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**INDEPENDENT
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- ◆ Groundwater & Dewatering
- ◆ Contaminated Land
- ◆ Dust Monitoring
- ◆ Environmental Management Plans

Amended Biting Insect Management Plan For Proposed Residential Subdivision “Altitude Aspire”

Location:

Lot 1 DP 304649, Lot1 DP 175235, Lot 2 DP 778727, Lot 1 DP 781687,
Lot 1 DP 781697, Lot 1 DP 169490, Lots 40 & 43 DP254416
Fraser Drive, Terranora NSW

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EXECUTIVE SUMMARY

HMC Environmental Consulting Pty Limited (HMC) was engaged by Newland Pty Ltd to prepare a Biting Insect Management Plan (BIMP) for a proposed subdivision. The proposal is a residential development of 272 Lots comprising 257 residential lots, 4 medium density lots, 9 public reserves, 1 drainage reserve, and 1 community lot, located at Terranora in northern NSW.

Under section 3A of the *Environmental Planning & Assessment Act 1979* (EPA Act 1979), a major projects application was lodged with the Department of Planning. Director General's Environmental Assessment Requirements (DGEARs) were issued dated 23rd November 2009 (**MP 09_0166**).

The Environmental Assessment Report, including the BIMP, was assessed by the DoP and a Test of Adequacy response issued (dated 5th November 2010). HMC subsequently amended the BIMP, dated November 2010, to address these comments.

Following submissions from the public and State Agencies, and subsequent amendments to the proposed Concept Plan, this BIMP has been revised to provide additional information

The Director General's Environmental Assessment for this proposed development required an assessment of the potential for an increase in impact of biting insects on the amenity of the area. Where severe, a Biting Insect Management Plan is to be prepared in accordance with Tweed Shire Council's Development Control Plan Section A6 – Biting Midge & Mosquito Control, 2008. The Tweed Shire Council Section B24 Area E Urban Release Development Code was adopted by Tweed Shire Council in December 2011 but is not yet in effect. A requirement of this provision is that a Wetland Restoration Plan and Habitat Restoration Plan must be prepared to Council's satisfaction for all land zoned for Environmental Protection. The plan would need to demonstrate that any wetland on the land would be restored and managed to the consent authority's satisfaction to restore freshwater wetland values and minimise breeding habitat for saltwater mosquitoes and biting midges.

The Preferred Project Report does not propose any physical works in the SEPP14 Wetland (Lot 227) rather, following negotiations with Council Officers, the developer and Council propose to enter into a Voluntary Planning Agreement which will, inter alia, include provisions for the initial creation of an easement for drainage over the whole of Lot 227 (this will provide a lawful point of discharge for Altitude Aspire) and ultimately for the acquisition of the fee simple in Lot 227 and vesting it in Council. In addition, the Voluntary Planning Agreement will require that a Wetland Restoration Plan be prepared and that rehabilitation of the wetland be progressively undertaken in accordance with the approved Restoration Plan. But this cannot commence until the wetland is in public ownership.

The site borders the Terranora Broadwater estuary and the existing Banora Point urban and Terranora rural residential areas. Mosquito and biting midge nuisance has been a problem in this area with historic drainage and clearing works within the SEPP 14 wetland area north of the site resulting in changes in the hydrology and vegetation providing a significant breeding ground for these insect vectors. Tweed Shire Council has previously undertaken biological treatment within this drained area, however, recent flood gate modifications has allowed the water levels within the levee to be controlled reducing breeding areas and encouraging the introduction of predator species.

To protect the SEPP 14 wetland a minimum 100m buffer zone (Conservation Area) has been provided. A Vegetation Management and Rehabilitation Plan (VMRP) has been prepared by James Warren & Associates to address removal of weeds and planting to restore the native vegetation to pre-clearing form within the proposed Conservation Area. This restoration, is likely to reduce biting insect habitat.

A Conceptual Stormwater Assessment and Management Plan was prepared by Gilbert and Sutherland in 2010 outlining strategies to manage surface water across the site. To address subdivision design modifications and submissions a more detailed assessment (Stormwater Assessment & Management Plan (SWAMP) April 2012 and Hydrologic & Hydraulic Assessment (HHA) April 2012) has been undertaken. The SWAMP includes details on the proposed bioretention basins. The basins would be constructed to manage stormwater flows and would drain to ensure biting insect breeding conditions were minimised. The proposed lake would also be designed to maximise the introduction and habitat for larvivorous insects and fish. Details of the proposed bioretention basins are included and are designed to achieve best practice in controlling biting insect populations.

A funded project ("*Fish In Mozzies Out*"), located within the mangrove area west of the proposed subdivision, is also investigating strategies including tidal flushing to improve fish and crustacean habitat and minimise biting insect breeding habitat.

Management strategies to minimise biting insect breeding sites within the proposed subdivision and exposure of persons to these vectors have been included.

This report states that the presence of biting insect breeding habitat nearby the proposed Altitude Aspire development site does present a risk of biting nuisance and negative impact on human health from transmission of Ross River virus and Barmah Forest virus for the future occupants of the proposed residential subdivision.

Although the proposed development would place a new population within an area subject to biting insect nuisance, it is likely the proposed stormwater management infrastructure and implementation of the VMRP within the Conservation Area would lead to reduced biting insect habitat in the Terranora area. The implementation of the future Wetland Restoration Plan would also significantly reduce the biting insect habitat adjoining the proposed development. The proposed work would build on recent improvements in biting insect management including habitat modification in areas bordering Terranora Broadwater.

Recommendations within the report relate to strategies to help minimise the biting insect nuisance and focus on the water cycle and vegetation. Measures that occupants can implement including personal protection are also included.

The following summary includes both active and passive management strategies:

- Provide breaks in vegetation to reduce biting insect corridor to dwelling sites
- Ensure earthworks including fill placement and roadway embankments do not impound surface water and create ponded breeding sites

- Where applicable install “Dry” stormwater drainage systems.
- Ongoing maintenance of stormwater structures
- Actions by householders to minimise biting insect nuisance
- Provide buffers between breeding sites and dwelling houses
- Water quality in lakes should be suitable for survival of larvivorous fish
- Waterway design to minimise emergent vegetation

It is concluded that the proposed improvements in the stormwater management, habitat restoration in the Conservation Area, in conjunction with the habitat modification measures being implemented off-site would reduce biting insect breeding in the area. Future SEPP 14 Wetland Restoration on the area immediately north of the project site would also significantly reduce biting insect habitat. These actions, together with the implementation of the recommendations within Section 7 of this Biting Insect Management Plan would help ensure that the public health and biting nuisance risk to residents in the proposed subdivision would be minimised.

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1 INTRODUCTION

HMC Environmental Consulting Pty Limited (HMC) was engaged by Metricon Qld Pty Ltd to prepare a Biting Insect Management Plan (BIMP) in accordance with items 14.1 and 14.2 of the Director General's Environmental Assessment Requirements for Major Project No. 09-0166, as detailed below:

- "14.1 Address the potential for an increase in the impact of biting insects on the amenity of the area, in particular salt marsh mosquitoes. The assessment should address impacts on future residents, and potential increases in mosquito borne disease. Undertake consultation with Council and the NSW Area Health Authority and provide for measures to control and ameliorate their effects, including measures to minimise their breeding habitat. Prepare a biting insect management plan if the problems are considered severe.*
- 14.2 Provide evidence of consultation with Tweed Shire Council regarding a recently submitted project entitled 'Fish Move In, Mosquitoes Move Out', and discuss the implications of this project for the development within the assessment."*

Biting insect nuisance has been recognised in various studies and planning strategies for this area. The rezoning of the Terranora Urban Release Area (Area E) required the restoration of a disturbed wetland adjoining the project site. This Preferred Project Report does not propose any physical works in the SEPP14 Wetland (ie. Lot 227) rather, following negotiations with Council Officers, the developer and Council propose to enter into a Voluntary Planning Agreement which will, inter alia, include provisions for the initial creation of an easement for drainage over the whole of Lot 227 (this will provide a lawful point of discharge for Altitude Aspire) and ultimately for the acquisition of the fee simple in Lot 227 and vesting it in Council. In addition, the Voluntary Planning Agreement will require that a Wetland Restoration Plan be prepared and that rehabilitation of the wetland be progressively undertaken in accordance with the approved Rehabilitation Plan. But this cannot commence until the wetland is in public ownership.

A funded research project immediately west of the Terranora Urban Release Area also aims to develop strategies to improve fish and crustacean habitat and reduce existing biting insect habitat

The BIMP is prepared in accordance with "Tweed Shire Council's Development Control Plan 2008 Section A6 – Biting Midge & Mosquito Controls" for a site located within the recently re-zoned Terranora Urban Release Area (Area E) in northern NSW.

This BIMP should be read in conjunction with the following documents prepared for the development:

- *Amended Landscape Master Plan* (Form Landscape Architects March 2012); (LM)
- *Vegetation Management & Rehabilitation Plan* (James Warren & Associates March 2012);(VMRP)
- *Ecological Assessment* (James Warren & Associates March 2012);(EA)
- *Stormwater Assessment & Management Plan* (Gilbert & Sutherland April 2012); (SWAMP)
- *Hydrologic & Hydraulic Assessment* (Gilbert & Sutherland April 2012).(HHA).

1.1 Project Name and Location

The 36 hectare project, known as *Altitude Aspire*, is a staged residential subdivision within the Terranora Area E Urban Land Release. The proposal is a residential development of 272 Lots comprising 257 residential lots, 4 medium density lots, 9 public reserves, 1 drainage reserve, and 1 community lot.

Table 1 – Project Information

Property Description	Lot 1 DP 304649, Lot1 DP 175235, Lot 2 DP 778727, Lot 1 DP 781687, Lot 1 DP 781697, Lot 1 DP 169490, Lots 40 & 43 DP 254416 Fraser Drive, Terranora <u>Major Project Application No. 09-0166</u>
Applicant	Newland Pty Ltd
Local Government Authority	Tweed Shire Council
Site Area	Approx.36ha
Location Plan	Refer to Appendix 1
Zoning	2(c) Residential – Urban Expansion 7(a) Environmental Protection – Wetlands & Littoral Rainforests
Elevation	~RL 0 – RL 85 mAHD
Proposed Subdivision Plan	Refer to Appendix 2

1.2 Site Description

The site is located within the Terranora Urban Release Area (Area E) within the locality of Terranora in the Tweed Shire Council area on the North Coast of New South Wales.

The site is a rural landholding, extensively cleared, with intermittent cattle grazing. Other agricultural uses including cropping are common in the area. The southern end of Terranora Broadwater, forming part of the tidal Tweed River estuary, is located immediately north of the site. Fraser Drive separates the site from the Banora Point residential area to the east. South and west of the site are Terranora rural residential areas. Improvements include farm dams, several dwellings and storage sheds.

An area of wetland (includes designated SEPP 14) adjoining the northern boundary of the site has previously been disturbed and partially drained. This land has been the source of significant biting insect nuisance since the 1980s.

1.3 Purpose & Scope

The purpose of this report is to:

- Assess the potential for an increase in the impact of biting insects on the amenity of the area due to construction works and occupation of the site as part of the proposed development.
- Identify strategies to assist in minimising biting insect nuisance on and surrounding the development site.
- Undertake consultation with Tweed Shire Council and the NSW Area Health Authority where applicable to biting insect management.

