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8 March 2017

Hunter Water Corporation
Emailed

Att: Holly Marlin

Dear Holly

Eagleton Quarry EIS – Review of Water Assessment

Please find attached a copy of our review of the water assessment associated with the above development proposal. As requested our review has focused on the management of surface runoff within the site and the potential risks to downstream surface water quality. Specifically, the following documents were reviewed by Alluvium:

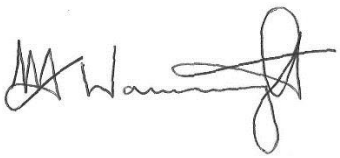
- Hunter Water letter dated 10 May 2016 to DPE outlining HWC's concerns with the proposed development (ref HW2016-492.001);
- Eagleton Hard Rock Quarry Water Assessment Final prepared by Umwelt Pty Ltd, October 2016; and
- Relevant sections of the Eagleton Quarry EIS prepared by JBA Urban Planning Consultants, January 2017.

Within our review we have included text boxes that summarise key comments on particular issues for consideration by Hunter Water.

Based on the information provided by the applicant, it is considered that the development has not demonstrated achievement of the NorBE targets.

If you have any questions on our review, please do not hesitate to contact the undersigned.

Sincerely



Mark Wainwright
Senior Water Resources Engineer

1 Introduction

Hunter Water Corporation (HWC) is preparing a submission to the Department of Planning on the proposed Eagleton Quarry for which the EIS is currently on public exhibition. HWC is interested in determining the potential of the proposed development to adversely affect water quality in the Grahamstown Dam catchment.

HWC has engaged Alluvium to complete an independent review of the proposed water quality and quantity management infrastructure associated with the proposal. The scope of the review focuses on the management of surface runoff within the site and the potential risks to downstream surface water quality.

HWC has requested that the following documents be reviewed by Alluvium:

- Hunter Water letter dated 10 May 2016 to DPE outlining HWC's concerns with the proposed development (ref HW2016-492.001);
- Eagleton Hard Rock Quarry Water Assessment Final prepared by Umwelt Pty Ltd, October 2016; and
- Relevant sections of the Eagleton Quarry EIS prepared by JBA Urban Planning Consultants, January 2017.

Within the following review, references to page, table or plate numbers in parenthesis e.g. (pg. 5, Plate 5.3) are references to page, table or plate numbers in the Eagleton Hard Rock Quarry Water Assessment Final report prepared by Umwelt Pty Ltd. This report prepared by Umwelt is referred to as the 'Water Assessment' throughout this review.

HWC has requested that Alluvium provide comment on the following specific elements of the water management strategy:

- Adopted water quality targets for discharge from the site;
- Adopted design criteria for the proposed water management dams;
- Accuracy of the design storm runoff estimates;
- Size of the proposed water management dams;
- Appropriateness and long-term sustainability of the proposed stormwater management measures;
- Appropriateness of the proposed water quality monitoring sites and monitoring program;
- Cumulative impacts on the Grahamstown Dam drinking water catchment; and
- Ability of the proposed development to meet NorBE under all weather conditions.

The proposed development will progress over a 30-year period. The key components of the strategy are two dams (Dams 1 and 2) proposed downslope of the quarry extraction areas. For the purposes of this review, our comments focus on the water management strategy performance at two key stages in the development lifecycle when potential risks to water quality would be high. The first stage is at Year 5 after extraction areas have progressed significantly when Dam 1 is in place, but Dam 2 is yet to be constructed. The second stage is at Year 30 when the exposed extraction area is at its maximum with Dams 1 and 2 in place.

2 Objectives and Targets for Drinking Water Catchments

2.1 Hunter Water Regulation 2015

The Hunter Water Regulation 2015 (the Regulation) defines "Special Areas" as areas which are important for protecting drinking water supply. HWC Special Areas include the Grahamstown Catchment that the proposed development site is located within.

The Regulation specifies that a person or organisation shall not pollute waters in a Special Area. *Pollute waters has the same meaning as pollution of waters in the Protection of the Environment Operations Act 1997, but extends to include disturbing geological or other matter (whether natural or artificial) in such a manner as to change, or to be likely to change, the physical, chemical or biological condition of the waters*.

It is the Department of Planning and Environment's (DPE) responsibility as the relevant consent authority to ensure adherence with the Regulation for any proposed development within the Special Areas. The primary mechanism to fulfil this responsibility is the review of all development applications that trigger the Regulation during the approval process. DPE is required to refer relevant development applications to Hunter Water Corporation for comment.

