Geraldine Stormwater Management Plan

- Prepared for

Timaru District Council

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Executive Summary

This management plan ('Plan') sets out a framework for enhancement of the primary drainage functions of the Geraldine stormwater network and to ensure that the effects on the receiving environment are minimised. The Plan seeks to maintain the current water quality in the Waihi River, which is unaffected by urban stormwater discharge, while also improving the water quality of the Serpentine Creek.

Geraldine is fortunate to have favourable topography and soil conditions which have historically facilitated a satisfactory standard of stormwater drainage. However, it has been identified that the level of service, in some areas of the locality, is particularly limited compared with current national standards and guidelines. This is particularly the case in the areas to the south of the town centre, where the stormwater network has yet to be extensively developed and to the east of the Waihi River, where the stormwater is drained to the ground by a combination of private and public soakaways.

Ultimately, all stormwater discharges from Geraldine are discharged to the Waihi River, whether it be via initial discharge to the shallow groundwater aquifers, to the Raukapuka Stream, Downs Creek, Serpentine Creek or directly to the Waihi River floodway. However, the stormwater discharges from urban Geraldine form only a very small proportion of the total discharges to the Waihi River which has a total upstream catchment area of over one hundred square kilometres.

The urban stormwater drainage network in Geraldine has primarily been developed to avoid nuisance and damage from flooding via runoff generated from the urban area of Geraldine. Stormwater runoff from the Geraldine urban area has a negligible impact on the hydraulic capacity and flooding in the Waihi River floodway. Although the impact of urban flows are greater on Serpentine Creek, the water way is considered to have sufficient capacity to convey runoff from at least a rainfall event with a 2% probability of occurring in any single year (2% AEP) without significant flooding. The critical section of Serpentine Creek is located at the downstream periphery of the urban area. At this location the capacity of channel to receive stormwater to an acceptable standard is dependent on the channel being maintained free of excess vegetation and debris. This includes various fencing structures that cross the channel downstream of the stormwater management area. Maintenance of channel vegetation is currently the responsibility of the individual landowners but may be undertaken by Environment Canterbury. Additional flooding in all the receiving waterways may occur with debris blockages of culverts and bridges.

Adverse water quality effects in the receiving waterways associated with discharge from the stormwater network may potentially occur. This would be as a result of stormwater discharges with high concentrations of sediment, heavy metal and hydrocarbon contaminants in rainfall related runoff, as well as non-rainfall related discharges, where the stormwater network can also act as a pathway for accidental spills, or unintentional discharges of other contaminants

from the adjacent land-use activities. It is important that all of these potential sources of contaminant discharges are adequately controlled to avoid adverse effects on the receiving environment from discharges from the stormwater network.

Proposed Stormwater Management Strategy

An adaptive management strategy is proposed to ensure that the stormwater network is managed to achieve the objective of minimising flooding and protecting the water quality of the receiving environment.

This will include but not limited to the following aspects:

- Network management;
- Capital works upgrades;
- Operations and maintenance;
- Monitoring of network performance and effects on the environment;
- Pollution control measures and awareness to minimise the effects of contaminant discharges associated with land-use activities; and
- Improved awareness and training of management staff, Timaru District Council staff, Te Rūnanga o Arowhenua, Aoraki Environmental Consultancy, Ngai Tahu, external stakeholders and general public.

Management of impacts of stormwater discharges on surface water quality

The potential adverse effects of stormwater contaminants in a water body depend on both the water quality characteristics of the discharge(s) and the receiving water body, and any dilution provided by the waterway.

The level of dilution provided by the receiving waterway varies quite considerably. At times low flows are lost to and gained from groundwater along both the Serpentine Creek and the Waihi River. Significant concentrations of nutrients and microbiological contaminants are also likely to be periodically discharged to both the Waihi River and Serpentine Creek from their respective rural catchments.

In the absence of any relevant base environmental data collected by Environment Canterbury, Timaru District Council has undertaken a programme of water quality sampling in the Waihi River and Serpentine Creek. This was undertaken to assess the baseline characteristics of these waterways, and to assess if there are any long-term effects associated with the urban stormwater discharges. This included an initial evaluation of sediments and ecological indictors to assess the general health of the waterways and specifically identify if there is any change in the ecological condition of the waterways.

Waihi River Water Quality

Investigations undertaken by TDC have, to date, shown that there were no obvious changes in the waterway water quality and ecological conditions downstream of the urban stormwater discharges to the Waihi River. The Waihi River remains in a "healthy" ecological condition with some elevated bacteria and nutrient concentrations throughout the section of the river investigated.

Serpentine Creek Water Quality

Serpentine Creek has lower water quality characteristics and ecological condition than the Waihi River, with high levels of nutrients, bacteria and heavy metal contaminants. There is some evidence of an increase in nutrients and bacterial concentrations downstream of the urban catchment where the stream channel passes through farmland. While, the heavy metal contaminants observed are consistent with effects of stormwater discharges, there are particularly high concentrations of dissolved zinc in the dry weather baseflow(s) that may not appear to be directly related to stormwater discharges. Therefore, additional investigations and monitoring are recommended to determine the sources of heavy metal contaminants in the Serpentine Creek.

Environmental Monitoring

The water quality assessments to date are limited to two water quality sampling rounds and a single assessment of sediment bound contaminants in Serpentine Creek. The understanding of the effects of stormwater discharges will improve with further monitoring and sampling and water and sediment quality sampling are considered to be important management tool to provide details of the effects of stormwater discharges on the receiving environment.

Defining the characteristics and effects of stormwater discharges is a complex problem and can be difficult and time consuming to definitively quantify. The cost and benefit of environmental monitoring needs to be balanced against undertaking/implementing physical (or educational) improvements to reduce stormwater contaminants discharged to the receiving environment.

Management of Effects of Discharges to Groundwater

Infiltration into the ground is considered the most effective measure of reducing the effects of contaminants in the stormwater may have on adjacent waterways. Geraldine has significant areas of the network to the east of the Waihi River (Raukapuka) and to the south of the town centre that contain soils potentially suitable for discharging some or all of the stormwater discharges to the ground. This approach is consistent with Te Rūnanga o Arowhenua expectations that discharges are filtered by Papatūānuku before discharge to the receiving waters.

More investigations are desirable to confirm the long-term maximum groundwater levels to establish the effectiveness of this stormwater disposal method during wet years when groundwater levels would be elevated.

The discharge of stormwater to the ground is generally considered an effective stormwater management strategy and mitigates the environmental and health impacts on local surface waterways. Whilst this Plan recognises that stormwater discharges have the potential to contaminate surrounding groundwater, and could impact private drinking-water supplies (e.g. with microbial contaminant), no monitoring or anecdotal evidence suggests this is occurring. On-going management of these potential effects is provided with additional groundwater monitoring to understand these risks better. It is also important to note that there are no public drinking water supplies and very few domestic drinking water supplies potentially affected by stormwater discharges to the ground in Geraldine. Therefore, the potential contamination from stormwater discharges to the ground are considered to present a low health risk and would be undisguisable to the potential health risks from existing surrounding agricultural land uses and any discharges into the surrounding waterways.

In addition to the proposed monitoring groundwater for possible stormwater contaminants, Timaru District Council proposes to (1) control where new developments will discharge stormwater and minimise the effect on any surrounding bores and (2) implement a public education programme with the intent to control some of the principal sources of microbial contamination in stormwater, specifically from domestic animals in public and private places, and actively promote sound land-use activities to minimise the risk contaminants entering groundwater.

Management of Land Use Activity Effects

The extent of contaminants in stormwater discharges may be influenced by variations in climate as well as land use activities. Whilst the cause of climate change and the resultant increase in intensity of rainfall events cannot be changed, the effect of land use activities on water quality can be mitigated through provision of stormwater treatment facilities, controls and limits on discharges and public education.

Intermittent discharges from the stormwater network resulting from accidental spills and unintended discharges can occasionally cause severe environmental effects that are potentially much greater in effect than those resulting from regular contaminant discharges associated with more regular climatic events.

It is proposed that the Timaru District Council will be actively involved in ensuring adequate erosion and sediment controls are in place to limit sediment leaving construction sites and passing sediment through the stormwater network into the receiving waterways. It is anticipated that this will require consideration and specification of sediment control requirements during the subdivision and building consent approval processes.

Site specific operational controls with specific design (and consenting) will be necessary to monitor and control the potential spills risks of activities that involve hazardous materials as listed in Schedule 3 of Environment Canterbury's Land and Water Regional Plan from discharging to the stormwater network.

Similarly, specialist assessment of possible effects and consent approvals are likely to be recommended for contaminated land where soil contaminant concentrations are higher than accepted background concentrations.

Education of internal and external stakeholders and the general public is considered an important tool to minimise the effects of adverse activities such as littering, discharge of vehicle/property wash-down water to stormwater, control of domestic animal faecal material being washed to stormwater, as well as the development of feedback publication and information of the performance of the Geraldine stormwater network and effects on the environment.

Affordability

Consideration of likely cost to provide full best practical stormwater treatment and desirable capacity capital upgrades to the existing stormwater network to bring the discharges up to current standards is estimated to require an annual expenditure in the order of $1,000 per property per year over thirty years or at least $20M capital investment by the community. The improvements that this investment would provide need to be considered against other competing needs and costs faced by the community including the effects of upstream Waihi catchment activities may have on the water quality in the Waihi River.

Therefore, an adaptive management programme is proposed with on-going environmental monitoring and improvements only being undertaken within the financial capacity of the community and when the environmental improvements warrant the expenditure.

Future Management Opportunities

Future management of the stormwater network is expected to continue to include provisions in the following areas:

i. ***Asset Management***

On-going review and replacement of the stormwater asset condition is currently provided for within the Timaru District Council's Stormwater Activity Management Plan. This includes condition assessments of the pipes within the stormwater network to identify assets that are nearing the end of their life. During any programmed replacement of assets it is anticipated that opportunities to upgrade the capacity of the network will be considered.

ii. Operations and Maintenance

The maintenance of the Serpentine Creek channel condition is critical in the lower reaches of Serpentine Creek for the channel capacity to be sufficient to receive stormwater discharges from the Geraldine SMA.

The channel maintenance programme needs to specifically focus on the in-channel vegetation condition and fence structures in lower Serpentine Creek to minimise flooding risks. This will be a collaborative

implementation with TDC and Environment Canterbury's Rivers and Drainage Department with a Memorandum of Understanding between the two parties that clearly defining the responsibilities between the two parties to maintain the channel of Lower Serpentine Creek so that the objectives of this Plan can be achieved.

iii. Provision for Growth

Growth of up to 15% over the next 30 years is proposed. New development is anticipated to be located to the north-east of the Waihi River and to the south of Geraldine town centre. The majority of new discharges from these new development areas are anticipated to be either to the Waihi River or by soakage to ground. A best practical treatment standard is proposed for all new development, to minimise any impacts of new development on water quality.

iv. Capacity Upgrades

A preliminary assessment of the capacity of the existing stormwater network in Geraldine has identified that a large proportion of the network has a lower level of service than the current Timaru District Council and New Zealand Building Regulation require for new developments. Therefore, any infill development may require network upgrades to accommodate new developments along with meeting the expectations of the general public regarding the acceptable level of nuisance flooding (inundation) to the streets and private property. Similarly, changes in public expectations with respect to the nuisance flooding (inundation) may also occur with population increases and land use changes within Geraldine, and a higher level of service may also be expected by the community.

Timaru District Council maintains a hydraulic computer model of Serpentine Creek to ensure the receiving waterway channel has sufficient hydraulic capacity to receive additional stormwater discharges. Similar assessments will need to be undertaken for the Raukapuka Stream and Downs Creek waterways to accept any significant new stormwater discharges from new developments.

v. Stormwater Treatment

General Requirements

New development and capacity improvements to the existing stormwater network are likely to result in stormwater discharges entering the receiving waterways quicker and with a greater peak flow rate.

Best practical levels of treatment will be required for new development to minimise increases in the contaminant mass discharged to the receiving waterways. Also, any capacity upgrades to the existing

stormwater network will need to consider measures to provide or retain the same level of stormwater treatment, so as to avoid adverse effects of conveying higher masses of contaminants to the receiving waterway(s).

Although treatment of stormwater at the point of source is considered more desirable, more cost-effective stormwater treatment may be achieved by providing fewer yet larger treatment devices near the point of discharge to the receiving waterway.

A number of direct stormwater discharges occur from individual private properties to the Waihi River or Serpentine Creek and its tributaries without passing through the Timaru District Council's stormwater network. It is likely that Timaru District Council will have had historical responsibility for approving these discharges. However, the council now has limited means to manage these discharges. In the Serpentine Creek urban catchment, approximately 20% of the catchment does not discharge via the Council stormwater network.

Treatment Standards and Requirements for New Development and Upgrades

Timaru District Council is in the process of developing a Code of Practice for development to encourage the use of Low Impact Design Solutions as a preferred option for stormwater management where it is a practical solution. The aim of this is to mimic natural processes, as close as practical to the source of the stormwater, thereby helping to reduce adverse effects associated with the discharges.

This will be used for new development, upgrades of the existing network or street renewal upgrades and its purpose will be to assist TDC, and to inform and assist developers, to provide effective and appropriate stormwater treatment solutions.

Review of current best practice methods used nationally and internationally to provide engineered stormwater treatment devices indicates that, at best, these will only provide removal of up to 75% of sediment and 50% of other typical stormwater contaminants. Discharge of at least the initial first flush of stormwater flows to ground is considered the most effective means of reducing contaminants discharged to the receiving waterways. The preferred method of stormwater treatment will be determined on a case by case basis; predominant factors affecting selection are likely to be (a) land area to locate, (b) suitability of soil types to soak to ground and (c) cost.

Ongoing environmental monitoring is intended to assist with the selection of an efficient stormwater treatment device(s) in the design. This will permit requirements to be adapted to meet current best understanding of the issues as they are uncovered and discovered.

Specific treatment provisions recommended to be implemented initially for Geraldine with capital upgrade projects include:

(A) Riparian Buffers

The Waihi River does not receive any stormwater discharged directly to the low flow river channel, and any base flows are filtered through the existing riparian buffers prior to discharge to the receiving aquatic environs. It is proposed that these are retained as the existing riparian margins provide filtering of the discharges prior to treatment. The Serpentine Creek channel is a lot more confined and it is not always possible to avoid discharges directly to the aquatic environment. The Serpentine Creek channel is located on largely privately owned property, which restricts available space for riparian enhancement and provision of stormwater treatment prior to discharge to the receiving water.

(B) Litter

Geraldine has high-use recreational locations centred around both Serpentine Creek (Geraldine Domain) and the Waihi River. Litter traps are recommended on sump inlets at high profile discharge locations on the Waihi River and Serpentine Creek.

(C) Hydrocarbon Capture

Inspections of industrial and commercial premises and sediment sampling in Serpentine Creek indicate some evidence of spills and discharges of hydrocarbon contaminants to the stormwater network. Contaminant load modelling indicates that up to 80% of hydrocarbon contaminants are expected to be discharges from high traffic use roads (Talbot Street, Waihi Terrace, Cox Street and State Highway 79). Therefore, it is proposed that all collection sumps on these roads include submerged outlets to capture spills and leaks on these roads.

(D) Serpentine Creek Sediment Traps

It is proposed to investigate the effectiveness of utilising the existing flood detention storages on Serpentine Creek to trap sediment from the upstream rural catchment in order to limit sedimentation effects in Serpentine Creek.

(E) Rain Gardens and Proprietary Treatment Devices

Rain gardens and proprietary treatments may be able to be retrofitted into existing street landscapes and sites for source treatment,

Space limitations in existing developed areas may limit treatment devices to the use of rain gardens and proprietary treatment devices to achieve the above standards of treatment.

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1.0 Introduction

1.1 Purpose of this Document and Structure

This Stormwater Management Plan (SWMP) is an important component and a principle tool used to manage the effects of stormwater in Geraldine. The SWMP documents how surface stormwater is managed in Geraldine to ensure that existing and future stormwater discharges to the streams and creeks in the Geraldine Stormwater Management Area (SMA) meet the catchment objectives.

To achieve the catchment objectives, stormwater quality and other issues need to be addressed; this will include not only engineering or physical changes, but also include source control, planning requirements, and education.

The structure of the SWMP is outlined below:

- Section 1: Introduction.
- Section 2: Regulatory Requirements.
- Section 3: Current State of the Catchment, its values and current issues.
- Section 4: A summary of the technical reports, statement of the knowledge associated with the aquatic environment, flooding, inundation, and effects of stormwater on the environment within the Geraldine stormwater catchment.
- Section 5: Outlines the Stormwater Management Approach.
- Section 6: Summarises the approach to manage potential inundation of property, roads, within the catchment.
- Section 7: Outlines the approach to manage stormwater quality and potential adverse effects on the aquatic environment.
- Section 8: Describes the implementation approach, monitoring requirements, triggers and response plans. Along with funding mechanisms and communication requirements with internal and external stakeholders.

1.2 Background

Geraldine Township is located near the base of the foothills in South Canterbury. The town is separated by the Waihi River which differentiates the main township on the western side of the river with the Raukapuka community on the east side of the river.

Geraldine Township started as an old European settlement located some 36 kilometres north of Timaru. Geraldine's population is in the order of 2,400 residents (2013 Census) (Statistics NZ, 2017).

Geraldine is a typical farming community that has prospered on the back of agriculture, from farming dairy cows, sheep, cattle and deer through to growing crops and fruits. Initially a support town for agriculture in the past, Geraldine has grown a commercial district, which has an array of shops that now cater for tourists and travellers who take a break on their trips to and from major tourist destinations within the South Island.

This SWMP focuses on the Geraldine urban stormwater network (Figure 1) which covers a total area of 239 ha; of this, 164 ha discharge directly to four receiving surface waters:

- The Waihi River (46 ha, excluding Serpentine and Downs Creek areas);
- Serpentine Creek (97 ha);
- Raukapuka Stream (7 ha); and
- Downs Creek (14 ha).

Ultimately the Serpentine, Downs Creek and Raukapuka Stream discharge all into the Waihi River, and stormwater runoff from a further 75 ha discharges to ground.