- Address relevant provisions within Sections A6 and B24 (adopted Dec 2011 but not yet in effect) of the Tweed Shire Development Control Plan 2008 (DCP)
- Respond to submissions from the public and State Agencies, and incorporate subsequent amendments to the proposed Concept Plan

1.4 Legislation & Guidelines

1.4.1 Tweed Local Environment Plan 2000 (Amendment 10).

The Tweed LEP 2000 was amended in 2007 to include provisions relating to Area E. Clause 53D 2 (c) is included *“to ensure that any wetlands in the area are restored and protected and breeding habitat for salt water mosquitoes and biting midges is minimised”*.

Clauses 53D 3 (c) states that development on the site cannot be granted unless a DCP has been prepared and *“any wetland on the land will be restored and managed to the consent authority’s satisfaction to restore freshwater wetland values and minimise breeding habitat for saltwater mosquitoes and biting midges,..”*

This provision highlights the biting insect nuisance in the area and the need to restore the disturbed wetland on the land to minimise the breeding habitat.

1.4.2 Tweed Shire Development Control Plan 2008.

Two sections in this DCP relate to biting insects and the project site. Section A6 *Biting Midge & Mosquito Control* highlights the risks with biting midge and mosquitoes to residential developments generally within the coastal areas of the Tweed Shire Council area, and guides such development to minimise and control these risks. The wetland areas on and adjacent the site have been mapped as breeding grounds for Saltmarsh Mosquitoes (see Appendix 7).

Section B24 *Area E Urban Release Development Code*, adopted by Tweed Shire Council in December 2011, but not yet in effect, applies to the urban release area including the project site. This section includes a provision that any development application for subdivision must *“demonstrate that any wetland on the land will be restored and managed to the consent authority’s satisfaction to restore freshwater wetland values and minimise breeding habitat for saltwater mosquitoes and biting midges”*.

1.5 Local Studies

1.5.1 Draft Cobaki and Terranora Broadwater Catchment and Estuary Management Plan

Within this 2009 publication by Tweed Shire Council, Table 0.1 summarises catchment management issues, potential impacts and key catchment management responses. Mosquitoes and biting midges are noted as abundant in the local wetland and inter-tidal areas and that Tweed Shire Council are committed to ongoing mosquito abatement and monitoring.

The following impacts on the catchment are listed

- Poorly managed agriculture areas may contribute to mosquitoes and biting midges.
- New development may create more mosquito breeding habitat, for example in the design of stormwater treatment systems.
- Changing salinity regimes determine mosquito breeding and can increase populations.

The following key catchment actions are recommended

- Current best practice in wetland design should be adhered to where inconsistency with designs proposed in DCP A6 arises.
- Restoration of the bund in Area E to reduce mosquito breeding habitat.

1.5.1.1 Coastal Zone Management Plan for Cobaki Broadwater and Terranora Broadwater December 2010

Australian Wetlands included several actions relating to mosquito and biting midge management.

“10.1 Design considerations for stormwater treatment waterbodies may conflict with the guidelines in DCP A6 Biting Midge and Mosquito Control, however, current best practice in wetland design should be adhered to, ie water bodies should not be designed to be deeper than 2m. (Assessment of wetland and lake designs with consideration of DCP A6 to be undertaken as part of all development applications).

10.2 Restoration of the bund in Area E to prevent salt water intrusion into the freshwater wetland area to reduce mosquito breeding habitat.”

1.5.2 Terranora Broadwater Sustainability Assessment Report, December 2006

Letcher (2006) as part of the sustainability assessment for Terranora Broadwater included the impact of urban development associated with Terranora Area E and/or Banora Point. The biting insect assessment is limited to a summary table (Table 3) where urban development in various scenarios for both areas results in a moderate increase in mosquitoes. Table 1 in the assessment does confirm that the data quality used in the assessment is poor and based on assumptions and a model developed by the Australian National University. Expert and local data review is suggested.

The TSC entomologist would be considered the best source for both the expert and local data review. He has had a long association with this site and is driving biting insect management through habitat modification via manipulation of the recently modified floodgates/sluiceways servicing the previously drained and bunded wetland area adjoining the project site.

1.6 Relevant Preferred Project Reports

1.6.1 Stormwater Management

A more detailed stormwater assessment has been prepared by Gilbert & Sutherland (G & S) to address the amended development layout resulting from public exhibition of the environmental reports following the Part 3A application process. A more detailed modelling approach has been adopted by assessing the efficacy of the proposed treatment train for the development.

Stormwater quantity is also addressed in more detail within the G & S report titled Hydrologic and Hydraulic Assessment dated April 2012.

1.6.1.1 Conceptual Stormwater Assessment and Management Plan Proposed Residential Development, Altitude Aspire, Terranora (Gilbert and Sutherland November 2010)

Gilbert & Sutherland (2010) addressed the stormwater quality discharge into the Environmental Protection and SEPP 14 wetland areas (see Environmental Assessment Annexure). It is noted that constructed wetlands within the project site would be a part of the integrated water cycle management for the site. This report notes that rehabilitation and enhancement of the SEPP 14 saltmarsh and wetland species would be undertaken by Tweed Shire Council to meet the objectives within the Draft Cobaki and Terranora Broadwater Catchment and Estuary Management Plan.

G & S also addressed biting insect issues with surface water management within the rehabilitated areas being controlled, repaired and improved to help control the mosquito and midge problem. It is noted that previous agricultural drainage works, particularly along the southern edge of the SEPP14 wetland area may require additional levelling, filling and limited excavation to ensure the highest ecological benefit from the rehabilitated areas.

The issue of biting insects was addressed in the conceptual design specification for the wetlands and bypass channel in S3.2.4 of G & S where it was stated:

“Care would be taken in the design of the bypass channel and the wetlands to ensure that they would not become a haven for biting midges or mosquitoes.”

It is currently proposed that the bypass channel would have a number of weirs/riffles to control flow velocities. These weirs would not cause ponding and flowing water in the channel would not be conducive to mosquito breeding.

Edge treatments of the wetland would be designed to ensure that mosquito breeding areas such as still, shallow areas of water are not created.”

Section 8.2 also specifically addressed biting insect management in the design of the stormwater discharge point:

“Diffuse stormwater discharge would be provided for the freshwater systems and would be achieved through the construction of under-drained swales with level-spreader devices. Again, this presents a number of benefits from engineering, ecological and pest management perspectives.

The ecological benefits centre on the health of rehabilitated areas and the ongoing fisheries habitat contribution to the Broadwater ecosystem. Additionally, by controlling, repairing and improving the surface water management within the rehabilitated areas, the mosquito and biting midge problem can be controlled.”

The constructed wetlands would be designed to achieve best practice in managing biting midge and mosquito populations (see Appendix 3).

The report concluded that *“the quality of runoff to be discharged from the proposed development into the SEPP 14 area (where further polishing would occur before release to the Broadwater) is considered acceptable.”*

1.6.1.2 Stormwater Assessment and Management Plan Proposed Residential Development, Altitude Aspire, Terranora. (Gilbert and Sutherland April 2012)

Section 6.2 states *“Diffuse stormwater discharge would be provided for the freshwater systems and would be achieved through the construction of underdrained swales with level-spreader devices. Again, this presents a number of benefits from engineering, ecological and pest management perspectives. The ecological benefits centre on the health of rehabilitated areas and the ongoing fisheries habitat contribution to the Broadwater ecosystem. Additionally, by controlling, repairing and improving the surface water management within the rehabilitated areas, the mosquito and biting midge problem can be controlled.”*

Previous agricultural drainage works, particularly along the southern edge of the SEPP14 wetland area may require additional levelling, filling and limited excavation to ensure the highest ecological benefit from the rehabilitated areas. For this reason, the proposed SEPP14 area rehabilitation should take a staged approach, allowing for adjustment, revision and ongoing consultation with stakeholders.”

1.7 Vegetation Management

1.7.1 Vegetation Management and Rehabilitation Plan (James Warren & Associates March 2012)

This report identifies Open Space and Conservation Areas that require management. The most relevant to the BIMP are the Stormwater Treatment Area and the Conservation Area. The Stormwater treatment Area is located within the central gully and discharges into the Conservation Area located on the northern part of the site immediately south of the SEPP 14 wetland.

Within the Stormwater treatment area, revegetation works will be completed both within and surrounding the stormwater devices. Aquatic species will be planted within the stormwater treatment areas and wetland trees, shrubs and groundcovers will be planted in the surrounds

The Conservation Area is intended to provide a buffer between the proposed development and the SEPP 14 Wetland which occurs adjacent to the northern site boundary.

No recreation is proposed within the Conservation Area. The primary focus within this area will be the retention and protection of existing native vegetation, the rehabilitation of degraded areas (including the degraded Freshwater wetland EEC, and the provision of offsets for the removal of small degraded patches of Lowland rainforest EEC from the development footprint.

Section 5.4 of the VMRP addresses long term management and notes that maintenance of existing vegetation will occur except where water sensitive urban design facilities/devices are required. Landscaping of infiltration drains, swales and other stormwater management facilities/devices will also be implemented to facilitate integration of these facilities/devices into the surrounding natural environment.”

1.7.2 Ecological Assessment (James Warren & Associates dated March 2012).

This impact assessment identified the Freshwater EEC within the proposed Conservation Area.

Section 3.4.3 indicates that the degraded freshwater wetland will be retained within the proposed Conservation Area and will be protected and restored through the implementation of the VMRP.

Section 3.7.2 notes that measures to improve the biodiversity on the project site would include the removal of constructed dams (i.e. obstructions to the natural flow) and the construction of an efficient drainage line (and associated habitat) along the natural drainage line of the subject site.

1.7.3 Amended Landscape Masterplan (Form Landscape Architects March 2012)

This landscape plan addresses open space and public areas within the proposed development. The Conservation Area north of the proposed Broadwater Parkway is not included. The central gully is included in the Creekline and Wetland precinct. Detail is provided on vegetation and landscaping. The stormwater treatment including the bioretention basins are located within this precinct. Improvements in drainage and biodiversity would minimise the biting insect habitat in this area.

1.8 SEPP14 Wetland Restoration Plan

The degraded SEPP14 wetland north of the project site has been identified as an area requiring restoration. Various planning instruments have included provisions requiring the preparation of a Wetland Restoration Plan to improve native habitat, restore the freshwater regime and reduce biting insect breeding areas. Section B24 of the recently adopted DCP also includes provisions requiring the preparation of this plan

This Preferred Project Report does not propose any physical works in the SEPP14 Wetland (ie. Lot 227) rather, following negotiations with Council Officers, the developer and Council propose to enter into a Voluntary Planning Agreement which will, inter alia, include provisions for the initial creation of an easement for drainage over the whole of Lot 227 (this will provide a lawful point of discharge for Altitude Aspire) and ultimately for the acquisition of the fee simple in Lot 227 and vesting it in Council. In addition, the Voluntary Planning Agreement will require that a Wetland Restoration Plan be prepared and that rehabilitation of the wetland be progressively undertaken in accordance with the approved Rehabilitation Plan. But this cannot commence until the wetland is in public ownership.

1.9 Consultation

1.9.1 Tweed Shire Council

Tweed Shire Council's Entomological Control Officer, Mr Clive Easton, has been consulted for the preparation of this report with respect to the existing biting midge and mosquito nuisance in this location.

Mr Easton advised (per. comm. 18/6/10) that the drained and bunded SEPP 14 wetland adjoining the project site has historically been a problem mosquito breeding ground. Recent modifications to the existing floodgate/sluice gate have improved the tidal flushing of the leveed area. The tidal flow was now being managed to maintain the biological diversity within the bunded area. Mr

Easton highlighted the need to control the flow into this area as freshwater wetland habitat also needed to be protected. The regime within the levee varies from fresh to brackish and supports a wide suite of biological activity.