2.2 Hunter Water Guidelines for Development in the Drinking Water Catchments 2016

Following the introduction of the Hunter Water Regulation 2015, Hunter Water prepared these guidelines to provide guidance to Applicants on HWC requirements for development in their drinking water catchments. Hunter Water expects that all development in their drinking water catchments will demonstrate a Neutral or Beneficial Effect (NorBE) impact on water quality. NorBE is achieved if the development:

(a) has no identifiable potential impact on water quality, or

(b) will contain any water quality impact on the development site and prevent it from reaching any watercourse, waterbody or drainage depression on the site, or

(c) will transfer any water quality impact outside the site where it is treated and disposed of to standards approved by the consent authority.

Eagleton Hard Rock Quarry development proposal is targeting achievement of NorBE by containing water quality impacts within the development site to avoid impacts on Seven Mile Creek.

2.3 Hunter Water Catchment Management Plan 2011

The Hunter Water Catchment Management Plan (CMP) was prepared to outline a long-term water quality improvement plan for the drinking water catchments and water sources in the lower Hunter. The plan provides clear priorities for improving the protection of the drinking water catchments.

HWC's risk assessments carried out as part of the CMP have concluded that the current barriers within the existing drinking water treatment and supply system downstream of dams are generally robust. These barriers include treatment, disinfection, chlorination and distribution in a closed system. The CMP identifies improved source catchment management and reservoir protection as the barriers that offer the greatest potential for further reducing risks to source water quality. The CMP recommended that preventive measures be applied as close to the source as possible with a focus on prevention in catchments rather than sole reliance on the water treatment and supply system.

The CMP identifies that runoff from developed areas currently poses the greatest risk to source drinking water quality. Key pollutants from developing catchments that HWC is concerned with include bacteria, viruses, protozoa, turbidity, suspended solids, nutrients, heavy metals, fuels, pesticides, organics, algal toxins, endocrine disrupting chemicals, and taste/odour compounds.

2.4 Port Stephens Council LEP 2013

Clause 7.8 of the LEP outlines an objective to protect drinking water catchments by minimising the adverse impacts of development on the quality and quantity of water entering drinking water storages. This clause applies to land identified as 'Drinking Water Catchment' on the 'Drinking Water Catchment Map'. The proposed Eagleton Quarry development is located within the Drinking Water Catchment.

Before determining a development application for development on land to which this clause applies, the consent authority must consider the following:

- *whether or not the development is likely to have any adverse impact on the quality and quantity of water entering the drinking water storage, having regard to:*
    - *the distance between the development and any waterway that feeds into the drinking water storage;*
    - *the on-site use, storage and disposal of any chemicals on the land;*
    - *the treatment, storage and disposal of waste water and solid waste generated or used by the development; and*
    - *any appropriate measures proposed to avoid, minimise or mitigate the impacts of the development.*

- *Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that the development is designed, sited and will be managed to avoid any significant adverse impact on*
    - *water quality and flows, or*
    - *if that impact cannot be reasonably avoided—the development is designed, sited and will be managed to minimise that impact, or*
    - *if that impact cannot be minimised—the development will be managed to mitigate that impact.*

3 Comments on the Water Assessment

3.1 Proposed water management strategy

The primary components of the water management strategy are two sediment / water storage dams (Dam 1 and Dam 2) proposed to be located adjacent to an unnamed southern tributary of Seven Mile Creek. The dams would be located downslope of the ultimate extraction area extents and have a combined water storage capacity of 57 ML.

The water assessment indicates that Dam 1 would be constructed prior to commencing extractive works in Year 1. Dam 1 would have a storage capacity of 28 ML and be positioned downstream of the two extraction areas (Extraction Areas A and B). A catch drain constructed adjacent to a proposed haulage road through the site would convey overflow runoff from Extraction Areas A and B to Dam 1.

Dam 2 would be constructed in Year 6 to support water management from the ultimate extraction extents. After Year 6, the extraction area would progress towards Dam 1 and Dam 2. A bund would be formed on the downslope side of the dams and the ultimate extraction extents would encompass the extraction floor and dams within a contained bunded area.

In addition to the Dam 1 and Dam 2, the proposed water management strategy would also include the following mitigation measures:

- A ‘clean water’ diversion channel along the western side of the proposed quarry to divert forested catchment areas around the quarry extraction areas.
- A central dirty water catch drain to convey runoff from the haul road to the dams.
- ‘Dirty water’ catch drains constructed on the perimeter of the extraction and processing areas to direct runoff towards the dams. Catch drains would be grass or rock lined with check dams.
- Sediment traps installed at changes in grade along the dirty water catch drains.
- Extraction areas graded away from a central catch drain/haul road towards bunds to create wedge shaped sump areas.
- An earth bund at the downslope edge of the graded extraction area (height varying between 1 and 1.5 m depending on the development stage) to prevent uncontrolled overland flow from the extraction areas leaving the site.
- Low flow pipes constructed into the bund to manage discharges to downslope dams and provide detention of the PMF event.
- An oil skimming facility to treat runoff from the workshop areas and washing plant areas prior to transfer to dirty water catch drains and then to the dams.

