FUTURE PROOFING RICHMOND'S STORMWATER INFRASTRUCTURE

Denis O'Brien (MWH New Zealand Ltd) and Jeff Cuthbertson (Tasman District Council)

ABSTRACT

Tasman District Council embarked on the long term planning for Richmond's future growth in 2006 and has decided to rezone 300 ha of land for future developments. This is the largest and most complex planning change that the Council has undertaken, and the requirements for future infrastructure is a critical element to this project.

Borck Creek serves a 1,400 ha catchment which flows through the proposed Richmond West development area. This area is low lying and is prone to flooding without engineering input.

This paper will outline the key challenges and solutions in planning the stormwater infrastructure including:

- our desire to provide stormwater capacity for very long term growth to ensure the drainage corridors are future proofed.
- how to create and stimulate public use of these drainage corridors, which are up to 70m wide.
- how to integrate the hydraulic design with the landscape design to create the multi use function required.
- how the stormwater greenbelt could be used effectively as a buffer between the residential and mixed business zones.
- how council structured the funding for this infrastructure given its long-term nature and need to acquire land for the drainage corridors.
- how the infrastructure engineers and the policy planners worked together to achieve the above.

KEYWORDS:

Plan change, future proofing, climate change, environmental channel.

PRESENTER PROFILE

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1 INTRODUCTION

Tasman District has been one of the fastest growing regions in New Zealand over recent times and faces a shortage of both residential and business land to cater for this growth. Richmond is only 15 km from Nelson and while they are separate Territorial Authorities both areas have a shortage of land zoned for industrial development.

In 2006 Council embarked on the long term planning for Richmond's future growth and has decided to rezone a total 300 ha of land for future developments.

The Richmond West Development Area (RWDA) is the area of land bounded by State Highway 6 along the north western margin of Richmond, State Highway 60 to the West and Waimea estuary to the east. The land is primarily used for agriculture and horticulture at present and it has high soil productive values. Adjacent to the site is the existing industrial land operated by Nelson Pine Industries. Figure1 details the location of the RWDA in relation to Borck Creek and urban Richmond.

The Borck Creek stormwater drain bisects the RWDA and its upgrade would be required to enable this land to be developed. Council recognised that if it rezoned the land without considering long term channel capacity, development would occur up to the existing channel banks limiting future opportunities to increase capacity. This lead Council to consider the long term future and develop a 'future proofed solution'.

In considering the future proofed solution it became evident that this stormwater delima required inputs from the whole of Council to provide a public open space that was attractive to the community and integrated the stormwater, amenity, environmetal and landscape requirements.

2 PROPOSED DEVELOPMENT AREA

2.1 EVOLUTION OF THE RWDA

Tasman District has been one of the fastest growing regions in New Zealand over recent times. In addition Nelson City which is less than 15km from Richmond has very limited land for business development available. Council has been undertaking urban development planning for Richmond since 2000 and published the Richmond Development Study (RDS) in 2002. The RDS considered three strategies, namely should Richmond grow up, grow out or stay put. At the time, concern was raised about the possibility of urban sprawl and there was little support for development on the Waimea plains which have high productive value.

A study undertaken for Council in 2005, determined that the existing land zoned for business would be fully utilized in 5 years. The report also highlighted that the demand for and supply of business land could not be considered separately for Richmond and Nelson, and that a regional approach was required. Given that Nelson City has very limited land suitable for business use, it was concluded that in the future Richmond would attract a higher proportion of business activity due than in the past. It was estimated that approximately 100 hectares of land is needed for business development in Richmond to meet demand until 2030.

In addition residential demand in Richmond would outstrip the existing supply before 2020. It was estimated that approximately 15,000 residential lots would be required for the combined Richmond and Nelson area by 2030.

For these reason Council started the Richmond West Development Area (RWDA) with the aim to create a high amenity urban environment for residential and business development, more specifically:

- Residential development that provides primarily for standard density but some clusters of compact residential development.
- Mixed Business Development that provides specifically for large format retail, trade supply and light industry,
- the defining characteristics of the development would be low impact and clean nature on the environment and on the surrounding people.