Mr Easton advised that since the floodgate modifications were installed the mosquito problem had been manageable without the need to treat with biological controls. During the drought in 2009 the leveed area had dried out resulting in oxidation of acid sulfate soil with associated acidity problems. Mr Easton confirmed that the floodgate modifications would also assist in reducing this “drying out” and thus acidification.

Mr Easton also identified levee maintenance as a management strategy that would need to be included in any Wetland Restoration Plan. The work undertaken to date has been on an ad hoc basis. The agreement to undertake the wetland restoration within any consent would provide a guaranteed source of funding for the required ongoing work that would not be available without the development of Area E.

The implications of the work that has been undertaken are significant for the proposed development in that the floodgate modification and associated work has lead to management of the mosquito problem without the need for biological larvicide applications. Council’s Entomologist noted the ad hoc nature of the work undertaken to date and welcomed the guaranteed funding for works that would be undertaken with the implementation of the Wetland Restoration Plan as part of the Area E development process.

1.9.2 Fish In Mozzies Out Project.

Mr Easton (pers comm. 18/6/10) advised that this project was funded in late 2009 through the Industry and Investment NSW Habitat Action Grant Program. Part of the revenue collected from recreational fishing licences was distributed through the Fishing Trusts to 26 on-ground habitat rehabilitation projects in NSW. The local project commenced in April 2010 and is still underway.

This collaborative (Griffith University, Tweed Shire Council, Industry and Investment NSW) project is based on an area of mangroves approximately 1 km west of the project site near the end of Mahers Lane, Terranora. This area has been subjected to changes in natural drainage and flushing with the earlier installation of levees and drains. This area has been a problem breeding ground with restricted flushing reducing predation and levees restricting flushing/drainage especially during spring tides. Treatment is restricted to aerial spraying (bacteria) due to access issues and during windy conditions treatment is not an option.

The collaborative project aims to collect information on the mangrove area using mapping, data logging water depth, and mosquito counts/identification. Information on fish and crustaceans is also being collected. Water quality (acidity and dissolved oxygen) is recorded after rainfall events.

Following the collection of the baseline data and completion of mapping, a more informed decision can be made on the likely implications on overall diversity, biting insect habitat and predation, water quality and fish and crustacean habitat with any future changes in the hydrology ie installing channels in levees. It is expected that a controlled increased flushing would have benefits to fish/crustacean habitat whilst also reducing biting insect habitat.

The Fish In Mozzies Out project aims to improve the baseline information in a known biting insect breeding area impacting on the Altitude Aspire project. This funded project would provide valuable information for the design of breeding habitat modification works that aim to reduce biting insect nuisance in affected residential areas.

Discussions with NSW Fisheries (pers. comm. Patrick Dwyer) in April 2012 confirmed that the project had completed the baseline data collection and trials were underway to test management strategies to improve flushing and reduce biting insect habitat. Preliminary results appear promising, however trials are continuing.

1.9.3 NSW Department of Health

Previous discussions were held with The NSW North Coast Area Health Service in Lismore in June 2010. A formal request was forwarded to Greg Bell Assistant Director, Public Health on 16 November 2010 with attached copies of the Environmental Assessment and the Biting Midge Management Plan. A response was received on 24 November 2010 and stated:

It is noted from your attached correspondence, that the requirements/recommendations set out in the abovementioned planning process have received due consideration for the development stage of the proposal.

The response goes on to note the challenge in sustaining the management plan and processes after the development is approved. This is a matter that has been addressed through the passive design elements within the stormwater management system and the biting insect habitat modification within the Wetland Restoration Plan.

2 RISK ASSESSMENT

2.1 Risk Management Approach

The biting midge and mosquito risk assessment and management methodology used follows the subsequent basic steps:

- Identify the Hazards to Humans: mosquito borne disease; biting nuisance.
- Identify Risk of Exposure: mosquito breeding site locations; development design.
- Prioritise Risks
- Control the Important Risks

3 MOSQUITO & BITING MIDGE HAZARDS

For this report the identifiable hazards associated with mosquitoes and biting midge are identified as:

- Mosquito-borne disease transmission of Ross River virus and Barmah Forest virus.
- Intense biting activity by mosquitoes and biting midge causing nuisance to humans.
- Negative impacts on human health caused by allergic conditions and secondary infections due to intensive biting midge attack.

Potential sources of mosquitoes and biting midge nuisance include:

- the previously disturbed (drained and bunded) wetland area immediately north of the site
- semi-tidal mangrove and saltmarsh areas west of the site off the end of Mahers Lane, Terranora.
- proposed constructed wetlands within the project site
- widespread breeding grounds in tidal and non-tidal areas around the Cobaki-Terranora Broadwater Estuary

3.1 Disease

According to the NSW Department of Medical Entomology (Doggett, S. 2004), in Australia, it is mosquitoes that present the greatest risk of vector-borne disease transmission to humans. It is the mosquito's need to feed on blood on repeated occasions that create the opportunity for disease causing blood parasites, including several specialised viruses and protozoa, to be transmitted from human carriers to susceptible human hosts.

Like mosquitoes, the female biting midge takes a blood meal to provide protein to develop her eggs, however biting midges are not known to carry any diseases affecting humans in Australia (Tweed Shire Council, 2005).

Human pathogens transmitted by mosquitoes pose a significant threat to population health in New South Wales. Within the State, there is annual activity of Ross River (RR) virus and Barmah Forest (BF) virus, occasional activity from Kunjin virus and Sindbis virus, and rare epidemics of Murray Valley encephalitis virus (Doggett, S. 2004).

The NSW Arbovirus Surveillance & Vector Monitoring Program (ASVMP) reports that, in NSW, outbreaks of Ross River and Barmah Forest viruses occur regularly in coastal northern NSW. In 2007, there were 839 notifications of Ross River virus and 573 notifications of Barmah Forest virus. The age-adjusted rate of Ross River virus was 12.0 per 100,000 population and 8.2 per 100,000 population for Barmah Forest virus.

With RR infection, a wide variety of symptoms may occur from rashes with fevers, to arthritis that can last from months to years. There are no specific treatments, and actions which reduce mosquito bites are the best form of prevention against these debilitating diseases.

For most of Australia, peak incidence of the diseases is through the summer and autumn months, particularly from January through to March, when the mosquito vectors are most abundant. In NSW, the ASVMP reports that for coastal northern NSW, notification patterns for these conditions are seasonal, with peak numbers typically occurring around May each year. Areas under intensive irrigation and localities close to saltmarshes, are most productive for mosquito populations and hence tend to result in the highest number of human cases of disease. Outbreaks occur when local conditions of rainfall, tides and temperature promote vector abundance.

RR and BF viruses have been isolated from many mosquito species, indicating wide susceptibility among mosquitoes. Along coastal regions, saltmarsh mosquitoes represent the major threat, including *Ochlerotatus vigilax* in the coastal region (Doggett and Russell, DME). *Verrallina funerea* is also a possible carrier of Ross River virus (Tweed Shire Council, 2005). In addition, according to the NSW Arbovirus Surveillance & Vector Monitoring Program, there is evidence to suggest that *Oc. notoscriptus* may be a vector in the domestic urban situation.

3.2 Biting Nuisance

3.2.1 Mosquitoes

Mosquitoes belong to the insect order *Diptera* which include many common and familiar insects such as mosquitoes, midges and house flies. Some are important pests or vectors of disease while others are beneficial, and by virtue of their parasitic or predatory nature play an important role in regulating populations of many plants and animals that adversely affect human welfare.

The female mosquito adults generally require a blood meal to effectively develop their eggs. A meal of protein in the form of blood is required to complete the reproductive process. These insects are opportunistic feeders that will feed on many species of birds and mammals. Humans tend to be the most abundant source of food in many local areas close to wetland breeding areas favoured by these insects.

Problems therefore arise where human activities or habitation, occur in proximity to these insect breeding areas. The extensive areas of wet low-land and intertidal areas along the Tweed coastal districts represent extensive breeding areas for both mosquitoes. As a result of the proximity of these low-land areas and urban development in the Tweed Council area, biting insect nuisance is likely to occur in many areas within this district from time to time.

As a general rule, the areas where mosquito problems will regularly be a nuisance to our human populace will be within 1km of extensive biting insect breeding areas.

3.2.2 Biting Midge

Although biting midge are not considered responsible for direct disease transmission to humans, there are however indirect health impacts caused by the sometimes intense biting of these insects around estuarine habitat.

Both mosquitoes and biting midge secrete saliva containing an anti-coagulant to prevent blood clotting when feeding. The saliva may produce an allergic response in humans (and other animals) sensitive to antigens. Due to the lacerating action of biting midge mouth parts, allowing a relatively large wound to pool blood from which the insect draws its feed, increased action of biting midge saliva often leads to an intense allergic reaction and irritation. The subsequent itch can be very severe. Uncontrolled scratching of bite wounds can lead to secondary infection. This is a particular problem in children and may require medical intervention to treat both the allergy and infections.

4 RISKS OF EXPOSURE

4.1 Biting Midge & Mosquito Breeding Areas

4.1.1 Tweed Shire Coastal District

According to the NSW Arbovirus Surveillance & Mosquito Monitoring Program (Dept. Medical Entomology, University of Sydney), the geography of New South Wales has defined 3 broad 'virogeographic' zones for arbovirus activity: the inland, tablelands and coast. The subject land lies within the coastal zone of the Northern Rivers region of NSW.

On the coast, rainfall is more consistent and mosquito activity more regular. Tidal inundation also promotes breeding of mosquitoes in the saltmarshes. A combination of high tides and heavy rainfall has resulted in some of the largest arboviral outbreaks in the State. This includes the Barmah Forest virus epidemics of 1995 (south coast) and 2001 (mid-north coast), and the combined Ross River virus and Barmah Forest virus epidemic of 2003 (northern rivers). Freshwater breeding mosquitoes may breed in large numbers after rain, with arbovirus activity ensuing. The Ross River virus outbreaks of 1996 (northern rivers) and 1997 (western Sydney), and the Barmah Forest virus cases in 2002 (western Sydney), were all probably the result of transmission via freshwater mosquitoes. (Doggett, S.L., 2004).

Arbovirus activity is dependent on numerous factors: the availability of water (especially rainfall and tidal amplitude), temperature, mosquito vectors, reservoir hosts, past activity, geography,

and population demographics. Mosquitoes require water to breed; more water means more mosquitoes and disease. Mosquito activity is linked to temperature and therefore more cases of arbovirus infection occur in the warmer north of the State with its longer mosquito season. Competent vectors (that is, mosquitoes able to transmit the virus) are present in most of New South Wales. (Dogget, S.L, 2004).

There are 2 monitoring sites within Tweed Shire (see Appendix 10)–

- Site 1 Anconia Street, Piggabeen
- Site 2 Beltana Drive, Terranora

These sites are located near the Terranora Cobaki Broadwater estuary with Site 2 approximately 2 km west of the proposed subdivision. The sites include mosquito traps and captured mosquitoes are forwarded for laboratory testing for arboviroses. The mosquito counts are also used to estimate potential biting insect nuisance . The results available for 2010 indicate that mosquito numbers were significantly higher than long term averages in the early part of the year however numbers were reduced in March and April.

As stated in Tweed Shire Council's DCP (Section A6, 2008), mosquitoes and biting midge are abundant in this region of Australia. The extensive areas of wet low-land and intertidal areas along the Tweed coastal districts represent extensive breeding areas for both mosquitoes and biting midge.

