

PHO M2799

The Director – General
Department of Planning
PO Box 39
Sydney NSW 2001

**PACIFIC HIGHWAY UPGRADE SAPPHIRE TO WOOLGOOLGA PROJECT
PROPOSED MODIFICATION OF THE PROJECT APPROVAL**

Dear Michael,

The Roads and Maritime Services (RMS) are requesting a modification of the project approval for the Sapphire to Woolgoolga Pacific Highway upgrade project to incorporate a rest area at Arrawarra.

Rest area withdrawn from original project

The environmental assessment of the Sapphire to Woolgoolga Pacific Highway project identified a rest area location at the Arrawarra Interchange (section 7.5.11 of the environmental assessment). During the exhibition of the environmental assessment, a number of submissions were received in relation to the rest area location.

On the basis of the range of concerns raised in relation to the proposed rest area, including ecological, amenity and need, the Department of Planning and Infrastructure advised the RMS that it could not support the inclusion of the rest area in this location at this time. These issues included:

- The cultural and environmental sensitivity of the area including the surrounding Yarrawarra and Arrawarra Estuary systems;
- Its habitat value for endangered frogs, gliders and microbats;
- Its location within a wildlife corridor between the vegetation on the western side of the proposal and Garby Nature Reserve on the east;
- Fragmentation of existing glider habitat which could lead to long term decline in glider populations east of the Pacific Highway; and
- Potential noise, lighting and visual impacts on the Arrawarra Beach community.

Based on the submissions received, the RMS recognised the need for further consideration into the location of a rest area. The RMS therefore decided to remove the proposed rest area at Arrawarra interchange from the project approval process. Condition 1.1d) removed the rest area from the Project approval.

Roads & Maritime Services

The Director-General's report for the approval of the Sapphire to Woolgoolga upgrade of the Pacific Highway advised that any future proposal to reinstate a rest area at this location would need to consider and address the issues raised in submissions. The attached Sapphire to Woolgoolga upgrade: Rest Area Environmental assessment Report, April 2011 and Sapphire to Woolgoolga upgrade: Rest Area Environmental assessment Submissions Report October 2011 considers and addresses the above issues.

Rest area comparative assessment

The RMS further reviewed options for a location of a rest area and produced the Rest Area Assessment Report (Sapphire to Woolgoolga Upgrade: Rest Area Assessment Report, September 2009). The report identified a number of options for potential future highway service centres and examined and compared the key features of the options. Sixty-two submissions were received from the exhibition of the Rest Area Assessment Report.

From these submissions the Sapphire to Woolgoolga Upgrade: Rest Area Assessment Submissions Report, May 2010 was prepared.

Selection of preferred location for rest area

The Arrawarra interchange was selected as the preferred location for a rest area for the upgrade based on consideration of issues raised in submissions, consultation with government agencies and RMS's own technical investigations.

The Arrawarra interchange was selected as the preferred location as, compared to the south Woolgoolga option, it would:

- Have less noise and other amenity impacts.
- Have less impact on existing agricultural properties.
- Have less impact on properties proposed to be rezoned for industrial purposes.
- Be less expensive to build.

It is acknowledged that a rest area at Arrawarra would have a greater impact on native vegetation and animals than one at south Woolgoolga. To avoid impacts on the native vegetation in the State Forest north of Arrawarra Beach Road, the possible future highway service centre has been moved to the rest area south of Arrawarra Beach Road. The concept design for the rest area site has been refined to accommodate the possible future highway service centre.

Display of Rest Area Environmental Assessment Report by RMS

With the location of the rest area identified, the RMS prepared an environmental assessment for the preferred rest area location at Arrawarra. The Sapphire to Woolgoolga Upgrade: Rest Area Environmental Assessment Report, April 2011 (Rest Area Environmental Assessment Report) was displayed for public comment by RMS between 6 April 2011 and 9 May 2011.

During the exhibition of the Rest Area Environmental Assessment Report, 16 submissions were received in relation to the Report. Several submissions were received by the RMS after the advertised period for public comment. All submissions received until the end of September 2011 have been addressed within the Rest Area Environmental Assessment Submissions Report (December 2011).

This submissions report addressed issues and concerns raised in submissions received in response to the rest area environmental assessment report, a modification to the Sapphire to Woolgoolga Pacific Highway Upgrade project.

The Submissions Report and the application for the proposed modification (Modification No. MP06_0293 MOD 6) was lodged with DP&I on 11 November 2011.

Display of Rest Area Environmental Assessment Report by Department of Planning and Infrastructure (DP&I)

DP&I displayed the Environmental Assessment Report between 1 and 16 December 2011. Sixteen submissions were also received in relation to the second display of the Report, 14 from individuals, one from Coffs Harbour City Council and one from the Environment Protection Authority.

The issues raised in the 14 submissions from individuals were the same as the issues raised in the submissions received following the display of the Environmental Assessment by RMS in April and May 2011 and responded to in the Rest Area Environmental Assessment Submissions Report (December 2011).

The submissions tracking table below identifies the individual submissions received following the display of the Environmental Assessment by DP&I in December 2011 and the sections of the Rest Area Environmental Assessment Submissions Report (December 2011) which provides responses to the issues raised in the submissions.

Submission	Relevant section of the Rest Area Environmental Assessment Submissions Report (December 2011)
(name withheld)	2.2, 2.3
Elizabeth Dray	2.3, 2.6, 2.7
Enid Walter	2.3, 2.7, 2.9, 2.10
(name withheld)	2.3, 2.6, 2.9
Prue Mitchell and Peter Murphy	2.2, 2.6, 2.7, 2.8, 2.9
Alexandra Townsend	2.2, 2.3, 2.6
Lorraine Boyd	2.6, 2.7
Greg Butler two submissions	2.3, 2.6
David Scotts	2.3, 2.6
Laurie Mossuto	2.2, 2.3
Pat Johnson	2.2, 2.3
Nathan Folkes	2.3
Rod McKelvey	2.3, 2.5, 2.6, 2.7

RMS responses to submissions received from Coffs Harbour City Council (CHCC) and from the Environment Protection Authority (EPA) in relation to results of revised studies are provided as attachments to this letter.

Submissions that were received in relation to potential for flooding and water quality/pollution have been addressed in Sections 2.7 and 2.8 of the Arrawarra Rest Area Submissions report. Additional information for submissions that refer to Sections 2.7(Hydrology/stormwater) and 2.8(Water Quality/Pollution) are below:

Hydrology/Stormwater

Section 2.7 Hydrology/Stormwater of the Rest Area Environmental Assessment Submissions Report (December 2011) advised that further assessment on the stormwater system would be undertaken during the detailed design stage to ensure that the stormwater detention arrangements are sized appropriately to accommodate run off that would be generated from the site and minimise impacts to surrounding land and creek water levels and quality.

A review of the stormwater drainage arrangements for the proposed rest area was commissioned in response to the submissions received. A copy of the review report by Lyall and Associates dated 17 May 2012 is attached. When compared to pre-highway upgrade conditions should the proposed Rest Area be constructed, the total catchment area at the existing culvert under Eggins Drive north of Arrawarra Beach Road will be reduced by approximately 1.7ha (i.e. from 70.1 ha to 68.4 ha). The balance of the catchment area will be diverted further south to Arrawarra Creek.

A range of rainfall events were analysed, including design storm events corresponding to 1, 2, 5, 10, 20, 50 and 100 year ARI and results incorporated into the review. The results of the review indicate that, should the proposed Rest Area be constructed, the Sapphire to Woolgoolga Pacific Highway Upgrade (including the rest area) would have only a minor impact on peak flows in the drainage system that runs to the north of Arrawarra Beach Road, eg peak flows for design rainfall events of up to 2 year ARI will have a increase of approximately 1% (0.04 m³/s). For design rainfall events larger than 2 year ARI, peak flows will be reduced by approximately 3% as a result of the Upgrade.

The drainage review also assessed the volume of runoff from the upgrade (including the rest area) into the drainage system that flows into the existing culvert under Eggins Drive north of Arrawarra Beach Road. The modelled volume of runoff is expected to increase in the more frequent events, that is rainfall events with a 2 year ARI or those occurring more frequently than 2 year ARI. In events less frequent than 2 year ARI the volume of runoff will be less than both the existing highway and the approved project.

Water Quality/Pollution

Controls are proposed to be implemented to manage flows and volumes of stormwater runoff and potential pollutants including hydrocarbons. These controls would include the installation and upgrade of culverts (new and existing) with appropriate scour protection in the form of placed rock rip rap, and the installation of swales and bioretention systems to protect the downstream ecosystems from runoff of poor water quality.

The stormwater treatment currently proposed consists of swales that would remove coarse sediment runoff as it passes through the swale, and which would also act as a natural channel to reduce the maintenance of the area in addition to increasing the habitat value. Additional treatment measures to include bioretention capacity of the swales are also proposed. Modelling of bioretention system scenarios has been undertaken to compare the expected removal of pollutants such as hydrocarbons to the target levels outlined in the NSW Urban Stormwater Targets identified in the DECC NSW: Managing Urban Stormwater: Environmental Targets, Consultation draft – October 2007. (See Leighton Fulton Hogan Joint Venture Discussion Paper dated 21 March 2012)

The Discussion Paper assessed four bioretention system scenarios. The option proposed for the rest area is Scenario 2 which provides the following outcomes:

- 83.6% of Total suspended solids removed. (NSW target 85% removal).
- 64.8% of Total phosphorous removed. (NSW target 65% removal).
- 33.8% of Total nitrogen removed. (NSW target 45% removal).

Scenario 2 provides 310m² of swales and 103m² of bioretention treatment area.

With this scenario, the expected removal of total suspended solids falls slightly short of the targets, the removal of total phosphorous nearly reaches the target, and the removal of total nitrogen falls substantially below the target. However, it is generally recognised that the removal of nitrogen is one of the most difficult pollutants to remove from the water.

An alternate bioretention treatment system (Scenario 4) that would fully comply with the target levels has also been considered. Scenario 4 provides 890m² of swales and 197m² of bioretention treatment area. However, this scenario is not the preferred scenario due to:

- The increased size of the system (310m² to 890m² of swales and 103m² to 197m² of bioretention treatment area) with associated increased construction and maintenance costs.
- The relatively modest improvement in water quality achieved by the significant increase in the size of the system, viz. Total suspended solids removal increased from 83.6% to 87.7%/89.9% and total phosphorous removal increased from 64.8% to 70.9%/71.4%.
- The requirement to clear an additional 200m² (approximately) of the area of proposed retained vegetation in the south-eastern corner of the site.

On balance it is considered that, compared to Scenario 2, the relatively modest water quality improvements provided by Scenario 4 do not merit the significant increase in the size and cost of the scenario and the additional clearing of the area of proposed retained vegetation.

The bio-retention systems are able to remove stormwater pollutants through physical, biological and chemical processes and treat petroleum hydrocarbons primarily through sorption and filtration. These systems have shown to remove between 80 and 95% of total petroleum hydrocarbons (Hong et al. 2006). These studies also showed that biodegradation of petroleum hydrocarbons took place in a thin layer of mulch placed on the surface of bio-retention media. Most of the petroleum hydrocarbons were biodegraded within two to eight days after a runoff event (depending on the particular compound).

Request for Modification of Project Approval

In consideration of the above, the RMS seeks the approval of the Minister for Planning for a modification of the Project approval under Part3A of the EP&A Act to include the Rest Area as described in the Rest Area Environmental Assessment Report.

If approved, construction of the rest area is proposed to be undertaken as part of the Sapphire to Woolgoolga Pacific Highway Project.

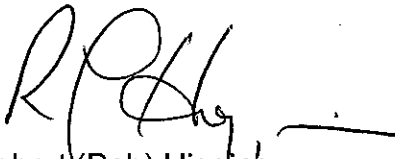
Please find attached;

- The Sapphire to Woolgoolga Upgrade: Rest Area Environmental Assessment Submissions Report, December 2011
- RMS response to submission from EPA
- RMS response to submission from CHCC
- Arrawarra Rest Area Bio-retention System Variation Proposal
- Review of Flooding in the vicinity of Arrawarra Beach Road, Arrawarra

The application for the proposed Modification (Modification No. MP 06_0293 MOD 6) was lodged with DP&I on 11 November 2011.

Please contact Chris Clark on 02 6690 7013 or Belinda Bock on 02 6604 9331 should you require any additional information or require clarification on any of the above.

Yours sincerely



Robert (Bob) Higgins
General Manager, Pacific Highway

3/7/12

Encl.

the form of placed rock rip rap, and the installation of swales and bioretention systems to protect the downstream ecosystems from runoff of poor water quality.

The stormwater treatment currently proposed consists of swales that would remove coarse sediment runoff as it passes through the swale, and which would also act as a natural channel to reduce the maintenance of the area in addition to increasing the habitat value. Additional treatment measures to include bioretention capacity of the swales are also proposed. Modelling of bioretention system scenarios has been undertaken to compare the expected removal of pollutants such as hydrocarbons to the target levels outlined in the NSW Urban Stormwater Targets identified in the DECC NSW: Managing Urban Stormwater: Environmental Targets, Consultation draft – October 2007. (See Leighton Fulton Hogan Joint Venture Discussion Paper dated 21 March 2012)

The Discussion Paper assessed four bioretention system scenarios. The option proposed for the rest area is Scenario 2 which provides the following outcomes:

- 83.6% of Total suspended solids removed. (NSW target 85% removal).
- 64.8% of Total phosphorous removed. (NSW target 65% removal).
- 33.8% of Total nitrogen removed. (NSW target 45% removal).

Scenario 2 provides 310m² of swales and 103m² of bioretention treatment area.

With this scenario, the expected removal of total suspended solids falls slightly short of the targets, the removal of total phosphorous nearly reaches the target, and the removal of total nitrogen falls substantially below the target. However, it is generally recognised that the removal of nitrogen is one of the most difficult pollutants to remove from the water.

An alternate bioretention treatment system (Scenario 4) that would fully comply with the target levels has also been considered. Scenario 4 provides 890m² of swales and 197m² of bioretention treatment area. However, this scenario is not the preferred scenario due to:

- The increased size of the system (310m² to 890m² of swales and 103m² to 197m² of bioretention treatment area) with associated increased construction and maintenance costs.
- The relatively modest improvement in water quality achieved by the significant increase in the size of the system, viz. Total suspended solids removal increased from 83.6% to 87.7%/89.9% and total phosphorous removal increased from 64.8% 70.9%/71.4%.
- The requirement to clear an additional 200m² (approximately) of the area of proposed retained vegetation in the south-eastern corner of the site.

On balance it is considered that, compared to Scenario 2, the relatively modest water quality improvements provided by Scenario 4 do not merit the significant increase in the size and cost of the scenario and the additional clearing of the area of proposed retained vegetation.

The bio-retention systems are able to remove stormwater pollutants through physical, biological and chemical processes and treat petroleum hydrocarbons primarily through sorption and filtration. These systems have shown to remove between 80 and 95% of total petroleum hydrocarbons (Hong et al. 2006). These studies also showed that biodegradation of petroleum hydrocarbons took place in a thin layer of mulch placed on the surface of bio-retention media. Most of the petroleum hydrocarbons were biodegraded within two to eight days after a runoff event (depending on the particular compound).

Brett Nudd
Manager North Coast Region
Environment Protection Authority
PO Box 498
GRAFTON NSW 2460

Dear Sir,

I refer to the Environment Protection Authority's (EPA) submission to the Department of Planning and Infrastructure in response to the display of the Rest Area Environmental Assessment Report for the Sapphire to Woolgoolga Pacific Highway Upgrade Project by the Department in December 2011 (EPA reference Doc11/56845). It is noted that EPA has reiterated its comments from the previous display of the report by Roads and Maritime Services (RMS) in April and May 2011 and added some additional Aboriginal Cultural Heritage comments. In this manner, the Rest Area Environmental Assessment Submissions Report, December 2011 provides responses to the majority of issues raised in EPA's submission. For convenience, the responses to all issues are provided below.

1 – Preferred Layout

EPA preference for the amended site layout is noted.

2 – Potential Impacts

EPA considers that the Modification Environmental Assessment Report does not adequately assess impacts to the local Squirrel Glider population. As noted previously the assessment does not adequately address the numerous NSW Wildlife Atlas records and abundance of Squirrel Gliders recorded in the vicinity of the proposal, nor the presence of contiguous habitat adjacent to the site.

The rest area environmental assessment report was prepared to complement the work undertaken on the environmental assessment of the Sapphire to Woolgoolga upgrade project. The ecological assessments undertaken for the environmental assessment that assessed the Arrawarra location included an ecological assessment of the Arrawarra interchange site (including the rest area location) (Arrawarra Interchange Pacific Highway Upgrade - Sapphire to Woolgoolga, Flora and Fauna Report, August 2007) and a targeted frog survey (Proposed Pacific Highway Upgrade between Sapphire and Arrawarra: Targeted Frog Survey, March 2006). These reports were appended to the environmental assessment as Appendix F. A further ecological assessment of the rest area location was undertaken in 2009 as part of the Rest Area Assessment Report (Pacific Highway Upgrade Sapphire to Woolgoolga Comparison of Ecological Constraints for Potential Rest Area and Service Centre Options (appended as Appendix C)) . This assessment detailed

the impacts of the rest area, of which a summary was provided in the Rest Area Assessment Report and the rest area environmental assessment report.

These assessments identified the potential for frog, glider and bat species in certain locations including through the Wedding Bells State Forest and at the Arrawarra interchange and rest area locations. The Arrawarra interchange flora and fauna report (Appendix F of the environmental assessment) identified that the removal of hollow bearing trees could impact on the habitat resources for glider and bat species. As a result of these assessments, the environmental assessment report, consultation with agencies and community feedback, a number of statements of commitments were identified for future stages of the project.

The additional ecological assessment undertaken in 2009 identified that the Arrawarra site "contains known habitat resources for eight fauna species and potential habitat resources for an additional 21 fauna species ..." These species included the Wallum Froglet, Glossy Black Cockatoo, Koala, Yellow-bellied and Squirrel Gliders, Grey Headed Flying Fox and other microbat species including the Hoary Wattled Bat.

During discussions with representatives of Office of Environment and Heritage (OEH) on 25 May 2011, RMS undertook to erect a glider crossing pole in the highway median adjacent to Arrawarra Creek. This pole would provide a connection between the vegetation to the east of the highway (Wedding Bells State Forest and the Garby Nature Reserve) and the Wedding Bells State Forest to the west of the highway for gliders.

Since that time, there have been design refinements to allow retention of old growth timbers on the eastern side of the alignment adjacent to Arrawarra Creek. Despite the retention of additional vegetation, more recent investigations have revealed that the installation of two poles would be required to facilitate glider movements in this area:

- a pole in the median strip between north and south-bound lanes of the highway upgrade; and
- a pole in the median strip between the south-bound lanes of the highway upgrade and the retained existing road.

Provided there are no safety or design issues with proposed location behind guardrails and barriers and any possible interference with power lines; these glider poles will be installed.

A two stage clearing process would be used with pre-clearing fauna checks by a qualified ecologist, in accordance with the Sapphire to Woolgoolga Flora and Fauna Construction Environmental Management Plan.

A similar comment to the above is made for the Hoary Wattled Bat which was recorded near the site in 2002 (Wildlife Atlas) but is only recorded as possibly occurring at the site. If it is confirmed that this species is present on the site further consideration will need to be given to mitigation measures.

Refer above comments.

In Section 7.8.2 Potential impacts of the rest area hydrology and hydraulics it is claimed that the rest area "would potentially increase the volume of stormwater runoff? The Modification Report should provide clarification as to what extent will runoff increase from current levels and what is the nature of the potential pollutant in the runoff.

The rest area will involve hard stand areas (around 18,000m²) which will potentially increase run-off and pollutants. The pollutants are anticipated to include hydrocarbons and gross pollutants.

Controls are proposed to be implemented to manage flows and volumes of stormwater runoff and potential pollutants including hydrocarbons. These controls would include the installation and upgrade of culverts (new and existing) with appropriate scour protection in the form of placed rock rip rap, and the installation of swales and bioretention systems to protect the downstream ecosystems from runoff of poor water quality.

When compared to pre-highway upgrade conditions should the proposed Rest Area be constructed, the total catchment area at the existing culvert under Eggins Drive north of Arrawarra Beach Road will be reduced by approximately 1.7ha (i.e. from 70.1 ha to 68.4 ha). The balance of the catchment area will be diverted further south to Arrawarra Creek.

A review of the stormwater drainage arrangements for the proposed rest area was commissioned in response to the submissions received in relation to the proposed modification. A copy of the review report by Lyall and Associates dated 17 May 2012 is attached. A range of rainfall events were analysed, including design storm events corresponding to 1, 2, 5, 10, 20, 50 and 100 year ARI and results incorporated into the review. The results of the review indicate that, should the proposed Rest Area be constructed, the Sapphire to Woolgoolga Pacific Highway Upgrade (including the rest area) would have only a minor impact on peak flows in the drainage system that runs to the north of Arrawarra Beach Road, eg peak flows for design rainfall events of up to 2 year ARI will have a increase of approximately 1% (0.04 m³/s). For design rainfall events larger than 2 year ARI, peak flows will be reduced by approximately 3% as a result of the Upgrade. Compared to the approved Sapphire to Woolgoolga upgrade project, the inclusion of the rest area would result in decreases in peak flows for all rainfall events.

The drainage review also assessed the volume of runoff from the upgrade (including the rest area) into the drainage system that flows into the existing culvert under Eggins Drive north of Arrawarra Beach Road. The modelled volume of runoff is expected to increase in the more frequent events, that is rainfall events with a 2 year ARI or those occurring more frequently than 2 year ARI. In event less frequent than 2 year ARI the volume of runoff will be less than both the existing highway and the approved project.

Compared to the approved project, the inclusion of the rest area would also result in decreases in the volume of runoff for events less frequent than a 2 year ARI event.

The report also assessed the 26 January 2012 rainfall event. The report found that, for equivalent rainfall events, the drainage arrangements in place on 26 January 2012, would result in increases in both peak flows and volumes of runoff compared to the highway prior to the upgrade, the approved project (without the rest area) and the upgrade with the rest area. These increases will reduce as the drainage arrangements for the upgrade are implemented.

3 – Mitigation

The Modification Report states in section 7.7.2 ..." the site is likely to provide an effective and important corridor function to a broad range of native wildlife"; including known glider records in suitable habitat on both sides of the existing and new highway in this location. EPA recommends the corridor function can be enhanced in an east west direction by the inclusion of a glider crossing structure within the general location of the rest area. For example, connectivity could be achieved by placement of a pole in the bridge median over Arrawarra Creek. Additionally the aerial corridor function could be maintained by the retention of vegetation in the median and on road verges north of the Arrawarra interchange. Additionally Arrawarra Beach Road could be designed to the absolute minimum width to reduce the barrier impact for fauna moving in the north and south corridor.