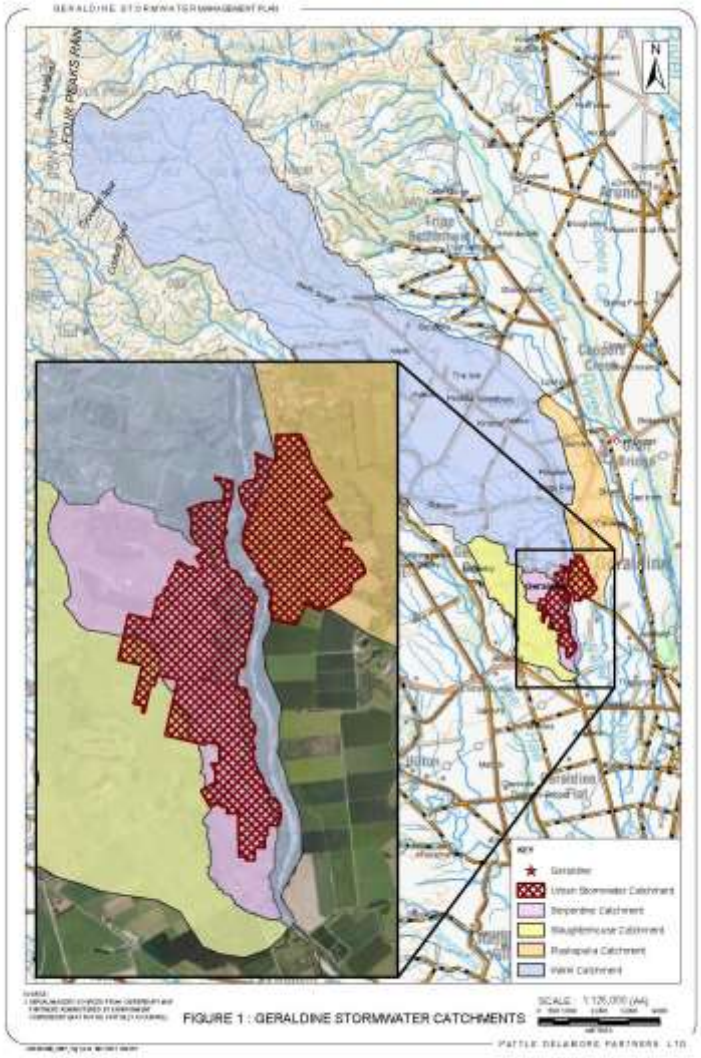

Figure 1: Geraldine Stormwater Catchments

2.0 Regulatory Requirements

2.1 Local Government Requirements

Under the Local Government Act (2002), the Timaru District Council (TDC) is required to promote the social, economic and environmental well-being of their communities by adopting a sustainable development approach. Schedule 10 of the Local Government Act (2002) requires TDC to develop relevant long-term plans to achieve these goals, with Activity Management Plans (AMP) providing the direction for infrastructure activities undertaken by the council.

This SWMP links into this management framework, with the SWMP providing specific details on implementation, and provides a key input into development of TDC's Stormwater Services AMP (TDC, 2015). In addition, the AMP will evolve to reflect the aims and objectives of this SWMP; capital works will be forecast in the AMP in addition to Annual and Long-Term Plans.

In implementing the SWMP, the Local Government Act (2002) requires TDC to consider the following plans, acts and regulations:

- Timaru District Plan
- Timaru District Council Water Services By-law (2012)
- Timaru District Council Long Term Plan 2015-2025
- Timaru District Council Annual Plan (Current)
- Timaru District Council Stormwater Activity Management Plan 2015-2025
- Building Act 2004
- Building Regulations 2004.

2.2 Resource Management Act Requirements

The management of the water resources in the vicinity of the Geraldine SMA is governed by the Resource Management Act (1991) and associated national and regional policies and plans as summarised below:

- Resource Management Act (1991)
- National Policy Statement (NPS) for Freshwater Management (2020)
- National Policy Statement Sources of Drinking Water (2008)
- National Environmental Standard for Fresh Water Management Regulations (2020)
- National Policy Statement Assessing and Managing Contaminants in Soil to Protect Human Health (2010)
- Hazardous Substances and New Organisms Act (1996)
- Environment Canterbury Land and Water Regional Plan (LWRP) (2017)
- Environment Canterbury Opihi River Regional Plan 2000

- Canterbury Regional Policy Statement 2013
- Environment Canterbury Flood Protection and Drainage By-law (2013)
- Te Rūnanga o Ngāi Tahu Statutory Acknowledgements.

In addition, the SWMP considers the following non-statuary documents:

- Canterbury Water Management Strategy
- Orari-Opihi-Pareora Zone Implementation Programme
- Orari-Waihi-Temuka Floodplain Management Plan 1994.

2.3 Timaru District Council Stormwater Strategy

Timaru District Council adopted a strategy for management of their stormwater networks, including their stormwater management goals for the next thirty years and what TDC proposed to do to achieve these goals. The following key areas were identified to as important in order to address the key stormwater management issues that the district faces:

- Planning and regulation
- Asset management
- Protection of the Receiving Environment
- Stakeholder Engagement and Education

It was identified that the effectiveness of the Stormwater Strategy would be dependent on on-going monitoring and review.

This stormwater management plan has bene prepared to support the implementation of the stormwater strategy for the Geraldine network.

2.4 Management Area Resource Consent

This stormwater management plan has been prepared to support the procurement of a stormwater management area (SMA) resource consent to discharge stormwater from the Geraldine stormwater network to the receiving environment, to be sourced under the Resource Management Act (1991) from Environment Canterbury (ECan). The discharge is limited to acceptance of stormwater runoff from:

- Roofs, roading and hardstand areas (impervious areas), and pervious areas associated with:
  - Development that existed prior to the commencement of the consent
  - Redevelopment of existing private sites up to 4 hectares
  - New development sites up to 4 hectares
- Exposed soils during construction of any new development or redevelopment.
- Within the Geraldine Stormwater management Area (SMA).

It is expected that TDC will endeavour to manage the network to obtain the following outcomes:

- Ensure the capacity of the network is understood and the capacity is adequate to avoid flooding of habitable buildings in a 20% AEP rainfall event in residential areas and 10% AEP rainfall event in commercial and industrial areas. It is also desirable to provide a suitable stormwater outfall to avoid nuisance to all downstream properties in smaller events.
- Undertake regular inspections and maintain the network to ensure it operates as required by TDC.
- Undertake monitoring to identify effects on the environment from stormwater discharges.
- Undertake capital works to maintain or improve the network performance, to improve the network capacity and reduce effects on the downstream environment where unacceptable adverse effects are identified.
- Require that new developments and additional discharges to the receiving waterways are provided with low impact design solutions with best practicable level of stormwater treatment.
- Discharges to the stormwater network during site construction activities shall be controlled via best practicable erosion and sediment control. An Erosion and Sediment Control Plan is prepared and reviewed with planning and building consent applications.
- Discharges from private properties are managed to minimise contaminants discharged to the environment through Site Environmental Management Plans that are prepared and reviewed with planning and building consent applications.
- Provide a public education programme to minimise risks and improve public awareness and of:
  - Accidental spills or unintentional discharges draining to the stormwater network;
  - Contaminants from domestic animals discharging through the network;
  - Waste minimisation and litter reduction;
  - Wash down activities draining directly to the stormwater network; and
  - Raise public awareness of the effects of stormwater related contamination and TDC's efforts to manage it.

3.0 Current State of the Catchment – Values and Issues

3.1 Goals and Objectives

The objectives and goals of this SWMP are to achieve the following:

- Improve the water quality of the surface water resources;
- Reduce the risk of adverse effects from stormwater inundation and/or flooding;
- Improve the health of the ecosystem of surface water resources;
- Support and encourage community education and involvement with the management of the surface water resources;
- Protect and restore Tangata Whenua values associated with surface water resources;
- Implement sustainable and affordable solutions to support the goals above;
- Comply with regulatory requirements:
  - Local Government Act (2002)
  - Building Act (2004) / Regulations
  - Resource Management Act (1991) and any Resource Consents

3.2 Key Issues and Constraints

Key issues and constraints relating to stormwater discharges to be addressed by this SMWP include but are not limited to:

Water Quality

- Understanding of wider catchment issues and limitations of specific flow and water quality data;
- Limit effects of contaminants discharged to the receiving waterways;
- Minimise excess sediment loads to the receiving waterways;
- Address low water quality and ecological conditions in Serpentine Creek;
- Maintain and enhance the higher water quality and ecological conditions in Waihi River;
- Recognise and work within the limitations of the existing waterway land ownership for improvement works;
- Provide affordable and effective best practical stormwater treatment;
- Provide best practical stormwater treatment standards for new developments;
- Protect the Waihi River fishery from adverse effects; and
- Recognise and provide for Iwi values.

Flooding and Inundation

- Recognise and understand the flooding issues relating to the stormwater network and flooding from the Waihi River;
- Manage the limiting channel capacity in Lower Serpentine Creek;
- Manage the effects of upgrades to areas of the network with a limited existing level of service;
- Manage the performance and level of service from detention basins
- Limitations of soakage drainage performance and capacity;
- Performance and reliability of private soakage drainage works;
- Provide the necessary capacity requirements for any new developments;
- Waterway land ownership constraints; and
- Climate change.

Biodiversity and Waterway Values

- Provide and enhance accessibility where possible;
- Minimise effects of litter discharged to the receiving environment;
- Maintain and enhance riparian buffers and wetlands;
- Community involvement and ownership of the stormwater network management;
- Maintain and enhance Waihi River amenity and recreation;
- Provide fish passage where required; and
- Cultural values.

Photo 1: Waihi River running through Geraldine is a highly valued amenity and place of recreation.

4.0 Summary of Technical Reports

The development of the SWMP includes the following Technical Reports commissioned by TDC between 2013 and 2017:

- 'Waihi River & Serpentine Creek – Geraldine Urban Reaches, Ecological Assessment', Opus International Consultants Ltd, 14 November 2013. Assessment of the ecology within the Waihi River and Serpentine Creek.
- 'Water Quantity Modelling Serpentine Creek & Waihi River', Opus International Consultants Ltd, December 2014. Assessment of the impact of stormwater discharges on Serpentine Creek and the Waihi River.
- 'Groundwater and Contaminated Sites Assessment', Opus International Consultants Ltd, April 2014. Provides background information of the groundwater and contaminated sites within the stormwater management area.
- 'Cultural Assessment of Waihi Catchment Waterways', Tipa & Associates Ltd, January 2014. Provides an assessment of waterway conditions against the significance of the site to Maori, Mahinga kai, and a measure of stream health.
- 'Contaminant Load Modelling Serpentine Creek', Opus International Consultants Ltd, November 2014. Provides an understanding of the potential contaminant loads and sources within the Serpentine Creek Catchment.
- 'Industrial Sites Assessment', Opus International Consultants Ltd, October 2014. Provides an assessment of the risk of industrial sites discharging contaminants into the council stormwater network.
- 'Supplementary Receiving Environment Assessment for Geraldine Stormwater Management Plan', Pattle Delamore Partners Ltd, November 2016. Additional water quality, sediment and ecological data for Serpentine Creek and the Waihi River in the vicinity of Geraldine Township.
- 'Geraldine Stormwater Network – Preliminary Infrastructure Capacity Assessment', Pattle Delamore Partners Ltd, 2017. Provides a capacity assessment of the stormwater pipework, outfalls, and soakpits within the Geraldine Stormwater Network.
- 'Geraldine Stormwater Contaminant Load Modelling and Treatment Strategy', Pattle Delamore Partners Ltd, March 2017 (Draft Report). Provides an understanding of the potential contaminant loads and sources for the Geraldine township and surrounding areas, and provides three potential stormwater treatment strategies.
- 'Timaru, Temuka and Geraldine Design Rainfalls', Opus International Consultants Ltd, October 2015. Site specific design rainfall depths

including provision for increased rainfall depths as a result of climate change.

- Contaminant Transport Assessment for Geraldine Stormwater Consent Application. Report prepared by Pattle Delamore Partners 27 August 2021

4.1 Physical Context

4.1.1 Climate and Rainfall

Geraldine is located near the base of the Southern Canterbury foothills and is dominated mainly by westerly and southerly airflow. Rainfall has been estimated at 500 to 700 mm per year and highlights the position of Geraldine being in the westerly wind, rain shadow zone. The mean annual temperature for Geraldine is 10.1 to 12 degrees centigrade based on NIWAs Climate NZ Temperature Graph for 1971 to 2000 with typical daily summer temperatures from 18 to 26 degrees during the day.

An analysis of the design rainfall depth(s) taking into consideration of likely changes in rainfall intensities due to climate change to 2090 was completed by Opus (2015), which has been summarised in Table 1.

Table 1: Design Rainfall Depth for Geraldine to 2090 (projected climate change) (in mm)

ARI	10 min	1 hour	24 hours	48 hours
5 year	7	21	92	117
10 year	10	26	115	147
50 year	14	42	165	211
100 year	16	48	186	237

Notes:
1. *Source* (Opus, 2015)
2. *Values include a 16% allowance for climate change*

4.1.2 Flood Risk

Major flooding disasters from the Waihi River have affected Geraldine at regular intervals throughout the community's brief history since European settlement. Along with many other parts of New Zealand, Canterbury has developed on river floodplains. These locations are desirable due to the availability of flat land, fertile soils, proximity to water for irrigation, and for recreation, transport and access.

While there are benefits to living in these areas the result is that many of Canterbury's communities have settled in areas exposed to flood risk. The flat nature of the Canterbury Plains means large floods are able to spread over comparatively larger areas.

Significant flooding events have occurred in Geraldine related to the Waihi River in 1868, 1902, 1929, 1945 and the most recent major flood event in 1986, which was reported by the New Zealand Meteorological Service as the worst flood since 1929. The 1986 flood flows, as assessed by ECan, are thought to be in order of a 2% to 1% probability of occurring in any one year (i.e. 1 in 50 – 1 in 100 year return period flood event), the extent of which is presented in Figure 2.

Limited reliable flood flow records of these events are available to draw a robust comparison of the relative magnitude of the events. However, an assessment of the daily rainfalls in Geraldine, during these events, is tabulated below (Table 2).

Table 2: Historical maximum daily Rainfalls in Geraldine

Year	Daily Rain (mm) 0900-0900hrs
1868	unknown
1902	104.6
1929	92.5
1945	146.6
1986	102.4

Notes:
1. *Source NIWA CLIFLO Database*

While flood frequency is also related to runoff and antecedent ground conditions at the time of rainfall, it should be noted that daily rainfalls in excess of 100 mm a day also occurred in 1941 (123 mm), 2000 (107 mm) and 1980 (105 mm). The above rainfalls are of a similar magnitude as the 1986 flood, indicating that such event are not unusual with significant floods occurring at least every thirty to fifty years.

A range of flood mitigation measures are available for implementation by ECan, TDC and other organisations to help sustainably manage development in the floodplains within the Geraldine SMA. Provision of these flood mitigation measures for the Waihi River is outside the scope of the SWMP.

The Timaru District Plan includes controls on development to require floor levels to be construction to sufficient height such that the risk of flood waters rising to that level shall not exceed a 1 in 200 year (or 0.5% AEP) flood event. The 0.5 % AEP flood extent from the Waihi River covers significant areas of the Geraldine SMA as shown on Figure 3; it is highly likely that several of the key stormwater outfalls will be affected by flood backwater effects during large flood events.

