TRANSIT NEW ZEALAND
CHRISTCHURCH SOUTHERN MOTORWAY

Stormwater Management System
Project Review

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Stormwater Management System Project Review

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1 Introduction

Opus has been commissioned by Transit New Zealand to provide design and consenting information on the stormwater management system adopted for the Christchurch Southern Motorway (CSM) project. **Appendix A** of this report shows the location of key features.

The CSM project is being procured on a design and construct basis and the following information is based on the Specimen Design developed for the project in support of resource consents. Resource consents have not yet been secured and hence aspects of the stormwater solution could be varied by the outcome of the statutory processes.

This report is part of the Final Stormwater Management Standard and Valuation Review undertaken by Transit New Zealand.

2 Environmental Factors

2.1 Description of Catchments

For the purposes of determining the stormwater management requirements (quality and peak quantity flows) the route of the CSM has been divided into catchments based on the discharge locations. The CSM catchment area comprises of both the new impervious areas area as well as the pervious corridor limit. These areas are presented in Table 1 below. Also see **Appendix B** Stormwater Management Concept Drawings.

Table 1: Subcatchment Area Summary

Motorway Catchment	Location	Catchment Description	Catchment Area
HJR Basin	Ch2300	• Halswell Junction Road (Ch0000 – Ch2400) Total CCC Catchment	• A imp = 385,000 • A perv = 315,000 • Aimp new ~ 1.25ha
Mushroom Device	Ch2900	• Mainline (Ch2500 – Ch3100) including Springs Road intersection.	• A imp = 18,200 • A perv = 16,400
Lee Device	Ch3350	• Mainline (Ch3100 – Ch3550).	• A imp = 11,250 • A perv = 9,900
Carrs Device	Ch4200	• Mainline (Ch3550 – Ch4160).	• A imp = 15,250 • A perv = 13,420
Carrs Attenuation Swales	Ch4160	• Mainline (Ch4160 – Ch4500)	• A imp = 8,500 • A perv = 7,480

Motorway Catchment	Location	Catchment Description	Catchment Area
Kirkwood South Device	Ch4950	• Mainline (Ch4500 – Ch5200) including Awatea Rd over bridge	• A imp = 23,425 • A perv = 38,169
Upper Heathcote Attenuation Swales	Ch5260	• Mainline (Ch5200 – Ch5600)	• A imp = 10,000 • A perv = 8,800
Musgroves Device	Ch5950	• Mainline (Ch5600 – Ch5980) including Nash Rd over bridge	• A imp = 14,675 • A perv = 20,941
Dry Stream Attenuation Swales	Ch 5980	• Mainline (Ch5980 – Ch6150)	• A imp = 4,250 • A perv = 3,740
Wigram East Attenuation Swales	Ch 6480 & Ch 6790	• Mainline (Ch6150 – Ch7300)	• A imp = 28,750 • A perv = 25,300
Curletts Device	Ch7700	• Mainline (Ch7300 – Ch7970) including contributing area from Curletts Road	• A imp = 24,520 • A perv = 22,490
Duplication AS(i)	Ch7950	• Mainline (Ch7950 – Ch8900)	• A imp = 15,625 • A perv = 21,800
Duplication AS(ii) & AS(iii)	Ch9280	• Mainline (Ch9000 – Ch9365)	• A imp = 5,813 • A perv = 10,220
Attenuation Swale AS(iv)	Ch9440	• Mainline (Ch9365 – Ch9430)	• A imp = 813 • A perv = 1,820
Attenuation Swale AS(v)	Ch9860	• Mainline (Ch9430 – Ch9710)	• A imp = 5,390 • A perv = 5,060
Attenuation Swales AS(vi) and AS(viii)	Ch9960 N	• Mainline (Ch9600 – Ch9900)N • Mainline (Ch9900 – Partial)N	• A imp = 8,500 • A perv = 7,725
Attenuation Swales AS(viii) Partial	Ch10150	• Mainline (Partial)N	• See AS(vi) and AS(viii) above
Attenuation Swales AS(vii) and AS(ix)	Ch9960 S	• Mainline (Ch9600 – Ch10330)S	• A imp = 14,395 • A perv = 12,330

2.1.1 Terrain

The Christchurch Southern Motorway project essentially comprises 10.5 km of proposed carriageway through varying land uses including pasture, residential, commercial and industrial.

2.1.2 Area

The Christchurch Southern Motorway project essentially comprises the:

Upgrade Section

This section of the CSM extends approximately 2.5km from the Halswell Junction Road Springs Road intersection along Halswell Junction Road to Main South Road at the western limit.

Reticulation for the Halswell Junction Road catchment was planned in the late 70s and installed in the early 90s to cater for the fast developing, mainly industrial, catchment. The existing Christchurch City Council reticulation is designed to convey the runoff from the fully developed catchment under 20% AEP rain event. Currently there is no formal stormwater treatment system, and discharge is to the existing Halswell Junction Retention basin.

The majority of runoff from Halswell Junction Road is to informal roadside swales and infiltration, with parts of the road having had kerb and channel installed. CCC's existing HJR pipe network has current capacity limitations for the extent of development within the catchment.

Photo 1: Halswell Retention Basin – Pond Inlet Area

Greenfield (New) Section

This section of the CSM is currently Greenfield. The proposal will extend approximately 5km west from Curletts Road, south of Wigram Aerodrome until it connects into Halswell Junction Road at its junction with Springs Road.

Apart from the two principal waterway crossings (Upper Heathcote River and Haytons Drain), stormwater drainage at the greenfield section of works is generally informal with discharge predominantly occurring by soakage and informal overland routes. No treatment occurs here apart from the limit of works that falls within the Haytons Drain Catchment (which discharges to the Wigram East Retention Basin).

Duplication Section

The existing section of CSM was constructed in the early 1980's, and was originally to be a four lane motorway between Barrington Street in the east and Main South Road, west of Halswell Junction Road. The scope was reduced to the existing two lane arrangement immediately prior to construction.

This section of the CSM is approximately 3 km in length with its start located about 3 km south west of the city centre at the intersection with Barrington Street. The western end of this section terminates at Curletts Road.

The duplication section is predominantly located within the Upper Wilderness Drain, Jacksons Creek, and the Curletts Road Drain Catchment. Currently, stormwater runoff from the area designated for the additional two lanes of the CSM upgrade is conveyed by swales, to discreet entry points (typically sumps) to the CCC piped stormwater network. The main exception to this is between Wrights and Curletts Road where swales convey stormwater to a surface water discharge point to Curletts drain. The existing CCC network is of limited capacity. CCC has plans for some sections of the network to be renewed and upgraded. No treatment or attenuation is currently provided here.

Photo 2: Duplication Alignment – Looking West from Barrington

2.1.3 Topography

The route is located on the relatively flat alluvial flood plain of the Waimakariri River. The only significant river which crosses the route is the upper reach of the Heathcote River and this is incised by up to 3 m into the river plains. Other more minor streams and water courses include Haytons Stream and a small tributary of the Heathcote River.

2.1.4 Drainage Features

The proposed CSM alignment traverses, or runs parallel to, a number of drainage features. A summary of these features follows:

Curletts Road Stream - runs parallel to the north side of the existing motorway and is piped across the motorway. It receives stormwater from a large industrial and commercial area with little or no existing stormwater treatment.

Haytons Stream - is a modified system with the section upstream of Wigram Road sized to accommodate large runoff from the catchment. Downstream of Wigram Road to Wigram Retention Basin the stream is more naturalised with extensive riparian planting.

Halswell Retention Basin - was constructed in 1992 by CCC to receive stormwater from the surrounding industrial and business area.

There are a number of dry remnant channels within the project area as follows:

Upper Jacksons Creek – flow varies greatly on a daily and weekly basis due to the Lane Walker Rudkin cooling water discharge.

