APPENDIX C: RECEIVING WATER QUALITY MODELLING DETAILS

Model Background

The Receiving Water Quality Model (***RWQM***) Version 2 (***V2***) model has been developed, calibrated, validated and applied on numerous occasions by BMT WBM on behalf of the HWP and other key SEQ stakeholders, including an assessment of water quality within Pumicestone Passage (WBM 2005). It is a two-dimensional, depth averaged model which is based on heritage code from the Resource Management Associates (RMA) finite element model, originally developed by Professor Ian King. In development of ***RWQM V2***, significant enhancements to the water quality algorithms were undertaken by scientists at the HWP and what was then the Queensland EPA. The model has a strong track record and pedigree of application in the region.

In this application, BMT WBM has excised from larger scale (regional) modelling the relevant sections of models which encompass Pumicestone Passage. Of interest, this particular portion of the model was developed and initially calibrated by BMT WBM for the HWP in 2005 as a stand-alone model before being incorporated, with some refinements, into a regional model. In this study, the Pumicestone Passage model was re-excised from the full 2005 model, and temporal and spatial boundary conditions extended to cover periods since 2005. It was then recalibrated and subsequently used for impact assessments of various potential development scenarios in the Caloundra South landholding. These works are detailed below.

It is noted that the excised model of Pumicestone Passage was adopted in this study due to constraints placed on the study by model run times. In particular, it was found that, even with the fastest computers available, executing the full RWQM2 domain over multiannual periods was not tractable (given the number of scenarios and calibration runs), and as such the excised model was adopted.

Model Data Sets and Model Configuration

Bathymetry

Pumicestone Passage is a relatively shallow, estuarine body of water with extensive mangrove areas which wet and dry each tidal cycle. BMT WBM is constantly updating a Digital Elevation Model (DEM) of all marine and estuarine waterways in SEQ as new data comes to hand as this DEM is regularly used in many of our modelling activities. For the Pumicestone Passage modelling conducted for Stockland, we have configured the ***RWQM V2*** model with the most recent bathymetry.

Boundary Conditions

The Pumicestone Passage ***RWQM V2*** model is forced by boundary conditions in Deception Bay to the south and offshore from Caloundra to the north. Relevant tidal boundaries for these locations have been extracted from regional modelling studies and also validated against Queensland Department of Transport (DOT) tide tables. Specifically, the full ***RWQM V2*** model was interrogated at the boundary locations of the excised and updated Pumicestone Passage model to provide tidal water level conditions for the excised model. These original model tidal conditions were used to generate tidal cycles over a 13-month lunar year which consists of approximately 383 days. This

lunar year was replicated and appended in sequence through 2010 to obtain tidal conditions for each calendar year from 2006 to 2010.

Catchment Inflows

Results from the ***Source Catchments*** model of the Pumicestone Passage catchment described earlier in this report were extracted and used to define catchment inflows to the model due to catchment runoff and associated diffuse source pollutant loads.

Meteorological Forcing

Relevant meteorological (e.g. wind speed and direction) and other salient atmospheric (e.g. solar radiation) forcing data are required for ***RWQM V2*** execution. These data were obtained from BOM Meso-LAPS modelling simulation results available to BMT WBM from other studies we are currently conducting in SEQ. Meso-LAPS is a fine scale version of the BOM Limited Area Prediction System (LAPS) software.

Initial Conditions

Initial conditions, specifically related to start-up of the water quality model, were established by initialising the model with constant average EHMP values across the model and executing the model for a warm up period of three months prior to the model starting period (i.e. commencement of results interrogation).

Model Calibration and Validation

Hydraulic Calibration and Validation

The excised model has previously been calibrated to Acoustic Doppler Current Profiler (ADCP) data collected over a tidal cycle at several locations along Pumicestone Passage. This exercise was not repeated here as the model used in this study was the same as that original model in all hydrodynamic respects. Notwithstanding this, some comparisons of tidal water elevation along Pumicestone Passage were undertaken to ensure model consistency.

Water Quality Calibration and Validation

The model was calibrated to a period of significant 'wet' conditions (this period being 1/7/2007 to 30/6/2008) and validated to a period of predominantly 'dry' conditions (this period being 1/7/2006 to 30/6/2007). This approach was adopted as it lends considerable support to the coupled catchment-receiving water quality model system in its ability to reliably simulate a suitable range of seasonal and climatic conditions within Pumicestone Passage.

Calibration entailed comparison of model predictions with monthly EHMP data, with commensurate adjustments to relevant water quality model process coefficients until suitable model results were obtained. Key literature was used to inform any model coefficient modifications. For the validation assessments, these model process coefficients were kept constant and only boundary/inflow conditions were changed to suit the different temporal setting.

Discussion

As much as was practical in establishing this model calibration, water quality parameters set in the previous study were maintained with only minor adjustment for a few constituents. The following items with respect to this calibration are noted:

The original model calibration was over a dry period (i.e. the year 2000 – the same year as used in the original (then) Queensland EPA calibration), so this study represents the first attempt to apply the excised Pumicestone Passage model over a wet period. This is justification for the required parameter adjustments undertaken here (in addition to that required due to the more extensive EHMP data available and the modified influence of the upgraded catchment model used here compared to that used earlier).

The calibration and validation results show the model is accurately capturing the effects of catchment inflows, tidal flushing and subsequent salt recovery within Pumicestone Passage. This is a direct validation of the advection-dispersion characteristics of the model, of which the correct representation is essential in an assessments-style analysis such as the current study. In some locations especially in northern reaches of the estuary, modelled salinities appear to be lower than the target EHMP data, however, this is expected because the ***RWQM V2*** does not simulate evaporation, which may be creating higher salinities during the summer periods in shallower waters.