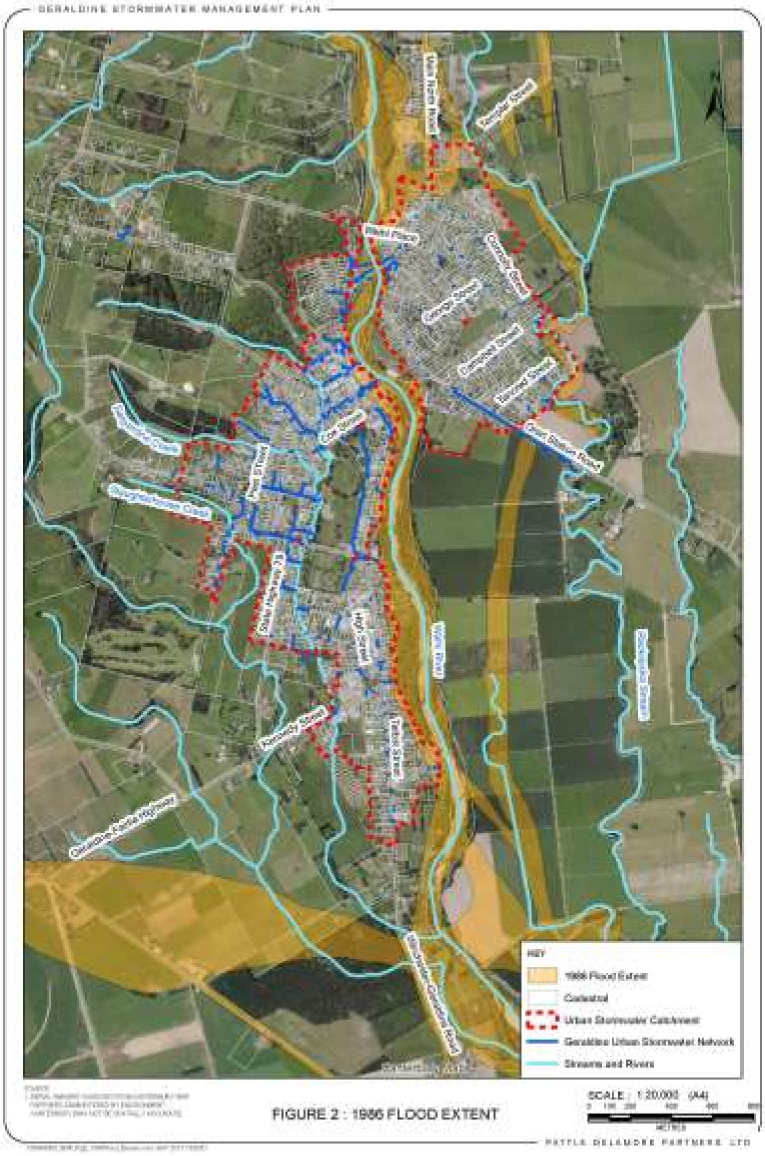

Figure 2: 1986 Flood Extent

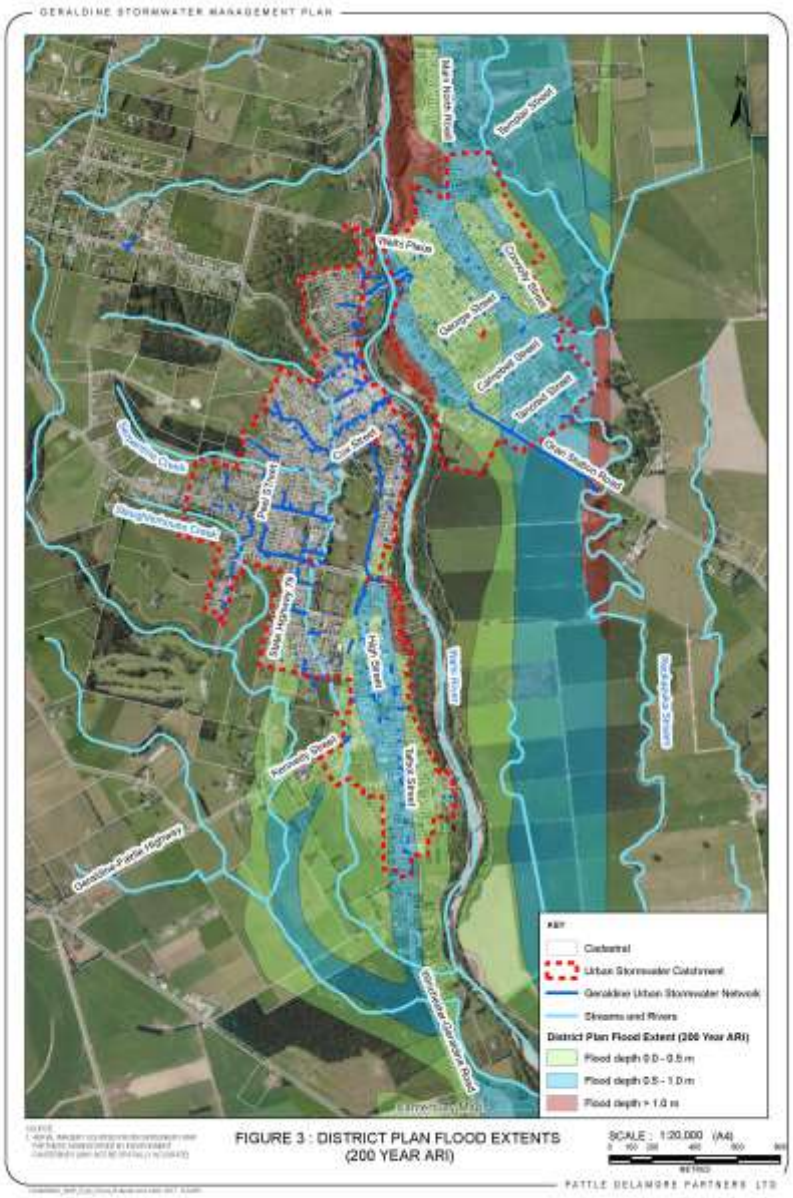

Figure 3: District Plan Flood Extents (200 Year ARI)

4.1.3 Stormwater Flooding in Geraldine

Stormwater flooding and inundation in Geraldine is more sensitive to short duration rainfall intensities, for which there are even fewer available historical hydrological records than Waihi River flooding records and reports.

Severe flooding occurred in Geraldine on 8-9 February 1996. "Sun Dried Bricks" at 21-27 Kennedy Street suffered flooding with overland flood flows from both Serpentine Creek and from High Street reported as flooding the property to depths of 50-300 mm deep. Rainfall in Geraldine was estimated at between 107.5-120.5 mm over 7-8 February 1996 with a maximum one hour rainfall intensity of 8 mm/hr.

Newspaper reports provided by Environment Canterbury indicate that further heavy flooding in Geraldine was experienced in February 1998, which caused surface flooding of properties west of the main street. No serious damage was reported to have occurred but wooden pallets were discovered in parts of Serpentine Creek obstructing flood flows. Properties were affected in Hislop Street, Peel Street, Cox Street, North Terrace, South Terrace and Majors Road, with three families evacuated as a precautionary measure. Recorded maximum rainfall intensities in the Geraldine area during February 1998, were similar to 1996 rainfall intensities.

Following these events two flood detention dams to store rural runoff from above Geraldine at the upper ends of Peel Street and Hislop Street were constructed by Timaru District Council to reduce flows from the rural catchment in Serpentine Creek. Photo 2 shows the Hislop Street Flood detention area.

Flooding was reported on 19th January 2016, where flooding was reported in the Timaru Herald on Cox Street following a rainfall of nearly 40 mm in less than a day, with a maximum rainfall of 6 mm/hr. Geraldine experienced a rainfall of approximately 107 mm over 24 hours on 21-22 July 2017, with maximum rainfall intensities of 7-8 mm/hr at Woodbury. Inspections by TDC stormwater staff indicated some street flooding along Talbot Street and Serpentine Creek broke its banks just upstream of Majors Road. Surface flooding also occurred in Raukapuka Domain with overland flows through to Campbell Street. Post flood inspections showed debris built up on fence structures across the waterway structures between Talbot Kennedy Street and Majors Road. These observations are consistent with the expected flooding and illustrate the criticality of maintenance of the lower sections of Serpentine Creek.

All of the above mentioned historical records show significant stormwater related flooding and inundation from the stormwater system with considerably lower rainfall intensities than indicated in Table 2 (above).

4.1.4 Geology

The Geraldine flats are underlain by quaternary alluvial deposits bounded to the west by the extrusive igneous Geraldine Basalt which forms the Geraldine Downs (Cox & Barrell, 2007). The Raukapuka area is underlain by quaternary gravels from the last glacial period; these gravels also underlie the western side of the

Waihi River on the Geraldine flats with younger quaternary deposits closer to the Waihi River. The slopes of Talbot Forest are underlain by the Geraldine Basalt. There is a loess cap on top of the Basalt which is assumed to grade into river deposits over the lower slopes of the Geraldine Downs.

Photo 2: Serpentine Creek – Downstream of Hislop Street Detention Area

4.1.5 Soils

The soils underlying the Geraldine Township are typical of alluvial gravel and silt floodplain deposits with the loess silt loams basalt outcrops on the gentle slopes to the north-west of the town.

Typically, soils on the eastern side of the Waihi River in the Raukapuka area, and to the south of the town centre on the western side of the Waihi River, are much more freely draining as a result of the recent floodplain activity. As a result, soak pit devices are the main feature of stormwater management in the eastern area of Geraldine.

Photo 3: Spring-fed Raukapuka Stream downstream of Geraldine

4.1.6 Receiving Waterways

The urban Geraldine stormwater network intersects four waterway catchments (Figure 4), the Waihi River, Raukapuka Creek, Serpentine Creek and Downs Creek. Ultimately the Raukapuka Creek, Serpentine Creek and Downs Creek discharge into the Waihi River.

The Waihi River is the main water body located in the vicinity of the Geraldine Township. The Waihi River is a hill fed tributary of the Opihi River, with a catchment area of approximately 10,000 ha upstream of Geraldine. The land use is dominated by sheep, beef, dairy and deer farming, although dairy support has increased on areas of the alluvial floodplain in recent years. The Waihi River is typical of many small to medium hill-fed rivers in Canterbury in that the river can be divided into two distinct areas: the steeper, permanently flowing headwaters and the active gravel bed channel across the alluvial floodplain. Flows are intermittent in the reaches below Geraldine Township, as they are lost in seepage to the groundwater during dry periods and reappear lower down the floodplain in the vicinity of Temuka. The Waihi River is fed by small hill fed tributaries (e.g., Serpentine, Barkers and Downs Creeks), small spring fed plains streams (e.g., Dobies Stream and Raukapuka Creek) that are fed by shallow alluvial groundwater aquifers.

Raukapuka Stream is a small spring-fed stream with a total upstream catchment area of over 820 ha that runs around the eastern perimeter of the Geraldine SMA. Approximately 7 ha of the SMA is drained directly to Raukapuka Stream.

Serpentine Creek is a small hill fed tributary of the Waihi River that drains approximately 220 ha of the gentle to moderate sloping hillside of Talbot Forest and Geraldine township on the western side of the Waihi River before entering the Waihi River on its southern bank downstream of Geraldine. It runs through farm land prior to discharging into the Waihi River some 2.7 km downstream of the Geraldine town centre. Serpentine Creek is heavily influenced by the urbanisation that has occurred in and around Geraldine. Approximately 97 ha of the Geraldine SMA drains to Serpentine Creek. Riparian planting through residential areas is generally abundant, with less riparian plants in the more southern industrial area of town due to lower amenity values in this light industrial area.

A small portion (14.3 ha) of the SMA on the western side of Geraldine in the vicinity of Downs Road and Gresham St drains into a minor tributary Downs Creek. Downs Creek is predominantly a rural hillside catchment of over 600 hectares and ultimately joins the Waihi River close to Serpentine Creek

These waterways receive both direct and indirect stormwater discharges. As Serpentine Creek flows into the Waihi River, and channel intercepts shallow groundwater is prior to the Waihi River, and the Waihi River ultimately receives almost all stormwater runoff from the Geraldine Stormwater Management Area (SMA).

4.1.7 Groundwater conditions and interaction with surface waterways

Groundwater to the east of Geraldine in the Raukapuka area is within the unconfined alluvial aquifers of the Canterbury Plains. Raukapuka Creek is sourced from groundwater in the alluvial gravels in the Orari-Waihi Floodplain to the north of the Geraldine SMA.

Downs Creek and Serpentine Creek are fed from groundwater present either within fissures in the underlying Geraldine Downs basalt or from seepage at the soil bedrock interface although at low yielding quantities. Groundwater in the area is recharged both from rainfall recharge and surface waterway losses as the channel nears the Waihi River.

Downs Creek is sourced from a much larger hill country catchment to the west of Geraldine that recharges the alluvium deposited in the valley floor. Water is also expected to be lost to the underlying gravel aquiver as the floodway merges with the Serpentine Creek and Waihi River floodplains

4.1.8 Current Stormwater Network

The Geraldine stormwater network consists of a series of pipes, open channels, manholes, soak pits and detention dams (Figure 4) in the following quantities:

- 5.2 km of piped network;
- 3.8 km of open channels;

- 60 manholes;
- 58 soak pits; and
- 2 detention dams.

Photo 4: Serpentine Creek in Geraldine Recreational Reserve (near Wright Street)

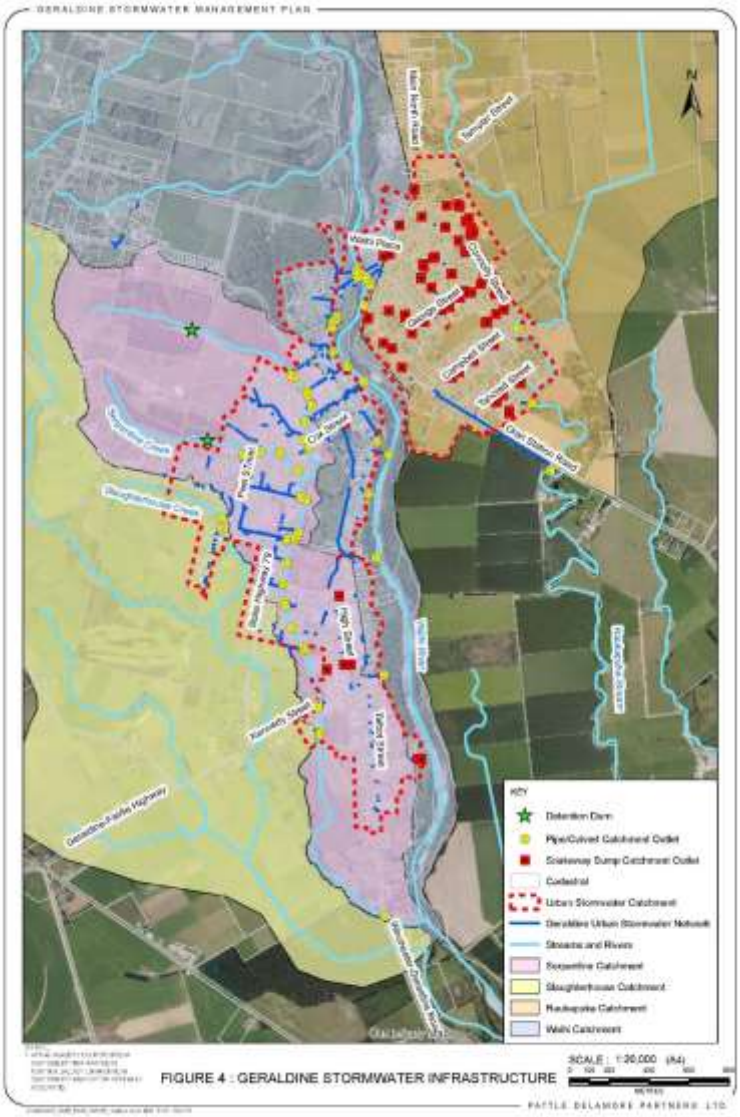

Figure 4: Geraldine Stormwater network Infrastructure

A number of private properties discharge directly to the adjacent receiving waters without passing through the public stormwater network. Private discharges to ground also exist in the form of roof drainage and privately constructed soak pits in driveways.

The majority of the pipes network (65%) consists of concrete pipes.

The SMA is divided by the Waihi River which flows from north to south through the town. On the west side of the river, stormwater discharges run through a series of open channels or pipes before discharging to an outfall and subsequently into the Waihi River or Serpentine Creek (which subsequently flows into the Waihi River). Serpentine Creek has at least 28 public stormwater discharge points along its length and numerous private discharges from properties adjacent to the stream and its tributaries. The Waihi River has discharge outfalls in at least 12 locations within the scheme area with the majority of these on the western side of the river. There are over 50 soakaway drainage points on the eastern side of the Waihi River in the Raukapuka area and at least six inland discharge points (soak pits) on the western side of river, to the south of the town centre.

Two stormwater detention dams are located at the base of the Geraldine Downs, in the headwaters of Serpentine Creek. These are designed to retain flows from the upstream rural catchment to buffer flows from the downstream urban catchment during heavy long duration rainfall events. The portion of the scheme in the Raukapuka area predominantly consists of soakage discharge points that discharge to ground via road sumps and private soakage drainage due to the gravelly soils in this area being highly permeable. However, there is also a limited piped drainage system to the Raukapuka Stream provided along parts of Mckenzie Street, Tancred Street, Cascade Place and Orari Station Road to supplement the discharges to land where soakage rates were considered insufficient.

At least three stormwater outlets discharge to a minor tributary of Downs Creek on the western side of Geraldine.

4.2 Cultural Health Assessment

The Geraldine district is a significant area for the Takata Whenua, Ngāi Tahu, and Te Rūnanga o Arowhenua in particular. The area has long associations with Māori.

Arowhenua is the principal Māori settlement of South Canterbury and lies between the junction of the Temuka and Opihi Rivers just 2 km south of Temuka.

A cultural health assessment of streams in the Waihi Catchment using the Cultural Health Index (Tipa & Teirney, 2003) was conducted in December 2013 (Tipa & Associates Ltd, 2014). The assessment identified the following:

- The Waihi catchment is of immense significance to whanau. The assessment noted that the catchment is heavily used and the whanau aspire to continue to use it; in addition whanau see there is an

opportunity to work with TDC and others to restore sites within the Geraldine Township.

- Within the Serpentine Creek, the cultural health assessment identified that the major issue was the lack of water within the creek, excess sediment in the channel and the loss of connections within the creek and the Waihi River.
- Whilst the Ngāi Tahu Whānui noted the good quality of the water in the Waihi River, but were concerned about the lack of flow (water quantity).
- The assessment raised concerns that flows in the streams and creeks were lower than they should be and were impacting on the passage of migratory fish species. In the Serpentine Creek, whanau believe that an improved residual flow should be possible.
- Ngāi Tahu Whānui wants to see better conditions and greater opportunities for Mahinga kai within the Waihi Catchment.
- Addressing sediment build-up is a priority for Ngāi Tahu Whānui. This could be achieved by greater flow or more regular freshes within the Waihi Catchment.
- Before identifying opportunities to restore or reconstruct habitats in such a modified catchment, it is important that no further losses of existing wetlands, springs, remnants of native vegetation occur.
- More appropriate instream management was desired with less use of spraying of instream vegetation which whanau considered would protect instream values.
- Te Rūnanga o Arowhenua are seeking commitment from TDC to develop management strategies to deliver the following outcomes:
  - Biodiversity gains of indigenous species.
  - Improved waterway management that is more compatible with their values.
  - Improving instream habitat.
  - Naturalise the appearance of streams, where applicable
  - Opportunities for enhancement of aquatic ecosystems, in particular enhancement to bring back mahinga kai values

Arowhenua wishes TDC to provide for Arowhenua's values to be incorporated into the stormwater management plan including:

- Improved water quality of the stormwater discharges.
- Reduction in sediment discharged.
- Riparian plantings and naturalisation of the channels of the downstream waterways to provide and encourage greater biodiversity filtration of contaminants.

4.3 Surface Water Quality

Surface water quality investigations are limited to two sampling studies undertaken by (PDP, 2016) and Opus (2013). These are limited to water quality sampling of the base flow in Serpentine Creek and the Waihi River. Common stormwater related contaminants investigated included heavy metals (particularly copper and zinc), hydrocarbons, nutrients (nitrogen and phosphorus), and microbial contaminants (assessed from *E. coli* bacteria).

This provides an indication of residual stormwater related contaminants in continuous flow regime and the baseline chemical characteristics of the receiving waterway.

No residual heavy metal contaminants were identified in the Waihi River baseflow, nor was any significant change in chemical water quality or microbial were identified in the through the Waihi River reach that regularly receives stormwater discharges.