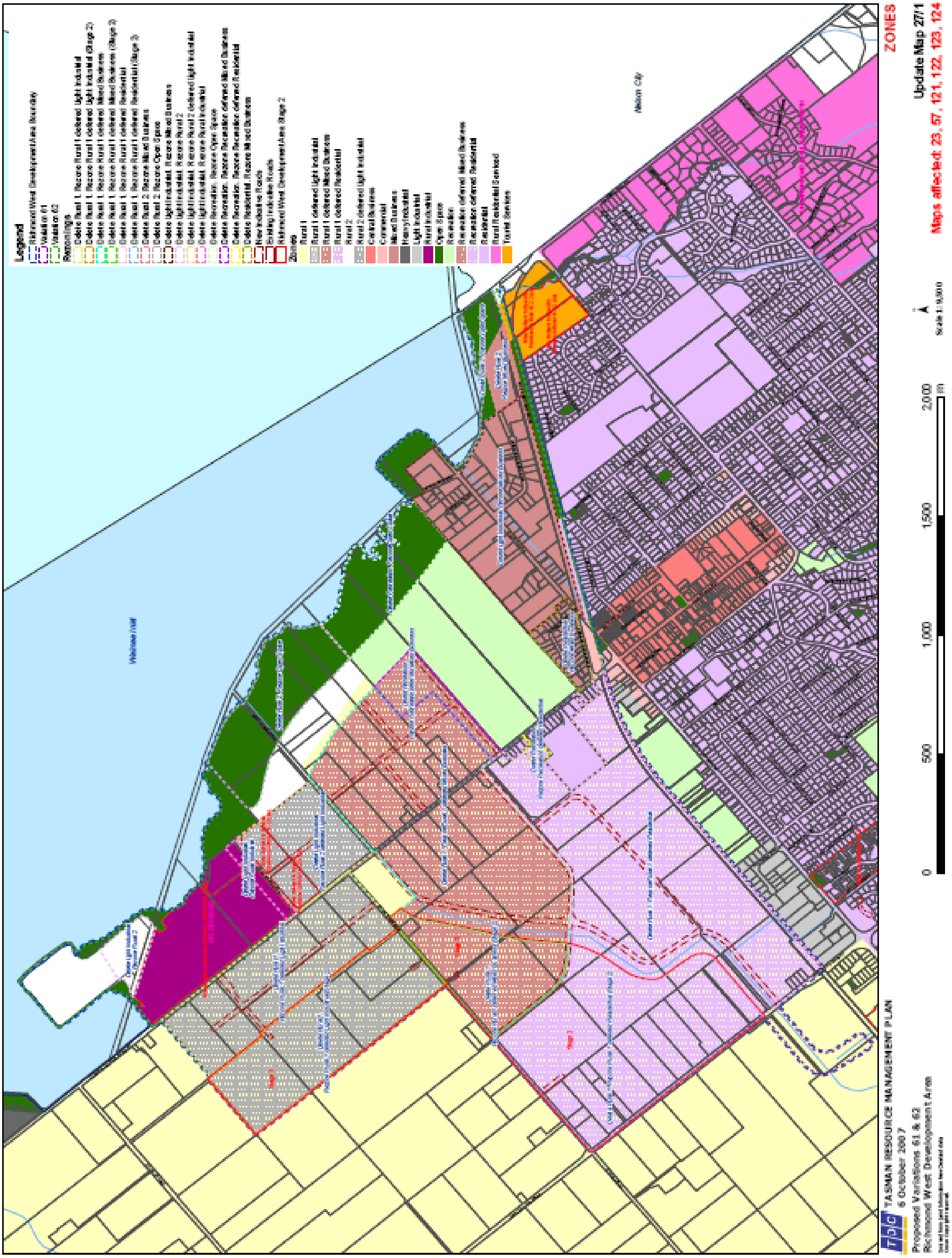

Figure 1: Richmond West Development Areas

2.2 PLAN CHANGE PROCESS

Council embarked on the statutory planning process in early 2005 and the process was not completed until 2009 when the Council adopted the Richmond West Plan Change. During this process Council either commissioned or prepared in-house some 30 detailed reports on the matters relating to the plan change. These reports ranged from land use assessments, traffic studies and reports on alternative options. In addition Council embarked on three rounds of public consultation where the public were invited to contribute to the process.

During 2007 a group of landowners submitted a resource consent application for the subdivision of 103 hectare of the Richmond West area. This application was for 900 residential lots on both sides of the Borck Creek. This application was declined by Council as it was a direct threat to the vision of the structure plan and the desire to provide land for mixed business. This was a major undertaking for Council as it showed that it was unified on its approach to the future developments.

Given the complexity of the process Council decided to hear the submissions on the plan change and on the major roading designations at the same time because of the complexity and overlap between the issues. After four months of deliberations by Council the final decision resulted in some changes, with residential zoning been reduced from 122 ha to 60ha, while land for mixed business has been increased from an initial 82ha to 121ha. About 100ha of land, 40ha more than first suggested, has been zoned for light industrial businesses. All the zoning changes are deferred until major infrastructure works are completed.

