Appendix I

Stormwater Review (Tonkin & Taylor Ltd)

REPORT

BECA PLANNING LTD

Te Rapa Bypass Notice of Requirement
Assessment of Drainage & Stormwater Design

Report prepared for:

BECA PLANNING LTD

Report prepared by:

TONKIN & TAYLOR LTD

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1 Introduction

This report has been prepared by Mr Peter Cochrane. Mr Cochrane is a senior environmental scientist and director of Tonkin & Taylor Ltd.

He has over 15 year's experience in water and stormwater management and has been engaged by Beca Planning to review matters related to stormwater management associated with the Notice of Requirement (NOR) Application by Transit NZ for the Te Rapa Bypass.

The scope of this review includes:

- Review of the documents prepared by Transit NZ in support of the NOR;
- Attendance at a pre-application meeting convened by Transit NZ;
- A site walk over inspection;
- Discussions and consultation with Environment Waikato staff; and
- An assessment of the potential effects of the stormwater management proposal on surface water resources, and the adequacy of the proposed designation to ensure that any potential adverse effects can be managed within the area sought in the Application.

The documents reviewed include:

- SH1 Te Rapa Bypass NZ Notice of Requirement, August 2007 prepared by Transit NZ;
- Te Rapa Bypass - Section 92 Response, December 2007, prepared by Transit NZ;
- Te Rapa Bypass Summary of Submissions by Topic, report prepared by BECA Planning, March 2008;
- Te Rapa Bypass Summary of Submissions by Submitter, report prepared by BECA Planning, March 2008;
- SH1 Te Rapa Bypass NZ Notice of Requirement (incorporating s92 Response), January 2008 prepared by Transit NZ;
- Rotokauri Structure Plan 2007;
- Proposed Rotokauri Structure Plan, prepared by Hamilton City Council 24 September 2007;
- Rotokauri Staging Map, prepared by Hamilton City Council 10 September 2007;
- Proposed District Plan Appendix 6.9-III Rotokauri Rule 6.9-7 Staging of Development, prepared by Hamilton City Council (HCC) September 2007.

In the course of this review we have read the original submissions pertaining to scope of his brief.

Unless otherwise stated, reference to the NOR in this report refers to the January 2008 version of the application, which includes the s92 responses.

2 Information Request and Adequacy of Response

In October 2007 the NOR was reviewed to determine the adequacy of information and to identify whether any additional information was needed to assess the effects of the NOR on the environment.

As a result of this review the following additional information was sought:

- A plan(s) showing the stormwater catchments, proposed drainage and treatment measures and proposed discharge points;
- Clarification of the use of a stormwater collector pipe (as set out in Section 8.10 and Drawing sheet 150 of the NOR August 2007);
- Clarification of the use of stormwater ponds as discussed in Section 5.5 of the Ecological Report;
- Clarification of the management of stormwater on proposed bridges;
- Details of consultation with drainage asset managers in Waikato District Council and Environment Waikato.

The Section 92 Report prepared by Transit NZ was reviewed in December 2007, and concluded that with the exception of one minor item the report provided sufficient information for notification.

The exception was around consultation with the drainage asset managers in Waikato District Council and Environment Waikato. It was our view at the time that this matter could be dealt with as the application progressed by discussions directly with asset management staff from these organisations.

3 Drainage Design

3.1 Introduction

In general the NOR envisages:

- Culverting of existing open drains and watercourses;
- The use of grass swales on both sides of the bypass to provide for drainage, treatment and storage of stormwater run-off;
- Piped reticulation under the grassed swales to assist with storage, and regulate groundwater levels;
- The use of kerb and channel on raised embankments and bridge structures;
- Piping of stormwater between 7,000 m and 8,477 m to tie into the HCC's stormwater drainage system at Avalon Drive; and
- The construction of a sediment treatment and storage pond at Gilchrist & Tasman Roads.

