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Report

Prince of Wales / Omāroro Reservoir - Draft Construction Erosion and Sediment Control Plan

Prepared for Wellington Water Ltd

Prepared by CH2M Beca Ltd

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Revision History

Revision Nº	Prepared By	Description	Date
A	Josie Burrows	Preparation of Preliminary Draft Plan	23/02/2017
B	Josie Burrows / Mhairi Rademaker	Update following client review	30/03/2017
C	Mhairi Rademaker	Final for RMA lodgement	01/09/2017

Document Acceptance

Action	Name	Signed	Date
Prepared by	Josie Burrows		30/03/2017
Reviewed by	Hugh Leersnyder		14/04/2017
Approved by	Wayne Estment		26/04/2017
on behalf of	CH2M Beca Ltd		

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1 Introduction

This Construction Erosion and Sediment Control Plan (CESCP) provides a high level overview and framework of the erosion and sediment control measures associated with the earthworks required for the Prince of Wales/Omāroro Reservoir development works. It will support the application to Wellington City Council (WCC) for an easement to locate, construct, and operate the reservoir within the Wellington Town Belt under the Town Belt Act and the subsequent resource consent application required for earthworks to Greater Wellington Regional Council (GWRC).

Phase-specific erosion and sediment control plans will be produced when the phase and construction methodologies are determined. These plans will identify specific control measures, and their locations and sizing. The plans will be reviewed by WCC and GWRC prior to any construction works commencing.

This CESCP will:

- Describe the existing environment, including the Papawai Stream and tributary of the Waitangi Stream
- Describe the Project and specific aspects that may contribute to erosion and sediment generation
- Assess the level of impact on the local environment, including the Papawai Stream and tributary of the Waitangi Stream
- Identify and assess mitigation measures to minimise impacts, including identification of control measures that could be implemented and recommendation of a monitoring regime

1.1 Site description

The Prince of Wales Park is located in Mount Cook, Wellington (refer to Figure 1), within the Wellington City Council Inner Town Belt. It is used for sports and recreation purposes, with two sport fields (upper and lower), the Wellington Harriers Club building, and a number of bush walk paths.

The park topography is that of a rounded spur landform sloping downhill from Dorking Road to the reservoir site on the open grassed and vegetated rounded knoll (see the Site Overview Plan in Appendix A). The knoll slopes down to a small, vegetated gully with an unnamed tributary of the Waitangi Stream to the north-west. To the north, the tree and grass vegetated bank slopes down to the flat, grassed upper playing field. To the west, the knoll descends down a vegetated slope to the lower playing field to the east.

The Papawai Stream runs through the park site and along the western side of the lower playing field. There are a number of existing pathways providing access through the Park, ranging from ‘tracks through grass’ to gravelled or paved pathways.

The underlying geology is Rakaia terrane, described as sandstone with mudstone conglomerate basalt chert limestone[1].

[1] Heron D. W. (custodian) 2014. Geological Map of New Zealand 1:250 000. Institute of Geological & Nuclear Sciences.

Figure 1: Aerial view of Prince of Wales Park

1.2 Papawai Stream receiving environment

The project area contains two small tributaries of the Waitangi Stream:

- **Papawai Stream**: flows through the site along the edge of the lower field and exits the site into the stormwater network at the top of Papawai Terrace. The stream is separated from the lower field by an earth bund, constructed some years ago to prevent on-going flooding of the field.

  The stream is subject to flood damage and there is significant scouring near the changing sheds on the lower field. There is also evidence of sediment deposition where the stream runs alongside the field. Downstream residents note that the stream regularly floods adjoining property.

  Papawai Stream is perennial; of the two tributaries in the vicinity of the project area, one is dry without flow or pools, the other is intermittent in its lower reaches reducing to ephemeral further up.

- **An unnamed tributary of the Waitangi Stream:** flows down a gully to the west of the site, which exits the site into the stormwater network at the top of Rolleston Road.

  This unnamed tributary is perennial in its lower reaches, but reduces to intermittent pools and eventually becomes ephemeral.

The ultimate receiving environment for these waterways is Wellington Harbour.

The ecological assessment notes that both the Papawai Stream and unnamed tributary provide relatively poor habitat (low Physical Habitat Assessment scores). The Papawai Stream contains only one species of fish – banded kopoku. No fish species were recorded in the unnamed tributary, however, koura were present.

Notwithstanding the low habitat availability and lack of fish species identified, the ecological assessment notes that the Papawai Stream and unnamed tributary of the Waitangi Stream represent two of only a very few fragments of the Waitangi Stream that remain un-piped and therefore have high and medium ecological values respectively as remnants to the once much larger system.

2 Description of development

2.1 Prince of Wales Reservoir Project

The Project involves the construction of a fully buried single combined reservoir with tunnel at the Upper Prince of Wales Park. The reservoir has a storage volume of 35,000 m^3 and design life of 100 years. It will supply water to the Wellington Low Level Water Supply Zone, including the Central Business District, Mount Cook, and Newtown. It has been designed for a seismic load (equivalent to a 1000-year return period event) and will contribute toward enhancing the operational and strategic resilience of Wellington's water storage network.

2.2 Overview

Earthworks will take place within an area of approximately 2.6-3.6 ha. There are three potential earthworks scenarios[2] (all volumes exclude topsoil and are approximate in-situ values so do not provide for bulking):

Scenario 1: The reservoir construction requires excavation of 56,000m^3 of material. Of this, 25,000m^3 of suitable material will be stockpiled on the upper and/or lower sports field and used as backfill once the reservoir is constructed. The surplus material (30,800 m^3) will be disposed of off-site.

Scenario 2: The reservoir construction requires excavation of 56,000 m^3 of material. Of this, 25,000 m^3 of suitable material will be stockpiled on the upper and/or lower sports field and used as backfill once the reservoir is constructed. In addition, the upper sports field will be raised by up to 1.5 m using 8,000 m^3 of additional suitable excavated material. The surplus material (22,700 m^3) will be disposed of off-site.

Scenario 3: The reservoir construction requires excavation of 56,000 m^3 of material. Of this, 25,000 m^3 of suitable material will be stockpiled on the upper and/or lower sports field and used as backfill once the reservoir is constructed. In addition, both the sports field will be raised by up to 1.5 m using 16,100 m^3 of additional suitable excavated material. The surplus material (14,700 m^3) will be disposed of off-site.

In addition, approximately 5,500m^3 of earth/rock material will be imported for use as fill material under all three of the scenarios. This will include material for reservoir foundations and drainage material.

Table 1: Approximate earthworks volumes under each of the three potential scenarios (all volumes in-situ).

