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Report

STORMWATER MANAGEMENT REVIEW

SH2 DOWSE TO PETONE UPGRADE

Prepared for Transit New Zealand (Client)

By Beca Infrastructure Ltd (Beca)

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Revision History

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Introduction

Transit New Zealand commissioned Beca to carry out a review of the State Highway 2 Dowse to Petone Upgrade (SH2 D2P) project and provide stormwater related information on the catchments and the design.

The SH2 D2P Upgrade project involves the upgrade of a 3km section of the existing highway in the Hutt Valley, Wellington. It generally involves the construction of a grade-separated interchange; overbridges a local road and another for the railway station carpark; improving the road geometry and pavement; providing new barriers to separate the north and southbound lanes; railway carpark rearrangement; and the construction of new local roads. Refer Figure 1 in Appendix A for a schematic diagram of the SH2 D2P Upgrade.

The design was developed and completed prior to a focus being made on stormwater attenuation and treatment in the Wellington region.

This information is provided Transit to use in their Stormwater Management Standard project.

1 Environmental Factors

This section briefly describes the environmental factors characterising the SH2 D2P catchments.

1.1 Description of Catchments

1.1.1 Terrain

The SH2 D2P corridor is located at the bottom of the escarpment formed by the Western Hills and is positioned between the hillside and the Hutt Valley railway line. Refer pictures 1, 2 and 3 taken recently during construction that illustrate the terrain.

The catchments that drain to SH2 D2P are typically steep with incised gullies and valleys that are drained by small streams and/or Council piped stormwater networks. The valley floor beyond the escarpment is very flat and fully developed. It also forms part of the wider Hutt River floodplain.

The upper catchments are part residential with regenerating native bush whereas and the lower parts are industrial areas leading into commercial and residential zones further beyond the railway.

The largest example of this type of catchment is the Korokoro Stream catchment. This drains a significant part of the Belmont Regional Park. It contains mainly pastoral land with native bush including only some small areas of residential development.

Picture 1: Western end of the site showing Korokoro Stream valley on the left with the stream outfall in Wellington Harbour in the foreground (photos courtesy of Above Ground Ltd).

Pictures 2 and 3: Western half of the SH2 D2P site looking west towards the Harbour (left photo) and the eastern half of the site looking east towards the Hutt River (photos courtesy of Above Ground Ltd).

1.1.2 Area

The catchments can be separated into two principal areas:

i. Western Hills Culvert Catchment — 177 ha (including the Percy Stream catchment of 78ha)

ii. Korokoro Stream Catchment — 1,650 ha

The highway east of Korokoro Road (shown in Figure 1 or the bridge crossing the railway in photo 3) generally drains to the Western Hills Culvert and the highway west of Korokoro Road drains to the Korokoro Stream.

1.1.3 Topography

The upgraded SH2 D2P corridor groundlevel varies from approximately a reduced level of 9m at the eastern end to 3m at the western end of the site. The highway gently undulates along its length between these levels.

The adjacent escarpment rises very steeply by approximately 20-40m before flattening out into less abrupt but still steep hill slopes.

The Western Hills Culvert catchment rises to a maximum reduced level of 248m over a horizontal distance of approximately 1.5km.

The Korokoro Stream catchment rises from sea level to a maximum height of 456m over a distance of approximately 6km.

1.1.4 Drainage Features

i. Existing Features

The larger hillside gullies contain old stormwater detention dams generally constructed for stormwater runoff attenuation. The newer dams are drained by piped outlets and the older by open channel spillways into small streams. The condition of the dams vary and many are silted up.

The residential suburbs in the Western Hills are generally drained by Hutt City Council piped drainage networks to either the Western Hills Culvert or to Korokoro Stream. The Western Hills Culvert is an old Council box shaped culvert (1.5m x 1.2m) that delivers stormwater flow to the lower reaches of the Hutt River – close to Wellington Harbour.

The area west of Korokoro Road is currently drained by a relatively small piped drain to Korokoro Stream. A few soakage sumps are also in this area and are reportedly not functioning very well.

The Korokoro Stream is very constricted in the reach immediately up and downstream of SH2. It passes under an old access bridge, under several buildings, the highway bridge, a rail bridge and a culvert before discharging to the Harbour at Petone beach.

Photo 4: Existing entrance to the Western Hills Culvert

ii. New Features

Where effected by the SH2 D2P works Council drains are being diverted, extended, strengthened and/or increased in diameter. This includes a new 350m long 1800ø culvert to replace the old Percy Stream culvert and ditch draining to the Western Hills Culvert.