The statement of commitments (in particular F12 and F15) identified in the environmental assessment (and environmental assessment submissions report), outlined measures to minimise impacts to fauna habitat and maintain terrestrial fauna connectivity. As the crossing impacts at this location would relate to the widened highway corridor, rather than the rest area, these would be mitigated through the statements of commitments:

- F14 – Culverts identified in the environmental assessment as having a potential role in fauna crossing will be designed to facilitate fauna movements.
- F14A – The locations of fauna movement structures will be consistent with forest management zoning and the management intent of the adjacent Wedding Bells State Forest and identified in consultation with (the then) DPI (Forests).
- F15 – Expert advice will be sought to assist in identifying the need and location for crossing points for glider populations. If required, and in consultation with the relevant government agencies, the location and design of crossing points will be incorporated into the Proposal.

The Sapphire to Woolgoolga Pacific Highway Upgrade makes provision for fauna fencing along the Woolgoolga bypass through the Wedding Bells State Forest. To the east of the highway, fauna fencing would be erected along Eggins Drive to the Arrawarra Beach Road intersection before traversing along Arrawarra Beach Road to the highway and running parallel to the northern extent of the project (refer to the EA section 17).

Fauna crossings consist of both dedicated structures and drainage structures that provide incidental fauna passage. The fauna passage provisions for the length of the approved highway upgrade have been developed as a cohesive strategy. The Arrawarra rest area will not adversely impact on the fauna crossing strategy developed as part of the Sapphire to Woolgoolga Pacific Highway Upgrade.

During discussions with representatives of OEH on 25 May 2011 the RTA undertook to erect a glider crossing pole in the highway median adjacent to Arrawarra Creek. This pole would provide a connection between the vegetation to the east of the highway (Wedding Bells State Forest and the Garby Nature Reserve) and the Wedding Bells State Forest to the west of the highway for gliders.

Since that time, there have been design refinements to allow retention of old growth timbers on the eastern side of the alignment adjacent to Arrawarra Creek. Despite the retention of additional vegetation, more recent investigations have revealed that the installation of two poles would be required to facilitate glider movements in this area:

- a pole in the median strip between north and south-bound lanes of the highway upgrade; and
- a pole in the median strip between the south-bound lanes of the highway upgrade and the retained existing road surface.

Provided there are no safety or design issues with proposed location behind guardrails and barriers and any possible interference with power lines; these glider poles will be installed.

A two stage clearing process would be used with pre-clearing fauna checks by a qualified ecologist, in accordance with the Sapphire to Woolgoolga Flora and Fauna Construction Environmental Management Plan.

The ecological assessment for the environmental assessment has identified that the rest area site contains potential habitat for some frog species, including the Wallum Froglet.

A two stage clearing process would be used with pre-clearing fauna checks (including frogs) by a qualified ecologist, in accordance with the Sapphire to Woolgoolga Flora and Fauna Construction Environmental Management Plan. Accordingly, the direct impacts to frogs will be minimised. Vegetation retained on site could be used as a refuge for frogs during the site clearing for the rest area.

The project also makes provision for fauna fencing along the Woolgoolga bypass through the Wedding Bells State Forest. To the east of the highway, fauna fencing would be erected along Eggins Drive to the Arrawarra Beach Road intersection before traversing along Arrawarra Beach Road to the highway and running parallel to the northern extent of the project (refer to EA section 17). Where appropriate the fauna fencing would include frog exclusion fencing installed in a manner similar to a number of other Pacific Highway projects. The design for the frog exclusion fencing would be developed with OEH and take into account frog monitoring results.

Through the Wedding Bells State Forest section of the Sapphire to Woolgoolga Pacific Highway upgrade, there are a number of fauna crossing structures. Little Arrawarra Creek and Arrawarra Creek bridges would enable fauna movement, with a glider crossing pole proposed at Arrawarra Creek. The project also includes fauna fencing through the Wedding Bells State Forest to the west of the highway. To the east of the highway, fauna fencing would be erected along Eggins Drive to the Arrawarra Beach Road intersection before traversing along Arrawarra Beach Road to the highway and running parallel to the northern extent of the project. These measures would facilitate the cross highway fauna movement, while limiting access to the highway.

Wallum Froglet and Giant Barred Frog threatened species are recorded within or adjacent to the site. The Modification Report requires further clarification on what specific mitigation measures are planned to manage impacts to this species during construction and operation. EPA recommends this would include but not be limited to fencing and water quality management.

Refer comments above

Sections 5.5 and 7.8.2 highlights the inclusion of a 700m² of stormwater detention basin and stormwater quality control ponds and also discusses implementing Water Sensitive Urban Design (WSUD). While these mitigation structures and principles are generally supported, the Modification Report should be amended to demonstrate that the proposed controls will capture and /or treat any pollution (in particular hydrocarbons and gross pollutants) from the site and provide an appropriate level of protection for Arrawarra Creek. It is important that the Modification Report provides a high degree of confidence that any pollution will be effectively managed to protect the sensitive receiving environment, which forms part of the Solitary Island Marine Park and is an intermittently closed and open lagoon.

The stormwater treatment currently proposed consists of swales that would remove coarse sediment runoff as it passes through the swale, and which would also act as a natural channel to reduce the maintenance of the area in addition to increasing the habitat value. Additional treatment measures to include bioretention capacity of the swales are proposed. Modelling of bioretention system scenarios has been undertaken to compare the expected removal of pollutants such as hydrocarbons to the target levels outlined in the NSW Urban Stormwater Targets identified in the DECC NSW: Managing urban stormwater: environmental targets, Consultation draft – October 2007. (See Leighton Fulton Hogan Joint Venture Discussion Paper dated 21 March 2012)

The Discussion Paper assessed four bioretention system scenarios. The option proposed for the rest area is Scenario 2 which provides the following outcomes:

- 83.6% of Total suspended solids removed. (NSW target 85% removal).
- 64.8% of Total phosphorous removed. (NSW target 65% removal).
- 33.8% of Total nitrogen removed. (NSW target 45% removal).

Scenario 2 provides 310 m² of swales and 103 m² of bioretention treatment area.

With this scenario, the expected removal of total suspended solids falls slightly short of the targets, the removal of total phosphorous nearly reaches the target, and the removal of total nitrogen falls substantially below the target. However, it is generally recognised that the removal of nitrogen is one of the most difficult pollutants to remove from the water.

An alternate bioretention treatment system (Scenario 4) that would fully comply with the target levels has also been considered. Scenario 4 provides 890m² of swales and 197m² of bioretention treatment area. However, this scenario is not the preferred scenario due to:

- The increased size of the system (310m² to 890m² of swales and 103m² to 197m² of bioretention treatment area) with associated increased construction and maintenance costs.
- The relatively modest improvement in water quality achieved by the significant increase in the size of the system, viz. Total suspended solids removal increased from 83.6% to 87.7%/89.9% and total phosphorous removal increased from 64.8% 70.9%/71.4%.
- The requirement to clear an additional 200m² (approximately) of the area of proposed retained vegetation in the south-eastern corner of the site.

On balance it is considered that, compared to Scenario 2, the relatively modest water quality improvements provided by Scenario 4 do not merit the significant increase in the size and cost of the scenario and the additional clearing of the area of proposed retained vegetation.

The bio-retention systems are able to remove stormwater pollutants through physical, biological and chemical processes and treat petroleum hydrocarbons primarily through sorption and filtration. These systems have shown to remove between 80 and 95% of total petroleum hydrocarbons (Hong et al. 2006). These studies also showed that biodegradation of petroleum hydrocarbons took place in a thin layer of mulch placed on the surface of bio-retention media. Most of the petroleum hydrocarbons were biodegraded within two to eight days after a runoff event (depending on the particular compound).

Aboriginal Cultural Heritage

EPA highlights the possibility that Aboriginal objects maybe located within the project area and it is expected that the proponent will develop appropriate management strategies to address this possibility.

Noted. The Project has implemented a Construction Heritage Management Plan which details procedures to be adopted in the event of unexpected heritage finds.

If Aboriginal objects or sites are uncovered due to development activities any approval, if issued, should require that all works halt in the immediate area to prevent any further impacts to the objects.

Refer above comments

The EPA also understands that any cultural material recovered from the project area during the proposed construction activities is to be collected by the project archaeologist and then temporarily cared for by the Coffs Harbour and District Local Aboriginal Land Council (CH&DLALC), prior to being redeposited in an area to be conserved within the project area. The EPA supports this process and notes that any proposed custodial arrangements comply with the provisions of Section 85A of the NPW Act.

Noted.

The EPA acknowledges the consultation process undertaken by the proponent and encourages the applicant to continue to engage with the local Aboriginal community in developing appropriate cultural heritage outcomes for the life of the proposed development.

EPA comments are noted

Please contact Chris Clark on 02 6690 7013 or Belinda Bock on 02 6604 9331 should you require any additional information or require clarification on any of the above.

Yours sincerely


Robert (Bob) Higgins
General Manager, Pacific Highway

18/6/12

Clyde Treadwell
Land Use Planning
Coffs Harbour City Council
Locked Bag 155
Coffs Harbour 2450

Dear Sir,

I refer to the Coffs Harbour City Council (CHCC) submission dated 15 December 2011 (your ref: 2955723; our ref PHO M2799) in response to the display of the Rest Area Environmental Assessment Report for the Sapphire to Woolgoolga Pacific Highway Upgrade Project by the Department in December 2011. Please find responses to the issues raised Council's letter below.

6.2.1 Water Quality

Stormwater treatment to include consideration of treatment required for animal refuse as a provision for stock truck stopover.

- The treatment system for stormwater runoff from the site has been modelled based on the pollutant load expected from highways. The pollutant load on the treatment system will cater for the wide range of vehicles expected to stop at the rest area. While stock vehicles have not been specifically modelled; animal refuse from the expected number and length of stay of stock vehicles in the proposed rest area is not anticipated to exceed the design requirements for the proposed stormwater runoff treatment system.

Provision of water connection for use by stock trucks and rainwater tanks for flushing amenities or reuse of harvested stormwater from detention ponds.

- Having regard to the Australian Model Code of Practice for the Welfare of Animals: Land Transport of Cattle, watering of stock is only required if the cattle have not had access to water for more than 36 hours. Generally speaking, the long haulage of cattle occurs in western regions. In order to provide for watering of stock in transit, the stock must be off-loaded and kept in holding facilities. This presents safety issues in relation to other users of the rest area, proximity to the highway (potential cattle escaping onto the highway) and potential noise issues for cattle being offloaded, held and reloaded onto carriers. The provision of stock holding facilities is not considered to be a use compatible with the general public use of the rest area. RMS does not provide cattle holding yards at any of its rest areas. In the case of Arrawarra Rest Area, cattle holding areas is not included in the design due to safety concerns, amenity issues, incompatibility with use of the rest area by the general public and insufficient area to include holding yards. These holding and watering areas are typically provided at Saleyards and Abattoirs.

Roads & Maritime Services

- The possible provision of rainwater tanks for flushing amenities will be considered during the detailed design phase.
- Detention ponds are no longer included in the design of the rest area.

The design of stormwater control systems to cater for the potential future development of a service centre should be provided.

- Stormwater control systems have been designed to cater for the proposed use of the site. If a future service centre is developed additional stormwater treatment measures will be provided at that time, if required.

Note 5 on figure 6.1 refers to "possible stormwater detention basins" what alternatives are proposed if these are not possible?

- Treatment measures including vegetated swale drains have been designed in lieu of detention basins due to the physical constraints on the site. RMS propose to install a bio-retention system along with the vegetated swales to treat the runoff. Bio-retention systems are able to remove stormwater pollutants through physical, biological and chemical processes. Modelling of a bio-retention system at this site has shown that the following pollution reductions are expected to be achieved from the proposed stormwater treatment measures:
 - o 83.6% of total suspended solids (NSW target of 85% removal);
 - o 64.8% of total phosphorus (NSW target 65% removal)
 - o 33.8% of total nitrogen (NSW target 45% removal).
 - o 80-95% of total petroleum hydrocarbons.

Council's WSUD Policy has specific water quality control requirements, this proposal should meet these.

To ensure the protection of waterways in NSW, the Environmental Protection Authority has derived draft environmental targets for the treatment of stormwater (DECC NSW, Managing Urban Stormwater: Environmental Targets, Consultation Draft – October 2007).

These targets are:

- 85% reduction in the average annual total suspended solids load
- 65% reduction in the average annual total phosphorus load
- 45% reduction in the average annual total nitrogen load

The table below shows the pollution reduction levels that were obtained from modelling of the proposed bio-retention system and vegetated swales.

MUSIC modelling results for the areas representing all potential treatment opportunities

	Source	Residual (after treatment)	% removal	NSW Target (% removal)
Total Suspended Solids (kg/yr)	3560	583	83.6	85
Total Phosphorus (kg/yr)	7.42	2.61	64.8	65
Total Nitrogen (kg/yr)	51.4	34	33.8	45

What are the identified receiving water objectives, therefore what control measures will be in place to maintain these? No detail is provided in the supplied documentation.

Refer comments above.

7.8.2 Infiltration rates

Fill of 33,000 m³ – Council acknowledges that most is to be for earth noise mounds, however the proponent is required to provide geotech to confirm use of fill will not impact infiltration rates of WSUD treatments post development and to demonstrate- how this will be achieved?

- The RMS proposal attempts to minimise the amount of fill used for the proposed rest area. While a substantial amount of fill is required, this is anticipated to have a small impact on the permeability of the soils in the grassed swales. The proposed stormwater treatment arrangements utilise swales and bioretention systems which do not rely on significant amounts of infiltration.

Landscaping design to incorporate WSUD treatments such as street pits to provide additional water quality treatment.

- The proposed stormwater treatment arrangements would be incorporated into the urban and landscaping design for the rest area.

Amenities to be water efficient (use of rainwater tanks and stormwater reuse on site for flushing and other non-potable uses may be required).

- Amenities will be water efficient and include dual flush cisterns. The use of rainwater tanks for non-potable uses will be considered during the detailed design phase. Stormwater harvesting for reuse is not possible as there is no opportunity to install stormwater detention basins.

7.7.3 Nest Boxes

Nest boxes should be mandatory replacement for removed hollows at a ratio one hollow removed equals four nest boxes replaced where hollow can not be otherwise restrung. This should not be a feasible /reasonable scenario, this should be a must achieve replacement ratio as removal of hollows is a key threatening process.

- A nest box management plan has been developed and approved for the project. Nest box numbers and types will be provided in accordance with the requirements of this management plan and in consultation with the Project's ecologist.

7.8.2 Potential impact of the rest area- hydrology and hydraulics

What are the proposed impacts of the proposed fauna crossing culvert?

- No exclusive fauna culverts are proposed in the vicinity of the rest area. The closest stormwater drainage culverts are at:
 - o Ch.31.55 south of Arrawarra interchange. This culvert discharges into a watercourse which drains in a south easterly direction to Arrawarra Creek
 - o Ch.31.90 north of Arrawarra Beach Road. This culvert is an extension of the existing culvert under the highway which discharges into the area between the

highway and Eggins Drive north of Arrawarra Beach Road. This area is, in turn, drained by the existing culvert under Eggins Drive north of Arrawarra Beach Road.

The runoff from carpark and hardstand areas will most certainly be increased with a one hectare (10,000 m²) increase in impervious area, to an otherwise natural pervious ground site. Provide details of ponds.

- Controls are proposed to be implemented to manage flows and volumes of stormwater runoff and potential pollutants including hydrocarbons. These controls would include the installation and upgrade of culverts (new and existing) with appropriate scour protection in the form of placed rock rip rap, and the installation of swales and bioretention systems to protect the downstream ecosystems from runoff of poor water quality.

When compared to pre-highway upgrade conditions should the proposed Rest Area be constructed, the total catchment area at the existing culvert under Eggins Drive north of Arrawarra Beach Road will be reduced by approximately 1.7ha (i.e. from 70.1 ha to 68.4 ha). The balance of the catchment area will be diverted further south to Arrawarra Creek.

A review of the stormwater drainage arrangements for the proposed rest area was commissioned in response to the submissions received in relation to the proposed modification. A copy of the review report by Lyall and Associates dated 17 May 2012 is attached. A range of rainfall events were analysed, including design storm events corresponding to 1, 2, 5, 10, 20, 50 and 100 year ARI and results incorporated into the review. The results of the review indicate that, should the proposed Rest Area be constructed, the Sapphire to Woolgoolga Pacific Highway Upgrade (including the rest area) would have only a minor impact on peak flows in the drainage system that runs to the north of Arrawarra Beach Road, eg peak flows for design rainfall events of up to 2 year ARI will have a increase of approximately 1% (0.04 m³/s). For design rainfall events larger than 2 year ARI, peak flows will be reduced by approximately 3% as a result of the Upgrade. Compared to the approved Sapphire to Woolgoolga upgrade project, the inclusion of the rest area would result in decreases in peak flows for all rainfall events.

The drainage review also assessed the volume of runoff from the upgrade (including the rest area) into the drainage system that flows into the existing culvert under Eggins Drive north of Arrawarra Beach Road. The modelled volume of runoff is expected to increase in the more frequent events, that is rainfall events with a 2 year ARI or those occurring more frequently than 2 year ARI. In event less frequent than 2 year ARI the volume of runoff will be less than both the existing highway and the approved project.

Compared to the approval project, the inclusion of the rest area would also result in decreases in the volume of runoff for events less frequent than a 2 year ARI event.

The report also assessed the 26 January 2012 rainfall event. The report found that, for equivalent rainfall events, the drainage arrangements in place on 26 January 2012, would result in increases in both peak flows and volumes of runoff compared to the highway prior to the upgrade, the approved project (without the rest area) and the upgrade with the rest area. These increases will reduce as the drainage arrangements for the upgrade are implemented.

The document states “the configuration of the rest area provides opportunities to implement water sensitive urban design (WSUD) techniques to treat and control stormwater run off. Conventional road drainage would be provided to internal rest area roads.” This does not indicate commitment to provision of WSUD treatments as it states “...Provides opportunities to implement “. The proponent is to provide detail on what WSUD treatments are proposed and what water quality parameters will then be met.

- Treatment measures including 310m² of vegetated swale drains have been designed in lieu of detention basins due to the physical constraints on the site. RMS also propose to install 103m² of bioretention treatment area along with the vegetated swales to treat the runoff. Bio-retention systems are able to remove stormwater pollutants through physical, biological and chemical processes. Modelling of a bio-retention system at this site has shown that the following pollution reductions are expected to be achieved from the proposed stormwater treatment measures:
 - o 83.6% of total suspended solids (NSW target of 85% removal);
 - o 64.8% of total phosphorus (NSW target 65% removal)
 - o 33.8% of total nitrogen (NSW target 45% removal).
 - o 80-95% of total petroleum hydrocarbons..

Operation phase seems to indicate final and future use as opposed to construction phase. This document refers to construction phase activities. What are the plans for ongoing treatment and control?

When operational, the rest area would be managed by RMS as part of the management of the Pacific Highway. Management arrangements for the rest area could be reviewed if a highway service centre is established on the site in the future.

“Opportunities to include water management methods such as bio-retention swales between the internal roads would also be investigated to treat and control stormwater runoff”. Again, WSUD controls are to be investigated – this does not provide solid commitment. The proponent needs to provide future detail.

Refer comments above.

Biodiversity

The Rest Area Environmental Assessment contains no comprehensive flora or fauna assessment report. Therefore, no conclusions regarding the impact on threatened species can be substantiated. There are some general statements regarding the dominant flora species of each stratum and statements drawn from the larger Environmental Assessment regarding fauna, but no comprehensive study has been undertaken on the site. Accordingly the minimum requirements to determine the impact on threatened, populations and communities have not been met.

The proposed rest area has been the subject of two comprehensive flora and fauna assessments. The first report was part of the Environmental Assessment for the Sapphire to Woolgoolga Section of the Pacific Highway Upgrade in 2007, the second was prepared as part of the “Rest Area Assessment Report” 2009. Both of these documents are available on the Roads and Maritime Services website

http://www.rta.nsw.gov.au/roadprojects/projects/pac_hwy/coffs_harbour_ballina/sapphire_woolgoolga/documents/sapphire_woolgoolga_rest_area_assessment_report/s2w_rest_area_report_part_a.pdf

EA Flora and Fauna

http://www.rta.nsw.gov.au/roadprojects/projects/pac_hwy/coffs_harbour_ballina/sapphire_woolgoolga/documents/environmental_assessment/chapter_17_flora_and_fauna.pdf

The initial Sapphire to Woolgoolga Environmental Assessment gave only cursory consideration to flora and fauna values of the subject area because it was not considered as part of the proposed site of direct impact.

The rest area site was included in the proposal assessed in the environmental assessment for the Sapphire to Woolgoolga section of the Pacific Highway Upgrade (see Section 7.5.11). The environmental assessment included an assessment of the direct impacts of the rest area on the site.

The environmental assessment for the project was displayed for community comment between 29 November 2007 and 15 February 2008. Based on the number of submissions received in regard to the rest area proposal and the issues raised, the then RTA recognised the need for further consideration into the location of a rest area. The then RTA therefore decided to remove the proposed rest area at Arrawarra interchange from the project approval process. The then RTA advised the Department of Planning of this decision on 29 October 2008.

In October 2009, the then RTA published a Rest Area Assessment Report which comparatively assessed two short-listed locations for the rest area, Arrawarra and south Woolgoolga. The assessment report included an ecological assessment of the two sites. The report was placed on public display for community comment. All submissions received were considered and addressed in the Rest Area submissions report (May 2010).

The proposed rest area falls within the only Coffs Harbour City Council identified regional wildlife corridor (NR3) between Red Rock and Emerald Beach which links consolidated coastal habitat with Wedding Bells State Forest. (Coffs Harbour Corridors Footprint).

The state government has also recognised this area as a State Significant Corridor under the Biodiversity Conservation Lands layer. Similarly, Council has identified this area to be Category 2 – High Conservation Lands under Coffs Harbour City Council's draft Priority Habitats and Corridors Strategy 2010 as exhibited.

The proposal will further fragment important coastal habitat. A number of planning reports and strategies have identified the critical importance of retaining large consolidated coastal remnants along the northern beaches. The Little Arrawarra area is one of those important habitat areas and its significance further reinforced through recognition of its corridor value.

The ecological significance of the site is acknowledged. The selection of this site has been a comprehensive process that has taken into account a broad range of competing priorities. The site selection process concluded that while the site A3 at Arrawarra has higher ecological value than the South Woolgoolga location it is the more suitable of the two locations as, compared to the South Woolgoolga location, it would:

- Have less noise and other amenity impacts.
- Have less impact on existing agricultural properties.

- Have less impact on properties proposed to be rezoned for industrial purposes.
- Be less expensive to build.

The detailed assessment of the proposed sites for the rest area was reported in the Rest Area Assessment Report that was published by the Roads and Traffic Authority in September 2009.

Rest Area Assessment report – September 2009

http://www.rta.nsw.gov.au/roadprojects/projects/pac_hwy/coffs_harbour_ballina/sapphire_woolgoolga/documents/sapphire_woolgoolga_rest_area_assessment_report/s2w_rest_area_report_part_a.pdf

The rest area sits within a very low relief floodplain whose catchment feeds Little Arrawarra Creek, part of the Solitary Marine Park at its high water mark. Hard surface associated with the Rest Area are likely to increase discharge rates and water contaminants into the creek and estuary which feed into the Marine Park.