Dry Stream – is down stream of the small pond at Musgroves. It feeds into the Heathcote River.

Upper Heathcote River – stormwater currently discharges into the Heathcote River from new subdivisions but there is no permanent flow until approximately 1.9km downstream.

Upper Knights Stream – in the vicinity of the CSM the stream is permanently dry. Periodic flow does not occur until approximately 2.3km downstream of Halswell Junction Road.

2.1.5 Geotechnical Limitations and Opportunities

The groundwater regime in the area of the CSM comprises a series of predominantly unconfined aquifers in gravel layers which become confined by overlying and inter-layered fine sediments near the coast.

Groundwater levels decrease from about RL 15m (about 5m below ground level) at the Halswell Road Springs Road Intersection to about RL 10m (about 1.5m below ground level) at Barrington Street. The groundwater contours indicate groundwater flows are towards the southeast.

Limitations

Where the Christchurch Southern Motorway passes through historic landfill sites there is potential for the contaminants to be released from the landfill material and be transported to the aquifer. Disposal to ground is not possible over historic landfill sites.

Opportunities

Where the ground water is low there is an opportunity to utilise infiltration to ground. The design soakage rates for the Basins in areas of low ground water are presented in Table 2 below. The soakage rates are 1 dimensional with a safety factor of 3.

Table 2: Design Soakage Rates (1- dimensional)

Basin	Design Soakage Rate (1D)
HJR Basin	N/A
Mushroom Device	500mm/hr
Lee Device	70mm/hr
Carrs Device	470mm/hr
Kirkwood South Device	N/A
Musgroves Device	45mm/hr
Curletts Device	N/A

2.1.6 Soils

In the duplication section of the motorway, silt and sand alluvium up to 22 m thick and intermediate gravel layer of up to 6 m thick overlie the Riccarton Gravel formation. The intermediate gravel layer is not present near Curletts Road. Ground water levels are between 1 m and 3 m depth below ground level.

In the extension section of the motorway, a surface layer of fine alluvium of up to 6 m thick was encountered which predominantly comprises silt, but with some thin layers of sand. This is underlain by gravel, with thin layers of silt and sand. Groundwater is indicated to be 3 m to 5 m below the ground surface. The highway extension will cross over or nearby a number of known former landfill areas.

The near surface groundwater regime in the area of the southern motorway is indicated to comprise perched water and unconfined aquifers while the aquifer in the Riccarton gravels is artesian at Barrington Street end and sub-artesian elsewhere.

The Proposed Natural Resources Regional Plan (Environment Canterbury (ECan), July 2007 – Variation 6), describes the motorway corridor as generally being characterised by the absence of an adequate surface confining layer and the absence of upwards groundwater pressure, i.e. underlain by an unconfined aquifer. The motorway corridor is located within the land surface recharge area for the Christchurch Groundwater System. Information obtained from the North Canterbury Catchment Board and Regional Water Board (NCCB, December 1986) indicates that the currently used productive aquifers in the Sockburn and Halswell areas extend to respective depths of 82 and 107 m below ground level.

The main groundwater fed surface waterway in the area is the Heathcote River. The Heathcote River flows in an easterly to south-easterly direction. The other surface waterway is the Halswell River, which flows in a southerly direction.

Groundwater beneath the motorway corridor is expected to flow in a general easterly to south-easterly direction (NCCB 1986), although the drainage influences of both the Heathcote and Halswell Rivers may also influence this direction. The presence of more permeable coarse sand and gravel channels within the near surface strata may vary some localised flow directions, as could localised influences from the backfill material and its level of compaction.

Because of the unconfined nature of the underlying aquifer the Christchurch Southern Motorway has the potential to have an adverse effect on the aquifer through transport of contaminates. The proposed treatment has been designed to provide the best practicable treatment method to protect the aquifer.

2.1.7 Erosion Potential

Due to the site's flat topography and well draining soils, the risk of erosion from raindrop impact, sheet flows or concentrated water flows over most of the project length is relatively low. However, wind erosion is likely and dust control will be important.

2.1.8 Flooding

Owing to the particularly flat topography along the route and associated catchment area, the risk and consequence of flooding is relatively low (i.e. any surface flooding is generally shallow and low velocity). Localised flooding generally only occurs when the primary drainage/waterway systems are overwhelmed because storm peak flows exceed the capacity of the drainage systems.

Upgrade Section: Some surface flooding is reported to occur at the road surface at the western limit of Halswell Junction Road. However, there are a number of secondary flow routes that alleviate the flood risk.

Along the upgrade section of works, secondary flows will generally follow the road corridor towards the Springs Road interchange from where runoff will informally follow Halswell Junction Road to the natural depressions which discharge to the Upper Knights Stream drainage network.

Greenfield Section: There are no records of specific flooding issues along the Greenfield section.

At the Greenfield section of works, secondary flows will be routed along the treatment train (i.e. swales, treatment devices, and discharge routes) for safely managed discharge to the main receiving networks (e.g. Upper Knights Drain, Upper Heathcote River, Haytons Drain, etc).

Duplication Section: There are no specific flooding issues identified at the duplication section of work. However the CCC receiving network (pipe and open channels) does have some design capacity limitations.

At the duplication section of the CSM project, secondary flow will generally be routed to follow the alignment of the principal reticulation networks. The existing motorway network effectively limits secondary flow from passing from the north to south side of the alignment, and secondary flow connectivity is limited to safely pass along the local road network via interchanges.

Flood Hazard Maps

There are no flood hazards reported along the CSM route alignment, although CCC maps do indicate flooding at the ultimate receiving environments of the Heathcote and Halswell River networks. The flood hazard maps do not identify areas that are at risk of groundwater ponding. However it is reported that in 1977 many properties within the region were exposed to temporary groundwater ponding. In some low-lying areas this ponding is reported to have lasted for several weeks.

Waimakariri River Flooding

Environment Canterbury has applied for resource consent to upgrade the Waimakariri River flood protection project. When this is complete the system will be capable of containing 6,500 cumecs (an estimated 1 in 10,000 year return flood event). This level of service will provide sufficient protection that the effects of flooding at Christchurch from the Waimakariri River can be ignored. Because the topography along the CSM route is so flat, secondary flow generally passes informally overland as sheet flow (i.e. shallow depth and low velocity).

Construction of the Christchurch Southern Motorway will impact on the existing secondary flow paths that will be bisected by the motorway corridor. All secondary flow paths have been identified and provision made for conveyance of the flows during the detailed design stage of the motorway. Secondary flow paths up to the 1% AEP rainfall storm can be managed within the designation for safely managed discharge to the principal secondary flow routes of the receiving environment. Secondary flow routes will generally be aligned with the primary flow routes.

2.1.9 Design Storm Event

Water quality and quantity design rainfall events are shown in Table 3 below.

Table 3: Design Rainfall Events

	Upgrade	Greenfield	Duplication
Receiving Environment	Halswell River	Halswell River and Heathcote River	Heathcote River
Water Quality Treatment for new impermeable surfaces (25mm depth)	Yes	Yes	Yes
Water Quantity Control (flow attenuation)	• 2% AEP for critical duration of 60hrs.	• 2% AEP for critical duration of 60hrs at discharge to Halswell River • 2% AEP for critical duration of 36hrs at discharge to Heathcote River	• 2% AEP hydrologic neutrality for critical duration of receiving pipe network, and attenuation to match 20% AEP capacity of existing CCC reticulation.

2.1.10 Vehicle Kilometres Travelled at Time of Opening

Table 4 below presents projected vehicle kilometres travelled for the year 2013 when the CSM is planned to be opened.

