24 October 2019

OTAGO REGIONAL COUNCIL
RECEIVED DUNEDIN
29 OCT 2019
FILE No 9A65368
DIR TO Karen

Otago Regional Council
Private Bag 1914
DUNEDIN 9054

Attention: Joanna Gilroy

Clutha District Council
PO Box 25
BALCLUTHA 9240

Attention: Ian McCabe

Dear Jo / Ian

NEW BEAUMONT BRIDGE - NOTICE OF REQUIREMENT AND RESOURCE CONSENT APPLICATIONS – NZ TRANSPORT AGENCY

Enclosed is a Notice of Requirement for an Alteration of Designation and the necessary Resource Consent applications for the construction of the New Beaumont Bridge, at Beaumont from the NZ Transport Agency.

The notice and applications are accompanied by an assessment of environmental effects, supporting technical assessment and plans.

Please note the NZ Transport Agency requests these applications are publicly notified and jointly processed.

If you could advise of your requirements for the payment of the lodgement fee and I can make the necessary arrangements.

Please contact me with any questions.

Kind Regards

Shane Roberts
Work Group Manager - Planning & Property

WSP
Dunedin
197 Rattray Street
Dunedin 9016
New Zealand
+64 3 471 5500
wsp.com/

NZ TRANSPORT AGENCY
WAKA KOTAHI

New Beaumont Bridge

Notice of Requirement for an Alteration to a Designation and Resource Consent Applications

Quality Assurance Statement	
	Project Manager: Simon Underwood
	Prepared by: Shane Roberts
	Reviewed by: Richard Shaw
	Approved for issue by: Simon Underwood

Revision Schedule

Rev. No	Date	Description	Prepared by	Reviewed by	Approved by
1	October 2019	For lodgement	SR	RS	SU

NZ Transport Agency

Contents

Form 18
Notice of Requirement for an Alteration of Designation

Pursuant to Section 181 of the Resource Management Act 1991 (RMA)

TO: **CLUTHA DISTRICT COUNCIL (CDC)**
PO Box 25
BALCLUTHA 9240

FROM: **NZ TRANSPORT AGENCY (the Transport Agency)**
PO Box 5245
DUNEDIN

(NOTE: address for service given below)

Notice is given to CDC of a requirement by the Transport Agency for an alteration to a designation for a public work.

The land parcels affected by this Notice of Requirement fall into two categories: land required for road, and land required for construction.

Included within the designation will be traffic lanes, cycle/pedestrian connections, stormwater infrastructure, landscaping, ancillary infrastructure, and road construction.

The term sought to give effect to the designation is 10 years, in accordance with Section 184(1)(c) of the Resource Management Act 1991.

The designation over land required for construction is required until such time as road construction is complete, after which these parts of the designation will be uplifted.

Further details of the required designation are as follows:

Location:

The location to which this Notice of Requirement applies is generally described as a section of State Highway 8 at the Beaumont bridge and approaches.

The land parcels affected by this Notice of Requirement are as set out in the Land Requirement Schedules below and their location is shown on the Designation Plan attached to and forming part of this Notice of Requirement.

LAND DESIGNATION SCHEDULE– LAND REQUIRED FOR STATE HIGHWAY PURPOSES		
REFERENCE	DESCRIPTION	ADDITIONAL LAND TO BE DESIGNATED (m^2)
1a	SECTION 4 TN OF BLK XVI DUNKELD, OT207/11 PETERS FAIRFIELD TRUSTEES NO 3 LIMITED	195
1b	SECTION 3 TN OF BLK XVI DUNKELD, OT207/11 PETERS FAIRFIELD TRUSTEES NO 3 LIMITED	230
1c	SECTION 2 TN OF BLK XVI DUNKELD, OT207/11 PETERS FAIRFIELD TRUSTEES NO 3 LIMITED	280
1d	SECTION 1 TN OF BLK XVI DUNKELD, OT207/11 PETERS FAIRFIELD TRUSTEES NO 3 LIMITED	320
1e	SECTION 5 TN OF BLK IX DUNKELD, OT207/11 PETERS FAIRFIELD TRUSTEES NO 3 LIMITED	550
1f	SECTION 6 TN OF BLK IX DUNKELD, OT207/11 PETERS FAIRFIELD TRUSTEES NO 3 LIMITED	575
1g	SECTION 7 TN OF BLK IX DUNKELD, OT207/11 PETERS FAIRFIELD TRUSTEES NO 3 LIMITED	865
1h	SECTION 8 TN OF BLK IX DUNKELD, OT207/11 PETERS FAIRFIELD TRUSTEES NO 3 LIMITED	875
1i	SECTION 9 TN OF BLK IX DUNKELD, OT207/11 PETERS FAIRFIELD TRUSTEES NO 3 LIMITED	835
1j	SECTION 1 SURVEY OFFICE PLAN 23609 OTAGO, OT14B/673 PETERS FAIRFIELD TRUSTEES NO 3 LIMITED	965
1k	SECTION 4 SURVEY OFFICE PLAN 23609 OTAGO, OT14B/673 PETERS FAIRFIELD TRUSTEES NO 3 LIMITED	2865
2a	LOT 3 DEPOSITED PLAN 8804 444076 DUNBROOK DAIRIES LIMITED	1965
3a	PT SECTION 4 TN OF BLK XI DUNKELD OT331/181 JOHN ADRIAN NICHOLAS VAN ROSSEM	15
4a	SECTION 4 TN OF BLK VIII DUNKELD 473740 ALISON MARY MILLS GUNNAR EGILSSON	4065
4b	SECTION 1 TN OF BLK VIII DUNKELD 473740 ALISON MARY MILLS GUNNAR EGILSSON	450
4c	SECTION 2 TN OF BLK VIII DUNKELD 473740 ALISON MARY MILLS GUNNAR EGILSSON	1175
7a	CROWN LAND BLOCK VII TOWN OF DUNKELD DOC	865
7b	SECTION 1 50 23609 OTAGO OT148/673 DOC	125
7c	CROWN LAND RIVER BED LINZ	8500
8a	SECTION 2 SURVEY OFFICE PLAN 23610 OT14B/688 DOC	2920

8b	SECTION 2 SURVEY OFFICE PLAN 23610 OT14B/688 MITCHELL	9990
8c	SURVEY 2 OFFICE PLAN 23610 OT14B/689 MITCHELL	14620
9a	SECTION 1 TN OF BLK XX DUNKELD OT176/254 MARGARET FRANCES YARKER MICHAEL BRIAN HEALY	35

For completeness the following pieces of land are not being designated, but will be acquired for 'local road' and are shown on the designation plans as such

Land to be acquired for local road		
REFERNCE	DESCRIPTION	AREA (m^2)
2b	LOT 3 DEPOSITED PLAN 8804 444076 DUNBROOK DAIRIES LIMITED	255
5a	SECTION 8 TN OF BLK I DUNKELD 444075 JOSEPH CHRIS THEO SCHOLTEN	10
6a	PT SECTION 9 TN OF BLK I DUNKELD OT211/109 LAWRENCE TOWNHOUSE ACCOMMODATION LIMITED	10

The nature of the proposed public work (*or* project or work) is:

State highway purposes.

Included in the attached Assessment of Environmental Effects are:

a) The nature of the proposed conditions that would apply
b) The effects that the public work (or project or work) will have on the environment, and the ways in which any adverse effects will be mitigated
c) Alternative sites, routes, and methods have been considered
d) Why the public work (or project or work) and designation (or alteration) are reasonably necessary for achieving the objectives of the requiring authority
e) A statement of consultation

The following resource consents are needed for the proposed activity and have been applied for:

From Clutha District Council – Land use consent under the Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011 (NESCS).

From Otago Regional Council – a range of land use consents (s9 and s13 RMA), water permits and discharge permits are required.

The Transport Agency attaches the following information required to be included in this notice by the district plan, regional plan, or any regulations made under the Resource Management Act 1991.

Assessment of Environmental Effects and designation plans.

Richard Shaw

Richard Shaw – Team Leader Consents and Approvals

Pursuant to authority delegated by the NZ Transport Agency

Date: 24 October 2019

<u>Address for Service</u>:
NZ Transport Agency
c/- WSP Opus
Private Bag 1913
DUNEDIN 9054

ATTENTION: Shane Roberts

Ph (03) 454 5029
Mobile 027 237 1168
Email shane.l.roberts@wsp.com

Form 9
Application for Resource Consent

Pursuant to Section 88 of the Resource Management Act 1991 (RMA)

TO: **CLUTHA DISTRICT COUNCIL (CDC)**
PO Box 25
BALCLUTHA 9240

FROM: **NZ TRANSPORT AGENCY (the Transport Agency)**
PO Box 5245
DUNEDIN

(<u>NOTE</u>: address for service given below)

1. **The Transport Agency** applies for the following types of resource consent:

RMA	Activity	Duration Sought
Land use consent S9 RMA	Disturb soil Under the Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011 (NESCS).	10 years
	Land use consent to construct road & extend Hotel carpark	
	Land use consent to trim scheduled trees	

2. **The activity to which the application relates (the proposed activity) is as follows:**

Earthworks associated with the construction of the new Beaumont Bridge and approaches at Beaumont.

Refer to the Assessment of Effects on the Environment (AEE) for a detailed description of the proposed activities.

3. **The site at which the proposed activity is to occur is as follows:**

State Highway 8 and surrounds at the Beaumont bridge and approaches.

4. **The full name and address of each owners and occupier (other than the applicant) of the site to which the applicates relates is as follows:**

- Clutha District Council
- M & M Healy, 2 Weardale Street, Beaumont
- D & J Mitchell, 1773 Beaumont Highway, Beaumont
- T & K Peters, 1910 Beaumont Highway, Beaumont

5. **Additional resource consents required in relation to the proposal are as follows.**

From Otago Regional Council – a range of land use consents (s9 and s13 RMA), water permits and discharge permits are required.

6. **Attached is an assessment of the proposed activity's effect on the environment that—**

a) includes the information required by clause 6 of Schedule 4 of the Resource Management Act 1991; and
b) addresses the matters specified in clause 7 of Schedule 4 of the Resource Management Act 1991; and

c) **includes such detail as corresponds with the scale and significance of the effects that the activity may have on the environment.**

7. **Attached is an assessment of the proposed activity against the matters set out in Part 2 of the Resource Management Act 1991.**

8. **Attached is an assessment of the proposed activity against any relevant provisions of a document referred to in section 104(1)(b) of the Resource Management Act 1991, including the information required by clause 2(2) of Schedule 4 of that Act.**

Richard Shaw – Team Leader Consents and Approvals

Pursuant to authority delegated by the NZ Transport Agency

Date: 24 October 2019

<u>Address for Service</u>:
NZ Transport Agency
c/- WSP Opus
Private Bag 1913
DUNEDIN 9054

ATTENTION: Shane Roberts

Ph (03) 454 5029
Mobile 027 237 1168
Email shane.l.roberts@wsp.com

Form 9
Application for Resource Consent

Pursuant to Section 88 of the Resource Management Act 1991 (RMA)

TO: **OTAGO REGIONAL COUNCIL**
PRIVATE BAG 1954
DUNEDIN 9054

FROM: **NZ TRANSPORT AGENCY (the Transport Agency)**
PO Box 5245
DUNEDIN

(NOTE: address for service given below)

1. **The Transport Agency** applies for the following types of resource consent:

RMA	Activity	Duration Sought
Land use consent S9 RMA	Earthworks on a contaminated site	10 years
Land use consent S13 RMA	Erection of structures and associated bed disturbance of the Clutha River Mata-Au	
	Gravel extraction from the Clutha River Mata-Au	
	Removal of vegetation in the bed, including associated disturbance of the bed of the Clutha River Mata-Au	
Water Permit S14 RMA	Permanent diversion of the Clutha River Mata-Au	
	Temporary diversion of the Clutha River Mata-Au	
Discharge Permit S15 RMA	Discharge of stormwater to surface water and/or land where it may enter water (construction)	
	The discharge of a sediment associated with construction activity	

2. **The activity to which the application relates (the proposed activity) is as follows:**

The construction and operation of the new Beaumont Bridge and approaches at Beaumont.

Refer to the Assessment of Effects on Environment (AEE) for a detailed description of the proposed activities.

3. **The site at which the proposed activity is to occur is as follows:**

State Highway 8 and surrounds at Beaumont.

4. **The full name and address of each owners and occupier (other than the applicant) of the site to which the applicates relates is as follows:**

- The Crown (river bed)
- M & M Healy, 2 Weardale Street, Beaumont
- D & J Mitchell, 1773 Beaumont Highway, Beaumont
- T & K Peters, 1910 Beaumont Highway, Beaumont

5. **Additional resource consents required in relation to the proposal are as follows.**

From Clutha District Council – Land use consent under the Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011 (NESCS).

Land use consent for road construction and the trimming of scheduled trees.

6. **Attached is an assessment of the proposed activity's effect on the environment that—**

d) includes the information required by clause 6 of Schedule 4 of the Resource Management Act 1991; and
e) addresses the matters specified in clause 7 of Schedule 4 of the Resource Management Act 1991; and
f) includes such detail as corresponds with the scale and significance of the effects that the activity may have on the environment.

7. **Attached is an assessment of the proposed activity against the matters set out in Part 2 of the Resource Management Act 1991.**

8. **Attached is an assessment of the proposed activity against any relevant provisions of a document referred to in section 104(1)(b) of the Resource Management Act 1991, including the information required by clause 2(2) of Schedule 4 of that Act.**

Richard Shaw

Richard Shaw – Team Leader Consents and Approvals

Pursuant to authority delegated by the NZ Transport Agency

Date: 24 October 2019

<u>Address for Service</u>:
NZ Transport Agency
c/- WSP Opus
Private Bag 1913
DUNEDIN 9054

ATTENTION: Shane Roberts

Ph (03) 454 5029
Mobile 027 237 1168
Email shane.l.roberts@wsp.com

1. Introduction

The Transport Agency is a Crown entity with its objective, functions, powers and responsibilities set out in the Land Transport Management Act 2003 and the Government Roading Powers Act 1989. The Transport Agency is also a requiring authority under s.167(3) of the Resource Management Act (RMA).

Our purpose is creating transport solutions for a thriving New Zealand. The Transport Agency shapes New Zealand's transport networks and people's safe and efficient use of them. The Transport Agency connects families, help businesses take goods to market, and help others work, study and play.

An integrated approach to transport planning, funding and delivery is taken by the Transport Agency. This includes investment in public transport, walking and cycling, local roads and the construction and operation of State Highways. The Transport Agency exhibits a sense of social and environmental responsibility when undertaking this work.

Purpose and Scope of this AEE Report

This Assessment of Effects on the Environment (AEE) report and supporting documentation have been prepared in support of the Notice of Requirement (NoR) for the designation alteration and applications for resource consents which would authorise, under the Resource Management Act 1991 (RMA), the construction, operation and maintenance of the Project.

This AEE report includes a comprehensive and integrated assessment of environmental effects, which addresses all aspects relevant to the consideration and determination of the NoR and resource consent applications.

Structure of this Report

The documentation required for the NoR and resource consent applications is contained in two volumes:

- Volume A: Applications and AEE Report and Technical Appendices
- Volume B: Plans and Drawings.

This AEE report, in conjunction with plans and technical reports, has been prepared in support of the applications sought for the Project. It provides the following:

- Project background and reasons for the project
- A description of the existing environment
- An assessment of the alternatives that have been considered
- A description of the consultation and engagement undertaken through the development of the Project and the identification of persons affected by the Project
- A description of both the construction and operation of the Project
- An assessment of any actual or potential effects on the environment that may result through the construction, operation and maintenance of the Project (including proposed measures to mitigate adverse effects)
- Proposed conditions to be attached to the designation and consents
- An assessment of the statutory matters to be considered in respect of the Project.

2. Reasons for the Project

2.1 Project Objectives

The primary objective of the project is to achieve security of route for State Highway 8 (SH8), across the Clutha River Mata-Au at Beaumont. In addition to the primary project objective, the following key design influences have been identified:

1. Maintaining the highway function and standard in context with the adjacent state highway environment
2. Minimising social impact on the Beaumont community
3. Optimising environmental and heritage opportunities, where directly associated with the highway works
4. Ensuring the existing structure provides an attractive facility for ongoing use as a pedestrian and cycle linkage between the Clutha Gold Cycle Trail and wider Beaumont town services

2.2 Need for the Project

The bridge at Beaumont forms part of SH8 between the Clutha and Central Otago Districts. The route is the primary traffic and freight route between Dunedin and Queenstown; and while other and notably longer alternative routes are available for general traffic, this route is the only High Productivity Motor Vehicles (HPMV) capable route between the same centres.

The bridge is a single lane, five span, truss bridge; and more significantly in this context was opened in 1887 with wrought iron materials. Across the trusses there are clear signs of fatigue within the wrought iron, nominally associated with the age of the structure and the increase of live loads from its initial service to the present day. Although the structural integrity of the existing bridge does not translate to a public safety risk, the bridge condition is such that the Transport Agency is unable to retain confidence as to its long-term serviceability.

A Detailed Business Case to replace the bridge has been undertaken through which the problem and benefits were defined, and a preferred alignment option (incorporating a new structure) was established.

2.2.1 Problem

Broadly speaking, there are three key problems associated with the current bridge:

- Seismic capacity is considerably lower than today's standard for a structure on a State Highway route.
- Fatigue/corrosion reducing the remaining useful life of the structure for carrying traffic and heavy vehicles.
- Does not meet current standards for width and has no adequate pedestrian and cyclist provision.

<u>Current condition of Beaumont Bridge</u>

The current Beaumont Bridge is exhibiting a number of physical symptoms of deterioration, which requires constant ongoing management including the following:

i) Strengthening repairs to the lower chord in the highest risk areas where existing cracks could lead to sudden deterioration without warning.

ii) Annual maintenance of the timber deck includes stringer strengthening, replacement and tightening of running boards and deck boards and packing between stringers and deck boards to reduce vibration.

iii) Installing full scaffold to allow access for on-going inspection and testing.

iv) Setting up a testing and monitoring programme to track crack propagation and identify any new cracks.

Monitoring includes:

- Surface and edge notch cracks. Non-destructive testing is carried out on selected representative features. Testing includes a full sweep of higher stress and poorer quality areas looking for cracks not yet visible to the eye. The routine surveillance plan focusses on changes in the condition of selected features; such features being used as indicators of the overall rated deterioration.
- The western abutment, that has settled and cracked, is founded on gravels whereas the piers are all founded on rock.
- The wrought iron transoms that have been strengthened using a king post/tie rod system which provides a degree of pre-tension, reducing the stresses in the transoms. Maintenance includes replacement of the relatively lightly designed connections and ensuring the tie rods are in tension.

(v) Reducing the dynamic load on the structure by installing traffic lights. All vehicles are stopped prior to crossing the bridge. In addition there is a maximum 30kph posted speed limit for all heavy commercial vehicles. Some overweight vehicles are restricted to crawl speed.

2.2.2 Potential impacts of problem

As identified above, there are a number of issues associated with the current bridge. Should it become unusable for any reason the following are potential impacts that would be realised:

- When the bridge has been closed for maintenance this results in traffic impacts between Lawrence and Roxburgh with a diversion via Clydevale or Balclutha which increases this trip from 40 minutes to 1.5 hours or 2.25 hours, respectively.
- The only other crossing between these two bridges of the Clutha River is the Tuapeka Mouth Ferry which operates daily 8am till 10am and 4pm until 6pm, river level permitting and strict weight restrictions. These restrictions make this unreliable as a crossing point.
- Due to the condition of the Millers Flat Beaumont Road, which is a single car width for the majority of this 20km unsealed shared track, this is not an encouraged alternative route and therefore not discussed.

2.2.3 Proposed Solution

The Transport Agency has proposed a new bridge to improve the road safety, resilience and connectivity, travel time and capacity. The new bridge is proposed to be located immediately downstream of the existing bridge and is detailed in Section 5.

2.3 Need for the Designation

Part VIII of the RMA allows for requiring authorities to request land be designated in District Plans for projects and works for which the Requiring Authority has financial responsibility. The Transport Agency is a Requiring Authority and has financial responsibility for the designation and the works proposed.

The designation is considered both reasonably necessary and to be the preferred planning mechanism for the Project. Over the long term, a designation provides greater certainty and flexibility than a resource consent. This certainty is important as the Transport Agency is making a long-term commitment to this Project, which will result in some permanent land use changes. A resource consent would result in less certainty for the

Transport Agency and the community in terms of process and outcome, and there is less scope for minor changes to design detail once approved.

2.4 Benefits of the Project

The completion of the Project will assist in both regional and national economic growth and have a number of other key benefits, including those set out below. The Project will:

- Increase resilience and reliability of the state highway network.
- Provide improved connectivity and predictable travel between Dunedin and Central Otago.
- Improve safety to road users.
- Improve load and traffic capacity of the crossing.

3 Statutory Approvals Sought under the RMA

The RMA outlines a number of relevant considerations for the determination of NoR and applications for resource consent. In this section the key statutory matters under the RMA and their relevance to the Project are set out being:

- Notices of requirement for designations and outline plans (Part 8 RMA)
- Applications for resource consent (Part 6 RMA).

This section only seeks to set out the statutory matters. The assessment of the Project in relation to these matters is provided in Section 9 of this report.

3.3 Notice of Requirement

The Transport Agency has requiring authority status and is seeking to alter the designation for the Project as part of undertaking their legislative functions.

The prescribed form for a NoR is set out in Form 18 of the Resource Management (Forms, Fees, and Procedure) Regulations 2003. The NoR for the Project has been prepared in accordance with these regulations.

Section 176A provides that an outline plan must be submitted to a territorial authority before commencing construction of a project or work under a designation unless certain circumstances apply (which are not relevant to the Project). An outline plan will be lodged with Clutha District Council following the confirmation of the designation, and subsequent detailed design.

3.4 Resource Consents

Land Use consent is required form the Clutha District Council for the construction of a Road (outside of the area designated for State highway).

The regional consents required for the project under the Operative Regional Plan: Water for Otago and Regional Plan: Waste for Otago are set out below and discussed in detail in Section 9 of this report.

The extent of consents required from the Otago Regional Council include activities within or affecting the water or the beds and riparian margins of the Clutha River Mata-Au.

The Transport Agency is applying for resource consents for the following broad group of activities:

- Section 9 of the RMA: disturbance of contaminated land
- Section 13 of the RMA: erection of new structures and associated bed disturbance
- Section 14 of the RMA: diversions and temporary damming
- Section 15 of the RMA: discharges of sediment-laden water from construction.

Land use consent under the Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011 (NESCS) is also required from Clutha District Council.

Consent is also required from the Clutha District Council for local road construction and the trimming of scheduled trees.

Table 1: Resource consents required from Otago Regional Council / Permitted Activities

Consent Type	Activity	Regional Rule(s)	Activity Class	Scope of Application
Land use consent s9	Disturbance of land at a contaminated site.	5.6.1	Discretionary	Land disturbance associated with construction activity.
Land use consent s13	Erection of structures (temporary working platform(s), new bridge, the placement of rip rap (rock armouring), deposition of material, and the associated disturbance to the bed of the Clutha River.	RPW 13.2.1.1	Discretionary	Erection of new bridge structure. Abutment scour protection – rock rip rap Temporary culverts to access site Associated disturbance to the bed of Clutha River Mata-Au.
	Removal of vegetation in the bed, including associated disturbance of the beds.	13.2.1.1	Discretionary	Vegetation removal in the banks of the riverbed and associated disturbance to the bed.
	Use of structures and maintenance including associated disturbance.	13.3.1.1	Permitted	Use and maintenance of bridge once constructed.
	Removal of structure – temporary working platform.	13.4.1.1	Permitted	Removal of temporary working platform.
Water permit s14	Diversion of watercourses.	12.3.4.1(i)	Discretionary	Clutha River Mata-Au– temporary diversion to allow for construction works. Clutha River Mata-Au – permanent diversion from the bridge piers.
	Taking of ground water – dewatering (non-consumptive take).	12.2.2.2	Permitted	Site dewatering will not exceed 25,000L/day.

Consent Type	Activity	Regional Rule(s)	Activity Class	Scope of Application
Discharge permit s15	Discharge of contaminants to Air.	RPA 16.3.13.1.2	Permitted	The discharge of contaminants to air from road construction is a permitted activity – providing the discharge is not noxious, dangerous, offensive or objectionable at or beyond the boundary of the property.
	Discharge of stormwater from a road.	13.B.1.9	Permitted	

Table 2 - Resource Consents Required from Clutha District Council

Consent Type	Activity	District Rule(s)	Activity Class	Scope of Application
Land use consent s9	For the disturbance of contaminated land under the Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011 (NESCS)	N/A – subject to NES	Discretionary	Disturbance to land from earthworks
	Road construction	TRAN.1(1)(iii) / INF.2(iii)	Restricted Discretionary Discretionary	Upgrades to Dee Street, Westferry Street / Ronagahere Road intersection / turning head construction Westferry Street and Weardale Street.
	Hotel carpark construction	RST.4	Controlled	Extension of existing Beaumont Hotel Carpark.
	Modification of Heritage Item (trees)	HER.1(iv)	Discretionary	Trimming of trees potentially in excess of 'minor pruning'.

4 Existing Environment

4.1 Location

The existing Beaumont Bridge over the Clutha River Mata-Au is located on SH8 at the small Otago settlement of Beaumont, located between Lawrence and Raes Junction on SH8. The settlement of Beaumont straddles both sides of the Clutha Mata-Au River. Surrounding land use is a mixture of agriculture, rural residential and residential activity.

4.2 Existing Transport Network

The existing transport network in the vicinity of the site is as follows. From west to east, the SH8 enters the town after a left hand bend, with a 75km/h advisory speed, and with Westferry Street forming an intersection with the SH8 (on an acute angle) on the right hand side. From here the SH8 continues straight, passing through the Dee Street priority controlled intersection and over a small rise in front of the Beaumont Hotel. The highway then passes through the Rongahere Road intersection before reaching the existing single lane, traffic signal controlled, bridge over the Clutha River. Rongahere Road provides access along the true right bank of the Clutha River Mata-Au to Clydevale, though Westferry Street provides the most direct access from SH8 highway to Rongahere Road for traffic entering the town from the west. An informal gravel track at the northern end of Rongahere Road provides river access downstream of the existing bridge. Continuing east from the bridge, SH8 turns through a reverse curve signed with a 55km/h advisory speed and with intersections with Craig Flat Road, Weardale Street and Stonewall Street. Craig Flat Road provides access to a parking area adjacent the existing bridge with access to the Clutha Gold cycle trail. Weardale Street and Stonewall Street provide access to residential properties on the eastern side of the river, as well as community facilities such as the Beaumont Hall and Beaumont Cemetery. The Clutha Gold trail runs along Craig Flat Road, Weardale Street, Eastferry Street and across farmland before joining SH8 to the east of the town. SH8 passes over the Low Burn Bridge 200m east of Stonewall Street at the eastern end of the town.

Aside from the roads in the vicinity of the site, there is also limited use of the surface of the Clutha River Mata-Au for transport – mainly related to tourism and recreation.

4.3 Existing Pedestrian and Cycle Links

Beaumont township does not have any formed footpaths and any pedestrians in the area make use of existing roadside verges. The existing bridge features a very narrow pedestrian walkway on the downstream side of the bridge.

No specific walking and cycling infrastructure has been installed on SH8 by the NZ Transport Agency though it is noted that a manually operated push-button has been installed on the traffic signals to allow cyclists to access the bridge in advance of traffic.

The existing Clutha Gold Trail traverses the site. The trail crosses SH8 on the eastern approach to the existing Beaumont Bridge, and runs along the western side of SH8 to the intersection with Weardale Street. From here the Trail runs 'on road' along Weardale Street, turning left into Eastferry Street, across Stonewall Street and onto a short off road section starting at the Beaumont Hall, across the Low Burn watercourse and finishing at Chinaman Flat Road, at which point the trail formation is located on the southern edge of SH8 and continues on in the direction of Lawrence.

4.4 Land Use/Surrounding Area

The zoning surrounding the site is 'Rural Settlement Resource Area' which then transitions to 'Rural Resource Area'. This is reflective of the underlying land use which consists of the small rural township of Beaumont, which is characterised by dispersed residential activity on larger allotments, and low levels of commercial activity including the Beaumont Hotel and other accommodation providers on Rongahere Road. Surrounding land use is dominated by agriculture.

4.4 Landscape

The broader landscape context of the Project is that of the broad river valley of the Clutha Mata-au River where the river flows out of the relatively short Island Block-Beaumont Gorge, through the local Beaumont Flats and south into the Beaumont-Tuapeka Mouth Gorge area. In general, the landscape is characterised by river flats and terraces and undulating to steep hill country, representative of an underlying geology of blocky to weathered schist. Landforms within the area include flat to undulating terraces and the river channel itself. The local topography is contained by hill country on all sides.

4.6 Geology and Geohydrology

The geological map of the local area (NZ 1: 250,000 scale Geological Map) indicates that the site is located within a valley plain identified as having been deposited in the late quaternary. These deposits typically consist of unconsolidated to poorly consolidated mud, sand, gravel and peat of alluvial and colluvial origin. The wider area, including the adjacent hills comprise Caples Group Grade TZIII schist rock. The schist rock is identified to be heavily foliated. Geological records indicate that the schist typically has a strong foliation dip towards the south and east at about 30 to 40 degrees.

The New Zealand Geology Web Map by GNS Science indicates the bridge site is underlain by late Pleistocene River Deposits (Unit Q). This unit generally comprises middle Pleistocene (units Q4 – Q12) and late Pleistocene (units Q2 – Q3) deposits consisting of sand, clay, silt and gravel.

Groundwater monitoring records are not available within the local area. However, vegetation observed during the site walkover indicates that shallow groundwater conditions (poor draining soils) overlying the bedrock should be anticipated on both the east and west banks of the Clutha River Mata-Au. It is considered likely that a deeper groundwater table exists that may be in continuity with the river levels. Seasonal groundwater fluctuations can be expected to be in the order of 1m to 2m and may be influenced strongly by the Clutha River Mata Au flows.

The geological map indicates the active Tuapeka Fault to be present approximately 100m south of the existing bridge alignment. The Fault is recorded as a normal fault and generally trends in the south-east / north-west direction. The recurrence interval and the estimate magnitude of displacements of this fault are currently unknown.

4.7 Ecology

4.7.1 Freshwater

The Clutha River Mata Au downstream of Roxburgh Dam is affected by daily flow fluctuations resulting from power generation at the Roxburgh Power Station. This creates a “varial zone”, an area of the riverbed that is intermittently wetted and dried, which reduces the suitability of this area for aquatic life.In terms of the project site, the ‘varial area’ is most noticeable on the western bank of the river, downstream of the existing bridge.

Five species of fish have been recorded as being present in the mainstem of the Clutha River Mata Au in the immediate vicinity of the proposed works: longfin eel (Anguilla dieffenbachii), torrentfish (Cheimarrichthys fosteri), common smelt (Retropinna retropinna), quinnat salmon (Onchorhynchus tshawytscha) and brown trout (Salmo trutta) (New Zealand Freshwater Fish Database, downloaded 12 April 2019). In addition, several other species are expected to reside in or pass through this area including lamprey (Geotria australis), shortfin eel (Anguilla australis), common bully (Gobiomorphus cotidianus), upland bully (Gobiomorphus breviceps), kōaro (Galaxias brevipinnis) and rainbow trout (Onchorhynchus mykiss).

Whilst no macroinvertebrate sampling has been undertaken at the site, sampling has previously been undertaken nearby at Beaumont (1 km upstream of the site of the proposed new bridge), Rongahere Road (11 km downstream) and Bernards Beach (22 km downstream) and are relevant to the proposed works. Macroinvertebrate fauna at Beaumont and Rongahere Road (near Birch Island) is dominated by nymphs of the common mayfly Deleatidium, while chironomid larvae (Orthocladiinae and Tanytarsini) and the cased-caddis Pycnocentrodes were also abundant at the Beaumont site. The composition of the macroinvertebrate fauna at Bernards Beach is slightly different in that it was numerically dominated by chironomid larvae (Orthocladiinae and Tanytarsini), the common mudsnail Potamopyrgus antipodarum and the cased-caddis Pycnocentrodes, with Deleatidium mayfly nymphs being less abundant at this site. So whilst it could be expected similar species will be found at the site, the presence of the ‘varial area’ as identified above can result in low densities of macroinvertabrates as the frequent wetting and drying compromises habitat suitability.

4.7.2 Terrestrial

Flora

Generally speaking the areas to be disturbed by the project are either existing pasture, roadside verges and riparian areas adjacent to the river. The Ryder report assessed the project footprint and identified eighty plant species (16 native, 64 exotic) within the footprint. The flora within the footprint was typical of pasture, road-side and disturbed riparian vegetation, being dominated by exotic grasses and herbs with a scattering of mainly introduced trees and shrubs. Native plants comprised <1% of the total cover. No nationally, or regionally, threatened or at-risk plant species were detected.

Fauna

Avifauna recorded were primarily exotic species, and included mallard duck, blackbird, hedge sparrow, thrush, starling, magpie, spur-wing plover and chaffinch. Native species present over the areas affected by the proposed realignment were bellbird, Australasian harrier and grey warbler.

Lizard species may occur within the footprint given the presence of suitable habitat along the edges of pasture and existing roads. All lizard species are protected under the Wildlife Act (1953), administered by the Department of Conservation.

4.8 Water Quality

The National River Water Quality Network (NRWQN) includes two sites in the Clutha River Mata Au downstream of Lake Roxburgh: Clutha River at Millers Flat and Clutha River at Balclutha. Water quality at the Millers Flat site is generally good, with relatively low water temperatures, high levels of dissolved oxygen, low levels of nutrients and generally low levels of E. coli present. However, water clarity at this site is generally low (average 2 m, maximum 5.95 m), and, conversely, turbidity is generally quite high. Water quality at the Millers Flat site complies with all corresponding RWP Schedule 15 limits when applied as a 5-year 80th percentiles. The values for many of the water quality variables at the Clutha River at Balclutha are similar to those at Millers Flat, although nutrient concentrations (particularly nitrate-nitrite nitrogen and total nitrogen) and average E. coli concentrations are markedly higher at Balclutha than at Millers Flat (Table 2). Water quality at the Balclutha site complies with all corresponding RWP Schedule 15 limits when applied as a 5-year 80th percentiles, with the exception of nitrate-nitrite nitrogen, which exceeds the RWP Schedule 15 limit of 0.075 mg/L.

Of the two sites, water quality measured at the Millers Flat site is likely to be most representative of the water quality in the reach affected by the construction of the bridge at Beaumont, as the Millers Flat site is 22 km upstream of Beaumont and no major tributaries or discharges that are expected to have an appreciable effect on water quality in the Clutha/Mata-Au enter it between these two locations.

4.9 Archaeology and Heritage

Adjacent to the site are a number of registered significant trees. These are trees the Clutha District Plan define as 'trees of historic or botanical significance or trees that are of landmark significance or contribute significantly to scenic and/or amenity values of a location the trees'. The variety of significant trees present are English Oak, Irish strawberry, English Elm and Ash (Raxinus), none of which are indigenous to New Zealand.

The existing Beaumont Bridge is also identified in the Clutha District Plan as an item of historic significance.

Table 3: Items of Historic Significance

Identifier	Name and Address	Reason for Registration
H61	Beaumont Bridge, Clutha River, Beaumont	Historic Structure
H80C	English Oak, Weardale Street, Beaumont	Significant tree/significant group of trees - scenic and landmark significance
H80D	English Oak, Weardale Street, Beaumont	Significant tree/significant group of trees - scenic and landmark significance
H80E	English Oak, Weardale Street, Beaumont	Significant tree/significant group of trees - scenic and landmark significance
H80F	English Oak, Weardale Street, Beaumont	Significant tree/significant group of trees - scenic and landmark significance
H80G	Ash (Fraxinus), Weardale Street, Beaumont	Significant tree/significant group of trees - scenic and landmark significance
H80I	Irish Strawberry, Weardale Street, Beaumont	Significant tree/significant group of trees - scenic and landmark significance

An archaeological assessment of the site has also been undertaken and is Attached in Appendix 5. The assessment has identified a number of areas within the project site that will require archaeological monitoring during construction being:

- Beaumont Hotel site
- A small area opposite the Beaumont Hotel
- Eastern and western banks of the Clutha River Mata-Au
- Existing Beaumont Bridge
- Adjacent to the Lowburn Bridge.

These sites are visually illustrated in Figures 32 and 33 of the Archaeological Assessment.

4.10 Cultural Values

The Clutha River Mata-au is a statutory acknowledgement under the Ngāi Tahu Claims Settlement Act 1998. The Mata-au was part of a mahinga kai trail that led inland and was used by Ōtākou hapū including Ngti Kurī, Ngāti Ruahikihiki, Ngāti Huirapa and Ngāi Tuahuriri.

The river was also very important in the transportation of pounamu from inland areas down to settlements on the coast, from where it was traded north and south.

There are known archaeological sites in the wider vicinity of the settlement of Beaumont, which is a reflection of discovery related to the historic activity described above. No archaeological sites have been located in close proximity to the proposed works; however, as the banks of the river are considered a higher risk site in terms of potential discovery.

There is a nohoanga – Te Kowhai – located approximately 1 kilometre upstream of the existing Beaumont Bridge, on the true left bank.

Consultation with Aukaha and Te Ao Marama has highlighted the impacts of the project on these locations of interest as being of importance. Ngā Rūnanga have also highlighted that sediment control and effects on water quality and quantity are of importance. They also seek an archaeological authority is sought and an associated accidental discovery protocol is adopted.

4.11 Social and Community

The Beaumont Township provides a mix of community facilities, small commercial services and recreational areas including:

- Immediately downstream of the existing bridge, is a rest area and launch spot for boats into the river. The author has observed multiple vehicles and boat trailers parked there at times, and this has also been confirmed in discussion with locals. An existing picnic table at the site also attests to its use as a rest area. The area is also used for access to the river by anglers. It is noted that the formed access to this site crosses private land and is not protected by easement.
- On the eastern bank of the existing bridge is a small informal carparking area, as well as some information panels and a plaque commemorating the opening of the Beaumont Bridge.

- The Beaumont Hall (which includes a small museum) is located on Eastferry Street
- The Beaumont Cemetery is located at the end of the formed section of Weardale Street
- Beaumont Swimming Pool (owned by a Charitable Trust)
- The Beaumont Hotel and associated camp ground/accommodation is located on SH8 on the western side of the river
- Small scale visitor accommodation providers are known to be located on Rongahere Road.
- Other former community facilities remain but are in private ownership (Beaumont School) or are no longer remaining (Beaumont Racecourse).

4.12 Utilities

There are no Clutha District Council 3 Waters reticulation in the project area. Existing services within the project area include:

- Buried communication cables (copper), operated by Chorus
- 11kV and 400V overhead power lines, operated by PowerNet
- Private water and sewer supplies serving individual private properties (not affected by the project works)
- A historic water supply network (original purpose related to the former Beaumont Railway Station) from a gully northeast of the bridge site and feeding an unknown number of properties understood to include 12 Weardale Street, the old store and water troughs on the Mitchell property.
- A communal skip for refuse collection is located on Dee Street on the north side of SH8. This is available for use by local Beaumont residents.

5 Project Description

5.1 Overview

The project seeks to construct a new bridge over the Clutha River Mata-Au at Beaumont. This will require construction of new bridge approaches, improvement to the local road networks, physical road closures and access changes. It will also require the relocation of power and communication infrastructure.

5.2 Alignment and Elevation

The alignment for the new bridge and approaches is shown below. The alignment is based on highway geometric requirements and founding considerations with a central bridge pier positioned on a prominent rock outcrop within the main river channel.

It is noted that the elevation of the new alignment will differ from that which currently exists at the site. Approaching from the east, the highway will begin to gently rise from Stonewall Street / SH8 intersection. At the corner of Weardale Street the alignment will be approximately 2.5 metres above existing ground level, and at Rongahere Road approximately 3.7 metres above existing ground level. Adjacent the Beaumont Hotel, the highway surface will be at a level consistent with the existing SH8 pavement surface. This rise in elevation from east to west is a function of the existing topography at the site, improved vertical geometry for the highway, as well as the style of construction of the proposed bridge and the need to provide for freeboard during flood events.

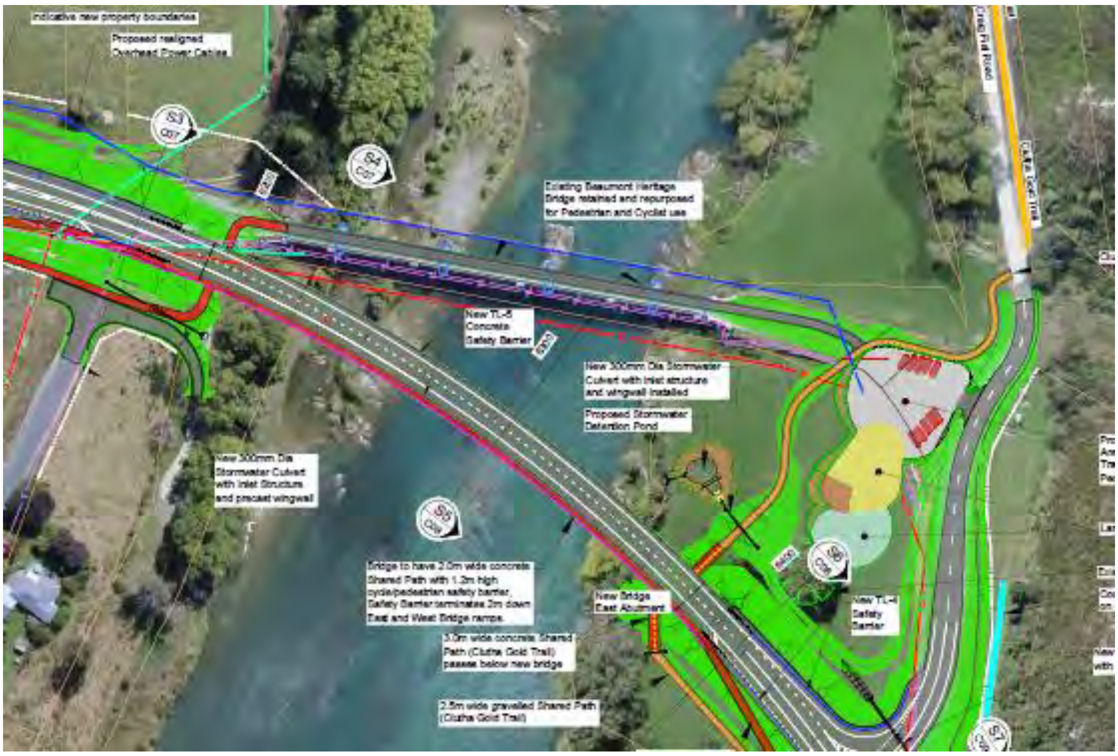

Figure 1: Proposed New Beaumont Bridge and Approaches

5.3 Intersections and Property Access

As part of the project, the existing state highway intersections with Westferry Street, Rongahere Road and Weardale Street are proposed to be closed due to road safety considerations as outlined below.

Rongahere Road intersects the proposed SH8 alignment in close proximity to the proposed bridge location. The concrete barriers on the new bridge severely restrict sight distance to the east for vehicles turning out of Rongahere Road. This is a significant road safety concern and therefore this intersection will be closed. Additionally the difference in elevation between Rongahere Road and the new SH8 alignment (~3.8m) means that considerable works would be required to upgrade the intersection to maintain connectivity.

With the Rongahere Road intersection closed, traffic previously using this intersection will be required to travel by Dee Street or Westferry Street. Of the two remaining intersections where vehicles turn on and off SH8, Dee Street provides for increased opportunity for improvement than Westferry Street, particularly due to the acute angle of the Westferry Street / SH8 intersection. It is therefore proposed to also close the Westferry Street intersection with SH8, and upgrade Dee Street (seal the carriageway and provide a suitable intersection treatment with SH8) which will provide the safest option for traffic accessing SH8. Some minor intersection improvements will also be undertaken at the intersections of Westferry Street / Dee Street and Westferry Street/Rongahere Road to promote the Dee Street linkage as the primary route south.

Options for retaining the Weardale Street intersection with SH8 have been investigated, with the outcome of it not being possible to achieve the recommended Safe Intersection Sight Distance to the west of the intersection due to existing vegetation and the proposed bridge barrier/approach barrier. Given that an alternative route via Stonewall Street is readily available it is proposed to close the Weardale Street Intersection on road safety grounds.

All closed intersections will be configured with turning heads.

Access arrangements to the Beaumont Hotel and associated camping ground have been reconfigured to address road safety considerations with a new access road proposed to link the Hotel car park to Dee Street and a single entry only access to the Hotel and camping ground from the SH8, along with improvements to the Hotel carpark.

5.4 Road Cross Sections

The typical cross sections of the proposed highway bridge approaches and modified side roads are detailed in figures below.

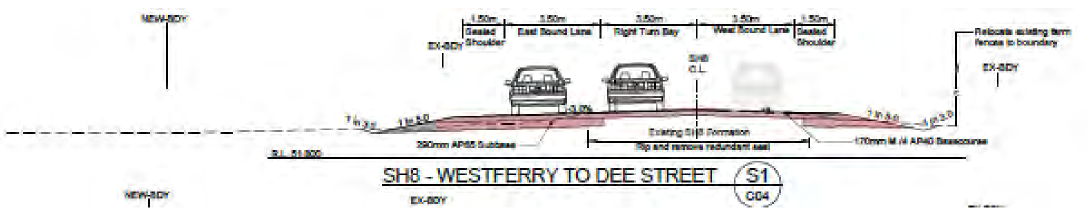

Figure 2: Cross Section - Westferry Street to Dee Street

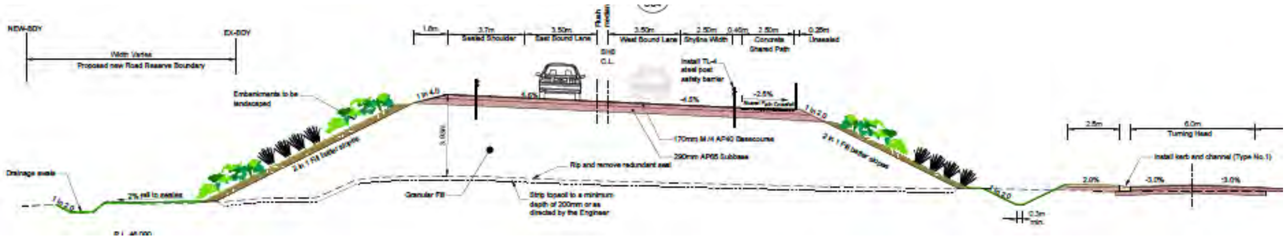

Figure 3: Cross Section - Rongahere Rd / SH8 Intersection

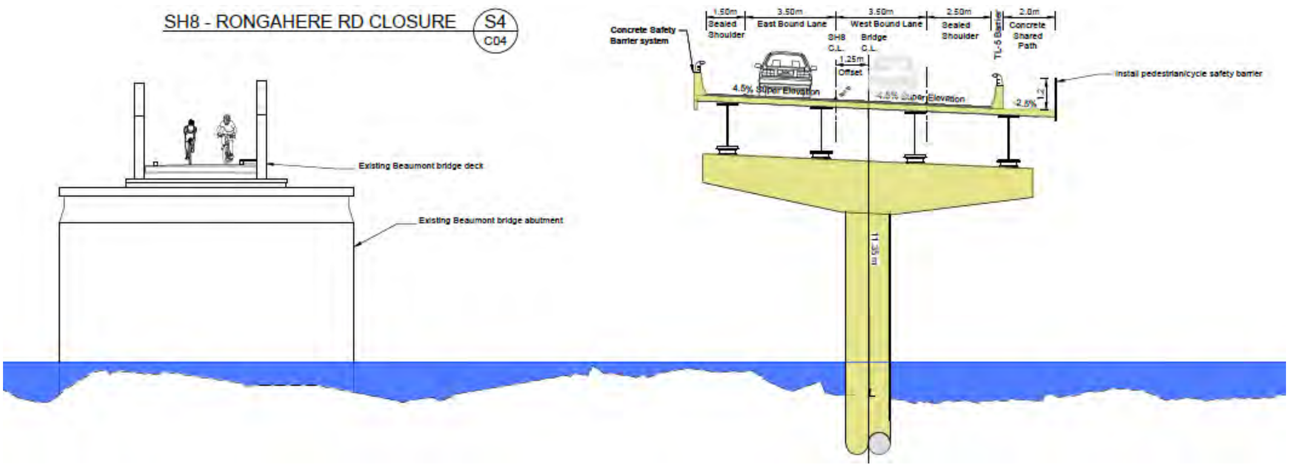

Figure 4: Bridge Cross Section showing existing and new bridges

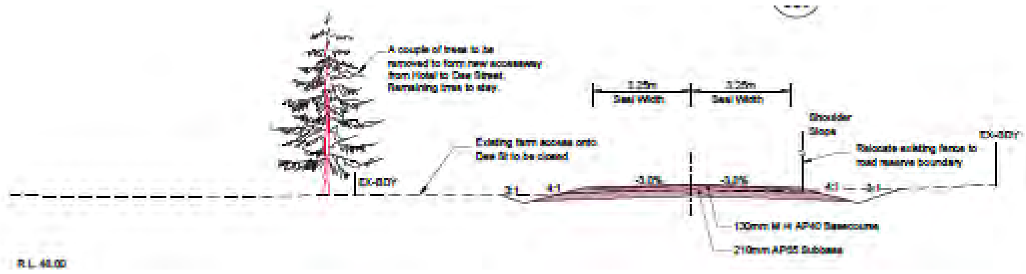

Figure 5: Cross Section - Dee Street

5.5 Bridge Construction

The proposed new bridge has been designed in accordance with the NZTA bridge and highway design standards, in particular the NZTA Bridge Manual requirements.

Design has progressed on the basis of a 193m long curved bridge, with span lengths of 32m-40m-40m-45m-36m (west to east) to enable founding on prominent rock outcrops within the river channel and river banks, provide adequate flood conveyance, and to facilitate routing of the Clutha Gold cycle trail below the eastern and western abutment.

The structural form of the bridge is a continuous steel multi girder superstructure, with composite concrete deck, founded on reinforced concrete hammerhead piers (i.e. single pile). This provides a cost effective and functional solution for the site constraints.

The likely methodology for the construction of the bridge will comprise of the following:

- A partial work platform may be constructed from both (or one) banks of the river. **Figure 6** illustrates what a staging work platform looks like.
- The partial work platform will require temporary piles that support a trestle type structure that the contractor can work from.
- The platform will be located on one side (likely downstream) of the new bridge so that it can be used for access to piling and pier construction, as well as lifting in the beams once the bridge substructure is complete. Gravel work platforms (causeways) located at ground level (constructed on top of the existing river bed) may also be used for access to pier locations where practical instead of, or to supplement, any temporary staging.
- Construction of bridge pier foundations will require excavation of bedrock up to 10m below ground level to form cylindrical piles, one at each pier location. Reinforcing steel will be placed into the pile excavation and backfilled with concrete to form the foundation which will be extended above ground level to form the bridge pier.
- Prefabricated steel beams will be transported to the site and installed by crane lifting from either the platform or causeway, as appropriate.

Figure 6: Photograph of temporary platforms - Kawarau Bridge

In the event of high flow events if any temporary gravel causeway was overtopped and washed away (or partially washed away) this would require the causeway to be reformed. The work could be undertaken throughout the construction period as required. All work would be in accordance with the contractor's Erosion, Sediment and Dust Control Plan (ESDCP). On completion of the bridge construction, all temporary causeways will be disestablished, and the riverbed reinstated.

As part of constructing concrete piles for piers once the pile is driven, reinforcing will be placed inside the casing and the casing will be filled with concrete (by piping concrete under water down to the base of the pile – known as the tremie method) – shown in **Figure 7** below. It may be near impossible to pump out water from the piles during this process meaning that as concrete is placed it will displace the water. In these cases, the contractor will allow the displaced water to spill out of the casing onto adjacent areas where it will be captured and prevented from being discharged to the river. In cases where the liquid has high sediment levels, normally the last 1-2m of water above the wet concrete, the liquid will be collected and removed from the pile casing.

Figure 7: Example of Pile setup

Bridge Foundations

Bridge piers have been positioned to meet the geometric requirements for the new SH8 alignment and optimise founding on prominent rock outcrops within the river channel. Foundation options were considered in detail with the preferred solution identified comprising single cylinder foundations for each pier socketed into the bed rock. Founding depth for bridge piles is influenced by rock mechanics of the upper weathered schist in conjunction with the geometry of the rock at the central outcrop.

Scour Protection

Scour protection for the proposed SH8 Beaumont Bridge has been designed in the form of a rock revetment. Scour protection for the piers has not been designed as the piles will be founded sufficiently deep into rock to structurally survive scour to the surrounding rock material.

Geotextile fabric is required to prevent fill material from passing through the rock revetment. This geotextile will be installed to wrap around the toe of the rock revetment and extend to the crest of the rock revetment. A granular geotextile protection layer is proposed to protect the geotextile from damage, particularly during the construction phase.

The rock revetment will wrap around the full abutment in line with the abutment face to minimise risk of undermining. The bridge embankments will have batter slopes of 2:1 (horizontal: vertical), however the south corner of the eastern abutment may require a steeper batter slope of 1.5:1. The toe of the rock revetment will be positioned to mitigate against significant risk of undermining by scour. This would typically be achieved by locating the toe of the rock revetment beneath the scour depth, or by including a launching pad in the rock revetment so that natural scour processes shift the rock material down to the scour depth. However these approaches are not suitable for this location and therefore the toe of the rock revetment is keyed into existing natural rock outcrop capable of withstanding the scour. Drawings of the proposed revetment are included in Appendix 5.

5.6 Pedestrian and Cycle Ways

Pedestrian and cycleway facilities include:

- 2.5m wide unsealed shared path matching the existing Clutha Gold Trail on the eastern side of the river, with the exception of the section under the new bridge which will be concreted for maintenance reasons.
- A 2.5m wide concrete shared path on the western bank of the river and providing a new linkage between the existing bridge and the Beaumont Hotel and camping ground.
- Repurposing of the existing Beaumont Bridge for pedestrian and cycle use (refer Section 6.7.7).
- The new bridge will also provide for cyclists and pedestrians in the form of a 2 metre wide shared path located on the downstream side of the bridge. This will be separated from the traffic lanes by a concrete barrier.

Unsealed shared paths will incorporate a maximum grade of 1 in 14 and minimum 15m sight lines.

A minimum headroom of 2.5m will be provided where the track passes below bridge abutments.

A number of options have been considered for routing of the pedestrian and cycle path at the confluence of the proposed and existing bridges on the western bank of the Clutha River Mata-Au. The new bridge is positioned immediately downstream of the current bridge with the new road level elevated around 2.7m above existing. It is proposed to utilise the existing bridge for pedestrian and cyclist use and construct an off-road path linking the existing bridge to Rongahere Road, the Beaumont Hotel and western approach of SH8.

5.7 Safe Stopping Area

A safe stopping area (previously known as a rest area) will be established on the eastern bank of the river, immediately downstream of the existing bridge. This will replace the existing informal area at the current intersection of Craig Flat Road and SH8. In addition to a parking area, some landscaping is proposed, and it will also feature the current prominent walnut tree on the site.

5.8 Lighting

Lighting will be limited to flag lighting at the SH8 / Dee Street intersection, SH8 / Stonewall Street intersection. Both these intersections currently have single flag lights mounted on overhead power poles. No flag lighting is proposed at the SH8 / Craig Flat Road intersection given the extremely low traffic volumes.

There is existing flag lighting at the SH8 / Rongahere Road intersection and SH8 / Weardale Street intersection which will be removed as these intersections are closed as part of the project. Flag lighting of the hotel and campground entrance will also be provided. The lighting will be designed to comply with AS/NZS 1158 and NZTA M30 Specification and Guidelines for Road Lighting Design.

Flag lighting will be mounted on power poles where practical or on standalone lighting columns.

5.9 Earthworks

The excavation of land for the construction of the eastern and western approaches, and local road improvements will require topsoil stripping, bulk fill for the embankments and excavation, including some excavation of contaminated land. Approximately 50,000m^3 of cut and fill is required – made up of approximately 15,000m^3 of cut and 35,000m^3 of fill.

Construction material will be transported to construction areas within the project area and stockpiled for use.

The earthworks required falls into the following four broad categories:

- Stripping of topsoil and unsuitable surface material
- Excavation and removal of any unsuitable material
- Construction of road embankments
- Ground improvements required for the construction of road embankments

5.10 Site Dewatering

In order to construct any manholes / sump chambers and stormwater pipelines associated with the new highway alignment, some minor dewatering may be required. This will be undertaken in accordance with industry best practice.

5.11 Stormwater Management

The stormwater design will be completed in accordance with the NZTA Stormwater Treatment Standard for State Highway Infrastructure and will incorporate a mixture of grassed roadside swales, piped conveyance and a landscaped detention basin on the eastern approach.

Roadside swales will be sized to convey a 1% AEP rainfall event without flooding the road pavement (surfacing, basecourse and subbase). Associated pipework will be designed to convey a 5% AEP storm without surcharging where flood storage or suitable overland flow paths are available for more significant rainfall events. Where this is not the case, the pipework shall also be designed to convey a 1% AEP event.

Very low intensity rainfall events of low rainfall depth will most likely infiltrate to ground through the swales topsoil lining during warmer periods when the catchments soils are drier. During higher intensity / depth summer events and during cooler periods infiltration may not be sufficient to deal with runoff from the road corridor. In these cases flow will result in water being stored above the lining of swales until infiltration or evaporation.

The proposed detention basin is intended to provide treatment of stormwater from the new bridge prior to discharge into the Clutha River (i.e. flow attenuation is not the primary objective). The landscaped detention basin will be planted with native grasses and other occasional native specimen plantings and will be constructed at particularly flat grades to ensure very low flow velocities. The basin will incorporate an amount of depression storage due to small undulations in the bed and an element of infiltration will occur during summer months when the soils are drier. The outlet of the basin will be restricted via a small diameter orifice pipe to ensure full capture of the Water Quality (WQ) event (15mm rainfall over the catchment) and its slow release. During low frequency events, the basin will either be bypassed or overtopped, with any overland flow routes being channel away from the neighbouring property and where possible away or under the proposed Cycle Trail. The plant species used will be both wet and dry tolerant to ensure minimal die off. The combination of grassed swales and the landscaped detention basin will ensure a very high standard of stormwater treatment is achieved. Given that the stormwater system will only discharge to the Clutha River occasionally, and the river has a high constant baseflow, the effect of the discharges on the quality of water in the river will be less than minor.

Stormwater from the project will be dealt with in the following manner:

Eastern Catchments

- On the new bridge: Stormwater will be conveyed along the face of the downstream barrier to the eastern abutment. From here the stormwater will be piped to a planted detention basin located to the north of the approach embankment. The detention basin will be designed to encourage infiltration and will incorporate a high level overflow to the Clutha River for larger events. ·
- SH8: Grassed swales will be constructed to provide infiltration and overland conveyance towards the proposed detention basin and the Low Burn watercourse to suit topography. Culverts will be provided across side roads and property entrances. ·
- Weardale Street: It is expected that there is some current discharge from the northern end of Weardale Street into the ditch that runs along the northern side of the Healey property. Provision will be made to convey any existing flows into the proposed detention basin or to retain the existing ditch if this is not practical.
- Stonewall Street: No modifications other than at the intersection are proposed. ·
- Cycle Trail: The proposed cycle trail will be designed to shed water to adjacent land with minor shaping to avoid ponding of surface water causing serviceability issues. Culverts across the cycleway will be installed at low points to accommodate flow paths.

Western Catchments

- SH8: Construction of grassed swales within the roadside verge to capture carriageway runoff from the widened SH8 carriageway. Existing culverts passing under Rongahere Road and property entrances will be retained or replaced if required. The use of soakage pits will be considered to encourage infiltration or where outfalls to adjacent watercourses are not possible. The stormwater solution will aim to capture the majority of carriageway runoff from the bridge approach to minimise conveyance of stormwater across the expansion joint at the western abutment. It is expected that an overland discharge path will need to be formed via a planted strip from the western abutment to the Clutha River.

- Dee Street: Construction of grassed swales within the roadside verge to capture carriageway runoff from the sealed and widened carriageway. Existing culverts below property entrances will be retained or replaced if required. The use of soakage pits will be considered to encourage infiltration depending on soil conditions encountered. ·
- Rongahere Road and Westferry Street: potential for the construction of grass swales.

5.12 Watercourses

The Clutha River Mata-Au is the dominant watercourse at the site. The river is a large single stem which passes though a comparatively narrow rocky section at the site. Flows at the site are affected on a daily basis through the impacts of the Roxburgh Dam which influences the flow of water dependant on the amount of water being used to generate electrictity.

In addition to the Clutha River Mata-Au, at the eastern end of the site is the Low Burn, a small creek with a single channel and low banks, draining the farmland and hill slopes to the north east of Beaumont. The Low Burn is a tributary of the Clutha River Mata-Au. Running alongside the northern boundary of the Healey property is a drainage ditch that currently catches road and other run-off before discharging to the Clutha River Mata-Au.

5.13 Construction Works and Programme

Temporary construction management areas will be located within the boundaries of the designation to avoid or minimise effects on the function of existing roads and adjoining land use activities during construction. These areas are likely to contain items and facilities such as:

- site offices, staff facilities and parking
- plant, machinery and mobile fuel storage facilities
- construction materials and stockpiles
- site access and egress points.

The current programme assumes a 2-year construction period. Works will generally occur during daylight hours six days a week.

The contractor will be required operate in accordance with Transport Agency safety protocols, develop and implement a Construction Environmental Management Plan (CEMP) and comply with designation and resource consent conditions. The proposed conditions are in Appendix 4.

The Transport Agency will have oversight of construction works via a consultant Engineers Representative and Engineer to Contract. Regular visits will be undertaken by the Engineers Representative.

6 Consideration of Alternatives

As part of the detailed business case for the new bridge, two alignments (Ribbons A and B as shown below in **Figure 8**) were investigated and consulted on with the community. Ribbon A is a curved route to the immediate south of the existing bridge. Ribbon B (in a general sense) would follow the alignment of Eastferry / Westferry streets. A clear preference from the community was for an alignment on the north side of the Beaumont township as opposed to the 'straight line' option (for further detail refer to Section 7). It is also noted the Ribbon B would require a much longer SH8 realignment and impact considerably more properties than Ribbon A.

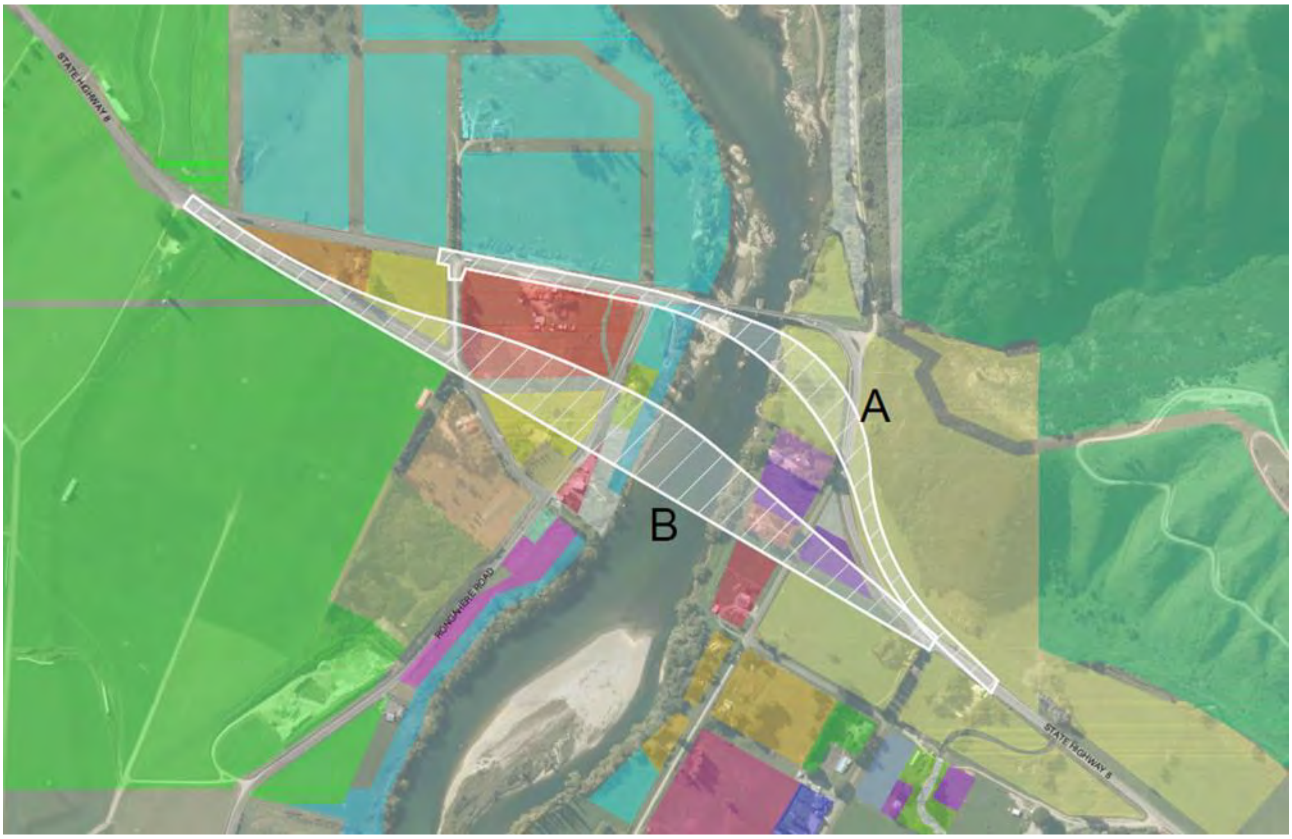

Figure 8: Business Case Option

Existing Bridge

One of the other options explored was the use of the current bridge alignment. This was discounted for 2 reasons (1) would necessitate the demolition of the current historic bridge structure and (2) would result in the closure of the river crossing for the duration of construction.

Do Nothing

Given the condition of the existing bridge, the do-nothing option was not a consideration.

Discharge Alternatives

Section 105 of the RMA requires that consideration be given to the applicant's reason for the proposed choice and any possible alternative methods of discharge, including discharge into any other receiving environment.

In developing the stormwater treatment and disposal options, consideration was given to: avoiding where possible sensitive environments; the physical limitations of the site; discharging to ground in preference to surface water; and the level of treatment. In doing so, all alternative methods and locations were assessed for their suitability.

Summary

The current proposal is the Transport Agency's preferred solution for achieving the objectives for the Project. Significant investigations were carried out prior to determining the proposed solution. The proposal is based on the outcome of an evaluation of the engineering, economic and environmental aspects of the alternatives considered along with feedback from consultation.

7 Consultation

7.1 Business Case Stage

Two option ribbons were used for consultation purposes with property owners and the Beaumont community to gain an understanding of potential issues, and preferences. The ribbons were first sent to property owners who would potentially be affected by the works, in addition to an information letter and feedback form.

An open day was held on 15th December 2016 at the Beaumont Community Hall. This provided the project team with an opportunity to discuss the potential options with the property owners as well as the Beaumont community. Representatives from the local and regional councils were also in attendance to discuss ideas.

Feedback from the potentially affected property owners and the community was collated and reviewed by the team before progressing the business case.

7.2 Design stage

Clutha District Council (CDC)

- Consultation carried out on 24 August 2018.
- Future proofing opportunities were discussed regarding whether the Council want to run any services over the bridge.
- Consideration given to what the end of Rongahere Road and Westferry Street would look like (cul de sac head v hammerhead.
- Regarding Westferry Street CDC suggest leaving it as it (do not rip up formed portion).
- CDC requested a detailed design for Westferry/Rongahere intersection be provided, including swept paths of vehicles. CDC prefer a painted median option at the intersection.
- CDC indicated a soakhole might need land at Westferry/Dee Street intersection.

Otago Regional Council

A preapplication meeting was held on 1 February 2019. The main issues bought up by Council departments are listed below.

Hazards:

- Need to address morphology of bed and upstream/downstream flooding, cumulative impacts of both bridges.

Engineering:

- Walkway under bridge (no rails to catch debris)
- The new bridges ability to withstand flood events during construction and during implementation, the temporary platforms ability to withstand floods and the contractor needing to remove during high flow.
- The structural integrity of the old bridge

Consenting:

- An AEE appropriate to scale of activity, including but not limited to the following

- Cumulative effect of having both bridges
- Site Management plan with high level restrictions for the contractor
- Visual, recreational and amenity effects
- Instream effects, the applicant was concerned about the time work will not be undertaken during spawning, this will need to be taken up with affected parties and covered off with reasoning in application
- Sediment, the applicant was concerned about sediment during natural flows affecting consent condition, however these will be specific to the works
- Storm water → permitted
- Moving power cable → permitted
- Noise

Powernet

Consultation carried out on 24 August 2018 in Balclutha. General points of discussion included:

- Powernet preferred the overhead option for lines.
- Ducting not an issue for the proposal.
- Could thrustbore under road to supply lights at the bridge.
- A ‘corridor’ for power is required. Powernet would be able to do install most of it.

Aukaha (Otago Rūnanga)

- No concerns regarding geotechnical investigations, apart from requesting the use of clean locally sourced materials.
- Aukaha expressed interest in accompanying the project archaeologist on any site walkover.
- Aukaha noted there are features of cultural significance in the area, and therefore they require the design and the construction methodology are sensitive to these.
- Aukaha would like the impact of the project on the Mata-au (which is a Statutory Acknowledgement Area under the Ngāi Tahu Claims Settlement Act 1998) to be considered.
- Management and mitigation measures to be implemented to contain sediment run off during construction works, and reduce adverse effects on any adjoining waterways.
- Ngā Rūnanga would request that the following be a condition of the resource consent: An Archaeological Authority is sought from Heritage New Zealand and an associated accidental discovery protocol is adopted.

Te Ao Marama Incorporated (TAMI)

Te Ao Marama points of discussion included:

- Approval of clean locally sourced material being sought for the works.
- General interest in the archaeological risk, interested in accompanying the project archaeologist on any site walkover.

Otago Fish and Game

Main points of discussion included:

- Raised some concerns particularly around the impacts of fish spawning from sediment discharge and request the risk of sedimentation that could affect spawning will be adequately mitigated.

Clutha Gold Trail Trust

Consultation was carried out with Clutha Gold Trail Trust on 25 February 2019. Clutha Gold Trust main points of discussion included:

- The Trust will take no responsibility for any shared path that is formed on the old bridge or the western side of the Clutha Mata-Au.
- The Trust is happy with the Trail realignment on the eastern bank of the Clutha Mata-Au.
- Firm view that the designs for the new bridge should provide for cycling and walking (including a barrier from traffic). Additionally, the Trust suggest work on the old bridge is not a good investment.

Landowners

- Consultation has been undertaken and is ongoing with landowners directly affected by the designation (land required)

Mitchell

- Consultation was carried out on 19 December 2018. Land owners' main points of discussion:
- Supportive of having the power realigned to the north side of the old bridge whilst impacts on their land on north side of the bridge are minimised.
- Raised issue of the private water supply being more extensive, including running over bridge to west bank to the Hewitts property, and potentially the Hotel.

Peters

- Consultation was carried out on 19 December 2018.
- Land owners' main points of discussion:
- Land owner clarified the existing powerline at the east of site ran to a pump shed disused. However, they wish to retain power.
- Land owner indicated they drive stock over the current bridge and wish this to continue, therefore a gate will need to be installed in the south-east corner of their paddock, linking to the old bridge.
- Did not raise any issues in terms of land acquisition.

Beaumont Hotel

- Land owners' main points of discussion.
- No significant concerns raised.
- Agreed with benefits of the proposed layout.
- Further meeting was held on 19 December 2018, to present landowner with updated plans for carparking area. Land owner's main points:

- Agreeable to maintain any planting undertaken within area between hotel and SH8.
- Approved the idea to provide a pull over area across SH8 for larger vehicles (e.g. trucks).

Healy

- Consultation was carried out on 2 October 2018. Proposed impacts on their property were discussed including a 14m^2 property acquisition, the removal of 2 sycamore trees, possible trimming of oak trees, and unknown impacts on oak root zones. Owners were informed compensation requirements under PWA. The land owners were informed the existing highway will be raised 3 metres and an underpass for the cycle trail could be required.
- Land owners' main points of discussion:
- No general issue with proposal.
- The issue of noise was raised, the owners were informed of increased noise and potential vibration during construction.
- Indicated concern that the construction would require a work area beyond the land take. The owner was reassured the contractor would need to work 'up to' the property boundary.

Other Interested Parties

- Cold Gold Clutha (Peter Hall) Cold Gold Clutha have a resource consent to dredge for gold in the area. Cold Gold Clutha provided dimensions of their consented dredge.

Public Open Day

Consultation was carried out with the general public on the Open Day. Their key points of discussion were as follows:

- General support for the project.
- General support for retaining the existing bridge.
- Traffic safety issues with speed, passing and lighting through the township.
- Queries around ongoing management of the safe stopping area and what sort of facilities could be provided.
- Some concerns about the impact of local road closures (particularly Rongahere).
- Recognition of the safety issue at the Westferry Street / SH8 intersection.

8 Assessment of Effects

8.1 Overview

This section describes the effects the project is likely to have on the environment along the route. The focus of the effects assessed below is on those effects that will remain after taking into consideration the proposed mitigation measures.

The actual or potential effects of the Project are considered to be as follows:

- Positive effects
- Traffic
- Air Quality
- Landscape and visual
- Lighting
- Noise and vibration
- Contaminated Land
- Water Quality
- Aquatic Ecology
- Terrestrial Ecology
- Hydrology and Hydraulics
- Cultural Values
- Archaeology and Heritage
- Social and Recreation
- Infrastructure

These actual or potential effects have been assessed. The effects assessments are detailed in the technical appendices attached to this Notice of Requirement and resource consent applications.

The NoR includes land required for construction. Although these areas are to be designated for *State highway purposes*, along with the additional land required for road. Following the completion of construction, the designation over the land required for construction will be uplifted.

The activities that will occur on land required for construction will be the same as those activities that will occur on land required for road, and therefore any actual or potential adverse construction effects in these respective land areas will be managed in the same manner, as identified in the following sections. With the mitigation measures proposed any actual or potential adverse construction effects will be temporary.

8.1.1 Mitigation Measures

The Assessment of Effects below identifies actual and potential adverse effects that might arise as a result of the project. Mitigation measures are identified in each section below. A full set of proposed conditions contained in Appendix 4 implement these mitigation measures where appropriate.

Notwithstanding the above, a Construction and Environmental Management Plan (CEMP) is proposed to provide the overall environmental management framework and approach. The plan will contain a series of sub-plans to address activity specific matters. Such plans are an accepted means of addressing effects and are a useful way to show how compliance with the more specific controls or parameters laid down by the other conditions of a consent will be met. So, for example, in the case of stormwater quality limits, specific parameters can be laid down but the way in which these are complied with is left with the consent holder to determine, that is, a management plan is a means for providing information about the method of compliance. However, because technology and knowledge might change over time the consent holder should have the ability to update management plans without having to go through the process of seeking a change to the conditions of consent.

A copy of the finalised CEMP will be provided prior to the commencement of construction activities. The matters to be addressed in the CEMP shall include, but may not be limited to, the following:

(i) General:

- Plan purpose
- Plan revision and compliance issue resolution processes
- Roles and responsibilities
- Training and education

(ii) Mitigation of Effects:

- Environmental objectives and principles
- Environmental management approach and methods

(iii) Plan Requirements:

- Contractual requirements;
- Monitoring, maintenance, audit and reporting;
- Mitigation/contingency measures, including emergency spill management procedures

(iv) Activity Specific Requirements:

- Operating procedures, processes and controls, together with timing for specific activities supported by supplementary plans as required
- Stockpiling
- Refuelling
- Site facilities
- Air quality management including fugitive dust during construction

The following Specific Management Plans (SMPs) will form subsets of the CEMP:

(a) Erosion, Sediment & Dust Control Management Plan

(b) Bridge Construction Management Plan

(c) Hazardous Substances/Spill Contingency Plan

(d) Temporary Traffic Management during Construction Management Plan(s)

(e) Construction Noise and Vibration Management Plan

8.2 Positive Effects

The project is expected to have a number of positive effects on the State Highway network and the wider community.

The new Beaumont Bridge and road alignment will lead to significant positive effects including: security of route, improved provision for pedestrian and cycling facilities and improved road geometrics. There will be a shared pedestrian/cycleway path on the bridge to provide connectivity within the project area. Private property access will be maintained with access modifications for some landowners.

The purpose of the proposed new bridge and road alignment is to provide a safe and reliable connection within the Clutha District to enable residents to enhance their safety and provide for their social and economic wellbeing. The condition of the existing bridge continues to deteriorate and requires replacement. As such the project's main positive effect is security of route. Additional positive effects of the project include:

- Provisions for pedestrian and cycling footway across the new bridge
- Reduction of waiting time and delays through a two-lane bridge
- Wider and stronger structural capacity of the bridge in accommodating heavy loads
- Safety of road users
- Contributing to being part of an integrated and sustainable transport network.

8.3 Traffic

8.3.1 Traffic Management during Construction

The contractor will be required to implement suitable traffic management during construction in accordance with Transport Agency requirements.

One notable matter in this regard is the upgrade of Dee Street. Given both the Westferry Street and Rongahere Road intersection will be closed as part of the project, the programme of works will be such that Dee Street will be upgraded to the proposed standard prior to any physical road closures. This includes the formation of turning heads on Westferry Street and Rongahere Road.

Similarly the Weardale Street turning head will be formed prior to any physical closure.

It should also be noted that due to the project including a new alignment (particularly on the eastern bank) a large proportion of the road construction works will be able to be undertaken 'off line' (i.e. no or limited works on the existing SH8 carriageway).

8.3.2 Post Construction

Following completion of construction and commissioning traffic movements through the Beaumont township will have changed. With Westferry Street and Rongahere Road intersection with SH8 closed all traffic wishing to access south of the State Highway on the western bank will be directed down the newly upgraded Dee Street. It is noted for those current residences on Westferry Street the predominant flow of vehicles approaching from the south (Rongahere Rd) or West (SH8) are already travelling via Westferry Street, as the most direct route. Therefore, there will be a limited increase in traffic on Westferry Street with overall traffic flows remaining low and with any effects considered to be minor in the context of the existing traffic flow .

For other residences on the now 'dead end' sections of Westferry Street and Rongahere Road, there will be a reduction in traffic.

8.3.3 Summary

During the construction period a Temporary Traffic Management Plan will be put in place to manage the traffic and property access within the project area. The development and implementation of the plan will ensure that any potential conflicts, including access to the riverbed, are appropriately managed.

8.4 Air Quality

The project area is predominantly within a rural environment. It is likely that the dust created during construction works of the new bridge, road alignment, and movement of machinery will have a temporary effect on localised air quality.

8.4.1 Construction Related Effects

Construction phase air quality has also been considered. The majority of the alignment will be constructed through pastoral land. Potentially the most affected receptors are the residences to the south of SH8.

Potential sources of airborne dust include: wind-blown dust from exposed surfaces and stockpiles and vehicle movements on unsealed roads. A range of appropriate dust mitigation measures are available and, if implemented as necessary during construction, fugitive dust emissions from construction activities can be kept within the acceptable thresholds and trigger levels. The construction work will be managed so that it will not cause noxious, offensive or objectionable levels of dust beyond the designation or construction area boundaries.

8.4.2 Mitigation Measures

An Erosion, Sediment and Dust Control Management Plan (ESDCMP) is to be prepared as part of the CEMP and shall give effect to:

(i) Best practicable methods for avoiding or mitigating dust emissions during construction

(ii) A complaints procedure

(iv) Inspection and auditing procedures and contingency plans if controls fail.

Appropriate measures to avoid, remedy or mitigate potentially significant adverse dust emissions will be available and implemented when unfavourable weather conditions occur, such as the following:

- Watering to keep construction materials damp
- Controlling the speed of vehicles and machinery operating within the construction area and on access roads
- Liaison with local communities regarding any concerns or complaints
- Avoiding as far as practicable the stockpiling of materials with dust generation potential close to sensitive receiving areas. Long term stockpiling of material outside of the road formation that has the potential to generate a dust nuisance should be located at least 100 m from sensitive receiving areas. The location of stockpiling sites should be considered on the case-by-case basis taking into account the separation distance, volume and properties of materials, appropriate mitigation measures and liaison with potentially affected or interested or concerned parties.

The requirement for an ESDCMP is contained in the proposed conditions in Appendix 4. With the implementation of the ESDCMP, the effect of fugitive dust emissions on the local environment will be less than minor.

8.4.3 Summary

Effects on air quality is likely to occur from dust produced during construction works primarily. The construction work will be managed through the ESDCMP so that activities will not cause noxious, offensive or objectionable levels of dust beyond the designation or construction area boundaries.

8.5 Landscape and Visual Effects

With any project there is the potential of its impact on the surrounding landscape and visual amenity of the area. The appearance and structural form of the new bridge will be designed according to current bridge standards which will contrast with the existing bridge. Certain design elements of the proposed new bridge, such as abutments and concrete edge barriers present opportunities for enhancement of bridge aesthetics.

The placement of a new structure and realigned route will permanently alter the landscape. These effects need to be considered against the environment in which the bridge will be located, which includes the presence of existing built development in Beaumont, as well as the existing SH8 alignment and bridge. It should also be noted that the redundant sections of state highway will be returned to pasture or appropriately landscaped.

The visual amenity and natural character of the area will be impacted during construction from general site disturbance including the construction of temporary trestle platforms and the presence of heavy machinery operating in the site.

The construction works will be visible to passing motorists travelling on SH8 within the project area however, given the duration of works, the effect on visual amenity is considered to be temporary and less than minor in nature.

The few residences that live nearby to the project area, on the southern and northern side of the river, will have a view of the construction works at the site. Screening from the vegetation in the riparian margins the Clutha River / Mata-Au and orientation of residential properties will limit the view of some residences to the site.

However, the effects on the landscape are considered to be minor as it will not significantly change the surrounding landscape given that it already includes the existing bridge structure and SH8 network.

8.5.1 Landscaping Treatment

The landscape plans are provided in Appendix 1. The urban and landscape design principles for the project are to:

- Ensure the proposed bridge is context sensitive in terms of acknowledging local cultural aspects, heritage, landforms, land use, views and rural environment
- Ensure good urban design outcomes are achieved, utilising creative and innovative measures to integrate sustainable design measures including structures, street furniture, drainage and ecology
- Ensure that the Project relates to the future growth of the township, the cycle trail and a range of connections to the wider landscape
- Ensure the design is environmentally sensitive

- Ensure the design is aligned with Transport Agency's and Council policies and objectives
- Ensure the design collaborates with local community and interest groups

8.5.2 Mitigation Measures

It is considered that the adverse effects on landscape and visual amenity of the area from the project will be less than minor post construction. The majority of the effects on the visual amenity and landscape will occur only during the construction period and these effects are considered to be temporary and less than minor in nature. The adverse effects post construction will be mitigated through the use of proposed landscaping within the project area and screen planting to complement the existing environment as well as to enhance its amenity value.

8.5.3 Summary

In terms of visual effects, the majority of the effects will be produced during construction works from the presence of machinery working on site. The construction works will be visible to passing motorists and residences that reside near the project area, however the visibility of works will be partially screened by existing vegetation in the riparian margins which will reduce the effects. It is considered that the effects on visual amenity during construction will be temporary in nature.

Landscaping treatments are proposed to manage and mitigate the effects on the visual amenity and landscape of the area whilst enhancing the amenity value and ensuring the proposed landscaping complements the surrounding environment.

8.6 Lighting

As identified above, some minor changes to existing road lighting in the area are proposed, for safety reasons.

The lighting will be designed to comply with relevant standards.

No 'feature lighting' on the proposed bridge is envisaged.

8.7 Noise and Vibration

Given the project will result in a changed highway alignment, and that there will be considerable construction required including piling, an assessment of the effects, both from construction and from operational have been assessed (WSP-Opus 2019). The noise and vibration assessment assessed 14 locations as shown in Figure 9 below.

The Clutha District Plan identifies the potential for adverse noise and vibration effects from operation and construction of the roading network. The Clutha District Plan recognises 'operation of transport systems is defined as a land use activity by virtue of Section 9(4) of the RMA' and states Council shall 'exercise control' in respect of noise but road-traffic noise limits are not provided. The Clutha District Plan does not provide construction noise limits, considering existing New Zealand Standards are adequate controls and referring to *NZS 6803: 1984 The measurement and assessment of noise from construction, maintenance and demolition work*. The Clutha District Plan provides a general rule that vibration levels are assessed in accordance with *NZS 4403: 1976 Code of practice for storage, handling and use of explosives* and for Infrastructure requires vibration from construction activity shall comply with the peak particle velocity limits in table 1 of German Standard *DIN 4150-3: 1999 Structural Vibration – Effects of vibration on structures*.

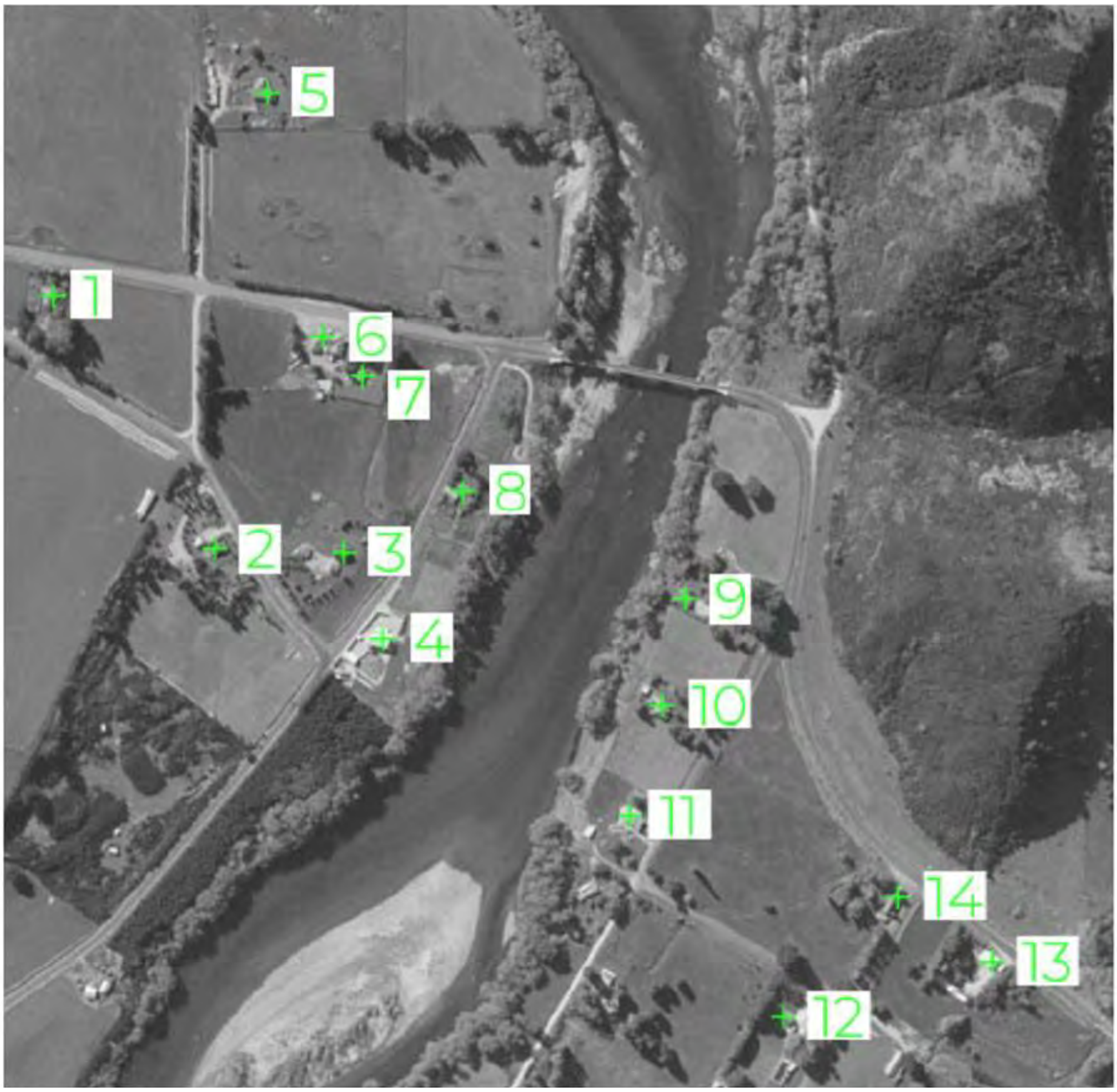

Figure 9: Noise and Vibration Assessment Locations

8.7.1 Construction Noise and Vibration

It should be noted that the construction noise and vibration assessment is based upon preliminary construction methodologies, however fundamental construction techniques are unlikely to change significantly.

The assessment of construction noise and vibration is based on preliminary construction methodologies although the fundamental construction techniques are unlikely to vary significantly. The assessment has found that a potential or likely construction noise limit of 75dB L_{Aeq} will be exceeded at a number of properties for piling, earthworks and sealing activities if no additional management is exercised.

It is likely that once the construction methodology is confirmed, some form of noise and vibration mitigation will be required for the works and will mitigate any adverse effects. The exact form of the mitigation should be decided at the stage that the construction methodology is confirmed. This mitigation will need to address the findings of the assessment to ensure any noise and vibration effects are appropriately avoided, remedied or mitigated.

8.7.2 Operational Noise and Vibration

The operational noise effects of the Project are considered to be reasonable without additional mitigation or management.

The modelling done with the NZTA Road Traffic Noise Calculator has found that the Project does not meet the NZS 6806 definitions for classification as 'new road' or noise 'altered road' for which criteria for mitigating noise are given, so it is interpreted that the road-traffic noise from the project can be considered reasonable without (further) assessment or mitigation.

It is noted that the sites 8 and 9 are predicted to see increases in noise due to the Project. These increases in noise may be perceptible or noticeable but the increases are still considered reasonable given the total noise level of the environment, using the NZS6806 methodology and therefore no specific mitigation is considered necessary.

With regards to operational vibration the assessment has also concluded that the effects are expected to be reasonable without any mitigation or management. One of the assumptions in reaching this conclusion is that the finished project will not contain any large changes in road level from poor seal joints, poorly specified or constructed bridge joints or sunken service covers as these features have the ability to generate large vibration levels. Low noise/vibration bridge joints will be specified for the project.

8.8 Contaminated Land

A Preliminary Site Assessment (PSI) has been undertaken due to historic land uses being identified through the Business Case phase of the project, in particular the former Beaumont Railway Station and extensive previous orcharding in the area.

The PSI was prepared in general accordance with CLMG No1 and the NES for Assessing and Managing Contaminants in the Soil to Protect Human Health (2011), and provided an assessment of the historical land uses and intended land use to determine whether or not the activities have, more likely than not, resulted in contamination of the soil that may be hazardous to human health.

The activities identified in the PSI were:

- Former stockyards / sheep dip
- Historic orchard (Peters property)
- Carpark /boat access to the river
- Former rail corridor
- Historic settlement
- Historic gold mining

The report stated that it is more likely than not that the risk to human health associated with the development identified on the site is low. As such, it is considered highly unlikely that there will be a risk to human health associated with the proposed development.

On this basis the report recommended that should any ground conditions be encountered across the site which are not anticipated from the findings of this report a Suitably Qualified and Experienced Practitioner (SQEP) should be consulted in order to reassess the risks to human health. No specific control measures were recommended.

On this basis it is considered any effects arising from the presence of contaminated land are less than minor.

8.9 Water Quality

The National River Water Quality Network (NRWQN) includes two sites in the Clutha River Mata Au downstream of Lake Roxburgh: Clutha River at Millers Flat and Clutha River at Balclutha (Figure 3). Water quality at the Millers Flat site is generally good, with relatively low water temperatures, high levels of dissolved oxygen, low levels of nutrients and generally low levels of E. coli present (Table 2). However, water clarity at this site is generally low (average 2 m, maximum 5.95 m), and, conversely, turbidity is generally quite high2 (Table 2). Water quality at the Millers Flat site complies with all corresponding Schedule 15 limits when applied as a 5-year 80th percentiles. The values for many of the water quality variables at the Clutha River at Balclutha are similar to those at Millers Flat, although nutrient concentrations (particularly nitrate-nitrite nitrogen and total nitrogen) and average E. coli concentrations are markedly higher at Balclutha than at Millers Flat (Table 2). Water quality at the Balclutha site complies with all corresponding Schedule 15 limits when applied as a 5-year 80th percentiles, with the exception of nitrate-nitrite nitrogen (), which exceeds the Schedule 15 limit of 0.075 mg/L.

Of the two sites, water quality measured at the Millers Flat site is likely to be most representative of the water quality in the reach affected by the construction of the bridge at Beaumont, as the Millers Flat site is 22 km upstream of Beaumont and no major tributaries or discharges that are expected to have an appreciable effect on water quality in the Clutha River Mata-Au enter it between these two locations.

Based on the effective stormwater treatment systems proposed, the impact on water quality of the Clutha River Mata-Au will be less than minor and no significant change to water quality will occur.

An ESDCP will be prepared and implemented during construction works to effectively manage discharge impacts on receiving environments.

During rainfall events, exposed surfaces of the ground can mobilise sediments to discharge into waterways which can impact the quality and ecosystem of the receiving waterway. Where possible construction stormwater will be discharged to land. Stormwater that cannot discharge to land will discharge into the river and stream via treatment.

There will be incidental discharge of sediments to water during construction works from bed disturbance associated with the movement of machinery in the riverbed, and piling activity. This will occur with the construction of the new bridge, installation of rock rip rap structures on the bridge abutments, forming and removing the temporary staging platform. It is considered that the quantity of sediment release will not exceed the amount of sediment expected to be released during high flow events.

8.9.1 Mitigation Measures

The actual and potential effects on water quality are mitigated through:

Operational

- Adequate stormwater treatment systems are proposed and designed to a capacity to withstand overflow during high rainfall.

Construction

- All construction phase stormwater being managed by way of an ESDCP prepared in accordance with industry guidelines.

8.9.2 Summary

The proposed stormwater treatment systems have been designed to accommodate stormwater runoff volumes during low intensity and high intensity rainfall periods. This will mitigate any potential discharge of contaminants from entering the waterways.

Throughout the project area best practice erosion and sediment control measures to prevent fine sediment entering adjacent waterways will be managed by way of an ESDCP prepared in accordance with guidelines.

8.10 Aquatic Ecology

8.10.1 Operational Effects on Aquatic Ecology

It is considered that the stormwater runoff volume from the road embankments, once the bridge is in operation, will be greater than the existing bridge due to the increase of the road surface area with the bridge becoming two lanes. Potential contaminants arising from vehicles on the road such as diesel particulate matter, brake lining dust and other sediments, pathogens and road film, is likely to be carried by the stormwater runoff and to essentially end up in waterways. In order to mitigate adverse effects on aquatic ecosystems, stormwater treatment systems have been proposed. A stormwater detention basin will be installed to trap sediments washing off from the road on the eastern side of the proposed bridge.

8.10.2 Construction Effects on Aquatic Ecology

Construction activity has the potential to impact on the habitat of aquatic ecology at the site, though the following activities:

- Enabling works in the bed including construction of any temporary gravel working platforms;
- Construction and deconstruction of the staging platform;
- Piling.

These activities have the potential to disturb the bed, and also to mobilise sediment.

Five species of fish have been recorded as being present in the main stem of the Clutha River Mata-Au in the vicinity of the proposed works :

- longfin eel (Anguilla dieffenbachii);
- torrentfish (Cheimarrichthys fosteri);
- common smelt (Retropinna retropinna);
- quinnat salmon (Onchorhynchus tshawytscha) and
- brown trout (Salmo trutta).

In addition to these species, it has been identified that several other species could be reasonably expected to reside in or pass through this area:

- lamprey (Geotria australis);
- shortfin eel (Anguilla australis);
- common bully (Gobiomorphus cotidianus);
- upland bully (Gobiomorphus breviceps);
- kōaro (Galaxias brevipinnis) and
- rainbow trout (Onchorhynchus mykiss)

The construction of the bridge piles is likely to cause a minor amount of habitat loss and sediment release from the disturbance to the bed. The increase in turbidity from machinery operating in the riverbed can affect feeding rates of fish species and limit migration and recruitment. Sedimentation release in the waterway can harm life expectancy and habitats of fish species by blocking interstitial spaces, reducing fish cover, shelter, foraging areas, food supply and spawning sites.

The report prepared by Ryder notes that downstream of the Roxburgh Dam the river is affected by daily flow fluctuations resulting from electricity generation. The report states that this causes a "varial zone", an area of the riverbed that is intermittently wetted and dried, which reduces the suitability of this area for aquatic life. This wetting and drying activity is noted as resulting in low densities and diversity of macroinvertebrates, as few freshwater invertebrates are adapted to frequent wetting and drying (p14). The report goes on to state the fluctuations in the varial zone reduce the suitability for fish habitat, and also the lower densities in invertebrates (identified above) reduces the local food availability for any fish present.

Mitigation Measures

In order to mitigate the effects on aquatic and terrestrial ecosystems and their habitats within the Clutha River Mata-Au from the proposed works, the following mitigation measures have been included in the construction methodology:

Bridge works:

- An emergency contingency plan for concrete spills should be prepared prior to any works commencing.

Stormwater discharge:

- An ESDCP Plan will be put in place to manage any adverse effects.
- The stormwater basin will be installed on the eastern side of the realignment to trap sediments that have washed off from the road. The proposed planting will aid in filtering sediments and contaminants.

8.10.3 Summary

The adverse effects on aquatic ecosystems during construction works and operation of the bridge can be appropriately mitigated and managed through the mitigation measures, noting the low aquatic habitat value of parts of the site, due to wetting and drying effects associated with frequent water level changes. It is considered that aquatic habitats will be disturbed and/or lost during construction works however any effects associated with this are less than minor.