The NOR has identified that stormwater from the bypass will discharge to surface water bodies, rural drains and HCC's reticulated network at five locations:

- The Te Rapa Stream at Bern Road;
- An unnamed tributary of the Te Rapa Stream at Onion Road;
- At five separate locations into a rural drain system at Exelby Road (this system is a tributary of the Te Rapa Stream);
- HCC's stormwater system at Avalon Drive.

3.2 Design Standards

Transit NZ proposes to design its drainage system to the following standards:

- Culverts to pass 1% annual exceedance probability (AEP) flood event;
- Bridge crossings to pass the 1% AEP flood event;
- Grassed swales to convey stormwater run-off from the 2% AEP time of concentration rainfall event;
- Kerb and channel on both bridges and parts of the road on embankments to convey the 5%, 10 minute time of concentration rainfall event.

In establishing these design standards the NOR (Section 8) refers to the following documents:

- Hamilton City Development Manual;
- Environment Waikato Best Practice Guidelines for Waterway Crossings (EW Technical Report 2006/25); and
- Transit NZ Bridge Design Manual.

The HCC Development Manual sets out the requirements for stormwater infrastructure that will be vested with Council. The Development Manual has been prepared for use in Hamilton City, but has also been adopted for use (with some modifications) by the Waikato District Council. With due consideration to the purpose of the manual (for council infrastructure) we consider that its use is relevant to this application.

Council's requirements for stormwater design are set out in Section 4 of the Development Manual. In particular, it requires:

- Culverts to provide an unobstructed waterway capable of passing the 1% AEP rainfall event while maintaining at least 0.5 m of freeboard to building platforms on upstream properties;
- Stormwater overland flow paths having the capacity to pass run-off from a 2% AEP rainfall event, assuming blockage of inlets;
- The reticulated pipe network sized to pass run-off from a 20% or 10% AEP rainfall event for industrial and commercial land respectively (roads are not specifically dealt with in the Development Manual);

The Transit Bridge Design Manual (Section 2.0) requires bridges on primary lifeline routes to be able to pass a 1% AEP event with a minimum freeboard to the underside of the bridge superstructure of 0.6 m, and culverts to pass the same design storm with a minimum freeboard of 0.5 m.

Environment Waikato's Best Practice Guidelines for Waterway Crossings provides guidance on waterway crossing design types and sets out a minimum design requirement to ensure the passage of flow from a 2% AEP storm event. This standard is less conservative than that proposed by Transit NZ in the NOR.

In summary, the design standards adopted in the NOR are appropriate and are consistent with industry practice. The design standard for the kerb and channel on bridge sections is somewhat higher that that set out in the Hamilton City Development Manual, but is otherwise appropriate.

The proposed design standards also need to contemplate projected effects of climate change. The Ministry for the Environment has established guidelines[1] for local authorities to take into account the effects of climate change on infrastructure design. This has not been addressed in the NOR, but is not otherwise a significant omission and can be addressed later at a detailed design stage.

3.3 Culverts

Six main culverts are proposed where the bypass crosses surface water bodies or rural drains. These include:

- A box culvert over the Te Rapa Stream at Bern Road;
- A 900 mm diameter culvert crossing a tributary of the Te Rapa Stream at Onion Road;
- Two box culverts and one 1800 mm diameter culvert crossing the Exelby Road drainage system at three locations; and
- A crossing of an open drain at the Avalon Drive end of the bypass at chainage 7000 m.

The designs have not taken into account changes in catchment areas with development, but have included likely changes to storm flows brought about be development of the Rotokauri and Horotiu Structure Plan areas.

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[1] : Climate Change Effects and Impacts Assessment: A guidance manual for Local Government in New Zealand: Ministry for the Environment Publication ME513, May 2004.