	Volume excavated	Volume stockpiled for backfill	Additional volume utilised	Volume imported fill	Volume surplus material
Scenario 1	56,000 m^3	25,000 m^3	Nil	5,500m^3	30,800m^3
Scenario 2	56,000 m^3	25,000 m^3	8,000 m^3 to raise upper sports field	5,500m^3	22,700 m^3
Scenario 3	56,000 m^3	25,000 m^3	16,100 m^3 to raise both sports fields	5,500m^3	14,700 m^3

The volumes above are based on an assumption that a large percentage of the excavated material will be suitable for reuse either as backfill for the reservoir or for raising of the fields. Should the excavated material

[2] There is a fourth possible scenario – using both the upper and lower fields for stockpiling, but only raising the lower field; however, this is unlikely and earthworks volumes are similar to scenario 2 so it has not been considered separately.

not meet fill requirements, the volume required to be imported and disposed of off-site will increase. The same assumption applies for topsoil.

2.3 Programme of works

Construction is expected to commence in late 2018 or 2019, with works expected to take approximately two to three years. The expected phases of work are described below.

Site establishment

- Site accommodation set-up (site offices, site parking, changes to Rolleston Street parking)
- Site fencing
- Construction of erosion and sediment control measures (see **Appendix N**)
- Construction of access tracks
- Clearance of vegetation and top soil (with suitable top soil stockpiled for reuse)
- Service relocation

Reservoir excavation

- Excavation of material from reservoir site
- Stockpiling of excavated material on upper and/or lower fields
- Removal of excess material from the site
- Raising of the upper and/or lower fields may be done at this time to avoid double handling of material

Reservoir construction

- Construction of the reservoir and pipe tunnel including in-situ and precast concrete as required
- Connection of services
- Import of required material and components to the site
- Testing

Backfill

- Burying reservoir (using stockpiled material where possible)

Site restoration

- Reinstatement and landscaping of the reservoir site including planting and reinstatement of tracks and pathways
- Raising of the upper and/or lower fields (may be undertaken earlier in the construction process to reduce double handling of material) including construction of retaining walls and terramesh walls and installation of subsurface drainage where required
- Reinstatement of the upper and/or lower fields including reshaping/levelling, installation of surface drainage, topsoiling, grassing, and marking

3 Principles of Erosion and Sediment Control

The key principles to be employed in an erosion and sediment control plan are to undertake land disturbing activities in a manner that reduces the potential for the erosion of bare soils to occur (erosion control), and to employ devices to treat sediment laden water prior to discharge from the site (sediment control).

The nine key principles of erosion and sediment control, as outlined in *Erosion and Sediment Control Guidelines for the Wellington Region*[3] will be applied to the development, as and when appropriate:

- Minimise Disturbance – Only work in those areas required for construction, and be mindful of environmental conditions such as wet or steep land
- Stage construction – Carefully plan and stage works to minimise time and area of erosion-prone land exposed at any one time
- Protect steep slopes – Protect steep slopes from erosion using erosion controls
- Protect watercourses – Map all waterbodies and drainage patterns prior to works commencing
- Stabilise exposed areas rapidly – Stabilise disturbed soils using methods including sowing, mulching polymer or geotextiles
- Install perimeter controls – Divert clean water away from areas of disturbance, and divert runoff from disturbed areas to sediment control measures
- Employ detention devices – Capture and treat runoff to allow sediment to settle out
- Make sure the ESCP evolves – Update ESCP as construction progresses, the nature of the land disturbing activities change or in relation to weather events
- Inspect – Inspect, monitor and maintain control measures regularly and after weather events

[3] *Erosion and Sediment Control Guidelines for the Wellington Region*, Greater Wellington Regional Council (2002, reprinted 2006)

4 Earthworks management

The following section presents a high-level summary of how the site is proposed to be managed. It may be amended by the contractor prior to construction to take into account actual staging and layout requirements. Any changes must be approved by WCC and GWRC.

Draft Erosion and Sediment Control Drawings are provided in **Appendix A**.

4.1 Site access

The main access to the site will be via the upper sports field entrance on Rolleston Street. The entrance will be stabilized, with appropriate drainage put in place to carry runoff. Alternative access for light vehicles may be provided from the lower sports field entrance off Salisbury Terrace. This will also be stabilised.

It may be necessary to restrict and reorganize kerb-side parking to enable heavy vehicles to operate on Rolleston Street. As a result of this, additional parking may be provided on the upper playing field for residents. Any parking provided will be on a suitably stabilised surface to minimise tracking of material onto Rolleston Road.

The majority of vehicle movements to the site will be trucks associated with removing excess material and material unsuitable for reuse, and importing required fill material. Transport movements associated with the pre-cast units will be dependent on whether panels are cast on site (concrete transit mixers, return journeys) or off site (articulated truck, return journeys), or a mixture (return journeys both concrete transit mixers and articulated trucks).

4.2 Internal access

Within the site, heavy vehicle access is required between the upper and lower sports fields to facilitate stockpiling on the lower field and raising of the lower field (should either of these activities be required depending on the scenario – see section 2.3).

The existing access between the two fields will be upgraded and appropriately stabilised to provide an all-weather access route. A drainage channel and edge protection (bund or silt fence) will be installed to manage runoff and reduce the risk of sediment-laden water reaching the Papawai Stream.

4.3 Site establishment

Site establishment will commence with the construction of the access road to the reservoir location including a stabilised entranceway off Rolleston Street, and the construction of an access track from the park entrance to the reservoir location. The access track between the upper and lower fields will be formed when required.

A cleanwater diversion bund will be put in place above the main excavation to divert upslope clean runoff from entering the excavation site, and a dirty water diversion bund installed around the site (including the upper and lower fields) as perimeter control. A super silt fence is expected to be required between the main excavation and the Papawai Stream and the unnamed tributary.

Topsoil will be stripped from the designated stockpiling area/s to provide space for the temporary stockpiling of excavated material. Topsoil will also be stripped from the wider sports fields at the appropriate time if the fields are to be raised under Scenarios 2 or 3. Topsoil suitable for reuse will be stockpiled in designated areas. New topsoil will be imported at an appropriate time, if required.

Temporary sediment retention ponds (SRPs) are anticipated to be required either on the upper sports field under Scenarios 1 and 2, or on both the upper and lower playing fields under Scenario 3. Potential SRP locations are shown on the drawings in **Appendix A**; however, the final location (and discharge points) will be confirmed by the contractor prior to construction as the final staging may impact topography during construction. SRP location will also be contingent on geotechnical and contaminated land investigations.

These SRPs will be treated using chemical flocculant dosing to manage runoff from stockpiles and the main excavation site.

4.4 Bulk earthworks and stockpiling

The development involves the removal of 56,000 m^3 of earth material from the approximate 140m x 140m (1.96ha) reservoir location. The intent of the earthworks is to provide space for the construction of the reservoir, and then to backfill around and over the reservoir to return to a similar land profile.

Under the three scenarios outlined in Section 2.3, various volumes of material are required to be stockpiled on the upper and/or lower sports fields.