Turbidity timeseries predict results associated with storm events that are not necessarily captured in the EHMP data – such rainfall related increases are a direct consequent of the ***Source Catchments*** predictions. The general behaviour of turbidity, however, is adequately captured by the model.

The model accurately predicts the seasonality and summer period growth of algae within Pumicestone Passage. In some areas there are slight under-predictions of chlorophyll *a* concentrations during the dry season, however the model demonstrates the seasonal pattern and magnitude of algae growth appropriately. This result is deemed satisfactory.

Pumicestone Passage is characterised by a shallow northern channel and deeper southern channel. The calibration results show that the model captures the influence of these north/south entrances well in that the estuary is highly influenced by catchment inflows in the mid to northern reaches and more influenced by the ocean boundary in the southern channel.

Finally, the calibration and validation of the excised model is deemed satisfactory for the purposes of this study. In general, satisfactory agreement between the recorded EHMP data and the model results was achieved both for the calibration (wet) and the validation (dry) periods, to an extent appropriate for the purposes of this study.

Model Application

Model Study Period

In order to capture the effects of both wet and dry conditions for an assessment analysis, the model was executed for a period of approximately 4 years, beginning on 1/7/2006 and ending on 31/5/2010. This results in almost 4 years of continuously modelled flows, pollutant loads and water quality within the estuary.

Modelled Constituents

Based on associated performance objectives, the relevant water quality constituents considered for impact analysis were:

- Total nitrogen;
- Total phosphorus;
- Total suspended solids;
- Chlorophyll *a*; and
- Salinity.

Dissolved oxygen, although simulated and included as a secondary constituent in the validation process, has not been included in this impact analysis. It is possible to do so in future.

Modelled Conditions

Various modelled scenarios include an existing condition (or basecase) scenario that establishes the conditions against which subsequent scenarios are compared were assessed using the model.

APPENDIX D: STORMWATER QUALITY MODELLING DETAILS

Model Background

MUSIC has been used in this study to define how various levels of stormwater quality management intervention, specifically via the application of water sensitive urban design (WSUD) techniques, can affect the flows and loads of stormwater borne pollutants from the Caloundra South site, following development. The ***MUSIC*** modelling investigations were informed by ***Urban Developer*** modelling (see Appendix E) and were subsequently used to inform how loads from the ***Source Catchments*** modelling of the urban portions of the Caloundra South site needed to be modified in order to reproduce the influence of WSUD interventions.

Modelling Methodology

Preamble

A representative 270 ha portion of the site was selected to assess stormwater management issues. This portion of the development area is referred to as 'Area MP1'.

Area MP1 will primarily include a mix of residential lots, industrial areas, a school, retirement village and parkland – within an area of 270 ha.

Software

The *MUSIC* software (Version 4) of the eWater CRC has been used in these assessments.

Source Nodes

Within *MUSIC*, the user is required to specify source nodes. The source nodes represent the pollutant generating areas of the site.

Rainfall-runoff and pollutant export characteristics for the existing (pre developed) site were developed based on the data collected by BMT WBM's previously described baseline monitoring program at the Caloundra South site.

Rainfall-runoff and pollutant export characteristics as given by Water by Design's (2010) "MUSIC Modelling Guidelines" were applied for the 'developed' land usage scenarios. The Water by Design (2010) *MUSIC* properties for the 'industrial' land usage classification were used to describe the industrial areas, whilst the properties for the 'residential' classification were used for all other areas within the site.

For the developed land use scenario, the site was discretised into lot, road reserve and parkland – with the lot areas further discretised into roof areas (draining to a rainwater tank and/ or directly to drainage) and 'ground level' (i.e., 'non-roof') areas (in accordance with Water by Design (2010)).

For the purposes of this study, the site was not separated into individual sub-catchments.

Meteorological Data

Modelling was performed for a period of ten years (from 1st January 1997 to 31st December 2006), using recorded pluvio data from the Caloundra Water Treatment Plant (Station 40496) and monthly areal Potential Evapotranspiration.

Modelled Conditions

Various modelled scenarios include an existing condition (or basecase) scenario that establishes the conditions against which subsequent scenarios are compared were assessed using the model.

APPENDIX E: WATER BALANCE MODELLING DETAILS

Model Background

Urban Developer is a modelling tool developed by the eWater CRC. Its primary focus is on enabling rigorous and robust analyses of Integrated Water Cycle Management (IWCM) processes, specifically focussing on assessments of how advanced water sustainability initiatives such as rainwater tanks, greywater reuse, third pipe systems and demand management can influence urban water processes.

The primary reasons ***Urban Developer*** was applied in relation to Caloundra South are as follows:

- To understand how IWCM processes can deliver desired SCRC water cycle performance objectives.
- To understand how rainwater capture and reuse initiatives will operate based on the local climatic regime and most importantly to enable this understanding to then be used in forcing the associated ***MUSIC*** urban stormwater quantity/quality modelling (i.e. rainwater capture and reuse will significantly reduce the quantity of urban stormwater, this will then enable WSUD infrastructure on the site to perform much more efficiently).