Culverts can provide a barrier to the migration or movement of aquatic fauna particularly swimming fish. This can occur due to barriers created by changes in bed level between the culvert and adjacent stream bed, or the concentration of flows providing a velocity barrier that fish can not otherwise negotiate and swim against. These are important design considerations, and in our opinion should be considered in detailed design for the main crossings identified in the NOR.

The construction of culverts will require consent from Environment Waikato, and these considerations can be incorporated into the design at that stage. However, we also consider that it is appropriate that the Hearings Committee recommends the design and construction of culverts to be in accordance with the design standards proposed by Transit, and with the Best Practice Guideline for Waterway Crossings published by Environment Waikato.

3.4 Road Drainage

Transit is proposing to drain run-off from the bypass through a combination of grassed swales and piped reticulation.

Grassed swales will be located on either side of the bypass and will have 2H:1V sides and will vary in depth from 100 mm to 600 mm below ground level. Transit is proposing to have a collector pipe located beneath the lowest point (invert) of each swale. This pipe will help to keep low gradient parts of the swale drained, and provide for some (albeit minor) additional capacity.

The swales (including the under swale pipe) will be designed to convey stormwater run-off from the 2% AEP event. This will allow run-off from extreme rainfall events to be safely conveyed to a stormwater outlet. However the sizing of overland flow paths is normally based on an assumed failure of the primary piped system (as set out in the Hamilton City Development Manual).

We have checked the likely level of performance of the swales and consider that the concept design will be able to convey stormwater run-off from the 2% AEP event, without the benefit of the 450 mm diameter under drain. The design therefore meets what we would regard an appropriate design standard.

There are few details in the NOR regarding the design of the 450 mm drain. We understand the purpose of the pipe is to drain the swale, and control groundwater levels. This will most likely be achieved through the use of a perforated plastic pipe or butt joined concrete pipe that will allow the ingress of water. The pipe may also be connected to catchpits that drain the swale. Although subject to further design, these details have been confirmed by the engineering consultancy engaged by Transit NZ for NOR[2].

The use of catchpits in the base of the swales is supported, but they need to be spaced to ensure that the swale would provide the necessary treatment of stormwater quality as discussed in Section 4.2.

We consider that that the Hearings Committee recommends the design of the swale have the capacity to convey run-off from the 2% AEP event, assuming blockage of the under swale pipe.

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[2] Bridget Fitzgerald, Opus International Consultants Ltd verbal communication, 2 April 2008.

3.4.1 Kerb and Channel

Transit NZ considers that run-off from the sealed carriage way can enter the swales through sheet flow off the side of the road, but for embankments greater than 1 m in height it proposes to drain water from the carriageway through kerb and channel with stormwater discharging into catchpits which are piped to the adjoining swales at regular intervals. This will avoid the potential for stormwater flows to erode the steeper road embankment formations.

3.5 Bridge Drainage

The bridges are to drain to a kerb and channel system designed to accommodate flows from a 5% AEP 10 minute duration storm event. For the shorter bridges, stormwater will flow along the kerb and channel to the adjoining abutments. For longer bridges, stormwater will be piped to discharge into the road swales.

The design standard is acceptable and in both instances Transit NZ's design appears appropriate. Further detail however, will be required to ensure that the discharges from the bridges (either at the abutments, or from the piped sections of the bypass) will be able to discharge into the road side swales without erosion of the swale, or the abutments themselves. We consider that this will be a matter of detailed design.

4 Assessment of effects

This section presents our assessment of the likely effects of the proposed drainage system on the environment. This section focuses on technical matters in the NOR that require further attention and discussion, and the issues raised by submitters (as set out in Section 5.0). In particular this section addresses the potential adverse effects of the NOR on:

- The Exelby Road drainage system;
- Water quality;
- Scour and erosion of water bodies around stormwater outlets;
- Flooding;
- Future land uses within the catchment; and
- Construction effects.

4.1 Effects on Exelby Road Drainage System

The application proposes the discharge of stormwater to the Exelby Road drainage system at five points, and there is some potential for discharges from this part of the bypass to affect the capacity of the system.