Further discussion on these proposed mitigation measures is provided in the following sections.

3.2 Water management targets

The Hunter Water Guidelines for Development in the Drinking Water Catchments 2016 were prepared to provide guidance on their requirements for assessing development activities in the drinking water catchments. HWC expects that all development in drinking water catchments will demonstrate a Neutral or Beneficial Effect (NorBE) on water quality.

Grahamstown Dam functions as a sink for many pollutants conveyed from the catchment. We understand it is the potential accumulation of pollutants generated by the development in Grahamstown Dam that is of most concern to Hunter Water. Whilst concentrations are important, it is the total load of pollutants generated from the development that is of most concern. This requires the implementation of mitigation measures that target management of both water quality and quantity.

HWC confirmed their requirements for management of water within the site in a letter to DPE dated 10 May 2016. HWC indicated that the proposed development should demonstrate NorBE and noted that the requirement to achieve NorBE includes wet years and during storm events. HWC provided an example of the proposed Kings Hill development in the adjacent catchment where HWC is requiring the developer to avoid runoff discharging into the dam for all events up to the 0.2% AEP design flooding event. For that site, the proposed runoff management approach was accepted by HWC as achieving the NorBE targets.

We understand that the proposed Eagleton Hard Rock Quarry is targeting achievement of NorBE by containing water quality impacts within the development site and preventing these impacts from reaching Seven Mile Creek. We understand that if the applicant can demonstrate that the total catchment/pollutant load from the site following development with mitigation measures in place does not exceed the pre-development loads this would achieve the NorBE targets. This would also require the applicant to demonstrate that pollutants unlikely to be found in the current site (e.g. particular chemicals, fuel, oils etc.) can be appropriately isolated from mixing with runoff.

To demonstrate achievement of NorBE for this development, the applicant has two assessment approaches that would be acceptable to HWC:

1. Approach 1 would be to demonstrate that the catchment/pollutant loads from the development can be sustainably managed within the site to ensure that loads discharged into Seven Mile Creek would not exceed existing loads over the long-term.

2. Approach 2 would be to demonstrate that all catchment loads up to an agreed rare flooding event can be retained completely within the site without discharge to Seven Mile Creek. HWC has previously accepted a 0.2% AEP design event standard as being acceptable for other developments in the catchment. We understand that no discussions have been held with HWC to confirm an acceptable design standard for this site.

The Water Assessment does not provide any estimates of the existing catchment/pollutant loads. Without an appreciation of the magnitude of the current catchment loads, it is not possible to confirm if the proposed mitigation strategy would achieve the NorBE targets considering Approach 1 outlined above. In addition, the applicant has not estimated the catchment/pollutant loads that would be released from the site in the long-term.

The applicant has adopted Approach 2 outlined above for their assessment. This approach uses a 100 year ARI, 24-hour duration design storm burst as the design storm for retention of runoff in storages within the site. HWC provided an example in their letter to DPE dated 10 May 2016 that a 0.2% AEP (i.e. 500 year ARI) design event standard had previously been accepted for other developments in the catchment. The design standard previously accepted by HWC would require greater retention storage to be provided in the site than the standard adopted by the applicant.

It is our opinion that in circumstances where runoff is to be retained within a site rather than diverted around a drinking water storage along a channel (as is the case for the King Hill development example), an assessment based on Approach 1 outlined above is most appropriate. It is considered that there are limitations with sizing appropriate retention storages based on discrete storm events that form the basis for Approach 2. These limitations can result in increased risks to water quality that can occur during relatively small storm events. Further discussion on this is provided in the following sections.

There is conflicting discussion in the Water Assessment regarding the adopted water quantity management targets. Whilst the strategy appears to target the retention of all runoff up to the 100 year ARI 24-hour event within the site to avoid discharge to Seven Mile Creek, the Water Assessment also includes a commitment to detain runoff from the PMF behind the bunded area and control discharges during this event through low flow pipes constructed in the bund (pg. 5). Providing low flow pipes through the bunds appears to conflict with the objective to use the bunds for retaining runoff. Low flow pipes would result in runoff being able to drain to the dams which would overflow when full.

It is considered that clear objectives and targets for water management within the site have not been established to address Hunter Water's concerns for protection of water quality in the Grahamstown Dam drinking water catchment.

Key comments:

- Existing catchment/pollutant loads have not been estimated as a basis for NorBE assessment
- Applicant has adopted a 100 year ARI, 24-hour duration design storm burst as the standard for retention of runoff within the site. Hunter Water has previously required other developers in the catchment to adopt a 0.2% AEP (500 year ARI) standard for water management.
- It is unclear what range of events the applicant is targeting management for. There is some discussion in the Water Assessment about detaining the PMF that appears to conflict with the strategy for managing the 100 year ARI, 24-hour event.
- A strategy based on retention of a design storm event burst is not appropriate for managing water quality risks of the development.