Model Data Sets and Model Configuration

Lot Layout

The primary focus of ***Urban Developer*** in this project has been to understand how IWCM actions will affect water cycle management at the lot scale. The model has the capability to simulate IWCM processes also at up to the suburb scale, however in this case such functionality has not been required. As such, we have focussed on IWCM simulations of a 'typical' lot, with such a lot having the following relevant characteristics:

- Lot area 400 $m^{2;}$
- Roof area 200 $m^{2;}$
- 3 residents; and
- Varying IWCM configurations.

Water Consumption

With Caloundra South being a greenfield site, there are no available water consumption data with which to test/calibrate ***Urban Developer***. As such, the approach we have taken has been as follows:

- Develop a base model configured around 'pre-millennium drought' water consumption behaviour. That is, typical water consumptions pre drought were of the order of 300 L/c/day and the intent is for the model to reproduce this rate.
- Develop a 'post drought' demand model which simulates demand management and outdoor water use behavioural changes following the 'millennium drought'.
- Undertake a range of IWCM simulations to enable identification of how water usage/discharge patterns are likely to change. The obvious intention here is to see compliance with the desired SCRC objectives of 80% reductions in potable water supply and wastewater discharge.

Rainfall

All modelling assessments have been conducted using a 10-year duration (1978-1986), 6-minute time step, rainfall series derived for the site. Relevant statistics describing this rainfall series are provided in the table below.

Rainfall Statistics – *Urban Developer* Modelling

Parameter	Value
Average Annual Rainfall	1327 mm
Maximum Annual Rainfall	2090 mm
Minimum Annual Rainfall	969 mm

Potential Evaporation

Relevant average monthly evaporation data were sourced and used to inform/force the model.

Temperature

Relevant daily temperature data were sourced and used to inform/force the model.

Model Calibration and Validation

It was not possible to rigorously calibrate and validate the model as Caloundra South is a greenfield site and no locally specific water usage data were available. Rather, the following approach was adopted:

- The model was 'calibrated' by being set up, using the data described above, to reproduce 'pre-millennium drought' water use conditions. This calibration essentially relates to the model demand nodes, as those other elements of the model are essentially parameterised, and require no real calibration. The following relevant South-East Queensland, pre-drought, water use statistics were adopted:
  - Typical internal water uses in South East Queensland were of the order of 150-200 L/c/day;
  - Typical external water uses in South East Queensland were of the order of 40% of total use; and
  - Hence, total usage of water was of the order of 260-310 L/c/day.
- ***Urban Developer*** was run with default internal water uses, with no demand management modifications in place and with external water uses turned off. The resultant average internal water usage/mains demand was subsequently predicted to be 169 L/c/day, which compares favourably with the aforementioned 150-200 L/c/day range, especially as these values will reflect the additional effect of system losses, leakage, etc, whereas the ***Urban Developer*** predictions are at the lot scale and do not include such additional flows.

Urban Developer was subsequently run with relevant external water uses such that the total water consumption was equivalent to the 260-310 L/c/day range cited above, with an actual modelled value of 294 L/c/day being achieved.

- Model 'validation' was undertaken by attempting to reproduce the post-millenium drought water use paradigm, where internal water appliances are more efficient and patterns of external water demands have significantly changed (reduced). Specifically, the changes made to the ***Urban Developer*** demand model were to improve internal water use by changing key appliances as follows, together with halving external water demands.
  - Shower: 'standard' to 'A' rating;
  - Washing machine: 'top loader' to 'front loader'; and
  - Toilet: single flush to dual flush (11/6 litre).
- By making these changes, the ***Urban Developer*** model simulated per capita water demands of 188 L/c/day, which is acceptably close to the desired Queensland Water Commission (QWC) "no restriction" water use target of 200 L/c/day, especially given the small lot size of the modelled allotment. Of this 188 L/c/day, on average 67% was used internally and 33% externally.

Model Application

The Caloundra South ***Urban Developer*** model was subsequently applied to simulate various IWCM cases, of progressively greater complexity and water saving/reuse potential.

APPENDIX F: RESPONSES TO THIRD PARTY REVIEWERS COMMENTS (AUGUST 2013)

Preamble

A detailed review of a previous (November 2012) version of the report "*Caloundra South Water Quality Monitoring Program*" was completed by external consultants (Cardno) on behalf of the Department of State Development, Infrastructure and Planning (DSDIP). The program outlined in the aforemenetioned report was "*considered to be generally acceptable subject to the minor revisions identified below*".

Responses to Comments

Items requiring attention (as outlined in the aforementioned correspondence) are given below in *black italics*, whilst responses from BMT WBM to these items are provided below in blue text.

Item 1: Inclusion of Relevant Conditions

Given the length of time over which monitoring will be completed, it is requested that the conditions of approval addressed by the report (8 and 31) be included in full in Section 1 or an Appendix. This will allow any reporting completed in relation to the site to be reviewed in terms of both the conditions of approval and the adopted monitoring program.

These conditions have been provided in Appendix G of this report.

Item 2: Timing of Monitoring

For consistency within the report, minor revisions are requested. The reference to timing in Section 2.1.1 (ambient monitoring) will either need to be repeated in Section 2.1.2 (event based monitoring) or moved to the preamble to Section 2.1 to relate to both ambient and event based monitoring.

This is not appropriate. The frequency of event-based monitoring will be dependent on flow conditions within the waterways – and is subsequently not possible to nominate a defined interval for undertaking (e.g. monthly intervals as per the ambient monitoring). As outlined in Section 2.1.2 of the report, the event-based monitoring "*samplers will be triggered by flows in either of the creeks, and will collect composited, flow proportional samples from significant run-off events.*"

Further, the timing of monitoring schedule in Section 4 refers to a minimum of 6 months of monitoring prior to the commencement of works for ambient and event based monitoring. To be consistent with Section 2.1, these values will need to be increased to 12 months.

