29 July 2025

File Ref: OIAPR-1274023063-40789

[redacted]
By email: [redacted]

Tēnā koe [redacted],

Request for information – 2025-226

I refer to your request for information which was received by Greater Wellington Regional Council (Greater Wellington) on Tuesday 1 July 2025. You have requested the following:

"Can you supply me with a link to the 2021 Whakatikei Storage Reservoir Optimisation Study Final Report prepared by MWH please."

Greater Wellington's response follows:

I can confirm that we will be releasing the requested report to you. However, we will be withholding some information under the following Local Government Official Information and Meetings Act 1987 sections:

- 7(2)(a) - protect the privacy of natural persons, including that of deceased natural persons.
- 7(2)(h) - withholding necessary to enable any local authority holding the information to carry out, without prejudice or disadvantage, commercial activities,
- 7(2)(i) - withholding necessary to enable any local authority holding the information to carry on, without prejudice or disadvantage, negotiations (including commercial and industrial negotiations)

We apologise for the delay as this document is large it will take some time to apply the redactions above.

It is our intention to release the document to you by **1 August 2025**.

If you have any concerns with the decision(s) referred to in this letter, you have the right to request an investigation and review by the Ombudsman under section 27(3) of the Local Government Official Information and Meetings Act 1987.

Nāku iti noa, nā

Julie Knauf
Kaiwhakahaere Matua, Ratonga Rangapū | Group Manager Corporate Services

MWH

BUILDING A BETTER WORLD

DRAFT FINAL REPORT

Whakatikei Storage Reservoir Optimisation Study

Prepared for Greater Wellington Regional Council

MARCH 2012

MWH

This document has been prepared for the benefit of Greater Wellington Regional Council. No liability is accepted by this company or any employee or sub-consultant of this company with respect to its use by any other person.

The information contained in this report is accurate to the best of our knowledge at the time of issue. MWH NZ has made no independent verification of this information beyond the agreed scope set out in the report.

Actual ground conditions encountered may vary from the predicted subsurface conditions. For example, subsurface groundwater conditions often change seasonally and over time. No warranty is expressed or implied that the actual conditions encountered will conform exactly to the conditions described herein.

Where conditions encountered at the site differ from those inferred in this report MWH NZ should be notified of such changes, and should be given an opportunity to review the report recommendations made in this report in light of any further information.

This report does not purport to describe all the site characteristics and properties. Subsurface conditions and testing relevant to construction works must be undertaken and assessed by any contractors as necessary for their own purposes.

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QUALITY STATEMENT

PROJECT MANAGER	PROJECT TECHNICAL LEAD
s7(2)(a)	s7(2)(a)

PREPARED BY		
s7(2)(a), s7(2)(a), s7(2)(a)	.....	...../...../.....
CHECKED BY		
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REVISION SCHEDULE

Rev No	Date	Description	Signature or Typed Name (documentation on file). Prepared by	Checked by	Reviewed by	Approved by

MWH

Rev No	Date	Description	Signature or Typed Name (documentation on file)			
			Prepared by	Checked by	Reviewed by	Approved by

MWH

Executive Summary

MWH New Zealand (MWH) were engaged by Greater Wellington Regional Council (GWRC) to identify and assess alternative sites for water storage along the Whakatikei River in Upper Hutt. This study follows on from the Live Storage Assessment (LSA) work that was completed by MWH in 2007 that, through a series of Multi Criteria Analysis (MCA) workshops, identified the Whakatikei River as being the preferred location of three alternatives.

The scope of this study is to build on this LSA work by identifying alternative sites based on an engineering assessment and maximising the recreational/landscape benefits of the sites.

The preferred site from the 2007 LSA work (Option 1) was sized to supply a regional population of 486,000 and was then compared against two alternatives from this study.

The first alternative site (Option 2) considered in this assessment is located approximately 90m upstream of Option 1. Option 2 was selected as it would reduce the visual impacts when compared to Option 1 and it could potentially allow for the retention of the lower gorge rock pools which were considered to have potential for recreation benefits. The desktop geotechnical assessment and limited visual site inspections completed confirmed that Option 2 has no significant geological features that would eliminate it from further consideration for a dam structure.

The other alternative site selected (Option 3) is located approximately 250m upstream of Option 1. Option 3 is situated around a tight bend in the gorge and therefore would significantly reduce the visual impacts when viewed from the ridgeline off the end of Bulls Run Road. Option 3 would also completely protect the lower gorge rock pools. As with Option 2, no significant geological features were identified that would eliminate Option 3 from further consideration.

For the purposes of this study it was agreed that the location of the storage dam along the Whakatikei River will have minimal impact on the storage curves, and this was confirmed through a high level calculation.

All three options were costed on the basis that the storage dam will have an identical top water level (TWL) to the 2007 LSA preferred site. This was to ensure a fair comparison could be made.