Richmond West's 50-year plan

- 590 new residential sections.

- 442 mixed business sites.

- 536 light-industrial lots.

- A greenway along Borck Creek for drainage, cycle and walkways.

- Residential property frontages on Lower Queen St and McShane Rd to be bought for road widening.

3 STORMWATER ISSUES

3.1 CATCHMENT DESCRIPTION

Borck Creek system drains a total of 1430 ha located west of urban Richmond, and comprises of 800 ha of hill country, 410 ha of intermediate terraces and 230 ha of floodplain. The catchment drainage system rises at the watershed of the Barnicoat Range, west of Richmond. The topography falls steeply to the flat Waimea Plains located northwest of Haycocks Road / Hill Street. In the hills the waterways follow the natural topography.

On the plains there is a network of drains were excavated through swamp lands in west Richmond in the 1970's by the Nelson Catchment Board. The drains divert floodwater away from the main town area into Borck Creek which conveys floodwater to ultimately discharge into the Waimea Inlet in the vicinity of Headingly Lane. The lower 500m of Borck Creek is tidal

Under natural pre-settlement conditions floods on the plains would probably have spread out over the floodplain. After settlement for farming, the first development of the creek would have been to realign the natural channels as agricultural drains. Indications are that the design capacity of the original drains was small and therefore floods would still have spread out over the flood plain. Later, with more development on the flood plain, some reaches of Borck Creek have been improved to have adequate capacity to handle the design flood flow, but other reaches still have significantly inadequate capacity. The existing level of service is largely less than a 1 in 5 year event.

3.2 HYDROLOGY

MWH was commissioned by TDC to develop an improvement strategy for Borck's Creek in order to establish the level of service provided by the existing waterway system, and to assess the impacts of major flooding events on the catchment. This was undertaken by hydrological modelling of the rainfall response in the catchment, and hydraulic modelling of the floods through the waterway system. Overland flow paths were incorporated into the hydraulic models to assess overland flooding in critical places. The original Borck's Creek model consists of a fully dynamic MIKE UD hydraulic model with input from a MIKE NAM Hydrological model. Both models were calibrated to three recorded, albeit small storm events and verified on a further two storm events. This was subsequently incorporated into the InfoWorks model for the Richmond Urban Stormwater network.

3.2.1 METHODOLOGY FOR ESTIMATION OF FLOOD PEAK

In view of the limited data available to calibrate the hydrological model, particularly for major flood events, five methods were used to determine the magnitude of the 50-year ARI flood event in the Borck Creek catchment in order to obtain improved confidence in the estimate of flood runoff. The results of this comparison are presented in table 1.

FLOOD ESTIMATION METHOD	**50 YEAR ARI PEAK FLOW 2007 RAINFALL DEPTHS**
Rational method	40 m3/s
Modified Rational Method	32
Flood Frequency Method	42
SCS Method	33
NAM	41

Table 1: Existing Flood Flow Comparison

Following this comparison it is considered that the calibrated catchment model, based on the SCS flood estimation technique, gives a reasonable result and was adopted to estimate design stormwater runoff from the various sub-catchments in the study area.

3.2.2 EXISTING SYSTEM PERFORMANCE

The hydraulic model was used to determine the hydraulic capacities of the various components of the stormwater system and to determine the existing level of service. The results highlighted that virtually the full length of Borck Creek was under capacity and flooding extending into the floodplain occurs regularly. Figure 2 below illustrates the extent of the flooding from a 50 year event. A major storm occurred in June 2003 and this resulted in widespread flooding with the proposed development areas. This was estimated to be approximately a Q10 to Q15 flood event and this is illustrated in the photos below.

In addition overland flows from this rural area also flooded a number of residents close to the main urban settlement.

Of particular importance for the Richmond West development was that virtually the entire development area was prone to flooding. In addition the flat nature of the terrain meant that the secondary flow paths were not well defined and tended to spill excess flows in various directions. This would require the channel capacities to be improved well upstream of the proposed development areas as otherwise the overland flows could still flood the development areas.

