## Table 3-37: High Manning's "n" HEC-RAS model results

| Reach | Chainage | Flow | Min Channel Elev. | Water Surface Elev. | Max Channel Depth | Channel Velocity | Flow Area | Top Width |
|---|---|---|---|---|---|---|---|---|
| | | (m3/s) | (m) | (m) | (m) | (m/s) | (m2) | (m) |
| 2 | 1500 | 13.1 | 93.84 | 95.01 | 1.17 | 1.55 | 8.46 | 14.55 |
| 2 | 1450 | 13.1 | 89.49 | 90.86 | 1.37 | 1.31 | 10.02 | 15.08 |
| 2 | 1400 | 13.1 | 82.72 | 84.04 | 1.32 | 2.56 | 5.13 | 7.75 |
| 2 | 1350 | 13.1 | 76.96 | 78.82 | 1.86 | 1.12 | 11.71 | 12.59 |
| 2 | 1300 | 13.1 | 74.64 | 74.82 | 0.18 | 1.32 | 9.89 | 56.47 |
| 2 | 1250 | 13.1 | 67.89 | 69.68 | 1.79 | 0.91 | 14.39 | 14.19 |
| 2 | 1200 | 26.2 | 67.02 | 67.58 | 0.56 | 1.08 | 24.34 | 52.07 |
| 2 | 1150 | 26.2 | 60.58 | 61.66 | 1.08 | 2.21 | 11.87 | 18.69 |
| 2 | 1100 | 26.2 | 48.11 | 49.82 | 1.71 | 2.88 | 9.09 | 10.71 |
| 2 | 1050 | 26.2 | 41.88 | 44.20 | 2.32 | 1.35 | 19.46 | 16.57 |
| 2 | 1000 | 26.2 | 39.81 | 40.25 | 0.44 | 1.82 | 14.40 | 43.14 |
| 2 | 950 | 26.2 | 35.47 | 37.10 | 1.63 | 0.98 | 26.74 | 27.38 |
| 2 | 900 | 26.2 | 33.87 | 34.87 | 1.00 | 1.49 | 17.54 | 32.49 |
| 2 | 850 | 38.8 | 24.62 | 25.84 | 1.22 | 2.95 | 13.15 | 14.87 |
| 2 | 800 | 38.8 | 20.40 | 22.72 | 2.32 | 1.12 | 34.62 | 27.44 |
| 2 | 750 | 38.8 | 19.26 | 19.92 | 0.66 | 1.89 | 20.50 | 56.57 |
| 2 | 700 | 38.8 | 16.56 | 18.38 | 1.82 | 0.53 | 72.75 | 59.43 |
| 2 | 650 | 38.8 | 16.56 | 18.06 | 1.50 | 0.63 | 61.21 | 55.19 |
| 2 | 600 | 38.8 | 16.56 | 17.11 | 0.55 | 1.18 | 32.91 | 62.87 |
| 2 | 550 | 38.8 | 10.92 | 12.06 | 1.14 | 1.87 | 20.73 | 32.14 |
| 2 | 500 | 38.8 | 10.42 | 11.60 | 1.18 | 0.41 | 95.05 | 98.42 |
| 2 | 450 | 53.5 | 10.11 | 10.76 | 0.65 | 1.35 | 39.67 | 108.75 |
| 2 | 400 | 53.5 | 5.83 | 7.27 | 1.44 | 1.07 | 49.88 | 67.79 |
| 2 | 350 | 53.5 | 3.99 | 5.68 | 1.69 | 0.94 | 57.06 | 69.82 |
| 2 | 300 | 53.5 | 3.43 | 4.68 | 1.25 | 0.74 | 72.03 | 88.76 |
| 2 | 250 | 53.5 | 2.44 | 3.83 | 1.39 | 0.68 | 78.88 | 118.58 |
| 2 | 200 | 53.5 | 1.95 | 3.35 | 1.40 | 0.49 | 108.19 | 109.18 |
| 2 | 150 | 53.5 | 1.59 | 3.00 | 1.41 | 0.54 | 98.30 | 129.90 |
| 2 | 100 | 53.5 | 1.13 | 2.66 | 1.53 | 0.42 | 128.72 | 151.87 |
| 2 | 50 | 53.5 | 0.51 | 2.61 | 2.10 | 0.22 | 248.07 | 149.84 |
| 2B | 850 | 7.2 | 108.92 | 109.75 | 1.91 | 1.92 | 3.76 | 9.96 |
| 2B | 800 | 7.2 | 95.61 | 96.65 | 1.04 | 1.26 | 5.72 | 12.74 |
| 2B | 750 | 7.2 | 87.04 | 88.10 | 1.06 | 2.28 | 3.16 | 5.97 |
| 2B | 700 | 7.2 | 80.31 | 81.24 | 0.93 | 1.10 | 6.54 | 14.49 |
| 2B | 650 | 14.3 | 71.16 | 72.44 | 1.28 | 2.08 | 6.89 | 15.94 |
| 2B | 600 | 14.3 | 57.39 | 58.51 | 1.12 | 2.21 | 6.82 | 14.88 |
| 2B | 550 | 14.3 | 44.49 | 45.69 | 1.20 | 2.24 | 6.38 | 12.32 |

| Reach | Chainage | Flow | Min Channel Elev. | Water Surface Elev. | Max Channel Depth | Channel Velocity | Flow Area | Top Width |
|---|---|---|---|---|---|---|---|---|
| | | (m3/s) | (m) | (m) | (m) | (m/s) | (m2) | (m) |
| 2B | 500 | 14.3 | 30.70 | 31.91 | 1.21 | 2.54 | 5.62 | 8.50 |
| 2B | 450 | 14.3 | 15.61 | 16.57 | 0.96 | 1.66 | 8.60 | 13.70 |
| 2B | 400 | 14.3 | 13.03 | 13.68 | 0.65 | 0.72 | 19.92 | 46.17 |
| 2B | 350 | 14.3 | 8.99 | 9.41 | 0.42 | 1.33 | 10.72 | 59.07 |
| 2B | 300 | 14.3 | 5.00 | 6.17 | 1.17 | 0.63 | 22.77 | 38.18 |
| 2B | 250 | 14.3 | 3.18 | 3.72 | 0.54 | 1.50 | 9.51 | 41.66 |
| 2B | 200 | 14.3 | 1.59 | 2.64 | 1.05 | 0.29 | 49.77 | 112.92 |
| 2B | 150 | 14.3 | 1.39 | 2.61 | 1.22 | 0.11 | 132.22 | 128.96 |
| 2B | 100 | 14.3 | 0.40 | 2.60 | 2.21 | 0.06 | 234.68 | 154.81 |
| 2B | 50 | 14.3 | 0.00 | 2.60 | 2.60 | 0.03 | 408.76 | 191.68 |
| 3 | 600 | 18.5 | 32.92 | 33.59 | 1.97 | 1.97 | 9.41 | 23.76 |
| 3 | 550 | 18.5 | 17.60 | 19.20 | 1.60 | 1.48 | 12.47 | 13.65 |
| 3 | 500 | 18.5 | 13.03 | 14.10 | 1.07 | 2.06 | 8.98 | 16.14 |
| 3 | 450 | 18.5 | 9.71 | 10.70 | 0.99 | 1.07 | 17.29 | 21.38 |
| 3 | 400 | 18.5 | 7.38 | 8.26 | 0.88 | 1.20 | 15.44 | 28.16 |
| 3 | 350 | 18.5 | 6.15 | 6.61 | 0.46 | 0.55 | 33.80 | 74.75 |
| 3 | 300 | 18.5 | 4.00 | 5.10 | 1.10 | 1.16 | 15.93 | 22.17 |
| 3 | 250 | 18.5 | 1.87 | 2.67 | 0.80 | 0.72 | 25.84 | 80.36 |
| 3 | 200 | 18.5 | 1.24 | 2.61 | 1.37 | 0.13 | 137.79 | 152.47 |
| 3 | 150 | 18.5 | 0.62 | 2.60 | 1.98 | 0.06 | 326.63 | 223.37 |
| 3 | 100 | 18.5 | 0.25 | 2.60 | 2.35 | 0.04 | 486.81 | 267.13 |
| 3 | 50 | 18.5 | 0.11 | 2.60 | 2.49 | 0.03 | 614.35 | 289.06 |

## Table 3-38: Low Manning's "n" HEC-RAS model results

| Reach | Chainage | Flow | Min Channel Elev. | Water Surface Elev. | Max Channel Depth | Channel Velocity | Flow Area | Top Width |
|---|---|---|---|---|---|---|---|---|
| | | (m3/s) | (m) | (m) | (m) | (m/s) | (m2) | (m) |
| 2 | 1500 | 13.1 | 93.84 | 94.83 | 0.99 | 2.19 | 5.99 | 12.26 |
| 2 | 1450 | 13.1 | 89.49 | 90.55 | 1.06 | 2.23 | 5.87 | 11.56 |
| 2 | 1400 | 13.1 | 82.72 | 84.04 | 1.32 | 2.56 | 5.13 | 7.75 |
| 2 | 1350 | 13.1 | 76.96 | 78.21 | 1.25 | 2.48 | 5.29 | 8.46 |
| 2 | 1300 | 13.1 | 74.64 | 74.82 | 0.18 | 1.32 | 9.89 | 56.47 |
| 2 | 1250 | 13.1 | 67.89 | 68.90 | 1.01 | 2.44 | 5.36 | 8.82 |
| 2 | 1200 | 26.2 | 67.02 | 67.40 | 0.38 | 1.73 | 15.11 | 49.61 |
| 2 | 1150 | 26.2 | 60.58 | 61.60 | 1.02 | 2.43 | 10.77 | 17.91 |
| 2 | 1100 | 26.2 | 48.11 | 49.82 | 1.71 | 2.88 | 9.09 | 10.71 |
| 2 | 1050 | 26.2 | 41.88 | 43.44 | 1.56 | 2.87 | 9.14 | 10.98 |
| 2 | 1000 | 26.2 | 39.81 | 40.25 | 0.44 | 1.82 | 14.40 | 43.14 |
| 2 | 950 | 26.2 | 35.47 | 36.45 | 0.98 | 2.34 | 11.18 | 19.98 |
| 2 | 900 | 26.2 | 33.87 | 34.71 | 0.84 | 2.08 | 12.61 | 28.53 |
| 2 | 850 | 38.8 | 24.62 | 25.84 | 1.22 | 2.95 | 13.15 | 14.87 |
| 2 | 800 | 38.8 | 20.40 | 21.82 | 1.42 | 2.76 | 14.06 | 18.14 |
| 2 | 750 | 38.8 | 19.26 | 19.92 | 0.66 | 1.89 | 20.50 | 56.57 |
| 2 | 700 | 38.8 | 16.56 | 17.50 | 0.94 | 1.35 | 28.78 | 41.50 |
| 2 | 650 | 38.8 | 16.56 | 17.31 | 0.75 | 1.55 | 25.06 | 40.72 |
| 2 | 600 | 38.8 | 16.56 | 16.92 | 0.36 | 1.85 | 21.03 | 60.94 |
| 2 | 550 | 38.8 | 10.92 | 11.92 | 1.00 | 2.37 | 16.35 | 28.59 |
| 2 | 500 | 38.8 | 10.42 | 11.03 | 0.61 | 0.92 | 42.33 | 84.98 |
| 2 | 450 | 53.5 | 10.11 | 10.68 | 0.57 | 1.69 | 31.58 | 108.33 |
| 2 | 400 | 53.5 | 5.83 | 6.88 | 1.05 | 2.09 | 25.63 | 58.08 |
| 2 | 350 | 53.5 | 3.99 | 5.19 | 1.20 | 2.09 | 25.64 | 58.16 |
| 2 | 300 | 53.5 | 3.43 | 4.15 | 0.72 | 1.90 | 28.10 | 75.65 |
| 2 | 250 | 53.5 | 2.44 | 3.32 | 0.88 | 1.92 | 27.87 | 73.54 |
| 2 | 200 | 53.5 | 1.95 | 2.74 | 0.79 | 1.18 | 45.39 | 92.95 |
| 2 | 150 | 53.5 | 1.59 | 2.59 | 1.00 | 1.10 | 48.48 | 112.84 |
| 2 | 100 | 53.5 | 1.13 | 2.60 | 1.47 | 0.45 | 118.63 | 151.71 |
| 2 | 50 | 53.5 | 0.51 | 2.60 | 2.09 | 0.22 | 247.02 | 149.79 |
| 2B | 850 | 7.2 | 108.92 | 109.75 | 1.91 | 1.92 | 3.76 | 9.96 |
| 2B | 800 | 7.2 | 95.61 | 96.49 | 0.88 | 1.89 | 3.82 | 10.43 |
| 2B | 750 | 7.2 | 87.04 | 88.10 | 1.06 | 2.28 | 3.16 | 5.97 |
| 2B | 700 | 7.2 | 80.31 | 81.02 | 0.71 | 1.88 | 3.83 | 10.75 |
| 2B | 650 | 14.3 | 71.16 | 72.44 | 1.28 | 2.09 | 6.86 | 15.91 |
| 2B | 600 | 14.3 | 57.39 | 58.50 | 1.11 | 2.33 | 6.63 | 14.70 |
| 2B | 550 | 14.3 | 44.49 | 45.68 | 1.19 | 2.26 | 6.34 | 12.27 |

