – 2013 to 2017

Parameter	Units	LOR	ANZECC (2000) Guideline	Date Sampled 5/04/13	2/10/13	4/04/14	2/10/14	2/04/15	2/10/15	5/04/16	4/10/16	3/04/17	3/10/17	Statistical Analysis Records Below LOR	% Below LOR	Average	Minimum	Max	95th %ile
pH	pH unit	0.01	N/A	4.54	4.99	4.97	5.07	5.1	4.75	4.9	4.83	5.2	5.28	0	0%	4.96	4.54	5.28	5.24
Conductivity @ 25ºC	µS/cm	1	N/A	172	168	163	158	161	131	150	161	178	153	0	0%	160	131	178	175
Hydroxide Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Carbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	2	<1	8	4	7	70%	5	2	8	8
Sulphate	mg/L	1	N/A	37	34	32	34	32	28	29	26	24	24	0	0%	30	24	37	36
Chloride	mg/L	1	N/A	23	25	23	22	26	22	26	21	23	24	0	0%	24	21	26	26
Calcium	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Magnesium	mg/L	1	N/A	4	5	4	4	4	4	4	4	4	2	0	0%	4	2	5	5
Sodium	mg/L	1	N/A	18	20	20	18	20	18	21	19	22	20	0	0%	20	18	22	22
Potassium	mg/L	1	N/A	4	4	4	2	2	2	2	2	3	2	0	0%	3	2	4	4
Aluminium – total	mg/L	0.01	0.055	1.05	0.99	0.77	0.84	0.75	0.88	0.59	0.72	0.26	0.53	0	0%	0.74	0.26	1.05	1.02
Arsenic – total	mg/L	0.001	0.013	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	10	100%	NA	NA	NA	NA
Cadmium – total	mg/L	1E-04	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	10	100%	NA	NA	NA	NA
Chromium – total	mg/L	0.001	ID	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	9	90%	0.001	0.001	0.001	0.001
Copper – total	mg/L	0.001	0.0014	0.006	0.005	0.004	0.002	0.002	0.004	0.002	0.003	<0.001	0.003	1	10%	0.003	0.002	0.006	0.006
Lead – total	mg/L	0.001	0.0034	0.01	0.008	0.005	0.003	0.005	0.005	0.003	0.003	<0.001	0.003	1	10%	0.005	0.003	0.01	0.009
Manganese – total	mg/L	0.001	1.9	0.012	0.015	0.018	0.006	0.008	0.009	0.006	0.006	0.013	0.008	0	0%	0.010	0.006	0.018	0.017
Nickel – total	mg/L	0.001	0.011	0.002	0.002	0.002	<0.001	0.002	<0.001	0.001	0.001	<0.001	<0.001	4	40%	0.002	0.001	0.002	0.002
Selenium – total	mg/L	0.01	0.005	<0.01	<0.01	<0.01	<0.01	<0.001	<0.01	<0.01	<0.01	<0.01	<0.01	10	100%	NA	NA	NA	NA
Zinc – total	mg/L	0.005	0.008	0.091	0.114	0.096	0.043	0.063	0.038	0.034	0.031	0.06	0.048	0	0%	0.062	0.031	0.114	0.1059
Boron – total	mg/L	0.05	0.37	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	10	100%	NA	NA	NA	NA
Iron – total	mg/L	0.05	ID	0.15	0.2	0.27	<0.05	0.09	0.2	0.06	0.07	0.41	0.2	1	10%	0.18	0.06	0.41	0.35
Mercury	mg/L	1E-04	0.00006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	10	100%	NA	NA	NA	NA
Fluoride	mg/L	0.1	N/A	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	10	100%	NA	NA	NA	NA
Nitrite as N	mg/L	0.01	N/A	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	10	100%	NA	NA	NA	NA
Nitrate as N	mg/L	0.01	0.7	0.4	0.07	0.26	0.07	0.14	0.14	0.28	0.1	<0.01	0.08	1	10%	0.17	0.07	0.4	0.35
Nitrite + Nitrate as N	mg/L	0.01	N/A	0.4	0.07	0.26	0.07	0.14	0.14	0.28	0.1	<0.01	0.08	1	10%	0.17	0.07	0.4	0.35
Total Anions	meq/L	0.01	N/A	1.42	1.41	1.43	1.33	1.4	1.2	1.38	1.13	1.31	1.26	0	0%	1.33	1.13	1.43	1.43
Total Cations	meq/L	0.01	N/A	1.21	1.38	1.3	1.16	1.25	1.16	1.29	1.21	1.36	1.08	0	0%	1.24	1.08	1.38	1.37

Groundwater Quality – Bore CQ11D – 2013 to 2017

Parameter	Units	LOR	ANZECC (2000) Guideline	Date Sampled										Statistical Analysis					
				5/04/13	2/10/13	4/04/14	2/10/14	2/04/15	2/10/15	5/04/16	4/10/16	3/04/17	3/10/17	Records Below LOR	% Below LOR	Average	Minimum	Max	95th %ile
pH	pH unit	0.01	N/A	4.76	4.95	4.82	4.93	5.12	4.61	4.88	4.77	4.77	4.84	0	0%	4.85	4.61	5.12	5.04
Conductivity @ 25ºC	µS/cm	1	N/A	167	169	168	169	174	148	160	173	181	160	0	0%	167	148	181	178
Hydroxide Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Carbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	2	<1	<1	<1	9	90%	2	2	2	2
Sulphate	mg/L	1	N/A	42	38	38	41	41	38	29	30	29	30	0	0%	36	29	42	42
Chloride	mg/L	1	N/A	22	23	22	20	21	21	26	21	24	23	0	0%	22	20	26	25
Calcium	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Magnesium	mg/L	1	N/A	4	5	5	4	5	5	4	4	5	3	0	0%	4	3	5	5
Sodium	mg/L	1	N/A	19	20	20	19	21	20	21	18	23	20	0	0%	20	18	23	22
Potassium	mg/L	1	N/A	1	1	2	1	2	2	2	2	2	2	0	0%	2	1	2	2
Aluminium – total	mg/L	0.01	0.055	1.58	1.58	1.56	1.6	1.35	1.66	1.21	1.36	1.16	1.14	0	0%	1.42	1.14	1.66	1.63
Arsenic – total	mg/L	0.001	0.013	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	9	90%	0.001	0.001	0.001	0.001
Cadmium – total	mg/L	1E-04	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	0.0002	<0.0001	<0.0001	8	80%	0.0002	0.0002	0.0002	0.0002
Chromium – total	mg/L	0.001	ID	<0.001	0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	9	90%	0.004	0.004	0.004	0.004
Copper – total	mg/L	0.001	0.0014	0.004	0.002	0.001	0.002	0.005	0.009	0.003	0.003	0.002	<0.001	1	10%	0.003	0.001	0.009	0.007
Lead – total	mg/L	0.001	0.0034	0.042	0.006	0.008	0.009	0.038	0.144	0.029	0.01	0.009	0.006	0	0%	0.030	0.006	0.144	0.098
Manganese – total	mg/L	0.001	1.9	0.019	0.015	0.014	0.013	0.023	0.021	0.016	0.012	0.016	0.015	0	0%	0.016	0.012	0.023	0.022
Nickel – total	mg/L	0.001	0.011	0.002	0.002	0.002	0.001	0.003	0.002	0.002	0.002	0.001	0.001	0	0%	0.002	0.001	0.003	0.003
Selenium – total	mg/L	0.01	0.005	<0.01	<0.01	<0.01	<0.01	<0.001	<0.01	<0.01	<0.01	<0.01	<0.01	10	100%	NA	NA	NA	NA
Zinc – total	mg/L	0.005	0.008	0.266	0.199	0.148	0.137	0.197	0.172	0.097	0.067	0.102	0.092	0	0%	0.148	0.067	0.266	0.236
Boron – total	mg/L	0.05	0.37	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	10	100%	NA	NA	NA	NA
Iron – total	mg/L	0.05	ID	0.43	0.22	0.11	0.26	0.43	0.47	0.28	0.18	0.29	0.13	0	0%	0.28	0.11	0.47	0.45
Mercury	mg/L	1E-04	0.00006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	10	100%	NA	NA	NA	NA
Fluoride	mg/L	0.1	N/A	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	10	100%	NA	NA	NA	NA
Nitrite as N	mg/L	0.01	N/A	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	10	100%	NA	NA	NA	NA
Nitrate as N	mg/L	0.01	0.7	0.12	<0.01	0.06	0.02	0.02	0.39	0.03	0.06	0.01	0.01	1	10%	0.08	0.01	0.39	0.282
Nitrite + Nitrate as N	mg/L	0.01	N/A	0.12	<0.01	0.06	0.02	0.02	0.39	0.03	0.06	0.01	0.01	1	10%	0.08	0.01	0.39	0.282
Total Anions	meq/L	0.01	N/A	1.5	1.44	1.5	1.42	1.45	1.38	1.46	1.22	1.28	1.27	0	0%	1.39	1.22	1.5	1.50
Total Cations	meq/L	0.01	N/A	1.18	1.31	1.33	1.18	1.38	1.33	1.29	1.16	1.46	1.27	0	0%	1.29	1.16	1.46	1.424

Groundwater Quality – Bore CQ12 – 2013 to 2017

Parameter	Units	LOR	ANZECC (2000) Guideline	Date Sampled										Statistical Analysis					
				5/04/13	2/10/13	4/04/14	2/10/14	2/04/15	2/10/15	5/04/16	4/10/16	3/04/17	3/10/17	Records Below LOR	% Below LOR	Average	Minimum	Max	95th %ile
pH	pH unit	0.01	N/A	4.45	4.81	4.72	4.73	4.6	4.23	5.04	4.42	4.44	4.41	0	0%	4.585	4.23	5.04	4.937
Conductivity @ 25ºC	µS/cm	1	N/A	125	146	142	142	149	118	120	140	149	130	0	0%	136.100	118	149	149
Hydroxide Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Carbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	1	<1	<1	<1	9	90%	1	1	1	1
Sulphate	mg/L	1	N/A	18	26	25	30	28	26	27	25	22	25	0	0%	25.200	18	30	29.1
Chloride	mg/L	1	N/A	22	18	24	17	21	17	18	15	17	16	0	0%	18.5	15	24	23.1
Calcium	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Magnesium	mg/L	1	N/A	3	6	5	5	5	5	5	5	6	4	0	0%	4.9	3	6	6
Sodium	mg/L	1	N/A	13	12	13	11	12	11	12	10	13	12	0	0%	11.9	10	13	13
Potassium	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	1	<1	<1	<1	9	90%	1	1	1	1
Aluminium – total	mg/L	0.01	0.055	0.51	0.97	1.08	1.18	0.98	1.11	0.78	1.07	0.83	1.08	0	0%	0.96	0.51	1.18	1.1485
Arsenic – total	mg/L	0.001	0.013	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	10	100%	NA	NA	NA	NA
Cadmium – total	mg/L	1E-04	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	10	100%	NA	NA	NA	NA
Chromium – total	mg/L	0.001	ID	<0.001	<0.001	<0.001	0.001	0.001	0.001	<0.001	<0.001	<0.001	<0.001	7	70%	0.001	0.001	0.001	0.001
Copper – total	mg/L	0.001	0.0014	0.002	<0.001	0.004	0.001	0.002	<0.001	<0.001	0.002	0.001	<0.001	4	40%	0.002	0.001	0.004	0.004
Lead – total	mg/L	0.001	0.0034	0.005	<0.001	0.003	<0.001	0.002	<0.001	<0.001	0.001	0.002	<0.001	5	50%	0.003	0.001	0.005	0.005
Manganese – total	mg/L	0.001	1.9	0.004	0.002	0.007	<0.001	0.001	<0.001	0.003	0.002	0.005	0.002	2	20%	0.003	0.001	0.007	0.006
Nickel – total	mg/L	0.001	0.011	0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	8	80%	0.001	0.001	0.001	0.001
Selenium – total	mg/L	0.01	0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	10	100%	NA	NA	NA	NA
Zinc – total	mg/L	0.005	0.008	0.177	0.01	0.056	<0.005	0.018	<0.005	0.016	0.022	0.057	0.009	2	20%	0.046	0.009	0.177	0.135
Boron – total	mg/L	0.05	0.37	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	10	100%	NA	NA	NA	NA
Iron – total	mg/L	0.05	ID	<0.05	<0.05	0.15	0.13	0.08	0.13	0.1	0.16	0.07	0.16	2	20%	0.12	0.07	0.16	0.16
Mercury	mg/L	1E-04	0.00006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	10	100%	NA	NA	NA	NA
Fluoride	mg/L	0.1	N/A	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	10	100%	NA	NA	NA	NA
Nitrite as N	mg/L	0.01	N/A	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	9	90%	0.01	0.01	0.01	0.01
Nitrate as N	mg/L	0.01	0.7	1.18	0.57	0.93	0.49	0.57	0.45	<0.01	0.52	0.7	0.66	1	10%	0.67	0.45	1.18	1.08
Nitrite + Nitrate as N	mg/L	0.01	N/A	1.18	0.57	0.94	0.49	0.57	0.45	<0.01	0.52	0.7	0.66	1	10%	0.68	0.45	1.18	1.08
Total Anions	meq/L	0.01	N/A	1	1.05	1.2	1.1	1.18	1.02	1.09	0.94	0.94	0.97	0	0%	1.05	0.94	1.2	1.19
Total Cations	meq/L	0.01	N/A	0.81	1.02	0.98	0.89	0.93	0.89	0.96	0.85	1.06	0.85	0	0%	0.92	0.81	1.06	1.04