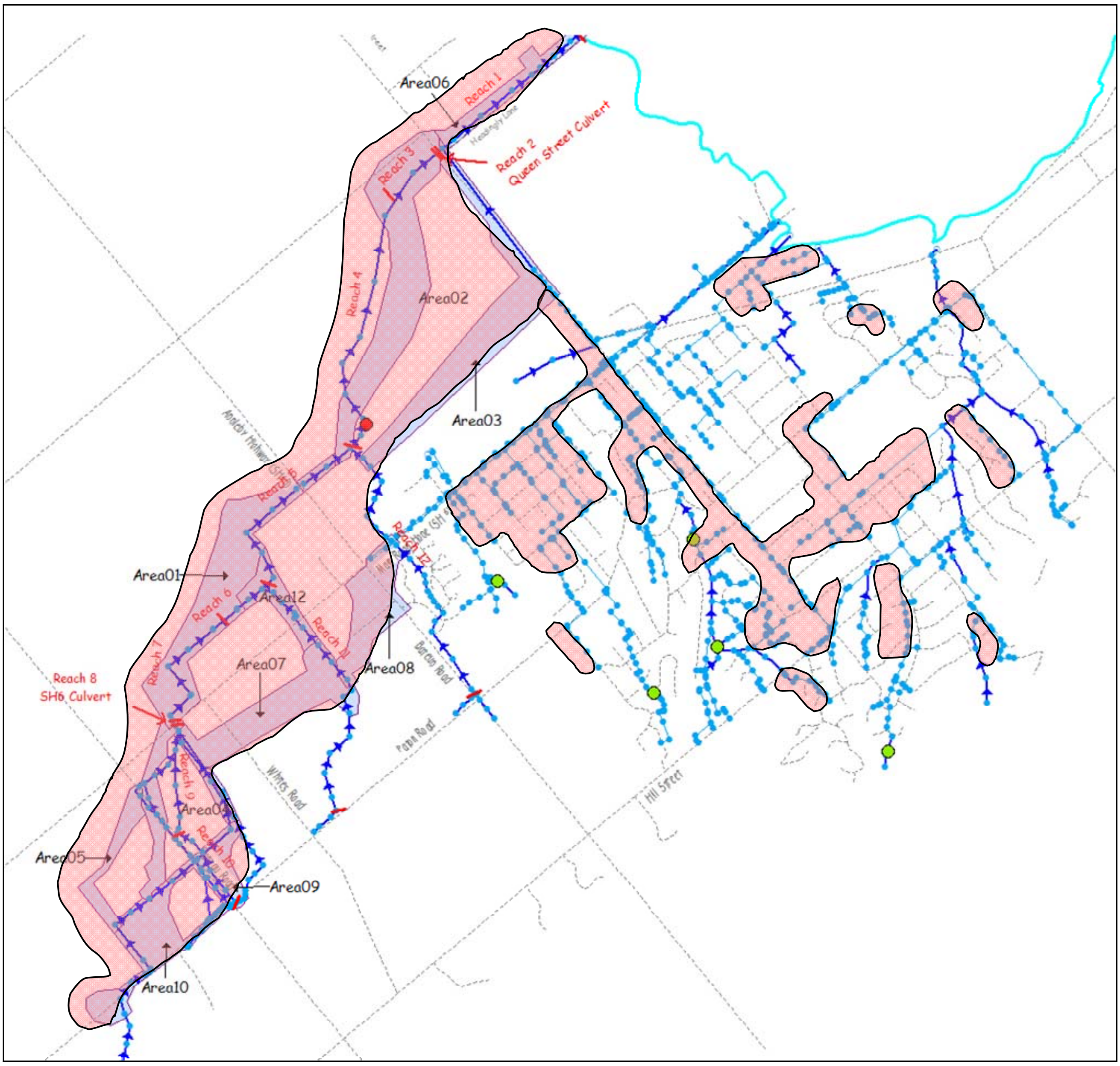

Figure 2: Map showing areas with under capacity drainage systems.

Clearly any significant urban development in the area proposed could only go ahead once significant capacity improvements were completed.

Photographs of Existing Drainage System under Normal and Flood Conditions

Typical existing appearance **Q10-Q15 flood event 2003**

2007 **2003**

Photograph 1: Borck Creek upstream of Lower Queen Street Bridge

2007 **2003**

Photograph 2: Borck Creek through development

3.3 CLIMATE CHANGE CONSIDERATIONS

The Resource Management Act Amendment Act 2004 requires Councils to 'have particular regard to the effects of climate change. Incorporating climate change predictions into stormwater design is important if infrastructure is to maintain the same level of service through its lifetime. This is particular relevant for this project as the specific aim was to cater for long term growth and changes within the catchment and to produce a future proofed solution. The most significant implication of climate change for stormwater design is from the expected increase in maximum rainfall associated with heavy rainfall events.

The Ministry for the Environment publication "incorporating climate change into stormwater design' summaries in Table 2 the key climate changes and their relevance for stormwater planning.