Earthworks and stockpiling will be managed in general accordance with the erosion and sediment controls specified in this Plan and the proposed Phase Specific ESCPs. In addition to these controls, the following practical measures can be taken by the Contractor to minimize the effects of the works:

- Minimise the extent and duration of open areas, and stabilise any area that will not be worked for a period of longer than four weeks (unless otherwise agreed with GWRC).
- Stabilise earthworked areas immediately on completion (where practical) – this will generally be through grassing, where the Contractor is responsible for ensuring an even and thorough strike rate as soon as possible. This may require watering of a seeded area if completion occurs during a dry period.
- Works will not be undertaken during inclement weather conditions or if heavy rains or severe winds are forecast.

5 Proposed Erosion and Sediment Control Measures

This section provides an overview of the types of erosion and sediment control practices, which may be used throughout the construction works. All erosion and sediment control measures will be designed, constructed, and maintained in accordance with the *Erosion and Sediment Control Guidelines for the Wellington Region*. The actual measurements and design specifications will be provided in the phase-specific ESCPs.

Plans showing the proposed erosion and sediment controls to be implemented during the works under Scenarios 1-3 are attached in **Appendix A**.

5.1 Erosion Control Measures

General erosion control measures that may be applied or implemented during the construction period are described in Table 2 below.

Table 2: Erosion control measures

<table>
<tr><th>Control measure</th><th>Description and design criteria</th></tr>
<tr><td>Progressive stabilization</td><td>

Minimising open and unstabilised areas by stabilising the site as works progress to reduce sources of dust nuisance and erosion.
Stabilisation can include top soiling, seeding/hydroseeding, mulching, turfing, or compacted aggregate.
The access track between the upper and lower fields should be stabilised to all use in all weather conditions and minimise sediment-laden runoff.

</td></tr>
<tr><td>Stockpiling</td><td>

Any material requiring stockpiling will be stockpiled in a designated area with appropriate sediment control measures.
Under Scenario 1 and 2, the designated area has been identified as the upper playing field, with a 10m clearance on the west side adjacent to Rolleston Street, 5m clearance along north, east and south sides, and 15m at the north-west corner. Under Scenario 3, the designated areas are the upper playing field as described above and a portion of the lower playing field.
The stockpile will not exceed 8.5m above the field level with existing topsoil removed, and have side slopes of 1.5:1.

</td></tr>
<tr><td>Stabilised entrance</td><td>

Stabilised construction entrance of aggregate on a filter cloth base to reduce the generation of sediment and dust and tracking of sediment onto public roads.
It is expected that the entrances from Rolleston Street and Salisbury Terrace will be stabilised. Ensure drainage is provided to carry runoff from entrance to appropriate sediment control measure, and aggregate meets specifications below:

<table>
<tr><td>Aggregate Size</td><td>50-75mm Washed Aggregate</td></tr>
<tr><td>Thickness</td><td>150mm Minimum</td></tr>
<tr><td>Length</td><td>10m Minimum</td></tr>
<tr><td>Width</td><td>4m Minimum</td></tr>
</table>
</td></tr>
<tr><td>Cleanwater diversion</td><td>

Channel or bund to divert upslope runoff from entering the site, thereby reducing quantity of water requiring treatment at base of site.
It is expected that a cleanwater diversion will be put in place above the main excavation.

</td></tr>
</table>

<table>
<tr><th>Control measure</th><th>Description and design criteria</th></tr>
<tr><td></td><td>

Design to carry flow from 5% AEP period storm, on slopes no more than 2% unless armoured (eg with geotextile, vegetative stabilisation or rock check dams).
Design channel internal slopes no steeper than 3:1 and external slopes no steeper than 2:1, bund side slopes no steeper than 3:1.

</td></tr>
<tr><td>Benched slopes</td><td>

Reverse sloping sections on slope to reduce water velocity and volume, and divert to appropriate sediment control devices.
Design to be a minimum of 2m wide, with reverse slope of 15% of flatter to the toe of the upper slope and minimum depth of 0.3m.
Design bench gradient to be less than 2% to outlet, with flow length less than 250m, and following height between benches:

<table>
<tr><th>Slope Angle (%)</th><th>Vertical Height Between Benches (m)</th></tr>
<tr><td>50</td><td>10</td></tr>
<tr><td>33</td><td>15</td></tr>
<tr><td>25</td><td>20</td></tr>
</table>
</td></tr>
<tr><td>Contour drains</td><td>

Temporary ridge or channel (or combination) to limit slope length, reduce water velocity and direct runoff to appropriate sediment control devices. These are temporary structures and can be installed prior to forecast heavy rainfall.
Design to gradients no greater than 2% and keep drains as short as practicable (max 50m) with following spacing:

<table>
<tr><th>Slope of Site (%)</th><th>Suggested Spacing of Contour Drains (m)</th></tr>
<tr><td>5</td><td>50</td></tr>
<tr><td>10</td><td>40</td></tr>
<tr><td>15</td><td>30</td></tr>
</table>
</td></tr>
<tr><td>Surface roughening</td><td>

Roughening of a bare earth surface with horizontal grooves or construction equipment tracking to reduce runoff velocity, increase infiltration, reduce erosion, and aid in seed establishment.
Apply to sites requiring slope stabilisation with vegetation (particularly slopes steeper than 25%).

</td></tr>
<tr><td>Dirty water diversion channel/bund</td><td>

Channel or bund used to direct runoff to appropriate sediment control devices in a controlled manner.
It is anticipated that a dirty water diversion bund will be put in place as a perimeter control.
Design to carry flow from 5% AEP period storm, on slopes no more than 2% unless armoured (eg with geotextile, vegetative stabilisation or rock check dams).
Design channel internal slopes no steeper than 3:1 and external slopes no steeper than 2:1, bund side slopes no steeper than 3:1.

</td></tr>
<tr><td>Drop structure/flume</td><td>

Temporary pipe or flume structure from top to bottom of a slope to covey surface runoff down an un-stabilised slope

</td></tr>
</table>

Control measure	Description and design criteria
	■ Construct all structures from watertight materials with minimum slope of 3%, and extend structure beyond toe to slope with outlet protection from erosion (eg riprap over geotextile). ■ Install flared entrance section of compacted earth with geotextile fabric to minimise erosion. If runoff is from a disturbed catchment area, ensure it discharges into sediment retention pond. Ensure structure meets following design requirements:

Pipe Diameter (mm)	Maximum Catchment Area (ha)
150	0.05
300	0.2
450	0.6
500	1.0
600	1.0

5.2 Sediment Control Measures

General sediment control measures that may be applied or implemented during the construction period are described in Table 3 below.