Residual levels of *E. coli* were detected throughout both the Serpentine Creek and Waihi River baseflows. Environment Canterbury also regularly undertakes water quality monitoring both at the Waihi Gorge and at the Wilson Street Footbridge in the Waihi River, which also regularly exceeds *E. coli* recreational (e.g. swimming) water quality alert limits following rainfall. There is no difference in the measured maximum E.coli values at the upstream Waihi Gorge and Wilson Street site in Geraldine.

No residual levels of hydrocarbons were found in Serpentine Creek and Waihi River base-flows.

Laboratory analysis demonstrated elevated levels of dissolved heavy metal contaminants (zinc and copper) in base-flow surface water samples throughout Serpentine Creek, with possible additional nutrient and faecal coliform inputs being observed downstream of the urban areas in Serpentine Creek. The high dissolved zinc as high as 0.052 g/m^3 in the base-flow surface water at several of the sites within Serpentine Creek is of interest as it could present a significant toxicity risk to aquatic biota, whilst TPH (total petroleum hydrocarbons) were below the laboratory detection limits. It was not possible to determine the effects of the urban stormwater discharges or baseline levels of these contaminants upstream of the urban areas owing to low baseflows at the time of sampling.

4.4 Sediment Quality

PDP (2016) assessed the quality of the sediments in Serpentine Creek. No significant sediment deposits occur from the adjacent stormwater discharges in the Waihi River gravel bed to justify sampling.

When compared to (ANZECC, 2000) interim sediment quality guidelines (ISQG) for species protection trigger values, the lead and mercury concentrations exceeded the ISQG –low trigger values in two (2) of the seven (7) sample sites within Serpentine Creek. Hydro-carbon related contaminants (PAH and TPH) above the ISQG-low trigger levels were observed in Serpentine Creek sediment,

upstream of Huffey Street. Elevated concentrations of TPHs were also observed at the confluence of Serpentine Creek and Waihi River. The observed hydrocarbon contaminants are typical of heavy fuel oils and lubricating oils found in stormwater discharges from roads.

The contaminants identified in the Serpentine Creek Sediment are considered most likely to be sourced from the urban stormwater network. However, limited evidence has been found that indicates that these contaminants are mobilised into the water column and the sediment sampling to date has yet to identify the source of high levels of zinc found in the water column during low flows in Serpentine Creek and whether it is related to stormwater.

4.5 Freshwater Ecology

The studies undertaken suggest that there is no observable adverse effect caused by Serpentine Creek on the water quality and ecological condition of the Waihi River downstream of the confluence with Serpentine Creek.

These investigations to date indicate that ecological health in the Serpentine Creek is currently low and that input of sediment, nutrients and toxicants from the surrounding catchment is likely to be contributing to this. The ecological health of the Waihi River is generally good, but the ecological health may be affected by the flow losses to the shallow groundwater system during dry periods.

It is known that water levels and flows in both the receiving waterways do fluctuate during the year, with sections of the waterways consistently going dry and/or receding throughout summer and autumn. As the water flows vary it is likely that the ecology within these waterways will be shifting to adapt to survive these types of conditions. PDP (2016) noted that species associated with receding/drying reaches are generally less sensitive taxa[1]. This makes assessment of the ecological conditions sensitive to the flow conditions.

4.6 Fish Survey

Opus (2013) assessed the fish species in the Geraldine SMA; the species present are generally considered to be reflective of the water quality flow conditions present.

The Waihi River is listed as a popular trout fishing river and fish species observed in the Waihi River included the upland bully, common bully, Canterbury galaxias and Koaro. Both long finned and short finned eels are listed in the NIWA freshwater fish database.

The fish observed in Serpentine Creek were limited to short fined eels and common bullies.

4.7 Wetlands

As result of wetland mapping for the National Environmental Standards Regulations (2020), Environment Canterbury identified a potential wetland in the

[1] Taxa – unit grouping of a biological classification or taxonomy.

gully between Peel Street and the upstream detention dam. These regulations require Timaru District Council to maintain or enhance the wetland.

4.8 Groundwater Quality

There is limited data to describe the variability of groundwater levels or water quality in the SMA.

The groundwater table below the Geraldine SMA is understood to be typically 2-5 m below ground level (Opus, 2014a). Groundwater levels are expected to vary according to the season, precipitation events and surface water levels predominantly in the Waihi River.

In the absence of groundwater water quality observations within the SMA, sampling observations within 2 km of the Geraldine SMA are considered to be generally representative of background water quality conditions around Geraldine.

These aquifers are have historically been used as unsecure drinking water sources, and the hydrogeology of the aquifers are susceptible to contamination from surrounding land-use activities. In addition, the discharge to ground has the potential to result in adverse environmental effects where it emerges as surface water. Historic groundwater monitoring in the vicinity of Geraldine is limited to nitrate, *E. coli* and faecal coliforms. The average nitrate-nitrogen concentration was 1.7 mg/L (maximum 4 mg/L). Whilst the Drinking Water Standards of New Zealand (Ministry of Health, 2008) specifies a maximum acceptable value of 11.3 mg/L, environmental requirements for surface water are much lower with maximum limits set by Environment Canterbury at 3.8 mg/l (Schedule 8 LWRP), and dissolve dissolved limits of 1.5 mg/l (Schedule 5 LWRP) for lowland spring fed streams.

Bacterial contaminants in excess the Drinking Water Standards of New Zealand criteria (Ministry of Health, 2008) have been periodically recorded in 6 of the 7 bores identified within four kilometres of Geraldine. The bacterial indicators do not display any spatial pattern and higher values appear to be caused by local influences and are indicative of general shallow aquifer water quality conditions rather than stormwater discharges. These bacterial levels are considered to be typical of the shallow unconfined groundwater aquifers in the vicinity of Geraldine.

Contaminant transport modelling undertaken by (PDP, 2021)indicates that cumulative effects from stormwater discharges may potentially cause some risk to drinking water supplies abstracted within 100m of the SMA, and a sensitivity assessment of stormwater discharges with very high levels of e-coli, could potentially affect drinking water supplies around 200m from the SMA.

The analysis shows that these risks are considered similar to the risk of "contaminants" being discharged to the aquifer from the following activities:

- Permitted activity stormwater discharges
- Groundwater interactions with the Waihi River

- Surrounding agricultural land uses and standard onsite wastewater systems

There are no public water supply bores within 4 km of the SMA and limited private water supplies. Therefore, it is considered that the SMA poses limited risk to drinking water supplies and the surrounding agricultural land uses will provide a similar or higher risk to nearby wells used for drinking water.

4.9 Industrial and Contaminated Sites and Stormwater Management

An evaluation of 35 industrial sites within the Geraldine stormwater network (Opus, 2014) identified 10 sites as having on-site stormwater systems with no direct discharge to the Geraldine Stormwater Network. A sample of 10 sites from the 35 sites identified as discharging to the network was audited by Timaru District Council stormwater and trade waste staff in 2014, with deficiencies noted in two of the ten sites. Whilst it was noted that many of these sites were generally well kept, several indicated hydrocarbon/oil staining within the site that may present a source of polycyclic aromatic hydrocarbon (PAH) in the stormwater that leaves the site(s). A follow up audit of the two sites identified with major deficiencies was completed in 2017, and this indicated that the improvements recommended to the owners had been completed and better site practices were in place

This study highlighted the need for further interaction with other council groups e.g. TDC's trade waste section and possibly the ECan pollution control section, so as to control and/or limit potential adverse effects of stormwater discharges to the Geraldine stormwater network.

4.10 Stormwater Related Flooding

The stormwater related discharges to the Waihi River, Raukapuka Stream, and Downs Creek contribute less than 1% of the contributing catchment area and are considered to provide negligible downstream impact on any flooding in the Waihi River from these waterways. Notwithstanding, the Down's Creek and Raukapuka Stream waterway channels both have limited capacity that will need to be carefully reviewed if any significant flows are discharged to these waterways.

The urban area of Geraldine contributes approximately 40% of the catchment area to the Serpentine Creek Catchment. Two flood detention dams were constructed in the upstream rural catchment in the early 2000's to provide additional capacity in the downstream stream channels to receive urban stormwater runoff. OPUS (2016) undertook a review of the operation and capacity of these detention dams and concluded that the Serpentine Creek channel had sufficient capacity to receive existing flood floods up to 2% AEP rainfall events. This review also recommended updating the cross-section details upstream of Kennedy Street to the detention dams to provide improved confidence in the flood risk assessment.

The critical section of the Serpentine Creek channel is located at the downstream periphery of the SMA in the vicinity of Kennedy Street and Majors Road. The

detention dams have little mitigating influence to the extent of the flooding at this point, where flooding occurs as the gradient flattens and channel depth reduces as the Serpentine Creek fan meets the Waihi River floodplain.

Stormwater Inundation Risk

A preliminary assessment of the capacity of the existing stormwater infrastructure in the Geraldine SMA (PDP, 2017b) identified that approximately 45% of the pipe infrastructure and 90% of the soakage infrastructure are likely to have less capacity than the 20% Annual Exceedance Probability (AEP) and 10% AEP respectively, for one hour rainfall durations respectively.

Most of the soakage infrastructure in Raukapuka is likely to be undersized for the design 10% AEP 1-hour rainfall event. The results also show that there are a large number of overland flow paths that will pass through private properties when no other disposal options are available, or the soakage outfalls are blocked or under capacity.

Despite the potential issues with under-sized infrastructure identified (PDP, 2017b), public consultation undertaken by TDC suggests that the public do not perceive Geraldine as having a significant flooding issue(s) related to the stormwater network.

Possible reasons for these perceptions are thought to be related to:

- The nature of the terrain, which falls consistently towards either Serpentine Creek or the Waihi River. There are also a relatively low number of significant ponding areas which intersect with private properties. These factors mean that stormwater flows will most likely drain quickly towards one of the waterways following a rainfall event – even when some pipe infrastructure is under capacity.
- The relatively low permeable soils in Geraldine south and in the Raukapuka area favour drainage at lower rainfall intensities; significant runoff is not anticipated from the previous land in these areas until infrequent heavy rainfall events occur.
- TDC flooding complaints do not indicate any significant building flooding, which points to "nuisance" flooding effects that cause inconvenience during heavy rainfall events rather than significant damage to private property.

4.11 Stormwater Contaminant Load Modelling and Treatment Requirements

The key contaminants associated with the Geraldine stormwater network discharges to surface water waterways are expected to be suspended sediment, zinc and copper compounds, and TPHs. Bacterial contaminants are of most concern for discharges to ground where there are downstream water supplies drawn from the groundwater aquifer.

An assessment of the current stormwater treatment practices (PDP, 2017a) determined that these are unlikely to provide sufficient treatment of the stormwater to meet the likely levels of treatment needed to achieve possible LWRP stormwater discharge targets with minimal baseflows in the receiving waterways.

In addition the PDP (2017a) study evaluated the likely performance of possible treatment options to improve the water quality of the stormwater, including estimates of the indicative cost to implement the option(s). The cost of providing best practical treatment to treat between 70-90% of the Geraldine stormwater discharges to surface water was estimated to be in the order of $9.5 - $10.6M (+/-30%). Such treatment works are unlikely to meet the water quality levels specified in schedule 5 of the LWRP at times of low flows in the receiving waterways.

4.12 Climate Change

The most common cause of river flooding and inundation in Geraldine is as the result of heavy rainfall which can greatly increase the water levels in rivers and stormwater infrastructure, potentially leading to water overflowing into surrounding areas.

The projections for climate change in New Zealand have been made using six greenhouse gas emission scenarios developed for the Intergovernmental Panel

on Climate Change (IPCC). The scenarios consider different combinations of socio-economic profiles, energy use and transport choices into the future. In turn these scenarios have been applied to project future changes in annual mean temperature and rainfall by region. The Ministry for the Environment have prepared guidance documents to assist Timaru District Council to prepare for future flooding (MfE, 2010).

As a result TDC engaged Opus to update the site specific design rainfall for Timaru, Temuka and Geraldine (Opus, 2015). The assessment included projected climate change to 2040 and 2090 and provisions have been made to include an allowance for climate change in the Timaru District Councils stormwater design guidelines and the Code of Practice.

4.13 Timaru District Growth Strategy 2017

A growth strategy for the Timaru District has evaluated the district and identified the preferred growth location options for the district. Details of the strategy and growth assumptions are documented in (TDC, 2017a) and (TDC, 2017b) respectively.

The strategy has recommended allowance for the following development and growth within Geraldine:

- Residential
  - Up to 164 additional households will be required in Geraldine by 2043 (approximately 15% increase in households)
  - Preference is likely to be for locations east of the Waihi River and close to the town centre
  - Preference for the new housing development to be located on Orari Station Road; this has the potential to result in additional stormwater discharged to groundwater, Raukapuka Creek and the Waihi River.

It is currently proposed to provide additional industrial zoned land outside the SMA. The growth study (TDC, 2017a) favoured the rezoning of the "Tiplady Road" block (from the Tiplady/Winchester-Geraldine Roads intersection to near Serpentine Creek and Waihi River confluence). This area is outside the current stormwater management area and is located within the Downs Creek catchment. Such development would be provided with its own stormwater management requirements and would be covered by a separate consent.

5.0 Stormwater Management Requirements and Proposed Approach

5.1 Flood and Inundation Risk Management

5.1.1 Target Levels of Service

The following levels of service relating to flooding and inundation are defined in the Stormwater Services Asset Management Plan:

- Zero flooding of habitable floor levels in a 20% Annual Exceedance Period (AEP) rainfall event for residential areas and a 10% Annual Exceedance Period (AEP) rainfall event for industrial and commercial areas
- Less than 10 complaints per 1,000 connections per year;
- Flooding reports in residential areas investigated and reported for all rainfall events less than one in five year return period;
- Flooding reports in residential areas investigated and reported for all rainfall events less than one in ten year return period;

The Building Act (2004) requires TDC to consider surface water (flooding and inundation) performance requirements specified in the Building Code (1992), specifically that TDC ensures the following level of service is provided for any new or redevelopment(s):

- Surface water (i.e. flooding or inundation), resulting from an event having a 2% of occurring annually (AEP), shall not enter buildings[2]; and
- Runoff from buildings or siteworks shall be disposed of in a way that avoids the likelihood of damage or nuisance to other property, resulting from an event having a 10% probability of occurring annually.

The Waihi, Temuka, and Orari Floodplain Management Plan also sets a 0.5% AEP level of service for building flooding for the Waihi River Floodplain.

5.1.2 Existing Level of Service

The Waihi, Temuka and Orari Floodplain management plan identifies that a considerable area of Geraldine will be flooded from a 0.5 % AEP Flood event (Figure 3). Hydraulic modelling of Serpentine Creek shows that the Serpentine Creek channel is capable of receiving runoff up to a 2% AEP event apart from some out of channel flows in the vicinity of Kennedy Street during a 2% AEP flood event.

Preliminary assessment of the stormwater outfalls to the Waihi River (PDP, 2017b) showed that three of the six pipe outfalls had a pipe capacity of less than a 20% AEP level of service. This assessment also showed that many of the Serpentine Creek outfalls also have limited capacities. Review of flooding

[2] This requirement only applies to housing, communal residential and communal non-residential buildings (churches, cinemas, schools, and day-care etc.).

complaints between 2000 and 2016 suggests that this has not led to flooding of any habitable buildings.

5.2 Stormwater Quality Management

5.2.1 Water Quality Requirements

Both the Land and Water Regional Plan (LWRP) and the Opihi River Regional Plan (ORRP) apply to the Geraldine SMA; the ORRP is the current operative management plan for surface water quality in Geraldine to provide the basis of the water quality requirements included in the SWMP. This plan is less specific than the LWRP and requires a discharge result of no significant adverse effect from the discharge of any contaminants. Once the ORRP has been integrated into the LWRP the water quality outcomes from stormwater discharges from Geraldine are anticipated to become more stringent and specific. They are also likely to be aligned to similar streams and creeks adjacent to the Opihi River Region.

Following preliminary discussions with ECan (PDP, 2016), it is likely that creeks and streams within the Geraldine SMA will ultimately have the LWRP Water Quality Classifications, as outlined in Table 3 against the baseline water quality characteristics in Serpentine Creek, which in turn sets limits on the receiving water standards following any stormwater discharges.

5.2.2 Existing Water Quality Characteristics

The presence of contaminants in stormwater is well understood nationally and internationally. However, the monitoring of the characteristics of stormwater related runoff in Geraldine is limited by the proximity of Timaru District Council's base and trained sampling staff.

The understanding of the water quality characteristics in the surrounding waterways in Geraldine is limited to two baseflow water quality sampling surveys, undertaken in 2014 and 2016.

The water quality characteristics of the receiving waterways are potentially affected by a number of different contaminant sources and effects other than stormwater discharges. This includes effects from agricultural land use, and the low flow characteristics of the receiving waterways. Specific effects of stormwater discharges are difficult to disseminate from other sources. Therefore, potential effects of stormwater discharges have been determined from the following factors:

- The presence of residual common stormwater related contaminants in the base flows in the receiving waterways.
- Changes in ecological conditions upstream and downstream of the SMA.
- Consideration of other possible effects such as reductions in flows and contaminant sources.

Water quality is measured using a number of chemical and ecological parameters, to assess the concentrations of various contaminants and effects on

the waterway ecology. The water quality testing completed to date shows that both the Waihi River and Serpentine Creek are potentially both greatly affected by the effects of seasonal flows. High levels of nutrients (nitrogen and phosphorus) exist in both Serpentine Creek and the Waihi River. These contaminants are considered to be much more likely related to the surrounding agricultural land use rather than stormwater related discharges.

The best indicators of possible effects from stormwater discharges in surface waters are considered to be from the presence of residual heavy metals in bed sediments or water column and changes in the ecological conditions upstream and downstream of the stormwater discharges.

It is considered that there are limited effects of the stormwater discharges on the ecology in the Waihi River, with low levels of heavy metals present in the baseflows and healthy ecological conditions present. The 2014 water quality survey indicated healthy ecological and water quality conditions throughout the Waihi River, but in lower flow conditions in 2016, there was a noticeable reduction in the MCI ecological indicator and significant change in the composition of species present in the river, without any noticeable change in chemical composition of the water.