Table 4: Vehicle Kilometres per Day (2013)

Section	Average Daily Traffic (AADT) - vpd	Length of section	Vehicle kilometres per day
Upgrade	12,400	2.5km	31,000
Greenfield	21,600	5km	108,000
Duplication	41,000	3km	123,000
Total			**262,000**

2.1.11 Discharge Points

Primary Outfall Locations

A summary of proposed permanent discharges, including unique identifier, location, type of discharge, and identification of the receiving environment is shown in Table 5 below.

Table 5: Discharge Locations

ID	Location (approx)	Coordinate (approx)	Discharge Type	Receiving Environment	Discharge Source/Catchment
DP1	Ch 2180	383826, 803430	• CCC reticulation	• Upper Knights Stream • Halswell River	• HJR Basin
DG1	Ch 2920	384355, 802899	• Ground	• Upper Knights Stream • Halswell River	• Mushroom Device
DP2i	Ch 3050	384457, 802803	• Surface Controlled discharge to CCC reticulation	• Upper Knights Stream • Halswell River	• Mushroom Device
DP2ii	Ch 3020	384563, 802688	• Future proposed Surface Controlled discharge to CCC reticulation	• Upper Knights Stream • Halswell River	• Mushroom Device • Lee Device
DG2	CH 3390	384848, 802864	• Ground	• Upper Knights Stream • Halswell River	• Lee Device
DS1	Ch 4150	385603, 802814	• Surface Controlled discharge	• Nottingham Stream Headwaters • Halswell River	• Mainline
DG3	Ch 4230	385696, 802951	• Ground	• Nottingham Stream Headwaters • Halswell River	• Carrs Device
DS2	Ch 5260	386638, 803221	• Surface Controlled discharge	• Upper Heathcote River • Heathcote River	Kirkwood South Device (and attenuation bunds east)
DG4	Ch 5990	387200, 803722	• Ground	• Dry Stream • Heathcote River	Musgroves Device
DS3	Ch 5980	387150, 803737	• Surface Controlled discharge	• Dry Stream • Heathcote River	Dry Stream Culvert
DS4	Ch 6010	387218, 803735	• Surface Controlled discharge	• Dry Stream • Heathcote River	Musgroves Device

ID	Location (approx)	Coordinate (approx)	Discharge Type	Receiving Environment	Discharge Source/Catchment
DS5	Ch 6360	387218, 803735	• Surface Controlled discharge	• Hayton Drain Tributary • Wigram East Basin • Heathcote River	A&P Subway
DS6	Ch 6480	387385, 804171	• Surface Controlled discharge	• Hayton Drain • Wigram East Basin • Heathcote River	Haytons Drain Culvert
DS7	Ch 6790	387599, 804377	• Surface Controlled discharge	• Hayton Drain Tributary • Wigram East Basin • Heathcote River	East Wigram East Culvert
DS8	Ch 7240	387963, 804634	• Surface Controlled discharge	• Curletts Road Drain Tributary • Heathcote River	Curletts West Culvert
DS9	Ch 7800	388456, 804839	• Surface Controlled discharge	• Curletts Drain • Heathcote River	Curletts East Culvert: Curletts Basin, and Attenuation Swale AS(i)
DP3	Ch 9290	389898, 804725	• CCC reticulation	• Cardigan Place network of Upper Wilderness Drain • Heathcote River	Attenuation Swales AS(ii) & AS(iii)
DP4	Ch 9440	390043, 804693	• CCC reticulation	• Lincoln Road network of Upper Wilderness Drain • Heathcote River	Attenuation Swale AS(iv)
DP5	Ch 9860	390483, 804650	• CCC reticulation	• Edinburgh St - Upper Wilderness Drain • Heathcote River	Attenuation Swale AS(v)
DP6	Ch9960 (north)	390564, 804736	• CCC reticulation	• Barrington St Network of Upper Wilderness Drain • Heathcote River	Attenuation Swales AS(vi) and AS(viii)
DP7	Ch9960 (south)	390560, 804674	• CCC reticulation	• Barrington St Network of Upper Wilderness Drain • Heathcote River	Attenuation Swales AS(vii) and AS(ix)
DP8	Ch10140 (North)	390747, 804782	• CCC reticulation	• Jacksons Creek • Heathcote River	Attenuation Swale AS(viii) - Partial

Ultimate Outfall Locations

The ultimate discharge points are the Heathcote and Halswell River

2.1.12 Catchment Classification

(Refer to the Transit document: NSHS-2007)

The majority of project catchment can be classified as **peri-urban**, according to the SHS-2007 document.

This is where the adjacent properties have various land uses such as commercial, industrial low/medium density residential subdivisions and pasture land.

The exception to this is the upgrade section of Halswell Junction Road where the speed limit will be reduced to 60kph through an existing commercial/Industrial area.

2.2 Sensitivity of Receiving Environment

This section is referred to the Transit Document, 2007: “Identifying Sensitive Receiving Environments at Risk from Road Runoff, Land Transport New Zealand Research Report 315”.

2.2.1 Schematic of SRE Rating Framework

The proposed method is based on a hierarchical system whereby the receiving environment (RE) is sequentially classified according to three attributes:

- Physical ‘type sensitivity’ (depositional vs. dispersive),
- Ecological values,
- Human use values (including cultural values).

Within each of the above attributes, the receiving environments are classified as being of ‘high’ (H), ‘medium’ (M), or ‘low’ (L) sensitivity and assigned a numerical score accordingly.

The overall sensitivity rating for each receiving environment is calculated by adding the scores for the type sensitivity, ecological value and human use value. The sensitivity rating is grouped under three broad categories, based on the total score, with high ratings indicative of high sensitivity, as follows:

- High sensitivity (high potential risk from road runoff): Total score >40
- Medium sensitivity (moderate potential risk from runoff): Total score 20-40
- Low sensitivity (low potential risk from road runoff): Total score <20

2.2.2 Sensitivity of Receiving Environment

Specific ecological surveys have been undertaken for the route alignment including identifying avian, terrestrial and freshwater ecological values, and human use values, etc, which supports the sensitivity classification presented in Table 6 below.

Table 6: Overall sensitivity rating (Summary)

Attributes	Sensitivity	Score
Sensitivity	High	30
Ecological Value	Low	5
Human Use Value	Low	2
Overall Sensitivity Rating (Sum)	**Medium**	**37**

Based on the scores found for each attributes the receiving environment along the CSM has a **medium overall sensitivity rating**.

The sensitivity rating is supported by the brief attribute assessment descriptions as follows.

Freshwater Ecology

The Freshwater Ecology report by Shelley McMurtrie has assessed 11 main waterbodies along the route (including the Halswell Junction Retention Basin), and has established that there are no known freshwater species of conservation significance, and that existing freshwater ecological values are limited as most waterways crossing the route are ephemeral, and existing ponds are either in process of being filled or are considered too small to support aquatic communities. Fish have only been recorded within Haytons Drain. The Freshwater ecological assessment endorses an approach of promoting base flow and waterway enhancements to optimise aquatic ecology.

A summary of the surface waters is provided below. .

Curletts Road Stream - runs parallel to the north side of the existing motorway and is piped across the motorway. It receives stormwater from a large industrial and commercial area with little or no existing stormwater treatment. The invertebrate community is predominately made up of worms reflecting the 'poor' quality status as determined by the macroinvertebrate community index (MCI). Shortfin eels and upland bullies have been recorded downstream of the motorway but only shortfin eels upstream.

Haytons Stream - is a modified system with the section upstream of Wigram Road sized to accommodate large runoff from the catchment. Downstream of Wigram Road to Wigram Retention Basin the stream is more naturalised with extensive riparian planting. The invertebrate community is dominated by taxa tolerant of degraded conditions. The non-migratory native upland bully is the only fish species found in the stream with distribution limited to downstream of Wigram Road.

Halswell Retention Basin - was constructed in 1992 by CCC to receive stormwater from the surrounding industrial and business area. There are no surface water connections to any natural waterbodies.