Table 2: Sediment control measures

Control measure	Description and design criteria
Sediment retention pond (SRP)	■ Temporary pond for the retention and treatment of sediment-laden water ■ Under Scenario 1 and 2, it is expected a SRP will be required on the upper playing field to control runoff from the stockpiles and main excavation site. Under Scenario 3, a SRP on both the upper and lower playing fields would be expected to be required. ■ The pond(s) will discharge either to the Papawai Stream or to the piped stormwater network, depending on final pond locations. Due to the location of the piped network relative to the gradient of the site, it is likely that discharges from SRPs on both the upper and lower fields will be to the Papawai Stream. ■ Final sediment pond designs will be provided in phase-specific ESCPs and will meet requirements as outlined in *Erosion and Sediment Control Guidelines for the Wellington Region.*
Chemical flocculation treatment	■ Chemical treatment system used to increase sediment capture performance of retention ponds. Treatment can be via automatic dosing, batch dosing or the use of flocculant socks. ■ Refer to the Chemical Treatment Plan (**Appendix B**) for further details on proposed bench testing, implementation, monitoring and maintenance for chemical flocculation treatment of sediment.
Silt fence	■ Temporary barrier made of woven geotextile fabric to intercept sediment from sheet flow runoff. ■ Trench with minimum depth of 200mm and width of 100mm, with top height of fence 400mm, supporting posts on downside of trench approximately 3m apart and 0.4m deep. Silt fence wings to be installed at either end projecting upslope to prevent outflanking.

<table>
<tr><th>Control measure</th><th>Description and design criteria</th></tr>
<tr><td></td><td>
Design criteria based on slope angle:
<table>
<tr><th>Slope (%)</th><th>Slope Length (m)</th><th>Spacing of Returns (m)</th><th>Length (m)</th></tr>
<tr><td><2%</td><td>Unlimited</td><td>N/A</td><td>Unlimited</td></tr>
<tr><td>2-10%</td><td>40</td><td>60</td><td>300</td></tr>
<tr><td>10-20%</td><td>30</td><td>50</td><td>230</td></tr>
<tr><td>20-33%</td><td>20</td><td>40</td><td>150</td></tr>
<tr><td>33-50%</td><td>15</td><td>30</td><td>75</td></tr>
<tr><td>>50%</td><td>6</td><td>20</td><td>40</td></tr>
</table>
</td></tr>
<tr><td>Super silt fence</td><td>

Temporary barrier made of woven geotextile fabric over chain link fence to intercept sediment from runoff.
It is expected that a super silt fence will be required between the main excavation and the Papawai Stream, as slope is too steep for a diversion bund and between the main excavation and the unnamed tributary, due to space constructions.
Design trench with minimum depth of 200mm and width of 100mm, supporting posts (No 3 rounds, No 2 half rounds or waratahs) approximately 3m apart, 1.8m length and 1m depth. Geotextile to base of trench (minimum 200mm).
Design criteria based on slope angle:

<table>
<tr><th>Slope %</th><th>Slope Length (m)</th><th>Length (m)</th></tr>
<tr><td>0-10</td><td>Unlimited</td><td>Unlimited</td></tr>
<tr><td>10-20</td><td>60</td><td>450</td></tr>
<tr><td>20-33</td><td>30</td><td>300</td></tr>
<tr><td>33-50</td><td>30</td><td>150</td></tr>
<tr><td>>50</td><td>15</td><td>75</td></tr>
</table>
</td></tr>
<tr><td>Decanting earth bund</td><td>

Temporary berm/ridge of compacted earth to intercept sediment-laden runoff where sediment can settle prior to discharge.
Design requires a constructed outlet structure and spillway. Ensure maximum contributing catchment is less than 0.3 ha and decant inlet is positioned to provide 5% live storage volume with minimum distance of 5m of flat ground from outlet.

</td></tr>
</table>

5.3 Dust Control Measures

Due to the exposed location of Prince of Wales Park on a hill in Central Wellington, there is a risk of dust generation. The following dust control measures will be implemented as and when required:

- Minimising drop heights when loading and unloading vehicles
- Minimising soil exposed through staging of works
- Consolidating loose surface material
- Wetting of loose material with water spray
- Application of hydroseeding or polymer
- Covering of stockpiles or exposed material
- Stockpile stabilisation if to be left untouched for longer than one month

5.4 Phase Specific Erosion and Sediment Control Plans

Phase Specific Erosion and Sediment Control Plans will be produced for each of the construction phases associated with the reservoir construction. These Plans will follow the principles as outlined in this CESCP, and will provide detailed information on the specific erosion and sediment controls to be implemented, their locations, maintenance, and monitoring requirements.

It is expected that Phase Specific Erosion and Sediment Control Plans will be produced for the following construction phases:

- Site establishment
- Reservoir excavation
- Reservoir construction
- Backfilling
- Site restoration, sports field remediation, and site completion

It is expected that conditions on the easement approval from WCC and resource consents from GWRC will require these phase-specific ESCPs to be certified prior to commencement of the relevant stage of construction.

5.5 Minor Amendments

Minor changes to controls implemented on site will not require discussion with or agreement from GWRC or WCC. Minor changes are amendments that will not materially change the manner in which the works are undertaken, or the way in which outcomes are achieved. This includes:

- Repositioning or implementation of silt fences and super silt fences
- Installation of additional diversion bunds, check dams and inlet protection
- Changing the form of control from a diversion bund or site contouring to a silt or super silt fence
- Mulching, top soiling or any site stabilisation

5.6 Decommissioning

No erosion and sediment control measures will be removed until the upstream catchment is stabilized (or an alternative measure has been installed).

Stabilisation is defined as inherently resistant to erosion or rendered resistant, such as by using indurated or by the application of basecourse, colluvium, grassing, mulch or other methods as agreed with GWRC. Where grassing or seeding is used on a surface that is otherwise not resistant to erosion, the surface is considered to be stabilized once vegetation cover of 80% has been established.

6 Erosion and Sediment Monitoring and Maintenance

6.1 Routine Monitoring and Maintenance

As part of the erosion and sediment control methodology, on-going site monitoring by the Project Engineer will be undertaken to ensure that the proposed control measures have been installed correctly, methodologies are being followed, and they are functioning effectively throughout the duration of the works. All maintenance of erosion and sediment controls will be undertaken in accordance with the *Erosion and Sediment Control Guidelines for the Wellington Region*.

Table 3: Erosion and sediment control monitoring and maintenance requirements

Control type	Inspection and maintenance requirements	Frequency
Weather forecast	■ Check MetService New Zealand and Metvuw for short and long range rainfall and wind forecasts	■ Daily
Silt fences and super silt fences	■ Ensure silt fences are toed in correctly ■ Inspect for tears and other damage ■ Repair/replace any areas of collapse, decomposition or ineffectiveness immediately ■ Remove sediment accumulation when bulges develop or deposition reaches 50% of the silt fence height	■ Weekly ■ Before and after rainfall events
Diversion channels and bunds	■ Check embankments and outlets for scour and areas of breach ■ Repair immediately to ensure capacity is maintained ■ Remove any accumulated sediment to maintain capacity	■ Weekly ■ Before and after rainfall events
Contour drains	■ Check they are instated prior to heavy rain forecast (if required) ■ Ensure gradient does not exceed 2%	■ Prior to forecast heavy rain
Sediment retention ponds and decanting earth bunds	■ Inspect inlet and embankment for signs of erosion ■ Inspect the outlet structure and pipe for erosion, seeping or blockage ■ Check flocculant levels and ensure system is working correctly ■ Remove any accumulated sediment before deposition reaches 20% of pond capacity – any removed sediment must be deposited in a location where it is unable to re-enter a waterbody	■ Weekly ■ Before and after rainfall events
Sediment discharge points	■ Inspect for signs of erosion	■ Weekly ■ Before and after rainfall events
Stabilised entranceway	■ Check sufficient clean aggregate cover exists ■ Replace or top-up aggregate as necessary	■ Weekly
Stabilised areas	■ Check there is sufficient stabilisation (grass should have 80% cover) ■ Re-seed or mulch as necessary	■ Weekly
Rainfall event monitoring	■ Confirm the erosion and sediment control measures are operating as designed ■ Determine if excessive sediment is discharging to roads, land or watercourses, and identify and implement (when possible) additional controls as required	■ During rainfall events

7 Environmental Monitoring

The ultimate receiving environment for runoff from the Prince of Wales Reservoir/Omāroro development is the Papawai Stream and an unnamed tributary of the Waitangi Stream.