| Reach | Chainage | Flow | Min Channel Elev. | Water Surface Elev. | Max Channel Depth | Channel Velocity | Flow Area | Top Width |
|---|---|---|---|---|---|---|---|---|
| | | (m3/s) | (m) | (m) | (m) | (m/s) | (m2) | (m) |
| 2B | 500 | 14.3 | 30.70 | 31.91 | 1.21 | 2.54 | 5.62 | 8.50 |
| 2B | 450 | 14.3 | 15.61 | 16.39 | 0.78 | 2.27 | 6.29 | 11.98 |
| 2B | 400 | 14.3 | 13.03 | 13.43 | 0.40 | 1.55 | 9.21 | 37.76 |
| 2B | 350 | 14.3 | 8.99 | 9.41 | 0.42 | 1.33 | 10.72 | 59.07 |
| 2B | 300 | 14.3 | 5.00 | 5.68 | 0.68 | 1.84 | 7.79 | 22.84 |
| 2B | 250 | 14.3 | 3.18 | 3.72 | 0.54 | 1.50 | 9.55 | 41.69 |
| 2B | 200 | 14.3 | 1.59 | 2.60 | 1.01 | 0.32 | 44.92 | 112.56 |
| 2B | 150 | 14.3 | 1.39 | 2.60 | 1.21 | 0.11 | 131.04 | 128.83 |
| 2B | 100 | 14.3 | 0.40 | 2.60 | 2.20 | 0.06 | 233.97 | 154.77 |
| 2B | 50 | 14.3 | 0.00 | 2.60 | 2.60 | 0.04 | 408.05 | 191.65 |
| 3 | 600 | 18.5 | 32.92 | 33.59 | 1.97 | 1.98 | 9.36 | 23.71 |
| 3 | 550 | 18.5 | 17.60 | 18.78 | 1.18 | 2.55 | 7.24 | 10.91 |
| 3 | 500 | 18.5 | 13.03 | 14.05 | 1.02 | 2.26 | 8.18 | 15.68 |
| 3 | 450 | 18.5 | 9.71 | 10.25 | 0.54 | 2.16 | 8.56 | 17.88 |
| 3 | 400 | 18.5 | 7.38 | 8.04 | 0.66 | 1.92 | 9.63 | 25.83 |
| 3 | 350 | 18.5 | 6.15 | 6.34 | 0.19 | 1.34 | 13.76 | 73.37 |
| 3 | 300 | 18.5 | 4.00 | 4.74 | 0.74 | 2.16 | 8.55 | 18.06 |
| 3 | 250 | 18.5 | 1.87 | 2.57 | 0.70 | 0.98 | 18.81 | 64.22 |
| 3 | 200 | 18.5 | 1.24 | 2.60 | 1.36 | 0.14 | 136.81 | 152.25 |
| 3 | 150 | 18.5 | 0.62 | 2.60 | 1.98 | 0.06 | 326.29 | 223.35 |
| 3 | 100 | 18.5 | 0.25 | 2.60 | 2.35 | 0.04 | 486.69 | 267.12 |
| 3 | 50 | 18.5 | 0.11 | 2.60 | 2.49 | 0.03 | 614.35 | 289.06 |

The following observations were made from the hydraulic modelling of the channels under developed conditions:

- 1 in 100 year ARI event flows are contained within the main channel sections, and are within the areas unsuitable for development as determined in the "Area E" – Terranora – Planning Report & Structure Plan for Terranora Landowners Group, (Jim Glazebrook & Associates Pty Ltd, 2002. With the exception of upstream of chainage 500 in Reach 2B;
- channel top widths are on average 60 m (low Manning's "n") and 65m (high Manning's "n");
- the top channel width for Reach 2 chainages 450 – 750, 1200 and 1300, Reach 2B chainage 350 and Reach 3 chainage 350 are affected by existing farm dam in these locations;
- velocities within the channels are on average 1.2 m/s (high Manning's "n") and 1.7 m/s (low Manning's "n"), which is reasonable, considering the steepness of the channels; and
- maximum velocities within the channels range up to 2.95 m/s, at the steepest sections.

### 3.4.6 Recommendations

The issues discussed in the previous sections provide an understanding of the stormwater issues associated with the development of the Tweed Area "E". The following table discusses a number of recommendations and management actions based on this information.

**Table 3-39: Recommendations and management actions**

| Item | Recommendation | Management Action |
|---|---|---|
| 1 | Adopt relevant source controls to limit development impacts | Educate the community about environmental values and the importance or maintaining water quality from the catchment. |
| 2 | Adopt a treatment train approach for structural stormwater controls | Adopt the treatment train measures modelled in mitigation option 4 that include rainwater tanks, grassed swales, bio-retention and wetlands.<br>Identify any site constraints during the preliminary design stage to ensure that measures can perform efficiently. |
| 3 | Ensure all treatment measures adopt best practice design guidelines to ensure maximum performance. | Adopt the design parameters discussed with each mitigation option unless further modelling or analysis suggests otherwise.<br>Councils design specifications, D5 – Stormwater Drainage and D-7 Water Quality, together with other best practice design guidelines should be referenced together with the Council's Subdivision Manual Development Control Plan No 16. |
| 4 | Undertake a monitoring program to identify the impact of development and the performance of adopted treatment measures | Monitor background water quality pollutants in Terranora Broadwater and the adjacent wetlands.<br>Continue to monitor during development construction and the operational period to determine development impacts and the performance of adopted treatment measures.<br>Review monitoring results to highlight elevated parameters that may harm environmental values. Identify catchment activities resulting in poor water quality and take action to limit the impacts. |
| 5 | Rehabilitate existing main flow paths | Protect natural gullies and retain for overland flow paths for all storm events<br>Rehabilitate existing gullies with natural vegetation where required to protect against erosion and provide valuable habitat. |
| 6 | Adopt rainwater tanks to reuse stormwater and save potable water supply | Promote the use of roof water tanks to collect and store stormwater. It is suggested that the tanks are buried to allow collection from all roof areas and save space. A pump will be required to circulate water for non-potable uses around the home. |

The MUSIC model analysis indicates that the recommended stormwater treatment train measures reduce developed pollutant loads sufficiently to meet Council's water quality objectives (TSS, TN and TP).

Although the modelling suggests that the treatment train mitigation option 4 (WSUD incorporating wetlands) provides little benefit in terms of reducing nutrient loads entering the Terranora Broadwater, it is recommended that they be considered as part of the stormwater treatment strategy for the area. The wetlands will provide additional treatment should the actual performance of the grassed swales or bio-retention be less than expected due to alternative lot layouts or site constraints not previously identified. The wetlands will provide additional benefits such as the attenuation of more frequent events and assist in limiting the impact of increased levels of imperviousness through the new development. The measures also assist in minimising the disturbance of development on flow regime with a wide range of flows mimicking natural flow frequencies.

The cost estimates for the mitigation options, indicates that the rainwater tanks and wetlands are high compared with the costs of grassed swales and bioretention systems, however the cost of rainwater tanks could be met by developers or residents. Subsidies could be provided to residents, as occurs in other local authorities, to encourage their use. Alternatively, Council could request that they be mandatory for all residents as a development constraint to ensure compliance with the WSUD approach to stormwater within the development area.

## 3.5 Biting Insects

Development Control Plan No 25 - Biting Midge and Mosquito Control identifies parts of Area E adjacent to Terranora Broadwater as mosquito breeding habitat (see Figure 3.31). As a general rule, the areas where biting midge and mosquito problems will regularly be a nuisance to humans will be within 1km of extensive biting insect breeding areas. It is noted from the DCP that habitat changes caused by some forms of development, such as creation of canal estates, reduced water quality through nutrient load or acidic runoff, altered drainage systems and siltation problems may expand biting insect problems.

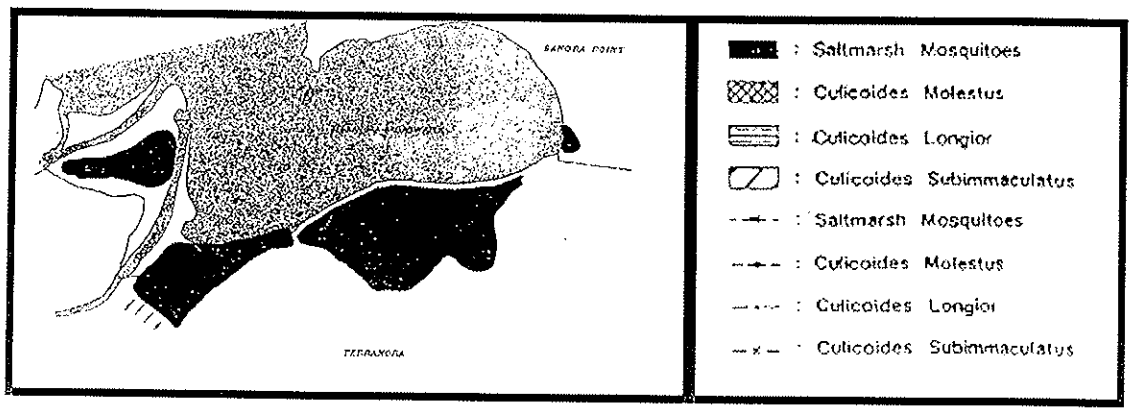


**Figure 3-31: Saltmarsh mosquito habitat (Source: DCP 25, Tweed Shire Council, 1993)**

Mosquitoes in general 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 and biting midge. 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.

Mosquitoes are an important group of blood sucking insects, not only because of the nuisance and annoyance of their bite but also because of the possibility of disease transmission to humans and other warm blooded animals. It is as vectors of disease that mosquitoes are often of most concern. An insect that transmits a disease-causing organism from one vertebrate host to another is called a disease vector. An example of a disease transmitted locally by mosquitoes is Ross River Fever (TSC, 1993).

Discussions with Tweed Shire Council's entomologist further identified that the area of wetlands was previously modified with the resulting effect being a change form a largely freshwater to a saline hydraulic regime which has created breeding habitat for salt marsh mosquitos. Salt marsh mosquitoes have an extensive range and in the right climatic conditions could range throughout the extent of the study area which would affect the potential for residential development of this land.

Without rehabilitation to return the wetlands to a largely freshwater regime the salt marsh mosquitoes from the wetlands area would be an ongoing cause of nuisance to any residential development within the vicinity. There is also the potential of further saline influence which would be triggered by the failure of existing floodgates could result in the area also becoming potential breeding habitat for biting midge, that would further compound insect nuisance not only within Area E but also within surrounding residential areas (Clive Easton, pers. comm. 2003).

Biting insect problems associated with this area would be exacerbated by the introduction of increased population numbers that would result from residential development of the area and would require frequent intervention by Council to address the problem, as such becoming a long term issue to Council.

The potential solution to this issue is to undertake rehabilitation of the wetlands area to return it largely to a freshwater regime which would eliminate breeding habitat for salt marsh mosquitoes. This would also have the advantage of ensuring that this area of known PASS/ASS was kept inundated thus limiting potential for ASS discharge events. While the area would still provide breeding habitat for freshwater breeds of mosquitoes their effective range is substantially limited and with control of vegetation corridors which may provide routes for mosquito travel their range could be substantially contained to areas adjacent to the wetlands area.

Appropriate measures for the rehabilitation of the wetlands areas will need to be determined via further studies of the site and the funding for rehabilitation could be dealt with through the introduction of a Section 94 Plan that levied contributions towards these works. Alternate sources of funding may include wetland funding opportunities available from State and federal government Sources.

### 3.5.1 Summary and conclusion

It is noted above that biting midge and mosquito problems will regularly be a nuisance to humans within a 1 kilometre radius of extensive biting insect breeding areas. The development that has been undertaken within the surrounds of Area E has caused habitat changes and therefore reduced water quality through nutrient load or acidic runoff, altered drainage systems and siltation problems that may expand biting insect problems.

The wetland area has been modified from its historical form resulting in the change from largely freshwater to a saline hydraulic regime. This change in hydraulic regime has created a breeding habitat for salt water marsh mosquitos. Furthermore, if a failure of the floodgates occurs, this could lead to further saline influence resulting in a favourable breeding habitat for the biting midge. This would provide a nuisance not only within Area E but also within surrounding residential areas.

### 3.5.2 Recommendations

The key recommendation for biting insects is for the rehabilitation of the wetlands area to return it largely to a freshwater regime ensuring the elimination of potential breeding habitat for salt marsh mosquitoes. The freshwater mosquito species have a substantially limited range of nuisance. Furthermore, this action would also ensure that the areas identified as PASS and ASS remains inundated, limiting potential ASS discharge events.