Groundwater Quality – Bore CQ13 – 2013 to 2017

Parameter	Units	LOR	ANZECC (2000) Guideline	Date Sampled										Statistical Analysis					
				5/04/13	2/10/13	4/04/14	2/10/14	2/04/15	2/10/15	5/04/16	4/10/16	3/04/17	3/10/17	Records Below LOR	% Below LOR	Average	Minimum	Max	95th %ile
pH	pH unit	0.01	N/A	4.39	4.77	4.6	4.6	4.55	4.35	4.27	5.36	4.37	4.24	0	0%	4.55	4.24	5.36	5.095
Conductivity @ 25ºC	µS/cm	1	N/A	235	240	240	235	234	184	200	216	224	187	0	0%	220	184	240	240
Hydroxide Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Carbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Sulphate	mg/L	1	N/A	<1	<1	1	1	<1	1	2	1	<1	2	4	40%	1	1	2	2
Chloride	mg/L	1	N/A	38	39	41	35	38	33	36	30	34	32	0	0%	36	30	41	40
Calcium	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Magnesium	mg/L	1	N/A	8	8	8	7	8	7	6	6	7	4	0	0%	7	4	8	8
Sodium	mg/L	1	N/A	18	27	27	26	24	22	23	21	24	20	0	0%	23	18	27	27
Potassium	mg/L	1	N/A	1	1	2	1	1	2	1	1	2	1	0	0%	1	1	2	2
Aluminium – total	mg/L	0.01	0.055	1.04	1.14	1.08	1.08	0.84	1.05	0.98	0.97	0.69	0.68	0	0%	0.96	0.68	1.14	1.113
Arsenic – total	mg/L	0.001	0.013	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	10	100%	NA	NA	NA	NA
Cadmium – total	mg/L	1E-04	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	10	100%	NA	NA	NA	NA
Chromium – total	mg/L	0.001	ID	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	9	90%	0.002	0.002	0.002	0.002
Copper – total	mg/L	0.001	0.0014	0.004	0.002	0.002	0.001	0.003	0.002	0.002	0.003	<0.001	<0.001	2	20%	0.002	0.001	0.004	0.004
Lead – total	mg/L	0.001	0.0034	0.01	0.003	0.003	0.002	0.003	0.003	0.001	0.004	0.001	<0.001	1	10%	0.003	0.001	0.01	0.008
Manganese – total	mg/L	0.001	1.9	0.006	0.003	0.003	0.003	0.004	0.005	0.003	0.006	0.002	0.002	0	0%	0.004	0.002	0.006	0.006
Nickel – total	mg/L	0.001	0.011	0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	8	80%	0.001	0.001	0.001	0.001
Selenium – total	mg/L	0.01	0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	10	100%	NA	NA	NA	NA
Zinc – total	mg/L	0.005	0.008	0.052	0.024	0.024	0.012	0.048	0.026	0.011	0.04	0.014	0.01	0	0%	0.026	0.01	0.052	0.050
Boron – total	mg/L	0.05	0.37	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	10	100%	NA	NA	NA	NA
Iron – total	mg/L	0.05	ID	0.18	0.08	<0.05	0.09	0.1	0.31	0.22	0.33	<0.05	0.09	2	20%	0.18	0.08	0.33	0.32
Mercury	mg/L	1E-04	0.00006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	10	100%	NA	NA	NA	NA
Fluoride	mg/L	0.1	N/A	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	9	90%	0.1	0.1	0.1	0.1
Nitrite as N	mg/L	0.01	N/A	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	9	90%	0.02	0.02	0.02	0.02
Nitrate as N	mg/L	0.01	0.7	11	11.5	12.6	10.9	10.2	8.81	9.05	8.21	8.56	7.23	0	0%	9.81	7.23	12.6	12.11
Nitrite + Nitrate as N	mg/L	0.01	N/A	11	11.5	12.6	10.9	10.2	8.81	9.05	8.21	8.56	7.23	0	0%	9.81	7.23	12.6	12.11
Total Anions	meq/L	0.01	N/A	1.07	1.1	2.08	1.79	1.07	1.58	1.7	1.45	0.96	1.46	0	0%	1.43	0.96	2.08	1.95
Total Cations	meq/L	0.01	N/A	1.47	1.86	1.88	1.73	1.73	1.58	1.52	1.43	1.67	1.22	0	0%	1.61	1.22	1.88	1.87

Groundwater Quality – Bore CP4– 2013 to 2017

Parameter	Units	LOR	ANZECC (2000) Guideline	Date Sampled										Statistical Analysis					
				5/04/13	2/10/13	4/04/14	2/10/14	2/04/15	2/10/15	5/04/16	4/10/16	3/04/17	3/10/17	Records Below LOR	% Below LOR	Average	Minimum	Max	95th %ile
pH	pH unit	0.01	N/A	5.43	NR	NR	NR	4.93	NR	NR	NR	NR	NR	0	0%	5.18	4.93	5.43	5.41
Conductivity @ 25ºC	µS/cm	1	N/A	221	NR	NR	NR	182	NR	NR	NR	NR	NR	0	0%	202	182	221	219
Hydroxide Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	NR	NR	NR	<1	NR	NR	NR	NR	NR	2	100%	NA	NA	NA	NA
Carbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	NR	NR	NR	<1	NR	NR	NR	NR	NR	2	100%	NA	NA	NA	NA
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	2	NR	NR	NR	<1	NR	NR	NR	NR	NR	1	50%	2	2	2	2
Sulphate	mg/L	1	N/A	15	NR	NR	NR	23	NR	NR	NR	NR	NR	0	0%	19	15	23	23
Chloride	mg/L	1	N/A	39	NR	NR	NR	33	NR	NR	NR	NR	NR	0	0%	36	33	39	39
Calcium	mg/L	1	N/A	4	NR	NR	NR	3	NR	NR	NR	NR	NR	0	0%	4	3	4	4
Magnesium	mg/L	1	N/A	6	NR	NR	NR	4	NR	NR	NR	NR	NR	0	0%	5	4	6	6
Sodium	mg/L	1	N/A	18	NR	NR	NR	20	NR	NR	NR	NR	NR	0	0%	19	18	20	20
Potassium	mg/L	1	N/A	4	NR	NR	NR	2	NR	NR	NR	NR	NR	0	0%	3	2	4	4
Aluminium – total	mg/L	0.01	0.055	0.17	NR	NR	NR	1.02	NR	NR	NR	NR	NR	0	0%	0.60	0.17	1.02	0.98
Arsenic – total	mg/L	0.001	0.013	<0.001	NR	NR	NR	<0.001	NR	NR	NR	NR	NR	2	100%	NA	NA	NA	NA
Cadmium – total	mg/L	1E-04	0.0002	0.0002	NR	NR	NR	0.0001	NR	NR	NR	NR	NR	0	0%	0.0002	0.0001	0.000 2	0.0002
Chromium – total	mg/L	0.001	ID	0.005	NR	NR	NR	0.001	NR	NR	NR	NR	NR	0	0%	0.003	0.001	0.005	0.0048
Copper – total	mg/L	0.001	0.0014	0.027	NR	NR	NR	0.003	NR	NR	NR	NR	NR	0	0%	0.015	0.003	0.027	0.026
Lead – total	mg/L	0.001	0.0034	0.021	NR	NR	NR	0.009	NR	NR	NR	NR	NR	0	0%	0.015	0.009	0.021	0.020
Manganese – total	mg/L	0.001	1.9	0.023	NR	NR	NR	0.003	NR	NR	NR	NR	NR	0	0%	0.013	0.003	0.023	0.022
Nickel – total	mg/L	0.001	0.011	0.091	NR	NR	NR	<0.001	NR	NR	NR	NR	NR	1	50%	0.091	0.091	0.091	0.091
Selenium – total	mg/L	0.01	0.005	<0.01	NR	NR	NR	<0.01	NR	NR	NR	NR	NR	2	100%	NA	NA	NA	NA
Zinc – total	mg/L	0.005	0.008	0.325	NR	NR	NR	0.107	NR	NR	NR	NR	NR	0	0%	0.216	0.107	0.325	0.314
Boron – total	mg/L	0.05	0.37	<0.05	NR	NR	NR	<0.05	NR	NR	NR	NR	NR	2	100%	NA	NA	NA	NA
Iron – total	mg/L	0.05	ID	1	NR	NR	NR	0.87	NR	NR	NR	NR	NR	0	0%	0.94	0.87	1	0.99
Mercury	mg/L	1E-04	0.00006	<0.0001	NR	NR	NR	<0.0001	NR	NR	NR	NR	NR	2	100%	NA	NA	NA	NA
Fluoride	mg/L	0.1	N/A	<0.1	NR	NR	NR	<0.1	NR	NR	NR	NR	NR	2	100%	NA	NA	NA	NA
Nitrite as N	mg/L	0.01	N/A	<0.01	NR	NR	NR	<0.01	NR	NR	NR	NR	NR	2	100%	NA	NA	NA	NA
Nitrate as N	mg/L	0.01	0.7	5.52	NR	NR	NR	1.36	NR	NR	NR	NR	NR	0	0%	3.44	1.36	5.52	5.31
Nitrite + Nitrate as N	mg/L	0.01	N/A	5.52	NR	NR	NR	1.36	NR	NR	NR	NR	NR	0	0%	3.44	1.36	5.52	5.31
Total Anions	meq/L	0.01	N/A	1.45	NR	NR	NR	1.41	NR	NR	NR	NR	NR	0	0%	1.43	1.41	1.45	1.45
Total Cations	meq/L	0.01	N/A	1.58	NR	NR	NR	1.4	NR	NR	NR	NR	NR	0	0%	1.49	1.4	1.58	1.57