Both the 2014 and 2016 water quality sampling rounds indicated the zinc and copper heavy metal contaminant levels in Serpentine Creek were in excess of the standards required under required under Schedule 5 of the LWRP and poor ecological conditions were measured at all locations sampled. The Serpentine Creek monitoring shows high levels of heavy metals are present in the stream baseflows in Geraldine township, decreasing downstream of the urban area as flows decrease. The ecological conditions also improve with the decreasing flows and metal contaminants.

The 2016 sampling round indicated no discernible effects on the water quality and ecology in the Waihi River baseflows from Serpentine Creek discharges.

Sediment contaminant levels in Serpentine Creek indicated low levels of lead, mercury and poly-aromatic hydrocarbon compounds in the sediments in Serpentine Creek. Limited contamination of bed sediments with zinc and copper were found during this survey, which raises doubts about the source and extent of the zinc and copper contaminants found in the baseflow water column. Further water quality and sediment sampling is recommended to identify and locate the source of these contaminants prior to implementing capital works.

No groundwater quality monitoring has been completed within or adjacent to the SMA. However, groundwater monitoring in the surrounding shallow aquifer indicates that microbial contamination of the shallow drinking bores within and surrounding is to be expected regardless of stormwater discharges.

Table 3: Likely LWRP Receiving Water Standard and existing background water quality – Water Quality Class

Name	Water Quality Class	DOC [1,2] (g/m^3)	pH (range)	Temp Change [2] (°C)	Clarity[2] % change	Colour[2,3] % change	DIN [2] mg/l	DRP [4] (g/m^3)	*E. coli no/100 ml*	Zn (g/m^3)	Cu (g/m^3)	Pb (g/m^3)
Serpentine Creek	Hill-fed Lower – Urban	2%	6.5–8.5	2%	20%	5%	0.47 (0.48-1.611)[6]	0.006 (0.075-0.15)	550 (520-980)	0.015 (0.007-0.023)	0.0018 (0.0008-0.002)	0.0056 (0.00012-0.00114)
Downs Creek	Hill-fed Lower – Urban	2%	6.5–8.5	2%	20%	5%	0.47	0.006	550	0.015	0.0018	0.0056
Raukapuka Creek	Spring-fed – plains	2%	6.5–8.5	2%	35%	5%	1.5	0.016	550	0.008	0.0014	0.0034
Waihi River	Hill-fed Lower	2%	6.5–8.5	2%	20%	5%	0.47 (0.57-1.182)	0.006 (0.012-0.016)	550 (25-74)	0.008 (<0.0001)	0.0014 (<0.005)	0.0034 (<0.005)
Groundwater [7]							5.5 [5] (0.5-3.3)		<1 [5] <1-, >2000	3		

Notes:

1. *DOC – Dissolved organic carbon*
2. *As a result of the discharge following reasonable mixing, as measured at the end of the mixing zone, the water quality in the water body shall not change more than the limit specified*
3. *Measured in turns of Munsell Scale*
4. *DRP – dissolved reactive phosphorous*
5. *Based on DWSNZ* (2008)
6. *Bracketed values indicate existing ranges*
7. *Groundwater requirements measured at the point of discharge*

5.3 Proposed approach to meet the desired levels of service

A preliminary assessment was undertaken to identify possible options to implement best practice stormwater treatment solutions to improve the water quality of the stormwater discharge, and measures to reduce the risk (frequency) for stormwater inundation to current requirements, (PDP, 2017a) and (PDP, 2017b) respectively. These assessments identified that the cumulative capital expenditure could be in the order of $20.7 million (-25% to +40%) should TDC implement these options.

The cost to implement the measures outlined in these assessments would equate to an average of $20,500 per household for each of the existing 1,008 households within the Geraldine SMA (TDC, 2017a). Alternatively, paying the above costs back over 30 years would increase the annual rates per household in the order of $1,320. The latter would increase the typical annual rates from $2,500 to $3,820, representing a 53% increase. However, the benefits of implementing such a programme may be limited with only a reduction of flooding nuisance rather than property damage during heavy rain fall events and limited improvement in baseflow water quality and ecological conditions (in the Waihi River at least).

Whilst the implementation of all these options might be considered, the resultant capital expenditure is considered to be unaffordable for the Geraldine community. In addition, the initial ecological effects assessments suggest that the adverse effects are limited to those within Serpentine Creek.

Urban growth within the Geraldine SMA is anticipated to be modest, and in conjunction with current stormwater management practices and policies it is unlikely that the aquatic environment will be further adversely affected through additional development.

Nonetheless, the objectives and policies of the SWMP and TDC stormwater strategy, which specifically aim to progressively improve the aquatic environment and Mahinga Kai of the streams and rivers, requires TDC to improve the performance of the current stormwater network. To work within current and future funding restraints, as well as the uncertainty around the precise location of where potential future improvements to the stormwater network will occur, TDC is proposing to implement an 'adaptive management' approach to manage the effects of stormwater from the Geraldine SMA (Figure 5).

Adaptive management is a precautionary approach in which the continued discharge of stormwater is allowed to occur, whilst undertaking appropriate monitoring, reporting and assessment of any adverse effects. Thresholds have been provided to trigger remedial actions before the possible effects become overly damaging; in addition, the effects that may arise can be remedied before they become irreversible.

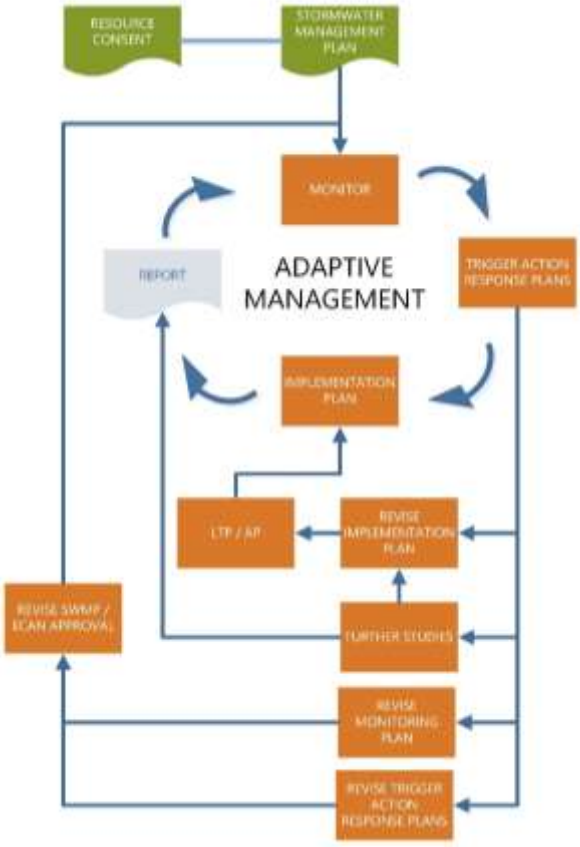

Figure 5: Adaptive Management Framework

TDC have identified a list of tools, policies and some structural improvement to the Geraldine Stormwater Network that will manage the current and future potential adverse effects of stormwater discharge from the Geraldine SMA. As outlined earlier, the aim of the adaptive management approach is to progressively improve the quality of the stormwater discharge and/or reduce the risk of future stormwater inundation, whilst working within sustainable funding levels. Operating within the adaptive management framework requires TDC to fully understand the 'baseline' performance of the current stormwater infrastructure and or current environment. Target objectives associated with systematic monitoring, associated assessment, and reporting will ensure that any improvements in the receiving environment are observed. More importantly any increase(s) in adverse effects are promptly detected, allowing for remedial actions to be undertaken.

The principal advantage of an adaptive management approach is that trigger levels, and with response plans that are able to evolve in response to changes in the catchment, for example changes in:

- The knowledge of the receiving environment and/or sensitivity to the stormwater discharges;
- Performance of the existing and future treatment system(s) in the Geraldine SMA context;
- Effectiveness of community engagement, and any future changes in TDC policies;
- Changes to stormwater management aims and objectives in the future.

6.0 Flooding and Inundation Adaptive Management and Mitigation Measures

The proposed management approach is to maintain the current level of service, and progressively increase the resilience of the stormwater infrastructure to flooding and the risk of localised inundation, with any subsequent redevelopment and/or renewal of existing infrastructure.

A suite of tools, methods, and systems are currently operated by TDC to address the risk of flooding and inundation within the Geraldine SMA. These fall into the following five broad categories:

- Systems Management;
- Capital Works;
- Operations and Maintenance;
- Performance Monitoring; and
- Education.

6.1 Systems Management

6.1.1 Asset Data Collection

TDC maintains an asset database register based on the 'Infor (Hansen)' computerised asset management system. The asset management system is capable of being interfaced with the INFOWORKS hydraulic modelling software, the Council's Geographical Information Mapping Software, Councils Corporate Information and Financial Management Systems, and Contractor Event Management Systems.

The asset register includes the following details:

- Public flooding complaints
- Manhole and culvert inspections
- Asset Invert surveys
- CCTV condition inspections and assessments
- Construction and maintenance records

6.1.2 Flooding Complaints

Timaru District Council relies on the incidences of public flooding complaints as a principal indicator of the network performance. Each flooding complaint is investigated by an appointed council officer to assess the response required, which may be one of the following:

- Additional maintenance required if the complaint resulted from a blockage or minor defect of the system;

- No action if the network performed as expected in a heavy rainfall event;
- Capital works if the effect of the flooding or inundation is severe enough to require more extensive works to resolve (Capital works project are dependent on the extent of the works required);
- Review of the network asset database for the pipe capacity assessment indicated that the database is incomplete and additional data collection is desirable to have a good indication of the network performance;
- Channel and culvert inspections after major floods to ensure that material washed down in floods are not causing blockages in the network.

6.1.3 Asset Condition Assessments

Asset condition assessments include:

- Pipe CCTV inspections;
- Downstream channel inspections; and
- Outfall inspections.

TDC's Stormwater Asset Management Plan indicates approximately 20% of the stormwater network has unknown pipe materials, and manhole & CCTV surveys are proposed to be carried out prior to 2018 to update the asset database. The renewals system is based on a criticality assessment, along with maintenance requests is used to determine when pipes are required to be assessed for replacement or rehabilitation. This was last completed in Geraldine in 2008, and is expected to be completed once the asset database verification is completed and prior to 2025.

The downstream channels are currently maintained by Environment Canterbury under the Orari, Waihi, Temuka Flood Plain Management Plan.

Currently, TDC does not have an active maintenance inspection programme for the downstream channels and outfalls. However, vegetation and the effects of instream structures can affect both the performance of the stormwater system and the downstream flood levels of the discharged stormwater flows, and therefore TDC will maintain an active interest in the condition of the downstream floodways to ensure that the floodplain management completed by Environment Canterbury is appropriate to the adjacent land use and the performance of the stormwater system.

6.1.4 Hydraulic Capacity Assessments

(a) Surface water collection and discharge systems

Timaru District Council has held an INFOWORKS hydraulic computer model to assess the capacity of the Serpentine Creek channel to receive stormwater flows since the late 1990's. This computer model has recently been updated to include

updated survey information for the Lower Serpentine Creek between the Waihi River and Kennedy Street for specific investigations relating to flooding in the vicinity of Kennedy Street and management of the detention dams.

High level investigations for this SWMP assessed the capacity of piped outfalls to the Waihi River and Serpentine Creek and defined contributing catchment areas, potential ponding areas and overland flow paths to the outlets.

In the future it is intended to update the model to include updated channel survey information and the stormwater network to accurately assess the capacity of the network. This will require updating and completing of TDC's asset database.

(b) Soakaway Drainage Capacity Assessments

The capacity of the soakaway drainage systems are dependent on both the permeability of the receiving soil types and the maximum groundwater levels that may inhibit discharges to ground. There is currently limited information on both of these parameters.

It is recommended that infiltration assessments used to complete Building Consent applications are retained and specific groundwater monitoring is completed in areas where soakage drainage may be proposed to ensure that TDC has the best information to assess the soakage drainage capacity of its discharge points.

6.1.5 New Development Controls and Requirements

TDC staff provide assistance with assessing both resource consent and building consent applications. This includes, but is not limited to, ensuring the following issues are addressed:

- Setting of appropriate floor levels;
- Approving connection points;
- Confirming capacity upgrades that are required to permit development;
- That new works in accordance with the TDC Standards for development; and
- Sufficient erosion sediment control and spill management plans are in place where required.

6.2 Capital Upgrades

Capital upgrades and improvement works are generated in response to the asset management condition assessment and monitoring activities and then included in the Council's Long Term (LTP) and Annual Plans and Stormwater Asset Management Plan (AMP). Capital stormwater upgrades are also considered with other activities such as roading and street works.

6.3 Operations and Maintenance

Operations and Maintenance activities undertaken by TDC include but not limited to the following activities:

- Investigation of flood complaints;
- Road sweeping;
- Sump cleaning (a two tier cleaning frequency programme with more critical sumps programmed to be cleaned every six months, other non-critical sumps cleaned yearly;
- Litter collection;
- Pipe cleaning / clearances of blockages (completed with CCTV and pipe blockages on a reactionary basis);
- Vegetation control at outfalls (to be undertaken at least once per year);
- Monitoring of vegetation in receiving waterways at least twice per year (Autumn and Late Spring));
- Soakaway cleaning (programmed once per five years);
- Channel maintenance and vegetation control in the Serpentine Creek corridor
- Detention dam inspections (programmed once per year and after storm events).

In 2020, Timaru District Council agreed with Environment Canterbury's Rivers and Drainage department to take responsibility for the maintenance of the Serpentine Creek Channel in order to ensure the performance measurements of this plan are met. A Memorandum of Understanding is being developed between the two parties to clearly define the responsibilities between the two parties.

Timaru District Council has the ability through their Activity Management Plan and Long Term Plans to vary their maintenance activities based on the performance of the network and adjust the operational requirements to provide the required performance.

6.4 Performance Monitoring

The performance of the stormwater network may be monitored through the following performance assessments and against the specified levels of service and requirements through the following inspections and assessments:

- Flooding complaints (public complaints received) (annual review);
- Flood inspections and reporting (response to flooding complaints and inspections by TDC Stormwater staff following significant flooding events);

- Channel condition assessments to confirm vegetation is not excessive against the hydraulic model requirements (min 2 x yearly and following major floods);
- Hydraulic model assessment used to confirm and predict flooding locations (model updated complete with base data at least every twenty years and used for design of significant upgrades);
- Detention Dams inspections and as required by the Dam Safety Guidelines (2015) and relevant resource consent conditions;
- Litter surveys (based on channel inspections).

6.5 Education

6.5.1 Internal Education

The following details are to be maintained and distributed to improve TDC's internal knowledge of the stormwater network:

- Catchment and overland flow path definitions from overland flow assessment to assist with flood constraints assessments, building control and planning assessments;
- Existing Wāihi Flood Hazard Maps are available to assist with building control and planning assessments and to differentiate between river flooding and stormwater inundation issues. Backwater effects from the Waihi River need to be considered to define capacity requirements;
- Serpentine Creek hydraulic modelling results can assist with flood complaints, building control and planning assessments. Further improvement to the hydraulic model to include the stormwater network and updated channel information above Kennedys Road, and the inclusion of pipe network details;
- Groundwater level monitoring results to provide design parameters for planning and building consent assessments. An initial 12 month study of the groundwater levels is recommended to better define the seasonal variability of the groundwater levels across Geraldine;
- Soakage rates to provide design parameters for planning and building consent assessments. It is recommended that a database of soakage rates is obtained from Building and Planning Consent Applications to improve the knowledge of soakage drainage potential in Geraldine.

6.5.2 Public Education

The above details may also be rolled out as public information.

In addition, a key part of the maintenance efforts for the Serpentine Creek channel will include an Education and Engagement Plan to enable public and

Commented [UD1]: Revised

private property owners to assist with the maintenance and water quality improvement efforts outlined in 7.9.2. for the Serpentine Creek Channel.

6.5.3 Technical Resources

Technical resources to be developed to assist TDC manage flooding and stormwater inundation from their stormwater network includes but is not limited to:

- A Code of Practice/Design Guidelines for stormwater design and construction standards;
- Catchment definitions from the overland flow assessments;
- Hydraulic Modelling for flooding locations and flood levels for floor levels;
- Groundwater level monitoring to determine maximum groundwater levels in various parts of Geraldine where soakage drainage is used;
- Soakage drainage rates database; and
- Waihi River Flood Hazard mapping.

7.0 Water Quality - Adaptive Management and Mitigation Measures

7.1 Introduction

The proposed management approach is to maintain the current the level of treatment and associated effects on the receiving environment, and to progressively improve the stormwater infrastructure to avoid or remove contaminants from the stormwater discharges and/or stormwater contaminants currently within the receiving environment (e.g. sediments within creeks and rivers) with any subsequent redevelopment and/or renewal of existing infrastructure.

A suite of tools, methods, and systems are proposed by TDC to progressively improve the performance of the stormwater network. These fall into the following six broad categories:

- Systems Management
- Capital Works
- Operations and Maintenance
- Performance Monitoring
- Pollution Control
- Education

7.2 Systems Management

7.2.1 Asset Data Collection

TDC maintains an asset database register based on the 'Infor (Hansen)' computerised asset management system. The asset management system is capable of being interfaced with the INFOWORKS hydraulic modelling software, the Council's Geographical Information Mapping Software, Councils Corporate Information and Financial Management Systems, and Contractor Event Management Systems.

The asset register includes the following details:

- Public pollution complaints
- Stormwater treatment device inspections and surveys
- Treatment construction and maintenance records

7.2.2 Environmental Monitoring

As well as determining compliance with regulatory requirements, the environmental and cultural monitoring are essential tools to assess and manage the impacts of the stormwater discharges on the receiving waterways.

The water quality of the receiving water ways may be affected by a number of different sources in addition to stormwater discharges. Therefore, it is important that the community cost effectively addresses these issues, with informed assessment of the cause of the issues. This is a complex task and it is essential that TDC is actively involved in obtaining an improved understanding on behalf of its ratepayers, to ensure stormwater funding is cost effectively appropriated and applied.