Monitoring of the Papawai Stream is proposed to be undertaken to identify any effects of stormwater discharges from the site on water quality and aquatic ecology. No monitoring has been proposed in the unnamed tributary as only a minor portion of the works site drains to this catchment.

The following monitoring is proposed, with the expectation that it will be developed and refined with GWRC throughout the consenting process. Trigger levels have also been proposed to assist with determining when management action may be required in order to avoid or minimize any on-going adverse effects on the stream.

7.1 Monitoring Sites

Water quality monitoring will be undertaken at the Papawai Stream upstream of the works and downstream of the lowest discharge point.

7.2 Routine SRP Monitoring

Routine monitoring will be undertaken to ensure the SRPs are operating as expected and to ensure that no alterations to the flocculant dosage are required. The routine monitoring is required as per the attached Chemical Treatment Plan. Each SRP should be tested daily in the initial three days of pond operation to ensure it is operating effectively. Following this, monthly monitoring should be undertaken until the SRP catchments have been stabilised.

No routine monitoring of Papawai Stream is proposed.

7.3 Event Triggered Monitoring

Event triggered monitoring of the SRPs and Papawai Stream will be undertaken for the duration of the construction period. The rainfall trigger level is to be confirmed.

In the case of a triggered monitoring event, the site will be inspected as soon as is safe and practical (within daylight hours). If the SRPs are discharging, then water quality monitoring will be undertaken in accordance with the methodology outlined in **section 7.6** at the pond outlet. If trigger levels are reached, monitoring will also be undertaken in the Papawai Stream upstream and downstream of the discharge point.

7.4 Monitoring Trigger Levels

The following environmental trigger levels are proposed for both routine and event trigger monitoring. If any of the following trigger levels are reached, a management action is required.

Table 4: Monitoring trigger levels

Parameter	Trigger level at pond outlet	Trigger level in Papawai Stream
pH	<5.5 or >9	<5.5 or >9
Turbidity (NTU)	170 NTU	20% increase of upstream turbidity value as measured at downstream site
Residual flocculant (eg dissolved aluminium)	Eg >0.087 mg/L dissolved aluminium	Eg >0.087 mg/L dissolved aluminium

If PAC (Polyaluminium Chloride) flocculant is used, the trigger will be dissolved aluminium. Samples for residual aluminium testing have to be sent to the lab for analysis, with results taking approximately one week to be returned. This means there will be a delay in the implementation of any required actions. This may change depending on the flocculant used.

7.5 Trigger Level Exceedance Actions

pH or aluminium exceedances

If the pH or residual aluminium trigger levels are exceeded at the SRP outlet, the following steps will be implemented:

- Dosing of the sediment retention pond shall cease immediately until remedial actions are taken
- Pond decants may be raised to temporarily increase dead storage and prevent discharge
- Header tank to be checked and emptied if necessary, as this may cause overdosing
- If pH is below 5.5, lime dosing may be required to increase pH to neutral
- Review the dosage rate and alter as required

It is not expected that the pH or aluminium triggers would be exceed in the Papawai Stream unless also exceeded at the pond outlet.

NTU exceedances

If the NTU trigger level is exceeded at the SRP outlet or in the Papawai Stream, the following steps should be followed:

1. Check the pond capacity, dosing system and dosing rate.

2. Undertake an immediate site inspection of all discharge points and erosion and sediment control measures to determine if a discharge is occurring that may be contributing to elevated NTU levels.

3. If a discharge is occurring, prepare and implement an action plan to remedy the situation. This should be undertaken in conjunction with the site contractor and include consideration of the weather forecast and requirements of this plan.

4. Undertake NTU monitoring in the Papawai Stream at locations both upstream and downstream of the sediment retention pond (if not already done).

5. In the event of an increase in NTU of greater than 20% at the downstream site, a deposited sediment survey will be undertaken within 5 days (but not before the stream is safe and running clear) (TBC).

6. If the results from the deposited sediment sampling analysis indicate exceedances of the deposited sediment trigger levels, macroinvertebrate sampling will be undertaken (TBC).

7.6 Monitoring Methodology

Water quality

Water quality monitoring should be undertaken with a handheld device where possible to provide instant results. Residual flocculant tests can be confirmed following bench testing and selection of an appropriate flocculant, but it is likely that lab testing will be required.

Deposited sediment sampling

Monitoring of deposited sediment will be undertaken in accordance with the Sediment Assessment Method (SAM-2). This method involves an in-stream visual assessment of the surface area of the streambed covered by sediment.

At each sample site, five random transects will be located along a section of run. An underwater viewer will be used to carry out the visual estimate of deposited sediment (percentage cover) at four random locations along each transect.

The sampling can be undertaken during any flow where there is sufficient water clarity to properly assess the stream bed.

Macroinvertebrate sampling

Biological monitoring of the macroinvertebrate communities in the Papawai Stream will be undertaken using a kick-net following the hard bottomed, semi-quantitative Protocol C1 method. The sampling method involves the disturbance of 0.6 - 1.0 m^2 of streambed. Samples are placed in denatured ethanol and processed in accordance with P2 (200 fixed count plus scan for rare taxa).

Macroinvertebrate sampling will as far as practicable be avoided within two weeks of a flood event, however this may be unavoidable.

Five biological indices will be calculated from the macroinvertebrate data obtained from each survey – taxonomic richness, number of EPT taxa, proportion of EPT taxa, macroinvertebrate community index (MCI) and taxonomic composition of the community. These results, as well as a review of the taxonomic composition of the community, will provide an indication of the general health of the macroinvertebrate community at each site at the time of sampling.

Comparing macroinvertebrate results with previous surveys (particularly baseline) and between sites during the same survey can assist with determining whether there has been a marked change in the community at a particular site.

The environmental data recorded at each site during the survey can also assist with identifying any changes in environmental conditions that could contribute to changes in the state of the macroinvertebrate community.

7.7 Reporting

The results of all environmental monitoring and any resulting management actions will be provided to GWRC and WCC. Table 5 outlines the monitoring reporting information requirements.