The text provided in Section 2.1 of the May 2012 report was mistaken. In accordance with Section 4 of the May 2012 report (and Section 4.1 of this report), we believe monitoring should commence a six (not twelve) months prior to commencement of works. This six-month timeline is in accordance with the ULDA Master Plan approved Water Quality Monitoring Program (given in Section C4.7 of the Draft PER for Caloundra South).

It should also be noted that (as outlined above) flow conditions within the creeks will determine when event-based sampling can be undertaken (following the installation of the event-based monitoring infrastructure).

Note: Condition 8(b) requires that testing commence a minimum of six months prior to the commencement of works and continue for a minimum of 12 months following development. The adoption of 12 month and 3 year periods respectively for ambient monitoring is commended. In particular, the extension of the monitoring period prior to the commencement of works will provide a greater amount of data upon which to consider water quality data obtained during the construction/operation phases.

As outlined above, it should be noted that the text provided in the May 2012 report was mistaken. As described above, monitoring is to commence six (not twelve) months prior to the commencement of works. Furthermore, monitoring is to be undertaken until 12 months (not 3 years) following development in the catchment. Both of these requirements are in accordance with the ULDA Master Plan approved Water Quality Monitoring Program (given in Section C4.7 of the Draft PER for Caloundra South). These corrections have been included in this revised report.

Item 3: Event Based Monitoring

However, in addition to sampling for suspended solids, Total Nitrogen and Total Phosphorus, it is requested that the program also include testing for pH, iron and aluminium.

We do not believe that this is appropriate. This is because of the following reasons:

- These parameters will be tested as part of the monthly ambient monitoring
- It is not possible to measure pH in samples collected in an auto-sampler (as the result will change too rapidly to provide a reliable result).
- It is anticipated that the proposed monitoring is suggested to assess acid sulphate soil management activities. However, event-based monitoring would not be a good indicator of poor acid sulphate soil management – as this would influence ambient conditions far more. Therefore, monitoring of pH, Al and Fe in events is not scientifically justifiable.
- The addition of these parameters to event-based monitoring will add no real value – but will add significant expense and/ or prejudice the collection of data for other (more important) analytes.

A single auto-sampler system is proposed at each site, and the necessary bottles/ treatments required to obtain reliable iron and aluminium results will prejudice the collection of data for the other (more important) analytes. Alternatively, a second autho-sampler system would be required – adding significant expense to the monitoring and add no real value.

DSDIP acknowledge this in their comments given below "*It is acknowledged that the use of samplers will limit the range of parameters for testing compared to the parameters nominated in the conditions.*"

The program does not include information in relation to the triggers for the collection of event based samples. Although there is greater flexibility with respect to the specification and adjustment of sampling when water quality samplers are used, it would be beneficial for the initial settings for the samplers to be nominated together with the expected frequency at which events will be captured (with the intention of not capturing too few or too many events). It is noted that the settings can be varied as part of the annual review of the sampling program in the event of too many or too few event based samples being collected.

This statement is noted. However, whilst it "*would be beneficial for the initial settings for the samplers to be nominated together with the expected frequency at which events will be captured*", it is not possible to specify these initial settings at this stage. Furthermore, the expected frequency at which events will be captured will be heavily dependent on climatic conditions (which are obviously difficult to predict).

It is, however, acknowledged that it may be appropriate to target some minimum number of samples (e.g. 3 to 5 per year, as suggested by Cardno's Martin Giles in personal communication) will be collected and analysed – and that we should specify a maximum number of samples for analysis (to minimise excessive expenditure). Section 5.1.3 of this report has subsequently been revised to include a recommended minimum and maximum number of samples to be collected and analysed.

It should also be noted that the samples are to be composited, flow-weighted sample to allow rapid assessment of the suitability of the pollutant export rate of the site and how that compares to the modelling, such that future assessments can be modified on the basis of this better data.

Note: The parameters nominated for sampling in Section 2.1.2 of the report are a subset of the list nominated in Condition 8 (b) (iv). When the condition was written, it was envisaged that event based sampling would be completed using manual sample collection methods, for which it is possible to test for a greater range of parameters. Given the problems associated with this method of sample collection, the specification of water quality samplers in the monitoring plan is considered preferable. It is acknowledged that the use of samplers will limit the range of parameters for testing compared to the parameters nominated in the conditions.

Item 4: Ambient and Event based monitoring sites

The location of the ambient sites is considered to be adequate. Consideration may need to be given to siting an additional ambient point on the Bruce Highway at the point at which the northern tributary of Bells Creek South crosses the highway.

This comment is noted. Consideration was given to an additional ambient monitoring location, but one is not proposed.

Based on Figure 1, event based sampling is proposed at two locations. The collection of samples at the downstream end of the site does not allow the influence of runoff from external areas to be considered and may result in the erroneous conclusion that runoff from the site is resulting in poor water quality when the poor water quality may be due to conditions upstream of the site and out of the control of site. The event based sampling should occur at the same locations as the ambient monitoring unless justified otherwise.

We do not believe it is necessary or appropriate to undertake event-based sampling at all of the same locations as the ambient monitoring. Doing so would add significant cost and provide little added value.