The SH2 D2P works include significant quantities of new general carriageway catchpit/sump, pipe and manhole drainage part of which is for upgrading the undersized drain noted above.

The works also include construction of a new 400m long concrete open channel drain discharging to the Korokoro Stream. This channel drains a new local road while also acting as a cut off drain running along the foot of the escarpment so protecting the highway.

Refer Section 2.2.2 for a general breakdown of the drainage works.

Photos 5 & 6: New open channel cut off drain and the new 1800 diameter Percy culvert inlet during heavy rainfall part way through construction

1.1.5 Geotechnical Limitations and Opportunities

SH2 is built on the flat alluvial valley floor adjacent to a steep and often unstable Greywacke escarpment. This creates significant limitations for positioning drainage appropriately. Coupled with achieving adequate longitudinal falls to the limited outfall points creates significant difficulties for drainage.

The escarpment also makes it very difficult to construct the drainage (ie trenching along the foot of +7m near vertical cut faces) without previously constructing retaining walls or other slope stabilisation.

The groundwater table varies from approximately 500mm to 3m below ground but is most commonly 2m below ground. This is so far consistent with the conditions found during construction. At the western end of the site the groundwater table is influenced by the tide.

There are some soakage devices along the carriageway but these reportedly do not to function. Further use of soakage devices was not considered given the space constraints, soil types, runoff volumes, groundwater depth, maintenance considerations and the poor performance of existing soakage devices.

Some areas of the works have also been found to contain very high contaminated fill (heavy metals) where old industrial yards used to be located.

1.1.6 Soils

Soils on the hill slopes are mainly weathered Greywacke with a shallow topsoil layer.

The flat areas are generally formed from inter-layered alluvial silts and gravels to an approximate depth of 3m. Some areas have also been filled with crushed Greywacke as part of past construction work.

1.1.7 Erosion Potential

Significant erosion occurs throughout the steep hillslopes and associated gullies above SH2. The erosion potential upstream of the highway is therefore high.

Downstream of SH2 the erosion potential is low due to the piped nature of the watercourses.

The Korokoro Stream has a rocky bed as a result of erosion in its catchment. Erosion, deposition and bed load transportation are continual factors in this stream.

1.1.8 Flooding

Flooding is a significant hazard in the SH2 catchments. Flooding occurs on a local scale throughout the site, especially along the western section that drains to the Korokoro Stream.

This flooding is generally due to the downstream capacity constrictions of the existing Council drainage and the Korokoro Stream.

The Korokoro Stream has overtopped its banks before causing widespread flooding. In 1976 an extreme flood event inundated much of the surrounding land including the highway.

Secondary flow paths have been identified and allowed for as part of the upgrade design.

1.1.9 Design Storm Event

The design standards adopted were:

i. SH2 carriageway drainage	1 in 20yr ARI
ii. SH2 culvert crossings	1 in 100yr ARI – with 500mm freeboard
iii. Secondary flow	1 in 50yr ARI
iv. Local roads	1 in 10yr ARI
v. Council Carparks	1 in 5yr ARI

However, due to the constricted nature of the downstream systems a exemption of these standards was allowed by Transit’s Scope and Standards Committee. This meant that the drainage would be designed to function to the above standards if the downstream constrictions were alleviated in the future.

1.1.10 Vehicle Kilometres Travelled

The most recent Transit figures record the AADT at 36,299 for 2007 including 6.1% heavy. The site is 2.7km long therefore the kilometres travelled is 98,007 km/day.

1.1.11 Discharge Points

The area west of Korokoro Road discharges to Korokoro Stream. The area east of Korokoro Road generally discharges to the Western Hills Culvert - as shown in Figure 1.

Both the Stream and the culvert have a lower capacity than Transit's standards.

Secondary flow generally crosses the highway in two locations:

i. just east of Korokoro Stream bridge; and,

ii. approximately adjacent the Western Hills Culvert.

1.1.12 Catchment Classification

The highway corridor is peri-urban as determined by the method described in NSHS – 2007.

Although, it is noted that the Korokoro Stream catchment is better described as rural in nature.

1.2 Sensitivity of the Receiving Environment

The sensitivity of the receiving environments has been determined by the method described in Land Transport's Research Report 315: Receiving Environments at Risk from Road Runoff, and is set out below.