3.3 Event-based modelling

Runoff volume estimates
The applicant has completed event-based modelling to estimate the runoff volume from the development during specific design storm bursts at various stages of the development lifecycle. Modelling was completed for 100 year ARI (24-hour duration), 500 year ARI (24-hour duration) and PMP (6-hour duration) events. The design storm burst volumes were estimated using XP-STORM software and methods outlined in ARR 1987.

At the Year 30 stage (the ultimate extraction extents), the following total runoff volumes were estimated from the 30.4 ha site (pg. 44, Table 3.2):

- 100 year ARI 24 hour – Rainfall = 259mm and runoff = 69.3 ML (equal to a runoff depth of 228mm)
- 500 year ARI 24 hour – Rainfall = 330mm and runoff = 88.3 ML (equal to a runoff depth of 290mm)
- PMF 6hr – Rainfall = 910mm and runoff = 555.3 ML (equal to a runoff depth of 1827mm)

Although we have not reviewed the models, the runoff estimates for the 100 and 500 year 24-hour design storm bursts appear reasonable adopting conservative estimates for initial and continuing loss rates (e.g. IL 15mm, CL 0.5mm). The ratio of design rainfall for the PMF event to the 100 year ARI event is approximately three which is consistent with our experience. There does appear to be an error with the PMF runoff volume estimate as the estimated runoff depth (converted from runoff volume) is approximately double the estimated rainfall (page 44, T.3.2).

Whilst it is considered that the runoff volume estimates presented in the report for the 100 and 500 year 24-hour design storm bursts are reasonable, it is considered that the estimates have limited application in evaluating potential risks of the development on water quality in the Grahamstown Dam catchment. The reasons for this are discussed below.

Key comments:

- Runoff volume estimates for the 100 and 500 year 24-hour design storm bursts completed by the applicant are considered reasonable.
- There appears to be an error with the PMF runoff volume estimate.
- Event-based storm burst runoff volume estimates have limited application for evaluating potential risks of the development on water quality in the Grahamstown Dam catchment.

Limitations of event based modelling
Event bursts not total volumes

The runoff volumes estimated by Umwelt are for intense rainfall bursts within a larger storm, rather than the complete storm. Additional rainfall and runoff would occur before and after these storm bursts (refer Figure 1 below from ARR 2016) and therefore storages sized based on the burst only would not capture all runoff from the event.

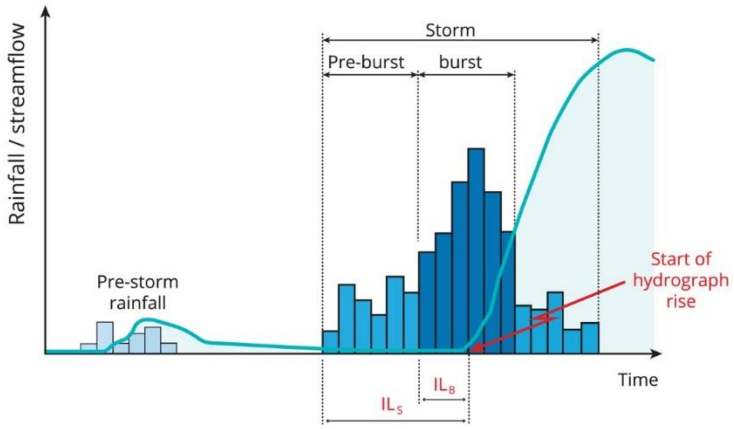


Figure 1 Embedded storm burst

Similar runoff volumes from more frequent design events

The volume of runoff generated in a 100 year ARI, 24-hour duration storm burst can also occur during more frequent longer duration storms. For example, based on the ARR 1987 design rainfall intensities, a 20 year ARI, 48-hour duration storm burst would generate a similar runoff volume as the 100 year ARI, 24-hour duration event. This means that a storage sized to retain the 100 year ARI, 24-hour design storm runoff, may overflow on average once every 20 years (or more frequently) during longer duration events. It is also possible for wet weather to extend over a number of days or weeks that does not lead to flooding, but cumulatively generates a large volume of runoff that would fill the proposed storages.

To address these concerns, continuous hydrologic simulation models (e.g. SIMHYD or the derivative sub-daily RAINRUN model incorporated into the MUSIC model) are typically used to evaluate overflow risks. The applicant prepared a daily continuous simulation model to complete the water balance calculations using GoldSim software. Further discussion on continuous simulation modelling is provided in Section 3.4.