Controls are proposed to be implemented to manage flows and volumes of stormwater runoff and potential pollutants including hydrocarbons. These controls would include the installation and upgrade of culverts (new and existing) with appropriate scour protection in the form of placed rock rip rap, and the installation of swales and bioretention systems to protect the downstream ecosystems from runoff of poor water quality.

When compared to pre-highway upgrade conditions should the proposed Rest Area be constructed, the total catchment area at the existing culvert under Eggins Drive north of Arrawarra Beach Road will be reduced by approximately 1.7ha (i.e. from 70.1 ha to 68.4 ha). The balance of the catchment area will be diverted further south to Arrawarra Creek.

A review of the stormwater drainage arrangements for the proposed rest area was commissioned in response to the submissions received in relation to the proposed modification. A copy of the review report by Lyall and Associates dated 17 May 2012 is attached. A range of rainfall events were analysed, including design storm events corresponding to 1, 2, 5, 10, 20, 50 and 100 year ARI and results incorporated into the review. The results of the review indicate that, should the proposed Rest Area be constructed, the Sapphire to Woolgoolga Pacific Highway Upgrade (including the rest area) would have only a minor impact on peak flows in the drainage system that runs to the north of Arrawarra Beach Road, eg peak flows for design rainfall events of up to 2 year ARI will have a increase of approximately 1% (0.04 m³/s). For design rainfall events larger than 2 year ARI, peak flows will be reduced by approximately 3% as a result of the Upgrade.

The drainage review also assessed the volume of runoff from the upgrade (including the rest area) into the drainage system that flows into the existing culvert under Eggins Drive north of Arrawarra Beach Road. The modelled volume of runoff is expected to increase in the more frequent events, that is rainfall events with a 2 year ARI or those occurring more frequently than 2 year ARI. In event less frequent than 2 year ARI the volume of runoff will be less than both the existing highway and the approved project.

Minor hydrological changes and flooding have already resulted in significant erosion of the banks of the two creeks which feed Little Arrawarra estuary to the point where major works are now required to protect the Little Arrawarra Caravan Park at its entrance. This situation

is likely to be further exacerbated by reducing vegetated cover and increasing hard surfaces in the sub-catchment.

Refer comments above.

The 2.47 hectare is not considered mature forest, however in future years it will provide an important resource for arboreal species such as the squirrel glider which has a population stronghold in the Arrawarra-Garby Nature Reserve area.

The Arrawarra rest area has been refined to reduce the ecological impacts. The incorporation of space for a potential future service centre within the footprint of the rest area would avoid impacting on the EEC to the north of Arrawarra Beach Road.

The rest area site would directly impact on approximately 2.47 hectares of Black Butt/Grey Iron Bark Very Tall Open Forest vegetation community. However, not all of this vegetation would be removed for the rest area, with existing vegetation being retained in the south eastern corner of the site. The removal of vegetation could also impact on fauna that use the vegetation for nesting or feeding. However, this vegetation type is also found on surrounding land.

Other Matters:

Council is concerned that the pavement integrity of Eggins Close would not cater for additional vehicle movements. Any use of Eggins Close would require NSW Transport to upgrade and rehabilitate the Eggins Close pavement.

Roads and Maritime Services will upgrade the section of Eggins Drive south of Arrawarra Beach Road. There are no anticipated increases in heavy vehicle volumes on Eggins Drive due to the proposed rest area.

Council has had representations from the Woolgoolga Chamber of Commerce about the potential impact of the rest area service centre and in general the Pacific Highway upgrade bypassing Woolgoolga. The Chamber and Council request an Economic and Social Impact Assessment be carried out by NSW Transport with regard to the Woolgoolga Township.

RMS has not sought approval for a service centre. The approval sought is for a rest area only. The impact of the proposed rest area on business activity is assessed in Section 7.6.5 of the Rest Area Environmental Assessment Report (RTA 2011) As there are no commercial facilities associated with the rest area, the rest area would not be "competing" with any business in Woolgoolga. Consequently, the introduction of a rest area at Arrawarra is not considered to be the type of development that would take business away from existing businesses in Woolgoolga. However, it is possible that highway users who require a stop may stop at the rest area instead of stopping within Woolgoolga itself. This may result in some minor loss of incidental trade for businesses within Woolgoolga.

Appropriate directional, tourist information and advertorial signs at the rest stop area may be appropriate. Council would invite further consultation on the style and location of these signs.

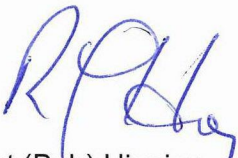
RMS will seek comment from Council in relation to signage within the Rest Area in the event that the facility is approved. Any signage provided would be in accordance with applicable RMS and State Government signage policies.

Council would encourage the provision of bike stands at the rest area.

The provision of bike stands at the rest area will be considered during the design development phase of the project.

Please contact Chris Clark on 02 6690 7013 or Belinda Bock on 02 6604 9331 should you require any additional information or require clarification on any of the above.

Yours sincerely



Robert (Bob) Higgins
General Manager, Pacific Highway

18/6/12

Roads and Maritime Services
PO BOX 9082
MOONEE BEACH NSW 2456

Job No. AM307

Attn: Mr Matthew Francisco

22 May 2012

Re: Review of Flooding in the vicinity of Arrawarra Beach Road, Arrawarra – Sapphire to Woolgoolga Pacific Highway Upgrade

Dear Sir

This letter sets out the findings of an investigation which was carried out by Lyall & Associates Consulting Water Engineers (LACE) on behalf of the Roads and Maritime Services (RMS) to assess the impact of the current Sapphire to Woolgoolga Pacific Highway Upgrade works (S2W) on local drainage patterns in the vicinity of Arrawarra Beach Road at Arrawarra. The investigation also deals with the impact that the proposed Arrawarra Rest Area would have on flooding in this area.

Figure 1 shows the route of the Pacific Highway upgrade west of Arrawarra Village and the drainage line along which local residents claim drainage patterns have been altered as a result of the road works (denoted herein as **Drainage Line A**).

S1 Key Findings and Conclusions

The impacts of the highway upgrade in terms of increases in peak flow in **Drainage Line A** are limited to storms with average recurrence intervals (ARI's) up to about 2 years. These increases have been shown to be relatively minor, in the order of 5-7% when compared to pre-upgrade conditions were RMS to decide not to build the Arrawarra Rest Area. It has also been shown that the impact of the highway upgrade on peak flows would reduce should RMS decide to build the Arrawarra Rest Area. This is because runoff from a portion of the catchment which presently contributes to flow in **Drainage Line A** would be diverted into an adjacent catchment.

The impacts of the highway upgrade in terms of increases in the volume of flow in **Drainage Line A** are also limited to storms with ARI's up to about 2 years. The degree to which the highway upgrade impacts on the volume of flow in **Drainage Line A** varies depending on the antecedent moisture condition of the catchment which lies to the west (upstream) of the highway corridor at the onset of runoff producing rainfall. For example, the volume of flow in **Drainage Line A** would be up to double that of pre-upgrade conditions for the case where the upstream catchment is in a rather dry condition at the onset of runoff producing rainfall (i.e. when antecedent moisture conditions in the catchment are relatively low), whereas the impact of the highway upgrade on the volume of flow in **Drainage Line A** is negligible for the case where the upstream catchment is in a rather wet condition at the onset of runoff producing rain (i.e. when antecedent moisture conditions in the catchment are relatively high).

It is important to note that the volumes of flow in **Drainage Line A** are an order of magnitude greater for the case where storms of up to about 2 year ARI occur on a rather wet catchment (when compared to a dry catchment) and that under these conditions the highway works will have negligible effect.

Whilst it has been demonstrated that the road works had only a minor impact on the rate (and volume) of runoff discharging to **Drainage Line A** during the recent 26 January 2012 storm event, observations by local residents of unprecedented flooding in the vicinity of Arrawarra Village during the event suggest that longer duration storms than those found to maximise peak flows in **Drainage Line A** (i.e. longer than about 1 hour) may be critical for maximising water levels in the area. This is because bursts of rainfall of between 3 and 6 hours embedded in the storm had equivalent ARI's which exceeded 100 years.

If it is the case that longer duration storms are critical for maximising water levels in the drainage lines east of the highway upgrade, this would suggest that flooding behaviour east of the highway is sensitive to changes in both the rate and volume of runoff. Given the lack of relief in the terrain and the limited conveyance capacity in the receiving drainage lines, it is possible that potentially large increases in the volume of runoff associated with the road works for storms with ARI's up to about 2 years could lead to nuisance flooding problems east (downstream) of the highway corridor.

Whilst difficult to determine, it is also possible that any nuisance flooding experienced by local residents is being exacerbated by construction activities, given the increased runoff potential associated with the large amount of clearing which has taken place in the corridor.

1. Introduction

The purpose of this present investigation is to address the concerns that have been raised by local residents regarding a perceived increase in the severity of flooding experienced in the vicinity of Arrawarra Village since the commencement of S2W construction activities on the adjacent section of highway in late 2011. Heavy rainfall and resultant flooding experienced in the area on 26 January 2012 has contributed to these concerns. The investigation also responds to residents' concerns that the Rest Area proposed on the eastern side of the upgraded highway adjacent to the Arrawarra Interchange will further exacerbate drainage and flooding issues in this area.

This letter presents the findings of an analysis of available rainfall data in the vicinity of Arrawarra Village to assess the approximate recurrence interval of the January 2012 event.

Hydrologic modelling was undertaken to assess changes in the hydrologic response of the catchments upstream (west) of Arrawarra for a number of construction scenarios. Impacts are described in terms of estimated changes to peak flow rates and volumes of runoff in the drainage line immediately north of Arrawarra Beach Road for a range of design and recorded rainfall events, including that of January 2012.

A site inspection was undertaken on 28 February 2012 to ground-truth existing drainage arrangements both within and downstream of the highway corridor.

2. Background to Flooding on 26 January 2012

Figure 1 provides an overview of Arrawarra Village and surrounding areas, including Arrawarra Beach Road and Eggins Drive. The extent of current highway upgrade works and the proposed Rest Area site are also shown on **Figure 1**.

Heavy rainfall on the morning of Thursday 26 January 2012 led to flooding of a number of properties and roads in the vicinity of Arrawarra Village. This followed several days of wet weather in the area, which extended to much of the mid-north coast of NSW. Whilst no reports of above-floor level inundation were made at Arrawarra Village, it is understood that several properties within the Village and along Arrawarra Beach Road experienced extensive flooding.

Floodwaters also covered sections of Arrawarra Beach Road and Eggins Drive, concentrated at the intersection of these two roads to a depth sufficient to close these roads to traffic. Resident reports suggest these roads remained impassable for several hours into the afternoon on 26 January. **Plate 1** in **Annexure A** shows floodwaters over the intersection, with heavy discolouration due to the sediment load from adjacent S2W upgrade works.

Note that flooding on 26 January was widespread and not limited to the general vicinity of Arrawarra Beach Road. **Plate 2** in **Annexure A** shows floodwaters over Eggins Drive approximately 2 km north of Arrawarra Beach Road, which lies beyond the extent of S2W upgrade works.

3. Drainage System in the Vicinity of Arrawarra Beach Road

Arrawarra Village and surrounds, including Arrawarra Beach Road and Eggins Drive, are located in a low-lying coastal area situated between the Pacific Highway and the ocean. The area is drained by a network of small unnamed drainage lines which ultimately flow into Arrawarra Creek and Yarrawarra Creek (refer **Figure 1**). These drainage lines have limited capacity to convey runoff due to their small size and flat grades, owing to the lack of relief in the terrain.

The drainage line that feeds runoff from the highway corridor into the intersection of Arrawarra Beach Road and Eggins Drive is shown on **Figure 1** as **Drainage Line A**.

3.1 Catchment Conditions Prior to Commencement of Highway Upgrade Works

Figure 1 shows the location of an existing cross drainage structure under the current two lane carriageway which comprises 5 off 2200 mm wide by 900 mm high reinforced concrete box culverts (RCBC's). This cross drainage structure has a waterway area of 9.9 m² and controls a 62.3 ha catchment which lies to the west of the highway corridor. The extent of this catchment is shown on **Figure 2**. The designers of the highway upgrade have assessed the hydrologic standard of this cross drainage structure to be greater than 100 year ARI.

Figure 1 also shows the location of a second cross drainage structure a short distance downstream (east) of the highway corridor where **Drainage Line A** crosses Eggins Road. This cross drainage structure comprises 4 off 750 mm diameter reinforced concrete pipes (RCP's) and has a waterway area of 1.8 m², which is approximately 18% of the waterway area available at the five cell box culvert system under the highway. The extent of the 7.8 ha catchment which contributed runoff to **Drainage Line A** at Eggins Road prior to the commencement of the highway upgrade is shown on **Figure 2**.

Downstream (east) of Eggins Road, **Drainage Line A** flows generally to the north, feeding a series of small water bodies which drain slowly to the north into Yarrawarra Creek. The Yarrawarra Creek system ultimately joins Arrawarra Creek at its outlet to the ocean (refer **Figure 1**).

3.2 Proposed Highway Upgrade Works

Figure 1 shows the extent of the S2W upgrade works in the vicinity of Arrawarra Beach Road. The S2W upgrade will include a range of permanent drainage works to manage runoff generated both upstream and within the highway corridor.

Because the existing five cell box culvert system has a hydrologic standard of at least 100 year ARI, the existing structure will be retained and simply extended at both ends to suit the widened dual carriageway configuration.

Scour protection measures, in the form of an energy dissipating outlet structure and dumped rock riprap, will be provided at the outlet of the lengthened cross drainage structure to reduce the risk of future scouring of **Drainage Line A** downstream (east) of the highway.

The lengthened cross drainage structure under the upgraded highway will also convey runoff captured by a new pavement drainage system within the widened highway corridor immediately to the south, extending over a length of approximately 150 m along the new dual carriageways and including the northbound entry ramp to the new Arrawarra Interchange and part of its southbound exit ramp.

Annexure B contains a series of design drawings for the highway upgrade that highlight the extent of the new pavement drainage systems that will contribute to runoff in **Drainage Line A**.

3.3 Proposed Arrawarra Rest Area

Figure 1 shows the site of the proposed Rest Area at Arrawarra, located on the eastern side of the upgraded highway between Arrawarra Interchange and Arrawarra Beach Road.

Runoff from the Rest Area would be controlled by a separate drainage system to that serving the adjacent section of upgraded highway. Runoff generated in the northern section of the Rest Area would be controlled by a series of swales, pits and piped drainage discharging to **Drainage Line A** immediately upstream (west) of Eggins Road.

Annexure C contains a design drawing for the proposed Rest Area that highlights the extent of the drainage system that would contribute to runoff in **Drainage Line A** (refer elements highlighted in blue). Note that for the purpose of this present investigation, it was assumed that the portion of drainage system upstream of pit **Z6/RA07/07** (refer **Annexure C** for location) would be directed south towards Arrawarra Creek based on advice from RMS.

Runoff generated in the southern section of the Rest Area, as well as the portion upstream of pit **Z6/RA07/07**, would be discharged to the eastern side of Eggins Drive adjacent to the proposed Arrawarra Interchange and drain generally to the south-east towards Arrawarra Creek, away from Arrawarra Beach Road.

3.4 Temporary Construction-Phase Drainage Arrangements

During construction of the highway upgrade, a range of temporary drainage arrangements will be utilised for the purpose of controlling runoff generated both upstream and within the highway corridor. These temporary drainage arrangements will involve the following:

- Works to control and capture sediment-laden runoff generated by surfaces within the highway corridor that are disturbed by construction activities.
- Works to divert 'clean' runoff generated upstream of the highway corridor through the construction site.

These arrangements are subject to ongoing modification as construction progresses to suit site requirements and to ensure compliance with environmental licensing obligations.

4. Analysis of Rainfall Data

The purpose of rainfall data analysis was to determine the approximate recurrence interval of the 26 January 2012 event.

Whilst RMS has requested this analysis be extended to the event occurring in June 2011, such assessment was prevented due to lack of suitable rainfall data for the earlier event. This is discussed in more detail in **Section 4.2** below.

4.1 January 2012 Event

Analysis of the recent January 2012 event was undertaken based on rainfall recorded by the Leighton Fulton Hogan Joint Venture's (LFHJV's) Woolgoolga weather station near Bark Hut Road, which is located approximately 4.5 km to the south of Arrawarra. Continuous rainfall data is available from this station at 5 minute intervals, with full coverage available for this particular storm event.

Table 1 shows the daily rainfall depths (24 hours to 9.00 am) which were recorded at Woolgoolga over the five day period between 23 and 27 January 2012. Whilst the largest rainfalls occurred on the calendar day of 26 January, **Table 1** shows that substantial rainfall also occurred over the preceding days.

TABLE 1
DAILY RAINFALL TOTALS FOR JANUARY 2012 EVENT
(mm)

Date	Rainfall depth for 24 hours to 9.00 am	
	LFHJV Station at Woolgoolga	Boyd property at Arrawarra
23 January 2012	28	27
24 January 2012	43	42
25 January 2012	16	13
26 January 2012	98	110
27 January 2012	195	164
Total 2-day rainfall depth (26 – 27 January 2012)	293	274
Total 5-day rainfall depth	380	356

Table 1 also shows corresponding rainfall depths reported by Arrawarra resident Lorraine Boyd for comparative purposes, which shows close agreement for both daily rainfall depths and the five day rainfall total. This indicates that rainfall at Woolgoolga over this period was reasonably consistent with that experienced at Arrawarra.

Figure 3 is a plot of cumulative rainfall depth for the calendar day of 26 January 2012, which shows that approximately 250 mm fell over the 21 hour period between midnight and 9.00 pm. **Figure 3** also shows that most of this rain occurred over a three hour period in the middle of the day when approximately 155 mm fell between 10.30 am and 1.30 pm. The heaviest burst during this period occurred around 11.00 am.

Figure 4 provides a graphical assessment of the ARI of the 26 January 2012 event for a range of storm durations between 5 minutes and 24 hours, based on design rainfall data derived for Arrawarra. This demonstrates that bursts of rainfall embedded in the overall event exceeded 100 year ARI for periods of between 3 and 6 hours. However, for a period of 2 hours the ARI of the storm reduced to below 50 years, falling further to approximately 15 years for a period of 1 hour.

4.2 June 2011 event

Review of continuous rainfall data recorded by LFHJV's Woolgoolga weather station for the June 2011 event shows a gap in the record, most likely due to instrument failure. Unfortunately this data gap coincides with the most intense bursts of rainfall experienced early on the morning of 14 June, which prevents any meaningful assessment of the ARI of this event.

Table 2 shows the daily rainfall depths (24 hours to 9.00 am) which were recorded at the Bureau of Meteorology's (BoM's) weather station located in Clear Place, Woolgoolga over the two day period of 13 – 14 June 2011. Whilst corresponding rainfall depths reported at the Boyd property are also provided in **Table 2**, comparison is limited by underestimation of rainfall at the Boyd property on 14 June due to overflow of the rain gauge.

TABLE 2
DAILY RAINFALL TOTALS FOR JUNE 2011 EVENT
(mm)

Date	Rainfall depth for 24 hours to 9.00 am	
	BoM Station at Woolgoolga (Clear Place)	Boyd property at Arrawarra
13 June 2011	121	142
14 June 2011	250	170 ⁽¹⁾
Total 2-day rainfall depth	371	312 ⁽¹⁾

(1) Rainfall depth underestimated due to rain gauge overflow

4.3 Comparison of Historic Rainfall Events

Lack of continuous rainfall data for the June 2011 event prevents comparison of the ARI of this event with that of January 2012.

Whilst 24 hour and 48 hour rainfall depths were higher for the June 2011 event, peak flow rates in **Drainage Line A** at Eggins Road are maximised by bursts of rainfall occurring over a much shorter period, in the order of 1 to 2 hours. Note that further discussion of storm durations in the context of maximising peak flow rates is provided in **Section 5.3** below.

It is noted that resident reports suggest that the extent and depth of flooding along Arrawarra Beach Road was greater for the January 2012 event than in June 2011. However, without continuous rainfall records for both events that are representative of local conditions, no further conclusions can be drawn on the relative magnitude of the two flood events.

The closest location for which continuous rainfall data is available for both events is at the BoM's gauge in Coffs Harbour. However, review of daily rainfall totals for this gauge against the data in **Tables 1** and **2** above shows that both events were much smaller in terms of rainfall depths at Coffs Harbour and therefore not representative of conditions at Arrawarra.

5. Hydrologic Modelling

5.1 Methodology

Investigation of the impact the road works will have on peak flow rates and volumes of runoff entering **Drainage Line A** downstream (east) of the highway corridor and proposed Rest Area was undertaken using the DRAINS software. DRAINS is a simulation program which converts rainfall patterns to stormwater runoff and routes flows through networks of piped drainage systems, culverts, storages and open channels. It develops hydrographs and calculates hydraulic grade lines throughout the drainage network, enabling users to analyse the magnitude of overflows and stored water for established drainage systems. It is applicable to both rural and developed catchments, or any combination of the two, and is therefore well suited to this present investigation.

DRAINS models reflecting the following four scenarios were developed to assess the potential impact of both temporary construction-phase drainage arrangements and permanent drainage works proposed as part of the S2W upgrade:

- **Scenario 1** – under pre-highway upgrade conditions;
- **Scenario 2** – under post-highway conditions, without the proposed Arrawarra Rest Area;
- **Scenario 3** – under post-highway upgrade conditions, including the proposed Arrawarra Rest Area; and
- **Scenario 4** – during construction of the highway upgrade, circa 26 January 2012.

The DRAINS models incorporate the full extent of the catchment area that contributes to runoff in **Drainage Line A** at Eggins Road. A range of data was used in the development of the models, including:

- various DRAINS models developed as part of the detailed design for the new transverse and pavement drainage systems;
- ground survey data;
- highway upgrade design data and various design drawings; and
- observations and measurements made during site inspection.

In the absence of gauged streamflow data that could otherwise be used to calibrate the DRAINS models, peak flows arriving at the highway corridor were tuned as close as was practicable to peak flow estimates derived using the Probabilistic Rational Method (PRM).

It is understood that the highway corridor in the vicinity of Arrawarra Beach Road had been largely cleared of existing vegetation and subject to extensive earthworks prior to 26 January 2012. A conservative approach was therefore adopted for the purpose of assessing **Scenario 4**, whereby the full width of the highway corridor was assumed to be disturbed and generating runoff equivalent to a paved surface. This scenario can therefore be considered to represent an upper bound (i.e. worst case) in terms of the likely impact of temporary construction phase drainage arrangements on peak flows downstream of the highway corridor at the time of recent flooding in January 2012.

A range of rainfall events were analysed, including design storm events corresponding to the 1, 2, 5, 10, 20, 50 and 100 year ARI. The 26 January 2012 event was also analysed, whilst the June 2011 event was not due to lack of continuous rainfall data.

5.2 Change in Catchment Area Contributing Runoff to Drainage Line A

Table 3 provides a summary of the catchment area contributing runoff to **Drainage Line A** at Eggins Road for the above-mentioned scenarios.