Environmental monitoring can involve monitoring physical, chemical, and ecological conditions of both the source and receiving waters, as well assessing actual effects.

Specific additional water quality and sediment investigations are intended to provide an improved understanding of the baseline water quality and sediment quality conditions in Serpentine Creek, in order to differentiate between possible stormwater effects, and natural geological characteristics or effects from the upstream rural environment.

7.2.3 Cultural Monitoring and Consultation

This could include iwi cultural assessment, general public survey of water way values as well as specific interest groups such as Forrest and Bird, Fish and Game, Geraldine Environment Trust and Talbot Forest and Wāhi Working Groups.

It is important that these consultative contacts are continued periodically to ensure TDC continues to maintain a sound understanding of the Takata Whenua and other specific interest groups.

7.2.4 New Development Controls and Requirements

New development controls are required to limit additional impacts on the receiving waterways and to ensure that new developments discharge as close as practically possible to the target water quality limits required in Schedule 5 of the LWRP.

TDC is developing a Code of Practice to inform both Council staff and developers of the range of acceptable treatment solutions.

The treatment strategies developed by PDP (2017a) showed that it is more cost effective to provide treatment to larger catchments. Therefore, there may be opportunity to provide public treatment facilities assisted by new development levies. This may be particularly appropriate where networks capacity upgrades are required for new developments.

Management of new development will also include measures to control and manage discharges to the stormwater network from new developments to ensure the discharge is of a quality acceptable to be received by the TDC stormwater network and subsequently the receiving waterways.

The flowchart below shows the proposed approval process for all new development connections.

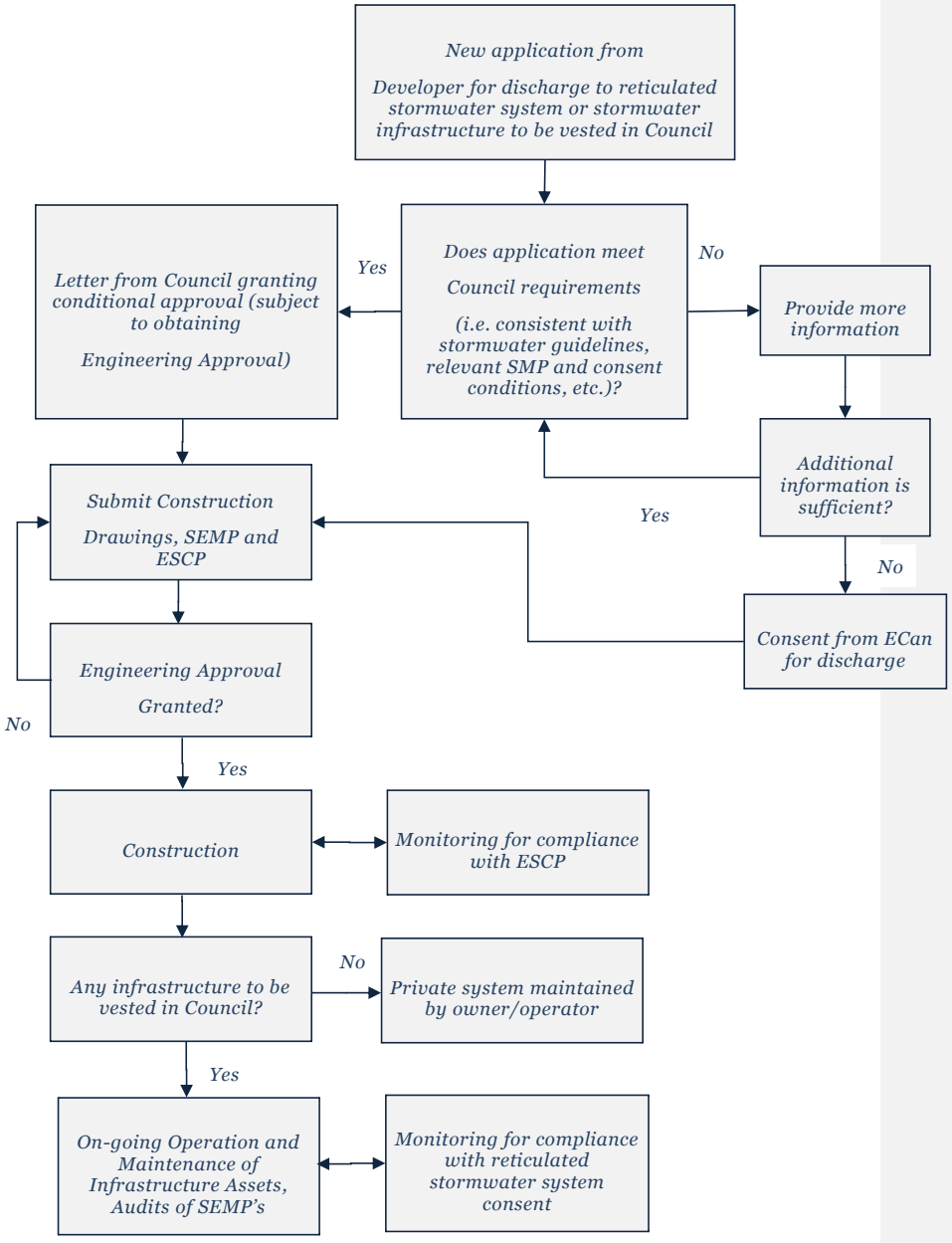

Figure 6: Proposed Approval Process for all New Development Connections

Key components of the process to control the water quality of new stormwater discharges to the environment include:

- Review and approval of proposed stormwater works
- Review and approval of erosion and sediment control works during construction
- Review and approval of site environmental management plans during operational phase to ensure that adverse land use activities upgradient of the stormwater network do not impact on the discharges to the stormwater network.

7.2.5 Discharges to Land

The protection of safe drinking water is considered paramount by TDC. Community water supply schemes have additional controls and protections, specifically they require the implementation of an approved (Drinking) Water Safety Plan and the scheme is overseen by the water services regulator ('Taumata Arowai'). Smaller domestic bore water supplies are required to comply with the Water Services Act (2021) which can be achieve by implementing an 'Drinking Water Acceptable Solution'.

In addition, TDC is proposing to implement some additional controls on any stormwater discharge established under this SWMP, specifically that they shall not be located within any domestic and community drinking water supply protection zone equivalent to the protection areas specified in Schedule 1 of the LWRP, unless, in the case of domestic drinking water supply, the Consent Holder has made a reticulated water supply available to the property.

A shorter separation distance to a domestic and community drinking water supply well may be utilised based on an assessment of site-specific information undertaken and certified by the Canterbury Regional Council that the water quality standards for drinking water set out in the Drinking-Water Standards for New Zealand 2005 (Revised 2018) or any successor document will not be exceeded for any domestic and/or community drinking water supply.

7.2.6 Stormwater Treatment Standards

All future stormwater upgrades and development will be encouraged to be designed in accordance with low impact design principles to mimic natural runoff where practical.

The following treatment contaminant removal standards are proposed as best practical options.

Table 4: Recommended Minimum Target Treatment Contaminant Removal Rates[3] for Geraldine Stormwater Network[1]	
Suspended Solids	> 75%
Total Zinc[2]	> 50%
Total Copper[2]	> 50 %
Total Petroleum Hydro-carbons	> 50 %
Nutrients (Nitrogen, Phosphorus)	> 50 %
Bacteria	> 50 %

Notes:

1. *To be determined on accepted established empirical studies, and stormwater influent quality to be defined based on land use*
2. *Design and selection of device to consider likely dissolved metal proportion based on latest TDC investigations.*
3. *Target rates include Rainfall frequency*

These treatment standards are not directly compatible with the target levels of services required by the Environment Canterbury Regional Resource Management Plan(s), but have been specified to provide a practical and measurable performance standard for stormwater treatment devices.

While at-source control and treatment of contaminants is desirable, it is acknowledged where practical, that it is more cost effective to provide treatment to large areas or catchments. Catchment treatment also provides a lower operational and maintenance legacy footprint for the community to maintain.

7.3 Capital Upgrades

Capital upgrades and improvement works are generated in response to the asset management condition assessment and monitoring activities and then included in the Council's Long Term (LTP) and Annual Plans and Stormwater Asset Management Plan (AMP). Capital stormwater upgrades are also considered with other activities such as roading and street works.

No specific capital upgrade projects to improve the stormwater network discharge quality are included in the current AMP and LTP's. TDC has the ability to vary this with the programmed AMP and LTP reviews to accommodate rate payer requirements.

As much of Geraldine is already developed, the feasibility of installing stormwater treatment devices in Geraldine will be determined by the existing land use constraints present. The most likely options for stormwater treatment devices appropriate to the constraints present in Geraldine have been identified as follows (PDP, 2017a):

- Infiltration basins where ground conditions are suitable groundwater levels are low enough (Raukapuka, and Geraldine South subject to confirmation of maximum groundwater levels);
- Street rain gardens for source control and streetscape upgrades or where land uses prevent installing treatment devices on the pipe outfalls (e.g. Geraldine Town Centre);
- Proprietary devices on outlets where available areas limited (e.g. Stormfilters).

The following measures have been identified as cost effective capital upgrade measures for inclusion in minor capital upgrades and asset replacements when they arise:

- Installation of hydrocarbon traps and greater sump capacity on the heaviest traffic routes (Talbot Street, Waihi Terrace, SH79) to address higher levels of hydrocarbons that are expected to be discharged in these areas.
- Installation of litter traps in high profile areas (discharges into Serpentine Creek and Town Centre sumps that discharge into Waihi River).
- Detention dam outlet upgrades to reduce total sediment discharges into Lower Serpentine Creek, and provide some enhancement of stream baseflows.
- Provide enhanced riparian buffers utilising endemic indigenous planting that enhances all outfalls where practical (and particularly to the Waihi river outfalls), to provide improved treatment of stormwater flows and to provide an attractive amenity feature with improved biodiversity features for the floodway and enhances mahinga kai.

Photo 5: Existing example of existing enhanced riparian buffer in the Rhododendron Dell adjacent to the Waihi River.

7.3.1 Stormwater Treatment with capacity upgrades and other capital works

Capacity improvements have the potential to discharge greater volumes of contaminants to the receiving waterways. Therefore, low impact design solutions will be required to be considered with all renewals and street upgrade projects where practical.

Priorities are for the provision of additional stormwater treatment for other areas include:

- The industrial area to the south of Geraldine town centre: this area has limited capacity and upgrades may be desirable in the near future, which will have a significant impact on the contaminants discharged to Serpentine Creek.
- Town centre discharges: at source control could also be considered for Town Centre upgrades, which may also potentially add additional amenity value(s).

7.4 Operations and Maintenance

Operations and Maintenance activities, undertaken by TDC, include but are not limited to the following:

- Investigating public complaints
- Road sweeping;
- Sump cleaning;
- Litter collection;
- Pipe cleaning / clearances of blockages (completed with CCTV and pipe blockages on a reactionary basis);
- Outfall & waterway inspections and sampling; and
- Spill management procedures / response plans.

Outfall inspections and litter collection are considered particularly important to maintain and enhance the amenity of the Waihi River floodway, which is a popular place for recreational activities.

Timaru District Council has the ability through their Activity Management Plan and Long Term Plans to vary maintenance activities based on the performance of the network and adjust the operational requirements to provide the required performance.

7.5 Performance Monitoring

The performance of the stormwater network on the receiving waterways may be monitored through the following performance assessments and against the specified levels of service and requirements through the following inspections and assessments:

- Public complaints (Visual Condition);
- Surface water quality;
- Groundwater quality;
- Ecological condition;
- Sediment quality;
- Outfall inspections;
- Litter surveys (based on channel inspections);
- Cultural Monitoring.

Owing to the limited discharges from the SMA to the Raukapuka Stream and Downs Creek, it is only proposed to provide performance monitoring for discharges to the Waihi River and Serpentine Creek.

As outlined in Figure 8, a three level system of response to the receiving waterway water quality conditions is proposed. Where a bottom line standard (Trigger Level 1) that is required to be met and at least maintained, a trigger standard (Level 2 Low Trigger) that indicates response and a target water quality standard (Level 3 Target). The Level 1 (High Trigger) standards are based on the existing water quality condition, and the Level 3 (Target) water quality conditions are based on the regulatory requirements. Full definitions of the proposed Level 1 -3 conditions are included in Appendix C and the basis of these conditions is discussed in the following sections.

As the understanding of the existing water quality condition is currently based on limited investigations undertaken by Timaru District Council, it is expected that over time, the understanding of the existing condition will change and the SWMP is developed with the intention that the target, Level 2 (Low Trigger) and Level 1 (High Trigger) values are adapted as the knowledge improves.

7.6 Surface Water and ecological condition - Water Quality performance monitoring

7.6.1 Waihi River – Level 1 High Trigger

The following water quality and ecological conditions are proposed:

a) A Level 1 (High Trigger) water quality standard of 95% level of protection of stormwater related contaminants dissolved zinc and copper as defined in Schedule 5 of the LWRP present in the baseflow is proposed for the Waihi River. This Level 1 (High Trigger) standard is proposed to ensure that no potential adverse residual stormwater contaminants are having a prolonged presence in the Waihi River.

b) A Level 1 (High Trigger) ecological condition of less than less than 20% reduction in the macroinvertebrate indicator parameter, MCI, through Geraldine and upstream and downstream of Serpentine Creek. This Level 1 (High Trigger) standard is included to ensure significant impacts on ecological condition of the Waihi River are responded to appropriately. The ecological condition is expected to be affected by variations in flow as surface flow is lost to groundwater during dry periods. The full extent of the seasonal variability is still being understood, and this may be refined following the initial monitoring period. Other ecological parameters are also required to be measured to interpret the impacts of the flow and contaminants discharged to the receiving waterway. This criteria is included to ensure that any significant effects of short term elevated stormwater contaminants are identified.

Photo 6: Waihi River downstream Serpentine Creek at Coach Road – losses of flow to groundwater presents challenges in assessing impact of stormwater on water quality and ecological condition of the Waihi River.

7.6.2 Serpentine and Downs Creek – Level 1 (High Trigger) Requirements

The following Level 1 (High Trigger) water quality, sediment and ecological conditions are proposed for Serpentine Creek.

a) A Level 1 (High Trigger) water quality standard of 90% level of protection for stormwater related contaminants dissolved zinc and copper as defined in Schedule 5 of the LWRP. These water quality characteristics are to be assessed prior to discharge to the Waihi River, and measured in the base flow at least three days following rainfall. High levels of both zinc and copper have been observed in the base flows in Serpentine Creek in the Geraldine urban area. It is not known whether these relate to effects from the stormwater discharges or are a natural state. Concentrations of these metals to date have been shown to decrease below this standard downstream of the urban area where stream flows have decreased due to seepage to groundwater.

b) A Level 1 (High Trigger) standard for stormwater related sediment contaminants are proposed to match the high trigger levels defined in the ANZECC (2008) guidelines at all sites where sediment bound contaminants have been tested.

   To date the sediment sampling in Serpentine Creek has indicated some presence of elevated hydrocarbons, lead, and mercury in the bed sediments within the urban area. Measures are included to

provide improvements with improved hydrocarbon capture at high contaminant discharge points to Serpentine Creek. Additional monitoring is also proposed in the first year to provide a better indication of the spatial distribution of the contaminated sediments.

A Level 1 (High Trigger) ecological condition of less than 20% reduction in the macroinvertebrate indicator parameter, MCI, in the Waihi River upstream and downstream of Serpentine Creek. This Level 1 (High Trigger) standard is included to ensure significant impacts on ecological condition of the Waihi River are responded to. The ecological condition of Serpentine and Downs Creek are considered low owing to their variable low flow characteristics of Serpentine Creek, which makes it difficult to set any meaningful ecological condition standard for these waterways.

When any of these requirements are not met TDC are to investigate and, if necessary, ensure remedial measures are in place to ensure that such changes were not caused by stormwater discharges.

Owing to the complex nature of water quality issues, in some instances, this may involve additional monitoring to determine the causes of the water quality issues and refine the target and trigger values. For instance, additional monitoring is proposed in Serpentine Creek to provide a better understanding of the high levels of dissolved zinc levels in the baseflows. Should these metals prove to be naturally sourced and originate outside the stormwater network, it may be appropriate to accept a higher concentration of zinc to be measured within Serpentine Creek. Notwithstanding, any such decision will need to consider the impact of other stormwater based contaminants.

Photo 7: Serpentine Creek downstream of Kennedy Street – the channel reduces in depth as the stream meets the Waihi River Floodplain. Flow is also lost to groundwater.

7.6.3 Surface Water Quality Wāihi River and Serpentine Creek- Water Quality Level 3 (Targets)

The water quality receiving waterway Level 3 (Targets) remain as defined by Schedule 5 of the LWRP for both the Waihi River and Serpentine Creek (i.e. 95% and 90 % level of levels protection accordingly). It may be difficult to meet these requirements at periods of low flow in Serpentine Creek and the Waihi River, which will have potentially limited flow to dilute the discharges and available treatment technologies cannot provide the necessary level of treatment.

7.6.4 Surface Water performance monitoring – Raukapuka Stream and Downs Creek

No specific performance monitoring is proposed for Raukapuka Stream or Downs Creek owing to the limited contributing areas.

Notwithstanding, the same improvement policies and management strategies applicable for the Serpentine Creek and the Waihi River (i.e. new development treatment requirements, hydrocarbon collection, riparian enhancement, public and internal technical resources, pollution control measures etc.) are applicable

for these outlets and should see improved water quality outcomes. Similarly, any adaption to the improvement plans for the Waihi or Serpentine will be applicable to these waterways.

7.6.5 Macro-invertebrate Index (MCI)

In addition to the above classifications, performance standards are also assigned according to the measured MCI index in accordance with the following classifications provided in the Ministry for the Environment document "A User Guide for the Macro invertebrate Index" 2007.