Groundwater Quality – Bore CP5 – 2013 to 2017

Parameter	Units	LOR	ANZECC (2000) Guideline	Date Sampled										Statistical Analysis					
				5/04/13	2/10/13	4/04/14	2/10/14	2/04/15	2/10/15	5/04/16	4/10/16	3/04/17	3/10/17	Records Below LOR	% Below LOR	Average	Minimum	Max	95th %ile
pH	pH unit	0.01	N/A	4.2	4.75	4.68	4.76	4.59	4.24	4.33	4.38	4.4	4.31	0	0%	4.46	4.2	4.76	4.76
Conductivity @ 25ºC	µS/cm	1	N/A	231	249	247	240	192	186	201	174	149	191	0	0%	206	149	249	248
Hydroxide Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Carbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Sulphate	mg/L	1	N/A	2	<1	1	1	2	2	3	3	5	2	1	10%	2	1	5	4
Chloride	mg/L	1	N/A	20	25	25	20	21	19	21	17	18	19	0	0%	21	17	25	25
Calcium	mg/L	1	N/A	2	1	1	1	1	1	1	1	2	<1	1	10%	1	1	2	2
Magnesium	mg/L	1	N/A	13	16	15	13	10	12	12	8	6	9	0	0%	11	6	16	16
Sodium	mg/L	1	N/A	13	13	14	14	11	11	12	10	10	12	0	0%	12	10	14	14
Potassium	mg/L	1	N/A	2	2	2	2	2	2	2	2	3	2	0	0%	2	2	3	3
Aluminium – total	mg/L	0.01	0.055	0.95	0.86	0.84	0.8	0.67	0.71	0.63	0.61	0.43	0.57	0	0%	0.71	0.43	0.95	0.91
Arsenic – total	mg/L	0.001	0.013	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	10	100%	NA	NA	NA	NA
Cadmium – total	mg/L	1E-04	0.0002	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	8	80%	0.0002	0.0001	0.0002	0.0002
Chromium – total	mg/L	0.001	ID	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	9	90%	0.002	0.002	0.002	0.002
Copper – total	mg/L	0.001	0.0014	0.03	0.054	0.018	0.059	0.019	0.006	0.007	0.02	0.013	0.005	0	0%	0.023	0.005	0.059	0.057
Lead – total	mg/L	0.001	0.0034	0.011	0.007	0.002	0.002	0.002	0.002	0.001	0.002	0.001	<0.001	1	10%	0.003	0.001	0.011	0.009
Manganese – total	mg/L	0.001	1.9	0.002	0.002	0.002	0.002	0.003	<0.001	0.002	0.003	0.002	0.001	1	10%	0.002	0.001	0.003	0.003
Nickel – total	mg/L	0.001	0.011	0.002	0.009	0.002	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	6	60%	0.004	0.001	0.009	0.008
Selenium – total	mg/L	0.01	0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	10	100%	NA	NA	NA	NA
Zinc – total	mg/L	0.005	0.008	0.026	0.584	0.11	0.014	0.022	0.008	0.01	0.054	0.007	0.024	0	0%	0.086	0.007	0.584	0.371
Boron – total	mg/L	0.05	0.37	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	10	100%	NA	NA	NA	NA
Iron – total	mg/L	0.05	ID	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	10	100%	NA	NA	NA	NA
Mercury	mg/L	1E-04	0.00006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	10	100%	NA	NA	NA	NA
Fluoride	mg/L	0.1	N/A	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	10	100%	NA	NA	NA	NA
Nitrite as N	mg/L	0.01	N/A	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	10	100%	NA	NA	NA	NA
Nitrate as N	mg/L	0.01	0.7	17.4	18.9	21.2	18.3	13.1	14.5	15.6	10.1	6.72	13.6	0	0%	14.94	6.72	21.2	20.17
Nitrite + Nitrate as N	mg/L	0.01	N/A	17.4	18.9	21.2	18.3	13.1	14.5	15.6	10.1	6.72	13.6	0	0%	14.94	6.72	21.2	20.17
Total Anions	meq/L	0.01	N/A	0.61	0.71	2.23	1.87	0.63	1.69	1.76	1.26	0.61	1.55	0	0%	1.29	0.61	2.23	2.07
Total Cations	meq/L	0.01	N/A	1.79	1.98	2.02	1.78	1.4	1.57	1.61	1.19	1.1	1.31	0	0%	1.58	1.1	2.02	2.00

Groundwater Quality – Bore CP6 – 2013 to 2017

Parameter	Units	LOR	ANZECC (2000) Guideline	Date Sampled 5/04/13	2/10/13	4/04/14	2/10/14	2/04/15	2/10/15	5/04/16	4/10/16	3/04/17	3/10/17	Statistical Analysis Records Below LOR	% Below LOR	Average	Minimum	Max	95th %ile
pH	pH unit	0.01	N/A	4.2	NR	4.63	4.73	4.59	4.26	4.35	4.8	4.26		0	0%	4.48	4.2	4.8	4.78
Conductivity @ 25ºC	µS/cm	1	N/A	196	NR	188	197	190	160	175	193	192	<1	1	11%	186	160	197	197
Hydroxide Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	NR	<1	<1	<1	<1	<1	<1	<1	<1	9	100%	NA	NA	NA	NA
Carbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	NR	<1	<1	<1	<1	<1	<1	<1	<1	9	100%	NA	NA	NA	NA
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	NR	<1	<1	<1	<1	<1	<1	<1	<1	9	100%	NA	NA	NA	NA
Sulphate	mg/L	1	N/A	9	NR	6	6	7	5	7	5	8	7	0	0%	7	5	9	9
Chloride	mg/L	1	N/A	28	NR	30	22	29	24	26	21	26	21	0	0%	25	21	30	30
Calcium	mg/L	1	N/A	<1	NR	<1	<1	<1	<1	<1	<1	<1	<1	9	100%	NA	NA	NA	NA
Magnesium	mg/L	1	N/A	6	NR	8	8	7	8	8	7	7	6	0	0%	7	6	8	8
Sodium	mg/L	1	N/A	20	NR	18	16	18	17	16	15	18	16	0	0%	17	15	20	19
Potassium	mg/L	1	N/A	1	NR	<1	<1	<1	<1	<1	<1	<1	<1	8	89%	1	1	1	1
Aluminium – total	mg/L	0.01	0.055	0.76	NR	1.04	0.96	0.79	0.69	0.63	0.74	0.75	0.69	0	0%	0.78	0.63	1.04	1.01
Arsenic – total	mg/L	0.001	0.013	<0.001	NR	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	9	100%	NA	NA	NA	NA
Cadmium – total	mg/L	1E-04	0.0002	<0.0001	NR	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	9	100%	NA	NA	NA	NA
Chromium – total	mg/L	0.001	ID	<0.001	NR	0.008	<0.001	0.001	<0.001	0.001	<0.001	<0.001	<0.001	6	67%	0.003	0.001	0.008	0.007
Copper – total	mg/L	0.001	0.0014	0.038	NR	0.014	0.005	0.008	0.004	0.008	0.006	0.013	0.003	0	0%	0.011	0.003	0.038	0.028
Lead – total	mg/L	0.001	0.0034	0.004	NR	0.003	0.005	0.001	<0.001	0.002	0.002	0.005	0.001	1	11%	0.003	0.001	0.005	0.005
Manganese – total	mg/L	0.001	1.9	0.011	NR	0.006	0.001	0.004	<0.001	0.002	0.002	0.005	0.001	1	11%	0.004	0.001	0.011	0.009
Nickel – total	mg/L	0.001	0.011	0.008	NR	0.001	<0.001	0.002	<0.001	0.002	<0.001	<0.001	<0.001	5	56%	0.003	0.001	0.008	0.007
Selenium – total	mg/L	0.01	0.005	<0.01	NR	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	9	100%	NA	NA	NA	NA
Zinc – total	mg/L	0.005	0.008	0.419	NR	0.062	0.016	0.094	0.042	0.049	0.034	0.037	0.013	0	0%	0.085	0.013	0.419	0.289
Boron – total	mg/L	0.05	0.37	<0.05	NR	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	9	100%	NA	NA	NA	NA
Iron – total	mg/L	0.05	ID	0.09	NR	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	8	89%	0.09	0.09	0.09	0.09
Mercury	mg/L	1E-04	0.00006	<0.0001	NR	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	9	100%	NA	NA	NA	NA
Fluoride	mg/L	0.1	N/A	<0.1	NR	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	9	100%	NA	NA	NA	NA
Nitrite as N	mg/L	0.01	N/A	<0.01	NR	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	9	100%	NA	NA	NA	NA
Nitrate as N	mg/L	0.01	0.7	8.18	NR	9.77	10.5	7.84	9.02	9.47	8.97	7.12	9.19	0	0%	8.90	7.12	10.5	10.21
Nitrite + Nitrate as N	mg/L	0.01	N/A	8.18	NR	9.77	10.5	7.84	9.02	9.47	8.97	7.12	9.19	0	0%	8.90	7.12	10.5	10.21
Total Anions	meq/L	0.01	N/A	0.98	NR	1.69	1.53	0.96	1.43	1.56	0.7	0.9	1.45	0	0%	1.24	0.7	1.69	1.64
Total Cations	meq/L	0.01	N/A	1.39	NR	1.49	1.35	1.36	1.4	1.35	1.23	1.36	1.19	0	0%	1.35	1.19	1.49	1.45

Groundwater Quality – Bore CP7 – 2013 to 2017

				Date Sampled										Statistical Analysis					
Parameter	**Units**	**LOR**	**ANZECC (2000) Guideline**	**5/04/13**	**2/10/13**	**4/04/14**	**2/10/14**	**2/04/15**	**2/10/15**	**5/04/16**	**4/10/16**	**3/04/17**	**3/10/17**	**Records Below LOR**	**% Below LOR**	**Average**	**Minimum**	**Max**	**95th %ile**
pH	pH unit	0.01	N/A	5.71	5.04	5.49	5.07	5.51	4.76	5.53	5.06	6.2		0	0%	5.37	4.76	6.2	6.00
Conductivity @ 25ºC	µS/cm	1	N/A	141	177	124	114	108	108	114	124	103	<1	1	10%	124	103	177	163
Hydroxide Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Carbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	2	<1	2	<1	<1	<1	2	<1	10	<1	6	60%	4	2	10	9
Sulphate	mg/L	1	N/A	25	26	24	19	21	24	28	21	14	21	0	0%	22	14	28	27
Chloride	mg/L	1	N/A	10	17	7	13	9	14	13	13	7	13	0	0%	12	7	17	16
Calcium	mg/L	1	N/A	7	8	5	4	3	5	4	4	4	3	0	0%	5	3	8	8
Magnesium	mg/L	1	N/A	4	6	3	3	2	3	3	3	2	2	0	0%	3	2	6	5
Sodium	mg/L	1	N/A	6	8	7	7	6	6	7	7	5	8	0	0%	7	5	8	8
Potassium	mg/L	1	N/A	10	9	9	4	8	6	8	6	12	6	0	0%	8	4	12	11
Aluminium – total	mg/L	0.01	0.055	0.1	0.38	0.2	0.17	0.07	0.19	0.13	0.17	0.71	0.2	0	0%	0.23	0.07	0.71	0.56
Arsenic – total	mg/L	0.001	0.013	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	10	100%	NA	NA	NA	NA
Cadmium – total	mg/L	1E-04	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	10	100%	NA	NA	NA	NA
Chromium – total	mg/L	0.001	ID	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	10	100%	NA	NA	NA	NA
Copper – total	mg/L	0.001	0.0014	0.003	<0.001	0.011	<0.001	0.001	<0.001	0.002	0.001	0.015	<0.001	4	40%	0.006	0.001	0.015	0.014
Lead – total	mg/L	0.001	0.0034	<0.001	0.001	0.002	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	7	70%	0.001	0.001	0.002	0.002
Manganese – total	mg/L	0.001	1.9	0.293	0.02	0.257	0.01	0.185	0.013	0.291	0.02	0.033	0.073	0	0%	0.120	0.01	0.293	0.292
Nickel – total	mg/L	0.001	0.011	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	9	90%	0.001	0.001	0.001	0.001
Selenium – total	mg/L	0.01	0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	10	100%	NA	NA	NA	NA
Zinc – total	mg/L	0.005	0.008	0.044	0.028	0.177	0.023	0.028	0.016	0.021	0.013	0.04	0.018	0	0%	0.041	0.013	0.177	0.117
Boron – total	mg/L	0.05	0.37	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	10	100%	NA	NA	NA	NA
Iron – total	mg/L	0.05	ID	0.78	3.02	2.52	0.15	1.13	0.16	7.83	0.62	0.54	2.21	0	0%	1.90	0.15	7.83	5.67
Mercury	mg/L	1E-04	0.00006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	10	100%	NA	NA	NA	NA
Fluoride	mg/L	0.1	N/A	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	10	100%	NA	NA	NA	NA
Nitrite as N	mg/L	0.01	N/A	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	10	100%	NA	NA	NA	NA
Nitrate as N	mg/L	0.01	0.7	4.53	5.78	2.92	2.5	1.99	1.99	0.34	1.22	1.18	1.56	0	0%	2.40	0.34	5.78	5.22
Nitrite + Nitrate as N	mg/L	0.01	N/A	4.53	5.78	2.92	2.5	1.99	1.99	0.34	1.22	1.18	1.56	0	0%	2.40	0.34	5.78	5.22
Total Anions	meq/L	0.01	N/A	0.84	1.02	0.95	0.76	0.69	0.89	0.99	0.8	0.69	0.8	0	0%	0.84	0.69	1.02	1.01
Total Cations	meq/L	0.01	N/A	1.2	1.47	1.03	0.85	0.78	0.91	0.96	0.9	0.89	0.79	0	0%	0.98	0.78	1.47	1.35