TABLE 3
COMPARISON OF CATCHMENT AREA CONTRIBUTING RUNOFF
TO DRAINAGE LINE A AT EGGINS ROAD
(ha)

Component	Scenario 1 Pre-highway Upgrade	Scenario 2 Post-highway Upgrade (no Rest Area)	Scenario 3 Post-highway Upgrade (with Rest Area)	Scenario 4 Construction Phase (circa 26 January 2012)
Paved Area	0.9	1.8	2.2	6.2
Grassed Area	69.2	68.4	66.2	64.4
Total Area	70.1	70.2	68.4	70.6

Whilst the total catchment area at Eggins Road will be essentially unchanged under post-highway upgrade conditions excluding the proposed Rest Area (i.e. **Scenario 2**), the paved proportion of this catchment will be doubled (i.e. from 0.9 ha to 1.8 ha).

The total catchment area at Eggins Road will be reduced by approximately 1.7 ha (i.e. from 70.1 ha to 68.4 ha) when compared to pre-highway upgrade conditions should the proposed Rest Area be constructed, with the balance of the area drained further to the south towards Arrawarra Creek, away from Arrawarra Beach Road. However, the paved proportion of the catchment will be increased by 1.3 ha.

Table 3 shows that under temporary construction phase conditions, the total catchment area at Eggins Road could be increased by up to 0.5 ha (i.e. from 70.1 ha to 70.6 ha), with a potential increase in effective paved area of up to 5.3 ha (i.e. from 0.9 ha to 6.2 ha). Note that this assessment corresponds to a worst case scenario, as described above in **Section 5.1**.

5.3 Impact on Peak Flows in Drainage Line A

Table D1 in **Annexure D** provides a comparison of estimated peak flows in **Drainage Line A** immediately downstream of Eggins Road for the above-mentioned scenarios and rainfall events.

Tables D2 and **D3** in **Annexure D** provide a comparison of estimated volumes of runoff in **Drainage Line A** immediately downstream of Eggins Road for the above-mentioned scenarios assuming initial losses from the pervious portion of the catchment of 5 and 20 mm, respectively. Note that an initial loss of 5 mm would be representative of a rather wet catchment (i.e. representative of a catchment where the antecedent moisture condition [AMC] is relatively high at the onset of runoff producing rainfall), whilst an initial loss of 20 mm would be representative of a rather dry catchment or relatively low AMC.

The following sections provide further interpretation and discussion of these results.

Note that peak flow rates downstream of Eggins Road were found to be maximised for design storm durations in the range of 1 to 2 hours for all four scenarios analysed.

5.3.1 Impact of S2W Upgrade excluding Rest Area (Scenario 2)

The results in **Table D1** in **Annexure D** demonstrate that the S2W upgrade excluding the proposed Rest Area (i.e. **Scenario 2**) will have only a minor impact on peak flows in **Drainage Line A**.

Peak flows for the smaller, more frequent storm events will be slightly increased, with the largest increase of approximately 7% for the 2 year ARI design event. However, peak flows for events larger than 2 year ARI will be slightly reduced as a result of the S2W upgrade.

For a rainfall event similar in magnitude to that experienced on 26 January 2012, the S2W upgrade is expected to have essentially no impact on peak flows downstream of Eggins Road.

Based on hydrologic modelling of the 26 January 2012 event undertaken as part of this present investigation, peak flows in **Drainage Line A** downstream of Eggins Road were equivalent to a storm of approximately 10 year ARI for all four scenarios analysed.

It is noted that this recurrence interval is more frequent, and therefore implies an event of lesser magnitude, than the 15 year ARI determined for the corresponding maximum rainfall depth occurring over a period of 1 hour (refer **Section 4**). This minor difference in recurrence interval can be attributed to a temporal distribution of rainfall that was slightly less 'peaky' for the 26 January 2012 event when compared to a design storm burst of 1 hour duration.

This is demonstrated in **Figure 5**, which provides a comparison of rainfall intensity over the peak 1 hour burst on 26 January 2012 against the 10 year ARI, 1 hour design storm event. The design storm contains three consecutive five minute periods with rainfall intensity greater than 90 mm per hour, peaking at 180 mm per hour, whereas the 26 January 2012 event contains an isolated five minute burst peaking at 150 mm per hour.

By comparison of the volumes given in **Tables D2** and **D3** in **Annexure D**, it can be seen that the volume of runoff in **Drainage Line A** will be increased as a result of the S2W upgrade. This effect is greatest for the larger initial loss value of 20 mm, where the volume of runoff in the drainage line could potentially be doubled for the more frequent, short duration events. Increases in volumes are generally less than 2% for storms with ARI's of 10 years and larger. For an initial loss of 5 mm, the increase in runoff volume associated with the more frequent, short duration events could be up to 3%, with increases generally less than 1% for storms with ARI's of 10 years and larger.

Note that whilst the higher initial loss value will generate greater impacts as a result of the highway upgrade, this case will also result in lower overall volumes of runoff entering **Drainage Line A**. For example, under post-highway upgrade conditions the 1 year ARI 1 hour duration event will result in:

- generation of 7,912 m³ of runoff for an initial loss of 5 mm, which is a 3% increase relative to pre-highway upgrade conditions; or
- generation of 590 m³ of runoff for an initial loss of 20 mm, which is a 102% increase relative to pre-highway upgrade conditions.

The difference in runoff volumes owing to the adopted initial loss value is lower for the larger, less frequent design storm events.

5.3.2 Impact of S2W Upgrade including Rest Area (Scenario 3)

The results in **Table D1** in **Annexure D** demonstrate that should the proposed Rest Area be constructed, the S2W upgrade (i.e. **Scenario 3**) will still have only a minor impact on peak flows in **Drainage Line A**.

Peak flows for design events up to 2 year ARI will be subject to a minor increase of approximately 1%. For design events larger than 2 year ARI, peak flows will be slightly reduced as a result of the S2W upgrade.

For a rainfall event similar in magnitude to that experienced on 26 January 2012, the S2W upgrade incorporating the proposed Rest Area would result in a minor reduction in peak flows downstream of Eggins Road.

By comparison of the volumes given in **Tables D2** and **D3** in **Annexure D**, it can be seen that the volume of runoff in **Drainage Line A** will generally be increased as a result of the S2W upgrade for the more frequent storm events up to an ARI of 2 years. This effect is greatest for the larger initial loss value of 20 mm, where the volume of runoff in the drainage line could potentially be increased by almost 150% for the more frequent, short duration events. For an initial loss of 5 mm, the increase in runoff volume associated with the more frequent, short duration events could be up to 2%. **Tables D2** and **D3** demonstrate that for storms with ARI's of 10 years and larger, the volume of runoff in **Drainage Line A** will generally be reduced as a result of the S2W upgrade for either initial loss value.

Note that whilst the higher initial loss value will generate greater impacts as a result of the highway upgrade for the more frequent, short duration events, this case will also result in lower overall volumes of runoff entering **Drainage Line A**. For example, under post-highway upgrade conditions including the proposed Rest Area, the 1 year ARI 1 hour duration event will result in:

- generation of 7,803 m³ of runoff for an initial loss of 5 mm, which is a 2% increase relative to pre-highway upgrade conditions; or
- generation of 721 m³ of runoff for an initial loss of 20 mm, which is a 147% increase relative to pre-highway upgrade conditions.

The difference in runoff volumes owing to the adopted initial loss value is lower for the larger, less frequent design storm events.

5.3.3 Impact of Temporary Construction Phase Drainage Arrangements (Scenario 4)

The results in **Table D1** in **Annexure D** demonstrate that peak flows in **Drainage Line A** could be increased during construction of the highway upgrade for events up to and including 20 year ARI, with peak flows unchanged for larger events. The impact on peak flows is greatest for the smaller, more frequent events, with a maximum increase of up to 31% for the 1 year ARI event. The impact is reduced for larger events, with an increase in peak flow of up to 11% for the 20 year ARI event.

For a rainfall event similar in magnitude to that experienced on 26 January 2012, the impact of temporary construction phase drainage arrangements on peak flows downstream of Eggins Road is minor, with an estimated increase of up to 1%.

Note that this analysis assumes that the highway corridor is fully disturbed and that the runoff characteristics of the disturbed area are similar to a fully paved surface. In reality this is not the case, and the impact of the highway construction works on peak flows would be less than that given in **Table D1**.

For example, in the case where half the highway corridor was assumed to be behaving as a fully paved surface, peak flows in **Drainage Line A** would be increased by up to 15% for the 1 year ARI, and by up to 8% for the 20 year ARI. Given the changing nature of temporary landforms, surface treatments and progressive rehabilitation within the highway corridor during construction, it is not possible to put a finer point on likely impacts during the construction phase.

By comparison of the volumes given in **Tables D3** in **Annexure D**, it can be seen that the upper limit of potential increases in the volume of runoff in **Drainage Line A** could be as high as 600% for a 1 year ARI event of 60 minutes duration.

We trust that the findings of this investigation will assist RMS in its understanding of the impact the S2W upgrade, and proposed Rest Area, will have on flooding in the vicinity of the intersection of Arrawarra Beach Road and Eggins Road at Arrawarra. If we can be of any further assistance, please do not hesitate to contact the undersigned.

Yours faithfully

Lyll & Associates Consulting Water Engineers



Scott Button
Principal

Attachments

Figure 1	Location Plan
Figure 2	Catchment Plan – Pre-Highway Upgrade Conditions
Figure 3	Cumulative Rainfall for 26 January 2012 Event
Figure 4	Comparison of 26 January 2012 Event with Design Rainfall Data
Figure 5	Comparison of 26 January 2012 Peak Rainfall Burst with Design Storm Event
Annexure A	Photographs of 26 January 2012 Flooding
Annexure B	Design Drawings for S2W Upgrade
Annexure C	Design Drawings for Proposed Rest Area
Annexure D	Summary of DRAINS Model Results

ANNEXURE A
PHOTOGRAPHS OF 26 JANUARY 2012 FLOODING



Plate 1

View looking east along Arrawarra Beach Road towards intersection with Eggins Drive, showing floodwaters over the intersection and extending east along Arrawarra Beach Road

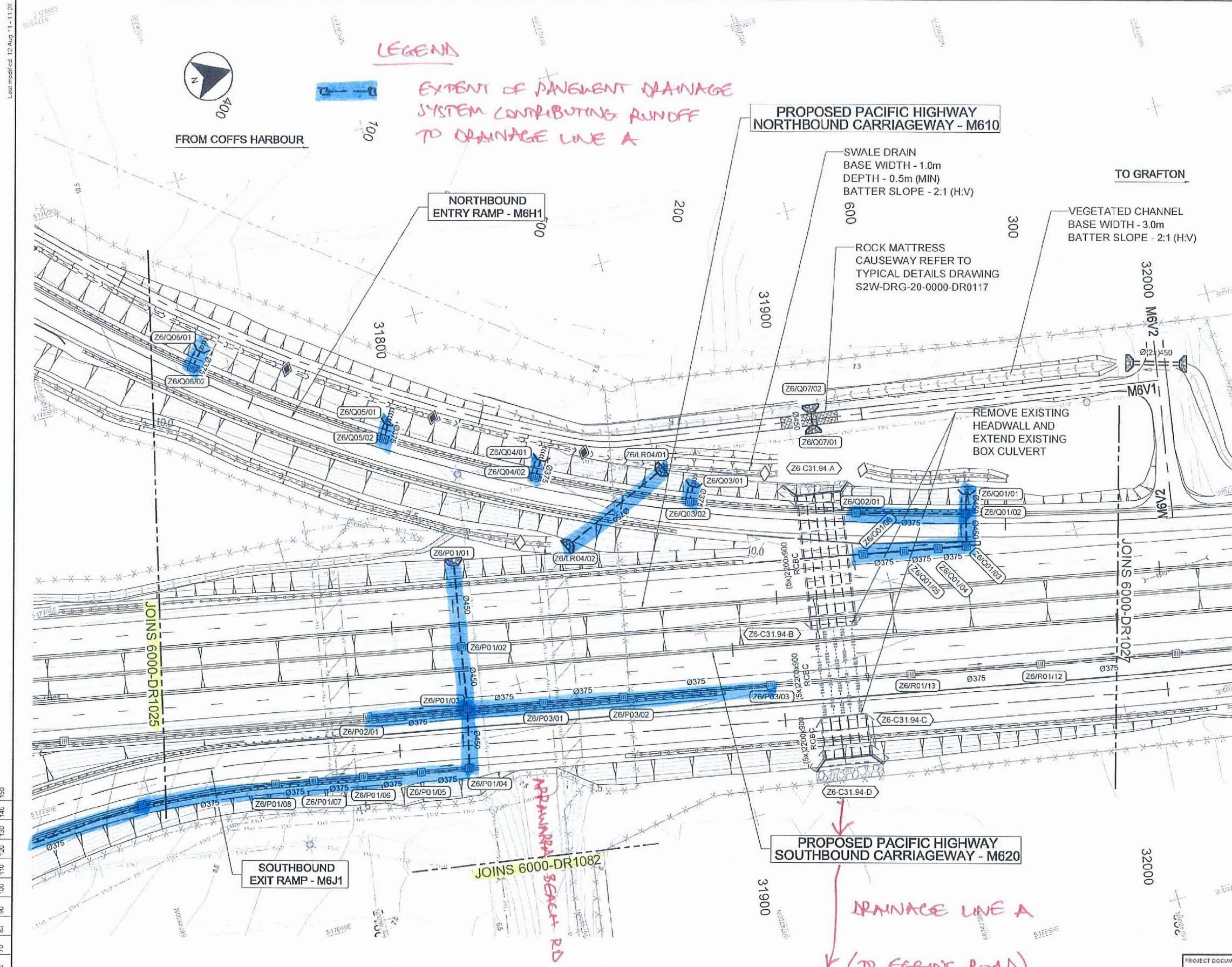


Plate 2

View towards the northern end of Eggins Drive from Pacific Highway exit (approximately 2 km north of Arrawarra Beach Road), showing floodwaters over Eggins Drive

ANNEXURE B
DESIGN DRAWINGS FOR S2W UPGRADE

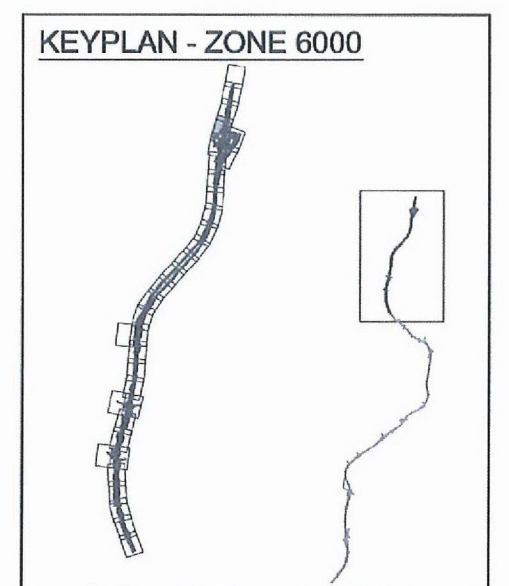
Last modified: 12 Aug '11 11:20



LEGEND	
	HEADWALL WITH ROCK MATTRESS OR RIP-RAP APRON
	HEADWALL WITH CONCRETE APRON
	HEADWALL WITH TYPE A DISSIPATOR U.N.O.
	HEADWALL WITH ROCK VEGETATED APRON
	PIPE/BOX CULVERT AND FLOW DIRECTION
	EXISTING PIPE/BOX CULVERT
	SWALE - VEGETATED
	CATCH DRAIN - VEGETATED (TYPE 'A' U.N.O.)
	CATCH DRAIN - ENKAMAT (TYPE 'A' U.N.O.)
	CATCH DRAIN - CONCRETE (TYPE 'A' U.N.O.)
	CHANNEL - VEGETATED
	CHANNEL - CONCRETE U.N.O.
	BERM DRAIN - VEGETATED U.N.O.
	BERM DRAIN - CONCRETE U.N.O.
	TABLE DRAIN - VEGETATED
	TABLE DRAIN - CONCRETE U.N.O.
	TRANSVERSE DRAINAGE TAG
	PAVEMENT DRAINAGE TAG
	STORMWATER PIT / BATTER DRAIN

NOTES

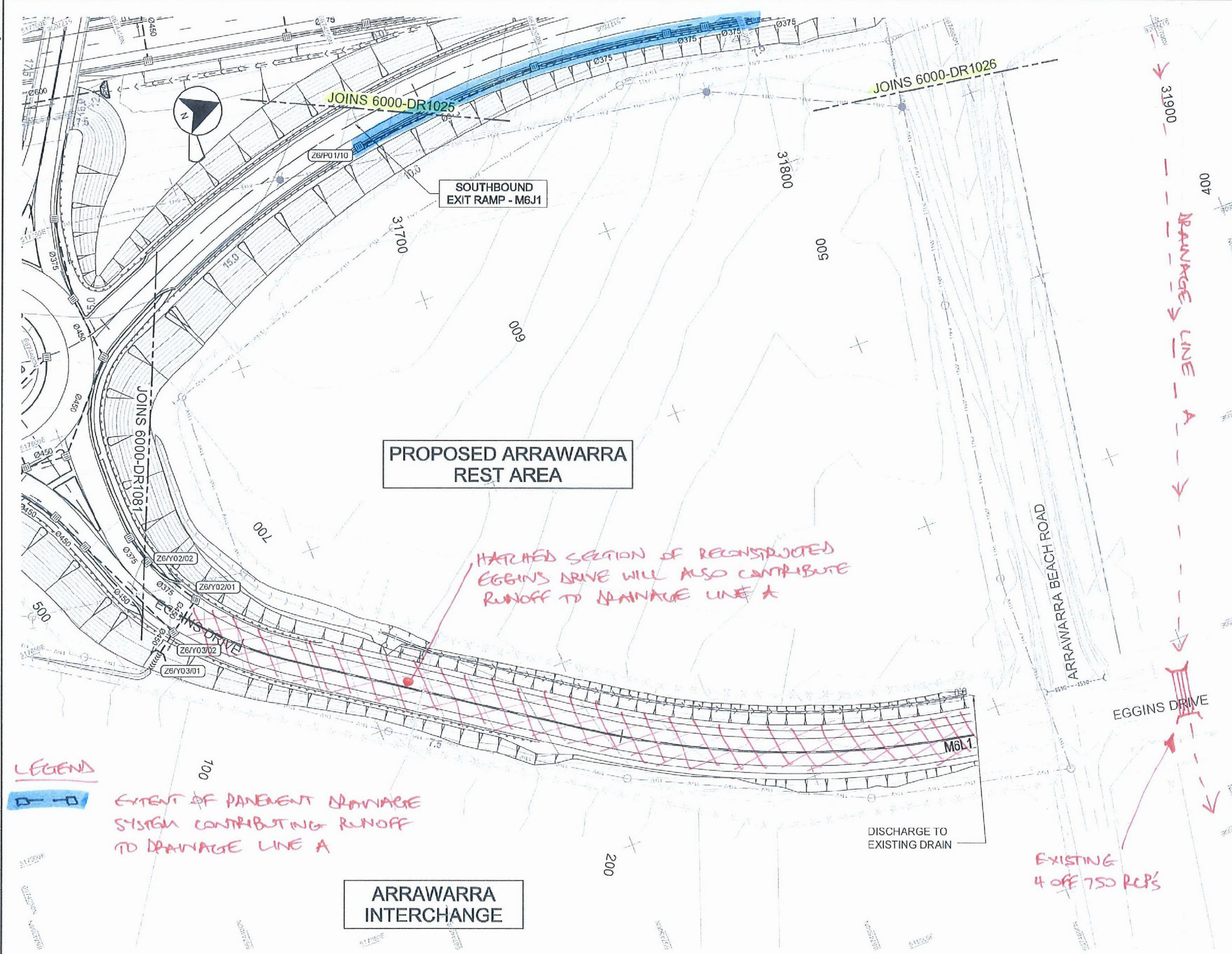
1. FOR GENERAL NOTES AND ADDITIONAL LEGEND REFER TO DRAWING DR0021.



