NATURAL CHANNEL DESIGN IN THE TASMAN REGION

S Conn and B Quilter (Tonkin+Taylor) in collaboration with W Woortman (Tasman District Council)

ABSTRACT

The Nelson Tasman region is experiencing unprecedented growth with the development of greenfield areas. Stream channels within these growth areas are being modified and Tasman District Council (TDC) has perceived a lost opportunity to provide for enhanced ecological and fluvial-geomorphological functions or processes.

In the absence of any specific guidance material available at national or regional levels, the current approach is resulting in mixed and sometimes undesirable outcomes. Stream channels are often over-armoured with large rock or erosion is being exacerbated by unsuitable channel design. These changes can lead to the cumulative loss of habitat heterogeneity for aquatic biota, altered stream behaviour, increased sediment loading, risk to infrastructure from erosion, and increased future management and maintenance costs.

The principles of stream dynamics and function have been understood by the scientific and engineering communities both internationally and within New Zealand for some time. International literature and case studies regarding stream design and management have also become available in recent years. However, comprehensive stream design guidelines in New Zealand are effectively absent. TDC acknowledged the need for authorities to provide greenfield developers and resource consent applicants a practical design philosophy in order to improve on the current design of stream channels. As a result, the Natural Channel Design Guidelines project was developed to integrate ecological, fluvial-geomorphological and engineering principles as well as good practice.

TDC has developed Natural Channel Design Guideline Part One as a 'vision' for Natural Channel Design (NCD)

The Part One Guideline contains local stream type definitions that the guidelines apply to, an overview of 'type specific' stream channel processes and potential risks to constructed stream channels, an ideal project plan, and some high level guidance on the four stages of investigation and design. While the guideline does not provide a step-by-step process of how to design a stream channel at this point, it does provide the guiding vision and intent of each of the steps in a stream design processes, from project scoping, preliminary assessments, concept design, detailed design and ongoing monitoring. It also aligns with the Water Sensitive Design (WSD) principles of the Nelson Tasman Land Development Manual.

The Part One Guideline will aid land development project teams to scope stream design projects, and as a last resort, design stream diversions through their developments. It is envisaged that the Guideline will also help developers, practitioners, resource consent applicants and TDC to meet the statutory requirements of the Resource Management Act (RMA), the Tasman Regional Policy Statement and Tasman Resource Management Plan. The Guideline incorporates cross-discipline principles to meet local and national objectives, leaving streams in a better state for the next generation.

TDC intend to develop Part Two of the guideline, which will be a step-by-step methodology for all eight steps in the stream design process.

KEYWORDS

River engineering; design philosophy; ecology; fluvial-geomorphology; technical guidance; good practice.

PRESENTER PROFILE

Selene Conn has over nine years' experience as a fluvial geomorphologist specialising in geomorphic assessments of waterways and evolutionary trajectory assessments of river systems in both New Zealand and Australia. Selene has extensive experience working on largescale waterway diversions in Queensland, undertaking monitoring of geomorphic condition and revegetation success. Selene co-authored an Australian Coal Association Research Project (ACARP) developing a monitoring methodology for revegetation on constructed waterways to facilitate the mine closure process, and provided technical input on the review of the industry standard ACARP Index of Diversion Condition method.

Bryn Quilter is a water resources engineer with extensive experience in the field of integrated civil engineering, water sensitive design, ecological engineering and stormwater modelling. Bryn's experience ranges from urban and rural flood scheme development and renewals through to preparation of restoration options for urban streams, ponds, wetlands and fish structures.

1 INTRODUCTION

The purpose of Part One of the Natural Channel Design Guideline (Guideline) is to provide guidance to developers and their agents for the design of stream diversions, restoration and alterations within future developments and to aid resource consent applications. It is also to support Tasman District Council (TDC) as a Unitary Authority to holistically protect, enhance and manage streams within urban developments. The guideline is intended to sit outside of the Nelson Tasman Land Development Manual (NTLDM), but links to the NTLDM when aspects of the Natural Channel Design cross-over with existing guidance in the NTLDM.

A significant amount of national and international literature and guidance on stream design, or stream restoration was reviewed as part of this project. Existing international guidelines were critically assessed to determine the suitability for streams in the Tasman region, and to determine what 'good practice' might look like in a New Zealand context. All international literature and guidance referred to the need for any stream design project to be soundly based upon an understanding of the geomorphic processes in the catchment and reach in question to ensure constructed streams become a sustainable component of the landscape.

2 DISCUSSION

2.1 WHAT IS NATURAL CHANNEL DESIGN

Natural Channel Design (NCD) is important for all waterways, but are especially important where streams are being diverted or modified as part of land development activities.

The principle of NCD is based on providing the required hydraulic conveyance of a drainage channel and floodway while maximising its potential ecological, cultural, amenity and/or recreational values. This holistic approach combines the disciplines of hydraulic engineering, fluvial geomorphology and in-stream and riparian ecology.