8.11 Terrestrial Ecology

8.11.1 Construction effects

Flora

The project will have the potential to impact on terrestrial ecology through the general land disturbance associated with the project. Generally speaking the areas to be disturbed by the project are either existing pasture, roadside verges and riparian areas adjacent to the river. The Ryder report assessed the project footprint and identified eighty plant species (16 native, 64 exotic) within the footprint. The flora within the footprint was typical of pasture, road-side and disturbed riparian vegetation, being dominated by exotic grasses and herbs with a scattering of mainly introduced trees and shrubs. Native plants comprised <1% of the total cover. No nationally, or regionally, threatened or at-risk plant species were detected.

The report also identified that because the existing vegetation values of the footprint are very low weed species are not considered to pose a significant threat to the existing vegetation in the footprint. The report did not that there is the potential for new weed species to be introduced to the site (e.g. on construction machinery or in aggregates).

Fauna

In terms of birdlife, the report noted that the loss of mature trees (the large macrocarpa on the eastern bank, as well as willow species), may result in the loss of potential roosting habitat of grey teal or black shags. Any loss of this habitat is localised at the site, and similar habitat stretches for many kilometres up and downstream of the site.

The report did not assess potential lizard and invertebrate fauna-habitats but identifies lizard species may occur within the footprint given the presence of suitable habitat along the edges of pasture and existing roads. All lizard species are protected under the Wildlife Act (1953), administered by the Department of Conservation, and a dedicated lizard survey is recommended prior to works commencing. This has been promoted as a draft condition of the designation.

8.11.2 Mitigation Measures

Any effects on vegetation (and associated habitat loss) within the project area will be mitigated through replanting of the areas disturbed as part of the proposed landscaping treatment. These areas will be replanted with appropriate plant species.

Summary

The vegetation within the project area is highly modified with almost no indigenous vegetation present. The areas of vegetation disturbance will be replanted through the proposed landscaping treatment with appropriate species. This will mitigate any adverse effects on vegetation ecosystem within the area.

8.12 Hydrology and Hydraulics

The placement of a new structure in the bed of the Clutha River Matau-Au has the potential to adversely affect the downstream morphology of the river through changes to the flow characteristics bought about by the new piers in the wet bed.

Additional to this, the bridge also needs to be designed to remain serviceable in flood events, and to not have any impacts on up or downstream flood levels

Performance in Flood Events

A flood frequency analysis has been completed for the Clutha River based on flow records from the Roxburgh Dam, 50km upstream of the proposed bridge, and flow records at Balclutha, approximately 60km downstream of the bridge.

The analysis estimates the following design flood flows for various Annual Recurrence Intervals (ARIs) including for climate change effects:

- 20 year ARI (to inform design of pedestrian and cyclist linkages) = 3,140m^3
- 100 year ARI (Serviceability Limit State (SLS)) event for bridge design) = 5,250m^3
- 1,000 year ARI (Upper Limit State (ULS)) event for bridge design) = 7,100m^3

Further details of the analysis are contained in the Hydrological Assessment Report attached in Appendix 5.

The design flood flows from the hydrological assessment and hydrographic survey outputs (river cross sections) have been incorporated in a hydraulic flood model to assess design flood levels for the new bridge and associated pedestrian / cyclist linkages.

The modelling indicates the following design flood levels for various Annual Recurrence Intervals (ARIs) including for climate change effects:

- 20 year ARI (to inform design of pedestrian and cyclist linkages – linkage remains open) = RL45.31m
- 100 year ARI (SLS event for bridge design – bridge remains open) = RL 47.93m
- 1,000 year ARI (ULS event for bridge design – bridge closed due to flooding, but remains intact) = RL 49.91m

Scour protection for the proposed bridge piers and abutments, and hydraulic loadings against the bridge structure require careful consideration. The desired response in a 100 year ARI flood event is that bridge will remain serviceable, and that in a 1,000 year ARI flood event the bridge structure will not be undermined to the extent of destabilising the bridge piers, and the bridge structure will not be weakened under pier rotation or horizontal deflection but will not be useable due to flooding. Brittle behaviour in bridge members and the risk of structural collapse has been considered. The close proximity of the two bridges to each other can amplify the scour at the downstream bridge depending on the relative location of the piers and this has been considered when assessing scour protection works.

Velocities have been output from the hydraulic model to assist with the design of scour protection to bridge abutment and piers. The proposed scour protection will consist of a rock revetment around the abutments as described above in Section 5.

Effects on existing flood risk

The proposed bridge's abutments will reduce the flow of floodwaters across the floodplain, and its piers will further impede the flow of water down the Clutha River Matau Au channel. Consequently, it can be expected that the water levels upstream of bridge will increase. The Hydraulic Assessment Report attached in Appendix 5 details the existing flood levels, and the expected change in flood levels following the construction of the proposed bridge for a range of flood events.

The results in the Hydraulic Assessment Report demonstrated the effect of the proposed SH8 Beaumont Bridge across the Clutha River Matau Au will have a less than minor effect on the flood risk upstream of the existing SH8 Bridge. The maximum increase in flood level for the scenarios considered is 0.10 m, which is within the model error range.

The existing Beaumont bridge soffit level was surveyed to be 48.68 m RL. This provides 0.52 m of freeboard to the 100 year ARI flood event including the effects of climate change out to 2120 in the existing situation. Freeboard will reduce to 0.42 m following the construction of the proposed bridge which provides acceptable provision for passing flood flows including potential debris.

Temporary Staging Platform

Freeboard requirements for the SLS flood event are not specified in the NZTA Bridge Manual. 600mm freeboard to the 25 year event is considered appropriate and shall be incorporated in the Project Specification, to ensure any effects from the presence of the temporary staging platform in a flood event can be adequately mitigated.

8.13 Cultural Values

As identified in Section 4 consultation has been undertaken with Aukaha and Te Ao Marama throughout both the business case phase of the project, and as part of the current phase of the project.

The cultural values associated with Mata-Au particularly as a Statutory Acknoweldgement conveys the importance of undertaking ongoing consultation with Aukaha and Te Ao Marama in development of the bridge and alignment design. Ongoing consultation with Aukaha and Te Ao Marama has been and will be undertaken throughout the duration of the project to ensure correct measures are implemented to avoid, remedy and mitigate any actual or potential effects on cultural values. Further to this, opportunities to incorporate cultural elements into the detailed design of the project (for example aesthetic treatments to bridge abutments) are being explored with Aukaha and Te Ao Marama.

An Accidental Discovery Protocol will be implemented during the construction works. The proposed landscaping will contribute to enhancing the cultural values of the area.

8.14 Archaeological and Heritage values

Archaeology

An archaeological assessment of the site has been undertaken, to identify the archaeological risk for the project, and to accompany an application for an Archaeological Authority.

The recorded sites identified in proximity of the project area are shown below in Table4.

Table 4: NZAA Entries

NZAA ID	Site Type	Distance from Project Area	Details
G44/3	Midden/Oven	0.3 km	Site recorded along 1966 fence line leading down small gully as ovens over 1.5 acres. Recorded as ploughed, which bought charcoal, ovenstones and flakes to the surface. SRF contains limited information, although an update in 2012 notes that it was down Chinamans Flat Road in middle of paddock on left-hand side, past landowners house. During the site upgrade, a test pit revealed that there is undisturbed material below the plough zone.
G44/4	Artefact find	0.7 km	Site recorded as a find spot of a 1A adze on Mrs Morris's land. Recorded in 1965 and not revisited during the Site Upgrade Project.
G44/64	Mining - gold	1 km	Located upstream of Beaumont Bridge on river's true left. Recorded as tailing and dredge ponds across the whole flat, approximately 600 m upstream of the Beaumont River Mouth.
G44/86	Historic – domestic	0.9 km	Site recorded as a hut/floor site, associated with the railway. Site situated on river side of old railway formation approximately 20-30 metres north of the Beaumont River.
G44/87	Transport/ communication	0.8 km	Old road bridge next to the old railway bridge. It is a mortared schist bridge abutment on both banks of the Beaumont creek.
G44/88	Mining – gold	0.8 km	Water race approximately 40 metres from new bridge. Is revetted in places. Race is 1.5 m wide.
G44/143	Historic – domestic	0.8 km	Hut platform by a revetment, supposedly built after 1900. Includes a hut floor site and a

			benched track that runs to the south of the project area.

All pre-1900 archaeological sites are protected under the provisions of the HNZPTA, whether the sites are recorded or not. It is illegal to destroy or modify archaeological sites without an archaeological authority from Heritage New Zealand. This archaeological assessment has identified that there are risk areas associated with the Project works at Beaumont to realign the road and provide an alternate bridge crossing.

There is a risk of encountering unrecorded archaeological remains within the Project area. These potential remains are likely to be modified or destroyed by the road realignment and associated works.

There are potential effects posed to known or potential archaeological sites surrounding the Beaumont area associated with tranches of the work required to successfully realign the road and bridge around Beaumont. Works around the banks of the Clutha River Mata-au pose risk for encountering unrecorded Māori archaeological remains, such as ovens. Excavation in these zones will be required for the bridge approaches and the realignment of the road. The potential effects of these proposed works are destruction of any archaeological features.

The archaeological assessment has identified the following areas of archaeological risk, which will be included in the application for an archaeological authority -

- Site of the former Bridge Hotel, stables and blacksmith.
- Proximity to the Clutha River Mata-au and Low Burn - potential for encountering Māori ovens and occupation sites.
- Existing Beaumont Bridge and approaches.
- Proximity to the historic house site along Rongahere Road (immediately south of the existing bridge).

Heritage

As part of the Detailed Business Case (DBC) investigation an assessment of the Heritage Assessment of the Beaumont Bridge was undertaken (Opus, 2016). The assessment concluded that the Beaumont Bridge has high aesthetic and cultural value, and exceptional historic, contextual, technological, scientific and archaeological value; and the settlement of Beaumont has exceptional cultural, archaeological, historic and social value.

Subsequent to the DBC the option chosen by the NZ Transport Agency was to:

- Retain the Beaumont Bridge;
- Find a new use for the Beaumont Bridge taking advantage of existing opportunities such as cycle trails;
- Undertake repair works necessary to make the bridge suitable for the selected alternative use;
- In designing the new bridge consider the heritage significance of both the existing bridge and the Beaumont settlement;
- Undertake an Archaeological Assessment for the Beaumont Bridge and the wider area to be affected by works.

In terms of the above recommendations above the proposed alignment ensures the existing bridge can be retained, a use for it has been proposed (pedestrian and cycle linkage), the heritage significance of both the bridge and settlement was considered in selecting a new bridge option and an archaeological assessment has been undertaken (and authority applied for).

In terms of the repair works to the existing bridge, and the preparation of a Conservation Management Plan, these are matters that the Transport Agency, as asset owner, will undertake outside of this RMA process. This includes seeking an archaeological authority, if required.

Aside from the existing bridge, the other listed items in the Clutha District Plan are a series of scheduled trees near the corner of Weardale Street and SH8. Of these trees, there is the potential for some of the northern limbs of trees H80E and H80F (both English Oak) to be trimmed as these will 'hang' over the new highway alignment. The extent of this will be fully documented in any Outline Plan submitted. These works will be supervised by an arbourist to ensure an appropriate level of care is undertaken.

Summary

There will be some minor adverse effects on archaeology and heritage values from the proposal, particularly the loss of some limbs on two scheduled trees. Apart from that, appropriate measures are proposed to ensure any other actual and potential effects on archaeology and heritage are appropriate mitigated.

8.15 Social and Recreation

The proposed alignment of the SH8 route will affect properties within and immediately adjacent the project area during construction. This will be through temporary elevated levels of noise, presence of machinery, traffic management, and other construction related activities. The contractor will be required to address and manage these effects through the implementation of the CEMP.

No property accesses are proposed to be closed as part of the project.

There will be some temporary restrictions on access to the river downstream of the existing bridge for safety reasons during construction, due to the footprint of works. The access to the river on the western bank will be reinstated on completion of the works. Maintaining the river access ensures that the river remains accessible to the local residents, wider community and tourists to continue to carry out their desired recreational activity. This retains the recreational value of the area.

Consultation has also been undertaken with the harbourmaster regarding safety for river users during construction. Appropriate signage to manage river users will be in place for the duration of the works to alert river of access restrictions, and where necessary demarcate any temporary platform / working area in the river.

The project will produce positive effects to the community. The accessibility in relation to social impacts is considered to be positive. The provision for pedestrian and cycling facilities within the project area will improve the connectivity within Beaumont. Providing sustainable transport modes across the bridge will facilitate more public movement around areas within the township and with more choice. Enhancement of the rest area on the eastern river bank adjacent Craig Flat Road will also further support recreation and amenity values in the project area.

It is considered that the project will have a positive impact on the social and recreational value of the area.

8.16 Infrastructure

Telecommunications

Consultation with service providers has confirmed existing Chorus copper services routed along SH8 and across the existing bridge. As part of the new bridge project, the existing services will need to be retained/protected with localised relocation anticipated around the Rongahere Road intersection where the new bridge approach is elevated. To future proof for possible future fibre optic installation a 100mm duct is to be installed across the new bridge and extended as a continuous length along the approach embankments and terminated in chambers in the shoulder/verge.

Electricity

11kV and 400V overhead power lines operated by PowerNet located at the site conflict with the proposed bridge and approach alignment. A preferred power relocation option has been developed in liaison with PowerNet and comprises diversion of the 11kV network to a new overhead crossing of the river upstream of the existing bridge.

Private Reticulation

Consultation has identified a gravity water feed on the eastern side of the river supplied from a gully northeast of the existing bridge, making use of an intake that was installed to service the former Beaumont Railway Station. The water supply is understood to feed water troughs within the Mitchell property, a residential dwelling at 12 Weardale Street and the old store. The proposed alignment on the eastern approach to the bridge crosses the pipeline and this will need to be located and reinstalled in a duct below the alignment.

Futureproofing

It is proposed to install an additional four 150mm ducts through the new bridge abutments to allow for any potential future power or service relocations. This low-cost option will eliminate the need to core through reinforced abutment headwalls in the future. This would also enable retrofit of street lighting across the bridge in the future, however, given the location, this is not envisaged to be required. No provision has been made for future water or sewer supplies across the new bridge and discussions with Clutha District Council (Chris Bopp) indicate these are not anticipated. Notwithstanding this, the bridge form is amenable to future retrofit of services between steel girders should this be required.

8.17 Summary of Effects

The effects assessment shows that there will a number of positive effects from the project. The project will be able to provide security and reliability of route within the Clutha District. It will also improve safety within the project area for road users and local residents. The provision for pedestrian and cyclist facilities on both bridges will improve connectivity and encourage alternative modes of transport to and from the Beaumont Township. The geometry of the new bridge will provide improved provision for the movement of heavy/large loads across the bridge and reduce traffic delays and risk of incidents.

Noise generated will be limited to the duration of construction works. The effect from construction noise is considered to be temporary in nature and less than minor. The vibration from construction works will be intermittent and managed through Construction Noise and Vibration Management measures in the CEMP to reduce any adverse effect on nearby properties and structures to an appropriate level. Any dust generated from construction works will be managed by the ESDCP to mitigate the risk of dust beyond the designation or construction area boundaries. Public access to Clutha River Mata-Au will be retained on the western side of the river through the relocated access track.

There is expected to be some effect to the landscape and visual amenity values of the surrounding area during construction. However, these effects are considered to be less than minor and temporary in nature for road users and nearby residents. The new bridge structure and route alignment will permanently alter the landscape of the area. In order to mitigate any adverse effects, landscaping treatments are proposed to provide an attractive landscape which complements the surrounding environment.

Discharge of stormwater during construction and post construction will have a less than minor effect on water quality of the Clutha River Mata-Au. The ESDCP will be put in place during construction works to mitigate the adverse effects on water quality. Stormwater treatment systems will be used to manage and treat stormwater runoff from the bridge and road embankments. This will ensure the mitigation of contaminants entering the receiving waterways. The discharge of contaminants during construction of the new bridge will be limited to sediments and the movement of machinery in the waterway will create temporary effects to the water quality of the Clutha River Mata-Au.

There is a potential that archaeological material will be found during the removal earthworks associated with the project. The effects to archaeological values will be managed through the guidance of the Archaeological Authority Management Plan during construction works.

Noise and vibration effects will need to be managed through a construction noise and vibration management plan.

There will be some effects on scheduled trees at the site, which will be managed through the use of an arborist to oversee any trimming required.

This application does not propose to remove the existing Beaumont Bridge.

Overall, the adverse effects generated from the proposal and associated construction works will be minor.

A set of draft conditions for both the Notice of Requirement and the resource consents are contained in Appendix 4 of this document.

9. Statutory Assessment

This section outlines the statutory and planning provisions that are relevant to the Notice of Requirement and consenting of the Project. As outlined, a number of resource consents are required from the Otago Regional Council and Clutha District Council under the RMA.

9.1 Notice of Requirement

9.1.1 Section 181 RMA

Section 181(1) of the RMA, in summary, provides that a requiring authority may give notice to a territorial authority of its requirement to alter an existing designation in an operative district plan or a requirement for a designation in a proposed district plan.

Furthermore, subject to Section 181(3) of the RMA, a territorial authority may at any time alter an existing designation or a designation requirement if certain conditions are met as follows:

> *A territorial authority may at any time alter a designation in its district plan or a requirement in its proposed district plan if –*
>
> *(a) The alteration—*
>
> *(i) Involves no more than a minor change to the effects on the environment associated with the use or proposed use of land or any water concerned; or*
>
> *(ii) Involves only minor changes or adjustments to the boundaries of the designation or requirement; and*
>
> *(b) Written notice of the proposed alteration has been given to every owner or occupier of the land directly affected and those owners or occupiers agree with the alteration; and*
>
> *(c) Both the territorial authority and the requiring authority agree with the alteration -*
>
> *and sections 168 to 179 and 198AA to 198AD shall not apply to any such change.*

If all of the criteria of Section 181(3) are satisfied, the designation alteration may occur without further formality (i.e, on a non-notified basis).

The effects criterion is one of two options available to the requiring authority under Section 181(3)(a). The other relates to a determination of the extent of change or adjustment to the boundaries of the designation.

It is important to note that it is not necessary to satisfy both the effects and boundaries tests of Section 181(3)(a)(i) and (ii). The two limbs of Section 181(3)(a)(i) and (ii) are disjunctive, so it is only necessary to satisfy one of the two criteria.

The extent to which this Notice of Requirement for designation alteration is able to satisfy the tests of Section 181(3) of the RMA is discussed below.

9.1.2 Effects on the Environment

Actual or potential adverse effects on the environment are assessed as minor, and can be avoided, remedied or mitigated to the extent that any such effects will likely be minor, and positive effects will arise. The designation alteration will therefore result in no more than a minor change to the effects on the environment. In this context the proposal can be regarded as satisfying the effects test of Section 181(3)(a)(i) of the RMA.

9.1.3 Extent of Boundary Alteration

The existing SH8 designation needs to be altered to cater for the new location of the bridge and changes to the bridge approaches. The extent to which the designation alteration departs from the boundaries is relatively minor when considered in relation to the SH8 designation. It is therefore considered the proposal can be regarded as satisfying the boundaries test of Section 181(3)(a)(ii) of the RMA.

9.1.4 Directly Affected Party Approvals

To satisfy section 181(3)(b) it is necessary to obtain the written approvals to the designation alteration from every owner or occupier of land directly affected, that is, land required for the project and not owned by the Transport Agency.

Written approvals have not been sought. The Transport Agency has instead requested public notification of the application.

9.1.5 Territorial Authority and Requiring Authority Agreement

To satisfy Section 181(3)(c) of the RMA, both the requiring authority and the territorial authority must agree to the designation alterations. The Transport Agency, as requiring authority, agrees to the designation alterations.

9.1.5 Section 171(1) Resource Management Act 1991

When considering a notice of requirement and any submissions received, a territorial authority, subject to Part 2 consider the effects on the environment of allowing the activity, having particular regard a number of matters including:

> *(b) whether adequate consideration has been given to alternative sites, routes, or methods of undertaking the work if—*
>
> > *(i) the requiring authority does not have an interest in the land sufficient for undertaking the work; or*
> >
> > *(ii) it is likely that the work will have a significant adverse effect on the environment; and*
>
> *(c) whether the work and designation are reasonably necessary for achieving the objectives of the requiring authority for which the designation is sought;*

In this instance the Transport Agency does not have an interest in the land sufficient for undertaking the work. At present funding for the property acquisition component of the project is not available and therefore the Transport Agency has not been in a position to undertake property acquisition with directly affected landowners. The alternatives were considered at length at the business case phase of the project as detailed above in Section 6.

For the reasons discussed in the assessment of environmental effects above, the proposal is not expected to give rise to any significant adverse environmental effects.

The work and designation are reasonably necessary for achieving the objectives of the requiring authority for which the designation is sought for the reasons outlined in Section 2 of this document.

9.1.6 National Policy Statements

There are five National Policy Statements (NPS) in place. These are:

- Electricity Transmission
- Renewable Electricity Generation
- NZ Coastal Policy Statement
- Freshwater Management
- Urban Development Capacity

Only the NPS on freshwater management is considered to be of relevance to the applications.

9.1.7 National Environmental Standards

There are five National Environmental Standards (NES) in force as regulations. The following NES is considered relevant to the proposed designation to which CDC must consider.

Assessing and Managing Contaminants in Soil to Protect Human Health

The NES for Assessing and Managing Contaminants in Soil to Protect Human Health is relevant to this proposal. An application to Clutha District Council under the NES for is being applied for as part of this application.

9.1.8 Regional Policy Statements

In considering the proposal the consent authorities must have particular regard to the regional policy statements.

Currently Otago has two regional policy statements, the Partially Operative Regional Policy Statement for Otago 1998 and the Partially Operative Otago Regional Policy Statement 2019. Both RPS's are broad policy documents which consider all of the Otago's regionally significant resource management issues and provides objectives, policies and methods to address those issues. It sets out how natural and physical resources are to be managed in an integrated way to promote sustainable management. Sections 104 and 171(1)(a) of the RMA directs the consent authorities to have particular regard to the proposed RPS when considering the effects on the environment of allowing the requirement and granting resource consents.

Another key issue is consistency with relevant objectives and policies of the proposed RPS itself. Objectives and policies from the RPS's that are relevant to consideration of the proposal and are considered in this AEE relate to:

- Provision for Ngai Tahu and their relationship with resources
- Resilient and Sustainable Communities
- Use and Development of resources
- Regionally Significant Infrastructure
- Land and Water
- Air Quality

Relevant objectives and policies are listed in Appendix 3 Table 1 and an assessment as to the consistency of the project with these is also summarised in Appendix 3 Table 1. It is considered the proposed designation alteration is at least consistent with, and even promotes, the relevant Objectives and Policies contained within the RPS.

9.1.9 Clutha District Plan

The Clutha District Plan provides a framework to help manage the use, development and protection of the physical and natural resources of the Clutha District. Specifically, the District Plan sets down objectives, policies and rules to guide the use and development of land in a way that promotes the wellbeing of people and the environment.

A designation means that the District Plan rules no longer apply to the designated sites(s) however, it is necessary to consider the designation in the context of the policy framework. The designation should be consistent with the direction set by the District Plan policies.

Objectives and policies from the District Plan that are relevant to consideration of the proposal are listed in Appendix 3 Table3 and an assessment as to the consistency of the project with these is also summarised in Appendix 3 Table 3.

The evaluation finds the proposal is consistent with these objectives and the associated policies.

The need for the work, the proposal, and the alternatives considered, are discussed above respectively. It is considered this discussion demonstrates that the proposal will have an overall positive effect on the capacity, security, safety and efficiency of the road network, and form part of a sustainable, integrated transport system for the Otago Region.

9.2 Resource Consent Applications

9.2.1 Section 104 RMA

Section 104 of the RMA applies to the consideration of resource consent applications.

> **104** ***Consideration of applications***
>
> *(1) When considering an application for a resource consent and any submissions received, the consent authority must, subject to Part 2, have regard to –*
>
> *(a) any actual or potential effects on the environment of allowing the activity; and*
>
> *(b) any relevant provisions of –*
>
> *(i) a national environmental standard:*
>
> *(ii) other regulations:*
>
> *(iii) a national policy statement:*
>
> *(iv) a New Zealand coastal policy statement:*
>
> *(v) a regional policy statement or proposed regional policy statement:*
>
> *(vi) a plan or proposed plan; and*
>
> *(c) any other matter the consent authority considers relevant and reasonably necessary to determine the application.*
>
> *(2) When forming an opinion for the purposes of subsection (1)(a), a consent authority may disregard an adverse effect of the activity on the environment if a national environmental standard or the plan permits an activity with that effect.*

An assessment of the actual or potential effects on the environment has been undertaken in Section 8 above. The extent to which the proposed resource consent is able to satisfy Section 104(1)(b) and(c) and Part 2 of the RMA is considered below.

9.2.2 National Environmental Standards

There are five National Environmental Standards (NES) in force as regulations. The following NES are considered relevant to the proposed consent applications to which ORC must consider.

Air Quality

The NES for Air Quality includes standards for PM10 – fine particulate. The standard for PM10 is 50 $\mu g/m^3$ as a 24-hour average with one exceedance permitted in any 12 month period. The NES is relevant in that air discharge permits can be declined if a proposal is likely to result in exceedance of the standards.

Air quality may be a potential issue during construction where fugitive dust emissions from disturbed ground have the potential to create an adverse effect. However, fugitive dust can be managed and controlled through specific on-site measures. The contractor will be required to prepare and implement an ESDCP which will identify how fugitive dust emissions will be managed.

9.2.3 Other Regulations

It is considered there are no other regulations relevant to the consideration of this resource consent application.

9.2.4 National Policy Statements

Only the NPS on Freshwater Management is considered to be of relevance to the proposed resource consents.

The proposed new bridge and road alignment will require stormwater disposal, which has the potential to affect water quality and freshwater ecosystems.

The stormwater treatment system uses roadside swales and a treatment pond to treat stormwater runoff. The stormwater runoff from the bridge will be treated using a treatment pond. It is considered that the design of the treatment system will hold low intensity and high intensity rainfall volumes.

It is therefore considered the discharges will also be consistent with the relevant objectives and policies of the NPS on freshwater management.

9.2.5 Regional Policy Statements

Otago currently has two Regional Policy Statements: the 1998 Regional Policy Statement for Otago: Partially Operative at January 2019, Partially Operative Regional Policy Statement 2019. The relevant objectives and policies of both RPS's are listed in Appendix 3 Table 1 and an assessment as to the consistency of the project with these is also summarised in Appendix 3 Table 1. It is considered the proposal is at least consistent with, and even promotes, the relevant Objectives and Policies contained within the RPS's.

9.2.6 Regional Plans

Regard needs to be had to the relevant Regional Plans – being the Regional Plan: Water for Otago, and the Regional Plan: Waste. A key issue is consistency with relevant objectives and policies of these plans.

These relevant objectives and policies are listed in Appendix 3 Table 2 and an assessment as to the consistency of the project with these is also summarised in Appendix 3 Table 2.

Actual or potential effects of the proposal on the environment are assessed above as minor, particularly with the mitigation measures proposed above and in Appendix 4.

Overall, it is considered the proposal is consistent with the relevant objectives and policies.

9.2.7 Section 107 RMA

Section 107 of the RMA places restrictions on the ORC in granting discharge permits (e.g. to discharge stormwater). In particular the Council must not grant a discharge permit if, after reasonable mixing, the contaminant or water being discharged is likely to give rise to certain effects in the receiving waters. These effects include any one or more of the following in the receiving waters:

- the production of any conspicuous oil or grease films, scums or foams or floatable or suspended materials
- any conspicuous change in the colour or visual clarity
- any emission of objectionable odour
- the rendering of fresh water unsuitable for consumption by farm animals
- any significant adverse effects on aquatic life.

The discharge of stormwater from the project to water will not cause the above effects.

9.3 Other Matters

9.3.1 Iwi Environmental Management Plans

The *Kāi Tahu Ki Otago Natural Resource Management Plan 2005* is relevant as it provides important guidance for in the resource management decision-making framework in Otago. The document outlines environmental outcomes sought by Te Runanga and the means by which they are seeking to work with resource management agencies to achieve the outcomes. One of the key sections, as relevant to this proposal, is on water quality. Central to the objectives and policies is the need to restore, maintain and protect the mauri of freshwater resources. More specifically the policies seek to adopt a catchment approach so that integrated management occurs, identify freshwater resources where the mauri is affected and unaffected and protect the opportunities for future use of freshwater resources.

Similarly *The Cry of the People Te Tangi a Tauira Ngāi Tahu ki Murihiku Natural Resource and Environmental Iwi Management Plan 2008* seeks to maintain the mauri of waterbodies, protect cultural values and uses and protect instream values (instream flora and fauna).

The stormwater treatment system uses grassed roadside swales and a pond to treat stormwater runoff. The stormwater runoff from the bridge will be treated using a treatment pond. It is considered that the design of the treatment system will hold low intensity and high intensity rainfall volumes.

In addition, the proposed alignment is considered to be a better outcome for the township of Beaumont township compared to the alternative alignments considered in the Detailed Business Case and discussed in Section 5 of this application. The proposed alignment provides the closest retainment of the existing route through Beaumont, has the least impact on properties and waterways and least potential adverse effects on the environment.

9.3.2 Other Statutory Approvals Required

Outline Plan

An Outline Plan in terms of Section 176A(3) of the RMA for the proposed works will be lodged following confirmation of the designation.

Heritage New Zealand Pouhere Taonga Act 2014

An authority from the Heritage New Zealand will be required to destroy, damage or modify archaeological sites that may be impacted by the project will be lodged following the confirmation of the alteration to designation.

9.4 RMA Part 2

In assessing the proposal against the need to meet the sustainable management of natural and physical resources sections 6 to 8 are assessed below with each analysis contributing to the final evaluation of section 5 – the Purpose of the RMA.

9.4.1 Section 6

Section 6 of the RMA sets out those matters of national importance that are to be recognised and provided for in achieving the purpose of the RMA. Matters in Section 6 that are of relevance to the project are considered to include the following.

Section 6(a) of the RMA requires recognition and provision of '*The preservation of the natural character of …wetlands, and lakes and rivers and their margins and the protection of them from inappropriate subdivision, use and development'.*

The proposed alignment crosses over the Clutha River Mata-Au, downstream of the existing bridge. The riverbanks in this location will require earthworks and vegetation clearance to provide for the construction of bridge abutments and rock rip rap structures. Once the works are completed, the margins will be reinstated with appropriate landscaping.

Section 6(c) of the RMA requires the *'protection of indigenous vegetation and significant habitats of indigenous fauna'.*

There are no areas of significant indigenous vegetation identified along the proposed alignment. As identified there is the potential for lizards to be present at the site. As such a lizard survey is being promoted as a pre-construction condition.

Section 6(d) of the RMA addresses the *'maintenance and enhancement of public access to and along rivers'.* During construction there may be some restrictions on public access to and along the Clutha River Mata-Au particularly in relation to the 'boat ramp' area on the western bank downstream of the existing bridge. This is because the river access falls within the project area and a part of the western riverbank will be required as additional land for construction purposes, to eventually become State highway. Once works are completed, public access along the river will be maintained through the relocated western river access.

In regard to the relationship of Māori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga (Section 6(e)), on-going consultation with Aukaha and Te Ao Marama will ensure that correct measures are implemented to avoid, remedy and mitigate any actual or potential effects on tangata whenua. Further to this engagement is being undertaken to get feedback on some design aspects of the bridge to recognise the importance of the Mata-Au to Ngāi Tahu.

Under Section 6(f), historic heritage is to be protected from inappropriate use and development. There are no recorded archaeological sites within the project area. As such, the proposal will not impact on any recorded archaeological sites. However, an archaeological authority will be sought for physical works associated because of the potential for encountering unrecorded prehistoric archaeological sites. Earthworks will be covered by the Accidental Discovery Protocol (ADP) developed by the Transport Agency, Heritage NZ and Ngāi Tahu.

It is considered none of these Section 6 matters will be adversely affected by the proposal, based on the assessment of actual or potential effects of the proposal on the environment and the proposed mitigation measures.

9.4.2 Section 7

Section 7 of the RMA sets out those other matters that a consent authority is to have particular regard to in achieving the purpose of the RMA. Matters in Section 7 that may be of relevance to the proposal are considered to include the following.

The proposed mitigation measures in respect of cultural heritage and archaeology will help meet Section 7(a) of the RMA.

Section 7(b) requires a consideration of whether a proposal is an efficient use and development of natural and physical resources. A proposal may provide an efficient use of a resource, noting that the existing state highway is a physical resource, if it enables people to provide for their social and economic well-being but only to the extent that it: does not impair the social well-being and health of other people and the community; avoids, remedies, or mitigates adverse effects on the environment; and maintains and enhances amenity values and the quality of the environment. The proposal will contribute to the efficient use and development of the state highway network as a physical resource in the Clutha District and Otago Region, satisfying Section 7(b) of the RMA.

Considering the maintenance and enhancement of amenity values (Section 7(c)) and the maintenance and enhancement of the quality of the environment (Section 7(f)) requires an all-encompassing view of amenity and the environment. There will be some impacts on amenity and quality of the environment during construction. Post construction the environment would be different due to the presence of a new bridge structure, but it is not considered that there would be a significant adverse effect on the quality of the environment.

In having regard to the intrinsic values of ecosystems (Section 7(d)) it is necessary to consider the RMA definition of 'intrinsic values' being:

in relation to ecosystems, means those aspects of ecosystems and their constituent parts which have value in their own right, including—

(a) Their biological and genetic diversity; and

(b) The essential characteristics that determine an ecosystem's integrity, form, functioning, and resilience.

The ecological assessment report has considered the values and effects on the freshwater and terrestrial ecosystems. The proposed mitigation measures in respect of stormwater discharges and ESDCP will help avoid, remedy or mitigate adverse effects.

Section 7(g) requires a consideration of the finite characteristics of natural and physical resources. The proposed mitigation measures in respect of stormwater management and ecology will avoid, remedy or mitigate adverse effects.

It is considered none of these Section 7 matters will be adversely affected by the proposal, based on the assessment of actual or potential effects of the proposal on the environment and the proposed mitigation measures.

9.4.3 Section 8

In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall take into account the principles of the Treaty of Waitangi (Te Tiriti o Waitangi).

The wording shall take into account requires decision makers to consider the principles of the Treaty with all other matters.

Ongoing consultation with Aukaha and Te Ao Marama will ensure that appropriate methods are implemented to avoid, remedy and mitigate any actual or potential effects on tangata whenua. Recommendations have been made to avoid remedy or mitigate adverse effects on tangata whenua values with specific measures having been adopted by the Transport Agency and /or incorporated into the project.

9.4.4 Section 5

Applying Section 5 involves an assessment of whether an application would promote the sustainable management of natural and physical resources. This recognises that the RMA has a single purpose.

Section 5 goes on to elaborate on the definition of sustainable management that in summary, includes managing resources in a way that enables people and communities to provide for their social, economic, and cultural wellbeing and for their health and safety, while achieving specified bottom line environmental outcomes.

Case law has indicated that making a judgement under Section 5 is not a balancing exercise between positive and negative effects, that adverse effects must under section 5(2)(c) be avoided, remedied or mitigated, regardless of positive effects[1].

That is not to say however that adverse effects are not acceptable, rather it is a question of fact and degree. In this case, there will be positive benefits as the project will, for example:

- Achieve security of route
- Increase resilience and reliability of the State Highway network.
- Provide connectivity and predictable travel on the West Coast.
- Improve safety to road users.
- Improve load and traffic capacity of the crossing.

Significant regard has been given to the existing environmental values along the alignment route within the technical assessments. As a result, the proposal has been developed to ensure that where adverse effects

[1] *NZ Rail Ltd v Marlborough DC* [1994] NZRMA 70 (HC), *Campbell v Southland DC* W114/94 (PT).

cannot be avoided they have been adequately remedied or mitigated. Overall, it is considered that with the mitigation measures proposed, the proposal will achieve the purpose of the RMA.

10. Summary

The Transport Agency proposes to construct, use and maintain the new Beaumont Bridge and alignment. The bridge will essentially replace the existing Beaumont Bridge for general traffic use and become part of the existing SH8 network through the realigned bridge approaches. An alteration of designation is sought from Clutha District Council which will include the entire infrastructure of the alignment and areas needed for construction. Resource consents are also required from ORC and CDC.

The proposal will achieve the primary objective of the project being security of route within the Clutha District, improve efficiency, connectivity and accessibility, provide pedestrian and cycling facilities across the river and improve the load carrying capacity of the bridge.

The need for the proposed work has been outlined in the Notice of Requirement above and has been demonstrated as being reasonably necessary for the Transport Agency as the requiring authority to achieve its objectives. The extent of the proposed designation is considered reasonably necessary in order for the Transport Agency as the requiring authority to undertake the work.

Technical assessments have been undertaken and form part of this application. These technical assessments have identified where there is the potential for adverse effects to arise within the project area from construction works and operation of the bridge. Where adverse effects cannot be avoided, appropriate mitigation measures have been proposed in order to remedy or mitigate those effects.

The key RMA tests for consideration of both a notice of requirement and a resource consent, as contained in sections 171 and 104 RMA respectively, are assessed in Section 9 above. It is the conclusion of this assessment that the proposed designation and resource consent application meets the purpose and principals of the RMA.

The NZ Transport Agency requests these applications are publicly notified.

Appendix 1 Design Plans

NZ TRANSPORT AGENCY
SH8 BEAUMONT OTAGO
NEW BEAUMONT BRIDGE

ISSUED FOR RMA APPROVALS

Project No: 6-CT012.00
Date: OCTOBER 2019

SHEET INDEX TABLE			
SHEET No.	REVISION	DRAWING TITLE	
C01	B	DRAWING INDEX	CIVIL WORKS
C02	B	OVERALL LAYOUT PLAN	RP 5615 - 7100
C03	B	PROPOSED SH8 CENTRELINE LONGITUDINAL SECTION	RP 5659 - 7095
C04	B	LAYOUT PLAN	RP 5615 - 6200
C05	B	LAYOUT PLAN	RP 6200 - 6600
C06	B	LAYOUT PLAN	RP 6600 - 7100
C07	B	TYPICAL CROSS SECTIONS	S1 TO S4
C08	B	TYPICAL CROSS SECTIONS	S5 TO S6
C09	B	TYPICAL CROSS SECTIONS	S7 TO S10
P01	B	BRIDGE GENERAL ARRANGEMENT	PLAN AND SECTION
P02	C	BRIDGE GENERAL ARRANGEMENT	ABUTMENT
P03	B	BRIDGE GENERAL ARRANGEMENT	PIER AND MIDSPAN ELEVATIONS

300 mm 200 100 50 10 mm 0

ISSUED FOR RMA APPROVALS

Revision	Amendment	Approved	Revision Date
A	ISSUED FOR RMA APPROVALS	MD	21/08/2019
B	REVISIONS UPDATED	MD	14/10/2019

NZ TRANSPORT AGENCY
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Designed	Approved	Approved Date
B MULHOLLAND	M DAVIES	14/10/2019

Drawn	Scales
B MULHOLLAND	N.A.

Project
NZ TRANSPORT AGENCY
SH8 BEAUMONT OTAGO RS 401 / 6300
NEW BEAUMONT BRIDGE

Sheet
SHEET INDEX
CIVIL WORKS

Project No.	Sheet. No.	Revision
6-CT012.00	C01	B

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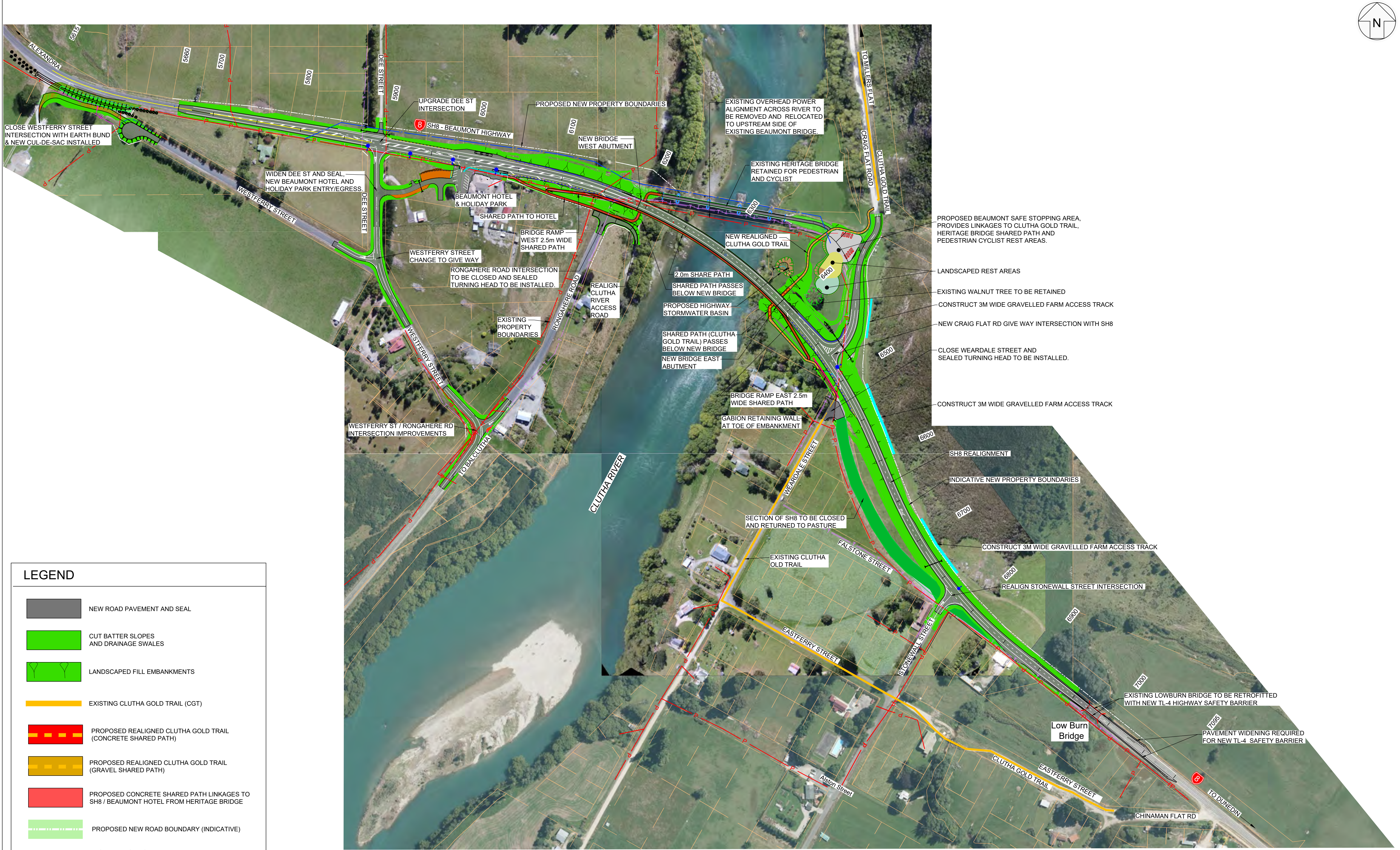

LEGEND

- NEW ROAD PAVEMENT AND SEAL
- CUT BATTER SLOPES AND DRAINAGE SWALES
- LANDSCAPED FILL EMBANKMENTS
- EXISTING CLUTHA GOLD TRAIL (CGT)
- PROPOSED REALIGNED CLUTHA GOLD TRAIL (CONCRETE SHARED PATH)
- PROPOSED REALIGNED CLUTHA GOLD TRAIL (GRAVEL SHARED PATH)
- PROPOSED CONCRETE SHARED PATH LINKAGES TO SH8 / BEAUMONT HOTEL FROM HERITAGE BRIDGE
- PROPOSED NEW ROAD BOUNDARY (INDICATIVE)
- HIGHWAY ROAD SAFETY BARRIER
- LIGHTING COLUMN (NEW)
- P — PROPOSED OVERHEAD POWER REALIGNMENT ROUTE (INDICATIVE)
- P — EXISTING OVERHEAD POWER CABLES
- T — EXISTING CHORUS CABLES

1:2000 @ A1 0 20 40 60 80 100 120 140 160 180 200 m
1:4000 @ A3

ISSUED FOR RMA APPROVALS

Revision	Amendment	Approved	Revision Date
A	ISSUED FOR RMA APPROVALS	MD	21/08/2019
B	TITLEBLOCK UPDATED	MD	14/10/2019

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DESIGNED	Approved	Approved Date
B MULHOLLAND	M DAVIES	14/10/2019

Drawn	Scales
B MULHOLLAND	A1 1:2000 (A3 1:4000)

Project
NZ TRANSPORT AGENCY
SH8 BEAUMONT OTAGO RS 401 / 6300
NEW BEAUMONT BRIDGE

Sheet
OVERALL LAYOUT PLAN
RP 5615 - 7100

Project No.	Sheet. No.	Revision
6-CT012.00	C02	B

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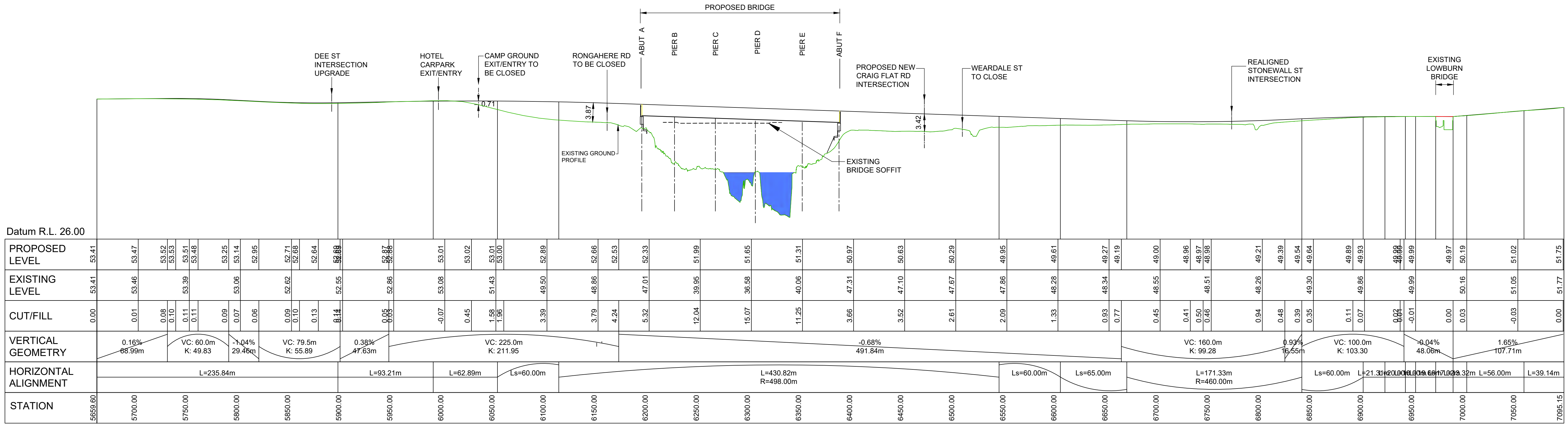

PROPOSED ROAD CENTRELINE LONGSECTION

ISSUED FOR RMA APPROVALS

Revision	Amendment	Approved	Revision Date
A	ISSUED FOR RMA APPROVALS	MD	21/08/2019
B	ADDED RIVER HATCH	MD	14/10/2019

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Designed	Approved	Approved Date
B MULHOLLAND	M DAVIES	14/10/2019

Drawn	Scales
B MULHOLLAND	Hz. A1 1:2000 (A3 1:4000) Vt. A1 1:400

Project
NZ TRANSPORT AGENCY
SH8 BEAUMONT OTAGO RS 401 / 6300
NEW BEAUMONT BRIDGE

Sheet
PROPOSED SH8 CENTRELINE LONGITUDINAL SECTION
RP 5659 - 7095

Project No.	Sheet. No.	Revision
6-CT012.00	C03	B

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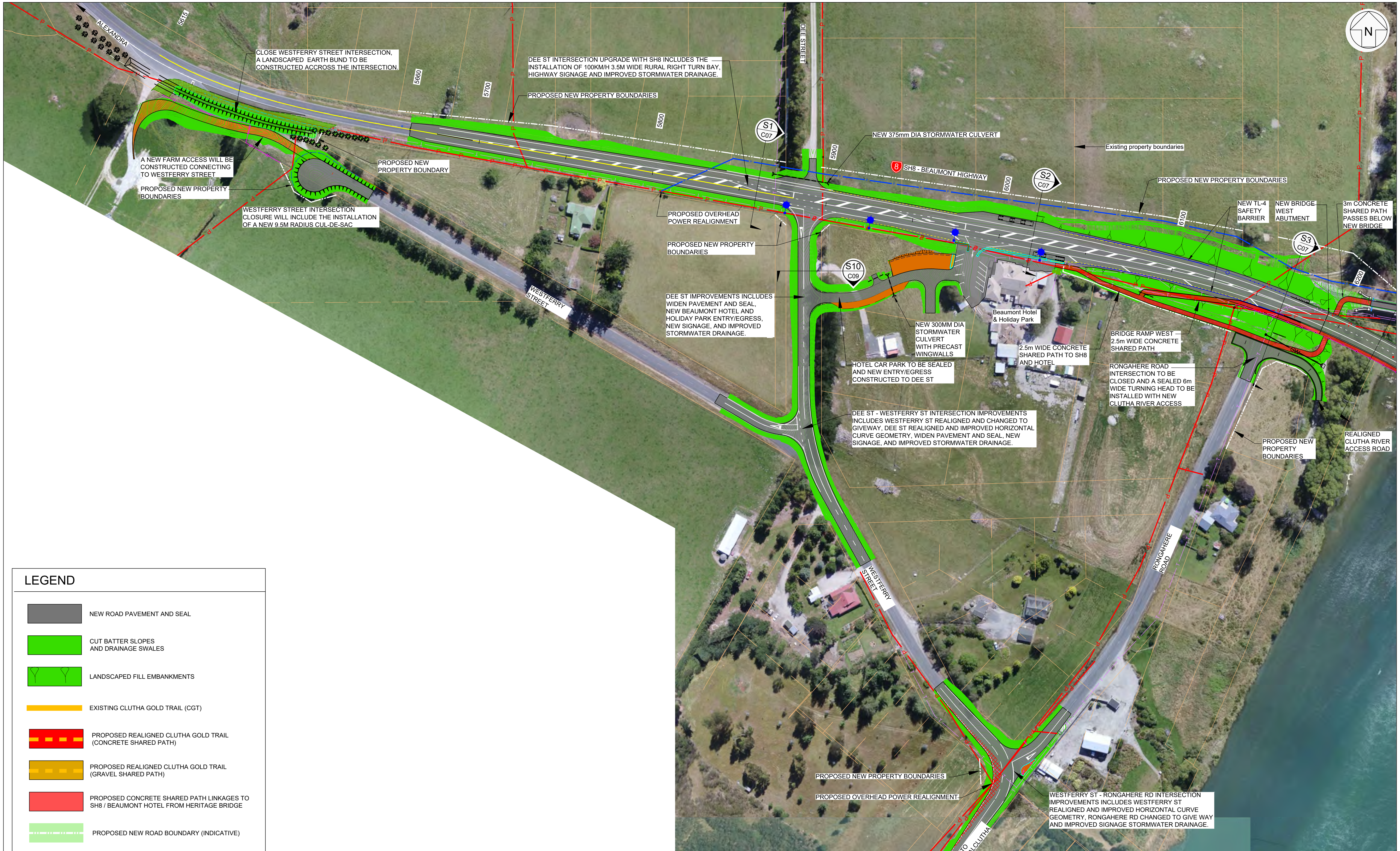
1:4000 @ A3 0 20 40 60 80 100 120 140 160 180 200 m

Original Sheet Size A1 [841x594] Plot Date 2019-10-14 at 9:05:39 AM Path S:\Pro\NZ\6C\6-CT012.00 Beaumont Bridge Replacement\Home\800 Drawings\(C) Civil\Civil3D\6-CT012.00 C01-C09(B).dwg C03(B)



LEGEND

- NEW ROAD PAVEMENT AND SEAL
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- LIGHTING COLUMN (NEW)
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- P EXISTING OVERHEAD POWER CABLES
- T EXISTING CHORUS CABLES

1:1000 @ A1 / 1:2000 @ A3 — 0 10 20 30 40 50 60 70 80 90 100 m

0 10 mm 50 100 200 300 mm

ISSUED FOR RMA APPROVALS

Revision	Amendment	Approved	Revision Date
A	ISSUED FOR RMA APPROVALS	MD	21/08/2019
B	TITLEBLOCK UPDATED	MD	14/10/2019

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Designed	Approved	Approved Date
B MULHOLLAND	M DAVIES	14/10/2019

Drawn	Scales
B MULHOLLAND	A1 1:1000 (A3 1:2000)

Project: NZ TRANSPORT AGENCY
SH8 BEAUMONT OTAGO RS 401 / 6300
NEW BEAUMONT BRIDGE

Sheet: LAYOUT PLAN
RP 5615 - 6200

Project No.	Sheet. No.	Revision
6-CT012.00	C04	B

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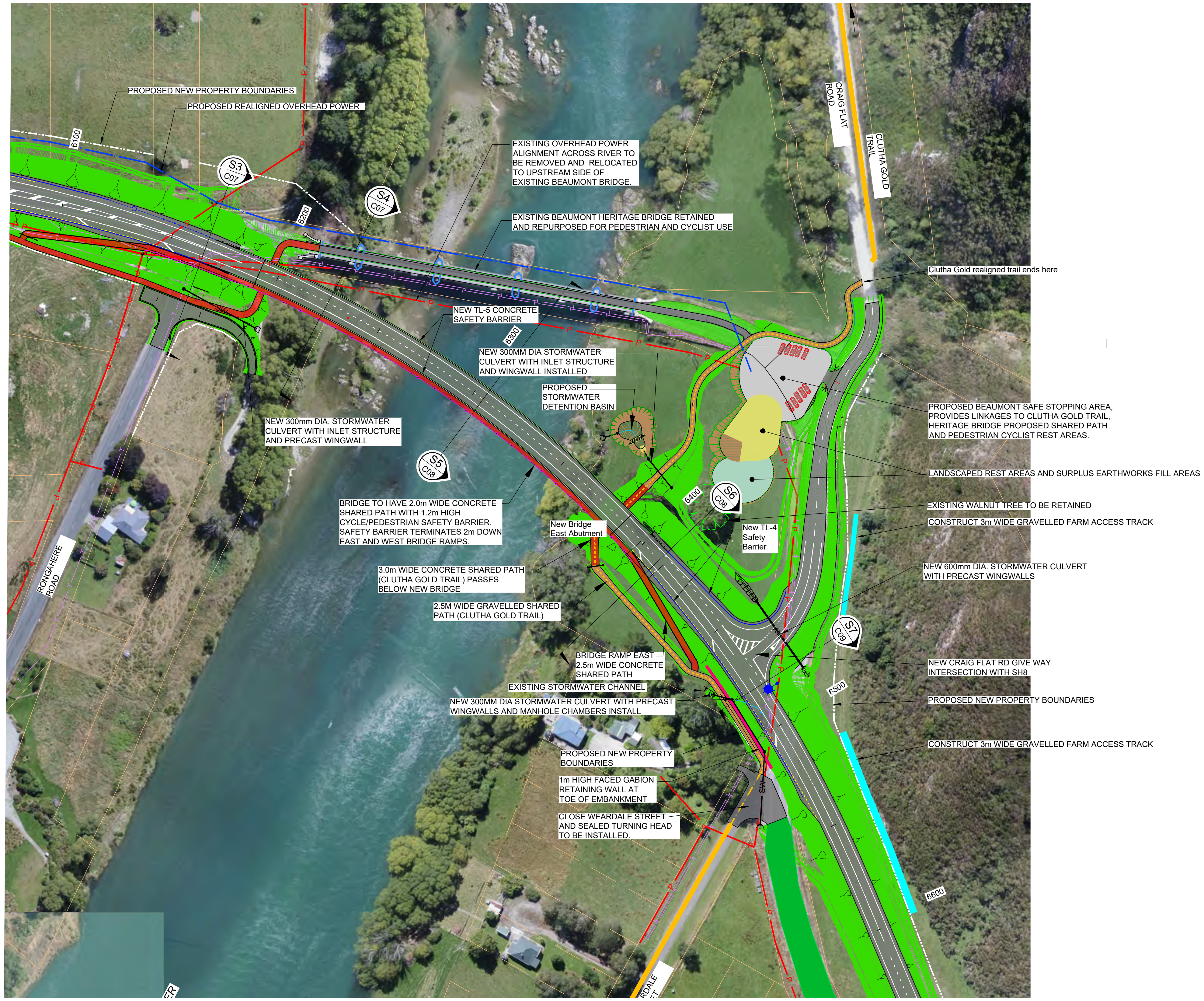

LEGEND

- NEW ROAD PAVEMENT AND SEAL
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- P — EXISTING OVERHEAD POWER CABLES
- T — EXISTING CHORUS CABLES

1:1000 @ A1
1:2000 @ A3 0 10 20 30 40 50 60 70 80 90 100 m

300 mm 200 100 50 10 mm 0

ISSUED FOR RMA APPROVALS

Revision	Amendment	Approved	Revision Date
A	ISSUED FOR RMA APPROVALS	MD	21/08/2019
B	TITLEBLOCK UPDATED	MD	14/10/2019

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Designed	Approved	Approved Date
B MULHOLLAND	M DAVIES	14/10/2019

Drawn	Scales
B MULHOLLAND	A1 1:1000 (A3 1:2000)

Project
NZ TRANSPORT AGENCY
SH8 BEAUMONT OTAGO RS 401 / 6300
NEW BEAUMONT BRIDGE

Sheet
LAYOUT PLAN
RP 6200 - 6600

Project No.	Sheet. No.	Revision
6-CT012.00	C05	B

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LEGEND

- NEW ROAD PAVEMENT AND SEAL
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- P — EXISTING OVERHEAD POWER CABLES
- T — EXISTING CHORUS CABLES

1:1000@ A1 1:2000@ A3 0 10 20 30 40 50 60 70 80 90 100 m

ISSUED FOR RMA APPROVALS

Revision	Amendment	Approved	Revision Date
A	ISSUED FOR RMA APPROVALS	MD	21/08/2019
B	TITLEBLOCK UPDATED	MD	14/10/2019

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Designed	Approved	Approved Date
B MULHOLLAND	M DAVIES	14/10/2019

Drawn	Scales
B MULHOLLAND	A1 1:1000 (A3 1:2000)

Project
NZ TRANSPORT AGENCY
SH8 BEAUMONT OTAGO RS 401 / 6300
NEW BEAUMONT BRIDGE

Sheet
LAYOUT PLAN
RP 6600 - 7100

Project No.	Sheet. No.	Revision
6-CT012.00	C06	B

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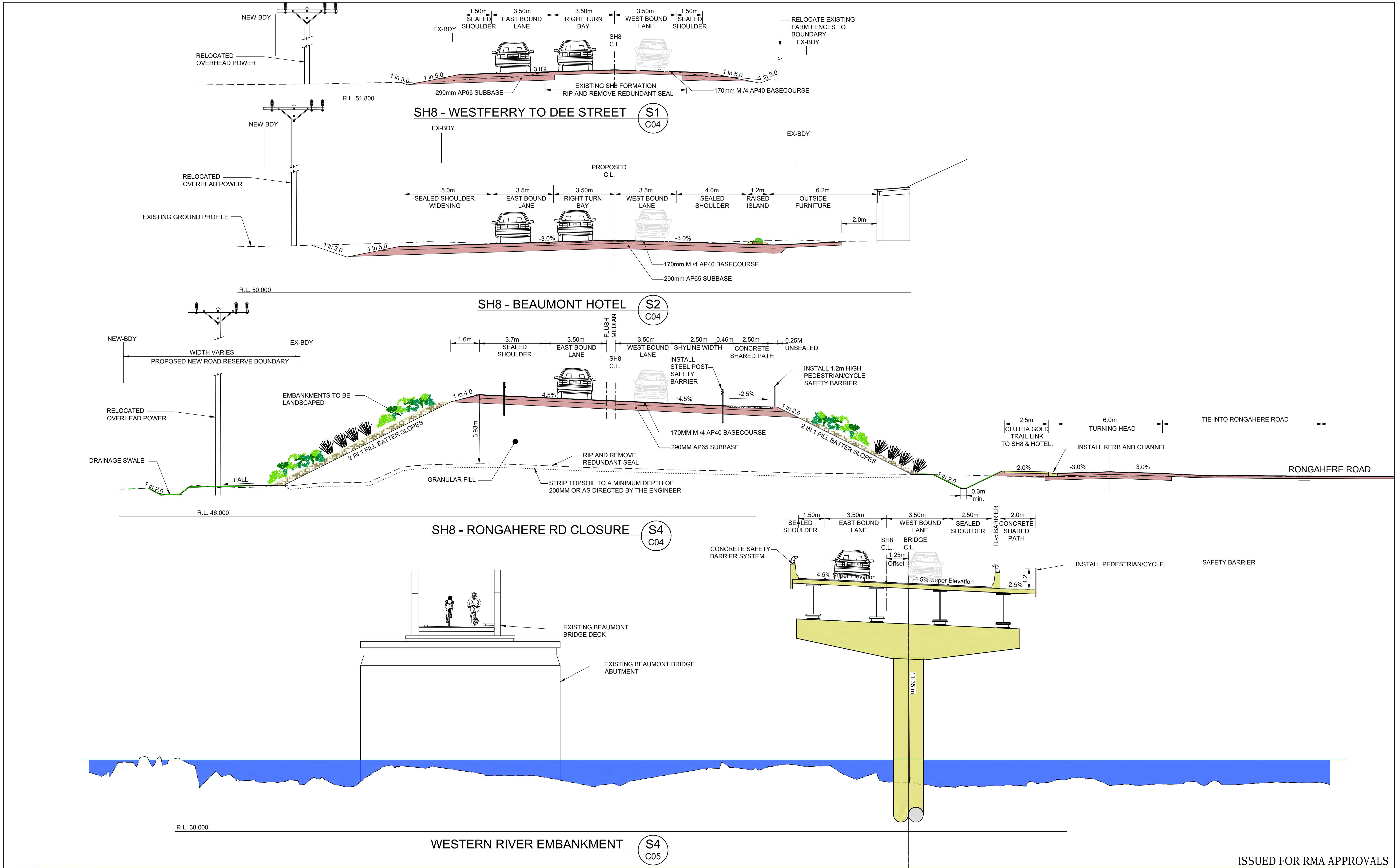

ISSUED FOR RMA APPROVALS

Revision	Amendment	Approved	Revision Date
A	ISSUED FOR RMA APPROVALS	MD	21/08/2019
B	TITLEBLOCK UPDATED	MD	14/10/2019

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Designed	Approved	Approved Date
B MULHOLLAND	M DAVIES	14/10/2019

Drawn	Scales
B MULHOLLAND	A1 1:100 (A3 1:200)

Project
NZ TRANSPORT AGENCY
SH8 BEAUMONT OTAGO RS 401 / 6300
NEW BEAUMONT BRIDGE

Sheet
TYPICAL CROSS SECTIONS - S1 TO S4

Project No.	Sheet. No.	Revision
6-CT012.00	C07	B

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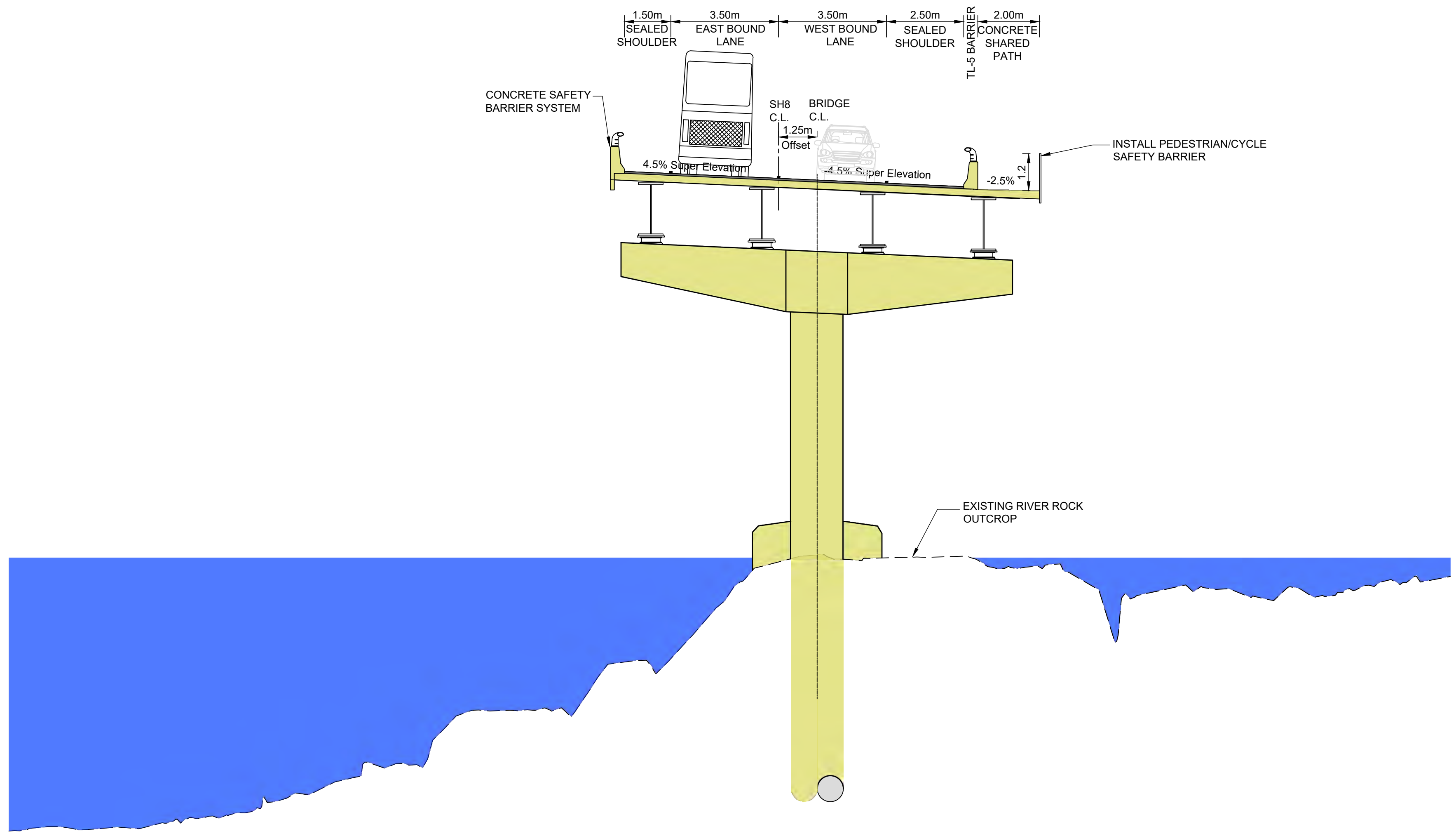
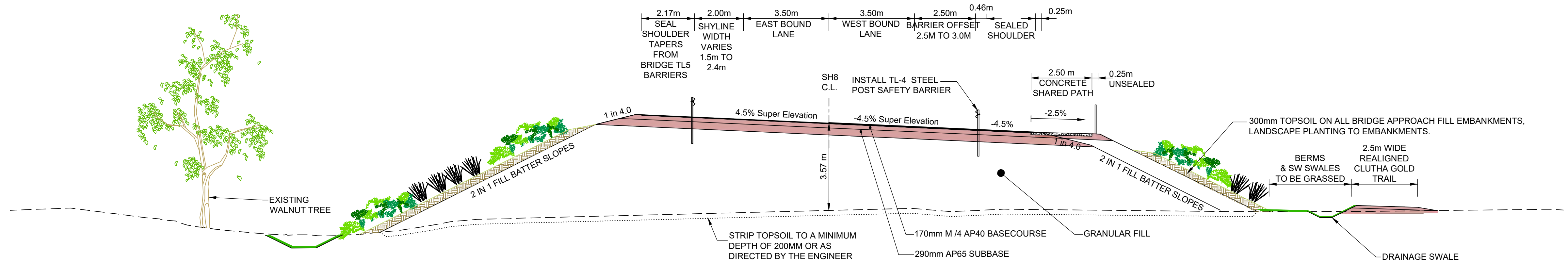


CLUTHA RIVER ROCK OUTCROP PIER LOCATION S5 C05



SH8 - BETWEEN EASTERN ABUTMENT AND CRAIG FLAT ROAD S6 C05

ISSUED FOR RMA APPROVALS

Revision	Amendment	Approved	Revision Date
A	ISSUED FOR RMA APPROVALS	MD	21/08/2019
B	TITLEBLOCK UPDATED	MD	14/10/2019

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Designed	Approved	Approved Date
B MULHOLLAND	M DAVIES	14/10/2019

Drawn	Scales
B MULHOLLAND	A1 1:100 (A3 1:200)

Project
NZ TRANSPORT AGENCY
SH8 BEAUMONT OTAGO RS 401 / 6300
NEW BEAUMONT BRIDGE

Sheet
TYPICAL CROSS SECTIONS - S5 TO S6

Project No.	Sheet. No.	Revision
6-CT012.00	C08	B

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1:200 @ A3
0 1 2 3 4 5 6 7 8 9 10 m

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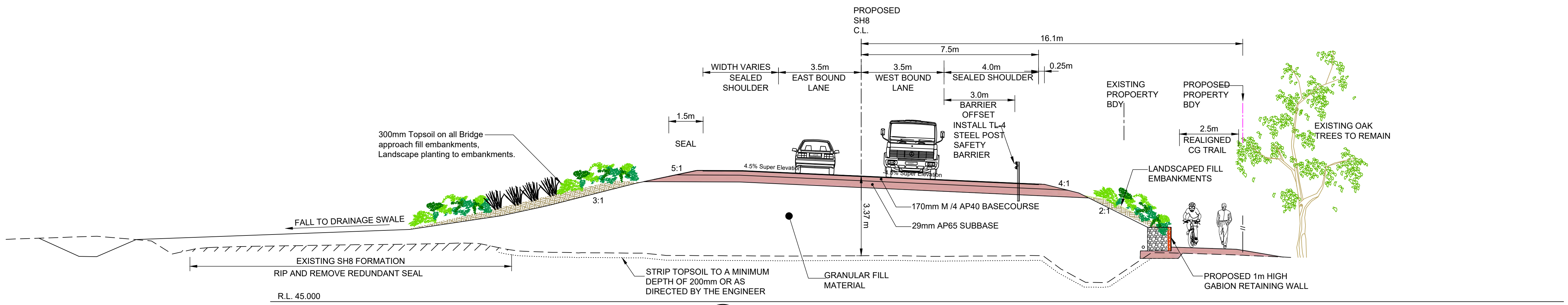
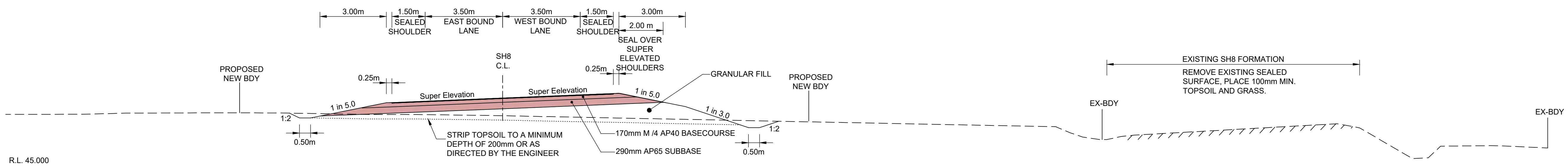
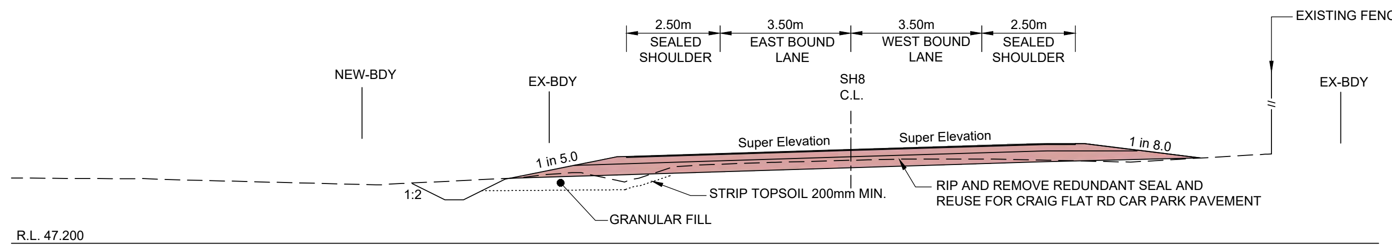


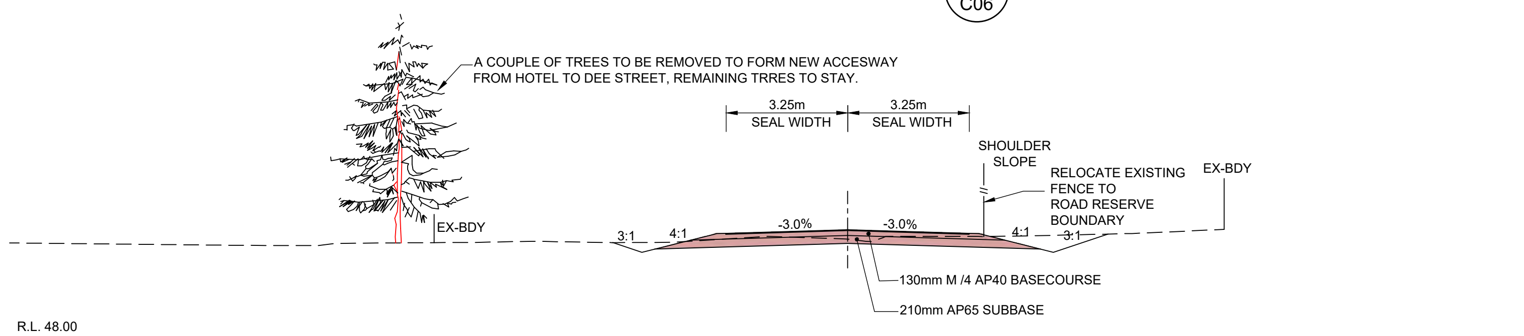
SH8 - CRAIG FLAT RD TO WEARDALE ST S7 C05



SH8 - WEARDALE ST TO STONEWELL ST S8 C06



SH8 - STONEWELL ST TO LOWBURN BRIDGE S9 C06



LOCAL ROAD - DEE STREET S10 C04

ISSUED FOR RMA APPROVALS

Revision	Amendment	Approved	Revision Date
A	ISSUED FOR RMA APPROVALS	MD	21/08/2019
B	TITLEBLOCK UPDATED	MD	14/10/2019

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Designed	Approved	Approved Date
B MULHOLLAND	M DAVIES	14/10/2019
Drawn	**Scales**	
B MULHOLLAND	A1 1:100 (A3 1:200)	

Project
NZ TRANSPORT AGENCY
SH8 BEAUMONT OTAGO RS 401 / 6300
NEW BEAUMONT BRIDGE

Sheet
TYPICAL CROSS SECTIONS - S7 TO S10

Project No.	Sheet. No.	Revision
6-CT012.00	C09	B

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1:200@ A3 0 1 2 3 4 5 6 7 8 9 10 m

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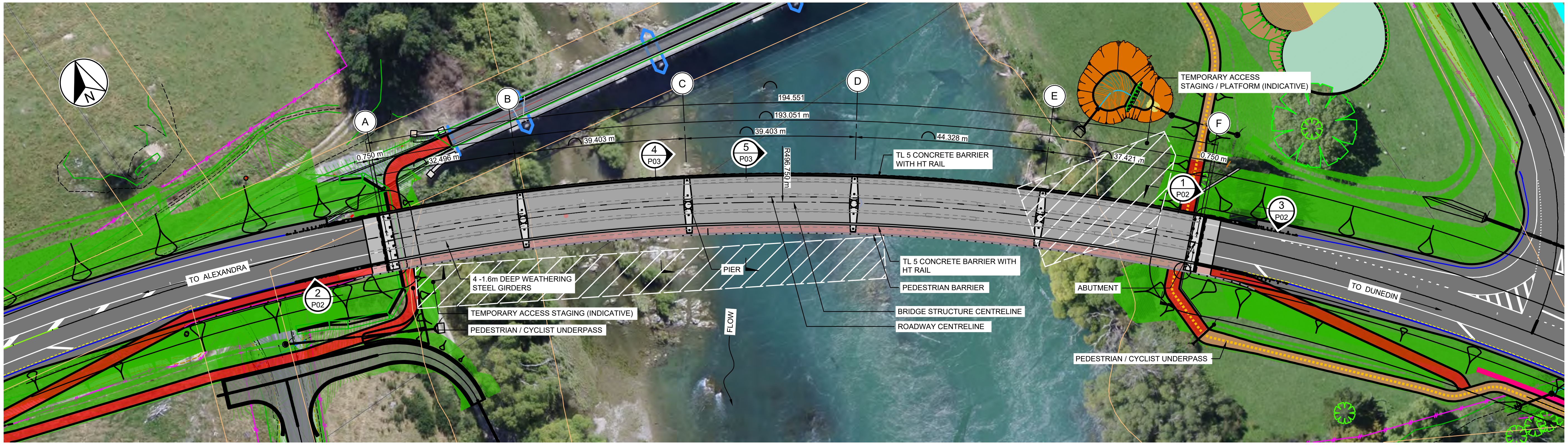
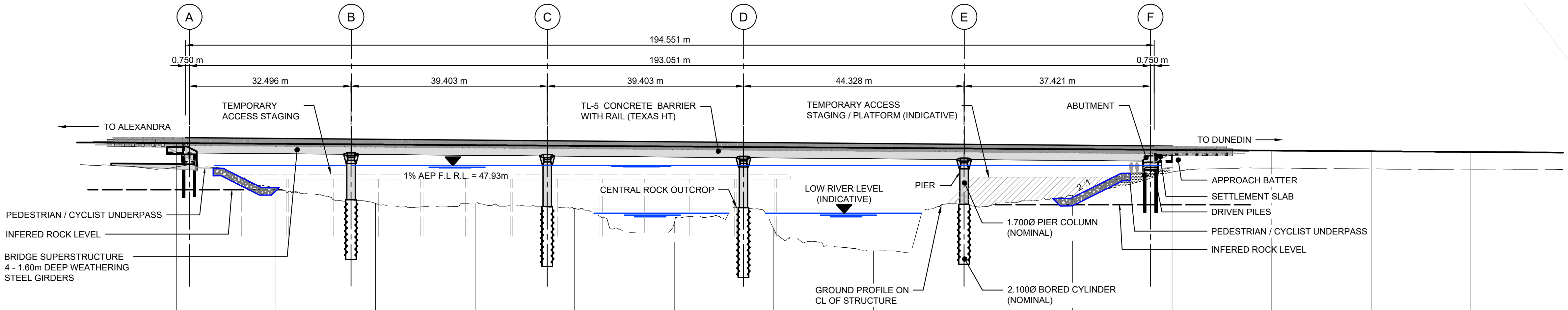


LAYOUT PLAN

SCALE: 1:500 (DIMENSIONS ON BRIDGE CL)



Datum R.L. 15.00

STATION	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00	240.00	260.00	280.00	298.50
PROPOSED LEVEL		52.34	52.21	52.07	51.93	51.80	51.66	51.53	51.39	51.25	51.12	50.98	50.84	50.71	50.57	
EXISTING LEVEL	48.14	47.57	43.41	40.24	40.37	39.24	36.27	35.10	30.76	39.73	41.90	46.54	47.36	47.17	47.12	47.05
CUT/FILL		4.78	8.80	11.83	11.56	12.56	15.39	16.43	20.63	11.52	9.22	4.44	3.48	3.54	3.45	
VERTICAL GEOMETRY	-0.68% 298.50m															
HORIZONTAL ALIGNMENT																

BRIDGE CENTRELINE LONGSECTION
CH: 0.00 to 298.50
Scale 1:500 Hz. 1:500 Vt.

DOWN STREAM ELEVATION (DIMENSIONS ON BRIDGE CL)

SCALE: 1:500

ISSUED FOR RMA APPROVALS

Revision	Amendment	Approved	Revision Date
A	STRUCTURAL OPTIONS REPORT	M.D.	04 19
B	ISSUED FOR RMA APPROVALS	M.D.	08/19

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Drawn: P. JANSSENS | Scales: AS SHOWN

Project: NZ TRANSPORT AGENCY
BEAUMONT, OTAGO
SH8 BEAUMONT BRIDGE REPLACEMENT

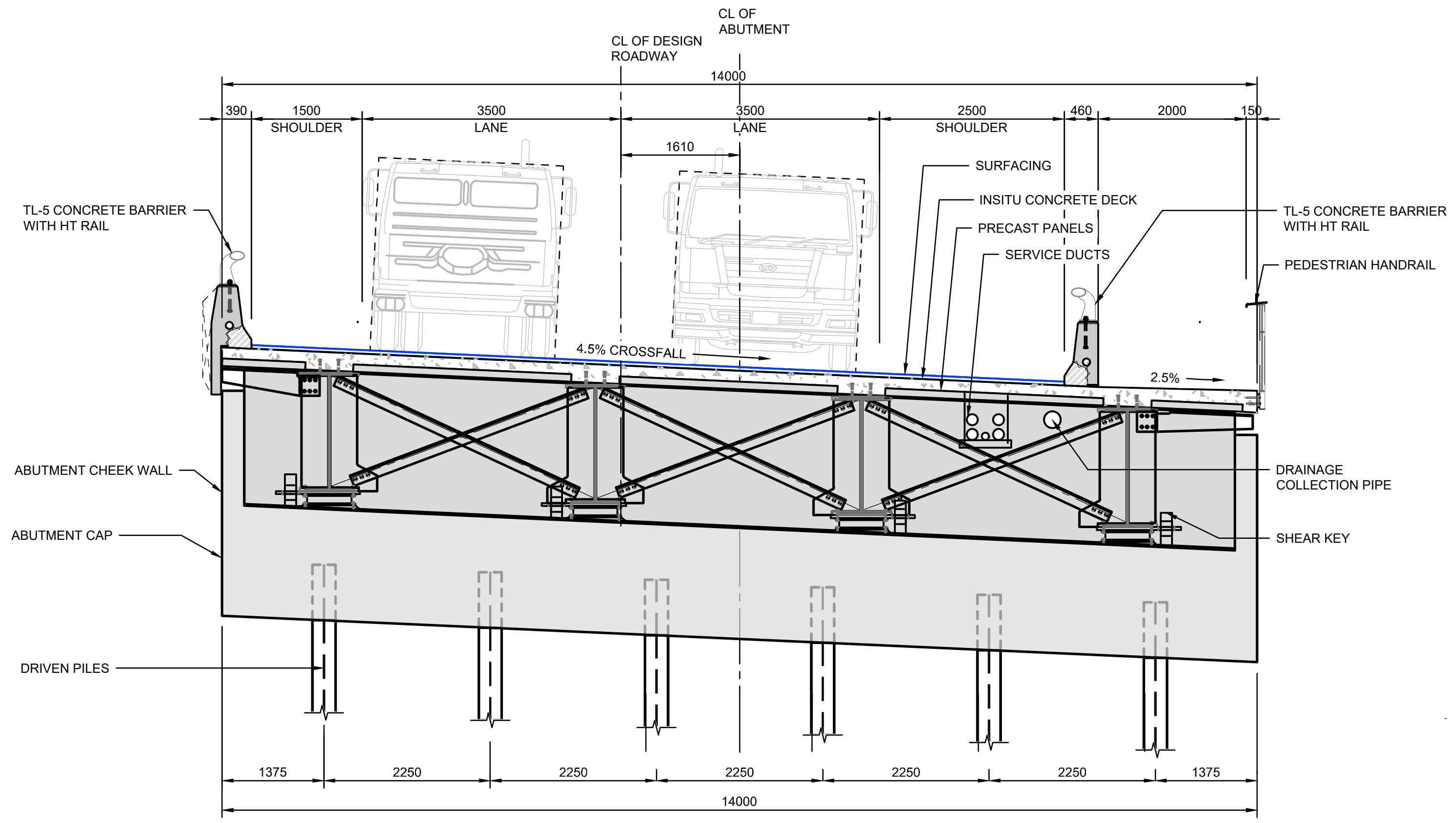
Sheet: GENERAL ARRANGEMENT
PLAN AND SECTION

Project No.: 6-CT012.00 | Sheet. No.: P01 | Revision: B

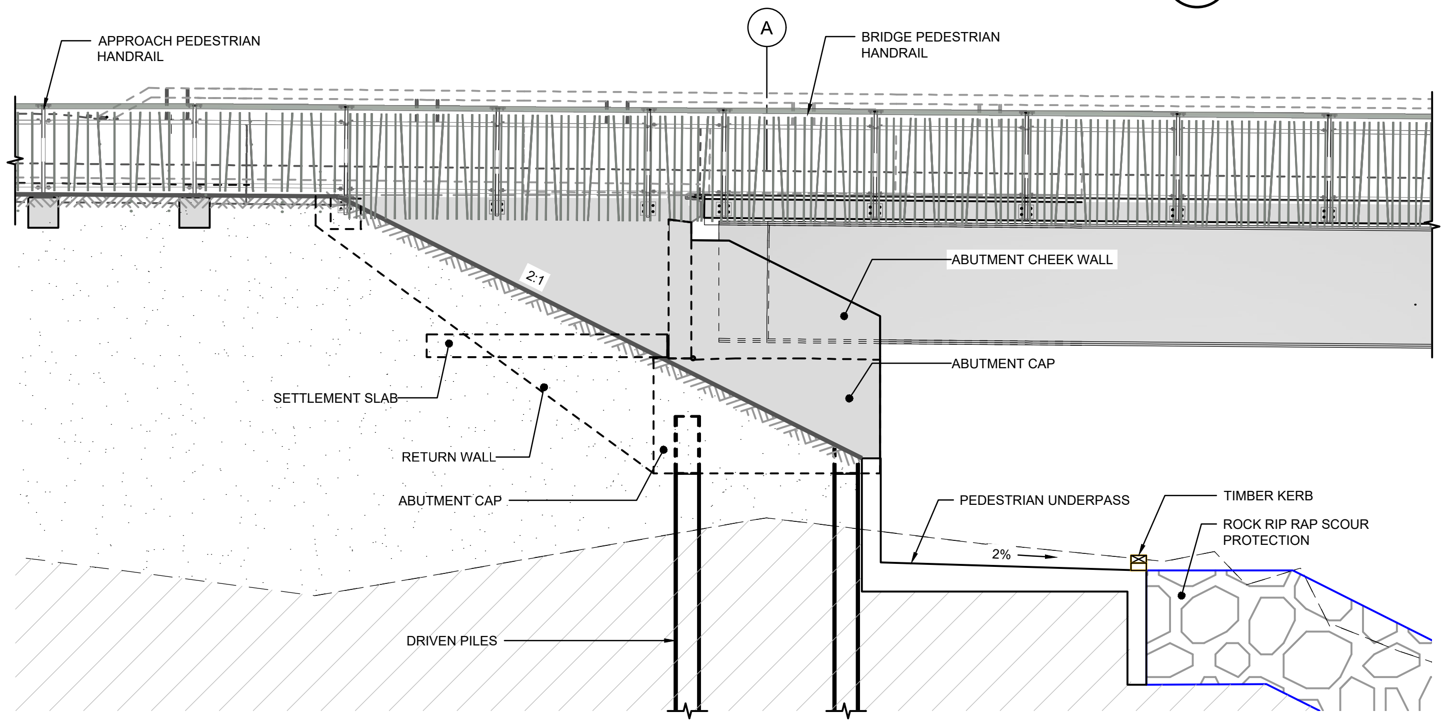
1:500 @ A1
1:1000 @ A3
0 5 10 15 20 25 30 35 40 45 50 m

Original Sheet Size A1 [841x594] Plot Date 2019-08-30 at 1:27:16 PM Path S:\Proj\NZ\6C\6-CT012.00 Beaumont Bridge Replacement\Home\800 Drawings\(C) Civil\ACAD\6-CT012.00_prelim bridge sketches GA_3.dwg PLAN AND ELEVATION

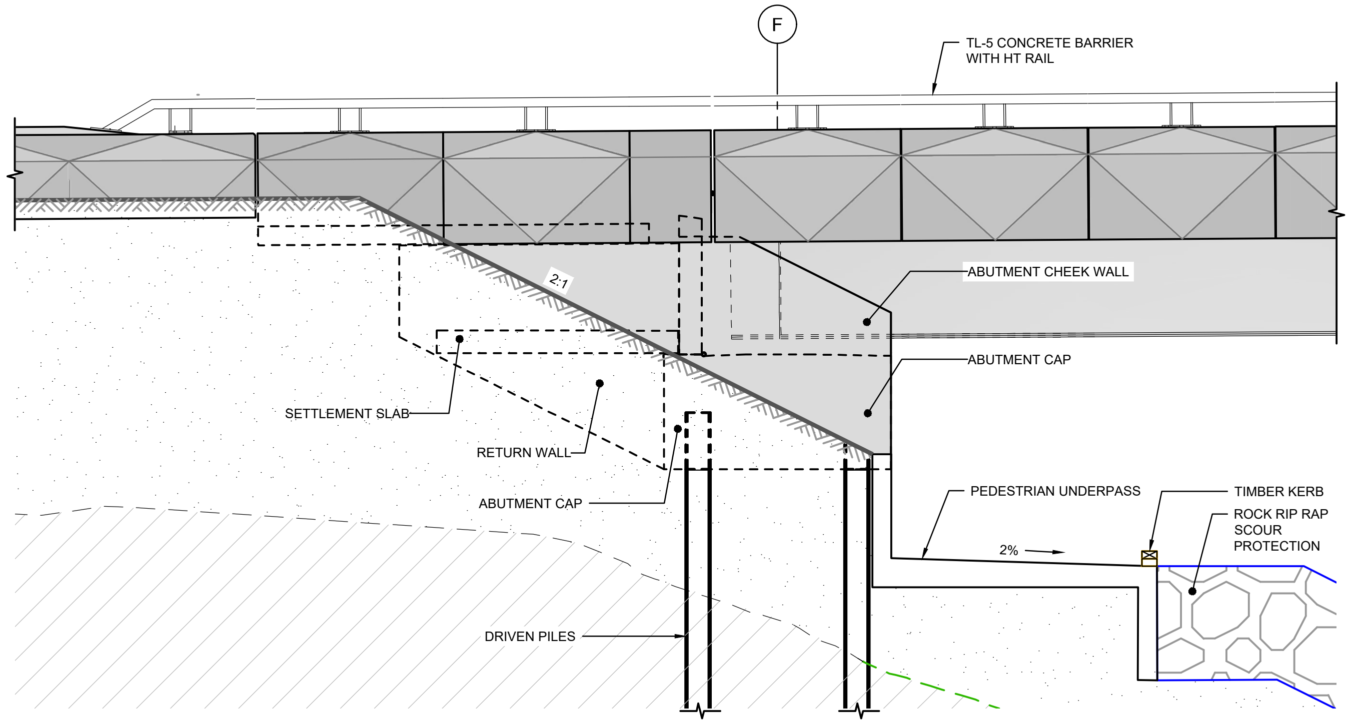
NOTE:
BARRIER AND HANDRAIL ARCHITECTURAL
DESIGN INDICATIVE AND SUBJECT TO CHANGE



1 / P01 ABUTMENT F ELEVATION
SCALE: 1:50 (UNDERPASS NOT SHOWN)



2 / - ABUTMENT A END VIEW
SCALE: 1:50 (DOWNSTREAM)



3 / P02 ABUTMENT F END VIEW
SCALE: 1:50

ISSUED FOR RMA APPROVALS

Revision	Amendment	Approved	Revision Date
A	STRUCTURAL OPTIONS REPORT	M.D.	04 19
B	ISSUED FOR RMA APPROVALS	M.D.	08/19
C	NOTE ADDED	M.D.	10/19

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Approved Date: 08/19
Drawn: P. JANSSENS
Scales: AS SHOWN

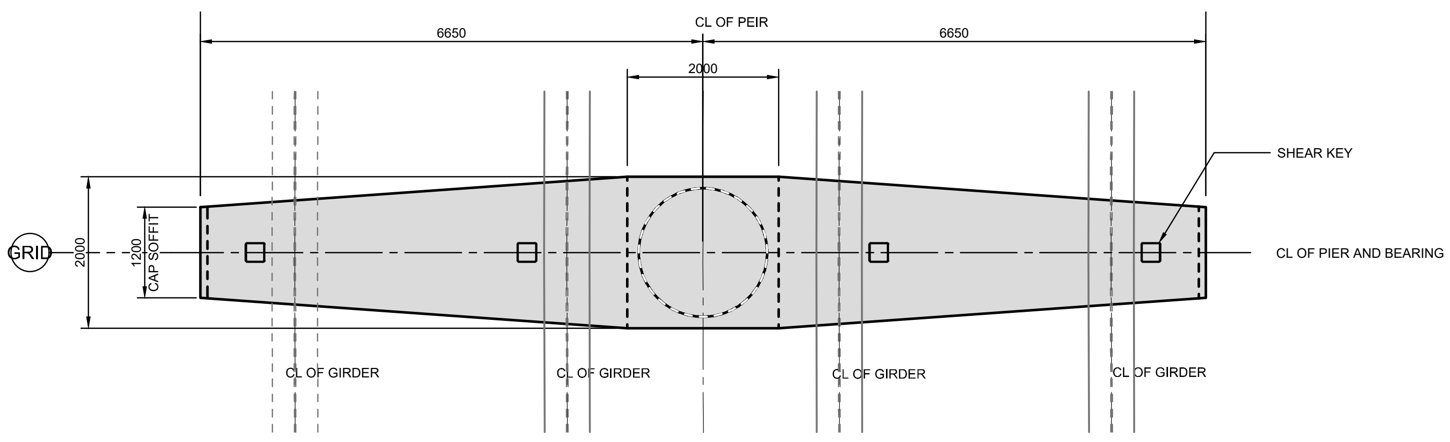
Project:
NZ TRANSPORT AGENCY
BEAUMONT, OTAGO
SH8 BEAUMONT BRIDGE REPLACEMENT

Sheet:
GENERAL ARRANGEMENT
ABUTMENT

Project No.: 6-CT012.00
Sheet. No.: P02
Revision: c

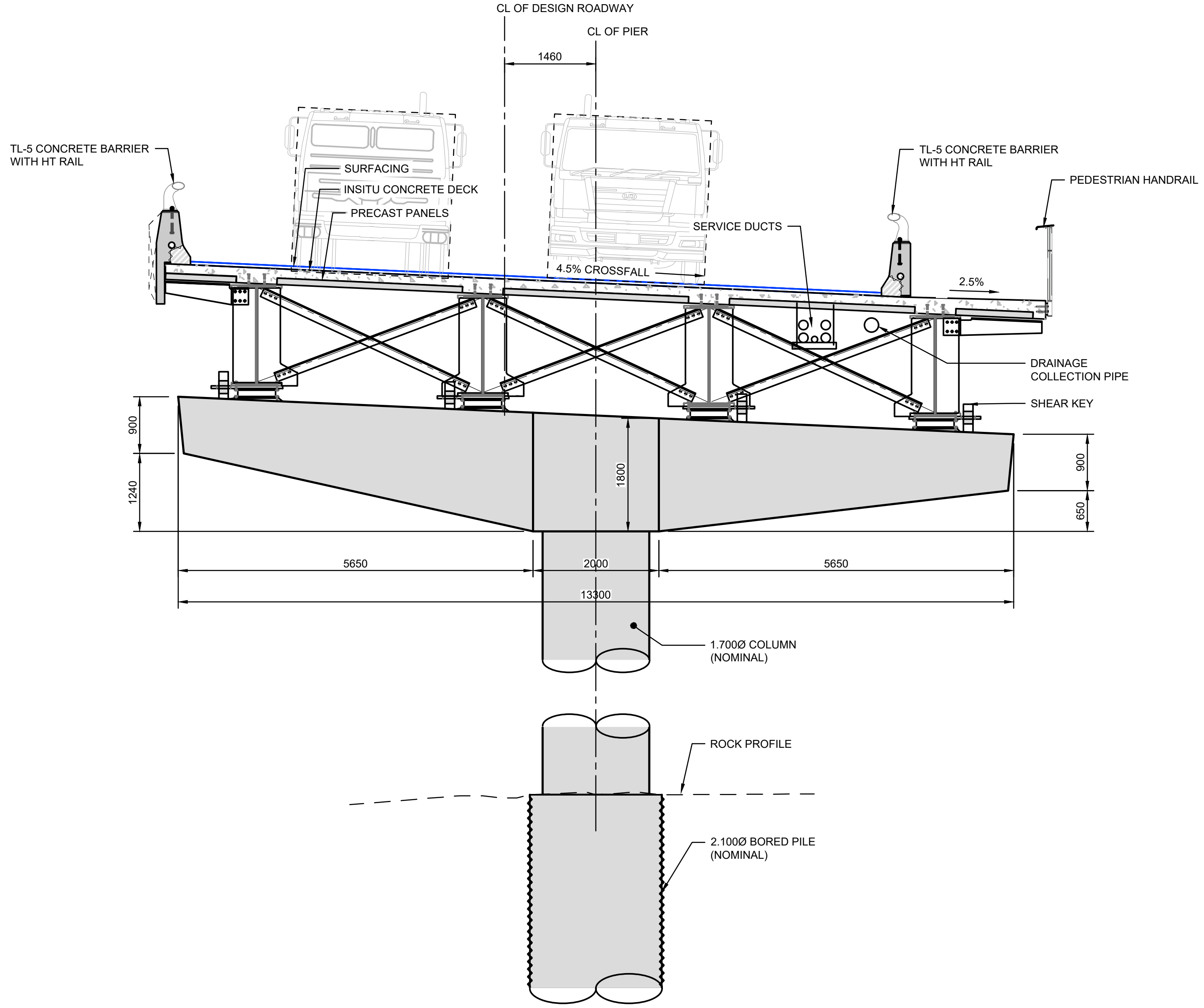
1:50@ A1 0 1 2 3 4 5 m
1:100@ A3

Original Sheet Size A1 [841x594] Plot Date 2019-10-15 at 10:48:24 AM Path S:\Proj\NZ\6C\6-CT012.00 Beaumont Bridge Replacement\Home\800 Drawings\(C) Civil\ACAD\6-CT012.00_prelim bridge sketches GA_3.dwg ABUT



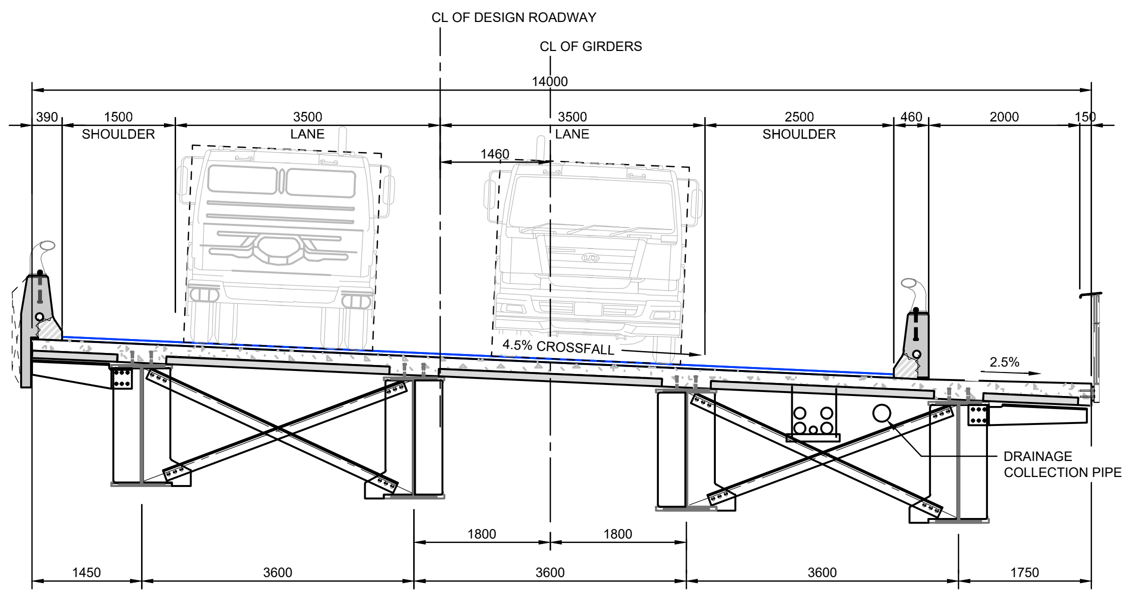
PIER PLAN

SCALE: 1:50 (SUPERSTRUCTURE NOT SHOWN)



4 P01 PIER ELEVATION - TYPICAL

SCALE: 1:50



5 P01 MID SPAN ELEVATION

SCALE: 1:50

ISSUED FOR RMA APPROVALS

Revision	Amendment	Approved	Revision Date
A	STRUCTURAL OPTIONS REPORT	M.D.	04 19
B	ISSUED FOR RMA APPROVALS	M.D.	08/19

NZ TRANSPORT AGENCY
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J.JENNINGS	M. DAVIES	08/19

Drawn	Scales
P. JANSSENS	AS SHOWN

Project
NZ TRANSPORT AGENCY
BEAUMONT, OTAGO
SH8 BEAUMONT BRIDGE REPLACEMENT

Sheet
GENERAL ARRANGEMENT
PIER AND MID SPAN ELEVATIONS

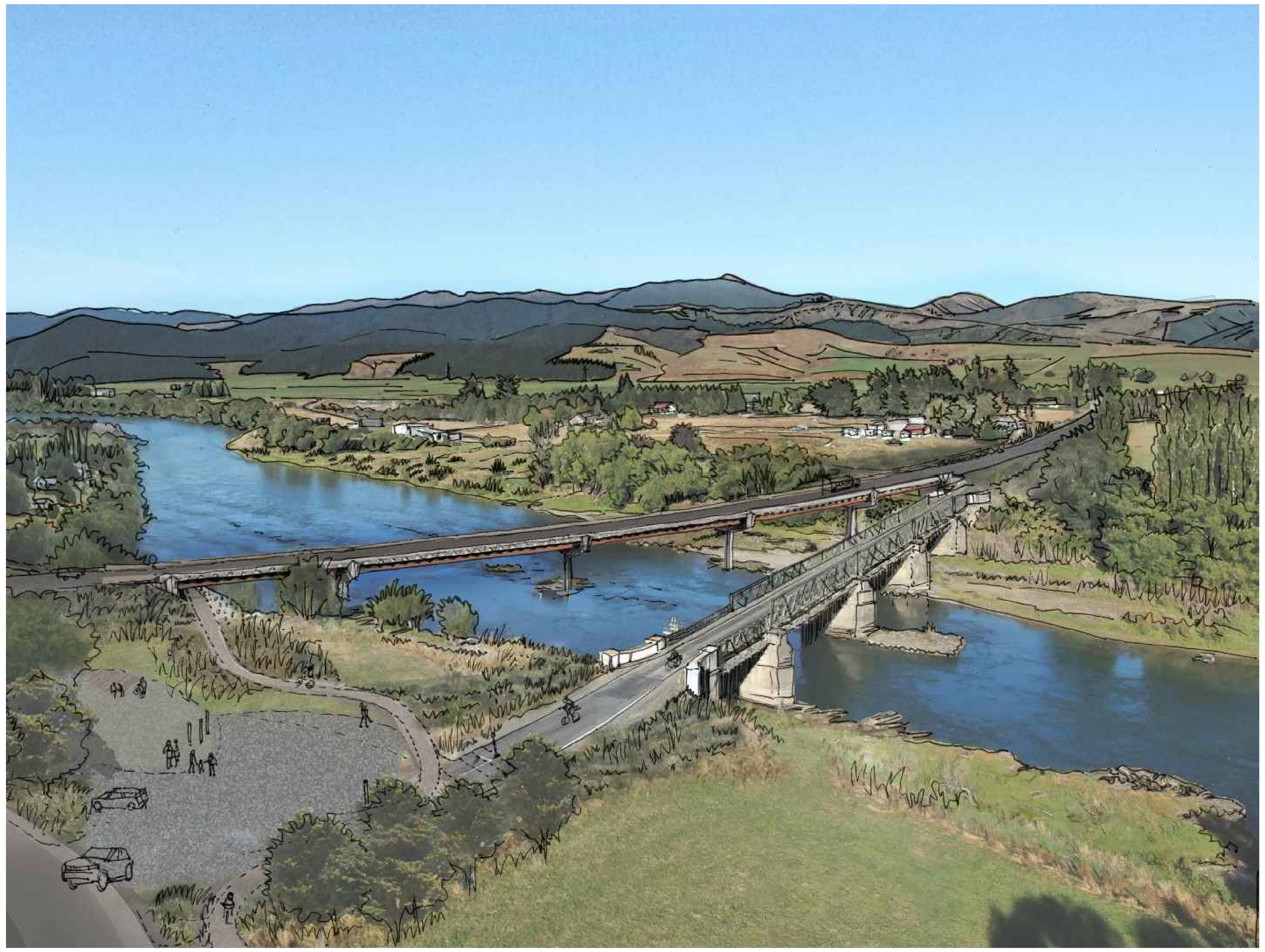
Project No.	Sheet. No.	Revision
6-CT012.00	P03	B

1:50@ A1 1:100@ A3 0 1 2 3 4 5 m

300 mm 200 100 50 10 mm 0

Original Sheet Size A1 [841x594] Plot Date 2019-08-30 at 1:20:13 PM Path S:\Proj\NZ\6C\6-CT012.00 Beaumont Bridge Replacement\Home\800 Drawings\(C) Civil\ACAD\6-CT012.00_prelim bridge sketches GA_3.dwg PIER

Appendix 2 Designation Plan



NZ TRANSPORT AGENCY
SH8 BEAUMONT OTAGO
NEW BEAUMONT BRIDGE

ISSUED FOR LAND DESIGNATION

Project No: 6-CT012.00
Date: OCTOBER 2019

wsp | OPUS

NZ TRANSPORT AGENCY
WAKA KOTAHI

LAND DESIGNATION SCHEDULE- LAND REQUIRED FOR ROAD

REFERENCE	DESCRIPTION	ADDITIONAL LAND TO BE DESIGNATED (m^2)
1a	SECTION 4 TN OF BLK XVI DUNKELD, OT207/11 PETERS FAIRFIELD TRUSTEES NO 3 LIMITED	195
1b	SECTION 3 TN OF BLK XVI DUNKELD, OT207/11 PETERS FAIRFIELD TRUSTEES NO 3 LIMITED	230
1c	SECTION 2 TN OF BLK XVI DUNKELD, OT207/11 PETERS FAIRFIELD TRUSTEES NO 3 LIMITED	280
1d	SECTION 1 TN OF BLK XVI DUNKELD, OT207/11 PETERS FAIRFIELD TRUSTEES NO 3 LIMITED	320
1e	SECTION 5 TN OF BLK IX DUNKELD, OT207/11 PETERS FAIRFIELD TRUSTEES NO 3 LIMITED	550
1f	SECTION 6 TN OF BLK IX DUNKELD, OT207/11 PETERS FAIRFIELD TRUSTEES NO 3 LIMITED	575
1g	SECTION 7 TN OF BLK IX DUNKELD, OT207/11 PETERS FAIRFIELD TRUSTEES NO 3 LIMITED	865
1h	SECTION 8 TN OF BLK IX DUNKELD, OT207/11 PETERS FAIRFIELD TRUSTEES NO 3 LIMITED	875
1i	SECTION 9 TN OF BLK IX DUNKELD, OT207/11 PETERS FAIRFIELD TRUSTEES NO 3 LIMITED	835
1j	SECTION 1 SURVEY OFFICE PLAN 23609 OTAGO, OT14B/673 PETERS FAIRFIELD TRUSTEES NO 3 LIMITED	965
1k	SECTION 4 SURVEY OFFICE PLAN 23609 OTAGO, OT14B/673 PETERS FAIRFIELD TRUSTEES NO 3 LIMITED	2865
2a	LOT 3 DEPOSITED PLAN 8804 444076 DUNBROOK DAIRIES LIMITED	1965
3a	PT SECTION 4 TN OF BLK XI DUNKELD OT331/181 JOHN ADRIAN NICHOLAS VAN ROSSEM	15
4a	SECTION 4 TN OF BLK VIII DUNKELD 473740 ALISON MARY MILLS GUNNAR EGILSSON	15
4b	SECTION 1 TN OF BLK VIII DUNKELD 473740 ALISON MARY MILLS GUNNAR EGILSSON	82
4c	SECTION 2 TN OF BLK VIII DUNKELD 473740 ALISON MARY MILLS GUNNAR EGILSSON	1114

LAND DESIGNATION SCHEDULE- LAND REQUIRED FOR ROAD

REFERENCE	DESCRIPTION	ADDITIONAL LAND TO BE DESIGNATED (m^2)
7a	CROWN LAND BLOCK VII TOWN OF DUNKELD DOC	3000
7b	SECTION 1 50 23609 OTAGO OT148/673 DOC	125
7c	CROWN LAND RIVER BED LINZ	8500
8a	SECTION 2 SURVEY OFFICE PLAN 23610 OT14B/688 DOC	2920
8b	SECTION 2 SURVEY OFFICE PLAN 23610 OT14B/688 MITCHELL	9990
8c	SURVEY 2 OFFICE PLAN 23610 OT14B/689 MITCHELL	14817
8d	SURVEY 2 OFFICE PLAN 23610 OT14B/689 MITCHELL	768
8e	SECTION 47 BLK III BEAUMONT SD OT13D/125 MITCHELL	322
9a	SECTION 1 TN OF BLK XX DUNKELD OT176/254 MARGARET FRANCES YARKER MICHAEL BRIAN HEALY	35

LAND TO BE VESTED AS LOCAL ROAD

REFERENCE	DESCRIPTION	ADDITIONAL LAND TO BE DESIGNATED (m^2)
2b	LOT 3 DEPOSITED PLAN 8804 444076 DUNBROOK DAIRIES LIMITED	255
5a	SECTION 8 TN OF BLK I DUNKELD 444075 JOSEPH CHRIS THEO SCHOLTEN	29
6a	PT SECTION 9 TN OF BLK I DUNKELD OT211/109 LAWRENCE TOWNHOUSE ACCOMMODATION LIMITED	21

NOTE:
LAND TO BE DESIGNATED INCLUDES LAND REQUIRED FOR CONSTRUCTION PURPOSES FOR WHICH THE DESIGNATION IS TO BE UPLIFTED UPON PROJECT COMPLETION.