Type of change	Relevance for stormwater planning
Increase in heavy rainfall	Increase in total rainfall depth for design storm events for durations of up to 72 hours
Change in mean rainfall	Change in antecedent soil moisture saturation
Increase in mean temperature	Change in evaporation from soils and ponds, which changes antecedent soil moisture saturation
Increase in wind	Changes in rainfall over complex topography – increase upwind of hills and ranges

Table 2: Climate changes relevant for stormwater design (Source MfE)

DESIGN RAINFALL

In 2007 Council updated their Engineering standards and as part of this process climate change predictions were incorporated by

- increasing the level of service for stormwater systems
- increased rainfall depth to 2080 projections
- set minimum levels to account for sea level rise

For the future design scenarios the 2080 estimated storm rainfall depth, which includes the effects of climate change, were used to assess the performance of the stormwater system under future land use conditions. The 2080 rainfall depths are approximately 15% higher than the current rainfall depths.

4 DEVELOPING AN INTEGRATED FUTURE PROOFED WATERWAY

4.1 FUTURE DEVELOPMENT SCENARIOS

As noted earlier Council required Borck Creek to be future proofed to prevent it from being built out before adequate provision has been made for possible future flows. This is because once the area adjacent to the creek is developed then it will be difficult and expensive to get any additional land for stormwater capacity. This would put the properties along the creek at risk of future flooding. For this reason Council want to adopt a precautionary approach as this is the key stormwater asset for the catchment.

The estimation of flows was considered for various development scenarios with the aim to better understand the maximum possible future flows. The following development scenarios were investigated:

- Future scenario 1 30 % of catchment developed
- Future Scenario 2 45% of catchment developed
- Future Scenario 3 65 % of catchment developed

It should be noted that these future scenarios were not considering that 65 % of the catchment would be developed in residential or similar but that the land use could change in the future and the development scenarios were to test the sensitivity of the catchment to land use changes. For example approximately 15 % of the current catchment is in developed pine plantations which will be harvested within 10 years. Recent trends has seen significant plantations not replanted due to poor returns from forestry and this was one of the scenarios tested to determine the sensitivity of land use changes.

Scenario Modelled	**Peak Flow m3/s** **50 Year ARI**	**Peak flow m3/s** **100 year ARI**
Existing situation current rainfall	33	39
Existing situation (2080 rainfall) (approximately 15 % development)	40	47
Future scenario 1 30 % catchment developed	43	51
Future Scenario 2 45% catchment developed	48	57
Future Scenario 3 65 % catchment developed	52	62

Table 3: Future Flood Flows

For the purposes of planning the key stormwater infrastructure Council adopted to use the future scenario of 65% development for future growth in the catchment as the upper bound limit. It was recognised by Council that this level of development may not be reached for some considerable time, but this may be the only opportunity TDC have to protect the strategic drainage corridors.

4.2 CHANNEL DESIGN OPTIONS

Historically drainage channels were designed as the most efficient hydraulic channel and little regard was given to incorporating natural features to enhance the environment and ecology. For this project Council were determined that the drainage network would be a legacy for future generations so a balanced design was required.

During the development phase of the project, a series of workshops were held with Environmental & Planning department, Community Services Department and Engineering Department to determine the key requirements for the design. This process of understanding the different drivers for the open space was critical to developing a balanced design that reflected the community's expectations. At these workshops various option were reviewed and all parties agreed that the traditional hydraulic channel would not provide the additional environmental and amenity values required.

When Council undertook community surveys they revealed that the public prefer to see natural looking, visually appealing stormwater features. For this reason the landscaped design is of critical importance to the design and it must provide a recreation and ecological framework for the drains hydraulic requirements. The key objective of these designs is to stimulate public use through a variety of flexible spaces and promote activity across a range of environments. The potential for future walkways and cycleways to be provided along the stormwater drains, which would fit with Council's urban walkway strategy for Richmond, to link the mountains with the sea.

To incorporate the hydraulic, amenity and aesthetic values into a workable solution, an 'environmental' channel design was developed jointly with all parties. This channel design would require significantly more land than a conventional channel but the multi use functions outweighed this limitation.

4.3 CHANNEL DESIGN IMPLICATIONS

The design criteria for the 'environment' channel were adjusted from the Council Engineering standards due to the considerable width of these drains and the consideration of the very long term development horizons already detailed above. The key design levels of services were defined as follows:

- Hydraulic capacity: 1 in 100 year storm event (increased from 1 in 50 year event)
- Freeboard 250 mm above 100 year event, as opposed to 500 mm above 50 year event in engineering standards.