We do acknowledge, however, that it may be appropriate to undertake event-based monitoring at the upstream end of the site to (to, as noted in the comments, assess potentially poor water quality from upstream areas external to the site). Two additional event-samplers have subsequently been proposed (both at the upstream ends of Bells Creek North and Bells Creek South, within the site – as shown in Figure 5-1). Both of these locations were not proposed as part of the May 2012 report.

Item 5: Groundwater Monitoring

The groundwater monitoring component of the program (Section 2.2) is considered to be generally acceptable. However, the condition requires the completion of sampling at quarterly intervals, increasing to monthly monitoring when construction is taking place. In comparison, the program nominates annual sampling at sites some distance from construction activities, with biannual sampling following the completion of construction activities. As the significant cost associated with water quality monitoring programs is appreciated, a reduction in sampling frequency from quarterly to biannual is considered acceptable for bores well outside the construction work zone and for the period following active construction.

This comment is noted.

It should also be noted that the report already states that (as per Section 2.2 of the May 2012 report and Section 4.2 of this report) "*those bores within catchments where there are construction activities occurring and which are in close proximity (i.e. within 500m) to areas of active construction works will be sampled on a **monthly** basis.*"

Further, the groundwater monitoring section also needs to include a reference to monitoring in the period prior to the commencement of construction in order that the natural variability in groundwater quality is accounted for.

This recommendation is accepted, has been included in this report (see Section 4.2 of this report).

Item 6: Reporting

The program suggests that reports be prepared on a six monthly basis, rather than the quarterly timetable nominated in the conditions. It is considered that the preparation of reports should be completed initially on a quarterly basis, with the annual review allowing a reduction in report frequency should consistent acceptable results be obtained over the first stages (ie 3 years) of development.

We would disagree that the frequency of reports should be on a quarterly basis, as we do not believe it adds any additional management value.

Extensive monitoring is proposed to influence management actions on-site. Whilst reporting provides a summary of the various monitoring and associated risk-based management actions (to monitor/ manage day-to-day water quality issues) – reporting is not used for operational/ management

purposes. Providing reporting on a quarterly basis (instead of six-monthly) does not provide any additional management value.

To be consistent with the requirements of the conditions, it would be beneficial for the program to nominate the requirement for sampling points to be located with GPS coordinates and for groundwater bores to be levelled.

This recommendation is accepted, and details are provided in Appendix H.

Similarly, the report needs to include requirements as per b(xi) for the initial review of laboratory results and emails to the developer in relation to results as they are received.

This recommendation is accepted, and the report (in Section 4.3) has been revised to incorporate this requirement.

While the program nominates corrective actions with respect to the EHMP sites, corrective actions also need to be nominated with respect to the ambient and event based sampling program. The proposed corrective actions in this regard should be submitted for review prior to revision of the water quality monitoring program.

This recommendation is accepted, and will be provided to Cardno for review prior to completion/ submission of a revised version of the report.

Note: The reporting and corrective action section of the program is considered to be generally acceptable. Section 3.2.1 of the program suggests that the annual report include the consideration of the value of the monitoring works, with recommendations made in relation to the revision of the program if appropriate. This approach is supported and is in line with the intention that the monitoring program is reviewed based on collected data to ensure that it is tailored to the requirements of the project and that superfluous monitoring is not undertaken. Similarly, the review allows for the specification of additional testing should anomalous results be obtained in a particular area.

APPENDIX G: CONDITIONS OF APPROVAL (ITEMS 8 AND 34)

As outlined in Appendix F, a detailed review of a previous (November 2012) version of the report "*Caloundra South Water Quality Monitoring Program*" was completed by external consultants (Cardno) on behalf of the Department of State Development, Infrastructure and Planning (DSDIP). They requested that the revised report include a copy of the conditions of approval addressed by the report (8 and 31). A copy of these conditions has subsequently been provided within this appendix.

urban land development authority

Queensland Government

15 June 2012

ULDA Ref No: DEV2011/200

Stockland Caloundra Downs Pty Ltd
c/ - Brad Williams
RPS
PO Box 149
WURTULLA QLD 4575

Dear Mr Williams

RE: UDA DEVELOPMENT APPROVAL – UDA DEVELOPMENT PERMIT FOR RECONFIGURING A LOT (PART OF 3 LOTS INTO 19 LOTS) AND UDA PRELIMINARY APPROVAL FOR A MATERIAL CHANGE OF USE FOR APPROVED USES DESCRIBED IN PARTS 6 AND 8 OF THE CALOUNDRA SOUTH MASTER PLAN (AS AMENDED IN RED 13 JUNE 2012) AND GENERALLY IN ACCORDANCE WITH PARTS 5 – 13 OF THE APPROVED CALOUNDRA SOUTH MASTER PLAN (AS AMENDED IN RED) DATED MAY 2012 AT BELLVISTA BOULEVARD, CALOUNDRA WEST AND BELLS CREEK ROAD, BELLS CREEK DESCRIBED AS PART OF LOT 22 ON SP190373, PART OF LOT 505 ON RP884348 AND PART OF LOT 3 ON RP910849 – DEV2011/200

I am pleased to inform you that your application was approved pursuant to s. 59 of the *Urban Land Development Authority Act 2007* on 15 June 2012. The conditions of the development are set out in the **enclosed** decision notice.

The application and the decision notice can also be viewed in the Urban Land Development (ULDA) Development Approvals Register via our website at www.ulda.qld.gov.au.

Should you have any queries in relation to the decision notice, please do not hesitate to contact Stephen Conner, Director – Planning on (07) 3024 4153.