Revision	Amendment	Approved	Revision Date
A	FIRST ISSUE	MND	28/05/2019
B	TITLE BLOCK AMENDED	MND	10/10/2019
C	DRAWINGS UPDATED	MND	16/10/2019

NZ TRANSPORT AGENCY
WAKA KOTAHI

APPROVED BY TEAM LEADER - CONSENTS AND APPROVALS.

24/10/19

RICHARD SHAW DATE:__________

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Designed	Approved	Approved Date
BEDE M	MND	10/10/2019

Drawn	Scales
MSA	N.T.S.

Project
NZ TRANSPORT AGENCY
BEAUMONT, OTAGO
SH8 BEAUMONT BRIDGE REPLACEMENT

Sheet
LAND DESIGNATION PLAN SCHEDULE

Project No.	Sheet. No.	Revision
6-CT012.00	V51	C

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Original Sheet Size A1 [841x594] Plot Date 2019-10-16 at 4:25:14 PM Path S:\Pro\NZ\6C\6-CT012.00 Beaumont Bridge Replacement\Home\800 Drawings\(C) Civil\Civil3D\6-CT012.00_V50-V54(C).dwg V51(C)

NOTE:
LAND TO BE DESIGNATED INCLUDES LAND REQUIRED FOR CONSTRUCTION PURPOSES FOR WHICH THE DESIGNATION IS TO BE UPLIFTED UPON PROJECT COMPLETION.

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A	FIRST ISSUE	MND	28/05/2019
B	TITLE BLOCK AMENDED	MND	10/10/2019
C	DRAWINGS UPDATED	MND	16/10/2019

NZ TRANSPORT AGENCY
WAKA KOTAHI

APPROVED BY TEAM LEADER - CONSENTS AND APPROVALS.

Richard Shaw 24/10/19

RICHARD SHAW DATE:

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Designed	Approved	Approved Date
BEDE M	MND	10/10/2019

Drawn	Scales
MSA	NTS

Project
NZ TRANSPORT AGENCY
BEAUMONT, OTAGO
SH8 BEAUMONT BRIDGE REPLACEMENT

Sheet
LAND DESIGNATION PLAN
OVERVIEW PLAN

Project No.	Sheet. No.	Revision
6-CT012.00	V52	C

Original Sheet Size A1 [841x594] Plot Date 2019-10-16 at 4:25:26 PM Path S:\Pro|NZ\6C\6-CT012.00 Beaumont Bridge Replacement\Home\800 Drawings\(C) Civil\Civil3D\6-CT012.00_V50-V54(C).dwg V52(C)

NOTE:
LAND TO BE DESIGNATED INCLUDES LAND REQUIRED FOR CONSTRUCTION PURPOSES FOR WHICH THE DESIGNATION IS TO BE UPLIFTED UPON PROJECT COMPLETION.

1:1000 @ A1
1:2000 @ A3
0 10 20 30 40 50 60 70 80 90 100 m

Revision	Amendment	Approved	Revision Date
A	FIRST ISSUE	MND	28/05/2019
B	TITLE BLOCK AMENDED	MND	10/10/2019
C	DRAWINGS UPDATED	MND	16/10/2019

NZ TRANSPORT AGENCY
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APPROVED BY TEAM LEADER - CONSENTS AND APPROVALS.
24/10/19
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Designed	Approved	Approved Date
BEDE M	MND	10/10/2019

Drawn	Scales
MSA	1:1000 @ A1, 1:2000 @ A3

Project
NZ TRANSPORT AGENCY
BEAUMONT, OTAGO
SH8 BEAUMONT BRIDGE REPLACEMENT

Sheet
LAND DESIGNATION PLAN
WEST APPROACH

Project No.	Sheet. No.	Revision
6-CT012.00	V53	C

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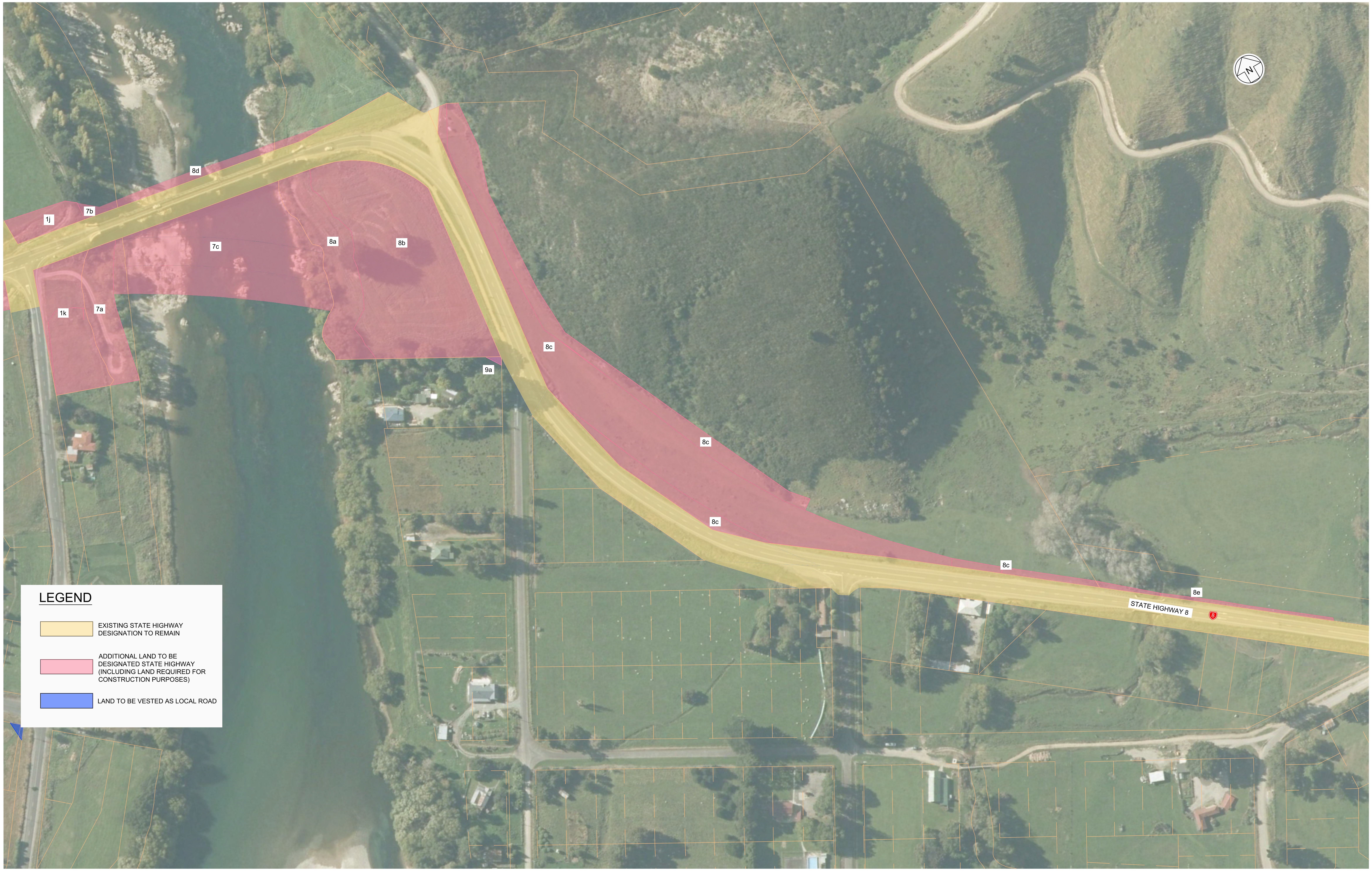

NOTE:
LAND TO BE DESIGNATED INCLUDES LAND REQUIRED FOR CONSTRUCTION PURPOSES FOR WHICH THE DESIGNATION IS TO BE UPLIFTED UPON PROJECT COMPLETION.

1:1250 @ A1 1:2500 @ A3 0 20 40 60 80 100 120 m

Revision	Amendment	Approved	Revision Date
A	FIRST ISSUE	MND	28/05/2019
B	TITLE BLOCK AMENDED	MND	10/10/2019
C	DRAWINGS UPDATED	MND	16/10/2019

NZ TRANSPORT AGENCY
WAKA KOTAHI

APPROVED BY TEAM LEADER - CONSENTS AND APPROVALS.
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Designed	Approved	Approved Date
BEDE M	MND	10/10/2019

Drawn	Scales
MSA	1:1250 @ A1, 1:2500 @ A3

Project
NZ TRANSPORT AGENCY
BEAUMONT, OTAGO
SH8 BEAUMONT BRIDGE REPLACEMENT

Sheet
LAND DESIGNATION PLAN BRIDGE AND EAST APPROACH

Project No.	Sheet. No.	Revision
6-CT012.00	V54	C

Original Sheet Size A1 [841x594] Plot Date 2019-10-16 at 4:25:49 PM Path S:\Pro\NZ\6C\6-CT012.00 Beaumont Bridge Replacement\Home\800 Drawings\(C) Civil\Civil3D\6-CT012.00_V50-V54(C).dwg V54(C)

Appendix 3 - Relevant Objectives and Policies

TABLE 1: REGIONAL POLICY STATEMENT FOR OTAGO 1998: PARTIALLY OPERATIVE AS OF 14 JANUARY 2019	
OBJECTIVE / POLICY	**COMMENT**
Chapter 5 - Land	
Objective 5.4.1 To promote the sustainable management of Otago's land resources in order: (a) To maintain and enhance the primary productive capacity and life-supporting capacity of land resources; and (b) To meet the present and reasonably foreseeable needs of Otago's people and communities.	The proposal will result in the loss of some small areas of productive land in Beaumont. This land is required to construct the approaches to the new Beaumont Bridge to meet the needs of Otago's people and communities. It should also be noted that some of the land that is currently highway will be returned to pasture post construction. The proposal will also result in the loss of some small disturbance to riparian margins. These areas will be appropriately rehabilitated, where practicable following completion of the works. No significant indigenous flora has been identified in these areas.
Policy 5.5.5 To minimise the adverse effects of landuse activities on the quality and quantity of Otago's water resource through promoting and encouraging the: (a) Creation, retention and where practicable enhancement of riparian margins; and (b) Maintaining and where practicable enhancing, vegetation cover, upland bogs and wetlands to safeguard land and water values; and (c) Avoiding, remedying or mitigating the degradation of groundwater and surface water resources caused by the introduction of contaminants in the form of chemicals, nutrients and sediments resulting from landuse activities.	
Chapter 6 - Water	
Objective 6.4.2 To maintain and enhance the quality of Otago's water resources in order to meet the present and reasonably foreseeable needs of Otago's communities.	The proposal will result in some short term effects on water quality through the remobilisation of sediments associated with bed disturbance. Stormwater from the project will be disposed of via roadside swales and as identified above stormwater from the bridge will be captured and discharged to land on the eastern bank of the river. Riparian vegetation disturbance will be kept to a minimum. It is also noted that no riparian vegetation of any significance has been identified at the site.
Objective 6.4.4 To maintain and enhance the ecological, intrinsic, amenity and cultural values of Otago's water resources.	
Objective 6.4.5 To avoid, remedy or mitigate degradation of water resources resulting from the use, development or protection of the beds and banks of Otago's water bodies and of adjacent land areas.	

Policy 6.5.7 To maintain and where practicable enhance existing well vegetated riparian margins and, where necessary, to promote the creation of further such margins: (a) To provide for the preservation of the natural character of wetlands, rivers, lakes and their margins; and (b) To maintain and enhance water quality; and (c) To maintain and enhance ecological, amenity, intrinsic and habitat values; while considering the need to reduce threats posed by flooding and erosion.	
Chapter 10 - Biota	
10.4.1 To maintain and enhance the life-supporting capacity and diversity of Otago's biota.	There will be some vegetation disturbance and removal to enable to project. None of this vegetation has been identified as being of significance. Additionally landscaping, including native plants is proposed as part of the overall project.

TABLE 2: PARTIALLY OPERATIVE OTAGO REGIONAL POLICY STATEMENT 2019: APPEALS VERSION	
OBJECTIVE / POLICY	**COMMENT**
Chapter 1 – Resource Management in Otago is integrated	
Objective 1.13 - Otago's resources are used sustainably to promote economic, social, and cultural wellbeing for its people and communities	In order to ensure the economic and social wellbeing of Otago's communities a new bridge across the Clutha River Mata-Au at Beaumont is required, which is the primary objective of the project. In undertaking the project, the Transport Agency had provided for the matters identified in (a) – (f) though incorporating feedback obtained through consultation, undertaking appropriate mitigation, and ensuring resilience and accessibility through the construction of a modern bridge over the Clutha River - Mata-Au.
Policy 1.1.21 - Social and cultural wellbeing and health and safety - Provide for the social and cultural wellbeing and health and safety of Otago's people and communities when undertaking the subdivision, use, development and protection of natural and physical resources by all of the following: a) Recognising and providing for Kāi Tahu values; b) Taking into account the values of other cultures; c) Taking into account the diverse needs of Otago's people and communities; d) Avoiding significant adverse effects of activities on human health; e) Promoting community resilience and the need to secure resources for the reasonable needs for human wellbeing; f) Promoting good quality and accessible infrastructure and public services.	
PART B Chapter 2 Kāi Tahu values and interests are recognised and kaitiakitaka is expressed	
Objective 2.1 - The principles of Te Tiriti o Waitangi are taken into account in resource management processes and decisions.	The Transport Agency have undertaken consultation with iwi through the phases of the project to date and this will continue as the project proceeds through detailed design (and the outline plan process in relation to the designation). The Transport Agency will to continue consultation with iwi to ensure the mauri of the Mata-Au is maintained as the project proceeds.
Objective 2.2 Kāi Tahu values, interests and customary resources are recognised and provided for	
Part B – Chapter 3 – Otago has high quality natural resources and ecosystems	
Objective 3.1 The values (including intrinsic values) of Otago's ecosystems and natural resources are recognised, and maintained, and or enhanced where degraded.	The values associated with ecosystems at the site have been assessed in the ecological assessment.

Policy 3.1.2 Beds of rivers, lakes, wetlands, and their margins Manage the beds of rivers, lakes, wetlands, their margins, and riparian vegetation to: a) Safeguard the life supporting capacity of fresh water; b) Maintain good quality water, or enhance it where it has been degraded; c) Maintain or enhance bank stability; d) Maintain or enhance ecosystem health and indigenous biological diversity; e) Maintain or enhance, as far as practicable: i. Their natural functioning and character; and ii. Amenity values; f) Control the adverse effects of pest species, prevent their introduction and reduce their spread; and, g) Avoid, remedy or mitigate the adverse effects of natural hazards, including flooding and erosion.	With regards to the matters identified in Policy 3.1.2 provided the proposed mitigation measures are implemented, the matters identified in (a) to (g) will be addressed. The proposal will result in some localised loss of riparian vegetation. There will be localised loss of natural character however in the context of the modified nature of the environment this is considered less than minor. Air quality will be managed though the implementation of a CEMP.
Policy 3.1.6 Air quality Manage air quality to achieve the following: a) Maintain good ambient air quality that supports human health, or enhance air quality where it has been degraded; b) Maintain or enhance amenity values	
Part B – Chapter 4 – Communities in Otago are resilient, safe and healthy	
Objective 4.3 – Infrastructure is managed and developed in a sustainable way Policy 4.3.13 - Managing infrastructure activities Recognise and provide for infrastructure by all of the following: a) Protecting and providing for the functional needs of lifeline utilities and essential or emergency services; b) Increasing the ability of communities to respond and adapt to emergencies, and disruptive or natural hazard events; c) Improving efficiency of natural and physical resource use; d) Minimising adverse effects on existing land uses, and natural and physical resources; e) Managing other activities to ensure the functional needs of infrastructure are not compromised.	The existing bridge is obviously requiring replacement and therefore NZTA as managing the State highway network in a sustainable manner seeks to construct a new bridge. In the construction and ongoing management of the new bridge NZTA will have regard to the matters identified in Policy 4.3.13 particularly (a) and (d). As being infrastructure of regional significance it is important to recognise the need for this infrastructure balanced with managing the adverse effects of the infrastructure. The Transport Agency has achieved as appropriate balance in this regard through the provision of a new bridge, coupled with appropriate mitigation measures.

Policy 4.3.2 - Nationally and regionally significant infrastructure Recognise the national and regional significance of all of the following infrastructure: a) Renewable electricity generation activities, where they supply the, National Grid and or local distribution network; b) National Grid; c) Electricity sub-transmission infrastructure; d) Telecommunication and radiocommunication facilities; e) Roads classified as being of national or regional importance; f) Ports and airports and associated navigation infrastructure; g) Defence facilities; h) Rail infrastructure Structures for transport by rail.; i) Municipal infrastructure. Policy 4.3.4 Adverse effects of nationally and regionally significant infrastructure (1) Minimise Manage adverse effects from of infrastructure that has national or regional significance, by all of the following: a) Giving preference to avoiding its location in all of the following: i. Areas of significant indigenous vegetation and significant habitats of indigenous fauna in the coastal environment; ii. Outstanding natural features, landscapes and seascapes; iii. Areas of outstanding natural character; ii. Outstanding natural character in the coastal environment; iii. Outstanding natural features and natural landscapes, including seascapes, in the coastal environment; iv. Areas of significant indigenous vegetation and significant habitats of indigenous fauna beyond the coastal environment; v. Outstanding natural character in areas beyond the coastal environment; vi. Outstanding natural features and landscapes beyond the coastal environment;	

viiiv. Outstanding water bodies or wetlands; viii. Places or areas containing significant historic heritage of regional or national significance.	
Part B Chapter 5 – People are able to enjoy Otago's natural and built environment	
Policy 5.1.1 Public access Maintain and or enhance public access to the natural environment, including to the coast, lakes, rivers and their margins, and where possible areas of cultural or historic significance, unless restricting access is necessary for one or more of the following: a) Protecting public health and safety; b) Protecting the natural heritage and ecosystem values of sensitive natural areas or habitats; c) Protecting identified sites and values associated with historic heritage or cultural significance to Kāi Tahu; d) Ensuring a level of security consistent with the operational requirements of a lawfully established activity.	Whilst there will be some localised necessary restrictions on public access to the bed of the Clutha River Mata-Au during construction for health and safety reasons on completion of the project this will be restored.
Objective 5.4 Adverse effects of using and enjoying Otago's natural and physical resources are minimised	
Hazardous Substances	
Objective 15.2.1 – To ensure that the adverse effects from the discharge of hazardous substances into or onto land, on water and soil quality, social, cultural, and amenity values, indigenous flora and fauna, and human health are avoided, remedied or mitigated.	Mobile fuel tanks will be stored on site for refuelling purposes of machinery. Mitigation measures will be put in place to avoid spillage and leakage of fuel tanks and mitigate any effect on water quality, soil quality and aquatic ecosystems.
Policy 15.3.1 – To avoid inappropriate disposal or discharge of hazardous substances to land.	

TABLE 3: REGIONAL PLAN: WATER FOR OTAGO	
OBJECTIVE / POLICY	**COMMENT**
Chapter 5 – Natural and Human Use Values of Lakes and Rivers	
Objective 5.3.1 To maintain or enhance the natural and human use values, identified in Schedules 1A, 1B and 1C, that are supported by Otago's lakes and rivers.	The proposed mitigation measures will ensure the natural and human use values, and schedule 1D matters of the Clutha River Mata-Au are maintained. As identified above the site is of low natural character (aside from the river itself) and it is not considered the activity is an inappropriate use in the location. Public access to the river will be disrupted in a localised manner during construction, however existing levels of access will be restored on completion of the project.
Objective 5.3.2 To maintain or enhance the spiritual and cultural beliefs, values and uses of significance to Kai Tahu, identified in Schedule 1D, as these relate to Otago's lakes and rivers.	
Objective 5.3.3 To protect the natural character of Otago's lakes and rivers and their margins from inappropriate subdivision, use or development.	
Objective 5.3.5 To maintain or enhance public access to and along the margins of Otago's lakes and rivers.	
Chapter 7 Water Quality	
Objective 7.A.1 To maintain water quality in Otago lakes, rivers, wetlands, and groundwater, but enhance water quality where it is degraded.	Water quality at the site will be largely maintained through both the construction stages of the project, particularly having regard to the relatively small amounts of bed disturbance in the context of the large active bed. It is also noted upon completion of piling the majority of construction activity will be able to be undertaken out of the wet bed.
Objective 7.A.2 To enable the discharge of water or contaminants to water or land, in a way that maintains water quality and supports natural and human use values, including Kāi Tahu values.	
Policy 7.B.3 Allow discharges of water or contaminants to Otago lakes, rivers, wetlands and groundwater that have minor effects or that are short-term discharges with short-term adverse effects.	
7.C.2 When considering applications for resource consents to discharge contaminants to water, or onto or into land in circumstances which may result in any contaminant entering water, to have regard to: (a) The nature of the discharge and the sensitivity of the receiving environment to adverse effects; (b) The financial implications, and the effects on the environment of the proposed method of discharge when compared with alternative means; and (c) The current state of technical knowledge and the likelihood that the proposed method of discharge can be successfully applied.	

<table>
<tr><th colspan="2">Chapter 8 – The Beds and Margins of Lakes and Rivers</th></tr>
<tr><td>Objective 8.3.1 To maintain:
(a) The stability and function of existing structures located in, on, under or over the bed or margin of any lake or river;
(b) The stability of the bed and bank of any lake or river; and
(c) The flood and sediment carrying capacity of any lake or river.</td><td rowspan="3">The project will not give rise to any adverse effects on the stability of existing structures or river banks. The effects on flood carrying capacity have been assessed in the hydraulic assessment and have been found to be negligible.
Water clarity will be largely unaffected noting the identification in the ecological report of low water clarity existing in the Clutha River Mata-Au.</td></tr>
<tr><td>Objective 8.3.2 To minimise reduction in water clarity caused by bed disturbance.</td></tr>
<tr><td>Policy 8.6.1 In managing the disturbance of the bed or margin of any lake or river, to have regard to any adverse effect on:</td></tr>
<tr><th colspan="2">TABLE 4: REGIONAL PLAN: WASTE FOR OTAGO</th></tr>
<tr><th>OBJECTIVE / POLICY</th><th>COMMENT</th></tr>
<tr><th colspan="2">Chapter 5 – Contaminated Sites</th></tr>
<tr><td>Objective 5.3.1 To avoid, remedy or mitigate any adverse effects of contaminated sites.</td><td rowspan="2">Whilst contaminated land will be disturbed as part of the project, appropriate investigations have been undertaken and determined the disturbance is highly unlikely to pose a risk to human health.</td></tr>
<tr><td>Policy 5.4.3 To contain contaminated sites and rehabilitate them to the extent that is practicable having regard to the use to which the land is to be put.</td></tr>
</table>

TABLE 5: OPERATIVE CLUTHA DISTRICT PLAN	
OBJECTIVE / POLICY	**COMMENT**
Section 3.3 Transportation	
Objective TRAN.1 - To achieve and maintain appropriate public safety levels in respect of the District transportation network.	The project has been designed in accordance the Transport Agency safety requirements, and has been designed, and will be constructed in accordance with Transport Agency standards. In undertaking the design of the project the Transport Agency has sought to ensure that adverse effects on the environment are avoided, remedied or mitigated as discussed above in Section 8.
Objective TRAN.3 - To maintain the amenity values of the District, while enabling the continual development and upgrading of the transportation network.	
Policy TRAN.7 - To manage the transportation network and its development and maintenance to ensure that adverse effects on the environment are avoided, remedied or mitigated.	
Policy TRAN.9 - To require that new roads and access points be constructed to a standard appropriate to their intended use, and that the adverse effects of maintenance, upgrading and construction be avoided, remedied, or mitigated.	
Section 3.5 Heritage	
Objective HER.1 - To recognise the importance of, and provide for the appropriate protection, conservation, use and where possible, enhancement of the District's natural, built, and cultural heritage resources.	As identified above, there will be some trimming of trees that are identified as heritage items in the Clutha District Plan. This will be done under appropriate supervision to ensure it is undertaken in an appropriate manner. The other item of heritage value at the site – the existing Beaumont bridge is proposed to be retained.
Policy HER.4 - To conserve the heritage values of those buildings and structures, identified in the Register of Heritage Items contained in Table 13.1.	
Section 3.6 Water	
Objective WAT.3 – Environment - To ensure that structures erected and activities carried out upon the waters surface or within the margins of the Districts waterbodies, avoid, remedy or mitigate adverse effects on the environment, particularly the natural character of the Districts waterbodies and their margins.	The proposal will result in some localised loss of riparian vegetation. There will be localised loss of natural character however in the context of the modified nature of the environment this is considered less than minor.
Policy WAT.4 To ensure structures, land use, and water surface activities avoid, remedy, or mitigate any adverse effects that they may have on the aesthetic and ecological values (including indigenous vegetation and habitats of indigenous fauna) of the Districts waterbodies and their margins.	

Section 3.13 Noise	
Objective NSE.1 - To protect the Districts amenity values and the wellbeing of the Districts people from the adverse effects of noise. Policy NSE.1- To mitigate the adverse effects of noise on (i) The well-being of the people of the District; and (ii) The amenities of the District.	As identified above there will be some noise generated by the project particularly during construction. Having identified that some of these noise levels will be elevated during construction, and what that likely level is, the Transport Agency will require a Construction Noise and Vibration Management Plan to be developed and implemented by the contractor, to ensure these effects are appropriately mitigated.
Section 4.1 Rural Resource Area	
Policy RRA.4 - To ensure that the adverse effects land use activities can have on the water quality within the Districts waterbodies are avoided, remedied or mitigated by requiring the use of buffer zones or similar management methods. Policy RRA.5 To ensure that the use, development and/or protection of land within riparian margins is managed so as to avoid, remedy or mitigate adverse effects on waterbodies including the effects of · reducing bank stability · increasing nutrient and sediment loadings · reduction in habitat quality	Water quality at the site will be largely maintained through both the construction stages of the project, particularly having regard to the relatively small amounts of bed disturbance in the context of the large active bed. It is also noted upon completion of piling the majority of construction activity will be able to be undertaken out of the wet bed.
Section 4.6 Rural Settlements	
Objective RST.1 - To maintain the low density and quiet amenity values of rural settlements. Policy RST.3 - To avoid, remedy or mitigate the adverse effects that activities can have on the amenity values of rural settlements.	The proposal will not increase the density of the Beaumont community. As identified, there will, particularly during construction, be some changes to the noise environment in the location. Noise and vibration will be managed through a construction noise and vibration management plan, once the proposed construction methodology is known.

Appendix 4 Proposed Conditions

Proposed Consent Conditions (Otago Regional Council)

Resource Consent No	Type of resource consent	Activity/Location
	Land Use Consent	Earthworks and vegetation clearance in riparian margins, earthworks and the excavation of land and deposition of material in areas where excavation has occurred
	Land Use Consent	Erection of structures and associated bed disturbance of the Clutha River Mata-Au
	Water Permit	To temporarily divert water associated with bridge construction and deconstruction works
	Water Permit	To permanently divert the Clutha River Mata-Au
	Discharge Permit	To discharge contaminants to land associated with construction works
	Discharge Permit	To discharge contaminants to water associated with bridge construction and deconstruction works

PROPOSED CONDITIONS APPLYING TO ALL REGIONAL COUNCIL CONSENTS

1. The works shall be carried out in general accordance with the details contained in the consent application submitted to the Consent Authority, except where inconsistent with these conditions.

2. The Consent Holder shall supply any agent or contractor working under these consents with a copy of the consents.

3. Any person working under these consents shall have a copy of the consent conditions on site and present it to an officer of the Consent Authority upon request.

4. All activities under these consents shall generally be undertaken at the location identified and in accordance with the site plans attached and any more detailed plans developed as part of the Construction Environmental Management Plan (CEMP).

5. All equipment refuelling, lubrication, mechanical repairs and storage of fuels shall be undertaken in an area that provides sufficient mitigation measures to ensure that no spillages onto the land surface or into water occur. No refuelling or lubrication shall be undertaken within the bed of the Clutha River Mata-Au, with the exception of equipment that is required to be located in the bed of the river for an extended period and is not practically moveable, including equipment located on temporary staging. For this equipment refuelling, lubrication and mechanical repairs within the bed of the river will be kept to a minimum as far as practicable and mitigation measures specified in the CEMP (Hazardous Substances/Spill Contingency Procedures) will be put in place.

6. The Consent Holder shall ensure that all machinery is cleaned in accordance with Biosecurity New Zealand's hygiene procedures before entering water to minimise the entry of petroleum products, other contaminants and/or pest plants/weeds including didymo.

   Advice note: You can access the most current version of these procedures from the Biosecurity New Zealand website http://www.biosecurity.govt.nz

7. All practicable measures shall be undertaken to prevent sediment from entering water including, but not limited to:

a. establishing sediment controls prior to the onset of works and maintaining them in place until disturbed areas are stabilised;
b. stabilisation of disturbed areas as soon as practicable following the works;
c. no washing down of plant shall where sediment may enter any waterbodies.

8. The Consent Holder shall submit a Construction Environmental Management Plan (CEMP) to the Consent Authority at least ten working days prior to the commencement of the construction activities, outlining all practices and procedures to be adopted in the construction of the road bridge and bridge approaches. The submission of the CEMP, including any amendments, to the Consent Authority shall be for the purpose of information, assurance and to enable comment from the Consent Authority on the proposed management practices and procedures.

9. The CEMP shall contain as a minimum the following information:
   a) An Erosion, Sediment and Dust Control Management Plan;
   b) A Hazardous Substances/Spill Contingency Procedure;
   c) Bridge Construction Management Plan;

10. The CEMP shall detail, as a minimum, how the following objectives shall be achieved for the duration of the consents:
    a) The practices and procedures to be adopted to achieve compliance with the conditions of these consents;
    b) How any adverse effects of construction activities will be avoided or mitigated;
    c) How the discharge of sediment during the earthworks will be avoided or mitigated; and
    d) How the disturbance of the riverbed and riparian margins of the Clutha River Mata-Au will be limited to the extent necessary to undertake construction works and avoid or mitigate adverse effects on the quality and flow of surface water and aquatic habitats.

    Advice Note: In the event of any conflict between the conditions of these consents and the CEMP practices and procedures, the resource consent conditions shall take precedence.

11. The Bridge Construction Management Plan shall include, but not be limited to the following:
    a) details of the specific bridge construction contractors and contact details;
    b) the proposed bridge construction methodology and programme;
    c) details of any temporary access staging required for bridge construction works;
    d) methods for managing any concrete pours and potential spillages during the bridge construction works;
    e) flood contingency measures; and
    f) methods for managing any potential impacts upon river users.

12. Pursuant to section 128 of the resource management act 1991, the consent authority may review the conditions of these consents by serving notice within a one month period of each anniversary of the date of commencement of the consents for any of the following purposes:
    a) to deal with any adverse effect on the environment which may arise from the exercise of these consents and which it is appropriate to deal with at a later stage.
    b) to require the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment.

To disturb the bed of Clutha River Mata-Au associated with construction and discharge contaminants to water

13. The Consent Holder shall maintain fish passage for the duration of the works.

14. Any sediment discharges associated with disturbance of the riverbed shall not give rise to any conspicuous change in the colour or visual clarity of the waters in the river, beyond the timeframe of works taking place in the active watercourse.

15. Any material excavated from the bed for the construction of temporary staging or new bridge piles shall be captured and removed from the wet bed.

16. The Consent Holder shall ensure that the site is restored on completion of the physical works as follows:
    (a) The banks are left in a stable condition and exposed soil areas not being used for the ongoing operation of the road bridge and shall be revegetated as soon as practicable after the completion of the construction works;
    (b) All rubbish, left over materials and debris are removed from site and disposed of in a legal manner;
    (c) All equipment and signs associated with the construction works are removed; and
    (d) Any disturbed areas of the river bed are reshaped to a natural form.

To temporarily divert water associated with bridge construction works

17. The Consent Holder shall ensure that the temporary diversion does not:
    a) Cause or exacerbate flooding of another person's property, erosion, land instability, sedimentation or property damage;
    b) Leave any fish stranded.

PROPOSED CONDITIONS APPLYING TO THE CDC RESOURCE CONSENTS

1. The works shall be carried out in general accordance with the details contained in the Resource Consent Application submitted to the Consent Authority, except where inconsistent with these conditions.

2. Any trimming of Significant Trees H80D, H80E and H80F shall be undertaken under the supervision of a suitably qualified arborist.

3. Prior to construction works commencing, plans and specifications for any road construction activity to be undertaken on Clutha District Council's roading network must be provided to Council's Group Manager Service Delivery for certification.

4. The Consent Holder shall submit a Construction Environmental Management Plan (CEMP) to the Consent Authority at least ten working days prior to the commencement of the construction activities, outlining all practices and procedures to be adopted in construction of the works. The submission of the CEMP, including any amendments, to the Consent Authority shall be for the purpose of information, assurance and to enable comment from the Consent Authority on the proposed management practices and procedures.

5. The CEMP shall contain as a minimum the following information:
    a) An Erosion, Sediment and Dust Control Management Plan;
    b) A Hazardous Substances/Spill Contingency Procedure;
    c) Construction Noise and Vibration Management Plan.

6. The CEMP shall detail, as a minimum, how the following objectives shall be achieved for the duration of the consents:
    a) The practices and procedures to be adopted to achieve compliance with the conditions of these consents;
    b) How any adverse effects of construction activities will be avoided or mitigated;
    c) How the discharge of sediment during the earthworks will be avoided or mitigated; and

d) How noise and vibration effects from the construction works will be avoided or mitigated.

Advice Note: In the event of any conflict between the conditions of these consents and the CEMP practices and procedures, the resource consent conditions shall take precedence.

PROPOSED CONDITIONS APPLYING TO THE ALTERATION OF DESIGNATION

1. The works shall be carried out in general accordance with the details contained in the Alteration to Designation Application submitted to the Consent Authority, except where inconsistent with these conditions.

2. The Consent Holder shall submit a Construction Environmental Management Plan (CEMP) to the Consent Authority at least ten working days prior to the commencement of the construction activities, outlining all practices and procedures to be adopted in construction of the works. The submission of the CEMP, including any amendments, to the Consent Authority shall be for the purpose of information, assurance and to enable comment from the Consent Authority on the proposed management practices and procedures.

3. The CEMP shall contain as a minimum the following information:
   a) An Erosion, Sediment and Dust Control Management Plan;
   b) A Hazardous Substances/Spill Contingency Procedure;
   c) Construction Noise and Vibration Management Plan.
   d) The results of a lizard survey undertaken to confirm the presence, or otherwise, of native lizards.

4. The CEMP shall detail, as a minimum, how the following objectives shall be achieved for the duration of the construction activities:
   a) How any adverse effects of construction activities will be avoided or mitigated.
   b) How the discharge of sediment during the earthworks will be avoided or mitigated.
   c) How noise and vibration effects from the construction works will be avoided or mitigated.
   d) If the lizard survey required by condition 3 above identifies the presence of lizards, a description of the methodology for survey, trapping and relocation of lizards.

Appendix 5 Technical Reports

A - Ecology Report

B - Preliminary Site Investigation

C - Hydraulic Report

D - Hydrology Report

E - Archaeological Assessment

F - Noise and Vibration Assessment

WSP Opus

Beaumont Bridge Replacement: Assessment of Ecological Effects

Beaumont Bridge Replacement: Assessment of Ecological Effects

Prepared for: WSP Opus

By: Ryder Environmental Limited
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Document version: 2/05/2019

Cover photo: The Clutha River/Mata-Au and surrounding area in the vicinity of the proposed bridge realignment.

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CONTENTS

1. Introduction

The NZ Transport Agency have identified that the single lane bridge over the Clutha River/Mata-Au at Beaumont on State Highway 8 requires replacement. Of the proposed options, the recommended approach is for a new 200 m long two-lane bridge located approximately 40 m downstream of the existing bridge structure (Figure 1). The recommended approach also includes road alignment and improvements to adjacent intersections, shared paths, and facilities (Figure 1).

Figure 1 Artists impression of the new State Highway 8 bridge over the Clutha River at Beaumont, looking downstream showing the existing bridge in the foreground.

Activities associated with the bridge replacement have the potential to impact the water quality and aquatic ecology of the Clutha River/Mata-Au. Potential effects on water quality and aquatic ecology include disturbance of the river bed (e.g., drilling, temporary structures, extraction of alluvium, bed alteration) and disturbance to the water (e.g., diversion of water, discharge of stormwater and sediments, potential discharge of other contaminants). This report considers measures to avoid/minimise any effects of the proposed activities, including the timing of the construction works (including consideration of fish spawning and migration periods) as well as measures to ensure that any discharges to the Clutha River/Mata-Au meet the water quality requirements of the Otago Regional Council Regional Plan: Water for Otago.

In addition to potential effects on the river, there is potential for the bridge replacement to impact terrestrial values.

This report presents information relevant to the assessment of the environmental effects of the construction of the proposed new bridge on aquatic and terrestrial ecosystems including presenting information on the existing environment, an assessment of potential effects and discussion of mitigation options.

2. Ecological values

2.1 Aquatic ecological values

Schedule 1A of the Regional Plan: Water identifies the natural and human use values of surface water bodies in Otago. The section of the Clutha River/Mata-Au (Island Block to Balclutha) that the Beaumont bridge works will fall within is identified as containing significant habitat for adult and juvenile trout and salmon, trout and salmon spawning, eel, rare fish and fish diversity (Table 1).

Table 1 Natural and human use values of the Clutha River/Mata-Au in the vicinity of the proposed bridge works.

Water body	Ecosystem Values	Outstanding natural feature or landscape	Significant iindigenous vegetation and significant habitat of indigenous fauna	Areas with a high degree of naturalness
Clutha River /Mata-Au *between Island Block and Balclutha*	Psize, Ppass, Psand, Pgravel, Hspawn(t&s), Hjuve, Eel, Trout, Salmon, Sigveg, Birddiv, Rarefish, Fishdiv, Gbird between Balclutha and Tuapeka River mouth	Beaumont and Rongahere Gorge.	Significant habitat: Remnant indigenous ecosystem at Birch Island. Significant vegetation: Rare association of aquatic plants above confluence with Tuapeka.	
Clutha River /Mata-Au *between Balclutha and the sea*	Psize, Ppass, Psand, Pgravel, Hspawn(s), Hjuve(t&s), Trout, Eel, Salmon, Fishdiv, Rarefish, Gbird			

2.2 Terrestrial Ecology

2.2.1 Ecological Region/District

Beaumont is located in the Lawrence Ecological District (ED), within the Lammerlaw Ecological Region. The Lawrence ED consists primarily of low, rolling, dissected hill country surrounding the town of Lawrence. It has a maximum elevation of 687m on the northern boundary. The climate is semi-continental with rainfall of 700-800mm p.a. The district is drained by three major rivers; the Clutha, Tuapeka and Waitahuna Rivers.

The pre-human vegetation of the district would have consisted primarily of forest, along with some scrub and shrubland. Silver beech forest was probably the dominant forest type on the hillslopes, with red and mountain beech locally. On warmer, more fertile sites (e.g. river terraces, riparian zones and lower north facing slopes) broadleaf, ribbonwood, lacebark and kowhai would have been prominent canopy trees, along with podocarps such as matai, kahikatea and true totara.

The original vegetation of the ED has been largely lost or modified due to human activities. Early Maori burning resulted in large areas of fire-induced tussock grassland. Vegetation clearance continued with European occupation. Today, much of the lower parts of the district are farmed (semi-intensive sheep and cattle). Exotic plantation forestry is also a significant land use (McEwen 1987). Consequently, few, large areas of indigenous vegetation or habitat remain. Significant protected areas are mainly administered by DOC and are located to the north and east of Beaumont in the northern portion of the ED. These include Tuapeka Conservation Area, Bowlers Creek Scenic Reserve, Gabriel's Gully Bush Reserve Conservation Area and Cotton Scenic Reserve. In the south are Tuapeka West Scenic Reserve, Beaumont Conservation Area and Blue Mountains Conservation Area (the latter mostly within Tapanui Ecological District with small portions within the Lawrence ED). Throughout the district, land cleared of forest and subsequently allowed to revert carries secondary shrubland and low forest, generally kanuka/manuka, hardwoods and Scotch broom.

3. Existing Environment

3.1 Aquatic ecology

3.1.1 Hydrology

The Clutha River/Mata-Au is New Zealand's largest river by flow, with a mean flow of 614 m^3/s and a 7-day mean annual low flow of 309 m^3/s (Duncan & Woods 2013). The lower Clutha/Mata-Au is subject to significant flow fluctuations as a result of flood events and hydro-electric power generation at Roxburgh Power Station (e.g., Figure 2).

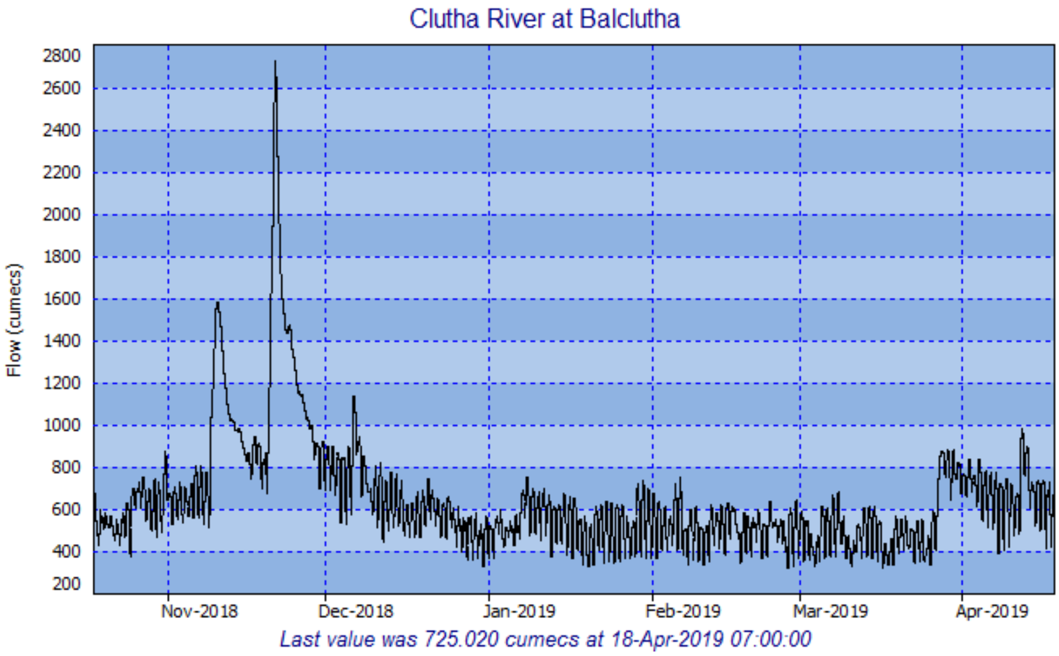

Figure 2 Hydrograph from the lower Clutha River at Balclutha hydrological site showing flood events and frequent daily flow fluctuations over the November 2018 to April 2019 period resulting from hydroelectric power generation at Roxburgh Power Station. Figure from the ORC website[1].

[1] https://www.orc.govt.nz/managing-our-environment/water/water-monitoring-and-alerts/lower-clutha/clutha-river-at-balclutha-flow

3.1.2 Water quality

National River Water Quality Network data

The National River Water Quality Network (NRWQN) includes two sites in the Clutha River/Mata-Au downstream of Lake Roxburgh: Clutha River at Millers Flat and Clutha River at Balclutha (Figure 3). Water quality at the Millers Flat site is generally good, with relatively low water temperatures, high levels of dissolved oxygen, low levels of nutrients and generally low levels of *E. coli* present (Table 2). However, water clarity at this site is generally low (average 2 m, maximum 5.95 m), and, conversely, turbidity is generally quite high[2] (Table 2). Water quality at the Millers Flat site complies with all corresponding Schedule 15 limits when applied as a 5-year 80th percentiles.

The values for many of the water quality variables at the Clutha River at Balclutha are similar to those at Millers Flat, although nutrient concentrations (particularly nitrate-nitrite nitrogen and total nitrogen) and average *E. coli* concentrations are markedly higher at Balclutha than at Millers Flat (Table 2). Water quality at the Balclutha site complies with all corresponding Schedule 15 limits when applied as a 5-year 80th percentiles, with the exception of nitrate-nitrite nitrogen (), which exceeds the Schedule 15 limit of 0.075 mg/L.

Of the two sites, water quality measured at the Millers Flat site is likely to be most representative of the water quality in the reach affected by the construction of the bridge at Beaumont, as the Millers Flat site is 22 km upstream of Beaumont and no major tributaries or discharges that are expected to have an appreciable effect on water quality in the Clutha/Mata-Au enter it between these two locations.

[2] Water clarity and turbidity are inversely related. Turbidity is a measure of how "cloudy" the water is, whereas water clarity measures how far light travels through the water.

Table 2 Water quality parameters for two sites in the lower Clutha River over the period February 1989-September 2018. Data from the NRWQN, downloaded 9 April 2018[3].

Variable	Unit	Clutha River at Millers Flat (AX4)			Clutha River at Balclutha (DN4)		
		Mean	Min	Max	Mean	Min	Max
Water temperature	°C	11.8	4.7	19.6	12.0	4.5	20.5
pH		7.76	7.12	8.19	7.79	7.34	8.41
Specific conductance	µS/cm	71.7	63.5	89.3	73.8	40.8	118.3
Dissolved oxygen	mg/L	10.9	8.8	13.1	11.0	9.0	13.4
Dissolved oxygen	%	101.1	90.0	113.0	101.2	94.4	110.6
Ammoniacal nitrogen	µg/L	0.004	<0.001	0.026	0.005	<0.001	0.034
Nitrate-nitrite nitrogen	µg/L	0.037	0.007	0.203	0.093	0.002	0.748
Total nitrogen	µg/L	0.097	0.040	0.483	0.186	0.045	1.255
Dissolved reactive phosphorus	µg/L	0.001	<0.001	0.016	0.002	<0.001	0.032
Total phosphorus	µg/L	0.010	0.002	0.213	0.017	0.002	0.558
E. coli	cfu/100 ml	40.4	<1	2419.2	193.1	2.0	2613.0
Turbidity	NTU	4.1	0.3	120.0	5.7	0.3	135.0
Water clarity	m	2.00	0.05	5.95	1.45	0.03	5.93

[3] Downloaded from https://hydrowebportal.niwa.co.nz/

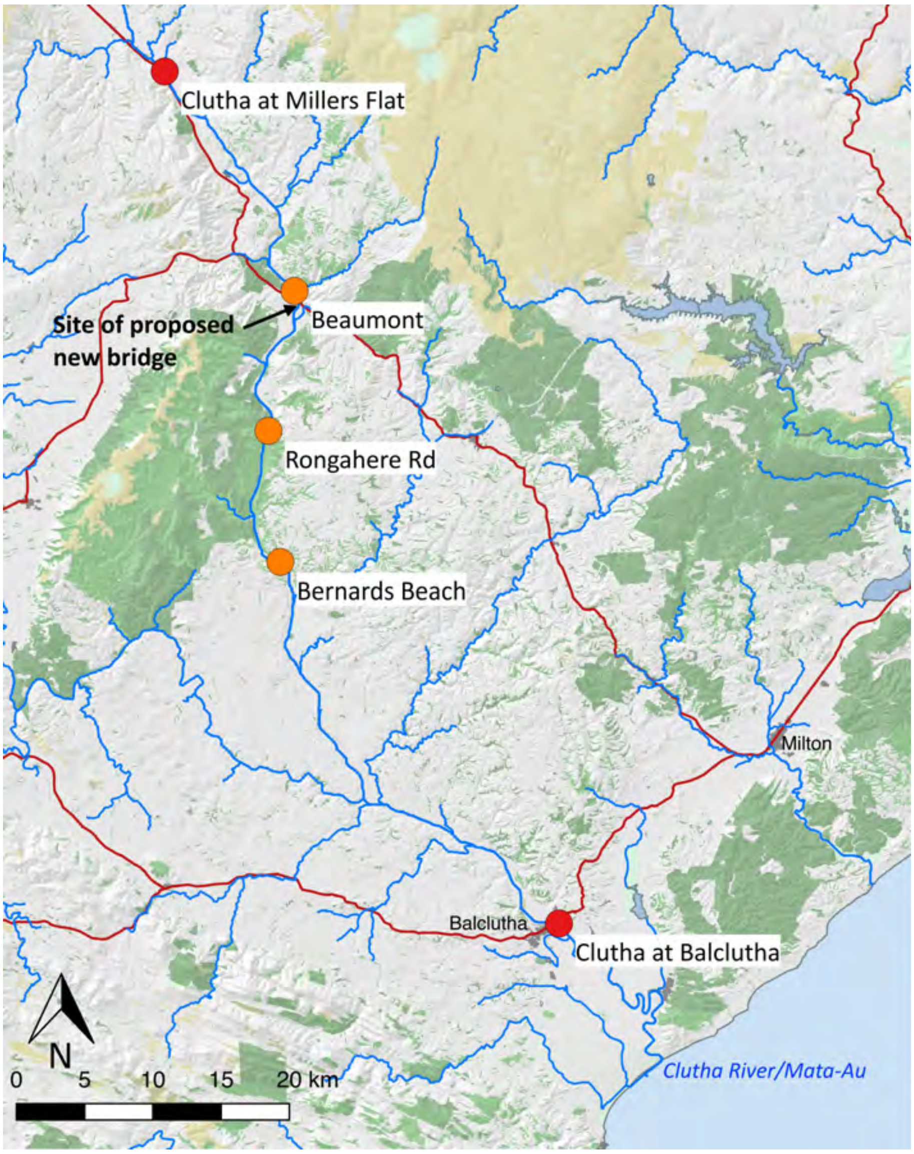

Figure 3 Water quality and invertebrate sampling locations on the mainstem of the Clutha River/Mata-Au from the National River Water Quality Network (NRWQN; red dots) and Ludgate & Ryder (2014) (orange dots).

3.1.3 Periphyton

There is limited information on the periphyton community of the lower Clutha River/Mata-Au given its very large size and the practical and safety challenges this creates for assessing its periphyton communities. Ludgate & Ryder (2014) undertook surveys in 10 riffle/beach sites in the lower Clutha/Mata-Au, when flows were lowered by Contact Energy to facilitate the surveys. They recorded that the invasive stalked diatom *Didymosphenia geminata* (didymo) *"covered large areas of the river bed at most sites, with only the Roxburgh, Rongahere Road and Manuka Island sites generally clean of didymo"*. A photograph of Didymo at the Beaumont monitoring site is shown in Figure 4.

Underwater video footage collected by Underwater Solutions Ltd. in August 2018 showed that bedrock outcrops had cover of didymo and bryophytes (aquatic mosses), while gravels generally had little or sparse periphyton cover.

Figure 4 Photograph of the bed substrate and representative algae cover at the Beaumont sampling site in April 2014 by Ludgate & Ryder (2014).

Periphyton communities in the Clutha River/Mata-Au downstream of Roxburgh Dam are affected by daily flow fluctuations resulting from power generation at the Roxburgh Power Station (see Section 3.1). This creates a "varial zone", an area of the riverbed that is intermittently wetted and dried, which reduces the suitability of this area for aquatic life. Ludgate & Ryder (2014) noted that the varial zone at sites in the lower Clutha River/Mata-Au was covered with large mats of drying didymo.

3.1.4 Macroinvertebrates

Ludgate & Ryder (2014) presented the results of macroinvertebrate sampling undertaken at 10 sites in riffle/beach habitats in the mainstem of the Clutha River/Mata-Au between Roxburgh Dam and Balclutha. Of these, sites at Beaumont (1 km upstream of the site of the proposed new bridge), Rongahere Road (11 km downstream) and Bernards Beach (22 km downstream) are relevant to the proposed works at Beaumont Bridge. The locations of these sites are shown in Figure 3.

The sampling by Ludgate & Ryder (2014) found that the macroinvertebrate fauna at Beaumont and Rongahere Road (near Birch Island) was dominated by nymphs of the common mayfly *Deleatidium*, while chironomid larvae (Orthocladiinae and Tanytarsini) and the cased-caddis *Pycnocentrodes* were also abundant at the Beaumont site. The composition of the macroinvertebrate fauna at Bernards Beach was slightly different in that it was numerically dominated by chironomid larvae (Orthocladiinae and Tanytarsini), the common mudsnail *Potamopyrgus antipodarum* and the cased-caddis *Pycnocentrodes,* with *Deleatidium* mayfly nymphs being less abundant at this site. The raw results of the macroinvertebrate sampling done by Ludgate & Ryder (2014) is attached as Appendix A.

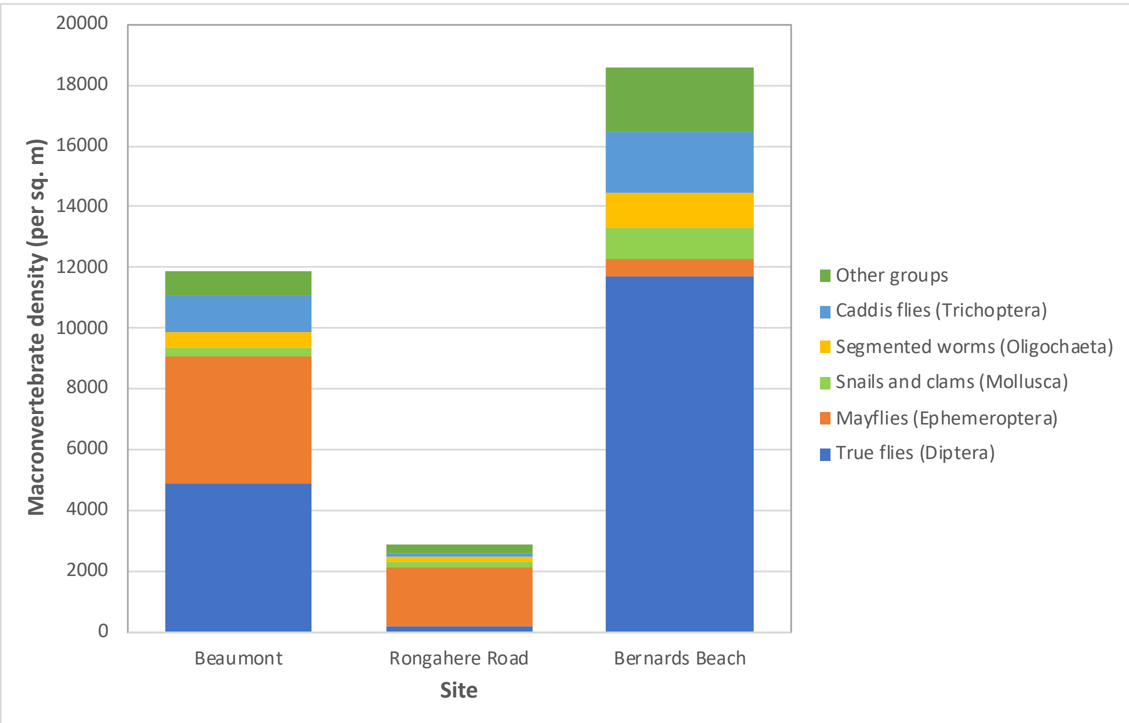

Figure 5 Density of macroinvertebrate groups at three sites in the Clutha River. From Ludgate & Ryder (2014).

As discussed above, the Clutha River/Mata-Au below Roxburgh Dam is affected by daily flow fluctuations as a result of power generation (see Section 3.1), which creates a “varial zone”, an area of the riverbed that is intermittently wetted and dried. Such wetting and drying can result in low densities and diversity of macroinvertebrates, as few freshwater invertebrates are adapted to frequent wetting and drying (Fisher and LaVoy 1972, Baxter 1977, Stark & Suren 2003).

3.1.5 Fish

Five species of fish have been recorded as being present in the mainstem of the Clutha River/Mata-Au in the immediate vicinity of the proposed works: longfin eel (*Anguilla dieffenbachii*), torrentfish (*Cheimarrichthys fosteri*), common smelt (*Retropinna retropinna*), quinnat salmon (*Onchorhynchus tshawytscha*) and brown trout (*Salmo trutta*) (New Zealand Freshwater Fish Database, downloaded 12 April 2019). In addition, several other species are expected to reside in or pass through this area including lamprey (*Geotria australis*), shortfin eel (*Anguilla australis*), common bully (*Gobiomorphus cotidianus*), upland bully (*Gobiomorphus breviceps*), kōaro (*Galaxias brevipinnis*) and rainbow trout (*Onchorhynchus mykiss*). The conservation status (from Dunn *et al.* 2018) of these species is listed in Table 3.

Table 3 *Conservation status of fish recorded from, or expected to be present in the Clutha River/Mata-Au in the vicinity of the Beaumont Bridge. Conservation status from Dunn* et al. *2018.*

Species	Scientific name	Conservation status
Shortfin eel	*Anguilla australis*	Not threatened
Longfin eel	*Anguilla dieffenbachii*	Declining
Torrentfish	*Cheimanrrichhthys fosteri*	Declining
Upland bully	*Gobiomorphus breviceps*	Not threatened
Common bully	*Gobiomorphus cotidianus*	Not threatened
Kōaro	*Galaxias brevipennis*	Declining
Lamprey	*Geotria australis*	Nationally vulnerable
Common smelt	*Retropinna retropinna*	Not threatened
Rainbow trout	*Onchorhynchus mykiss*	Introduced and naturalised
Quinnat salmon	*Onchorhynchus tshawytscha*	Introduced and naturalised
Brown trout	*Salmo trutta*	Introduced and naturalised

The lower Clutha River/Mata-Au is recognised as a regionally significant fishery (Otago Fish & Game Council 2015), supporting substantial angler effort (23,520 ± 5,470 angler days in the 2014/15 season) (Unwin 2016). Trout fishing accounts for the majority of angler usage (16,660 ± 2,770 angler days in the 2014/15 season), although angler effort for salmon is also substantial (6,760 ± 2700 angler days in the 2014/15 season) (Unwin 2016).

As discussed above, flow fluctuations resulting from power generation (see Section 3.1) create a "varial zone", an area of the riverbed that is intermittently wetted and dried. These fluctuations will reduce the suitability of available habitat for fish within the varial zone as well as resulting in low densities of macroinvertebrates (see Section 3.1.4), which will reduce local food availability for any fish present.

3.2 Terrestrial ecology

3.2.1 Site Description

Beaumont is situated approximately 60km inland at an altitude of 60m. The areas affected by the proposed realignment (the 'footprint') are located on terraces either side of the Clutha River/Mata-Au, and include minor areas of riparian habitat. Soil information, derived from S-Map (Landcare Research), indicates soils on the upper terrace, on both sides of the river, are shallow, stony, silt loams (cemented firm brown soils). Lower lying areas near the Clutha River/Mata-Au are poor to well drained silty loams derived from alluvium, schist and/or sandstone (weathered fluvial recent soils or typic orthic gley soils).

Surrounding Landuse

The land-uses surrounding the footprint are primarily sheep and beef farming, short rotation cropping and exotic plantation forestry.

Nearby Natural Habitats and Connectivity

Affected areas have no connectivity with any adjoining indigenous vegetation. The nearest substantial indigenous habitat remaining is protected within the Beaumont Conservation Area, located c. 800m north of the Beaumont Bridge on the true left of the Clutha River/Mata-Au. This area consists of a mosaic of beech forest, manuka/kanuka scrub, exotic grassland and gorse and/or Scotch broom. Extensive mixed exotic and indigenous scrub (kanuka/manuka) is found on some of the adjoining hillslopes.

The Clutha River/Mata-Au is an important landscape feature. Riparian vegetation in the vicinity of Beaumont Bridge, however, is highly modified. Upstream, it consists primarily of crack willow with some hawthorn (*Crataegus monogyna*), khasia berry (*Cotoneaster* *simsonii*), occasional kanuka and exotic grasses/herbs. Crack willow dominates the Clutha River margin downstream. Further afield, the Rongahere Gorge and Beaumont Gorge areas (*c.* 10km downstream and 3km upstream respectively from Beaumont) have significant natural character values. The Rongahere Gorge supports remnant indigenous forest, including hardwood-podocarp forest and stands of red and mountain beech (Clutha District Plan 1998).

3.2.2 Vegetation

Vegetation in the vicinity of the area of the proposed works was surveyed on 3 April 2019. At the time of this survey, the flow in the Clutha River/Mata-Au was relatively high and therefore some low-lying vegetation normally exposed at moderate to low flows was underwater and could not be inspected. Three dominant vegetation types occurred over the areas affected by the proposed realignment; riparian crack willow treeland, developed pasture grassland and roadside vegetation. All vegetation types were highly modified and dominated by exotic plant species.

Riparian area – west of river (Figures 6-8)

East of Rongahere Road, between the Beaumont Bridge and the boat ramp, vegetation was highly modified and consisted of a scrubland/grassland dominated by Scotch broom (*Cytisus scoparius**), blackberry (*Rubus fruticosus**), bracken (*Pteridium esculentum*), convolvulus (*Convolvulus arvensis**), gorse (*Ulex europaeus**), various rank grasses (exotic species) and some small crack willow (*Salix fragilis**). A little further south, a tall (c. 14m) crack willow treeland occurs over a range of exotic grasses and herbs, primarily cocksfoot (*Dactylis glomerata**) and tall fescue (*Schedonorus arundinaceus**).

Riparian area – east of river (Figure 9)

Crack willow (c. 8m tall) dominated the riparian zone east of the river. Pasture grasses, with scattered exotic weeds such as Californian thistle (*Cirsium arvensis**), foxglove (*Digitalis purpurea**) and blackberry dominated the understory ground cover. A few small clumps of gorse and Scotch broom provided some protection for indigenous plants from grazing stock, allowing a few small native species to persist including pohuehue (*Muehlenbeckia australis*), pennyworts (*Hydrocotle* spp.), bitter cress (*Cardamine deblis*), shield fern (*Polystichum vestitum*) and little hard fern (*Blechnum penna-marina*). Scattered rushes (*Juncus* spp.) within exotic pasture-grasses, occupied wet low-lying areas nearest to the river..

Pasture grassland (Figures 10-12)

Developed pasture land occurred on the eastern side of the river, north of SH8, in a line roughly between Stonewall Street and Weardale Street; and through the small square paddock south of the bridge and west of SH8. On the western side of the river, areas affected by the proposed realignment are primarily on the northern side of SH8; the vegetation over these areas was primarily introduced pasture grasses dominated by brown top (*Agrostis capillaris**), crested dogstail (*Cynosorus cristatus**), barley (*Hordeum vulgare**), perennial ryegrass (*Lolium perenne**) and *Phleum pratense**, with occasional mouse-ear chickweed (*Cerastium fontanum**), thistles (*Cirsium** spp.), woolly mullein (*Verbascum thapsis**) and other exotic herbs.

Roadside Vegetation (Figures 13 & 14)

The largest areas of roadside vegetation within the footprint are along SH8 west of the river. The vegetation here was dominated by exotic grasses and herbs, including cocksfoot*, tall fescue*, brown top*, and sweet vernal (*Anthoxanthus odoratum**). Herbs included clover (*Trifolium repens**), convolvulus*, creeping buttercup (*Ranunculus repens**), yarrow (*Achillea millefolium**), birdsfoot trefoil (*Lotus pedunculatus**), plantains (*Plantago* spp.*) and broad-leaved dock (*Rumex obtusifolius**). Occasional pampas (*Cortaderia sp.**), flax (*Phormium tenax*), crack willow saplings, broom, and khasia berry (*Cotoneaster simsonii**) were also found here.

Figure 6 Riparian area (west of Clutha River/Mata-Au) showing an overview of the area south of Beaumont Bridge towards the existing boat ramp.

Figure 7 Riparian area (west of Clutha River/Mata-Au) showing a close-up view of vegetation immediately south of the existing Beaumont Bridge.

Figure 8 Riparian area (west of Clutha River) c. 20m below existing Beaumont Bridge. Taller crack willow and rank grass dominated the vegetation at this location.

Figure 9 Riparian area (east of Clutha River/Mata-Au) showing crack willow dominant with pasture grassland..

Figure 10 Pasture Grassland (east of Clutha River/Mata-Au). View looking north-west towards Beaumont Bridge. The adjacent hill-slope primarily supported Scotch broom, gorse and other scattered exotic trees.

Figure 11 Pasture Grassland (east of Clutha River/Mata-Au) looking south-east towards Low Burn..

Figure 12 Pasture Grassland (east of Clutha River/Mata-Au). View across a small paddock towards the Clutha River showing a large macrocarpa tree (centre) adjacent to a small totara (not visible), both of which will likely be removed for the realignment.

Figure 13 Roadside vegetation (west of river). View west towards Beaumont Hotel.

Figure 14 Roadside and pasture grassland (west of Clutha River/Mata-Au). View west towards Beaumont Hotel.

3.2.3 Flora

In total, eighty plant species (16 native, 64 exotic) in total were recorded within the footprint (see Appendix B for a full plant species list, and Table 4). The flora within the footprint was typical of pasture, road-side and disturbed riparian vegetation, being dominated by exotic grasses and herbs with a scattering of mainly introduced trees and shrubs (Table 4). Native plants comprised <1% of the total cover. No nationally, or regionally, threatened or at-risk plant species were detected, but several large English oak trees were present near the intersection of Weardale Street and State Highway 8, some of which are on the Clutha District Council's Register of Significant Trees (see planning map Beaumont North U8 and Table 13.2 of operative Clutha District Plan). However, based on information to hand, these appear to be outside the footprint.

Table 4 Lifeform of indigenous (native) and exotic flora recorded from all areas affected by the proposed realignment (the footprint).

Life form	no. exotic species	no. native species	Total no. species
Herbs	32	6	38
Trees/Shrubs	14	3	17
Grasses	11	0	11
Rushes/Sedges	3	2	5
Climbers/Scramblers	3	1	4
Ferns	0	3	3
Other monocots	1	1	2
Totals	**64**	**16**	**80**

3.2.4 Fauna

Avifauna recorded were primarily exotic species, and included mallard duck, blackbird, hedge sparrow, thrush, starling, magpie, spur-wing plover and chaffinch. Native species present over the areas affected by the proposed realignment were bellbird, Australasian harrier and grey warbler.

Potential lizard and invertebrate fauna-habitats were not assessed; lizard species may occur within the footprint given the presence of suitable habitat along the edges of pasture and existing roads. All lizard species are protected under the Wildlife Act (1953), administered by the Department of Conservation, and a dedicated lizard survey is required prior to works commencing.

3.2.5 Terrestrial Ecology Significance Assessment

The Clutha District Plan (1998) requires Council to recognise and provide for the protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna, where significance is determined by the criteria outlined in POLICY HER.2B of the operative Clutha District Plan:

In assessing any application for resource consent that involves the clearance, modification or removal of indigenous vegetation, the significance of the resource shall be determined by regard to the following matters:

a. The representativeness, rarity and distinctiveness, naturalness, diversity and pattern and its relationship with other areas of indigenous vegetation and habitats of indigenous fauna (ecological context) of the indigenous vegetation or habitat of indigenous fauna.

b. Whether the affected indigenous vegetation or habitat of indigenous fauna is one of the four priorities specified in the Statement of National Priorities for Protecting Rare and Threatened Indigenous Biodiversity on Private Land (Ministry for the Environment 2007). These priorities are:

1. National Priority 1: To protect indigenous vegetation associated with land environments, (defined by Land Environments of New Zealand at Level IV), that have 20 percent or less remaining in indigenous cover.

2. National Priority 2: To protect indigenous vegetation associated with sand dunes and wetlands

3. National Priority 3: To protect indigenous vegetation associated with 'originally rare' terrestrial ecosystem types not already covered by priorities 1 and 2.

4. National Priority 4: To protect habitats of acutely and chronically threatened indigenous species.

c. Whether the area has been identified as a Significant Wetland in (Table 13.5) or as an Area of Significant Habitat of Indigenous Fauna (Table 13.8).

An assessment of the vegetation significance of the affected areas against the above criteria is provided in Table 5. A full assessment of significance, combining both flora and fauna values of the site, can only be completed following the lizard survey referred to above. In terms of vegetation-significance, the vegetation of the footprint was dominated, in terms of both composition and structure, by introduced grasses, herbs and trees characteristic of improved pasture, roadside and disturbed riparian vegetation. Native species comprised only <1% of the total cover, and 20 % of plant species recorded (Table 4). As such, all areas had very low naturalness and representativeness, to the extent that the vegetation could not be categorised as an "indigenous ecosystem" using the national classification system of Singers and Rogers (2014).

No nationally or regionally rare/threatened species were detected and the footprint plays a negligible role in ecological connectivity at larger scales. The area, therefore, failed to meet any of the ecological criteria for significance (i.e. representativeness, rarity, distinctiveness, diversity/pattern, ecological context) detailed in Policy HER.2B of the operative Clutha District Plan. Furthermore, the areas affected by the proposed realignment have not been identified by the Clutha District Council as a significant wetland (Table 13.5 of operative Clutha District Plan), or an area of significant habitat of indigenous fauna (Table 13.8 of operative Clutha District Plan). It should also be noted that no regionally significant wetlands, as identified in the Regional Plan: Water are identified as present at the site.

The footprint, however, does occur within a Category 1 Acutely Threatened land environment, and as a result, the area does meet one of the four Ministry for the Environment (2007) criteria for the protection of indigenous vegetation on private land (Table 5). However, given the highly modified nature of the vegetation and its negligible representativeness, this has limited practical application except for the area's potential to be restored, post-development.

Table 5 Vegetation ecological significance assessed against the Clutha District Plan (1998) and the National Priorities for Protection on Private Land (Ministry for the Environment 2007).

Terrestrial Ecology Significance Assessment		
Significance Criteria for Indigenous Vegetation (Clutha District Plan 1998)		
Criteria	*Assessment*	*Comments*
Representativeness	Very low	The vegetation of the areas affected by the proposed realignment (the 'footprint') were highly modified and vegetation structure and composition are dominated by exotic species. Indigenous plant cover is <1%.
Rarity/Distinctiveness	Nil	No rare or threatened plant species, plant communities or ecosystems were detected over the footprint, or are likely to be present.
Diversity/Pattern	Low	Low native plant diversity; moderate exotic plant diversity; low vegetation-habitat diversity. No ecological gradients or patterns were discernible.
Ecological Context	Very low	The footprint does not buffer or connect to any adjacent areas of indigenous terrestrial vegetation.
Significant Wetland (Table 13.5 Clutha District Plan)	No	No wetlands were present. The area is not identified as a significant wetland in Table 13.2 of the Plan.
Area of Significant Habitat of Indigenous Fauna (Table 13.8 Clutha District Plan)	No	The area is not identified as a significant habitat of indigenous fauna in Table 13.8 of the Plan. Note: No formal fauna field assessment has been carried out.
Protecting our Places – National Priorities for Protection on Private Land (MFE 2007)		
Criteria	*Assessment*	*Comments*
National Priority 1: To protect indigenous vegetation associated with land environments (LENZ level IV) that have 20 percent or less remaining in indigenous cover.	Yes	The area occurs over a Category 1 Acutely Threatened land environment where less than 10 % of indigenous vegetation remains.
National Priority 2: To protect indigenous vegetation associated with sand dunes and wetlands.	No	The area does not contain indigenous vegetation associated with sand dunes or wetlands.
National Priority 3: To protect indigenous vegetation associated with 'naturally uncommon' ecosystem types.	No	The area does not comprise a 'naturally uncommon' ecosystem type.
National Priority 4: To protect habitats of acutely and chronically threatened indigenous species.	No	No acutely or chronically threatened indigenous plant species were detected. No formal fauna field assessment has been carried out.

4. Assessment of Environmental effects

4.1 Aquatic environment

4.1.1 Disturbance to the river bed

Much of the river bed in the vicinity of the works is comprised of bedrock, with periphyton cover dominated by didymo and bryophytes. Areas within a few metres of the banks (especially on the true right (western) bank) are likely to be within the varial zone created by flow fluctuations resulting from power generation, which will reduce the likelihood of adverse ecological effects of construction activities, given that this area of the riverbed already has reduced ecological values (reduced macroinvertebrate densities and diversity) and will be dominated by taxa that are tolerant of disturbance (see Sections 3.1.3 & 3.1.4).

In addition, any disturbance to the riverbed will be limited to the duration of construction activities, and recolonization of disturbed areas by periphyton and macroinvertebrates is expected to be rapid.

4.1.2 Temporary structures

During the construction of the bridge, it may be necessary to construct structures to divert water away from/around working areas as well as the construction a temporary trestle bridge to facilitate construction, which will require bed disturbance during installation / removal. There may be some disturbance to the bed during the placement and removal of these structures, but the extent of such disturbance is expected to be limited. There is the potential to strand fish if water is diverted away from or pumped out of previously wetted areas. The risk of fish stranding could be minimised by erecting such temporary structures when flows are low and fish are not present and/or by salvaging any fish present during dewatering.

4.1.3 Potential discharges

Sediment

The works associated with the construction of the proposed new bridge will result in the disturbance of land on both banks of the Clutha River/Mata-Au, which may, under some circumstances, result in sediment entering water. There is also the potential for stormwater run-off during heavy rainfall that may transport sediment from disturbed areas of land and transport this to water.

Fine sediments can have significant negative impact on aquatic life, especially at high concentrations or where they form deposits on the stream bed. High suspended solid concentrations can lead to sedimentation of gill surfaces (of fish and invertebrates), the smothering of eggs or redds (nests), and lead to abrasive damage of skin or respiratory surfaces. Indirect effects include changes in invertebrate prey resulting from sedimentation of substrates.

Suspended sediment can also lead to changes in the clarity and colour of receiving waters, with flow-on effects on ecosystems. For example, reduced water clarity can reduce the effective feeding range of trout and juvenile salmon by reducing their ability to see and intercept prey. Changes in clarity and water colour can also reduce light penetration, which can affect the depth range of macrophytes and periphyton. The community in the vicinity of the works includes species that are known to be sensitive to fine sediments, including macroinvertebrates such as the common mayfly *Deleatidium* which was among the most abundant taxa at most sites surveyed by Ludgate & Ryder (2014), and many of the fish recorded from or likely to be present in the vicinity of the works are also expected to be sensitive to high levels of suspended sediment/turbidity.

Rowe *et al.* (2004) determined the maximum turbidity levels that could be tolerated by four native fish species over a 24-hour period. Of the species likely to be found in the Clutha River/Mata-Au in the vicinity of the proposed works, only smelt were considered by Rowe *et al.* (2004), with 50% mortality rates for smelt ranging from 1,700 to 3,000 NTU. However, the turbidity resulting from the activities associated with the construction of the new Beaumont bridge are unlikely to reach such levels.

Rowe (2008) also provided a brief overview of effects of suspended sediment levels on salmonids. He noted studies where juvenile chinook salmon, exposed to a suspended sediment concentration of 1,400 g/m^3 over 36 hours, incurred a 10% mortality rate, 50% mortality at an exposure of 9,400 g/m^3 and 90% mortality at 39,000 g/m^3 exposure (Newcomb & Flagg 1983). Rowe (2008) also noted a study where feeding rates of juvenile chinook salmon were not reduced by turbidities of up to 320 NTU (approximately 350 g/m^3 suspended solids) (Gregory and Northcote 1993), and migratory adult salmon still homed to their natal stream despite exposure to suspended solids levels of 650 g/m^3 (Whitman *et al.* 1982, cited in Rowe 2008). As stated above, the levels of turbidity expected resulting from the activities associated with the construction of the new Beaumont bridge are unlikely to reach such levels.

Given the very large volume of flow in the Clutha River/Mata-Au (see Section 3.1), the water velocities and the natural sediment load and low water clarity of the lower Clutha River/Mata-Au, the effects of the inputs of sediments from activities associated with the construction of the new bridge are expected to be short-lived and less than minor. Any potential effects of sediment discharge on incubating ova or alevin[4] from spawning that may have occurred in close proximity to the proposed works could be avoided by undertaking works outside of the main spawning and incubation period for brown trout and salmon in the Clutha River/Mata-Au (April-September), however, it is arguable that such a restriction is not necessary given the expectation that the effect of any discharge

[4] Alevin are newly hatched larval trout that still have a yolk sac attached.

is expected to be short-lived and less than minor.

The Regional Plan: Water (RPW) prohibits the discharge of sediment from disturbed land to any waterbody <u>where no measure is taken to mitigate sediment runoff</u> (Rule 12.C.0.3). The discharges of fine sediment should be minimised by limiting the amount of disturbance of the bed or banks of the Clutha River/Mata-Au and by using sediment controls that comply with good management practices, such as those outlined in Auckland Council's erosion and sediment control guideline document (Leersnyder *et al*. 2018).

Rule 12.C.1.1(d)(i) of the Regional Plan Water makes it a permitted activity to discharge sediment to water providing the discharge does not result in a conspicuous change in colour or visual clarity; or a noticeable increase in local sedimentation, in the receiving water. The phrase "conspicuous change" is somewhat ambiguous, although Ministry for the Environment (1994) goes some way to defining what would constitute a "conspicuous change" in clarity, with a 20% reduction in clarity likely to be noticed by the casual observer.

It is possible that in the event of heavy rainfall, sediment discharges from areas disturbed as part of the proposed works will result in a conspicuous change in visual clarity in the Clutha River/Mata-Au, although such discolouration is expected to be localised. Therefore, there is a risk that they would not comply with the permitted activity rule and consent for any such discharges should be sought. However, given the very large flow in the Clutha River/Mata-Au in the vicinity of the works, the relatively low existing water clarity particularly during flood events (which are likely to be associated with heavy rainfall) (see Section 3.1.2), the limited duration and extent of the proposed works, the effects of such discharges are not expected to be more than minor.

Concrete works

Construction of the bridge is likely to include the use of concrete in close proximity to water. Concrete and wastewater from concrete are very toxic to aquatic life, largely due to their alkalinity (pH 12-13) (Auckland Regional Council, undated), which can cause burns to fish and can kill aquatic life. Given the very large volume of flow in the Clutha River/Mata-Au (see Section 3.1), any discharge is expected to be quickly diluted and/or buffered, meaning that any effect of the discharge of concrete or concrete water is expected to be extremely localised and limited. In any case, all steps should be taken to avoid concrete or concrete wastewater from entering water and any water that seeps from the boxing during curing of the concrete should be disposed of onto a grassy area away from waterbodies or pumped into storage containers and removed from the site and disposed of appropriately elsewhere away from watercourses.

Other potential discharges

Without appropriate environmental management plans, the presence of construction machinery presents a risk of contaminants (e.g. diesel, lubricants) entering watercourses with the potential to harm aquatic life. This matter can be appropriately addressed by way of an appropriate on-site contaminant management plan. Any possible contaminants stored on site should be kept away from watercourses, bunded and stored in appropriate containers (e.g. double skinned tanks). Refuelling of machinery should also take place away from watercourses.

Run off from the new bridge will be captured on the bridge and then discharged to land on the eastern bank. There is the potential stormwater may then find its way to the Clutha River/Mata-Au. The main contaminant likely to be present in such stormwater is sediment, although it may also contain other contaminants present in road run-off (such as PAHs, metals). It is difficult to quantify the effects of this, as disposal of this stormwater to land will result in a level of retention of these contaminants in vegetation and soils prior to it entering water. However, given the very large flow in the Clutha River/Mata-Au, the relatively low existing water clarity particularly during flood events (which are likely to be associated with heavy rainfall) (see Section 3.1.2), the effects of such discharges are expected to be no more than minor.

4.1.4 Nuisance weed/algae introduction

Machinery and personnel involved in construction could potentially transfer nuisance weeds/algae to local watercourses. Didymo is currently present in the Clutha River/Mata-Au in the vicinity of the works and it is likely that the invasive oxygen weeds *Elodea canadensis* and *Lagarosiphon major* are also present. Despite this, it is recommended that equipment and other items are first inspected and if necessary cleaned prior to work being undertaken to prevent the introduction of any other nuisance species.

In addition, it is recommended that equipment and other items are inspected and cleaned prior to moving them from the worksite to any other waterway to prevent the species known/suspected to be present in the vicinity of Beaumont Bridge being spread to other waterways.

4.2 Terrestrial ecology

4.2.1 Terrestrial Vegetation and Avifauna

The effects of the proposed realignment are predicted here to have only a negligible impact on indigenous vegetation of the footprint; this negligible effect due to the scale of the effects and the limited existing natural values over the footprint. The footprint consisted of roadside verges, improved pasture grassland and riparian vegetation; all of which had very low ecological values locally, and also low value when the wider context was considered. The overall loss of indigenous plant species will be minimal, as the larger plants present (e.g. flax, toetoe, *Coprosma crassifolia*, totara and *Pittosporum tenuifolium*) are represented by 1-3 individuals at most; these losses can easily be offset with planting, post-development. The only conspicuous losses within the pasture grassland areas will be one large macrocarpa (*Cupressus macrocarpa**) and a small adjacent totara (*Podocarpus totara*) from the paddock on the eastern side of the Clutha River (Figure 12). In addition, approximately 12 crack willow* could be removed from the riparian areas. These localised losses represent a loss of potential roosting habitat or shelter for riverine birds such as grey teal or black shags. It is not known, however, how often these birds are present within the footprint (none were sighted at the time of the vegetation survey); and similar habitat exists for many kilometres upstream and downstream of the footprint.

4.2.2 Nuisance weed introductions - terrestrial

Existing weeds of the footprint include convolvulus*, blackberry*, periwinkle (*Vinca major**), pampas*, sycamore (*Acer pseudoplatanus**), silver birch (*Betula pendula**), khasia berry*, hawthorn*, Scotch broom*, Eucalyptus sp.*, apple (*Malus x domestica**), grey willow (*Salix cinerea**), crack willow*, elderberry (*Sambucus nigra**) and gorse*. Many of these species are environmental weeds of riparian zones, native and exotic shrublands, and regenerating forest; and are already present or naturalised within, or in close proximity, to the footprint. Gorse and broom are currently uncommon in the riparian areas of the footprint. An increase in these two species, locally, could impact on recreational use of the river and environs for swimming and cycling; gorse and broom should be controlled if disturbance during construction causes an expansion in their distribution.

Because the existing vegetation values of the footprint are very low, all of these weeds are not considered to pose a significant threat to the existing vegetation of the footprint. That said, the potential impact from any new weed introductions (i.e. those inadvertently introduced on machinery) as a result of the bridge realignment should be assessed on an individual basis e.g. buddleia (*Buddleja davidii*).

5. Conclusions

5.1 Aquatic ecology

The Clutha River/Mata-Au in the vicinity of the proposed works supports high aquatic ecological values including a regionally significant trout and salmon fishery (Otago Fish & Game Council 2015).

Any effects of the proposed works are expected to be short-lived, localised and should be viewed in the context of the environment affected – the Clutha River/Mata-Au is a very large river (mean flow of 614 m^3/s) meaning that it has a very high capacity to dilute and disperse any contaminants (particularly sediment) that may enter it. However, sediment control measures are necessary to ensure that the activity is not prohibited by Rule 12.C.0.3 of the Regional Plan: Water for Otago and such measures should comply with good management practices, such as those outlined in Auckland Council's erosion and sediment control guideline document (Leersnyder *et al*. 2018). Concrete water is highly toxic to aquatic life and steps should be taken to avoid uncured concrete or concrete water from entering water. The risks associated with other contaminants are low provided appropriate steps are taken to avoid or minimise the risk of these entering water in the case of a spill.

Much of the area of the bed of the Clutha River/Mata-Au potentially affected by the proposal is within the varial zone, the area affected by fluctuations in water level resulting from hydroelectric power generation at Roxburgh Dam. These short-term flow fluctuations adversely affect aquatic communities in the area subject to periodic wetting and drying, resulting in reduced macroinvertebrate densities and diversity and reduced habitat value for fish. As a result, the effects of bed disturbance associated with the proposed works are expected to be no more than minor.

It may be necessary to install temporary structures to divert water away from areas while works are undertaken. The disturbance of the bed associated with this is expected to be minor given the large flow in the Clutha River/Mata-Au and the fact that most areas likely to be affected will be within the varial zone. However, there is a risk of fish stranding if these temporary diversions result in the dewatering of previously wetted areas. This risk could be minimised by undertaking such diversions during low flows. If this is not possible, fish could be salvaged from affected areas during dewatering. Given the small footprint of the areas expected to be affected by such activities and that they largely occur within the varial zone, such effects are expected to be minor.

5.2 Terrestrial ecology

The areas affected by the proposed realignment consisted of small areas of crack willow in riparian areas; improved pasture grassland and roadside vegetation. The flora was typical of such areas, being dominated by exotic grasses and herbs with a scattering of mainly introduced trees and shrubs. Indigenous plants were scarce and comprised <1% of the total cover. No nationally/regionally threatened or at-risk plant species were detected. Casual observations of avifauna recorded primarily exotic bird species and no lizard survey was conducted, meaning significance assessments were vegetation-centric.