There are a number of dry remnant channels within the project area as follows:

Upper Jacksons Creek – flow varies greatly on a daily and weekly basis due to the Lane Walker Rudkin cooling water discharge. The invertebrate fauna in the lower areas are typical of an urban system. Fish are absent due to a 2km piped section prior to discharge into the Heathcote River

Dry Stream – is down stream of the small pond at Musgroves. It feeds into the Heathcote River.

Upper Heathcote River – stormwater currently discharges into the Heathcote River from new subdivisions but there is no permanent flow until approximately 1.9km downstream.

Upper Knights Stream – in the vicinity of the CSM the stream is permanently dry. Periodic flow does not occur until approximately 2.3km downstream of Halswell Junction Road.

The freshwater ecology effects are considered likely to be negligible, given the current degraded nature of the aquatic communities, and the nature of stormwater treatment proposed which is considered more than adequate and unlikely to have a significant adverse effect on flows. Where culverts are proposed these have been assessed as likely to be more than adequate for facilitating fish passage. The proposed expansion of the Halswell Retention Basin is not regarded as a major consideration as its primary purpose is that of stormwater detention and treatment; however it is considered likely it will retain its existing aquatic values. Proposed sediment-control measures are considered more than adequate to avoid, remedy or mitigate any construction-related effects such that the effects will be no more than minor.

Terrestrial Ecology

The Terrestrial Ecology study by Dr Colin Meurk has identified only one area along the route that requires specific protection owing to the terrestrial ecology values (i.e. the “dry plains grasslands” of Wilmers Reserve). The vegetation along the route is generally dominated by exotic plants.

A summary of the terrestrial ecology along the CSM corridor is outlined below.

The vegetation of the CSM corridor is composed almost entirely of exotic species. Apart from the productive and amenity species there are also many pest plants including environmental weeds that here are sward grasses and shrubs capable of displacing small remnant areas of native dry grasslands if left unmanaged.

Some localised “primary habitats” of remnant indigenous plant communities survive. “Primary habitats” are “sites with some native plants that have a presumed continuous pedigree with former pristine vegetation on generally uncultivated soils that retain original structure, microbiota and invertebrate fauna”.

Of the remaining localised primary habitats of remnant indigenous plant communities that have been identified along the CSM corridor, only three are identified in 2007 as significant. These are summarised as follows:

Approximately 2ha of native grasslands exists at the intersection of Halswell Junction, Springs, and Wilmers Roads (“the Wilmers Road grasslands”). Although the Wilmers Road grasslands are now degraded and semi-natural, this area still contains populations of various species of indigenous plants of significance, including some that are regionally rare, such as *Geranium solanderi* and *Muehlenbeckia* spp., in a range of locations throughout the grasslands area. In terrestrial ecological terms the Wilmers Road grasslands is considered the most valuable site along the CSM corridor, and is identified in the City Plan as *“Ecological Heritage Site 15.06 - Danthonia grassland”;*

The Upper Heathcote River, where crossed by the CSM corridor, contains populations of various species of indigenous plants of significance, including the regionally rare marsh species *Rorippa palustris.* The Upper Heathcote River is identified in the City Plan as *“Ecological Heritage Site 15.21 - Riparian willow woodland (with native trees, shrubs, ferns and sedges)”;* and

Planted riparian vegetation along Haytons Drain, where crossed by the CSM corridor, is considered significant due to its rarity in the district.

With the implementation of the proposed mitigation measures there are no other effects on terrestrial ecology that need to be considered. The technical assessment concluded that with the mitigation measures the proposal will result in a net benefit to natural values and landscaping in southwest Christchurch.

Avian Ecology

The Avian Ecology study by Professor Ken Hughey has identified that a range of bird species inhabit land along the corridor, with increased concentrations in proximity to wet pond areas and waterways (eg Halswell Junction Retention Basin, Owaka Lake (currently being infilled), the Upper Heathcote River, Musgroves Lake (currently being infilled), Haytons Drain and the associated Wigram East Retention Basin, and in proximity to the Curletts Road Drain network. Species include Pukeko and a variety of ducks. A summary of the avian ecology along the CSM corridor is outlined below.

There are two main sets of wildlife (bird) values of potential conservation interest: those associated with a range of wetlands (mainly ponds) in the area, and those associated with the farmed grasslands. The latter are considered insignificant in national, regional or even a local context, as grassland species are considered widespread in New Zealand, occur in very large numbers and are unlikely to be impacted significantly by the CSM and are consequently not considered further. Regarding the wetlands (mainly ponds) of the area, a former pond at Musgrove Bros has been infilled. In addition, Owaka Pond is currently being infilled by landfill. Consequently there are now no wetland avian values at Musgroves and those at the Owaka pond are extremely poor and are even of low local value due to the high rate of habitat deterioration.

The Upper Heathcote River supports little or no wetland avian habitat, except maybe on temporary bases after heavy rainfall. Haytons Drain flows permanently and has riparian fencing for vegetation management and has value as a wildlife (avian) habitat.

Plantings associated with the motorway, which are proposed to be predominantly native, can be used in the case of shrublands to provide habitat for passerines such as fantails, grey warbler and possibly over time bellbird.

Overall, it is considered the proposed CSM duplication and extension will have a less than minor effect on existing avian wildlife and their habitats and may provide positive benefits.

Photo 3: Pukeko

Cultural, Historical and Archaeological Context

A summary of the cultural, historical and archaeological context within which the CSM project is situated is outlined below.

The tangata whenua for the area are Te Runanga O Ngai Tahu. The proposal passes through the respective rohe of both Te Ngai Tuahuriri Runanga and Te Taumutu Runanga.

The Deed of Settlement between the Crown and Te Runanga O Ngai Tahu (and subsequent Ngai Tahu Claims Settlement Act 1998) recognises a number of areas as being of importance to Ngai Tahu. No Nohoanga Sites or Statutory Acknowledgements have been identified in the vicinity of the proposal.

One archaeological site has been recorded in the immediate vicinity of the project route. No new archaeological sites have been observed or recorded within the vicinity of the route. However, there is a potential for further unobserved or unrecorded archaeological sites within the vicinity of the route.

A small number of historic places in the wider vicinity of the proposal have been registered or listed by the New Zealand Historic Places Trust ("NZHPT") and/or the CCC. Those recorded are in the wider vicinity and will not be affected by the proposal.

A Cultural Impact Assessment (CIA) was commissioned by Transit. Overall, field work found no visible archaeological material or features; however historical research has showed the likelihood of encountering sub-surface archaeological deposits in several areas. For this reason Transit has applied to the New Zealand Historic Places Trust ("NZHPT") for an archaeological authority in terms of Section 12 of the Historic Places Act 1993 to destroy, damage, or modify archaeological sites which may be impacted on by earthmoving work required for construction of the proposed CSM duplication and extension.

Landscape

Existing riparian vegetation is particularly sparse at waterways along the CSM route. The predominant vegetation is low land tussock and grass, with some enhancement having been undertaken at Haytons Drain.

Planting of the stormwater swales and retention basins and the margins of waterways within the motorway corridor with appropriate species will assist in the treatment of runoff from the motorway.

Overall, it is considered any actual or potential significant adverse effects on landscape amenity from the proposed motorway duplication and extension can be avoided, remedied or mitigated through adoption of the landscape, visual and urban design mitigation measures proposed.

3 Designed Solutions

This section provides a brief description of:

- The design philosophy,
- The stormwater management devices method used for the design, positioning and construction,
- Cost and time.