Groundwater Quality – Bore CP8 – 2013 to 2017

Parameter	Units	LOR	ANZECC (2000) Guideline Value	Date Sampled										Statistical Analysis					
				5/04/13	2/10/13	4/04/14	2/10/14	2/04/15	2/10/15	5/04/16	4/10/16	3/04/17	3/10/17	Total Records Below LOR	% Below LOR	Average	Minimum	Max	95th %ile
pH	pH unit	0.01	N/A	4.33	4.78	4.68	4.76	4.62	4.32	4.44	4.71	4.44		0	0%	4.56	4.32	4.78	4.77
Conductivity @ 25ºC	µS/cm	1	N/A	162	156	154	151	154	121	139	142	139	<1	1	10%	146	121	162	159.6
Hydroxide Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Carbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Sulphate	mg/L	1	N/A	6	6	6	9	7	7	10	8	10	10	0	0%	8	6	10	10
Chloride	mg/L	1	N/A	33	35	35	28	28	29	32	25	32	27	0	0%	30	25	35	35
Calcium	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Magnesium	mg/L	1	N/A	3	3	3	2	2	2	2	2	2	1	0	0%	2	1	3	3
Sodium	mg/L	1	N/A	20	21	22	16	20	17	20	17	20	19	0	0%	19	16	22	22
Potassium	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Aluminium – total	mg/L	0.01	0.055	0.76	0.57	0.74	0.56	0.5	0.52	0.68	0.63	0.68	1.21	0	0%	0.69	0.5	1.21	1.01
Arsenic – total	mg/L	0.001	0.013	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	10	100%	NA	NA	NA	NA
Cadmium – total	mg/L	1E-04	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	10	100%	NA	NA	NA	NA
Chromium – total	mg/L	0.001	ID	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	8	80%	0.002	0.002	0.002	0.002
Copper – total	mg/L	0.001	0.0014	0.002	0.001	0.002	<0.001	4.62	4.32	0.006	0.002	<0.001	0.004	2	20%	1.120	0.001	4.62	0.005
Lead – total	mg/L	0.001	0.0034	0.002	<0.001	0.001	<0.001	154	121	0.002	<0.001	<0.001	0.003	4	40%	45.835	0.001	154	0.0029
Manganese – total	mg/L	0.001	1.9	0.01	0.002	0.004	<0.001	<1	<1	0.012	0.003	0.001	0.007	3	30%	0.006	0.001	0.012	0.011
Nickel – total	mg/L	0.001	0.011	<0.001	<0.001	<0.001	<0.001	<1	<1	<0.001	<0.001	<0.001	<0.001	10	100%	NA	NA	NA	NA
Selenium – total	mg/L	0.01	0.005	<0.01	<0.01	<0.01	<0.01	<1	<1	<0.01	<0.01	<0.01	<0.01	10	100%	NA	NA	NA	NA
Zinc – total	mg/L	0.005	0.008	0.018	0.006	0.024	<0.005	7	7	0.033	0.012	<0.005	0.038	2	20%	1.766	0.006	7	0.04
Boron – total	mg/L	0.05	0.37	<0.05	<0.05	<0.05	<0.05	28	29	<0.05	<0.05	<0.05	<0.05	8	80%	28.5	28	29	NA
Iron – total	mg/L	0.05	ID	0.09	<0.05	0.13	<0.05	<1	<1	0.2	0.13	<0.05	<0.05	6	60%	0.14	0.09	0.2	0.19
Mercury	mg/L	1E-04	0.00006	<0.0001	<0.0001	<0.0001	<0.0001	2	2	<0.0001	<0.0001	<0.0001	<0.0001	8	80%	2	2	2	NA
Fluoride	mg/L	0.1	N/A	<0.1	<0.1	<0.1	<0.1	20	17	<0.1	<0.1	<0.1	<0.1	8	80%	18.5	17	20	NA
Nitrite as N	mg/L	0.01	N/A	<0.01	<0.01	<0.01	<0.01	<1	<1	<0.01	<0.01	<0.01	<0.01	10	100%	NA	NA	NA	NA
Nitrate as N	mg/L	0.01	0.7	2.26	1.89	2.28	1.8	0.5	0.52	1.64	1.32	1.43	0.18	0	0%	1.38	0.18	2.28	2.27
Nitrite + Nitrate as N	mg/L	0.01	N/A	2.26	1.89	2.28	1.8	<0.001	<0.001	1.64	1.32	1.43	0.18	2	20%	1.6	0.18	2.28	2.27
Total Anions	meq/L	0.01	N/A	1.06	1.11	1.11	0.98	<0.0001	<0.0001	1.11	0.87	0.93	0.9	2	20%	1.01	0.87	1.11	1.11
Total Cations	meq/L	0.01	N/A	1.12	1.16	1.2	0.86	<0.001	<0.001	1.03	0.9	1.03	0.82	2	20%	1.02	0.82	1.2	1.18

Groundwater Quality – Bore MW7 – 2013 to 2017

Parameter	Units	LOR	ANZECC (2000) Guideline	Date Sampled 5/04/13	2/10/13	4/04/14	2/10/14	2/04/15	2/10/15	5/04/16	4/10/16	3/04/17	3/10/17	Statistical Analysis Records Below LOR	% Below LOR	Average	Minimum	Max	95th %ile
spH	pH unit	0.01	N/A	4.77	4.87	4.75	4.79	4.67	4.48	4.68	4.73	4.55	4.48	0	0%	4.68	4.48	4.87	4.83
Conductivity @ 25ºC	µS/cm	1	N/A	120	124	120	122	126	104	114	126	129	119	0	0%	120	104	129	128
Hydroxide Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Carbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Sulphate	mg/L	1	N/A	3	3	3	4	3	3	5	3	3	4	0	0%	3	3	5	5
Chloride	mg/L	1	N/A	29	31	33	27	27	29	32	27	30	29	0	0%	29	27	33	33
Calcium	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Magnesium	mg/L	1	N/A	2	2	1	1	2	2	2	2	2	1	0	0%	2	1	2	2
Sodium	mg/L	1	N/A	16	17	18	11	16	15	17	16	18	17	0	0%	16	11	18	18
Potassium	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Aluminium – total	mg/L	0.01	0.055	0.3	0.28	0.36	0.26	0.35	0.27	0.23	0.31	0.25	0.28	0	0%	0.29	0.23	0.36	0.36
Arsenic – total	mg/L	0.001	0.013	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	10	100%	NA	NA	NA	NA
Cadmium – total	mg/L	1E-04	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	10	100%	NA	NA	NA	NA
Chromium – total	mg/L	0.001	ID	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	10	100%	NA	NA	NA	NA
Copper – total	mg/L	0.001	0.0014	0.004	0.001	0.003	0.002	0.004	0.001	<0.001	0.004	<0.001	0.001	2	20%	0.003	0.001	0.004	0.004
Lead – total	mg/L	0.001	0.0034	0.002	<0.001	0.001	<0.001	0.002	<0.001	<0.001	0.001	<0.001	<0.001	6	60%	0.002	0.001	0.002	0.002
Manganese – total	mg/L	0.001	1.9	0.011	0.005	0.008	0.005	0.008	0.004	0.006	0.011	0.007	0.008	0	0%	0.007	0.004	0.011	0.011
Nickel – total	mg/L	0.001	0.011	0.001	0.001	0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	6	60%	0.001	0.001	0.001	0.001
Selenium – total	mg/L	0.01	0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	10	100%	NA	NA	NA	NA
Zinc – total	mg/L	0.005	0.008	0.079	0.012	0.028	0.009	0.05	0.013	0.01	0.013	0.033	0.025	0	0%	0.027	0.009	0.079	0.066
Boron – total	mg/L	0.05	0.37	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	10	100%	NA	NA	NA	NA
Iron – total	mg/L	0.05	ID	0.13	0.06	0.11	<0.05	0.14	0.06	<0.05	0.11	<0.05	0.06	3	30%	0.10	0.06	0.14	0.14
Mercury	mg/L	1E-04	0.00006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	10	100%	NA	NA	NA	NA
Fluoride	mg/L	0.1	N/A	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	10	100%	NA	NA	NA	NA
Nitrite as N	mg/L	0.01	N/A	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	10	100%	NA	NA	NA	NA
Nitrate as N	mg/L	0.01	0.7	0.86	0.08	0.16	0.1	0.07	0.12	0.08	0.17	0.08	0.18	0	0%	0.19	0.07	0.86	0.55
Nitrite + Nitrate as N	mg/L	0.01	N/A	0.86	0.08	0.16	0.1	0.07	0.12	0.08	0.17	0.08	0.18	0	0%	0.19	0.07	0.86	0.55
Total Anions	meq/L	0.01	N/A	0.88	0.94	0.99	0.84	0.82	0.88	1.01	0.82	1.01	0.9	0	0%	0.91	0.82	1.01	1.01
Total Cations	meq/L	0.01	N/A	0.86	0.9	0.87	0.56	0.86	0.82	0.9	0.86	0.9	0.82	0	0%	0.84	0.56	0.9	0.90