In addition, the preservation of vegetation corridors will provide routes for mosquito travel and thus contain mosquitos to areas adjacent the wetlands area.

Rehabilitation of this wetland and the subsequent positive impacts on saltmarsh mosquito breeding habitat will benefit the whole of Area E and as such it is appropriate that all landholders contribute to the rehabiltiation of the wetland. In the first instance a study to determine the appropriate rehabilitation measures should be undertaken and a subsequent Section 94 contribution plan developed to ensure that funds are collected for the wetland rehabiltiation.

## 3.6 Contaminated Land

In order for Area E to be redeveloped, the land should be suitable for its intended use. This requires that the presence and concentration of contaminants (if any) is investigated with the appropriate rigour. Concentrations of contaminants (if present) must be within the appropriate guideline levels for the land uses proposed. This review assesses the prior work done at the site, some of the uncertainties with respect to the contaminant potential at the site that have not yet been addressed and a method for assessing and remediating potential contaminant impacts while a staged development process in line with the SEPP 55 requirements.

### 3.6.1 Potential Contaminants of Concern

Based upon a review of prior reports and prior experience on contaminants on rural properties, the potential contaminants of concern include contaminants from the following sources:

- Septic tank and sewerage systems;
- Farm pesticide and chemical storage;
- Farm cattle dips;
- Farm fuel storage;
- Farm waste disposal;
- Asbestos and lead paint containing building materials; and
- Diffuse source pesticide application.

The indications or potential for these contaminant sources and the proposed analyses to assess potential impacts are discussed below.

### 3.6.2 Septic Tank and Sewerage Systems

Septic tank systems can be a source of localised soil and groundwater contamination for Faecal Coliforms, E.Coli and a range of other bacteriological contaminants.

The Draft Interim Strategic Plan (TSC, 1995) states "there are widespread concerns of the efficiency of current effluent disposal system in use in rural areas (eg, septic tanks, enviro-cycle systems)'.

This highlights the potential for bacteriological contamination of soils at poorly run or maintained septic systems.

### 3.6.3 Pesticides and Farm Chemicals

The Ardill & Associates report (1993, table 3) identified the presence of 'arsenic and endosulfan residues below EPA concerns' on land adjacent to the study area. The study undertaken in 1992 analysed targeted samples for arsenic, organochlorine and organophosphate pesticides. Five samples were collected and results showed low levels of arsenic in excess of background concentrations, endosulfans, and DDE at detectable concentrations. While concentrations recorded were within guidelines (at the time) for low density residential land use, the sample density is not sufficient to meet current guidelines and serves to indicate the presence of contaminants in the area.

Wilkie Fleming and Associates (1994) reported results for samples collected for a preliminary assessment of the site. Sampling was undertaken at a rate of one sample per 20 ha. More detailed sampling is recommended by NSW EPA guidelines to assess banana plantation sites.

Samples were composited from five sub-samples. The NSW EPA guidelines for assessing Banana Plantation Sites (1997) and NEHF (1996) Composite Sampling monograph recommend that no more than four samples are composited. In addition, the compositing of samples by mixing can lead to loss of semi-volatile and volatile components.

The samples for the Wilkie Fleming and Associates (1995) study were reportedly mixed by 'thorough mixing of the cores in a clean plastic bucket'. Therefore, semi-volatile pesticides could have been lost in the process.

In addition, when comparing the analytical results of a composite sample analysis to an investigation guideline, the guideline should be divided by the number of samples forming the composite (NEHF, 1996). If the results are compared to guideline values as adjusted for a composite, sample nine samples exceed the adjusted guideline for DDT.

**Table 3-40: Analytical results from Wilkie Fleming and Associates (1995) & adjusted guideline values**

| | DDE | DDD | DDT | OPs | As | Pb |
|---|---|---|---|---|---|---|
| Field No | | | | | | |
| T01/1 | <0.02 | <0.02 | <0.02 | <0.1 | 8 | <10 |
| T01/2 | <0.02 | <0.02 | <0.02 | <0.1 | 6 | <10 |
| T02/1 | 0.15 | <0.02 | 0.04 | <0.1 | 10 | <10 |
| T02/2 | 0.17 | <0.02 | 0.04 | <0.1 | 14 | <10 |
| T02/3 | 0.15 | <0.02 | 0.06 | <0.1 | 3 | <10 |
| T03 | <0.02 | <0.02 | <0.02 | <0.1 | 18 | <10 |
| T05 | 0.03 | <0.02 | <0.02 | <0.1 | 10 | <10 |
| T07/1 | 0.08 | <0.02 | <0.02 | <0.1 | 5 | <10 |
| T07/2 | <0.02 | <0.02 | <0.02 | <0.1 | 8 | <10 |
| T08 | 0.2 | <0.02 | 0.08 | <0.1 | 2 | <10 |
| T09/1 | <0.02 | <0.02 | <0.02 | <0.1 | 17 | <10 |
| T09/2 | <0.02 | <0.02 | <0.02 | <0.1 | 11 | <10 |
| T10/1 | 0.23 | <0.02 | 0.12 | <0.1 | 7 | <10 |

| | DDE | | | DDD | DDT | OPs | As | Pb |
|---|---|---|---|---|---|---|---|---|
| T10/2 | | 0.27 | | <0.02 | 0.19 | <0.1 | 6 | <10 |
| T11 | | 0.31 | | <0.02 | 0.21 | <0.1 | 8 | <10 |
| T12/1 | | 0.25 | | <0.02 | 0.24 | <0.1 | 4 | <10 |
| T12/2 | | 0.13 | | <0.02 | 0.07 | <0.1 | 9 | <10 |
| Guideline | 0.01[1] | 4[2] | 1.7[3] | | 0.2 | | 100 | 300 |
| Composite Adjusted Guideline | 0.002 | 0.8 | 0.34 | | 0.04 | | 20 | 60 |

*1 - MHSPE 2000 Dutch target value*

*2 - MHSPE 2000 Dutch trigger value*

*3 - US EPA Preliminary Remedial Goal for residential land use.*

Other chemicals used on farms are often stored in farm sheds and handling practices often lead to localised spills. Common farm contaminants include:

- Organochlorine and organophosphate pesticides;
- DDT and derivatives;
- Herbicides;
- Arsenic based dips and sprays; and
- Petrol and diesel fuels.

A site visit of the area identified an above ground diesel storage tank (c. 1,000 L), electrical transformers (potential source of PCBs) and pesticide and herbicide storage in earthen floored sheds, and dumping of empty and partially full containers including:

- Lorsban (organophosphate pesticides);
- Dimethoate and Gramoxone (paraquat);
- Roundup (glyphosate, POEA);
- Nematicides (organspohosphates/carbamides);
- Oils; and
- Split bags of a white powder (either superphosphate, pesticides or arsenic).

As well as indicating point source areas of potential contamination where chemical handling took place, the chemical storage area also indicates the potential for broad acre use of pesticides at the site.

### 3.6.4 Recent Report Review

An assessment of the potential for contaminant impacts was undertaken on certain lots by Gilbert & Sutherland in 2003.

Review of the report has highlighted the following uncertainties with respect to the requirements for assessing site contamination.

The site history provided in the report does not meet NSW EPA requirements for reporting and should be revised to include all the information required by the NSW EPA.

The sampling strategy is based upon an assessment of human health impacts from soils at the site, sampling also needs to assess the potential for environmental impacts to dams and sediments as these areas could from sinks for contaminants build up and areas where bioaccumulation of contaminants could later impact human health (i.e. yabbies in dam bioaccumulate contaminants and are later caught by children/residents and eaten).

Farm chemical storage areas appear to have either have targeted samplings occurred around rather than in the storage areas, or have not had targeted samples collected.

A stock race at Lot 2/77827 was not reported on or targeted for the presence of dip chemicals.

Samples with elevated detection limits (i.e. sample #A Shed in Lot1 DP215959 reported a MDL of <3.56 for DDT+DDD+DDE) do not have an explanation for the raised detection limit.

The interpretation of the human health analytical results does not include an assessment of compounds detected such as Endosulfans. Endosulfans were detected in samples #A Shed at 20.53 mg/kg for a total of Endosulfan1, Endosulfan2 and Endosulfan Sulfate. While there are no Australian guideline criteria for Endosulfans, the Dutch (MHSPE 2000) guideline intervention value is 4 mg/kg and is exceeded by both individual and total Endosulfan results. The Dutch intervention values are indicative of the level of impact above which there is a serious case of soil contamination. This result does not correlate with the conclusion of the report that "As no contamination hotspots were encountered, no additional sampling or analysis appears to be required". Further assessment of this result is required and this highlights the need for a NSW EPA accredited auditor to be involved in the review of assessment reports, the development control plan for the site and final statutory sign-off for residential landuse.

### 3.6.5 Waste Disposal

In addition to localised contamination around storage areas, pesticides and other contaminants can impact soils from diffuse source use and inappropriate disposal in farm rubbish dumps. Drums were seen dumped up to 50m from the chemical storage area.

### 3.6.6 Groundwater

Shallow groundwater is present within the upper 5m of the soil profile and often within 1 m of the surface (Wilkie Fleming and Associates 1995). Therefore, if significant soil impacts are present there is potential for soil impacts to impact groundwater at the site.

### 3.6.7 Contaminated Land Assessment

A review of prior data and common practices for the past land uses at the site indicate that both identified contamination and the potential for further contaminants to exist at the site. Interim advice has been received from an Accredited Site Auditor ( Marc Salmon of JBS Environmental (NSW EPA 0103)) indicating that no information has been revealed during the review of documents or site inspection which would preclude the rezoning of the site to a residential with accessible soil landuse (Column 1, EPA 1998), provided measures are put in place to ensure that the potential for contamination and the suitability of the land for any proposed use are assessed once detailed proposals are made.

Figure 3.32 illustrates potential contaminants sources, and receptors identified to date.

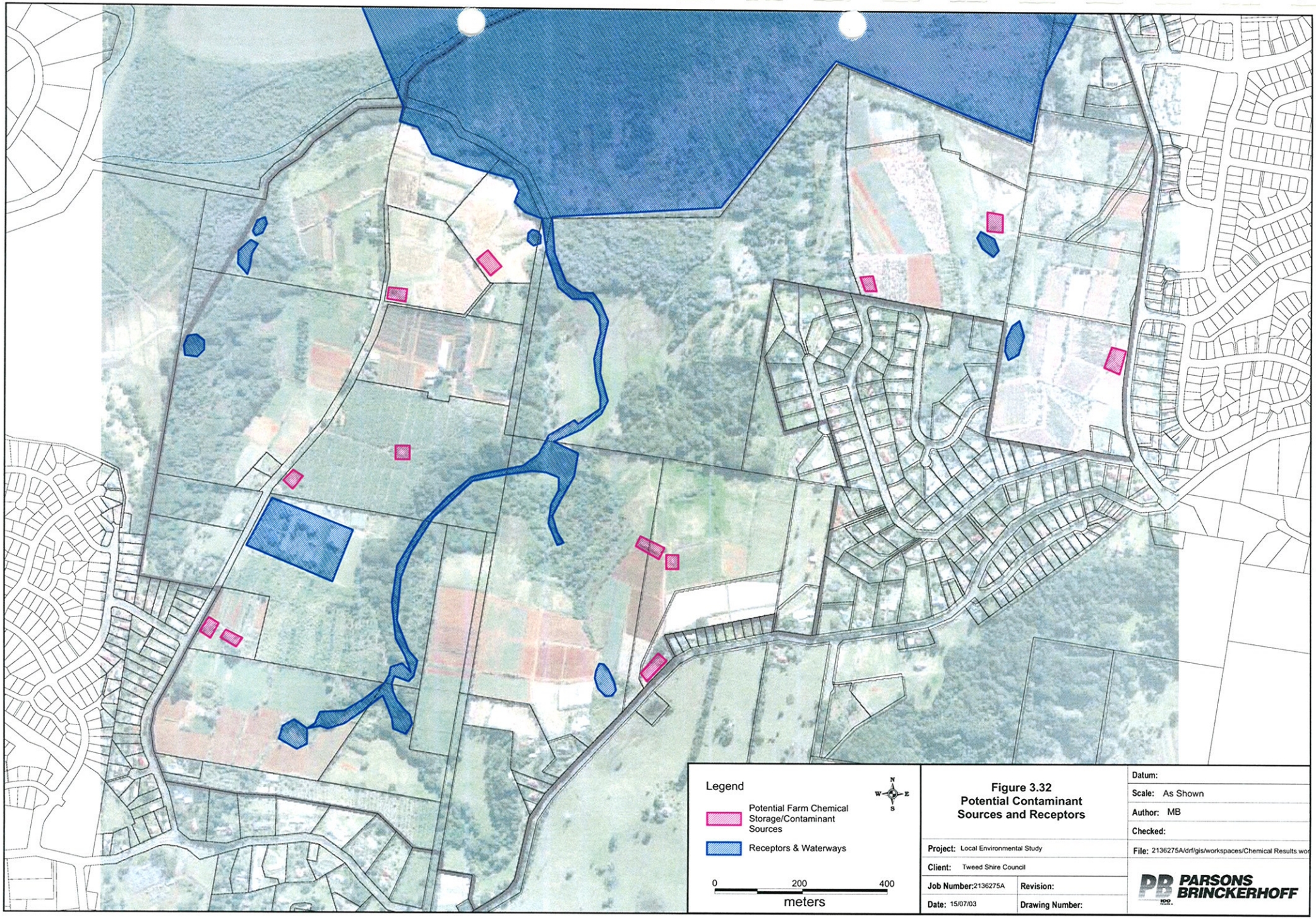


**Figure 3.32**
**Potential Contaminant Sources and Receptors**

| | |
|---|---|
| Datum: | |
| Scale: | As Shown |
| Author: | MB |
| Checked: | |
| Project: | Local Environmental Study |
| File: | 2136275A/drf/gis/workspaces/Chemical Results.wor |
| Client: | Tweed Shire Council |
| Job Number: | 2136275A |
| Revision: | |
| Date: | 15/07/03 |
| Drawing Number: | |

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### 3.6.8 Summary and conclusion

The following points outline significant considerations or constraints for development of the Area E site:

- Poorly maintained septic systems create a potential for bacteriological contamination of soils.
- Previous reports have outlined the presence of endosulfan residues requiring further investigation.
- An above ground diesel storage tank (c. 1,000L), electrical transformers (potential source of PCBs) and pesticide and herbicide storage in earthen floored sheds and dumping of partially full containers was identified within the site. In addition to locating point source areas of potential contamination from past chemical handling, the chemical storage area also indicated the potential for a wider use of pesticides at the site.
- Apart from localised contamination in the proximity of storage areas, pesticides and other contaminants may impact on soils from diffuse source use and inappropriate disposal in farm rubbish dumps.
- Assessment of potential contaminant impacts to environmental receptors needs to be undertaken.