Antecedent water levels

The ability of the proposed water storages to retain all runoff volume from a specific design storm event depends on the antecedent water level in the storages when the design event occurs. The applicant has indicated that the combined proposed storage capacity of Dams 1 and 2 is 57 ML. If these storages are near empty when the 100 year ARI, 24-hour burst occurs, around 57 ML of the estimated 69.3 ML design storm burst could be captured by the dams. If the storages are near full, then the 69.3 ML would need to be stored elsewhere within the site to prevent discharge to Seven Mile Creek.

In-pit and extraction area storage

The Water Assessment indicates that the proportion of the runoff volume in the 100 year ARI, 24-hour event exceeding the Dam 1 and 2 storage capacity would be retained within the extraction area behind bunds. Prior to the quarry floor extending to Dams 1 and 2 (and the containment bund positioned downslope of the dams), it is unclear how the system of proposed retention storages would practicably function within the site. It is assumed for the system to function as planned, runoff from all events would initially be intercepted inside the bunded extraction areas. After the conclusion of a storm event, a decision would then be required on how much runoff could be pumped/released to Dams 1 and 2 based on how full these storages were at the time. If the dams are already full, then runoff would need to be retained in the bunded areas until such time as the dams are drawn down (through re-use) sufficiently to provide additional storage.

If the bunded areas do not initially intercept the runoff volume there would be a high risk of overflow from Dams 1 and 2, with overflows potentially occurring during even small runoff events when the dams are already full.

Operational impacts

Considering the proposed final quarry floor grading of 0.5% and a 1m high containment bund, it is apparent that a high proportion of the site would be inundated to store up to 69.3 ML of runoff outside the dams. In circumstances where the Dams 1 and 2 are almost at capacity prior to the design storm event, it is likely to take a considerable period to reduce the water stored in the bunded area. Without discharge from the site, this will be challenging as the stored water will restrict operations and consequently also reduce water demands.

Key comments:

- Calculated event-based runoff volumes are for storm bursts only and do not represent the entire runoff volume from the event. Storages sized to intercept storm burst only would be undersized for capturing entire storm events.
- The runoff volume from a 100 year ARI 24-hour event can also occur from more frequent longer duration storm events (e.g. 20 year 48-hour event). Water storages sized based on a discrete storm event can therefore overflow more frequently than designed.
- The proportion of runoff from a design storm event that can be retained within the quarry will be highly dependent on the antecedent water level in the storages. If the available storage is near full when the 100 year ARI 24-hour event occurs a high proportion of the runoff would overflow from the site.
- Runoff would initially need to be held in the bunded quarry extraction areas to prevent discharges from the site when the dams are full. Runoff could only be released from the bunded areas at a stage when surplus storage was available in Dams 1 or 2 to prevent uncontrolled discharge from the site.
- Without discharging runoff from the site to Seven Mile Creek there is likely to be significant impacts on the operation of the quarry over extended periods when extraction areas are inundated with stored runoff.
- A continuous simulation modelling approach is more appropriate than a design storm event based approach for designing and assessing the long-term performance of the water management strategy.

3.4 Continuous simulation water balance modelling

Modelling approach

A site water balance was undertaken by the applicant adopting a continuous simulation daily time step modelling approach. In addition to evaluating the site water balance, it is considered that this approach is preferable to the event-based modelling approach for confirming appropriate sizes for water storages within the site. Provided model inputs are appropriate, it is considered that this approach would yield better estimates of water storages required to minimise risks to the drinking water catchment.

The Water Assessment indicates that the system will be designed to contain all runoff from a 100 year ARI 24-hour event on site with no discharges to Seven Mile Creek. The design intent is that runoff during this event would be retained within bunded areas of the site and the dams.

Model inputs

A site water balance model was prepared using GoldSim software. The model inputs included 43 years of evaporation and rainfall data sourced from BoM Station 61078 Williamtown RAAF. Additional rainfall data was sourced from a local Eagleton daily rainfall station to incorporate a period of extreme rainfall that occurred

over April-May 2015. The additional data included a two-day period (21 and 22 April 2015) where 595mm rainfall was observed (pg. 64). Although, the temporal distribution of this rainfall was not available from the daily station, a 48-hour average rainfall intensity of 12.4 mm/hr exceeds the 100 year ARI design rainfall intensity. It is considered that the adopted evaporation and rainfall input data would be appropriate for the purposes of preparing a representative continuous simulation model for the site.

Our comments on the water balance modelling are based on the model outputs only. At this stage, we have not reviewed the GoldSim model that also incorporates water demands for crushed rock processing, dust suppression, exposed area irrigation, dam evaporation, groundwater inflow, infiltration and in-pit storage volume relationship inputs. Our review focuses on the water balance results for the Year 5 and Year 30 scenarios that represent stages in the development lifecycle where the proposed dams would experience their highest potential runoff loading.