3.1 Design Philosophy

3.1.1 Objectives

Assumptions

Opus objectives for developing the stormwater design were:

In general, the philosophy and objectives for Stormwater Management can be broken down into **short-term** (associated with the construction and earthworks activities) and **long-term** (permanent stormwater management solution) objectives, as follows:

Short-Term Stormwater Management

The principal short-term effect of the CSM proposal will be on water quality, arising from runoff during construction. During the works, there will be two main concerns:

(a) Erosion and Sediment Control to ensure that the discharge of sediment downstream, both from earthworks sites and road construction is minimised.

(b) Dust control, which will be principally by water sprinkling.

Proposed earthworks activities will be managed such that proposed E&SC measures will best practicably minimise erosion, sedimentation and dust generation. Four fundamental principles generally apply to the short-term stormwater management philosophy:

- Control run on water;
- Separate ‘clean’ water from ‘dirty’ water;
- Protect the land surface from erosion;
- Minimise sediment leaving the site.

An Erosion and Sediment Control (E&SC) Plan will be required in accordance with the Environment Canterbury, 2007. *Erosion and sediment control guidelines for the Canterbury region*. Report No. R06/23, Canterbury Regional Council.

As part of their Environmental Management Plan, the Contractor will prepare and obtain approval for the E&SC Plan for the construction phase of this project.

Long-Term Stormwater Management

Long-term stormwater management relates to the ‘day to day’ management of the quantity and quality of stormwater discharge. Effective carriageway drainage is essential for traffic safety and levels of service, as well as pavement durability.

In addition to these functions, the management of stormwater must also address quantity effects to control erosion and flooding, and quality effects as runoff is one of the principal mechanisms for transfer of road/traffic generated contaminants to the environment.

The high level philosophy and objectives for managing stormwater run-off have been developed to ensure relevant statutory duties and strategic priorities are achieved for permanent stormwater management including:

- Legislative and Environmental compliance (eg LTMA objectives for an integrated, safe, responsive and sustainable, roadway, and the Transit EMP objectives)
- Provision of effective drainage;
- Achieve hydrologic neutrality (i.e. pre-development discharges to mimic post-development discharges);
- Achieve hydrologic connectivity (i.e. maintain groundwater levels, and flow regimes);
- Treatment to meet (or exceed) regional/territorial standards;
- Centralised/Integrated stormwater systems preferable;
- Site specific practices: eg no single solution panacea;
- Discharge to land is preferred, where practicable;
- The "treatment train" approach is preferable (eg grass swales, infiltration, etc);
- Ensure efficient and effective maintenance;
- Landscape: Naturalised eco-systems, and promoting variety of communities;
- Bird Habitat: Give judicious consideration to scope for habitat;
- Fish Passage: Restore or facilitate;
- Ecological Value and Passage: Protect, preserve, improve;

- Cultural & Heritage Values: Recognise values and kitianga mauri, etc, eg maintain (enhance) water quality, promote indigenous species, maintain flow regimes, etc;
- Recreation: Promote linkages and interface with stormwater (non contact);
- Education: Consider local communities (eg walkers), school groups (interpretive), casual visitors (interpretive), special interest groups (eg NZWERF, NZWWA).
- Partnerships: Integration with CCC, ECan, Iwi, etc;

Sources of Information

- A Scheme Assessment Report ("SAR") was produced in June 2002 with an Addendum in December 2002 and June 2006. The SAR considered engineering, economic and environmental aspects influencing the alternatives considered in formulating this proposal. The SAR included a draft AEE that was finalised in March 2005.
- Opus International Consultations Ltd, 2007. Christchurch Southern Motorway Stormwater Management Report.
- Christchurch City Council, 2007 (Draft). Integrated Catchment Management Plan (ICMP) for the South-West Area Plan. First Draft at April 2007.
- Christchurch City Council, 2003. Waterways, Wetlands and Drainage Guide - Ko Ta Anga Whakaora mo Nga Arawai Repo. Part A: Visions. Christchurch City Council, Christchurch.
- Christchurch City Council, 2003. Waterways, Wetlands and Drainage Guide - Ko Ta Anga Whakaora mo Nga Arawai Repo. Part B: Design. Christchurch City Council, Christchurch.

Photo 4: Healthy Christchurch Waterway

Options Analysis

A Stormwater Scheme Assessment Report (SAR) was undertaken for the CSM proposal in 2000. During the intervening period new standards, policies, objectives, and expectations, of best practice stormwater management have become established, meaning that some findings of the scheme assessment have now been superseded.

The general findings related to **2000 stormwater management SAR** were:

Upgrade Section

The scheme assessment proposal for stormwater treatment and disposal at this section of the motorway was to formalise the stormwater collection and conveyance system for the road by installing kerb and channel with sumps collecting the road runoff and discharging to the existing Christchurch City Council reticulation. No water quality treatment or flow attenuation was proposed in the Scheme Assessment.

Greenfield (New) Section

The scheme assessment proposal for stormwater management at the new section of motorway (Greenfield) was to form grass swales and pipe reticulation to convey road runoff for treatment at infiltration basins and discharge disposal by soakage to ground. At the time of the Scheme Assessment work, water quality improvement was proposed, but no flow attenuation was required.

Duplication Section

The scheme assessment proposal for stormwater management at this section of the motorway was to formalise the existing swale system, and discharge to the CCC stormwater network. No water quality treatment or flow attenuation proposed in the Scheme Assessment.

Stormwater Management Philosophy

The general philosophy for the stormwater management is to utilise a treatment train approach. The idea of the "treatment train" is to acknowledge the fact that individual stormwater management tools are unlikely to achieve all of the stormwater management objectives for any given site. Several devices may be needed to achieve multiple objectives such as stormwater quantity, quality and aquatic ecosystem protection, etc.

A generic concept for addressing stormwater management for the project is as follows:

- Initially, stormwater falling on paved surfaces will be collected, conveyed, treated, and at some locations partially attenuated by swales, with both the treated and excess runoff collected by catchpits and directed into pipes for conveyance to appropriate devices (for primary or secondary polishing treatment, and for flow attenuation), or discharged to the receiving network (eg pipe, ground, or surface water);

- Treatment devices will be designed to treat runoff for the design stormwater quality and quantity event, and not extreme flows. Flow in excess of the design storm would be safely discharged to the nearest receiving waterway along the route (eg high flow by-pass, or overflow diversion). This approach helps to avoid flooding of treatment devices by rain storms exceeding the design criteria, and also helps to maintain the natural flow regime. This also allows for optimised pipeline design, reducing the cost of the surface drainage system;

- Wherever possible, clean stormwater arising from outside of the paved area should be kept separate from contaminated road surface runoff;

- Where feasible grass swales should be utilised as they can be designed to provide flow reduction as well as an effective and efficient treatment system. Swales designed with appropriate bunds, overflow facility, and underdrainage, can achieve both the treatment and flow attenuation requirements. Swales should be accommodated within clear zones, between the edge of the sealed shoulder and the outer edge of designated clear zones. Where swales pass over landfill zones impermeable lining will be required to minimise the risk of contaminant leaching;

- Treatment devices frequently comprise an initial sediment treatment component, whether in the form of a first flush forebay or a sedimentation chamber, etc, followed by a second stage treatment such as infiltration/detention basins, and soakage chamber or ‘controlled -release’ disposal, etc. Sediment chambers should also be designed for elementary oil and grease removal;

- Discharge disposal by soakage to ground is preferred.

In general, a site-specific Best Practicable Option (BPO) treatment train will be developed such that no single solution is deemed a panacea.

The **2008 proposed stormwater specimen concept design** for each of the three sections of the CSM is as follows:

Upgrade Section: Due to the formalising nature of proposed works (i.e. standard kerb and channel, and footpath) for the Halswell Junction Road upgrade limit of proposed works, the surface drainage system will be a conventional pipe and catchpit system. The collection and conveyance system will effectively formalise the road stormwater system at Halswell Junction Road to connect with the principal pipe network within Halswell Junction Road. Scope for swale development here is limited primarily owing to the space (designation) constraints, and the nature of land use activity along this road (i.e. primarily industrial/commercial land) meaning a number of vehicle access crossings of swales would be required, and the risk and consequence of swale damage by heavy vehicles is high. Treatment will be at the proposed upgraded Halswell Retention Basin whereby the stormwater quality and quantity management improvements will inherently exceed local and regional standards and expectations (at no additional time or cost).