During each reporting round, the Ecologist will review all available information and assess whether the results indicate a significant adverse effect may be attributable to discharges from the site.

Table 5: Monitoring reporting information requirements

Monitoring	Frequency	Information required
Routine environmental monitoring	Monthly – within 20 working days of each monitoring round	■ Results of routine SRP monitoring, and any triggered event, deposited sediment and macroinvertebrate sampling undertaken during the previous month ■ Summary of any actions taken to avoid, remedy or mitigate any identified effects ■ Analysis of the results in regards to the effects that the discharges from the site are having on the ecology of the Papawai Stream ■ Recommendations to remedy or mitigate any identified effects
Triggered event monitoring	Within 10 working days of an exceedance of NTU	■ Results and analysis of water quality results and a summary of any findings from the site inspection ■ Recommendations to remedy or mitigate any identified adverse effects
Post-stabilisation	Within one month of site stabilisation	■ Results of all surface water quality, deposited sediment and macroinvertebrate sampling undertaken during the construction period ■ Assessment of effects of discharges from the site on water quality and in-stream aquatic life at the monitoring sites ■ Recommendations (where applicable) to remedy or mitigate any identified adverse effects

8 Roles and Responsibilities

Site Engineer
Name: TBC
Contact:

Contractor
Name: TBC
Contact:

Triggered erosion and sediment control monitoring
Name: TBC
Contact:

SRP chemical treatment monitoring and maintenance
Name: TBC
Contact:

9 Summary

The Prince of Wales Reservoir Project involves the construction of a fully buried single combined 35,000 m^3 reservoir with tunnel at the park. This reservoir is to supply water to the Wellington Low Level Water Supply Zone, servicing the Central Business District, Mount Cook, and Newtown, and contributing towards enhancing the operational ans strategic resilience of Wellington's water network.

The Project will involve removal of 56,000 m^3 of material from the reservoir site, with between approximately 25,000 and 41,000 m^3 of this material to be stockpiled on site and used to backfill the reservoir and for raising of one or both of the sports fields, with the remainder to be disposed of offsite. In addition to this, 5,500 m^3 of earth/rock material is to be imported to the site for reservoir fill.

This Construction Erosion and Sediment Control Plan provides a high level overview and framework for the erosion and sediment control measures to be associated with the Prince of Wales Reservoir development earthworks. Phase Specific Erosion and Sediment Control Plans will be produced for each of the four construction phases – site establishment, initial excavation of reservoir site, reservoir tank construction, and backfilling and site completion. These Plans will identify the specific control measures, and their locations, maintenance and monitoring requirements.

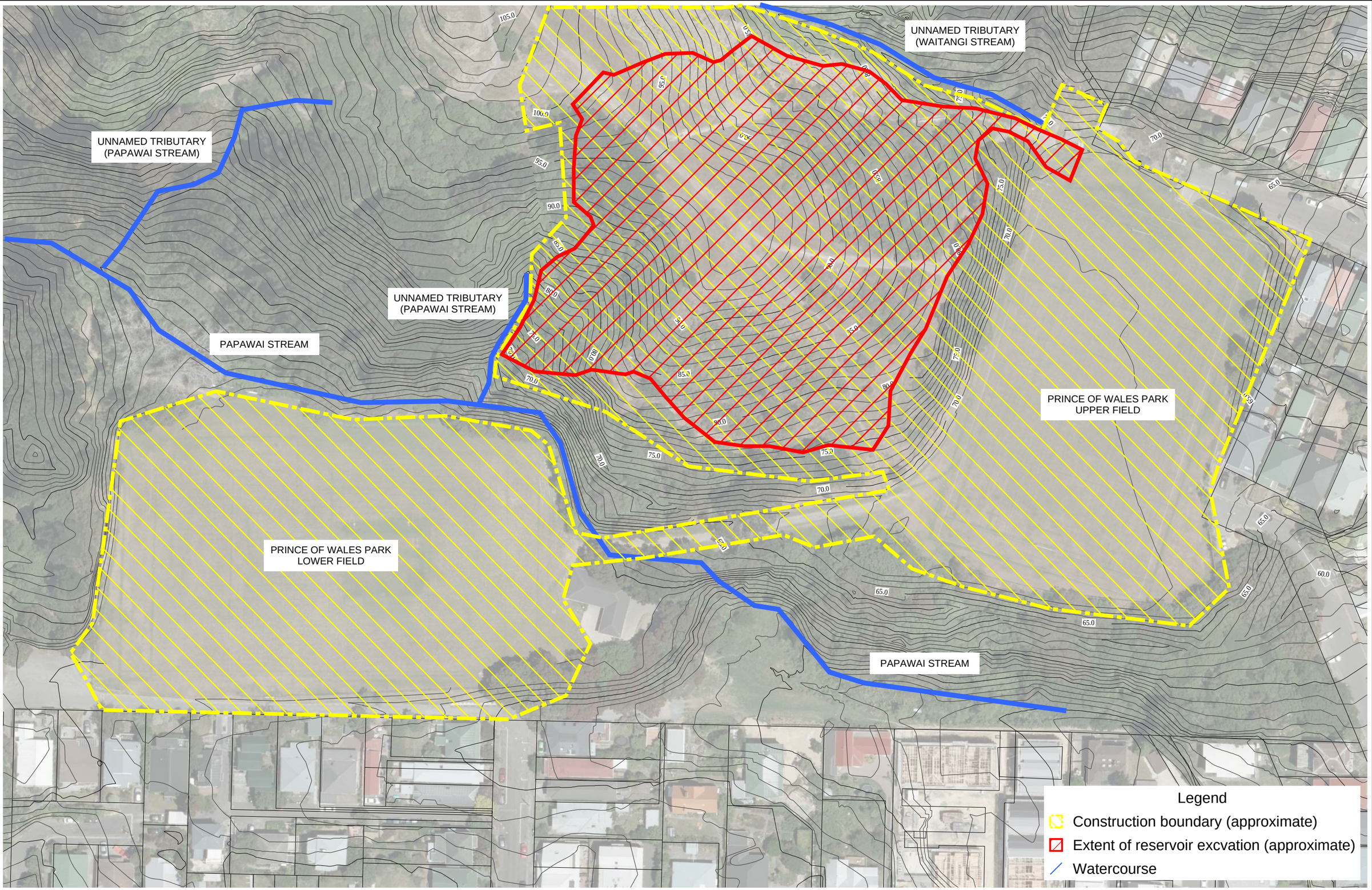
With the imposition of the types of control measures and the monitoring and maintenance actions outlined in this plan, the potential impacts of the earthworks associated with the reservoir development and potential raising of the sports fields can be appropriately managed. The proposed monitoring of the SRP outlets and the Papawai Stream will alert the contractor to discharges that could have an effect on the stream and indicate that changes in on site management are required.

It is considered that the implementation of this plan and the required phase-specific ESCPs (required to be certified by GWRC and WCC) constitutes good erosion and sediment management and effects on the receiving environment will be less than minor.