As a result of the above issues, it is unlikely that any change in land use will be supported until the investigations to the appropriate guidelines have been completed for contaminated land.

### 3.6.9 Recommendations

The most significant issue with regard to contaminated land is that full and further assessment of identified and potential sources and receptors of contaminants is undertaken to fully assess potential contaminant issues at the site.

All assessment reports should meet NSW EPA guidelines for the assessment of contaminated sites. Where impacts from compounds without NSW EPA criteria are identified these should be assessed against relevant alternate criteria to illustrate the suitability of the land for residential landuse.

In accordance with SEPP 55 section 4.1.2 a generalised rezoning can be undertaken (subject to suitable controls) given that potential impacts to the area can reasonably be expected to remediate to eventually make the land suitable for residential landuse.

SEPP 55 section 4.1.2 for Generalised Rezonings states that:

*"Rezonings that cover a large area, for example, more than one property, usually describe proposed land uses very generally both in type and location. This makes it difficult for a planning authority to be satisfied that every part of the land is suitable for the proposed use(s) in terms of contamination at the rezoning stage. In these cases, the rezoning should be allowed to proceed, provided measures are in place to ensure that the potential for contamination and the suitability of the land for any proposed use are assessed once detailed proposals are made. However, if the rezoning includes the identification of locations for sensitive uses, such as childcare centres, then it may be appropriate to determine the suitability of the land in those locations at the rezoning stage.*

*For some rezonings contamination will not be an issue if, for example, there is no change of use or where there is a change to a similar use."*

Interim advice has been received from an Accredited Site Auditor ( Marc Salmon of JBS Environmental (NSW EPA 0103)) indicating that no information has been revealed during the review of documents or site inspection which would preclude the rezoning of the site to a residential with accessible soil landuse (Column 1, EPA 1998), provided measures are put in place to ensure that the potential for contamination and the suitability of the land for any proposed use are assessed once detailed proposals are made.

It is therefore recommended that:

- The land is rezoned for proposed residential landuse subject to the completion of contamination assessment and remediation in accordance with NSW EPA Guidelines.
- It should be stipulated that only infrastructure such as roads and utilities maybe constructed with suitable environmental management plans and controls until such time as a Statutory Site Audit Statement for each lot is supplied by a NSW Accredited Auditor for contaminated land.
- It should be stipulated that preliminary release of land allowing emplacement of infrastructure should not be taken as an indication that later residential construction and occupancy can be expected to take place. This will be based upon the suitability of the land based upon provision of suitable site auditor statements and other planning requirements.

## 3.7 Heritage

### 3.7.1 European heritage

The NSW Heritage Office website maintains the State Heritage Inventory, comprising of heritage significant items protected under Section 130 of the Heritage Act 1977 and items listed in the Tweed LEP 2000, and by other State Government Agencies.

A search was undertaken of the State Heritage Inventory on 9 June 2003 establishing that there were no items of heritage significance protected under Section 130 of the Heritage Act 1977, otherwise entered in the Tweed LEP 2000, North Coast REP or listed by State Government, within Area E.

### 3.7.2 Indigenous heritage

In the preparation of the LES, Council acted under Section 62 of the Environmental Planning and Assessment Act 1979, in seeking comment from the Tweed Byron Local Aboriginal Land Council. Council sent correspondence at or around 4 February 2002 to determine their interests in the site, if any.

No response from the Tweed Byron Local Aboriginal Land Council to the initial Section 62 Consultation was received. Further telephone calls, messages and facsimile messages were made to the Land Council on 3 and 4 June 2003, for which Parsons Brinckerhoff received no response. Given the lack of input from the Tweed Byron Local Aboriginal Land Council, it is not conclusive as to whether the development of Area E for urban purposes would directly compromise indigenous heritage or associated conservation values. However, it is noted that

the Area E landscape has been highly disturbed as a result of previous intensive agricultural practices throughout the site and as such the presence of any artefacts is less likely.

In addition, as Aboriginal sites are generally protected under the National Parks and Wildlife Act 1974, future development proponents of individual sites will be required to address this issue as part of any Form 1 Development Application made to Council.

### 3.7.3 Summary and Conclusion

The Area E landscape has been highly disturbed as a result of previous intensive agricultural practices throughout the site and generally Aboriginal sites are protected under the National Parks and Wildlife Act 1974. This issue will be required to be addressed as part of any Form 1 Development Application made to Council.

There were no items of European heritage significance identified on site, as outlined under Section 130 of the Heritage Act 1977, otherwise entered in the Tweed LEP 2000, North Coast REP or listed by State Government

### 3.7.4 Recommendations

Due to the degree of disturbance of the site it is unlikely that Aboriginal cultural heritage will pose a significant constraint on the development of the site. Any development applications for Area E should address this issue and should any artefacts be unearthed during construction work should cease and the artefacts dealt with in accordance with the requirements of the National Parks and Wildlife Act 1974 and associated legislation.

## 3.8 Traffic and access

This section of the LES is an assessment of transport and access for Area E. The objectives of this traffic and access study are to:

- review the existing surrounding transport network;
- describe the proposed internal access route for the proposed development;
- review future improvements to the transport network;
- review existing traffic volume data;
- identify future traffic generation of the proposed development;
- determine the impact of the proposed development on the surrounding transport network; and
- potential improvements to the transport network required to accommodate the potential development of Area E.

### 3.8.1 Key Issues

The key issues for the proposed Area E development in relation to existing traffic and access conditions include:

- the quality and suitability of existing routes between the proposed development and external destinations;
- the capacity of existing routes to support traffic generation from the proposed development; and

- future development and transport infrastructure improvements that may affect the impact of the proposed development on the surrounding network.

### 3.8.2 Existing traffic and access conditions

#### 3.8.2.1 Surrounding road network

Most trips generated by the future residential development at Area E are anticipated to occur in a northeast direction towards destinations in Banora Point, Tweed Heads, Coolangatta and the Gold Coast.

Most of the external trips generated from Area E are anticipated to use the Pacific Highway, which is the main arterial link that would provide access between Area E and key destinations in the northeast. Therefore, suitable distributor links between Area E and the Pacific Highway are essential.

There are four routes linking Area E with key destinations to the northeast (assuming a future extension of Mahers Lane to Fraser Drive):

- Route 1 - Terranora Road – 2 lane, 2 way road providing access to north and southbound Pacific Highway via a signalised intersection;
- Route 2 - Fraser Drive, Leisure Drive and Darlington Drive - 2 lane, 2 way road providing access to north and southbound Pacific Highway via a on-ramps;
- Route 3 - Fraser Drive, Leisure Drive, Greenway Drive and Minjungbal Drive– 2 lane, 2 way road providing access to southbound Pacific Highway via on-ramp, and access to Tweed Heads/Coolangatta via Minjungbal Drive; and
- Route 4 - Fraser Drive, Dry Dock Road - 2 lane, 2 way road providing the most direct access from Area E to Tweed Heads/Coolangatta.

Routes 1, 2 and 3 link to the Pacific Highway, whereas route 4 uses Dry Dock Road to link to the local road network. The four route options are shown in Figure 3.33.

#### 3.8.2.2 Internal Access

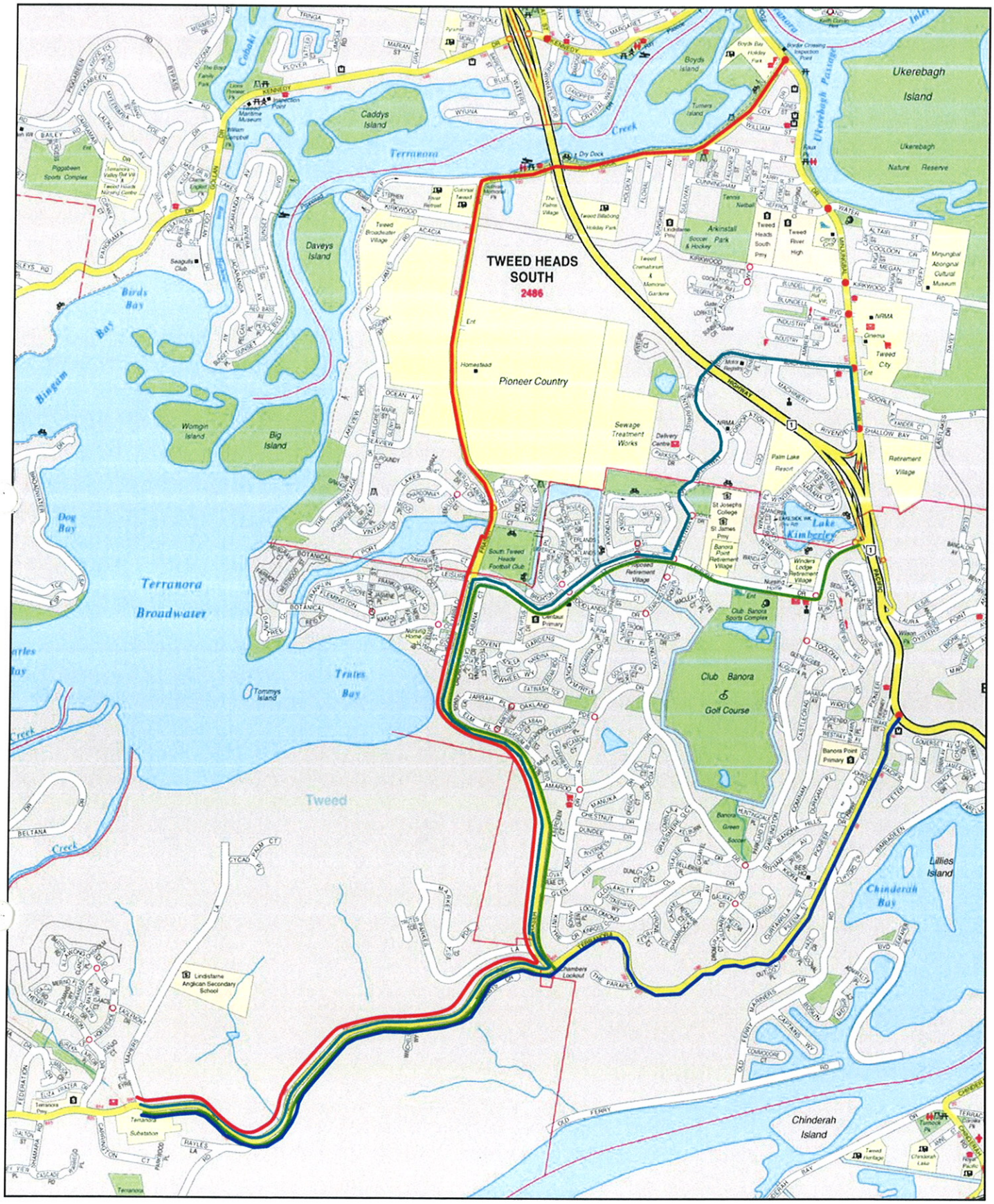
Area E is currently accessed by two roads being Mahers Land in the west and Parkes Lane in the east. Terranora Road and Fraser Drive bound the southern and eastern boundaries of the site respectively however only there are no public access points from these roads into Area E.