Level 1 (High Trigger) MCI = "Poor", MCI < 80

Level 2 (Low Trigger) Standard MCI = "Fair", 80< MCI< 100

Level 3 (Target) Standard MCI = "Good", or Better MCI > 100

7.6.6 Discharge Observations

The presence of surface oils, grease, or foams on discharges is a fundamental standard included in S70 and S107 of the Resource Management Act

- Conspicuous oil, grease, scums or foams, or floatable or suspended materials
- Conspicuous change in colour or clarity
- Any objectionable odour
- Any significant adverse effects on aquatic life

While , the presence of such contaminants are not necessarily associated with regular discharges, the presence of these characteristic are all considered to require an immediate response by TDC, which is considered a considered Level 1 (High Trigger) standard. These observations shall be undertaken at all channel and outfall inspections as well as industrial site inspections

7.6.7 Physical Characteristics

Similarly, the following Level 1 (High Trigger) physical characteristics shall apply to stormwater discharges and these parameters shall be assessed with all water quality measurements.

- Temperature Difference maintained less than 3° C
- 6.5 > pH < 8.5
- Dissolved Oxygen > 80% Saturation

7.7 Groundwater quality performance monitoring

7.7.1 Groundwater Quality Requirements - Level 1 (High Trigger) Requirements

Potential contaminants are to be limited to no greater than 50% of maximum acceptable values (MAV) defined in the New Zealand Drinking Water Standards DWSNZ (Ministry of Health, 2008).

Additional contaminants are to be tested for where activities listed under Schedule 3 are located upgradient of the monitoring sites. Site audits of these sites will also be used to identify other potential contaminants on such sites

7.7.2 Groundwater Quality Requirements - Level 3 (Targets)

Ground water quality objectives are specified in Table 1a and Schedule 8 of the LWRP form the basis of the groundwater quality Level 3 (Targets) requirements. However, it is acknowledged that it may not be possible to meet these requirements owing to flow regimes that are present, the available stormwater treatment techniques and also community affordability.

The groundwater quality objectives will need to be achieved through public education (to limit and control land use activities) in order to achieve the required levels of bacteria as specified in Schedule 8 of the LWRP.

It is recognised that shallow groundwater and surface waters are integrally connected, and that groundwater will potentially emerge as spring flows lower down the catchment. It is desirable that dissolved copper and dissolved zinc in groundwater meet the water quality Level 3 (Target) corresponding to the 95% level of protection in Schedule 5 of the LWRP.

No specific criteria are considered appropriate for bacterial contaminants in discharges to groundwater beyond level 1 criteria, which is due to the difficulty in providing effective treatment as well as the likely downstream interaction with groundwater in the Waihi River and Serpentine Creek. Nonetheless, it is expected that indicator bacteria levels will be no greater than the levels in the surrounding aquifers. This may be reviewed on completion of the first year of monitoring.

Requirements to provide treatment for new developments and capacity upgrades, and public education about animal control and land use impacts, will help provide mechanisms to reduce bacterial discharges to groundwater.

7.8 Pollution Control

Unauthorised discharges of contaminants into Timaru District Council's stormwater network have the potential to cause significant harm to the environment if measures are not in place to protect and/or respond to the possible ingress.

Potential sources and preventative measures may include, but are not limited to, the following:

- Control of sediment from construction sites or other earthworks within the Geraldine SMA;
- Draining of swimming pools;
- Inadequate wash down collection and bunding systems at sites that contain or use materials hazardous to the environment;
- Domestic animal sourced faecal contaminants;
- Accidental spills from of hazardous wastes from commercial or industrial premises; and
- Contaminated land influences on the contaminants in stormwater discharges.

While Environment Canterbury has a responsibility to respond to water pollution, Timaru District Council also has a role through controlling the approval of activities in many of these areas, as well as managing the stormwater network. This provides an opportunity to minimise risks of potential harmful effects on the environment from discharges from the stormwater network, primarily without extensive capital works.

7.8.1 Construction Stormwater Controls

It is proposed that Timaru District Council is involved in ensuring adequate erosion and sediment control measures are in place, to limit the amount of sediment discharged from construction sites into the Council's stormwater network.

This may require the assistance and cooperation of Building Control Officers and Environment Canterbury Control staff with cost effective implementation and enforcement.

7.8.2 Site Operational Controls

Land uses, with activities which are associated with higher risk of contaminants being discharged to the environment, will require a site-specific SEMP (e.g. all properties with a Schedule 3 listed activity). This will need to be updated with changes in land use activities on the site.

It is proposed that each new high-risk stormwater connection will provide a site environmental management plan (SEMP) to detail the on-going operational stormwater requirements and mitigations to ensure that good quality discharges will be maintained.

These will need to be controlled via Timaru District Council's "Consolidated By-law (2018)", which outlines its statutory duties and obligations and sets

standards for control of stormwater to ensure the maintenance of a healthy community.

7.8.3 Spill Management and Controls on Storage and Transportation of Hazardous Substances

Occasional accidental spillages of chemicals to the stormwater system can result in acute adverse effects on the environment. In addition, dilution in the receiving waterbody is typically significantly lower than would be experienced during a rainfall event. Activities that use substances potentially hazardous to the receiving environment are identified in Schedule 3 of Environment Canterbury's LWRP.

Given that final land uses and activities are not always determined at initial development and furthermore that land uses often change, TDC often has limited knowledge or control over the end land use after the consenting stages of any development. Therefore, site specific operational controls with specific design (and consenting) are necessary to monitor and control potential spills risks of hazardous materials discharging to the stormwater network.

TDC have undertaken a review of all properties with activities included in Schedule 3 of the LWRP (Opus, 2014a). This identified 10 industrial sites that were at risk of having a spill event that could readily enter the Geraldine stormwater network. Spills of hydrocarbon materials to the TDC stormwater network were identified at several sites as part of that audit.

It is proposed that TDC continue to audit commercial industrial sites with Environment Canterbury where activities identified in Schedule 3 are known to occur on an ongoing basis. Similar audits and review of stormwater facilities are being undertaken by TDC Tradewaste and Stormwater staff with ECan Pollution Control section (e.g. Washdyke Lagoon Catchment). This will be integrated into a district wide programme with the objective of auditing all stormwater discharges from commercial and industrial properties that include activities included in schedule 3 of the LWRP every five – ten years. This is proposed to be integrated into a district wide scheme within two years. All inspections shall note any evidence of discharge observations not complying with the characteristics included in 7.6.6 and any parameters included on the sites consent to discharge approvals.

The Hazardous Substances and New Organisms (HSNO) Act 1996 and associated Regulations controls and specifies specific standards for storing and transporting chemicals that are harmful to human health and the environment. However, these regulations currently have limited consideration for ecological effects. This is demonstrated in the limits for secondary containment of petrol and diesel products compared with those specified in the MfE (1998), which provide a lot more stringent and specific requirements than the HSNO regulations.

The proposed mitigation for each type of activity and hazardous material present will typically require a combination of stormwater treatment, limits on hazardous material storage volumes on site, secondary containment provisions and spill management requirements which provide useful controls for protecting the stormwater network. Over time, it is anticipated that requirements for common activities (e.g. car parks and wash-down areas) will be able to be incorporated into Council's Code of Stormwater Practice.

It is also desirable to develop spill management and response plans for the TDC's Operations Contractor(s).

7.8.4 Contaminated Land Effects

Both natural and urban stormwater runoff that has either run over or through contaminated soils can cause additional contamination effects on the environment receiving that stormwater runoff.

Activities on contaminated or potentially contaminated sites are controlled under the RMA (1991) and National Environment Standards for Assessing and Managing Contaminants in Soil to Protect Human Health (NESCS) which is administrated by TDC. While the potential for possible adverse environmental effects due to uncontrolled stormwater discharges may occur from sites with contaminant concentrations lower than those specified for the NESCS, the processes specified for the NESCS could provide the necessary screening process to assist in determining whether the soils present are likely to provide any risks to stormwater discharges entering TDC's stormwater network.

Environment Canterbury maintains a register of known land parcels that either have had known contamination issues or have had have potentially contaminated land through the Listed Land Use Register (LURR). The LLUR keeps a record of site where activities listed on the Hazardous Activities and Industries List (HAIL) are known to have occurred or are currently occurring. Schedule 3 of the LWRP contains a comprehensive list of land use activities that may be considered associated with hazardous substances. The known HAIL sites currently listed on the LLUR in Geraldine are shown on **Figure 7**. It should be noted that these sites, as identified on the LLUR, are not a comprehensive list of "potentially contaminated sites", and consideration must be made whether further investigation should be undertaken by a specialist assessment from a suitably qualified environmental professional (SQEP) (as defined for the NESCS) on a site by site basis.

Environment Canterbury has published acceptable background levels of chemicals in soils in Canterbury. While this may not be fully comprehensive of all soil conditions in Canterbury, it forms a consistent and defined standard to consider whether stormwater discharges can be accepted where they are discharged over or through soils that do not exceed the accepted background levels of contaminants. Assessment of effects where soil contaminants are present at levels higher than background levels is considered a specialist

assessment that will need to be examined on a case by case basis. It is proposed that in such sites, the stormwater discharges are not accepted without specialist assessment from a suitably qualified environmental professional or SQEP as defined for the NESCS.

If a piece of land that stormwater is discharged over or through does not have any evidence that it has had historical activities associated with hazardous substances (i.e. as listed in Schedule 3 of the LWRP), then it is considered that there is only a low risk that the land may be contaminated and no further soil testing is considered warranted to accept stormwater discharges over or through soils from such a site.

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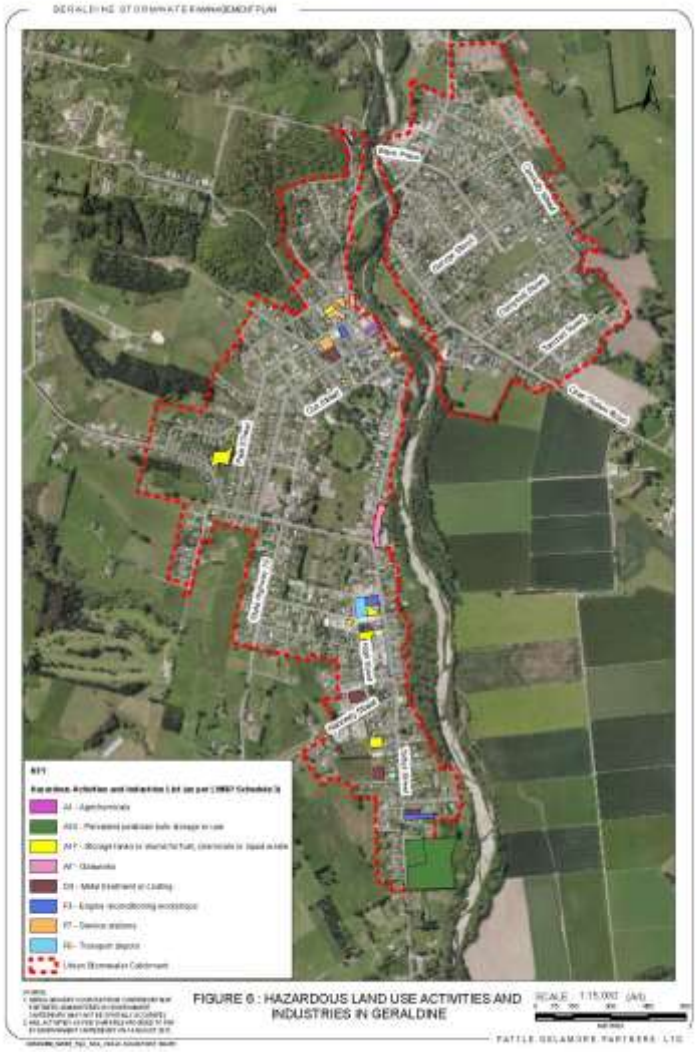

Figure 7 Hazardous Activities and Industries in Geraldine

7.8.5 Discharge Sources from Other Urban Activities

Other activities that could potentially cause discharge of contaminants through the stormwater network include but are not limited to the following discharges:

- Swimming pools emptying (chlorine)
- Vehicle and boat washing (detergents)
- Water supply reticulation operation and maintenance works (sediment/discoloration, chlorine)
- Runoff of contaminants from building materials (galvanised iron, copper roofing and drainage materials)

Such activities can be difficult to control through consenting.

Public education and provision of alternatives are recommended to limit the effects of such activities. Environmental limits for chlorine, visibility of oils, detergents and discoloration are included in the performance measures to be met.

Policy and guidelines will be required to be developed to ensure that such discharges may be controlled through Timaru District Council's "Consolidated By-law (2018)" or other suitable regulatory means.

Alternatives options with provision of public sites could be also be considered for vehicle and boat washing activities. However, this will require a cultural change whereby such activities are completed in a public place rather than in the place of residence.

7.9 Education

7.9.1 Internal Education and Training

Training is recommended to improve TDC's internal knowledge of the stormwater network requirements:

a) Stormwater Treatment Requirements
   - Training for TDC stormwater staff - stormwater treatment practices

b) Construction Stormwater Controls
   - Training of building control and stormwater staff – sediment control practices and requirements
   - Awareness of the stormwater network – outfall locations and contributing areas (updating of the asset database)

c) HSNO requirements
   - Training for TDC stormwater staff about the HASNO requirements so potential issues can be identified

d) Litter

Liaison and co-operation with other Council department programmes:

- Parks and reserves
- Roading
- Waste minimisation programmes
- Waste management
- Environment Canterbury Rivers section

7.9.2 Public Education

The following details may also be rolled out as public information, which should include:

- Public information and displays (Photo 8 demonstrates an example of a public mural adjacent to the Waihi River promoting awareness of waterway health);
- Details and tips on requirements to empty swimming pools;
- Schools education and information;
- Assisting and sponsoring waterway clean ups;
- Animal control impacts and requirements – additional waste bins and signage.
- Animal Control/Impacts

  TDC currently provides "bio-bags" to encourage people to pick up dog excrement. Additional source testing may also assist targeting such efforts to determine whether microbial contamination is associated with domestic animals or not;

- Wash-down Activities

  Common activities on residential properties such as the washing of cars, cleaning of paint brushes have the potential to cause contaminants to be discharged to the stormwater system. Options public information and advertising of possible or signage located on sumps and other potential discharge points reminding the public where the drains discharge to;

- Performance Monitoring Results

  It is considered useful to distribute results of ongoing performance monitoring and commentary on a regular basis to demonstrate the complexity of the issues, and also to demonstrate the TDC's ongoing commitment to providing solutions to adverse effects.

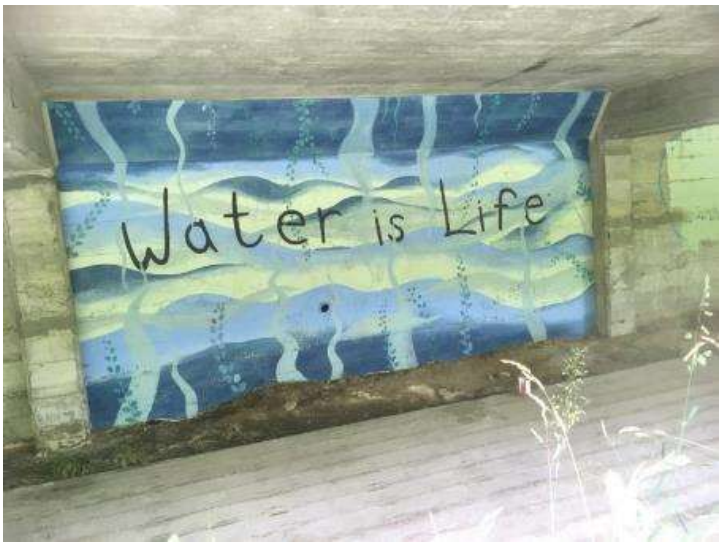

Photo 8: Existing public art adjacent to Waihi River

7.9.3 Technical Resources

Technical resources to be developed to assist TDC to manage water quality and quantity impacts include but are not limited to:

- A Code of Practice for stormwater design and construction standards;
- Supporting policy and guidance for the "Consolidated By-law (2018)" to assist with controlling the quality of discharges to the environment
- Catchment definitions from the overland flow assessments;
- Canterbury Stormwater Forum resources.

The following technical investigations provide an improved understanding for management of stormwater discharges, which include but are not limited to the following:

- Seasonal variability in the receiving waterways;
- Bacterial impacts on stormwater discharges to ground;
- Maximum groundwater levels in various parts of Geraldine;
- Mobility and presence of heavy metal contaminants in groundwater; and
- Dissolved zinc and copper levels in Serpentine Creek base flows.

8.0 Implementation Approach

8.1 Implementation

As outlined in Section 5.0 and 6.0 and 7.0, the adaptive management approach is multifaceted; the 'System Management' management tools compromise a set of asset management, procedures, stormwater asset condition and performance assessments that guide short term (including reactionary responses) and medium to longer term expenditure on Stormwater Infrastructure to progressively achieve the goals and objectives outlined in Section 3.1. These systems are currently in operation and are progressively reviewed and updated to provide continuous improvement.

Budget asset management, maintenance, monitoring and capital upgrades are included in TDC's Annual Plans, Long Terms Plans, and Infrastructure strategies as required by the Local Government Act.

The continued performance of the stormwater infrastructure is dependent on effective routine maintenance of pipes, sumps, culverts, channels, vegetation control in waterways etc. Whilst routine maintenance is intended to prevent deterioration in the performance and level of service of the current stormwater infrastructure, the monitoring and response plans (Appendix B & C) provide additional measures and assurance that possible deterioration will be identified and responded to in accordance with the triggers and actions outlined in the response plans (Appendix C).

Education and engagement of both internal and external stakeholders is outlined in Section 8.4. Effective communication of the objectives and performance of the Geraldine stormwater network will support the successful implementation of the Geraldine SWMP. Such communication will be required to achieve continued alignment of the community objectives with aims and objectives of the SWMP in future revisions of the SWMP.

The effectiveness of the SWMP to adaptively manage the potential effects on the environment and cultural values requires the development of appropriate monitoring (parameters, location and frequency) and associated triggers and response plans to observed results. As outlined in Figure 8, the following structure has been utilised to develop the monitoring, triggers, action and response plans described in Section 8.2. Possible "Contingency" or "Additional" solutions to provide improvements to water quality or flooding performance of the stormwater network are as summarised in the Executive Summary and included in sections 6 and 7 of this report (and with (PDP, 2017a) (PDP, 2017b))

It is important to note that the monitoring, triggers, and response plans can evolve in response to improvements in knowledge of the environment, or changes in the aims and objectives of the SWMP; similarly monitoring parameters could be dropped or frequency of assessment reduced if the potential risks on the environment are reduced and/or assessed as being less significant.