This would need to the subject of further investigation and design to determine the effect that the proposal has on the drainage system at this location and to develop methods to manage any adverse effects on the drainage system's capacity at this location.

Mitigation works could simply be a matter of upgrading the capacity of drainage system to manage increases in peak flows. It is unlikely that flow detention would be appropriate, because run-off from the road would occur rapidly, and stormwater detention may result in peak flows from the roads coinciding with peak flows from the wider catchment. In other words, it might be more practical to allow flows from the bypass to flow into the drainage system before the drain is subject to flood flows from the catchment as a whole.

These matters can and are more adequately addressed during detailed design.

4.2 Impacts on water quality

The system as proposed in the NOR will see stormwater from the paved road surface flowing over a vegetated road shoulder into a swale drain over most of its length.

Stormwater from the bypass is likely to contain the following contaminants:

- Suspended solids from the wearing of the road surface and vehicle tyres, deposition of dust and soil on the pavement and potentially from erosion of the soil along the shoulders of the road and within the swale itself;
- Metals (particularly zinc and copper) from wearing of vehicle components such as tyres and brake linings;
- Polynuclear aromatic hydrocarbons (PAH's) as particulate materials from vehicle exhausts that are deposited on the road and later washed off;

- Hydrocarbons (petrol and diesel, oil), which are deposited directly on the road; and
- Litter.

The concentrations of these contaminants are likely to be moderate but will vary in response to the type of rainfall event (i.e. the total amount of rainfall and its intensity) and duration of the intervening dry period. Rainfall may for example result in a first flush of contaminants at the start of an event, with the subsequent run-off being very much cleaner. In other instances, the concentrations of contaminants in stormwater may remain relatively constant throughout the rainfall event.

The proposed road design will see the removal of particulate contaminants through vegetative filtering as stormwater flows over grassed road shoulders. The grass will help slow the flow velocity which will help suspended materials to settle out.

Particulate contaminants will also be filtered out in the grass sward. Some dissolved contaminants (particularly zinc) will become adsorbed to soil particles present in the stormwater and will be removed by settling.

A proportion of the particulate and dissolved contaminants will be removed through adsorption to soil and grass surfaces. Similar processes will occur in the grassed swales, where contaminant removal will be via settling and vegetative filtering of suspended materials and adsorption of dissolved contaminants.

The degree of performance of these devices is difficult to judge at this stage as no detailed design has been carried out, but standard designs are readily able to achieve removal of between 60% and 70% of particulate contaminants in stormwater.

4.2.1 Role of the under swale drain

The applicant proposes to use an under swale drain to help maintain drained conditions in the bottom of the swale and to convey storm flows. The use of such a device will promote infiltration of stormwater from small rain events into the soil. This will promote the removal of contaminants through filtering in the soil and adsorption of dissolved contaminants to the soil. It will also help to ensure the growth of vegetation in the base of the swale which will help maintain its effectiveness.

4.2.2 Litter

In most instances litter will also get caught the swales, and its control is largely one of regular removal as an ongoing maintenance activity.

Some may remain but given the length of the swale proposed, it is likely that most will be trapped rather than discharged into waterways. The control of litter prior to discharge should be considered as a part of detailed design.

4.3 Stormwater outlet design

Transit NZ is proposing to discharge stormwater from the bypass into surface water bodies at eight locations. In some instances these bodies are somewhat lower in elevation than the swales and further design will be required to pipe or otherwise direct the stormwater to these points without causing erosion to the banks or beds

of these water bodies. Some erosion protection measures may also be required downstream, but in both situations these potential effects are likely to be able to be managed within the areas of land sought by the designation.

There may be some requirements to control stormwater flows to avoid adverse effects on the surface water bodies. This is potential effect can be addressed or avoided during detailed design.