All areas affected by the proposed bridge realignment had very low ecological values, and do not play a major role in facilitating connectivity with the surrounding landscape. The footprint, as a consequence, failed to meet any of the ecological criteria for significance outlined in the Clutha District Plan. Furthermore, the footprint has not been identified by the Clutha District Council as a significant wetland or a significant habitat of indigenous fauna. The footprint area does occur within a Category 1 Acutely Threatened land environment, but given the highly modified nature of the vegetation and its negligible representativeness, the only implication is the importance of the site should it be appropriately restored, post development. At the very least, any indigenous trees, *Coprosma crassifolia* and *Phormium tenax* (flax) removed for the development should be replaced using ecologically appropriate plants, at a ratio of 1 removed, 5 planted. The planting of indigenous plants should be guided by a Planting Plan that also details the on-going maintenance schedule (and replacement of dead plants if necessary) required until plants are established. As well as planting of indigenous plants, the removal of crack willow, grey willow and pampas grass from riparian areas immediately above and below the new bridge, would improve the aesthetics and naturalness of the area. Management of weeds, particularly crack willow, will likely be the main ongoing issue.

Apart from the localised loss of potential roosting habitat and shelter for riverine birds, the very limited existing natural values of the footprint mean that the actual and potential impacts on indigenous flora or fauna locally, will be negligible.

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Appendix A Macroinvertebrate data

Table A1 *Macroinvertebrate community composition at three sites in the Clutha River/Mata-Au from Ludgate & Ryder 2014).*

TAXON	MCI score	Beaumont mean	Beaumont SE	Rongahere Road mean	Rongahere Road SE	Bernards Beach mean	Bernards Beach SE
COLEOPTERA							
Elmidae	6	0.0	0.0	0.2	0.2	0.0	0.0
CRUSTACEA							
Paracalliope fluviatilis	5	0.0	0.0	0.0	0.0	0.2	0.2
DIPTERA							
Austrosimulium species	3	0.2	0.2	0.2	0.2	0.0	0.0
Empididae	3	2.2	1.2	0.0	0.0	4.8	2.3
Maoridiamesa species	3	5.6	2.1	0.2	0.2	5.6	3.0
Orthocladiinae	2	254.6	63.8	9.6	1.8	648.6	346.5
Tanytarsini	3	174.4	29.4	5.6	1.4	393.4	176.4
EPHEMEROPTERA							
Austroclima species	9	0.4	0.4	0.0	0.0	0.0	0.0
Deleatidium species	8	380.4	50.5	178.4	15.9	54.2	12.6
HEMIPTERA							
Unidentified Hemipteran	5	0.2	0.2	0.0	0.0	0.0	0.0
MEGALOPTERA							
Archichauliodes diversus	7	0.0	0.0	0.0	0.0	0.2	0.2
MOLLUSCA							
Physa / Physella species	3	0.2	0.2	0.0	0.0	0.0	0.0
Potamopyrgus antipodarum	4	24.6	2.8	15.6	7.5	89.4	13.8
OLIGOCHAETA	1	44.2	4.9	13.6	2.0	103.2	51.5
PLATYHELMINTHES	3	0.2	0.2	1.4	0.6	16.8	8.4
PLECOPTERA							
Zelandobius species	5	5.0	1.8	0.4	0.2	9.6	3.9
TRICHOPTERA							
Aoteapsyche species	4	1.8	1.6	3.4	1.5	1.4	0.7
Helicopsyche species	10	0.2	0.2	0.0	0.0	0.0	0.0
Hudsonema amabile	6	1.4	0.5	0.6	0.2	8.2	4.0
Hydrobiosidae early instar	5	0.0	0.0	0.0	0.0	0.4	0.2
Hydrobiosis clavigera group	5	0.2	0.2	0.0	0.0	0.0	0.0
Hydrobiosis species	5	0.6	0.6	0.0	0.0	0.2	0.2
Hydrobiosis umbripennis group	5	0.0	0.0	0.0	0.0	1.0	0.8
Neurochorema species	6	5.2	2.4	0.4	0.2	1.8	1.1
Oxyethira albiceps	2	6.0	3.1	0.4	0.2	18.4	4.4
Psilochorema species	8	0.8	0.4	1.2	0.8	0.4	0.2
Pycnocentria species	7	24.2	6.0	0.2	0.2	35.8	8.0
Pycnocentrodes species	5	70.8	15.9	1.6	0.5	114.6	19.7
Number of invertebrates (per sample)		1003.4	90.0	233.0	27.4	1508.2	573.9
Number of invertebrates (per m2)		11148.9	1000.3	2588.9	305.0	16757.8	6376.5
Number of taxa		14.8	0.5	10.2	1.0	15.4	0.7
Number of EPT taxa		8.6	0.6	5.0	0.6	8.6	0.7
% EPT taxa		57.9	2.8	48.5	3.2	55.5	3.1
% EPT		50.3	6.3	81.4	3.0	25.1	6.9
MCI score		90.4	1.6	83.8	3.0	86.4	2.8
QMCI score		4.88	0.29	6.86	0.13	3.34	0.30

Appendix B List of plant species in the footprint of the proposed realignment

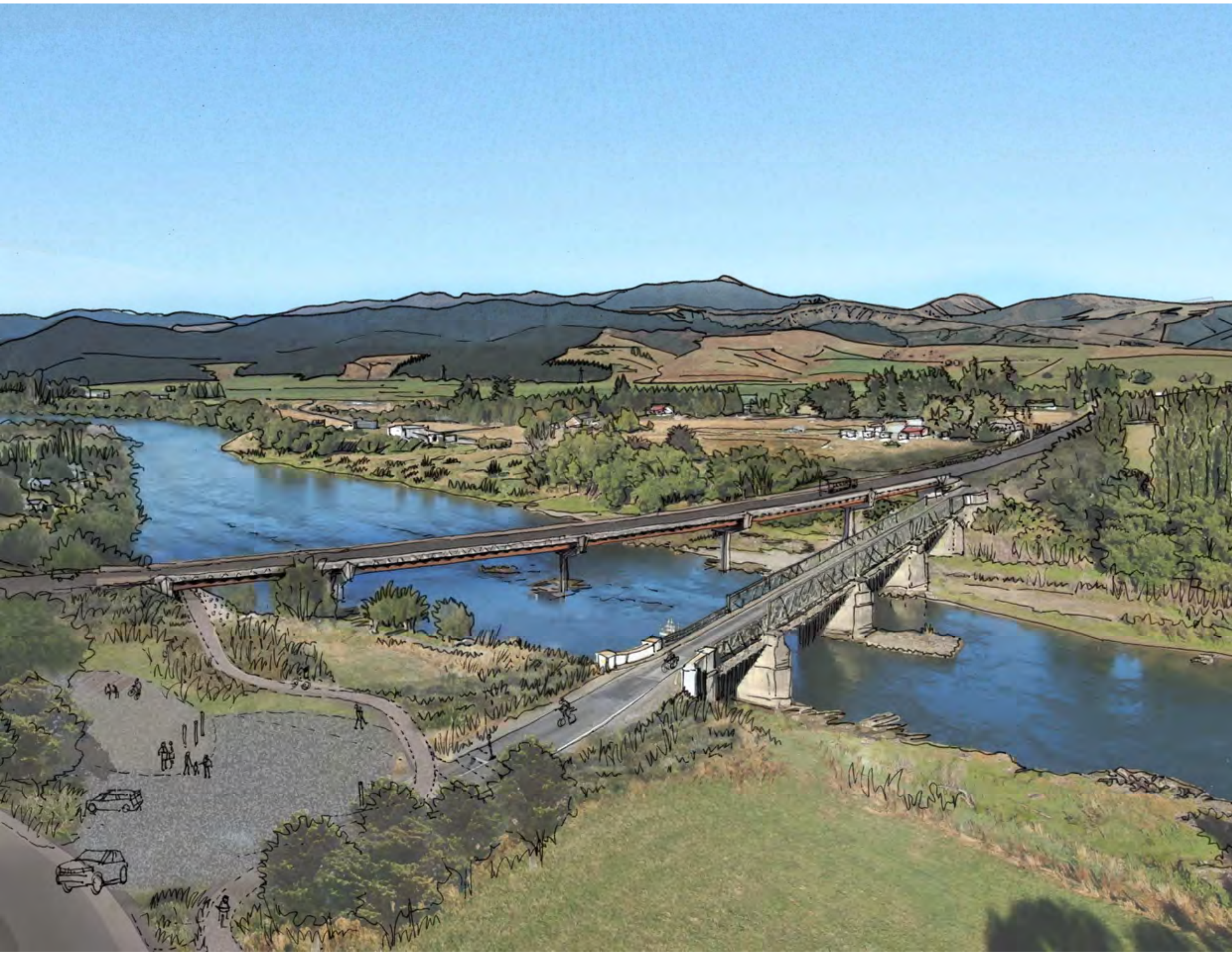
** denotes introduced species.*

Life form	Species Name	Common Name
Climber/Scrambler	*Convolvulus arvensis**	Convolvulus
Climber/Scrambler	*Muehlenbeckia australis*	pohuehue
Climber/Scrambler	*Rubus fruticosus**	blackberry
Climber/Scrambler	*Vinca major**	periwinkle
Fern	*Blechnum penna-marina*	alpine fern, little hard fern
Fern	*Polystichum vestitum*	puniu, prickly shield fern
Fern	*Pteridium esculentum*	aruhe, bracken
Grass	*Agrostis capillaris**	brown top
Grass	*Agrostis stolonifera**	creeping bent
Grass	*Anthoxanthus odoratum**	sweet vernal
Grass	*Cynosorus cristatus**	crested dogstail
Grass	*Dactylis glomerata**	cocksfoot
Grass	*Festuca rubra**	red fescue
Grass	*Holcus lanatus**	Yorkshire fog
Grass	*Hordeum vulgare**	barley
Grass	*Lolium perenne**	perennial ryegrass
Grass	*Phleum pratense**	timothy
Grass	*Schedonorus arundinaceus**	tall fescue
Herb	*Achillea millefolium**	yarrow
Herb	*Callitriche stagnalis**	starwort
Herb	*Cardamine deblis*	NZ bitter cress
Herb	*Cerastium fontanum**	mouse ear chickweed
Herb	*Cirsium arvense**	Californian thistle
Herb	*Cirsium vulgare**	Scotch thistle
Herb	*Conium maculatum**	hemlock
Herb	*Crepis capillaris**	hawksbeard
Herb	*Digitalis purpurea**	fox glove
Herb	*Epilobium ciliatum**	a willow herb
Herb	*Galium palustre**	a cleaver
Herb	*Galium perpusillum*	a cleaver
Herb	*Hydrocotyle heteromeria*	a penny wort
Herb	*Hydrocotyle moschata*	a penny wort
Herb	*Hydrocotyle novae-zelandiae*	a penny-wort
Herb	*Hypochoeris radicata**	catsear
Herb	*Jacobaea vulgaris**	ragwort
Herb	*Lotus pedunculatus**	birdsfoot trefoil
Herb	*Medicago sativa**	Lucerne
Herb	*Montia fontana*	Blinkswater chickweed, dwarf montia
Herb	*Mycelis muralis**	wall lettuce
Herb	*Persicaria maculosa**	willow weed
Herb	*Plantago lanceolata**	narrow leaved plantain
Herb	*Plantago major**	broad-leaved plantain
Herb	*Polygonum aviculare**	wireweed

Life form	Species Name	Common Name
Herb	*Prunella vulgaris**	selfheal
Herb	*Ranunculus repens**	creeping buttercup
Herb	*Rumex acetosella**	sheeps sorrel
Herb	*Rumex obtusifolius**	broad-leaved dock
Herb	*Solanum nigrum**	black nightshade
Herb	*Sonchus oleraceus**	sow thistle
Herb	*Stellaria media**	chickweed
Herb	*Taraxacum officinale agg. **	dandelion
Herb	*Trifolium dubium**	suckling clover
Herb	*Trifolium pratense**	red clover
Herb	*Trifolium repens**	white clover
Herb	*Verbascum thapsis**	woolly mullein
Herb	*Vicia sativa**	vetch
Monocot	*Cortaderia sp.**	pampas
Monocot	*Phormium tenax*	NZ flax
Rush/Sedge	*Eleocharis acuta*	sharp spike sedge
Rush/Sedge	*Juncus articulatus**	jointed rush
Rush/Sedge	*Juncus bufonius**	toad rush
Rush/Sedge	*Juncus edgariae*	wiwi, Edgar's rush
Rush/Sedge	*Juncus effusus**	
Tree/Shrub	*Acer pseudoplatanus**	sycamore
Tree/Shrub	*Betula pendula**	silver birch
Tree/Shrub	*Coprosma crassifolia*	
Tree/Shrub	*Cotoneaster simsonii**	khasia berry
Tree/Shrub	*Crataegus monogyna**	hawthorn
Tree/Shrub	*Cupressus macrocarpa**	macrocarpa
Tree/Shrub	*Cytisus scoparius**	broom
Tree/Shrub	*Eucalyptus sp.**	a gum tree
Tree/Shrub	*Juglans regia**	walnut
Tree/Shrub	*Malus x domestica**	apple
Tree/Shrub	*Pittosporum tenuifolium*	kohuhu
Tree/Shrub	*Podocarpus totara*	totara
Tree/Shrub	*Quercus* sp.*	English oak
Tree/Shrub	*Salix cinerea**	grey willow
Tree/Shrub	*Salix fragilis**	crack willow
Tree/Shrub	*Sambucus nigra**	elderberry
Tree/Shrub	*Ulex europaeus**	gorse

New Beaumont Bridge

Preliminary Site Investigation



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Report Checklist

Summary contaminated sites report checklist					
Report contained in this document	☒	☐	☐	☐	☐
Report sections and information to be presented	**PSI**	**DSI**	**RAP**	**SVR**	**MMP**
Executive summary	☒	☐	☐	☐	☐
Scope of work	☒	☐	☐	☐	☐
Site identification	☒	☐	☐	☐	☐
Site history	☒	S	S	S	S
Site condition and surrounding environment	☒	S	S	S	S
Geology and hydrology	A	☐	S	S	S
Sampling and analysis plan and sampling methodology	A	☐	X	☐	☐
Field quality assurance and quality control (QA/QC)	N	☐	X	☐	S
Laboratory QA/QC	N	☐	X	☐	X
QA/QC data evaluation	N	☐	X	☐	X
Basis for guideline values	☒	☐	☐	☐	☐
Results	A	☐	☐	☐	S
Site characterisation	☒	☐	☐	☐	☐
Remedial actions	X	X	☐	S	S
Validation	X	X	X	☐	S
Contaminated materials management plan (CMMP)	X	X	☐	S	S
Ongoing site monitoring	X	X	X	N	☐
Conclusions and recommendations	☒	☐	☐	☐	☐

<u>Key:</u>

PSI - preliminary site investigation report SIR detailed site investigation report
RAP - site remedial action plan
SVR - site validation report
MMP - ongoing monitoring and management plan
A - Readily available information should be included
S - A summary of this section's details will be adequate if detailed information has been included in an available referenced report
N - Include only if no further site investigation is to be undertaken
X - Not applicable and can be omitted.

(MfE. *Contaminated Land management guidelines No. 1*. 2011a)

Contents

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Executive Summary

This executive summary presents the salient points of the report only and should not be referred to in isolation from the content of the whole report.

	Summary
Introduction	A Preliminary Site Investigation has been undertaken on behalf of NZTA (New Zealand Traffic Agency) for a site at the Beaumont Bridge, State Highway 8 (SH8), Beaumont, Clutha District (herein referred to as 'the site') in order to assess the potential for contamination to be present on the site. The site is located at the Beaumont Bridge (including the immediate area to the east and west of the current road bridge), State Highway 8, Clutha District and includes the surrounding area to the east and west of the current road bridge. This PSI has been commissioned as part of the realignment and replacement of the existing Beaumont Road Bridge.
Proposed Development	We understand the development of the site will the construction of a new bridge and realignment of the existing highway and Clutha Gold Trail Cycleway.
Environmental Setting	• The western and eastern banks of the River are underlain by the Late Pleistocene River Deposits; and • The eastern part of the site is underlain by Undifferentiated Caples terrane TZIII. • The Clutha River/Mata-au flows south through the centre of the site; • There is not a known aquifer beneath the site, but the area is considered sensitive
Site details	• Historical Māori presence in the area from the 13th century; • European use from 1853 with establishment of a township and gold mining from 1860's; • Gold dredging was ongoing from 1890's until 1930's goldrush; • Current Beaumont bridge was opened in 1887; • Railway was established in 1905 and closed in 1968; • Currently the site is pasture/farmland or reserve • Historical activities include an orchard to the north west and a sheep dip/drench to the south west of the proposed realignment; • The area to the west of the site comprises the Beaumont township with predominantly pasture/farmland surrounding that; and • No obvious signs of vegetation dieback were noted in any location across the site.
Discussion	It is considered more likely than not that the risks to human health associated with the development identified on the site, based on an industrial/commercial end use is **LOW**. As such, it is considered **highly unlikely** that there will be a risk to human health associated with the proposed development.

	Summary
Conclusions	The conceptual site model and initial qualitative human health risk assessment presented herein are based upon information gained from a site inspection, anecdotal evidence, information gained from CDC and other sources, to determine the chemical characteristics of determined contaminants of concern. The site identified in this investigation has been triggered under the NES as a result of a proposed development. The site history, anecdotal evidence, historical aerial photography and site inspections have identified that there is low potential risk of having contaminated the proposed development area on the basis of an industrial/commercial end use. On this basis, the risk to human health associated with the potential contaminants identified during this PSI for the site is considered to be **LOW**. This Preliminary Site Investigation identifies that on the proposed development area of the site it is **highly unlikely** that there is a risk to human health should the proposed land use change be undertaken. Any land use change and associated ground disturbance within this area is considered a permitted activity.
Recommendations	• Should any items or strata of potential archaeological interest be encountered an archaeologist should be consulted and the relevant authorities informed; • Should any ground conditions be encountered across the site which are not anticipated from the findings of this report a Suitably Qualified and Experienced Practitioner (SQEP) should be consulted in order to reassess the risks to human health; • This Preliminary Site Investigation report is submitted to the consenting authority; and • This Preliminary Site Investigation report is submitted to the regional authority in to facilitate updating the HAIL database.

1 Introduction

1.1 Background

A Preliminary Site Investigation has been undertaken on behalf of NZTA (New Zealand Traffic Agency) for a site at the Beaumont Bridge, State Highway 8 (SH8), Clutha District (herein referred to as 'the site') in order to assess the potential for contamination to be present on the site.

The site is located at the Beaumont, State Highway 8, Clutha District and includes the surrounding area to the east and west of the current road bridge. This PSI has been commissioned as part of the realignment and replacement of the existing Beaumont Road Bridge.

1.2 Purpose of this Report

Preparation of a PSI under the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (NESCS) Regulations (2011) will provide information as to whether soil contamination from potential HAIL activities are likely to be present and if so whether they are at levels that could adversely impact human health.

This PSI report will address these requirements in relation to any resource consent application in order to satisfy CDC's requirements under the NESCS Regulations 2011 relating to human health impacts from potentially contaminated land.

Part of the site is currently a working farm with livestock located in a paddock to the eastern bank downstream of the current bridge.

As such the following objectives have been identified:

- Assess the current site condition and its surrounding environment;
- Determine whether HAIL activities have occurred;
- Assess the risks to human health associated with these activities; and
- Characterisation of the site in line with NES guidance giving recommendations of remedial options should they be required.

1.3 Scope of Work

This Report will be prepared in general accordance with the requirements for a PSI referred to in the Users' Guide: National Environment Standard for Assessing and Managing Contaminants in Soil to Protect Human Health, Ministry for the Environment, April 2012 (NESCS Users' Guide) and the Ministry for the Environment's Contaminated Land Management Guideline No.1: Reporting on Contaminated Sites in New Zealand (MfE CLMG #1).

The PSI is likely to include the following:

- A site walkover to assess the current site condition and its surrounding environment;
- Discussions with current and previous site owners if possible;
- An assessment of historical information relating to the site and its surroundings (this may be from documented or anecdotal evidence), including the review of historical aerial photographs;
- A review of information relating to resource consents, geological conditions and hydrology of the site;
- An assessment of existing analytical information regarding soil quality from nearby investigations undertaken by ourselves and from other publicly available sources;

- A review of local authority records and searches of the Otago Regional Council's (ORC's) contaminated land register; and
- Site characterisation indicating the potential health and environmental risks associated with the site, along with recommendations for further work should it be deemed necessary.

The PSI will be presented in the form of a written report reviewed by a Suitably Qualified and Experienced Practitioner (SQEP), as required by the NESCS Regulations 2011.

2 Environmental Setting

2.1 Site Identification

The site is located at Beaumont Bridge SH8, approximately 34.75km southeast of Roxburgh town centre as shown on Figure 1 below. Site details are provided in Table 1.

Table 1: Site Identification

Site Address	Section 4 SO Plan 23609		Section 2 SO Plan 23610		Section 4 SO Plan 23610	
Territorial Authority	Clutha District Council (CDC)					
Legal Description	Section 4 Survey Office Plan 23609		Section 2 Survey Office Plan 23610		Section 4 Survey Office Plan 23610	
Titles	OB/673T		OT14B/688		OT14B/689	
Valuation No.	28607-01100		28603-00100		28603-01800	
Owner	Alexander Trevor Peters Karen Ann Peters Fairfield Trustees No 3 Limited		Dale Clifford Mitchell Jennifer Anne Mitchell		Dale Clifford Mitchell Jennifer Anne Mitchell	
Approximate total site area	3000m^3	0.3ha	10700m^3	1.07ha	76289m^3	7.6289ha
NES Permitted Activity threshold volumes: 1) disturbance, and 2) yearly off-site movement of soil based on the approximate parcel area	1) 150m^3 2) 30m^3		1) 535m^3 2) 107m^3		1) 3814.45m^3 2) 762.89m^3	

A Quickmap diagram detailing the current legal site boundaries, and appellations of properties nearby are shown in Figure 2 along with the approximate location of the site under investigation.

A current site layout plan is attached as Appendix A, with photographs taken during the site investigation presented in Appendix E.

Figure 1: Site Location Plan

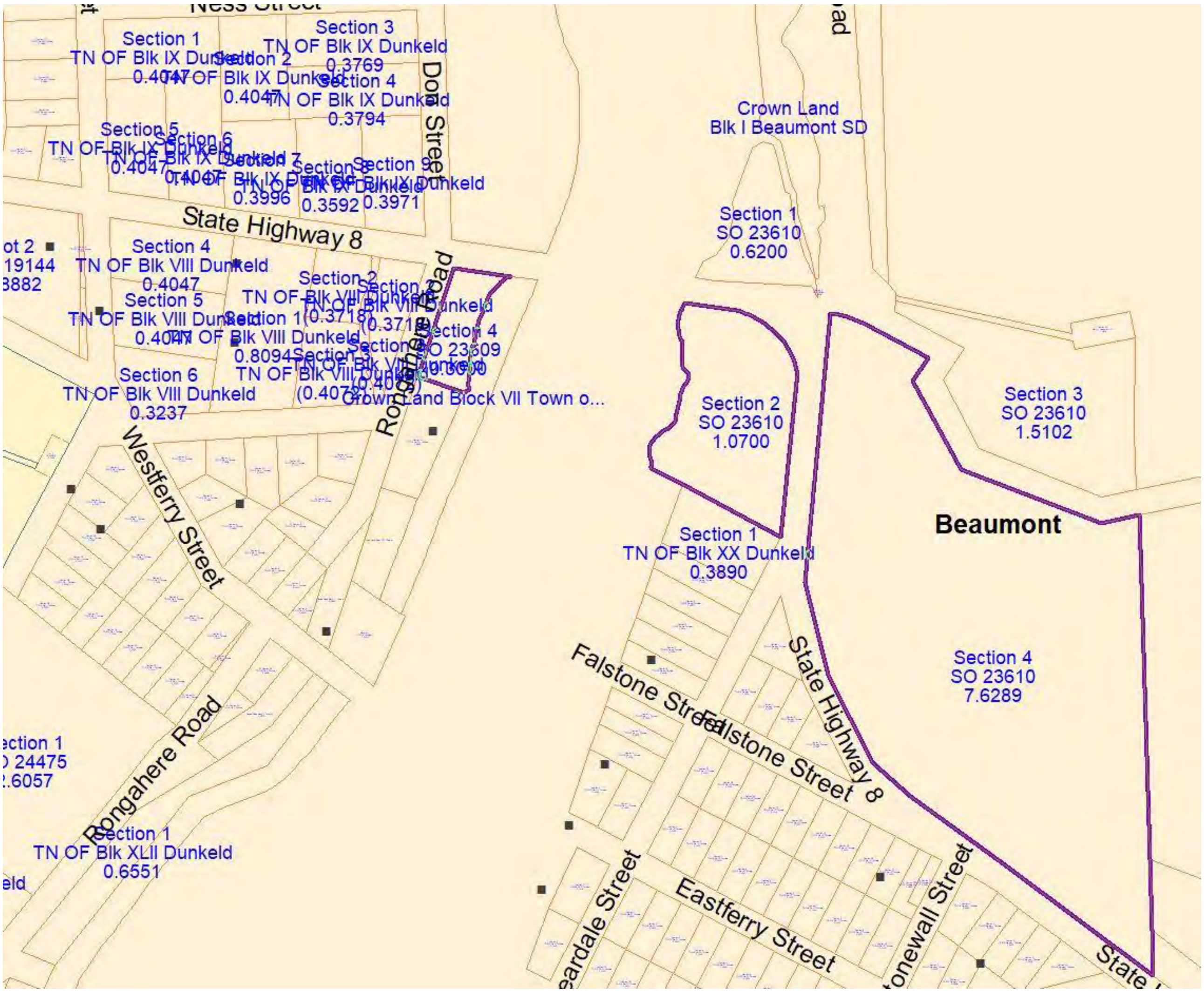


Figure 2: Quickmap of Site and Surrounds

2.2 Geology

The geology of the site is shown on the 1:250,000 scale GNS Geology Web Map extract (accessed February 2019) as shown in Figure 3 below.

This map indicates the western and eastern banks of Clutha River are underlain by the Late Pleistocene River Deposits commonly comprising sandy greywacke gravel overlain by loess; schist-greywacke-quartz sandy gravel in the Clutha catchment. The eastern part of the site is underlain by Undifferentiated Caples terrane TZIII Schist; a well foliated psammitic and pelitic schist with incipient segregation; minor greenschist and metachert; quartz veins common; TZ3[1].

A review of the GNS Active Faults Database indicates that the nearest active fault, the normal Tuapeka Fault, lies approximately 40m southwest of the site, as shown in Figure 3. No other information is known about this fault.

Figure 3: Extract from GNS Active Faults Database

2.2.1 Natural Hazards Database Report

The Otago Regional Council's Natural Hazards Database was used to produce two reports (one pertaining to the east bank of Clutha River the other detailing the west bank) relevant

[1] http://data.gns.cri.nz/geology/

hazard information with specific relation to the site. This report is presented within Appendix C.

Of the 10 hazards that the report looks at the highest risk to the site appears to be that of liquefaction. The seismic liquefaction map; for the west bank Figure 5, and the east bank Figure 6 shows that the parts of the site that are underlain by late Pleistocene River Deposits are possibly susceptible to liquefaction.

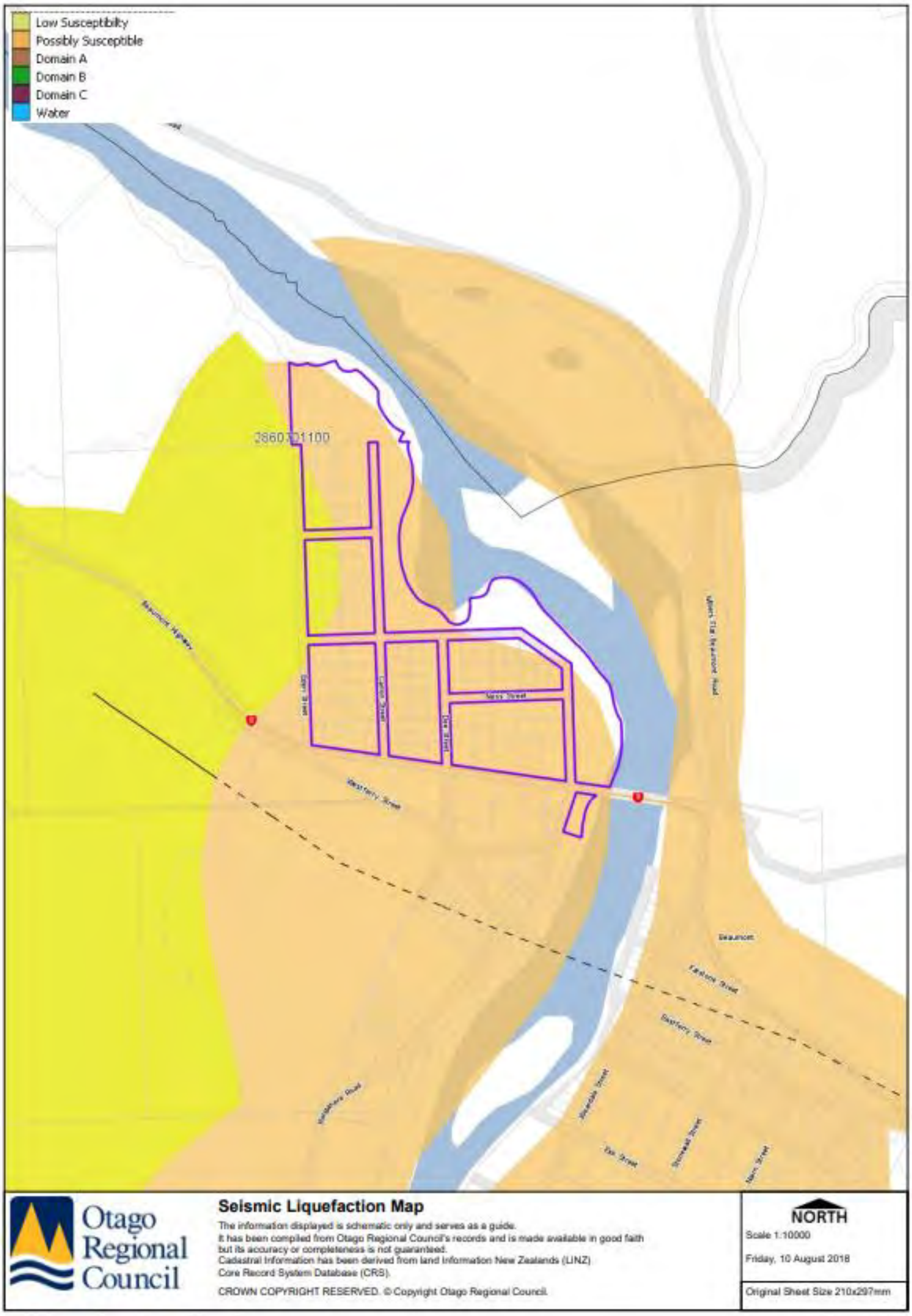


Figure 4: Seismic Liquefaction Map; West Bank Natural Hazards Database Report

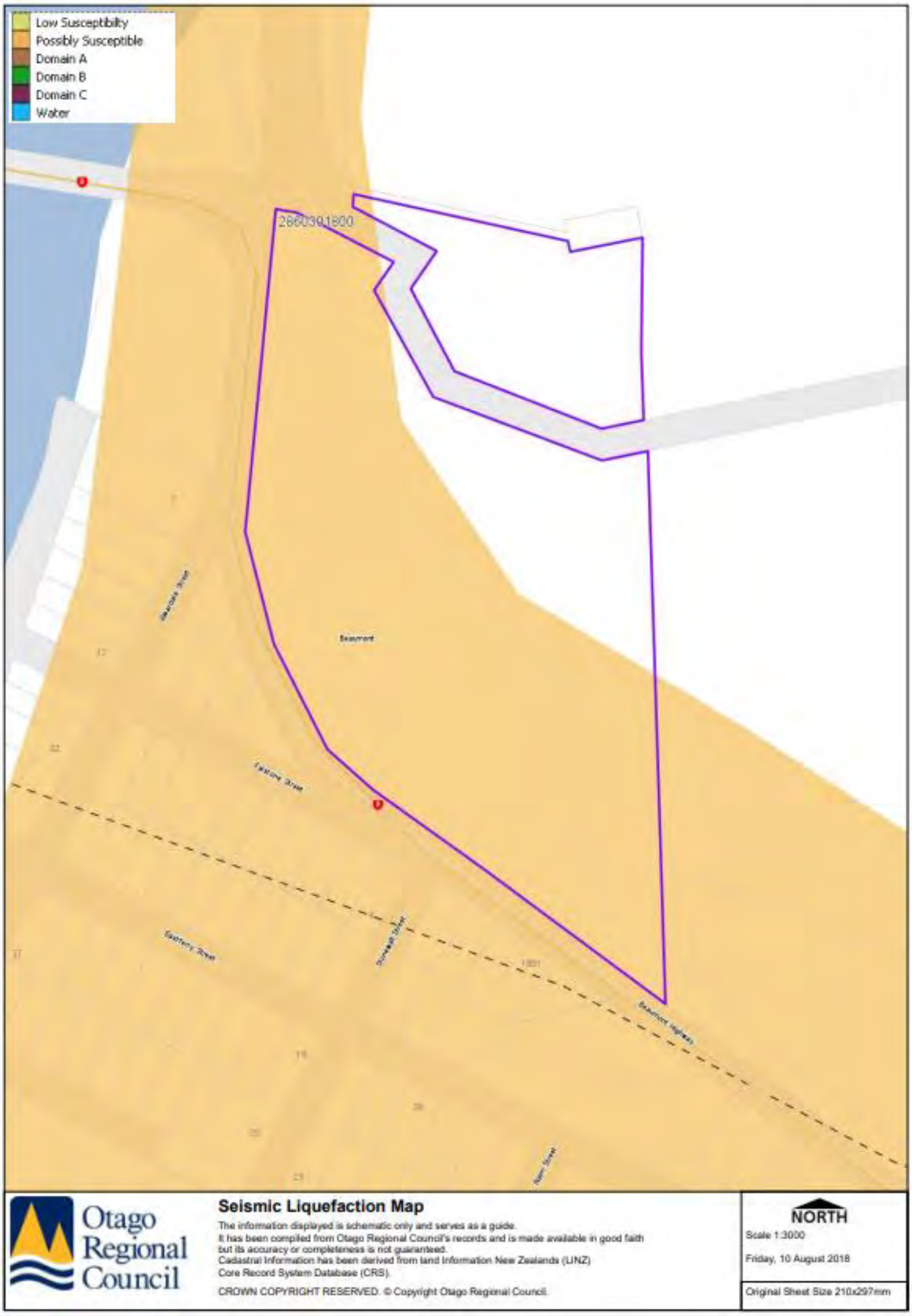


Figure 5: Seismic Liquefaction Map; East Bank Natural Hazards Database Report

2.3 Hydrology and Hydrogeology

Details of the site hydrology and hydrogeology have been gained from a review of sources including Google Earth, Grow Otago[2] and a search of council records.

Table 2: Summary of Hydrological and Hydrogeological Data

Nearest Surface Water Body	Clutha River / Mata Au passes through the centre of the site
General flow Direction	South
Groundwater Status	The area is not considered to be part of a known aquifer
No. of known Boreholes and wells within 500m[3]	2
Annual Median Rainfall	850mm/yr
Median Annual Potential Evaporation	520mm/yr

2.3.1 Groundwater Sensitivity Assessment

The site is not located on a named aquifer, however there are two borehole wells within 500m of the site. The nearest surface water body, is the Clutha/ Mata Au River running through the centre of the site.

The site area is considered to be in a sensitive ground water catchment zone due to the location of the Clutha Mata Au River in addition to the known boreholes and wells.

However, a wide range of factors may affect the migration of contaminants from soil to groundwater, including the presence of low permeability zones which may limit migration, or preferential pathways which may result in much more rapid migration of contaminants. Therefore, the Tier 1 soil acceptance criteria for the protection of groundwater quality should not be rigidly applied; rather, judgement should be applied when they are used, accounting for site-specific conditions.

Should analysis of soils reveal that contaminant concentrations are found to exceed the soil acceptance criteria, consideration should be given to a more detailed evaluation of the possible fate and transport of contaminants and the beneficial uses for which the aquifer is to be protected.

[2] https://www.orc.govt.nz/media/1293/map-c20.pdf
[3] http://data.orc.govt.nz/

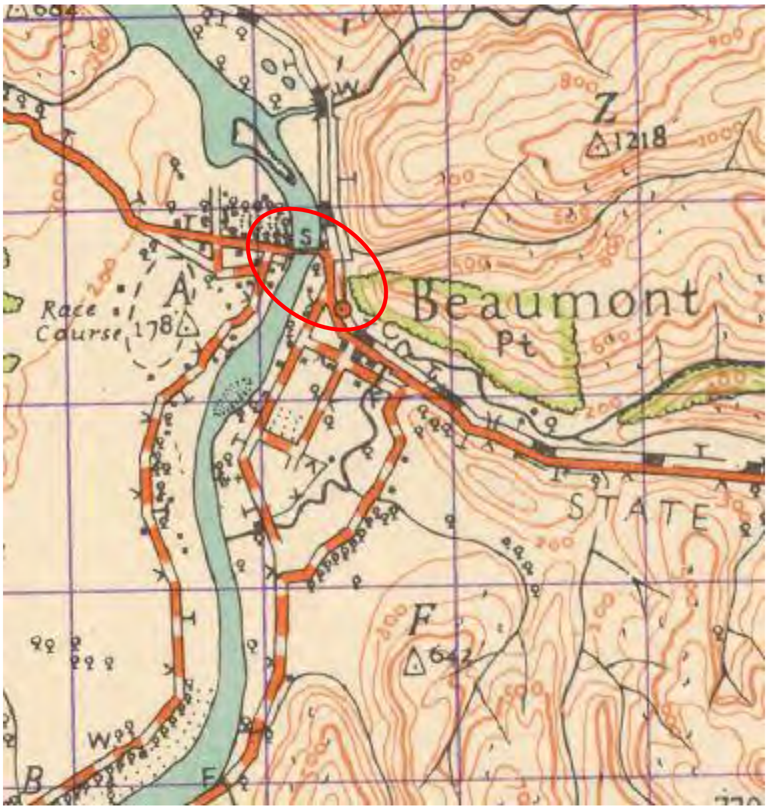
3 Identification of HAIL Activities

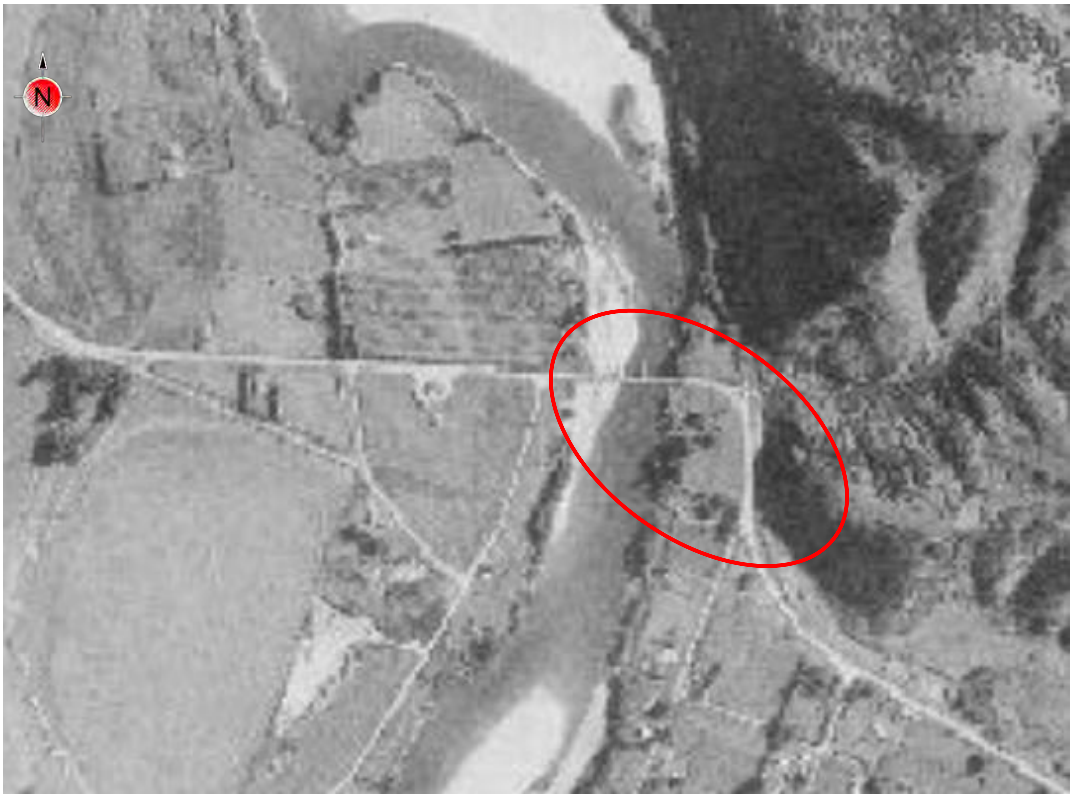
3.1 Site History

Details of the site history have been gained from a review of sources including historical aerial photographs from Google Earth and Retrolens, historical topographical maps from Maps Past, and a review of WSP Opus's Quickmap ArcGIS database. Historical information is presented in Appendix B with aerial photos presented in Table 3.

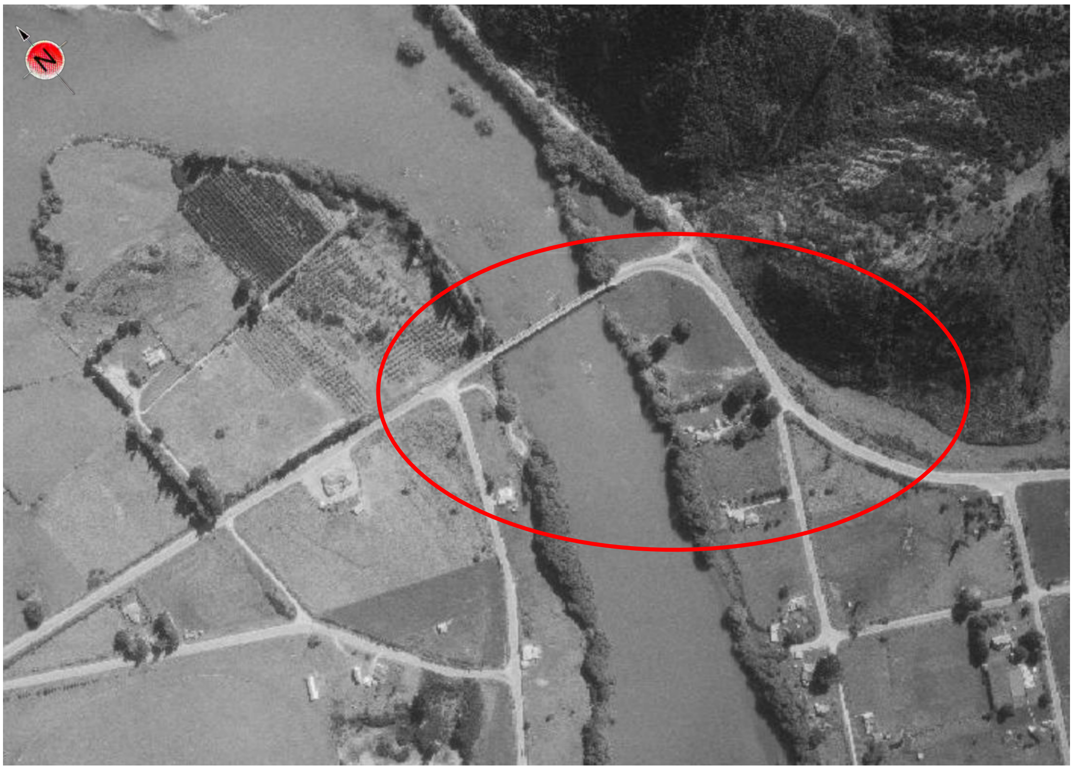
Table 3: Site History (approximate site location is outlined in red)

Photograph Year and Source	Observations
1929 Maps Past	 Only the eastern part of the site can be seen on this map. However, the road bridge is evident and at can be noted that a railway is running across the western most part of the site.

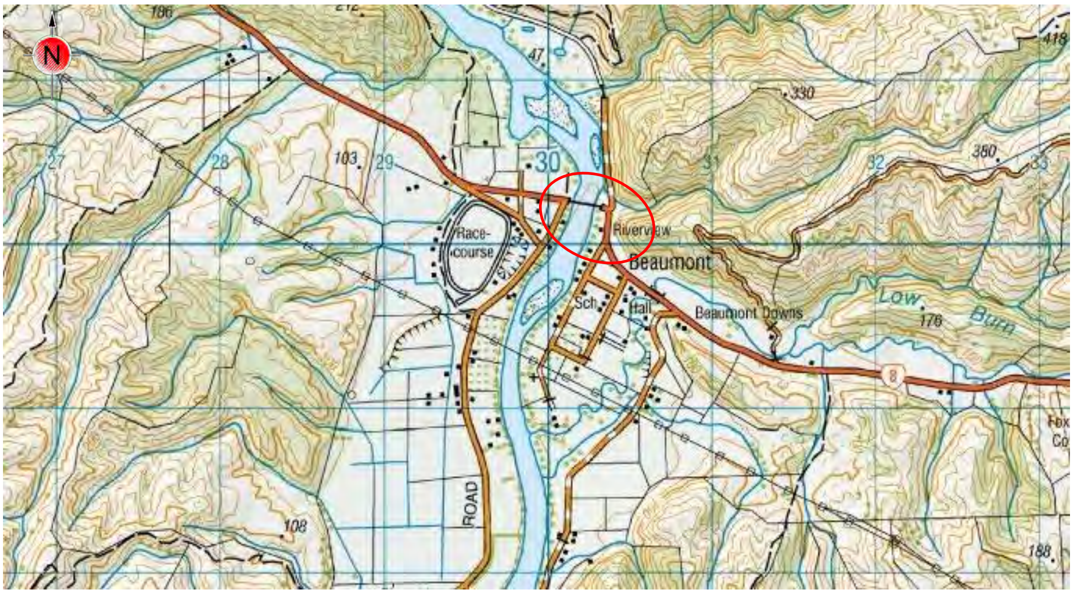
Photograph Year and Source	Observations
1949 Maps Past	 The whole of the site can be seen, the western back of the river appears to be built up.
1959 Maps Past	 The Railway can still be seen running north south through the site. An orchard can be seen to the northwest of the site.

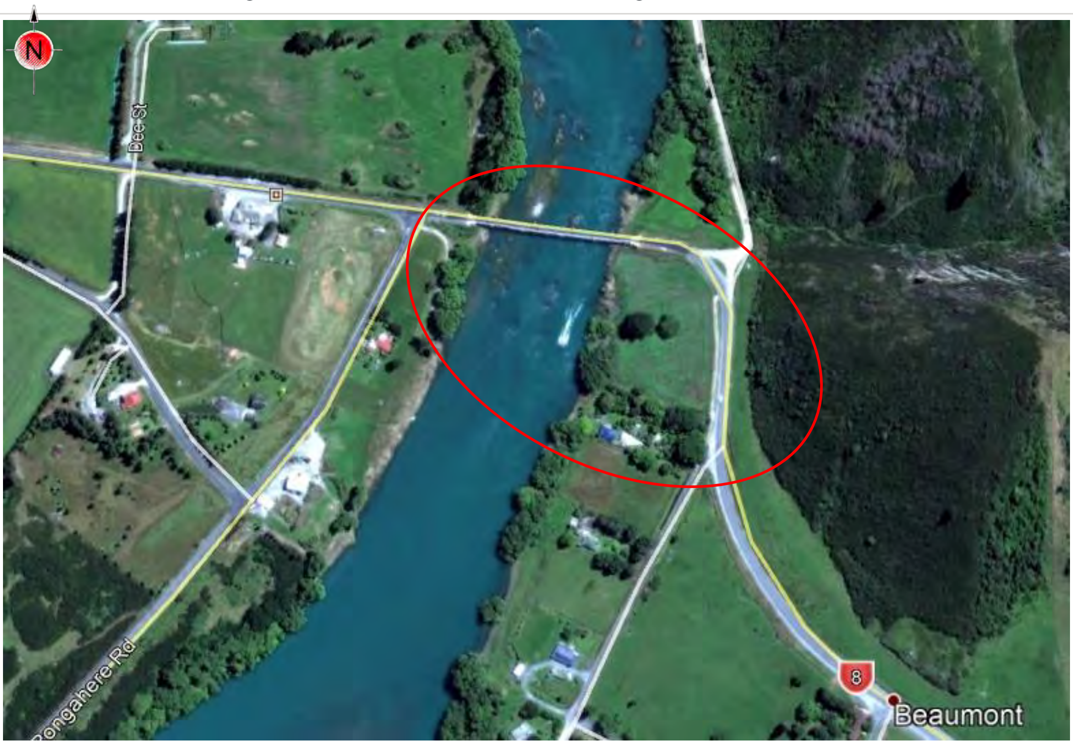
Photograph Year and Source	Observations
1959 Retrolens Aerial Photograph Survey No.: SN1053 Elevation: 16,500 Run No.: P Photo No.: 33 Scale: 44,500	 An orchard can be seen to the northwest of the site the remainder of the area appears to be State Highway 8 or pasture with the occasional building.
1960 Retrolens Aerial Photograph Survey No.: SN1271 Elevation: 16,500 Run No.: C Photo No.: 1 Scale: 44,500	 There are no apparent changes to the site and surrounding area.

Photograph Year and Source	Observations
1964 Retrolens Aerial Photograph Survey No.: SN1627 Elevation: 14,000 Run No.: B Photo No.: 1 Scale: 37,800	 A track can be seen extending towards the river in the western part of the site. There are no apparent changes to the surrounding area.
1979 Maps Past	 The railway is no longer apparent in the east of the site or in the surrounding area.

Photograph Year and Source	Observations
1980 Retrolens Aerial Photograph Survey No.: SN5682 Elevation: 4,000 Run No.: B Photo No.: 8 Scale: 8,000	 There are no changes to the site and surrounding area.
1983 Retrolens Aerial Photograph Survey No.: SN8215 Elevation: 27,000 Run No.: G Photo No.: 8 Scale: 50,000	 There are no changes to the site and surrounding area.

Photograph Year and Source	Observations
1984 Retrolens Aerial Photograph Survey No.: SN8286 Elevation: 25,000 Run No.: K Photo No.: 2 Scale: 50,000	 There are no apparent changes to the site and surrounding area.
1999 Maps Past	 There are no apparent changes to the site. The orchard is no longer apparent to the northwest of the site.

Photograph Year and Source	Observations
2009 Maps Past	 There are no changes to the site and surrounding area.
2010 Google Earth	 There are no changes to the site and surrounding area.

Photograph Year and Source	Observations
2012 Google Earth	 There are no changes to the site and surrounding area.
2013 Google Earth	 There are no changes to the site and surrounding area.

Photograph Year and Source	Observations
2017 Google Earth	 There are no changes to the site and surrounding area.

3.1.1 Heritage

The Heritage New Zealand Pouhere Taonga Act 2014 makes it unlawful for any person to modify or destroy, or cause to be modified or destroyed, the whole or any part of an archaeological site without the prior authority of Heritage New Zealand.

A heritage significance assessment was carried out by OPUS in October 2016 (ref: 6-CT010.00) in order to provide insights regarding the history and development of both the Beaumont Bridge and local Beaumont community, and identify and assess their cultural heritage values.

This report states that the earliest occupation was Māori dating back to at least the 13th century with seasonal expeditions and establishment of river trails.

First Europeans arrived in 1853; gold was discovered in the Beaumont area in 1860 as such the river crossing became vital. Dredging for gold was carried out from the 1890's to a second smaller gold boom in the 1930's.

The Beaumont township continued to grow with connections to steam powered trading vessels and the first bridge was constructed in 1873. In 1878 severe flooding destroyed this bridge. In 1883 construction of a replacement bridge began. In 1887 construction of the bridge was finished and the bridge was opened to the public. The bridge now forms part of SH8 through Central Otago. It is listed as a historic structure in Clutha District Council's Register of Heritage Buildings, item no. H61; but is not listed with Heritage New Zealand Pouhere Taonga.

In 1905 a railway like from Lawrence to Roxburgh through Beaumont was started, however it took almost 10 years to reach Beaumont. At this time the industries in the area included goldmining, sheep farming and fruit growing. By 1925 forestry had become established. The railway branch line was closed in 1968.

3.2 Council Records

A review of CDC's District Plan Maps indicates that the site lies in an area which is currently zoned as Rural on the western bank of the Clutha Mata-au River and as rural settlement on the immediate eastern back of the river. On the eastern side of SH8 the site is zoned as rural.

A review of the HAIL database held by ORC has revealed that the site does not currently appear on the database. However, a historic railway is known to have previously run through the site and in addition the current site is used for farming practices.

The response continues indicating that *"If your enquiry relates to a rural property, please note that many current and past activities undertaken on farms may not be listed on the database, as they can be more difficult to identify. Activities such as use, storage, formulation, and disposal of pesticides, offal pits, landfills, animal dips, and fuel tanks have the potential to contaminated land'.*

Similarly, the long-term use of lead-based paints on buildings can, in some cases, cases cause soil contamination. The use of lead-based paint is generally not recorded on the database."

A copy of the HAIL search results is provided in Appendix B.

It should be noted that the lack of detail on a property file or "no files of note" entry is not confirmation of no HAIL activities being present, or historically present on the site, it merely represents the council's knowledge of the site.

3.3 Certificates of Title

A search for relevant certificates of title was undertaken for the site along with any associated survey plans in order to help determine the historical ownership and layout of the site. These details may give an indication as to past uses on the site and the potential for HAIL activities. Relevant certificates of title and survey plans are also presented within Appendix B.

No indication of horticultural activities are noted on the certificates of title. However gold mining rights are mentioned on the titles.

4 Walkover Survey

4.1 Initial Site Condition and Surrounding Environment

A site walkover was undertaken as part of the investigation by a WSP Opus Engineer. A summary of the inspection is outlined in Table 4 below, and a selection of site photographs presented within Appendix E.

Table 4: Walkover Summary

	Western Bank	Eastern Bank	Eastern side of SH8
Site Access	Rongahere Road	State Highway 8	State Highway 8
Current Site Use	Copse of trees, with scrub and rough pasture. Rocky river bank with gravel beach for access. (reserve)	Pasture/farmland with rocky river bank	Pasture/farmland
Existing Structures	Unpaved car parking/ turning circle for river access.	Possible sheep run/drenching area	Historical railway – Clutha Gold Trail, cycleway
Existing Vegetation	Bushes, trees and grass	trees and grass	Bushes, trees and grass
Adjoining Sites Uses	Rongahere Road to the east and SH8 to the north beyond this Beaumont township, including historical orchards can be seen to the west.	The site is predominantly surrounded by pasture or farmland with a farm to the south	The site is predominantly surrounded by pasture or farmland
Surface Water Bodies	Clutha River/ Mata-au flowing the through the centre of the site		
Site Observations	The shorelines of the Clutha are clearly defined by rock outcrops with several exposures being visible and forming the base rock for the existing bridge foundations. An abandoned historic dredging barge was observed in the river (at low flow) downstream of the site.		
HAIL activities that apply under the NES guidance:	**A10: Persistent pesticide bulk storage or use including sport turfs, market gardens, orchards, glass houses or spray sheds** (historical orchards to the north west) **I: Any other land that has been subject to the international or accidental release of a hazardous substance in sufficient quantity that it could be a risk to human health or the environment** (Historical settlements and car park/boat access to the river)	**A8: Livestock dip or spray race operations** (potential sheep drenching area in the eastern bank paddock)	**I: Any other land that has been subject to the international or accidental release of a hazardous substance in sufficient quantity that it could be a risk to human health or the environment** (Historical Railway, close to the eastern site boundary)

5 Implications of Identified HAIL Activities

5.1 Contaminants of Potential Concern

The contaminants of potential concern associated with the identified HAIL activities are detailed in Table 5 below.

Table 5: Contaminants of Potential Concern

HAIL activity	Associated contaminants pertaining to this site
A8: Livestock dip or spray race operations (Potential Sheep Dip area)	Organochlorine pesticides and heavy metals (Arsenic)
A10: Persistent pesticide bulk storage or use including sport turfs, market gardens, orchards, glass houses or spray sheds (Historic orchard)	Organochlorine pesticides and heavy metals
I: Any other land that has been subject to the intentional or accidental release of a hazardous substance in sufficient quantity that it could be a risk to human health or the environment. (Carpark/ boat access to the river, Historical Railway, settlement and gold mining)	Heavy metals, polycyclic aromatic hydrocarbons and petroleum hydrocarbons and herbicides

5.2 Proposed Development

We understand the development of the site will involve the construction of a new bridge and the realignment of the existing highway and Clutha Gold Trail cycleway.

The layout of the site including a potential development location is shown in Appendix A.

5.3 Implications of the NES

The NES is relevant when specified activities are undertaken on HAIL sites. These activities are:

- Removing or replacing a fuel storage system;
- Sampling soil;
- Disturbing the soil;
- Subdividing land; and
- Changing the use of the piece of land.

The proposed development includes a change of land use and disturbing the soil.

It is recommended that a planner determine the relevance of the NES to the proposed work.

5.4 Conceptual Site Model

A conceptual site model is used to support the decision-making process for contaminated land management.

The five basic activities associated with developing a conceptual site model are:

- Identification of potential contaminants;

- Identification and characterisation of the source(es) of contamination;
- Delineation of potential migration pathways through environmental media, such as groundwater, surface water, soils sediment, biota, air, service lines etc.;
- Identification and characterisation of potential receptors (human, ecological or building infrastructure);
- Determination of the limits of the study area or system boundaries.

Data gaps and uncertainties are identified during the preparation of the conceptual site model, which assists in designing any detailed investigation that may follow.

For there to be an effect on receptors there must be a contamination source and a mechanism (pathway) for contamination to affect human health or the environment (receptor).

Using the desk-based information on the site, a conceptual site model has been developed as shown in Figure 6 on the following page.

A possible pollutant linkage between the contaminant source and receptor is defined as one that has the potential to represent unacceptable risks to human health or the environment. Where a possible pollutant linkage has been identified above, further investigation and risk assessment through a DSI may be necessary to establish whether a significant pollutant linkage exists.

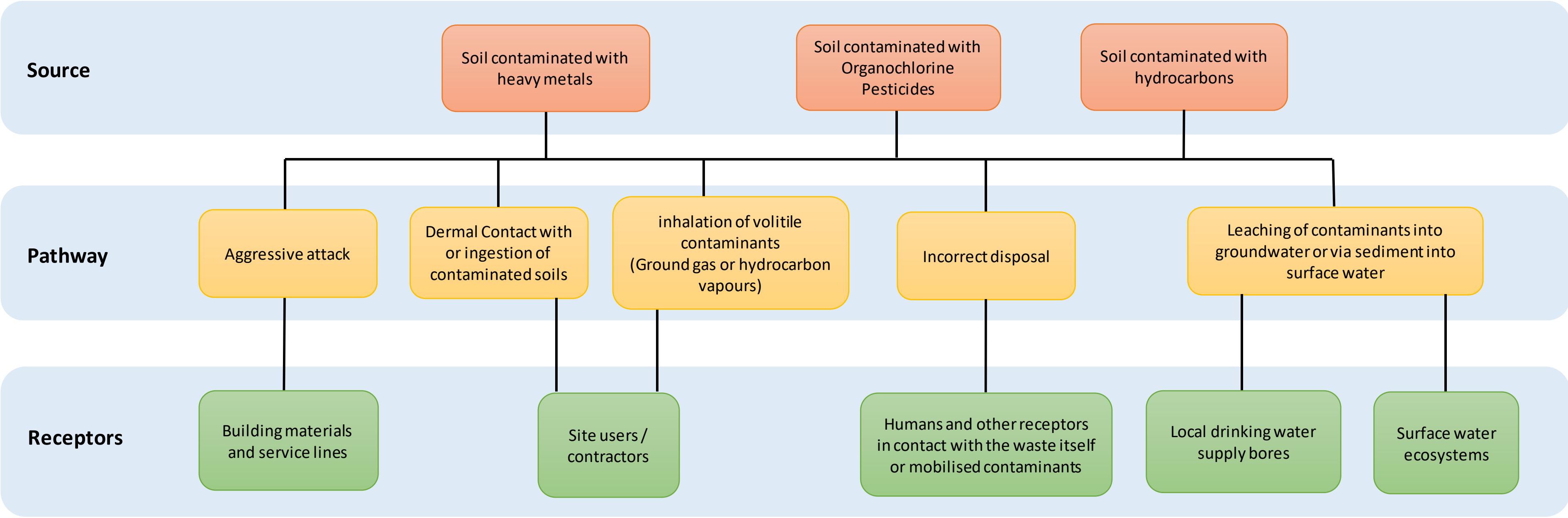


Figure 6: Conceptual Site Model

6 Statutory Provisions

6.1 National Environmental Standard

Regulation 8(3) of the NES makes provision for disturbing the soil as a permitted activity subject to meeting the following standards:

(a) controls to minimise the exposure of humans to mobilised contaminants must—

(i) be in place when the activity begins:
(ii) be effective while the activity is done:
(iii) be effective until the soil is reinstated to an erosion- resistant state:

(b) the soil must be reinstated to an erosion-resistant state within 1 month after the serving of the purpose for which the activity was done:
(c) the volume of the disturbance of the soil of the piece of land must be no more than 25 m^3 per 500 m^2:
(d) soil must not be taken away in the course of the activity, except that, —

(i) for the purpose of laboratory analysis, any amount of soil may be taken away as samples:
(ii) for all other purposes combined, a maximum of 5 m^3 per 500 m2 of soil may be taken away per year:

(e) soil taken away in the course of the activity must be disposed of at a facility authorised to receive soil of that kind:
(f) the duration of the activity must be no longer than 2 months:
(g) the integrity of a structure designed to contain contaminated soil or other contaminated materials must not be compromised.

If the proposed construction of a bridge and road infrastructure is to proceed as indicated, the NES regulations apply because:

The site accommodates potential HAIL activities.

The NES flow chart shown as Figure 8 demonstrates the various ways the NES could apply to sites and activities performed on those sites.

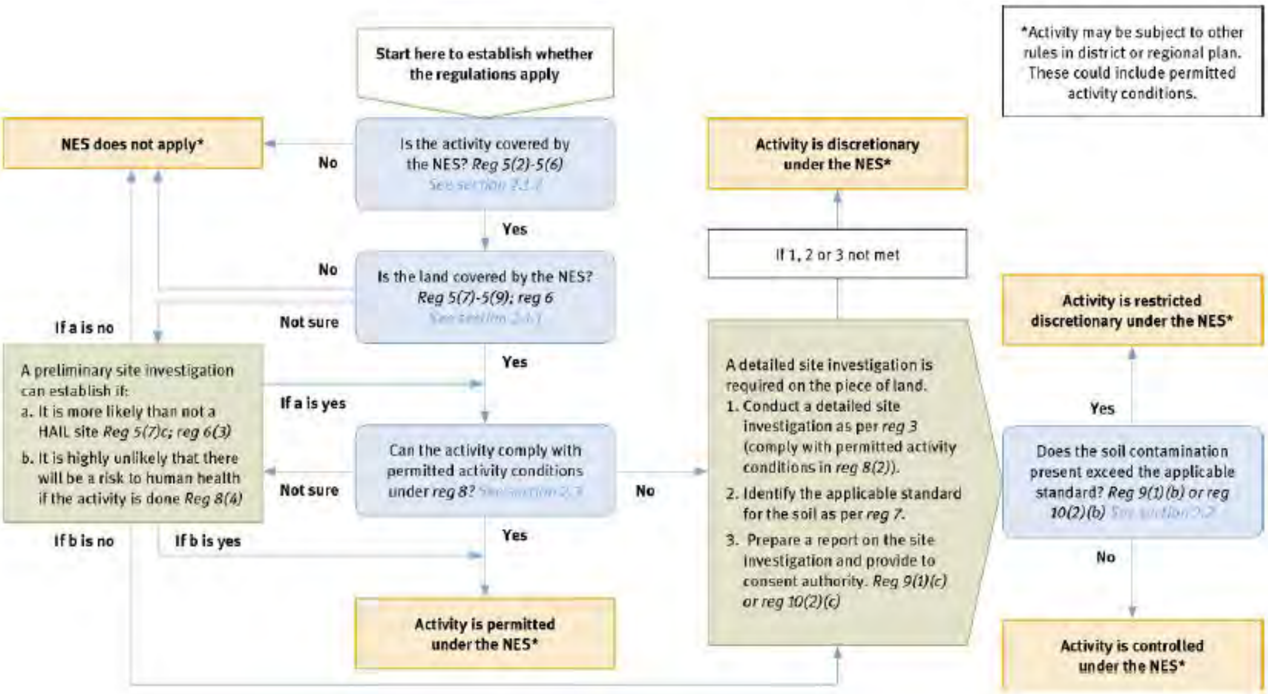


Figure 7: NES Flow Chart

7 Basis for Land Use Scenario

For contaminated site assessments, the hierarchy of reference documents containing guidelines for soils and waters, the MfE Contaminated Land Management Guidelines No 2 (November 2003) are referred to.

The site currently comprises open pasture land.

The primary human health receptors have been determined to be site workers, local residents and visitors following the construction of the new bridge.

As the proposed development involves the construction of the new Beaumont Bridge and associated road infrastructure, a commercial/ Industrial outdoor worker (unpaved) end use has been used to assess risks to site workers during construction, and to future users of the site.

The land use scenario is highlighted in Table 10 below.

Table 6: Land Use Scenario

Scenario	Description
Rural / lifestyle block	Rural residential land use, including home-grown produce consumption (25 per cent). Applicable to the residential vicinity of farm houses for protection of farming families, but not the productive parts of agricultural land. Note: Consumption of eggs, milk and meat from animals raised on site is excluded. Produce consumption is limited to home-grown vegetables. Sites for which consumption of home-grown eggs, milk or meat is important will need to be evaluated on a site-specific basis.
Residential	Standard residential lot, for single dwelling sites with gardens, including home-grown produce consumption (10 per cent).
High-density residential	Urban residential with limited soil contact, including small ornamental gardens but no vegetable garden (no home-grown produce consumption); applicable to urban townhouses, flats and ground-floor apartments with small ornamental gardens, but not high-rise apartments.
Parks / recreational	Public and private green areas and reserves used for active sports and recreation. This scenario is intended to cover playing fields and suburban reserves where children play frequently. It can also reasonably cover secondary school playing fields but not primary school playing fields.
Commercial / industrial outdoor worker (unpaved)	Commercial / industrial site with varying degrees of exposed soil. Exposure of outdoor workers to near-surface soil during routine maintenance and gardening activities with occasional excavation as part of maintaining subsurface utilities (ie, a caretaker or site maintenance personnel). Also conservatively applicable to outdoor workers on a largely unpaved site.

8 Discussion

The purpose of this PSI, in general accordance with CLMG No1 and the NES for Assessing and Managing Contaminants in the Soil to Protect Human Health (2011), is to provide an assessment of the historical land uses and intended land use to determine whether or not the activities have, more likely than not, resulted in contamination of the soil that may be hazardous to human health.

On this basis, a review of information currently available, as well as observations made during the site inspection, and through the compilation of a conceptual site model our assessment of the site is as follows:

- Historical Māori presence in the area from the 13th century;
- European use from 1853 with establishment of a township and gold mining from 1860's;
- Gold dredging was ongoing from 1890's until the 1930's goldrush;
- Current Beaumont bridge was opened in 1887;
- The railway was established in 1905 and closed in 1968;
- Currently the site is pasture/farmland or reserve
- Historic activities on the farmland include orchards to the north west and sheep drenching on site;
- The area to the west of the site comprises the Beaumont township with predominantly pasture/farmland surrounding that;
- No obvious signs of vegetation dieback were noted in any location across the site;
- The Clutha River/Mata-au flows south through the centre of the site;
- There is not a known aquifer beneath the site, but the groundwater in the area is considered sensitive
- It is understood that the development of the site will include the construction of a new bridge with realignment of the state highway and Clutha Gold Trail cycleway.
- The western and eastern banks of the River are underlain by the Late Pleistocene River Deposits; and
- The eastern part of the site is underlain by Undifferentiated Caples terrane TZIII.

Potential human health risks have been evaluated using the Likelihood and Consequence scales tabulated below to determine a risk level – low, moderate, high, very high or extreme. The assessed risk level allows prioritisation of investigations and assessment measures.

Table 7: Risk Allocation Table

	Consequence				
Likelihood	Insignificant	Minor	Medium	Major	Catastrophic
Almost certain	Moderate	Moderate	Very High	Extreme	Extreme
Likely	Low	Moderate	High	Very High	Extreme
Possible	Low	Moderate	Moderate	Very High	Very High
Unlikely	Low	Low	Moderate	High	Very High
Rare	Low	Low	Low	Moderate	High

The risks to human health have been assessed based on the historical activities which may have occurred on specific areas of the site based on an industrial/commercial end use and can be split in to the following contaminants:

Table 8: Level of Contamination Risk

HAIL	Location	Contamination Risk
A8: Livestock dip or spray race operations	Area surrounding the potential sheep dip area	Risk is **low**: The potential sheep dipping activities occurred in an area of the site that will not be disturbed in any way by the construction of the new bridge or highway realignment.
A10: Persistent pesticide bulk storage or use including sport turfs, market gardens, orchards, glass houses or spray sheds	Historical orchard to the north west of the site	Risk is **low**: Orchards are not known to have been present on the site itself and as such any risk of contamination by pesticides is considered highly unlikely.
I: Any other land that has been subject to the intentional or accidental release of a hazardous substance in sufficient quantity that it could be a risk to human health or the environment.	Carpark/boat access to the river	Risk is **low**: There is no visual or olfactory evidence of contamination and vehicles do not appear to use the area very often or for a long duration. As such it is considered highly unlikely this activity has contaminated the site or surrounding area.
	Historical railway	Risk is **low**: The site of the historic railway is now utilised by the Clutha Gold Trail Cycleway and, for the most part, will not be disturbed by the construction. Some slight changes to the cycle way are proposed to enable an easier river crossing however these are considered highly unlikely to pose a risk to human health.
	Historical settlement	Risk is **low**: While historic settlement may have occurred on the site it is considered to be a low risk with regards to human health. The area to be disturbed is relatively small and the nature of settlement intermittent. Should anything be discovered archaeologists will be contacted.
	Historical gold mining)	Risk is **low**: Gold mining is not known to have occurred directly on the site.

It is considered more likely than not that the risk to human health associated with the development identified on the site is **LOW**. As such, it is considered **highly unlikely** that there will be a risk to human health associated with the proposed development.

9 Conclusions and Recommendations

The conceptual site model and initial qualitative human health risk assessment presented herein are based upon information gained from a site inspection, anecdotal evidence, information gained from CDC and other sources, to determine the chemical characteristics of determined contaminants of concern.

The site identified in this investigation has been triggered under the NES as a result of a proposed development. The site history, anecdotal evidence, historical aerial photography and site inspections have identified that there is low potential risk of having contaminated the proposed development area in terms of an industrial/commercial end use. On this basis, the risk to human health associated with potential contaminants identified during this PSI for the site is considered to be **LOW**.

9.1 NES Implications

This Preliminary Site Investigation identifies that on the proposed development areas of the site it is **highly unlikely** that there is a risk to human health should the proposed land use change and subsequent (industrial/ commercial end use) development be undertaken.

As such, any land use change and associated ground disturbance within this area is considered a permitted activity.

9.2 Safety in Design

Safety in Design (SID) considers the safety of those who are involved in the construction of, maintenance of, cleaning of, repair of and demolition of a structure, or anything that has been constructed.

As part of the assessment of this site, we have taken reasonably practicable steps to assess the potential for hazards associated with potentially contaminated land to exist. We have, through the development of a conceptual site model assessed the qualitative level of risk posed to human health and have made various recommendations to address the plausible risks.

Where identified this report indicates hazards and risks to health and safety associated with contaminated land which must be communicated to the design team, the client and associated stakeholders as required by the Health and Safety at Work Act 2015.

9.3 Recommendations

Based on the results of this investigation, WSP Opus recommends that:

- Should any items or strata of potential archaeological interest be encountered an archaeologist should be consulted and the relevant authorities informed;
- Should any ground conditions be encountered across the site which are not anticipated from the findings of this report a Suitably Qualified and Experienced Practitioner (SQEP) should be consulted in order to reassess the risks to human health;
- This Preliminary Site Investigation report is submitted to the consenting authority; and
- This Preliminary Site Investigation report is submitted to the regional authority in to facilitate updating the HAIL database.

10 Limitations

10.1 Scope of Services

This PSI report (the report) has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the client and WSP Opus. In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

10.2 Reliance on Data

In preparing the report, WSP Opus has relied upon data, surveys, analyses, designs, plans and other information provided by the client and other individuals and organisations, most of which are referred to in the report (the data). Except as otherwise stated in the report, WSP Opus has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report (conclusions) are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. WSP Opus will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to WSP Opus.

10.3 Environmental Conclusions

In accordance with the scope of services, WSP Opus has relied upon the data and has conducted environmental field monitoring in the preparation of the report. The nature and extent of monitoring conducted is described in the report.

The conclusions are based upon the data and the environmental field monitoring and are therefore merely indicative of the environmental condition of the site at the time of preparing the report, including the presence or otherwise of contaminants or emissions. Should further data be obtained that differs from that presented in this report, then conclusions and recommendations may no longer be valid.

Also, it should be recognised that site conditions, including the extent and concentration of contaminants, can change with time. Within the limitations imposed by the scope of services, the monitoring and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, expressed or implied, is made.

The report is valid at the date of release. The condition of the site may change with time so that the results and interpretation are no longer valid. In addition, guidelines and legislation may change, making assessment of results and recommendations invalid.

This investigation concentrates on potential contamination levels in the soil within the site. However, any earthworks, should be undertaken with due care and should ground conditions other than those anticipated be encountered work should cease and an SQEP consulted to further assess the risks to human health.

10.4 Report for Benefit of Client

The report has been prepared for the benefit of the New Zealand Transport Agency and no responsibility is accepted to any third party for all or any part. WSP Opus assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of WSP Opus or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report).

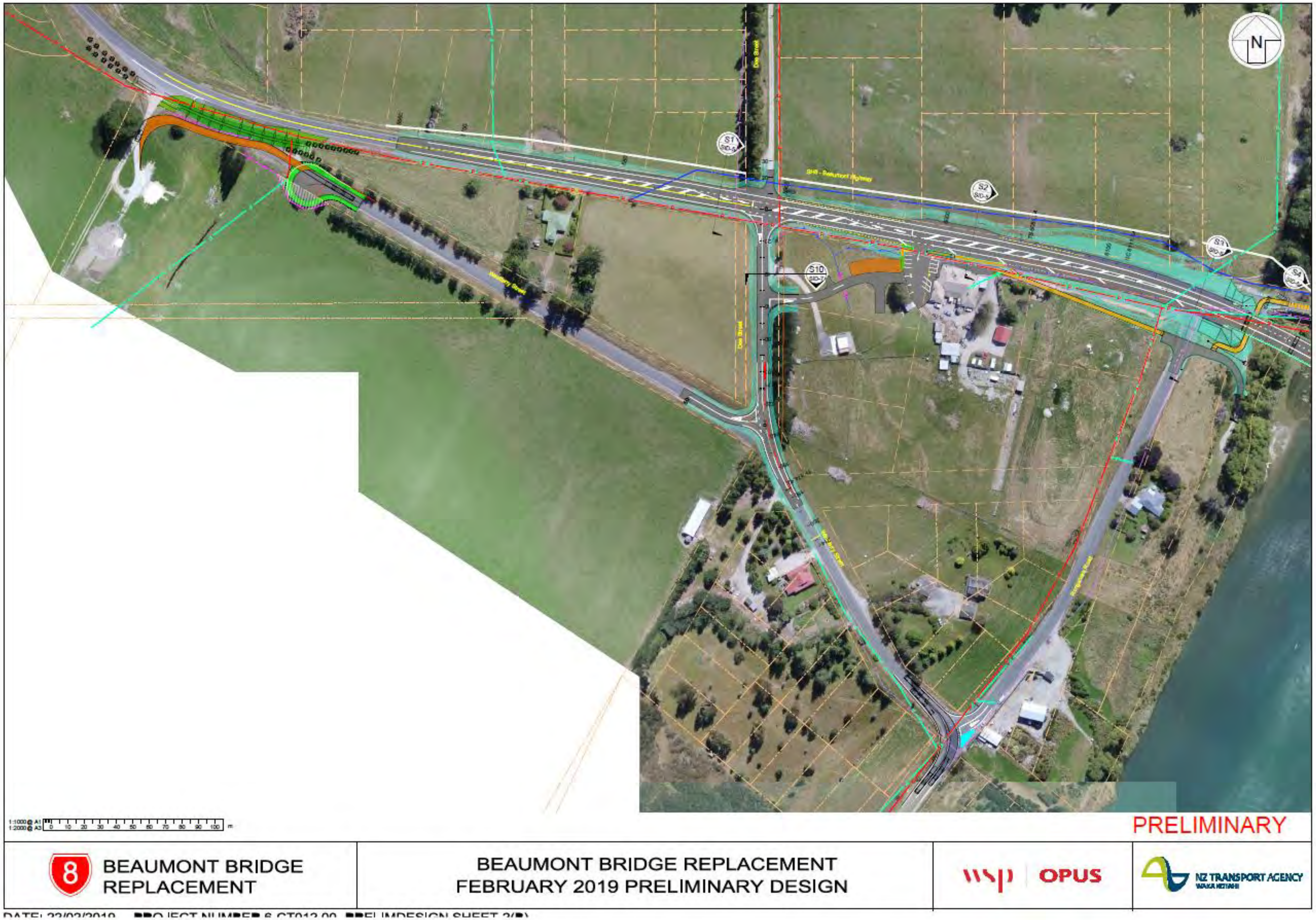
This report should not be relied upon or transferred to any other parties without the express written authorisation of WSP Opus. Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters. This report should only be reproduced in full.

10.5 Other Limitations

WSP Opus will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report. The scope of services did not include any assessment of the title to or ownership of the properties, buildings and structures referred to in the report nor the application or interpretation of laws in the jurisdiction in which those properties, buildings and structures are located.

Appendix A: Potential Development Plan

BEAUMONT BRIDGE REPLACEMENT	BEAUMONT BRIDGE REPLACEMENT FEBRUARY 2019 PRELIMINARY DESIGN	WSP OPUS	NZ TRANSPORT AGENCY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PRELIMINARY
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BEAUMONT BRIDGE REPLACEMENT
BEAUMONT BRIDGE REPLACEMENT
FEBRUARY 2019 PRELIMINARY DESIGN
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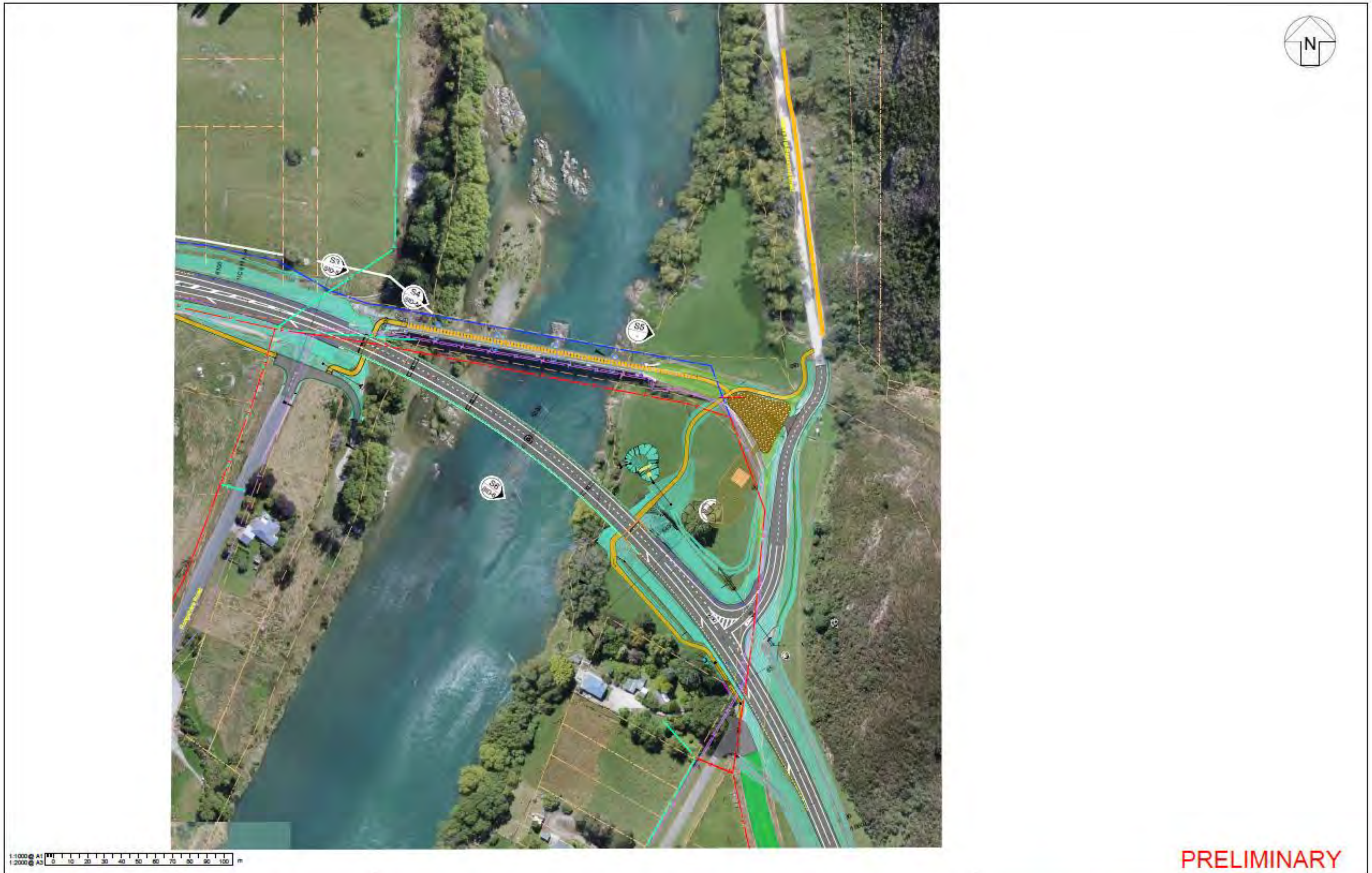
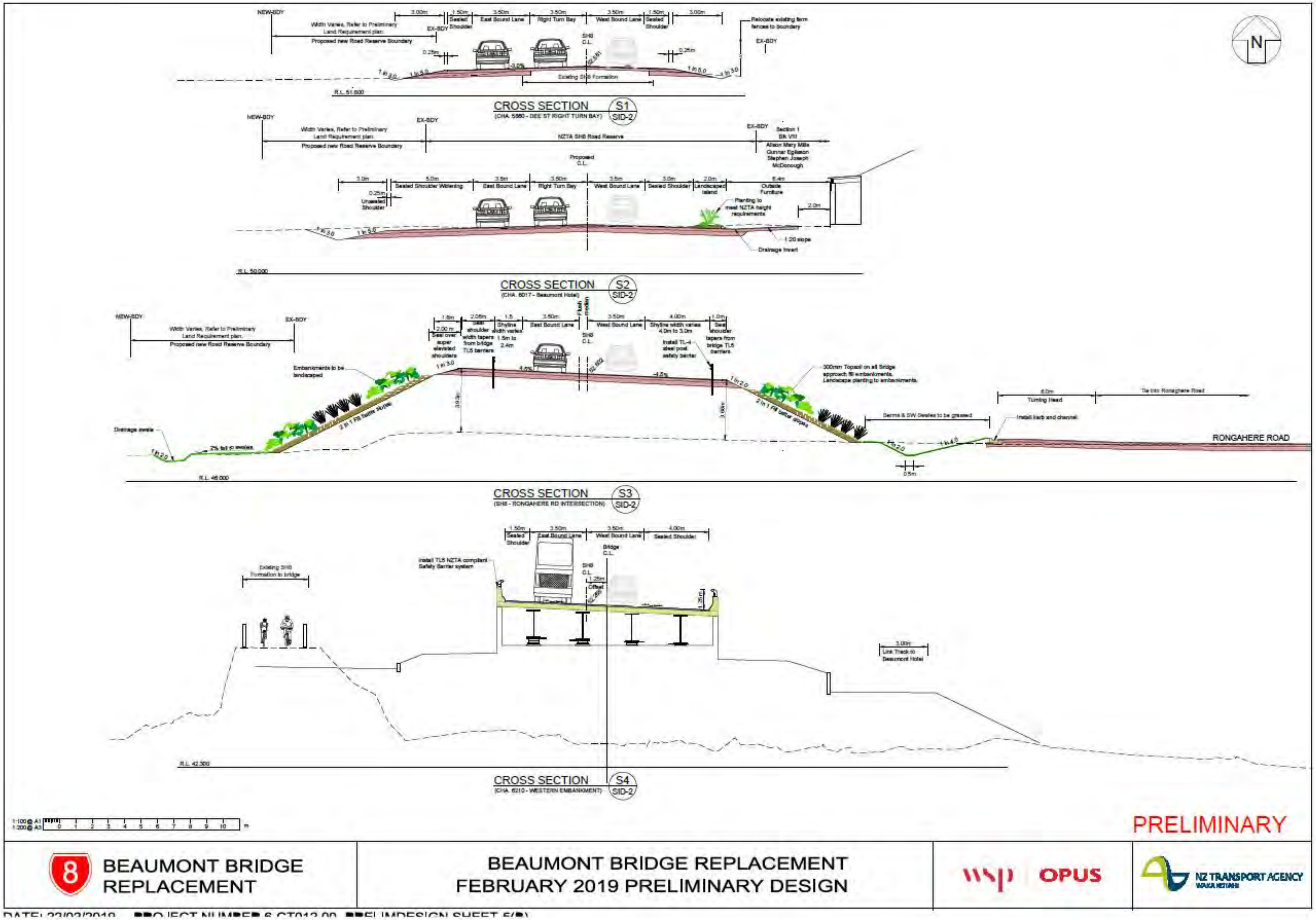
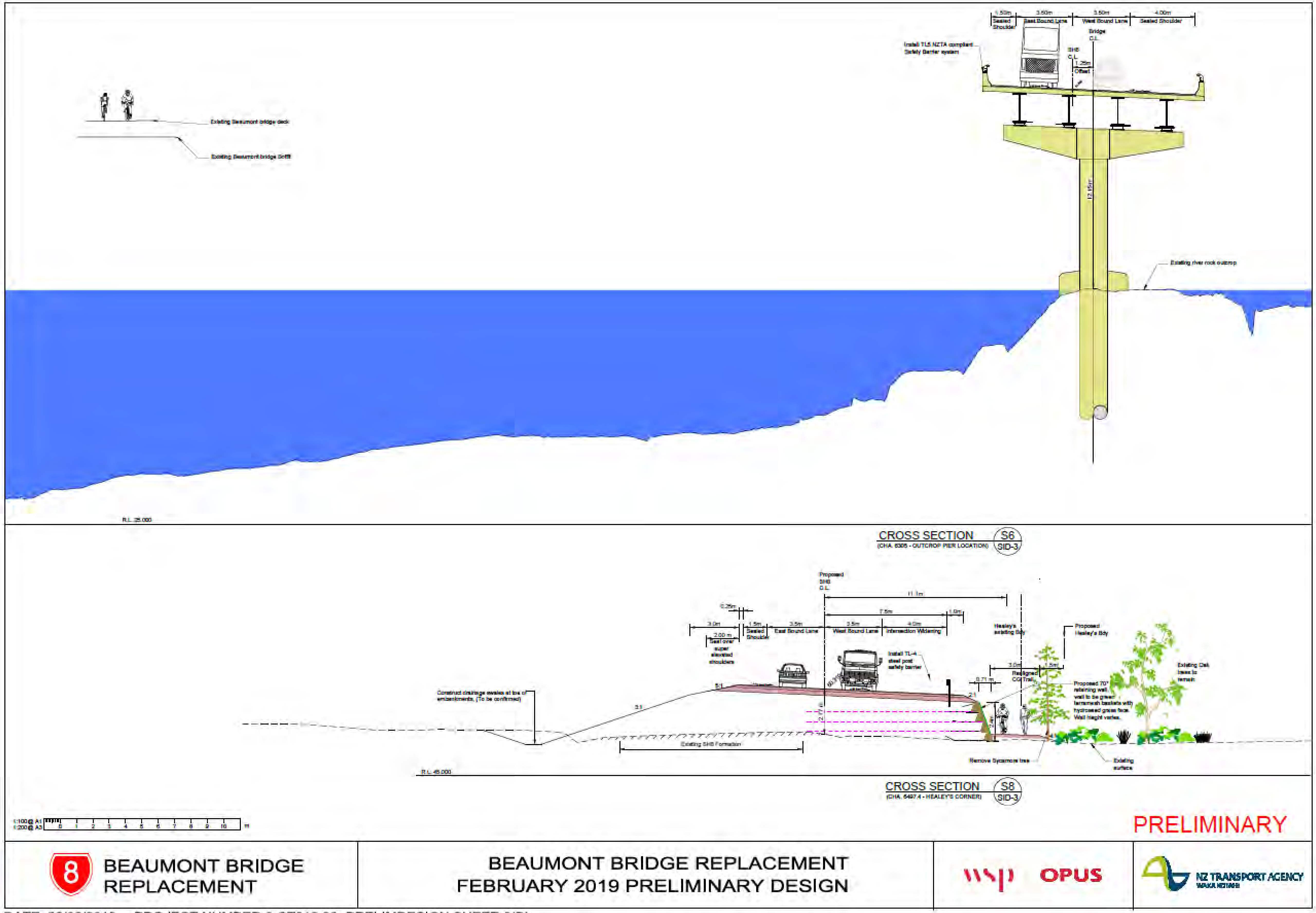


PRELIMINARY

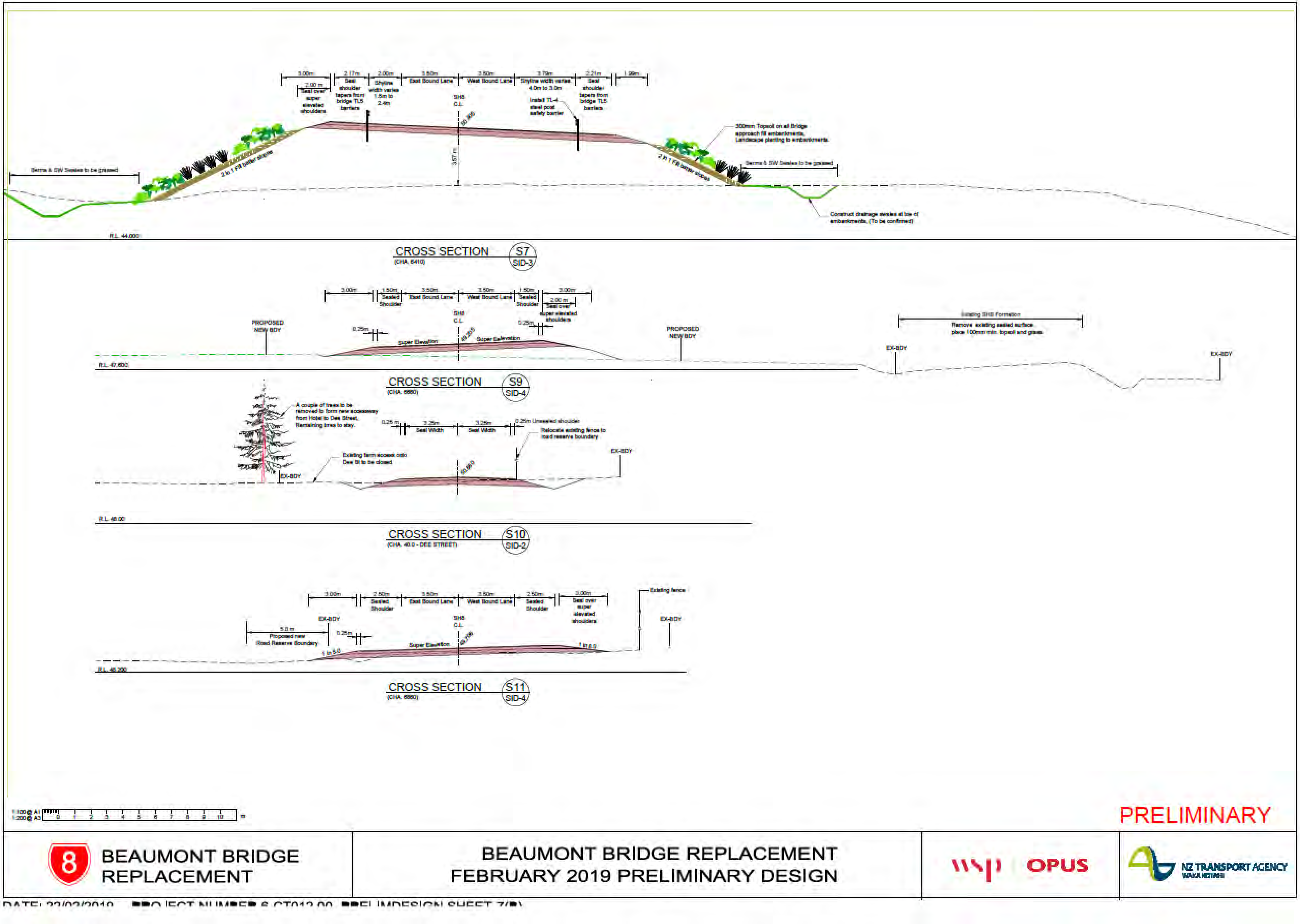
8 BEAUMONT BRIDGE REPLACEMENT	BEAUMONT BRIDGE REPLACEMENT FEBRUARY 2019 PRELIMINARY DESIGN	wsp OPUS	NZ TRANSPORT AGENCY WAKA KOTAHI

8 BEAUMONT BRIDGE REPLACEMENT	BEAUMONT BRIDGE REPLACEMENT FEBRUARY 2019 PRELIMINARY DESIGN	wsp | OPUS	NZ TRANSPORT AGENCY WAKA KOTAHI


CROSS SECTION S1 SID-2
CROSS SECTION S2 SID-2
CROSS SECTION S3 SID-2
RONGAHERE ROAD
CROSS SECTION S4 SID-2
PRELIMINARY
BEAUMONT BRIDGE REPLACEMENT
BEAUMONT BRIDGE REPLACEMENT
FEBRUARY 2019 PRELIMINARY DESIGN
NZ TRANSPORT AGENCY



1.50m
Sealed Shoulder
3.50m
East Bound Lane
3.50m
West Bound Lane
4.00m
Sealed Shoulder
Bridge C.L.
SH8 C.L.
1.25m Offset
Install TL5 NZTA compliant Safety Barrier system
Existing Beaumont bridge deck
Existing Beaumont bridge Soffit
Existing river rock outcrop
R.L. 25.000
CROSS SECTION S6 SID-3
(CHA. 6305 - OUTCROP PIER LOCATION)
Proposed SH8 C.L.
11.1m
7.5m
1.0m
0.25m
3.0m
2.00 m
Seal over super elevated shoulders
1.5m
Sealed Shoulder
3.5m
East Bound Lane
3.5m
West Bound Lane
4.0m
Intersection Widening
Healey's existing Bdy
Proposed Healey's Bdy
Install TL-4 steel post safety barrier
3.0m
1.5m
0.71 m
Realigned CG Trail
Existing Oak trees to remain
Proposed 70° retaining wall, wall to be green terramesh baskets with hydroseed grass face. Wall height varies.
Construct drainage swales at toe of embankments. (To be confirmed)
Existing SH8 Formation
Remove Sycamore tree
Existing surface
R.L. 45.000
CROSS SECTION S8 SID-3
(CHA. 6407.4 - HEALEY'S CORNER)
PRELIMINARY
8
BEAUMONT BRIDGE REPLACEMENT
BEAUMONT BRIDGE REPLACEMENT
FEBRUARY 2019 PRELIMINARY DESIGN
NZ TRANSPORT AGENCY


CROSS SECTION S7 SID-3
CROSS SECTION S9 SID-4
CROSS SECTION S10 SID-2
CROSS SECTION S11 SID-4
PRELIMINARY
8
BEAUMONT BRIDGE REPLACEMENT
BEAUMONT BRIDGE REPLACEMENT
FEBRUARY 2019 PRELIMINARY DESIGN
NZ TRANSPORT AGENCY

Appendix B: Historical Information and Site Searches

QuickMap Title Details
Historic Information

Information last updated as at 17-Feb-2019

FREEHOLD
DERIVED FROM LAND
INFORMATION NEW ZEALAND

Identifier	**OT14B/673**
Land Registration District	**Otago**
Date Issued	03 February 1992

Historic Memorials

The bed of the Clutha River is excluded from Section 1 SO Plan 23609

Subject to Part IV A Conservation Act 1987

Subject to Section 11 Crown Minerals Act 1991

5011169.1 Exploration Permit to Central Goldfields Mining Limited for a term of 5 years commencing on 10.10.2000 - 30.10.2000 at 9:54 am

6615393.1 Expiry of Exploration Permit 5011169.1 on 9.10.2005 - 19.10.2005 at 9:00 am

9992621.1 Transfer to Alexander Trevor Peters (1/3 share), Karen Anne Peters (1/3 share) and Alexander Trevor Peters, Karen Anne Peters and Fairfield Trustees No 3 Limited (1/3 share) - 31.3.2015 at 1:39 pm

10293471.1 Mortgage to ASB Bank Limited - 23.12.2015 at 4:38 pm

---

Historic Owners

CONTACT ENERGY LIMITED

QuickMap Title Details

Information last updated as at 05 Aug 2018

COMPUTER FREEHOLD REGISTER
DERIVED FROM LAND INFORMATION NEW ZEALAND

Identifier	**OT14B/688**
Land Registration District	**Otago**
Date Issued	03 February 1992

Prior References
OIC 796160

Type	Fee Simple
Area	1.6900 hectares more or less
Legal Description	Section 1-2 Survey Office Plan 23610

Proprietors
Dale Clifford Mitchell as to a 1/2 share
Jennifer Anne Mitchell as to a 1/2 share

The bed on the Clutha River and the bed of an unnamed stream are excluded
Subject to Part IV A Conservation Act 1987
Subject to Section 11 Crown Minerals Act 1991
9944846.3 Mortgage to Southland Building Society - 28.1.2015 at 3:14 pm

QuickMap Title Details
Historic Information

Information last updated as at 05 Aug 2018

COMPUTER FREEHOLD REGISTER DERIVED FROM LAND INFORMATION NEW ZEALAND

Identifier	**OT14B/688**
Land Registration District	**Otago**
Date Issued	03 February 1992

Historic Memorials

The bed on the Clutha River and the bed of an unnamed stream are excluded

Subject to Part IV A Conservation Act 1987

Subject to Section 11 Crown Minerals Act 1991

9944846.2 Transfer to Jennifer Anne Mitchell (1/2 share) and Dale Clifford Mitchell (1/2 share) - 28.1.2015 at 3:14 pm

9944846.3 Mortgage to Southland Building Society - 28.1.2015 at 3:14 pm

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Historic Owners

CONTACT ENERGY LIMITED

QuickMap Title Details

Information last updated as at 05 Aug 2018

COMPUTER FREEHOLD REGISTER
DERIVED FROM LAND INFORMATION NEW ZEALAND

Identifier	**OT14B/689**
Land Registration District	**Otago**
Date Issued	03 February 1992

Prior References

OIC 796160 GN 351014

Type	Fee Simple
Area	9.1391 hectares more or less
Legal Description	Section 3-4 Survey Office Plan 23610

Proprietors

Jennifer Anne Mitchell as to a 1/2 share
Dale Clifford Mitchell as to a 1/2 share

Subject to Part IV A Conservation Act 1987

Subject to Section 11 Crown Minerals Act 1991

9944846.3 Mortgage to Southland Building Society - 28.1.2015 at 3:14 pm

The information provided on this report forms a guideline only. As a result, Custom Software Limited cannot and does not provide any warranties or assurances of any kind in relation to the accuracy of the information provided through this report, the Site and Service. Custom Software Limited will not be liable for any claims in relation to the content of this report, the site and this service.