Groundwater Quality – Bore MW8 – 2013 to 2017

				Date Sampled										Statistical Analysis					
Parameter	**Units**	**LOR**	**ANZECC (2000) Guideline**	**5/04/13**	**2/10/13**	**4/04/14**	**2/10/14**	**2/04/15**	**2/10/15**	**5/04/16**	**4/10/16**	**3/04/17**	**3/10/17**	**Records Below LOR**	**% Below LOR**	**Average**	**Minimum**	**Max**	**95th %ile**
pH	pH unit	0.01	N/A	5.54	5.09	4.91	5.12	4.98	4.80	4.83	4.49	4.55	4.67	0	0%	4.898	4.49	5.54	5.35
Conductivity @ 25ºC	µS/cm	1	N/A	90	86	92	85	88	70	82	98	88	72	0	0%	85.1	70	98	95
Hydroxide Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Carbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	4	<1	<1	<1	<1	<1	<1	<1	<1	<1	9	90%	4	4	4	4
Sulphate	mg/L	1	N/A	4	4	5	5	4	4	7	4	4	6	0	0%	4.700	4	7	6.6
Chloride	mg/L	1	N/A	20	22	25	18	18	19	20	16	18	15	0	0%	19.1	15	25	23.7
Calcium	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Magnesium	mg/L	1	N/A	1	2	1	1	1	1	1	2	2	<1	1	10%	1.3	1	2	2
Sodium	mg/L	1	N/A	12	12	13	13	11	10	11	10	11	<1	1	10%	11.4	10	13	13
Potassium	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Aluminium – total	mg/L	0.01	0.055	0.23	0.2	0.33	0.16	0.28	0.18	0.25	0.16	0.2	0.52	0	0%	0.25	0.16	0.52	0.43
Arsenic – total	mg/L	0.001	0.013	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	10	100%	NA	NA	NA	NA
Cadmium – total	mg/L	1E-04	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	10	100%	NA	NA	NA	NA
Chromium – total	mg/L	0.001	ID	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	9	90%	0.001	0.001	0.001	0.001
Copper – total	mg/L	0.001	0.0014	0.002	0.001	0.008	0.002	0.006	0.01	0.006	0.004	0.001	0.003	0	0%	0.004	0.001	0.01	0.009
Lead – total	mg/L	0.001	0.0034	0.002	<0.001	0.001	<0.001	0.002	<0.001	0.002	<0.001	<0.001	0.001	5	50%	0.002	0.001	0.002	0.002
Manganese – total	mg/L	0.001	1.9	0.005	0.004	0.009	0.004	0.011	0.006	0.009	0.008	0.007	0.011	0	0%	0.007	0.004	0.011	0.011
Nickel – total	mg/L	0.001	0.011	<0.001	<0.001	0.002	<0.001	0.002	<0.001	0.002	<0.001	<0.001	<0.001	7	70%	0.002	0.002	0.002	0.002
Selenium – total	mg/L	0.01	0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	10	100%	NA	NA	NA	NA
Zinc – total	mg/L	0.005	0.008	0.041	0.033	0.066	0.021	0.086	0.024	0.064	0.05	0.044	0.04	0	0%	0.047	0.021	0.086	0.077
Boron – total	mg/L	0.05	0.37	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	10	100%	NA	NA	NA	NA
Iron – total	mg/L	0.05	ID	0.15	<0.05	0.14	<0.05	0.18	<0.05	0.13	0.07	0.11	0.43	3	30%	0.17	0.07	0.43	0.36
Mercury	mg/L	1E-04	0.00006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	10	100%	NA	NA	NA	NA
Fluoride	mg/L	0.1	N/A	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	10	100%	NA	NA	NA	NA
Nitrite as N	mg/L	0.01	N/A	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	10	100%	NA	NA	NA	NA
Nitrate as N	mg/L	0.01	0.7	0.16	0.1	0.31	0.21	0.29	0.19	0.48	1.08	0.17	0.14	0	0%	0.31	0.1	1.08	0.81
Nitrite + Nitrate as N	mg/L	0.01	N/A	0.16	0.1	0.31	0.21	0.29	0.19	0.48	1.08	0.17	0.14	0	0%	0.31	0.1	1.08	0.81
Total Anions	meq/L	0.01	N/A	0.73	0.7	0.81	0.61	0.59	0.62	0.71	0.53	0.59	0.55	0	0%	0.64	0.53	0.81	0.77
Total Cations	meq/L	0.01	N/A	0.6	0.69	0.65	0.65	0.56	0.52	0.56	0.6	0.64	0.43	0	0%	0.59	0.43	0.69	0.67

Groundwater Quality – Bore MW9 – 2013 to 2017

Parameter	Units	LOR	ANZECC (2000) Guideline	Date Sampled										Statistical Analysis					
				5/04/13	2/10/13	4/04/14	2/10/14	2/04/15	2/10/15	5/04/16	4/10/16	3/04/17	3/10/17	Records Below LOR	% Below LOR	Average	Minimum	Max	95th %ile
pH	pH unit	0.01	N/A	4.68	5.01	4.92	5.57	4.85	4.51	4.74	4.83	4.46	4.5	0	0%	4.807	4.46	5.57	5.32
Conductivity @ 25ºC	µS/cm	1	N/A	95	97	96	92	97	79	91	96	103	97	0	0%	94.300	79	103	100.3
Hydroxide Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Carbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Sulphate	mg/L	1	N/A	2	2	3	4	3	3	4	3	3	4	0	0%	3.1	2	4	4
Chloride	mg/L	1	N/A	24	26	28	20	23	21	24	20	22	23	0	0%	23.10	20	28	27.1
Calcium	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Magnesium	mg/L	1	N/A	1	1	1	<1	<1	1	1	1	1	<1	3	30%	1	1	1	1
Sodium	mg/L	1	N/A	12	13	14	12	14	12	14	12	14	14	0	0%	13.1	12	14	14
Potassium	mg/L	1	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	100%	NA	NA	NA	NA
Aluminium – total	mg/L	0.01	0.055	0.16	0.23	0.47	0.15	1.98	8.14	4.1	0.23	0.22	2.9	0	0%	1.86	0.15	8.14	6.32
Arsenic – total	mg/L	0.001	0.013	<0.001	<0.001	<0.001	<0.001	0.002	0.010	0.005	<0.001	<0.001	0.003	6	60%	0.005	0.002	0.01	0.009
Cadmium – total	mg/L	1E-04	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	10	100%	NA	NA	NA	NA
Chromium – total	mg/L	0.001	ID	<0.001	<0.001	0.002	<0.001	0.004	0.023	0.009	<0.001	<0.001	0.006	5	50%	0.009	0.002	0.023	0.0202
Copper – total	mg/L	0.001	0.0014	0.001	0.004	0.004	0.001	0.003	0.005	0.024	0.003	<0.001	0.003	1	10%	0.005	0.001	0.024	0.016
Lead – total	mg/L	0.001	0.0034	<0.001	0.005	0.002	<0.001	0.003	0.014	0.007	<0.001	<0.001	0.004	4	40%	0.006	0.002	0.014	0.012
Manganese – total	mg/L	0.001	1.9	0.006	0.007	0.012	0.004	0.009	0.013	0.009	0.008	0.006	0.01	0	0%	0.008	0.004	0.013	0.013
Nickel – total	mg/L	0.001	0.011	<0.001	0.002	0.002	<0.001	0.001	0.002	0.002	0.001	<0.001	0.003	3	30%	0.002	0.001	0.003	0.003
Selenium – total	mg/L	0.01	0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	10	100%	NA	NA	NA	NA
Zinc – total	mg/L	0.005	0.008	0.01	0.056	0.043	0.01	0.034	0.034	0.029	0.013	0.035	0.03	0	0%	0.029	0.01	0.056	0.050
Boron – total	mg/L	0.05	0.37	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	10	100%	NA	NA	NA	NA
Iron – total	mg/L	0.05	ID	<0.05	0.06	0.36	<0.05	1.63	9.7	3.79	0.11	0.07	2.93	2	20%	2.33	0.06	9.7	7.63
Mercury	mg/L	1E-04	0.00006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	10	100%	NA	NA	NA	NA
Fluoride	mg/L	0.1	N/A	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	9	90%	0.2	0.2	0.2	0.2
Nitrite as N	mg/L	0.01	N/A	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	10	100%	NA	NA	NA	NA
Nitrate as N	mg/L	0.01	0.7	0.18	0.22	0.41	0.19	0.21	0.26	0.24	0.2	0.2	0.2	0	0%	0.23	0.18	0.41	0.34
Nitrite + Nitrate as N	mg/L	0.01	N/A	0.18	0.22	0.41	0.19	0.21	0.26	0.24	0.2	0.2	0.2	0	0%	0.23	0.18	0.41	0.34
Total Anions	meq/L	0.01	N/A	0.72	0.78	0.85	0.65	0.71	0.65	0.75	0.63	0.68	0.73	0	0%	0.72	0.63	0.85	0.82
Total Cations	meq/L	0.01	N/A	0.6	0.65	0.69	0.52	0.61	0.6	0.69	0.6	0.69	0.61	0	0%	0.63	0.52	0.69	0.69

Groundwater Quality – Bore MW10 – 2013 to 2017

Parameter	Units	LOR	ANZECC (2000) Guideline	Date Sampled 5/04/13	2/10/13	4/04/14	2/10/14	2/04/15	2/10/15	5/04/16	4/10/16	3/04/17	3/10/17	Statistical Analysis Records Below LOR	% Below LOR	Average	Minimum	Max	95th %ile
pH	pH unit	0.01	N/A	4.21			4.93	4.56						0	0%	4.57	4.21	4.93	4.89
Conductivity @ 25ºC	µS/cm	1	N/A	139			135	138						0	0%	137	135	139	139
Hydroxide Alkalinity as $CaCO_3$	mg/L	1	N/A	<1			<1	<1						3	100%	NA	NA	NA	NA
Carbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1			<1	<1						3	100%	NA	NA	NA	NA
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1			<1	<1						3	100%	NA	NA	NA	NA
Sulphate	mg/L	1	N/A	5			6	5						0	0%	5	5	6	6
Chloride	mg/L	1	N/A	35			29	30						0	0%	31	29	35	35
Calcium	mg/L	1	N/A	<1			<1	<1						3	100%	NA	NA	NA	NA
Magnesium	mg/L	1	N/A	2			2	2						0	0%	2	2	2	2
Sodium	mg/L	1	N/A	15			16	16						0	0%	16	15	16	16
Potassium	mg/L	1	N/A	<1			<1	<1						3	100%	NA	NA	NA	NA
Aluminium – total	mg/L	0.01	0.055	0.83			1.09	0.94						0	0%	0.95	0.83	1.09	1.08
Arsenic – total	mg/L	0.001	0.013	<0.001			<0.001	<0.001						3	100%	NA	NA	NA	NA
Cadmium – total	mg/L	1E-04	0.0002	<0.0001			<0.0001	<0.0001						3	100%	NA	NA	NA	NA
Chromium – total	mg/L	0.001	ID	<0.001			<0.001	<0.001						3	100%	NA	NA	NA	NA
Copper – total	mg/L	0.001	0.0014	0.003			0.003	0.004						0	0%	0.003	0.003	0.004	0.004
Lead – total	mg/L	0.001	0.0034	0.003			0.002	0.003						0	0%	0.003	0.002	0.003	0.003
Manganese – total	mg/L	0.001	1.9	0.01			0.01	0.015						0	0%	0.012	0.01	0.015	0.0145
Nickel – total	mg/L	0.001	0.011	0.001			<0.001	0.002						1	33%	0.002	0.001	0.002	0.002
Selenium – total	mg/L	0.01	0.005	<0.01			<0.01	<0.01						3	100%	NA	NA	NA	NA
Zinc – total	mg/L	0.005	0.008	0.068			0.051	0.08						0	0%	0.066	0.051	0.08	0.079
Boron – total	mg/L	0.05	0.37	<0.05			<0.05	<0.05						3	100%	NA	NA	NA	NA
Iron – total	mg/L	0.05	ID	<0.05			0.06	0.06						1	33%	0.06	0.06	0.06	0.06
Mercury	mg/L	1E-04	0.00006	<0.0001			<0.0001	<0.0001						3	100%	NA	NA	NA	NA
Fluoride	mg/L	0.1	N/A	<0.1			<0.1	<0.1						3	100%	NA	NA	NA	NA
Nitrite as N	mg/L	0.01	N/A	<0.01			<0.01	<0.01						3	100%	NA	NA	NA	NA
Nitrate as N	mg/L	0.01	0.7	0.26			0.29	0.38						0	0%	0.31	0.26	0.38	0.37
Nitrite + Nitrate as N	mg/L	0.01	N/A	0.26			0.29	0.38						0	0%	0.31	0.26	0.38	0.37
Total Anions	meq/L	0.01	N/A	1.09			0.94	0.95						0	0%	0.99	0.94	1.09	1.08
Total Cations	meq/L	0.01	N/A	0.82			0.86	0.86						0	0%	0.85	0.82	0.86	0.86