The freeboard height has a significant impact on the width of storm channels as the existing drains are very shallow, and are only 1.7m in total depth. Once the freeboard and low flow channel depths are excluded, the available depth for storm flows is limited to 1.2m. It is worth noting that because these channels are wide with shallow sloping sides, small changes in the channel depth result in significant changes in the flow that can be accommodated. The designs are very sensitive to the available depth.

The environmental channels selected for the design have the following components:

- Low flow channel – Shallow channel to cater for small base flows.
- Active Channel – Sized to accommodate 1 in 1 year storm events.
- Storm Channel – Sized for maximum flood capacity to accommodate 1 in 100 year storm events.

Waterways with a more natural form will convey flows less efficiently than traditional straight lined channel forms. As a result, a natural form channel will require larger cross sectional area to convey the same flow. The effect of large quantities of vegetation can also be significant on the hydraulic design. The most common design approach that accounts for channel roughness is the use of the Manning formula and the appropriate roughness parameter 'n'. In this design the Manning n factor was increased to 0.04 for the active channel section with n of 0.055 for the flood channel. This is significantly higher than the typical n value for straight lined channels.

The widest section of environment channel is 70m to convey 62 m3/s of flood flow through Borck Creek. By comparison a straight hydraulic channel could have required a width of 40m. However, esplanade reserves and maintenance access ways would be required in addition to this and the overall land take would not be significantly different.

4.4 AMENITY FUNCTION OF PROPOSED CHANNELS

A key component of the vision for the future drainage network is that they will be a valuable community asset with a high amenity value. To achieve this, the Parks and Recreational department were a key member of the combined project team and they developed a concept design for the future use of this open spaces. By shaping and benching the channel, recreational spaces can be provided which copes with being inundated infrequently without damage. It is envisaged at this stage that some playing fields could be provided within the storm channel.

This channel will provide excellent potential for safe walking and cycling tracks that are well connected and separated from traffic. Council have a long term vision to connect the mountains to the sea and the stormwater network provides the perfect avenue for this vision. Given the present Governments funding for national cycleways there is the added opportunity that these cycleways along the stormwater channel will form part of the Nelson Tasman cycle trail.

Another significant benefit of integrating the stormwater design within the plan change process was that the wide stormwater corridor can be used very effectively as a buffer between the residential and mixed business developments. A traditional channel without the public use and open space would not have the attractiveness of a natural buffer. Traditionally stormwater open channels are not valued by the community as an asset and are used as a dumping ground. Additionally the drains are routinely fenced off to exclude the public which further adds to their isolation and lack of care by the community.

4.5 ENVIRONMENTAL ENHANCEMENTS

The ability to remodel the stormwater network within the development area presented a great opportunity to provide environmental enhancements which would provide a more sustainable solution. During the concept phase the team developed the following key landscape and environmental design guidance for this projects which will be used as a framework to undertake the detailed design.

- In the 70m wide channel section through RWDA, the esplanade reserve is provided within the overall channel width. In narrower channels upstream the esplanade reserves are outside of the drainage channel.

- The low flow channel and active channel will meander within the overall channel corridor to mimic natural stream characteristics.

- Low instream islands will be introduced which are designed to minimise resistance to flood flows within the overall storm channel. This will break the regularity of the drainage channel and enhance the visual appearance.

- Provide a series of pools and riffles along the low flow channel for environmental enhancement and to provide for aquatic habitat diversity.

- Retain existing trees where they can be integrated with into the development particularly where they are visible from beyond the RWDA

- Strategically locate trees as a backdrop to the development as this assists in ‘anchoring’ the development into the landscape.

- Undertake extensive riparian planting to improve instream and streamside values. Provide shade on North side of low channel where possible to keeps low flow channel cool in summer and retain higher dissolved oxygen within the waterway.

- Provide shallow gradients on transition from storm berms to water edge and provide access to the waters edge to encourage care of the waterways’ health.

- The careful selection of vegetation within the various levels of the creek is vital for for maintaining the hydraulic capacity. The vegetation would need to be tolerant of periodic inundation by flood flows, and minimise the resistance to flood flows.

- Establish massed vegetation in random groups along the creek rather than uniform coverage in same species, to create wildlife habitat and interest.

- Certain plant species would limit the hydraulic capacity over time if left unchecked, and would need to be excluded or used in very limited circumstances. Large flaxes were one such specie considered to be a potential problem.