Greenfield Section: For the Greenfield section of works (Springs Road to Curletts Road), the principal means of collection and conveyance of surface runoff will be swales at the motorway mainline formation with some kerb and channel formation associated with the proposed interchange/connectivity locations. A kerb and channel solution was not selected owing to cost implications, conveyance capacity limitations and due to the availability of a healthy designation width to accommodate a swale system that best achieves a balance of objectives (i.e. including the collection; conveyance; water quality treatment; and the flow attenuation requirements, etc). Swales (standard and bunded attenuation) at the Greenfield section will also assist in the formation of a semi rural aspect to the motorway, and best achieve the vision of the urban design and landscape development concept. Final treatment will be provided in the form on dry and wet stormwater treatment basins.

Duplication Section: For the section of proposed duplication works (Curletts Road to Collins Street), surface runoff will primarily be by swales (standard and bunded attenuation) with some localised kerb and channel formation associated with the interchange/connectivity locations, and some bridge deck drainage. A kerb and channel solution was not selected owing to cost implications, conveyance capacity limitations of kerb and channel, and due to the availability of a wide designation width to accommodate a swale system. The proposed swale system at the duplication section can also achieve the principal stormwater management objectives of water quality treatment and flow attenuation.

3.1.2 Criteria

Water Quality

The stormwater management approach will be generally consistent with the ECan Proposed Canterbury Natural Resources Regional Plan (NRRP), CCC Feb 2003 document (Parts A & B) *Waterways, Wetlands and Drainage Guide* (WWDG), the CCC Integrated Catchment Management Plan for South-west Christchurch, and the Auckland Regional Council (ARC), 2003 Technical Publication No 10 (TP10) Stormwater Management Devices Design Guideline Manual.

(i) For design purposes the water quality design storm is defined as being 25mm depth of rainfall (i.e. first flush contaminant capture).

(ii) For the new works it is proposed to adopt a best practicable approach for water quality management whilst recognising the objectives for the Canterbury Region.

(iii) The preliminary designs upon which the consent applications are based comprise treatment of new pavement areas only. A general objective is also to provide up to 30% treatment efficiency to those areas of existing impervious surfaces that are modified by the proposed works and feed into the new stormwater system. It should be noted that there is no intention to retrofit the existing duplication system as part of this project. Should works on existing pavement areas be undertaken in the future, consideration may be given at that stage for retrofitting stormwater treatment in conjunction with an assessment of the effects of the untreated discharge on the environment.

Preferred management solutions that are considered suitable for stormwater quality control at the CSM include swales, ponds, and infiltration basins. Swale designs will either be standard grass, lined at landfills, or attenuation bunded swales.

To be consistent with the local (CCC) and regional (ECan) approach, it is important to achieve hydrologic neutrality up to the critical duration 2% Annual Exceedance Probability (AEP) to manage the effects of erosion and flooding (i.e. post development discharge to best practicably mimic pre-development flows).

Management solutions suitable and preferred for stormwater quantity control at the CSM include swales (bunded for attenuation), ponds, infiltration/detention basins, and soakage disposal devices.

Water Quantity

Water quantity design attenuation objectives are shown within the Table 7 below.

Table 7: Design Rainfall Events

Upgrade	Greenfield	Duplication
• 2% AEP for critical duration of 60hrs.	• 2% AEP for critical duration of 60hrs at discharge to Halswell River • 2% AEP for critical duration of 36hrs at discharge to Heathcote River	• 2% AEP hydrologic neutrality for critical duration of receiving pipe network, and attenuation to match 20% AEP capacity of existing CCC reticulation.

Stream Channel Erosion Criteria

To mitigate erosion, appropriate erosion control and energy dissipation measures will be incorporated into the site-specific design. This will include at the interface between natural streams or swales and pipe inlet/outlets, as well as culvert headwall/wing-wall interfaces.

Adequate erosion protection will be provided to facilitate the transition from pipe flow to natural channel flow.

All outfall structures will be positioned and designed to minimise erosion. Outfall structures will include appropriate bed protection measures and energy dissipation (where necessary). Outfalls will be designed and landscaped to blend with the natural environment and minimise aesthetic impact.

Furthermore, attenuation of the runoff within the swales and basins and controlled discharge will, as far as practical, minimise stream channel erosion.

3.1.3 General

The benefits of the proposed system include:

- Reduction in peak runoff flows to the receiving environment;
- Improved stormwater quality discharging into a natural waterway, in particular a reduction in suspended solids concentrations and in turn a reduction in pollutants.

3.1.4 References

References used for the stormwater specimen design:

- Section 77, Land Transport Management Act, 2003 (LTMA)
- Environmental Plan, Version 1, Transit New Zealand, November 2004. This Plan is an evolving document. Always ensure the current version is used. Refer to www.transit.govt.nz
- Transfund NZ, Integrated Stormwater Management Guidelines for the NZ Roading Network, Transfund NZ Research Report No 260, 2004.
- Christchurch City Council, 2003. Waterways, Wetlands and Drainage Guide - Ko Ta Anga Whakaora mo Nga Arawai Repo. Part A: Visions. Christchurch City Council, Christchurch.
- Christchurch City Council, 2003. Waterways, Wetlands and Drainage Guide - Ko Ta Anga Whakaora mo Nga Arawai Repo. Part B: Design. Christchurch City Council, Christchurch.

- Christchurch City Council, 2007 (Draft). Integrated Catchment Management Plan (ICMP) for the South-West Area Plan. First Draft at April 2007.
- Auckland Regional Council, 2003. Technical Publication No 10 (TP10) Stormwater Management Devices Design Guideline Manual. Auckland.
- Environment Canterbury, 2007. Erosion and sediment control guidelines for the Canterbury region. Report No. R06/23, Canterbury Regional Council, Christchurch, New Zealand. ISBN No. 1-86937-607-2.
- NRB, 1977. Highway Surface Drainage: A Design Guide for Highways with a Positive Collection (first edition).
- Transit New Zealand, June 2003. Bridge Design Manual. SP/M/022, Transit New Zealand, ISBN No. 0-478-04132-2.
- Ministry for the Environment, May 2004. Climate Change effects and impacts assessment. A guidance manual for Local Government in New Zealand. Prepared by the New Zealand Climate Change Office. ME No. 513. ISBN No. 0-478-18934-6.
- Pattle Delamore Partners Ltd, 2004. Groundwater Assessment for South-West Christchurch Planning Study: Stage 2, prepared for Christchurch City Council.
- Pattle Delamore Partners Ltd, November 2007. Christchurch Southern Motorway Extension: Additional Landfill Investigations for Specimen Design, prepared for Opus International Consultants.
- Te Runanga o Ngai Tahu Freshwater Policy (1999)

Other key documents for the specimen design process will include:

Transit Specifications and Guideline Notes
Transit has a number of specification and guidelines that are relevant to elements of the specimen (indicative) design, including:

- TNZ F/01, 1977. Earthworks Construction;
- TNZ F/02, 2000. Pipe Subsoil Drain Construction;
- TNZ F/03, 2000. Pipe Culvert Construction;
- TNZ F/05, 2000. Corrugated Plastic Pipe Subsoil Drain Construction;
- TNZ F/06, 2003. Fabric Wrapped Aggregate Subsoil Drain Construction;
- TNZ F/07, 2003. Changes to Geotextiles;
- TNZ HM/24, 2006. Drainage Improvements.