FOR CONSTRUCTION	
PROJECT DOCUMENT NUMBER	S2W-DRG-20-6000-DR1026
REVISION	A
HIGHWAY No 10	SAPPHIRE TO WOOLGOOLGA UPGRADE
CITY OF COFFS HARBOUR	
ZONE 6000 DRAINAGE PLAN SHEET 26	
RTA PLAN REGISTRATION No OF PLANS	0010.110RC4207
ISSUE STATUS	FOR CONSTRUCTION
SHEET No	
ISSUE	

DRAWING FILE LOCATION/NAME Cad ref: C:\Projects\S2W5 CAD\13 Working\Dig120_Details\6000OR_Drainage\S2W-DRG-20-6000-DR1026.dwg		DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING S2W-MOD-20-6000-RD_DES_20110718-FC-A.TXT		S2W-MOD-20-6000-RD_DES_COMB_20110812-FC-A.12da	
EXTERNAL REFERENCE FILES		DESIGNERS SITE NOTE		CONTRACTOR	
REV		DATE		AMENDMENT / REVISION DESCRIPTION	
A		12 US 2011		ISSUED FOR CONSTRUCTION	
LOT SEQ No		APPROVAL		DESIGNER	
060A		SL		Fulton Hogan	
COORDINATE SYSTEM		HEIGHT DATUM		PROJECT	
MGA ZONE 55		A.H.D.		LEIGHTON	
SCALE AT A3 SIZE DRAWING		FULL SIZE A3		Fulton Hogan	
1:1000				AECOM	
				SMEC	

Last modified: 2 Aug 11 11:30

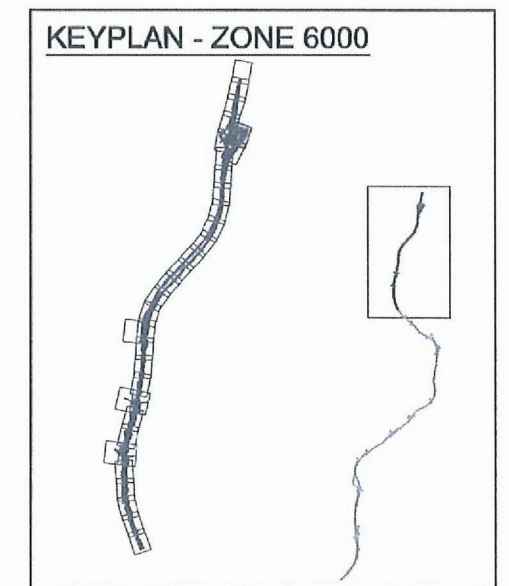


LEGEND

- HEADWALL WITH ROCK MATRESS OR RIP-RAP APRON
- HEADWALL WITH CONCRETE APRON
- HEADWALL WITH TYPE A DISSIPATOR U.N.O.
- HEADWALL WITH ROCK VEGETATED APRON
- PIPE/BOX CULVERT AND FLOW DIRECTION
- EXISTING PIPE/BOX CULVERT
- SWALE - VEGETATED
- CATCH DRAIN - VEGETATED (TYPE 'A' UNO)
- CATCH DRAIN - ENKAMAT (TYPE 'A' UNO)
- CATCH DRAIN - CONCRETE (TYPE 'A' UNO)
- CHANNEL - VEGETATED
- CHANNEL - CONCRETE UNO
- BERM DRAIN - VEGETATED UNO
- BERM DRAIN - CONCRETE UNO
- TABLE DRAIN - VEGETATED
- TABLE DRAIN - CONCRETE UNO
- TRANSVERSE DRAINAGE TAG
- PAVEMENT DRAINAGE TAG
- STORMWATER PIT / BATTER DRAIN

NOTES

1. FOR GENERAL NOTES AND ADDITIONAL LEGEND REFER TO DRAWING DR0021.

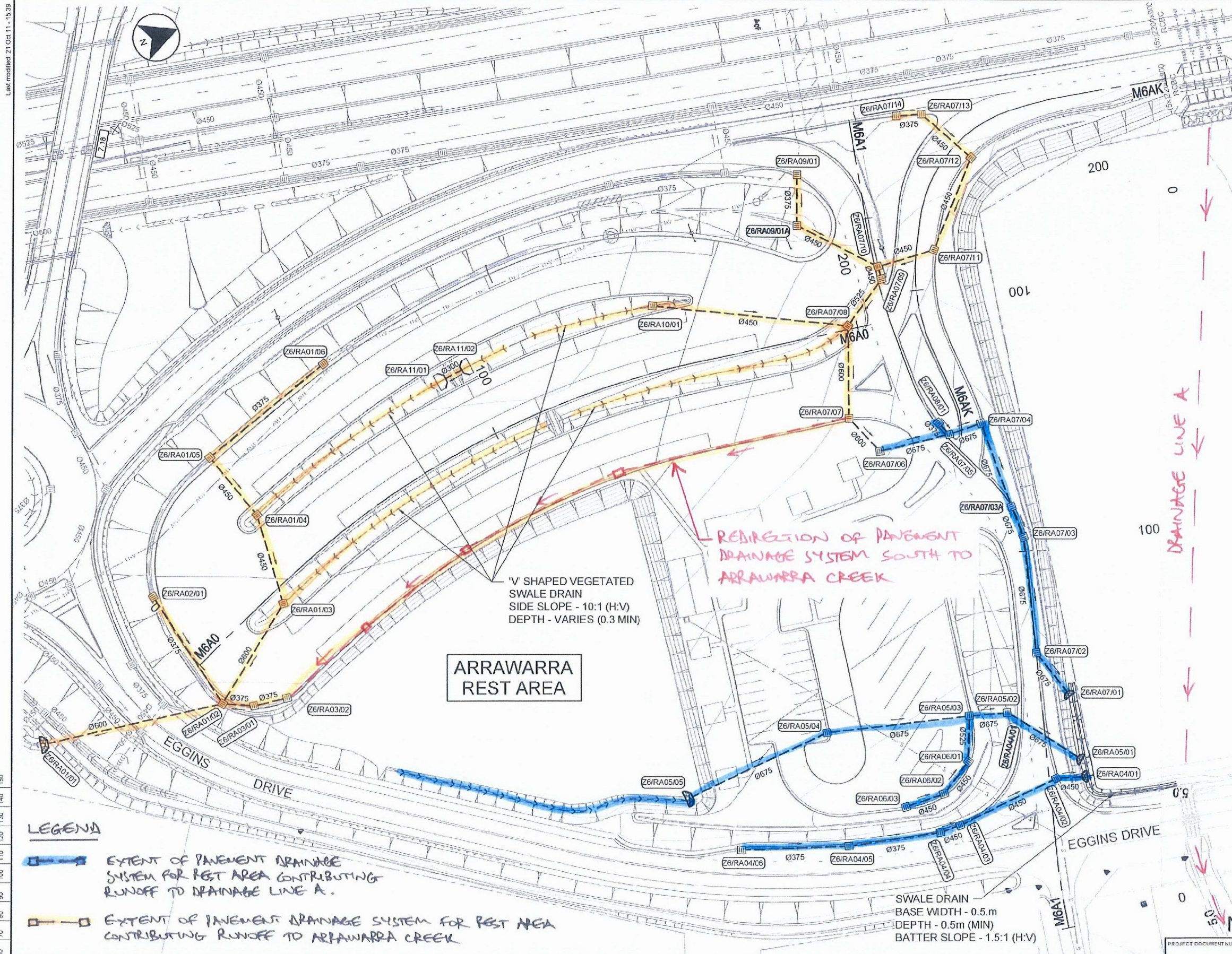


FOR CONSTRUCTION

DRAWING FILE LOCATION / NAME C:\projects\2011\20110718\20110718-FC-A.TXT		DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING S2W-MOD-20-6000-DR_DES_20110718-FC-A.TXT		S2W-MOD-20-6000-DR_DES_COMB_20110812-FC-A_12da		PROJECT DOCUMENT NUMBER S2W-DRG-20-6000-DR1082	REVISION A
EXTERNAL REFERENCE FILES		DESIGNERS SITE NOTE		CONTRACTOR LEIGHTON Fulton Hogan		HIGHWAY No 10 SAPPY TO WOOLGOOLGA UPGRADE CITY OF COFFS HARBOUR	
REV A		DATE 12.08.2011		AMENDMENT / REVISION DESCRIPTION ISSUED FOR CONSTRUCTION		ZONE 6000 DRAINAGE PLAN SHEET 33	
LOT SEQ. No 000A		APPROVAL SL		DESIGNER AECOM		RTA PLAN REGISTRATION No OF PLANS 0010.110RC4207	
COORDINATE SYSTEM MGA ZONE 55		HEIGHT DATUM AHD		SCALES AT A3 SIZE DRAWING 1:1000 FULL SIZE A3		ISSUE STATUS FOR CONSTRUCTION	
SHEET No 33		TOTAL SHEETS 33		PROJECT LEIGHTON Fulton Hogan		SHEET No 33	

ANNEXURE C
DESIGN DRAWINGS FOR PROPOSED REST AREA

Last modified: 21 Oct 11 - 15:39

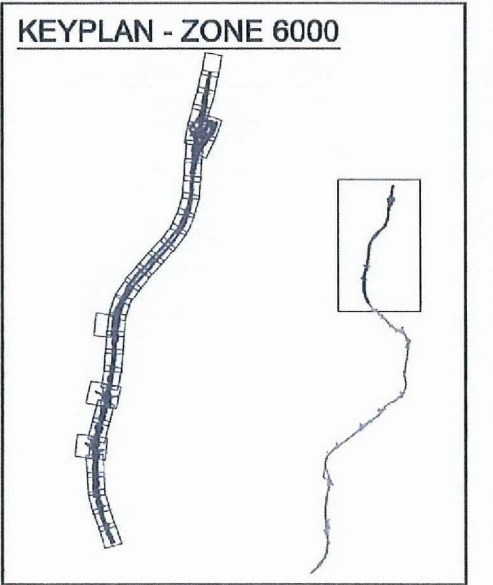


LEGEND

- HEADWALL WITH ROCK MATRESS OR RIP-RAP APRON
- HEADWALL WITH CONCRETE APRON
- HEADWALL WITH TYPE A DISSIPATOR U.N.O.
- HEADWALL WITH ROCK VEGETATED APRON
- PIPE/BOX CULVERT AND FLOW DIRECTION
- EXISTING PIPE/BOX CULVERT
- SWALE - VEGETATED
- CATCH DRAIN - VEGETATED (TYPE 'A' UNO)
- CATCH DRAIN - ENKAMAT (TYPE 'A' UNO)
- CATCH DRAIN - CONCRETE (TYPE 'A' UNO)
- CHANNEL - VEGETATED
- CHANNEL - CONCRETE UNO
- BERM DRAIN - VEGETATED UNO
- BERM DRAIN - CONCRETE UNO
- TABLE DRAIN - VEGETATED
- TABLE DRAIN - CONCRETE UNO
- PAVEMENT DRAINAGE TAG
- STORMWATER PIT

NOTES

1. FOR GENERAL NOTES AND ADDITIONAL LEGEND REFER TO DRG GE6021.



LEGEND

- EXTENT OF PAVEMENT DRAINAGE SYSTEM FOR REST AREA CONTRIBUTING RUNOFF TO DRAINAGE LINE A.
- EXTENT OF PAVEMENT DRAINAGE SYSTEM FOR REST AREA CONTRIBUTING RUNOFF TO ARRAWARRA CREEK

SWALE DRAIN
BASE WIDTH - 0.5m
DEPTH - 0.5m (MIN)
BATTER SLOPE - 1.5:1 (H:V)

DRAWING FILE LOCATION NAME Cad ref: C:\Projects\S2W5 CAD\05 3 Working\Org\20_Detailed\6000\GE_Genets\S2W-DRG-20-6000-GE6021.dwg				DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING S2W-MOD-20-6002-RD_DES_20111020-FD-02.TXT				S2W-MOD-20-6002-DR_DES_20111020-FD-02 12da			
EXTERNAL REFERENCE FILES				DESIGNERS SITE NOTE				CONTRACTOR			
REV				LOT SEQ. No				PROJECT			
01 16 09 2011				810A				S2W-DRG-20-6000-GE6021			
02 21 10 2011				810A				HIGHWAY No 10 SAPPHERE TO WOOLGOLGA UPGRADE CITY OF COFFS HARBOUR			
AMENDMENT / REVISION DESCRIPTION				APPROVAL				ZONE 6000			
ISSUED FOR PRELIMINARY DETAILED DESIGN				SL				ARRAWARRA REST AREA			
ISSUED FOR FINAL DESIGN				SL				DRAINAGE PLAN			
CO-ORDINATE SYSTEM				SCALE AT A3 SIZE DRAWING				RTA PLAN REGISTRATION No OF PLANS			
MGA ZONE 55				1:1000 FULL SIZE A3				0010.110RC4207			
HEIGHT DATUM: A.H.D.				CONTRACTOR				ISSUE STATUS			
				LEIGHTON				FINAL DESIGN			
				Fulton Hogan				SHEET No			
				AECOM				ISSUE			
				SMEC							

ANNEXURE D
SUMMARY OF DRAINS MODEL RESULTS

TABLE D1
COMPARISON OF PEAK FLOWS ⁽¹⁾ IN DRAINAGE LINE A
IMMEDIATELY DOWNSTREAM OF EGGINS ROAD

Event	Scenario 1	Scenario 2			Scenario 3			Scenario 4		
	Pre-highway Upgrade	Post-highway Upgrade (without Rest Area)			Post-highway Upgrade (including Rest Area)			Construction Phase (circa 26 January 2012)		
	Peak flow	Peak flow	Difference ⁽²⁾		Peak flow	Difference ⁽²⁾		Peak flow	Difference ⁽²⁾	
	(m ³ /s)	(m ³ /s)	(m ³ /s)	(%)	(m ³ /s)	(m ³ /s)	(%)	(m ³ /s)	(m ³ /s)	(%)
1 year ARI	2.93	3.07	0.14	5%	2.95	0.02	1%	3.85	0.92	31%
2 year ARI	5.28	5.64	0.36	7%	5.32	0.04	1%	6.49	1.21	23%
5 year ARI	9.20	9.08	-0.12	-1%	8.96	-0.24	-3%	10.2	1.0	11%
10 year ARI	11.8	11.6	-0.2	-2%	11.5	-0.3	-3%	12.5	0.7	6%
20 year ARI	15.3	15.1	-0.2	-1%	14.9	-0.4	-3%	17.0	1.7	11%
50 year ARI	19.9	19.7	-0.2	-1%	19.4	-0.5	-3%	19.9	0	0%
100 year ARI	23.3	23.0	-0.3	-1%	22.7	-0.6	-3%	23.3	0	0%
26 January 2012	11.7	11.7	0	0%	11.5	-0.2	-2%	11.8	0.1	1%

(1) Peak flows are quoted to more than one decimal place for ease of comparison only, where flows are relatively small

(2) Note that a positive difference represents an increase in peak flow as a result of the S2W upgrade works. Differences for all scenarios are shown relative to pre-highway upgrade conditions (i.e. Scenario 1).

TABLE D2
COMPARISON OF RUNOFF VOLUMES IN DRAINAGE LINE A
IMMEDIATELY DOWNSTREAM OF EGGINS ROAD
PERVIOUS AREA INITIAL LOSS = 5 mm

Event		Scenario 1 Pre-highway Upgrade	Scenario 2 Post-highway Upgrade (without Rest Area)			Scenario 3 Post-highway Upgrade (including Rest Area)			Scenario 4 Construction Phase (circa 26 January 2012)		
ARI	Duration	Volume	Volume	Difference ⁽¹⁾		Volume	Difference ⁽¹⁾		Volume	Difference ⁽¹⁾	
		(m ³)	(m ³)	(m ³)	(%)	(m ³)	(m ³)	(%)	(m ³)	(m ³)	(%)
1 year	1 hour	7,683	7,912	229	3.0%	7,803	120	1.6%	8,910	1,227	16%
	3 hour	11,848	12,171	323	2.7%	12,005	157	1.3%	13,748	1,900	16%
	6 hour	13,797	14,231	434	3.1%	14,066	269	1.9%	16,374	2,577	19%
2 year	1 hour	14,363	14,617	254	1.8%	14,321	-42	-0.3%	15,662	1,299	9.0%
	3 hour	21,892	22,231	339	1.5%	21,805	-87	-0.4%	23,905	2,013	9.2%
	6 hour	26,365	26,835	470	1.8%	26,355	-10	0.0%	29,128	2,763	11%
10 year	1 hour	28,846	29,135	289	1.0%	28,532	-314	-1.1%	30,276	1,430	5.0%
	3 hour	43,551	43,913	362	0.8%	42,951	-600	-1.4%	45,767	2,216	5.1%
	6 hour	53,301	53,802	501	0.9%	52,662	-639	-1.2%	56,395	3,094	5.8%
100 year	1 hour	52,482	52,852	370	0.7%	51,840	-642	-1.2%	54,094	1,612	3.1%
	3 hour	79,042	79,522	480	0.6%	77,678	-1,364	-1.7%	81,552	2,510	3.2%
	6 hour	98,420	98,990	570	0.6%	96,699	-1,721	-1.7%	101,957	3,537	3.6%
26 January 2012 (24 hours)		115,464	116,395	931	0.8%	113,807	-1,657	-1.4%	120,881	5,417	4.7%

(1) Note that a positive difference represents an increase in runoff volume as a result of the S2W upgrade works. Differences for all scenarios are shown relative to pre-highway upgrade conditions (i.e. Scenario 1).

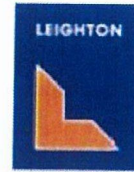
TABLE D3
COMPARISON OF RUNOFF VOLUMES IN DRAINAGE LINE A
IMMEDIATELY DOWNSTREAM OF EGGINS ROAD
PERVIOUS AREA INITIAL LOSS = 20 mm

Event		Scenario 1 Pre-highway Upgrade	Scenario 2 Post-highway Upgrade (without Rest Area)			Scenario 3 Post-highway Upgrade (including Rest Area)			Scenario 4 Construction Phase (circa 26 January 2012)		
ARI	Duration	Volume	Volume	Difference ⁽¹⁾		Volume	Difference ⁽¹⁾		Volume	Difference ⁽¹⁾	
		(m ³)	(m ³)	(m ³)	(%)	(m ³)	(m ³)	(%)	(m ³)	(m ³)	(%)
1 year	1 hour	292	590	298	102%	721	429	147%	2,037	1,745	598%
	3 hour	1,464	1,902	438	30%	2,064	600	41%	4,083	2,619	179%
	6 hour	3,414	3,964	550	16%	4,127	713	21%	6,704	3,290	96%
2 year	1 hour	3,972	4,331	359	9.0%	4,373	401	10%	5,997	2,025	51%
	3 hour	11,501	11,958	457	4.0%	11,860	359	3.1%	14,235	2,734	24%
	6 hour	15,975	16,566	591	3.7%	16,412	437	2.7%	19,460	3,485	22%
10 year	1 hour	18,451	18,859	408	2.2%	18,564	113	0.6%	20,610	2,159	12%
	3 hour	33,170	33,647	477	1.4%	33,009	-161	-0.5%	36,106	2,936	8.9%
	6 hour	42,926	43,539	613	1.4%	42,719	-207	-0.5%	46,736	3,810	8.9%
100 year	1 hour	42,089	42,586	497	1.2%	41,851	-238	-0.6%	45,451	3,362	8.0%
	3 hour	68,659	69,235	576	0.8%	67,750	-909	-1.3%	71,893	3,234	4.7%
	6 hour	88,041	88,765	724	0.8%	86,782	-1,259	-1.4%	92,301	4,260	4.8%
26 January 2012 (24 hours)		105,479	106,511	1,032	1.0%	104,244	-1,235	-1.2%	111,591	6,112	5.8%

(1) Note that a positive difference represents an increase in runoff volume as a result of the S2W upgrade works. Differences for all scenarios are shown relative to pre-highway upgrade conditions (i.e. Scenario 1).

Discussion Paper

Project : Sapphire to Woolgoolga Upgrade
Subject: Arrawarra Rest Area – Treatment of Stormwater runoff
Design Lot No: S2W-20-6000-DR818A
Document No: S2W-REP-20-6000-DR818A-FD-01
Phase: Final Design
Revision: 01
Date: 21-March-2012



1. Introduction

This discussion paper summarises the results and findings of the stormwater quality assessment undertaken for the Arrawarra Rest Area. To ensure the protection of downstream ecosystems from poor water quality associated with runoff from the Arrawarra Rest Area, stormwater quality modelling has been undertaken to quantify the extent of mitigation that can be provided.

2. Water quality

Stormwater runoff from impervious surfaces is typically of poorer quality than runoff from a natural or rural catchment. Therefore, it is proposed that stormwater treatment systems be provided to protect the downstream ecosystems from runoff of poor quality. Given the constraints of the site vegetated swales are proposed to provide stormwater treatment.

To ensure the protection of waterways in NSW, The Department of Environment and Climate Change NSW has derived draft environmental targets for the treatment of stormwater (DECC NSW, Managing urban stormwater: environmental targets, Consultation draft – October 2007).

These targets are:

- 85% reduction in the average annual total suspended solids load
- 65% reduction in the average annual total phosphorus load
- 45% reduction in the average annual total nitrogen load

Therefore, in assessing the impacts of urban runoff from the Arrawarra Rest Area, it is assumed that these targets are to be applied. The application of these targets requires that loads for these pollutants be estimated for the development. The stormwater quality modelling software MUSIC was used to estimate the pollutant loads generated by the site, and the effectiveness of the proposed treatment measures.

3. Proposed design and stormwater treatment measures

In assessing the pollutant loads generated by the Arrawarra Rest Area, the following assumptions were made.

- Only runoff from impervious surfaces was considered. Some areas of vegetation are part of the design and will drain to the drainage network; however these are a very small proportion, and generate few pollutants in comparison to impervious surfaces.
- The sizes of impervious catchments that comprise the Arrawarra Rest Area are listed in Table 1 and illustrated in Attachment A.

Table 1 Summary of Catchment Areas

Catchment Name	Area (m ²)
A	2065
B	1998
C	2369
D	1309
E	927
F	753
G	1268
H	1256

- Imperviousness for each catchment in the model was assumed to be 100%, other MUSIC parameters for source nodes were default values
- Meteorological data was 6 minute rainfall data from Coffs Harbour for 1998 to 2005. This period of data had a complete dataset with a mean annual rainfall reasonably close to the long term mean (1582 mm/year for the dataset, 1687 mm/year long term mean). Potential

evapotranspiration data was taken from the PET maps available from the Bureau of Meteorology)

The stormwater treatment currently proposed consists of swales. Swales remove coarse sediment runoff as it passes through the swale, and swales can also be designed as natural channels to reduce the maintenance burden of this landscape in addition to increasing the habitat value of these water conveyance corridors (see Figure 1).

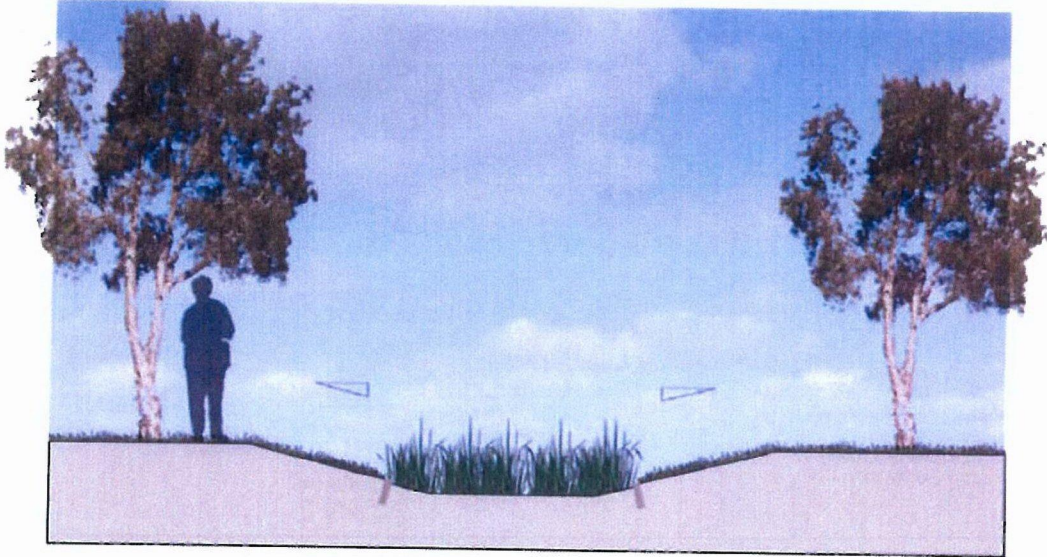


Figure 1. An example of the use of swales for flow conveyance and water quality improvement.

Additional treatment measures such as bioretention systems could also be adopted. Bioretention systems are highly adaptable in form and therefore are suited to distributed or streetscape systems (see Figure 2A and Figure 2B).