Mahers lane is a two lane residential road with a Type C intersection with Terranora Road. It serves the residential estate of Terranora Village, Lindisfarne Secondary School and a number of rural holdings within Area E.

Parkes Lane currently serves a number of rural residential lots situated and a small number of rural holdings.

Apart from these road the local road network within Area E is non-existent and development of the site for residential purposes would require the development of new intersections with the surrounding road network and an internal road hierarchy.

The main internal link which would provide access from within Area E to the external road network is an extension of the existing Mahers Lane traversing the Area E site and connecting to Fraser Drive. The need for the road link was identified and discussed in both




Legend

Route Options

- Route Option 1
- Route Option 2
- Route Option 3
- Route Option 4

Source: ABS, 2001

N W E S

**Figure 3.33**
**Area E Route Options**

| | |
|---|---|
| Datum: | |
| Scale: | As Shown |
| Author: | MB |
| Checked: | TC |
| Project: | Local Environmental Study |
| File: | 2136275A/drf/gis/workspaces/trafic.wor |
| Client: | Tweed Shire Council |
| Job Number | 2136275A |
| Revision: | |
| Date: | 09/12/03 |
| Drawing Number: | |

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**Figure 3-34: Area E study area and proposed Mahers Lane extension (Source: Halliburton KBR, 2002)**

### 3.8.2.3 Traffic volumes and capacity on existing routes

All routes connecting the proposed Area E and the Pacific Motorway are currently operating under capacity and are of sufficient quality for the existing traffic volumes. Traffic counts were obtained from the Tweed Shire Council for a number of sections of the surrounding road network in which average daily traffic (ADT) volumes were estimated. For counts recorded before year 2003, a nominal growth rate of 2% per year was adopted. The estimated ADT and capacity for the four routes are shown in Table 3.41, with volume capacity ratios indicating the degree of saturation of the road. Taking the most congested sections, routes one, two and three are operating at 90%, 74% and 74% respectively, with the most congested section occurring on Route One along Terranora Road, between Kiora Street and the Pacific Highway.

### 3.8.2.4 Public transport, cycling and pedestrian routes

The Area E development site is serviced by Surfside Buslines, which serves current residents in estates to the west and east of the proposed development and provide access north to Tweed City Shopping Centre and Coolangatta, and south to Murwillumbah. All bus routes run through residential collector streets before connecting with the Pacific Highway.

- Route 602: serves Tweed Heads, Greenbank, Tweed City, Tweed Heights via Leisure Drive, Darlington Drive, Glen Ayr Drive and Minjungbal Drive. Stops at the eastern side of Area E. Frequency: 40 minutes peak, 1 to 2 hourly off-peak.
- Route 604: serves Tweed Heads, Tweed City, Dry Dock Road, Hillcrest via Minjungbal Drive, Dry Dock Road, Fraser Drive, Vintage Lakes Drive. Frequency: 40 minutes peak, 2 hourly off-peak.
- Route 605: serves Tweed Heads, Banora Gardens, Terranora, Murwillumbah via Minjungbal Drive, Greenway Drive, Fraser Dive, Terranora Road and Mahers Lane. Services residents on the south and southwest side of Area E. Frequency: hourly peak, Twice on weekends.

If Area E is development the above bus routes would likely need to be re-structured to accommodate the requirements of the additional residential catchment. These negotiations would be required to be undertaken with the local bus operator in keeping with the staging for the Area E development. Ideally, any changes to the bus network should be undertaken at the same time as the residential area is first opened to capture trips associated with the development before they become accustomed to being reliant solely on their car for trips.

The rural-residential roads surrounding the proposed Area E development do not have allocated cyclists or pedestrian facilities. A cycleway and pedestrian walkway are provided to the north east servicing St. Josephs College and St. James Primary School. A cycle and pedestrian path are also provided along Terranora Creek, which partly runs along Dry Dock Road.

The Tweed Shire Council has planned to have an on-carriageway cycleway on Fraser Drive (between Terranora Road and Leisure Drive) and a proposed cycleway along the proposed Mahers Lane to Fraser Drive extension. These proposed cycle paths will provide good access to residents of Area E with activity centres to the northeast.

The public transport and pedestrian facilities are shown in Figure 3.35.

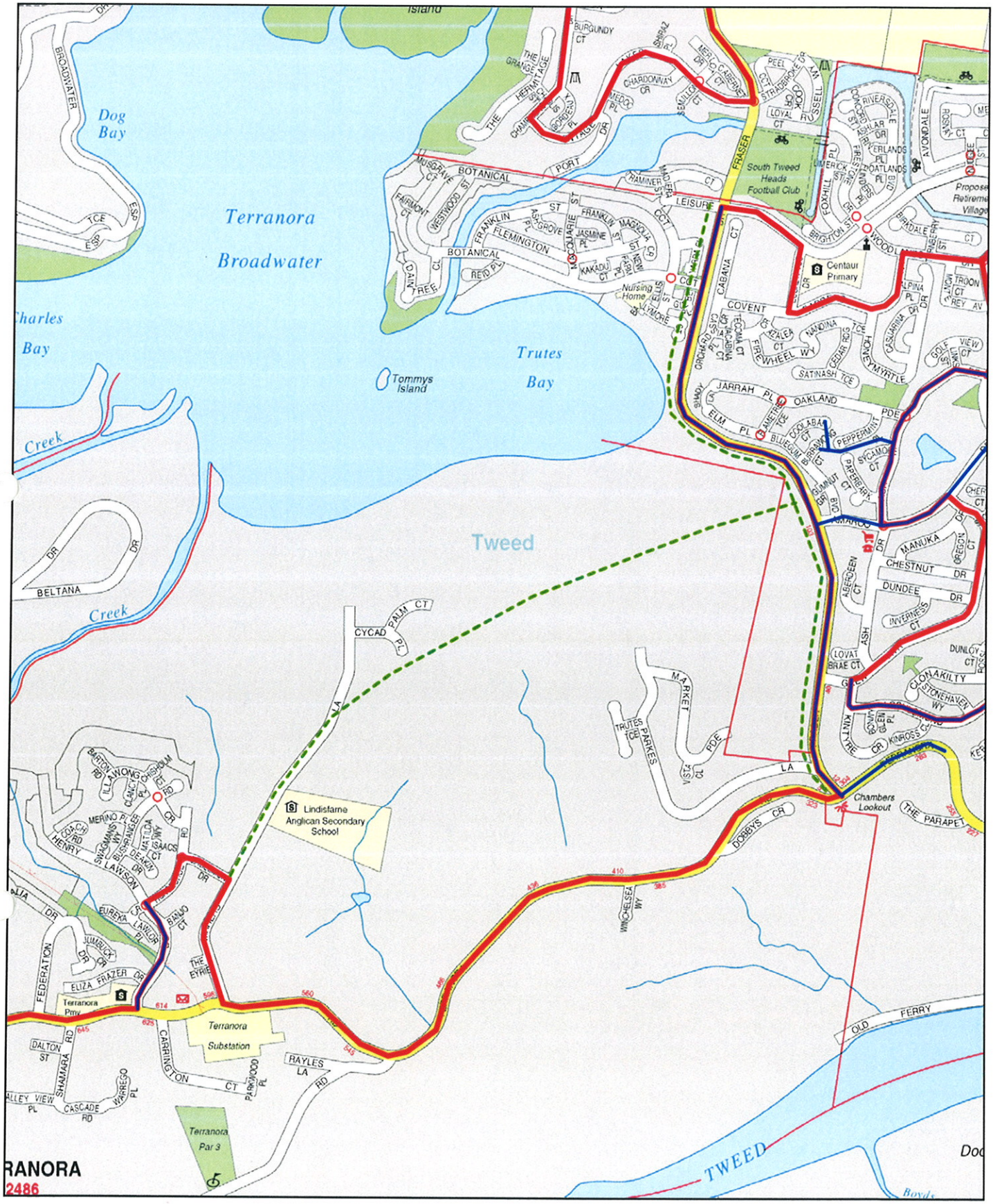
## Table 3-41: Midblock Capacity and ADT for connector routes between Area E and the Pacific Highway.

| Access Road | Section of Route | Section | Existing Capacity[1] | Estimated Average daily Traffic (ADT) Volumes[2] (2003) | | | |
|---|---|---|---|---|---|---|---|
| | | | (veh/day) | (veh/day) | Year | Factor[3] | V/C |
| Terranora Road | 1 | Bilambil Rd to Fraser Dr | 13,500 | 4852 | 2000 | 1.06 | 0.36 |
| | 1 | Fraser Dr to Kiora St | 13,500 | 5753 | 2003 | 1 | 0.43 |
| | 1 | Kiora St to Pacific Hwy | 13,500 | 8096 | 2003 | 1 | 0.60 |
| Fraser Drive | 2, 3 | Terranora Rd to Amaroo Dr | 13,500 | 5993 | 2002 | 1.02 | 0.44 |
| | 2, 3, 4 | Amaroo Dr to Leisure Dr | 13,500 | 5993 | 2002 | 1.02 | 0.44 |
| | 4 | Leisure Dr to Dry Dock Rd | 13,500 | 6504 | 2002 | 1.02 | 0.48 |
| Dry Dock Road | 4 | Entire length | 13,500 | 7516 | 2001 | 1.04 | 0.56 |
| Leisure Drive | 2, 3 | Fraser Dr to Greenway Dr | 13,500 | 6700 | 2003 | 1 | 0.50 |
| | 2 | Greenway Dr to Pacific Hwy | 13,500 | 6700 | 2003 | 1 | 0.50 |
| Greenway Drive | 3 | Entire length | 13,500 | 6324 | 2002 | 1.02 | 0.47 |

*1. Estimated two lane two way capacity of 13,500 vpd (equivalent Level of Service D( (Source Austroads, Part 2, Roadway Capacity Table 3.9)*

*2. Traffic counts obtained from Tweed Shire Council*

*3. Growth factor to convert from year of traffic count to 2003*




Legend

- Walk/Cycle Access
- Bus Routes
- Proposed cycleways/pedestrian paths.

N W E S

**Figure 3.35**
**Public transport, Cycling and Pedestrian Networks**

| | |
|---|---|
| Datum: | |
| Scale: | As Shown |
| Author: | MB |
| Checked: | TC |
| Project: | Local Environmental Study |
| File: | 2136275A/drf/gis/workspaces/trafic.wor |
| Client: | Tweed Shire Council |
| Job Number | 2136275A |
| Revision: | |
| Date: | 09/12/03 |
| Drawing Number: | |

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### 3.8.3 Future transport planning

#### 3.8.3.1 Relevant transport strategies

Relevant NSW State Government and Tweed Shire Council strategies were reviewed with respect to the proposed Area E development, including:

- Action for Transport 2010 (RTA);
- Tweed Shire 2000+ Strategic Plan (Tweed Shire Council, 1996) ;
- Tweed Road Development Strategy (Veitch Lister Consulting Pty Ltd, 1997);
- Tweed Road Contribution Plan (Tweed Shire Council, 2003); and
- Traffic Study of Banora Point/South Tweed (Veitch Lister Consulting Pty Ltd, 2003).

Matters from these reports relevant to this study are summarised below.

**Action for Transport 2010 (NSW)**

Action for Transport 2010 is the NSW Government's long-term strategic transport plan for the state. One of the key improvements proposed by the strategy relevant to this project is upgrade of the Pacific Highway between Newcastle and the Queensland border, with a vision to develop the entire length of the Highway to dual carriageway by 2012 (the Pacific Highway Reconstruction Program). This program includes bypasses of regional centres such as the Chinderah Bypass, south of the study area.

**Tweed Shire 2000+ Strategic Plan (1996)**

The Tweed Shire 2000+ Strategic Plan provides the broad direction for future planning and development in the Tweed Shire. The plan has the following policies and actions relevant to this study:

- Council will not approve development in the catchment of Kennedy Drive which would cause its traffic capacity and amenity to be exceeded;
- Council will complete the review of the Tweed Distributor Road Transportation Study and prepare a Section 94 Contributions Plan to fund the road network upgrading attributable to growth throughout the Shire; and
- The Strategic Plan will be implemented to establish Tweed Heads as a major retail, commercial and tourist centre.

**Tweed Road Development Strategy 1997**

The Tweed Road Development Strategy (TRDS) prepared by Veitch Lister Consulting, reviewed the Lower Tweed Transportation Study traffic forecast and developer contribution philosophy to address changes in future development patterns and incorporate contribution schemes for proposed development including Area E. The Tweed Road Development Strategy assessed the Tweed Shire's traffic needs and developed a long-term road networks strategy.

The Tweed Road Development Strategy acknowledges the need for a number of roadworks in the lower Tweed area to cater for anticipated growth. This includes works to Fraser Drive, Leisure Drive, Kirkwood Road, Terranora Road and the need for a link between Fraser Drive and Bilambil Road to provide access to Area E (later to become Mahers Lane/Fraser Drive extension). The strategy's model results shows that the ultimate traffic volumes generated by Area E would access the development via Fraser Drive north of the proposed Mahers Lane extension.