4.1.2 Local Area

The site is within the Terranora Area Urban Release Area (Area E). This site has been earmarked for future urban development in various strategic planning documents for a number of years. Biting insect nuisance has been highlighted as an issue to be assessed. This site is similar to many sites within coastal NSW near estuaries where biting insects are a nuisance and there is a need to implement strategies to minimise their impact on residents and visitors. The ultimate population is estimated at 744 persons assuming 310 lots @ 2.4 persons/lot.

Tweed Shire Council has been actively involved in mosquito abatement since 1983.

Activities include

- Mosquito monitoring traps
- Habitat reduction
- Aerial larviciding
- Biological larvicides

Midge control is also undertaken via the following activities

- Midge monitoring
- Midge larval control
- Potential biological control
- Habitat control
- Planning

Humans tend to be the most abundant source of food close to wetland breeding areas favoured by these insects. The Tweed Shire DCP also states, as a general rule, that areas where biting midge and mosquito problems will regularly be a nuisance to our human populace will be within 1km of extensive biting insect breeding areas.

Maps of mosquito and biting midge breeding areas have been produced by Tweed Shire Council for most of the Tweed coastal districts, and can be used to estimate those areas where potential biting insect problems will most likely occur.

5 IDENTIFICATION OF RISK AND PRIORITISATION

Risk is a function of hazards and risk of exposure presented by the proposed development. The hazards identified by this study include:

- Mosquito-borne disease transmission of Ross River virus and Barmah Forest virus.
- Intense biting activity of mosquitoes and biting midge with potential to
- Generation of complaints and negative impacts on a healthy living environment for humans.
- Indirect health impacts caused by allergic conditions and secondary infections due to exposure to intensive biting midge attack.

Item 14.1 of the Director General's Requirements included "*..address the potential for an increase in the impact of biting insects on the amenity of the area.*".

The proposed development is bounded by areas mapped by Tweed Shire Council as extensive mosquito breeding sites.

The Draft Cobaki Terranora Broadwater Catchment and Estuary Management Plan notes the following:

Mosquito species relevant to the Cobaki and Terranora Broadwater catchment include:

Ochlerotatus vigilax

This species favours hill and ridge tops overlooking tidal flats whose range includes Cobaki Inlet, Piggabeen, Bilambil Heights, Terranora and parts of West Tweed Heads.

Verrallina funerea

This species has been identified as a possible carrier of Ross River virus. It breeds in more elevated sites, including surrounding parts of Cobaki Broadwater and Terranora Broadwater.

Culex sitiens

This species breeds in fresh to brackish ponds in tidal saltmarsh pools and flooded low-land agricultural flats. This mosquito is a night feeder and may affect Cobaki Inlet and Terranora.

TSC has been undertaking mosquito abatement since 1983 and is currently carried out by Council's Environment and Community Services Division. Council monitors the following:

- *Weekly monitoring of mosquito species present, seasonal abundance and viral incidence to enable early waning of potential viral disease presence.*
- *Habitat reduction to reduce the breeding potential in semi-tidal saltmarshes*
- *Aerial larviciding after extensive areas hatch mosquito larvae following heavy rain or abnormally high spring tides.*
- *Biological larviciding when warranted.*

5.1.1 Biting Midge Management

Biting midges are not known to carry any diseases that affect human health in Australia, however they can directly impact human health due to allergens in midge saliva reacting on people with varying degrees of sensitivity and immunity, which can lead to scratching and infected sores (Tweed Shire Council, 2005)

Biting midge species relevant to the Cobaki and Terranora Broadwater catchment include:

Culicoides molestus

This species breeds in clean flocculated sand in the open or under light mangrove cover between mean tide level and mean high water spring tide level. They are found at the sandbar off Tony's Island at Banora Point.

Culicoides subimmaculatus

This species breeds in clean to muddy sand in the open or under light mangrove cover between mean high water neap tide level and mean high water spring tide level. Within the catchment, they are found on the upper Terranora passage islands.

Culicoides longior

This species breeds under tree cover amongst heavy fibrous muds, between mean high water neap and mean high water spring tide zone. They are found on Womgin Island, West Tweed Heads and parts of South Tweed Heads.

TSC has been researching and controlling midges since 1981 and is currently carried out by Council's Environment and Community Services Division. Council undertakes the following:

- Monthly midge monitoring along canal estate beaches
- Midge larval control with larvicide several times per year along artificial beaches of can developments
- Potential biological control
- Habitat control via removal of the midge breeding layer from a large river sandbar off Banora Point was investigated for over 10 years, but rejected.

There is concern that poorly managed agricultural or development areas may contribute to mosquitoes and biting midges. This includes the design of stormwater treatment systems that do not exacerbate mosquito or biting midge breeding.

The proposed subdivision would potentially increase the exposure of approximately 720 persons to biting insects. However, the project would be staged and initially the subdivision would have much lower population. Over time, the proposed restoration works in the adjoining wetland would reduce the exposure of both the subdivision residents and the wider community in the area. This restoration combined with the research undertaken as part of the Fish In Mozzies Out project within the mangrove area to the west is likely to provide a net benefit to the amenity of the area.

The proposed stormwater collection and treatment would also be designed to minimise biting insect habitat with detention basins draining following stormwater events and dissipation of flows into the SEPP 14 wetland to the north. The SWAMP notes that diffuse stormwater discharge would be provided for the freshwater systems and would be achieved through the construction of underdrained swales with level-spreader devices. This presents a number of benefits from engineering, ecological and pest management perspectives. By controlling, repairing and improving the surface water management within the rehabilitated areas, the mosquito and biting midge problem can be controlled.

A prioritised characterisation of mosquito-borne risk for the proposed subdivision is therefore described as a minor public health risk via exposure of future residents to Ross River virus, and Barmah Forest virus, and a seasonal biting nuisance, that can be persistent and aggravating.

6 CONTROL MEASURES

6.1 *Principles of Mosquito Management -*

The New South Wales Government identifies mosquito-borne disease as an issue that requires management. By controlling human exposure to mosquito biting, disease transmission and biting nuisance will be managed.

Management of the public health risks associated with mosquito-borne disease is best achieved using a number of integrated strategies each aimed at minimising exposure of humans to mosquito biting.

- Biological control uses or enhances natural enemies of mosquitoes such as fish; physical control makes habitats less suitable for mosquito production;
- Chemical control uses insecticides that target immatures or adults; and
- Legal control can force uncooperative parties to eliminate breeding habitats on their property or face financial penalties (Metzger, 2009)

The following list identifies the principles of integrated mosquito management, as described in "Framework for Mosquito Management in Victoria" (VDSE, 2004). These principles form the basis of the approach taken by this report to manage the mosquito impact on the future occupants of the proposed residential lots.

- Mosquito management involves health, environmental and socioeconomic values.
- While disease control is the primary focus, reduction in nuisance value of mosquitoes is a legitimate aspect of improved community well being.
- Mosquitoes are an integral part of the ecosystem and their treatment may have positive and negative environmental impacts.
- Effective mosquito management requires a holistic approach and the cooperation and coordination of all stakeholders.
- Integrated mosquito management includes mosquito reduction, personal protection, community education and land use planning.
- Coordinated programs and on-going monitoring are necessary for effective mosquito management in the long term.
- Treatment of mosquito larvae or adults is an on-going activity.
- Treating larvae is generally more effective and targeted than treating adult mosquitoes.

6.2 *Mosquito Management - Tweed Shire Council*

Tweed Shire Council carries out abatement measures against biting midge and mosquitoes throughout extensive areas within the Council boundaries. These measures are part of management strategies that have been developed and implemented by Tweed Shire Council for both land under Council control and private landholdings with the cooperation of the landowner.

Tweed Shire Council has not undertaken any of these control measures on any sites within 1km of the proposed residential lots.

As described within the Tweed Shire Council DCP, these integrated management measures include:

- Biological Chemical Control- biological larvicides such as the soil bacteria *Bacillus thuringiensis* var *israelensis* (Bti) and the insect growth regulator Methoprene.
- Chemical Control - chemical larvicides such as Temephos and Maldison.
- Chemical Control – thermal fogging using pyrethroid adulticides.

- Biological Control - larvivorous fish stocking.
- Habitat modifications have been carried out to some of Council's suitable biting insect breeding areas:
 - Runnelling.-interconnects open saltmarsh pools with shallow hand dug channels or "runnels", back to the estuary. .
 - Improved backwater flushing - tidal channels dug to bring daily tidal flushing to the area.
 - Partial impoundment - barrage maintains a more static water level in the wetland while still allowing tidal flushing.
 - Sandbar excavation - removing the top sand layer from tidal river sandbars breeding biting midge.

7 RECOMMENDATIONS

7.1 *Mosquito Management – Proposed Development*

7.1.1 *Development Site Vegetation/Landscaping*

The construction of access roads, services and stormwater treatment devices will require bulk earthwork activities across the majority of the site. Existing native vegetation will be retained within the Conservation Area and weed infestations removed before any supplementary planting is carried out.

The only proposed contiguous vegetative corridor is in the central part of the site. Only 20 dwelling sites border this area. The landscape plan shows a buffer on the northern side of the site and a major road bisecting the central vegetative corridor. A transmission line easement corridor is also located within the Conservation Area and provides a physical buffer between this area and the SEPP 14 wetland to the north. Both the road and the transmission easement would provide a significant break in the vegetative cover and provide a barrier to biting insects moving along the vegetative harbourage.

Where practicable, it is recommended that breaks are provided in the vegetation stands throughout the site to discourage biting insects using such vegetation as corridors to dwelling sites. Any vegetation removal must not breach Tree Preservation Orders or riparian and native vegetation protection requirements.

7.1.2 *Development Earthworks/Roadworks*

As recommended within the Development Control Plan (TSC, 2008):

- Land fill operations to elevate subdivisions above flood height should be carried out with due regard to minimising impedance of surrounding drainage systems.
- Roadway embankment construction should be designed to eliminate (if possible) any standing water impoundment or redirection of water flows into potential mosquito breeding areas.

7.1.3 *Design of Stormwater Management Devices*

The consideration of stormwater drainage design and route should aim to avoid silt accumulation at the stormwater estuary discharge points, and be free draining. Care must be taken to avoid increasing the tidal influence on freshwater wetland (TSC, 2008).

Dry systems designed to drain completely following a storm event and remain dry are generally recommended as best practice to minimise potential of mosquito breeding on the subject site.

Examples of dry systems as listed by “Managing Mosquitoes in Stormwater Treatment Devices” (Metzger, 2009) include:

- extended detention (dry detention) basins,
- vegetated swales,
- infiltration devices, and
- media filters.

As a general principle, such dry stormwater structures should be designed so they do not hold standing water for more than 72 hours. Piping should be designed with adequate slopes to drain fully and to prevent buildup of sediment between maintenance periods.

The stormwater management devices to be installed on the subject site should be selected using the hydraulic grade line of the site to enable water to flow by gravity through the structure. Pumps are not recommended because they are subject to failure and often require sumps that hold water.

The use of loose riprap, or concrete depressions to dissipate energy at stormwater outlets is not best practice for mosquito management as they may hold standing water. Consideration should be given to installing a low maintenance sloped concrete slab with imbedded rocks or concrete blocks is recommended as an alternative.

The SWAMP addresses these design requirements.

The three proposed detention basins are designed to be free-draining and would not provide biting insect habitat.

Diffuse stormwater discharge would be provided for the freshwater systems and would be achieved through the construction of under-drained swales with level-spreader devices. This presents a number of benefits from engineering, ecological and pest management perspectives.