Yours sincerely

PA Eagles
CHIEF EXECUTIVE OFFICER

No.	Condition	Timing	Nominated assessing authority
	information and the condition of approval (or element of the condition) is determined to have been met or b. if not satisfied with the information as submitted – notifies the applicant accordingly (e) If the applicant is notified under (d)(ii)b. above: (i) the information and plans addressing the concerns are to be resubmitted (ii) within a further 15 business days – the nominated assessing authority assesses the re-submitted plans and supporting information and:- a. if satisfied with the re-submitted information lodged - endorses the plans and supporting information and the condition of approval (or element of the condition) is determined to have been met or b. if not satisfied with the information as submitted – notifies the applicant accordingly. (f) If the applicant is notified under (e)(ii)b above, within **10 business days** - the nominated assessing authority and applicant will repeat steps (e)(i) and (ii). If either party is not satisfied by the outcome of this process, that party can elect to enter into a mediation process with an independent mediator agreed to by both parties or if there is no agreement, nominated by the President for the time being of the Queensland Law Society Inc. (g) When the nominated assessing authority and applicant are both satisfied with the re-submitted information lodged - the nominated assessing authority endorses the relevant instrument of document and the condition of the Approval (or element of the condition) is determined to have been met.		
General			
8.	**Water quality and monitoring** (a) A comprehensive water quality monitoring program shall be established prior to the commencement of works and shall continue throughout the construction phase and into the operational phase. (b) A water quality monitoring program shall be submitted to the nominated assessing authority for approval. All sampling and testing must be undertaken by a suitably qualified independent consultant with laboratory testing undertaken by a NATA certified laboratory. The water quality monitoring program shall generally be in accordance with the principles noted in Appendix I of the approved Integrated Water Management Plan prepared by BMT WBM dated May 2012, with the following requirements: (i) Monitoring shall commence a minimum of six months prior to the commencement of works to allow additional base line data collection (applicable to where development is within a creek catchment). (ii) Monitoring within water catchments to be undertaken until 12 months following development in the catchment. Monitoring can only cease provided satisfactory water quality objectives have been met. (iii) GPS coordinates shall be provided for each monitoring location, with levelling completed at each groundwater sampling point to allow the conversion of groundwater depths to reduced levels to the Australian Height Datum. (iv) Event based and ambient surface water quality monitoring shall be	Ongoing	ULDA

No.	Condition	Timing	Nominated assessing authority
	undertaken on Bells Creek South, Bells Creek North and Lamerough Creek. On each creek, monitoring shall be undertaken at points near the upstream boundary of the site, near the downstream boundary of the site, and within the site (at a convenient point for sampling near the midpoint in each stream). The program shall nominate conditions required for event based samples to be collected. The frequency of ambient monitoring shall be monthly, with event based and ambient testing completed for the following parameters as a minimum: a. pH; b. conductivity; c. temperature; d. turbidity; e. dissolved oxygen f. suspended sediment; g. total Nitrogen and fractions; h. total Phosphorus and fractions; i. Chlorophyll 'a'; j. Iron; and k. Aluminium. (v) Load based surface water quality monitoring shall be undertaken on at least two catchments draining to Bells Creek North and South and Lamerough Creek. The catchments shall be the same as those previously monitored by BMT WBM unless other catchments are deemed more appropriate. Sampling shall be completed for the parameters nominated in part (iii) above as a minimum. (vi) Load based monitoring of treatment devices shall be completed for initial stages of the development to confirm the efficacy of the treatment devices and to allow for the refinement of design in subsequent stages. The monitoring of treatment devices shall include the collection of data at the point of discharge to the creek and at least one representative upstream point to define the quality of runoff being treated. (vii) At the downstream monitoring points adopted for part (iii) above, telemetered monitoring with turbidity sensors will be established to provide base line data prior to construction and to allow alarms to be sent in the event of high turbidity levels occurring. The water quality monitoring program will nominate the trigger for turbidity alarms to be raised, and corrective actions that will be undertaken in the event of a turbidity alarm being triggered. (viii) Ecosystem health monitoring will be completed at a minimum of two locations on Bells Creek downstream of the site in accordance with the protocols adopted for the Ecosystem Health Monitoring Program (EHMP) by the SEQ Healthy Waterways Partnership. (ix) Groundwater monitoring shall be completed at each of the historical QUT sites and the shallow groundwater monitoring bores identified in Figure 5-11 of the approved Integrated Water Management Plan prepared by BMT WBM dated May 2012. Monitoring shall be completed at quarterly intervals, increasing to monthly monitoring when construction is taking place. Monitoring shall include the following		

No.	Condition	Timing	Nominated assessing authority
	parameters: a. water level; b. pH; c. conductivity; d. total Nitrogen and fractions; e. total Phosphorus and fractions; f. iron; and g. Aluminium. (x) In addition to this monitoring, water quality testing for metals (cadmium, chromium, copper, nickel, lead, manganese, zinc) shall be completed at a minimum frequency of once every six months. (xi) The program will nominate reporting and corrective action procedures together with time schedules for the completion of reports, the definition of corrective actions, and likely timeframes for the completion of corrective actions (which will vary according to the nature of the action required). At a minimum, water quality reports will be produced every four months, detailing the results of monitoring completed to date and a commentary on water quality trends and results compared to conditions prior to development. The report will provide action items as required and will be submitted to the nominated approving authority or other nominated party. The program shall provide for an initial review of laboratory results with an email to the developer indicating whether action is required within five days of the receipt of laboratory results, followed by the completion of reports within four weeks of the receipt of laboratory results.		
9.	**Acid Frog Management Plan** (a) Submit to the nominated assessing authority for compliance assessment and approval, an Acid Frog Management Plan which demonstrates how functioning populations of acid frogs can be maintained or enhanced for long term species viability. The plan must be generally in accordance with the approved Conservation Strategy as prepared by ARUP (as amended in red 13 June 2012) and outline specific protection measures including: (i) species profile ie general ecology, conservation status, distribution within and surrounding the UDA, habitat requirements (ii) determine suitable location for habitat provisions for the Federally listed acid frog (iii) sensitivities to disturbance including climatic influences (iv) potential impacts of the staged development on these species (b) Carry out development in accordance with the endorsed Acid Frog Management Plan.	With the first subsequent application for the site	ULDA