Modelling results

At the end of Year 5, the disturbed area draining to Dam 1 (prior to construction of Dam 2) will be at a maximum. The modelling results indicate that the maximum volume of water that would need to be stored in the site to avoid discharge to Seven Mile Creek would be 180 ML (pg. 72, Plate 5.3). Dam 1 has a proposed capacity of 28 ML and therefore 162 ML of additional storage (approximately six times the maximum storage available in Dam 1) would need to be available within the site to avoid overflow to Seven Mile Creek. Considering the 1m height of the proposed bund and proposed surface grading (2.5%) it is considered that the extraction area is likely to provide insufficient additional storage volume at Year 5 to prevent discharge to Seven Mile Creek.

The modelling results also indicate that if no discharge to Seven Mile Creek is undertaken there may be continuous periods of more than six years where the maximum storage level in Dam 1 is exceeded requiring continuous use of in-pit storage. It is considered that it would be impractical to provide this additional storage volume across the extraction area without significantly constraining site operations for an extended period.

Similarly, for Year 30 (ultimate stage) the maximum modelled water stored within the quarry would be 246 ML (pg. 76, Plate 5.5) when the combined Dam 1 and Dam 2 storage is 57 ML. Again, it is unclear how the additional 189 ML could practicably be retained within the site without having a long-term impact on site operations.

Key comments:

- The 43-year continuous simulation water balance modelling completed for the site is considered to provide an appropriate representation of the long-term performance of the water management strategy.
- The climatic inputs adopted for the water balance modelling are considered reasonable.
- The water demand quantities incorporated into the modelling were not checked, although the range of likely water demands considered by the applicant appear appropriate.
- The modelling results indicate that there would be times when the total runoff stored in the quarry extraction areas would be approximately six times that stored in Dam 1 to prevent discharge to Seven Mile Creek.
- The modelling results indicate that for periods up to six years, runoff would need to be stored within the quarry to avoid discharge to Seven Mile Creek.
- It is considered that the volumes and periods that runoff would need to be retained in the quarry outside of Dams 1 and 2 to prevent discharge to Seven Mile Creek would be unsustainable for long-term operation of the quarry.

3.5 Seven Mile Creek water quality

The Water Assessment includes a review of water quality data for Seven Mile Creek that would receive any runoff discharged from the site. The data reviewed included samples collected by Hunter Water and Umwelt at four locations along the main Seven Mile Creek tributary.

Water quality data has been collected since 2001 by HWC at a location along Seven Mile Creek just downstream of the Pacific Highway. Snapshot samples were collected irregularly in 2001, 2002, 2006, 2007 and 2013 by Hunter Water. Since August 2015, water quality data has been collected at regular weekly intervals, and this data would be most useful for establishing base line water quality conditions in the lower reaches of Seven Mile Creek. Water quality at this site is influenced by existing developments in the catchment including the Boral quarry, Garden Land, Hunter Valley Paintball and Barleigh Road Raceway sites. Each of these developments is likely to have contributed to varying degrees to the current water quality conditions observed in Seven Mile Creek just downstream of the Pacific Highway.

Available water quality data along Seven Mile Creek upstream of the Pacific Highway is limited. Umwelt collected five samples between 16-23 November 2015 and 4-6 January 2016 at four sites along the creek. The snapshot sampling presented in the Water Assessment indicates that water quality generally deteriorates moving downstream along Seven Mile Creek. Near the site, water quality was observed to be better than downstream areas impacted by runoff from existing developments.

The snapshot sampling suggests that development in the lower reaches of Seven Mile Creek has resulted in increased TSS, TP and TN concentrations. The snapshot sampling highlights the importance of providing effective mitigation measures within the development site to prevent similar impacts in the relatively undisturbed southern tributary of Seven Mile Creek that the development would discharge into.

No baseline water quality data has been collected for the southern tributary of Seven Mile Creek that the development proposes to discharge into. Data collected to date is along the northern tributary and areas downstream of the confluence. It is considered that the collected data may be unrepresentative of the existing condition in the southern tributary that currently drains a primarily forested catchment.

Water quality data were compared in the Water Assessment against default ANZECC guideline trigger values for ecosystem protection. For this development located in a drinking water supply catchment it is considered that alternative trigger values based on drinking water catchment protection should be considered. At this stage, there is insufficient water quality data to establish appropriate trigger values in the upper reaches of the northern tributary of Seven Mile Creek (only five samples collected at sites in the area, although effectively only for two points in time). Although as discussed above, it is considered that the total catchment/pollutant loads from the site are more relevant to protection of water quality in Grahamstown Dam. In addition, it is considered that data (that is currently unavailable) for the southern tributary would be more relevant to defining baseline conditions for the proposed development.