Appendix A

Site Plans with Proposed Controls

Drawing Plotted: 28 Mar 2017 9:07 a.m.



Legend

- Construction boundary (approximate)
- Extent of reservoir excvation (approximate)
- Watercourse

PRELIMINARY
NOT FOR CONSTRUCTION

No.	Revision	By	Chk	Appd	Date
+	UNDER REVISION				

Drawing Originator: CH2M BECA www.ch2mbeca.com

Original Scale (A1)	Design		Approved For Construction*
	Drawn		
Reduced Scale (A3)	Dwg Verifier		
	Dwg Check		Date

* Refer to Revision 1 for Original Signature

Client: Wellington Water

Project: OMARORO RESERVOIR

Title: EROSION AND SEDIMENT CONTROL SITE OVERVIEW

Discipline: ESCP

Drawing No.: ESCP 1

Rev.: A

Document No.: 6513361-CK-1200.DWG

DO NOT SCALE

IF IN DOUBT ASK.

www.ch2mbeca.com

Drawing Plotted: 28 Mar 2017 9:07 a.m.

CLEAN WATER DIVERSION TO BE CONSTRUCTED ABOVE THE SITE

TRIBUTARY ONLY FLOWS AFTER HEAVY RAIN

EXISTING BUND ALONG STREAM TO BE AUGMENTED WHERE NECESSARY

SSF TO BE CONSTRUCTED PARALLEL TO CONTOUR WHERE POSSIBLE BUT VEGETATION CLEARANCE TO BE MINIMISED

SRP1
CATCHMENT: 1.5HA
VOLUME: 300m^2
SIZE: 29x5m

SRP2
CATCHMENT: 1.1HA
VOLUME: 220m^3
SIZE: 25x5m

DETAIL AT EXISTING CULVERT CROSSING TO BE PROVIDED PRIOR TO CONSTRUCTION

DIVERSION CHANNEL OR SIMILAR CONTROL ALONG ACCESS TRACK. DRAIN TO BE CREATED ON INSIDE EDGE IF POSSIBLE.

Legend

- Cleanwater diversion
- Construction boundary (approximate)
- Diversion bund
- Extent of reservoir excavation (approximate)
- Proposed stockpile locations
- SRP
- Stabilised internal access
- Stabilised site entrance
- Super silt fence
- Watercourse

PRELIMINARY
NOT FOR CONSTRUCTION

No.	Revision	By	Chk	Appd	Date
+	UNDER REVISION				

Drawing Originator: CH2M Beca www.ch2mbeca.com

Original Scale (A1)
Reduced Scale (A3)

Design			Approved For Construction*
Drawn			
Dsg Verifier			
Dwg Check			Date

* Refer to Revision 1 for Original Signature

Client: Wellington Water

Project: OMARORO RESERVOIR

Title: EROSION AND SEDIMENT CONTROL PROPOSED CONTROLS

Discipline: ESCP
Drawing No.: ESCP 2
Rev.: A

Document No. 651361-GX-1200.DWG

DO NOT SCALE

IF IN DOUBT ASK.

www.ch2mbeca.com

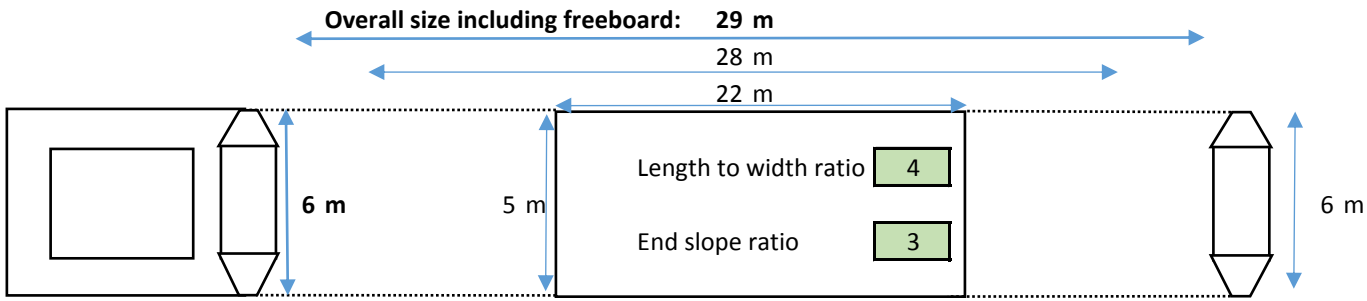
SEDIMENT RETENTION POND SIZING

Project: Prince of Wales/Omāroro Reservoir

Project number: 6513361

Control ID: SRP1

Pond catchment area	1.5	ha	Pond depth	2	m	Design volume (m^3)	300
Pond design capacity	2	%	Freeboard	0.3	m	Dead storage (m^3)	90
Required pond volume	300	m^3				Live storage (m^3)	210

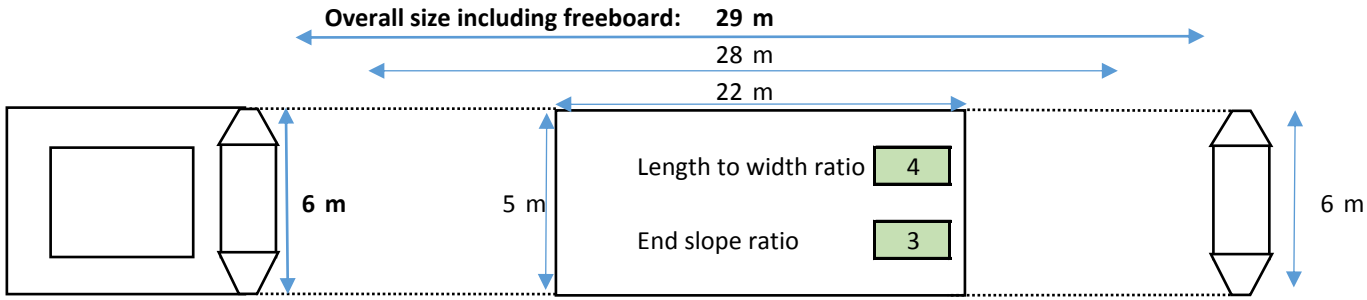


SEDIMENT RETENTION POND SIZING

Project: Prince of Wales/Omāroro Reservoir
Project number: 6513361

Control ID: SRP2

Pond catchment area	1.1	ha	Pond depth	2	m	Design volume (m^3)	252
Pond design capacity	2	%	Freeboard	0.3	m	Dead storage (m^3)	76
Required pond volume	220	m^3				Live storage (m^3)	176



Appendix B

Chemical Treatment Plan

Report

Chemical Treatment Plan: Prince of Wales Reservoir

Prepared for Wellington Water Ltd (Client)

By CH2M Beca Limited

23 February 2017

Table of Contents

1 Introduction

This Chemical Treatment Plan (CTP or Plan) has been prepared to support the Construction Erosion and Sediment Control Plan for the Prince of Wales Reservoir development.