34	**Stormwater** (a) In addition to the requirements set out in UDA Condition 4 of this Approval, an addendum to the approved infrastructure master plan for stormwater must be submitted to the nominated assessing authority for compliance assessment with the first subsequent application for the site and address the following matters to the satisfaction of the nominated assessing authority: • Flood Risk Management Strategy Report • Stormwater Management Report • Groundwater Quantity and Quality Report (b) A Flood Risk Management Strategy Report shall be prepared which includes an appropriate flood model to determine a flood assessment of the pre and post development scenario. The Flood Risk Management Strategy Report shall be generally in accordance with Section 3 of the approved Integrated Water Management Plan prepared by BMT WBM dated May 2012, with the following additional requirements: (i) No increase in flood level for events up to and including the 100 year event external to the site in areas other than open space unless the written consent of affected property owners is obtained. Afflux plots and the level of model accuracy for the purpose of determining impacts shall be ± 10 mm unless agreed otherwise. (ii) Flood modelling shall be completed with a grid spacing appropriate to the level of detail of the application. (iii) No increase in flood level at the boundary of the flood model. Flood model to be extended as required to achieve this outcome. (iv) No increase in peak flow downstream of the site in Bells Creek or Lamerough Creek (upstream of the Pelican Waters canal) for events with recurrence intervals of between 1 year and 100 years inclusive. (v) Flood modelling completed in support of the report shall consider the 1, 2, 5, 10, 20, 50 and 100 year recurrence interval events. (vi) Community infrastructure shall be provided an appropriate level of flood immunity as defined in Appendix 9 of the State Planning Policy 1/03 Guideline 'Mitigating the Adverse Impacts of Flood, Bushfire and Landslide' or subsequent updated document. In accordance with the recommendations of the Queensland Flood Commission, the risk management strategy shall consider issues of resident egress from Caloundra South under flood conditions that exceed the defined flood event. (vii) Demonstrate that development will not result in a significant reduction in the flood warning time in existing developed areas subject to inundation. (viii) The report shall include flood hazard mapping and shall address and provide appropriate risk management strategies for low, medium and high hazard areas. The strategy will need to consider velocity and depth of flow, rate of rise, and warning times. In particular, appropriate strategies shall be defined for recreational areas where a level of immunity less than 100 years is being proposed (for example the proposed lake area) prior to the use being permitted. (ix) The allowance to be made for climate change (in terms of sea level rise and impacts on rainfall intensity) shall be in accordance with guidelines current or likely to be adopted in the short term at the time of preparation of the report. (X) Minimum lot, non-habitable and habitable floor levels shall be identified based on the results of the flood modelling in accordance with the requirements of the Sunshine Coast Regional Council	With the first subsequent application for the site	ULDA

relative to the peak flood levels calculated for the climate change.

(xi) The report shall nominate the cross drainage requirements at each crossing (road and pedestrian) of a watercourse. The report shall also nominate the proposed conditions under which the crossing will be overtopped. In the event of overtopping occurring for the 100 year event, the depth and velocity of any overflow shall satisfy the requirements of the 'Queensland Urban Drainage Manual' (2007 or later version). It shall be demonstrated that lots do not become inundated in the event of the crossings (other than bridges) being 50 percent blocked by debris. In all cases, the minimum level of the crossing shall be less than the minimum ground level of upstream lots unless a bridge crossing is proposed.

(xii) For each nominated crossing point, measures taken to protect the Environmental Values of the watercourse (including fish passage as appropriate) shall be nominated.

(xiii) Flood modelling will include all proposed works in the floodplain. In particular, the modelling shall include the ephemeral wetlands (and other treatment measures) proposed for the development. Ephemeral wetlands shall be immune to inundation for Bells and/or Lamerough Creek flooding for events up to and including the 10 year event unless an alternate immunity is demonstrated to be satisfactory.

(xiv) The flood modelling shall confirm that the peak flow velocity in treatment devices during regional flooding does not exceed the limits nominated in the Healthy Waterways publication 'Water Sensitive Urban Design Technical Design Guidelines for South East Queensland' (2006 or later version) unless it can be demonstrated that higher velocities can be tolerated.

(xv) The report shall include a description of any water level data available for the catchment to allow the calibration of flood models. In the absence of calibration data, recourse shall be made to the following.

a. Comparison/ adjustment of hydrologic model to suit parameters derived from a hydrologically similar catchment
b. Comparison/ adjustment of hydrologic model to peak flow rates calculated using empirical methods such as the Rational Method.
c. Completion of a sensitivity analysis in relation to the hydraulic model by considering the 100 Year Post- Development Case with Mannings 'n' roughness values increased by 20 percent. In cases where the resultant levels could inundate floor areas, minimum lot and floor levels shall be raised accordingly.