Groundwater Quality – Bore MW13 – 2013 to 2017

Parameter	Units	LOR	ANZECC (2000) Guideline	Date Sampled										Statistical Analysis					
				5/04/13	2/10/13	4/04/14	2/10/14	2/04/15	2/10/15	5/04/16	4/10/16	3/04/17	3/10/17	Records Below LOR	% Below LOR	Average	Minimum	Max	95th %ile
pH	pH unit	0.01	N/A	5.31	NR	NR	5.37	4.72	NR	NR	NR	NR	NR	0	0%	5.13	4.72	5.37	5.36
Conductivity @ 25ºC	µS/cm	1	N/A	108	NR	NR	113	113	NR	NR	NR	NR	NR	0	0%	111	108	113	113
Hydroxide Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	NR	NR	<1	<1	NR	NR	NR	NR	NR	3	100%	NA	NA	NA	NA
Carbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	<1	NR	NR	<1	<1	NR	NR	NR	NR	NR	3	100%	NA	NA	NA	NA
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	N/A	1	NR	NR	<1	<1	NR	NR	NR	NR	NR	2	67%	1	1	1	1
Sulphate	mg/L	1	N/A	2	NR	NR	3	3	NR	NR	NR	NR	NR	0	0%	3	2	3	3
Chloride	mg/L	1	N/A	29	NR	NR	25	27	NR	NR	NR	NR	NR	0	0%	27	25	29	29
Calcium	mg/L	1	N/A	<1	NR	NR	<1	<1	NR	NR	NR	NR	NR	3	100%	NA	NA	NA	NA
Magnesium	mg/L	1	N/A	2	NR	NR	2	1	NR	NR	NR	NR	NR	0	0%	2	1	2	2
Sodium	mg/L	1	N/A	14	NR	NR	15	14	NR	NR	NR	NR	NR	0	0%	14	14	15	15
Potassium	mg/L	1	N/A	<1	NR	NR	<1	<1	NR	NR	NR	NR	NR	3	100%	NA	NA	NA	NA
Aluminium – total	mg/L	0.01	0.055	0.12	NR	NR	0.13	0.17	NR	NR	NR	NR	NR	0	0%	0.14	0.12	0.17	0.17
Arsenic – total	mg/L	0.001	0.013	<0.001	NR	NR	<0.001	<0.001	NR	NR	NR	NR	NR	3	100%	NA	NA	NA	NA
Cadmium – total	mg/L	1E-04	0.0002	<0.0001	NR	NR	<0.0001	<0.0001	NR	NR	NR	NR	NR	3	100%	NA	NA	NA	NA
Chromium – total	mg/L	0.001	ID	<0.001	NR	NR	<0.001	<0.001	NR	NR	NR	NR	NR	3	100%	NA	NA	NA	NA
Copper – total	mg/L	0.001	0.0014	0.004	NR	NR	0.005	0.007	NR	NR	NR	NR	NR	0	0%	0.005	0.004	0.007	0.007
Lead – total	mg/L	0.001	0.0034	0.002	NR	NR	0.001	0.002	NR	NR	NR	NR	NR	0	0%	0.002	0.001	0.002	0.002
Manganese – total	mg/L	0.001	1.9	0.037	NR	NR	0.038	0.04	NR	NR	NR	NR	NR	0	0%	0.038	0.037	0.04	0.040
Nickel – total	mg/L	0.001	0.011	0.002	NR	NR	0.002	0.003	NR	NR	NR	NR	NR	0	0%	0.002	0.002	0.003	0.003
Selenium – total	mg/L	0.01	0.005	<0.01	NR	NR	<0.01	<0.01	NR	NR	NR	NR	NR	3	100%	NA	NA	NA	NA
Zinc – total	mg/L	0.005	0.008	0.052	NR	NR	0.052	0.092	NR	NR	NR	NR	NR	0	0%	0.065	0.052	0.092	0.088
Boron – total	mg/L	0.05	0.37	<0.05	NR	NR	<0.05	<0.05	NR	NR	NR	NR	NR	3	100%	NA	NA	NA	NA
Iron – total	mg/L	0.05	ID	0.13	NR	NR	<0.05	0.1	NR	NR	NR	NR	NR	1	33%	0.12	0.1	0.13	0.13
Mercury	mg/L	1E-04	0.00006	<0.0001	NR	NR	<0.0001	<0.0001	NR	NR	NR	NR	NR	3	100%	NA	NA	NA	NA
Fluoride	mg/L	0.1	N/A	<0.1	NR	NR	<0.1	<0.1	NR	NR	NR	NR	NR	3	100%	NA	NA	NA	NA
Nitrite as N	mg/L	0.01	N/A	<0.01	NR	NR	<0.01	<0.01	NR	NR	NR	NR	NR	3	100%	NA	NA	NA	NA
Nitrate as N	mg/L	0.01	0.7	0.43	NR	NR	0.67	0.64	NR	NR	NR	NR	NR	0	0%	0.58	0.43	0.67	0.67
Nitrite + Nitrate as N	mg/L	0.01	N/A	0.43	NR	NR	0.67	0.64	NR	NR	NR	NR	NR	0	0%	0.58	0.43	0.67	0.67
Total Anions	meq/L	0.01	N/A	0.88	NR	NR	0.77	0.82	NR	NR	NR	NR	NR	0	0%	0.82	0.77	0.88	0.87
Total Cations	meq/L	0.01	N/A	0.77	NR	NR	0.82	0.69	NR	NR	NR	NR	NR	0	0%	0.76	0.69	0.82	0.8

Appendix 4

Maximum Harvestable Right Calculation

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WaterNSW

Maximum Harvestable Right Dam Capacity

Information provided by the user

1. The location of the proposed dam is:
   - Latitude: **-33.415247**
   - Longitude: **151.218099**
2. Total property area to use for calculating the size of the dam is **125.7 Hectares**

Result

The maximum Harvestable right dam capacity for your property is **11.9415** ML (Megalitres)

Date

27/07/2020

Name

RW Corkery

Limitations of the calculator

a) Where to site a dam

You can only construct a harvestable rights dam where the Harvestable Rights Orders apply, refer to NSW Government Gazette 40 dated 31 March 2006 (pages 1628 to 1631).

b) First and Second order streams

The maximum harvestable right calculator does not verify that the location of the proposed dam sits on a first or second order stream. A factsheet : "Where can they be built without a licence?" is available on WaterNSW website to help you work out the stream orders.

You will need to use the legislated topographic map for your area to identify the stream order. This map is the gazetted map as per NSW Government Gazette 37 dated 24 March 2006 (pages 1500-1509).

c) Size of property and dam

The calculator does not take into account other dams already on your property. If you have existing harvestable rights dams on your property, you must take the capacity of these dams into account when constructing a new dam. In the Eastern and Central Divisions other dams must also be taken into account, as described in the NSW Government Gazette 40 dated 31 March 2006 (pages 1628 to 1631).

d) Protected wetlands

The Harvestable Rights Orders specify that you are not allowed to build a dam on or within 3 km of a RAMSAR wetland site. There are 12 RAMSAR wetlands in NSW. Further information on the location of those 12 RAMSAR sites in NSW can be found on the NSW Environment and Heritage government website.

Appendix 5

Correspondence with Government Agencies

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Water Management and Monitoring Program (WMMP) – conditions 11-15, Schedule 3	Satisfactory (Yes/No)	Comment	Action Required
Prior to carrying out any development, the Applicant must prepare a Water Management Plan for the development, in consultation with the DPI-Water, and to the satisfaction of the Secretary. This plan must be prepared by a suitably qualified hydrogeologist/hydrologist whose appointment/s have been approved by the Secretary, and must include:			
a) a Water Balance; b) an Erosion and Sediment Control Plan; c) a Surface Water Monitoring Program; and d) a Groundwater Monitoring Program;	No	• Consultation with DPI Water has not been provided. • This condition requires the Secretary's approval of the expert preparing this plan. The Department is unable to find this correspondence. Please attach as an Appendix to the Management Plan. If approval has not been sought, the relevant expert's CV must be submitted to the Secretary for approval.	Please attach these items as an Appendix to the MP.
The Water Balance must:			
(a) include details of all water extracted (including water make), dewatered, transferred, used and/or discharged by the quarry; and	No	• Section 3.3.3 notes that the maximum groundwater seepage is 49ML/year but the seepage rate is likely to be much less than this. Considering that the predicted net gain of water is 20ML per year, and that groundwater seepage is likely to be much less than 49ML, what is the contingency if there is not enough water available?	n/a
(b) describe measures to minimise water use by the development.	Yes	-	n/a
The Erosion and Sediment Control Plan must:			
(a) be consistent with the requirements of the Department's *Managing Urban Stormwater: Soils and Construction* manual	Yes	• Section 4	n/a
(b) identify activities that could cause soil erosion and generate sediment;	Yes	• Section 4	n/a
(c) describe measures to minimise soil erosion and the potential for the transport of sediment to downstream waters;	Yes	• Section 4	n/a
(d) describe the location, function, and capacity of erosion and sediment control structures; and	Yes	• Section 4	n/a
(e) describe what measures would be implemented to maintain these structures over time.	Yes	• Section 4	n/a
The Surface Water Monitoring Program must include:			
(a) detailed baseline data on surface water flows and quality in waterbodies that could potentially be impacted by the quarry;	Yes	-	n/a

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Water Management and Monitoring Program (WMMP) – conditions 11-15, Schedule 3	Satisfactory (Yes/No)	Comment	Action Required
(b) surface water impact assessment criteria;	No	• The criteria set for these parameters are higher than the baseline data. How was this criteria derived? Justification for the appropriateness of this criteria must be provided.	Amend MP as per comment
(c) a program to monitor surface water flows and quality;	No	• The MP proposes monthly monitoring at Sites A & B. However, monitoring has been removed at Sites C, D, E & F from the approved 2006 Management Plan. The Department cannot agree to this reduced monitoring without adequate justification, due to the sites location within the Hawkesbury River Catchment. Additionally, it is unclear how surface water flows will be monitored.	Amend MP as per comment
(d) a protocol for the investigation, notification and mitigation of identified exceedances of the surface water impact assessment criteria; and	No	• All exceedances are to be reported to DPE and EPA. Refer to Noise and AQ Management Plan comments.	Amend MP to reflect correct incident notification.
(e) a program to monitor the effectiveness of the Erosion and Sediment Control Plan.	No	• Trigger Action Response Plan – Table 2 - Please provide further detail on the triggers for 'non-performing' erosion and sediment control structure. What would this look like?	Amend MP as per comment
The Groundwater Monitoring Program must include:			
(a) a program to collect detailed baseline data, based on sound statistical analysis, to benchmark the pre-quarrying natural variation in groundwater levels, yield and quality in groundwater bores within the predicted drawdown impact zone identified in the Amendment Report;	No	• The baseline data for water quality is based off two readings in 2015. Does historical data exist to provide a more comprehensive data set?	Amend MP as per comment
(b) groundwater impact assessment criteria for monitoring bores and privately-owned bores;	No	• It is understood that the Groundwater impact assessment criteria will be based on the ANZECC (2000) Guideline values for freshwater ecosystems. Please identify the parameters that would trigger an incident and response.	Amend MP as per comment
(c) a program to monitor impacts on the groundwater supply of potentially affected landowners, groundwater dependent ecosystems, and on vegetation; and	No	• The frequency of water quality monitoring has been altered from six monthly to annually and monitoring of pH and EC has been altered from two monthly to quarterly. Provide justification for the less frequent monitoring proposed.	Amend MP as per comment
(d) a program to monitor ground water level effects on vegetation, and on ground water supply to adjoining properties; and	Yes	-	n/a
(e) a protocol for the investigation, notification and mitigation of identified exceedances of the groundwater impact assessment criteria.	No	• Section 6.5 - All exceedances of the impact assessment criteria are to be reported to DPE.	Amend MP to reflect correct incident notification.