Based on our review of the water quantity management elements of the strategy, it is considered unlikely that the quarry as proposed could operate effectively without discharging to Seven Mile Creek. It is our opinion that closer consideration of existing water quality in the southern tributary is required to confirm appropriate discharge criteria including consideration of both concentrations and runoff volumes.

Key comments:

- Water quality samples have been collected weekly since August 2015 by Hunter Water at a location on Seven Mile Creek just downstream of the Pacific Highway.
- Limited water quality data is available for sites in the upper reaches of Seven Mile Creek near the proposed development and no water quality data is available for the southern tributary of Seven Mile Creek that the development would drain to.
- Snapshot water quality sampling was completed by Umwelt on behalf of the applicant between 16-23 November 2015 and 4-6 January 2016 at four sites along Seven Mile Creek. This snapshot sampling indicated that water quality generally deteriorated moving downstream along Seven Mile Creek.
- The snapshot sampling highlights the importance of providing effective mitigation measures within the development site to protect the southern tributary of Seven Mile Creek and prevent similar impacts to that observed in the lower reaches of the creek.
- There is currently insufficient data to establish appropriate trigger values for Seven Mile Creek near the site. Whilst establishing trigger concentrations for pollutants is of interest, the total load of pollutants from the site is of concern for protecting drinking water catchment and specifically Grahamstown Dam.
- Establishment of water quality concentration targets for the development should be undertaken in conjunction with runoff discharge volume targets to enable comparison with NorBE targets.

3.6 Performance of proposed mitigation measures

Dams 1 and 2 would intercept significant volumes of sediment over the life of the quarry. The volume of sediment intercepted by each dam will be related to how effective the upslope bunded areas, catch drains, check dams and sediment traps are at capturing sediment closer to the source. The effectiveness of these upslope measures will depend on the maintenance undertaken throughout the quarry lifecycle. Typically, many of these measures are often poorly maintained and at times modified inappropriately during operation. The important function of these measures is often not well understood or appreciated by site operators. This can lead to significant volumes of sediment being washed into the dams that will provide the last barrier prior to discharge into Seven Mile Creek. Insufficient maintenance of the sediment control measures is likely to be a key risk to long-term sustainability of water quality from the development.

The water management strategy indicates that Extraction Areas A and B would grade away from the catch drain at 2.5% towards a downslope 1m high bund (Figure 3.3). This suggests that the extraction floor area would be up to 5 m below the catch drain at the bund. Based on the indicated grading, the bund potentially would be breached prior to overflow from the extraction area to the catch drain. This potentially could result in overflow from the extraction areas bypassing Dam 1 and discharging directly into Seven Mile Creek.

To ensure that sufficient water is available for site activities, dams are often not drained to enable sediment to be removed. Over time this results in an increasing volume of the water being displaced by sediment reducing the water storage capacity. In addition, as the proposed dams will perform a dual function of sediment trapping and water storage, identifying an appropriate time to drain the dams to remove the sediment will be challenging (particularly prior to the construction of Dam 2). Water balance calculations should adopt a reduced capacity to allow for loss of storage due to sediment capture.

Discharge of runoff from the workshop areas and plant washing areas is proposed to be treated by an oil skimming facility prior to transfer to dirty water catch drains and then to the dams. It is suggested that these areas should be isolated and treated water directed away from the dams to minimise the potential for any

mixing with runoff. It is also considered important to isolate any other areas of the site where concentrated spills of oil, fuel, greases or chemicals have a high potential to enter the drainage system.

The system will rely on runoff initially being held in the bunded extraction areas before being released to the dams. This would be necessary to ensure that if a runoff event occurs when the dams are full that uncontrolled overflow from the site won't occur. This arrangement would significantly impact on the site operations.

The low flow pipes are proposed through the bunds to provide detention for the PMF. This would result in the bunds being ineffective for more frequent runoff events. For the bunds to be effective, they would need to be impermeable to avoid uncontrolled runoff draining to Dams 1 and 2, and potentially overflowing from the site.

Key comments:

- Water balance modelling completed to size water storages should consider that a proportion of the water storage will be displaced by trapped sediment.
- Limited information is provided on the closer to source erosion and sediment control measures to be provided throughout the extraction areas. Over the long-term these measures are often poorly maintained in many sites and at times inappropriately modified during operation which can lead to significant volumes of sediment being washed into the dams.
- Insufficient maintenance of the erosion and sediment control measures is a key risk to long-term sustainability of water quality from the development.
- Removal of sediment from the dams and particularly Dam 1 prior to construction of Dam 2 is expected to be challenging. The strategy relies on the dams functioning for water and sediment storage. Draining of the dams to remove sediment will impact on the security of water supply for the development.
- The proposed grading of the extraction area floor and the 1m high bunds in Extraction Areas A and B indicates that the bunds could be breached prior to overflow spilling to the central catch drain. This would result in overflow from the extraction areas bypassing the basins and discharging to Seven Mile Creek.
- Runoff from workshop areas and plant washing areas should be isolated and directed away from the dams. The strategy currently indicates that runoff/water from these areas would be drained to the dams.
- The proposed low flow pipes through the bunds intended to function for detention of the PMF event would compromise the performance of the strategy during frequent runoff events.