The proposed lake within the central gully would be designed to achieve best practice in managing biting midge and mosquito populations. Consultation with Council’s Entomological Officer is recommended to achieve the best outcome for this site. Stocking with larvivorous fish may help minimise biting insect breeding in the stored water area.

7.1.4 Maintenance of Stormwater Management Devices

There are several conditions that may increase the probability of breeding mosquitoes over time in various stormwater management devices following construction. Appropriate maintenance should be carried out on the stormwater management devices to minimise the occurrence of these conditions:

- Clogging
- Establishment of invasive or exotic vegetation
- Groundwater fluctuations
- Non-stormwater runoff (i.e., increases in runoff frequency, residence time, and/or volume)
- Scouring and sediment erosion generating silt accumulation
- Structural damage (e.g., shifting or settling, roots)
- Trash and sediment accumulation (e.g., formation of pools, clogging, redirected water flows)
- Vandalism
- Vegetation overgrowth

Attachment 14.1 in the SWAMP provides details on the Stormwater Management Plan including monitoring and maintenance. Maintenance guidelines for individual devices are primarily site-specific and are beyond the scope of this Biting Insect Management Plan.

7.1.5 Residential Living

Despite control measures being implemented at the design and construction stage of the subdivision, it is expected there will always be periods when the biting insect population on the subject site will become a nuisance to future occupants.

As suggested by Tweed Shire Council, the following actions will help alleviate or minimise the problem for the future occupants:

- Keep vegetation surrounding the house to a minimum and keep lawns well mowed. Landscaping with tallish vegetation with an upper tree canopy is preferable to low, dense vegetation in midge prone areas as it allows a much better airflow near ground level.
- Screen all openings to water tanks
- Ensure potential water holding containers such as old tyres, buckets, bottles are not stored outdoors where rainwater may fill them.
- Empty birdbaths and pet drinking dishes at least weekly.
- Keep roof gutters clean to avoid holding water for long periods.
- Keep ornamental ponds stocked with native species that will feed on mosquito larvae (see Tweed Shire Council for fish stock).
- Keep insect screens well maintained and use smaller mesh sizes if biting midge are a problem entering through fly screens. Screens can also be sprayed with low toxic surface sprays containing synthetic pyrethroids.
- Close leeward windows or keep more windows on the windward side of the dwelling open as this will tend to pressurise the dwelling and increase draft from the leeward side reducing the biting insects ability to enter.
- Ceiling fans or other air circulation devices that increase air flow inside the dwelling may also decrease biting insect nuisance indoors.
- Mosquito coils burning in the house may also be necessary during periods of severe biting insect nuisance.
- Insect trapping devices using ultra violet light as the attractant are generally useless for decreasing biting midge numbers in suburban yards. It is also unlikely they do much to reduce mosquito numbers in the yard. These traps will attract a broad spectrum of night flying insects to the light from some distances away. The problem, particularly with biting midge, is that the midge are too small to arc across the electrocuting grid so are brought into the area but not disposed of. May beneficial insects are also killed by these devices.
- Biting midge are biologically linked with the lunar cycle and related tidal cycles. The three major pest species in the Tweed area have different emergence periods. One species is at its peak just following the new full moon, other species around half moon period and the other during the period leading up to the new and full moon. If residents take note of the major attack periods in the area, they may be able to better plan their outdoor activities.

- Avoid outdoor activities like car washing and gardening during the early morning and late afternoon when biting insects are most active.
- Wear personal protection in the form of long sleeved clothing and insect repellants when outdoors during biting insect activity periods to minimise exposure to these insects. Sensitive individuals and young children can use liberal amounts of baby oil applied to exposed skin.
- Use vitamin B1 (thiamine) to prevent acute allergic reaction and allow development of immunity. See a medical practitioner or Tweed Shire Council for personal dosage information and advice .

7.1.6 Subdivisions

To help minimise biting insect nuisance in housing subdivisions proposed near biting midge or mosquito breeding areas the following is suggested:

- Specified open buffer zones between insect breeding areas and dwelling houses. This zone will vary widely with circumstances, from as little as 50m to 1km. The proposed subdivision adjoins identified mosquito breeding areas however the VMRP and the SWAMP include measures to minimise mosquito breeding in this area. The proposed Conservation Area including the degraded freshwater wetland EEC would be rehabilitated via regeneration and revegetation. Stormwater discharges into this area would be managed to ensure impacts were minimised. These measures would improve the current situation where un-treated agricultural runoff flows into the degraded, weed-infested area.

Biting insect, particularly biting midge, will follow vegetated corridors from breeding areas to residential areas. This can be contradictory to fauna habitat recommendations where a contiguous vegetated corridor is preferred.. The project site would be generally cleared of vegetation during bulk earthworks. The existing drainage system in the central gully area (isolated farm dams and informal agricultural drains) would be removed and a constructed stormwater treatment train installed incorporating measures to minimise biting insect habitat.

The central gully would be landscaped to provide a shaded rainforest gully and habitat for local fauna (LM, 2012). The proposed Broadwater Parkway and transmission easement would provide a physical barrier between the residential area and the biting insect habitat to the north. The VMRP includes a 100m buffer to the SEPP 14 wetland area to the north of the project site and the rehabilitation of this area would be in accordance with biting insect management best practice. Land fill operations to elevate subdivisions above flood height should be carried out with due regard to minimising impedance of surround drainage systems.

- Roadway embankment construction should be designed to eliminate (if possible) any standing water impoundment or redirection of water flows into potential mosquito breeding areas.
- Consideration of stormwater drainage design and route. Drains should be designed to avoid silt accumulation and be free draining. Exit points from drains into waterways or wetlands should be designed to avoid habitat changes at discharge points . Such will occur if organically enriched drainage from urban areas is directed into mangrove areas or tea tree wetlands. Misdirected stormwater into these habitats can create new midge and mosquito breeding sites or increase existing breeding by favouring certain aquatic and semi aquatic vegetation species that restrict drainage flow. Silt accumulation at stormwater estuary discharge points, combined with regular low flow water discharge particularly suite the biting midge species *C. Sumimmaculatus*. Care must be taken to avoid increasing tidal influence back up drains into freshwater wetlands as this increases saltmarsh mosquito favourability.

7.1.7 Water bodies (includes constructed wetlands)

- Water quality of lakes and lagoons should be suitable for mosquito eating larvivorous fish to breed.
- Water to be stocked with suitable native larvivorous fish. Council will advise and assist with this.
- Waterway design to avoid the potential for extensive emergent aquatic plant growth. Generally this will require the majority of the water body to be deeper than 2m, though shallow ingress and egress points supporting aquatic growth to act as sediment and nutrient traps are favoured. If water-lillies colonise waterbodies extensively, regular removal may be necessary to reduce the breeding potential of several opportunistic mosquito species that spend their larval stages attached to the stems of these plants.

The LM includes a lake within the central portion of the project site. This lake does not form part of the stormwater treatment train and the conflicting depth requirements for constructed wetlands (depth <2m for aquatic vegetation) would not apply in this case. The lake would be managed to encourage larvivorous fish breeding.

8 CONCLUSIONS

The presence of biting insect breeding habitat nearby the proposed Altitude Aspire development site presents a risk of biting nuisance and negative impact on human health from transmission of Ross River virus and Barmah Forest virus for the future occupants of the proposed residential subdivision.

This risk is proposed to be managed by minimising mosquito harbourage and breeding on the project site through the implementation of best practice landscape planning, vegetation and stormwater management during development, and encouragement of mosquito avoidance practices during occupation.

Recent modifications to the existing floodgates within the previously disturbed SEPP 14 wetland area have resulted in changes in the hydrology and biodiversity of this area. These changes have led to biting insect habitat being minimised.

The proposed Wetland Restoration Plan for the adjoining disturbed SEPP 14 wetland area and the funded "Fish In Mozzies Out" project targeting the mangrove area west of the development site aim to reduce biting insect habitat.

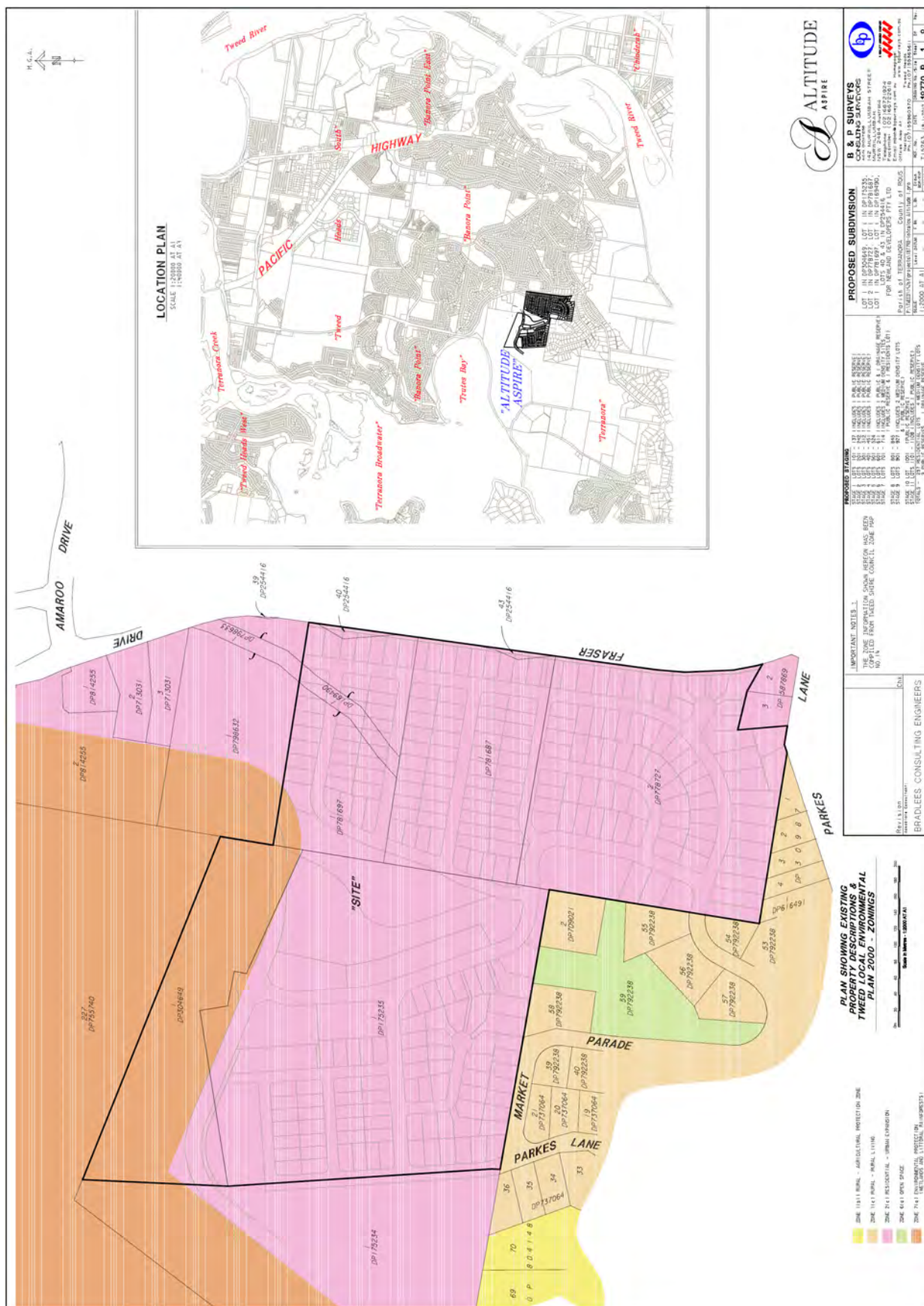
By implementing the recommendations within Section 7 of this Biting Insect Management Plan, in conjunction with the habitat modification measures being implemented off-site, the public health and biting nuisance risk to residents in the proposed subdivision would be reduced.