Christchurch City Council (CCC)
CCC has prepared a range of documents of direct relevance to the CSM stormwater management design including:

- *Proposed City Plan (Christchurch City Council, 1995.*
- *"Waterways Wetlands Asset Management Strategy, 1999.*
- *Services plans.*

Upgrade
- Historic plans/as-builts of HJR Pond

Greenfield
i "South West Christchurch Area Plan". (DRAFT)

ii Awatea block drainage (memorandum)

iii Wigram Drain Storage area – upper Heathcote River (CCC memorandum)

iv Paparua Stream upstream of Wigram Rd (CCC memorandum)

v *The "Heathcote River Floodplain Management Strategy" (Christchurch City Council, 1998),*

vi *"Heathcote River Flood Plain Management Strategy"*

vii *"Waimakariri Proposed Regional Plans"*

Duplication
- Upper Wilderness Drain Report (CCC memorandum)
- Curletts Rd Stream water quality improvements (CCC memorandum)
- Haytons Drain – Resource Consent (CCC memorandum)
- Haytons Stream below Washbournes Rd (CCC memorandum)
- Haytons stream diversion at Wigram Rd (CCC memorandum)
- Stormwater Investigation - Haytons Drain Catchment (Draft Report)
- In addition, CCC requires that no additional water be directed into the Heathcote catchment.

Other Council Design Guidelines

Auckland Regional Council (ARC) has developed a number of specific practice guidelines that should be given consideration during design of the CSM stormwater management system including:

- TP10 (2003) Stormwater Management Devices: Design Guidelines Manual;
- TP69 (1996) The Environmental Impacts of Accelerated Erosion and Sedimentation;
- TP90 (1999) Erosion and Sediment Control Guidelines for Land Disturbing Activities;
- TP124 (2000) Low Impact Design Manual for the Auckland Region;
- TP131 (2000) Fish Passage Guidelines for the Auckland Region;
- TP148 (2001) Riparian Zone Management: Strategy: Guidelines: Planting Guide;

Refer to the Auckland Regional Council (ARC) website [www.arc.govt.nz] for details and further references to these technical publications.

3.2 Stormwater Management Devices - Methods

3.2.1 Erosion and Sedimentation Control

Design Statement

Stormwater management for large earthworks projects rely on:

An Erosion, Sediment and Dust Control Plan (E&SC) will be prepared in accordance with the Regional Council's recently released erosion and sediment control guidelines. The E&SC plan will be prepared by the Contractor as part of the CEMP. The Plan will include measures to control the discharge of sediment-bearing runoff from earthworks adjacent to water bodies.

The key management tool in managing stormwater during construction from the site is the use of the E&SCP. The specific erosion and sediment control measures to be implemented will be detailed in the E&SCP, which forms part of the CEMP. The CEMP will include a construction programme and shall detail how work methodologies shall be undertaken and the E&SCP followed to minimise erosion and sediment problems. The proposed certification process will ensure that the measures selected are in accordance with the Regional Council guidelines. However, at a generic level, sediment control measures for earthworks throughout the project could comprise: buffer margins around waterways; silt fences and super silt fences; diversion channels; decanting earth bunds; and sediment retention ponds.

Resource consent has been sought to discharge to land and water. Stormwater will be managed to ensure that discharges are to land and that there are no direct discharges to water. However, it cannot be guaranteed that there will be no discharge to water. Runoff that discharges to land will occur within the designation of the CSM, that is, land owned by Transit. There is the potential for runoff to be generated along the total length of the project area however, this will not occur simultaneously as the works will be staged.

While the CSM project area has a long and narrow shape, the flatness of the site makes management of stormwater during construction simpler than a steep site with fragile soils. In addition, minimising runoff through the site by 'diverting' clean water where possible will reduce the amount of sediment generated.

The primary water quality objective is to remove suspended sediment before any discharge. During construction, excluding landfill works, the residual contaminants are likely to be restricted to sediment and to a very minor level hydrocarbons and metals from machinery use on site. It is not anticipated that other contaminants will be contained in the runoff. There will be a reduction in some contaminants, for example, agricultural land that will no longer be used for that purpose.

In terms of effects on the receiving environment, after having implemented the E&SCP, it is considered that these will be minor and primarily contained within the designation due to the site being flat and most of the earthworks being restricted to stripping top layers and importing fill in a progressive manner. There is no large scale excavation works required.

The excavation of landfill material is another activity has been considered to ensure that any runoff does not cause adverse effects that cannot be adequately avoided, remedied or mitigated.

During excavation of the landfills (if this is the chosen treatment option) it is not proposed to manage stormwater in any way other than through normal construction practices as the effects of runoff will be no different to the current situation. Currently stormwater from the landfills areas is not specifically controlled as it just percolates through the underlying soils as the landfills have no engineered cap. The area of landfill material exposed at any one time is more likely to be driven by the need to control landfill gas and odour. Timing of excavation is the key to managing stormwater with works with the need to avoid handling wet materials and excavations filling up with water (one of the other factors is the groundwater levels so that landfill material excavated is not saturated).

Therefore any stormwater associated with landfill excavation work will discharge to land as it currently does. However, where overland flow may occur across existing landfill areas, localised perimeter controls may be employed to control stormwater entry into any worked areas of landfill.

The effectiveness of the erosion and sediment control measures implemented will be monitored on a regular basis. Regular inspections are likely to occur on a weekly basis and daily if there is a specific need. The contractor will be required to prepare a maintenance monitoring programme together with a contingency plan for instances when sediment control devices are not operating optimally and for assessing sediment control devices after heavy rainfall. The processes involved include:

- assessing from inspections the suitability of the measures employed and the performance and methods modified and adjusted as needed;
- keeping documentation of inspections (this may include the use of checklists);
- if heavy rain is forecast, pre and post inspections will be undertaken as necessary;
- should a complaint be received, this will be investigated and reported; and
- the E&SCP will be periodically reviewed and updated/amended as required.

While no specific sampling of runoff is proposed as the discharge is primarily to land within the site, the E&SCP will include procedures to undertake standard sampling should a specific issue arise that needs to be assessed.

A suite of specific erosion, sediment, and dust control measures are proposed to be utilised for the short term management of the CSM project works including:

- ***Erosion Control Measures:*** runoff diversion channels and bunds, contour drains, check dams, level spreaders, pipe drop structure/flume, surface roughening, stabilised construction entrances, and stabilisation techniques such as geosynthetic erosion control systems, and/or revegetation techniques (eg topsoiling, seeding, hydroseeding, mulching, and turfing);
- ***Sediment Control Measures:*** sediment retention ponds, grit traps, silt fences, super silt fences, inlet protection, decanting earth bunds, and sump/sediment pits;
- ***Works in Waterbodies:*** temporary waterbody diversions, temporary waterbody crossings, dam and divert methodology;
- ***Dust Control Measures:*** watering of exposed areas, and/or stabilisation techniques such as geosynthetic stabilisation, revegetation, hydroseeding, mulching, or turf;
- ***Other Methods:*** wheel washdowns, etc.

3.2.2 Operational Stormwater Management (Permanent)

i. Collection

Stormwater will be collected via kerb & channel, catchpits and swales.

ii. Conveyance

Stormwater conveyance will primarily be by grass swales (standard and bunded attenuation) with traditional pipe network elsewhere.

iii. Attenuation

Attenuation will be provided by attenuation swales, basins and ponds.

iv. Treatment

The general philosophy for the stormwater management is to utilise a treatment train approach. The idea of the "treatment train" is to acknowledge the fact that individual stormwater management tools are unlikely to achieve all of the stormwater management objectives for any given site. The devices which may be utilised include:

- Catchpits/Sumps
- Swales (standard and bunded attenuation)
- Dry basins
- Wet ponds

3.3 Cost

3.3.1 Resource Consents

The approximate costs of the Stormwater related Resource Consents were:

- **$80,000** for the Consent Application and Processing Fees from ECan (note the application is still being processed so the amount is an estimate and based on a proportion (est. 40%) of the total costs for the CSM project),
- **$55,000** of Professional Fees for Consents application and documentation (includes AEE preparation, further information response, and evidence preparation). The estimate excludes the stormwater report.