3.7 Proposed monitoring program

Water quality is proposed to be monitored at two sites, one upstream of the quarry on the northern tributary and one downstream of the confluence of the northern and southern tributaries. The proposed upstream monitoring site is located downstream of the existing Boral quarry and it is expected that water quality at that monitoring site will be influenced by activities in that quarry. The proposed downstream monitoring site is located below the confluence of the northern and southern tributaries and the Garden Land and Hunter Valley Paintball sites. This would make it challenging to isolate future impacts of the quarry from other development in the catchment. It is suggested that sampling sites on the southern tributary upstream and downstream of where Dam 1 and 2 would overflow into this tributary would be more appropriate.

The water quality monitoring parameters proposed to be monitored include pH, electrical conductivity, TSS, TP and TN. It is recommended that turbidity also be monitored. Turbidity would be particularly relevant for monitoring colloidal particles that are not detected from TSS monitoring.

Flow monitoring is proposed to be undertaken in Seven Mile Creek by 'visual observation' on a monthly basis. Flow discharges from the site to Seven Mile Creek are particularly relevant and it is considered that installation

of an appropriate flow metering instrumentation at all surface water outlets from the site should be included in the monitoring to confirm that no flow (or any alternative agreed flow regime) is being discharged from the site.

The monitoring program includes a commitment to 'document' rainfall depths, water use, dam volumes and any discharges. It is considered that instruments should be installed to automate this process considering the sensitivity of the downstream receiving environment. It is suggested that the program should also include monitoring of sediment depths in Dams 1 and 2 along with a commitment to remove sediment and report on sediment volumes. Monitoring of the condition and maintenance of sediment and erosion measures installed along the catch drains and extraction areas will also be important for ensuring that sediment loads discharged to Dams 1 and 2 are minimised.

The monitoring plan includes discussion on 'contingency' measures to manage water surpluses. It is concluded that 'through the provision of dams and in-pit storages the quarry can be operated without discharging to Seven Mile Creek'. This conclusion is not supported by the water balance modelling which indicates discharges will be required to avoid lengthy interruptions to site operations. It is considered that the proposed 'contingency' measures to manage water surpluses should form a component of the base strategy, as the water balance modelling demonstrates that significant water surpluses are likely to be available. How these water surpluses are managed should form a key component of the base strategy as it is crucial to achieving the planned objective to not discharge to Seven Mile Creek except following rare flooding events.

Key comments:

- The proposed locations of water quality monitoring sites along Seven Mile Creek would not enable the impacts of the proposed development to be isolated from the impacts of other development in the catchment.
- It is suggested that more appropriate locations for sampling sites would be on the southern tributary upstream and downstream of where Dam 1 and 2 would overflow into this tributary.
- It is recommended that turbidity also be monitored.
- It is considered that the contingency measures outlined in the monitoring plan to manage water surpluses should be included in the base strategy as the water balance modelling results indicate that managing water surpluses to prevent site discharge is likely to be an ongoing issue for the development.

3.8 Impacts on Drinking Water Catchments

The Water Assessment concluded that the detailed water balance modelling demonstrates through the provision of dams and in-pit storage that the quarry can operate without discharging to Seven Mile Creek (pg. 88). The water balance modelling completed by the applicant indicates that there would be periods where water would be stored within the site outside the main dams for continuous periods exceeding six years. The water balance modelling also indicates that the additional water storage required outside the dams could be up to six times the maximum storage in the dams. It is considered that providing this additional in-pit storage would be impractical considering the likely pressure after an extended wet period for the quarry owner to continue operations to maintain the viability of their business.

As the Water Assessment concluded that the NorBE targets would be achieved by completely containing impacts within the site through provision of dams and in-pit storage, no estimates of the existing and future site catchment/pollutant loads were completed by the applicant.

Based on the water balance modelling included in the Water Assessment, it is our opinion that discharge of surface water (and entrained pollutants) would be necessary for periods throughout the proposed development lifecycle to prevent areas of the site being inundated for lengthy periods. Without an evaluation of the existing and future catchment/pollutant loads from the site it is not possible to assess the ability of the development to achieve the NorBE targets and confirm what the potential cumulative impacts on the Grahamstown Dam drinking water catchment would be.