Three receiving environments have been assessed: the Western Hills Culvert (including Percy Stream), Korokoro Stream and due to its immediate proximity the Wellington Harbour.

1.2.1 Western Hills Culvert

i. Type Sensitivity Value

Assessed as low due to the majority of the watercourse being culverted and the Percy Stream being relatively steep

ii. Ecological Value

Assessed as medium. Percy Reserve forms a part of the catchment. This reserve is indentified by the Hutt City Council as a significant natural resource. However, the majority of the catchment is developed with relatively low ecological value. Regional Council ecological maps describe the presence of native fish in this catchment as "not probable".

iii. Human Use Value

Assessed as low. The majority of the catchment is culverted and therefore not accessible for use. However, it is noted that the Percy Stream branch does include duck ponds feed by the stream.

Attribute Score	Sensitivity	Score
Type Sensitivity Value	L	5
Ecological Value	M	10
Human Use Value	L	2
Total	**L**	**17**

1.2.2 Korokoro Stream

i. Type Sensitivity Value

Assessed as medium due to moderate gradient and the tidally influenced outlet.

ii. Ecological Value

Assessed as high. Even though large parts of the catchment consist of pastoral land, including the Belmont Regional Park, GWRC record several native fish species to be present. The upper reaches of the stream also include nationally threatened indigenous species.

iii. Human Use Value

Assessed as medium. The reach downstream of SH2 is largely unused by the public until it reaches Petone beach where better access potentially allows greater contact. The upstream catchment includes moderately significant cultural and recreational areas of the Belmont Regional Park.

Attribute Score	Sensitivity	Score
Type Sensitivity Value	M	20
Ecological Value	H	20
Human Use Value	M	5
Total	**H**	**45**

1.2.3 Wellington Harbour

i. Type Sensitivity Value

Assessed as high due to the enclosed nature of the harbour. GWRC has also likened the harbour in many ways to a lake.

ii. Ecological Value

Assessed as high. The Petone foreshore is a reserve that is an important roosting and feeding ground for several threatened bird species. The wider harbour also provides habitat for the Blue Penguin.

iii. Human Use Value

Assessed as high. The harbour has a high contact and non-contact recreational usage and has high historical significance to Te Atiawa Maori and Europeans alike.

Attribute Score	Sensitivity	Score
Type Sensitivity Value	H	30
Ecological Value	H	20
Human Use Value	H	10
Total	**H**	**60**

2 Designed Solutions

This section provides a brief description of the designed stormwater modifications to the existing stormwater network that are included in the SH2 D2P works.

2.1 Design Philosophy

2.1.1 Objectives

Transit's and Beca's objectives for the design were:

i. Increase the carriageway stormwater drainage standard to manage a 1 in 20 year ARI storm;

ii. Avoid increasing flooding risk to others; and,

iii. Achieve the best possible flood protection for up to a 1 in 100 year ARI storm.

The above objectives were agreed between Transit and Beca during the development of the design.

The various options for achieving the objectives were investigated and weighed up in the earlier Preliminary Design study and an even earlier Stormwater Scoping report.

The standards described in these documents where subsequently revised by the Scope and Standards Committee decision noted in Section 1.1.9.

2.1.2 Criteria

The criteria for the stormwater design provided for relatively standard drainage solutions (ie pipes and channels) and did not require attenuation nor treatment measures to be considered.

Erosion control was managed by the provision of rock rip-rap and gabions where works were to be conducted in stream beds. This was designed in accordance to Wellington Regional Council requirements.

It is noted that the design solutions were developed and completed (early 2003) prior to the time when quality treatment and attenuation were focused on in the Wellington Region.

Transit's standards for stormwater design were generally in excess of the Council's downstream networks into which significant areas of the site drain.

2.1.3 References

The references used in developing the above objectives were:

i. TNZ Bridge Manual;

ii. Korokoro Stream Flood Control Proposals, Wellington Regional Water Board, 1979;

iii. Western Hills Stormwater Runoff, BMP, 1986;

iv. SH2 – Melling to Petone Upgrade: Stormwater Drainage Scoping Report, Beca, 1998;

v. SH2 – Stormwater Drainage Study Petone to Melling, Beca, 1999.

2.2 Stormwater Management Devices

2.2.1 Erosion and Sediment Control

Erosion and sediment control was designed in accordance with the Culvert Manual and Wellington Regional Council Guidelines. The solutions consist of stone rip-rap to inlets/outlets/stream banks, gabion baskets and hydroseeding earthworks surfaces.