(xvi) Electronic copies of the hydrologic and hydraulic models shall be submitted for review.

(c) A Stormwater Management Report shall be prepared detailing measures to be implemented to ensure the integrity and values of waterways is maintained and enhanced by providing appropriate management of water quality and water quantity. The Stormwater Management report shall be generally in accordance with Section 4 of the approved Integrated Water Management Plan prepared by BMT WBM dated May 2012, with the following additional requirements:

(i) Modelling of water quality shall be completed using the version of MUSIC (or other acceptable package) current at the time of preparing the report.

(ii) Model parameters, except those derived from site investigations, shall be in accordance with either the latest version of the 'MUSIC Modelling Guidelines' prepared by Water By Design or guidelines nominated by Sunshine Coast Regional Council as being applicable instead of the

	MUSIC Modelling guidelines. (iii) With respect to the proposed ephemeral wetlands, either provide the results of geotechnical investigations undertaken to justify the adopted exfiltration rate or demonstrate an alternative solution (eg stormwater harvesting and reuse) which has the same effect on the flows of stormwater from the site. (iv) With respect to the proposed ephemeral wetlands, the modelled saturated hydraulic conductivity shall be set at the hydraulic conductivity of the underlying soil unless underdrainage is to be provided. (v) With respect to the proposed ephemeral wetlands, the quantum of water draining to the groundwater table shall be reconciled with both the groundwater modelling and the proposed stormwater harvesting scheme. (vi) Unless it can be demonstrated otherwise, modelling of rainwater tanks shall assume the capture of a maximum of 50 percent of contributing roof area. (vii) Justification is to be provided in relation to assumptions relating to reuse rates in Commercial and Industrial areas. (viii) An electronic copy of the water quality model shall be submitted for review. (d) A Groundwater Quantity and Quality Report shall be prepared which provides an assessment of groundwater quality and quantity of the site in the pre and post development scenario. The report shall be generally in accordance with Section 5 of the approved Integrated Water Management Plan prepared by BMT WBM dated May 2012, with the following additional requirements: (i) Demonstrate that the development will not produce an adverse impact on groundwater quality. (ii) Incorporate drainage from ephemeral wetlands (quantity and quality) in groundwater considerations if this drainage is not replaced by stormwater harvesting and reuse measures. (iii) Provide ecological input in relation to potential impact of post development groundwater levels. (iv) An electronic copy of the groundwater model shall be submitted for review. (e) Demonstrate how the proposed infrastructure and other actions will contribute towards the achievement of an overarching site strategy for TWCM. (f) Address the timing of the delivery of the infrastructure. *Advisory Note: The inclusion of a detention basin west of the Bruce Highway may be appropriate where approval has been sought from other applicable parties.*		
35	**Integrated Water Management Plan** (a) In addition to the requirements set out in UDA Condition 4 of this Approval, an addendum to the approved overarching strategy for integrated water must be submitted to the nominated assessing authority for compliance assessment with the first subsequent application for the site and address the following matters to the satisfaction of the nominated assessing authority: (i) Integrated Water Management Plan shall contain or refer to a Flood Risk Management Strategy Report completed in accordance with the requirements of Condition 34. (ii) Integrated Water Management Plan shall contain or refer to a Stormwater Management Report completed in accordance with the	With the first subsequent application for the site	ULDA

APPENDIX H: CO-ORDINATES OF MONITORING LOCATIONS

Table H-1 provides GPS co-ordinates of the water quality monitoring locations illustrated in Figures 5-1, F-2 and F-3. It should also be noted that groundwater bores are to be levelled.

Table H-1 Co-Ordinates of Monitoring Locations

Reference	Easting (m)	Northing (m)
Surface Water Quality Monitoring		
BN1	504113.4	7035047
BS1	503773.1	7031030
BS2	505723	7032142
L1	507777.5	7035492
BN2	506396.8	7034079
BS3	507319.5	7032129
BN3	508065.4	7032796
L2	508641.7	7034761
Load Based Monitoring		
L1	505507.1	7033796
L2	505648.6	7032104
Pluviometer	504554.3	7031508
Existing Groundwater Monitoring		
GW10	504451.6	7034738
IF 10	503544.6	7032211
IF 9	503470.5	7031205
IF 1	504806.7	7034074
GW9	504543.4	7033116
IF 3	504427.3	7032399
GW8	504153.4	7031646
IF 7	504171.9	7030883
IF15 Deep	503653.3	7030581
IF 2	505307.4	7033627
IF 4	504960.7	7031445
IF 6	505011.1	7030682
BV8	506058.6	7034218
S1	505997.9	7033498
IF 14	505937.2	7032960
BH7	505746.3	7032101
IF 5	505762.7	7031179
IF 8	505390.9	7030316
BV7	506832.6	7035385
BV6	506407.6	7034680
GW5	506748	7032704
IF 12	506149.7	7030528
BV5	507257.5	7034483
IF 13	507356.1	7033619
BH3	507788.6	7032922
IF 11	507204.4	7031414

BV3	508107.3	7035021
BV4	508213.5	7034566
BV10 Deep	507963.1	7034059
BV1	509533.8	7035067
BV2	508676.4	7034665
BV9	508676.4	7034127
Proposed Groundwater Monitoring		
GW10	504453	7034762
G7	506866.2	7030970
G6	503572.7	7031557
G5	504546.9	7033141
G4	506748.7	7032718
G1	509515.7	7034506
G2	508161.7	7032504
G3	507550.6	7032120

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