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10 APPENDICES

10.1 Appendix 1 Existing Zone & Location Plan

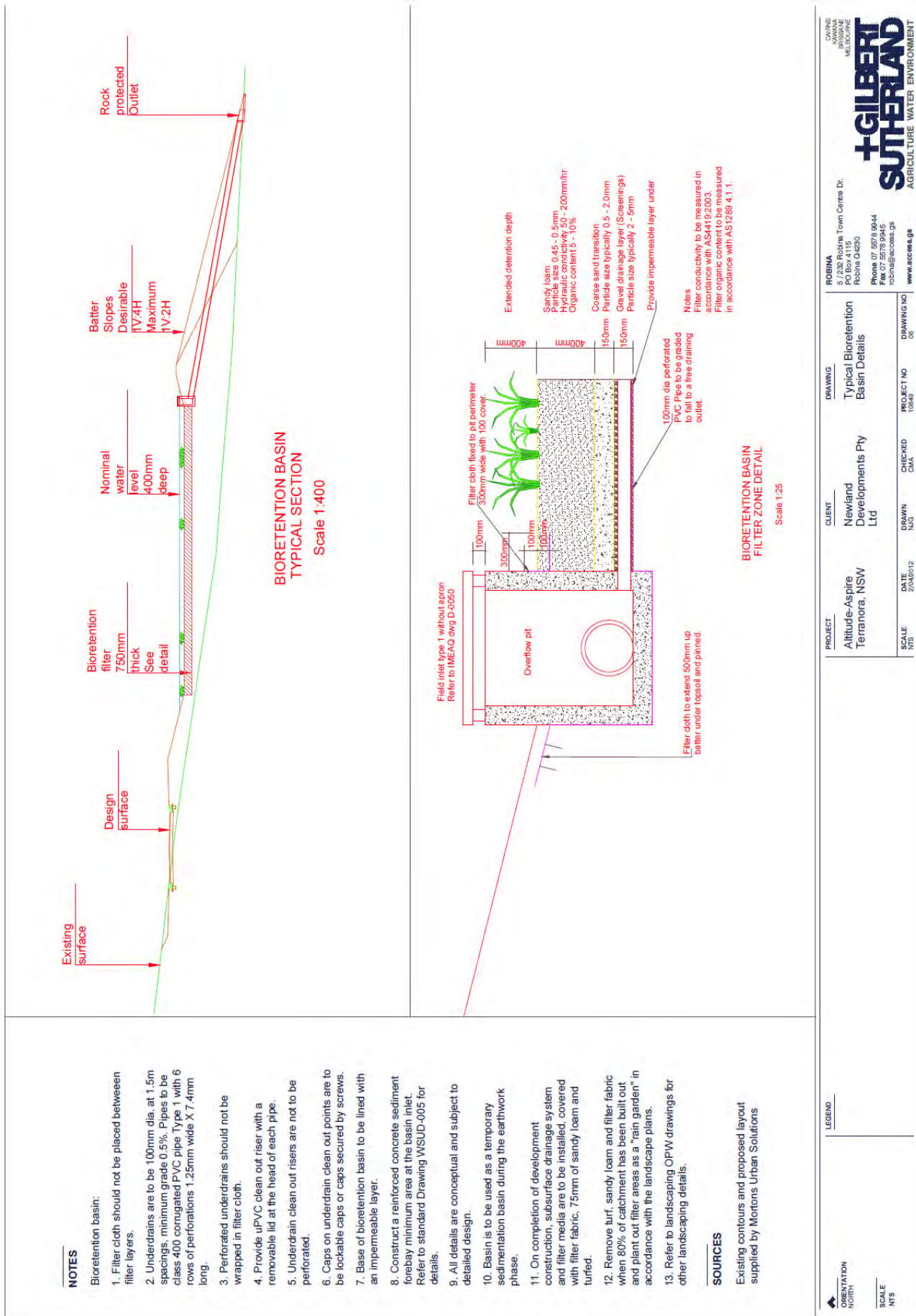


10.2 Appendix 2 Lot Layout & Context

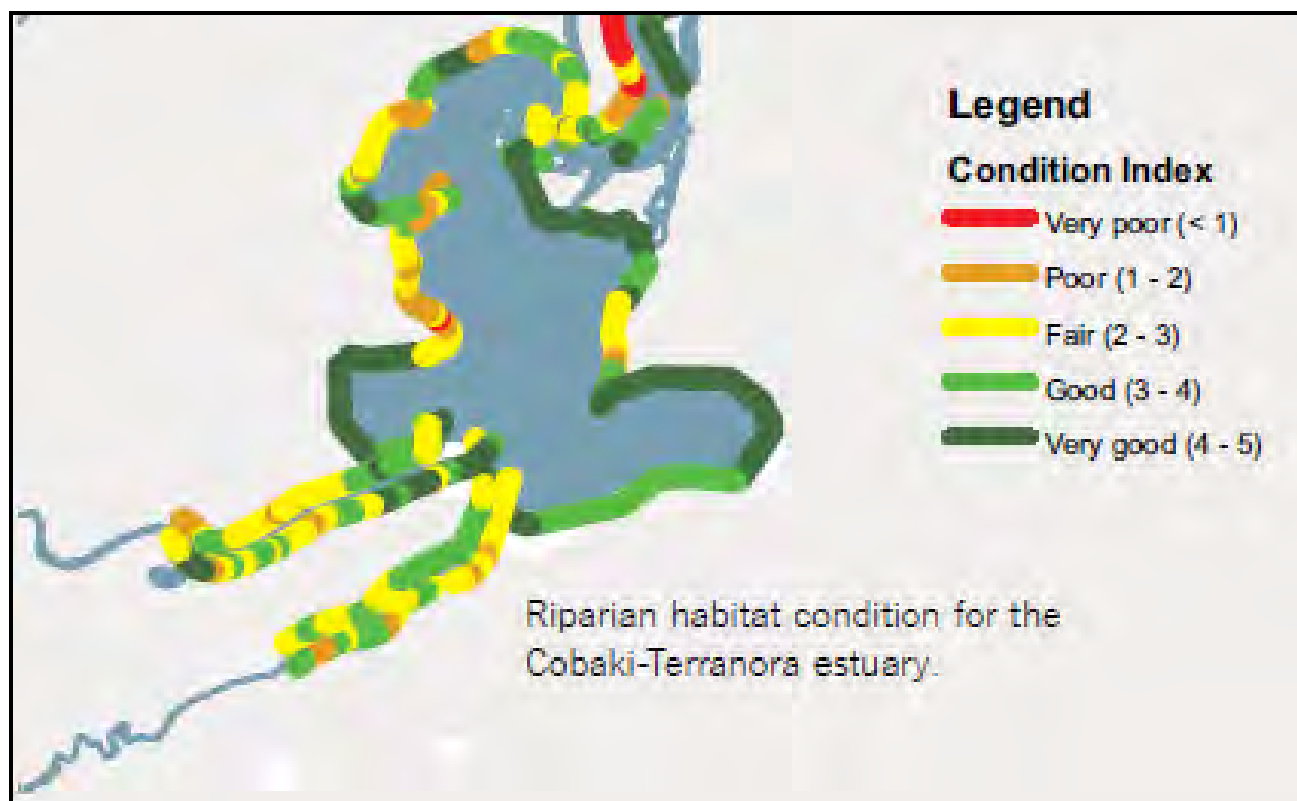


10.3 Appendix 3 Proposed Bioretention Basins (SWAMP, 2012)





10.4 Appendix 4 Riparian Habitat Condition (IWC, 2009)



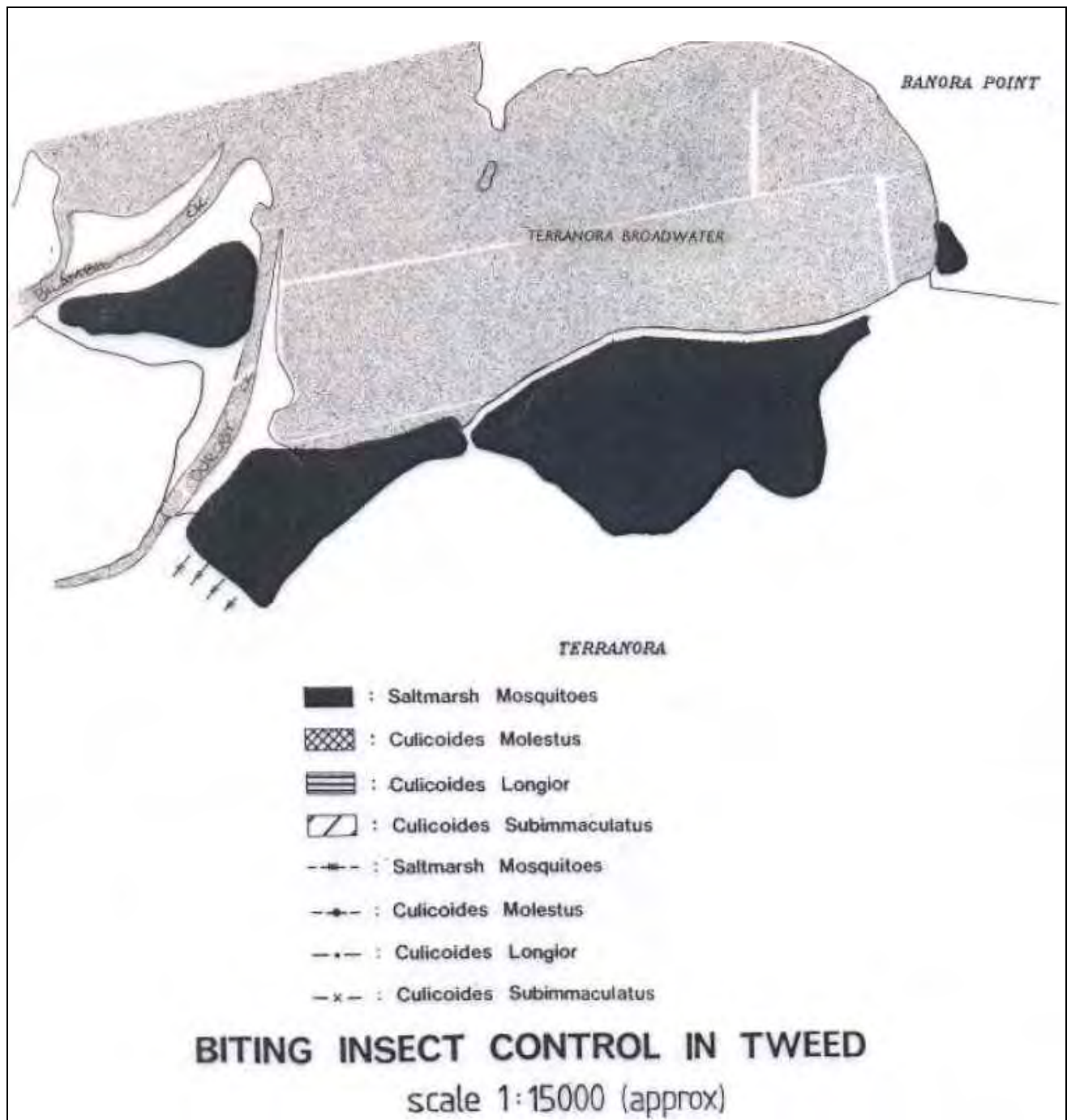
10.5 Appendix 5 Landscape Masterplan (LM 2012)



10.6 Appendix 6 Vegetation Rehabilitation Areas (VMRP 2012)



10.8 Appendix 8 Tweed Shire Council Biting Insect Breeding Ground Mapping



Source Tweed Shire (2008)

10.9 Appendix 9 NSW Health Fact Sheets

Infectious Disease Factsheet

Ross River Fever

Last updated: 16 January 2008

What is the Ross River fever?