So a total of **$135,000** including AEE, council Fees, other professional services

3.3.2 Building and other consents

To be lodged at a latter stage.

3.3.3 Final Design

The final design is yet to commence. Therefore, the final design cost cannot be provided. The specimen design cost of the Stormwater management system (surface collection and conveyance, waterway crossing systems, treatment devices, and discharges, etc) including field investigations, concept design, and documentation, etc, was approximately **$130,000.**

3.3.4 Construction

It is not possible to segregate the construction cost into collection, conveyance, attenuation and treatment as most devices are multi functional e.g. attenuation swales collect, convey, attenuate and treat runoff. Since the CSM is yet to be constructed, the value below is an estimate only.

Total stormwater management cost for the CSM is estimated at **$11,300,000 (base estimate, exclusive of any P&G costs)**

3.3.5 Monitoring Costs

The cost of monitoring is unknown as the construction phase of the CSM is yet to start, and costs will be influenced by the conditions of consent which are still subject to a hearing process at the time of this report.

3.3.6 Operation and Maintenance - Estimated Annual Cost

Operational and maintenance costs have been excluded from consideration in this report as they are unknown at this time and will be determined during subsequent phases (i.e. conditions of consent, detailed design, construction, and commission).

3.4 Time

3.4.1 Resource Consents

Resource consent applications were lodged in late February 2008; a hearing is expected in late September 2008 followed by a decision by December 2008, barring any appeals.

3.4.2 Building and other Consents

To be lodged at a latter detailed design stage.

3.4.3 Final Design Time

The specimen design for the CSM project was undertaken over about 9 months. The final design will be carried out during the latter D&C phase of the project.

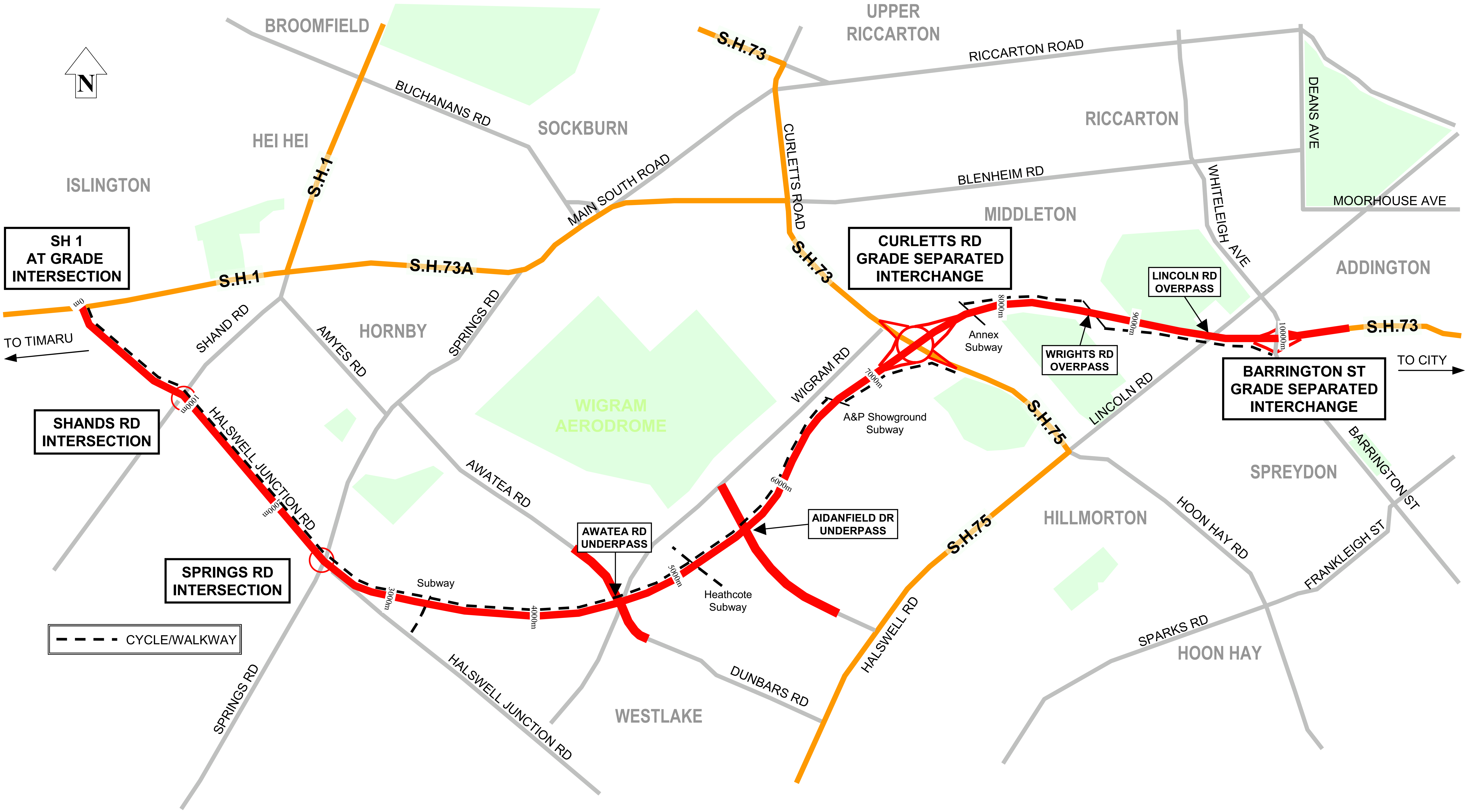
3.4.4 Construction

Physical works is yet to commence. The construction period is expected to be approximately 3 to 4 years.

3.4.5 Operation and Maintenance

Operation and maintenance timeframes have been excluded from consideration in this report as they are unknown at this time and will be defined and determined at the latter detailed design, construction and commissioning stage of the project.

Appendix A
Stormwater Management System - Location Plan


N
BROOMFIELD
UPPER RICCARTON
RICCARTON ROAD
S.H.73
BUCHANANS RD
SOCKBURN
HEI HEI
RICCARTON
ISLINGTON
S.H.1
MAIN SOUTH ROAD
CURLETTS ROAD
BLENHEIM RD
DEANS AVE
MOORHOUSE AVE
WHITELEIGH AVE
MIDDLETON
SH 1 AT GRADE INTERSECTION
S.H.73A
CURLETTS RD GRADE SEPARATED INTERCHANGE
ADDINGTON
LINCOLN RD OVERPASS
TO TIMARU
SHAND RD
AMYES RD
HORNBY
SPRINGS RD
Annex Subway
WRIGHTS RD OVERPASS
BARRINGTON ST GRADE SEPARATED INTERCHANGE
TO CITY
WIGRAM RD
LINCOLN RD
SHANDS RD INTERSECTION
HALSWELL JUNCTION RD
WIGRAM AERODROME
A&P Showground Subway
S.H.75
BARRINGTON ST
SPREYDON
AWATEA RD
AIDANFIELD DR UNDERPASS
HILLMORTON
HOON HAY RD
FRANKLEIGH ST
SPRINGS RD INTERSECTION
AWATEA RD UNDERPASS
Subway
Heathcote Subway
HALSWELL RD
SPARKS RD
HOON HAY
CYCLE/WALKWAY
DUNBARS RD
WESTLAKE
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Appendix B
Stormwater Management – Concept Design

Insert Concept Drawings Here