### Tweed Road Contribution Plan 2003

The Tweed Road Contribution Plan is based on the *Tweed Road Development Strategy* prepared by Veitch Lister Consulting (VLC).The plan enables Tweed Shire Council to levy s.94 developer contributions for the provision of additional road capacity to service increased traffic loading as a result of urban growth and/or development demands. It also permits Council to recoup past expenditures in the road network made in anticipation of development throughout the entire Tweed Shire.

The Tweed Road Contribution Plan takes road works identified and costed in the tweed road Development Strategy and apportions costs based on the nexus between development and use of roads. In assessing the standard contribution, the Plan uses a differential pricing system based on sectors (locality), thirteen in all, and land use. Pricing varies across the Shire depending on the value and amount of road space consumed by development in a particular area, and of course, the type of development involved. Land use tables indicate the amount of traffic generated by development types which in turn is calculated to determine and overall contribution rate for different development types. Contributions within each sector are generally represented in terms of a household as this represents a common form of development.

Council administers on behalf of land-owners/developers the assignment or apportionment of responsibility for works in localised areas. Area E is included entirely in Sector 5 and within this sector responsibility for all works falls to owners/developers of land within Area E.

Road works identified as applicable to Sector 13 are the construction of the Mahers Lane/Fraser Drive distributor road which is identified as costing in the order of $2.4 million. Within sector 5 the household contribution is $5,342. It would be expected that each household would be subject to this charge and that other land uses would be subject to a charge based on Tables 7.1 and 7.2 of the plan.

The Plan also identifies a number of other road works in the lower Tweed Area which will impact on traffic generated by Area E. These include significant upgrades to Leisure Drive.

### Traffic Study of Banora Point/South Tweed 2003

The purpose of this Working Paper was to present a preliminary examination of the long-term road network requirements of the Shire, with particular focus on the South Tweed Heads / Banora Point area. Preliminary forecasts were been produced for a scenario in which the Shire is fully developed (in accordance the Local Environmental Plan 2000), which may be reached sometime between 2030 and 2040. The initial intent of the report was to first identify a preferred 'ultimate' road network, and then use the 2011 model to assess the timing or programming of the works identified.

The key observations derived from the traffic forecasts and analyses presented in the report are:

*Base Network Deficiencies*

- Outside of the South Tweed Heads / Banora Point study area, the existing / planned road network is forecast to perform satisfactorily, with the following exceptions:
  - The Tugun Bypass, north of Cobaki Parkway, appears to justify upgrading to 6-lane capacity.
  - Cobaki Parkway, between Piggabeen Road and the Bilambil Heights collector road, appears to justify upgrading to 4-lane capacity.

- Further sections of Kennedy Drive may need upgrading to 4-lane capacity, depending on the outcome of the preferred network for South Tweed Heads.
- The Chinderah Road interchange with the Pacific Highway is expected to have inadequate capacity for demands generated by development on the Tweed Coast. (NB. the solution to this problem may lie in providing an additional interchange, rather than upgrading the 'symptom').

- Within the South Tweed Heads / Banora Point area, the following road network deficiencies have been forecast :
  - Strategic north-south capacity within and through the area, including the Pacific Highway at Sexton's Hill and bridge capacity across Terranora Creek.
  - The capacity of links forming the Darlington Drive / Minjungbal Drive interchange with the Pacific Highway, but more specifically the capacity of the two roundabouts.
  - Entry/exit capacity of the Greenway Drive / Machinery Drive precinct.

*Impacts of Area E*

- The development of Area E, as assumed in these forecasts, will add some reasonably significant volumes to the secondary road network in the South Tweed Heads / Banora Point area. Despite this, the majority of these impacts are capable of being sustained by the local network, as exists or is planned.
- The impacts of Area E on the strategic road network will be small, relative to the future base volumes and conditions. Any improvements which address the forecast base conditions should be capable of handling the additional impacts of Area E.
- Detailed planning of Area E and its integration with the surrounding road network should seek to encourage more use of Terranora Road.
-

*Potential Road Network Improvement*

- *Sexton's Hill Improvements* - The RTA's preferred scheme (Option 2) is considered sub-optimal. While it adequately serves through traffic, it disadvantages local access to the Highway and increases demands through the Darlington Drive interchange.
- *Kirkwood Road Ramps* – this provides solid benefits (both economic and reinforcement of the local road hierarchy), including appreciable relief to the Darlington Drive interchange. However, it is understood that weaving/merging/diverging issues do exist with this option and the RTA are currently investigating this option in more detail.
- *Enterprise Avenue Extension & Off-ramp* – this pair of links attract minimal traffic, if implemented on their own, and hence provide little relief or benefits.
- *Additional Bridge* - this also provides solid benefits (both economic and reinforcement of the local road hierarchy), although not as much as the Kirkwood Road ramps. The reduced benefit is a result of the need to remove the northbound off-ramp from the Tweed Heads Bypass to Kennedy Drive, in the particular bridge option tested.
- *Additional Bridge plus Enterprise Avenue Extension & Off-ramp* – the two components of this scheme complement each other, and provide an overall benefit in excess of their sum. Another weaving/merging/diverging problem is, however,

anticipated. The 3rd access route into the Greenway Drive / Machinery Drive precinct, provides reasonable relief to the 2 existing accesses.

- *Winders Place Link* – although this provides a degree of relief to the south end of Greenway Drive, it is not enough to justify the loss of residential amenity, etc.
- *Dry Dock Road Calming* – implementation of speed and capacity restraints halves the forecast volumes, but generates appreciable travel disbenefits
- *Kirkwood Road Extension* – on its own, this provides small-moderate benefits, which appear enough to justify its construction.

At its meeting of 17 September 2003 Council considered this report and in response resolved as follows:

- Detailed design work and preparation of a development application be commenced for Kirkwood Road between Fraser Drive and Falcon Way. The design is to allow for the future construction of north facing ramps to the Pacific Highway and the extension of Enterprise Avenue.
- When detailed design and development consent is obtained Council determine the construction timeframe given that a final decision regarding the north facing highway ramps will be likely in that time frame.
- Council formally advise the Roads & Traffic Authority that it objects to the Sexton Hill Deviation in regard to the Terranora Road intersection being restricted and that a full interchange at Terranora Road is required by Council and should be included in any Roads & Traffic Authority design work.
- The proposed Winders Place link road to Greenway Drive not be proceeded with.
- Council advises the Roads & Traffic Authority that it does not object to an off ramp from the Pacific Highway (northbound) into Enterprise Avenue being constructed by a private developer, subject to it not compromising the Kirkwood Road ramps.
- A report be prepared for Council to amend the Tweed Road Contribution Plan Works Program, based on the preceding recommendations and the modelling results.
- The final Veitch Lister report be made available to interested parties.
- Council places on display the Tweed Road Development Strategy - 2003 Revision, for three (3) days each, at the Tweed City and Tweed Mall Shopping Centres.

#### 3.8.3.2 Mahers Lane Extension

The Lower Tweed Transportation Study 1990 and the Tweed Road Development Strategy (1997) identified the need for a road link between Fraser drive and Naponyah Road. The requirements for tis road have since been reviewed by TSC and the road corridor has now been changed to connect with Mahers Lane with the corridor extension to Naponyah Road now abandoned. This corridor has been the subject of a preliminary environmental assessment (Halliburton KBR, 2002). This assessment identified that the following key issues:

- Commonwealth, State and Local values suggest that the corridor is not critically constrained on environmental grounds;
- there is a need to establish if the alignment crosses 'protected waters' under the Rivers and Foreshores Improvement Act 1948;

- numerous protected flora and fauna species have been recorded in the wider area and further surveys are required to determine the impact on these species from the road corridor;
- indirect impacts on the adjacent SEPP14 wetlands require careful consideration and implementation of appropriate management practices;
- short and long term impacts of elevated noise levels will require assessment;
- no known sites of heritage significance are recorded within or directly adjacent to the prosed alignment; and
- loss of agricultural land should be considered.

The report also proposed alternative routes and a wider corridor for consideration to allow realignment of the road to limit impacts (See Figure 3.36).Investigations undertaken during the preparation of this study have identified that the original proposed alignment intruded into significant lowland palm forest which is worthy of protection. In addition the alignment intrudes into the 50m buffer proposed adjacent to the SEPP 14 wetlands.

The route also traverses areas of known acid sulfate soils and as such future construction of the route would require this matter to be addressed in terms of establishing appropriate foundation conditions and dealing with potential oxidisation of acid sulfate soils. This is not an absolute constraint but rather a management issue.

The road alignment also crosses areas of land below the 1 in 100 year flood level (2.65m AHD) however these areas would require minimal filling to raise the alignment to a suitable design height. In conjunction with any filling it would be necessary to ensure that environmental flows to the adjacent wetland area were maintained. In addition the original proposed alignment enters some areas of steep slopes which should if at all possible be avoided.

The potential for adverse impacts from road noise has also been evaluated. As a detailed design has not been completed it is not possible to assess noise impacts of roads in any detail. Based on the type of road, types of traffic (mostly residential), the ability to buffer and anecdotal evidence regarding similar roads and situations, noise associated with the proposed road is unlikely to have a detrimental impact on the acoustic amenity of the area.

The preliminary environmental assessment (Halliburton KBR, 2002) of the road alignment suggests that there is scope for realignment of the road corridor in order to minimise impacts and based on additional investigations, this view is strongly supported.

It is concluded that having examined the potential to change the alignment in order to minimise impacts on vegetation and avoid steep slopes it is possible for the proposed road to be constructed in the general area, subject to some realignment. Realignment, generally as suggested in the preliminary environmental assessment (Halliburton KBR, 2002) and the adoption of appropriate design, construction and management techniques should ensure that the road can be provided in the general locality.


**Figure 3-36: Mahers Lane- Fraser Drive Road Alignment Options (Source: Halliburton KBR, 2002)**

### 3.8.4 Future proposed transport improvements

The following future transport improvements in the study area have been identified from the Tweed Road Contribution Plan and through discussion with Tweed Shire Council:

- A Pacific Highway interchange at Kirkwood Road, with a northbound on-ramp and southbound off ramp only, would improve access to the Pacific Highway, with funding allocated by Tweed Heads Shire Council and construction by the NSW Roads and Traffic Authority (RTA), (within the next 5 years). This proposal is currently undergoing negotiations between Tweed Shire Council and the RTA.
- Extension of Kirkwood Road over the Pacific Highway, depending on environmental approval, including signalisation of Kirkwood Road/Fraser Drive intersection (TSC, 1993).within 2-5 years).
- Duplication of Fraser Drive from 2 to 4 lanes between Leisure and Vintage Lakes Drive will provide greater capacity for connection to the Pacific Highway and activity centres to the northeast, (within 6-8 months).
- Duplication of Leisure Drive between Eucalyptus Drive and Fraser Drive from 2 to 4 lanes will provide a greater capacity for connections to the Pacific Highway (within next 6 months).
- Further upgrades to Leisure Drive from Fraser Drive to Greenway Drive and from Greenway Drive to the Pacific Highway, including upgrading roundabout at Leisure Drive and Greenway Drive, and signalisation of Fraser Drive/Leisure Drive intersection (within 6-8 months).
- Upgrading Terranora Road from Mahers Lane to Fraser Drive, including improvements to the Terranora Road/Mahers Lane intersection.
- The Tugun Bypass is a proposed bypass of the Gold Coast Highway between Tweed Heads Bypass and Stewart Road, Tugun. It would provide improved travel times between the study area and activity centres on the Gold Coast.

### 3.8.5 Proposed development traffic

#### 3.8.5.1 Traffic generation

The estimated traffic generated from the full development of Area E is 16,000 additional daily trips and 1,500 additional peak hour trips. These traffic estimates were based on the following assumptions:

- a development area of 141 ha, i.e. a gross urban expansion area of 188 ha less 25% for infrastructure, etc. (JGA, 2002);
- an average lot size of 800m$^2$ with dwelling houses, i.e. 1,800 lots; and
- 9 daily trips and 0.85 peak hour trips generated from each dwelling (RTA Guide to Traffic Generating Developments, 1993).

The Draft Interim Strategic Plan – Cobaki/Terranora/Bilambil (Tweed Shire Council, 1995) estimated 9,600 additional daily trips generated by the full development of Area E. These initial estimates were based on urban designs of 1,200 lots and allowing for 8 trips per dwelling. The current estimate of 16,000 additional daily trips is believed to be more representative of the traffic generation of the proposed development. The assumptions are more current and consistent with recent planning reports (i.e. JGA, 2002) and more closely reflect the size of the proposed development.

### 3.8.5.2 Traffic distribution

Most trips generated by the future residential development at Area E are anticipated to occur in a northeast direction towards destinations in Banora Point, Tweed Heads, Coolangatta and the Gold Coast, and most connecting to the Pacific Highway. The generated traffic to Area E has been assigned manually based on current traffic volumes, and the quality of existing routes and connections to the Pacific Highway.