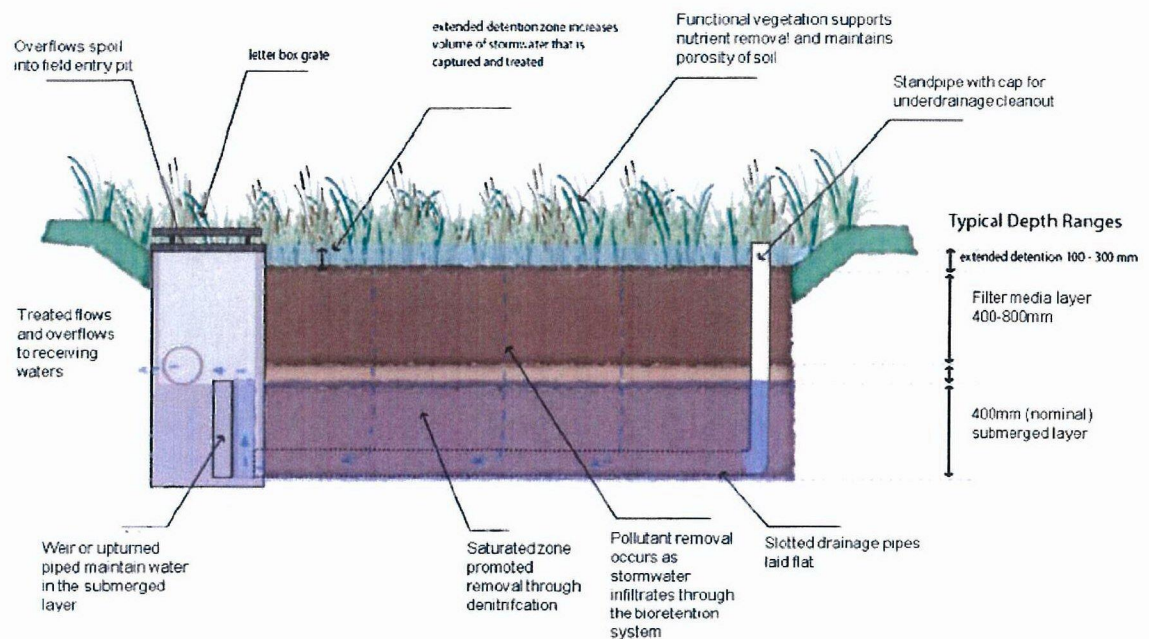


Figure 2A. Example section of a bioretention system for water quality improvement (above)



Figure 2B Example of a streetscape bioretention system at Bellvista on the Sunshine Coast, Queensland

4. Assessment of pollutant loads and pollutant removal

Initially, three scenarios were modelled for the purpose of assessing pollutant loads and pollutant removal. These are:

- Scenario 1 - The current drainage design that provides swale treatment
- Scenario 2 - The current drainage design that provides swale treatment with the addition of bioretention to treat runoff from catchments A, B, D and G
- Scenario 3 - The current drainage design that provides swale treatment with the addition of more vegetated swales and bioretention to treat runoff from catchments A, B, C, D, E, F and G.

Following this assessment, it was determined that the feasibility of adopting scenario 3 should be investigated further. However, this required the earthworks modelling and site drainage to be revisited to ensure that runoff from all catchments could be treated. Changes in the drainage design have altered the catchments that drain to each bioretention system, represented as scenario 4.

- Scenario 4 – As for Scenario 3 but the catchments have been redefined and the treatment systems adjusted to suit.

The parameters used to model the performance of swales and bioretention were as follows:

Swales

- Length varies depending on location
- Bed slope 1%
- Base width 0.5 to 10 m depending on location
- Batter slopes 1:3
- Vegetation height 0.25 m
- Swale depth 0.3 m
- Exfiltration rate 0.36mm/h (equivalent to heavy clay)

Bioretention Systems

- Extended detention 0.2 m
- Unlined filter media perimeter 0.01 m
- Saturated hydraulic conductivity 100mm/h
- Filter depth 0.5m
- TN content 800 mg/kg
- Organic material in filter <5%
- Orthophosphate content of filter media < 55mg/kg
- Base lined? – yes
- Vegetated with effective nutrient removal plants
- Underdrain present? – yes
- Submerged zone with carbon present? – yes
 - Depth 0.29m
- Exfiltration rate 0 mm/h

Other properties were the default settings.

Scenario 1

The existing scenario was modelled as providing the treatment listed in Table 2.

Table 2. Swale dimensions provided in the MUSIC model for Scenario 1 (current design).

Catchments	Impervious area (m ²)	Bioretention size (m ²)	Swale dimensions (m)
A	2065		40 x 2
B	1998		40 x 2
C	2369		
D	1309		10 x 2
E	927		
F	753		
G	1268		
H	1256		
Downstream of site			50 x 2
Total Bioretention Size (m ²)		0	

Scenario 2

The model for scenario 2 incorporated only those areas that are treatable within the current design. Within the current design it will not be possible to drain all catchments to a treatment device. Table 3 lists the catchments and footprints of treatment areas incorporated into the MUSIC model for scenario 2.

Table 3. Swale dimensions and bioretention system areas provided in the MUSIC model for Scenario 2 (areas treatable within the current design).

Catchments	Impervious area (m ²)	Bioretention size (m ²)	Swale dimensions (m)
A	2065	29	40 x 2
B	1998	38	40 x 2
C	2369		
D	1309	10	10 x 2
E	927		
F	753		
G	1268	26	15 x 2
H	1256		
Downstream of site			50 x 2
Total Bioretention Size (m ²)		103	

Scenario 3

In striving to meet the treatment targets for the site, further analysis was undertaken to identify opportunities for the incorporation of additional stormwater treatment. These opportunities are not confirmed and would be subject to design development. These opportunities would necessitate reshaping some of the terrain and reconfiguring parts of the drainage network. There may be opportunities to provide some swale and bioretention treatment for catchments C, E, and F. Table 4 includes the additional swale and bioretention areas that were included in this assessment of all potential treatment opportunities

Table 4. Swale dimensions and bioretention system areas provided in the MUSIC model for scenario 3 (all potential treatment opportunities).

Catchments	Impervious area (m ²)	Bioretention size (m ²)	Swale dimensions (m)
A	2065	29	40 x 2
B	1998	38	40 x 2
C	2369	35	10 x 10
D	1309	10	10 x 2
E	927	10	10 x 10
F	753	12	15 x 2
G	1268	26	15 x 2
H	1256		
Downstream of site			50 x 2
Total Bioretention Size (m ²)		160	

Scenario 4

Following the initial investigations for Scenario 3, the earthworks and stormwater drainage designs were revisited to determine if it would be possible to treat all catchments. This investigation revealed that it is feasible to treat all catchments; however the catchment boundaries and subsequent water quality modelling needed to be updated. Table 5 includes the swale and bioretention areas that were included in this assessment of all potential treatment opportunities. The updated catchments are illustrated in Attachment B and Figure 4.

Table 5. Swale lengths and bioretention system areas provided in the MUSIC model for scenario 4 (runoff from all surfaces treated).

Catchments	Impervious area m ²	Details	Bioretention size m ²	Swale dimensions m
C1	1504	100% impervious	19	40 x 5.5
C2	1593	100% impervious	22	40 x 5.5
C3	2729	100% impervious	45	No swale
C4	541	100% impervious	7	15 x 5.5
C5	1877	100% impervious	26	15 x 5.5
C6	1147 (Car park) 1240 Future amenities area	100% impervious car park, half of future amenities area at 50% imperviousness	24	15 x 5.5
C7	799 (Car park) 1240 Future amenities area	100% impervious car park, half of future amenities area at 50% imperviousness	18	15 x 5.5
C8	2253	100% impervious	36	10 x 6 (2 swales)
Total Bioretention Size (m ²)			197	

5. Results from stormwater quality modelling

Scenario 1

The MUSIC modelling results for the treatment provided by scenario 1 (the current design, Table 6) indicate that the swales do provide some treatment, but the removal of each of the pollutants falls short of the targets.

Table 6. MUSIC modelling results for the areas treatable within the current design

Scenario 1	Source	Residual	% removal	NSW Target (% removal)
Total Suspended Solids (kg/yr)	3730	843	77.4	85
Total Phosphorus (kg/yr)	7.28	3.27	55.1	65
Total Nitrogen (kg/yr)	50.8	42.3	16.7	45

Scenario 2

The MUSIC modelling results for scenario 2 (the areas treatable within the current design, Table 7) indicate that the removal of total suspended solids falls slightly short of the targets, and the removal of total phosphorus nearly reaches the target. The removal of total nitrogen falls substantially below the target.

Table 7. MUSIC modelling results for the areas treatable within the current design

Scenario 2	Source	Residual	% removal	NSW Target (% removal)
Total Suspended Solids (kg/yr)	3560	583	83.6	85
Total Phosphorus (kg/yr)	7.42	2.61	64.8	65
Total Nitrogen (kg/yr)	51.4	34	33.8	45

Scenario 3

The MUSIC modelling results for scenario 3 (all the opportunities for treatment used, (Table 8) indicated that if all the opportunities for treatment were realised, the removal of all of the pollutants modelled would exceed the treatment targets set for NSW. These results were further refined in Scenario 4.

Table 8. MUSIC modelling results for the areas representing all potential treatment opportunities

Scenario 3	Source	Residual	% removal	NSW Target (% removal)
Total Suspended Solids (kg/yr)	3570	308	91.4	85
Total Phosphorus (kg/yr)	7.39	1.91	74.1	65
Total Nitrogen (kg/yr)	51.8	27	47.9	45

Scenario 4

The MUSIC modelling results for scenario 4 (all the opportunities for treatment used, Table 9) indicated that if all the opportunities for treatment were realised, the removal of all of the pollutants modelled would exceed the treatment targets set for NSW.

Table 9. MUSIC modelling results for the areas representing all potential treatment opportunities

Catchments C1, C2, C3 (draining to the south)				
Scenario 4	Source	Residual	% removal	NSW Target (% removal)
Total Suspended Solids (kg/yr)	1740.0	213.0	87.7	85
Total Phosphorus (kg/yr)	3.52	1.02	70.9	65
Total Nitrogen (kg/yr)	25.0	12.7	49.2	45
Catchments C4, C5, C6, C7 and C8 (draining to the north)				
Total Suspended Solids (kg/yr)	2450.0	248.0	89.9	85
Total Phosphorus (kg/yr)	5.11	1.41	72.4	65
Total Nitrogen (kg/yr)	36.5	19.4	46.7	45

6. Design Considerations

Due to the constrained nature of the site, submerged zone bioretention systems have been used in the modelling of pollutant removal. Submerged zone systems have the advantage of higher rates of total nitrogen removal, however they are more complicated to build and require more specific materials. If more space for treatment is provided, conventional bioretention systems without submerged zones can be used. These have a slightly larger footprint, but are easier to build.

7. Removal of hydrocarbons

Swales provide some removal of hydrocarbons through the process of sedimentation of particles that may have hydrocarbons adsorbed to them. There is also the potential for hydrocarbons to adsorb directly to the soil as water moves through the swale. However, hydrocarbon removal may be limited in many instances because a substantial proportion of hydrocarbons are likely to be transported as a thin floating film on the water surface. The water in the swale therefore acts as a separating phase between the floating hydrocarbons and the soil.

To overcome this separation, it is recommended that treatment devices that include infiltration be employed. Infiltrating water into a soil filter media ensures that there is good contact between water-borne hydrocarbons and the soil, providing opportunities for the adsorption and thus removal of hydrocarbons from the water. Bioretention systems are suited to this purpose.

Bioretention systems remove stormwater pollutants through physical, biological and chemical processes that occur on the surface and within the filter media. Treatment of petroleum hydrocarbons occurs primarily through sorption and filtration. These processes include:

- sorption of hydrophobic hydrocarbon compounds to the surface of the soil profile where they can subsequently biodegrade (occurring on the surface of filter media)
- filtration of petroleum compounds associated with fine sediments by the filter media
- filtration of hydrophilic hydrocarbon compounds and through the soil/ microbial filter matrix, and subsequent biodegradation of the hydrocarbons by the soil microbes.

Bioretention systems can be designed to be freely draining, promoting an aerobic environment appropriate for the respiration/ biodegradation of carbon rich organic compounds. If hydrocarbons are a pollutant of concern then it is recommended that bioretention systems be constructed without submerged zones.

Bioretention systems have been shown to remove between 80 and 95% of total petroleum hydrocarbons (Hong et al. 2006). Studies by Hong et al. (2006) showed that biodegradation of petroleum hydrocarbons took place in a thin layer of mulch placed on the surface of bioretention media. Most of the petroleum hydrocarbons were biodegraded within two to eight days after a runoff event (depending on the particular compound). A summary of the results are presented in Table 10.

Table 10 Petroleum Hydrocarbon Treatment Performance of Bioretention Systems (Source: Hong et al. 2006)

Petroleum Hydrocarbon Compound	Inflow Concentration (mg/L)	Discharge Concentration (mg/L)	Petroleum Hydrocarbon Removal
Napthalene	1.6	0.2	88%
Toluene	2.7	0.1 - 0.6	78 – 96%
Motor Oil	30	3.4 - 5.4	82 – 89%

Bioretention systems have also been shown to be effective at removing polycyclic aromatic hydrocarbons (PAH) from urban runoff. DiBlasi *et al.* (2009) studied PAH removal in a field system that receives runoff from a university car park. Results showed that the polycyclic aromatic hydrocarbons are affiliated with suspended solids and were primarily treated by the top few centimetres of the soil media near the bioretention system inflow location. PAH removal by the bioretention system ranged from 60 to 99%, resulting in discharge concentrations of 0.05 to 0.37ug/L (based on inflow concentrations of 0.98 to 5 ug/L).

To ensure a reasonable level of protection from hydrocarbons for the receiving environment, it is recommended that stormwater treatment systems include bioretention, and that these systems be sized to meet the treatment targets of the Department of Environment and Climate Change NSW (now the Office of Environment and Heritage NSW).

8. Plant selection for swales and bioretention systems

The following plant lists are indicative only and are intended to indicate the type of plant material that can be used successfully in swales and bioretention systems. The final species chosen should be refined in collaboration with the landscape architect during detailed design.

The following plant species may be suitable for use in swales:

<i>Cynodon dactylon</i>	Couch grass
<i>Dichanthium sericeum</i>	Queensland bluegrass
<i>Gahnia aspera</i>	
<i>Gahnia clarkei</i>	
<i>Gahnia sieberana</i>	Red-fruit saw sedge
<i>Imperata cylindrica</i>	Blady grass
<i>Lepidosperma laterale</i>	Common sword sedge
<i>Lomandra longifolia</i>	Long-leaf lomandra
<i>Lomandra multiflora</i>	A lomandra
<i>Paspalidium distans</i>	A grass
<i>Paspalum scrobiculatum</i>	A grass
<i>Poa labillardieri</i>	Tussock poa

The following plant species may be suitable for use in bioretention systems

<i>Angophora leiocarpa</i>	Smooth-barked apple
<i>Callistemon pachyphyllus</i>	Wallum bottlebrush
<i>Callistemon salignus</i>	Willow bottlebrush
<i>Callitris macleyanus (p)</i>	Brush cypress pine
<i>Carex appressa</i>	
<i>Dianella caerulea</i>	Blue flax lily
<i>Dianella revoluta</i>	
<i>Dodonaea triquetra</i>	A hop bush
<i>Exocarpus cupressiformis</i>	Cherry ballart
<i>Hakea florulenta</i>	A hakea
<i>Imperata cylindrica</i>	Blady grass
<i>Leptospermum juniperinum</i>	Prickly teatree

<i>Leptospermum polygalifolium</i>	
<i>Lomandra longifolia</i>	Long-leaf lomandra
<i>Lomandra multiflora</i>	A lomandra
<i>Lophostemon confertus</i>	Brush box
<i>Melaleuca quinquenervia</i>	Broad-leaved paperbark
<i>Melaleuca sieberi</i>	A paperbark
<i>Melaleuca stypheloides</i>	
<i>Melaleuca thymifolia</i>	
<i>Poa labillardieri</i>	Tussock poa
<i>Pteridium esculentum</i>	Bracken fern
<i>Themeda australis</i>	Kangaroo grass

9. Maintenance Costs

In order to maintain the bioretention systems in a densely vegetated, stable and weed-free condition, maintenance is recommended for 2 years at a rate of approximately 64 hours per year (2 workers for one day every three months). Thereafter, ongoing maintenance of 48 hours per year is recommended (2 workers for one day every four months). This maintenance schedule accommodates weeding, plant replacement where required, stabilisation works where required and checks and clearing of the pit and pipe network.

The lifecycle of bioretention systems is not accurately understood, as these systems have only been in existence in Australia for 10 to 12 years. Experience with these older existing systems (such as Victoria Park Bioretention Systems in Zetland, Sydney, and Hoyland Street in Bracken Ridge in Brisbane) indicates that there is no apparent reduction in performance after 10 years. It is expected that bioretention systems could have a lifecycle of 25 to 50 years if appropriately designed.

Appropriate design includes provision for:

- Ensuring that the filter media of bioretention systems is protected from high sediment loads such as those associated with construction activity
- Protection from vehicular or pedestrian activity that could result in media compaction
- Flow controls to ensure energy dissipation and even distribution of water across the filter surface.
- Healthy and dense vegetation growth.

10. Conclusions

Opportunities exist to treat stormwater within the Arrawarra Rest Area. Within the current design, it is estimated that the implementation of stormwater treatment devices could provide substantial pollutant removal. Further, if opportunities to include additional treatment areas can be realised through design development, then the treatment targets set for NSW could be met.

As seen in table 7, Scenario 2 with an assumed total bioretention treatment area of 103 m² falls short of the target for total suspended solids, and the removal of total phosphorus. However, the removal of total nitrogen falls substantially below the target.

Giving consideration to the way in which these pollutants are removed from water highlights the reason for this. A substantial proportion of the removal of total suspended solids and total phosphorus occurs in the vegetated swales modelled for the site. Treatment devices such as swales rely on the sedimentation of particles, and are effective devices for the treatment of particulate-bound pollutants like total suspended solids and total phosphorus.

However, nitrogen is one of the most difficult pollutants to remove from water as a large proportion of total nitrogen occurs in dissolved, non-reactive forms. This means that treatment devices such as swales provide only limited removal of total nitrogen. The effective removal of nitrogen requires that water passes through a treatment system that allows for removal through biological uptake and transformation. These processes occur in treatment devices such as constructed wetlands or bioretention systems.

Therefore in order to provide treatment of runoff sufficient to meet the NSW guideline targets, a comparatively larger total surface area of bioretention systems is required for Scenario 4 compared to Scenario 2. Scenario 4 demonstrates that a total bioretention surface area of 197m² is required to provide sufficient nitrogen removal to reach the treatment targets.

11. References

DiBlasi et al. (2009). C. J. DiBlasi, H. Li, A. P. Davis and U. Ghosh. Removal and Fate of Polycyclic Aromatic Hydrocarbon Pollutants in an Urban Stormwater Bioretention Facility. *Environmental Science & Technology* 43(2): 494-502.

Hong *et al.* (2006). Hong, E. Y., E. A. Seagren and A. P. Davis. Sustainable oil and grease removal from synthetic stormwater runoff using bench-scale bioretention studies. *Water Environment Research* 78(2): 141-155.

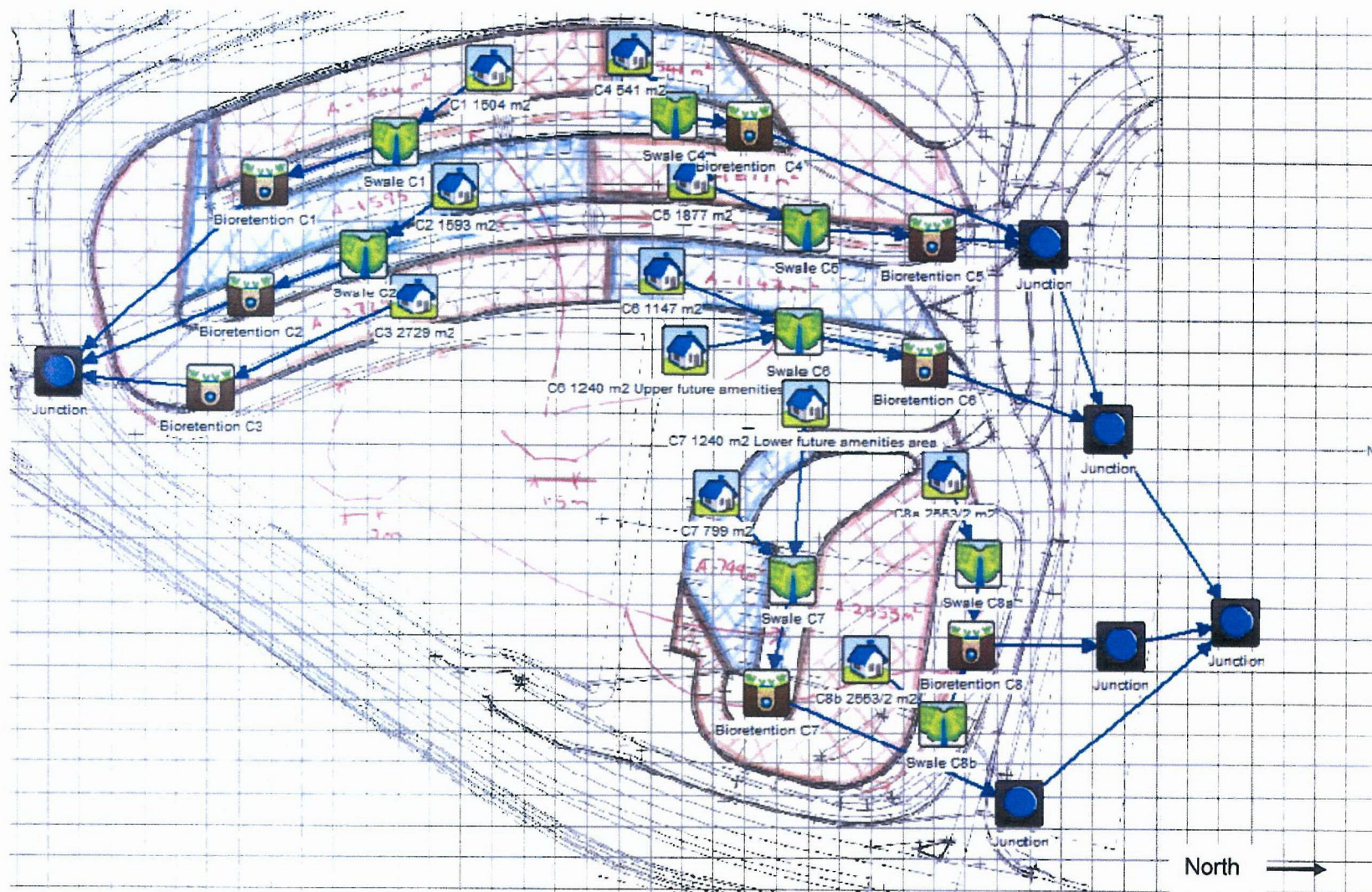


Figure 4: Structure of MUSIC modelling used for assessment of stormwater treatment performance of Scenario 4.

ATTACHMENT A



Sheet flow in the median

TRUCK

No pavement flow to this area

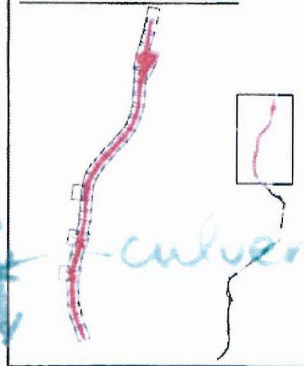
LEGEND

- HEADWALL WITH ROCK MATRESS OR RIP-RAP APRON
- HEADWALL WITH CONCRETE APRON
- HEADWALL WITH TYPE A DISSIPATOR UNO
- HEADWALL WITH ROCK VEGETATED APRON
- PIPE/BOX CULVERT AND FLOW DIRECTION
- EXISTING PIPE/BOX CULVERT
- SWALE - VEGETATED
- CATCH DRAIN - VEGETATED (TYPE 'A' UNO)
- CATCH DRAIN - ENKAMAT (TYPE 'A' UNO)
- CATCH DRAIN - CONCRETE (TYPE 'A' UNO)
- CHANNEL - VEGETATED
- CHANNEL - CONCRETE UNO
- BERM DRAIN - VEGETATED UNO
- BERM DRAIN - CONCRETE UNO
- TABLE DRAIN - VEGETATED
- TABLE DRAIN - CONCRETE UNO
- PAVEMENT DRAINAGE TAC
- STORMWATER PIT

NOTES

- FOR GENERAL NOTES AND ADDITIONAL LEGEND REFER TO DRG GE6021.