The desirable outcomes for the Guideline have been based on the Queensland Government's Guideline for Watercourse Diversions (DNRM, 2014) which state that:

> "A permanent watercourse diversion should be designed and operated to ensure that it is stable, self-sustaining and does not impact on the adjoining upstream and downstream reaches of the existing watercourse. A self-sustaining diversion functions without features or characteristics that rely on ongoing maintenance or that impose a financial or other burden on the proponent, government or the community."

By incorporating an understanding of existing stream processes and natural channel elements through the NCD process, the likelihood that the constructed channel will work with catchment conditions to be a stable and self-sustaining constructed stream that meets ecological, cultural, amenity and/or recreational expectations can be increased.

NCD principles are based on four levels of investigation and design:

1 Catchment level assessment of the stream;

2 Reach level of stream type assessment;

3 Channel cross-section and local planform design; and

4 Design of in-channel features.

2.1.1 WHAT ARE THE STEPS IN A STREAM DESIGN PROCESS?

There are essentially eight steps in any stream design process. These are:

1. Project scoping.
2. Preliminary investigations.
3. Concept design.
4. Consenting.
5. Detailed design.
6. Procurement.
7. Construction.
8. Post construction monitoring.

Historically, traditional channel modifications have had large impacts on stream processes and in-stream habitat/fauna. The intent of the project scoping phase is to assess the need for stream alteration, with stream alteration being the last resort. The project scoping phase also includes a desktop based catchment context assessment, as well as an opportunities and constraints assessment. Seven stream types have been pre-identified and assessed in development areas in the Tasman Region to help developers and their agents undertake the catchment assessment. The decision making process undertaken in the project scoping stage should be documented, and form part of the assessment sent to TDC for approval.

The preliminary investigations are undertaken once the decision to alter a stream has been made. This step includes more detailed investigations into the existing stream

processes to identify any potential risks to stream stability that may need to be addressed or mitigated in the design, and to inform stream design.

Concept design primarily focuses on those physical properties of the channel required for hydraulic stability. The design procedure is presented only as a guide and in most circumstances final channel dimensions should be linked to the existing channel upstream and downstream of the proposed constructed channel. This helps to ensure the stream design considers catchment scale processes, and doesn't negatively impact upstream and downstream reaches, while maintaining geomorphic continuity.

At this stage, a revegetation plan should be developed that meets the functional and ecological requirements of the stream design. The revegetation plan should be designed in collaboration with the project engineers to ensure the stream has been designed appropriately for the vegetation type and vice versa.

The intent is that the concept design will form part of the application for resource consent. This will ensure that the design meets TDC's expectations.

Detailed design refines the physical properties of the stream from the concept design, and includes the design of in-channel features. It's these features that have macro-scale geomorphic functions in terms of regulating processes (such as sediment transport and erosion processes), but also provide the critical in-stream habitat for aquatic fauna. All in-channel features require some design, and almost always link back to the physical properties of the channel design (such as meander wavelength), as well as the physical properties of the existing stream (such as bed material). It's recommended that an ecologist of fluvial geomorphologists assist at this stage to ensure features are appropriate for the stream, and are providing appropriate habitat.

Finally, it's recommended that there is post-construction monitoring undertaken to assess the effectiveness of the design. This evaluation is linked to the specific objectives set for the project in the concept design phase, and the evaluation is compared to the detailed design. Post construction monitoring is critical to early identification of problem areas where pro-active management or easy fixes can be employed to avoid problems getting out of hand and/or becoming 'too hard'.

Nationally, there is a lack of monitoring data on constructed streams and as such uncertainty about the applicability of channel form equations provided in published literature. Monitoring data sets are critical to informing and improving future stream design guidance in New Zealand.

TDC intend to develop Part Two of the guideline, which will be a step-by-step methodology for all eight steps in the stream design process. At present this is intended to be based on international guidance, and questions remain around the validity/uncertainty/applicability of some of the components of international design guidance in New Zealand. Using the post construction monitoring data (should it be available) in the development of Part Two will dramatically increase the applicability and usability of the step-by-step guidance in the Tasman region.

3 CONCLUSIONS

TDC has developed a 'vision guideline' for Natural Channel Design (NCD) to support the Nelson Tasman Land Development Manual. The Guideline is based on an extensive review of existing guidance.

The natural channel design guidelines are intended to provide guidance to developers and their agents for the design of stream diversions, restoration and alterations within future developments and to aid resource consent applications. It is also to support Tasman District Council (TDC) as a Unitary Authority to holistically protect, enhance and manage streams within urban developments.

The intent of the Natural Channel Design Guidelines is to create the required hydraulic conveyance of a drainage channel and floodway while maximising its potential ecological, cultural, amenity and/or recreational values. There are eight steps proposed in the Guideline, including post construction monitoring.

Should post-construction monitoring data be collated by TDC over the next few years, data sets may be used to assess the outcomes and inform/validate the proposed methodology and develop Part Two of the Guideline.

TDC intend to develop Part Two of the Guideline as a step-by-step methodology for all eight steps in the stream design process.

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