QuickMap Title Details
Historic Information

Information last updated as at 05 Aug 2018

COMPUTER FREEHOLD REGISTER DERIVED FROM LAND INFORMATION NEW ZEALAND

Identifier	**OT14B/689**
Land Registration District	**Otago**
Date Issued	03 February 1992

Historic Memorials

Subject to Part IV A Conservation Act 1987

Subject to Section 11 Crown Minerals Act 1991

9944846.2 Transfer to Jennifer Anne Mitchell (1/2 share) and Dale Clifford Mitchell (1/2 share) - 28.1.2015 at 3:14 pm

9944846.3 Mortgage to Southland Building Society - 28.1.2015 at 3:14 pm

---

Historic Owners

CONTACT ENERGY LIMITED

Quickmap Title Details

Information last updated as at 17-Feb-2019

RECORD OF TITLE
DERIVED FROM LAND INFORMATION NEW ZEALAND
FREEHOLD

Identifier	**OT14B/673**
Land Registration District	**Otago**
Date Issued	03 February 1992

Prior References
OIC 796160

Type	Fee Simple
Area	9.6000 hectares more or less
Legal Description	Section 1 and Section 4 Survey Office Plan 23609

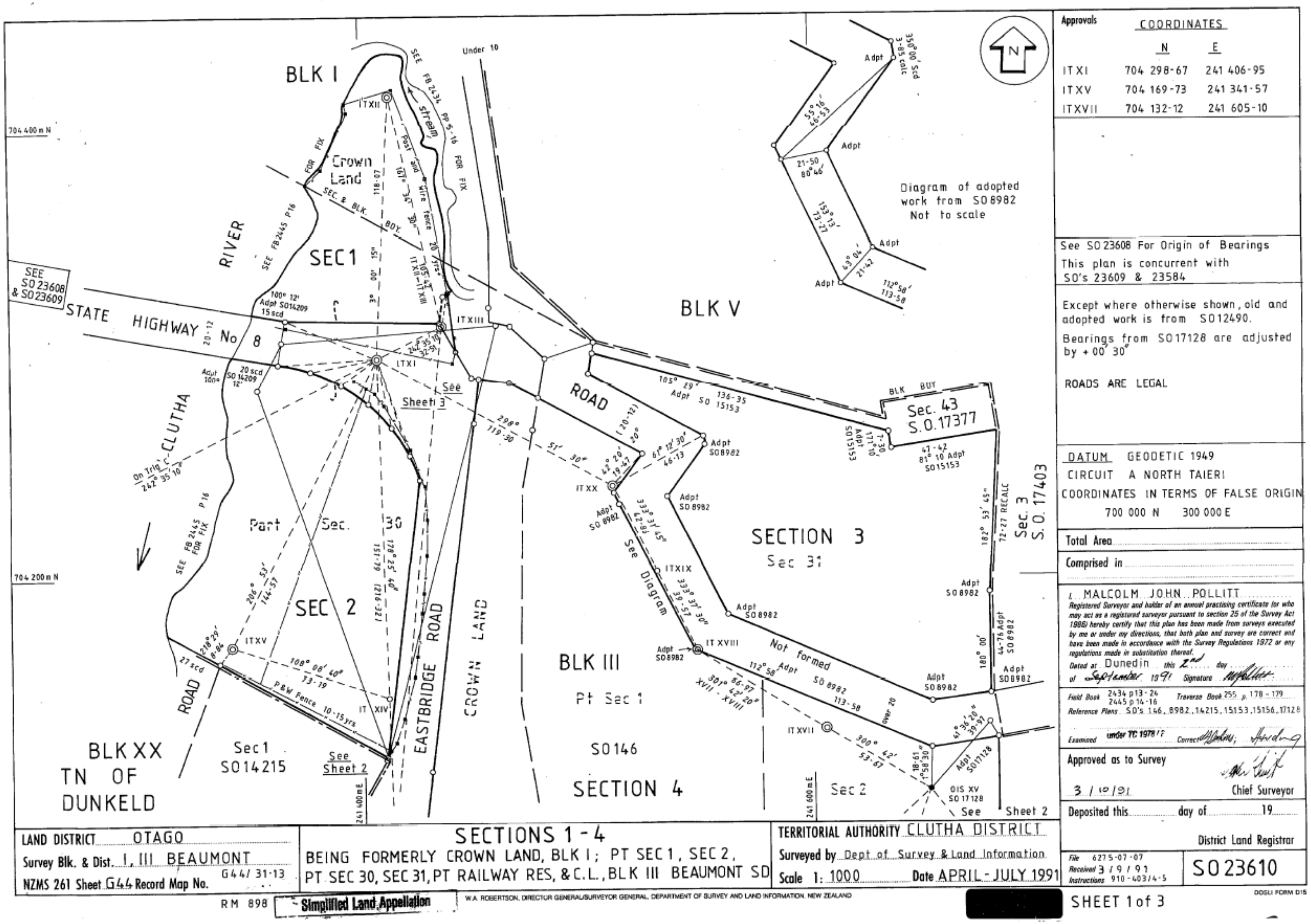
Registered Owners
Karen Anne Peters as to a 1/3 share
Fairfield Trustees No 3 Limited, Alexander Trevor Peters and Karen Anne Peters as to a 1/3 share
Alexander Trevor Peters as to a 1/3 share

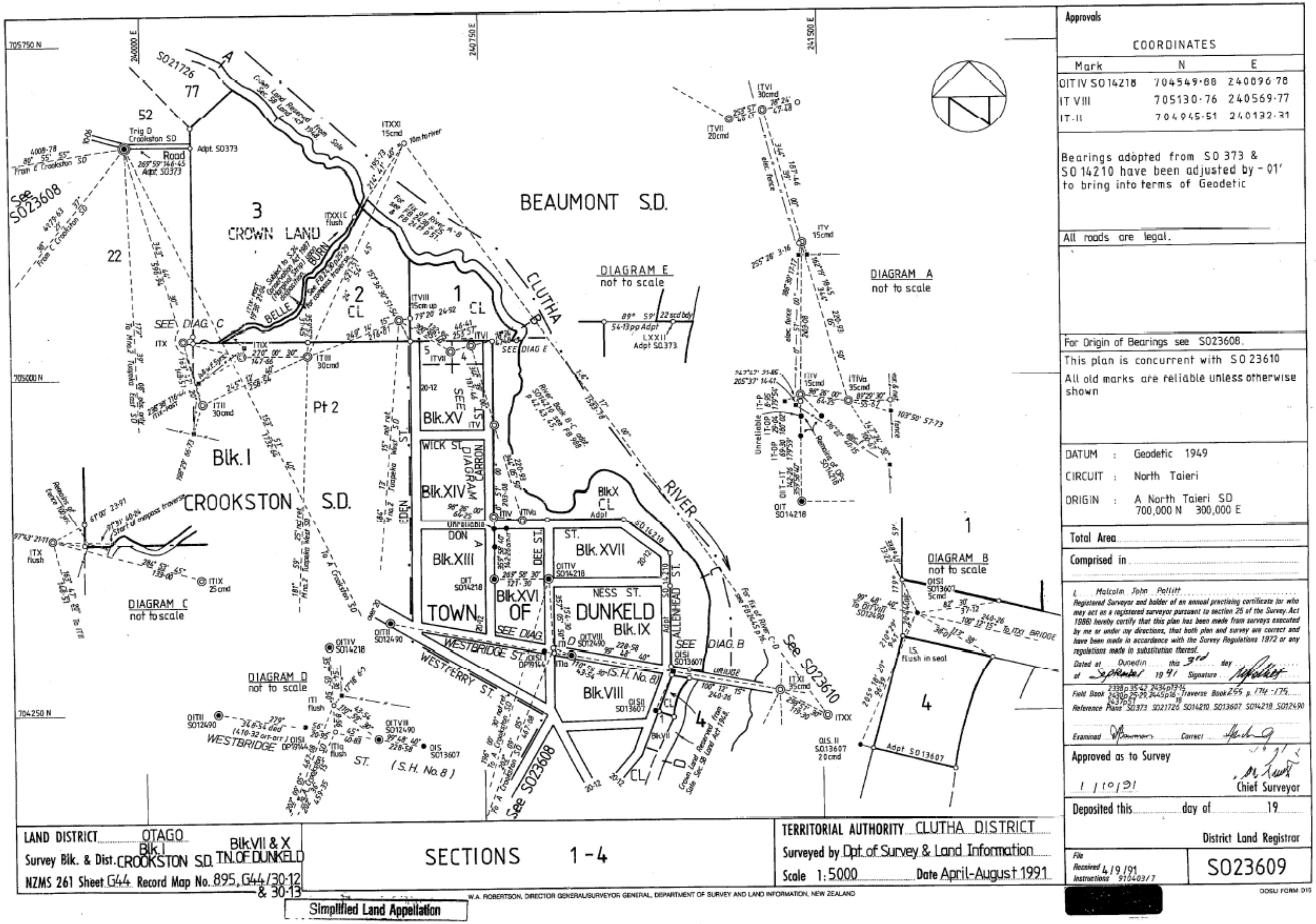
The bed of the Clutha River is excluded from Section 1 SO Plan 23609

Subject to Part IV A Conservation Act 1987

Subject to Section 11 Crown Minerals Act 1991

10293471.1 Mortgage to ASB Bank Limited - 23.12.2015 at 4:38 pm


Approvals
COORDINATES
N E
ITXI 704 298-67 241 406-95
ITXV 704 169-73 241 341-57
ITXVII 704 132-12 241 605-10
See SO 23608 For Origin of Bearings
This plan is concurrent with SO's 23609 & 23584
Except where otherwise shown, old and adopted work is from SO12490.
Bearings from SO17128 are adjusted by + 00' 30"
ROADS ARE LEGAL
DATUM GEODETIC 1949
CIRCUIT A NORTH TAIERI
COORDINATES IN TERMS OF FALSE ORIGIN 700 000 N 300 000 E
Total Area
Comprised in
Diagram of adopted work from SO8982 Not to scale
BLK I
BLK V
BLK III
BLK XX TN OF DUNKELD
SEC 1
SEC 2
SECTION 3
SECTION 4
Crown Land
STATE HIGHWAY No 8
RIVER CLUTHA
EASTBRIDGE ROAD
CROWN LAND
Not formed
Sec. 43 S.O.17377
Sec. 3 S.O. 17403
SO146
Sec1 SO14215
LAND DISTRICT OTAGO
Survey Blk. & Dist. I, III BEAUMONT
NZMS 261 Sheet G44 Record Map No. G44/ 31-13
SECTIONS 1 - 4
BEING FORMERLY CROWN LAND, BLK I; PT SEC 1, SEC 2, PT SEC 30, SEC 31, PT RAILWAY RES, & C.L., BLK III BEAUMONT SD
TERRITORIAL AUTHORITY CLUTHA DISTRICT
Surveyed by Dept of Survey & Land Information
Scale 1: 1000
Date APRIL - JULY 1991
I, MALCOLM JOHN POLLITT
Approved as to Survey
3 / 10 / 91
Chief Surveyor
Deposited this day of 19
District Land Registrar
SO 23610
RM 898
Simplified Land Appellation
[redacted]
SHEET 1 of 3


BEAUMONT S.D.
CROOKSTON S.D.
3
CROWN LAND
CLUTHA RIVER
DIAGRAM E
not to scale
DIAGRAM A
not to scale
DIAGRAM B
not to scale
DIAGRAM C
not to scale
DIAGRAM D
not to scale
Blk. I
Pt 2
Blk.XV
Blk.XIV
Blk.XIII
Blk.XVI
Blk.XVII
Blk.IX
Blk.VIII
TOWN OF DUNKELD
WESTBRIDGE ST.
WESTFERRY ST.
NESS ST.
DEE ST.
DON
WICK ST.
ALLENHEAD ST.
(S.H. No.8)
See SO23608
See SO23610
Approvals
COORDINATES
Mark N E
OIT IV SO 14218 704549·88 240096·78
IT VIII 705130·76 240569·77
IT-II 704945·51 240132·31
Bearings adopted from SO 373 &
SO 14210 have been adjusted by -01'
to bring into terms of Geodetic
All roads are legal.
For Origin of Bearings see SO23608.
This plan is concurrent with SO 23610
All old marks are reliable unless otherwise shown
DATUM : Geodetic 1949
CIRCUIT : North Taieri
ORIGIN : A North Taieri SD
700,000 N 300,000 E
Total Area
Comprised in
Approved as to Survey
1/10/91
Chief Surveyor
Deposited this day of 19
District Land Registrar
SO23609
LAND DISTRICT OTAGO
Survey Blk. & Dist. CROOKSTON SD Blk I, Blk VII & X TN.OF DUNKELD
NZMS 261 Sheet G44 Record Map No. 895, G44/30:12 & 30:13
SECTIONS 1 - 4
TERRITORIAL AUTHORITY CLUTHA DISTRICT
Surveyed by Dpt. of Survey & Land Information
Scale 1:5000 Date April-August 1991
Simplified Land Appellation

10 August 2018

Dear Beth,

Thank you for your enquiry regarding information that the Otago Regional Council may hold regarding potential soil contamination at the properties indicated below:

Legal Description / Title / Valuation Number
Section 4 Survey Office Plan 23609, Title No. OB/673T, valuation no. 28607-01100 Section 2 Survey Office Plan 23610, Title No. OT14B/688, valuation no. 28603-00100 Section 4 Survey Office Plan 23610, Title No. OT14B/689, valuation no. 28603-01800

The Otago Regional Council maintains a database of properties where information is held regarding current or past land-uses that have the potential to contaminated land. Land-uses that have the potential to contaminate land are outlined in the Ministry for the Environment's Hazardous Activities and Industries List (HAIL).

Where investigation has been completed, results have been compared to relevant soil guideline values. The database is continually under development, and should not be regarded as a complete record of all properties in Otago. The absence of available information does not necessarily mean that the property is uncontaminated; rather no information exists on the database. You may also wish to examine the property file at the relevant City or District Council to check if there is any evidence that activities occurring on the HAIL have taken place.

I can confirm that:

The above land does not currently appear on the database.

If your enquiry relates to a rural property, please note that many current and past activities undertaken on farms may not be listed on the database, as they can be more difficult to identify. Activities such as use, storage, formulation, and disposal of pesticides, offal pits, landfills, animal dips, and fuel tanks have the potential to contaminated land.

Similarly, the long-term use of lead-based paints on buildings can, in some cases, cases cause soil contamination. The use of lead-based paint is generally not recorded on the database.

Please feel free to contact me if you have any other enquires, or you would like to discuss the matter further,

Regards,

Simon Beardmore
Senior Environmental Officer

The enclosed/attached information is derived from the Otago Regional contaminated land register and is being disclosed to you pursuant to the Local Government Official Information and Meetings Act 1987. This information reflects the Otago Regional Council's current understanding of this site, which is based solely on the information obtained by the Council and held on record. It is disclosed only as a copy of those records and is not intended to provide a full, complete or entirely accurate assessment of the site. Accordingly, the Otago Regional Council is not in a position to warrant that the information is complete or without error and accepts no liability for any

Appendix C: Natural Hazard Report

Otago Regional Council

Natural Hazards Database Report

The information displayed is schematic only and serves as a guide.
It has been compiled from Otago Regional Council's records and is made available in good faith but its accuracy or completeness is not guaranteed.
Cadastral information has been derived from land information New Zealands (LINZ) Core Record System Database (CRS).

Friday, 10 August 2018

Valuation Information

Valuation Number
2860301800

Parcel Information

LINZ Parcel Information

Parcel Id	Appellation	Affected Surveys	Survey Area	Calculated Area
3131244	Section 4 SO 23610	SO 23610	76289	76487
3031503	Section 3 SO 23610	SO 23610	15102	15061

Title Information

LINZ Title Information

Title No	Status	Type	Land District	Issue Date	Guarantee Status	Estate Description	Owners
OT14B/689	LIVE	Freehold	Otago		Guarantee	Fee Simple, 1/1, Section 3-4 Survey Office Plan 23610, 91,391 m2	2

Otago Regional Council

Land Map

The information displayed is schematic only and serves as a guide.
It has been compiled from Otago Regional Council's records and is made available in good faith but its accuracy or completeness is not guaranteed.
Cadastral information has been derived from Land Information New Zealands (LINZ) Core Record System Database (CRS).

NORTH

Scale 1:3000

Friday, 10 August 2018

Original Sheet Size 210x297mm

NHDB Report - Otago Regional Council

Page 2 of 12

Otago Regional Council

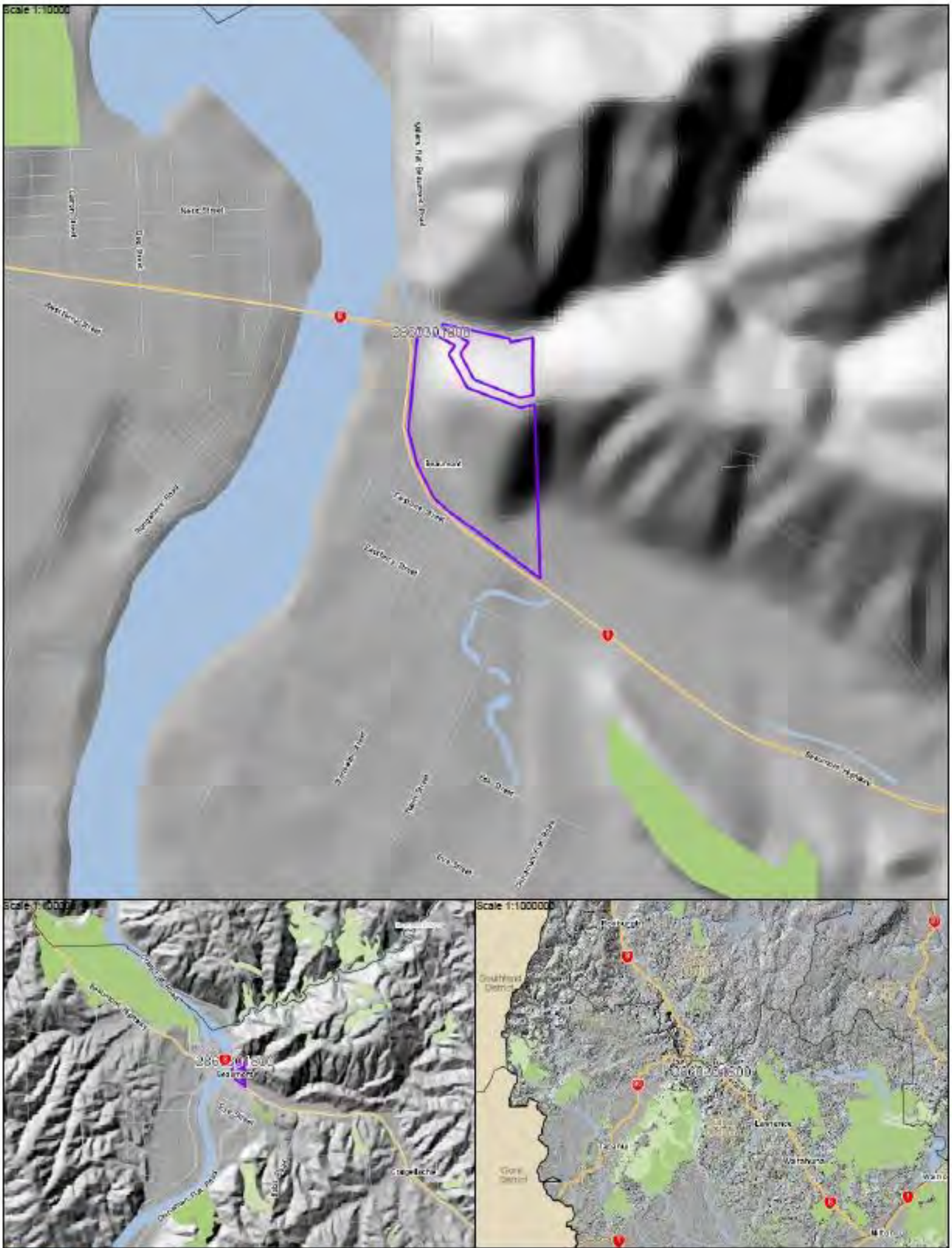
Aerial Photo Map

The information displayed is schematic only and serves as a guide.
It has been compiled from Otago Regional Council's records and is made available in good faith but its accuracy or completeness is not guaranteed.
Cadastral information has been derived from land Information New Zealands (LINZ) Core Record System Database (CRS).

NORTH
Scale 1:3000
Friday, 10 August 2018
Original Sheet Size 210x297mm

NHDB Report - Otago Regional Council

Page 3 of 12



Otago Regional Council

Location Maps

The information displayed is schematic only and serves as a guide.
It has been compiled from Otago Regional Council's records and is made available in good faith but its accuracy or completeness is not guaranteed.
Cadastral information has been derived from land Information New Zealands (LINZ) Core Record System Database (CRS).

NORTH

Friday, 10 August 2018

Original Sheet Size 210x297mm

NHDB Report - Otago Regional Council

Page 4 of 12

Otago Regional Council

Flooding Map

The information displayed is schematic only and serves as a guide.
It has been compiled from Otago Regional Council's records and is made available in good faith but its accuracy or completeness is not guaranteed.
Cadastral information has been derived from land Information New Zealands (LINZ) Core Record System Database (CRS).

NORTH

Scale 1:3000

Friday, 10 August 2018

Original Sheet Size 210x297mm

NHDB Report - Otago Regional Council

Page 5 of 12

Otago Regional Council

Flooding Data

The information displayed is schematic only and serves as a guide.
It has been compiled from Otago Regional Council's records and is made available in good faith but its accuracy or completeness is not guaranteed.
Cadastral Information has been derived from land Information New Zealands (LINZ) Core Record System Database (CRS).

Friday, 10 August 2018

Flooding Information

Flooding Information

Source Report	Flood Hazard Updated	Limitations	Description	Disclaimer
Clutha District Floodplain Report (July 1999)	July 1999	Accuracy of flood hazard margin indicative only		This Natural Hazards Database provides information about known occurrences of hazards. The hazard information is generally relevant over a reasonably wide area. As such, the information contained within this database is not a substitute for a Land Information Memoranda (LIM), which will provide relevant hazard information relating to specific parcels of land. A LIM may be obtained from the relevant local authority (District or City Council).

Otago Regional Council

Seismic Liquefaction Map

The information displayed is schematic only and serves as a guide.
It has been compiled from Otago Regional Council's records and is made available in good faith but its accuracy or completeness is not guaranteed.
Cadastral information has been derived from land Information New Zealands (LINZ) Core Record System Database (CRS).

NORTH

Scale 1:3000

Friday, 10 August 2018

Original Sheet Size 210x297mm

NHDB Report - Otago Regional Council

Page 7 of 12

Otago Regional Council

Seismic Liquefaction Data

The information displayed is schematic only and serves as a guide.
It has been compiled from Otago Regional Council's records and is made available in good faith but its accuracy or completeness is not guaranteed.
Cadastral information has been derived from land Information New Zealands (LINZ) Core Record System Database (CRS).

Friday, 10 August 2018

Liquefaction Information

Liquefaction Information

Source Report	Susceptibility	Description	Material Description	Disclaimer
Seismic Risk in the Otago Region (Mar 2005)	Possibly Susceptible	Very loose to medium dense sediments, liquefaction and settlement are possible with seismic shaking of sufficient intensity.	Peat, Mud, Swamp, Tailings, Reclamation, Fill, and Loose/Soft to Medium Dense: Alluvium, Lake Deposits, Beach Gravels & Sands, Scree, Alluvial Fans, Sand Dunes, Till.	This Natural Hazards Database provides information about known occurrences of hazards. The hazard information is generally relevant over a reasonably wide area. As such, the information contained within this database is not a substitute for a Land Information Memoranda (LIM), which will provide relevant hazard information relating to specific parcels of land. A LIM may be obtained from the relevant local authority (District or City Council).

Otago Regional Council

Documents

Friday, 10 August 2018

1. Flood Reports

List of Flood Reports for the Otago Region

Document Title	Relevance Category	Date Publication
Flood Response Handbook (June 2007) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=6	M	39203
The Natural Hazards of South Dunedin report - July 2016 Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=607		2016/07/01
Coastal Otago flood event 3 June 2015 (2015) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=606		2015/10/01
Flood event 24 - 29 May 2010 (June 2010) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=75	H	2010/06/01
July Floods 07 (Aug 2007) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=65	H	2007/08/06
Flood Procedures Summary Document (Nov 2006) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=64		2006/11/20
Otago Flood Event 25th and 26th April 2006 (May 2006) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=71	H	2006/05/25
Floodplain development and flooding risk in Otago (Sep 2005) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=90		2005/09/08
Flood in the Clutha Catchment (Oct 2002) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=84		2002/10/02
Flood in Waipahi , Lower Pomahaka and Catlins (May 2002) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=86		2002/05/27
Flooding of early January 2002 (Jan 2002) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=88	H	2002/01/21
The Project Seeking Practicable Solutions For Clutha River System Flooding (June 2000) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=97		2000/06/01
Clutha Hydro Dams - PMF Update (May 2000) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=127		2000/05/01
Clutha River Catchment November 1999 Flood Report (March 2000) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=23		2000/03/01
Clutha River Catchment Updated Flood Frequency Analyses (March 2000) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=25		2000/03/01
Clutha District Floodplain Report (July 1999) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=18		1999/07/01
Clutha District Floodplain Report (Nov 1998) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=140		1998/01/11
Clutha Flood Report for Flood of 14 December 1995 (March 1996) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=20		1996/03/01
October 1978 Clutha Flood Report (November 1995) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=28		1995/11/01
Clutha River Flood Audit For Flood of 9 to 10 January 1994 (Jan 1994) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=108		1994/01/28
Report on floodplains within the Clutha District (October 1991) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=30		1991/10/01
Clyde Power Project - Clyde Dam Break Analysis (Dec 1989) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=132		1989/12/31
Flood Forecasting on the Lower Clutha Catchment (Feb 1985) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=130		1985/02/01
Otago Catchment Board Flood Report 1980 - A Collection of Diary Notes, Reports, Data and Press Clippings (1980) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=17		1980/12/12

Document Title	Relevance Category	Date Publication
Clutha Flood of October 1978 (Dec 1978) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=123		1978/12/31
The 100 Year Flood - 1978 (1978) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=116	L	1978/12/31
Flood Disaster 1978 (Nov 1978) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=117		1978/11/30
The Great Flood of '78 (Aug 1978) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=118		1978/08/01
Clutha Power Development - Flows and Design Floods (Mar 1977) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=114		1977/03/01
Flood and Storm in Central Otago 1878 (1966) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=139	L	1966/01/01
Supplement to Floods in New Zealand 1920-53 - District Maps (1957) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=120		1957/12/31

2. Flood Protection Reports

List of Flood Protection Reports for the Otago Region

Document Title	Relevance Category	Date Publication
Flood Protection Management Bylaw (2012) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=575		2012/09/01
Flood Protection Management Bylaw (Sep 2012) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=556	H	2012/01/09
Clutha Flood November 1999 Operational Audit Clyde, Roxburgh and Hawea Dams (May 2000) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=494	L	2000/05/01

3. Alluvial Fan Reports

List of Alluvial Fan Reports for the Otago Region

Document Title	Relevance Category	Date Publication
Otago Alluvial Fans Project Supplementary Investigation (Apr 2009) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=267	H	39904
Otago Alluvial Fans Project Regional Review (Mar 2009) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=266	H	39873
Otago Alluvial Fans Project - Interim Report (May 2007) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=268	L	39203
Assessment of debris flow potential on alluvial fans in Otago, New Zealand, using morphometry (June 2010) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=276	L	2010/06/01
Otago Alluvial Fans Hazards (April 2009) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=271	H	2009/04/06
Otago Alluvial Fans Hazard Identification (June 2007) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=270	M	2007/06/01

4. Seismic Reports

List of Seismic Reports for the Otago Region

Document Title	Relevance Category	Date Publication
Seismic Risk in the Otago Region (Mar 2005) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=281	H	38412
Earthquake Hazards in the Otago Region (Aug 1995) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=282	M	34912
Evaluation of projected earthquake induced losses to underground water services assets, Clutha District (2012) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=571		2012/01/01
Report received Seismic Risk in the Otago Region (May 2005) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=285	M	2005/05/27
Strain Accumulation and Episodicty of Fault Movements in Otago (June 2004) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=289	L	2004/06/01

Document Title	Relevance Category	Date Publication
Otago Regional Council issues associated with the 22 August earthquake (Aug 2003) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=284	L	2003/08/25
Planning for Development of Land on or Close to Active Faults (July 2003) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=578		2003/07/01
Seismic Risk in Otago (May 2003) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=286	M	2003/05/21
Probability of Rupture of the Alpine Fault Allowing for Uncertainties (Sep 2000) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=287	L	2000/09/01
Probability and Consequences of the next Alpine Fault Earthquake (Mar 1998) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=295	L	1998/03/31
Seismotectonic Evaluation of Fault Structures in East Otago (1991) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=291	L	1991/12/31

5. Tsunami Reports

No Tsunami Reports available

6. Coastal Reports (including Storm Surge)

No Coastal Reports (including Storm Surge) available

7. Landslide Reports

List of Landslide Reports for the Otago Region

Document Title	Relevance Category	Date Publication
Regional Landslip Risk and Inventory Project (July 2006) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=369	H	2006/07/19
Regional Landslip Risk and Inventory Project Report (IID) (2006) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=584		2006/07/11
Geology of the Murihiku Area (2003) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=553	H	2003/01/01
Geology of the Wakatipu Area (2000) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=546	H	2000/01/01
Geology of Dunedin Area (1996) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=549	H	1996/01/01

8. General Natural Hazard Reports

List of General Natural Hazard Reports for the Otago Region

Document Title	Relevance Category	Date Publication
Trends and Variability of Temperature Extremes in Southern New Zealand (Nov 2007) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=485	L	2007/11/08
Emergency Management (Aug 2006) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=483	L	2006/08/01
Precipitation Variability in the South Island of New Zealand (Dec 2005) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=491	L	2005/12/01
Safeguarding Otago's Water Resources a State of the Environment Report (April 2001) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=504	L	2001/01/04
Clutha Catchment Monitoring Report (Nov 2000) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=506	L	2000/01/11
The effects of the 1999 Drought on Otago's Rivers (Jan 2000) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=570		2000/01/01
The Climate and Weather of the Otago Region (1968) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=502	L	1968/12/31
Rivers Commission Reports on Clutha River (1878 to 1920) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=496	L	1920/12/31

9. Gravel and Sedimentation Reports

List of Gravel and Sedimentation Hazard Reports for the Otago Region

Document Title	Relevance Category	Date Publication
Clutha River Sediment Budget (Nov 2000) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=462		2000/11/01

10. Snow Reports

List of Snow Reports for the Otago Region

Document Title	Relevance Category	Date Publication
The Potential Impact of Climate Change on Seasonal Snow Condition in NZ (Nov 2010) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=420	L	2010/01/11
Natural Hazards 2006 - The Canterbury Snowstorm (Mar 2007) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=418	L	2007/03/01

Otago Regional Council

Natural Hazards Database Report

The information displayed is schematic only and serves as a guide.
It has been compiled from Otago Regional Council's records and is made available in good faith but its accuracy or completeness is not guaranteed.
Cadastral information has been derived from land Information New Zealands (LINZ) Core Record System Database (CRS).

Friday, 10 August 2018

Valuation Information

Valuation Number
2860301800

Parcel Information

LINZ Parcel Information

Parcel Id	Appellation	Affected Surveys	Survey Area	Calculated Area
3131244	Section 4 SO 23610	SO 23610	76289	76487
3031503	Section 3 SO 23610	SO 23610	15102	15061

Title Information

LINZ Title Information

Title No	Status	Type	Land District	Issue Date	Guarantee Status	Estate Description	Owners
OT14B/689	LIVE	Freehold	Otago		Guarantee	Fee Simple, 1/1, Section 3-4 Survey Office Plan 23610, 91,391 m2	2

Scenario	Description
Rural / lifestyle block	Rural residential land use, including home-grown produce consumption (25 per cent). Applicable to the residential vicinity of farm houses for protection of farming families, but not the productive parts of agricultural land. Note: Consumption of eggs, milk and meat from animals raised on site is excluded. Produce consumption is limited to home-grown vegetables. Sites for which consumption of home-grown eggs, milk or meat is important will need to be evaluated on a site-specific basis.
Residential	Standard residential lot, for single dwelling sites with gardens, including home-grown produce consumption (10 per cent).
High-density residential	Urban residential with limited soil contact, including small ornamental gardens but no vegetable garden (no home-grown produce consumption); applicable to urban townhouses, flats and ground-floor apartments with small ornamental gardens, but not high-rise apartments.
Parks / recreational	Public and private green areas and reserves used for active sports and recreation. This scenario is intended to cover playing fields and suburban reserves where children play frequently. It can also reasonably cover secondary school playing fields but not primary school playing fields.
Commercial / industrial outdoor worker (unpaved)	Commercial / industrial site with varying degrees of exposed soil. Exposure of outdoor workers to near-surface soil during routine maintenance and gardening activities with occasional excavation as part of maintaining subsurface utilities (ie, a caretaker or site maintenance personnel). Also conservatively applicable to outdoor workers on a largely unpaved site.

Otago Regional Council

Aerial Photo Map

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NORTH

Scale 1:3000

Friday, 10 August 2018

Original Sheet Size 210x297mm

NHDB Report - Otago Regional Council

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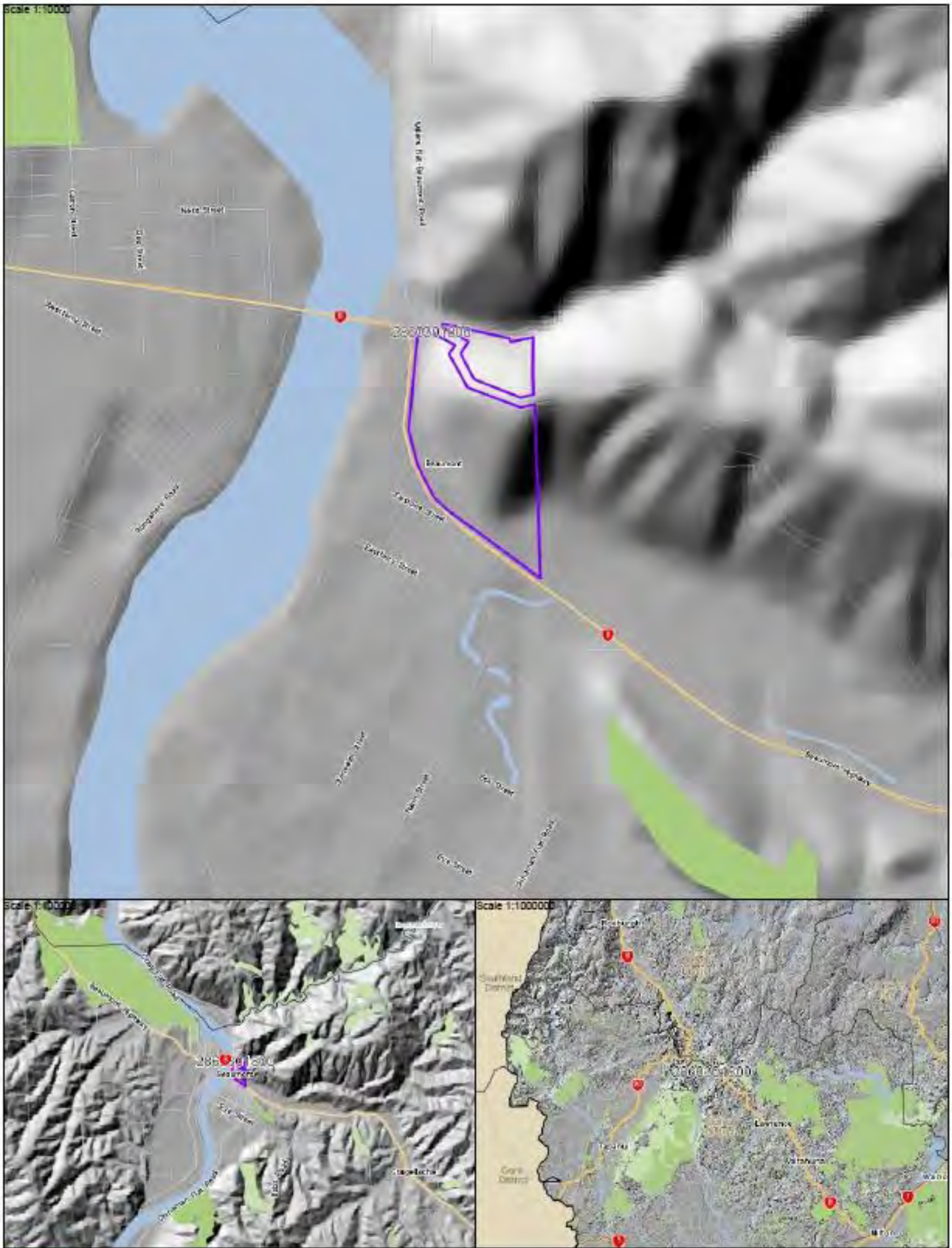

Otago Regional Council

Location Maps

The information displayed is schematic only and serves as a guide.
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NORTH

Friday, 10 August 2018

Original Sheet Size 210x297mm

NHDB Report - Otago Regional Council

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Flooding Map

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NORTH

Scale 1:3000

Friday, 10 August 2018

Original Sheet Size 210x297mm

NHDB Report - Otago Regional Council

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Otago Regional Council

Flooding Data

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Cadastral information has been derived from land Information New Zealands (LINZ) Core Record System Database (CRS).

Friday, 10 August 2018

Flooding Information

Flooding Information

Source Report	Flood Hazard Updated	Limitations	Description	Disclaimer
Clutha District Floodplain Report (July 1999)	July 1999	Accuracy of flood hazard margin indicative only		This Natural Hazards Database provides information about known occurrences of hazards. The hazard information is generally relevant over a reasonably wide area. As such, the information contained within this database is not a substitute for a Land Information Memoranda (LIM), which will provide relevant hazard information relating to specific parcels of land. A LIM may be obtained from the relevant local authority (District or City Council).

Otago Regional Council

Seismic Liquefaction Map

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Cadastral information has been derived from land Information New Zealands (LINZ) Core Record System Database (CRS).

NORTH

Scale 1:3000

Friday, 10 August 2018

Original Sheet Size 210x297mm

Otago Regional Council	**Seismic Liquefaction Data** The information displayed is schematic only and serves as a guide. It has been compiled from Otago Regional Council's records and is made available in good faith but its accuracy or completeness is not guaranteed. Cadastral information has been derived from land Information New Zealands (LINZ) Core Record System Database (CRS). CROWN COPYRIGHT RESERVED. © Copyright Otago Regional Council.	Friday, 10 August 2018

Liquefaction Information

Liquefaction Information

Source Report	Susceptibility	Description	Material Description	Disclaimer
Seismic Risk in the Otago Region (Mar 2005)	Possibly Susceptible	Very loose to medium dense sediments, liquefaction and settlement are possible with seismic shaking of sufficient intensity.	Peat, Mud, Swamp, Tailings, Reclamation, Fill, and Loose/Soft to Medium Dense: Alluvium, Lake Deposits, Beach Gravels & Sands, Scree, Alluvial Fans, Sand Dunes, Till.	This Natural Hazards Database provides information about known occurrences of hazards. The hazard information is generally relevant over a reasonably wide area. As such, the information contained within this database is not a substitute for a Land Information Memoranda (LIM), which will provide relevant hazard information relating to specific parcels of land. A LIM may be obtained from the relevant local authority (District or City Council).

Otago Regional Council

Documents

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Cadastral information has been derived from land Information New Zealands (LINZ) Core Record System Database (CRS).

Friday, 10 August 2018

1. Flood Reports

List of Flood Reports for the Otago Region

Document Title	Relevance Category	Date Publication
Flood Response Handbook (June 2007) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=6	M	39203
The Natural Hazards of South Dunedin report - July 2016 Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=607		2016/07/01
Coastal Otago flood event 3 June 2015 (2015) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=606		2015/10/01
Flood event 24 - 29 May 2010 (June 2010) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=75	H	2010/06/01
July Floods 07 (Aug 2007) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=65	H	2007/08/06
Flood Procedures Summary Document (Nov 2006) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=64		2006/11/20
Otago Flood Event 25th and 26th April 2006 (May 2006) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=71	H	2006/05/25
Floodplain development and flooding risk in Otago (Sep 2005) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=90		2005/09/08
Flood in the Clutha Catchment (Oct 2002) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=84		2002/10/02
Flood in Waipahi , Lower Pomahaka and Catlins (May 2002) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=86		2002/05/27
Flooding of early January 2002 (Jan 2002) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=88	H	2002/01/21
The Project Seeking Practicable Solutions For Clutha River System Flooding (June 2000) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=97		2000/06/01
Clutha Hydro Dams - PMF Update (May 2000) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=127		2000/05/01
Clutha River Catchment November 1999 Flood Report (March 2000) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=23		2000/03/01
Clutha River Catchment Updated Flood Frequency Analyses (March 2000) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=25		2000/03/01
Clutha District Floodplain Report (July 1999) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=18		1999/07/01
Clutha District Floodplain Report (Nov 1998) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=140		1998/01/11
Clutha Flood Report for Flood of 14 December 1995 (March 1996) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=20		1996/03/01
October 1978 Clutha Flood Report (November 1995) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=28		1995/11/01
Clutha River Flood Audit For Flood of 9 to 10 January 1994 (Jan 1994) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=108		1994/01/28
Report on floodplains within the Clutha District (October 1991) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=30		1991/10/01
Clyde Power Project - Clyde Dam Break Analysis (Dec 1989) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=132		1989/12/31
Flood Forecasting on the Lower Clutha Catchment (Feb 1985) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=130		1985/02/01
Otago Catchment Board Flood Report 1980 - A Collection of Diary Notes, Reports, Data and Press Clippings (1980) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=17		1980/12/12

Document Title	Relevance Category	Date Publication
Clutha Flood of October 1978 (Dec 1978) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=123		1978/12/31
The 100 Year Flood - 1978 (1978) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=116	L	1978/12/31
Flood Disaster 1978 (Nov 1978) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=117		1978/11/30
The Great Flood of '78 (Aug 1978) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=118		1978/08/01
Clutha Power Development - Flows and Design Floods (Mar 1977) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=114		1977/03/01
Flood and Storm in Central Otago 1878 (1966) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=139	L	1966/01/01
Supplement to Floods in New Zealand 1920-53 - District Maps (1957) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=120		1957/12/31

2. Flood Protection Reports

List of Flood Protection Reports for the Otago Region

Document Title	Relevance Category	Date Publication
Flood Protection Management Bylaw (2012) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=575		2012/09/01
Flood Protection Management Bylaw (Sep 2012) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=556	H	2012/01/09
Clutha Flood November 1999 Operational Audit Clyde, Roxburgh and Hawea Dams (May 2000) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=494	L	2000/05/01

3. Alluvial Fan Reports

List of Alluvial Fan Reports for the Otago Region

Document Title	Relevance Category	Date Publication
Otago Alluvial Fans Project Supplementary Investigation (Apr 2009) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=267	H	39904
Otago Alluvial Fans Project Regional Review (Mar 2009) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=266	H	39873
Otago Alluvial Fans Project - Interim Report (May 2007) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=268	L	39203
Assessment of debris flow potential on alluvial fans in Otago, New Zealand, using morphometry (June 2010) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=276	L	2010/06/01
Otago Alluvial Fans Hazards (April 2009) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=271	H	2009/04/06
Otago Alluvial Fans Hazard Identification (June 2007) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=270	M	2007/06/01

4. Seismic Reports

List of Seismic Reports for the Otago Region

Document Title	Relevance Category	Date Publication
Seismic Risk in the Otago Region (Mar 2005) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=281	H	38412
Earthquake Hazards in the Otago Region (Aug 1995) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=282	M	34912
Evaluation of projected earthquake induced losses to underground water services assets, Clutha District (2012) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=571		2012/01/01
Report received Seismic Risk in the Otago Region (May 2005) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=285	M	2005/05/27
Strain Accumulation and Episodicty of Fault Movements in Otago (June 2004) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=289	L	2004/06/01

Document Title	Relevance Category	Date Publication
Otago Regional Council issues associated with the 22 August earthquake (Aug 2003) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=284	L	2003/08/25
Planning for Development of Land on or Close to Active Faults (July 2003) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=578		2003/07/01
Seismic Risk in Otago (May 2003) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=286	M	2003/05/21
Probability of Rupture of the Alpine Fault Allowing for Uncertainties (Sep 2000) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=287	L	2000/09/01
Probability and Consequences of the next Alpine Fault Earthquake (Mar 1998) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=295	L	1998/03/31
Seismotectonic Evaluation of Fault Structures in East Otago (1991) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=291	L	1991/12/31

5. Tsunami Reports

No Tsunami Reports available

6. Coastal Reports (including Storm Surge)

No Coastal Reports (including Storm Surge) available

7. Landslide Reports

List of Landslide Reports for the Otago Region

Document Title	Relevance Category	Date Publication
Regional Landslip Risk and Inventory Project (July 2006) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=369	H	2006/07/19
Regional Landslip Risk and Inventory Project Report (IID) (2006) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=584		2006/07/11
Geology of the Murihiku Area (2003) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=553	H	2003/01/01
Geology of the Wakatipu Area (2000) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=546	H	2000/01/01
Geology of Dunedin Area (1996) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=549	H	1996/01/01

8. General Natural Hazard Reports

List of General Natural Hazard Reports for the Otago Region

Document Title	Relevance Category	Date Publication
Trends and Variability of Temperature Extremes in Southern New Zealand (Nov 2007) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=485	L	2007/11/08
Emergency Management (Aug 2006) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=483	L	2006/08/01
Precipitation Variability in the South Island of New Zealand (Dec 2005) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=491	L	2005/12/01
Safeguarding Otago's Water Resources a State of the Environment Report (April 2001) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=504	L	2001/01/04
Clutha Catchment Monitoring Report (Nov 2000) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=506	L	2000/01/11
The effects of the 1999 Drought on Otago's Rivers (Jan 2000) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=570		2000/01/01
The Climate and Weather of the Otago Region (1968) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=502	L	1968/12/31
Rivers Commission Reports on Clutha River (1878 to 1920) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=496	L	1920/12/31

9. Gravel and Sedimentation Reports

List of Gravel and Sedimentation Hazard Reports for the Otago Region

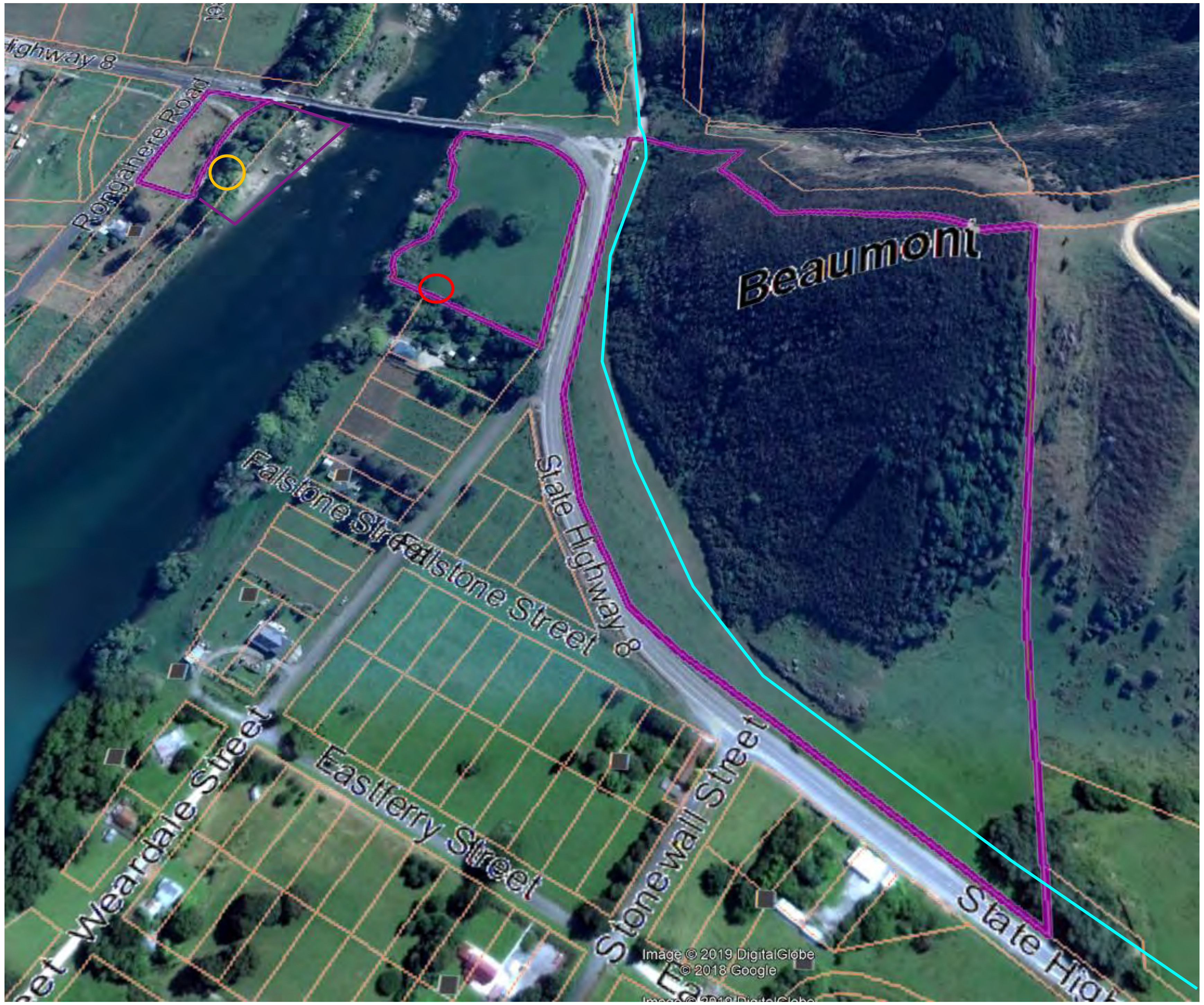
Document Title	Relevance Category	Date Publication
Clutha River Sediment Budget (Nov 2000) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=462		2000/11/01

10. Snow Reports

List of Snow Reports for the Otago Region

Document Title	Relevance Category	Date Publication
The Potential Impact of Climate Change on Seasonal Snow Condition in NZ (Nov 2010) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=420	L	2010/01/11
Natural Hazards 2006 - The Canterbury Snowstorm (Mar 2007) Link to Document: http://hazards.orc.govt.nz/intramaps/DMSNZ/NHDB/showPDF.aspx?did=418	L	2007/03/01

Appendix D: Site Layout Plan



Key

Approximate site boundary

Possiable Sheep dip

car parking area

Railway line

wsp | OPUS	Project:	Beaumont Bridge	Appendix D: Site Layout Plan
	Project Number:	6-CT012.00	
	Client:	NZTA	

Appendix E: Site Photographs

Photo 1: Eastern paddock on true left of SH8

Photo 2: Eastern Bank paddock on true right of SH8

Photo 3: Sheep dip/drenching run in eastern bank paddock

Photo 4: Eastern abutment of existing bridge

Photo 5: Western bank viewed from eastern bank

Photo 6: Eastern bank and existing bridge viewed from western bank

Photo 7: Eastern bank viewed from western bank

Photo 8: Rest area / boat ramp on western bank

Photo 9: Access road to rest area/ boat ramp

Photo 10: SH8 western side towards existing bridge

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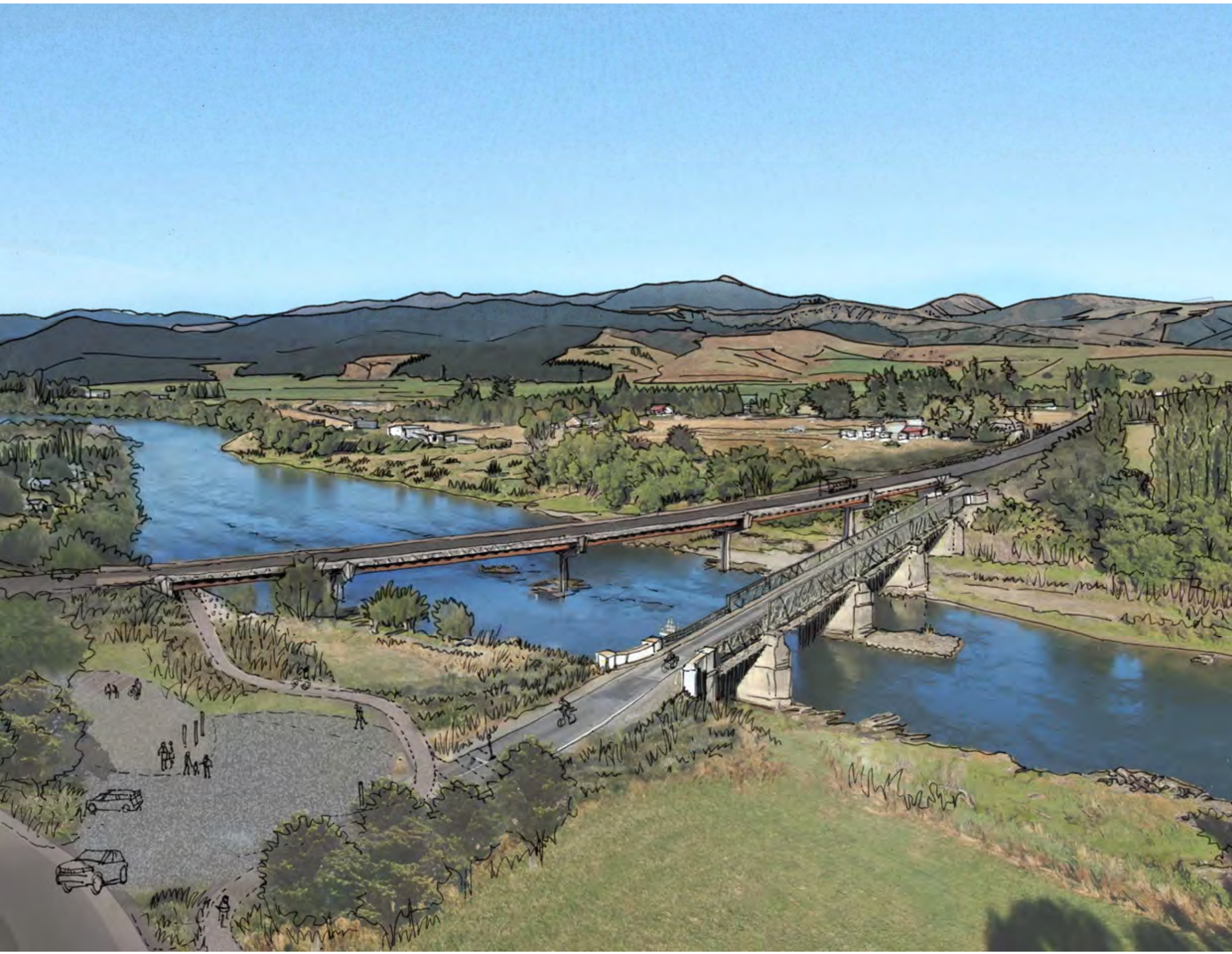
New Beaumont Bridge

Hydraulic Assessment & Design Information



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1	7 November 2018	D McMullan	F Maas	M Davies	First Issue
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Revision Details

Revision	Details
1	First issue of the document
2	Second issue of the document including the scour assessment and scour protection design

1 Introduction

1.1 Background

The SH8 Beaumont Bridge across the Clutha River is to be replaced by NZTA. The bridge will be located on a relatively straight section of the Clutha River just downstream of a river bend. The channel is incised with rock outcrops protruding the low flow water surface both in the centre of the channel and on the true right bank (see Figure 1-1). The location of the proposed replacement bridge is located immediately downstream of the existing SH8 Beaumont Bridge which is to be retained for pedestrian and cyclist use. Consequently, the hydraulic analysis will consider the effects of the existing bridge.

To support the design and construction of the replacement bridge, peak water levels and flow velocities for key design events have been estimated. These have then been used to assess the scour risk to the proposed bridge and to design appropriate scour protection

Figure 1-1 View of the Clutha River looking downstream from the existing bridge towards the site of the proposed bridge

1.2 Design Events

The two key design events for the bridge are detailed in the NZ Transport Agency Bridge Manual (NZTA, 2018). These are the Serviceability Limit State (SLS) flood event and the Ultimate Limit State (ULS) flood event. Based on the bridge being an importance level 3 bridge, these design events are the 1% annual exceedance probability (AEP) flood event including the effects of climate change to 2120 (+CC) and the 0.1% AEP +CC respectively.

The SLS design event is critical for setting the bridge soffit level to provide a specified freeboard, and to ensure scour during this flood event does not affect the bridge's serviceability; such as by eroding the approach road embankments. The ULS design event is critical to ensure the bridge structure is not undermined by scour at the piers or abutments during a flood event of this magnitude, and to ensure the bridge can withstand the hydrodynamic loading from the floodwaters.

2 Hydrological Assessment

A hydrological assessment was undertaken to derive design flood estimates at the location of the proposed bridge (WSP Opus, 2018). This hydrological assessment also provides a discussion on the data quality, flood frequency analysis methodology, implications of the 0.1% AEP design standard (equivalent to a 1,000-year average recurrence interval (ARI)), climate change scenarios, and on a low flow analysis to help facilitate the bridge construction.

The SLS and ULS flood estimates inclusive of climate change to 2120 are 5,250m^3/s and 7,100m^3/s respectively (highlighted in Table 2-1). The full range of flood estimates are provided, for both current and future climate conditions, in Table 2-1. Note that climate change projections have only been provided for floods greater than a 2% AEP.

Table 2-1 Design flood estimates adjusted for climate change (m^3/s). Values rounded to the nearest 50m^3/s

ARI (yr.)	*AEP (%)*	2018	2070[1]	2120[2]
2.33	*50*	1,580		
5	*20*	2,130		
10	*10*	2,630		
20	*5*	3,140		
25	*4*	3,280		
50	*2*	3,810	4,200	4,600
100	*1*	4,320	4,750	5,250
1000	*0.01*	5,850	6,450	7,100
2500	*0.04*	6,500	7,150	7,850

3 Hydraulic Assessment

3.1 Methodology

A comprehensive hydraulic assessment for a significant structure such as the Beaumont Bridge would commonly include a coupled one-dimensional and two-dimensional computational hydraulic model, representing the river channel and floodplain respectively. Furthermore, this model would be run in an unsteady state to represent the effects of attenuation across the floodplain. However, given that there have been few flooding concerns with the existing SH8 bridge structure across its extensive lifespan (greater than 130 years), it is expected that the hydraulic risk to the proposed structure is sufficiently low and a more basic hydraulic assessment is appropriate. It is also important to note that the hydrological assessment (WSP Opus, 2018) found that there was minimal attenuation between Roxburgh Dam and Balclutha, and so the effects of using a steady-state model are also likely to be minimal and within the model's margin of error.

On this basis, the methodology adopted for the hydraulic assessment of the proposed bridge structure is based on a one-dimensional steady-state hydraulic model. This is more simplistic than a fully comprehensive hydraulic assessment outlined above and does not fully represent the

[1] The flows in this column are as a result of 50 years of climate change.
[2] The flows in this column are as a result of 100 years of climate change.

floodplain or any effects of attenuation. To enhance the model, a portion of the surveyed cross-sections were extended on the left and/or right banks in post-processing to better represent the floodplain.

The simplification of the hydraulic modelling can lead, and likely will have led, to conservative model results by some minor to moderate extent. The one-dimensional nature of the model means that the river channel, and the immediate floodplain (50-100m width) on each channel bank, is represented by a cross-section perpendicular to the flow of water. Where the water reaches the edge of the surveyed cross-section, the model assumes that the cross-section has vertical walls. Therefore, to convey the modelled flow down the channel, the modelling approach causes the water level to increase more than might be expected, rather than allow the flow to spread out across the floodplain and have a smaller increase in water level. Without undertaking a comprehensive assessment, it is not possible to quantify the magnitude of the model's conservativism. However, the conservative outcome within the model will be discussed qualitatively alongside the model results in Section 3.4. It is important to note that the model was calibrated to a flow of 3,250m^3/s, as discussed below. Overall, the methodology is considered appropriate given the level of risk to the bridge structure by floodwater action.

The one-dimensional computational hydraulic model used in this assessment to estimate the peak water levels and flow velocities at the location of the proposed bridge structure was constructed using HEC-RAS[3] computational hydraulic modelling software package. This is discussed further in Section 3.3.

3.2 Survey Data

To inform the hydraulic assessment, Eliot Sinclair was engaged to conduct a hydrographic survey of the Clutha River in a reach approximately 350m long around the existing and proposed bridge structures (Eliot Sinclair, 2018). This survey included six river cross-sections perpendicular to the flow of the river, existing bridge soffit levels across the bridge span, and a hydrographic survey of the river bed at 2m spacings. The survey was undertaken on 3 July 2018 in Dunedin Vertical Datum 1958 (DVD58) and in NZGD2000 / North Taieri Circuit 2000. All levels in this report are in terms of this vertical datum and projection.

Cross-sectional survey data supplied by Otago Regional Council (ORC) was used in addition to the Eliot Sinclair survey data to inform the hydraulic assessment. The locations of these cross-sections are shown below in Figure 3-1.

The soffit level of the existing bridge structure was surveyed to be 48.68m RL (Eliot Sinclair, 2018).

[3] HEC-RAS is a computational hydraulic modelling software package developed by the United States Army Corps of Engineers (USACE) that is commonly used within the industry to model the hydraulics of water flow through open channels and bridges.

Figure 3-1 Cross-sections surveyed by Eliot Sinclair (shown in pink) and by ORC (shown in green)

3.3 HEC-RAS Model

3.3.1 Overview

As discussed in Section 3.1, a HEC-RAS model was created to estimate the peak water levels and flow velocities for key design events. This model is based on twelve cross-sections over a reach of 4370m, with the majority focused around a 1520m reach of the Clutha River. Surveyed cross-sections, historical bridge drawings (PWD, 1885), and the latest design information was used to represent the existing and proposed bridge structures in the model. The spill through abutments of the proposed bridge were modelled as vertical structures located at the toe of the abutments to provide flexibility in the design of the abutments.

Boundary conditions were defined based on design flows and an assumed average energy slope at the upstream and downstream ends of the model. The average energy slopes were 0.27% and 0.13% at the upstream and downstream boundaries of the model respectively.

3.3.2 Calibration

Two calibration flood events were run based on the January 1994 and December 1995 flood events. These events are still relevant as the flows in this reach of the Clutha River have been modified by the Roxburgh Dam since 1956 (WSP Opus, 2018). These floods were estimated to have peak discharges of 2,700m^3/s and 3,250m^3/s respectively (WCS, 1996). Flood levels at Beaumont estimated from surveyed debris marks were 44.45m RL and 45.62m RL for the 1994 and 1995 flood events respectively. It was found that by applying a Manning's n value of 0.049 to represent the roughness of the river, the model predicted peak water levels closest to the measured water levels of the calibration flood events. The 1994 flood event was over-estimated by 0.38m, and the 1995 flood event was under-estimated by 0.04m. Given that the 1995 flood event was the larger of the two flood events, more emphasis was placed on this flood event. On average, increasing or decreasing the Manning's n value by 0.001 increased or decreased the water levels by 0.09m. A summary of the calibration results is provided below in Table 3-1.

Table 3-1 Calibration results

Flood Event	Flow (m^3/s)	Surveyed Flood Level (m RL)	Modelled Flood Level (m RL)	Difference (m)
January 1994	2,700	44.45	44.83	+0.38
December 1995	3,250	45.62	45.58	-0.04

3.4 Key Results

The HEC-RAS model was run as part of the hydraulic assessment to estimate the water level and average cross-sectional flow velocity upstream of the proposed bridge for the SLS and ULS design events. These results are presented below in Table 3-2.

Table 3-2 Hydraulic assessment results for key design events upstream of the proposed bridge

Design Event	Estimated Flow (m^3/s)	Water Level Upstream of Proposed Bridge (m RL)	Average Flow Velocity (m/s)
SLS	5,250	47.93	3.4
ULS	7,100	49.91	3.6

To provide input into the design of the cycle pathways and other bridge features, the predicted water levels upstream of the proposed bridge for all flood events of current and future climate conditions have also been provided (see Table 3-3). The SLS and ULS flood events have been highlighted in orange.

Table 3-3 Predicted water levels upstream of the proposed bridge for all flood events of current and future climate conditions (m RL)

ARI (yr.)	AEP (%)	2018	2070	2120
2.33	50	43.01		
5	20	43.91		
10	10	44.62		
20	5	45.31		
25	4	45.53		
50	2	46.21	46.70	47.22
100	1	46.91	47.39	47.93
1000	0.01	48.45	49.26	49.91
2500	0.04	49.31	49.95	50.55

3.5 Effects on Existing Flood Risk

The proposed bridge's abutments will reduce the flow of floodwaters across the floodplain, and its piers will impede the flow of water down the Clutha River channel. Consequently, it can be expected that the water levels upstream of the new bridge will increase. Table 3-4 details the existing flood levels, and the expected change in flood levels following the construction of the proposed bridge, for a range of flood events.

Table 3-4 Predicted flood levels upstream of the existing SH8 Bridge in the existing and proposed situations, with the change in flood level shown in brackets. (m RL)

FLOOD EVENT	FLOW	EXISTING FLOOD LEVEL	FLOOD LEVEL IN PROPOSED SITUATION
50% AEP	1,580m^3/s	43.08	43.11 (+0.03)
20% AEP	2,130m^3/s	44.00	44.04 (+0.04)
10% AEP	2,630m^3/s	44.72	44.77 (+0.05)
5% AEP	3,140m^3/s	45.43	45.49 (+0.06)
2% AEP	3,810m^3/s	46.37	46.44 (+0.07)
1% AEP	4,320m^3/s	47.09	47.17 (+0.08)
1% AEP +CC2120	5,250m^3/s	48.16	48.26 (+0.10)

The results show that the effect of the proposed SH8 Bridge across the Clutha River will have a less than minor effect on the flood risk upstream of the existing SH8 Bridge. The maximum increase in flood level for the scenarios considered is 0.10m, which is within the model error range.

The existing bridge soffit level was surveyed to be 48.68m RL. This provides 0.52m of freeboard to the SLS flood event for the 2120 climate. This will reduce to 0.42m following the construction of the proposed bridge.

3.6 Sensitivity to Climate Change Scenarios

The hydraulic assessment results detailed above include the effects of climate change out to 2120 for climate change scenario RCP6.0. Further discussion on the various climate change scenarios and on the guidance from the Ministry for Environment is available in the hydrological assessment report (WSP Opus, 2018).

To quantify the effects of the uncertainty related to the expected amount of change to climate conditions, the SLS and ULS flood events have been run in the HEC-RAS model for the different climate change scenarios, taken out to 2120. The variation in water levels from RCP6.0 for each of these scenarios is presented in Table 3-5. It is important to note that the conservative approach inherent in the model still applies to each of the results in the table below.

The results below indicate that RCP6.0 is an appropriate climate change scenario to use for the design of the proposed SH8 Beaumont Bridge. The maximum increase in water level to RCP8.5 is only 0.30m. This is considered to be a minor risk to the bridge structure as designed should this climate change scenario occur. Alternatively, if climate change scenario RCP4.5 had been adopted, the difference in water level between RCP4.5 and RCP8.5 for the ULS event would be much more significant. This change in water level is estimated to be 0.73m, which would present a risk to the structure if designed to RCP4.5, should climate change scenario RCP8.5 eventuate.

Table 3-5 Predicted water levels for various climate change scenarios taken out to 2120, with the change in water level from RCP6.0 shown in brackets. (m RL)

SCENARIO	SLS	ULS
RCP2.6	47.17 (-0.76	48.79 (-1.12)
RCP4.5	47.60 (-0.33)	49.48 (-0.43)
RCP6.0	47.93	49.91
RCP8.5	48.15 (+0.22)	50.21 (+0.30)

4 Scour Assessment

4.1 Setting

As discussed in Section 1.1, the proposed bridge structure is to be located across a straight section of an incised channel immediately downstream of a bend (Figure 4-1). Consequently, the flow velocity is likely to be slightly higher on the true left (i.e. east or Dunedin) side of the river. The channel is characterised by rock outcrops that protrude from the low flow water level.

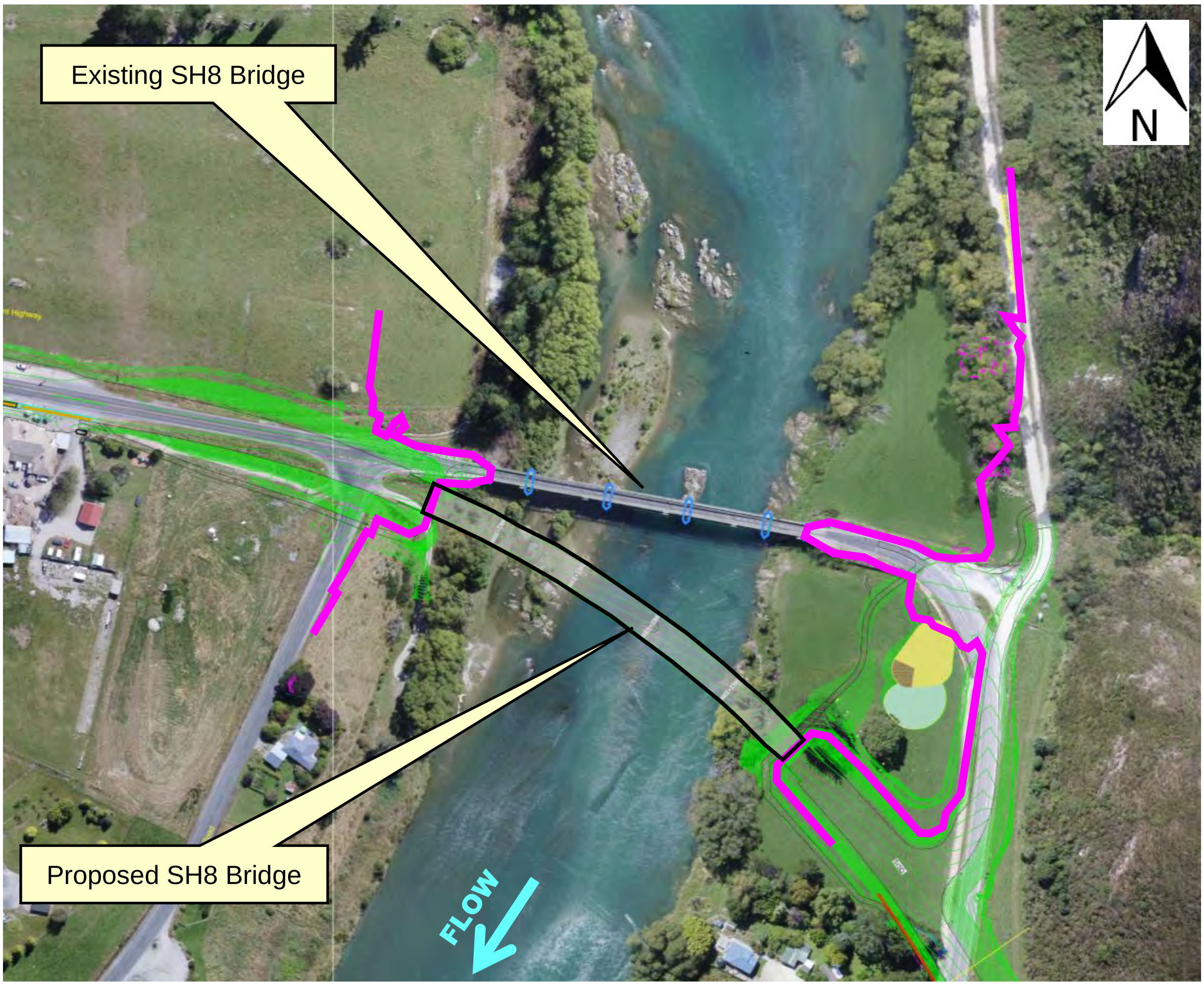

Figure 4-1 Detail of Clutha River and the existing and proposed SH8 bridges showing channel alignment and SLS event flood extent near the bridges (pink).

The proposed bridge structure (Figure 4-2) will have four single circular piers in between the abutments which are located on either side of the river channel. These piers will be founded upon the rock outcrops for ease of construction, to minimise the effects on the river flow, and to reduce the risk of scour undermining the bridge structure.

This scour assessment will focus on two key components; the scour risk to the piers located on the rock outcrops, and the scour risk to the abutments located on the floodplain either side of the river channel.

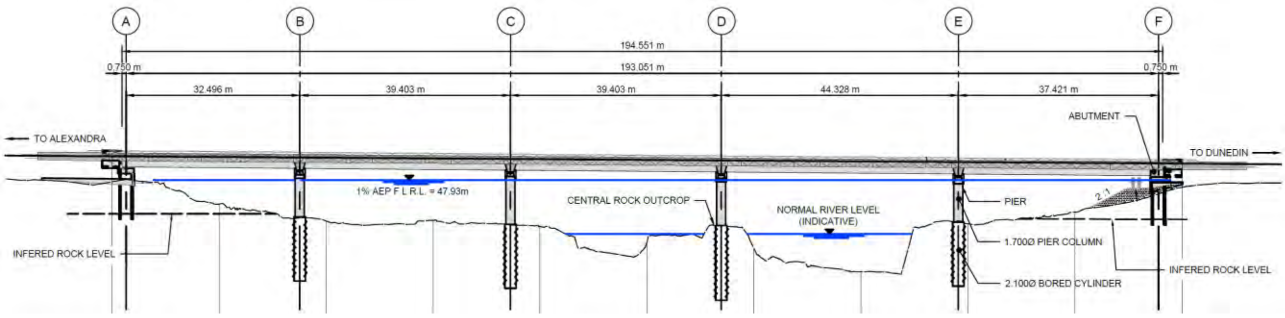

Figure 4-2 Structural long section of the proposed bridge viewed from downstream

4.2 Design Requirements

As discussed in Section 1.2, the two key design events are the SLS flood event (1% AEP for the 2120 climate), and the ULS flood event (0.1% AEP for the 2120 climate). It is critical that the road embankments are not washed out in the SLS flood event, and that the piers and abutments are not undermined during a ULS flood event.

4.3 Analysis of Potential Scour to Piers

The potential for scour to occur during a flood event is a result of the hydraulic forces applied by the floodwaters against the river bed material, and the ability of that river bed material to resist those hydraulic forces. Determining the magnitude of scour that could occur must be validated against observations of the surrounding river. In this case, it must be acknowledged that the existing SH8 bridge structure has had an asset life of approximately 135 years with minimal scour.

4.3.1 Existing Bridge

The existing SH8 bridge structure (Figure 4-3) was well founded with concrete footings on rock outcrops that have protected its piers during flood events. The only scour known to have occurred to the existing SH8 bridge structure is underneath Pier D where the rock, on which the concrete footing sits, has been locally undercut by up to 1.8m (Figure 4-4). Only 1.0m of that undercutting is directly under the pier footing with the opening width being a very small proportion of the entire footing perimeter. The deepest point of this scour is located approximately 2.5m beneath the top of the concrete footing. No repairs have been made to date and consequently it must be assumed that this scour is being monitored and is not currently of concern.

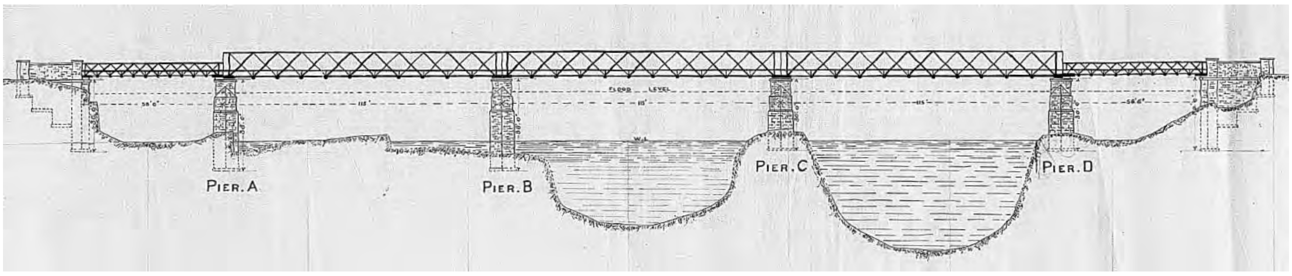

Figure 4-3 Existing bridge viewed from downstream (Source: PWD, 1885)

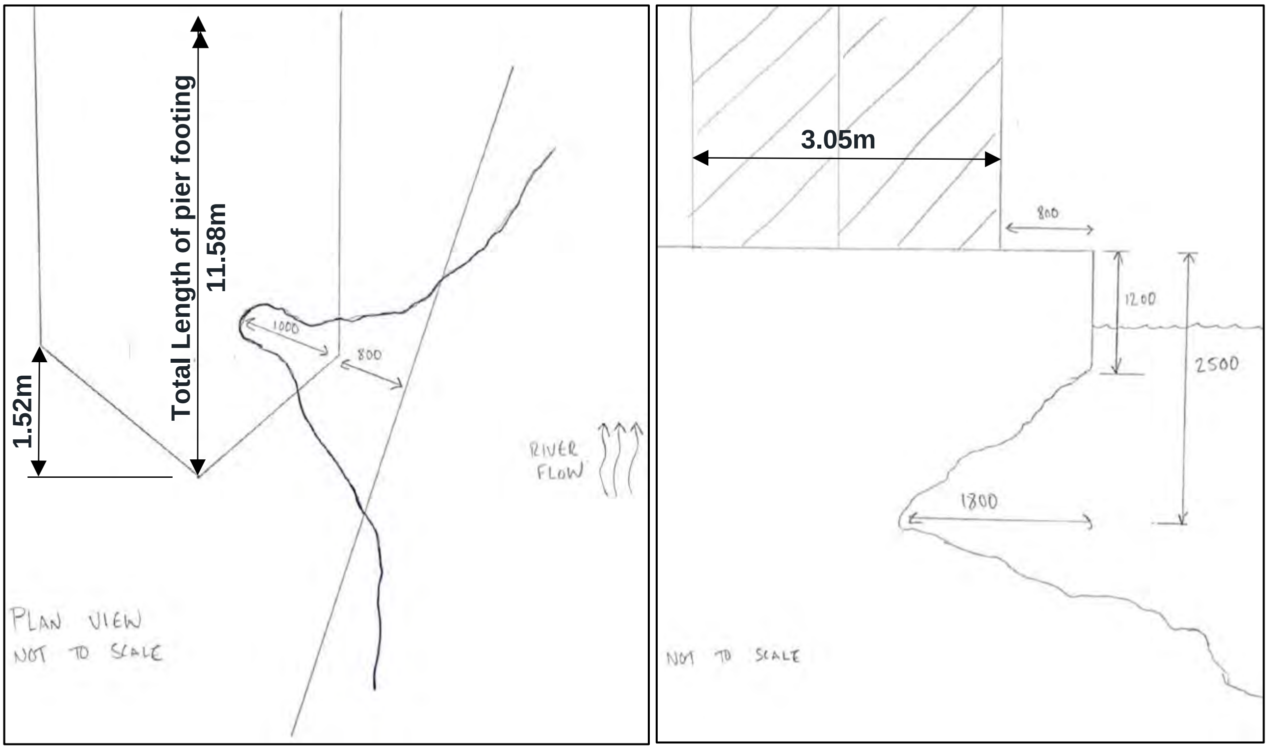

Figure 4-4 Plan (left) and section (right) of scour undercutting of Pier D of the existing SH8 bridge (Source: Underwater Solutions Ltd, 2014 and PWD, 1885)

4.3.2 Proposed Bridge

The proposed bridge pier piles will generally be founded on rock that is either phyllite or metasandstone. The geological properties of these rocks are discussed in detail in Grindley (2018). Consequently, significant scour is only likely to occur over multiple flood events over many years rather than during a single flood event as would occur for a river with non-cohesive bed material. A scour analysis of erodible rock was undertaken based on HEC-18 (FHWA, 2012). This analysis showed that only the weaker phyllite rock has the potential for some scour, such as at Pier E. This correlates well with a recent dive inspection of the key pier locations (Underwater Solutions Ltd, 2018). This dive inspection highlighted up to 2m of undercutting near the proposed location of Pier E, and up to 0.5m of undercutting at some of the other proposed pier locations. The proposed piles of Pier E are expected to be embedded deeper than the weaker phyllite rock into the harder metasandstone rock below.

4.3.3 Pier Scour Summary

The existing bridge is had a service life of approximately 135 years with minimal scour. There is however some evidence of minor long-term scour. The pier piles of the proposed bridge will be founded on the same rock material as that of the existing bridge. Hence scour is not a significant risk to the proposed bridge structure. It is however recommended that the potential for long-term scour (i.e. over many years) is considered during the design of the pier piles such that they can withstand some undercutting in areas of weaker rock material.

4.4 Analysis of Potential Scour to Abutments

The proposed abutments are located outside of the main channel on the true left and right floodplains. The proposed bridge will be constructed downstream of the existing bridge with the abutments set back slightly further from the main channel than the existing bridge. The average flow velocity in the main river channel in the SLS flood event is approximately 3.4m/s. The flow velocities on the floodplain are expected to be significantly lower. However, the south corner of the eastern abutment does protrude close to the main river channel where the flow velocities will be much closer to the average flow velocity. Figure 4-5 shows a plan image of this abutment.

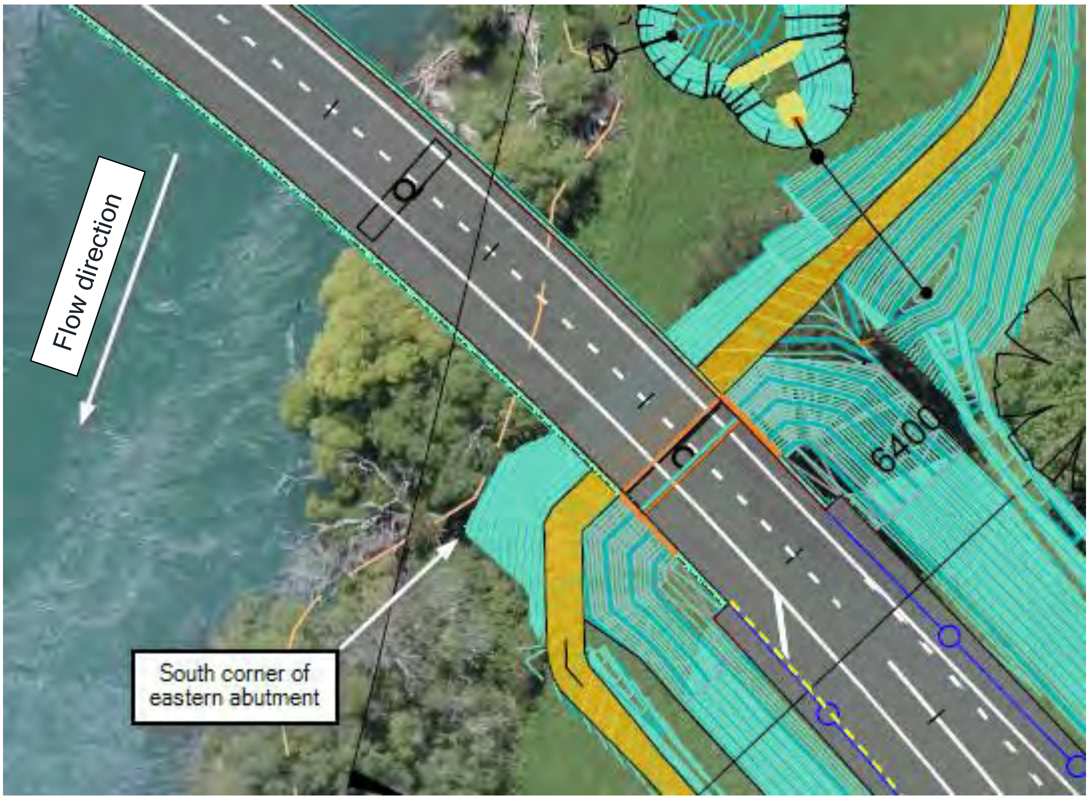

Figure 4-5 Location of eastern abutment in relation to the river channel

Both abutments will be founded in the metamorphic rock that, as noted previously, does not have a significant risk of scour. Boreholes BH02 and BH05 are close to the west and east abutments respectively and show that the metamorphic rock is found at RL 44m and RL 40m respectively. The material above the metamorphic rock consists of approximately 2.6m to 3m of sandy gravels and silty sand. The road embankments will be approximately 3m to 4m above existing ground level.

The only risk to the structure is therefore that the road embankment and the material that this is placed on will be scoured away during the SLS event. This can be mitigated by the provision of suitably designed scour protection.

5 Scour Protection Design

Scour protection for the proposed SH8 Beaumont Bridge has been designed to meet the design requirements outlined in Section 4.2.

5.1 Piers

Scour protection for the piers has not been designed as it is anticipated that the piles will be founded sufficiently deep into the scour-resistant metamorphic rock to structurally survive scour to the rock material in the channel.

5.2 Abutments and Embankments

5.2.1 *Rock Size*

Scour protection has been designed for the bridge embankments at the abutments for the SLS flood event in the form of a rock revetment based on methods described in Melville and Coleman (2000). This publication lists a large number of methods to determine the rock size required. Those based on Austroads (1994), Croad (1989) Richardson and Davis (1995) and Pagan-Ortiz (1991) were used as they are the most appropriate to use in the selection of rock for abutment protection. The results of these methods show that a median rock size (i.e. D_{50}) of 0.60m will be required. Table 5-1 summarises key parameters of the rock revetment design including the riprap rock layer.

Table 5-1 Rock revetment design parameters

PARAMETER	VALUE
Design approach flow velocity	3.4m/s
Design flow depth at toe	8.5m
Rock Revetment • crest level • slope	 Up to cycle path level 2H:1V; 1.5H:1V at south corner of eastern abutment
Riprap Rock Layer • Median rock size (D_{50}) • Layer thickness	 0.60m 1.20m
Granular Protection Layer • Median rock size (D_{50}) • Layer thickness	 63mm 200mm
Geotextile	Bidim A64 Geotextile or equivalent

5.2.2 Geotextile and Granular Protection Layer

A geotextile is required to prevent fill material from passing through the rock revetment. This geotextile will wrap around the toe of the rock revetment and extend to the crest of the rock revetment. A granular geotextile protection layer is proposed to protect the geotextile from damage, particularly during the construction phase. Table 5-1 summarises the key parameters of the geotextile and granular protection layer.

5.2.3 Revetment Extent

The rock revetment will wrap around the full abutment in line with the abutment face to minimise risk of undermining as per the minimum recommended extent in Figure 5-1. The bridge embankments will have batter slopes of 2H:1V, however the south corner of the eastern abutment may require a steeper batter slope of 1.5H:1V due to the limited space available and has been considered when selecting the size of the riprap rocks.

5.2.4 Revetment Toe

The toe of the rock revetment must be positioned such that it is not at significant risk of undermining by scour. This would typically be achieved by locating the toe of the rock revetment beneath the scour depth, or by including a launching pad in the rock revetment so that natural scour processes shift the rock material down to the scour depth (as shown in Figure 5-1). However, these approaches are not suitable for this location due to the nature of the deep incised channel at the toe of the rock revetment and the shallow depth of the natural rock. It is therefore recommended that the toe of the rock revetment is keyed into existing natural rock outcrop capable of withstanding the scour. This can be achieved through thickening the toe, use of larger rocks in the toe, trenching into the natural rock material or a combination of these and other methods. Figure 5-2 shows an indicative sketch of the proposed rock revetment at the south corner of the eastern abutment.

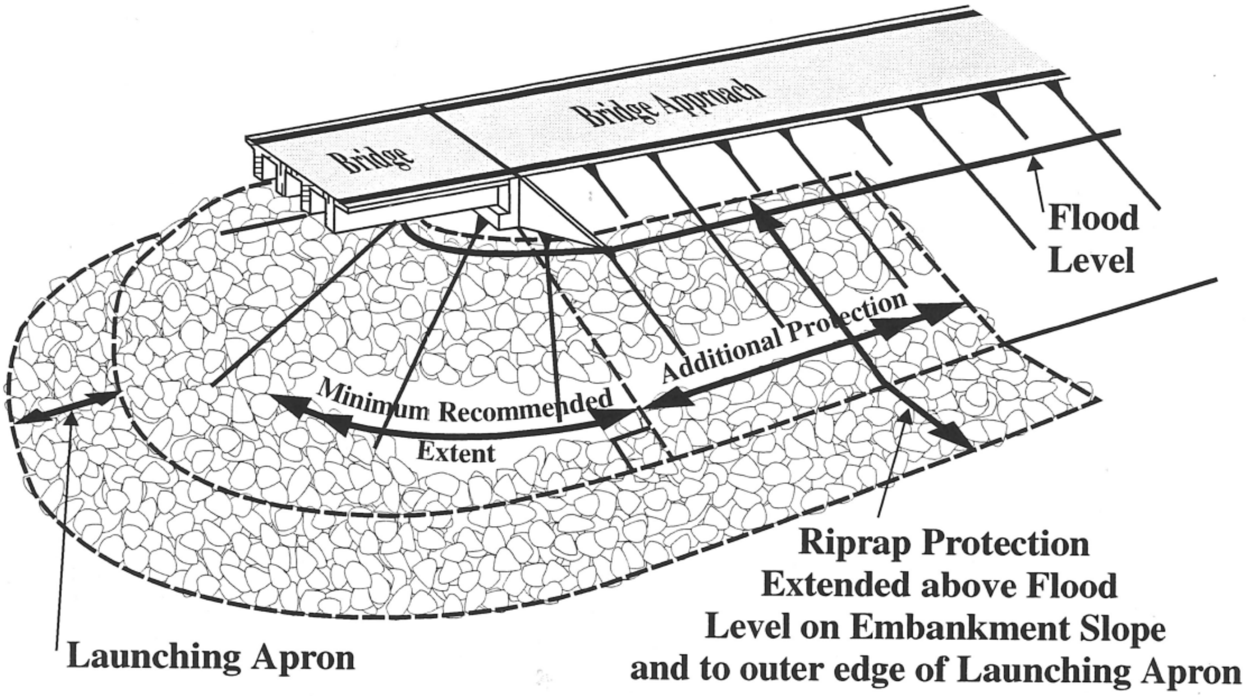

Figure 5-1 Recommended practice for the placement of riprap protection at bridge abutments (Source: Fig 9.29 in Melville and Coleman (2000)).

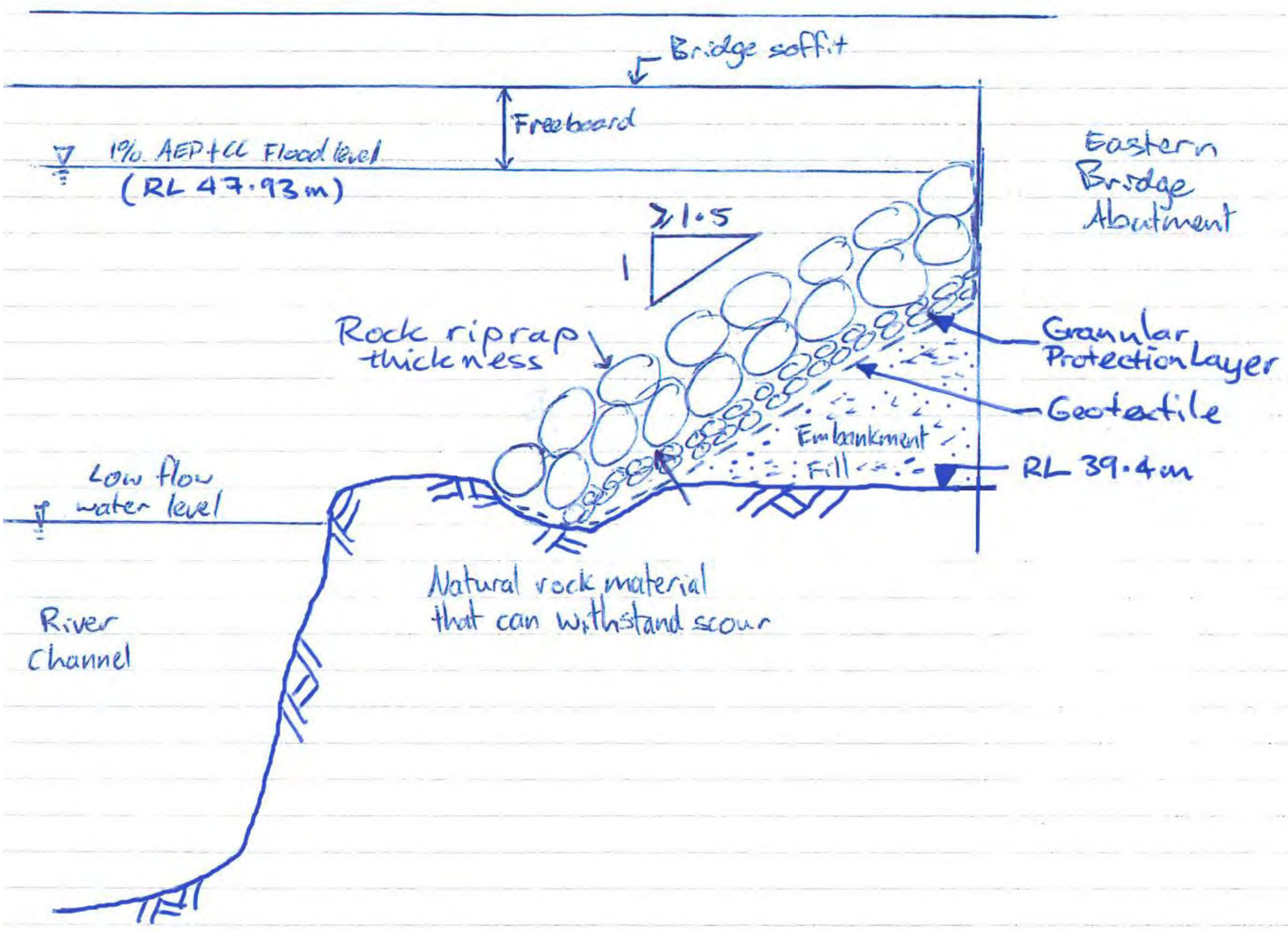

Figure 5-2 Sketch of rock revetment design at south corner of eastern abutment

5.2.5 Rock Grading Envelopes

Table 5-2 details the riprap armour layer grading. The rock grading has been specified to BS EN 13383:1-2002 based on design undertaken in accordance with The Rock Manual (CIRIA, 2007). The riprap grading selected is a "non-standard" Category A (facing) grading. Table 5-3 details the grading of the granular protection layer.

Table 5-2 Riprap armour stone grading

CLASS DESIGNATION	CLASS LIMIT DEFINITION BY WEIGHT				M_{em}
	ELL	NLL	NUL	EUL	
Passing requirements	<2%	<10%	>70%	>97%	Lower to upper limit
Category A Light Mass Riprap	80kg (D_s~390mm)	170kg (D_s~500mm)	650kg (D_s~780mm)	1,040kg (D_s~910mm)	300 to 420 kg (D_s ~ 600 to 670mm)

Table 5-3 Granular protection layer grading

CLASS DESIGNATION	CLASS LIMIT DEFINITION BY WEIGHT				M_{em}
	ELL	NLL	NUL	EUL	
Passing requirements	<5%	<15%	>90%	>98%	<50%
Type 1 granular geotextile protection layer	16mm	30mm	118mm	156mm	63mm

6 Conclusions and Recommendations

In conclusion, the hydraulics at the site of the proposed SH8 Beaumont Bridge have been assessed. A HEC-RAS model was developed with survey data, a hydrological assessment, historical flood data and bridge drawings to provide a robust tool for assessing water levels and flow velocities at the bridge structure.

The water levels upstream of the proposed bridge structure for the SLS and ULS flood events are estimated to be 47.93m RL and 49.91m RL respectively.