Standard sumps and catchpits provide sediment and gross litter traps in the finished works.

Construction erosion and sediment control is the Contractor's responsibility to manage in accordance with Regional Council requirements. To date this has meant the use of silt fences, temporary sediment control ponds, sand bagged sump inlets, vehicle washes, stabilised site entrances and hydroseeding.

2.2.2 Operational Stormwater Management (Permanent)

From the kerb and channel runoff is collected and conveyed by standard municipal style sump, pipe and manhole drainage.

The complex existing drainage networks in the Western Hills, with attenuation dams and small streams, was modelled with XP-SWMM software.

Cut off channels have been used where practical to intercept hillslope runoff before it reaches the carriageway.

Other than sumps there are no specific treatment devices or attenuation mechanisms in the design.

The positioning of the drainage was heavily dependant on the severe geographical confinements of the highway corridor. The limited longitudinal fall available and the flanking restrictions of the escarpment and rail corridor (and other private properties) coupled with the limited number of outfall locations effectively pre-determined many of the drainage routes.

The following generally summarises the quantity of the stormwater drainage works:

i. Sumps	142
ii. Manholes	107
iii. Greater than 1050ø pipes	330m
iv. Less than 1050ø pipes	4,500m
v. Open channels (mostly grassed)	1,100m
vi. Concrete open channels	670m
vii. Headwalls	21

2.3 Cost

2.3.1 Resource Consents

The stormwater consenting was part of a significant wider consenting project for all of the SH2 D2P Upgrade.

This included preliminary design investigations, public and stakeholder consultation, preparation of the Assessment of Environmental Effects for the Notice of Requirements, hearings and consenting. Due to this complexity the stormwater related costs are not able to be separately identified from the whole.

2.3.2 Building Consents

There were no specific Building Consents associated with drainage works however the whole SH2 D2P upgrade was approved by Hutt City Council during the Notice of Requirements procedure.

2.3.3 Final Design

The fee cost of the detailed drainage design, including production of construction drawings, was approximately $140,000.

2.3.4 Construction

The construction costs for the stormwater were tendered as part of the SH2 D2P Upgrade contract 418N as a Measure and Value contract.

In 2008 and subsequent to the tender being awarded, Transit and the Contractor agreed to a lump sum for the stormwater drainage component of the contract. The breakdown of the lump sum stormwater work is approximately:

i. Carriageway collection (sumps)	$270,000
ii. Collection and Conveyance (open channel cut off drains)	$840,000
iii. Conveyance (pipes & manholes)	$1,150,000
iv. Attenuation	$Nil
v. Treatment (erosion control rip-rap & gabions)	$42,000[1]
vi. Total Lump Sum Stormwater Drainage	$4,600,000

1: Cost of construction erosion and sediment control is built into the price for the wider drainage works.

2.3.5 Monitoring Costs

Beca is providing MSQA services to Transit for the construction of the SH2 D2P Upgrade. The stormwater component of this fee may be estimated as $150,000 for the total construction period.

There are no specific stormwater devices that require specific monitoring aside from that included in the general highway maintenance contract for the region.

2.3.6 Operational and Maintenance Estimated Annual Cost

The only regular annual operational and maintenance costs attached to the works is the cost to clean out the catchpits and sumps.

The highway maintenance contract for the Wellington region is a Hybrid Contract and as such the cost of cleaning out catchpits is part of a lump sum and not readily identifiable.

2.4 Time

2.4.1 Resource Consents

The Resource Consents, including several stormwater related consents, for the SH2 D2P Upgrade were applied for and granted in the following order:

Consent	Submitted	Approved
SH2 D2P Upgrade Notice of Requirements	30 March 2001	21 November 2001
Percy's Stream – 4 consents	1 May 2003	26 June 2003
Korokoro Stream – 4 consents	11 December 2002	13 August 2003

Several new consents and amendments to consents have also been required during the construction phase as unforeseen issues arise.

2.4.2 Building Consents

No Building Consents where required specifically for the stormwater drainage works. Also refer Section 2.1.1.

2.4.3 Final Design

The stormwater detailed design took approximately 20 weeks to complete. This excludes the earlier preliminary design and option development.

2.4.4 Construction

The contractor has programmed the stormwater drainage to take 59 weeks (often with works progressing concurrently on different parts of the site) out of an overall project duration of 118 weeks.