Of the four access routes into Area E the following traffic assignment was made:

- Route 1 (Terranora Road) will carry 40% of total Area E traffic;
- Route 2 (Leisure Drive) will carry 20% of total Area E traffic;
- Route 3 (Greenway Drive) will carry 20% of total Area E traffic; and
- Route 4 (Dry Dock Road) will carry 20% of total Area E traffic.

The above traffic distribution assumptions represent a reasonable estimate of the likely traffic distribution. Indeed, it could be considered a reasonable worst case scenario as it does not allow for a proportion of the traffic to head south. This is considered reasonable given that the majority of the activity centres within the Shire are situated to the north and north-east of Area E.

Therefore, with this traffic assignment, the section of Fraser Drive between Amaroo Drive and Leisure Drive will carry traffic from routes, two, three and four which is 60% of Area E's generated traffic.

The resulting future traffic volumes on routes one, two, three and four are shown in Table 3.42. Taking the most congested sections, routes one, two, three and four will operate at 107%, 73%, 71% and 79% of current capacity respectively, with the most congested section on route one occurring along Terranora Road between the Pacific Highway and Kiora Street and on section two, three and four occurring along Fraser Drive between Amaroo Drive and Leisure Drive.

The traffic generation and assignment has highlighted that all available routes connecting Area E with the Pacific Highway will likely operate under capacity with full development of Area E. The resulting volume capacity performances range between 0.71 and 1.16. It is also likely that one particular route section, that is Fraser Drive between Amaroo Drive and Leisure Drive may operate just over capacity. Generally, this indicates that at this point the surrounding network to Area E will be likely operating in a Level of Service Range of C – D at this point.

The analysis above assumes fairly even traffic distribution between the four route options described. In comparison, previous modelling conducted by Veitch Lister for the Tweed Road Development Strategy (1997) assumes that the majority of traffic generated by Area E would use Fraser Drive between Amaroo Drive and Kirkwood Road to access the Pacific Highway, and a future extension of Kirkwood Road to access the local network in Tweed Heads South. This information has now been updated and the results of the traffic analysis utilising this new traffic flow information is provided in the following section of this report, section 3.8.6.

## Table 3-42: Additional generated traffic to full development Area E

| Access Route | Section of Route | Section | Existing Capacity[1] | Estimated ADT Volumes[2] (2003) | Generated ADT "Area E" Volumes[3] | | Full Development Traffic Volumes | |
|---|---|---|---|---|---|---|---|---|
| | | | (veh/day) | (veh/day) | (veh/day) | % Total | (veh/day) | V / C |
| Terranora Road | 1 | Bilambil Rd to Fraser Dr | 9,000 | 4,852 | 6,400 | 40% | 11,252 | 1.25 |
| | 1 | Fraser Dr to Kiora St | 9,000 | 5,753 | 6,400 | 40% | 12,153 | 1.35 |
| | 1 | Kiora St to Pacific Hwy | 9,000 | 8,096 | 6,400 | 40% | 14,496 | 1.61 |
| Fraser Drive | 2,3 | Terranora Rd to Amaroo Dr | 9,000 | 5,993 | 6,400 | 40% | 12,393 | 1.38 |
| | 2,3,4 | Amaroo Dr to Leisure Dr | 9,000 | 5,993 | 9,600 | 60% | 15,593 | 1.73 |
| | 4 | Leisure Dr to Dry Dock Rd | 9,000 | 6,504 | 3,200 | 20% | 9,704 | 1.08 |
| Dry Dock Rd | 4 | Entire length | 9,000 | 7,516 | 3,200 | 20% | 10,716 | 1.19 |
| Leisure Drive | 2,3 | Fraser Dr to Greenway Dr | 9,000 | 6,700 | 6,400 | 40% | 13,100 | 1.46 |
| | 2 | Greenway Dr to Pacific Hwy | 9,000 | 6,700 | 3,200 | 20% | 9,900 | 1.10 |
| Greenway Drive | 3 | Entire length | 9,000 | 6,324 | 3,200 | 20% | 9,524 | 1.06 |

Notes:

1. Peak hour capacity of 900 veh/hr multiplied by 10.
2. Traffic counts obtained from Tweed Shire Council.
3. Volumes assigned assuming:
(a) 70% access the Pacific Highway and 30% destination is Tweed Heads/Coolangatta
(b) 40% use route 1, 20% use route 2, 20% use route 3 and 20% use route 4

### 3.8.6 Intersection and Route Analysis

The following sections of the report have been produced using the latest traffic flow information. In many respects this section of the report is an "update" of the previous traffic analysis section. Indeed, it is an extension to the previous sections of traffic analysis and in particular is introduced at the end of the previous section 3.8.5.2. These further analyses have been undertaken using the latest outputs from Veitch Lister Consulting (VLC) in relation to Area E development traffic volumes (VLC, January 2004).

#### 3.8.6.1 Intersection Analyses

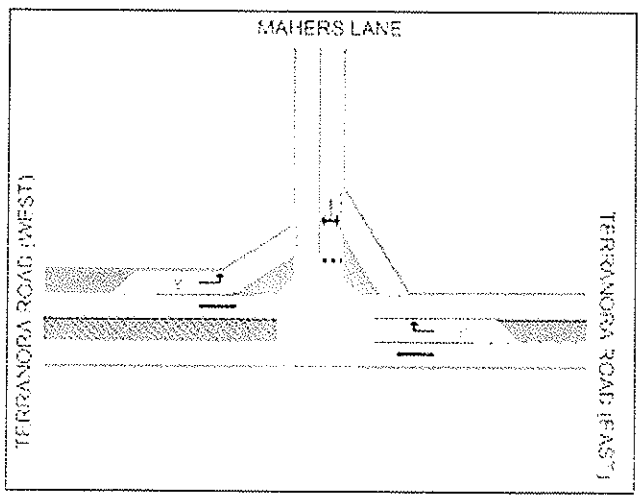
Intersection treatments were evaluated in aaSIDRA intersection traffic analysis software for the following intersections in 2011 and 2021:

- Maher's Lane and Terranora Road (Existing intersection);
- Terranora Road and Area E internal road;
- Maher's Lane Extension and Area E Internal road; and
- Fraser Dr, Amaroo Drive and Maher's Lane Extension (Existing 3-way with added western leg)

The traffic turn volumes were based on outputs from the VLC Tweed Area traffic model. A 1.1% per annum average growth rate was calculated using link volumes from the 2001 and 2031 "without Area E" models. For the purposes of the traffic analyses this growth rate was then applied to factor the 2031 "with Area E" turn volumes to determine the turn volumes for 2011 and 2021.

***Maher's Lane and Terranora Road***

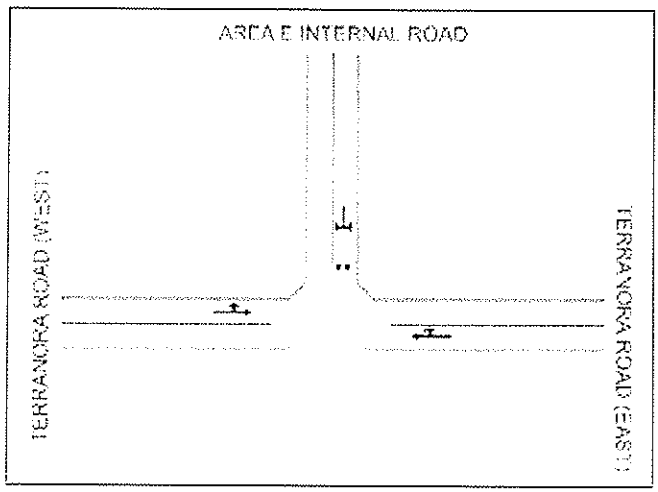
This intersection is an existing "Type C" intersection (Austroads Part 5, Fig 5.1 p 40) and was analysed as such. Analysis results show that the intersection is operating well in 2021. No upgrade is expected to be required to 2021 as the intersection is expected to operate with an acceptable level of service C during both peak periods in 2021.



| | 2011 | | 2021 | |
|---|---|---|---|---|
| | AM | PM | AM | PM |
| Max Degree of Saturation | 0.17 | 0.15 | 0.19 | 0.17 |
| 95th Percentile Queue Distance (m) | 5.0 | 5.0 | 6.0 | 6.0 |
| Worst Level of Service | C | C | C | C |
| Maximum Control Delay (seconds) | 15 | 15 | 16 | 16 |

### *Area E Internal Road and Terranora Road*

This proposed intersection was analysed as a Priority controlled (give-way) "Type A" intersection. This intersection form does not provide a separation of through and right turning traffic. However, from a traffic safety perspective it is recommended that consideration be given to the use of a Type B intersection. This is to reduce the potential for traffic crashes arising from the relatively poor vertical and horizontal geometry on the approaches. This affects the available sight distance for vehicles entering the intersection, especially increase the potential for rear-end crashed involving through movement crashing into the rear of right turning vehicles. Heavy vehicles also use Terranora Road, with resultant potential for more severe crashes, and as such it is recommended that a "Type B" arrangement be adopted for this location.

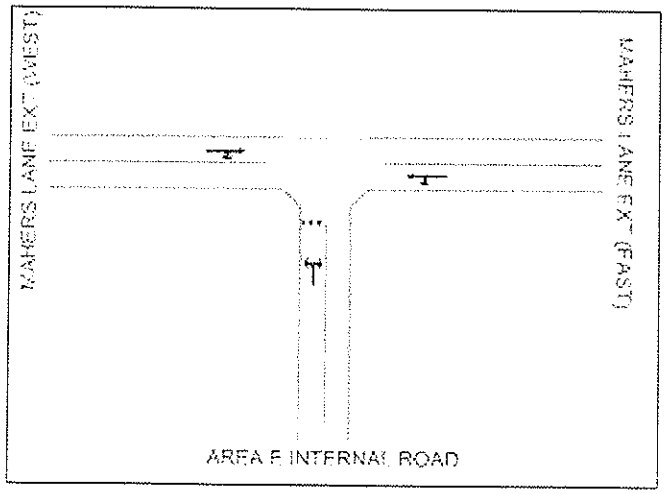



| | 2011 | | 2021 | |
|---|---|---|---|---|
| | AM | PM | AM | PM |
| Max Degree of Saturation | 0.2 | 0.3 | 0.2 | 0.3 |
| 95th Percentile Queue Distance (m) | 7 | 16 | 9 | 19 |
| Worst Level of Service | B | B | B | B |
| Maximum Control Delay (seconds) | 12 | 11 | 13 | 12 |

This intersection is expected to operate adequately to 2021 with very good levels of service for all movements. However, for safety reasons it is recommended a Type B priority treatment be adopted.

### *Area E Internal and Maher's Lane Extension*

This intersection was also analysed as a priority controlled (Give way) "Type A" intersection.

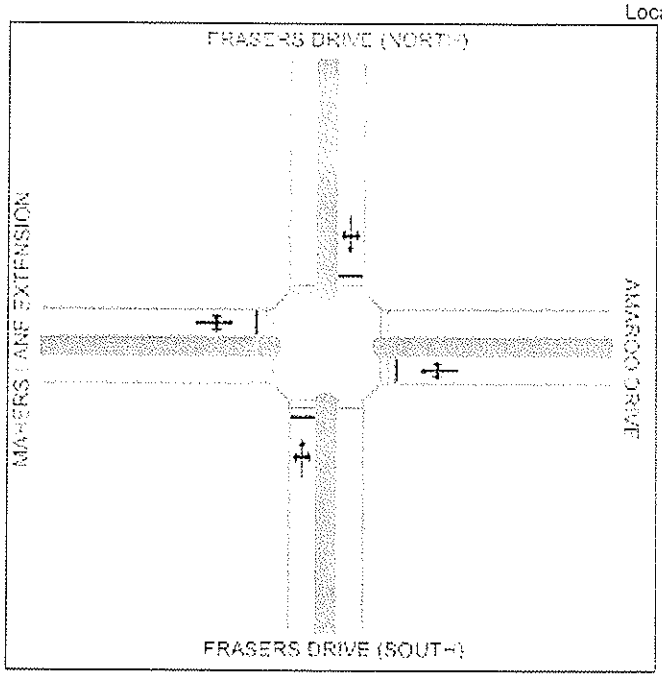



| | 2011 | | 2021 | |
|---|---|---|---|---|
| | AM | PM | AM | PM |
| Max Degree of Saturation | 0.5 | 0.3 | 0.6 | 0.4 |
| 95th Percentile Queue Distance (m) | 27 | 16 | 37 | 21 |
| Worst Level of Service | C | C | C | C |
| Maximum Control Delay (seconds) | 18 | 16 | 21 | 18 |

This intersection is expected to operate adequately to 2021 with an acceptable level of service C during both peak periods in 2021. Consideration may need to be given to the use of a "Type B" intersection if sub-standard sight distance becomes an issue once the final road layout and alignment is formulated.