8.2 Monitoring, Trigger and Response Plans

8.2.1 Overview

Current adaptive management actions are detailed within the TARP (trigger, action, and response plan) tabulated in tables 6-9. The actions and responses are based on the options discussed in sections 6 and 7.

8.2.2 Monitoring

Monitoring of water quality, aquatic ecology, stream sediment quality, and groundwater is outlined in detail in Appendix B. The monitoring programme has been designed to monitor performance and ecological impact of the SWMP and to enable proactive management and any additional maintenance of the stormwater infrastructure in Geraldine. Current adaptive management actions are detailed within the TARP (trigger, action, and response plan) tabulated in Appendix D along with the status of the network.

This includes the monitoring requirements that are recommended to be included in the resource consent as well as additional monitoring provided to assist TDC management of the network and understanding of the base environmental characteristics better.

The collection and analysis of all samples shall be undertaken in accordance with Standard Methods for the Examination of Water and Wastewater (APHA, 2012) or equivalent and superseding methods.

8.2.3 Database

In addition to any specific resource consent monitoring requirements, TDC will maintain an Environmental Compliance Database. This database will be used to record all aspects relating to compliance of the SMWP to resource consent requirement in addition to additional elements identified in this SWMP.

The Database/Register will be managed and maintained by the Drainage and Water Manager to ensure all SWMP compliance matters are addressed on time and in accordance with the monitoring requirements.

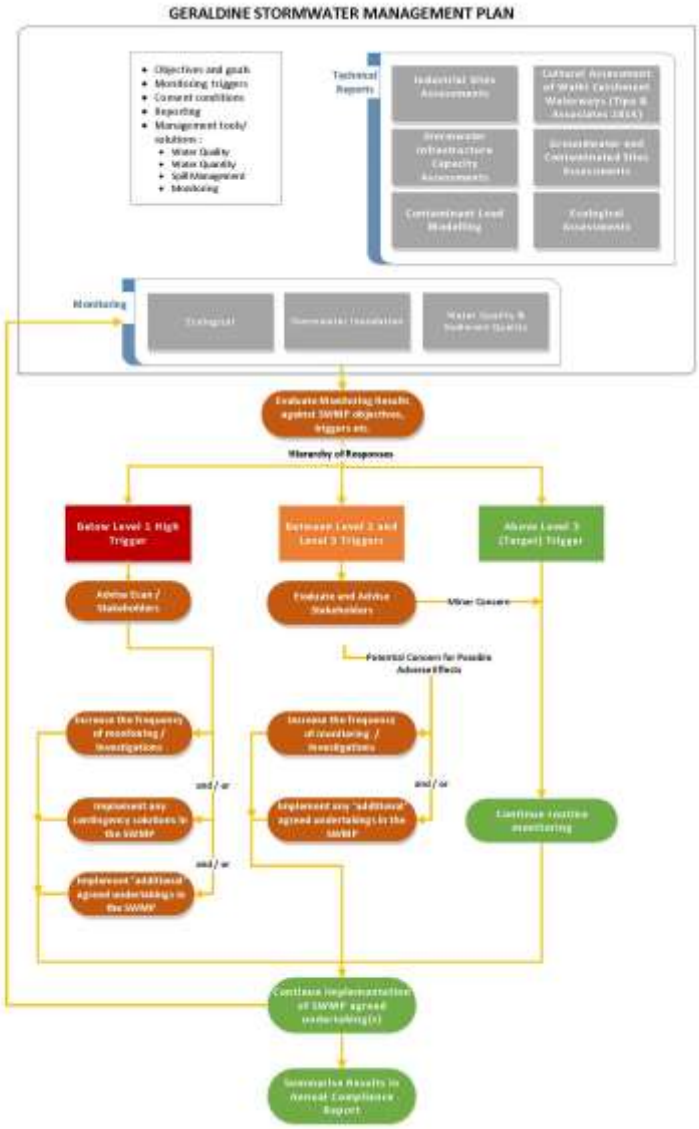

Figure 8. Implement of SWMP Monitoring Programme and Responses

8.3 Resources

The task activity plan is included in Appendix E. This shows the activities and their frequency required to implement this plan for each task proposed under this plan.

8.4 Communication and Reporting

Effective and regular communication of the objectives and performance of the Geraldine stormwater network is important to deliver the successful implementation of the Geraldine SWMP.

8.4.1 Internal Stakeholders

Internal communication refers to communication will TDC personnel (including maintenance and operations contractors) who are associated with providing and maintaining the stormwater infrastructure for Geraldine. Key internal communication mechanisms will include:

- Customer Services receiving and responding to any stormwater 'complaints' or 'problems', in accordance with TDC's service complaints management procedure;
- Monthly and Annual Reporting;
  - Asset data collection activities completed
  - Asset data collection activities programmed
  - Project status and milestones
  - Operations and maintenance activities
  - Capital programme progress
  - Monitoring results
  - Planned monitoring activities
  - Additional investigations required
  - Education activities completed
  - Education activities proposed
- Internal reporting & liaison, including but not limited to:
  - Waste Minimisation (Education programmes and monitoring)
  - Roading Section (O & M and Capital works programme)
  - Animal Control Section (Education programmes and monitoring)
  - Planning Section (new development requirements)

- Geraldine Community Board - (Upcoming projects and general activities, management plan milestones and achievements)
- Infrastructure Community – (upcoming projects)
- Environmental Services Committee – new development requirements and planned servicing upgrades

8.4.2 External Stakeholders

External stakeholders and details required may include but not limited to:

- Environment Canterbury (Pollution Control, waterway maintenance issues, environmental monitoring, compliance requirements)
- Orari Temuka Opihi Pareora (OTOP) Water Zone Committee
- Te Rūnanga o Arowhenua (Upcoming projects and general activities of interest, management plan milestones and achievements)

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10.0 Abbreviations

AEP	Annual exceedance probability
AMP	Activity management plans
CCTV	Close circuit television
CLM	Contaminant load model
ha	Hectare
ISQG	Interim sediment quality guidelines
IPCC	Intergovernmental Panel on Climate Change
LoS	Level of service
LWRP	Land and Water Regional Plan (Canterbury Regional Council)
MAV	Maximum acceptable value
MCI	Macroinvertebrate community index
NES	National Environmental Standard
PAH	Polycyclic aromatic hydrocarbon
QMCI	Quantitative Macroinvertebrate Community Index
SMA	Stormwater management area
SWMP	Stormwater management plan
TARP	Trigger, action, and response plan
TDC	Timaru District Council
TPH	Total petroleum hydrocarbons

Appendix A: Geraldine Stormwater Management Area Consent – Proposed Conditions

Appendix B: Geraldine SWMP Monitoring Parameters

Table B1 to B4 tabulates the monitoring requirements (location, frequency and parameters), whilst Figures B1 to B4 graphically present the location of the monitoring sites, the coordinates of which are tabulated in Table B5.

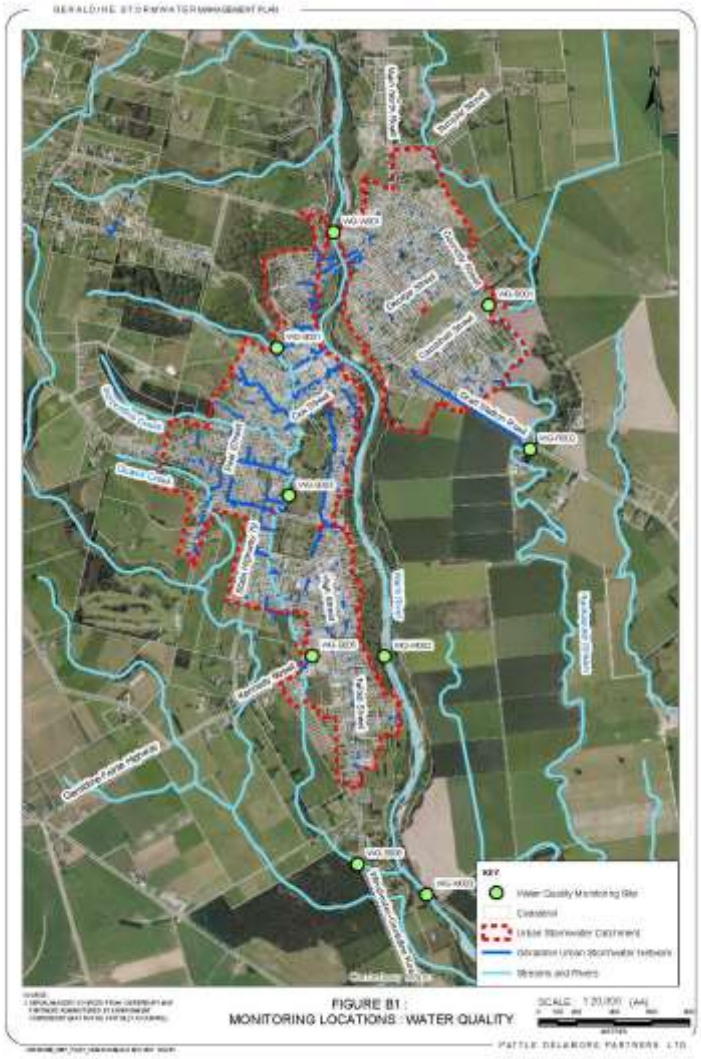

Figure B1: Surface Water

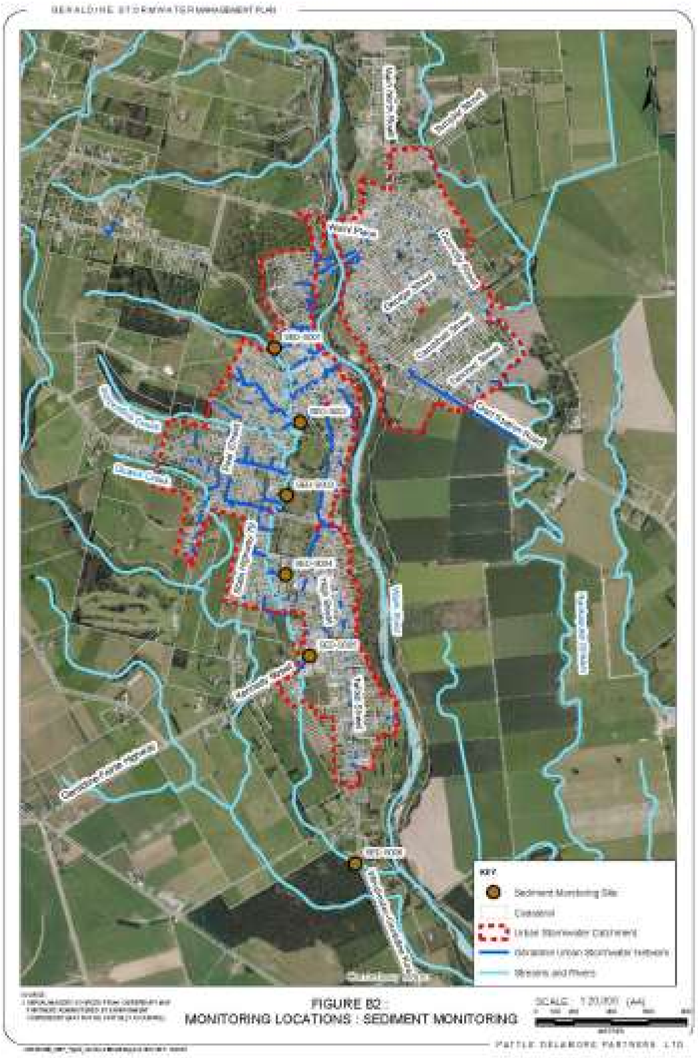

Figure B2: Sediment

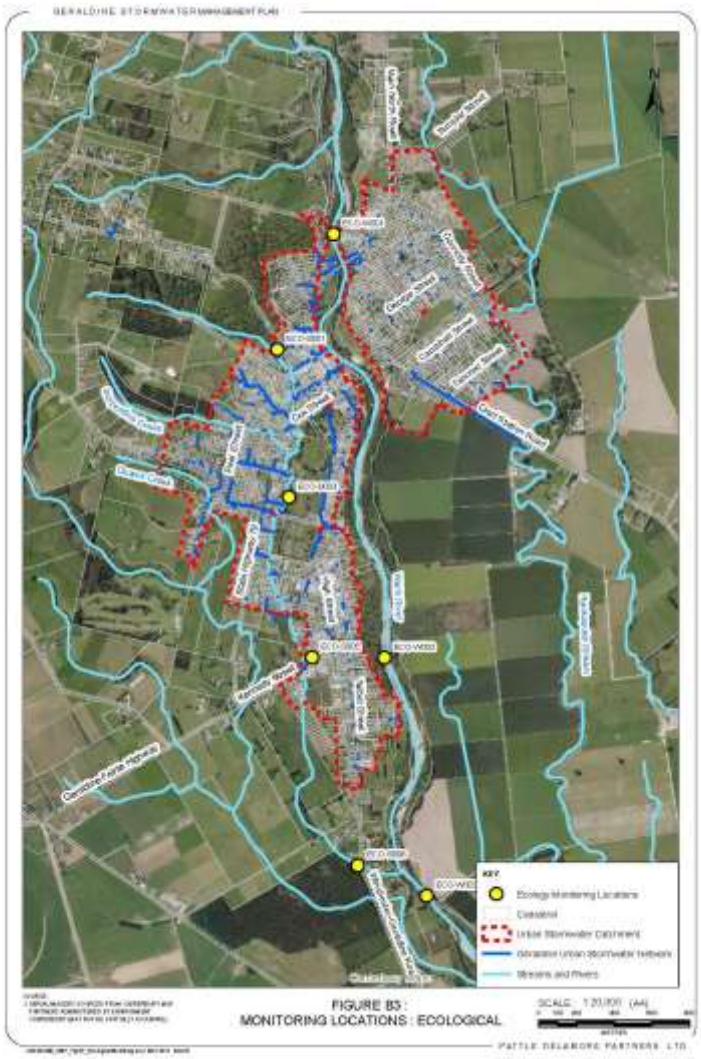

Figure B3 Ecology

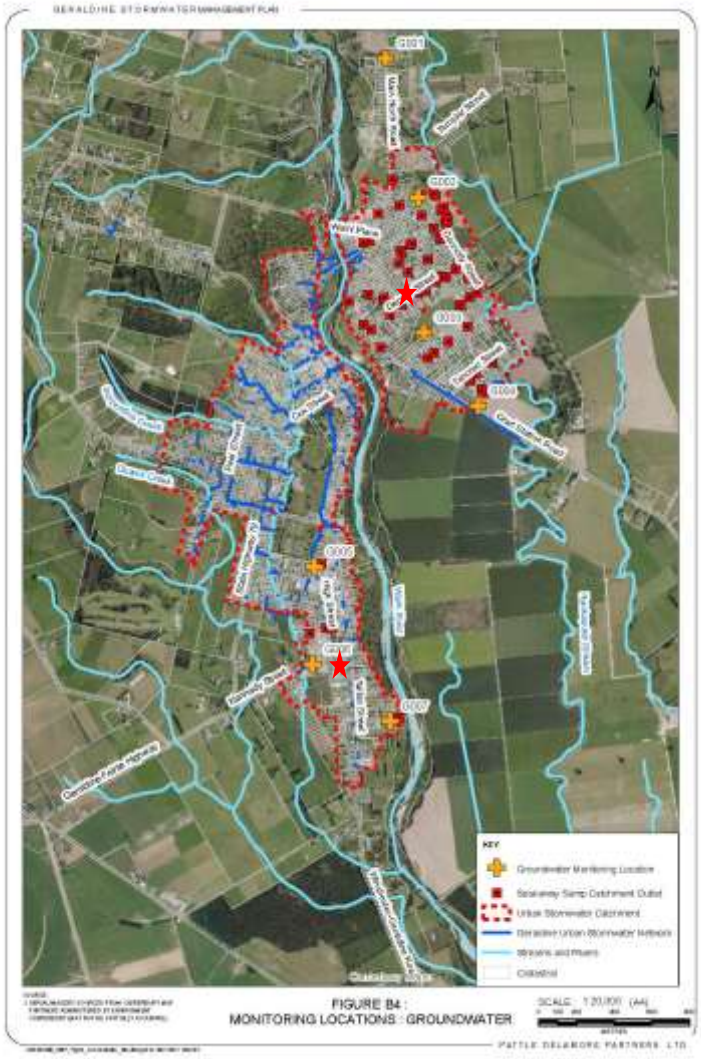

Figure B4 – Groundwater

Appendix C: Trigger Actions Response Plans

The following TARPs have been developed in order to initiate and guide any corrective actions required to correct deviations from normal operating conditions. The TARPs presented in Table C1 have been developed following a Risk Assessment undertaken following consideration of the Stormwater Management Area Consent conditions (Appendix A) and current understanding of the sensitivity of the aquatic environment to stormwater contaminants.

Appendix D: Waterway Photos

D1 Waihi River - Town Centre

D2 - Waihi River Upstream Serpentine Creek

D3 - Wāhi River downstream Serpentine Creek at Coach Road

D4 Serpentine Creek - Hislop Street Detention Area

D5 Serpentine Creek – Downstream Hislop Street Detention Area

D6 Enhanced Riparian Wāhi SW outlet channel - Rhododendron Dell, Wāhi River

D7 Serpentine Creek Talbot Forrest Channel

D8 Serpentine Creek near Cox Street

D9 Geraldine Recreational Reserve (near Wright Street)

D10 Serpentine Creek near Huffey Street

D11 Serpentine Creek near South Terrace

D12 Serpentine Creek Channel Downstream Kennedy Street

D13 Serpentine Creek Channel Upstream Kennedy Street

D14 Serpentine Creek Channel Downstream Winchester- Geraldine Road

D15 Blocked Sump

D16 Blocked sump

Appendix E: Schedule of Resources