4.4 Culverts

Culverts in waterways or drains are proposed at six points along the bypass route. The design standards proposed are appropriate, and the adoption of techniques outlined in the Environment Waikato guidelines will help minimise any adverse effects on the movement of aquatic organisms, and will avoid (or at least not exacerbate) any upstream flooding issues.

The culverts will need to consider changes in catchment land uses brought about by the Rotokauri, and to a lesser extent the Horotiu Structure Plans, and changes in run-off and surface water flows brought about by climate change. It is our view that these matters can be addressed during detailed design.

4.5 Integration with Rotokauri Structure Plan and Horotiu Structure Plan

The bypass passes through the Rotokauri Structure Plan area and passes to the southeast of the Horotiu Structure Plan area. Both Structure Plans are addressing stormwater management, and for the Rotokauri Structure Plan area the design recognises the presence of the bypass.

The main area of potential conflict is around chainage 5,500 m where the main stormwater channel (floodway and ecological corridor) that links Lake Waiwhakareke with Lake Rotokauri is proposed to run parallel to the bypass. A tributary of this drain runs perpendicular and will flow under a bypass bridge at this point. The NOR itself does not impact on that, but HCC's proposal may require this bridge span to be longer to accommodate this part of the Council's proposed drainage network. This can be addressed during detailed design and the through the provision of an outline plan.

The NOR also identifies a stormwater pond to be placed at about chainage 7000 m. No details are provided in the Application, and further detail would be required by HCC following detailed design.

4.6 Construction Effects

Section 8.14 of the NOR briefly outlines the measures to be taken to manage stormwater run-off and sediment generation during construction. These measures are generally adequately outlined, but there is little detail on the location and management of soil stockpiles. There appears to be only limited space to provide for and maintain stockpiles during the course of construction.

Appendix A shows the location of works proposed to manage stormwater during construction. While there are some areas where some details are lacking, the necessary erosion and sediment control works can be undertaken within the area of land sought by Transit for the NOR.

Environment Waikato has received an application from Transit NZ to undertake earthworks, and it is envisaged that the erosion and sediment control measures proposed (including the management of soil stockpiles) will be further developed as a result of that application. However, it is most likely that final design will only be available prior to construction.

We recommend that Transit NZ designs and implements all erosion and sediment control measures in accordance with Environment Waikato Guidelines for Soil Disturbing Activities[3] and that further detail on erosion and sediment control, including soil stockpile management is provided by Transit NZ as a part of its outline plan.

4.7 Summary

In summary, we consider that the proposed drainage concept design is appropriate and although subject to further design is likely to be able to be constructed and operated within the designated areas sought by the NOR. We consider that the design standards proposed are appropriate and are consistent with the relevant design standards and guidelines reviewed as part of this assessment.

The proposals to manage construction effects are appropriate, although we have some reservations about the ability to stockpile soils within the area sought by the designation.

[3] Erosion and Sediment Control Guidelines for Soil Disturbing Activities: Environment Waikato Technical Report 2002/01.

5 Submissions

Submissions related to the management of stormwater were received from four parties:

- Mark and Margaret Blackmore (submission No 2);
- Waikato Raupatu Trustee Company (submission No 27);
- Hamilton City Council (Submission No 33); and
- Environment Waikato (Submission No 37).

5.1 Mark and Margaret Blackmore

Mark and Margaret Blackmore wish to see the use of grassed swales reconsidered due to elevated groundwater levels.

Transit proposes to use under swale drains in the flatter areas of the bypass. This will help to maintain drained conditions in the base of the swales (particularly during winter) and will locally control groundwater levels. In our opinion the proposed design addresses the issue raised in this submission.