### *Fraser Drive, Amaroo Drive and Mahers Lane Extension: Signalised*

This intersection has been analysed as a signalised intersection. It was analysed with a "minimum pavement" layout and a 90 second cycle time. A signalised intersection is one option with an alternative roundabout option investigated in the following section of this report. For completeness, both options were tested. It is important to note that the signalised option was not tested against the RTA warrants and it is understood that negotiations would be required with the RTA to implement traffic signals at this location.

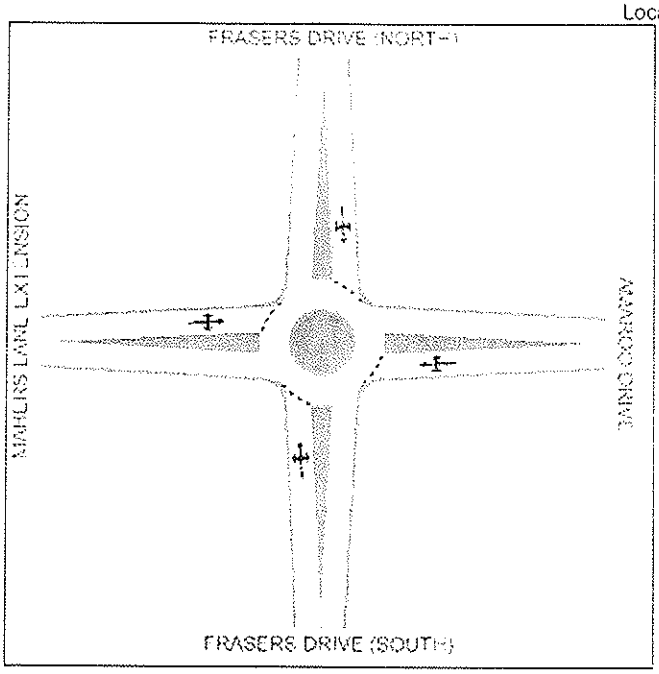



| | 2011 | | 2021 | |
|---|---|---|---|---|
| | AM | PM | AM | PM |
| Max Degree of Saturation | 0.71 | 0.66 | 0.79 | 0.77 |
| 95th Percentile Queue Distance (m) | 172 | 136 | 208 | 164 |
| Worst Level of Service | D | C | D | D |
| Maximum Control Delay (seconds) | 15 | 15 | 16 | 16 |

This intersection is expected to be more highly trafficked than the others. However, it is still expected to perform within acceptable limits to 2021. If a signalised option is chosen, then further features such as slip lanes and right turn lanes should be provided to accommodate the expected queue lengths, to maximise traffic throughput and enhance safety. Also, speed limit signage needs to be incorporated to ensure drivers are clear that an appropriate approach speed of 60km/h (or 50km/h for the side roads) is in place.

***Fraser Drive, Amaroo Drive and Mahers Lane Extension: Roundabouts***

This intersection was also analysed as a roundabout for up to 2021. The proposed roundabout has single lane entries and exits; a single 5m width circulating lane and a 15m diameter central island,




| | 2021 | |
|---|---|---|
| | AM | PM |
| Max Degree of Saturation | 0.86 | 0.67 |
| 95th Percentile Queue Distance (m) | 130 | 590 |
| Worst Level of Service | C | B |
| Maximum Control Delay (seconds) | 23 | 16 |

The analyses indicate that it is expected the roundabout will perform better to 2021 as a roundabout rather than as a signalised intersection in terms of most indicators including queue lengths, degree of saturation and delays. A roundabout may be more appropriate as several roundabouts already exist as methods of traffic control in the surrounding area. Again drivers should be made aware through the use of appropriate signage that an appropriate approach speed is 60 km/h or less.

### 3.8.6.2 Route analyses

The VLC Traffic Report (December 2003) traffic report identified that the Area E development will increase the instances of "rat-running" of cars through nearby residential areas. Specifically, the two routes that the VLC model indicated were:

- Amaroo Drive, Darlington Drive(south) and Banora Hills Drive to access Terranora Road; and
- Amaroo Drive and Darlington Drive (north) to access Leisure Drive.

These two routes are considered below. Amaroo Drive, Darlington Drive (south) and Banora Hills Drive to access Terranora Road

***Amaroo Drive, Darlington Drive (south) and Banora Hills Drive to access Terranora Road***

Though this route was identified in the traffic model as a possible rat-running route, in reality it is expected to be unlikely. The reasons for this conclusion are that firstly, Darlington Drive south of Amaroo already has several vertical displacement devices (speed bumps) which would already likely make the route unattractive to through traffic. Secondly, Banora Hills Drive is a very steep hill with the resultant difficulties in undertaking safe and successful "hill starts" for inbound movements onto Terranora Road. Both of these reasons make this route an unlikely choice for a "rat running" route. Notwithstanding, it is understood that anecdotal evidence also indicates that on occasion it used by "rat runners". To reduce the attractiveness of this route for "rat runners" the following measures may be adopted:

***Amaroo Drive and Darlington Drive (north) to access Leisure Drive***

This option is considered to be a potential "rat running" route. This route includes two roads, Amaroo Drive and Darlington Drive, each are long straight "uninterrupted" (relatively low side friction) roads, thereby providing an "attractive" through route via adjacent residential communities.

To minimise the potential for "rat-running" over this route, four standard methods of removing through traffic from local streets include:

- vertical displacement devices (Speed bump or Speed ramps);
- horizontal displacement devices (islands), including "pinch points" down to one traffic lane;
- banning right turns during peaks, with appropriate enforceable signage; and
- "Local Traffic Only" signs to discourage the use of defined routes by "rat runners".

The nature of the "rat running" in this case is not to avoid congestion, as aaSIDRA analysis shows main arterials are flowing freely. Rather, the vehicles are merely taking the quickest path between two points. This means that it is likely that the implementation of Vertical and Horizontal displacement devices would be of benefit. Over recent times there has been a move away from using speed bumps, due to concerns that these create unnecessary difficulties for Emergency Vehicles. Horizontal devices, such as mid-block island groups that force motorists to decelerate to manoeuvre through them, are becoming the preferred option. Often these will reduce available road width temporarily to a single lane, so that only one direction may pass at a time. Such devices make routes unattractive to through cars and often restrict traffic to local users.

The actual LATM devices that are appropriate for a defined area are tailored to the individual needs of a given area. The installation of LATM devices usually also requires input and support from the local community, in particular, the residents along the "rat running" streets. Given this, further more detailed investigations (and likely community consultation) is required to establish which devices and LATM strategy, if any at all, is appropriate for each "rat run" route.

### 3.8.7 Internal Movement Networks

The overall site is of a sufficient size and dimensions to allow the development of a well designed movement network which takes into account various physical constraints and policy requirements. Within Area E the movement network will be dictated by:

- TSC design requirements;
- proposed intersections with the surrounding area;
- proposed pedestrian /cycleways;
- public transport needs;
- the proposed Mahers Lane/Fraser Drive Distributor; and
- topography and Ecological constraints.

While it is not appropriate to dictate an internal movement network at this stage the following matters must be taken into account at future stages.

#### 3.8.7.1 TSC design requirements

Development Control Plan No 16 – Subdivision Manual includes extensive guidance on the design and layout of movement networks and this should be adhered to in the design of the movement network for Area E. This includes requirements for:

- overall permeability;
- intersection design;
- road hierarchy;
- public transport;
- pedestrian and cycle routes;
- streetscape;
- cross sections; and
- other general design requirements.

Of importance is the desire to create a permeable network. The network should be set within a clear sense of hierarchy. Such a network should be able to be accommodated within the study area given its relatively large size and the connectivity of land parcels. DCP 16 proposes a basic grid pattern for road construction which is modified to deal with topography. Given the steep slopes in some parts of the site this will be necessary. No significant impediments are seen to being able to achieve the performance criteria set out in DCP 16 with respect to an integrated movement network for Area E.

#### 3.8.7.2 Proposed intersections with the surrounding area

Access to Area E will be via three main access points:

- Mahers Lane (existing);
- Terranora Road (proposed); and
- Fraser Drive (proposed).

Some access will also occur via Parkes Lane which already has truncations at a number of points with Area E. Use of this access is however likely to be limited as there will be more direct/quicker routes enabling access to Fraser Drive for the majority of development within Area E. Connectivities need to be structured so that much of the existing development in Parkes Lane will be encouraged to utilise the movement network created within Area E.

These intersections will be major influences on the overall road hierarchy of the area given that their locations are largely fixed by topography. The number of connections to the surrounding area and their location provides sufficient scope to design a road network which will cater for residential development and traffic volumes anticipated.

### 3.8.7.3 Proposed pedestrian / cycleways

The size and dimensions of Area E provide significant opportunity to develop a pedestrian/cycleway network which integrates with the surrounding area and promotes the use of alternative modes of transport.

The rural-residential roads surrounding the proposed Area E development do not have allocated cyclists or pedestrian facilities. A cycleway and pedestrian walkway are provided to the north east servicing St. Josephs College and St. James Primary School. A cycle and pedestrian path are also provided along Terranora Creek, which partly runs along Dry Dock Road.

The Tweed Shire Council has planned to have an on-carriageway cycleway on Fraser Drive and Terranora Road and a cycleway along the proposed Mahers Lane to Fraser Drive extension. These proposed cycle paths will provide good access to residents of Area E with activity centres to the northeast.

In addition to this larger network an internal network of cycle and pedestrian ways will be required. These should be designed and implemented in accordance with the requirements of DCP 16. This network should be designed to link community focal points such as existing or proposed schools, shops, parks, community centres. The network should also be integrated with the wider network proposed above.

### 3.8.7.4 Public Transport Needs

Surfside Buslines serves current residents in estates to the west and east of the proposed development and provide access north to Tweed City Shopping Centre and Coolangatta, and south to Murwillumbah. Given the major road proposed through the site (Mahers Lane/Fraser Drive connection) the opportunity to provide a loop service rather than a linear service (current Route 605 runs out and back along Terranora Road) arises which should increase patronage and viability of this service. Current bus services are likely to be able to be expanded to the expanded residential catchment. Further investigations will be required at later stages of any Area E development. Indeed, any changes to public transport services should be incorporated prior to the opening of the Area E development so residents have access to a quality public transport service from the outset of the development.

The incorporation of roads with capacity to carry buses in accordance with commonly accepted safety and design standards can be achieved.

### 3.8.7.5 Proposed Mahers Lane/Fraser Drive Distributor

The Proposed Mahers Lane/Fraser Drive Distributor will be a key road servicing not only development within Area E but also existing and future development to the west of the site. Consequently preserving the capacity of this road is a key objective and the local road network should be designed to limit direct access onto this road. This must be considered in any subsequent local road network design.

### 3.8.7.6 Topography and Ecological constraints

Parts of Area E contain steep slopes which will constrain road geometry and design. While a modified grid pattern will be able to be implemented over the majority of the site) to create a permeable road network (meeting the requirements of DCP 16 in some steeper areas of the site it will be necessary to consider design outcomes which avoid steep slopes and/or extensive cut and fill.

Some parts of the site are also located below Q100 which may necessitate partial filling of a road corridor to ensure that flood free access can be provided.

Similarly areas have been identified throughout the site which are of ecological significance. These areas must be avoided in designing the internal road network.

#### 3.8.7.7 Road noise

One potential issue that will arise as the result of the construction of the Mahers Lane/Fraser Drive extension is that of potential traffic noise. This road is likely to be a two lane limited access distributor road (Halliburton KBR, 2002) which will carry the majority of Traffic from Area e and potentially much of the traffic from areas to the west.

The control of orad noise is important as the amenity of residential and other uses can be severely impacted upon by excessive noise. The effects can range from lack of residential amenity, to sleep deprivation and related side effects. Consequently control of noise will be important to ensure that residential amenity within the area is appropriate.

Noise levels from the road can not be speculated upon at this time as noise will be dependent on the total number and type of vehicles, road surfaces and the final location of the road. Road noise becomes an issue when there is a clear line-of-site between the noise source and the receptor. In the case of tweed Area E noise from the road will become an issue where sensitive receptors (i.e. houses, schools etc.) have a direct line of site to the road.

Road noise can be controlled via a number of mechanisms including:

- noise barriers (e.g. earth mounds, solid walls);
- buffers (noise dissipates over distance);
- control of speed and vehicle types;
- pavement surface (e.g. asphalt is quieter than concrete); and
- design of buildings (e.g. building construction, double glazing, locations of windows, location of living and sleeping areas).

Once final details of this road design have been determined it will be possible to analyse the full impacts of this road on noise in the surrounding area. Current Council policies including DCP 16 require the issue of noise to be addressed at subdivision stage.

Control of noise from internal roads will also be an issues but will generally be able to be addressed through road design which provides appropriate setbacks to roads that carry higher volumes of traffic and ensuring that overall volumes of traffic are controlled through geometric design, travel distance and design to effect the convenience of use of routes.

### 3.8.8 Conclusions

Generally, the traffic impacts of the potential development of Area E are likely able to be accommodated within the future road network proposed for the locality.