KEYPLAN - ZONE 6000



NOT FOR CONSTRUCTION

Legend

- Vegetated Swale
- Bioretention System

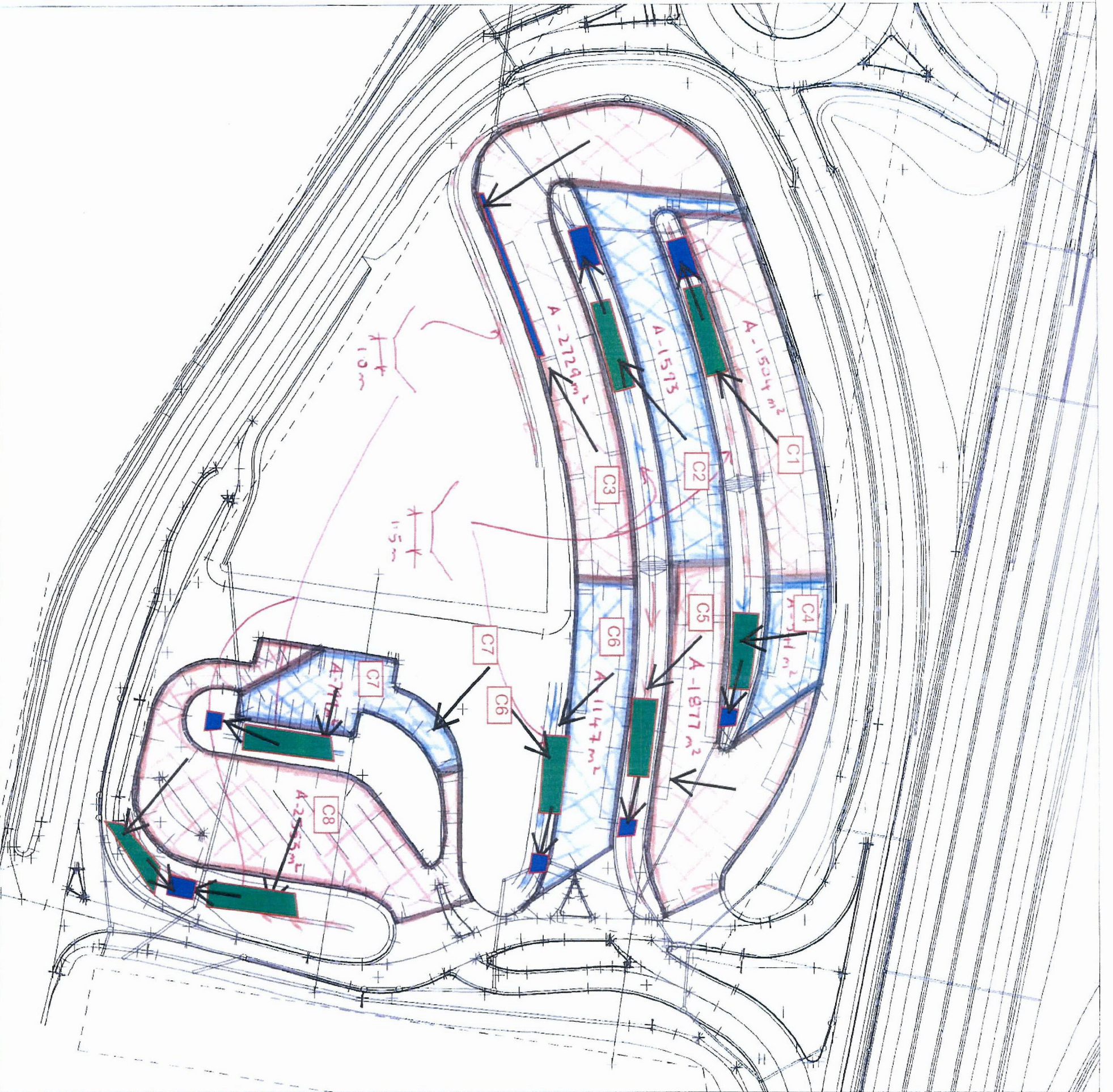
ARRAWARRA REST AREA

V' SHAPED VEGETATED SWALE DRAIN
SIDE SLOPE - 10:1 (H:V)
DEPTH - VARIES (0.3 MIN)

SWALE DRAIN
BASE WIDTH - 0.5m
DEPTH - 0.5m (MIN)
BATTER SLOPE - 1.5:1 (H:V)

DRAWING FILE LOCATION NAME C:\proj\20-6000-GE6021\20-6000-GE6021.dwg				DESIGN MODEL FILE: USED FOR DOCUMENTATION OF THIS DRAWING S2W-MOD-20-6002-RD_DES_20110909-DD-01.TXT				S2W-MOD-20-6002-RD_DES_20110915-DD-01.1208			
EXTERNAL REFERENCE FILE				DESIGNER'S SITE NOTE				CONTRACTOR			
REV	DATE	REVISION DESCRIPTION	UT	REV	UT	REV	UT	REV	UT	REV	UT
01	19/08/2011	ISSUED FOR PRELIMINARY DETAILED DESIGN									
SCALE: 1:1000				SCALE: 1:1000				SCALE: 1:1000			
PROJECT: LEIGHTON				PROJECT: LEIGHTON				PROJECT: LEIGHTON			
PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN			
PROJECT: AECOM				PROJECT: AECOM				PROJECT: AECOM			
PROJECT: SMEC				PROJECT: SMEC				PROJECT: SMEC			
PROJECT: LEIGHTON				PROJECT: LEIGHTON				PROJECT: LEIGHTON			
PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN			
PROJECT: AECOM				PROJECT: AECOM				PROJECT: AECOM			
PROJECT: SMEC				PROJECT: SMEC				PROJECT: SMEC			
PROJECT: LEIGHTON				PROJECT: LEIGHTON				PROJECT: LEIGHTON			
PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN			
PROJECT: AECOM				PROJECT: AECOM				PROJECT: AECOM			
PROJECT: SMEC				PROJECT: SMEC				PROJECT: SMEC			
PROJECT: LEIGHTON				PROJECT: LEIGHTON				PROJECT: LEIGHTON			
PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN			
PROJECT: AECOM				PROJECT: AECOM				PROJECT: AECOM			
PROJECT: SMEC				PROJECT: SMEC				PROJECT: SMEC			
PROJECT: LEIGHTON				PROJECT: LEIGHTON				PROJECT: LEIGHTON			
PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN			
PROJECT: AECOM				PROJECT: AECOM				PROJECT: AECOM			
PROJECT: SMEC				PROJECT: SMEC				PROJECT: SMEC			
PROJECT: LEIGHTON				PROJECT: LEIGHTON				PROJECT: LEIGHTON			
PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN			
PROJECT: AECOM				PROJECT: AECOM				PROJECT: AECOM			
PROJECT: SMEC				PROJECT: SMEC				PROJECT: SMEC			
PROJECT: LEIGHTON				PROJECT: LEIGHTON				PROJECT: LEIGHTON			
PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN			
PROJECT: AECOM				PROJECT: AECOM				PROJECT: AECOM			
PROJECT: SMEC				PROJECT: SMEC				PROJECT: SMEC			
PROJECT: LEIGHTON				PROJECT: LEIGHTON				PROJECT: LEIGHTON			
PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN			
PROJECT: AECOM				PROJECT: AECOM				PROJECT: AECOM			
PROJECT: SMEC				PROJECT: SMEC				PROJECT: SMEC			
PROJECT: LEIGHTON				PROJECT: LEIGHTON				PROJECT: LEIGHTON			
PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN			
PROJECT: AECOM				PROJECT: AECOM				PROJECT: AECOM			
PROJECT: SMEC				PROJECT: SMEC				PROJECT: SMEC			
PROJECT: LEIGHTON				PROJECT: LEIGHTON				PROJECT: LEIGHTON			
PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN			
PROJECT: AECOM				PROJECT: AECOM				PROJECT: AECOM			
PROJECT: SMEC				PROJECT: SMEC				PROJECT: SMEC			
PROJECT: LEIGHTON				PROJECT: LEIGHTON				PROJECT: LEIGHTON			
PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN			
PROJECT: AECOM				PROJECT: AECOM				PROJECT: AECOM			
PROJECT: SMEC				PROJECT: SMEC				PROJECT: SMEC			
PROJECT: LEIGHTON				PROJECT: LEIGHTON				PROJECT: LEIGHTON			
PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN			
PROJECT: AECOM				PROJECT: AECOM				PROJECT: AECOM			
PROJECT: SMEC				PROJECT: SMEC				PROJECT: SMEC			
PROJECT: LEIGHTON				PROJECT: LEIGHTON				PROJECT: LEIGHTON			
PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN			
PROJECT: AECOM				PROJECT: AECOM				PROJECT: AECOM			
PROJECT: SMEC				PROJECT: SMEC				PROJECT: SMEC			
PROJECT: LEIGHTON				PROJECT: LEIGHTON				PROJECT: LEIGHTON			
PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN			
PROJECT: AECOM				PROJECT: AECOM				PROJECT: AECOM			
PROJECT: SMEC				PROJECT: SMEC				PROJECT: SMEC			
PROJECT: LEIGHTON				PROJECT: LEIGHTON				PROJECT: LEIGHTON			
PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN			
PROJECT: AECOM				PROJECT: AECOM				PROJECT: AECOM			
PROJECT: SMEC				PROJECT: SMEC				PROJECT: SMEC			
PROJECT: LEIGHTON				PROJECT: LEIGHTON				PROJECT: LEIGHTON			
PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN			
PROJECT: AECOM				PROJECT: AECOM				PROJECT: AECOM			
PROJECT: SMEC				PROJECT: SMEC				PROJECT: SMEC			
PROJECT: LEIGHTON				PROJECT: LEIGHTON				PROJECT: LEIGHTON			
PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN			
PROJECT: AECOM				PROJECT: AECOM				PROJECT: AECOM			
PROJECT: SMEC				PROJECT: SMEC				PROJECT: SMEC			
PROJECT: LEIGHTON				PROJECT: LEIGHTON				PROJECT: LEIGHTON			
PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN			
PROJECT: AECOM				PROJECT: AECOM				PROJECT: AECOM			
PROJECT: SMEC				PROJECT: SMEC				PROJECT: SMEC			
PROJECT: LEIGHTON				PROJECT: LEIGHTON				PROJECT: LEIGHTON			
PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN				PROJECT: PUTTIN HOGAN			
PROJECT: AECOM				PROJECT: AECOM				PROJECT: AECOM			
PROJECT: SMEC				PROJECT: SMEC				PROJECT: SMEC			
PROJECT: LEIGHTON				PROJECT: LEIGHTON				PROJECT: LEIGHTON			
PROJECT: PUTTIN HOGAN				PROJECT:							

ATTACHMENT B



LEGEND

- Blue square: BioRetention System
- Green rectangle: Vegetated Swale

NOTE - not drawn to scale. Locations and sizes are indicative only

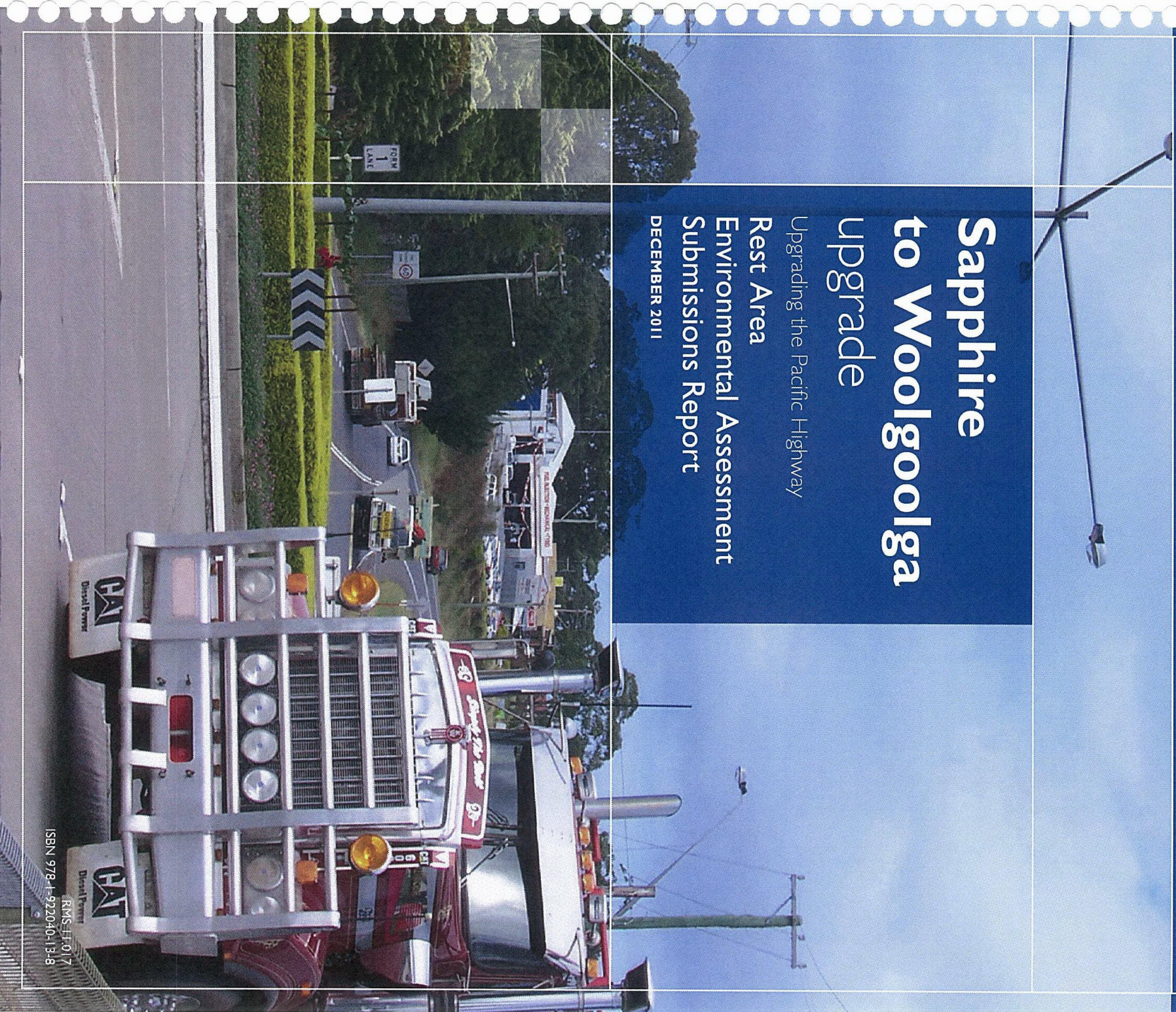
Annotated by AECOM, Courtney Henderson.
 2012.03.08



Transport
Roads & Maritime
Services

Sapphire to Woolgoolga upgrade

Upgrading the Pacific Highway
Rest Area
Environmental Assessment
Submissions Report
DECEMBER 2011



ISBN 978-1-922040-13-8
RMS-H-017

Roads and Maritime Services

Sapphire to Woolgoolga Pacific Highway Upgrade project

Rest area environmental assessment submissions report

December 2011

Prepared by



Aurecon Australia Pty Ltd
ABN 54 005 139 873
116 Military Road
(PO Box 538)
Neutral Bay New South Wales 2089
Australia

Document control



Document ID: Error! Reference source not found.

Rev No	Date	Revision details	Typist	Author	Verifier	Approver
01	8 June 2011	Draft	LC	LC	ML	
02	15 June 2011	Internal verification	LC	LC	ML	
04	22 August 2011	Draft including comments	LC	LC	ML	
05	30 September 2011	Draft including hydrocarbon modelling inputs	LC	LC	ML	ML

Contents

1	Introduction	1
1.1	Background to the Sapphire to Woolgoolga Pacific Highway Upgrade	1
1.2	Rest area background	1
1.3	Purpose of the report.....	3
2	Consideration of submissions	4
2.1	Response to submissions.....	4
2.2	Need for rest area	4
2.3	Selection of the site.....	5
2.4	Assessment process.....	6
2.5	Community consultation.....	7
2.6	Flora and fauna.....	8
2.7	Hydrology / stormwater.....	10
2.8	Water quality / pollution.....	11
2.9	Noise.....	13
2.10	Safety / security	13
2.11	Miscellaneous	14
3	Conclusion.....	15

I Introduction

1.1 Background to the Sapphire to Woolgoolga Pacific Highway upgrade

Roads and Maritime Services (RMS, formerly Roads and Traffic Authority) is upgrading the Pacific Highway from approximately eight kilometres north of Coffs Harbour at Sapphire, extending for approximately 25 kilometres to the vicinity of Arrawarra Beach Road, north of Woolgoolga (the project). The Minister for Planning approved the project (excluding the provision of a rest area at Arrawarra) subject to 56 conditions on 13 January 2009. The project is currently under construction.

RMS has prepared several documents as part of the process for seeking planning approval of the project under Part 3A of the Environmental Planning and Assessment (EP&A) Act 1979. Key recent documents prepared as part of this process include:

- Coffs Harbour Highway Planning Sapphire to Woolgoolga section Project Application Report, October 2006 (the project application report).
- Coffs Harbour Highway Planning Sapphire to Woolgoolga section Environmental Assessment, Volumes 1- 3, November 2007 (the environmental assessment).
- Coffs Harbour Highway Planning Sapphire to Woolgoolga section Environmental Assessment Submissions Report, July 2008 (the submissions report).
- Sapphire to Woolgoolga Upgrade: Rest Area Assessment Report, September 2009.
- Sapphire to Woolgoolga Upgrade: Rest Area Assessment Submissions Report, May 2010.
- Sapphire to Woolgoolga upgrade: Rest Area Environmental Assessment Report, April 2011 (rest area environmental assessment report).

1.2 Rest area background

1.2.1 Environmental assessment stage

The environmental assessment of the Sapphire to Woolgoolga Pacific Highway project identified a rest area location at the Arrawarra Interchange (Section 7.5.11 of the environmental assessment). During the exhibition of the environmental assessment, a number of submissions were received in relation to the rest area location.

The issues raised by community and government agencies in relation to the rest area predominantly included ecological impacts (fauna movement, removal of hollow bearing trees, impacts to vegetation communities etc) and suggested alternative locations for the rest area. These issues are identified in section 2.2.12 of the environmental assessment submissions report.

Based on the number of submissions received and issues raised, RMS recognised the need for further consideration into the location of a rest area. RMS therefore decided to remove the proposed rest area at Arrawarra Interchange from the project approval process. RMS advised the then Department of Planning of this decision on 29 October 2008.

1.2.2 Rest area comparative assessment

Based on submissions made, RMS further reviewed options for a location of a rest area and produced the Rest Area Assessment Report, September 2009. The report identified a number of options for potential rest area locations and provided a comparative assessment of two-short listed locations (south Woolgoolga and Arrawarra) relative to a "base case".

The base case is the Sapphire to Woolgoolga project as described in the environmental assessment exclusive of the rest area at Arrawarra Interchange. As well as comparing a rest area at both locations, the construction of a potential future highway service centre was also assessed.

1.2.3 Announcement of preferred rest area location and display of rest area submissions report

Submissions from exhibition of rest area assessment report

The rest area assessment report was placed on public display for community comment from 28 September 2009 to 30 October 2009. The report identified options for the location of rest areas and potential future highway service centres and examined and compared the key features of the options. Sixty-two submissions were received from the exhibition of the rest area assessment report.

The main issues raised in the submissions included:

- The need for a rest area.
- Impacts on road safety and traffic volumes.
- Business impacts.
- Impacts on existing and proposed land use.
- Impacts on native vegetation and animals.

Selection of preferred location for rest area

The Arrawarra Interchange was selected as the preferred location for a rest area for the upgrade based on consideration of:

- The issues raised in the submissions received from the exhibition of the rest area assessment report.
- Consultation with government agencies.
- RMS technical investigations.

The Arrawarra Interchange was selected as the preferred location as, compared to the south Woolgoolga option, it would:

- Have less noise and other amenity impacts.
- Have less impact on existing agricultural properties.
- Have less impact on properties proposed to be rezoned for industrial purposes.
- Be less expensive to build.

Refinements to the rest area at Arrawarra

It is acknowledged that a rest area at Arrawarra would have a greater impact on native vegetation and animals than one at south Woolgoolga.

To avoid impacts on the native vegetation in the State Forest north of Arrawarra Beach Road, the possible future highway service centre has been moved to the rest area site south of the road. The concept design for the rest area has been refined to accommodate the possible future highway service centre.

Key features of the refined rest area include:

- Heavy vehicle parking areas in the western portion of the rest area site.
- Light vehicle and bus parking areas, toilets and picnic facilities in the north eastern corner of the site.
- Noise walls and / or mounds along the northern and eastern boundaries of the rest area.
- Provision for possible additional heavy vehicle parking, if required in the future.
- Provision for a possible future highway service centre in the eastern portion of the site.

1.2.4 Display of Rest Area Environmental Assessment Report

With the location for the rest area identified, RMS prepared an environmental assessment for the preferred rest area location at Arrawarra. The rest area environmental assessment report was displayed for public comments between 6 April 2011 and 9 May 2011. The community was informed of the publication of the rest area environmental assessment by a media release, letters to all residents on the project database and by advertisements in local newspapers. The rest area environmental assessment was also available for public viewing on the project website. As a result of the exhibition, a number of submissions were made to RMS.

1.3 Purpose of this report

During the exhibition of the rest area environmental assessment report, 16 submissions were made in relation to the report. Several submissions were received by RMS after the period for public comment. All submissions received until the end of September 2011 have been addressed within this submissions report.

This report identifies the issues raised in community submissions received in response to the rest area environmental assessment and provides RMS's responses to those issues (section 2).

2 Consideration of submissions

2.1 Response to submissions

A total of 16 submissions were received from the community during and subsequent to the public display period. Each submission was reviewed individually and issues identified.

The following sections describe the issues raised by the community and provide RMS's response to each issue. Due to privacy reasons, respondents are not identified other than by an ID number. The exception is government agencies.

2.2 Need for rest area

Submission numbers

10, 15

Issue

A rest area at Arrawarra is not necessary as it is less than 50 km from Grafton and there is a rest area at Halfway Creek.

Response

In the *Pacific Highway Safety Review 2004*, a strategic plan for rest areas on the Pacific Highway recognised that additional areas need to be developed in the Coffs Harbour / Woolgoolga area. As part of the Pacific Highway Upgrade program, RMS is implementing a strategy to establish rest areas at approximately 50 km intervals along the upgraded highway.