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Hanson Response to DPE Comments September 2017 – Site Water Management Plan

Condition	DPE Comment	Response	Section of Report
Prior to carrying out any development, the Applicant must prepare a Water Management Plan for the development, in consultation with the DPI-Water, and to the satisfaction of the Secretary. This plan must be prepared by a suitably qualified hydrogeologist/hydrologist whose appointment/s have been approved by the Secretary, and must include: a) a Water Balance; b) an Erosion and Sediment Control Plan; c) a Surface Water Monitoring Program; and d) a Groundwater Monitoring Program;	Consultation with DPI Water has not been provided. This condition requires the Secretary's approval of the expert preparing this plan. The Department is unable to find this correspondence. Please attach as an Appendix to the Management Plan. If approval has not been sought, the relevant expert's CV must be submitted to the Secretary for approval.	CVs of relevant technical consultants involved in water management at the Calga Quarry has been provided in separate correspondence. The SWMP has been provided to the NSW Natural Resource Access Regulator for comment.	Specialists involved in preparation of the plan have been endorsed by DPE.
The Water Balance must: (a) include details of all water extracted (including water make), dewatered, transferred, used and/or discharged by the quarry; and	Section 3.3.2 notes that the maximum groundwater seepage is 49ML/year but the seepage rate is likely to be much less than this. Considering that the predicted net gain of water is 20ML per year, and that groundwater seepage is likely to be much less than 49ML, what is the contingency if there is not enough water available?	The DPE comments on the water balance noted that estimates of groundwater seepage indicated there may be insufficient water available for processing activities. However, following discussion with a DPE officer, it was clarified that as the estimate of groundwater seepage was a conservative estimate and that, given existing conditions and experience with these matters at the Quarry, it is likely that water seepage would be much less than that estimated, which would result in more water available for Quarry operations not less.	No change to document
The Surface Water Monitoring Program must include: (a) detailed baseline data on surface water flows and quality in waterbodies that could potentially be impacted by the quarry; (b) surface water impact assessment criteria;	The criteria set for these parameters are higher than the baseline data. How was this criteria derived? Justification for the appropriateness of this criteria must be provided.	The recent variation to EPL 11295 to approve a discharge point from the Quarry included the establishment of water quality criteria. These criteria have been adopted for the Surface Water Monitoring Program.	Section 6.2
(c) a program to monitor surface water flows and quality;	The MP proposes monthly monitoring at Sites A & B. However, monitoring has been removed at Sites C, D, E & F from the approved 2006 Management	The surface water monitoring program at the Calga Sand Quarry has historically included monitoring locations within and in the vicinity of the Quarry Site. The off-site monitoring locations were originally included to provide alternative measures of background conditions in addition to the upstream records at	Section 5.3

	Plan. The Department cannot agree to this reduced monitoring without adequate justification, due to the sites location within the Hawkesbury River Catchment. Additionally, it is unclear how surface water flows will be monitored.	Location B. Given the history of monitoring at the Quarry and the results available for review, some monitoring locations no longer provide data useful for the management of potential water quality impacts that may result from Quarry operations. Historic monitoring has occurred at the locations included on the attached **Figure A**. Of these locations, it is considered that only Location A and Location B provide useful data for the ongoing management of Quarry operations and assessment of compliance against the nominated water quality criteria. Location A is a small dam that is the point of discharge during high rainfall events. Location B is immediately upstream of the discharge point from the Quarry and therefore provides relevant information on receiving waters. Location C and Location E have been removed from the monitoring program following requests from land owners. Location D has historically provided an alternative background monitoring reference location, however this location is difficult to access and as it is also on a different tributary of Cabbage Tree Creek, does not provide results that are relevant to Quarry operations. Monitoring at Location F has also ceased as results at this location provide the same/similar information as that recorded at Location A and therefore are considered to be redundant. Monitoring results at Location A provide a more accurate reflection of water quality likely to be discharged from the Quarry during high rainfall events. Given the above, the proposed ongoing water monitoring program provides an acceptable level of information regarding water quality within the Quarry and at receiving waters, without the need for redundant monitoring. The Calga Quarry has historically maintained water management practices that have ensured that the Quarry is generally operating within the assessment criteria nominated for the Quarry.	
(d) a protocol for the investigation, notification and mitigation of identified	All exceedances are to be reported to DPE and EPA. Refer	Noted, Section 6.5 has been updated.	Section 6.5

exceedances of the surface water impact assessment criteria; and	to Noise and AQ Management Plan comments.		
(e) a program to monitor the effectiveness of the Erosion and Sediment Control Plan.	Trigger Action Response Plan – Table 2 – Please provide further detail on the triggers for 'nonperforming' erosion and sediment control structure. What would this look like?	Erosion and sediment control structures at the Quarry include drainage and sediment dams as well as the pumps and pipelines that form part of the water management system. Failures of these items would be triggers for remedial action. Specific triggers for action would include the following. • Drainage line failure or scouring. • Dam overflow or dam wall failure. • Excessive sediment visible in Dam 7a or 7b/c. • Failure of vegetative cover on terminal areas or other areas revegetated for temporary stabilisation.	Section 5.6 Table 2
The Groundwater Monitoring Program must include:			
(a) a program to collect detailed baseline data, based on sound statistical analysis, to benchmark the pre-quarrying natural variation in groundwater levels, yield and quality in groundwater bores within the predicted drawdown impact zone identified in the Amendment Report;	The baseline data for water quality is based off two readings in 2015. Does historical data exist to provide a more comprehensive data set?	Appendix 3 has been updated to reflect water quality data recorded over the past 5 years.	Section 7.3.2 and Appendix 3
(b) groundwater impact assessment criteria for monitoring bores and privately-owned bores;	It is understood that the Groundwater impact assessment criteria will be based on the ANZECC (2000) Guideline values for freshwater ecosystems. Please identify the parameters that would trigger an incident and response.	While the ANZECC (2000) guidelines are used for comparative purposes, the SWMP also notes that results would also be compared to historic trends. Anomalies in the results would principally be assessed against historic site-specific results and in the context of local land use. Hydrographs and field recorded monitoring data are provided in Appendix 2 of the SWMP and baselines groundwater quality data is presented in Appendix 3. The trigger for an investigation of groundwater levels or groundwater quality would be a result above the 80th percentile of historic results. In these instances, an investigation would include commissioning of a suitably qualified professional to undertake the following. • Review of meteorological conditions to establish relevant patterns. • Inspection of the bore and context of local land uses. • Review of results upgradient of the affected bore to establish a possible source of contamination. • Retesting of water levels or groundwater quality, whichever is relevant.	Section 7.4

		The recommendations of any review would be implemented where it is feasible to do so.	
(c) a program to monitor impacts on the groundwater supply of potentially affected landowners, groundwater dependent ecosystems, and on vegetation; and	The frequency of water quality monitoring has been altered from six monthly to annually and monitoring of pH and EC has been altered from two monthly to quarterly. Provide justification for the less frequent monitoring proposed.	pH and electrical conductivity (EC) monitoring at the Quarry has occurred on a bi-monthly or monthly basis since 2006. Since that time, it has been established that pH values commonly vary by no more than 20% based on what is believed to be seasonal influences to rainfall recharge. Variations to EC greater than 20% of historic levels have not been observed. It is therefore considered appropriate to reduce the frequency of field monitoring from bi-monthly to quarterly. However, triggers for investigation would remain. Modifications to the frequency of laboratory analysis of water quality were based on the recommendations of the Independent Groundwater Audit prepared each year by Dundon Consulting Pty Ltd. The same recommendations have been made each year in reporting for the audits since 2011. Dundon (2017) recommends that detailed laboratory analysis for groundwater quality should be reduced from six-monthly to annually as there is no evident seasonal trend in exceedances of metals or nitrates. The metal concentrations recorded in monitoring are considered to be natural and unrelated to the Quarry. High nitrate concentrations are considered to be due to off-site agricultural practices and also not related to the Quarry (see Section 7.2 of Dundon (2017)). However, all results would continue to be compared to the relevant ANZECC (2000) guideline values for freshwater ecosystem protection, where available, historic trends/triggers and considered in the context of local land uses. Dundon (2017) also recommends modifications to the groundwater monitoring program to exclude arsenic, selenium, boron and mercury from the ongoing analytical suite of tests of groundwater quality given that these analytes have not historically been detected at the Quarry Site.	
(e) a protocol for the investigation, notification and mitigation of identified exceedances of the groundwater impact assessment criteria.	Section 6.5 - All exceedances of the impact assessment criteria are to be reported to DPE.	Noted	Section 7.5
References: ANZECC (2000) - Australian and New Zealand Environment and Conservation Council (ANZECC) (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. October 2000			

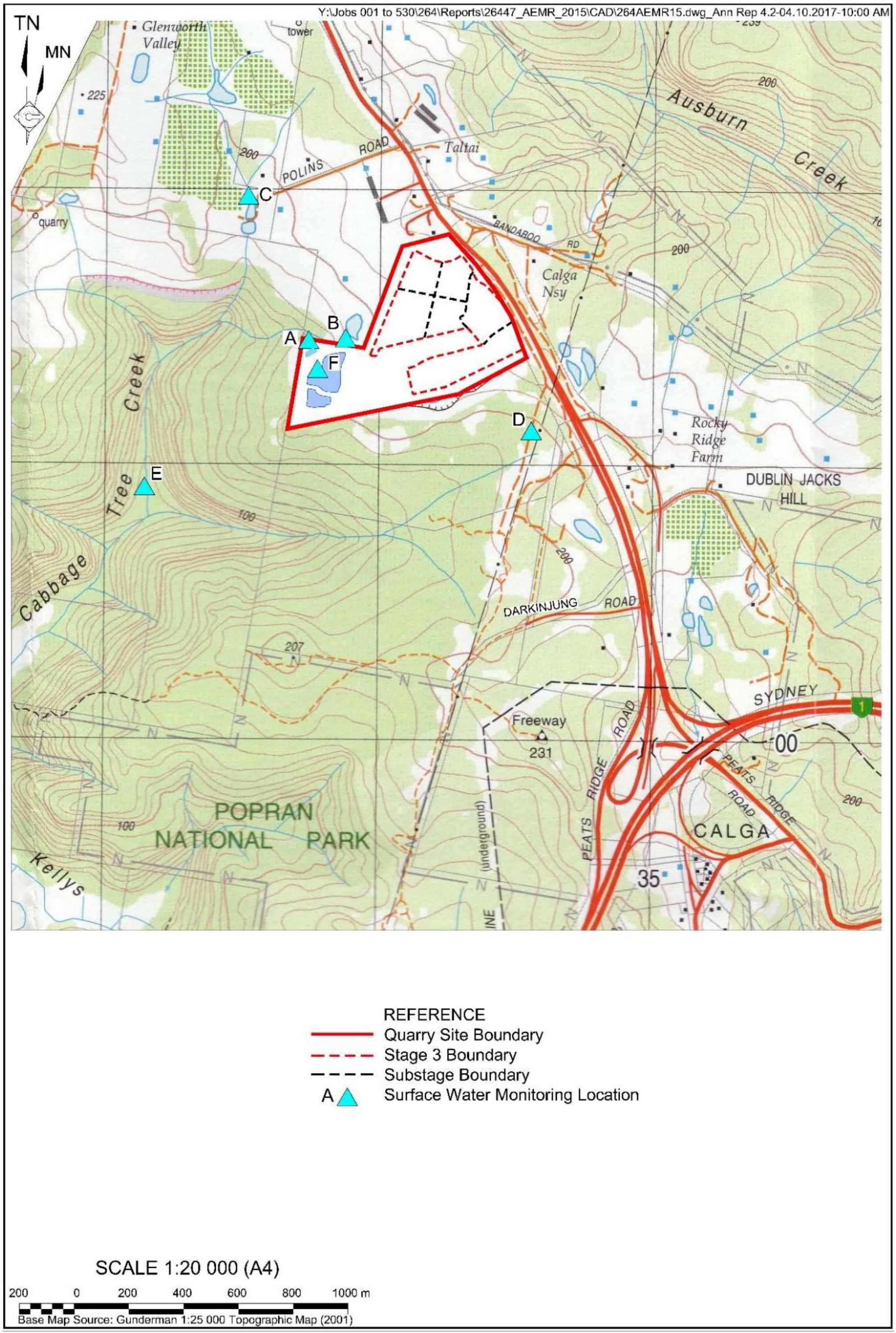

Figure A – Calga Sand Quarry – Historic Water Monitoring Locations

NSW GOVERNMENT | Department of Industry

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22 June 2020

Dear Belinda,

Calga Sand Quarry – Site Water Management Plan

Thank you for giving the Department of Planning, Industry and Environment – Water (DPIE-Water) and the Natural Resources Access Regulator (NRAR) the opportunity to review the updated Site Water Management Plan for Calga Sand Quarry. DPIE-Water and NRAR have reviewed the plan and provide the following comments:

1. The operator is to report on any water level impact exceedances at bores CQ10 and CQ11 and other offsite bores, the procedures followed in response, and the results of any investigation and/or mitigation actions.
2. The Site Water Management Plan:
   a. Provide prescriptive detail for water make, water extracted (e.g. dust suppression), transferred between storages (i.e. groundwater inflows) and offsite discharges stating where meters, pump records, logbook or models etc will be used to report on the different water balance inputs/outputs elements.
   b. Provide a timeframe for the testing of baseline groundwater quality, flow yield and water levels from the private bores within the predicted impact 500m radius area.
   c. Define the 1m bore water decline performance measure for the nominated reference bores, with levels given in AHD and presented in the hydrographs showing the time and duration of any exceedance.
   d. State performance measure for Groundwater Dependent Ecosystems impacts.
   e. Report the results for the above in the Annual Environment Report.
3. The Site Water Balance and Licences:
   (i) The project currently holds WAL: 17384 for an entitlement of 10ML under the Water Sharing Plan for the Central Coast Unregulated Water Sources, within the Mangrove Creek Water Source and within the Mangrove Plateau Management Zone. The projects harvestable rights entitlements according to the site being of 57 hectares is 4.56ML. The management plan has outlined the annual rainfall to be 219ML/year with 50% diverted into Dam 13 and Dam 7b/c. If dams 13 and 7b water capture is further separated by 50%, it is expected dam 7b/c captures approximately 54ML of water per year. The project currently holds entitlements for 10ML of surface water take and 4.56ML in harvestable rights. The Management Plan is to thoroughly explain this water take or the requirements for addition WAL entitlements.

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Further details on these comments can be found in the appendix of this letter. Should you have any further queries in relation to this submission please do not hesitate to contact the Natural Resources Access Regulator's Service Support Team at nrar.servicedesk@industry.nsw.gov.au.

Yours sincerely

Alison Collaros
Licensing and Approvals Manager (East)
Natural Resources Access Regulator
Department of Planning, Industry and Environment

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Appendix:

Site water balance

The water balance is required to report on all water extracted including water make, dewatered, transferred, used and or discharged by the quarry. An independent audit in 2018 identified that no meters had been installed, a logbook of water transfers had not been maintained and offsite discharges were not measured. In response, a meter was installed on the bore that supplies water to the amenities building, however, the SWMP remains deficient in a number of areas.

Detailed baseline data for private bores within the predicted drawdown impact zone

The 2018 Independent Audit found that the proponent has not adequately monitored all identified bores within 500m. The proponent has received approval from neighbours to monitor only two out of three properties, and no water level or flow metering equipment has been installed on any private bore. In response, the proponent states "Hanson is still in discussion with Peter Dundon on feasibility to install equipment to private bores that require water level/flow monitoring equipment". The SWMP remains deficient. A timeframe should be set to complete the testing outlined, more so now given that off-site impacts have been detected and is discussed in following points.

Groundwater impact exceedances and reporting

Water levels have declined by more than 1 meter in the closest monitoring bores to the quarry, breaching the action response trigger identified in the SWMP. The water level declines have occurred during a period of above average rainfall and contrast with rising groundwater levels recorded elsewhere nearby. It is unknown if the proponent has responded to these declines and whether an agency notification was initiated.

In August 2018 DPIE Water requested an investigation and report into the declining groundwater level trend observed in the south eastern corner of the operations. The issue remains unresolved.

The procedures that would be followed in the event of any exceedance of the groundwater impact trigger

The SWMP outlines a procedure to address any off-site groundwater impact exceedance. This includes a requirement to investigate changes in water security for neighbouring properties. The post approval 1m groundwater decline trigger has been exceeded. The operator has only acquired a singular event of hydraulic testing and this is limited to only some of the off-site bores. The ability to retrospectively quantify changes in offsite water security impacts to neighbouring bores attributable to the quarry is therefore compromised. In addition, there is no evidence the procedure as presented in the SWMP has been acted upon.

Calga Sand Quarry – Site Water Management Plan

DPIE – Water and NRAR Comments – September 2020

Comment	Response
1. The operator is to report on any water level impact exceedances at bores CQ10 and CQ11 and other offsite bores, the procedures followed in response, and the results of any investigation and/or mitigation actions.	Noted, see Section 7.5 which includes notification to NRAR of exceedances as soon as practical after any exceedance.
2. The Site Water Management Plan: a. Provide prescriptive detail for water make, water extracted (e.g. dust suppression), transferred between storages (i.e. groundwater inflows) and offsite discharges stating where meters, pump records, logbook or models etc will be used to report on the different water balance inputs/outputs elements. **Site water balance** The water balance is required to report on all water extracted including water make, dewatered, transferred, used and or discharged by the quarry. An independent audit in 2018 identified that no meters had been installed, a logbook of water transfers had not been maintained and offsite discharges were not measured. In response, a meter was installed on the bore that supplies water to the amenities building, however, the SWMP remains deficient in a number of areas.	A water use and water source schematic is presented as Figure 1. This includes how water is transferred and where water transfer is metered. This is intended to demonstrate how water use is calculated and assist reporting on different water balance inputs/outputs.
b. Provide a timeframe for the testing of baseline groundwater quality, flow yield and water levels from the private bores within the predicted impact 500m radius area. **Detailed baseline data for private bores within the predicted drawdown impact zone** The 2018 Independent Audit found that the proponent has not adequately monitored all identified bores within 500m. The proponent has received approval from neighbours to monitor only two out of three properties, and no water level or flow metering equipment has been installed on any private bore. In response, the proponent states "Hanson is still in discussion with Peter Dundon on feasibility to install equipment to private bores that require water level/flow monitoring equipment". The SWMP remains deficient. A timeframe should be set to complete the testing outlined, more so now given that off-site impacts have been detected and is discussed in following points.	Section 7.2.1 updated to reflect the outcomes of recent bore testing. Three additional bores were identified within 500m of the quarry as a result of the bore census: • CP13 – Bore was tested in 7 February 2014, and reported by letter report dated 12 February 2014. Routine monitoring started on 1 February 2019. • CP14 – Rocla and then Hanson were unable to obtain permission to monitor the bore. It is sealed by a plate welded across the top. The bore has never been used. • CP15 – Bore was tested on 21 November 2019, and reported by letter dated 6 December 2019. Routine monitoring started on 29 March 2019 (ie several months before testing). Both CP13 and CP15 were sampled bi-monthly for site measurement of pH and EC in 2019 (as part of routine monitoring). CP15 was sampled for lab analysis in 2019.

Comment	Response
c. Define the 1m bore water decline performance measure for the nominated reference bores, with levels given in AHD and presented in the hydrographs showing the time and duration of any exceedance.	Trigger levels are presented based a 1m decline below the 5th percentile lowest records for each bore (section 7.4.1) and hydrographs presented in Appendix 2 with the trigger level present. A trigger level based on the 5th percentile of lowest records is considered conservative as it takes into account seasonal variation in groundwater levels.
d. State performance measure for Groundwater Dependent Ecosystems impacts.	The annual ecological monitoring describes survey the original survey and establishment of monitoring plots. Each year the results of survey are compared to historical surveys. Specific performance measures are not considered appropriate given that it would be difficult to connect changes in ecological survey outcomes with changes to groundwater trends unless there was an obvious decline in groundwater levels that was associated with the Quarry operation. It should be noted that all monitoring of groundwater dependent ecosystems has noted no change to the setting. In addition, the groundwater dependent ecosystems are located to the south of the Quarry operation and all remaining extraction activities are occurring in the north.
e. Report the results for the above in the Annual Environment Report.	This is noted and reflected in Section 9 of the plan
3. The Site Water Balance and Licences: i. The project currently holds WAL: 17384 for an entitlement of 10ML under the Water Sharing Plan for the Central Coast Unregulated Water Sources, within the Mangrove Creek Water Source and within the Mangrove Plateau Management Zone. The projects harvestable rights entitlements according to the site being of 57 hectares is 4.56ML. The management plan has outlined the annual rainfall to be 219ML/year with 50% diverted into Dam 13 and Dam 7b/c. If dams 13 and 7b water capture is further separated by 50%, it is expected dam 7b/c captures approximately 54ML of water per year. The project currently holds entitlements for 10ML of surface water take and 4.56ML in harvestable rights. The Management Plan is to thoroughly explain this water take or the requirements for addition WAL entitlements.	Assuming the following parameters from the SWMP 1. Area outside Quarry of 10ha 2. 45% of rainfall as runoff 3. 50% diversion into the Quarry 4. Rainfall of 854mm The total requirement is 19.2ML (100,000m³ x 0.854 x 0.45 x 0.5). Hanson hold 10ML entitlement. In addition, the harvestable right of the property owned by Hanson is 11.95ML (takes into account land to the south that is owned by Hanson and covers approximately 125.7ha). Total entitlement is therefore 21.95ML and excess to requirements. A brief summary is presented in Section 3 to clarify this.

Comment	Response
Groundwater impact exceedances and reporting Water levels have declined by more than 1 meter in the closest monitoring bores to the quarry, breaching the action response trigger identified in the SWMP. The water level declines have occurred during a period of above average rainfall and contrast with rising groundwater levels recorded elsewhere nearby. It is unknown if the proponent has responded to these declines and whether an agency notification was initiated. In August 2018 DPIE Water requested an investigation and report into the declining groundwater level trend observed in the south eastern corner of the operations. The issue remains unresolved.	Section 7 presents the Groundwater Monitoring Program including baseline monitoring records, assessment criteria and triggers for investigation. All monitoring results have been reported in the Annual Review each year and drawdown that exceeds 1m has been investigated.
The procedures that would be followed in the event of any exceedance of the groundwater impact trigger The SWMP outlines a procedure to address any off-site groundwater impact exceedance. This includes a requirement to investigate changes in water security for neighbouring properties. The post approval 1m groundwater decline trigger has been exceeded. The operator has only acquired a singular event of hydraulic testing and this is limited to only some of the off-site bores. The ability to retrospectively quantify changes in offsite water security impacts to neighbouring bores attributable to the quarry is therefore compromised. In addition, there is no evidence the procedure as presented in the SWMP has been acted upon.	Section 7.5 presents the protocols for managing incidents including notifications, investigations and reporting. NRAR will be included in notifications for future investigations to ensure that accurate records are maintained.

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