The effects on the existing flood risk are shown to be minor, with a maximum increase in water level of 0.10m for the 1% AEP flood event including the effects of climate change out to 2120. The sensitivity of the design levels to different climate change scenarios were also presented and discussed. This shows that the approach adopted has limited risks.

The existing SH8 bridge structure has had an asset life of approximately 135 years with minimal scour. Like the existing bridge, the proposed bridge pier piles will generally be founded on rock that is either phyllite or metasandstone. The scour analysis shows that only the weaker phyllite rock has the potential for some scour, such as at Pier E. However, the proposed piles of Pier E are expected to be embedded deeper than the weaker phyllite rock into the harder metasandstone rock. Nevertheless, it is recommended that the potential for long-term scour (i.e. over many years) is considered during the design of the pier piles such that they can withstand some undercutting in areas of weaker rock material.

Both abutments will be founded in the metamorphic rock that does not have a significant risk of scour. The only risk to the structure is therefore that the road embankment and the material that this is placed on will be scoured away during the SLS event. This can be mitigated by the provision of suitably designed scour protection.

Scour protection will be provided by a rock revetment that will wrap around the full abutment on both banks in line with the abutment face to minimise risk of undermining. The facing riprap layer will be 1.2m thick and consist of rock with a median rock size (i.e. D_{50}) of 0.6m. It is recommended that the toe of the rock revetment is keyed into existing natural rock outcrop capable of withstanding the scour. This can be achieved through thickening the toe, use of larger rocks in the toe, trenching into the natural rock material or a combination of these and other methods.

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Appendix A – Erodible Rock Scour Calculations

SH8 Beaumont Bridge - Erodible Rock Scour - Critical Stream Power

Ref: FHWA (2012)

Approach flow for ULS event

WL	49.91	m RL	Water level	
Bed	36.41	m RL	Bed level	*(offset 70.07m of XS upstream of proposed bridge - in theory the most conservative location)*
K_b	1		Bend coefficient	(=1 for straight, Equation 4.4 otherwise)
ρ	1000	kg/m^3	density of water	
Υ	9810	N/m^3	Unit weight of water	
y	13.5	m	Depth	
s	0.0016		slope	*(slope taken from EG slope upstream of proposed bridge in HEC-RAS)*

Approach shear stress:

τ = 208.7 N/m^2 (Equation 4.3)

Approach stream power:

P_a = 0.75 KW/m^2 (Equation 7.39)

Determine scour depth

b =	2.1	m	Pile diameter
P_c =	4.95	KW/m^2	(Original)
	10.27	KW/m^3	(Foliation)
	51.61	KW/m^4	(J1)
	30.69	KW/m^5	(J2)
	30.69	KW/m^6	(J3)

The bend coefficient K_b is used to calculate the increased shear stress on the outside of a bend. This coefficient ranges from 1.05 to 2.0, depending on the severity of the bend. The bend coefficient is a function of the radius of curvature R_c divided by the top width of the channel T, as follows:

$$K_b = 2.0 \qquad \text{for } 2 \geq R_c/T$$

$$K_b = 2.38 - 0.206\left(\frac{R_c}{T}\right) + 0.0073\left(\frac{R_c}{T}\right)^2 \qquad \text{for } 10 > R_c/T > 2 \qquad (4.4)$$

$$K_b = 1.05 \qquad \text{for } R_c/T \geq 10$$

ys/b	y_s	P/P_a	P	Stream Power greater than critical ($P > P_c$)?				
	(m)	(Eq 7.40)	(kW/m^2)	Initial	Foliation	J1	J2	J3
0.01	0.02	8.36	6.26	yes	no	no	no	no
0.1	0.21	7.84	5.87	yes	no	no	no	no
0.2	0.42	7.30	5.47	yes	no	no	no	no
0.3	0.63	6.80	5.09	yes	no	no	no	no
0.4	0.84	6.33	4.74	no	no	no	no	no
0.5	1.05	5.90	4.42	no	no	no	no	no
0.6	1.26	5.49	4.11	no	no	no	no	no
0.7	1.47	5.12	3.83	no	no	no	no	no
0.8	1.68	4.76	3.57	no	no	no	no	no
0.9	1.89	4.44	3.32	no	no	no	no	no
1.0	2.10	4.13	3.09	no	no	no	no	no
1.1	2.31	3.85	2.88	no	no	no	no	no
1.2	2.52	3.58	2.68	no	no	no	no	no
1.3	2.73	3.34	2.50	no	no	no	no	no

Results:

- Only initial assessment based on conservative engineering assessmentshows up to 0.63m of scour
- Subsequent assessment of measured properties of 4 joints shows negligible scour

SH8 Beaumont Bridge - Erodible Rock Scour - Critical Stream Power - Initial Assessment

Ref: FHWA (2012)

UCS =	17.5	Mpa	Unconfined compressive strength
RQD =	13		Rock Quality Designation
J_n	2.73		Assumed (Table 4.23)
J_r	1		Assumed (Table 4.24)
J_a	10		Assumed (Table 4.25)

11 - 20	phyllitte
40 - 100	meta sandstones

M_s =	17.7	(Table 4.22)
K_b =	4.761905	(Equation 4.18)
K_d =	0.1	(Equation 4.19)
J_s =	1	Assumed (Table 4.26)

Erodibility Index

K = 8.428571 (Equation 4.17)

Critical stream power required to initiate scouring:

P_c = 4.947 KW/m^2 (Equation 7.38)

Table 4.22. Values of the Rock Mass Strength Parameter M_s.

Hardness	Identification in Profile	Unconfined Compressive Strength (MPa)	Mass Strength Number (Ms)
Very soft rock	Material crumbles under firm (moderate) blows with sharp end of geological pick and	Less than 1.7	0.87
	can be peeled off with a knife; is too hard to cut triaxial sample by hand.	1.7 – 3.3	1.86
Soft rock	Can just be scraped and peeled with a knife; indentations 1 mm to 3-mm show in the	3.3 – 6.6	3.95
	specimen with firm (moderate) blows of the pick point.	6.6 – 13.2	8.39
Hard rock	Cannot be scraped or peeled with a knife; hand-held specimen can be broken with hammer end of geological pick with a single firm (moderate) blow.	13.2 – 26.4	17.70
Very hard rock	Hand-held specimen breaks with hammer end of pick under more than one blow.	26.4 – 53.0 53.00 – 106.0	35.0 70.0
Extremely hard rock	Specimen requires many blows with geological pick to break through intact material.	Larger than 212.0	280.0

Table 4.23. Rock Joint Set Number J_n.

Number of Joint Sets	Joint Set Number (J_n)
Intact, no or few joints/fissures	1.00
One joint/fissure set	1.22
One joint/fissure set plus random	1.50
Two joint/fissure sets	1.83
Two joint/fissure sets plus random	2.24
Three joint/fissure sets	2.73
Three joint/fissure sets plus random	3.34
Four joint/fissure sets	4.09
Multiple joint/fissure sets	5.00

Table 4.24. Joint Roughness Number J_r.

Condition of Joint	Joint Roughness Number J_r
Stepped joints/fissures	4.0
Rough or irregular, undulating	3.0
Smooth undulating	2.0
Slickensided undulating	1.5
Rough or irregular, planar	1.5
Smooth planar	1.0
Slickensided planar	0.5
Joints/fissures either open or containing relatively soft gouge of sufficient thickness to prevent joint/fissure wall contact upon excavation	1.0
Shattered or micro-shattered clays	1.0

Table 4.25. Joint Alteration Number J_a.

Description of Gouge	Joint Alteration Number (J_a) for Joint Separation (mm)		
	1.0 $^{(1)}$	1.0 –5.0 $^{(2)}$	5.0 $^{(3)}$
Tightly healed, hard, non-softening impermeable filling	0.75	-	-
Unaltered joint walls, surface staining only	1.0	-	-
Slightly altered, non-softening, non-cohesive rock mineral or crushed rock filling	2.0	2.0	4.0
Non-softening, slightly clayey non-cohesive filling	3.0	6.0	10.0
Non-softening, strongly over-consolidated clay mineral filling, with or without crushed rock	3.0	6.0**	10.0
Softening or low friction clay mineral coatings and small quantities of swelling clays	4.0	8.0	13.0
Softening moderately over-consolidated clay mineral filling, with or without crushed rock	4.0	8.00**	13.0
Shattered or micro-shattered (swelling) clay gouge, with or without crushed rock	5.0	10.0**	18.0

Note:
(1) Joint walls effectively in contact.
(2) Joint walls come into contact after approximately 100-mm shear.
(3) Joint walls do not come into contact at all upon shear.
**Also applies when crushed rock occurs in clay gouge without rock wall contact.

Table 4.26. Relative Orientation Parameter J_s.

Dip Direction of Closer Spaced Joint Set (degrees)	Dip Angle of Closer Spaced Joint Set (degrees)	Ratio of Joint Spacing, r			
Dip Direction	Dip Angle	Ratio 1:1	Ratio 1:2	Ratio 1:4	Ratio 1:8
180/0	90	1.14	1.20	1.24	1.26
In direction of stream flow	89	0.78	0.71	0.65	0.61
In direction of stream flow	85	0.73	0.66	0.61	0.57
In direction of stream flow	80	0.67	0.60	0.55	0.52
In direction of stream flow	70	0.56	0.50	0.46	0.43
In direction of stream flow	60	0.50	0.46	0.42	0.40
In direction of stream flow	50	0.49	0.46	0.43	0.41
In direction of stream flow	40	0.53	0.49	0.46	0.45
In direction of stream flow	30	0.63	0.59	0.55	0.53
In direction of stream flow	20	0.84	0.77	0.71	0.67
In direction of stream flow	10	1.25	1.10	0.98	0.90
In direction of stream flow	5	1.39	1.23	1.09	1.01
In direction of stream flow	1	1.50	1.33	1.19	1.10
0/180	0	1.14	1.09	1.05	1.02
Against direction of stream flow	-1	0.78	0.85	0.90	0.94
Against direction of stream flow	-5	0.73	0.79	0.84	0.88
Against direction of stream flow	-10	0.67	0.72	0.78	0.81
Against direction of stream flow	-20	0.56	0.62	0.66	0.69
Against direction of stream flow	-30	0.50	0.55	0.58	0.60
Against direction of stream flow	-40	0.49	0.52	0.55	0.57
Against direction of stream flow	-50	0.53	0.56	0.59	0.61
Against direction of stream flow	-60	0.63	0.68	0.71	0.73
Against direction of stream flow	-70	0.84	0.91	0.97	1.01
Against direction of stream flow	-80	1.26	1.41	1.53	1.61
Against direction of stream flow	-85	1.39	1.55	1.69	1.77
Against direction of stream flow	-89	1.50	1.68	1.82	1.91
180/0	-90	1.14	1.20	1.24	1.26

Notes:
1. For intact material take J_s = 1.0.
2. For values of r greater than 8 take J_s as for r = 8.
3. If the flow direction FD is not in the direction of the true dip TD, the effective dip ED is determined by adding the ground slope to the apparent dip AD: ED = AD + GS

SH8 Beaumont Bridge - Erodible Rock Scour - Critical Stream Power - Foliation Joint

Ref: FHWA (2012)

UCS =	17.5	Mpa	Unconfined compressive strength
RQD =	13		Measured
J_n	2.73		Assumed (Table 4.23)
J_r	1		Measured (Table 4.24)
J_a	2		Measured (Table 4.25)

11 - 20 phyllitte
40 - 100 meta sandstones

M_s =	17.7	(Table 4.22)
K_b =	4.761905	(Equation 4.18)
K_d =	0.5	(Equation 4.19)
J_s =	0.53	Measured (Table 4.26)
		Dip = 38°, Direction = 227°

Erodibility Index
K = 22.33571 (Equation 4.17)

Critical stream power required to initiate scouring:
P_c = 10.274 KW/m^2 (Equation 7.38)

Table 4.22. Values of the Rock Mass Strength Parameter M_s.

Hardness	Identification in Profile	Unconfined Compressive Strength (MPa)	Mass Strength Number (Ms)
Very soft rock	Material crumbles under firm (moderate) blows with sharp end of geological pick and	Less than 1.7	0.87
	can be peeled off with a knife; is too hard to cut triaxial sample by hand.	1.7 – 3.3	1.86
Soft rock	Can just be scraped and peeled with a knife; indentations 1 mm to 3-mm show in the	3.3 – 6.6	3.95
	specimen with firm (moderate) blows of the pick point.	6.6 – 13.2	8.39
Hard rock	Cannot be scraped or peeled with a knife; hand-held specimen can be broken with hammer end of geological pick with a single firm (moderate) blow.	13.2 – 26.4	17.70
Very hard rock	Hand-held specimen breaks with hammer end of pick under more than one blow.	26.4 – 53.0 53.00 – 106.0	35.0 70.0
Extremely hard rock	Specimen requires many blows with geological pick to break through intact material.	Larger than 212.0	280.0

Table 4.25. Joint Alteration Number J_a.

Description of Gouge	Joint Alteration Number (J_a) for Joint Separation (mm) 1.0 (1)	1.0 – 5.0 (2)	5.0 (3)
Tightly healed, hard, non-softening impermeable filling	0.75	-	-
Unaltered joint walls, surface staining only	1.0	-	-
Slightly altered, non-softening, non-cohesive rock mineral or crushed rock filling	2.0	2.0	4.0
Non-softening, slightly clayey non-cohesive filling	3.0	6.0	10.0
Non-softening, strongly over-consolidated clay mineral filling, with or without crushed rock	3.0	6.0**	10.0
Softening or low friction clay mineral coatings and small quantities of swelling clays	4.0	8.0	13.0
Softening moderately over-consolidated clay mineral filling, with or without crushed rock	4.0	8.00**	13.0
Shattered or micro-shattered (swelling) clay gouge, with or without crushed rock	5.0	10.0**	18.0

Note:
(1) Joint walls effectively in contact.
(2) Joint walls come into contact after approximately 100-mm shear.
(3) Joint walls do not come into contact at all upon shear.
**Also applies when crushed rock occurs in clay gouge without rock wall contact.

Table 4.23. Rock Joint Set Number J_n.

Number of Joint Sets	Joint Set Number (J_n)
Intact, no or few joints/fissures	1.00
One joint/fissure set	1.22
One joint/fissure set plus random	1.50
Two joint/fissure sets	1.83
Two joint/fissure sets plus random	2.24
Three joint/fissure sets	2.73
Three joint/fissure sets plus random	3.34
Four joint/fissure sets	4.09
Multiple joint/fissure sets	5.00

Table 4.24. Joint Roughness Number J_r.

Condition of Joint	Joint Roughness Number J_r
Stepped joints/fissures	4.0
Rough or irregular, undulating	3.0
Smooth undulating	2.0
Slickensided undulating	1.5
Rough or irregular, planar	1.5
Smooth planar	1.0
Slickensided planar	0.5
Joints/fissures either open or containing relatively soft gouge of sufficient thickness to prevent joint/fissure wall contact upon excavation	1.0
Shattered or micro-shattered clays	1.0

Table 4.26. Relative Orientation Parameter J_s.

Dip Direction of Closer Spaced Joint Set (degrees)	Dip Angle of Closer Spaced Joint Set (degrees)	Ratio of Joint Spacing, r			
Dip Direction	Dip Angle	Ratio 1:1	Ratio 1:2	Ratio 1:4	Ratio 1:8
180/0	90	1.14	1.20	1.24	1.26
In direction of stream flow	89	0.78	0.71	0.65	0.61
In direction of stream flow	85	0.73	0.66	0.61	0.57
In direction of stream flow	80	0.67	0.60	0.55	0.52
In direction of stream flow	70	0.56	0.50	0.46	0.43
In direction of stream flow	60	0.50	0.46	0.42	0.40
In direction of stream flow	50	0.49	0.46	0.43	0.41
In direction of stream flow	40	0.53	0.49	0.46	0.45
In direction of stream flow	30	0.63	0.59	0.55	0.53
In direction of stream flow	20	0.84	0.77	0.71	0.67
In direction of stream flow	10	1.25	1.10	0.98	0.90
In direction of stream flow	5	1.39	1.23	1.09	1.01
In direction of stream flow	1	1.50	1.33	1.19	1.10
0/180	0	1.14	1.09	1.05	1.02
Against direction of stream flow	-1	0.78	0.85	0.90	0.94
Against direction of stream flow	-5	0.73	0.79	0.84	0.88
Against direction of stream flow	-10	0.67	0.72	0.78	0.81
Against direction of stream flow	-20	0.56	0.62	0.66	0.69
Against direction of stream flow	-30	0.50	0.55	0.58	0.60
Against direction of stream flow	-40	0.49	0.52	0.55	0.57
Against direction of stream flow	-50	0.53	0.56	0.59	0.61
Against direction of stream flow	-60	0.63	0.68	0.71	0.73
Against direction of stream flow	-70	0.84	0.91	0.97	1.01
Against direction of stream flow	-80	1.26	1.41	1.53	1.61
Against direction of stream flow	-85	1.39	1.55	1.69	1.77
Against direction of stream flow	-89	1.50	1.68	1.82	1.91
180/0	-90	1.14	1.20	1.24	1.26

Notes:
1. For intact material take J_s = 1.0.
2. For values of r greater than 8 take J_s as for r = 8.
3. If the flow direction FD is not in the direction of the true dip TD, the effective dip ED is determined by adding the ground slope to the apparent dip AD: ED = AD + GS

SH8 Beaumont Bridge - Erodible Rock Scour - Critical Stream Power - Joint J1

Ref: FHWA (2012)

UCS =	17.5	Mpa	Unconfined compressive strength
RQD =	13		Measured
J_n	2.73		Assumed (Table 4.23)
J_r	2		Measured (Table 4.24)
J_a	1		Measured (Table 4.25)

11 - 20	phyllitte
40 - 100	meta sandstones

M_s =	17.7	(Table 4.22)
K_b =	4.761905	(Equation 4.18)
K_d =	2	(Equation 4.19)
J_s =	1.14	Measured (Table 4.26)
		Dip = 87°, Direction = 110°

Erodibility Index

K = 192.1714 (Equation 4.17)

Critical stream power required to initiate scouring:

P_c = 51.614 KW/m^2 (Equation 7.38)

Table 4.22. Values of the Rock Mass Strength Parameter M_s.

Hardness	Identification in Profile	Unconfined Compressive Strength (MPa)	Mass Strength Number (Ms)
Very soft rock	Material crumbles under firm (moderate) blows with sharp end of geological pick and	Less than 1.7	0.87
	can be peeled off with a knife; is too hard to cut triaxial sample by hand.	1.7 – 3.3	1.86
Soft rock	Can just be scraped and peeled with a knife; indentations 1 mm to 3-mm show in the	3.3 – 6.6	3.95
	specimen with firm (moderate) blows of the pick point.	6.6 – 13.2	8.39
Hard rock	Cannot be scraped or peeled with a knife; hand-held specimen can be broken with hammer end of geological pick with a single firm (moderate) blow.	13.2 – 26.4	17.70
Very hard rock	Hand-held specimen breaks with hammer end of pick under more than one blow.	26.4 – 53.0 53.00 – 106.0	35.0 70.0
Extremely hard rock	Specimen requires many blows with geological pick to break through intact material.	Larger than 212.0	280.0

Table 4.23. Rock Joint Set Number J_n.

Number of Joint Sets	Joint Set Number (J_n)
Intact, no or few joints/fissures	1.00
One joint/fissure set	1.22
One joint/fissure set plus random	1.50
Two joint/fissure sets	1.83
Two joint/fissure sets plus random	2.24
Three joint/fissure sets	2.73
Three joint/fissure sets plus random	3.34
Four joint/fissure sets	4.09
Multiple joint/fissure sets	5.00

Table 4.24. Joint Roughness Number J_r.

Condition of Joint	Joint Roughness Number J_r
Stepped joints/fissures	4.0
Rough or irregular, undulating	3.0
Smooth undulating	2.0
Slickensided undulating	1.5
Rough or irregular, planar	1.5
Smooth planar	1.0
Slickensided planar	0.5
Joints/fissures either open or containing relatively soft gouge of sufficient thickness to prevent joint/fissure wall contact upon excavation	1.0
Shattered or micro-shattered clays	1.0

Table 4.25. Joint Alteration Number J_a.

Description of Gouge	Joint Alteration Number (J_a) for Joint Separation (mm)		
	1.0 [(1)]	1.0 –5.0 [(2)]	5.0 [(3)]
Tightly healed, hard, non-softening impermeable filling	0.75	-	-
Unaltered joint walls, surface staining only	1.0	-	-
Slightly altered, non-softening, non-cohesive rock mineral or crushed rock filling	2.0	2.0	4.0
Non-softening, slightly clayey non-cohesive filling	3.0	6.0	10.0
Non-softening, strongly over-consolidated clay mineral filling, with or without crushed rock	3.0	6.0**	10.0
Softening or low friction clay mineral coatings and small quantities of swelling clays	4.0	8.0	13.0
Softening moderately over-consolidated clay mineral filling, with or without crushed rock	4.0	8.00**	13.0
Shattered or micro-shattered (swelling) clay gouge, with or without crushed rock	5.0	10.0**	18.0

Note:
(1) Joint walls effectively in contact.
(2) Joint walls come into contact after approximately 100-mm shear.
(3) Joint walls do not come into contact at all upon shear.
**Also applies when crushed rock occurs in clay gouge without rock wall contact.

Table 4.26. Relative Orientation Parameter J_s.

Dip Direction of Closer Spaced Joint Set (degrees)	Dip Angle of Closer Spaced Joint Set (degrees)	Ratio of Joint Spacing, r			
Dip Direction	Dip Angle	Ratio 1:1	Ratio 1:2	Ratio 1:4	Ratio 1:8
180/0	90	1.14	1.20	1.24	1.26
In direction of stream flow	89	0.78	0.71	0.65	0.61
In direction of stream flow	85	0.73	0.66	0.61	0.57
In direction of stream flow	80	0.67	0.60	0.55	0.52
In direction of stream flow	70	0.56	0.50	0.46	0.43
In direction of stream flow	60	0.50	0.46	0.42	0.40
In direction of stream flow	50	0.49	0.46	0.43	0.41
In direction of stream flow	40	0.53	0.49	0.46	0.45
In direction of stream flow	30	0.63	0.59	0.55	0.53
In direction of stream flow	20	0.84	0.77	0.71	0.67
In direction of stream flow	10	1.25	1.10	0.98	0.90
In direction of stream flow	5	1.39	1.23	1.09	1.01
In direction of stream flow	1	1.50	1.33	1.19	1.10
0/180	0	1.14	1.09	1.05	1.02
Against direction of stream flow	-1	0.78	0.85	0.90	0.94
Against direction of stream flow	-5	0.73	0.79	0.84	0.88
Against direction of stream flow	-10	0.67	0.72	0.78	0.81
Against direction of stream flow	-20	0.56	0.62	0.66	0.69
Against direction of stream flow	-30	0.50	0.55	0.58	0.60
Against direction of stream flow	-40	0.49	0.52	0.55	0.57
Against direction of stream flow	-50	0.53	0.56	0.59	0.61
Against direction of stream flow	-60	0.63	0.68	0.71	0.73
Against direction of stream flow	-70	0.84	0.91	0.97	1.01
Against direction of stream flow	-80	1.26	1.41	1.53	1.61
Against direction of stream flow	-85	1.39	1.55	1.69	1.77
Against direction of stream flow	-89	1.50	1.68	1.82	1.91
180/0	-90	1.14	1.20	1.24	1.26

Notes:
1. For intact material take J_s = 1.0.
2. For values of r greater than 8 take J_s as for r = 8.
3. If the flow direction FD is not in the direction of the true dip TD, the effective dip ED is determined by adding the ground slope to the apparent dip AD: ED = AD + GS

SH8 Beaumont Bridge - Erodible Rock Scour - Critical Stream Power - Joint J2

Ref: FHWA (2012)

UCS =	17.5	Mpa	Unconfined compressive strength
RQD =	13		Measured
J_n	2.73		Assumed (Table 4.23)
J_r	2		Measured (Table 4.24)
J_a	2		Measured (Table 4.25)

11 - 20 phyllitte
40 - 100 meta sandstones

M_s =	17.7	(Table 4.22)
K_b =	4.761905	(Equation 4.18)
K_d =	1	(Equation 4.19)
J_s =	1.14	Measured (Table 4.26)
		Dip = 73°, Direction = 006°

Erodibility Index
K = 96.08571 (Equation 4.17)

Critical stream power required to initiate scouring:
P_c = 30.690 KW/m^2 (Equation 7.38)

Table 4.22. Values of the Rock Mass Strength Parameter M_s.

Hardness	Identification in Profile	Unconfined Compressive Strength (MPa)	Mass Strength Number (Ms)
Very soft rock	Material crumbles under firm (moderate) blows with sharp end of geological pick and	Less than 1.7	0.87
	can be peeled off with a knife; is too hard to cut triaxial sample by hand.	1.7 – 3.3	1.86
Soft rock	Can just be scraped and peeled with a knife; indentations 1 mm to 3-mm show in the	3.3 – 6.6	3.95
	specimen with firm (moderate) blows of the pick point.	6.6 – 13.2	8.39
Hard rock	Cannot be scraped or peeled with a knife; hand-held specimen can be broken with hammer end of geological pick with a single firm (moderate) blow.	13.2 – 26.4	17.70
Very hard rock	Hand-held specimen breaks with hammer end of pick under more than one blow.	26.4 – 53.0 53.00 – 106.0	35.0 70.0
Extremely hard rock	Specimen requires many blows with geological pick to break through intact material.	Larger than 212.0	280.0

Table 4.23. Rock Joint Set Number J_n.

Number of Joint Sets	Joint Set Number (J_n)
Intact, no or few joints/fissures	1.00
One joint/fissure set	1.22
One joint/fissure set plus random	1.50
Two joint/fissure sets	1.83
Two joint/fissure sets plus random	2.24
Three joint/fissure sets	2.73
Three joint/fissure sets plus random	3.34
Four joint/fissure sets	4.09
Multiple joint/fissure sets	5.00

Table 4.24. Joint Roughness Number J_r.

Condition of Joint	Joint Roughness Number J_r
Stepped joints/fissures	4.0
Rough or irregular, undulating	3.0
Smooth undulating	2.0
Slickensided undulating	1.5
Rough or irregular, planar	1.5
Smooth planar	1.0
Slickensided planar	0.5
Joints/fissures either open or containing relatively soft gouge of sufficient thickness to prevent joint/fissure wall contact upon excavation	1.0
Shattered or micro-shattered clays	1.0

Table 4.25. Joint Alteration Number J_a.

Description of Gouge	Joint Alteration Number (J_a) for Joint Separation (mm)		
	1.0 (1)	1.0 –5.0(2)	5.0(3)
Tightly healed, hard, non-softening impermeable filling	0.75	-	-
Unaltered joint walls, surface staining only	1.0	-	-
Slightly altered, non-softening, non-cohesive rock mineral or crushed rock filling	2.0	2.0	4.0
Non-softening, slightly clayey non-cohesive filling	3.0	6.0	10.0
Non-softening, strongly over-consolidated clay mineral filling, with or without crushed rock	3.0	6.0**	10.0
Softening or low friction clay mineral coatings and small quantities of swelling clays	4.0	8.0	13.0
Softening moderately over-consolidated clay mineral filling, with or without crushed rock	4.0	8.00**	13.0
Shattered or micro-shattered (swelling) clay gouge, with or without crushed rock	5.0	10.0**	18.0

Note:
(1) Joint walls effectively in contact.
(2) Joint walls come into contact after approximately 100-mm shear.
(3) Joint walls do not come into contact at all upon shear.
**Also applies when crushed rock occurs in clay gouge without rock wall contact.

Table 4.26. Relative Orientation Parameter J_s.

Dip Direction of Closer Spaced Joint Set (degrees)	Dip Angle of Closer Spaced Joint Set (degrees)	Ratio of Joint Spacing, r			
Dip Direction	Dip Angle	Ratio 1:1	Ratio 1:2	Ratio 1:4	Ratio 1:8
180/0	90	1.14	1.20	1.24	1.26
In direction of stream flow	89	0.78	0.71	0.65	0.61
In direction of stream flow	85	0.73	0.66	0.61	0.57
In direction of stream flow	80	0.67	0.60	0.55	0.52
In direction of stream flow	70	0.56	0.50	0.46	0.43
In direction of stream flow	60	0.50	0.46	0.42	0.40
In direction of stream flow	50	0.49	0.46	0.43	0.41
In direction of stream flow	40	0.53	0.49	0.46	0.45
In direction of stream flow	30	0.63	0.59	0.55	0.53
In direction of stream flow	20	0.84	0.77	0.71	0.67
In direction of stream flow	10	1.25	1.10	0.98	0.90
In direction of stream flow	5	1.39	1.23	1.09	1.01
In direction of stream flow	1	1.50	1.33	1.19	1.10
0/180	0	1.14	1.09	1.05	1.02
Against direction of stream flow	-1	0.78	0.85	0.90	0.94
Against direction of stream flow	-5	0.73	0.79	0.84	0.88
Against direction of stream flow	-10	0.67	0.72	0.78	0.81
Against direction of stream flow	-20	0.56	0.62	0.66	0.69
Against direction of stream flow	-30	0.50	0.55	0.58	0.60
Against direction of stream flow	-40	0.49	0.52	0.55	0.57
Against direction of stream flow	-50	0.53	0.56	0.59	0.61
Against direction of stream flow	-60	0.63	0.68	0.71	0.73
Against direction of stream flow	-70	0.84	0.91	0.97	1.01
Against direction of stream flow	-80	1.26	1.41	1.53	1.61
Against direction of stream flow	-85	1.39	1.55	1.69	1.77
Against direction of stream flow	-89	1.50	1.68	1.82	1.91
180/0	-90	1.14	1.20	1.24	1.26

Notes:
1. For intact material take J_s = 1.0.
2. For values of r greater than 8 take J_s as for r = 8.
3. If the flow direction FD is not in the direction of the true dip TD, the effective dip ED is determined by adding the ground slope to the apparent dip AD: ED = AD + GS

SH8 Beaumont Bridge - Erodible Rock Scour - Critical Stream Power - Joint J3

Ref: FHWA (2012)

UCS =	17.5	Mpa	Unconfined compressive strength
RQD =	13		Measured
J_n	2.73		Assumed (Table 4.23)
J_r	2		Measured (Table 4.24)
J_a	2		Measured (Table 4.25)

11 - 20	phyllitte
40 - 100	meta sandstones

M_s =	17.7	(Table 4.22)
K_b =	4.761905	(Equation 4.18)
K_d =	1	(Equation 4.19)
J_s =	1.14	Measured (Table 4.26)
		Dip = 65°, Direction = 048°

Erodibility Index

K =	96.08571	(Equation 4.17)

Critical stream power required to initiate scouring:

P_c = 30.690 KW/m^2 (Equation 7.38)

Table 4.22. Values of the Rock Mass Strength Parameter M_s.

Hardness	Identification in Profile	Unconfined Compressive Strength (MPa)	Mass Strength Number (Ms)
Very soft rock	Material crumbles under firm (moderate) blows with sharp end of geological pick and	Less than 1.7	0.87
	can be peeled off with a knife; is too hard to cut triaxial sample by hand.	1.7 – 3.3	1.86
Soft rock	Can just be scraped and peeled with a knife; indentations 1 mm to 3-mm show in the	3.3 – 6.6	3.95
	specimen with firm (moderate) blows of the pick point.	6.6 – 13.2	8.39
Hard rock	Cannot be scraped or peeled with a knife; hand-held specimen can be broken with hammer end of geological pick with a single firm (moderate) blow.	13.2 – 26.4	17.70
Very hard rock	Hand-held specimen breaks with hammer end of pick under more than one blow.	26.4 – 53.0 53.00 – 106.0	35.0 70.0
Extremely hard rock	Specimen requires many blows with geological pick to break through intact material.	Larger than 212.0	280.0

Table 4.23. Rock Joint Set Number J_n.

Number of Joint Sets	Joint Set Number (J_n)
Intact, no or few joints/fissures	1.00
One joint/fissure set	1.22
One joint/fissure set plus random	1.50
Two joint/fissure sets	1.83
Two joint/fissure sets plus random	2.24
Three joint/fissure sets	2.73
Three joint/fissure sets plus random	3.34
Four joint/fissure sets	4.09
Multiple joint/fissure sets	5.00

Table 4.24. Joint Roughness Number J_r.

Condition of Joint	Joint Roughness Number J_r
Stepped joints/fissures	4.0
Rough or irregular, undulating	3.0
Smooth undulating	2.0
Slickensided undulating	1.5
Rough or irregular, planar	1.5
Smooth planar	1.0
Slickensided planar	0.5
Joints/fissures either open or containing relatively soft gouge of sufficient thickness to prevent joint/fissure wall contact upon excavation	1.0
Shattered or micro-shattered clays	1.0

Table 4.25. Joint Alteration Number J_a.

Description of Gouge	Joint Alteration Number (J_a) for Joint Separation (mm)		
	1.0 (1)	1.0 –5.0 (2)	5.0 (3)
Tightly healed, hard, non-softening impermeable filling	0.75	-	-
Unaltered joint walls, surface staining only	1.0	-	-
Slightly altered, non-softening, non-cohesive rock mineral or crushed rock filling	2.0	2.0	4.0
Non-softening, slightly clayey non-cohesive filling	3.0	6.0	10.0
Non-softening, strongly over-consolidated clay mineral filling, with or without crushed rock	3.0	6.0**	10.0
Softening or low friction clay mineral coatings and small quantities of swelling clays	4.0	8.0	13.0
Softening moderately over-consolidated clay mineral filling, with or without crushed rock	4.0	8.00**	13.0
Shattered or micro-shattered (swelling) clay gouge, with or without crushed rock	5.0	10.0**	18.0

Note:
(1) Joint walls effectively in contact.
(2) Joint walls come into contact after approximately 100-mm shear.
(3) Joint walls do not come into contact at all upon shear.
**Also applies when crushed rock occurs in clay gouge without rock wall contact.

Table 4.26. Relative Orientation Parameter J_s.

Dip Direction of Closer Spaced Joint Set (degrees)	Dip Angle of Closer Spaced Joint Set (degrees)	Ratio of Joint Spacing, r			
Dip Direction	Dip Angle	Ratio 1:1	Ratio 1:2	Ratio 1:4	Ratio 1:8
180/0	90	1.14	1.20	1.24	1.26
In direction of stream flow	89	0.78	0.71	0.65	0.61
In direction of stream flow	85	0.73	0.66	0.61	0.57
In direction of stream flow	80	0.67	0.60	0.55	0.52
In direction of stream flow	70	0.56	0.50	0.46	0.43
In direction of stream flow	60	0.50	0.46	0.42	0.40
In direction of stream flow	50	0.49	0.46	0.43	0.41
In direction of stream flow	40	0.53	0.49	0.46	0.45
In direction of stream flow	30	0.63	0.59	0.55	0.53
In direction of stream flow	20	0.84	0.77	0.71	0.67
In direction of stream flow	10	1.25	1.10	0.98	0.90
In direction of stream flow	5	1.39	1.23	1.09	1.01
In direction of stream flow	1	1.50	1.33	1.19	1.10
0/180	0	1.14	1.09	1.05	1.02
Against direction of stream flow	-1	0.78	0.85	0.90	0.94
Against direction of stream flow	-5	0.73	0.79	0.84	0.88
Against direction of stream flow	-10	0.67	0.72	0.78	0.81
Against direction of stream flow	-20	0.56	0.62	0.66	0.69
Against direction of stream flow	-30	0.50	0.55	0.58	0.60
Against direction of stream flow	-40	0.49	0.52	0.55	0.57
Against direction of stream flow	-50	0.53	0.56	0.59	0.61
Against direction of stream flow	-60	0.63	0.68	0.71	0.73
Against direction of stream flow	-70	0.84	0.91	0.97	1.01
Against direction of stream flow	-80	1.26	1.41	1.53	1.61
Against direction of stream flow	-85	1.39	1.55	1.69	1.77
Against direction of stream flow	-89	1.50	1.68	1.82	1.91
180/0	-90	1.14	1.20	1.24	1.26

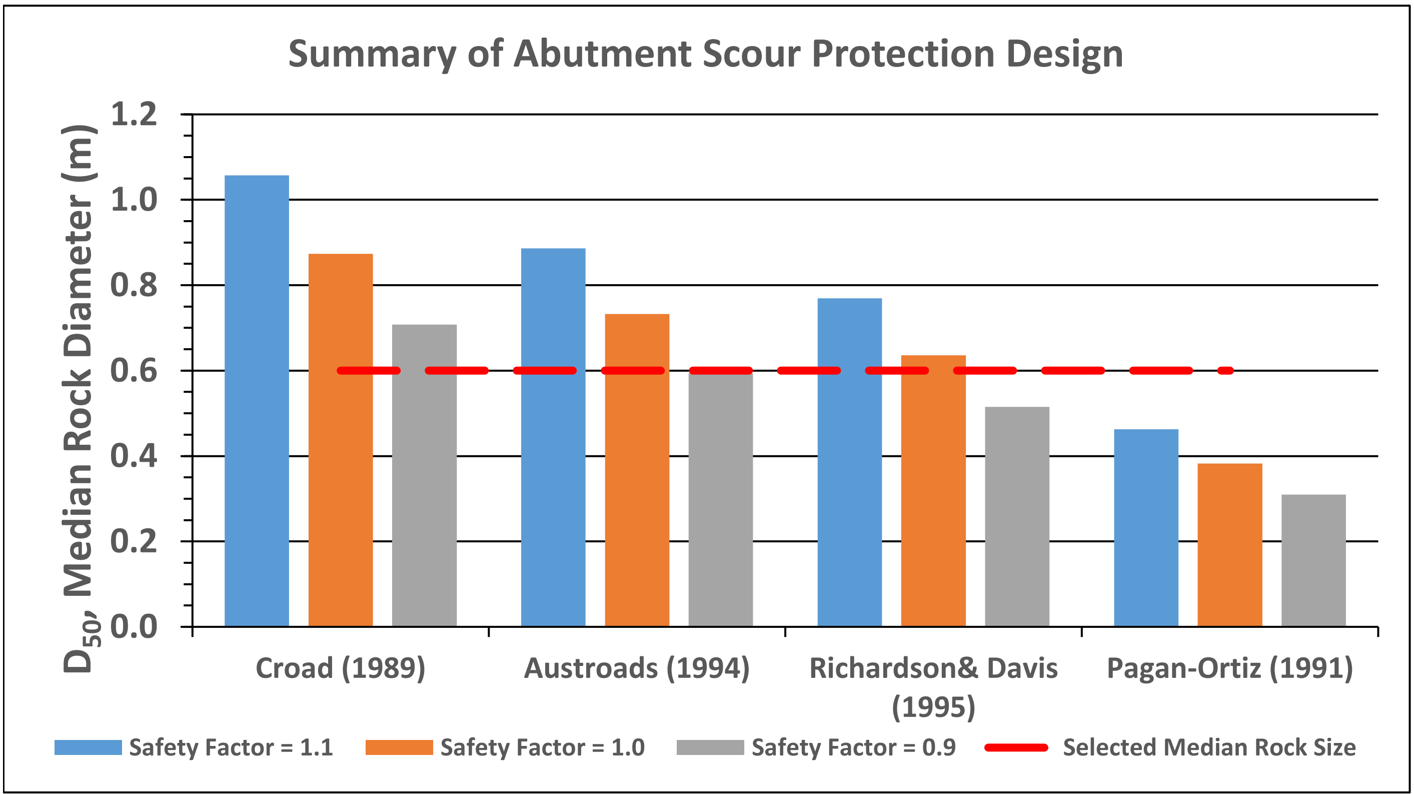
Notes:
1. For intact material take J_s = 1.0.
2. For values of r greater than 8 take J_s as for r = 8.
3. If the flow direction FD is not in the direction of the true dip TD, the effective dip ED is determined by adding the ground slope to the apparent dip AD: ED = AD + GS

Appendix B – Abutment Scour Protection Calculations

Project: SH8 Beaumont Bridge (Clutha River) Date: 13/06/2019
Project No: 6-CT102.00

Created by Daniel McMullan, Franciscus Maas

Safety Factor	Method	Croad (1989)	Austroads (1994)	Richardson& Davis (1995)	Pagan-Ortiz (1991)	Average	Max
1.1	d_{r50}	1.057	0.887	0.769	0.462	**0.972**	**1.057**
1	d_{r50}	0.874	0.733	0.636	0.382	**0.803**	**0.874**
0.9	d_{r50}	0.708	0.594	0.515	0.309	**0.651**	**0.708**



Project:	SH8 Beaumont Bridge (Clutha River)	Date:	13/06/2019
Project No:	6-CT102.00		
Created by	Daniel McMullan, Franciscus Maas		
Method:	Croad (1989)		

Input data:

g	9.81	m/s^2	
S_s	2.65		specific gravity of rock
V_{max}	3.40	m/s	Flow velocity
y	8.50	m	Water depth at toe

$$\frac{d_{r50}}{y} = \frac{0.91}{(S_s - 1)K_{sl}} Fr^2$$

$$Fr = \frac{V}{\sqrt{gy}}$$

α	26.5651	Slope angle
β	42	Angle of repose of riprap stone
K_{sl}	0.7438	embankment slop factor

$$K_{sl} = \sqrt{1 - \frac{\sin^2 \alpha}{\sin^2 \theta}}$$

Output data:

Safety Factor	V_b	Fr	dr_{50}
1.1	3.74	0.41	1.06
1	3.40	0.37	0.87
0.9	3.06	0.34	0.71

Project:	SH8 Beaumont Bridge (Clutha River)	Date:	13/06/2019
Project No:	6-CT102.00		
Created by	Daniel McMullan, Franciscus Maas		
Method:	Austroads (1994)		

Input data:

V_{max}	3.40	m/s	Flow velocity
y	8.50	m	Water depth at toe
g	9.81	m/s^2	
S_s	2.65	Specific gravity of rock	

$$\frac{d_{r50}}{y} = \frac{1.026}{(S_s - 1)} Fr^2$$

Output data:

Safety Factor	V_b	Fr	dr_{50}
1.1	3.74	0.41	0.89
1	3.4	0.37	0.73
0.9	3.06	0.34	0.59

Project:	SH8 Beaumont Bridge (Clutha River)	Date:	13/06/2019
Project No:	6-CT102.00		
Created by	Daniel McMullan, Franciscus Maas		
Method:	Richardson& Davis (1995)		

Input data:

V_{max}	3.40	m/s	Flow velocity
y	8.50	m	Water depth at toe
g	9.81	m/s^2	
S_s	2.65	Specific gravity of rock	
Ks	0.89	Shape Factor	

$$\frac{d_{r50}}{y_2} = \frac{K_s}{(S_s - 1)} Fr_2^{\,2}$$

K_s = shape factor
= 0.89 for spill-through abutments
= 1.02 for vertical wall abutments

Output data:

Safety Factor	V_b	Fr	dr_{50}
1.1	3.74	0.41	0.77
1	3.40	0.37	0.64
0.9	3.06	0.34	0.51

Project:	SH8 Beaumont Bridge (Clutha River)	Date:	13/06/2019
Project No:	6-CT102.00		
Created by	Daniel McMullan, Franciscus Maas		
Method:	Pagan-Ortiz (1991)		

Input data:

V_{max}	3.40	m/s	Flow velocity
y	8.50	m	Water depth at toe
g	9.81	m/s^2	
S_s	2.65	Specific gravity of rock	

Spill-through abutment:

$$\frac{d_{r50}}{y_2} = \frac{0.535}{(S_s - 1)} Fr_2^{\,2}$$

Output data:

Safety Factor	V_b	Fr	dr_{50}
1.1	3.74	0.41	0.46
1	3.40	0.37	0.38
0.9	3.06	0.34	0.31

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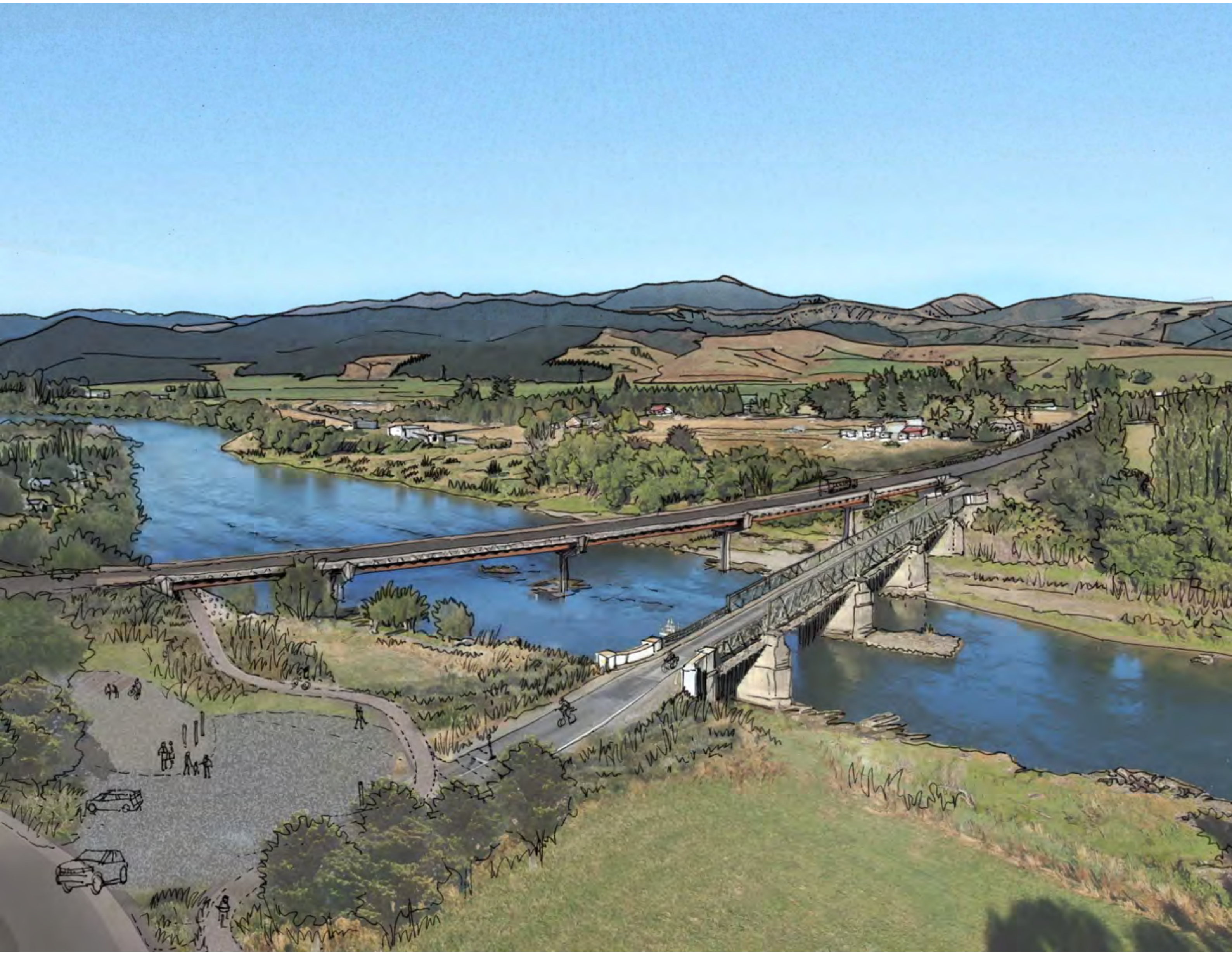
New Beaumont Bridge

Hydrological Assessment



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Contents

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1	August 2018	Sheryl Paine	Jack McConchie	Mike Davies	First Issue
2	September 2018	Lennie Palmer	Jack McConchie	Mike Davies	Second issue
3	October 2018	Lennie Palmer	Jack McConchie	Mike Davies	Third issue

Revision Details

Revision	Details
1	First issue of the document
2	Updated climate change adjustments based on MfE 2016 Climate Effects projections for Otago region
3	Updated flow design to include Q_{1000} based on Bridge Manual Amendment 3. Updated climate change based on MfE 2018 update.

1 Introduction

The SH8 Beaumont Bridge across the Clutha River is to be replaced by NZTA. To support the design and construction of the replacement bridge, the peak discharges and flood hydrographs for a range of design events, including the potential effects of climate change, were determined.

The Beaumont Bridge is located near the town of Beaumont, below the Roxburgh Dam in the Clutha catchment. The Roxburgh Dam is currently operated by Contact Energy Ltd. The Clutha River discharges into the Pacific Ocean, just downstream of the town of Balclutha (Figure 1.1).

The Teviot River is the only significant inflow to the Clutha River between Roxburgh Dam and the Beaumont Bridge. There is one other significant inflow between the Beaumont Bridge and the coast; the Pomahaka River.

Figure 1.1 Location of the Beaumont Bridge, Roxburgh Dam, and flow sites of relevance.

2 Hydrological Analysis

2.1 Flow data

To complete this analysis, several flow monitoring sites were investigated (Table 2.1). Otago Regional Council (ORC) maintain flow sites at several locations within the Clutha catchment; including at Balclutha, and on the Teviot and Pomahaka Rivers. Contact Energy Ltd hold data for the Total Discharge from Roxburgh Dam, and flow in the Clutha River approximately 2km downstream of the dam. Contact Energy have given permission to use these data.

Therefore, while there is no flow data for the Clutha River at the Beaumont Bridge, there are records on the Clutha River near the Roxburgh Dam and at Balclutha towards the coast (Figure 2.1).

Table 2.1 Flow sites on the Clutha River.

Name	Start date	End Date	Gaps (days)	Time-step
Clutha at Balclutha	6 Jul 1954	31 May 2018	138	15-min
Pomahaka at Burkes Ford	4 Aug 1961	24 May 2018	723	15-min
Teviot at Bridge Hut Road	16 Mar 1994	27 Oct 2004	181	15-min
Clutha at Below Roxburgh Dam	28 Mar 2001	26-Apr-2018	2.5	15-min
Roxburgh PS at Total Discharge	1 Aug 1965	1-Jun-2018	0	3-hourly

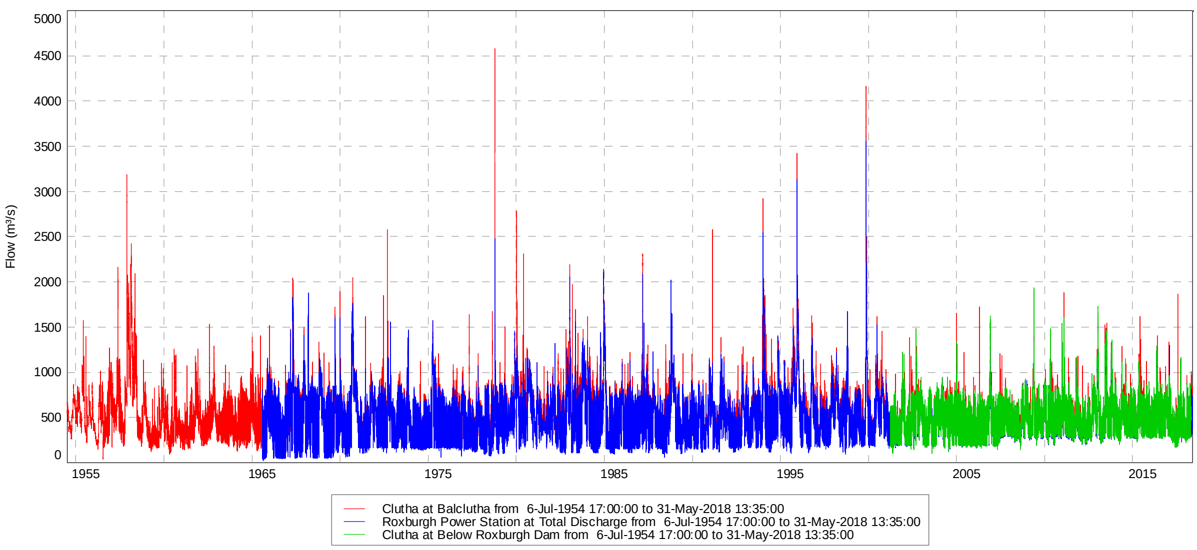

Figure 2.1 Comparison of the three flow records for the Clutha River.

Flows in the Clutha River have been modified by the Roxburgh Dam since it was commissioned in 1956, and the Clyde Dam since 1992. While the dams have a significant effect on the overall flow regime and flow duration curve of the Clutha River downstream, they have less effect on the frequency and magnitude of large flood events. The flood signature of the Clutha River appears to be largely unaffected by dam construction (Figure 2.1).

Since it is the furthest downstream, the Roxburgh Dam is likely to have the greater influence on the frequency and magnitude of floods experienced in the lower river i.e. near Beaumont. However, since any effects of the Roxburgh Dam have apparent since at least 1956, those effects are inherent in the instrumental flow records further downstream. Any effects of the dam are therefore included in any analysis of the annual flood maxima. This is appropriate since these effects are likely to also persist into the future.

2.2 Flow analysis

Since there is no flow gauge near the Beaumont Bridge, the flows at both Roxburgh Dam and Balclutha were investigated to determine their suitability for estimating the flows at Beaumont Bridge. Several flood events, when all three records could be compared, were analysed; 2013, 2009 and 2006 (Figure 2.2, Figure 2.3 & Figure 2.4).

These figures show that the Total Discharge from Roxburgh Dam and the Clutha River Below Roxburgh Dam records are very similar, as expected. The Total Discharge record is 'smoothed' as it is a 3-hour average, whereas the Below Roxburgh Dam gauge records instantaneous flows at 15-min intervals. The Balclutha record, also 15-min data, shows a similar pattern to those sites upstream, but is lagged by ~12-hours.

While the Balclutha recorder is much further downstream, with a 25% larger catchment area, the flows are similar to those upstream at Roxburgh Dam. Both the 1995 and 1999 floods show that the flows at Balclutha were ~10-15% larger than at Roxburgh Dam. This pattern is observed in many of the flood flows, but not all.

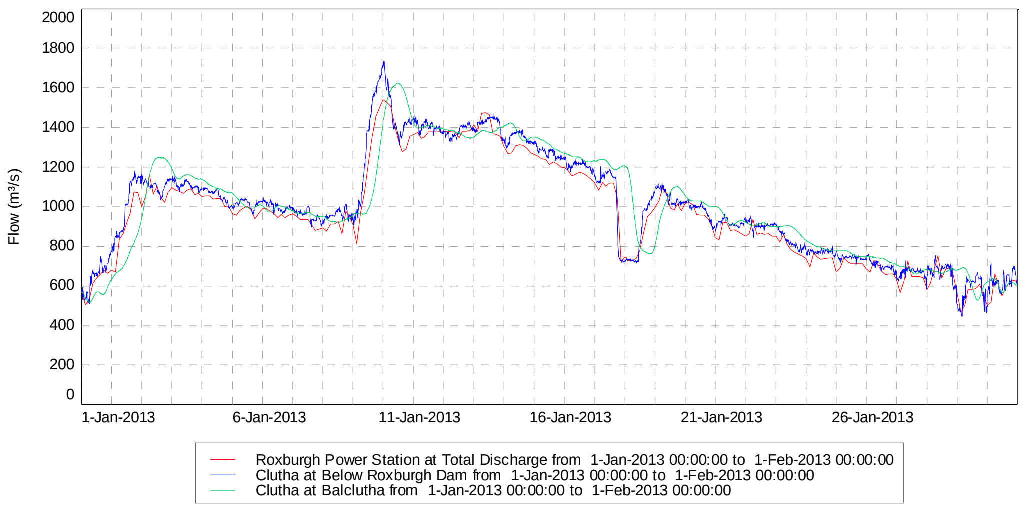

Figure 2.2 January 2013 flood. Comparison of the dam outflow, Clutha River below Roxburgh Dam, and the Clutha River at Balclutha.

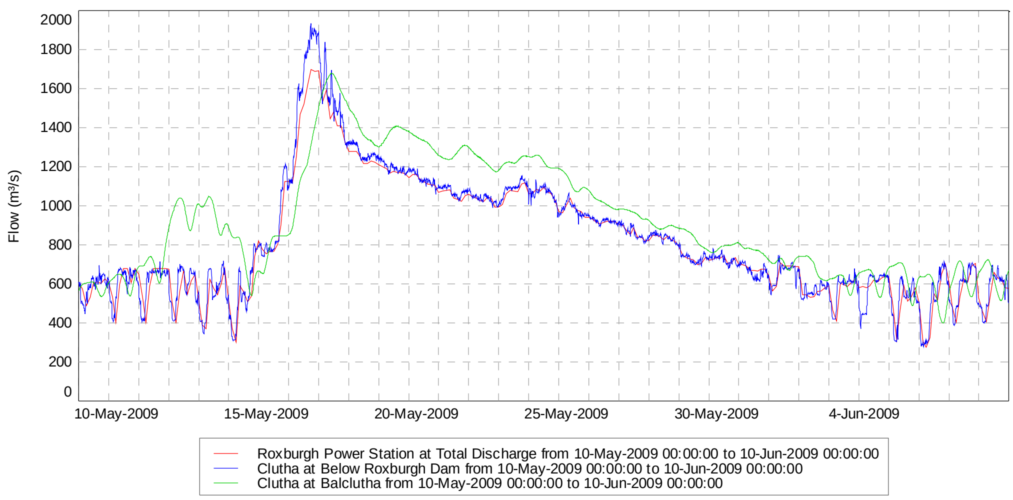

Figure 2.3 May 2009 flood.

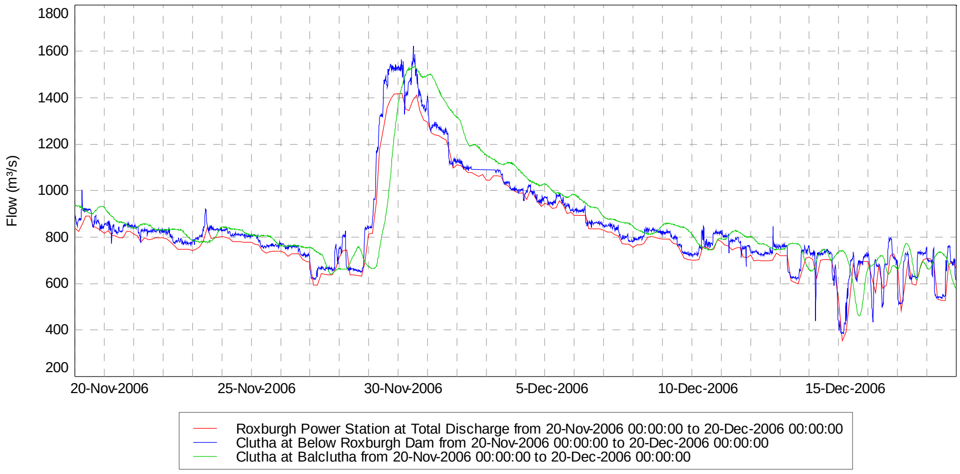

Figure 2.4 November 2006 flood.

It is therefore suggested that the Clutha River at Balclutha flow record be used to estimate flows at Beaumont Bridge, with no scale factor applied to account for the difference in catchment area. While this may over-estimate some flood peaks, because of the difference in catchment area, any difference in flow between the two locations is likely to be within the uncertainty of the flow measurement; especially during large flood events.

The current Beaumont Bridge is 134 years old and has therefore passed flows larger than 4000m^3/s safely.

2.3 Frequency analysis

An analysis of the annual flood maxima series was undertaken to determine the magnitude and frequency of the various design events. The frequency analysis was undertaken on the annual flood maxima series derived from the entire length of record. Three types of statistical distribution were assessed for how well they modelled the actual annual flow maxima series (i.e. Gumbel, Pearson 3 (PE3) and GEV). The distribution which provided the best fit to the annual maxima series was then used to estimate flows of design floods with specific annual exceedance probabilities (i.e. AEPs) or average recurrence intervals (i.e. ARIs).

As is standard practice, the frequency analyses were performed on a 12-month partition. That is, only the largest flood in each year was plotted, and the most appropriate statistical distribution fitted to those annual values. It is sometimes difficult to find a single statistical distribution that provides a robust model of the annual maxima series. In these situations, some subjectivity is required in selecting the most appropriate model. The criteria adopted in this study were:

- The distribution that provided the best-fit through all the flood maxima;
- The distribution with the most realistic shape; and
- The distribution that provides the closest approximation to the extreme floods.

While this process may appear subjective, in most cases the choice of a specific statistical distribution for the annual maxima series results in relatively minor differences in the estimated flow-frequency table.

Using this approach, the 50%, 20%, 10%, 2% and 1% AEP design flows were estimated from the Clutha at Balclutha flow record; assuming a PE3 distribution (Table 2.2). The corresponding frequency distribution is contained in Appendix A.

Table 2.2 Flood estimates for various design storm events.

ARI (yr.)	AEP (%)	Flow (m³/s)
2.33	50	1,580
5	20	2,130
10	10	2,630
20	5	3,140
50	2	3,810
100	1	4,320

The reliability of design flood estimates is a function of the length of flow record used in the analysis, and the appropriateness of the flow record to a particular flood model. As a rule of thumb, AEPs should not be extrapolated beyond twice the length of the annual flood maxima series (Davie, 2008). NIWA, however, use a general rule of thumb of five times the length of the maxima series. Uncertainty of the design flood estimates increases rapidly with more extreme events i.e. <1% AEP; therefore, the estimation of the extreme flows has large inherent uncertainties.

2.4 Estimation of the Q_{1000}

A recent amendment of the NZTA Bridge Manual (NZTA, 2018) lowered the design criteria for the replacement Beaumont Bridge, from an estimate of the likely magnitude of the 0.04% AEP event; i.e. the 2500-year design flood (Q_{2500}), to that of a 0.1% AEP event (the 1000-year design flood – Q_{1000}). As the Q_{2500} event had already been calculated, this report is updated to provide the Q_{1000} flood.

The Q_{1000} flood is the 'Ultimate Limit State' event defined in the NZTA Bridge Manual (3rd Edition, 2018) for permanent bridges on the State Highway Network that are classified as Arterial (such as the Beaumont SH8 Bridge). A lesser ULS standard is applied to bridges of lower importance. The ULS is the magnitude of the flood event under which bridge '*collapse shall be avoided*' (Section 2.3.2e); however, the bridge can be overtopped.

It is worth remembering that an extreme rainfall event (i.e. R_{1000}) does not necessarily generate a Q_{1000} flood event. Therefore, Q_{1000} flood events should be estimated from an instrumental flow record; rather than an extrapolated rainfall record, and an assumed rainfall-runoff relationship.

Extrapolating the results from the Clutha at Balclutha annual flood maxima series allows an estimate of the possible magnitude of the Q_{1000} event i.e. 5,850 (Figure 2.5), based on the GEV distribution. The Q_{2500} flow event previous determined was 6,500 m³/s.

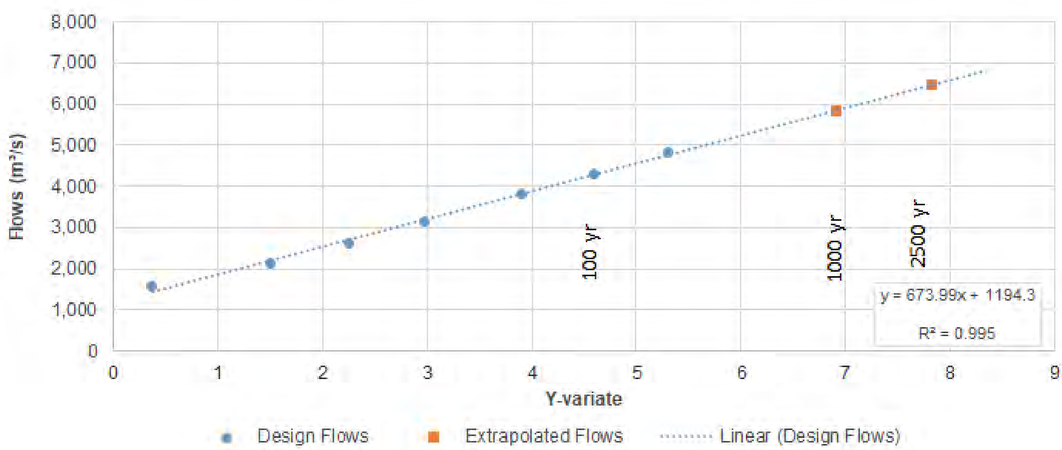

Figure 2.5 Estimation of the Q_{1000} flood event.

Although the NZTA Bridge Manual requires the magnitude of the Q_{1000} flow as an 'Ultimate Limit State' event to be estimated, the actual relevance of a flood of this magnitude in the Clutha River at the Beaumont Bridge, needs to be considered carefully. For example:

- Whether the design flood remains within the channel. In most situations, a Q_{1000} flow will include a significant overbank component. It is critical that the relevance and significance of both the 'in-channel' and 'out of channel' components of flow are considered from design and bridge safety perspectives;
- The size of the channel to be bridged. If the river is incised, then once the river banks have been overtopped the flood water will spread across the floodplain. If the extreme design flow does not remain in the channel, any scour estimates based on the total flow are likely to be misleading; and
- The nature of the topography upstream of the bridge.

Understanding the 'hydrological' context of the proposed bridge crossing, as well as the uncertainty inherent in any design flood estimation, are therefore critical considerations.

This is particularly the situation with the Clutha River. Since the river is incised only a relatively short depth below the adjacent floodplain, water will start 'leaving the channel' during extreme flood events. It is likely that during a 1% AEP flood, a significant portion of the flood will be 'out of the channel', and inundating the adjacent floodplain rather than affecting the bridge.

Rather than estimating the total design flow from the catchment, and assuming this will all pass through/under the proposed bridge, it would be better to determine the actual capacity of the channel, and the nature of the passage of flood-waters past the site. Scour protection can then be designed to mitigate the energy of these flows, rather than the total runoff from the entire upstream catchment.

2.5 Hydrographs

The expected design flood hydrograph is also required to support the design and construction of the Beaumont Bridge. For this study, the five largest floods from each of the three flow records were 'normalised', and then compared (Appendix B). The 'normalisation' process scales the hydrographs as a function of both time and peak discharge. This allows the direct comparison of the hydrograph shapes (Figure 2.6).

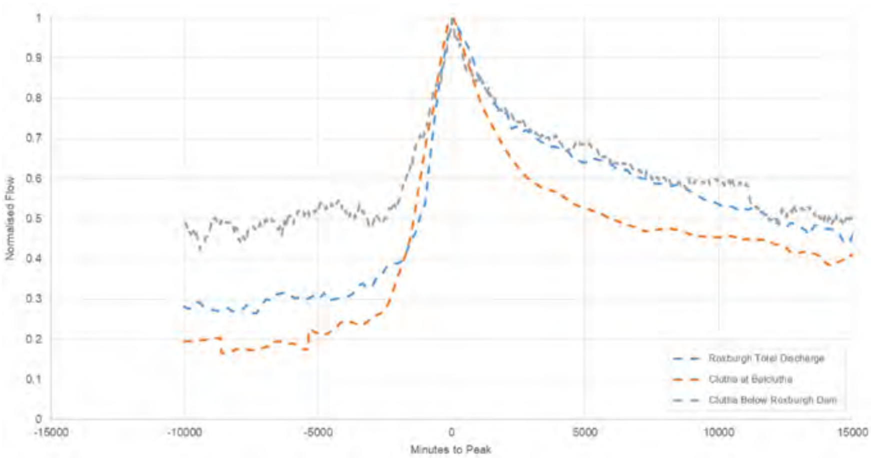

Figure 2.6 Comparison of the average normalised hydrographs for the three sites on the Clutha River.

Figure 2.6 shows that, while the average hydrographs for each site are different, they all approximate the same general shape. It is therefore suggested that the 'normalised' Clutha at Balclutha hydrograph be used to represent design floods at Beaumont Bridge.

3 Climate change

If predicted global warming eventuates, it may cause more than just a rise in the world's temperature. Warmer temperatures mean that more water vapour will enter the atmosphere, while also increasing the air's ability to hold moisture. Furthermore, sensitivity analysis has indicated that changes in rainfall are often amplified in runoff.

The Ministry for the Environment (MfE) have released climate change predictions for New Zealand (NZ) based on the IPCC 5th Assessment (MfE, 2016). For the IPCC 5th Assessment, a new set of four forcing scenarios was developed, known as representative concentration pathways (RCPs). These pathways are identified by their approximate total (accumulated) radiative forcing by 2100, relative to 1750.

These RCPs include; one mitigation pathway (RCP2.6) which requires removal of some of the CO_2 presently in the atmosphere, two stabilisation pathways (RCP4.5 and RCP6.0), and one pathway (essentially 'business as usual') with very high greenhouse gas concentrations by 2100 and beyond.

The ensembled average temperature increase for each of these scenarios is 0.7 °C, 1.4 °C, 1.8 °C and 3.0 °C by 2090 for NZ, but the results vary slightly for individual regions.

In 2018, MfE released a revision of the 2016 prediction report (MfE 2018). This revision is the same as the original report, except for the incorporation of results relating to very extreme rainfall – the "HIRDS" report (Carey-Smith *et al.*, 2018). That report updated "augmentation factors" for deriving extreme rainfall depths from future increases in temperature. These augmentation factors differ to those presented in earlier reports.

The HIRDs study used 6 of the Global Climate Models (GCMs) used for the IPCC future predictions of the 4 RCPs, for further downscaling to higher resolution Regional Climate Models (RCMs) for NZ. Results from these RCMs were used to the determine the rainfall augmentation factors which vary based on storm duration and ARI (*Table* 3-1), and future NZ temperatures increases (Table 3-2). It is important that the two tables are used in conjunction to each other.

Table 3-1: Percent increase in rainfall expected from 1°C increase in temperature. Most likely change shown on top line and the range provided in brackets. Values derived based on RCM results across NZ. Source: Table 13, MfE 2018.

Duration	ARI 50-year	ARI 100-year
24-hour	8.4 (5.1 - 12.5)	8.6 (5.2 - 12.8)
48-hour	7.4 (3.4 – 11.4)	7.5 (3.5 – 11.5)
72-hour	6.8 (2.9 – 11.1)	6.9 (2.9 - 11.2)
96-hour	6.4 (2.6 – 11.0)	6.5 (2.7 - 11.2)

Table 3-2: Projected increases in mean annual temperature by 2040, 2090, and 2110 for NZ (Source: Table 14, MfE, 2018). Extrapolated values for 2070 and 2120 are shaded.

Scenario	2040 (°C)	2090 (°C)	2110 (°C)	2070 (°C)	2120 (°C)
RCP2.6	0.59	0.59	0.59	0.6	0.6
RCP4.5	0.74	1.21	1.44	1.0	1.6
RCP6.0	0.68	1.63	2.31	1.2	2.6
RCP8.5	0.85	2.58	3.13	1.9	3.4

Note: The data in the first 3 columns are from Tables 14 in Ministry for the Environment (2018). The shaded values are extrapolated from the MfE tabulated data. The MfE table cover the projected mean temperature change between 1986-2005 and the periods 2031-2050 (2040), 2081-2100 (2090) and 2101-2120 (2110). They are the average of the 6 RCM model simulations (driven by different GCM).

The direct effect of global warming on runoff, and particularly flooding, has not been quantified. Since interest is generally in extreme events, when catchment storage is approaching saturation, it is assumed that an increase in rainfall will produce a similar increase in runoff.

The percentage increases in temperature (Table 3-2) are relative to the base period being 1986-2005 (1995). To provide the necessary level of service incorporating 50-year and 100-year adjustments for climate change, the required timeframes are now 2070 and 2120 respectively.

The rainfall augmentation factors vary based on storm duration and return. There has been no direct analysis of (rainfall) storm duration. However, from the analysis of observed flood events on the Clutha River (Figure 2-6 and Section 2.2), the time to peak ranges from 24 to 72 hours. Accounting for attenuation of the flood due to the size and storage available in the catchment, we can assume a storm duration ranges between 24 and 96 hours duration. Therefore, a rainfall augmentation factor of 8% (*Table* 3-1) was adopted.

Assuming the higher mitigation pathway of RCP6.0, with a New Zealand RCM predicted increase in temperature of 1.2°C by 2070 and 2.6°C by 2120 (Table 3-2), the 50-year and 100-year Clutha flow adjustment is 10% and 21% respectively (Table 3-3). The corresponding adjustment based on RCP8.5 is 15% and 27%.

Table 3-3: Climate change percent adjustments to rainfall (and flow) based on RCP6.0 and using an 10% increase in rainfall per degree of projected temperature increase.

Scenario	2070 (%)	2120 (%)
RCP2.6	5	5
RCP4.5	8	13
RCP6.0	10	21
RCP8.5	15	27

Table 3.4 illustrates the 50-year and 100-year RCP6.5 climate change adjustments. However, adjustments of the 2018 peak flow to allow for other climate change scenarios can be easily assessed. This can be done by: Identifying the desired scenario climate change adjustment from Table 3-3; and then using this new value to scale the 2018 design flood estimate.

Table 3.4 Design flood estimates adjusted for climate change (m^3/s) based on RCP6.0 and a 8% increase in rainfall per 1 degree increase in projected temperature. Values are rounded to the nearest 50 m^3/s

ARI (yr.)	AEP (%)	2018	2070	2120
50	2	3,810	4200	4600
100	1	4,320	4750	5250
1000	0.1	5,850	6,450	7,100
2500	0.04	6,500	7150	7850

4 Low flow analysis

It is possible that some construction activities would be facilitated by low flows in the Clutha River. Therefore, an analysis of the low flows at Beaumont Bridge was undertaken. This was to determine the seasonality of the flow series i.e. the times throughout the year when the lowest flows would be expected, and the diurnal pattern of river flow caused by management of Roxburgh Dam.

As for the previous analysis, the Clutha at Balclutha flow site was used for the low flow analysis. The summary statistics for Clutha at Balclutha are displayed in Table 4.1. Flows have been as low as 37m^3/s, but the mean and median flows are 572m^3/s and 532m^3/s respectively.

Table 4.1 Summary statistics of Clutha at Balclutha (1954-2018). Flows in m^3/s.

Name	Min.	Mean	Median	Max.	L.Q.	U.Q.
Clutha at Balclutha	37.1	572.1	531.7	4581.3	398.8	690.8

To determine the seasonality of flows, the average monthly statistics were derived; along with the absolute minimum and maximum monthly values. This established the overall range of flows that could be experienced at the site (Table 4.2).

Table 4.2 Monthly summary statistics for Clutha at Balclutha flow dataset. In m^3/s.

Month	Average Minimum	Average Mean	Average Maximum	Absolute Range (Min-Max)
January	329	628	1024	139-2921
February	272	526	871	133-2578
March	239	491	838	102-2309
April	245	490	826	99-2044
May	270	568	973	95-2163
June	297	595	1001	117-2314
July	258	522	908	37-1864
August	265	517	853	108-1679
September	282	543	895	113-2583
October	332	629	1023	109-4581
November	372	680	1043	122-4167
December	362	670	1045	159-3420

On average, the lowest flows occur in March and April i.e. autumn. The largest flows occur during spring and early summer; when flows are augmented by snow-melt from the upper catchment. Autumn tends to have lower flows, as temperatures and snowmelt decrease and rainfall is low.

On a daily scale, during these months i.e. March and April, the lowest flows at Balclutha occur in the early evening i.e. 19:00 (Figure 4.1). Flows begin to decrease quite rapidly from about 11:00, reach a minimum at about 18:00, and start to increase again from about 20:00.

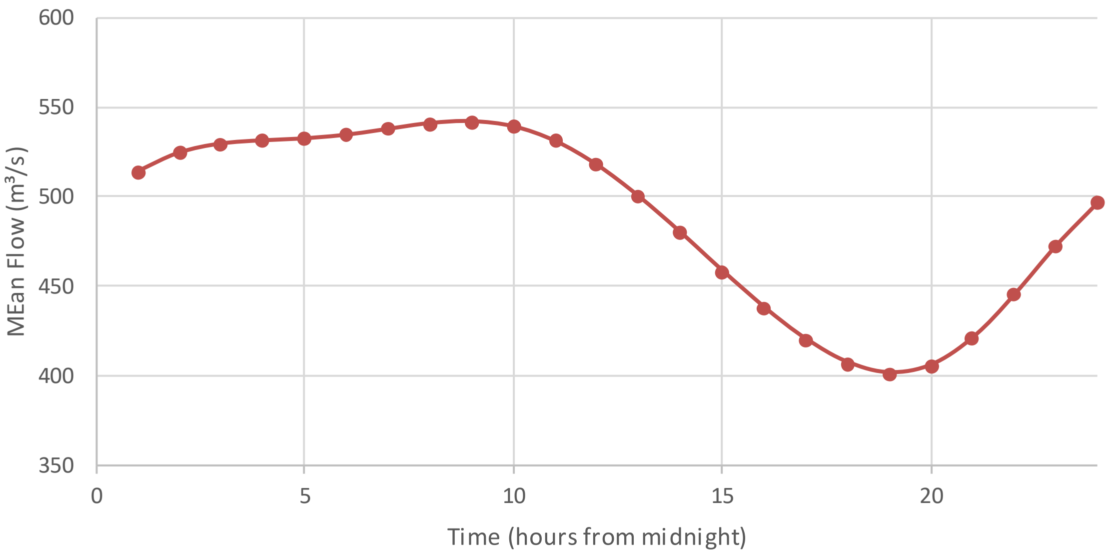

Figure 4.1 *Mean flows in March and April for Clutha at Balclutha based on flow record from 1954-2018.*

This pattern is a function of releases from Roxburgh Dam. While releases are greatest in the morning, there is an approximate 12-hour lag caused by travel time down the Clutha River to Balclutha.

The Beaumont Bridge is approximately 47km downstream of the Roxburgh Dam, and 60km upstream of Balclutha. This equates to a lag time of approximately 5.3 hours between Roxburgh Dam and the Beaumont Bridge; assuming an average flow velocity between the dam and Balclutha.

There is very limited data available currently relating to the diurnal pattern of flow, and therefore water level, variation near the Beaumont Bridge. Some limited data was collected over 3rd July 2018 by Elliot Sinclair. It is not known how representative these data are of the more general pattern of flow variability.

These data are compared with the total discharge from Roxburgh Power Station in Figure 4.2. The discharge from Roxburgh was lagged initially by 5.3 hours; however, this lag appears too long. A lag of 4.2 hours provides a better fit between the outflow from Roxburgh and changes in water level at Beaumont (Figure 4.2). This would be consistent with an expectation of a faster average velocity in the upper catchment.

Based on the limited data available, the lowest flows at Beaumont Bridge are likely to occur between 7am and 11am.

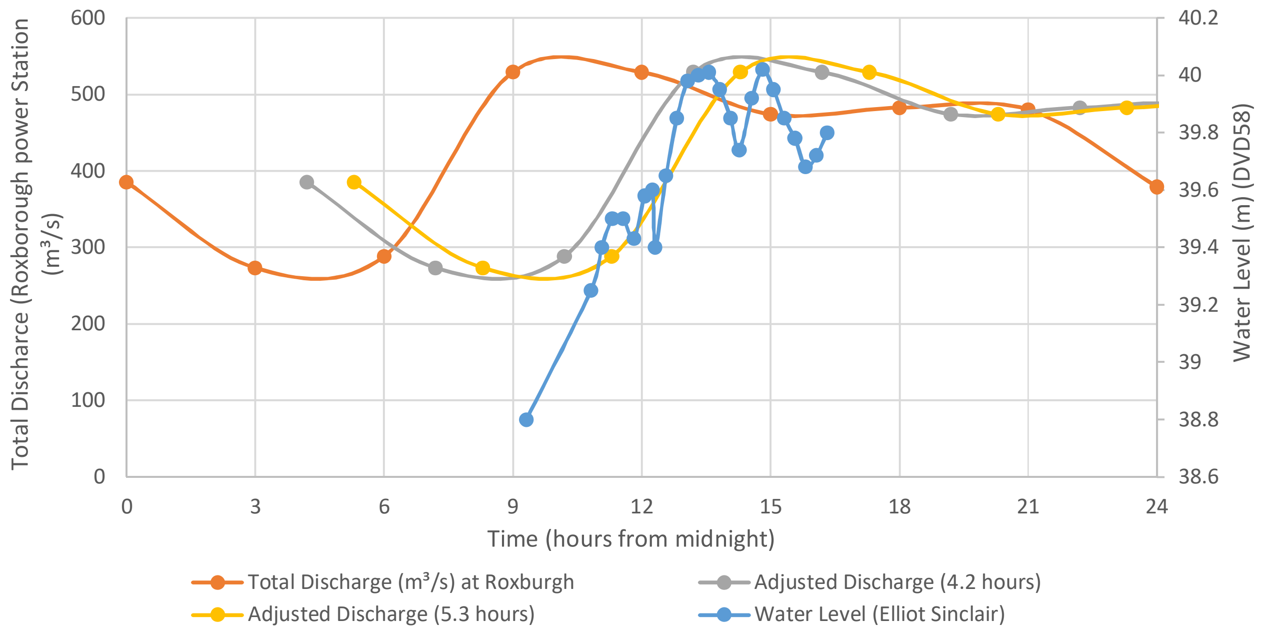

Figure 4.2: Comparison of water levels at Beaumont and discharges from Roxburgh Power Station, lagged to allow for different travel times.

5 Summary

The peak flows for a range of design events at Beaumont Bridge have been determined. A comparison of flows at Roxburgh Dam and Balclutha shows that the Clutha at Balclutha record is the best representation of those flows likely to be experienced at Beaumont Bridge.

A 1% AEP design event would be just over 4,300m³/s. This is likely to be slightly conservative i.e. high, because of inflows between Beaumont Bridge and Balclutha. The Q_{1000} design flow is expected to be 5,850m³/s.

Flows can be increased from current estimates by 10% and 21% respectively, to account for the potential effects of climate change out to 2070 (50-year) and 2120 (100-year).

Flows at Beaumont Bridge are likely to be lowest from 7am to 11am; although they start to decrease earlier. The optimum window from the perspective of 'expected low flows' is therefore likely to be in the early morning. This estimate, however, is based on very limited empirical data from Beaumont.

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Appendix A
Frequency analysis

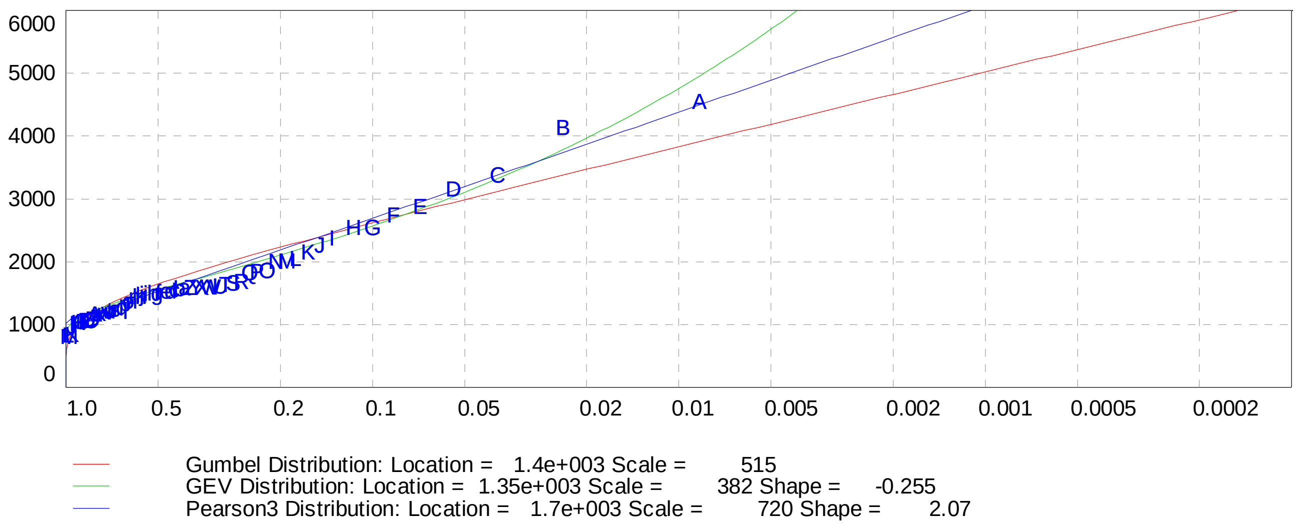

Figure 6.1 Frequency analysis of the Clutha at Balclutha flow record (1954-2018).

Appendix B
Normalised hydrographs

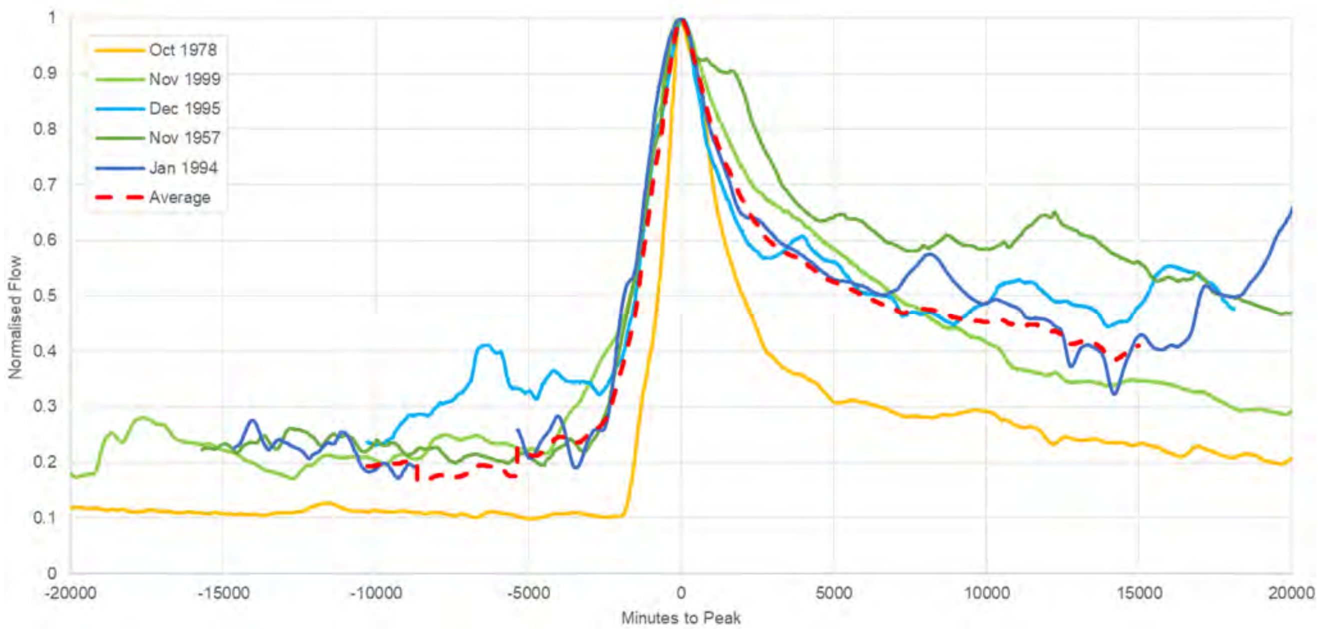

Figure 6.2 *Normalised hydrographs for the five largest events in the Clutha River at Balclutha.*

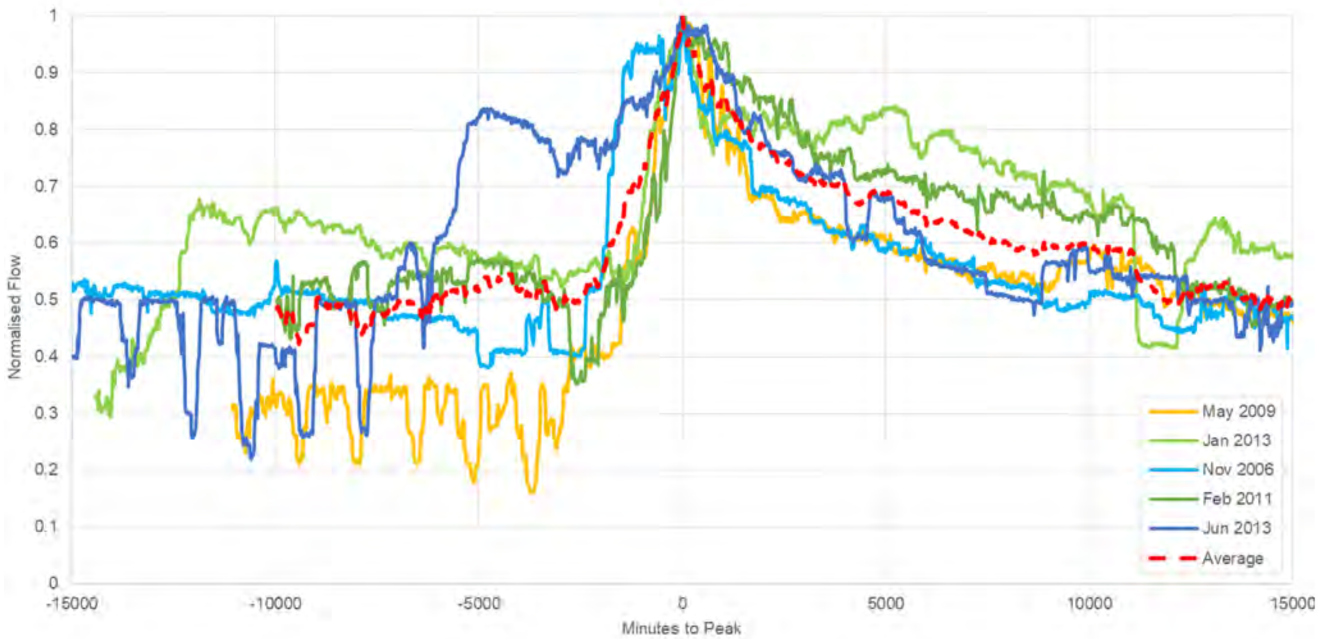

Figure 6.3 *Normalised hydrographs for the five the largest events in the Clutha River Below Roxburgh Dam.*

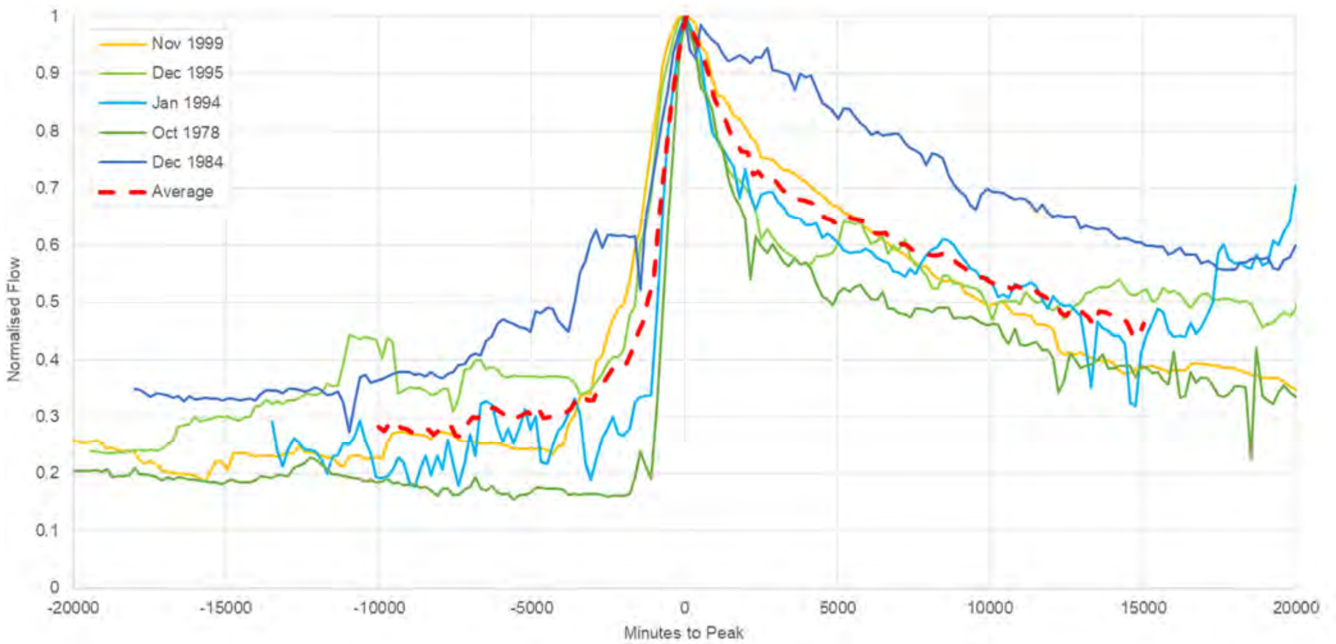

Figure 6.4 Normalised hydrographs for the five the largest Total Discharge events at Roxburgh Power Station.

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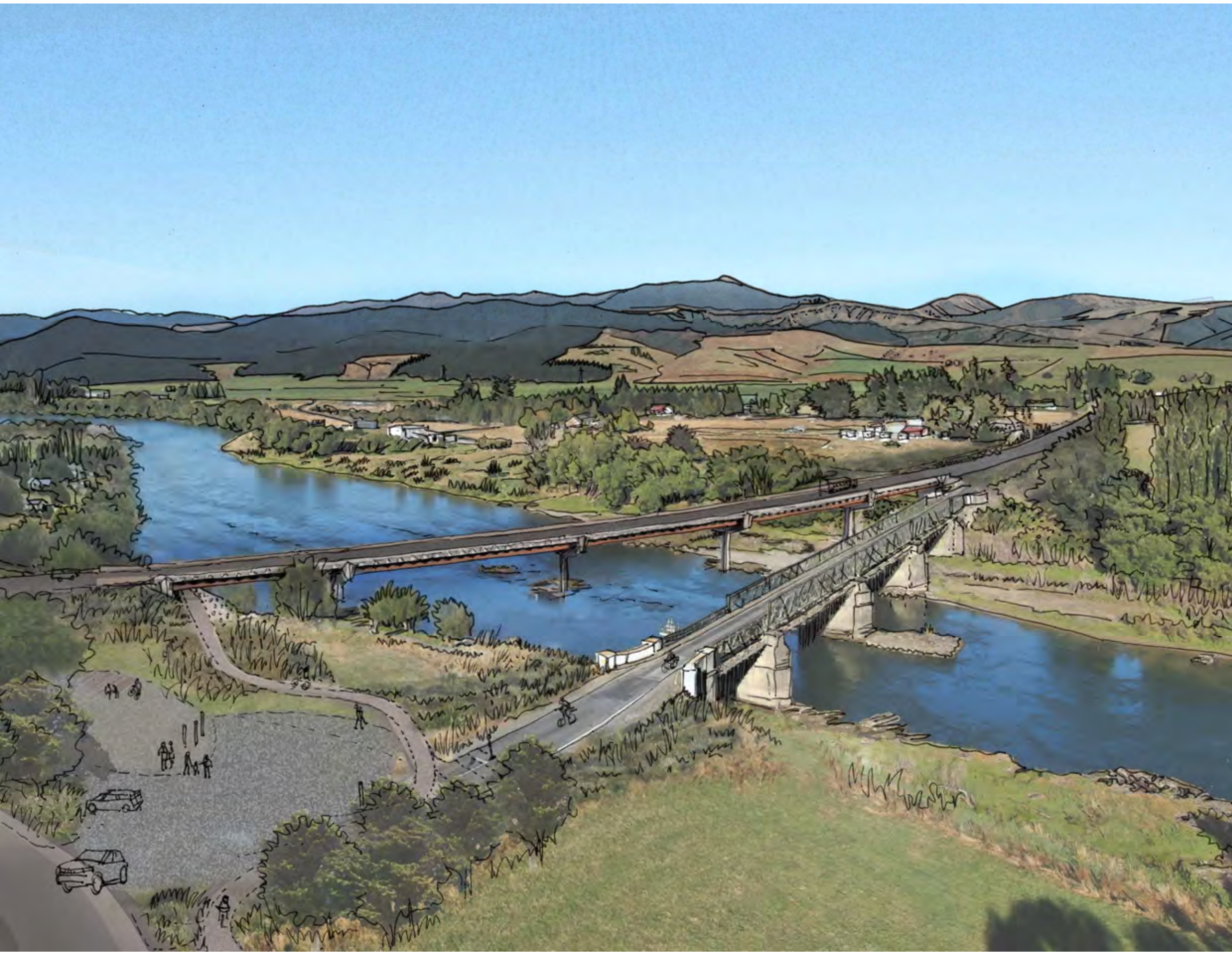
New Beaumont Bridge

Archaeological Assessment Report



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Revision	Date	Author	Reviewed by	Approved by	Status
1	29/04/2019	Sam Kurmann	TJ O'Connell		Draft 1
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Revision Details

Revision	Details
1	90% review
2	Final review
3	Final changes
4	Updated for NZTA Comments

Executive Summary

In May 2018, WSP Opus was engaged by the NZ Transport Agency (NZTA) to undertake the design and construction surveillance for the new State Highway 8 (SH8) Beaumont Bridge. SH8 is being realigned, and a new bridge will be constructed within this alignment downstream of the existing single lane bridge. This report presents the findings of the archaeological assessment for this project.

This report identifies potential and known archaeological risk to the Project, based on the results of the archaeological and historic research, when assessed next to the scope of works. The potential for encountering Māori archaeological remains are high. If Māori archaeological remains are found, the remains are assessed as high value. Archaeological values pertaining to European occupation around the Project area is medium to high. Known European archaeological sites relate to the existing 1880s Beaumont Bridge, the Beaumont Hotel site and a house site that were recorded following the compilation of this archaeological assessment.

This assessment recommends that the proposed works should proceed under an Archaeological Authority from Heritage New Zealand Pouhere Taonga. The following recommendations are made:

- That an Archaeological Authority should be applied for from Heritage New Zealand Pouhere Taonga prior to the works, under Section 44(a) of the HNZPTA. An Archaeological Management Plan should be prepared to support this application.
- That risk areas highlighted in Figure 32 and Figure 33 of this assessment be referred to as a guide to areas that should be monitored by an archaeologist during the construction phase of the new Beaumont Bridge.
- That further consultation with Iwi is undertaken as part of the archaeological authority application.
- That any encountered archaeological remains are recorded and investigated using standard archaeological practice.