In order to minimise the effects of sediment discharges on the Papawai Stream, it has been proposed that the site runoff is treated prior to off-site discharge. A sediment retention pond (SRP) will be installed and enhanced with a chemical flocculant treatment system.

All chemical treatment will be carried out in accordance with this Plan.

2 Design and Management

2.1 Bench Testing

Bench testing will be undertaken in accordance with the Greater Wellington Regional Council (GWRC) *Erosion and Sediment Control Guidelines for the Wellington Region*[1] to determine the most appropriate dosage rate based on the local environmental conditions. This dosage rate may be reviewed during the works if necessary.

2.2 Residual Testing

The Auckland Regional Council *Technical Publication 226*[2] sets out suitable sediment retention pond outlet water parameters, as indicated below:

- pH: 5.5 – 9.0
- Dissolved aluminium: <0.087 mg/L (US EPA chronic toxicity criterion)

2.3 Implementation

There are three methods that may be used for the chemical treatment of sediment. These are automatic dosing, batch dosing and the use of flocculant socks.

Automatic Dosing

Chemical treatment can be undertaken using an automatic rainfall activated or other electronic system. This method involves the automated or electronic dosing of liquid flocculant to the inflow of a sediment retention pond.

If implemented, a bund will be constructed around the chemical storage area to contain any accidental spills.

Batch dosing

[1] *Erosion and Sediment Control Guidelines for the Wellington Region*, Greater Wellington Regional Council (2002, reprinted 2006)

[2] *Technical Publication 226: Overview of the Effects of Residual Flocculants on Aquatic Receiving Environments,* Auckland Regional Council

Batch dosing is often useful in early earthworks stages to capture dispersive clays that are often produced during this stage.

To carry out treatment, the sediment retention device shall be blocked off (eg by raising the decanting arms), and water treated by spraying liquid flocculant across the pond surface.

Once treated, the water quality will be assessed in accordance with the standard monitoring trigger levels for pH and Turbidity (see the Construction Erosion and Sediment Control Plan) prior to being discharged off site.

Flocculant socks

Chemical treatment using flocculant socks may be appropriate and installed on an as required basis in bunds and decanting earth bunds, etc. Socks will be located to ensure that the maximum contact with water for treatment can be achieved. The socks should not block or detain flows, as this allows for the build-up of material and reduces effectiveness. The socks will be anchored in place using ground staples or similar.

3 Monitoring and Maintenance

3.1 Routine Monitoring

Monitoring will be carried out following the initial days of pond operation (to verify the bench testing results and ensure the correct flocculant dosage is being applied). Following this, routine monitoring will be undertaken monthly until the SRP catchments are stabilised. The following parameters will be monitored, with results recorded and provided to GWRC on request.

Parameter	Monitoring method	Trigger level
pH	pH strips	<5.5 or >9
Residual flocculant (eg dissolved aluminium)	Independent laboratory	Eg >0.087 mg/L dissolved aluminium
Turbidity (NTU)	TBC	170 NTU
Visual monitoring	Visual	Noticable signs of sediment entering the receiving environment

3.2 Event Triggered Monitoring

Sediment retention ponds will be monitored as part of the wider event triggered monitoring, as outlined in the Construction Erosion and Sediment Control Plan. The rainfall trigger level is to be confirmed.

3.3 Remedial Actions

Follow the below remedial actions for any trigger level exceedances.

Notify Greater Wellington Regional Council within 48 hours of any trigger level exceedances.

pH or aluminium exceedances

If the pH or residual aluminium trigger levels are exceeded at the sediment retention pond outlet, the following steps will be implemented:

- Dosing of the sediment retention pond shall cease immediately until remedial actions are taken
- Check dosing mechanisms to ensure operating correctly
- Pond decants may be raised to temporarily increase dead storage to prevent discharge
- If pH is below 5.5, lime dosing may be required to increase pH to neutral
- Review the dosage rate and alter as required

Turbidity exceedances

If the turbidity trigger is exceeded, the following steps will be implemented:

1. Check the pond capacity, dosing system and dosing rate.

2. Undertake an immediate site inspection of all discharge points and erosion and sediment control measures to determine if a discharge is occurring that may be contributing to elevated turbidity.

3. If a discharge is occurring, prepare and implement an action plan to remedy the situation. This should be undertaken in conjunction with the site contractor and include consideration of the weather forecast and requirements of this plan.

4. Undertake turbidity monitoring in the Papawai Stream at locations both upstream and downstream of the sediment retention pond (if not already done).

5. In the event of an increase in turbidity of greater than 20% of the upstream value at the downstream site, a deposited sediment survey will be undertaken within 5 days (but not before the stream is safe and running clear) (TBC).

6. If the results from the deposited sediment sampling analysis indicate exceedances of the deposited sediment trigger levels, macroinvertebrate sampling will be undertaken (TBC).

3.4 Maintenance

When the displacement tank is filled to a level where there is insufficient volume remaining to treat a large storm event, the water will be syphoned off and the reservoir tank topped up to the level of the outfall tank.

When sediment levels exceed 20% of the pond capacity, sediment is to be removed. To assist in gauging sediment levels, the 50% volume height will be clearly marked on the decant riser.

4 Decommissioning

Decommissioning will be undertaken in accordance with the Construction Erosion and Sediment Control Plan.

5 Health and Safety

5.1 Chemical Handling

A Material Safety Data Sheet (MSDS) for the flocculant(s) will be supplied to the contractor and kept on site at all times.

All flocculant onsite will be stored within the chemical treatment shed, with a bund created around the shed to contain any spills. No excess flocculant will be stored on site.

5.2 Spill Response

In the event of a chemical flocculant spill, any indoor areas will be ventilated and nominated contractor (TBC) will be contacted immediately.

Spill to ground

- Contain the spill immediately using bunds or spill kit to prevent discharge to water
- As much spilt chemical as possible should be recovered and put in polyethane containers
- If the product cannot be recovered, it should be mixed with a volume of soil equal to at least 10 times the volume of spilt chemical, before being mixed with dry soil on site or disposed of to landfill.

Spill to ponded water

If there is a spill to an enclosed sediment treatment device, any discharges from the device will be blocked immediately. A pH test will be undertaken, and the results will inform the appropriate actions (see **section 3.3**).

Spill to flowing water

- Notify GWRC immediately of the spill
- Record the volume of the spill
- If possible, pump the water and spilt chemical to a contained bund or pond until all of the chemical has been removed from the watercourse
- If the chemical cannot be removed from the water, any downstream users should be identified and advised. An action plan will be developed in association with GWRC.

6 Responsibilities

Setting of flocculant dose rates, routine monitoring and ongoing maintenance:
Person responsible: TBC
Contact number:

Triggered event monitoring:
As per the Construction Erosion and Sediment Control Plan

7 Review

In the event that this plan is identified as not providing sufficient management for the chemical treatment, or the chemical treatment is ineffective, this plan will be reviewed and updated in consultation with GWRC.