Ross River virus is one of a group of viruses called arboviruses (or arthropod-borne viruses), which are spread mainly by blood-sucking insects.

- Ross River virus is a germ that infects people, particularly in rural areas, sometimes causing a flu-like illness with joint pains, rash and fever.
- Ross River virus is not fatal.

What are the symptoms?

Many people who are infected with the virus will never develop symptoms.

- Some people will have flu-like symptoms that include fever, chills, headache and aches and pains in the muscles and joints.
- Some joints can become swollen, and joint stiffness may be particularly noticeable in the morning.
- Sometimes a rash occurs on the body, arms or legs. The rash usually disappears after seven to 10 days.
- A general feeling of being unwell, tired or weak may also occur at times during the illness. This may affect work performance.

How is the virus spread?

The virus is spread by certain types of female mosquitoes.

- Female mosquitoes feed on animals and people. If they feed on the blood of an infected animal, the mosquito may become infected. The virus then multiplies within the mosquito and is passed to other animals, or people when the mosquito feeds again.
- The number of infections tends to peak in the summer and autumn months.
- The virus is not spread directly from one person to another.
- Approximately 30 per cent of people infected with the virus will develop symptoms three to eleven days after being infected.

Who is at risk?

People who are in contact with known mosquito habitats and who live in warm, humid climates near bodies of water will be most at risk of a mosquito bite and as a consequence the Ross River virus.

How is it prevented?

- Avoid being bitten by mosquitoes, especially in the summer and autumn months when infections are more common.
- Various species of mosquitoes bite at different times. Avoid being outside in the late afternoon and dusk. Mosquitoes are usually most active up to one to three hours after sunset and again around dawn.
- When outside wear loose fitting, light coloured clothing that covers your arms and legs, and use an insect repellent that contains the chemical diethyl toluamide (DEET) or picaridin.
- Fit fly screens to all windows, doors and chimneys and keep them in good repair.
- Use a knockdown insecticide in bedrooms half an hour before going to bed. Use insecticides according to instructions.
- Ensure open containers of water are removed from around the home to prevent mosquitoes breeding. Cover the openings to water tanks with fine steel mesh to prevent mosquitoes from laying eggs in the tank.
- When camping take precautions such as using flyscreens on caravans and tents and by sleeping under mosquito proof nets. Take particular care while fishing, ensuring that you follow personal precautions to avoid being bitten by mosquitoes.

How is it diagnosed?

Ross River infection is diagnosed by detection of antibodies against the virus in the blood. Blood test taken early in the illness and again two weeks later may be required to confirm the infection.

How is it treated?

There is no specific treatment for Ross River virus infection.

- Your doctor will be able to advise you on medications that will help ease the discomfort of the symptoms.

What is the public health response?

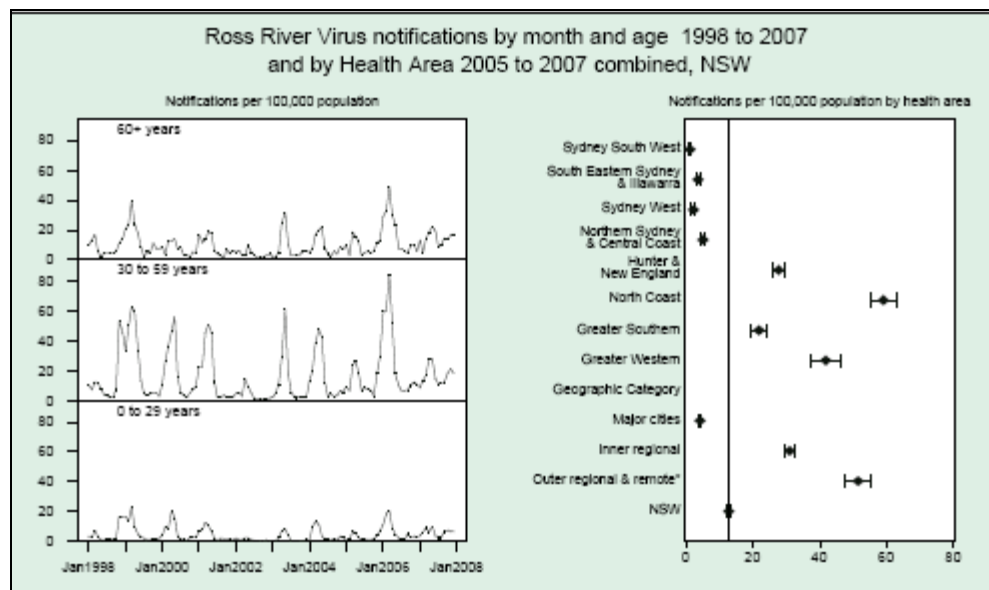
Laboratories are required to notify cases of Ross River, and other mosquito-borne disease to the public health unit. Public health staff monitor the geographic spread of Ross River virus infections and provide information about avoiding mosquito-borne diseases.

Ross River fever is caused by a viral infection, transmitted through mosquito bites. Prevention relies on avoiding mosquito bites. There is no specific treatment.

Source: <http://www.health.nsw.gov.au/factsheets/infectious/rossriver.html>

Source: http://www.health.nsw.gov.au/factsheets/infectious/barmah_forest_virus.html

10.10 Appendix 10 Arbovirus Reports



Source: NSW ASVMP, 2007

TABLE 2

NOTIFICATIONS AND RATES OF ROSS RIVER VIRUS DISEASE AND BARMAH FOREST VIRUS DISEASE BY AREA HEALTH SERVICE GROUPED ACCORDING TO VIROGEOGRAPHIC REGION, NEW SOUTH WALES, JANUARY 1995 TO FEBRUARY 2004

	Area health service	No. RRV disease cases	Crude rate per 100,000 per annum	No. BFV disease cases	Crude rate per 100,000 per annum
Sydney	CS	41	0.9	9	0.2
	NS	148	2.2	15	0.2
	WS	109	1.8	11	0.2
	WEN	181	6.5	8	0.3
	SWS	70	1.0	7	0.1
	SES	79	1.2	14	0.2
Coastal	NR	998	42.9	747	31.8
	MNC	803	34.8	984	42.1
	HUN	785	16.4	167	3.4
	CC	316	12.6	36	1.3
	ILL	275	9.0	114	3.7
	SA	230	14.1	218	13.5
Inland	NE	527	33.1	47	3.0
	MAC	440	47.5	18	1.9
	MW	202	13.5	10	0.7
	GM	928	40.3	51	2.2
	FW	391	88.5	35	8.0
All Sydney		628	1.9	64	0.2
All Coastal		3,407	20.4	2,266	13.5
All Inland		2,488	31.8	161	2.4

CS = Central Sydney, NS = Northern Sydney, WS = Western Sydney, WEN = Wentworth, SWS = South West Sydney, SES = South Eastern Sydney, NR = Northern Rivers, MNC = Mid-North Coast, HUN = Hunter, CC = Central Coast, ILL = Illawarra, SA = Southern Area, NE = New England, MAC = Macquarie, MW = MidWest, GM = Greater Murray, FW = Far West

RRV = Ross River virus, BFV = Barmah Forest virus

Source: Notifiable Diseases Database, Communicable Diseases Branch, NSW Department of Health; and GODSEND (Graphical Online Data Surveillance and Evaluation of Notifiable Diseases), Centre for Epidemiology and Research, NSW Department of Health.

Source: Doggett (2004)