5.2 Waikato Raupatu Trustee Company

The Waikato Raupatu Trustee Company Ltd seeks the implementation of appropriate stormwater treatment. The proposed road design will see the removal contaminants through vegetative filtering in the grassed road shoulders and swale drains and through infiltration into the soil. The degree of performance of these devices is difficult to judge as no detailed design has been carried out, but standard designs are readily able to achieve removal of between 60% and 70% of particulate contaminants. The provision of a recommendation to require Transit NZ to design the road drainage system to allow for the treatment of road run-off would in our view address this issue.

5.3 Hamilton City Council

Hamilton City Council (HCC) seeks to have sufficient provision for the City's stormwater drainage infrastructure. HCC's submission recognises that the bypass has been integrated into the preparation of the Rotokauri Structure Plan, and notes Transit NZ's acknowledgement that there will be differences in HCC's infrastructure between what exists now and what will be in place by the time the bypass is constructed. HCC notes that there will be a need for culverts to facilitate drainage across the bypass corridor, and confirms that it will take up the service corridor offered by Transit.

In part five of its submission, HCC requests council(s) to (*inter alia*) recommend that:

- Details of the proposed works are included in an outline plan to be submitted to HCC prior to construction;
- that final designs are submitted to HCC for approval; and
- Construction plans be submitted to HCC for approval of culvert crossings within the City's boundary, and that culverts provide for drainage of the Rotokauri area at locations and with capacities consistent with the overall

drainage plan proposed in the Rotokauri Catchment Management Plan (to be prepared in the future).

The plans submitted with the applications show integration of the bypass drainage works with that of the Rotokauri Structure Plan. However, the level of details of both proposals is at this stage preliminary and we support HCC's submission seeking the opportunity to review and approve detailed designs and construction plans, when they are produced.

5.4 Environment Waikato

Environment Waikato's submission seeks to ensure that the effects of works on existing land drainage systems is minimised. It requests that all culvert crossings are designed to pass the 1% AEP event taking into account the projected effects of climate change, and seeks to be consulted in regards to any alternations to the drainage network that may be required as a part of the works.

Environment Waikato notes that Transit NZ has made resource consent applications for activities related to the diversion of watercourses, the construction of culverts in the bed of watercourses and to discharge stormwater into water.

In some respects the issues raised by Environment Waikato will be address by it through its own resources consent processes. However, the provision of recommendations related to design standards for culverts and other crossings would address the issues raised in its submission, and we support these standards being included as a recommendation by the Hearings Committee.

6 Recommendations

Based on our review of the NOR documents and submissions, we recommend the Hearings Committee recommends the following in its decision:

- That all culverts crossing waterways shall be hydraulically designed to pass the 1% Annual Exceedance Probability (AEP) peak flow, in accordance with the with the Hamilton City Development Manual and the Transit NZ Bridge Design Manual. That all culverts crossing waterways shall be designed and constructed in accordance with the Hamilton City Development Manual and Environment Waikato Best Practice Guideline for Waterway Crossings.
- That all swales shall manage stormwater run-off from a 2% AEP time of concentration event, without overtopping, and assuming blockage of the under swale drain.
- That stormwater kerb and channels shall be designed and constructed to manage peak flows from 10% AEP 10 minute duration rainfall event.
- That an outline plan is prepared showing detailed design of the proposed stormwater drainage system. This plan shall be forwarded to Hamilton City Council and Waikato District Council for its approval prior to construction, and shall include:
  - Details and design calculations of all culvert crossings, and stormwater outlets, showing necessary works to avoid the discharge of litter and to manage potential adverse effects associated with scour and erosion of the bed of banks of the water bodies at or downstream of the outlets;
  - An assessment of the effects of discharges on the capacity of the drainage system Exelby Road and details of any remedial measures proposed;
  - Details of the proposed stormwater pond at Tasman Road and an assessment of the effect of the connection to HCC's reticulated network; and
  - Details of erosion and sediment control measures to manage construction effects, including effects from the stockpile of soil.

7 Applicability

This report has been prepared for the benefit of Beca Planning Ltd with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

TONKIN & TAYLOR LTD

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