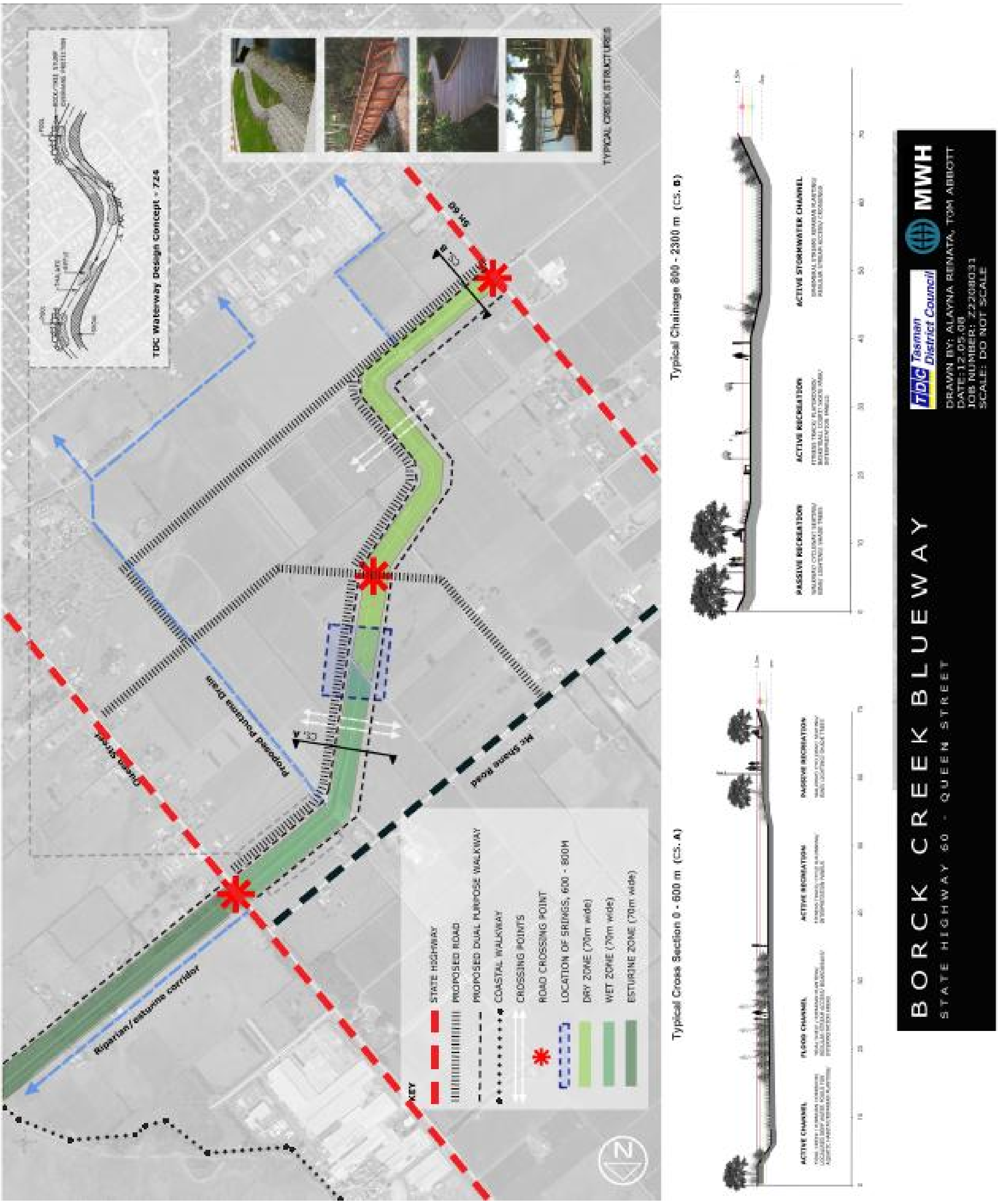

Figure 3: Illustrates the conceptual design for the waterways.

5 IMPLEMINTING THE SOLUTION

5.1 LAND DESIGNATION PROCESS

In September 2009 after the decision on the plan change was notified, the Engineering Service Department of Council served the required the Notice of Requirement (NOR) for the designation of the land for public works. The District Plan already included the location of the indicative reserves and major drainage channels so these were well signalled to the community and landowners.

Councils had to weigh up the options of being proactive and proceeding with the designation of the stormwater channels as opposed to passively waiting until the opportunities arise through sub divisions to influence how the developers will construct their sub divisions. The major advantages that the designation route presented were:

- Council are in control and therefore can deliver on the vision of shared use facilities encompassing walking and cycling as well as the required stormwater functions. These designations were for drainage and recreational reserves.
- Council were in control of timing of works and the sequencing they occurred
- The stormwater channels would be environmental friendly channels and not the minimum hydraulic requirement that developers would want to provide to limit land take.
- A designation secures the land and constraints any activities on the land that would prevent or hinder the designated activity without the consent of the requiring authority.
- The designation is a form of explicit public notification of the requiring authority's interest in the land.
- A designation enables the Public Works Act to be invoked so that land may be compulsorily acquired.
- Avoids difficulties of trying to get numerous different developers on a piecemeal basis to construct a legacy asset to your design instead of the minimum hydraulic solution.