A rest area is proposed to be located at the future Nambucca Heads Interchange as part of the upgrade of the highway between Warrell Creek south of Macksville and Urunga. As the proposed rest area at the Nambucca Heads Interchange and the existing rest area at Halfway Creek are located approximately 96 km apart, an additional rest area site is required in the Coffs Harbour / Woolgoolga area. The existing south Coffs Harbour facility has limited parking for heavy vehicles and would be bypassed by the proposed Coffs Harbour bypass. The facility is not included in the RMS's strategy for rest areas on the Pacific Highway.

The Arrawarra Interchange was selected as the preferred location for the rest area as, compared to the south Woolgoolga option, it would:

- Have less noise and other amenity impacts.
- Have less impact on existing agricultural properties.
- Have less impact on properties proposed to be re-zoned for industrial purposes.
- Be less expensive to build.

While Arrawarra has been selected as the preferred location for the rest area, RMS acknowledges that the site would result in greater ecological impacts than the south Woolgoolga site.

2.3 Selection of the site

Submission numbers

01, 04, 05, 06, 07, 08, 10, 11, 12, 13, 14, 15

Issues

1. Rest area should be located in a town like Woolgoolga.
2. Previous submissions express that the environmental impact would have been virtually nil in constructing the rest area and service centre at south Woolgoolga on old banana lands.
3. The decision to develop the rest area at Arrawarra was based on money.
4. Selection process and the skills of the RMS team who assessed the options must be carefully examined.
5. Better planning is required at the south Woolgoolga rest area option. If access could be resolved, it would be a better option than Arrawarra.

Response

- 1.-3. It is acknowledged that the Arrawarra location would have a greater impact on ecology than the south Woolgoolga option (biodiversity impacts have been addressed in Section 7.7 of the rest area EA report). However, a rest area / highway service centre at the south Woolgoolga Interchange would have greater socio-economic impacts than one at the Arrawarra Interchange, including:

- Greater noise and other amenity impacts.
- Impacts on agricultural properties and land identified by Coffs Harbour City Council for rezoning for industrial purposes.
- The acquisition of private property. (Rest Area Assessment Submissions Report, May 2010).

The Arrawarra Interchange site was selected as the preferred location for the rest area as, compared to the south Woolgoolga option, it would:

- Have less noise and other amenity impacts.
- Have less impact on existing agricultural properties.
- Have less impact on properties proposed to be re-zoned for industrial purposes.
- Be less expensive to build.

While RMS has selected Arrawarra as the preferred rest area location, in acknowledgement of the ecological impacts, RMS reduced the footprint of the rest area to minimise potential ecological impacts.

4. The selection of a preferred rest area location was based on information contained within the rest area assessment report (including specialist reports for ecology, noise and vibration and visual impact), submissions received from the public display of the report and consultation with Government Agencies and Coffs Harbour City Council. RMS, in determining the preferred site, sought to balance a range of issues through using a triple bottom line approach (balancing functionality, physical and social issues) and cost. Further details of the site selection process are detailed in Chapter 4 of the rest area assessment report.

5. Even if the access arrangements at the south Woolgoolga site could be improved, the site would still result in a number of additional impacts. These include:

- Increase in noise levels and other amenity impacts at adjacent residences.
- Additional impacts on privately owned agricultural properties.
- Impacts on private properties proposed to be re-zoned industrial.
- Possible future service centre could compete with businesses in Woolgoolga.

The Arrawarra Interchange site was selected as the preferred location for the rest area as, compared to the south Woolgoolga option, it would:

- Have less noise and other amenity impacts.
- Have less impact on existing agricultural properties.
- Have less impact on properties proposed to be re-zoned for industrial purposes.
- Be less expensive to build.

2.4 Assessment process

Submission numbers

05, 06, 07, 09, 10, 12

Issues

1. The rest area EA report is inadequate as it does not provide the detail required to assess the real impacts of the site. A new study should be commissioned.
2. While the environmental impacts at the site have been acknowledged, virtually nothing has been done to assess and evaluate and address the full extent of the impacts.
3. Thought that the decision on the rest area had been made but were informed by neighbours that the final decision had not been made.

Response

- 1.-2. RMS has undertaken a number of specialist reports to assess and evaluate the impact of the two short listed options (the south Woolgoolga and Arrawarra sites). The rest area environmental assessment report should be read in conjunction with the previously prepared documents which further detail the existing environment, potential impacts and mitigation measures to be implemented:

- Sapphire to Woolgoolga Pacific Highway Upgrade EA (Volumes 1 to 3) (the environmental assessment).
- Sapphire to Woolgoolga Pacific Highway upgrade submissions report.
- Sapphire to Woolgoolga rest area assessment report (including appendices).

It should be noted that an ecological assessment of the Arrawarra Interchange site was undertaken as part of the environmental assessment (Arrawarra Interchange Pacific Highway upgrade - Sapphire to Woolgoolga, Flora and Fauna report) - see Appendix C. A further ecological assessment was undertaken in 2009 as part of the rest area assessment report. This assessment detailed the potential ecological impacts of the rest area, of which a summary was provided in the rest area assessment report and the rest area environmental assessment.

Both of these ecological assessments have been published and are available on the RMS website.

From the rest area assessment report, RMS acknowledged the ecological impact that would result and altered the layout of the rest area to include any potential future service centre south of Arrawarra Beach Road. This altered layout avoided impacts to 1.41 hectares of endangered ecological community and fauna habitat.

3. Having considered the rest area assessment report, submissions received from the public display of the report and consultation with government agencies, RMS selected the Arrawarra Interchange as the preferred location for the rest area.

The Department of Planning and Infrastructure will consider the rest area environmental assessment report and this submissions report prior to making a decision as to whether to approve the proposed Arrawarra rest area.

2.5 Community consultation

Submission numbers

05, 07, 09, 10, 15

Issues

1. The letter accompanying the EA CD did not mention that an exhibition period was underway. However, the March 2010 community update stated that "an environmental assessment of the preferred rest area will be prepared and displayed for community comment. Following the display of the environmental assessment, RMS will again consider community submissions". Cover letter indicated that the reporting was finished. Many of the community did not notice that it included an opportunity for another submission.
2. The property at 1 Arrawarra Beach Road was bought from previous owners 2 years ago - the new owner has been unaware of the rest area proposal.

Response

1. The rest area environmental assessment report was displayed for public comment between 6 April 2011 and 9 May 2011. The community was informed of the publication of the rest area environmental assessment by a media release, letters to all residents on the project database and by advertisements in local newspapers. The rest area environmental assessment was also available for public viewing on the project website. As a result of the exhibition, a number of submissions were made to RMS. All submissions received up until 1 August 2011 are included in this submissions report. The first advertisement advised the community of the rest area environmental assessment and where it could be obtained from. This advertisement was published on 6 and 7 April 2011. The second advertisement, which was published on 21, 25 and 28 April, advised the community of the consultation period and where the rest area environmental assessment could be obtained from. The period for accepting comments was extended to include consideration of all comments that were received.
2. The rest area environmental assessment report was displayed for public comments between 6 April 2011 and 9 May 2011. The community was informed of the publication of the rest area environmental assessment by a media release, letters to all residents on the project database and by advertisements in local newspapers. The rest area environmental assessment was also available for public viewing on the project website. As a result of the exhibition, a number of submissions were made to RMS. All submissions received up until 1 August 2011 are included in this submissions report. The submission received from the resident at 1 Arrawarra Beach Road is included in this submissions report.

2.6 Flora and fauna

Submissions numbers

02, 03 OEH, 05, 07, 09, 10, 12, 15

Issues

1. The Arrawarra rest area is core habitat for threatened forest fauna including squirrel gliders and would impact on squirrel gliders, sugar gliders, feathertails and yellow bellied gliders in the areas.
2. Issues of the presence of squirrel gliders and the hoary wattled bat continue not to be addressed. Further investigations should be undertaken.
3. Supplementary planting of glider feed trees should be undertaken as part of the project and glider crossing structures be included to enhance the fauna corridor function of the site and beyond.
4. The Arrawarra regional habitat corridor links Garby Nature Reserve and Coffs Regional Park to Wedding Bells State Forest and hinterland forests and is an important resource for squirrel gliders and other animals including Wallum Froglet, Glossy Black Cockatoo, Grey headed flying fox and micro-bats.
5. Arboreal mammals are currently able to cross the existing highway by accessing the canopy trees now available near the Arrawarra Creek Bridge.
6. EA report does not identify safe animal movement passages. Squirrel and sugar gliders can cover distances of up to 50 metres. Yellow bellied gliders can reach up to 140 metres.
7. The construction of the Interchange, rest area and highway at Arrawarra will impact adversely on the free movement of all the native fauna.
8. No consideration has been given to appropriate fauna crossings as these were removed from the original plans for the rest of the highway upgrade Sapphire to Woolgoolga. Running water in culverts and bridges could be an obstacle to fauna movement, doubts that they would have adequate headroom for kangaroos.
9. What specific mitigation measures are planned to address the presence of Wallum Froglet and Giant Barred Frog.
10. The EA report is misleading for a process that is intended to be stages (two parts- one for the rest area and the other for the service centre).
11. Land clearing for the rest area would need to be restricted with much of the bush area retained.
12. The rest area would impact on the overall biodiversity values of Garby Nature Reserve if it became isolated from forested area to the west of the highway. The vegetation and connection between vegetation needs to be retained.

Response

- 1.-4. The rest area environmental assessment report was prepared to complement the work undertaken on the environmental assessment of the Sapphire to Woolgoolga upgrade project. The ecological assessments undertaken for the environmental assessment that assessed the Arrawarra location included an ecological assessment of the Arrawarra Interchange site (including the rest area location) (Arrawarra Interchange Pacific Highway Upgrade - Sapphire to Woolgoolga, Flora and Fauna Report, August 2007) and a targeted frog survey (Proposed Pacific Highway Upgrade between Sapphire and Arrawarra, targeted frog survey, March 2006). These reports were appended to the environmental assessment as Appendix F.

A further ecological assessment of the rest area location was undertaken in 2009 as part of the rest area assessment report (Pacific Highway Upgrade Sapphire to Woolgoolga Comparison of Ecological Constraints for Potential Rest Area and Service Centre Options (appended as Appendix C)). This assessment detailed the impacts of the rest area, of which a summary was provided in the rest area assessment report and the rest area environmental assessment report.

These assessments identified the potential for frog, glider and bat species in certain locations including through the Wedding Bells State Forest and at the Arrawarra Interchange and rest area locations. The Arrawarra Interchange flora and fauna report (Appendix F of the environmental assessment) identified that the removal of hollow bearing trees could impact on the habitat resources for glider and bat species. As a result of these assessments, the environmental assessment report, consultation with agencies and community feedback, a number of statement of commitments were identified for future stages of the project.

The additional ecological assessment undertaken in 2009 identified that the Arrawarra site "contains known habitat resources for eight fauna species and potential habitat resources for an additional 21 fauna species ...". These species included the Wallum Froglet, Glossy Black cockatoo, Koala, Yellow-bellied and Squirrel Gliders, Grey headed Flying Fox and other microbat species including the Hoary Wattled Bat.

5.-8. The statement of commitments (in particular F12 and F15) identified in the environmental assessment (and environmental assessment submissions report), outlined measures to minimise impacts to fauna habitat and maintain terrestrial fauna connectivity. As the crossing impacts at this location would relate to the widened highway corridor, rather than the rest area, these would be mitigated through the statements of commitments:

- F14 – Culverts identified in the environmental assessment as having a potential role in fauna crossing will be designed to facilitate fauna movements.
- F14A – The locations of fauna movement structures will be consistent with forest management zoning and the management intent of the adjacent Wedding Bells State Forest and identified in consultation with (the then) DPI (Forests).
- F15 – Expert advice will be sought to assist in identifying the need and location for crossing points for glider populations. If required, and in consultation with the relevant government agencies, the location and design of crossing points will be incorporated into the Proposal.

The Sapphire to Woolgoolga Pacific Highway Upgrade makes provision for fauna fencing along the Woolgoolga bypass through the Wedding Bells State Forest. To the east of the highway, fauna fencing would be erected along Eggins Drive to the Arrawarra Beach Road intersection before traversing along Arrawarra Beach Road to the highway and running parallel to the northern extent of the project (refer to the EA section 17).

Fauna crossings consist of both dedicated structures and drainage structures that provide incidental fauna passage. The fauna passage provisions for the length of the approved highway upgrade have been developed as a cohesive strategy. The Arrawarra rest area will not adversely impact on the fauna crossing strategy developed as part of the Sapphire to Woolgoolga Pacific Highway Upgrade.

During discussions with representatives of Office of Environment and Heritage (OEH) on 25 May 2011, RMS undertook to erect a glider crossing pole in the highway median adjacent to Arrawarra Creek. This pole would provide a connection between the vegetation to the east of the highway (Wedding Bells State Forest and the Garby Nature Reserve) and the Wedding Bells State Forest to the west of the highway for gliders.

A two stage clearing process would be used with pre-clearing fauna checks by a qualified ecologist, in accordance with the Sapphire to Woolgoolga Flora and Fauna Construction

9. The ecological assessment for the environmental assessment has identified that the rest area site contains potential habitat for some frog species, including the Wallum Froglet. A two stage clearing process would be used with pre-clearing fauna checks (including frogs) by a qualified ecologist, in accordance with the Sapphire to Woolgoolga Flora and Fauna Construction Environmental Management Plan. Accordingly, the direct impacts to frogs will be minimised. Vegetation retained on site could be used as a refuge for frogs during the site clearing for the rest area.
- The project also makes provision for fauna fencing along the Woolgoolga bypass through the Wedding Bells State Forest. To the east of the highway, fauna fencing would be erected along Eggins Drive to the Arrawarra Beach Road intersection before traversing along Arrawarra Beach Road to the highway and running parallel to the northern extent of the project (refer to EA section 17). Where appropriate, the fauna fencing would include frog exclusion fencing installed in a manner similar to a number of other Pacific Highway projects. The design for the frog exclusion fencing would be developed with OEH and take into account frog monitoring results.
- 10.-11. The service centre is not part of the current proposal for which approval is being sought. RMS is not proposing to construct a service centre at the Arrawarra Interchange. Any development of a service centre would be undertaken by a third party sometime in the future (and would be subject to a separate environmental assessment and approval for its construction and operation). The RTA would construct the rest area only and mature vegetation indicated within the rest area EA report for retention would be temporarily fenced during the construction period and protected.
12. Through the Wedding Bells State Forest section of the Sapphire to Woolgoolga Pacific Highway upgrade, there are a number of fauna crossing structures. Little Arrawarra Creek and Arrawarra Creek bridges would enable fauna movement, with a glider crossing pole proposed at Arrawarra Creek. The project also includes fauna fencing through the Wedding Bells State Forest to the west of the highway. To the east of the highway, fauna fencing would be erected along Eggins Drive to the Arrawarra Beach Road intersection before traversing along Arrawarra Beach Road to the highway and running parallel to the northern extent of the project. These measures would facilitate the cross highway fauna movement, while limiting access to the highway.

2.7 Hydrology / stormwater

Submission numbers

02, 03 OEH, 07, 09, 10, 12, 15

Issues

1. EA states that there could potentially be an increase in runoff - what is the extent of runoff increase and the nature of the potential pollutant in the runoff?
2. Concern about whether the increase in stormwater has been addressed. What effect would this have on the water levels of the Arrawarra and Yarrowarra creeks?
3. OEH requests further information on the revised design and demonstration of the efficiency of these improvements.
4. In areas of heavy rain, water backs up on low lying areas around Arrawarra Beach Road and Eggins Drive. Raising the rest area with fill will exacerbate this issue.

5. Impact on hydrology in Arrawarra as a result of the proposed rest area and Interchange need to be considered in conjunction with the Coffs Harbour Coastal Processes and Hazard Definition Study.
6. There are significant problems with erosion adjacent to Yarrawarra Creek on the southern tip of the Coffs Coast Regional Park containing SEPP 26 remnant littoral rainforests. The potential impacts of stormwater runoff has not been addressed fully enough as it relates to these issues.

Response

- 1.-6. The rest area will involve hard stand areas (around 10,000m²) which will potentially increase run-off and pollutants. The pollutants are anticipated to include hydrocarbons and gross pollutants (further information on stormwater pollutants is provided in Section 2.8). The rest area site is not anticipated to exacerbate flooding in the area, with stormwater and runoff to be detained on site via swales. The stormwater detention arrangements would detain stormwater on-site during rainfall events and release it slowly to the surrounding natural drainage. Hence the rest area will not exacerbate any flooding in Arrawarra Creek and to surrounding land and would not increase erosion of those drainage channels. A review of mapping from the Coffs Harbour Coastal Processes and Hazard Definition Study (BMT WBM Pty Ltd, 2011) indicates that the subject site and immediate surrounding land is not anticipated to be subject to inundation from extreme weather for the immediate, 2050 and 2100. The hydraulic assessment of the rest area will take into consideration the filling of the rest area site. Appropriate stormwater and runoff measures will be incorporated in the design for the rest area.

The stormwater detention arrangements would facilitate the retention of pollutants on site. Accordingly it is not expected that there would be any deterioration in water quality in the downstream creek system.

Further assessment on the stormwater system would be undertaken during the detailed design stage to ensure that the stormwater detention arrangements are sized appropriately to accommodate run-off that would be generated from the site and minimise impacts to surrounding land and creek water levels and quality.

2.8 Water quality / pollution

Submission numbers

03 OEH, 09, 10, 16, MPA

Issues

1. Seeks clarification on details of water management features and how they will achieve maintenance of high quality water leaving the site and into Arrawarra Creek catchment. Design should include controls to manage gross pollutants and hydrocarbons.
2. Not confident that the mitigation measures identified in the report will prevent contamination and siltation of Arrawarra Creek - which in turn would impact on the Solitary Islands Marine Park.
3. Stormwater detention ponds will detain stormwater however, over a period of time the hydrocarbons may enter the natural watercourse and accumulate in Arrawarra Creek having detrimental effects on the water quality and marine life.

4. Marine Parks Authority concerned that rubbish would enter the stormwater or be windblown into Arrawarra Creek catchment area.
5. The rest area would need to have proper recycling facilities.

Response

- 1.-3. The proximity of the proposed rest area to the Solitary Islands Marine Park is acknowledged, being situated just over 400 metres away from Arrawarra Creek. Use of the hardstand area (around 10,000m²) without any management measures could result in an increase in pollution entering the downstream stormwater system.

However, as part of the rest area design, swales, possibly in combination with a bio-retention system, would be provided on site. These management measures would be designed to contain and treat pollutants (such as hydrocarbons and gross pollutants typical of those found on highways), prior to the release of the water into the downstream water system.

Swales provide some removal of hydrocarbons through the process of settlement of particles which have hydrocarbons (as well as other forms of pollution) adsorbed to them. Modelling of the proposed rest area swales undertaken showed that their use would reduce the amount of pollutants in the stormwater by:

- 76% of Total suspended solids.
- 54% of Total phosphorous.
- 16% of Total nitrogen.

However, hydrocarbon removal may be limited because a substantial proportion of hydrocarbons are likely to be transported as a thin floating film on the water surface. The water in the swale therefore acts as a separating phase between the floating hydrocarbons and the soil.

To overcome this separation, it is recommended that treatment devices that include infiltration (such as bio-retention systems) be employed where practical. The use of bio-retention systems in the rest area would be considered further during detailed design. The bio-retention systems are able to remove stormwater pollutants through physical, biological and chemical processes and treat petroleum hydrocarbons primarily through sorption and filtration.

Stormwater quality modelling has been undertaken to quantify the extent of mitigation that could be provided through the use of bio-retention systems. The results of the modelling are shown below together with the NSW stormwater treatment targets identified in the DECC NSW, Managing urban stormwater: environmental targets, Consultation draft – October 2007:

- 92% of Total suspended solids removed. (NSW target 85% removal).
- 74% of Total phosphorous removed. (NSW target 65% removal).
- 48% of Total nitrogen removed. (NSW target 45% removal).

As shown above, this reduction in pollutants would exceed the NSW stormwater treatment targets. In addition, bio-retention systems have shown to remove between 80 and 95% of total petroleum hydrocarbons (Hong et al. 2006). These studies also showed that biodegradation of petroleum hydrocarbons took place in a thin layer of mulch placed on the surface of bio-retention media. Most of the petroleum hydrocarbons were biodegraded within two to eight days after a runoff event (depending on the particular compound).

In regards to sewage, this would be captured and pumped via an underground pump to Coffs Harbour City Council sewerage scheme at Arrawarra Beach and would not contaminate surrounding land or watercourses.

- 4.-5. Appropriate garbage disposal facilities will be provided for at the rest area. The site will also include on-site stormwater detention arrangements to minimise the risk of any waste being transported off site.

2.9 Noise

Submission numbers

10, 11, 15

Issues

1. Surrounding area would be subject to noise pollution. Considerable work on noise barriers would need to be done to restrict noise resonating into the Arrawarra area.
2. Excessive noise from trucks accessing the rest area- no noise walls could stop that noise.

Response

- 1.-2. Noise impacts and mitigation measures are addressed in Chapter 8 of the Rest Area Assessment Report, September 2010. The noise assessment assessed trucks accessing the Interchange ramps to enter or exit the rest area as well as moving through the rest area and while at rest.

To reduce potential increase in noise to residences in Arrawarra, a noise wall would be constructed to the north of the site and also along the eastern boundary (section 7.3.3 of the rest area submissions report).

Under the rest area only scenario, there would not be any change from the base case scenario (ie the upgraded highway with no rest area) at any nearby residence.

2.10 Safety / security

Submission numbers

11, 15

Issues

1. There are no police at Arrawarra at night should anything happen. Closest police are at Coffs Harbour.
2. There is the potential of people camping and lighting fires and would set the surrounding bushland and homes on fire.

Response

1. There are currently few examples of security issues at rest areas along the Pacific Highway, possibly due to the presence of users of the facility.
2. No BBQ facilities are proposed to be provided at the rest area. During periods of fire ban, open fires would be prohibited which would minimise the risk of fires getting out of control. Suitable signage indicating that camping is not permitted will be erected.

2.11 Miscellaneous

Submission numbers

12

Issues

- I. National Parks Association of NSW (NPA) made a submission to the Arrawarra Rest Area EA and was pleased to find many recommendations had been taken on board, particularly in environmental mitigation and compensatory habitat.

Response

- I. Noted.

3 Conclusion

This submissions report has addressed issues and concerns raised in submissions received in response to the rest area environmental assessment report, a modification to the Sapphire to Woolgoolga Pacific Highway upgrade project.

In consideration of the above, Roads and Maritime Services (formerly Roads and Traffic Authority) seeks the approval of the Minister for Planning under Part 3A of the EP&A Act for the rest area as described in the rest area environmental assessment report.

Should the rest area be approved, construction of the rest area facility is proposed to be undertaken as part of the construction for the Sapphire to Woolgoolga Pacific Highway upgrade project.

4 References

Hong et al. (2006). Hong, E. Y., E. A. Seagren and A. P. Davis. *Sustainable oil and grease removal from synthetic stormwater runoff using bench-scale bioretention studies*. Water Environment Research 78(2): 141-155.