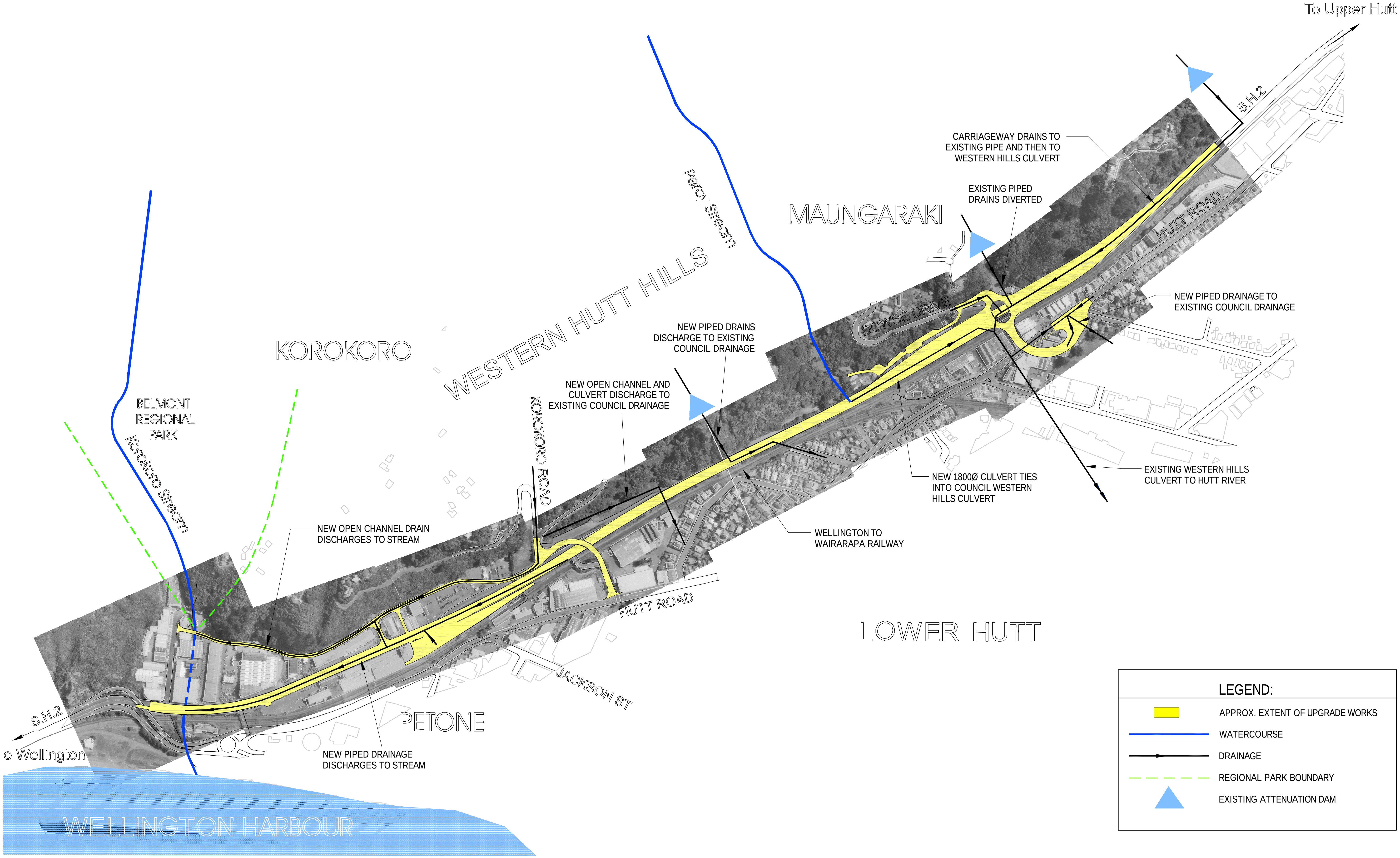
Separation into construction times for collection, conveyance, etc is not practical as they are generally being constructed at the same.

2.4.5 Operation and Maintenance

The life expectancy prior to the main drainage works varied with the life expectancy of parts of the network being significantly less than 50 years. Some drains constructed in the early 1900's have been found to be in a very poor condition and could not have been expected to last longer than 5 years under the amended SH2 alignment.

The estimated life expectancy for the renewal is generally 50 years with the expectancy of the large pipe work components being greater than 50 years.

Appendix A: Figure 1



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CAD FILE No.

SH2 DOWSE TO PETONE UPGRADE
SCHEMATIC DRAINAGE LAYOUT

FIGURE No. 1