The designation process however also has some drawbacks which needed to be understood:

- Council could be forced to acquire the land after the land is designated and well before it intended to implement the project. This can have significant funding implications for Council.
- Under section 185 of the RMA, landowners can seek an order from the Environment Court obliging the requiring authority to acquire or lease all or part of the land, if a designation has either resulted in the land becoming unable to be sold at market value or if the designation has prevented the reasonable use of land
- Developers would not have to fund the construction of the drain and they would be compensated for the land value before the development started.
- Developers would be required to provide esplanade strips to Council along the existing creek during a subdivision, and Council would not have to pay for this strip.

- They can be significant time period and effort required in preparing the NOR's as well as further rounds of submissions and hearings required. This was after the significant length of time Council has expended on the plan change process. There is also the possibility of appeals to the Environment Court on the designations in addition to the plan change appeals.

- It costs Councils more, earlier in the process.

After the funding strategy was derived, Council decided to proceed with the designation process and the NOR was issued on approximately 40 landowners covering 35 Ha of land for the 10km stretch of drainage channel. The key factor in Councils' decision was that they needed to be proactive with this development and not react in a piecemeal basis when individual landowners decided to develop.

5.2 FUNDING STRATEGY

The construction of the key stormwater infrastructure for the RWDA is a major commitment for Council. Council has a policy of "user pays", or those that get the benefit should pay for stormwater services. As stormwater is not funded by any general rate. The Council has one urban drainage areas (UDA) operating one 'group' account. Thus all ratepayers within the various UDA's in the district pay the same stormwater rates and development contributions. All major capital projects are loan funded with loans taken out for a fixed period, usually 20-30 years.

During the development of the 2009/10 LTCCP Council formulated a funding strategy for this project which had specific issues to address:

- What was the best mechanism to fund these project given that a major beneficiary would be the landowners that would ultimately develop the land
- How best should the land costs be funded?
- Was the existing mechanism of development contributions equitable to developers across the district?
- Should a new targeted rate be struck for this project only?

Council adopted to fund this project with the revenues from development contributions without any changes at this stage. Alternative options such as targeted rate will be considered in the future.

5.3 DELIVERY TIME FRAMES

Council have scheduled these projects in the long term plan and in 2009/10 Council developed a 20 year financial horizon in each the asset management plans (AMP). These projects are scheduled over a long timeframe with the funding spread from year 5 to year 15. The key elements are as follows:

Project	Capital Budget	Timeframe
Land purchases for designations	$5.5m	Spread from year 5 to 16 to suit construction timeframes
South Richmond	$2.8m	Constructed from years 14 to 18
Borck Creek	$8.7m	Spread over years 5 to 16 as development proceeds.

Table 4: Project Estimate Summary

6 CONCLUSIONS

The detailed consideration of the stormwater infrastructure was critical to the concept design for the RWDA. Tasman District Council had a vision to provide a future proofed stormwater solution that was also an attractive public open space and that integrated fully with its walkways and cycleway strategy.

As this example demonstrates stormwater considerations should be at the forefront of policy planners thinking when new development areas are considered. Stormwater is the one service that can define the land form and when major catchments are concerned the scale of the issues and the opportunities are significant.

The plan change process for a large development can be a complex, contentious and time consuming process but as this example demonstrates stormwater engineers and asset managers need to be involved with the process. At the outset of the plan change process stormwater engineers need to be able to define the problem and the range of solution that are possible.

In our current environment it is easy to miss the opportunity to take control of urban drainage. It needs local government to be:

- Ahead of the game in planning where and when
- Visionary in terms of long term opportunities to plan the future
- Multi-disciplinary and integrated across departments to develop sustainable solutions
- Be brave to take difficult options
- Be strong and unified to defend the vision because you will never please everyone
- Be prepared to invest

If Councils don't do it, no one else will.

In this instance, the stormwater asset changed from being an essential service to being the vehicle that enabled multiple objectives to be met. These include cycle separation, walkways linking the mountains to the sea, environmental enhancement and natural buffer between residential and commercial development. The minimum engineering solution is cheaper and easier but misses the opportunities of making the stormwater a central community asset that facilitates multiple desires.

ACKNOWLEDGEMENTS

Nick Regnault MWH senior planner for planning inputs

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