As part of the Project works the existing heritage bridge is to be retained and repurposed for pedestrian and cyclists use. These works are subject to a separate Heritage Assessment and management process and are not covered in this report.

1 Introduction

1.1 Purpose of this Report

WSP Opus were commissioned by the NZ Transport Agency (NZTA) to prepare an archaeological assessment for the new Beaumont Bridge and the associated road realignment, Beaumont, Otago (Figure 1).

This report presents an archaeological assessment of the project area in Beaumont. It identifies the presence and values of archaeological sites in the project footprint and discusses impacts on these sites from the proposed project activities. This report is also intended as a supporting document for an Archaeological Authority application to Heritage New Zealand Pouhere Taonga (HNZPT). It will be used to inform a separate Assessment of Environmental Effects (AEE) report.

Proposed works to repurpose the existing heritage bridge for pedestrian and cyclist use are subject to a separate Heritage Assessment and management process and are not covered in this report.

1.2 Project Location

Beaumont is situated in Central Otago, approximately 110 km west of Dunedin. The Beaumont township straddles the Mata-au/Clutha River, and the bridge provides the only physical connection between East and West Beaumont (and effectively east and west Otago). Beaumont straddles the Mata-au/Clutha River in Central Otago along State Highway 8 (Figure 1). The project area begins approximately 0.5 km south east of the Beaumont Bridge near Low Burn. The project area terminates approximately 0.8 km west of the Bridge, along the state highway. The new bridge will be approximately 60 metres south of the current Beaumont Bridge. The new alignment crosses through a paddock to meet the existing State Highway 8 in front of the Beaumont Hotel.

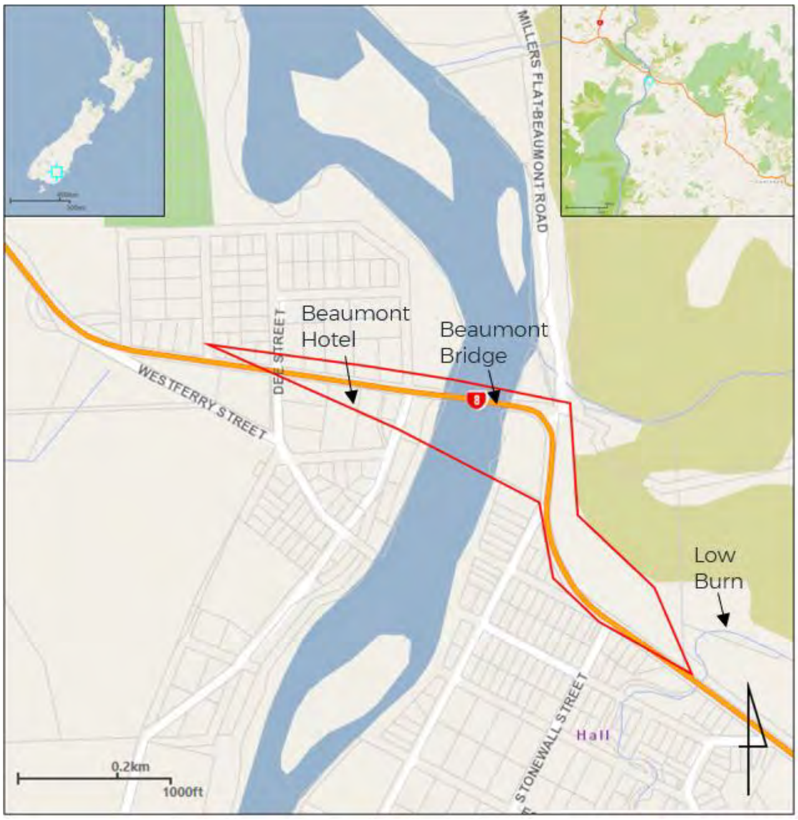

Figure 1. Map showing the general project area (red and blue outlines) for the Beaumont Road realignment (ArchSite)

1.3 Background and Proposal

The existing Beaumont Bridge was built in 1887 as a single lane, five span, wrought iron truss bridge. The Beaumont Bridge has an expansive recent history of issues around its structural integrity. For the last 30 years, it has been under scaffolding as various repairs, condition monitoring and strengthening works have been undertaken to manage the bridge for the current heavy vehicle traffic loading.

A design philosophy statement prepared by WSP Opus engineers in 2017 recognised that "the existing bridge is susceptible to fatigue cracking and has a limited remaining economic life" (in Stevens 2016). A solution was presented in the form of a new two-lane structure on a curved alignment, just downstream of the existing bridge and road alignment.

Plans for how to achieve these changes are being developed currently by the WSP Opus design team (see Appendix A). There will also be landscaping and planting activities associated with the car parking around the Beaumont Hotel and within the vicinity of the Project area. The proposed works include:

- Approximately 200m long, 5 span bridge with piled foundations to be excavated into the bedrock within the river and on the river banks;
- Realignment of State Highway 8 on the approaches to the new bridge and construction of approach embankments up to 3m high;
- Intersection modifications including closure of side road intersections with the state highway (Westferry Street, Rongahere Road, Weardale Street) and upgrade of state highway intersections (Dee Street, Craig Flat Road and Stonewall Street);
- Construction of pedestrian and cycle linkages connecting the Clutha Gold Cycle Trail to the Beaumont Hotel and Rongahere Road and repurposing of the existing single lane bridge (deck and handrail modifications) which will be retained to for pedestrian and cyclist use;
- Construction of highway stormwater systems including roadside swales, underground pipes and a landscaped stormwater treatment basin on the eastern side of the river;
- Relocation of overhead power and underground telecoms cables and installation of street lighting at side road intersections;
- Construction of a new safe stopping area (rest area) at the eastern end of the existing bridge comprising car park and picnic facilities accessed from Craig Flat Road.

To complete the project, proposed works will include earthworks (top soil stripping/stockpiling/re-spreading, excavation, placement of imported fill, rip-rap installation), trenching for underground services, pavement construction, excavation in rock for bridge foundations, bridge construction (reinforced concrete and structural steel), landscaping works and temporary works including construction of a temporary work platform into the river and establishment of contractors compound (storage for plant and materials and welfare facilities for workers).

The land parcels that are included in this assessment are listed in the below table:

Table 1. Legal Descriptions of Project Area from west to east

Lot 3 DP 8804	Section 6 TN of Blk IX Dunkeld	Section 1 TN of Blk VIII Dunkeld	Section 2 TN of Blk VIII Dunkeld
Road reserve	Section 7 TN of Blk IX Dunkeld	Section 2 TN of Blk VIII Dunkeld	
Lot 1 DP 19144	Section 8 TN of Blk IX Dunkeld	Section 4 SO 23609	
Lot 2 DP 19144	Section 9 TN of Blk IX Dunkeld	Section 1 SO 23610	
Section 5 TN of Blk IX Dunkeld	Section 4 TN of Blk VIII Dunkeld	Section 2 SO 23610	

2 Statutory Requirements

There are two main pieces of legislation in New Zealand that legislate for work affecting archaeological sites. These are the *Heritage New Zealand Pouhere Taonga Act* 2014 (HNZPTA) and the *Resource Management Act* 1991 (RMA).

2.1 The *Heritage New Zealand Pouhere Taonga Act* 2014

The HNZPTA promotes the identification, protection, preservation and conservation of the historic and cultural heritage of New Zealand. It provides blanket protection to all archaeological sites whether they are recorded or not, with the purpose of identifying, protecting, preserving and conserving evidence of New Zealand's society and history. The provisions of the HNZPTA are administered by Heritage New Zealand Pouhere Taonga (Heritage New Zealand). It is illegal to modify or destroy archaeological sites, without first gaining an archaeological authority to do so from Heritage New Zealand Pouhere Taonga.

The HNZPTA contains a consent (authority) process for any work affecting an archaeological site. An archaeological site is defined under Section 6 as: (a) any place in New Zealand, including any building or structure (or part of a building or structure), that— (i) was associated with human activity that occurred before 1900 or is the site of the wreck of any vessel where the wreck occurred before 1900; and (ii) provides or may provide, through investigation by archaeological methods, evidence relating to the history of New Zealand; and (b) includes a site for which a declaration is made under Section 43(1) of the Act.

Under Section 42 of the Act, any person who intends carrying out work that may modify or destroy an archaeological site, or to investigate a site using invasive archaeological techniques, must first obtain an authority from Heritage New Zealand under Section 44(a) of the Act. The process applies to sites on land of all tenure including public, private and designated land. The HNZPTA contains penalties for unauthorised site damage or destruction.

The archaeological authority process applies to all sites that fit the HNZPTA definition, regardless of whether:

- The site is recorded in the New Zealand Archaeological Association (NZAA) Site Recording Scheme or entered into the Heritage New Zealand List/Rārangi Kōrero,
- The site only becomes known about as a result of ground disturbance, and/or,
- The activity is permitted under a district or regional plan, or a resource or building consent has been granted.

2.2 The *Resource Management Act* 1991

Part II of the *RMA* outlines the Purposes and Principles of the RMA. In outlining the purpose of the RMA, Section 5 states:

(1) The purpose of this Act is to promote the sustainable management of natural and physical resources.

(2) In this Act, "sustainable management" means managing the use, development and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural wellbeing and for their health and safety while –

a) Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and

b) Safeguarding the life supporting capacity of air, water, soil, and ecosystems; and

c) Avoiding, remedying, or mitigating any adverse effects of activities on the environment.

Section 6 of the RMA outlines that "in achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall recognise and provide for the following matters of national importance." In 2003 amendments to the RMA elevated historic heritage to a Matter of National Importance under Section 6 (f), which identifies the need for "the protection of historic heritage from inappropriate subdivision, use, and development."

A definition of Historic Heritage was also added with the amendments to the RMA. This defines Historic Heritage as:

a) Those natural and physical resources that contribute to an understanding and appreciation of New Zealand's history and cultures deriving from any of the following qualities:

(i) archaeological;

(ii) architectural;

(iii) cultural;

(iv) historic;

(v) scientific;

(vi) technological; and

b) Includes –

(i) historic sites, structures, places, and areas; and (ii) archaeological sites; and (iii) sites of significance to Māori, including wāhi tapu; and (iv) surroundings associated with the natural and physical resources.

As such, when considering applications under the RMA, the consenting authority must have regard to historic heritage as a Matter of National Importance.

This assessment covers archaeological values only and is based on HNZPTA assessment requirements. It does not include an assessment of the archaeological values associated with the 1887 bridge. The heritage values of this bridge have already been assessed by Chessa Stevens in 2016. However, this archaeological assessment informs the AEE prepared by Shane Roberts (in prep.).

3 Methodology

This archaeological assessment report is based on desk-top research, a field survey and monitoring of the excavation of geotechnical test pits in the project area (as approved by Heritage New Zealand Pouhere Taonga). Research was carried out using a range of historic and archaeological information sources including:

- New Zealand Archaeological Association (NZAA) Site Record Database (ArchSite);
- The Heritage New Zealand Pouhere Taonga (HNZPT) List/Rārangi Kōrero;
- Kā Huru Manu, the Cultural Mapping Project by Ngāi Tahu;
- Archaeological journals, theses and reports associated with the area;
- Primary literature;
- LINZ survey plans, historic maps and photographs from various sources;
- Historic newspapers (Papers Past website);
- Published resources about the history of the Beaumont area.

Sam Kurmann carried out an initial site visit on the 10th of August 2018 to inspect the proposed works location. She made two further visits on the 15th and 16th of August and the 24th and 25th of October 2018 to archaeologically monitor the mechanical excavation of geotechnical test pits where the proposed road realignment will be located. While at Beaumont, site walkovers were also undertaken to identify and, where possible, relocate recorded archaeological sites near the project area.

The assessment of archaeological values was based on a consideration of the impacts of the proposed works on both potential and known archaeological sites in the area. These sites were characterised using the archaeological values of condition, rarity, contextual values, information potential, amenity value and cultural associations. This was done in accordance with the HNZPT guidelines.

3.1 Limitations

This report does not include an assessment of Māori cultural values. Statements are made regarding the location and nature of archaeological sites and their archaeological values. The views of Tangata Whenua are not presented in this report. Cultural values may encompass a wider scope than those considered in an archaeological assessment report.

4 Background

4.1 Environmental setting

The Beaumont township straddles the Mata-au (Clutha) River. The vegetation around the Project area is mainly grass and introduced shrub species. Some trees exist including macrocarpa (*Cupressus macrocarpa*) and other introduced species. The topography around the bridge is flat to undulating, with a steeper slope leading into the historic bridge approach. The geological landscape was provided by WSP Opus engineering geologists. This indicated that the project area is:

> "within a valley plain identified as having been deposited in the late quaternary. The geology is likely to comprise primarily of alluvium and colluvium.
>
> These deposits typically consist of unconsolidated to poorly consolidated mud, sand, gravel and peat of alluvial and colluvial origin. The wider area, including the adjacent hills comprise Caples Group Grade TZIII schist rock" (Taghipouran and Abbot 2019).

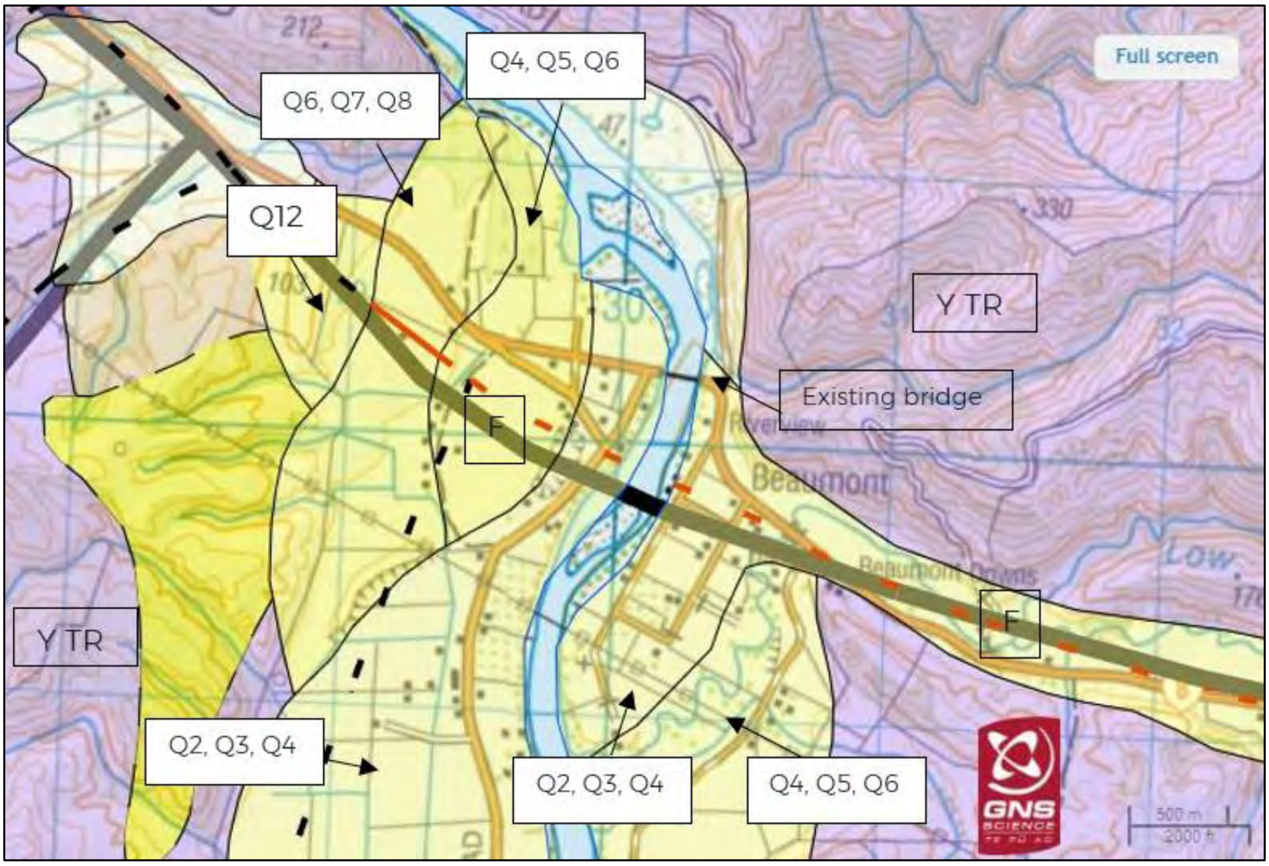

Figure 2. Geology Map, provided by WSP Opus Geologists, where F = Tuapeka Fault line; Y TR = Undifferentiated Caples terrane TZ Grade III Schist; Q = Pleistocene River Deposits (Q2-Q3 = late Pleistocene, Q4-Q12 middle Pleistocene). Consisting of sand, silt, clay and gravel. The description is that it is typically comprised of sandy greywacke gravel overlain by loess (Taghipouran and Abbot 2019)

4.2 Māori occupation of Beaumont and along Mata-au

The Southern South Island was a place of Māori occupation since the earliest peopling of New Zealand. The Waitaha people lived there earliest, followed by Ngāti Mamoe around the fifteenth and sixteenth century (Anderson 1998: 21-23). By the eighteenth century, Ngāi Tahu began migrating to the south. Māori from the earliest periods of arrival to Aotearoa up to European colonisation utilised the interior of Otago. The Clutha River/Mata-au was utilised as a transport route between Wānaka and coastal Otago (at the Clutha River Mouth) throughout the pre-European period. Anderson (2008: 41) describes coastal (temporary and permanent) settlements along the mouth of the Mata-au.

The Ngāi Tahu Atlas, 'Ka Huru Manu' explains that the Mata-au means swirling water. The inland region was utilised for fowling, fishing, trade of pounamu and access to inland resources such as stone sources. Weka were fat in winter time and eel were easily caught during the summer. Mata-au is a Statutory Acknowledgement Area where it was recognised under the Ngāi Tahu Claims Settlement Act for its basis as a descendant of the creation traditions, but also its use as a mahinga kai trail (from Otago Regional Plan - Appendix 2). The archaeological remains pertaining to Māori occupation of this area are detailed in Section 5.1.

4.3 Historic-era occupation of Beaumont

A thorough account of this history of Beaumont was provided by Stevens (2016). This is reproduced, with permission, in Appendix B. Here, it is summarised and tailored to fit the archaeological requirements of the assessment.

Differing accounts into who the first explorers were to Central Otago for gold surveys exist. Hall-Jones (2005: 9) stated that Thomas Archibald prospected for gold as far up the Mata-au as Beaumont Creek in 1851. Another record stated that Beaumont was initially visited by European Nathanael Chalmers in 1853, who accompanied Māori Rangatira Reko inland along the Mata-au. Māori settlements persisted along the river mouth and lower reaches of the river, and temporary settlements existed further up the Mata-au. Three years later, John Turnbull Thomson arrived in Otago as the chief surveyor. He surveyed Otago during 1857 to 1858 and published a map of his findings in 1860. Near Beaumont (also known as Dunkeld), several Stations were established around this time. Following the discovery of gold in Central Otago in 1860, miners began to flock there to establish claims. Beaumont played a pivotal role in the access to the Upper Clutha, where punt river crossings were fast established, and the road was formed to Beaumont by 1864 (Hall-Jones 2005: 65).

A decade later, Beaumont was a well-established stop off point for those travelling through to the gold fields and the interior (Figure 3 to Figure 5). The settlement had hotels, a school, a church and even a race course. Punts ran in the area and were free to use until the erection of the first Beaumont Bridge in September 1874 (Figure 4). The call for the erection of a bridge was made after several dangerous crossings in rough weather conditions. Hayes commissioned the bridge and it was in private ownership. The bridge was only open to foot traffic at this time, and the bridge approaches were not completed until November 1874 following completion of construction of the eastern bridge approach. Roads were only surveyed at this time, the crossing was not suitable for horses and the bridge crossing cost more than the punts, so punts remained the preferred transport route.

In 1875, Hayes put the bridge up for sale (*Tuapeka Times*, 22/09/1875, p.3) and it was sold to Kitching in 1876. Kitching also bought the punt at this time and built the Bridge Hotel. Holding the monopoly over the river crossings, Kitching fielded many complaints around the exorbitant fees being charged for these river crossings. 1876 survey plan SO 14210 shows the detail around the bridge location, including the surrounding Bridge Reserve on either side of the Beaumont Bridge (Figure 6). It also shows a house immediately south of the eastern approach of the bridge (Figure 7). The railway reserve is also depicted in this survey plan (Figure 8). In 1877, the Tuapeka County Council and Government investigated a purchase of the bridge after the complaints of locals were taken seriously. However, in 1878, the bridge was washed away by severe flooding. In a domino-like effect, the Clyde Bridge washed down stream and took out Beaumont Bridge, which together caused the demolition of the Balclutha Bridge (Thornton 2001: 231; *Bruce Herald*, 1/10/1878, p.5).

The Government investigating re-erecting the bridge for some years, which included negotiating the purchase of the same land from Kitching (*Tuapeka Times*, 12/07/1879, p.3). Construction of the bridge was slow. Contractual toing and froing contributed to the hold ups (*Press*, 12/05/1885, p.2) and shoddy building further delayed the opening, with some of the piers being built too high (*Tuapeka Times*, 11/08/1886, p. 3). One result of this back and forth was the survey of the town of Beaumont in 1882 (Figure 9 to Figure 11). Visible in this plan is the Bridge Hotel and its stables, a blacksmith, an historic water race, a house site, the ferry punt, the bridge location to the east (Figure 12). It was not until 1887 that the new Bridge opened (Figure 13), construction possibly being spurred by the drowning of a young girl in a punt accident in November 1886. The opening of the new bridge allowed people to travel into Beaumont and make the use of the town's facilities, which now included a store, bakery, blacksmith and post office.

The 1890s were favourable to the development of Beaumont, as advances in technology allowed more efficient dredges into the Clutha. This resulted in less work and higher yields of gold while dredging in the area. Around Beaumont, the Golden Gravel dredge operated just downstream of the Beaumont Bridge (Figure 14). Approximately 1-2 km upstream of the bridge, a cluster of hut sites associated with the gold mining rush are apparent. Newspaper records describe these as being inhabited by Chinese Miners, including Chung Low who was found dead at his hut in 1892 (*Star*, 23/05/1892, p.3).

Throughout Central Otago, the Roxburgh Line of the Railway was proposed in 1886. A survey was completed in the same year by the Public Works Office (AJHR 1886). There were several railway encampments along the Line. However, there were difficulties with the actual construction of the rail, such as the actual location and dealing with financial issues posed by recessions. The Roxburgh Line did not reach Beaumont until 1905, and was not opened in its entirety until 1928 (Yonge 1995:27; Churchman and Hurst 2001: 205-206; Cowan 2010).

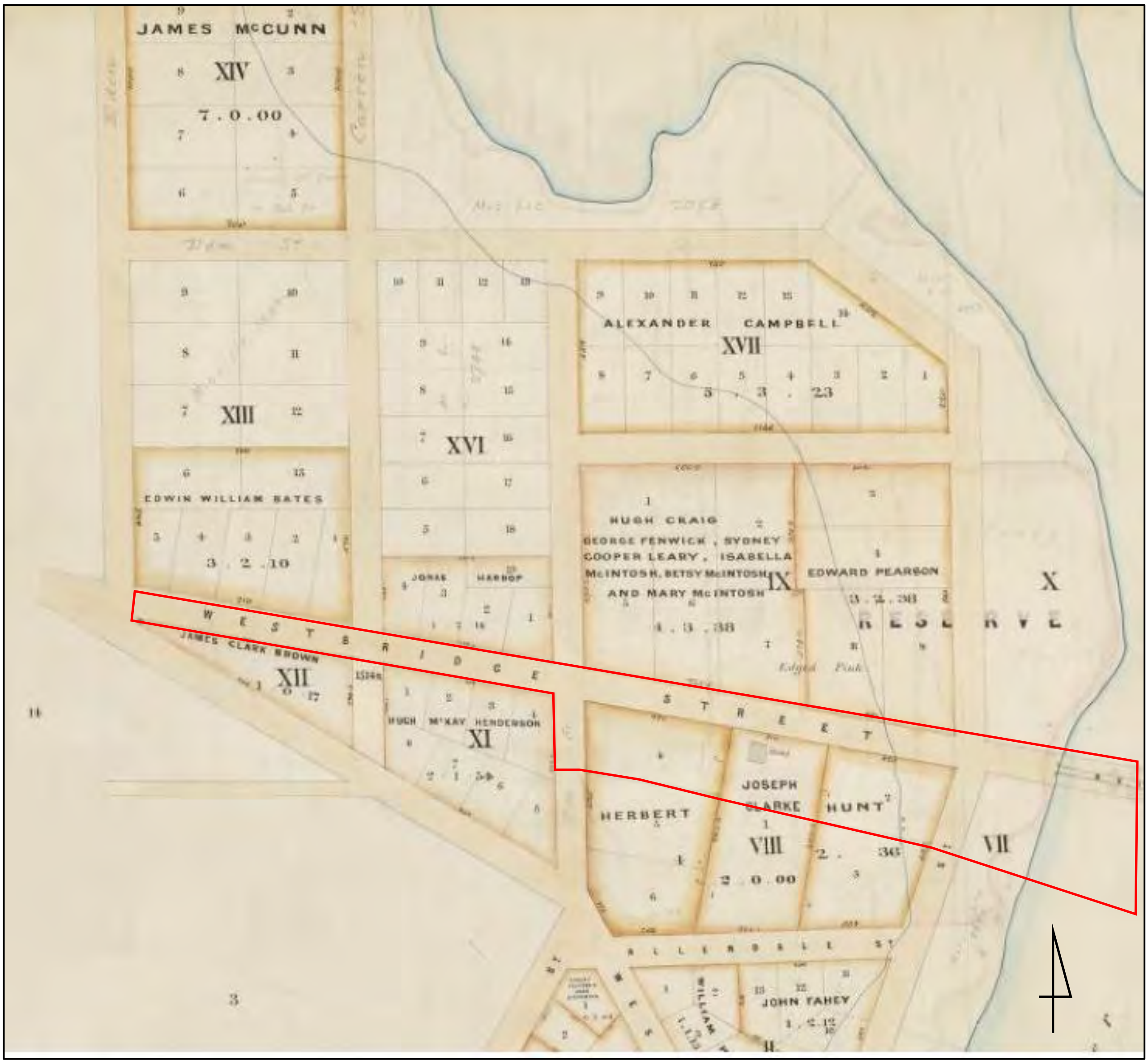

Figure 3. Detail of Town of Dunkeld Plan 1870 - Otago Crown Grant Index Record Map, north west extent of Project area (red outline; source: Archives NZ at archway.archives.govt.nz)

Figure 4. Detail of Town of Dunkeld Plan 1870 - Otago Crown Grant Index Record Map, south of the Project area but showing the punt location in blue (source: Archives NZ at archway.archives.govt.nz)

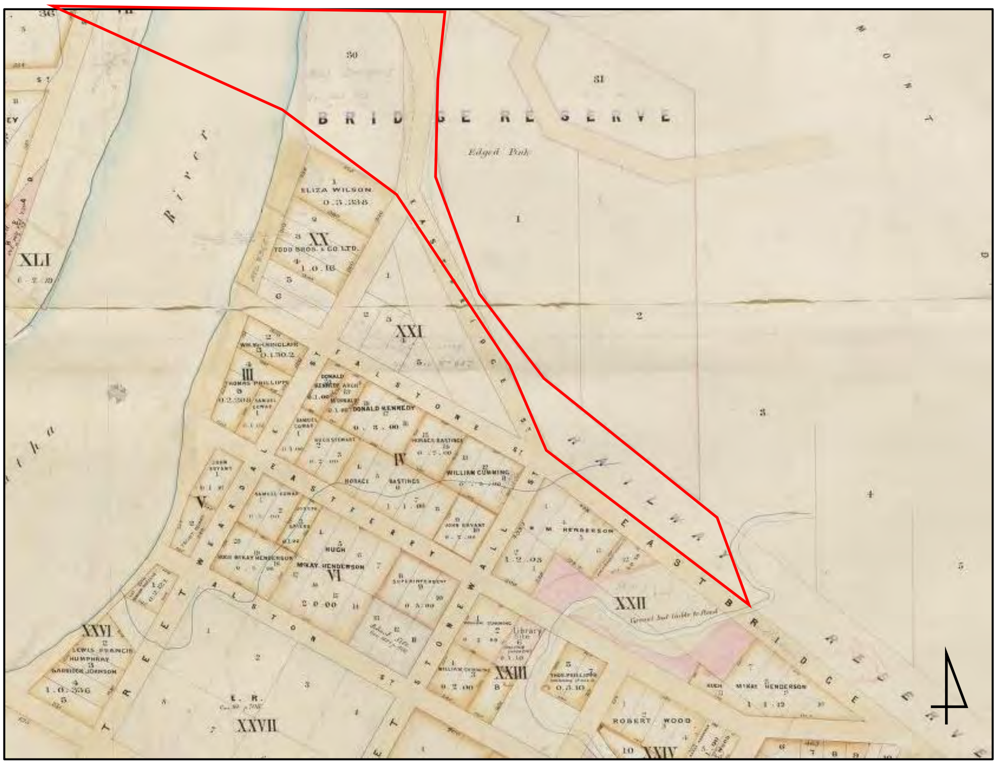

Figure 5. Detail of Town of Dunkeld Plan 1870 - Otago Crown Grant Index Record Map, eastern extent of Project area (red outline; source: Archives NZ at archway.archives.govt.nz)

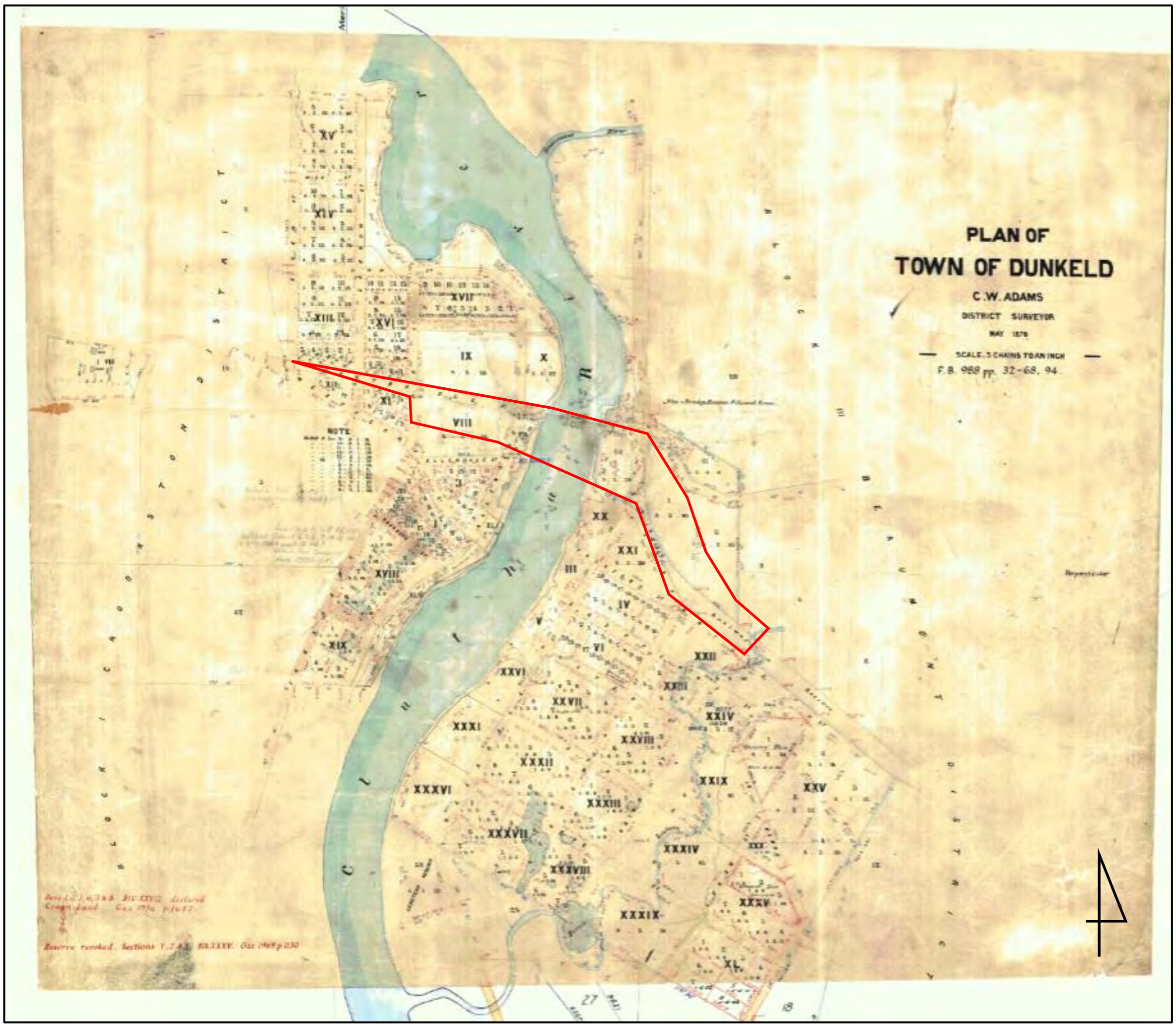

Figure 6. 1876 Plan of Town of Dunkeld (SO 14210; project area in red)

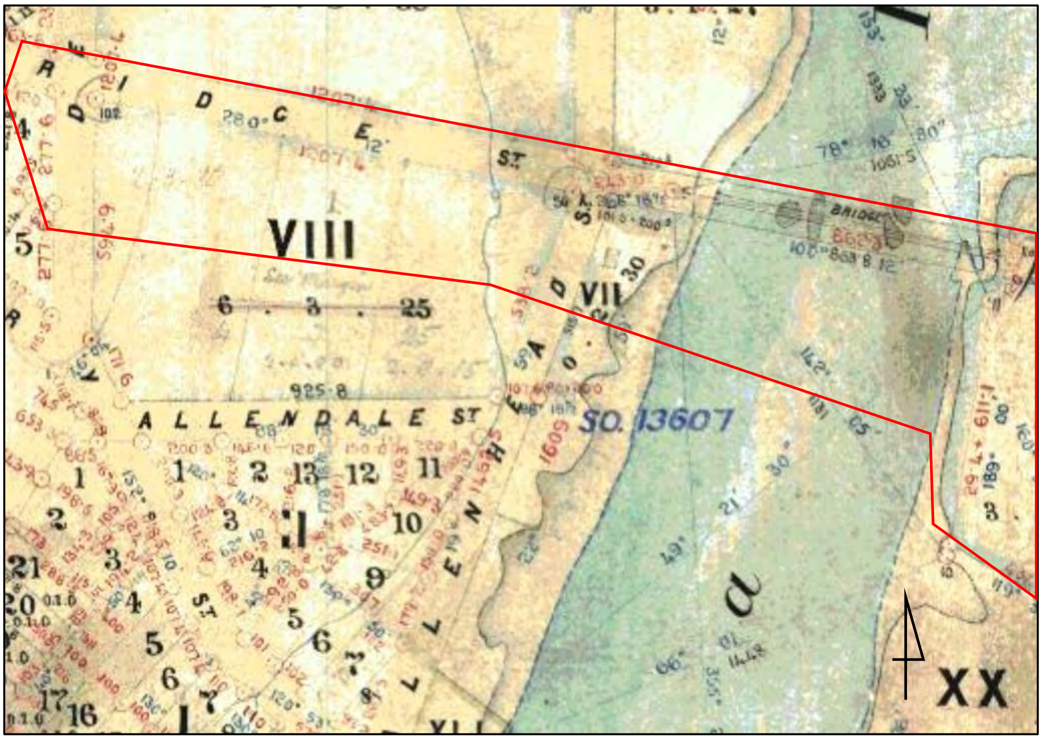

Figure 7. Detail of 1876 plan SO 14210 – showing the west side of Beaumont (project area in red)

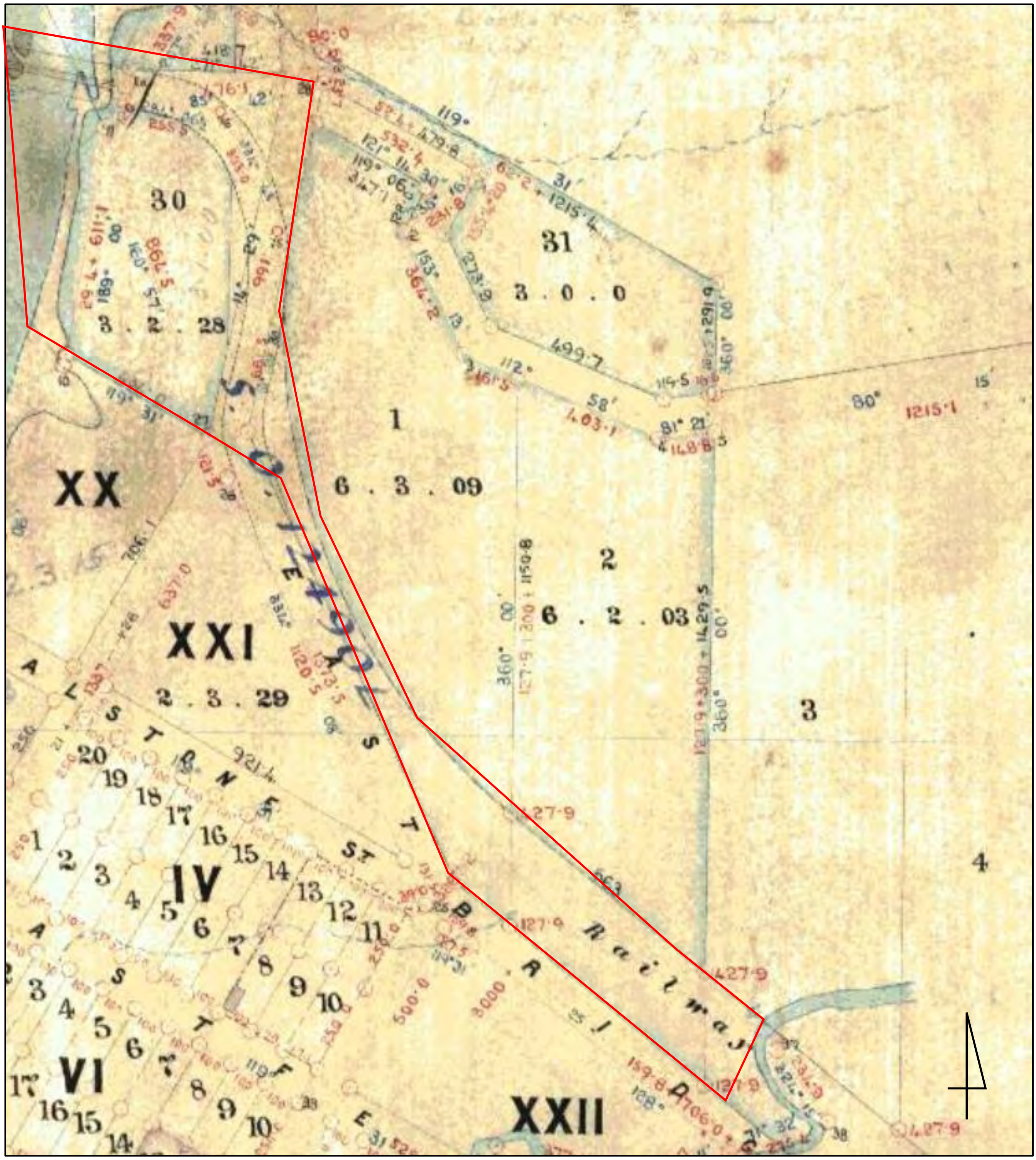

Figure 8. Detail of 1876 SO 14210 showing the eastern extent of the Project area (red outline), including the proposed railway reserve

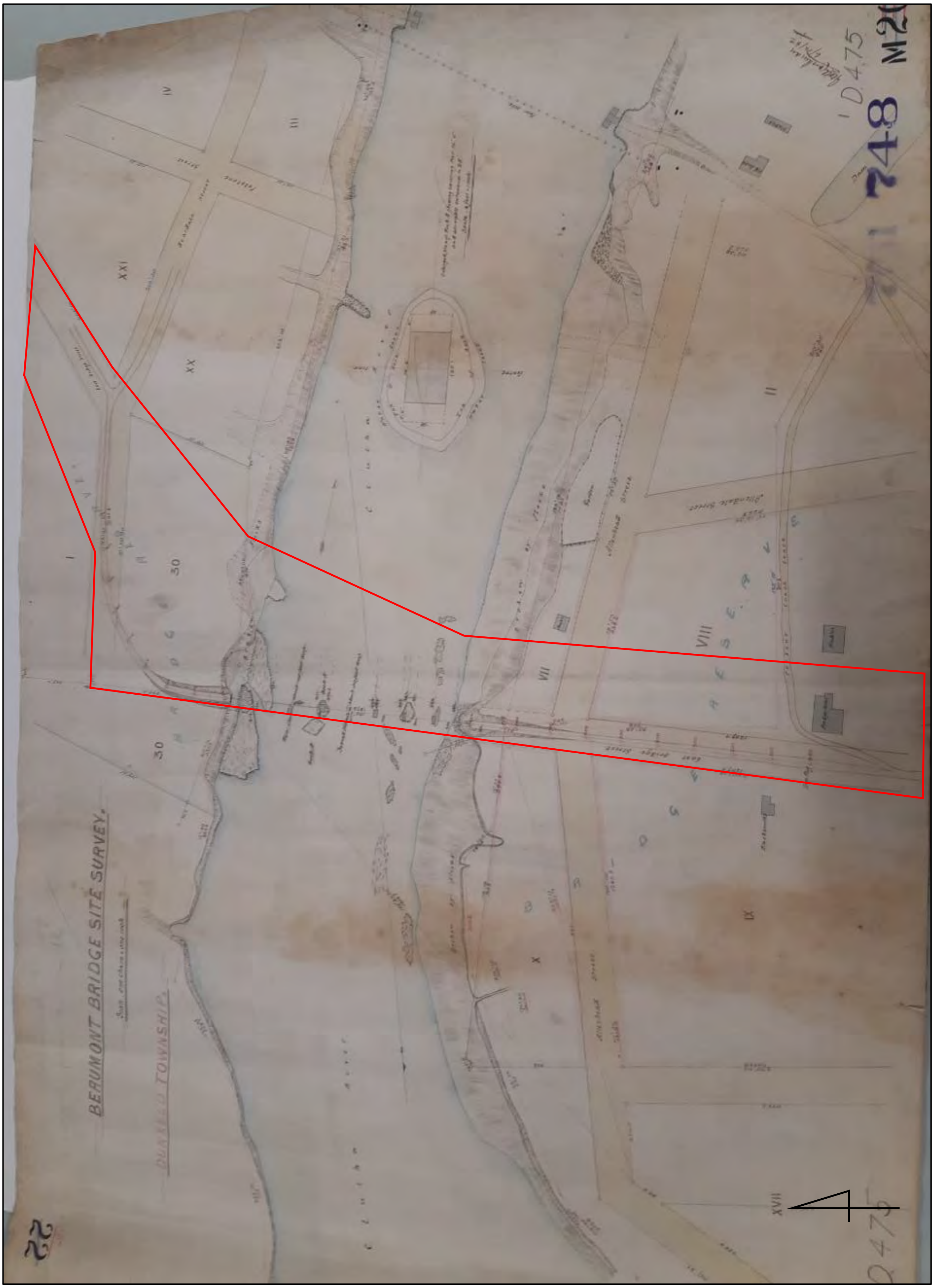

Figure 9. Beaumont Bridge Site Survey 1882, orientated east (project area in red; source: Archives New Zealand)

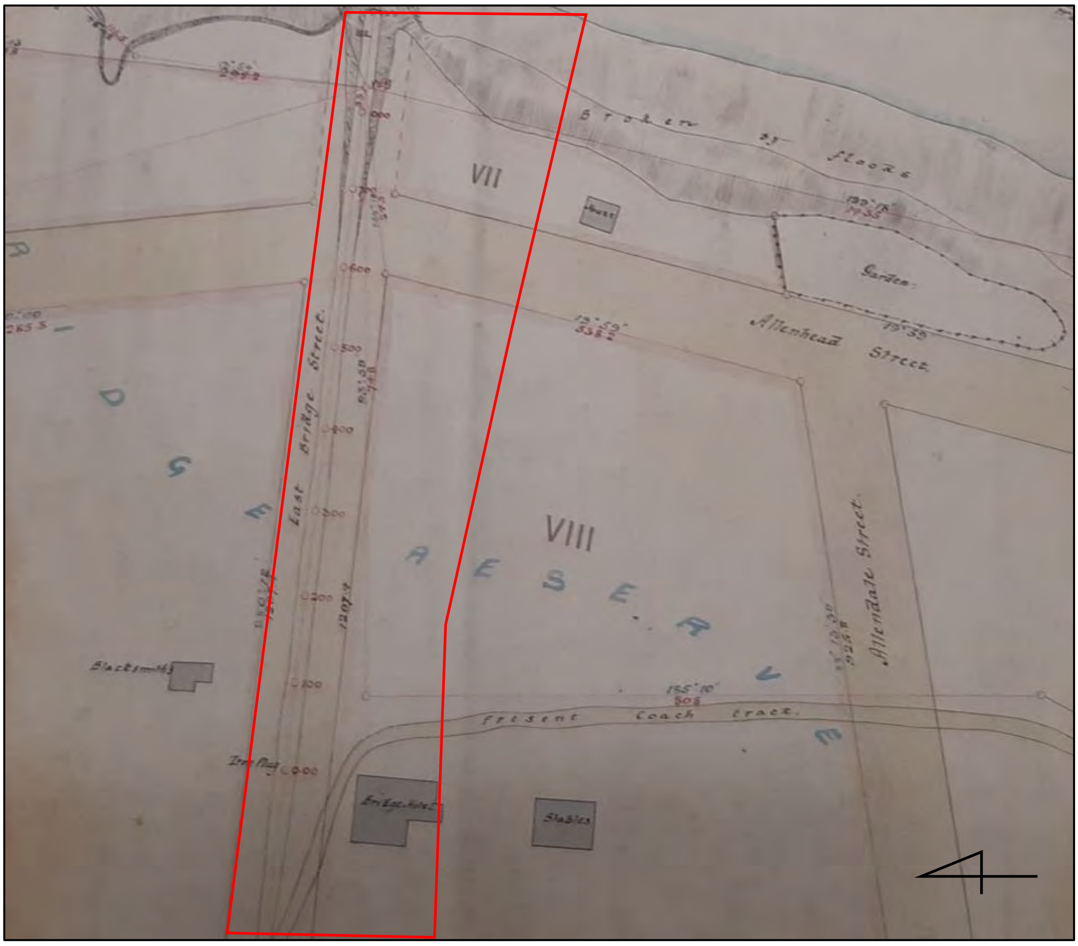

Figure 10. Detail of Beaumont Bridge Site Survey 1882, orientated east showing buildings in the north-western section of Beaumont project area (red outline; source: Archives New Zealand)

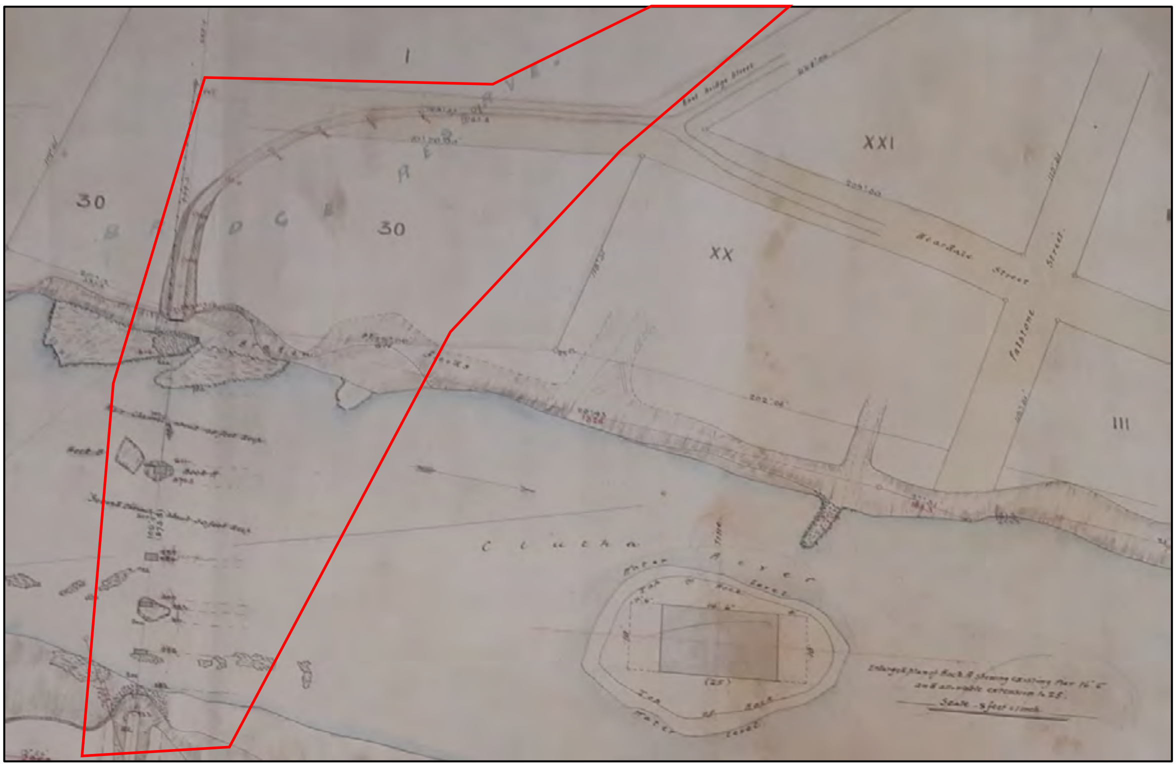

Figure 11. Detail of Beaumont Bridge Site Survey 1882, orientated east, showing the project area east of Beaumont (red outline; source: Archives New Zealand)

Figure 12. Photograph looking at the second and current Beaumont Bridge c.1890 (source: Hocken Collection Asset ID 6264)

Figure 13. Photograph showing the opening of the Beaumont Bridge in 1887 (source: Hocken Collections Asset ID 6263). The bridge approaches are clear here

Figure 14. Photograph of the Golden Gravel Dredging Co. Pontoon c. 1900 (Source: Hocken Collections. Asset ID 6266). The Beaumont Bridge is visible in the left background of the photograph

5 Previous Archaeological Work

5.1 General Archaeological Landscape

The archaeological landscape around Central Otago pertaining to Māori occupation consists of initial use predominantly for fowling, especially of moa (Hamel 2001: 15). Throughout Otago, these early sites were expansive and contained evidence of moa butchering and campsites that were repeatedly occupied. Few controlled excavations have occurred at these sites. Hamel (2001: 44) notes that many inland archaeological sites pertaining to Māori use of the interior are recorded as "ovens", a term that can encompass umu tī and large oven sites, although ploughing makes these features indistinguishable.

The largest known early period site along Mata-au and near to Beaumont is the Millers Flat site (G44/10) situated approximately 17 km upstream of Beaumont (Hamel 2001: 19). This site consists of highly clustered oven sites that extend over at least three acres (SRF G44/10). This site is situated along a river flat and is distinguishable by surface scatters of oven stones, flaked stone material, adze fragments and moa bones. These have been disturbed by farming practices such as ploughing. The Millers Flat site is important to the discussion on Beaumont because it shows that relatively flat areas along the Mata-au were occupied by Māori and the remains of these occupations are visible within the highly silted reaches of the banks of the Mata-au. Archaeological sites (discussed in Section 5.3) record Māori use around Beaumont, although these have not been formally surveyed.

The European archaeological landscape around the interior of Otago is focused on gold mining activities. These started in the region as early as the 1850s, although it intensified in the 1860s (Hamel 2001: 158). Industrial archaeological sites such as dredges and tailings can be found along Mata-au. Townships tended to be established around gold-bearing seams, allowing miners to reduce travel and farming practices also set up in the vicinity of these 'urban' centres. Historic domestic sites are found throughout the Central Otago region, as well as transport and communication and hotel archaeological sites.

5.2 Previous archaeological reports

An archaeological site survey was consulted that surveyed the Lower Clutha Area (Holdaway and Foster 1983). This report presented the results of eight weeks of survey prior to dam developments along the Clutha River, including the Project footprint. This survey looked at recorded archaeological sites that are discussed in Section 5.3. Holdaway and Foster characterised the Māori archaeological landscape in Beaumont as consisting of encampments. Information gathered for an archaeological survey revealed that river bank ovens are common archaeological site types throughout the area (Holdaway and Foster 1983: 15). During this survey, the authors noted that there was no visible surface evidence of the site (G44/3), however, test putting revealed that undisturbed material existed below the plough zone. The connection between this site was made with other early Māori sites such as the Miller's Flat site.

Brooks, Walter and Jacomb (2010) describe a dearth in archaeological knowledge regarding Māori in Central Otago, after the moa went extinct in the fourteenth century. Colonisation phase archaeological sites have been found throughout Central Otago, especially along major rivers that were utilised as transport routes. Māori archaeological sites throughout the area are typically stone quarries, artefact find spots, and midden and oven sites.

A heritage assessment was prepared by Chessa Stevens in 2016. This detailed the heritage components of the extant Beaumont Bridge structure and did not discuss the wider archaeology besides a brief discussion.

5.3 NZAA site records

Two archaeological sites, recorded in the 1960's, are located close to Beaumont Bridge (Figure 15). These are sites G44/3 (midden/oven) and G44/4 (find spot). Details are contained in Table 2. Following their initial recording in the 1960s and the revisit in the 1980s (Holdaway and Foster 1983). The sites were revisited in 2012, which revealed that oven sites remain below the plough zone (see Table 2). This is a clear indication that Māori were utilising the flat area around Beaumont.

Five other archaeological sites (G44/64, G44/86, G44/87, G44/88 and G44/143) are recorded between 0.8-1 km north of the Project area. These all pertain to historic era mining practices, including domestic and transport sites. Table 2 contains more detail about these recorded archaeological sites.

Table 2. Recorded archaeological sites around Beaumont

NZAA ID	Site Type	Grid Coordinates (NZTM)	Approximate distance to the nearest point of project area	Details from Site Record Forms
G44/3	Midden/Oven	E1330715 N4919071	0.3 km	Site recorded along 1966 fence line leading down small gully as ovens over 1.5 acres. Recorded as ploughed, which bought charcoal, oven stones and flakes to the surface. SRF contains limited information, although an update in 2012 notes that it was down Chinamans Flat Road in middle of paddock on left-hand side, past landowners house. During the site upgrade, a test pit revealed that there is undisturbed material below the plough zone.

G44/4	Artefact find	E1330286 N4919434	0.7 km	Site recorded as a find spot of a 1A adze on Mrs Morris's land. Recorded in 1965 and not revisited during the Site Upgrade Project.
G44/64	Mining - gold	E1330008 N4921080	1 km	Located upstream of Beaumont Bridge on river's true left. Recorded as tailing and dredge ponds across the whole flat, approximately 600 m upstream of the Beaumont River Mouth.
G44/86	Historic – domestic	E1330183 N4921035	0.9 km	Site recorded as a hut/floor site, associated with the railway. Site situated on river side of old railway formation approximately 20-30 metres north of the Beaumont River.
G44/87	Transport/ communication	E1330333 N4920922	0.8 km	Old road bridge next to the old railway bridge. It is a mortared schist bridge abutment on both banks of the Beaumont creek.
G44/88	Mining – gold	E1330369 N4920978	0.8 km	Water race approximately 40 metres from new bridge. Is revetted in places. Race is 1.5 m wide.
G44/143	Historic – domestic	E1330309 N4920959	0.8 km	Hut platform by a revetment, supposedly built after 1900. Includes a hut floor site and a benched track that runs to the south of the project area.

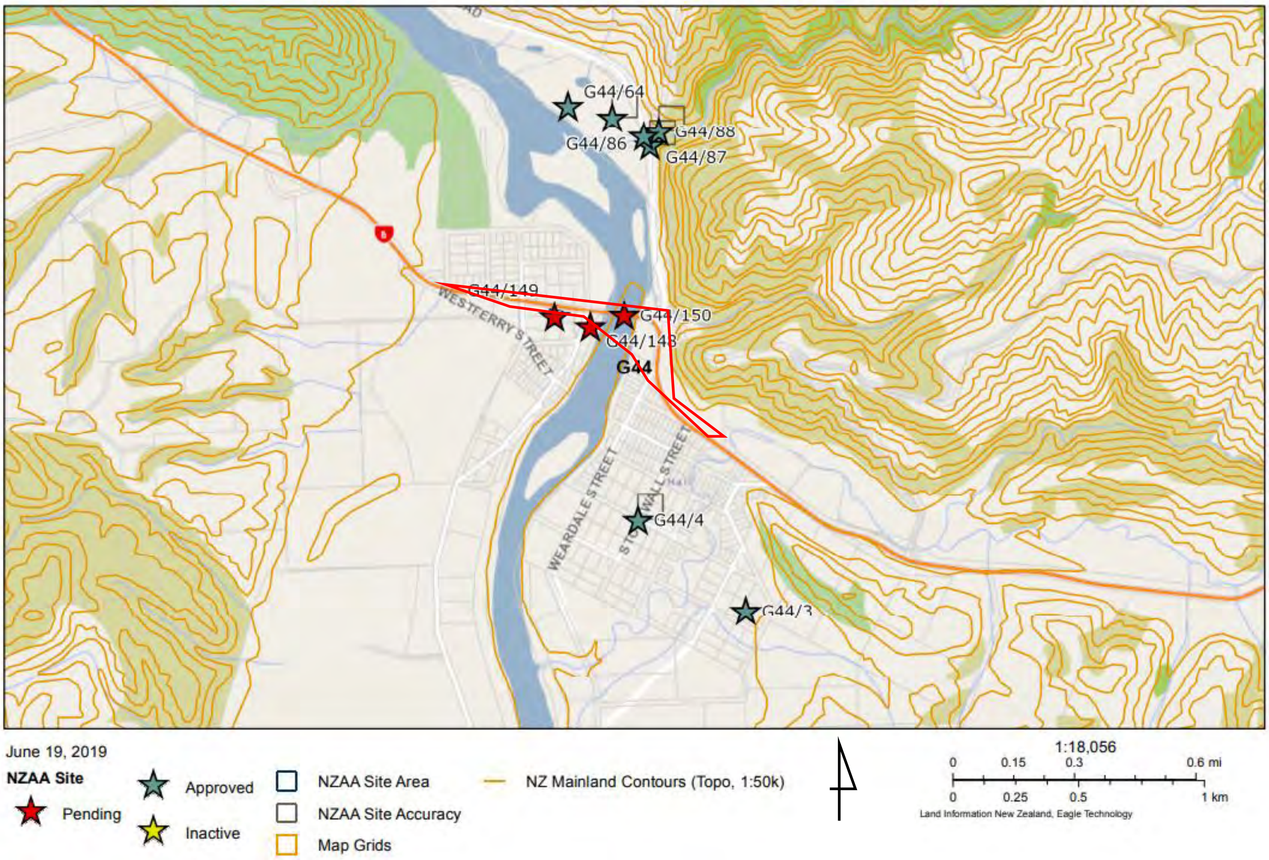

Figure 15. Map showing recorded archaeological sites in relation to the project area (red outline; source: ArchSite)

6 Site Visit Results

Three site visits were undertaken to the Beaumont Bridge by archaeologist Sam Kurmann. The first of these occurred on the 10th of August 2018 and was limited to a site walk over. The second occurred over the 15th and 16th of August 2018. The third occurred over the 24th and 25th of October 2018. The focus of the latter visits was to undertake monitoring of geotechnical trial pit excavations, which were undertaken to investigate the ground condition. Appendix C shows the locations of these trial pits, although note that Trial Pits 15 to 17 were not excavated. These geotechnical excavations were monitored under an Archaeological Discovery Protocol (ADP). This protocol worked under the limitations that if any intact archaeological deposits were encountered, the excavations had to stop, the archaeologist was required to record the archaeological remains and the trial pit could not be excavated further without an archaeological authority to do so from HNZPT.

The results of the archaeological survey and walk revealed two obvious subsurface archaeological remains near to the Project footprint. A house platform was encountered just south of the Project area (see below). The extant Beaumont Bridge approaches also comprised an obvious archaeological deposit.

The eastern extent of the road realignment was within a paddock (Figure 16 and Figure 17). The railway formation was visible in in some areas of the walkover. Trial Pits 18 to 22 were located in this area and monitoring of these pits occurred on the 16th of August 2018. Ground truthing near the 1905 railway alignment revealed that the railway ballast must have been removed during decommissioning of the Roxburgh Line because it was not present at the site. The ground consisted of medium brown loamy soil with water-rolled gravels overlying a yellow silty clay deposit (Figure 18). These deposits were standard of the stratigraphy in the Beaumont Project area.

In TP 20, one plain, frogged brick fragment was encountered within the medium brown loamy soil, but no other potential archaeological remains were encountered. No subsurface archaeological evidence existed to indicate that archaeological features pertaining to the 1905 railway station existed.

A walkover was undertaken around the extent of Low Burn, the eastern most part of the Project area (Figure 19). Two archaeological sites were recorded on the lower reaches of the stream, and it was considered that there was potential for further Māori archaeological remains to be located. There were no potential archaeological deposits encountered during the site walkover. An attempt was made to relocate the previously recorded oven site (G44/3), however, this was unsuccessful. No attempt was made to relocate the find spot site (G44/4).

The survey began on the eastern bank of the Mata-au and walked over the road alignment in that area. There was one depression in the ground on the eastern bank that was near to a macrocarpa tree. There was a small brick scatter in the area, but no other surface evidence archaeological features. The topsoil of a small area on the eastern side of the bridge was stripped to allow access of the drill rig to the river channel (Figure 20). This consisted of grey silt and grey silty sand deposits. These deposits were alluvial in origin and could have formed in this area following the commissioning of the Roxburgh and Clyde Dams upstream and flooding events throughout the area.

A brief inspection of the extant Beaumont Bridge approaches was undertaken (Figure 21). This showed a dry-stacked stone wing wall on the eastern approach that was possibly associated with the 1877 original bridge (Figure 22). There was a significant amount ground that had been modified to allow the bridge approach to reach the deck of the bridge (Figure 23). The western side of the bridge revealed a similar amount of ground that had been modified to form the bridge approaches.

On the western side of the Mata-au, three trial pits were excavated. One (Trial Pit 12) uncovered a ring seal bottle top within grey silt in the upper layers. The other two trial pits consisted of grey silt in the upper layers, which would have been deposited by flooding and general alluvial events. Other trial pits that were monitored that were further away from the river revealed a medium brown loamy soil with water-rolled gravels within it. The western area in proximity to the bridge abutments were terraced(Figure 24).

In the paddock immediately east of Rongahere Road existed a flat terraced platform (Figure 25 to Figure 27) near to where a house was depicted on the 1882 map (Figure 10). It is likely that this contains subsurface evidence pertaining to the house, such as a house foundation, rubbish pits and/or latrines. No subsurface investigations were undertaken.

Moving further west, the paddock that was immediately east of the Beaumont Hotel was examined because of the road alignment through this paddock (Figure 29). There was a shallow topsoil underlaid by bedrock encountered from within the two test pits in the Project area. The current Beaumont Hotel was built upon the same location as the old Bridge Hotel (Figure 30). A camping ground at the rear of the hotel site is located approximately where the stable was depicted in the 1882 map (Figure 10). No visible evidence of archaeological remains existed within this part of the Project area, however, these could survive below the surface.

Figure 16. Photograph showing the old rail alignment (red arrow) looking north from eastern extent of Project area

Figure 17. Photograph showing the old rail alignment looking north from further west

Figure 18. General strata throughout the geotechnical trial pits

Figure 19. Low Burn, looking north from near State Highway 8 (eastern extent of Project area)

Figure 20. Photograph detailing a batter edge on the true left of the bank of the Mata-au

Figure 21. Photograph looking east of the Beaumont Bridge in the background and the Project area in the foreground

Figure 22. View looking south of the eastern Beaumont Bridge abutment, showing the built-up bridge approach in foreground

Figure 23. View of the Beaumont Bridge from downstream on the true right

Figure 24. View of the new road location looking north west (from the western side of Mata-au)

Figure 25. Photograph from south west of the Beaumont Bridge within the project area. Visible is part of a structure likely associated with an 1870s house

Figure 26. Project area within the paddock on the true right side of the river, looking towards the historic garden site depicted in Plan 748

Figure 27. Approximate location of the 1870s house – visible is the flat platform area (red arrow)

Figure 28. View looking north west of the Beaumont Bridge west abutment

Figure 29. View of paddock between Rongahere Road and the Beaumont Hotel during monitoring, looking west

Figure 30. View of proposed car park extension in proximity to the Beaumont Hotel (background), looking east

Figure 31. Western extent of the Project area, looking east

7 Research Results

The documentary sources indicate that the Beaumont township was first utilised as a place of temporary encampments as Māori were moving through the landscape between coastal and central Otago. Research at the Millers Flat site (G44/10) reveal information about the largest known early Māori archaeological site along Mata-au. This site extends for a large area and consists of oven and midden features that contain large amounts of artefact scatters. In Beaumont, similar archaeological site types are recorded to the eastern extent of the Project area, along Low Burn. While no archaeological remains pertaining to Māori occupation were encountered during the course of this archaeological assessment, only a limited area surrounding the waterways was ground truthed and there is still huge potential for encountering unrecorded Māori archaeological remains within the Project area. Holdaway and Foster noted that the banks of the Mata-au were highly populated with Māori settlements and it is possible that further unrecorded archaeological remains could exist along the banks of the Mata-au.

Europeans later settled at Beaumont after the 1850s. Beaumont's potential was first realised when reports of gold were relayed back to coastal settlements around Dunedin in the 1850s. People travelled to Beaumont along Mata-au and started to prospect for gold. Beaumont as a township was centred around being a key transport route for both pre-European Māori and later European use. It provided the first river crossing during the start of the gold rush in the form of a punt that was established to the south of the current bridge site in the 1860s. By 1874 the first bridge site was established on the same alignment as the current bridge. Later, in 1887, the current bridge was erected and still remains. By 1882, hotels, houses and stables were also established in Beaumont, along with a school, a black smith and other commercial buildings. The railway formation also exists within the Project area, however, because this was not started until 1905, it does not warrant protection under the HNZPTA, and therefore, has not been discussed in further detail.

As a result of this research, three archaeological sites were recorded in ArchSite that existed near to or within the Project area. These pertained to the house site located east of Rongahere Road (G44/148), the Hotel and Stable site (G44/149) and the extant Beaumont Bridge (G44/150) – see also Appendix D. It is also considered that further archaeological remains pertaining to the Māori occupation of Beaumont possibly exist, especially in proximity to the water ways.

7.1 Constraints and Limitations

This report is an archaeological assessment of the archaeological values of the project area. Statements are made as to the location and nature of archaeological sites, and their archaeological values. There are no statements on the Māori cultural significance of the project area, nor are the views of Tangata Whenua represented in this report. An assessment of cultural significance will not necessarily correlate with an assessment of the archaeological significance of the area.

8 Archaeological and other Values

Archaeological values relate to the potential of a place to provide evidence and information on the history of New Zealand. This is framed within the existing body of archaeological knowledge and current research. Statements on archaeological values of the project area are made below in regard to the Heritage New Zealand Pouhere Taonga guidelines for writing archaeological reports. No recorded archaeological remains are situated within the area of proposed works. However, unrecorded archaeological potential was identified in the area resulting from historic research and the site investigations.

This section presents the archaeological values that relate to archaeological sites G44/148, G44/149 and G44/150 that were recorded during the course of this archaeological assessment. It also presents the potential archaeological values that are associated with as yet unrecorded Māori archaeological remains within the Project area. Based on the historic research for the Project area, it is unlikely that Chinese archaeological remains will be encountered. This statement considers the location of Chinese mining and encampment archaeological sites that are located to the north of the Project area, and the historic knowledge that Chinese communities were generally pushed to the fringes of European settlements (eg. Lawrence and Cromwell).

The following criteria are accounted for to assess archaeological values from within the project footprint:

- Condition – is the site in good condition?
- Rarity or uniqueness – is the site notable in any other way in comparison to other sites of its kind?
- Contextual value – context or group value arises when the site is part of a group of sites which taken together as a whole, contributes to the wider values of the group or archaeological, historic or cultural landscape. There are potentially two aspects to the assessment of contextual values; first, the relationship between features within a site, and second, the wider context of the surroundings or setting of the site.
- Information potential – what current research questions or areas of interest could be addressed with information from the site?
- Amenity value (e.g., educational, visual, landscape) – Does the site(s) have potential for public interpretation, access and education?
- Cultural associations – Does the site(s) have any special cultural associations for any particular communities or groups, e.g. Māori, European, or Chinese.

8.1 House site (G44/148)

This archaeological site is immediately south of the Project area on the true right river terrace of the Mata-au. It will not be directly affected by the current Project works; however, vehicle movements have the potential to affect the archaeological site.

Archaeological Values	House Site (G44/148)
Condition	The condition of the House Site is unknown. Any features will be in ground so may be relatively well preserved. However, it is possible that some damage to the site may have been caused by ploughing and other farming practice.
Rarity/Uniqueness	House sites are not rare throughout Central Otago, although few have been investigated through archaeological methods, making this a unique opportunity.
Contextual Value	The house site contains contextual value to other house sites throughout Beaumont, but also throughout the wider Central Otago region that pertain to gold mining era European occupation.
Information Potential	There is potential to gather information pertaining to foundation construction techniques. There is also potential to see diet from the contents of rubbish pits and latrines that could exist in the vicinity of the house site.
Amenity Value	The house site is situated on private property. However, it is close to the road, so the amenity values are moderate.
Cultural Associations	Colonial-era New Zealand

8.2 Bridge (Beaumont) Hotel and Stables (G44/149)

The Bridge Hotel and Stables sit within proximity to the Project area. It is possible that buried archaeological features relating to this archaeological site could be affected by the works.

Archaeological Values	Bridge (Beaumont) Hotel and Stables (G44/149)
Condition	The condition of the Hotel site and stables are unknown. Any features will be in ground so may be relatively well preserved. However, it is possible that some damage to the site may have been caused by farming practices or development associated with the current Beaumont Hotel and camp ground.
Rarity/Uniqueness	Hotel sites throughout Central Otago are not rare, although study's that use archaeological techniques to investigate hotel and stable sites throughout Central Otago are uncommon.
Contextual Value	The Bridge Hotel and Stables site will contain contextual value to other hotel sites throughout Beaumont, but also throughout the wider Central Otago region that pertain to gold mining era European occupation. The hotel and stable features would hold intra- and inter-site relationships between hotel sites from the late 1800s in relation to the Central Otago Gold Rush. There will also be contextual values to the colonial era landscape around Beaumont.
Information Potential	There is potential to gather information pertaining to the layout of the wider Hotel and Stable site. Relationships between the hotel landscape could be revealed, such as locations of hitching poles, paths that allowed access to the hotel and associated out buildings, locations of latrines and rubbish pits. The actual contents of these potential features will allow information into construction techniques and materials to be gathered. The potential to see diet from the contents of rubbish pits and latrines that could exist throughout the site.
Amenity Value	The Hotel and Stable site is situated on private property. However, it is used by the public. The amenity values are moderate.
Cultural Associations	Colonial-era New Zealand

8.3 Beaumont Bridge (including the approaches) (G44/150)

While the existing Beaumont Bridge is not within the scope of this report, the bridge approaches overlap the current Project area and are considered below given the potential to be affected by the works.

Archaeological Values	Beaumont Bridge (G44/150)
Condition	The condition of the bridge approaches is relatively intact.
Rarity/Uniqueness	Bridge sites throughout Central Otago are becoming more unique due to their age increasing. The Beaumont Bridge is especially unique because it is one of few iron-girder bridges. It has high heritage values, and the historic background in this report shows the importance that the bridge held to the Beaumont community but also the wider Central Otago connectivity that the bridge has allowed historically and presently.
Contextual Value	Holds contextual values with other bridges along Mata-au and other bridges around Central Otago, especially the Henley Bridge which is of a similar form to the Beaumont Bridge.
Information Potential	The Project will potentially be able to reveal some information about the construction of the bridge approaches.
Amenity Value	The Beaumont Bridge is situated on road reserve. The amenity values of the Bridge will improve as a result of this Project. It reduces the motor vehicle traffic over the bridge and will also be incorporated into the Clutha Gold Trail as primary access between the east and west sides of the Mata-au.
Cultural Associations	Colonial-era New Zealand

8.4 Unrecorded Māori archaeology sites

It is impossible to discuss these archaeological sites due to the nature of these sites not being found or possibly not in existence. However, potential values are presented based on local factors in and around the Beaumont realignment and Project area. They are also based on the likelihood of finding unrecorded archaeological remains in or near the Project area.

Archaeological Values	Unrecorded Māori archaeological sites
Condition	The area around Beaumont has been used for farming and is prone to flooding. Farming practices have often included processes such as ploughing. Ploughing is detrimental to archaeological sites, especially midden and oven sites. It is possible that if archaeological remains are found that pertain to these site types, that the archaeological remains may be impacting by these farming practices. Archaeological sites that have been affected by these types of farming practices are likely to be in a poor to moderate condition. The condition of midden and oven archaeological sites around Beaumont will also likely be affected by flooding. However, in some instances (especially closest to Mata-au), the flooding could result in better preservation of archaeological sites due to the deposition of silt. This deposition provides a

	cap, or protective layer, that results in the archaeological site being less prone to erosion. In this instance, any unrecorded archaeological sites that have been affected by this process are likely to be in moderate to good condition. It is likely that these sites may be investigated using archaeological methods.
Rarity/Uniqueness	While traditional accounts have strong evidence detailing the use of Mata-au as a thoroughfare between the coast and the interior, limited archaeological evidence has been located. The only known investigation of these sites is the Millers Flat site. This is due to issues such as mining and farming practices throughout Central Otago that have detrimentally affected the preservation of archaeological sites. Therefore, any potential archaeological remains that pertain to the Māori use of the Mata-au will have high rarity values. It will allow for investigation through archaeological methods that will add substantially to the archaeological knowledge of Central Otago. Moreover, it will add to the traditional knowledge of the area.
Contextual Value	The contextual value of any Māori archaeological remains will be high. These could relate to the archaeological landscape at a local Beaumont level, including in relation to recorded archaeological sites G44/3 and G44/4 that are outside of the Project area (and were unable to be relocated). It will also hold contextual value throughout the wider, regional archaeological landscape from Lake Wānaka to the Mata-au River Mouth and the wider catchment of the Mata-au.
Information Potential	Although information potential is largely dependent on the condition of any encountered archaeological sites, the information potential values range from moderate to high. There is potential to add to the knowledge about the Māori use of Otago's interior, including looking at practices around food procurement such as fishing (for tūna and other native fish species), fowling (for moa in early period but also there are strong traditions around weka hunting in the area) and harvesting of trees such as tī (*Cordyline australis*) through macro- (midden) and micro- (phytolith, starch etc) analyses. Depending on the preservation of the archaeological remains, there could also be some archaeological evidence pertaining to intra-site structure and layout. The information potential is high.
Amenity Value	It is impossible to comment on the amenity value of unknown sites.
Cultural Associations	There are cultural associations between multiple Ngāi Tahu whanui in the area. These are: - Te Rūnaka o Ōtākou - Hokonui Rūnaka - Te Rūnaka o Awarua - Te Rūnaka o Waihōpai.

9 Assessment of Effects

9.1 Proposed works

The following scope of works pertains to the package of works proposed by the WSP Opus design team. The Project comprises the construction of a new two-lane bridge downstream of the existing structure including:

- Installation of an approximately 200m long, 5 span bridge with piled foundations excavated into the bedrock within the river and on the river banks;
- Realignment of the state highway on the approaches to the new bridge and construction of approach embankments up to 3m high;
- Intersection modifications including closure of side road intersections with the state highway (Westferry Street, Rongahere Road, Weardale Street) and upgrade of state highway intersections (Dee Street, Craig Flat Road and Stonewall Street);
- Construction of pedestrian and cycle linkages connecting the Clutha Gold Cycle Trail to the Beaumont Hotel and Rongahere Road and repurposing of the existing single lane bridge (deck and handrail modifications) which will be retained to for pedestrian and cyclist use;
- Construction of highway storm water systems including roadside swales, underground pipes and a landscaped storm water treatment basin on the eastern side of the river;
- Relocation of overhead power and underground telecoms cables and installation of street lighting at side road intersections;
- Construction of a new safe stopping area (rest area) at the eastern end of the existing bridge comprising car park and picnic facilities accessed from Craig Flat Road.

To complete the project, works will require earthworks (top soil stripping/stockpiling/re-spreading, excavation, placement of imported fill, rip-rap installation), trenching for underground services, pavement construction, excavation in rock for bridge foundations, bridge construction (reinforced concrete and structural steel), landscaping works and temporary works including construction of a temporary work platform into the river and establishment of contractors compound (storage for plant and materials and welfare facilities for workers).

This work scope is relatively general and the specific areas that will be affected have not been highlighted with certainty. For that reason, the next section is deliberately broad.

9.2 Potential effects

All pre-1900 archaeological sites are protected under the provisions of the HNZPTA, whether the sites are recorded or not. It is illegal to destroy or modify archaeological sites without an archaeological authority from Heritage New Zealand. This archaeological assessment has identified that there are risk areas associated with the Project works at Beaumont to realign the road and provide an alternate bridge crossing.

There is a risk of encountering unrecorded archaeological remains within the Project area. These potential remains are likely to be modified or destroyed by the road realignment and associated works.

There are potential effects posed to known or potential archaeological sites surrounding the Beaumont area associated with tranches of the work required to successfully realign the road and bridge around Beaumont. Works around the banks of the Mata-au pose risk for encountering unrecorded Māori archaeological remains, such as ovens. Excavation in these zones will be required for the bridge approaches and the realignment of the road. The potential effects of these proposed works are destruction or modification of any archaeological features.

Intersection modifications could have effects on unrecorded archaeological remains, however, these effects are currently unknown.

Works to repurpose the existing 1880s Beaumont Bridge that may include modifications will require additional archaeological and heritage inputs. A separate Heritage Assessment will provide advice on how to deal with affects to the bridge, being prepared by Chessa Stevens. However, works to or around the bridge approaches as part of the road realignment will be included in this package of works covered by this archaeological assessment.

Trenching and landscaping for drainage and services also has the potential to effect known and potential archaeological remains.

The safe stopping area may involve excavation in an area near to the Beaumont Bridge approaches. This will involve modification to part of an archaeological site.

All of these works have the potential to affect archaeological remains.

9.3 Site management

The management of the archaeology risk posed by the Project works should be undertaken under the guidance of an archaeological authority. The archaeological authority should be applied for to manage the potential of encountering and affecting archaeological sites throughout the entire Project area.

The archaeological authority should also specifically pertain to the following two images that were prepared to highlight the risk areas associated with the scope of works at Beaumont (Figure 32 and Figure 33). The red polygons highlight the general risk areas, which are based on (from west to east):

- Proximity to the Bridge Hotel and Stables. Archaeological risk is posed by those features as well as potential latrines, cobbled paths near stables and rubbish pits. This archaeological site is likely to be affected by the Project works, especially car parking and landscaping.
- Proximity to black smith, north of the Bridge Hotel. This site is outside of the Project area and is unlikely to be affected.
- Proximity to the Mata-au, a risk area for encountering Māori ovens and occupation sites. Should unrecorded archaeological sites pertaining to Māori occupation exist within the Project area, these are likely to be affected by the Project works.
- Proximity to the Beaumont Bridge, including its approaches. This archaeological site is near the Project area and the approaches are likely to be affected.
- Proximity to the house site along Rongahere Road. This archaeological site is just south of the Project area. Vehicle movements and temporary storage facilities could affect this archaeological site.
- Proximity to Low Burn, a risk area for encountering Māori ovens and occupation sites. This archaeological risk area is immediately east of the road realignment. The potential to affect unrecorded archaeological sites exists but is likely to be outside of the Project area.

Works within the highlighted areas should be actively monitored by a suitably qualified archaeologist, as will be stated in the archaeological authority. Particularly, monitoring of topsoil stripping, bulk excavation and trenching will require active archaeological monitoring. Works outside of the identified risk areas should be included in the archaeological authority area but should be monitored using On-Call Procedures. Works in these areas will require archaeological briefing to contractors but will not be actively monitored by an archaeologist. Instead, the contractor will be responsible for informing the Project archaeologist of any encountered suspected archaeological material. The archaeologist may choose to undertake compliance checks throughout the course of this phase of works.

Once Project timelines and personnel have been finalised and the archaeological authority is in place, a brief Site Instruction document should be prepared to highlight responsibilities of consultants, contractors and other team members in regard to the archaeological authority. This will also detail contact mechanisms for Iwi, Heritage NZ and the Project archaeologist, where required.

Figure 32. Archaeological risk areas that require monitoring - western extent of Project area

Figure 33. Archaeological risk areas that require monitoring - eastern extent of Project area

10 Conclusion and Recommendations

NZTA are proposing to construct a new bridge across the Clutha River at Beaumont, downstream of the existing structure. This archaeological assessment has reviewed the archaeological landscape around the Project area in Beaumont, Clutha District.

The land around Beaumont has been used by people since Māori arrival to Aotearoa. Māori utilised Mata-au as a transport route into the interior of the South Island. Known early sites exist 16km of the Project area at Miller's Flat. There are other occupation sites throughout the Mata-au catchment, within 1 km of the Project area. Following European arrival, Beaumont was also utilised since the 1850s as part of the gold rush. Beaumont became a thriving township, centred on access to the gold fields and pastoral farming. Several different transport routes were bottlenecked at Beaumont, including the punts, the bridge and rail. These transport options were pivotal for the development of Central Otago during the latter half of the nineteenth century.

The proposed works are extensive within the Project footprint and involve the realignment of the road and supplementary works to provide services, improve intersections and associated landscaping activities. Some of these works have the potential to modify or destroy known and unknown archaeological sites. Therefore, a general archaeological authority should be applied for under Section 44(a) of the *Heritage New Zealand Pouhere Taonga Act* 2014 from Heritage NZ. This is a requirement prior to the works proceeding.

The processing of the archaeological authority application should be determined under Section 50(1)(a) of the HNZPTA, whereby it should be processed within 20 working days following a 5 working day acceptance period. There is a further 15 working day statutory stand-down period for appeals. Allowance for the processing time for the archaeological authority should be made within the programme for this Project. The statutory processes required under the RMA will be covered in more detail in the AEE, which this archaeological assessment report informs.

10.1 Recommendations

The following recommendations are made regarding the road realignment and new bridge construction at Beaumont:

- That an Archaeological Authority should be applied for from Heritage New Zealand Pouhere Taonga prior to the works, under Section 44(a) of the HNZPTA. An Archaeological Management Plan should be prepared to support this application.
- That risk areas highlighted in Figure 32 and Figure 33 of this assessment be referred to as a guide to areas that should be monitored by an archaeologist during the construction phase of the new Beaumont Bridge.
- That further consultation with Iwi is undertaken as part of the archaeological authority application.
- That any encountered archaeological remains are recorded and investigated using standard archaeological practice.

11 References

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11.1 Archaeological Site Record Forms

Site Record Form, G44/3, NZAA SRS, 20/09/2018, available at https://archsite.eaglegis.co.nz/NZAA/

Site Record Form, G44/4, NZAA SRS, 20/09/2018, available at https://archsite.eaglegis.co.nz/NZAA/

Site Record Form, G44/64, NZAA SRS, 20/09/2018, available at https://archsite.eaglegis.co.nz/NZAA/

Site Record Form, G44/86, NZAA SRS, 20/09/2018, available at https://archsite.eaglegis.co.nz/NZAA/

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Site Record Form, G44/143, NZAA SRS, 20/09/2018, available at https://archsite.eaglegis.co.nz/NZAA/

11.2 Newspaper Articles

Bruce Herald, 1/10/1878, p.5, available at paperspast.natlib.govt.nz

Press, 12/05/1885, p.2, available at paperspast.natlib.govt.nz

Star, 23/05/1892, p.3, available at paperspast.natlib.govt.nz

Tuapeka Times, 11/08/1886, p. 3, available at paperspast.natlib.govt.nz

Tuapeka Times, 12/07/1879, p.3, available at paperspast.natlib.govt.nz

Tuapeka Times, 22/09/1875, p.3, available at paperspast.natlib.govt.nz

11.3 Archive Records

Archives New Zealand: Beaumont Bridge Site Survey 1882

Archives New Zealand: Town of Dunkeld Plan 1870

Hocken Collections Asset ID 6263

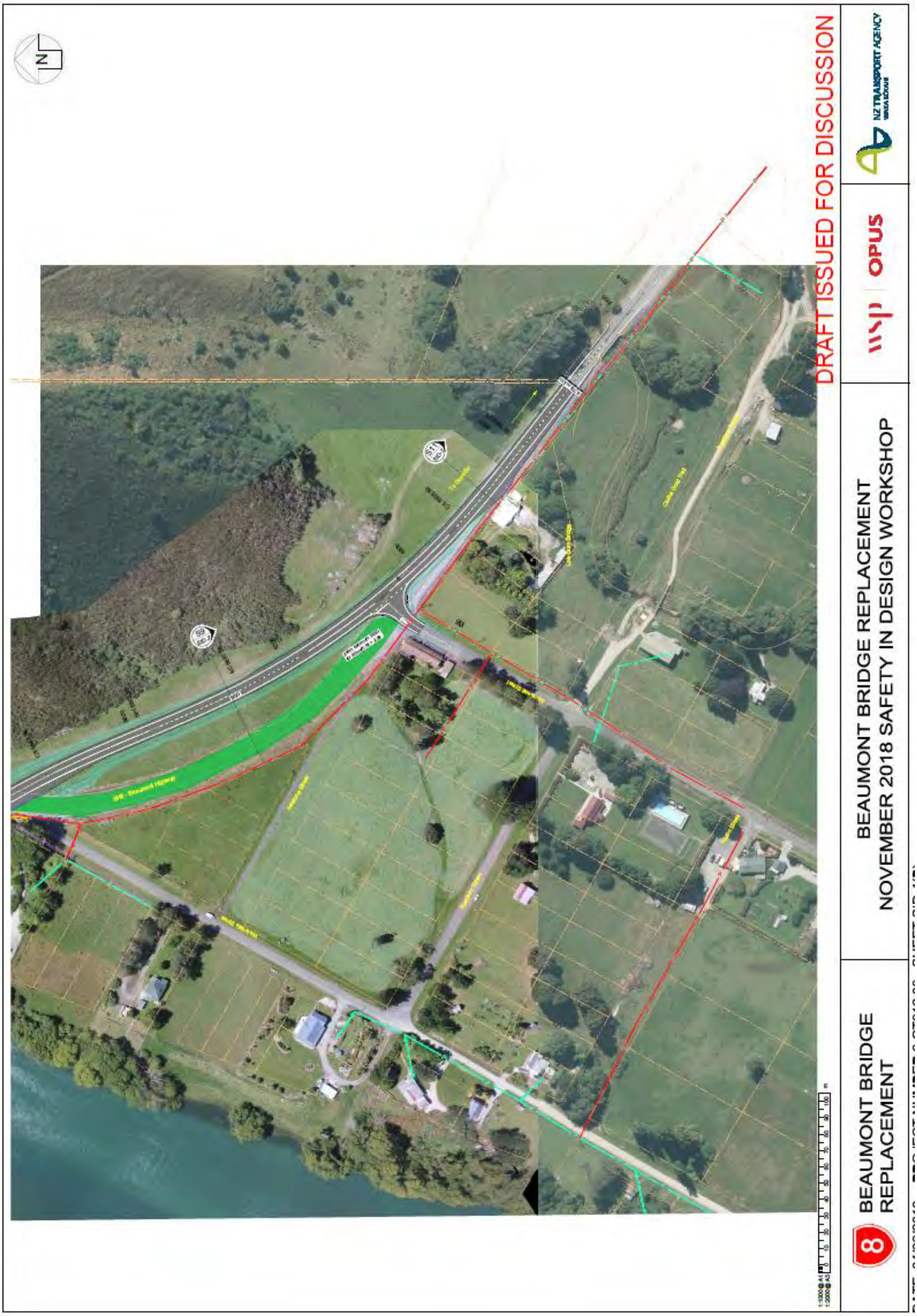
Hocken Collections Asset ID 6264

Hocken Collections Asset ID 6266

Survey Plans via Quickmap

Appendix A – Plans of road realignment


DRAFT ISSUED FOR DISCUSSION
NZ TRANSPORT AGENCY
wsp OPUS
BEAUMONT BRIDGE REPLACEMENT
NOVEMBER 2018 SAFETY IN DESIGN WORKSHOP
BEAUMONT BRIDGE
REPLACEMENT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BEAUMONT BRIDGE REPLACEMENT
NOVEMBER 2018 SAFETY IN DESIGN WORKSHOP
BEAUMONT BRIDGE
REPLACEMENT
NZ TRANSPORT AGENCY

Appendix B – History of the Site (Stevens 2016:6-22)

Archaeological research suggests that Maori presence in central and southern Otago dates back at least as far as the 13th century, and that the area was an important focus of activity during the Archaic (or moa hunting) period. Summarised histories prepared by community groups and local authorities refer to the seasonal explorations and establishment of river trails through inland Otago by early Maori; and particularly to mahinga kai trails along the Mata-au (Clutha River).

According to the Central Otago District Council:

> The Mata-au [Clutha River] marked the boundary between Ngāi Tahu and Ngāti Mamoe. Ngāi Tahu held the mana over the land north of the Mata-au and Ngāti Mamoe south. Eventually the division was overcome with union between the two tribes. For Ngāi Tahu the Mata-au was part of a mahinga kai trail that led inland used by Otakou hapu including Ngāti Kuri, Ngāti Ruahikihiki, Ngāti Huirapa and Ngāi Tuahuriri.

Archaeological discoveries of stone quarries, as well as tools, sharpening stones, feathers and bones indicate that these trails were also used to collect materials such as argillite, transport pounamu to and from the west coast, and hunt Moa. During these explorations, campsites or seasonal settlements were established; and the remains of such sites have been found near Beaumont. These were recognised from the earliest days of European Settlement, with one of the first stations to be established being named Oven Hills Station, referring to the high concentration of Māori ovens on the land. Urupa (burial places), tauranga waka (landing places), and battlegrounds have also been found along the Mata-au.

According to Brooks et al (2010):

> Very little is known of the use of the interior of southern New Zealand after the extinction of the moa [14th century] and it is possible that Central Otago was more or less abandoned until shortly before European contact.

The coastline of Otago was recorded by Captain James Cook during his navigation of New Zealand aboard Endeavour in 1770. Molineux's Harbour – the mouth of the dual branches of the Clutha River (Figure 2) - was named for Robert Molineux, the Endeavour's sailing master. However, Cook did not land in the area. The first contact between local Maori and Europeans is understood to have come sixty years later, when the American sea captain and explorer Benjamin Morrell visited Molineux's Harbour in 1830. In his disputed memoir, A Narrative of Four Voyages, Morrell refers to the harbour as "Molyneux" Harbour, and describes visiting a local Maori settlement inland from the harbour on the banks of the river.

It is by combination of these events that the Clutha River and wider area became known as "the Molyneux" as McLintock (1966) explains:

> The early whalers and settlers of South Otago called the [Clutha] river and the district the Molyneux, and the name survived well into the gold mining era. It has often been stated that Cook gave the name Molyneux to the river, but this is incorrect for he never saw it … The correct name is the Clutha, first suggested in 1846 when the Scottish emigrants were preparing to settle in Otago.

Clutha is derived from Cluaidh, the Scots Gaelic name for the River Clyde in Glasgow, Scotland.13

In 1853, the 23-year-old Nathanael Chalmers was the first European to venture up the Clutha River. Chalmers had first arrived in Otago in 1849 with his brother G. A. Chalmers; and, after a brief attempt at gold mining in Australia, returned to Invercargill from where he assisted in driving a mob of cattle overland to Dunedin. On this journey he met the Maori chief Reko, who agreed to take Chalmers inland to the north in search of good farming country. Travelling on foot, he was guided by Reko and another Maori chief, Kaikoura, from Tuturau, southwest of Gore, up to Lake Wakatipu and beyond. When Chalmers became ill with dysentery Reko and Kaikoura constructed a flax raft or mokihi, and travelled down the Clutha River back to European company, passing through the sites of later European settlement including Beaumont.

Explorer-surveyor John Turnbull Thompson was appointed to the position of chief surveyor of Otago following his arrival in New Zealand in 1856. Up until this time, only the coast of Otago had been mapped.

> … Thomson accepted the challenge of exploring and mapping this huge territory… During 1857 and early 1858 he carried out his marathon reconnaissance survey of Otago, covering the whole province on horseback in a series of sweeps that took him as far west as the Waiau River and as far north as Mt Cook … As a result of his survey the first map of the interior of Otago was published in 1860.

In the same year as Thomson began his surveys, European run holders began to explore the Upper Clutha valley in search of land suitable for establishing new sheep runs. Several large stations were soon established along the Clutha River, including: Bellamy Station, the starting point for run pioneers heading further into the Upper Clutha; Beaumont Station of over 30,000 acres on the eastern side of the river, named for Beaumont Burn on its southern boundary; Dunkeld Station, across the river from Beaumont Station; and Moa Flat Station of over 71,000 acres on the western side of the river.

In conducting his survey, Thomson named several areas after places in his home country of Scotland. Beaumont township, which was established at the location of a natural river crossing on the borders of Bellamy, Beaumont and Dunkeld Stations, was originally named by Thomson as "Dunkeld", a Gaelic name from Perthshire. However, the Beaumont Burn quickly became familiar to local residents and travellers, who inevitably began to refer to the area as "the Beaumont".

Following the discovery of gold at nearby Gabriel's Gully in May 1860, miners and prospectors began exploring the lower and upper Clutha en masse, and the river crossing at Beaumont quickly became vital. An account of Beaumont's history given by the website of the Beaumont Residents Group states that the first Beaumont punts operated from 1860; however, an article in the Otago Daily Times in 1864 states that various private applications to put punts in place at Beaumont and Teviot had been turned down by the Government on the grounds that they were about to undertake the works. It is evident that a punt was operating by 1868, when the lessee, Mr Botwell, requested that the approaches to the punt be repaired.

From 1863, Beaumont was also the head of navigation for steam-powered trading vessels travelling up the river from Balclutha. In this same year, gold dredging on the river was pioneered near the settlement as alluvial gold became scarce; though it was not until the 1890s that dredging became a popular method of sourcing gold.

By 1870, there were three hotels catering for travellers in the settlement – the Crookston, the Beaumont Ferry and the Duke of Edinburgh; the Beaumont Racecourse was opened; and the last town sections were put up for sale by auction at a cost of £5. The earliest survey map of the area that has been sourced in preparing this assessment is dated 1871 (Figure 8). Development continued throughout the 1870s, with the opening of a church and the school.

Around this time, a traveller through Beaumont observed:

> that several new buildings or improvements were in the course of erection. Mr. Cowap is having a commodious hotel built on the site of the old house, and I have no doubt the establishment will prove highly convenient to all travellers. My consternation may be imagined when I was informed that there was very little chance of my getting across [the

> river] as the high wind rendered the passage dangerous; however … I was safely ferried over the broad bosom of the Molyneux.

As this passage implies, the Beaumont punt was vulnerable to weather conditions and could be unreliable, leading to calls for the construction of a bridge. The first bridge at Beaumont was privately commissioned by William Hayes in 1873, and constructed by David McDonald. Supported by stone piers and abutments set onto rock, this bridge had six spans constructed in timber: two of 16 metres at each end, being "ordinary undertrussed girders"; and two of 30 metres in the centre, "built on the lattice girder principle". The cost of construction was approximately £7,000.

While construction commenced at pace, significant delays were caused when the wire rope used to convey the blocks of stone from the river banks to the piers snapped only a few months into the project. However, McDonald executed the installation of the 30 metre-long bridge girders without incident; and the bridge was opened to foot traffic in September 1874. While it was not heralded for its architectural beauty, the bridge was evaluated by the public as an imposing structure with "a look of strength and durability".

The construction of roads in the area was slow, and McDonald and his team were forced to build their own tracks to get materials to the bridge site. Roads connecting with the bridge were surveyed in 1874, and construction then began on the approaches. However, these remained incomplete when the bridge was opened to pedestrians; and it was not until November 1874 that the eastern approach, which had to be built up by approximately 10 metres, was passable for traffic.

It was expected that traffic on the road through Beaumont would be substantially increased as a result of the erection of the bridge; however, the slow construction of adequate roads servicing the area restricted use of the route, and therefore the bridge. The comparatively low cost of the punt, and the lack of facilities such as a hotel and paddocks for resting animals at the site, also contributed to the poor uptake in use of the bridge.

In 1875 Hayes placed the bridge on the market; and, in 1876, it was sold to the New Zealand Loan Company who on-sold it to J. F. Kitching. Kitching also purchased the punt. With his ownership over both methods of river crossing secured, Kitching increased the bridge tolls. This caused widespread complaint; however, Kitching refused to lower his prices, stating that the bridge being private property and he was entitled to charge as he pleased. Kitching also constructed a new hotel at the bridge – the Bridge Hotel – along with his own stables and outbuildings.

Towards the end of 1877 the Tuapeka County Council began investigating the purchase of the bridge; and the Government agreed to contribute the sum of £5,000 to the cost. While there was some dispute over the state of the bridge – particularly the extent of rot in the main timbers – and Kitching made it clear that he would not accept an offer of £5,000, the Council pursued the purchase. This had the general support of the community who were in favour of removing the tolls opening the bridge for free traffic.