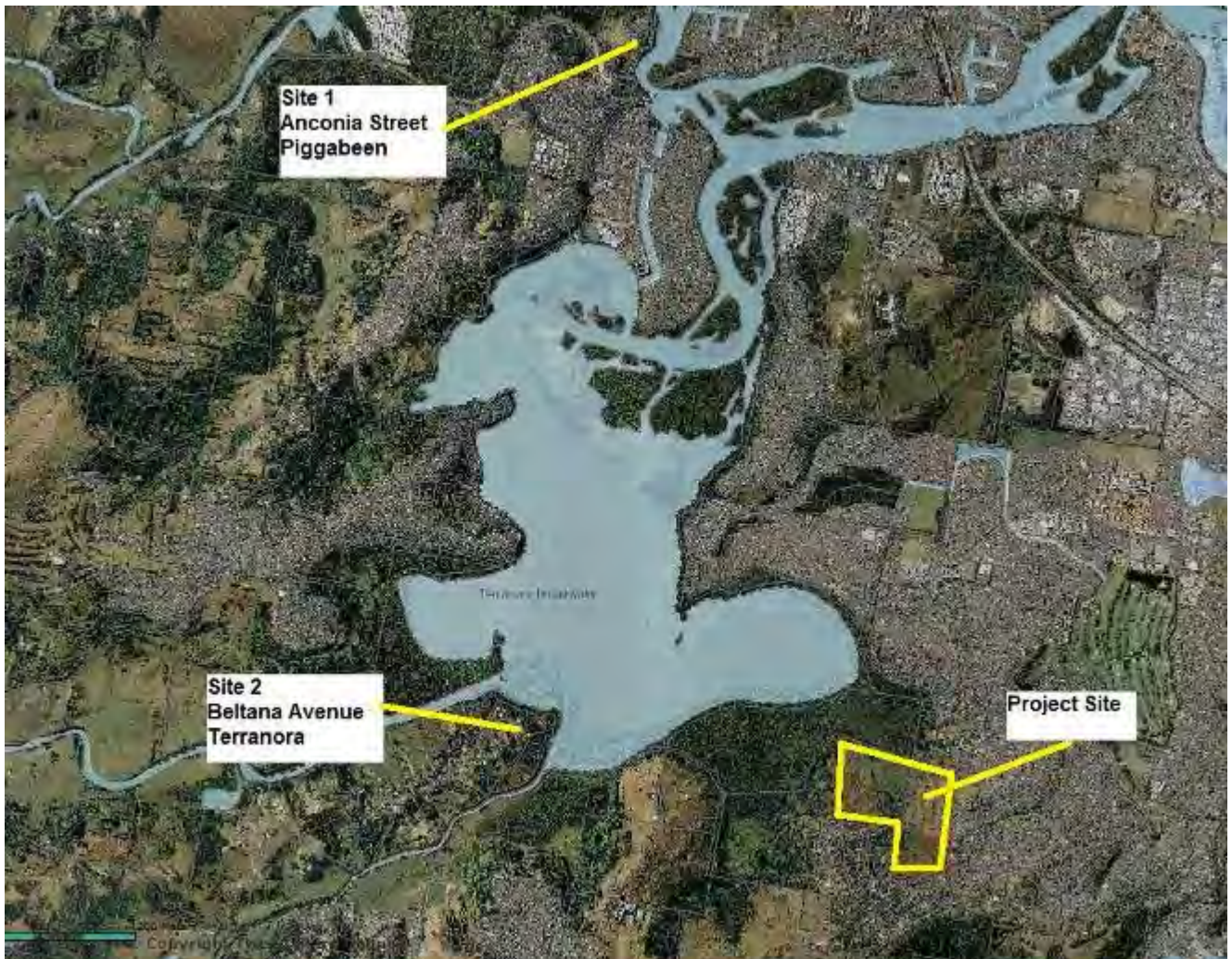
Feb 2010 - April 2010

Species	Feb 2010 >				Mar >				Apr >			
	7	14	21	28	7	14	21	28	4	11	18	25
<i>Aedes excrucians</i>		1										
<i>Aedes albopictus</i>	27	24		2	23	15	10		2		2	
<i>Ae. burginensis</i>		2										
<i>Ae. triseriatus</i>												
<i>Ae. albopictus</i>			1								1	
<i>Ae. albopictus</i>	2	3	23		3	5	1		2		4	1
<i>Ae. quinquevittatus</i>												
<i>Ae. triseriatus</i>		1	2								1	
<i>Ae. albopictus</i>												
<i>Ae. vigilans</i>	31	193	84	5	12	16	13		4		9	5
<i>Ae. vigilans</i> (M)						1						
<i>Anopheles annulipes</i>												
<i>Culiseta inornata</i>						1						
<i>Cu. annulipes</i>	1	3	1								2	
<i>Cu. annulipes</i> (M)												
<i>Culex annulirostris</i>	20	38	24	13	17	55	11		3		55	7
<i>Cu. annulirostris</i> (M)						1						
<i>Cu. australis</i>		1		1		2					2	2
<i>Cu. edwardsi</i>	2		1		2	9	1					4
<i>Cu. nebulosus</i>		1	2			3	2				12	3
<i>Cu. quinquevittatus</i>		8	1		2	1	1				1	
<i>Cu. allani</i>	02	381	99	5	29	12	20		1		37	4
<i>Cu. allani</i> (M)	1											
<i>Manicoria unifasciata</i>												
<i>Manicoria elegans</i> (M)												
<i>Chenobrya rufipes</i>												
<i>Verulima funebris</i>	2	28	17			10			4			
<i>Verulima</i> sp. Mark no. 52												
Weekly Totals	149	684	235	25	88	133	60		16		125	25
LTA Ae. vigilans	27	18	17	40	44	11	10	27	8	5	5	20
Long Term Ave. Total	125	139	139	200	187	124	143	126	68	35	51	63
Species	Feb 2010 >				Mar >				Apr >			
	7	14	21	28	7	14	21	28	4	11	18	25

10.11 Appendix 11 Historic aerial photography showing drained and banded wetland area



10.12 Appendix 12 Arbovirus monitoring - Tweed Heads area



Source: Google Earth 2010 (Base photography)

10.13 Appendix 13 Local News Articles (Tweed Link)

Mosquito control hampered by winds and ideal breeding conditions

Council's Entomology Unit has experienced a difficult mosquito control period.

Seasonal conditions including persistent strong winds have caused the cancellation of two aerial larvicide treatments.

Mosquitoes were a particular problem around parts of Cobaki, Bilambil Heights and Terranora over the last month.

The difficult mosquito season has developed from last year when the extremely dry winter/spring conditions allowed the drying out of wetlands and loss of fish and other natural mosquito larval predators.

The dry conditions led to increased mosquito productivity when the wetlands re-flooded after rain and big summer spring tides.



Mosquitos have been difficult to control following ideal breeding conditions.

The very dry conditions also led to acute water acidity in several large semi-tidal wetlands at Terranora and Cobaki following re-flooding.

Local mosquitoes are highly tolerant of acidic conditions; however, their natural predators avoid, or are killed by acidic water.

Mosquito larval monitoring carried out at Terranora indicated mosquito larval densities of over 30,000 per square metre of water covering many hectares of mangrove backwaters.

The recent heavy rain has flooded extensive lowland areas throughout the Tweed.

Treatment of mosquito larvae in highly productive sites in these areas was carried out last week.

The recent rainfall will also have filled containers in resident's yards.

Remember to empty or remove water from such containers to avoid contributing to the mosquito problem.

Mosquito outbreak fears

COUNCIL has started the aerial spraying of low-lying areas in the shire in a bid to prevent a mosquito outbreak following the recent flood rains.

Council entomologist Clive Easton said aerial spraying had been conducted over the Terranora Broadwater and further ground-level spraying will be conducted to eliminate breeding sites.

The spraying has been launched to avoid a potential outbreak of mosquito-borne diseases such as Ross River virus that are active at this time of the year.

However, Mr Easton warned that with the amount

Spraying starts on wetlands

of water lying around after the floods, it would be impossible to treat all the effected areas in the Tweed.

"The rapid development time of mosquitoes at this time of year and the vast areas of inundated land which requires survey, means control will not be possible in many areas," said Mr Easton.

"Residents can help in mosquito reduction by ensuring

water fill backyard containers such as old buckets, tyres and plastic cartons are emptied and stored under cover."

Mr Easton said the timing of the floods had coincided with the time of year when Ross River virus is at its most active.

"Some sites already surveyed have had extremely high mosquito larval densities, equivalent to 200 wrigglers per tea cup sized dip sample.

"An upsurge in mosquito numbers is likely to increase the risk of Ross River virus in the community."

Mr Easton said residents should wear loose-fitting long sleeved clothing and mosquito repellent.

Mosquitoes out in full force

COASTAL mosquito activity has begun very early this season and is likely to continue.

NSW Health recently issued mosquito-virus warnings for north coast areas and advice on mosquito avoidance.

These warnings were issued due to recent rainfall and a high likelihood of above-average summer rainfall in the region, a result of the established la nina event in the Pacific Ocean.

Council's Entomologist Clive Easton said long-term mosquito monitoring by Council in the region has shown that problem mosquito seasons occur when la-nina-like conditions cause above-average rainfall, following extended dry seasons. It is also common to have well-above predicted tides occurring during such conditions.

"Large tides flood saltmarsh areas causing additional mosquito hatches and therefore exacerbating the mosquito problem," Mr Easton said.

Council recently organised aerial spraying of mosquito larvae with mosquito-specific bacteria at North Tumbulgam and areas adjacent to Terranora Broadwater.

Many other mosquito-problem areas have also been treated by hand with biological larvi-

cides over the last month.

Large predicted tides for late November combined with likely rainfall events are predicted to hatch another generation of mosquitoes over coming weeks.

Where possible, Council plans to treat any extensive mosquito hatches by air.

Another series of very large tides are also predicted to occur over Christmas and are likely to cause mosquito eggs to hatch in extensive coastal lowlands. Aerial control is proposed for Boxing Day to control these mosquitoes.

Residents can help reduce the mosquito menace by removing water catching objects from their yards or tipping out any accumulated water in such objects. Maintaining roof gutter flow and water tank screens is also very important.

"Personal avoidance of mosquitoes can help reduce the risk of contracting Ross River fever or Barmah Forest virus," Mr Easton said.

"Avoidance can also be aided by keeping insect screens maintained and using an effective repellent combined with loose fitting, long clothing when mosquitoes are active - particularly around dawn and dusk," he said.

10.14 Appendix 14 NSW Department of Health Correspondence

Mr Darryl Anderson
Director
Darryl Anderson Consulting Pty Ltd
SUITE 7
Corporate House
8 Corporation Circuit
Tweed Heads South NSW 2486

NORTH COAST
AREA HEALTH SERVICE
NSW HEALTH

RECEIVED

24 NOV 2010

Your ref : MET 07 / 133 Pt 3

Dear Mr Anderson

Re – Proposed 317 Lot Residential Subdivision at Lot 1 DP 304649, Lot 1 DP 175235, Lot 1 DP 781687, Lot 2 DP 778727, Lot 1 DP 781697, Lot 1 DP 169490 and Lots 40 & 43 DP 254416 Fraser Drive, Terranora – Altitude Aspire (Major Project No. MP 09-0166).

Please find a brief response as requested on the abovementioned proposed residential subdivision, with particular comment on the impact of biting insects.

It must be noted that due to the request for a response within a week, this response is only a brief overview of the general public health considerations prior to development as identified by this office.

Ecologically Sustainable Development (ESD) can be defined as that which meets the needs of the present generation without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development, 1987). ESD is development that is broadly defined as desirable change based on social goals (which include good health), while sustainability entails eliminating the disruption and harmful effects of human activities on ecosystems (including the community's health). In NSW, ESD is legislatively defined in the Environmental Planning and Assessment Act 1979 [ref. Protection of the Environment Administration Act 1991 S.6(2)] and addressed in the Local Government Act 1993 under S.7 Purposes of Act; S.8(1) Council Charter; and S.89 Considerations for Approvals.

Important health issues associated with developments are sometimes overlooked because they are not adequately addressed in the initial planning process and the existing environmental impact assessment framework. To this end, I would draw your attention to the "North Coast Public Health Unit – Regional Planning and Public Health" document which is a brief summary of issues that need due consideration prior to development. (copy attached) Also, this office would recommend perusal of the "Healthy Urban Development Checklist" which provides a concise overview of health related issues that NSW Health considers to be important when planning and assessing proposed residential developments. (copy available – NSW Health website www.health.nsw.gov.au)

In regards to the impact of biting insect, it must be noted that the notification of arboviral diseases – notably Ross River and Barmah Forrest virus is very high for the Mid and Far North Coast Regional Areas.

With this in mind, this office would ask that the issue of mosquito management and control be given sincere attention. Mosquito management requires :- **1. Mosquito risk assessment** – Identification of actual and potential breeding habitats along

Population Health, Planning and Performance Directorate
Head Office: 31 Uralba Street PO Box 498 Lismore NSW 2480
Tel (02) 6620 7500 Fax (02) 6622 2151

with the identification of pest and vector species. In regards to urban development – assessment of the design of constructed wetlands and consideration of buffer zones where natural wetlands are concerned. Sound, scientifically verified surveillance and control strategies. The abovementioned risk assessment process needs to be informed by professional entomological advice. **2. Establishment of surveillance program** – Required foundation for management includes:- Knowledge of adult populations, routine sampling, use of efficient traps using multiple fixed sampling sites, knowledge of larval populations and finally sound knowledge of climate and possible adverse events. **3. Constant review of control strategies** – short or long-term strategies can include the use of :- Adulticides, traps, habitat modification, larvicides (*contact poisons / ingested toxins*), larval insect growth regulators and biological control. **4. Establishment of management plan** – Should include the following components :- surveillance/ quality control, ongoing knowledge of vectors and habitat, selection / identification of control strategies, emergency response (*event base*), balancing of public health risk with wetland objectives, cooperation with local authorities, ongoing funding streams, legal instruments / binding responsibilities and finally community education / issue identification.

Management control / operational instruments include:- NSW Government – Department of Planning – *Settlement planning guidelines – August 2007 – Mid and Far North coast Regional Strategies*. Local Environment Planning process and Development Control Planning process.

It is noted from your attached correspondence, that the requirements / recommendations set out in the abovementioned planning process have received due consideration for the development stage of the proposal.

This office would comment however, that past experience has show that despite very sound and sincere planning processes, the challenge is always the sustainability of the management plan and processes after the development proposal is approved. This has been a particular issue when dealing with mosquitoes and other biting insects. To ensure that risk assessment, environmental modification, vector monitoring and necessary control strategies are maintained in perpetuity is vital. Legally binding and fully funded management processes must be put in place when the development is approved, otherwise, once the blocks are sold and the population move in (*sometimes years down the track*) problems often occur and it is left up to local councils and even residents themselves to fund mosquito and biting insect control and mitigation strategies. Trusting that this quick response provides assistance to your organisation during current deliberations.

Should you wish to further discuss this issue, please do not hesitate to contact the undersigned on phone :- 02 66207500.

Yours truly,



Greg Bell
Assistant Director Public Health
North Coast Area Health Service
22nd November 2010

Encl