Before any purchase could be agreed, however, the Clutha River experienced severe flooding. On 27 September 1878, the water was reported as being right up to the roadway of the bridge, which was "shaking in a most dangerous manner". On 28 September, the Tuapeka Times reported that one of the piers and the abutments on the Lawrence side of the bridge had been carried away, and one of the "principal beams" of the bridge was cracked. Floodwaters subsided briefly, but began to rise again on the morning of 30 September; and the centre of the bridge was washed away that afternoon. The Evening Star described the event:

> Mr Jacob Davidson, with a buggy, was the last person to cross, and just as he landed on the Lawrence side the bridge went away in two pieces. Both sections of the superstructure sailed away down the river, locking like two large punts. One stone pier was carried away, and there are two apparently sound… The telegraph line crossing the river is broken and cannot be repaired, as there is no boat available, and it is questionable if one could live in such a torrent…

> Beaumont town is partly under water. Some of the residents cleared out last night. No communication can be held verbally with the opposite bank, owing to the high wind.

Several other bridges over the Clutha were also washed away in the flood.

Under the instruction of the County Engineer, work to construct a free punt across the river at the site of the bridge was commenced as a temporary measure while the re-erection of the bridge was discussed. However, Kitching, with his own punt back in operation, quickly asserted his right to both banks of the river for three miles either side of the bridge site. The Council conceded, and ceased construction of the free punt, while Kitching once again began to charge exorbitant tolls.

With the loss of the bridge, and the high cost of the punt, traffic between Dunedin and Alexandra, Clyde, Cromwell, Cardrona, and other goldfields in the area was diverted to other roads, and local businesses in Beaumont began to suffer. At a public meeting in March 1879, the Council agreed to offer Kitching the sum of £3,000 for purchase of the bridge site including the punt; however, negotiations between the two parties failed to result in an agreement.

In late 1879, the community petitioned the Government to re-erect the bridge, or to force the Council to do so. In response, the Parliamentary Public Petitions Committee stated that the Government had already agreed to contribute £5,000 for the purchase of the previous bridge, £3,000 of which had already been advanced to the Council for this purpose. Further, the Public Petitions Committee noted, the £3,000 had not yet been used to make the purchase, and they recommended the Government take immediate action to recover the money. Simultaneously, the New Zealand Loan and Mercantile Agency Company began demanding payment of the greed £3,000 with interest on Kitching's behalf.

The Tuapeka County Council finally paid to Kitching, with interest, the sum of £3,000 to purchase the land associated with the former bridge and existing punt in January 1880. The County Engineer, William Smaill, estimated the cost of constructing a new bridge in the same location at just over £7,000. The Council resolved to call for tenders for the construction of a new bridge on the basis that the Government's offer to contribute £2,000 to the cost of construction was secured. The Council was also faced with the cost of repairing roads and other bridges throughout the district following the floods, and finances were tight.

In February 1880, John McCormick, who had erected two bridges over the Kawarau River and was, at the time, erecting another on the Queenstown Road, made an offer to the Council to construct this bridge in iron imported from England, to plans and specifications prepared by "a competent Engineer". However, his offer was rejected by the Council on the grounds that no plans or specifications were presented to show the style, materials, height or width of the bridge; and his price was too high. This caused considerable debate within the Council, especially as some councillors considered it likely that the Government's offer to contribute a further £2,000 to the cost of the bridge would soon lapse.

The Government did not withdraw the funds; however, a letter from Public Works Office to the County Council in April 1880 confirmed that they would not enter into any agreement to provide the money unless and until the expenditure of money already advanced had been properly accounted for.

In May 1880 a second offer to construct the bridge was made to the Council, this time by R. Campbell & Co of Dunedin; and, like McCormick's offer, this was declined.

The Council continued to seek payment of the £2,000 from the Government; and, in June 1880, a deputation was put before the Minister of Public Works. The Minister responded that the Government "would be prepared to pay it as a first progress payment on the Council entering into a contract for the re-erection of the bridge". Still an agreement between the two parties could not be reached, with many councillors arguing that the County did not have the necessary funds to make its contribution; especially given the high cost of maintaining the roads in the area. Motions by pro-bridge councillors to call for tenders to construct the bridge were repeatedly lost to those who were against. Letters were exchanged between the Council, the Department for Public Works, and Treasury; but the Government remained unmoved. Meanwhile, the punt continued to operate at what many members of the community considered to be an unreasonably high cost.

Finally, the Council was advised to apply for assistance under the newly passed Roads and Bridges Construction Act 1882 for the balance of funds; and, after the Council applied for a much higher sum of £7,000 the Government agreed to contribute £6,000; however, this was also to cover the cost of re-erecting another bridge over the Clutha River at Roxburgh. Plans and specifications for the Beaumont Bridge, were received by the Tuapeka County Clerk in April 1883; and the first tenders were called for its construction.

Construction of the Beaumont Bridge was carried out under two contracts: the first for the piers and abutments; and the second for the superstructure. The first contract commenced in September 1883 and was set down for completion in January 1884; however, for reasons discussed in Section 2.2.1 it was not until mid-1885 that the piers and abutments were complete and construction of the superstructure was able to commence.

During this time, the punt continued to ferry passengers, vehicles, and stock across the river at Beaumont. In November 1886, it overturned, throwing the punt man, three passengers, and a wagon of goods drawn by four horses, into the river. Men working on the Beaumont Bridge witnessed the accident, and managed to rescue three of the four passengers from downstream. The forth passenger, a nine year old girl, was unable to be rescued. The punt reopened within a few weeks; however, the accident led some to believe that the state of the punt had been neglected by the Council due to the imminent completion of the bridge.

The Beaumont Bridge officially opened in March 1887, by which time the township of Beaumont had a store, butchery, bakery, blacksmith, and post office, in addition to the hotels, church and school. With the opening of the bridge, the punt was finally closed. This was a relief to the Council, who, by ruling of the Supreme Court, were held responsible for the punt accident. To recoup the resulting financial losses, the Council proposed to charge waggoners a toll for crossing the new Beaumont Bridge. Not surprisingly, this proposal was not viewed favourably, and the matter was later dropped.

Land on either side of the bridge, held in reserve, then became the subject of community debate, with the Land Board resolving to keep some in reserve, with a remainder being surveyed into one acre lots and offered for sale. The land held back was leased periodically to locals for pastoral purposes.

Beaumont boomed in the 1890s with the arrival of steam-powered and then electric-powered gold dredges to the Clutha. In 1895, a correspondent for the Tuapeka Times reported:

> The Molyneux and the Beaumont are now attracting the attention of the mining public. The local Co-operative Hydraulic Sluicing Co., whose claim is located a little above the Beaumont bridge, have started the cutting of their headrace. Two parties have contracted for over threefifths of the entire length… This claim has the reputation of having a very rich run of wash (an old bed or channel of the river) running through it. This channel or riverbed was followed by a party of miners in the sixties till they were bested by water… Two licensed holdings are also applied for, one above the Beaumont bridge and one below, and it now remains only a matter of time when the whole of his hitherto neglected, portion of the river will be taken up for dredging purposes.

Similar reports continued throughout the late 1890s, as reported in the Otago Witness:

> The Tuapeka Dredging Company, whoso claim is above the Beaumont bridge, are very reticent as to their returns. I was privileged, however, at their last week's wash-up to get; the yield handed to me for my judgment as to weight, and it was heavy, considering the ancient and outof-date dredge they have to work with. This party, I understand, are negotiating for a new and powerful dredge to supplant their present one, and when this is achieved something phenomenal in the way of returns is expected.

In January of this year [1897] three dredging claims were taken up in the Molyneux River – seven, nine and 12 miles respectively – below Beaumont bridge … the area of each of the claims is 50 acres, and the total capital proposed to be invested is £19,000.

It has been estimated that approximately 150 gold-dredges were active on the Clutha River during the 1890s. By the turn of the century the boom had reached its high point, and slowly began to decline; though dredging continued on the Clutha for several decades leading to a second, smaller boom in the 1930s.

In 1905, construction of a long awaited extension of the railway line from Lawrence, through Beaumont to Roxburgh, commenced. It was hoped that, by making access to the Upper Clutha easier, industries other than gold mining and sheep farming would begin to prosper – particularly the industry of fruit growing. However, construction of the line was slow, taking almost ten years to reach Beaumont. By this time, the local population had lost all expectation that the line would ever reach Roxburgh; and, instead, began to demand that the main road be made suitable for motor vehicles. Never-the-less, construction continued and, during the following decade, the population of Beaumont reached its highest point as railway workers and their families took up residence. Beaumont remained the terminus of the branch line until 1925 when the extension to Millers Flat finally opened. The line did not reach Roxburgh until 1928, by which time it was not just fruit growing, but also forestry, that had become established industries in Beaumont.

These industries saw Beaumont through the Great Depression. The Beaumont Racing Club continued to operate; and a new hotel was constructed to replace the Bridge Hotel shortly before the outbreak of the Second World War. This hotel remains operational at the time of preparing this Assessment.

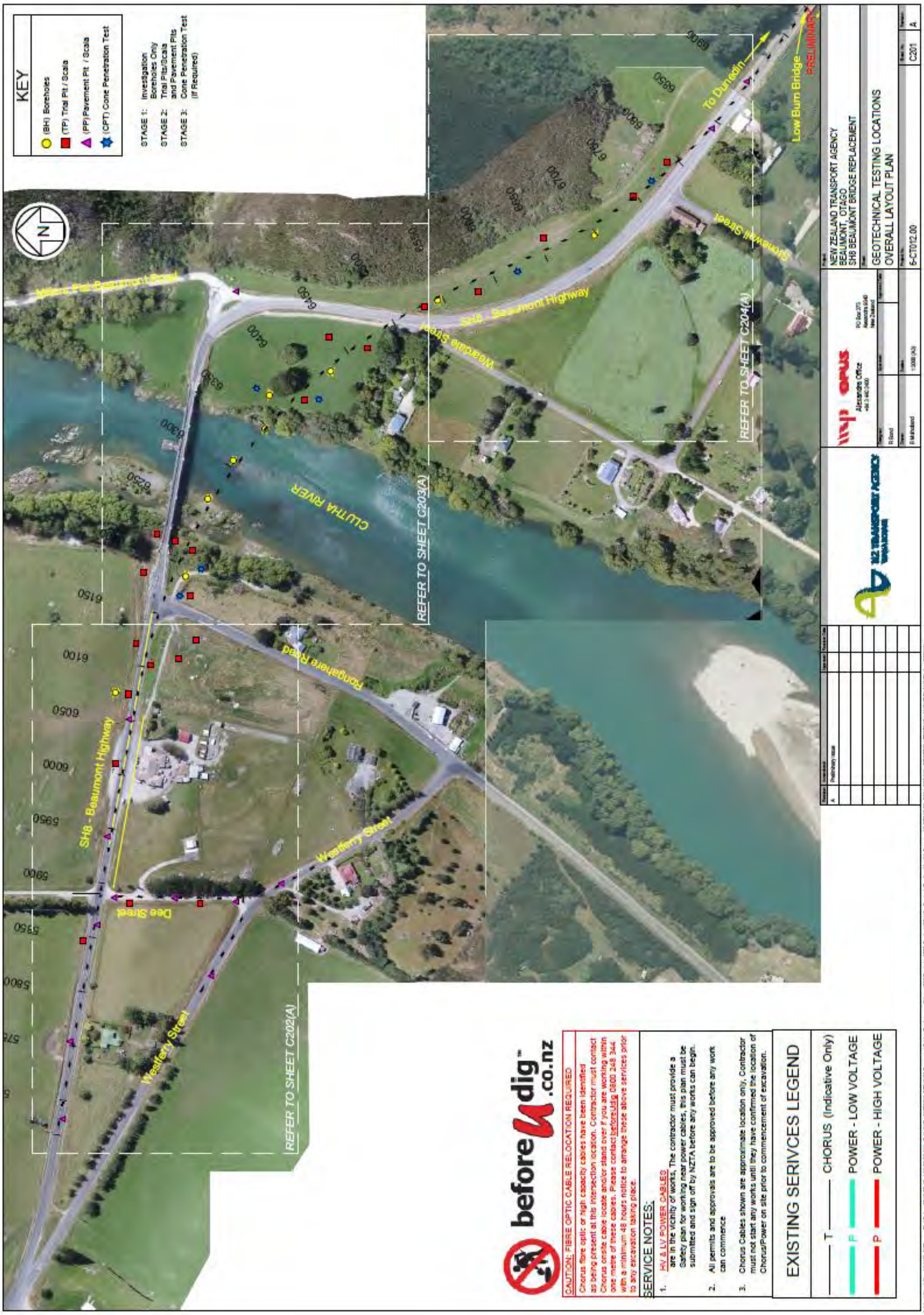
However, closure of the railway branch line in 1968 signalled the start of a significant decline that was exacerbated by the rise of large land holdings, changes in the horticultural sector, and closure of the local forestry headquarters. During the 1980s, the Racing Club and the school were officially closed. The school house remains extant today, though it is evident that it has been considerably modified over the course of its life. The racecourse has been utilised for horticultural purposes.

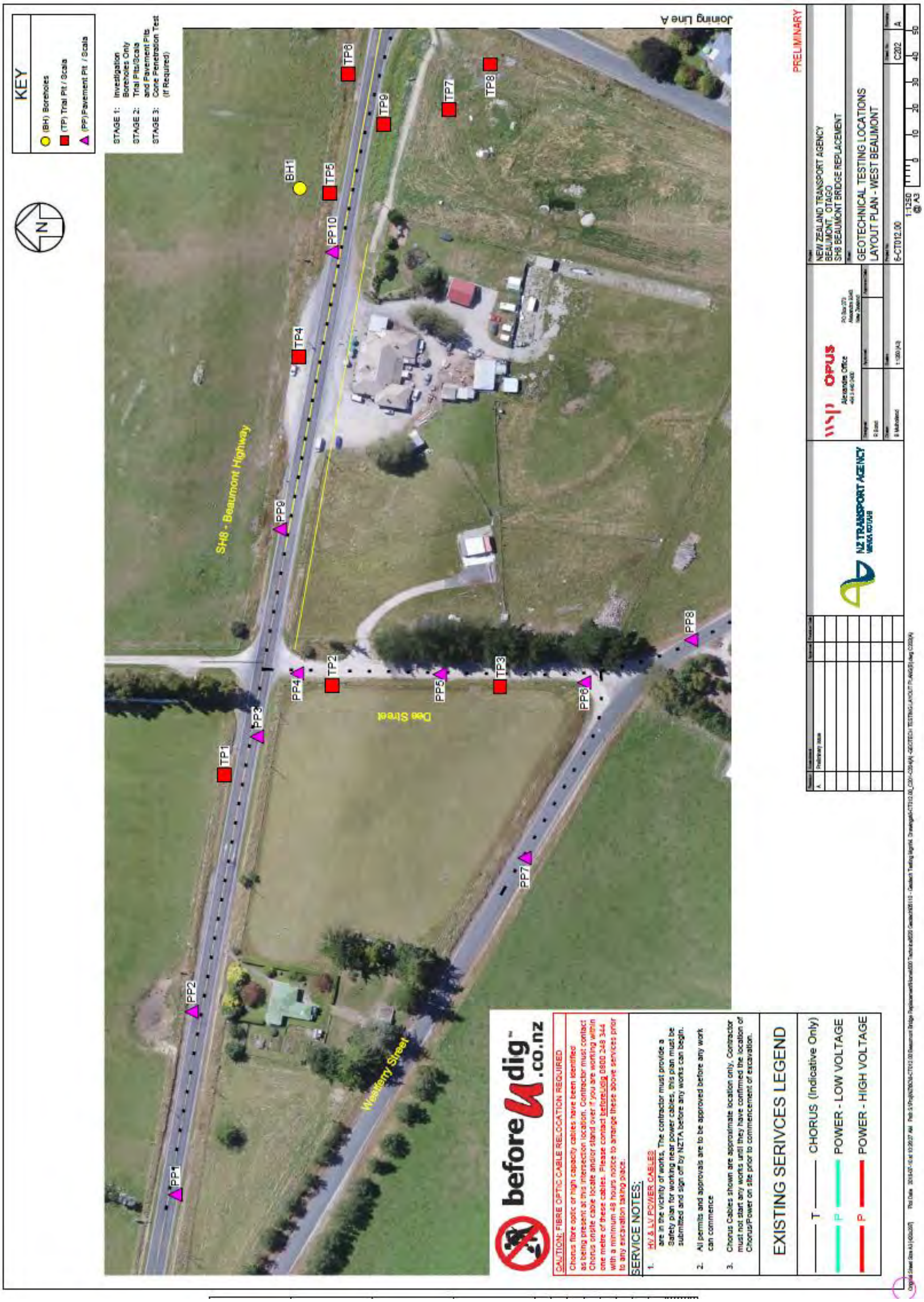
These factors notwithstanding, an aerial photograph of Beaumont taken in 1955 (Figure 18) indicates that the size of the settlement has changed little since this time. While some homes and farm buildings have been demolished, many remain though may have been extensively modified.

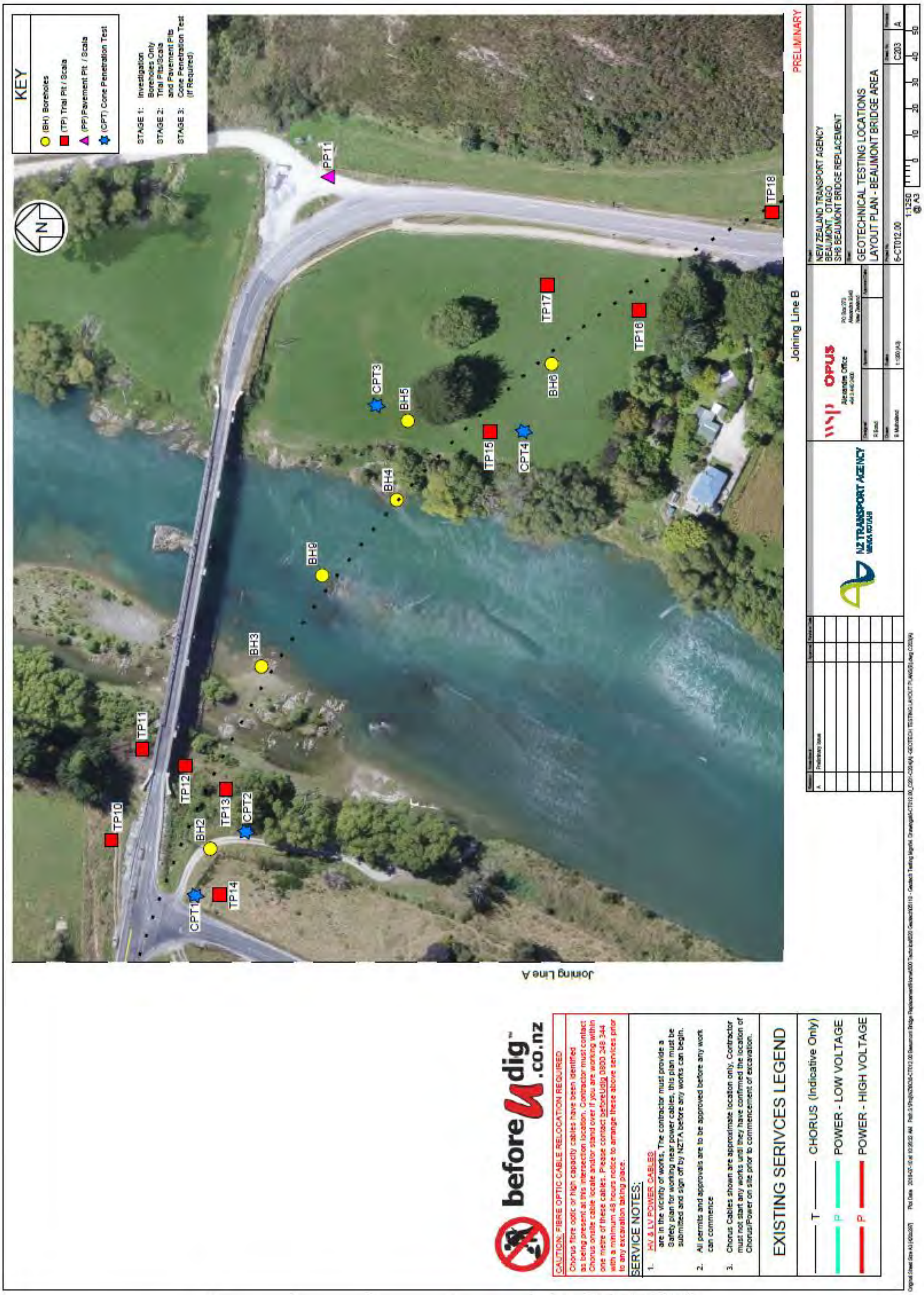
In 1992, the Electricity Corporation of New Zealand (ECNZ) proposed the construction of a dam at Tuapeka Mouth that would flooded 3,000ha of land, including all of Beaumont. Some locals agreed to sell their land; however, others were determined to resist, forming lobby groups including "Hands off Beaumont" to protect the township's "rich history and its attractive and distinctive environment". Plans for this dam, along with others along the Clutha, were officially abandoned in 2012.89

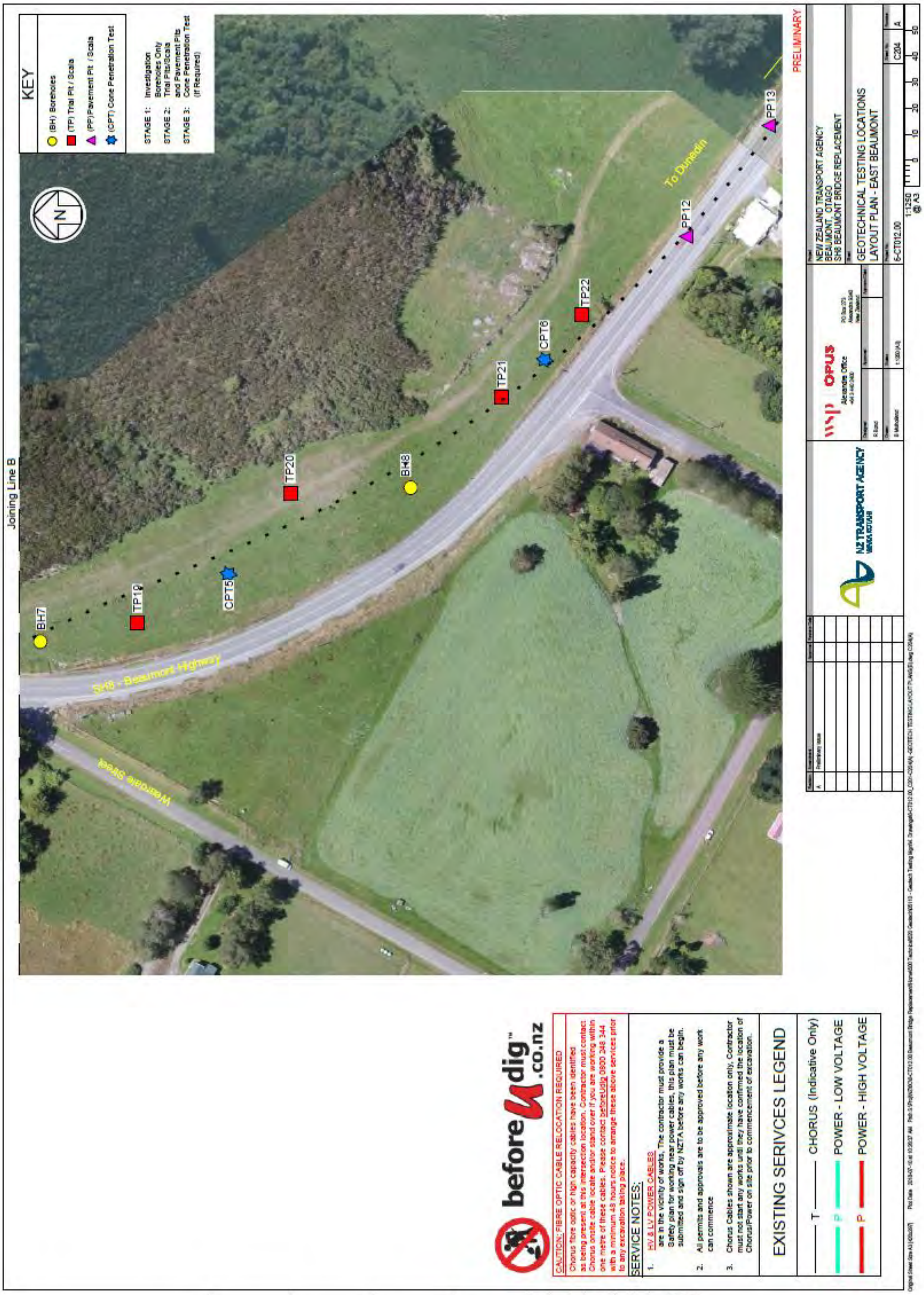
The Beaumont Hotel remains open for meals and accommodation, and hosts the annual Beaumont Motorcycle Rally along with other community events.

Appendix C – Locations of Trial Pits




KEY
(BH) Boreholes
(TP) Trial Pit / Scala
(PP) Pavement Pit / Scala
STAGE 1: Investigation Boreholes Only
STAGE 2: Trial Pits/Scala and Pavement Pits
STAGE 3: Cone Penetration Test (If Required)
N
SH8 - Beaumont Highway
Dee Street
Weatherly Street
Joining Line A
BH1
TP1
TP2
TP3
TP4
TP5
TP6
TP7
TP8
TP9
PP1
PP2
PP3
PP4
PP5
PP6
PP7
PP8
PP9
PP10
PRELIMINARY
beforeUdig.co.nz
SERVICE NOTES:
EXISTING SERIVCES LEGEND
CHORUS (Indicative Only)
POWER - LOW VOLTAGE
POWER - HIGH VOLTAGE
NEW ZEALAND TRANSPORT AGENCY
BEAUMONT, OTAGO
SH8 BEAUMONT BRIDGE REPLACEMENT
GEOTECHNICAL TESTING LOCATIONS
LAYOUT PLAN - WEST BEAUMONT
NZ TRANSPORT AGENCY
C202
A


KEY
(BH) Boreholes
(TP) Trial Pit / Scala
(PP) Pavement Pit / Scala
(CPT) Cone Penetration Test
STAGE 1: Investigation Boreholes Only
STAGE 2: Trial Pits/Scala and Pavement Pits
STAGE 3: Cone Penetration Test (If Required)
PP1
TP18
TP17
TP16
TP15
CPT3
CPT4
BH5
BH6
BH4
BH9
BH3
TP11
TP12
TP13
CPT2
BH2
TP10
TP14
CPT1
Joining Line A
Joining Line B
PRELIMINARY
NEW ZEALAND TRANSPORT AGENCY
BEAUMONT, OTAGO
SH8 BEAUMONT BRIDGE REPLACEMENT
GEOTECHNICAL TESTING LOCATIONS
LAYOUT PLAN - BEAUMONT BRIDGE AREA
6-CT012.00
C203
A
1:1250 @ A3
NZ TRANSPORT AGENCY
beforeUdig.co.nz
SERVICE NOTES:
EXISTING SERIVCES LEGEND
CHORUS (Indicative Only)
POWER - LOW VOLTAGE
POWER - HIGH VOLTAGE


KEY
(BH) Boreholes
(TP) Trial Pit / Scala
(PP) Pavement Pit / Scala
(CPT) Cone Penetration Test
STAGE 1: Investigation Boreholes Only
STAGE 2: Trial Pits/Scala and Pavement Pits
STAGE 3: Cone Penetration Test (If Required)
N
Joining Line B
BH7
TP19
CPT5
TP20
BH8
TP21
CPT6
TP22
PP12
PP13
To Dunedin
SH8 - Beaumont Highway
Weirdale Street
PRELIMINARY
NEW ZEALAND TRANSPORT AGENCY
BEAUMONT, OTAGO
SH8 BEAUMONT BRIDGE REPLACEMENT
GEOTECHNICAL TESTING LOCATIONS
LAYOUT PLAN - EAST BEAUMONT
6-CT012.00
C204
A
1:1250 @ A3
0 10 20 30 40 50
NZ TRANSPORT AGENCY
Alexandra Office
CAUTION: FIBRE OPTIC CABLE RELOCATION REQUIRED
Chorus fibre optic or high capacity cables have been identified as being present at this intersection location. Contractor must contact Chorus onsite cable locate and/or stand over if you are working within one metre of these cables. Please contact beforeUdig 0800 248 344 with a minimum 48 hours notice to arrange these above services prior to any excavation taking place.
SERVICE NOTES:
1. HV & LV POWER CABLES are in the vicinity of works. The contractor must provide a Safety plan for working near power cables, this plan must be submitted and sign off by NZTA before any works can begin.
2. All permits and approvals are to be approved before any work can commence
3. Chorus Cables shown are approximate location only. Contractor must not start any works until they have confirmed the location of Chorus/Power on site prior to commencement of excavation.
EXISTING SERIVCES LEGEND
T CHORUS (Indicative Only)
P POWER - LOW VOLTAGE
P POWER - HIGH VOLTAGE

Appendix D – Recorded Sites within Project area

NEW ZEALAND ARCHAEOLOGICAL ASSOCIATION

ARCHSITE
archaeological site recording scheme

Site Record Form

NZAA SITE NUMBER: G44/148

SITE TYPE: Historic - domestic

SITE NAME(s):

DATE RECORDED:

SITE COORDINATES (NZTM) Easting: 1330096 **Northing:** 4920201 **Source:** On Screen

IMPERIAL SITE NUMBER: **METRIC SITE NUMBER:** G44/148

Finding aids to the location of the site

In paddock east of Rongahere Road approximately 70 metres south of the SH8

Brief description

Recorded features

Foundations, House floor/ site

Other sites associated with this site

NEW ZEALAND ARCHAEOLOGICAL ASSOCIATION

SITE RECORD HISTORY	NZAA SITE NUMBER: G44/148

Site description

Updated 18/03/2019 (Field visit), submitted by samkurmann , visited 24/10/2018 by Kurmann, S
Grid reference (E1330096 / N4920201)

House platform of a house depicted in 1882 survey plan "Beaumont Bridge Site Survey".

Condition of the site

Updated 18/03/2019 (Field visit), submitted by samkurmann , visited 24/10/2018 by Kurmann, S

There is a flat terrace area at the same spot that a house is depicted on an 1882 survey map. It is likely that some below ground archaeological remains exist.

Statement of condition

Current land use:

Threats:

NEW ZEALAND ARCHAEOLOGICAL ASSOCIATION

ARCHSITE archaeological site recording scheme

Site Record Form

NZAA SITE NUMBER: G44/149

SITE TYPE: Commercial

SITE NAME(s): Beaumont Hotel

DATE RECORDED:

SITE COORDINATES (NZTM) Easting: 1329955 **Northing:** 4920240 **Source:** On Screen

IMPERIAL SITE NUMBER: **METRIC SITE NUMBER:** G44/149

Finding aids to the location of the site

Beaumont Hotel - same site. At the rear of the hotel is the stable location

Brief description

Recorded features

Building - accomodation/ boarding house, Building - hotel, Building - stable

Other sites associated with this site

Printed by: samkurmann 18/03/2019

NEW ZEALAND ARCHAEOLOGICAL ASSOCIATION

SITE RECORD HISTORY	NZAA SITE NUMBER: G44/149

Site description

Updated 18/03/2019 (Field visit), submitted by samkurmann , visited 15/08/2018 by Kurmann, Sam
Grid reference (E1329955 / N4920240)

The site of the original Beaumont Hotel. There is also an associated stable located out the back of the hotel.

Condition of the site

Updated 18/03/2019 (Field visit), submitted by samkurmann , visited 15/08/2018 by Kurmann, Sam

Recording based on historic records (Beaumont Bridge Site Survey from 1882). Surface evidence of either the hotel or stable was not visible, however, it is possible that subsurface remains exist.

Statement of condition

Current land use:

Threats:

NEW ZEALAND ARCHAEOLOGICAL ASSOCIATION

ARCHSITE archaeological site recording scheme

Site Record Form

NZAA SITE NUMBER: G44/150

SITE TYPE: Transport/ communication

SITE NAME(s): Beaumont Bridge

DATE RECORDED:

SITE COORDINATES (NZTM) Easting: 1330231 **Northing:** 4920247 **Source:** On Screen

IMPERIAL SITE NUMBER: **METRIC SITE NUMBER:** G44/150

Finding aids to the location of the site

The Beaumont Bridge, on State Highway 8 over the Mata-au/Clutha River, and it's approaches.

Brief description

Recorded features

Bridge

Other sites associated with this site

NEW ZEALAND ARCHAEOLOGICAL ASSOCIATION

SITE RECORD HISTORY	NZAA SITE NUMBER: G44/150

Site description

Updated 18/03/2019 (Field visit), submitted by samkurmann , visited 15/08/2018 by Kurmann, Sam
Grid reference (E1330231 / N4920247)

The following history is from Kurmann, S. 2019. Beaumont Bridge Archaeological Assessment. Unpublished report prepared for NZTA.

In 1875, Hayes put the original Beaumont bridge up for sale (Tuapeka Times, 22/09/1875, p.3) and it was sold to Kitching in 1876. Kitching also bought the punt at this time and built the Bridge Hotel. Holding the monopoly over the river crossings, Kitching fielded many complaints around the exorbitant fees being charged for these river crossings. 1876 survey plan SO 14210 shows the detail around the bridge location, including the surrounding Bridge Reserve on either side of the Beaumont Bridge.

In 1877, the Tuapeka County Council and Government investigated a purchase of the bridge after the complaints of locals were taken seriously. However, in 1878, the bridge was washed away by severe flooding. In a domino-like effect, the Clyde Bridge washed down stream and took out Beaumont Bridge, which together caused the demolition of the Balclutha Bridge (Thornton 2001: 231; Bruce Herald, 1/10/1878, p.5).

The Government investigating re-erecting the bridge for some years, which included negotiating the purchase of the same land from Kitching (Tuapeka Times, 12/07/1879, p.3). Construction of the bridge was slow. Contractual toing and froing contributed to the hold ups (Press, 12/05/1885, p.2) and shoddy building further delayed the opening, with some of the piers being built too high (Tuapeka Times, 11/08/1886, p. 3). One result of this back and forth was the survey of the town of Beaumont in 1882. Visible in this plan is the Bridge Hotel and its stables, a blacksmith, an historic water race, a house site, the ferry punt, the bridge location to the east.

It was not until 1887 that the Beaumont Bridge opened, construction possibly being spurred by the drowning of a young girl in a punt accident in November 1886. The opening of the new bridge allowed people to travel into Beaumont and make the use of the town's facilities, which now included a store, bakery, blacksmith and post office.

Condition of the site

Updated 18/03/2019 (Field visit), submitted by samkurmann , visited 15/08/2018 by Kurmann, Sam

The condition of the bridge was not formally assessed here. The Beaumont Bridge has been maintained over the last 120 years. The last 30 years have seen the Bridge covered in scaffolding to ensure the integrity of the structure. The concrete bridge abutments have considerable cracks in them. The superstructure has been repaired repeatedly over the last 120 years

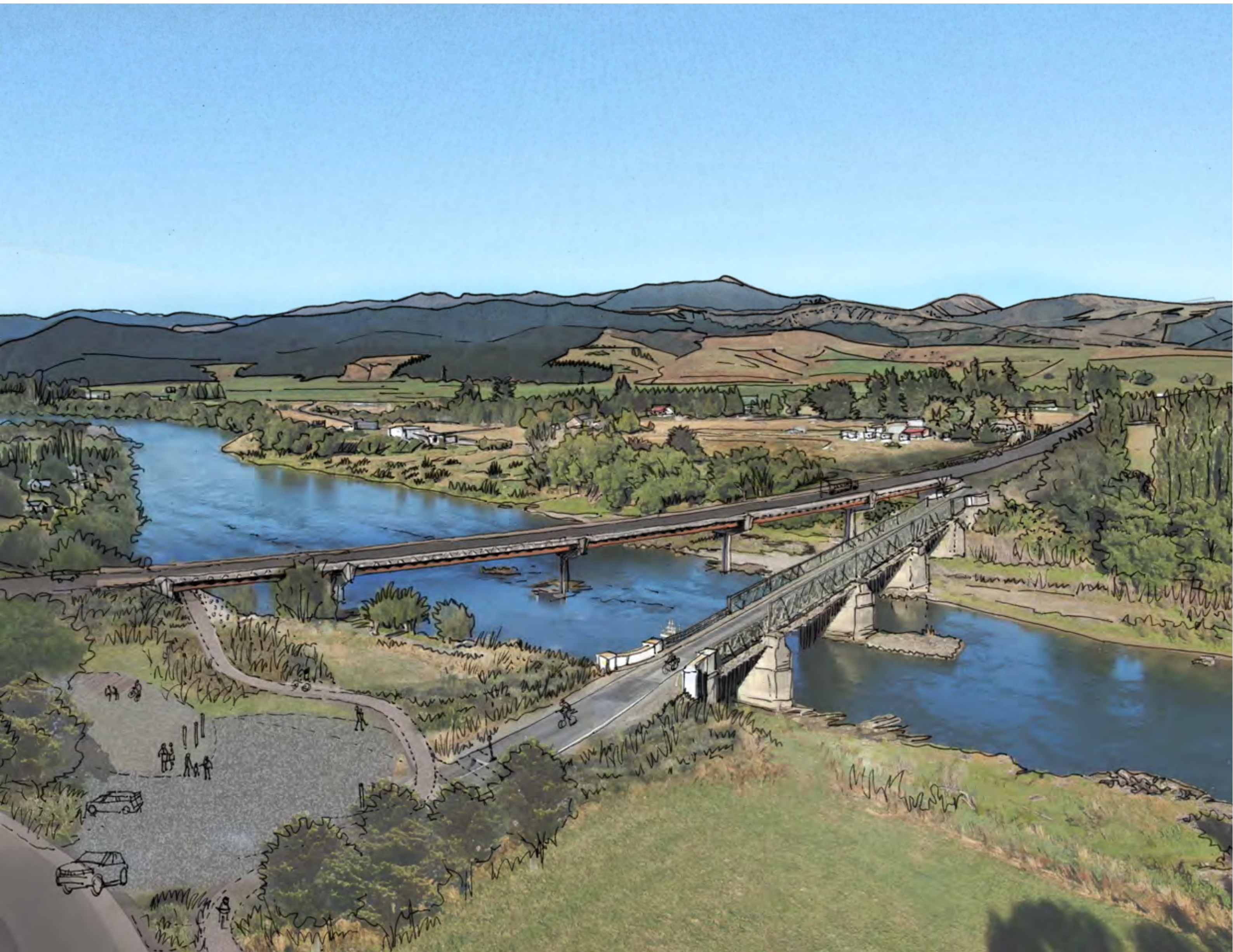
Statement of condition

Current land use:

Threats:

New Beaumont Bridge

Assessment of Noise and Vibration Effects



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Contents

Document history and status

Revision	Date	Author	Reviewed by	Approved by	Status
Issue 1	27/05/2019	I. McIver	T. Lester	P. Cenek	Draft
Issue 2	20/08/2019	I. McIver	T. Lester	P. Cenek	Second Issue
Issue 3	19/09/2019	I. McIver	T. Lester	P. Cenek	Third Issue

Revision details

Revision	Details
Issue 1	Initial draft of assessment.
Issue 2	Updated for NZTA comments
Issue 3	Updated for additional comments

1 Introduction

There is a proposal to install a new bridge over the Clutha River in Beaumont, Central Otago, and to re-align SH8 to allow traffic to use this new bridge. In this report the new bridge and realignment of SH8 will be referred to as the Project. The NZ Transport Agency is seeking a designation for the Project and this report describes assessment of the noise and vibration effects of the proposed designation and Project.

The new bridge will be installed slightly to the south of the existing bridge, which will be retained. An image of the proposed Project is shown below in Figure 1-1.

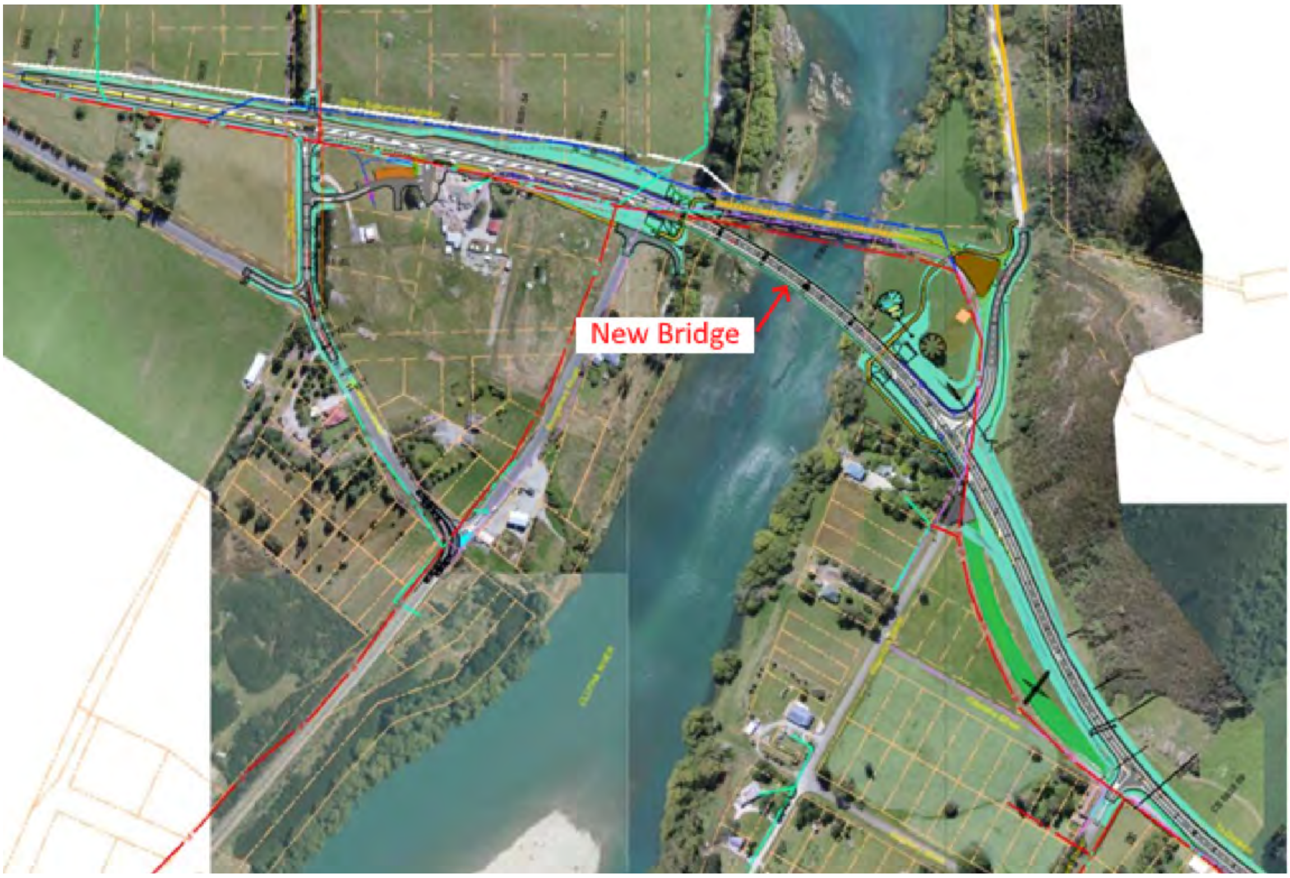

Figure 1-1. Image of the proposed new bridge and the realignment of SH8.

This assessment of noise and vibration effects is based on the understanding that the Project design is well-developed and substantive changes are unlikely. The Project road surface on the bridge approaches is to be finished with a chipseal (Grade 4, 5 or 6 single coat seal) and the bridge deck on the new structure will incorporate asphalt surfacing. This assessment assumes any bridge joints or road surface joins are constructed so that vehicle passes generate no significant additional noise or vibration effects.

1.1 Defining 'reasonable' noise and vibration effects

This noise and vibration assessment looks at the effects, both from an operational and construction perspective, of the Project. The overarching requirement for management of noise and vibration effects is established by the Resource Management Act, 1991 (RMA), as reinforced in section 1.2.4 of the Clutha District Plan. Section 16(1) of the RMA states

> *Every occupier of land (including any premises and any coastal marine area), and every person carrying out an activity in, on, or under a water body or the coastal*

> *marine area, shall adopt the best practicable option to ensure that the emission of noise from that land or water does not exceed a reasonable level.*

Noise includes vibration when interpreting the RMA.[1]

'Reasonable' noise and vibration levels are not defined in the RMA, so other sources of noise and vibration limits or recommendations are used for assessment of the noise and vibration effects of the project.

The Clutha District Plan identifies the potential for adverse noise and vibration effects from operation and construction of the roading network. The Clutha District Plan recognises 'operation of transport systems is defined as a land use activity by virtue of Section 9(4) of the RMA'[2] and states Council shall 'exercise control' in respect of noise[3] but road-traffic noise limits are not provided. The Clutha District Plan does not provide construction noise limits, considering existing New Zealand Standards are adequate controls and referring to NZS 6803: 1984 *The measurement and assessment of noise from construction, maintenance and demolition work*[4]. The Clutha District Plan provides a general rule that vibration levels are assessed in accordance with NZS 4403: 1976 *Code of practice for storage, handling and use of explosives*[5] and for Infrastructure requires vibration from construction activity shall comply with the peak particle velocity limits in table 1 of German Standard DIN 4150-3: 1999 *Structural vibration – Effects of vibration on structures*.

NZS 6806: 2010 *Acoustics – Road-traffic noise – New and altered roads* is proposed as appropriate for management of operational road-traffic noise effects of the Project. This standard provides noise level criteria with a procedure for determining how those criteria apply to premises and facilities near a roading project. The NZ Transport Agency supports the use of NZS 6806 for assessing and, where required, determining appropriate mitigation for road-traffic noise.[6]

NZS 6803: 1999 *Acoustics – Construction noise* is proposed as appropriate for management of construction noise effects of the Project. This standard provides guideline noise limits and management practices for construction and maintenance works. NZS 6803: 1999 has superseded NZS 6803: 1984 referenced in the Clutha District Plan.

Vibration levels from the Project operation and construction are assessed for effects on structures using the German Standard DIN 4150-3: 1999 *Structural vibration – Effects of vibration on structures*, which is the standard referenced in the Clutha District Plan rule for vibration from infrastructure construction activity. Traffic induced vibration effects on people are assessed using the Norwegian Standard NS 8176.E: 2005 *Vibration and shock - Measurement of vibration in buildings from land-based transport and guidance to evaluation of its effects on human beings*. There are no applicable New Zealand Standards for vibration from road-traffic. The Clutha District Plan rule for vibration from general activity references the NZS 4403: 1976 Code of practice for the storage, handling and use of explosives (Explosives Code) but the applicable limits in DIN 4150-3: 1999 and NS 8176.E: 2005 are more stringent than the applicable limits of NZS 4403: 1976.

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[1] RMA Part 1 Section 2

[2] Clutha District Plan section 3.3.1

[3] Clutha District Plan section 3.3.5, rule TRAN.1 Roading activity status

[4] Clutha District Plan section 3.13.4, rule NSE.2 Construction noise

[5] Clutha District Plan section 3.13.4, rule NSE.3 Vibration

[6] NZTA (2016) *Guide to assessing road-traffic noise using NZS 6806 for state highway asset improvement projects, version 1.1*. Available at https://www.nzta.govt.nz/assets/resources/guide-to-assessing-road-traffic-noise/docs/guide-to-assessing-road-traffic-noise.pdf

2 Current environment

A site visit was made to Beaumont on the 1st of May 2019 to take noise and vibration measurements. Figure 2-1 shows the locations used for the on-site noise and vibration measurements. Noise measurements were made at Locations A, B, D, E, F and G. Measurements were made of traffic induced vibrations at two locations, C and H, while measurements of soil vibration attenuation were made at Location E.

Figure 2-1. Noise and vibration measurement locations.

Noise measurements were made on site using a calibrated sound level meter[7] and generally in accordance with New Zealand Standard NZS 6801: 1991 *Measurement of sound*. Each noise measurement duration ranged from 15 minutes to 60 minutes, with traffic counted during the noise measurement. The noise measurements were intended to be used to validate the predictive road-traffic noise model rather than to establish the typical or representative noise levels at the locations.

The results of these noise measurements are shown in Table 2-1. For these measurements, traffic noise was the dominant source of noise although birds and the Clutha River were also audible (particularly at Location F). Near the bridge the sound of vehicles rattling the planks on the existing bridge was also audible (particularly at Location F). The measured noise levels are reported using the L_{Aeq} index, which represents the time-average sound pressure level or the equivalent continuous sound level over the measurement duration. $L_{Aeq(24h)}$ is known as the 24-hour average sound level and is the descriptor used in NZS 6806 for road-traffic noise. The L_{A10}, representing the

[7] B&K Type 2250 Sound Level Meter. Calibrated 10/01/2019.

noise level equalled or exceeded for 10 percent of the measurement duration, is also reported as this is the descriptor used in the Clutha District Plan.

Table 2-1. Measured noise levels from site visit.

Location	Distance to edge of SH8 [m]	Measured noise level		Notes
		[dB L_{Aeq}]	[dB L_{A10}]	
A	21	60.4	63.2	Dee Street just North of SH8.
B	13	63.8	65.8	Carpark of Beaumont Hotel
D	55	49.7	52.2[ɦ]	Rongahere Road
E	24	56.9	59.2	Picnic area
F	83	48.9	51.6	10 Weardale Street
G	21	55.1	57.6[ɦ]	Near intersection of SH8 and Weardale Street.

[ɦ] *Estimated from L_{Aeq} measurement.*

Vibration measurements were made using triaxial accelerometers that were sampled at a rate 1,000 Hz. The measured accelerations were filtered between 1 Hz and 80 Hz and numerically integrated to give vibration velocities in mm/s. The maximum vibration velocity from each event has been calculated as the Peak Particle Velocity (PPV). Traffic was monitored during the vibration measurements so that large vibrations could be matched with the source vehicles/events. The measurements at Location C found that the vibration levels were below the sensitivity of the accelerometers and as such have not been reported. Table 2-2 shows the five largest vibrations measured at Location H, with information on the source vehicle/event also given.

Table 2-2. The five largest traffic induced vibration signals measured at location H.

Location	Distance to road edge [m]	PPV [mm/s]	Vehicle / Event
H	9	0.45	Full logging truck
		0.42	Empty logging truck
		0.35	Hiab truck
		0.33	Two cars
		0.31	Empty logging truck

Vibration measurements were also taken at Location E and these have been used to calculate the soil vibration attenuation. These measurements found that the frequency independent attenuation coefficient, ρ, was between 1.11×10^{-3} and 1.77×10^{-3}. From NZTA Research Report 485[8], these attenuation coefficients relate to weak or soft soils. This matches well with the GNS Geology Web Map[9] which gives the local soils as 'IQa' or *unconsolidated to poorly consolidated mud, sand, gravel and peat of alluvial and colluvial origin*.

3 Assessment of effects

The properties assessed are shown below in Figure 3-1. For operational noise and vibration, properties within approximately 200 m of the Project have been assessed (all properties shown in Figure 3-1 other than PPF 4). All of the properties shown in Figure 3-1 have been assessed for construction noise and vibration. Predictive models of operational and construction noise and

[8] Cenek, P.D., Sutherland, A.J. and McIver, I.R. (2012) Ground Vibration from Road Construction, NZ Transport Agency Research Report 485, downloadable from: http://www.nzta.govt.nz/resources/research/reports/485/index.html
[9] https://data.gns.cri.nz/geology/

vibration are used, with data collected from measurements performed on site used to validate these models.

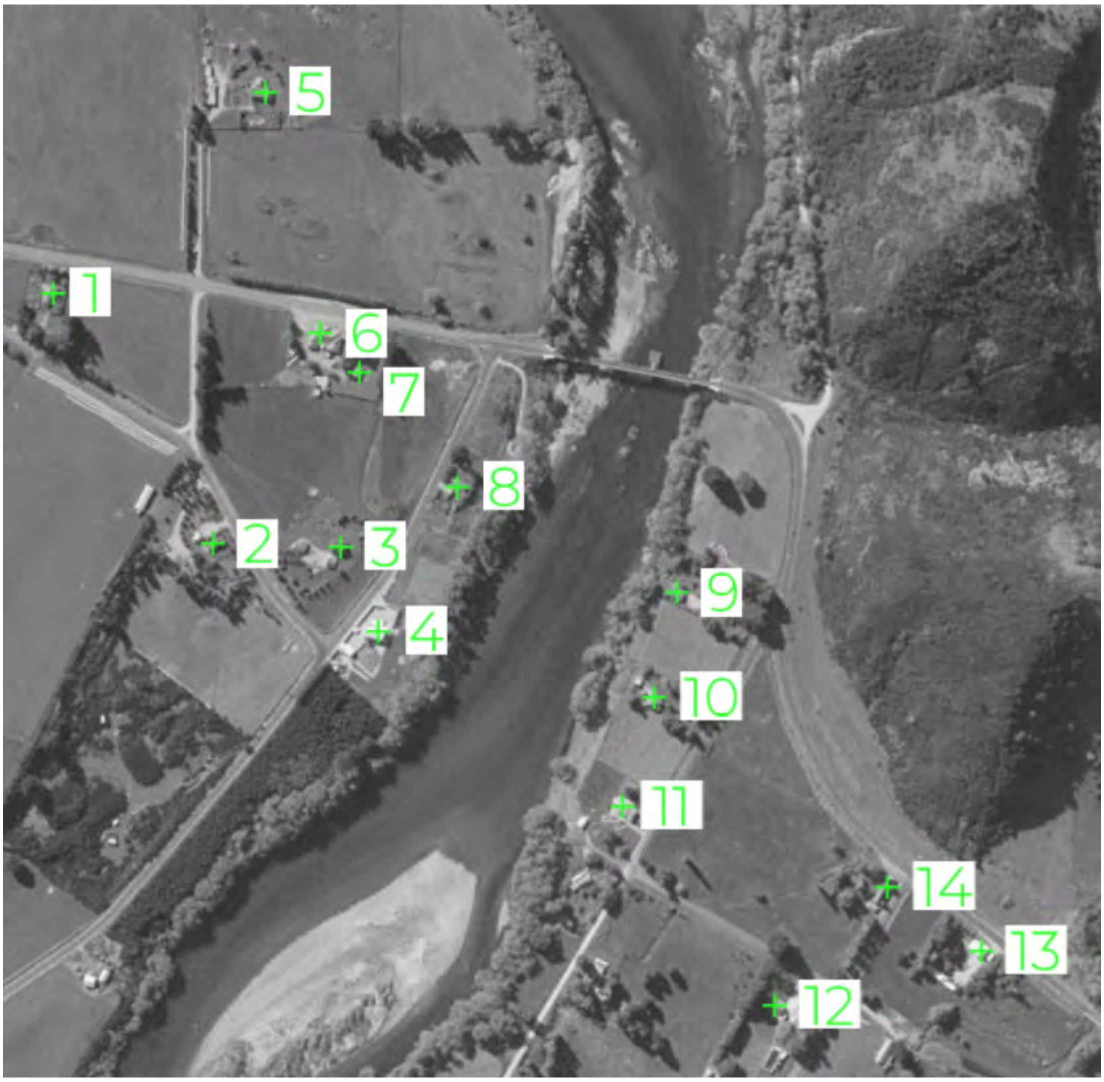

Figure 3-1. Locations of property buildings assessed for noise and/or vibration effects.

3.1 Operational noise assessment

The operational noise of the project has been assessed using the methodology of the current New Zealand Standard for road-traffic noise NZS 6806:2010.

The NZS 6806 methodology compares noise levels for different modelled situations, such as the existing situation and the situation with a project built, so the total road-traffic noise level and noise level changes can be considered. NZS 6806 considers how the physical works of a project affect the road-traffic noise environment through classifying roads or road sections as:

- 'new' where a section of road is to be constructed where no previously formed legal road existed[10], which may be interpreted as where a road or road section physically affected by a project would introduce a new road-traffic noise source, or
- 'altered' based on combinations of the total road-traffic noise level and noise level increase, which may be interpreted as where a road or road section physically affected by a project would be judged by the NZS 6806 criteria as altering a road-traffic noise source, or

[10] NZS 6806: 2010 clause 1.6

- some road sections physically affected by a project may be unclassifiable as either 'new' or 'altered', which may be interpreted as where a road or road section physically affected by a project would be judged by the NZS 6806 criteria as not altering the road-traffic noise.

The terms 'new' and 'altered' are used in this road-traffic noise assessment with the specific meanings of NZS 6806 clause 1.5 and clause 1.6. It is noted the terms may be used differently colloquially and by other disciplines or assessments.

NZS 6806 sets out criteria for mitigating noise from 'new' and 'altered' roads. 'The criteria are reasonable taking into account adverse health effects associated with noise on people and communities, the effects of relative changes in noise levels, and the potential benefits of new and altered roads.'[11] NZS 6806 does not provide criteria for mitigating noise from road sections unclassifiable as either 'new' or 'altered', from which it is interpreted as implying that road-traffic noise from those road sections can be considered reasonable without (further) assessment or mitigation.[12]

The first tasks of the operational noise assessment using the NZS 6806 methodology are to classify the Project road sections as 'new', 'altered', or unclassifiable.

3.1.1 Different situations to model for the NZS 6806 methodology

The NZS 6806 methodology uses three noise environments or situations. These are the 'existing', the 'do-nothing' and the 'do-minimum', each of which is explained below for the Project:

- The existing noise environment is the 'typical' road-traffic noise levels which currently exist in the area, i.e. the existing speed limits, existing road layout with the existing Beaumont Bridge and the existing road surfacing types, operating with the current (2019) average daily traffic volumes.
- The do-nothing noise environment is the situation that would exist in the future 'design year'[13], in this case 2036, as though nothing has changed from the existing built situation but operating with the design year traffic volumes, i.e. the existing speed limits, existing road layout with the existing Beaumont Bridge and the existing road surfacing types, operating with the design year (2036) traffic volumes.
- The do-minimum noise environment is the situation that would exist in the future 'design year' with the proposed Project layout with the new bridge and operating with the design year traffic volumes, i.e. the proposed speed limits, proposed road layout with the proposed new Beaumont Bridge and the proposed road surfacing types, operating with the design year (2036) traffic volumes.

'Do-minimum' means the Project implemented with features which may provide incidental noise mitigation (such as safety barriers or special road surfacing types) but not including any mitigation measures that would be undertaken for the sole purposes of reducing noise effects.[14]

NZS 6806 defines the premises and facilities considered to be potentially affected by road-traffic noise and to be included in the different situations modelled. 'Protected Premises and Facilities' (PPFs) is the NZS 6806 term for noise-sensitive receivers to which the Standard applies. PPFs include buildings used for residential activities and buildings used as temporary accommodation in residentially zoned areas, including hotels and motels, but excluding camping grounds.[15]

[11] NZS 6806: 2010 C6.1.1

[12] See NZS 6806: 2010 clause 1.5.1 and clause 1.3.2, and see also Dravitzki, V., Walton, D., and Wood, C. 2006. Road Traffic Noise – Determining the Influence of New Zealand Road Surfaces on Noise Levels and Community Annoyance. *Land Transport New Zealand Research Report 292*. 76 pp.

[13] The design year is selected at not less than 10 years but not more than 20 years after the opening of the project, as per the NZS 6806 definition.

[14] NZS 6806: 2010 clause 2.2

[15] NZS 6806: 2010 clause 1.4.1

3.1.2 Project road section classifications of the NZS 6806 methodology

The Beaumont Bridge replacement realigns SH8 close to the existing route, so it is considered not to be a 'new road'.

Table 3-1 shows how NZS 6806 considers the combination of total noise level and noise level change for classifying a road section as an 'altered' road where there is 'an existing road that is subject to alterations of the horizontal or vertical alignment'[16].

Table 3-1. Combination of total noise level and noise level change for altered' road classification as per NZS 6806[17].

Total noise level of the 'do-minimum' noise environment		Noise level increase of 'do-minimum' over 'do-nothing'	Comment
≥ 64 dB $L_{Aeq(24h)}$	and	≥ 3 dB increase	Both criteria required for classification as an 'altered' road.
≥ 68 dB $L_{Aeq(24h)}$	and	≥ 1 dB increase	Both criteria required for classification as an 'altered' road.

3.1.3 NZTA Road Traffic Noise Calculator for modelling of noise levels

The NZTA Road Traffic Noise Calculator[18] is used for modelling of noise levels at the PPFs. This tool is based on the CRTN[19] model which is an accepted method for modelling road-traffic noise in New Zealand and NZS 6806 recommends use of the tool for 'screening' whether a project includes 'altered' roads or roads unclassifiable as either 'new' or 'altered'.

For assurance that the NZTA Road Traffic Noise Calculator is suitable for modelling for the Project, the noise environment during the site visit has been modelled with the calculator and compared to the actual noise measurements. More information on the input data used for this modelling is available in Appendix A while the results of the comparison are shown below in Table 3-2. The values shown in Table 3-2 are for validating the modelling procedure only and not used directly for assessment of road-traffic noise at the PPFs. The measured noise levels do not necessarily represent the 'existing noise environment' as the noise measurements capture only a short-term snapshot of noise levels. The 'existing noise environment' is modelled with inputs such as average annual daily traffic volumes to represent the typical road-traffic noise levels, whereas the modelled noise levels in Table 3-2 are modelled with inputs, such as traffic volumes, as observed/counted during the noise measurements.

The final column in Table 3-2 shows the difference between the road-traffic noise level modelled and the noise level measured at the same location. The NZS 6806 methodology expects the difference between noise levels measured and modelled should not exceed ±2 dB.[20]

[16] NZS 6806: 2010 clause 1.5.2
[17] Tabulated version of NZS 6806: 2010 clause 1.5.2(a) and 1.5.2(b)
[18] https://www.nzta.govt.nz/roads-and-rail/highways-information-portal/tools/road-traffic-noise-calculator/
[19] Calculation of Road Traffic Noise 1988. Department of Transport, Welsh Office.
[20] NZS 6806: 2010 clause 5.3.4.2

Table 3-2. Validation of the NZTA Road Traffic Noise Calculator by comparison of noise levels measured and noise levels modelled with inputs as observed during the noise measurements.

Location	Measured Noise Level [dB L_{Aeq}]	Modelled Noise Level [dB L_{Aeq}]	Modelled minus measured noise level [dB]
A	60.4	61	0.6
B	63.8	64	0.2
D	49.7	53	3.3
E	56.9	58	1.1
F	48.9	48	-0.9
G	55.1	56	0.9

The NZTA Road Traffic Noise Calculator generally shows good representation of the noise environment and is therefore considered suitable for modelling noise from the Project. The larger differences between modelled and measured noise levels at locations D and E are expected, as these locations are positioned at each end of the existing bridge and the actual vehicle speeds observed are lower than the minimum allowable in the calculator (50 km/h). This discrepancy in speed is likely to be the main source of the difference between the modelled and measured noise levels.

3.1.4 'Do-nothing' and 'do-minimum' noise environments for the NZS 6806 methodology

The NZTA Road Traffic Noise Calculator has been used to model the do-nothing and do-minimum noise levels for the Project at the properties within approximately 200 m of the Project. The results are presented in Table 3-3 while the inputs used for the modelling are shown in Appendix A.

Table 3-3. Results of modelling using the NZTA Road Traffic Noise Calculator

PPF	Do-nothing [dB L_{Aeq}]	Do-minimum [dB L_{Aeq}]	Noise level change of 'do minimum' over 'do nothing' [dB]
1	60	57	-3
2	44	43	-1
3	44	44	0
5	46	44	-2
6	64	64	0
7	57	56	-1
8	49	51	2
9	49	52	3
10	47	47	0
11	46	45	-1
12	47	44	-3
13	67	65	-2
14	65	63	-2

From Table 3-3, no PPFs achieve the *combination* of total noise level *and* noise level change for classification as an 'altered' road following the NZS 6806 criteria as shown in Table 3-1. Where the total noise level of the do-minimum noise environment is greater than or equal to 64 dB $L_{Aeq(24h)}$ (PPFs 6 and 13), the noise level change of 'do minimum' over 'do nothing' is not greater than or equal to +3 dB, so the NZS 6806 criteria for 'altered' classification are not met. Where the noise level change of ‘do minimum’ over ‘do nothing’ is greater than or equal to +3 dB (PPFs 3, 9 and 10), the total noise level of the do-minimum noise environment is not greater than or equal to 64 dB $L_{Aeq(24h)}$, so the NZS 6806 criteria for the ‘altered’ classification are not met

The Project road sections do not meet the NZS 6806 criteria for classification as either ‘altered’ or ‘new’; they are unclassifiable as either ‘new’ or ‘altered’ using the NZS 6806 methodology. Therefore, it is interpreted that the road-traffic noise from the project can be considered reasonable without (further) assessment or mitigation.[21].

It is accepted that the NZTA Road Traffic Noise Calculator assumes a steady traffic flow. i.e. there is no contribution from acceleration and deceleration engine noise nor for the reduced tyre noise associated with vehicles slowing for the bridge. The NZTA Road Traffic Noise Calculator was used to only model the single dominant road-traffic noise source for each PPF and does not account for noise from other segments of road that will have some contribution to the total road-traffic noise level. The conclusions made from the Table 3-3 results are not affected by this. Through the route realignment, the Project is expected to increase traffic speeds, the effects of which have been modelled. The Project is expected to also reduce the acceleration and deceleration engine noise and bridge surface noise (provided bridge joints are specified and constructed appropriately), the effects of which have not been modelled.

3.2 Operational vibration assessment

Vibration levels from the measurements taken on the 1st of May and also those calculated from a predictive model (Section 3.2.2) are used to assess the vibration effects of the Project against the criteria from DIN 4150-3: 1999 and NS 8176E: 2005.

3.2.1 DIN 4150-3 and predicted Project vibration levels

The relevant criteria from DIN 4150-3: 1999 are shown in Table 3-4 below.

Table 3-4. DIN 4150-3: 1999 criteria for vibration effects on structures.

Type of Structure	Vibration thresholds for structural damage, PPV [mm/s]				
	Short-term				Long-term
	At foundation			Uppermost floor	Uppermost floor
	0 – 10 Hz	10 – 50 Hz	50 – 100 Hz	All frequencies	All frequencies
Commercial / Industrial	20	20 – 40	40 – 50	40	10
Residential	5	5 – 15	15 – 20	15	5
Sensitive / Historic	3	3 - 8	8 – 10	8	2.5

Note: when a range of velocities is given, the limit increases linearly over the frequency range.

3.2.2 Prediction of traffic induced vibrations

The probable maximum ground vibrations at a distance from the lane edge arising from heavy vehicle traffic were calculated using an approach developed for the US Federal Highway Administration (FHWA)[22]. This allows the effect of vehicle speed, vehicle mass, vehicle suspension type, surrounding soil type and road roughness on the calculated ground vibration level to be investigated.

[21] See NZS 6806: 2010 clause 1.5.1 and clause 1.3.2, and see also Dravitzki, V., Walton, D., and Wood, C. 2006. Road Traffic Noise – Determining the Influence of New Zealand Road Surfaces on Noise Levels and Community Annoyance. *Land Transport New Zealand Research Report 292.* 76 pp.

[22] Rudder, F.F. (1978) *Engineering Guidelines for the Analysis of Traffic-Induced Vibration.* Report No FHWA-RD-78-166, US Department of Transportation, Washington, D.C.

For the Project, the following inputs were used with the FHWA model:

- Mass of vehicle = 50 tonnes
- Suspension = leaf spring/walking beam
- Speed = 90 km/h
- Road roughness:
  Minimum = 70 NAASRA counts/km
  Maximum = 110 NAASRA counts/km.

The minimum roughness value used is the NZ Transport Agency's roughness specification for the construction of new chipseal surfaces[23]. The maximum roughness value is the target maximum value adopted by the NZ Transport Agency for state highways classified as "Regional Strategic".

The FHWA vibration model has been used to predict the separation distances required for vibrations to reach levels specified in DIN 4150-3 and also 'rule of thumb' levels typically accepted for human perception and complaint. These levels were:

- 0.3 mm/s – level of human perception.
- 1 mm/s – expected to result in complaints.
- 3 mm/s – minimum level for structural damage to sensitive receivers as per DIN 4150-3. While the PPFs near to the road would not be classified as historic or sensitive taking this level is a conservative approach.

The results of the modelling are shown in Table 3-5, showing the required offset from the edge of the road to achieve certain vibration levels.

Table 3-5. Results of operational vibration predictions.

Vehicle	Speed [km/h]	Road roughness [NAASRA]	Vibration level [mm/s]	Minimum required offset from road edge [m]
50 t HCV	90	70	0.3	3.1
			1	1.0
			3	<1
		110	0.3	4.1
			1	1.7
			3	<1

From Table 3-5, receivers must be very close to the road edge to experience vibration levels expected to cause complaint or structural damage, even assuming the most sensitive receivers (i.e. historic/sensitive as per DIN 4150-3). These predicted vibration levels are lower than what was measured during the site visit although those measurements still indicate that operational vibration levels will be low near the Project.

3.2.3 NS 8176E and measured vibration levels

For this Project the vibration levels should be within Class D from NS 8176E: 2005 which has an upper limit of 0.6 mm/s ($V_{w,95}$). However, the standard also states that an effort should be made to lower vibration levels at dwellings achieving Class D levels to bring them into Class C. For this reason, Class C criteria have been used for this assessment with an upper limit of 0.3 mm/s ($V_{w,95}$). It

[23] NZTA (2006). Network Operations Technical Memorandum No: TNZ TM7003 v1, *Roughness Requirements for Finished Pavement Construction.*

should be noted that this level is not a peak value but is a measure where levels in each 1/3 octave band are weighted and averaged by Root Mean Square (RMS).

Assessment against NS 8176E: 2005 is done through a complex calculation based on actual measured data. As this data cannot be collected before the Project is completed, another approach is required.

The vibration measurements taken during the site visit on the 1st of May 2019 indicate that the traffic induced vibrations are currently low with levels at Location C being around 0.2 mm/s and below while at Location H, they were no higher than 0.45 mm/s. The application of the NS 8176E: 2005 calculation to the vibration data measured at Location H results in a calculated vibration level $V_{w,95}$ of 0.21 mm/s. This indicates that vibration levels would fall comfortably within the Class C criteria.

The data collected during the site visit on the 1st of May was used with the NS 8176E analysis to give an idea of how vibrations from the existing road match with the standard's criteria. This is a practicable approach though it is noted that this approach does not strictly follow the procedure of the standard and the following deviations have been made:

- The standard requires 15 heavy vehicle passes to be assessed for the calculation. This assessment has used the five largest vibration recordings for heavy vehicles as 15 heavy vehicle passes were not recorded. This approach is reasonable as it provides information on where the current vibration levels sit with respect to the criteria in the standard.
- The standard requires measurements at a sensitive receiver. Measurements were made at Location H, 9 m from the road edge, which is comparable to the separation distance for the closest PPFs (13, 6 and 14 at distances of 8 m, 11 m and 12 m respectively). Again, this is reasonable for providing an indication of how the vibration levels are likely to compare to the criteria from the standard.

The Project's operational vibration effects on people are expected to be reasonable based on the operational vibration measurements made on site on the 1st of May 2019. It is also noted that for the majority of the dwellings the new road alignment is largely similar to the existing alignment, with the largest change being seen at PPF 9 where the new road is approximately 22 m closer than the existing road.

3.3 Construction noise and vibration assessment

Preliminary estimates of construction noise and vibration are assessed here to recommend an approach to management that will ensure construction noise and vibration effects are reasonable. The assessment considers the likely scale of noise and vibration levels if construction was undertaken without additional management and then recommends appropriate options to manage construction noise and vibration effects to be reasonable while also allowing practicable undertaking of construction.

The Project construction methodologies, equipment to be used, and scheduling are not known at this stage prior to consenting of the Project, however estimates have been made and these are considered robust for the purpose of this assessment.

The expected construction activities considered most likely to generate noise and vibration are:

- Piling activities for new bridge piers and temporary staging construction. Piling activities are known to generate high noise and vibration levels. Percussive piling has been assumed for a conservative assessment.
- Excavation / boring of sockets in rock for new bridge piers. No information is available on the likely noise and vibration effects from this activity. There is more discussion of this activity below.

- Earthworks associated with the realignment of SH8. These works involve construction of fill embankments on the bridge approaches and pavement construction/carriageway widening along the state highway corridor. The works will occur close to some of the nearby receivers and the noise and vibration from simultaneous operation of multiple pieces of construction equipment have been considered.
- Noise associated with laying the new road surface. Again, this is likely to occur near to some of the nearby receivers.

For the preliminary estimates of earthworks construction noise and vibration levels, it is assumed the same plant and equipment will be used for bulk earthworks (approach embankment fills) and pavement construction (state highway tie-in works and pavement construction/carriageway widening). It is noted that larger plant and higher compacting efforts are anticipated for the approach fill construction compared to the pavement works. The Project works also include carriageway widening/pavement construction along the Dee Street/Westferry Street/Rongahere Road corridor. These are more minor in nature and are therefore immaterial to the preliminary estimates of construction noise and vibration levels.

Construction noise has been assessed using NZS 6803: 1999. NZS 6803 recommends limits on construction noise are set based on the duration of the works, the day/time and the existing noise environment. For this preliminary assessment of construction noise effects, the works are assumed to have a duration exceeding 20 weeks ('long-term' for NZS 6803) and that the works will occur between 0730 and 1800 Monday to Saturday. This assessment uses the recommended upper noise limits from NZS 6803: 70 dB L_{Aeq} and 85 dB L_{Amax}. Construction noise has been estimated using the process detailed in NZS 6803 and using the construction equipment noise levels given in the standard.

In a similar way to the assessment of the operational vibrations, the vibrations have been assessed against limits derived from commonly accepted levels for vibration perception, vibration complaint and the onset of structural damage for historic/sensitive receivers. These vibration levels are 0.3 mm/s, 1 mm/s and 3 mm/s respectively (see Section 3.2.2). Vibration levels have been modelled using the equations and levels for construction equipment given in the NZTA Research Report 485.

For the preliminary estimates of likely vibration levels from construction activities, calculations have been based on generic vibration data assumed for similar activities. This is appropriate for this assessment as part of the Project's consenting and consideration of appropriate designation conditions.

From preliminary estimates of the likely scale of noise and vibration levels from construction of the Project, Table 3-6 indicates receivers where potential limits may be exceeded if no additional management is exercised, and therefore where additional management of construction noise and vibration effects should be investigated. The results are shown graphically in Appendix B. These estimates do not show that there *will* be a noise or vibration effect from construction activities, but rather the preliminary estimates are the basis for recommending where additional management of construction activities should be assessed further, prior to construction, and potential mitigation options investigated.

Table 3-6. Preliminary assessment of receivers that should be addressed in a Construction Noise and Vibration Management Plan. (Receiver numbers reference Figure 3-1.)

Construction Activity	Vibration (Potential)			Noise
	0.3 mm/s	1 mm/s	3 mm/s	75 dB $L_{Aeq(24h)}$
Percussive Piling	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 14	7, 8, 9	none	2, 3, 4, 5, 6, 7, 8, 9, 10, 11
Earthworks	1, 6, 7, 9, 13, 14	1, 6, 7, 9, 13, 14	1, 6, 7, 13, 14	1, 6, 7, 9, 13, 14
Sealing	--	--	--	1, 2, 6, 7, 9, 13, 14

It is good practice and expected by the NZ Transport Agency and NZS 6803: 1999 that the contractor has a Construction Noise and Vibration Management Plan (CNVMP) for the construction works. This management plan can be prepared after project consenting, at a time closer to the actual works and once construction methodologies can be finalised. It is recommended that a CNVMP is required as part of the designation conditions to ensure that construction noise and vibration effects are managed to be reasonable. CNVMPs are common for large roading projects and there is good guidance from the NZ Transport Agency and contained within NZS 6803 on what CNVMPs should include.

Potential mitigation for noise and vibration is best considered in the CNVMP once decisions have been finalised about the construction methodologies to be used. However, for mitigating effects from the Project some of the following options could be considered:

- Use of smaller equipment for earthworks and resealing works near to PPFs noting that pavement works along the state highway and local road corridors will likely use smaller plant than that adopted for the fill embankments on the bridge approaches.
- Consultation with residents to time works generating large noise or vibration levels to minimise effects. For instance, doing works while people are at work, or avoiding works near PPFs during children's nap times etc.
- Use of a piling method generating less noise and vibration than percussive piling (if practicable). Vibratory pile driving may be an option.
- The CNVMP should propose some form of noise (and potentially vibration) measurements during various activities to check compliance with limits. Noise and vibration monitoring with automated alerts could also be used to inform contractors when limits are being exceeded so methodologies can be adapted.
- Building condition surveys can be used as part of management of vibration effects. The CNVMP should consider appropriate timing for such condition surveys, if used, and it is recommended that condition surveys should be undertaken proactively, say before major construction activities start, rather than in response to concerns.
- No specific analysis has been performed here on construction works required to form sockets in the river rock for some of the bridge piles. These works have the potential to generate significant noise and vibration levels depending on the methodology selected. This construction activity should be specifically covered in the CNVMP with trial works with noise and vibration monitoring performed if necessary.

On the basis that a CNVMP is prepared and implemented for the Project, it is expected that noise and vibration can be readily managed to be reasonable. This should be confirmed as part of the noise and vibration level estimates and assessments completed as part of preparation and implementation of the CNVMP.

3.3.1 Vibration effects on existing bridge

The existing bridge will currently be exposed to high levels of vibration due to the traffic using it. During the construction of the new bridge, the existing bridge will be particularly close to some of the construction activities expected to generate the largest vibration levels, particularly pile driving. While it is not anticipated that vibrations from the construction activities will cause damage to the bridge, it is recommended that some regular condition monitoring of the bridge is outlined in the CNVMP. This condition monitoring may range from visual inspections to instrumentation to check for settlement etc.

4 Conclusion and summary

Operational and construction noise and vibration effects for the SH8 New Beaumont Bridge Project have been assessed.

This assessment has been performed for a specific Project geometry, design speed, traffic volume, road surfacing etc, understood to be well-developed and unlikely to substantively change. Any deviation from the design of the Project used for this assessment could lead to differing effects at nearby receivers.

Operational noise and vibration effects are expected to be reasonable without additional mitigation or management. However, it is recommended that specification and construction of any bridge joints, road surfacing joins or service covers, by example, be given special attention to minimise potential adverse noise and vibration effects.

Construction noise and vibration effects should be managed to be reasonable through preparation and implementation of a Construction Noise and Vibration Management Plan (CNVMP) in accordance with NZS 6803: 1999.

4.1 Operational noise

The operational noise effects of the Project are expected to be reasonable without additional mitigation or management.

The modelling done with the NZTA Road Traffic Noise Calculator has found that the Project does not meet the NZS 6806 definitions for classification as 'new' road or 'altered' road for which criteria for mitigating noise are given, so it is interpreted that the road-traffic noise from the project can be considered reasonable without (further) assessment or mitigation.

This assessment is based on the Project specifics as modelled and noted in Table A-3 of Appendix A. Any changes to these details may result in changes to the Project noise levels and alter this assessment.

It is noted that the PPFs at 8 and 9 are predicted to see increases in noise due to the Project. These increases in noise may be perceptible or noticeable but the increases are still considered reasonable given the total noise level of the environment, using the NZS 6806 methodology, and therefore no further specific road-traffic noise mitigation is considered necessary.

4.2 Operational vibration

The operational vibration effects of the Project are expected to be reasonable without additional mitigation or management.

The modelling and measured vibration levels have shown that traffic induced vibrations from the Project will not result in vibration levels exceeding the most stringent limits for the onset of structural damage as per DIN 4150-3. We have also shown that it is very unlikely that traffic induced vibrations will exceed the Class C criteria from NS 8176.E.

This assessment has assumed that the Project will be constructed to meet the NZTA requirements for road roughness (70 NAASRA). It is also assumed that the Project will not contain any large changes in road level from poor seal joints, poorly specified or constructed bridge joints or sunken service covers. If any of these features are present, they have the ability to generate large vibration levels. We would recommend that special attention is given to specifying low noise/vibration bridge joints for the project as these can have a significant noise and vibration effect. This could be managed through suitable designation conditions and/or contract requirements.

4.3 Construction noise and vibration

Preparation and implementation of a Construction Noise and Vibration Management Plan (CNVMP) is expected to manage construction noise and vibration effects of the Project to be reasonable while also allowing practicable undertaking of construction.

The assessment of construction noise and vibration is based on preliminary estimates of construction methodologies, although the fundamental construction techniques are unlikely to vary significantly. The preliminary estimates of construction noise and vibration levels indicates that additional management of construction noise and vibration effects should be investigated. The preliminary estimates do not show that there *will* be noise or vibration effects from construction activities, but rather the preliminary estimates are the basis for recommending that additional management of construction activities should be assessed further, prior to construction, and potential mitigation options investigated.

Therefore, it is recommended that preparation and implementation of a CNVMP is required as part of the designation conditions to ensure that construction noise and vibration effects are managed to be reasonable.

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Appendix A

Table A-1 shows the inputs used for modelling to validate the use of the NZTA Road Traffic Noise Calculator. These noise levels were calculated using traffic volumes and speeds based on traffic counts performed concurrent with the noise measurements during the site visit on the 1st of May 2019.

Table A-1. Inputs for noise modelling of the existing situation.

Location	A	B	D	E	F	G
AADT	1764	1958	2160	2565	1782	1782
HCV [%]	16	28	12	24	15	15
Speed [km/h]	90	70	50*	50*	70	70
Grdient [%]	1	3	1	2	0	0
Surface	3/5 chip	3/5 chip	3/5 chip	3/5 chip	4/6 chip†	4/6 chip†
Height above road [m]	1.5					
Distance to receiver [m]	21	13	55	24	83	24
Barrier	No					
Reflective surface opposite [°]	0					
View of road segment [°]	180	180	180	90	180♮	180
Propogation height [m]	1					
Ground absorption [%]	40-60	<10	40-60	<10	>90	>90
Measured level LAeq [dB]	60.4	63.8	49.7	56.9	48.9	55.1
Modelled level LAeq [dB]	61	64	53	58	48	56
Difference [dB]	-0.6	-0.2	-3.3	-1.1	0.9	-0.9

* Lowest modellable speed

† Modelled as grade 2 or 3 single coat

♮ highest modellable view of road segment

Table A-2 shows the inputs used to model the do-nothing situation required for NZS 6806 assessment. Table A-3 shows the inputs used to model the do-minimum situation required for NZS 6806 assessment.

Table A-2. Inputs for modelling the do-nothing situation.

PPF	1	2	3	5	6	7	8	9	10	11	12	13	14
AADT	2230												
HCV [%]	13												
Speed [km/h]	90	70	70	90	70	70	50[*]	70	70	80	90	90	90
Grdient [%]	1	3	3	1	3	3	1	0	0	0	1	1	1
Surface	3/5 chip	3/5 chip	3/5 chip	3/5 chip	3/5 chip	3/5 chip	3/5 chip	3/5 chip	4/6 chip[ǂ]	4/6 chip[ǂ]	4/6 chip[ǂ]	4/6 chip[ǂ]	4/6 chip[ǂ]
Height above road [m]	1.5												
Distance to PPF [m]	21	205	197	185	11	41	122	85	110	160	160	8	12
Barrier	No												
Reflective surface opposite [°]	0												
View of road segment [°]	180	180	180	180	180	180	180	180[♭]	180	180	180	180	180
Propogation height [m]	1												
Ground absorption [%]	>90	>90	>90	>90	<10	40-60	40-60	>90	>90	>90	>90	<10	<10
Modelled level LAeq [dB]	60	44	44	46	64	57	49	49	47	46	47	67	65

[*] Lowest modellable speed
[ǂ] Modelled as grade 2 or 3 single coat
[♭] highest modellable view of road segment

Table A-3. Inputs used for modelling the do-minimum situation.

PPF	1	2	3	5	6	7	8	9	10	11	12	13	14
AADT	2230												
HCV [%]	13												
Speed [km/h]	100												
Grdient [%]	1	1	1	1	1	1	1	1	1	1	1	1	1
Surface	Chipseal single-coat grades 4-6												
Height above road [m]	1.5	1.5	1.5	1.5	1.5	1.5	-2.0	-2.0	-2.0	-2.0	1.5	1.5	1.5
Distance to PPF [m]	21	205	197	185	11	41	112	68	130	200	180	8	12
Barrier	No												
Reflective surface opposite [°]	0												
View of road segment [°]	180	180	180	180	180	180	180	180[♭]	180[♭]	180[♭]	180	180	180
Propogation height [m]	1	1	1	1	1	1	1.5	1.5	1.5	1.5	1	1	1
Ground absorption [%]	>90	>90	>90	>90	<10	40-60	40-60	>90	>90	>90	>90	<10	<10
Modelled level LAeq [dB]	57	43	44	44	64	56	51	52	47	45	44	65	63

[*] Lowest modellable speed
[ǂ] Modelled as grade 2 or 3 single coat
[♭] highest modellable view of road segment

Appendix B

This appendix shows the noise and vibration contours used for assessing the construction noise and vibration effects if no additional management is exercised. Figure B-1 shows the contour for 75 dB L_{Aeq} estimated for piling operations while Figure B-2 shows the vibration contours estimated for the same activity. The highlighted areas on these plots show the areas where the stated level is predicted to be exceeded, if no additional management is exercised.

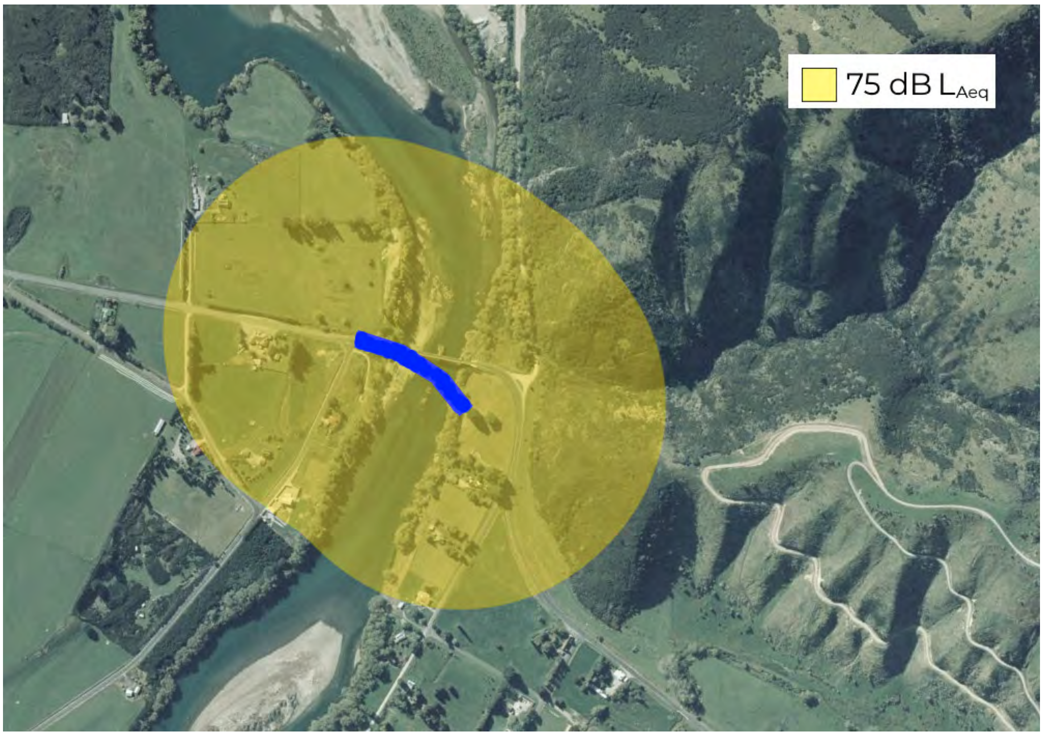

Figure B-1. Construction noise contour for percussive piling.

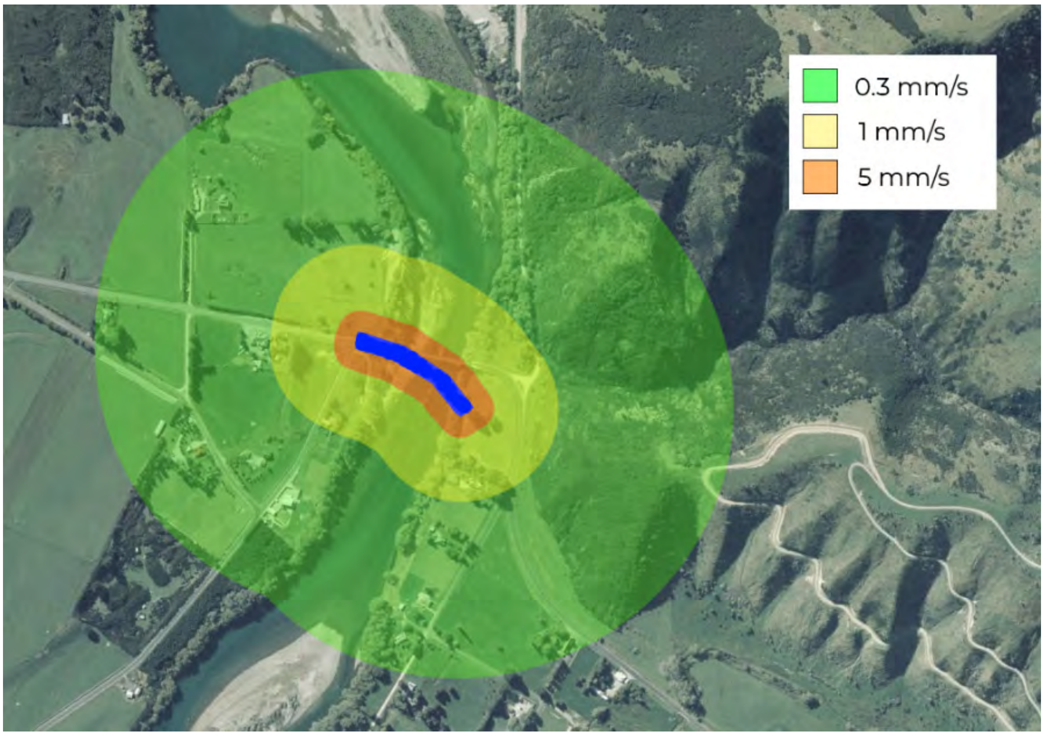

Figure B-2. Construction vibration contour for percussive piling.

Figure B-3 shows the construction noise contour estimated for earthworks and Figure B-4 shows the construction vibration contours estimated for the same activity, if no additional management is exercised.

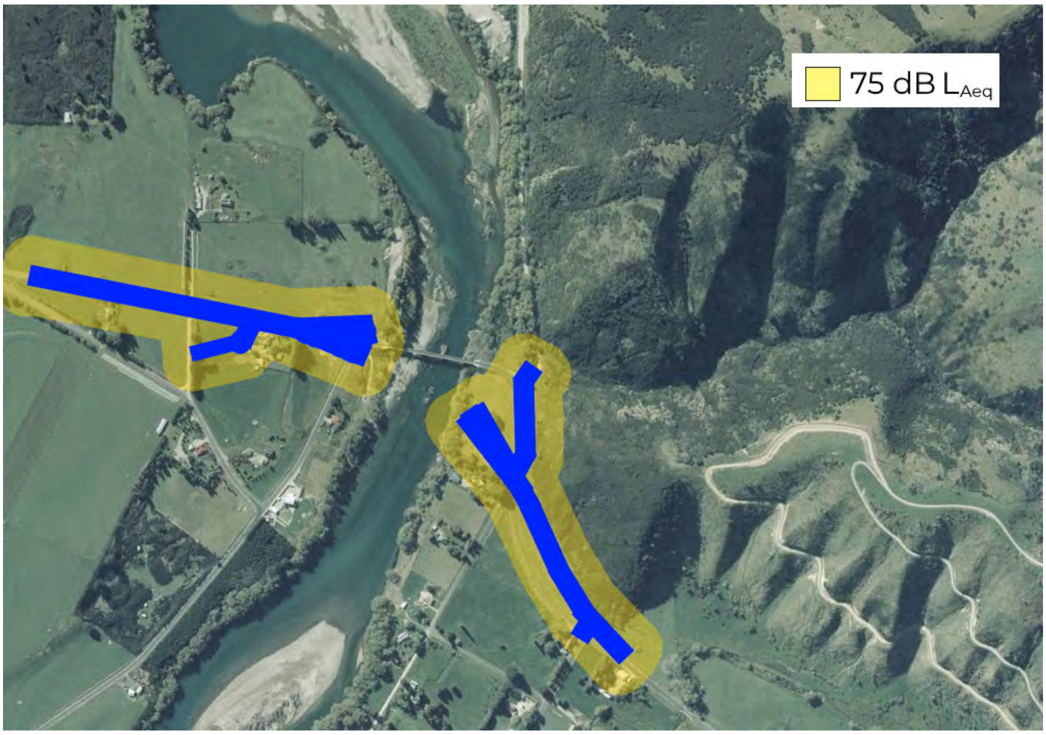

Figure B-3. Construction noise contour for earthworks activities.

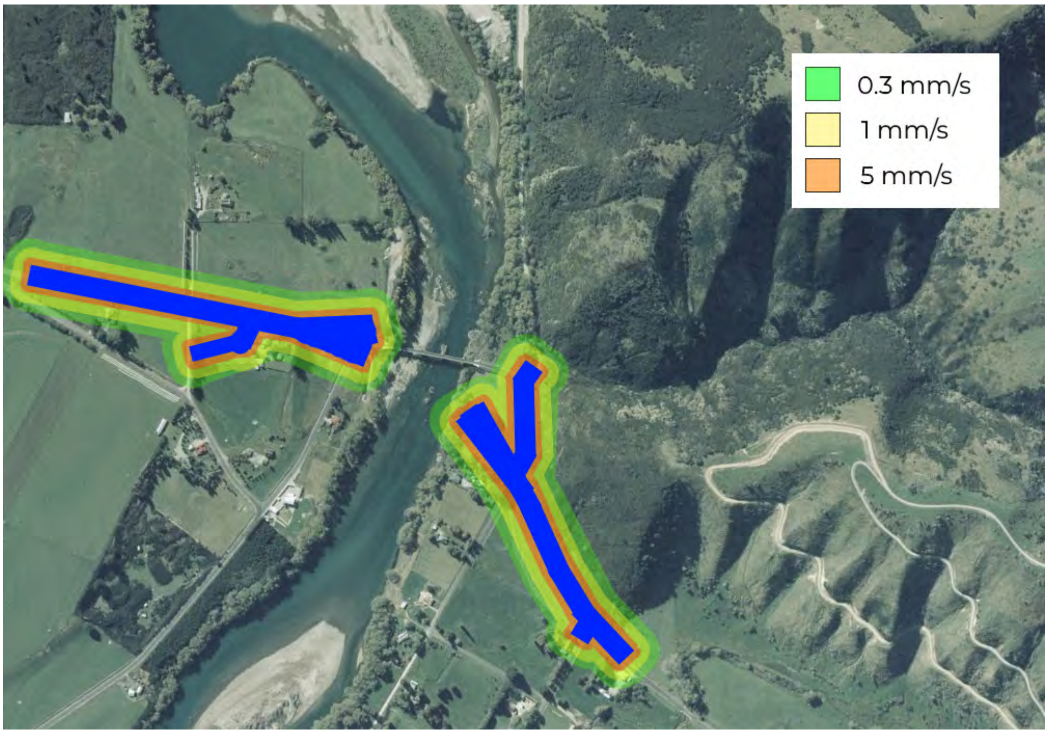

Figure B-4. Construction vibration contour for earthworks activities.

Figure B-5 shows the construction noise contour estimated for sealing activities, if no additional management is exercised.

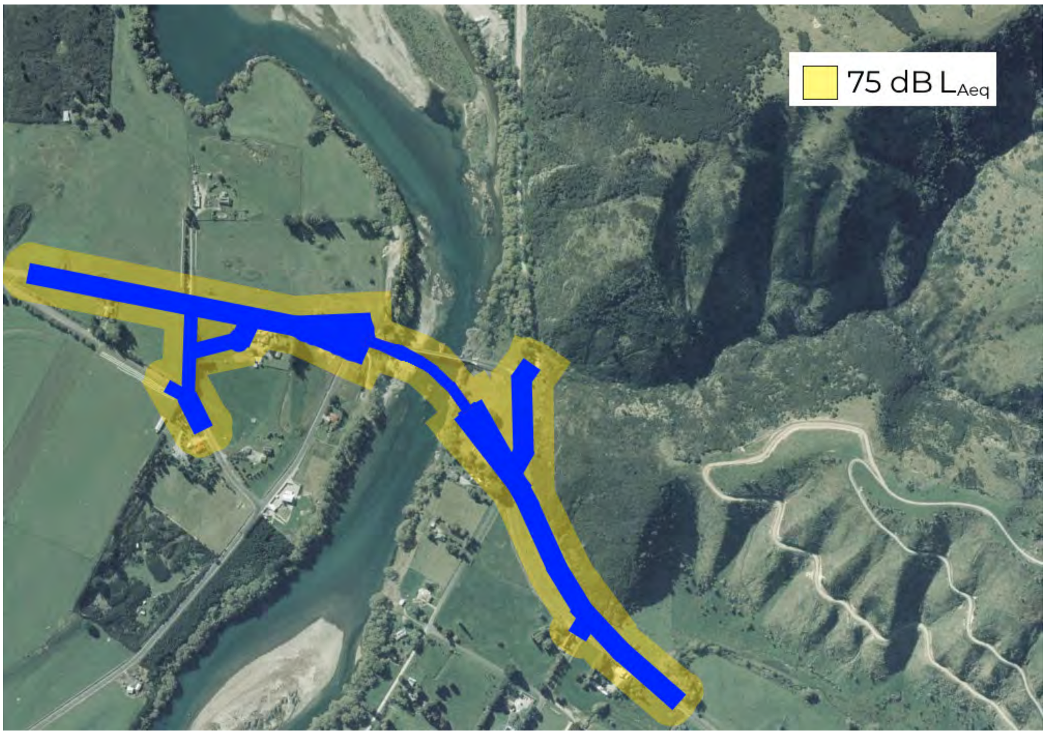

Figure B-5. Construction noise contour for sealing activities.

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