The comparison was undertaken and evaluated the three site options and focussed on the significant points of difference between them. The assessment focussed on Geology, Environmental Effects, Social, Constructability and Capital Cost and concluded that Option 3 was preferred on the basis that there were significant, Environmental and Social benefits from moving the dam around the tight bend. In addition to this there was no difference in geology comparison and little difference in Capital Cost as the additional pipeline and roading costs for Option 3 were largely offset by the lower dam structure volumes necessary given the narrower shape of the gorge at Option 3.

With Option 3 as the preferred site, two larger dam sizes were costed. These were to service a regional population of 500,000 and 550,000. s7(2)(h), s7(2)(i) [redacted]

A staged dam construction option was also considered as part of this study. It was concluded that staging the dam from the 486,000 population (2007 LSA size) to 550,000 population is possible but would require additional works, such as foundations for the larger dam, to be constructed early in order to facilitate the raising of the dam at a later date. s7(2)(h), s7(2)(i) [redacted]

Preferred site Option 3 was comparable on cost and provided significant recreational and landscape advantages over the other options. It also has the ability to be staged with a marginal cost increase over the total dam cost. This site provides GWRC with a viable Whakatikei storage option that can be assessed with other water supply alternatives for the Wellington Region.

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Whakatikei Storage Reservoir Optimisation Study

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1. Introduction

1.1 General

This work follows on from previous Live Storage Assessment (LSA) phases which investigated three potential storage dam sites within different catchments for the supply and provision of potable water to the Wellington Region. This work was completed in 2007 and is summarised in a variety of reports.

The outcome from the LSA Phase 2 work was that the proposed option of a storage dam on the Whakatikei River proved to be the preferred option over the Pakuratahi and Skull Gully alternatives. This was further confirmed through a series of multi-criteria analysis workshops involving regional water supply managers, Greater Wellington Regional Council (GWRC) staff and regional politicians.

The purpose of this study is to assist GWRC achieve three main objectives:

1. To recommend an optimum storage volume taking into account the cost, likely population growth, related existing infrastructure and the possibility of future enlargement of the storage lake and related infrastructure;
2. To explore the recreational opportunities that development of the Whakatikei storage might present, particularly immediately downstream of the dam structure;
3. To minimise the visual impact of the dam structure, especially when viewed from downstream.

1.2 Scope

MWH New Zealand Ltd (MWH) has been commissioned by GWRC to select a preferred site from three alternatives along the Whakatikei River and to assess this against the robust investigative work undertaken during LSA Phase 2 for the original Whakatikei Storage Dam site.

The objective is not to repeat the analysis undertaken during the previous phase but rather confirm that the two new alternative sites do not contain any significant new risks when compared to the original storage dam location.

Isthmus Group Ltd (Isthmus) was separately engaged by GWRC to undertake a Baseline Recreational Assessment. For completeness, the outputs from this assessment are included in this report.

The agreed scope of work for this investigation was limited to:

- A review of the pertinent previous reports;
- A desktop analysis to identify up to two alternative dam locations based on geological and geometric considerations in consultation with Isthmus;
- A site visit along the Whakatikei River to locate and assess the two new alternative sites;
- Discipline assessments on the alternative sites include;
    - A baseline landscape assessment report will be prepared by Isthmus Group Ltd.
    - Geological Assessment;
    - Site Geometry and Layout
    - Terrestrial Ecology
    - Aquatic Ecology
- Cost Estimates for the two alternative sites including an updated cost for the previous Whakatikei Storage Dam solution;
- Determine a preferred site from the alternatives;
- Preferred site cost estimates for two future population scenarios
- Consideration of a staged dam construction approach for different population growth scenarios.

GWRC provided the required storage volume for the new sites based on new future population projections. This eliminated the requirement for additional hydrological assessments at this stage.

2. Live Storage Assessment Stage 2

2.1 Previous Live Storage Assessment Work

This Whakatikei Storage Reservoir Optimisation Study is intended to refine the outcomes from the LSA Phase 2 study by identifying alternative sites along the Whakatikei River that meet the required engineering criteria and can maximise the recreational and visual amenity value of the area.

The wider assessment of the Whakatikei catchment area is presented in the final reports from the previous LSA Phase 2 work. The significant reports related to this investigation are in section 15.

2.2 LSA Phase 2 Engineering Report Conclusions

The following lists the key conclusions reached from the LSA Phase 2 work[1].

- The assessment focused on the potential dam sites within the Whakatikei, Pakuratahi and Skull Gully valleys, with an objective to define a single preferred site for each valley for public consultation if a live storage option is part of the Council's final water supply strategy.
- Phase 2 assessments progressed partly through what is termed the pre-feasibility stage for investigation for each of the dam sites, based on the information available in the geological assessment and advice received from GNS regarding the seismicity of the region.
- Contour data for the reservoir volume estimates and dam axis cross-sections was developed from LIDAR Survey around each of the sites.
- All sites are in highly seismic areas due to their proximity to either the Wellington Fault or Wairarapa fault. The Whakatikei dam site is also in proximity to the Moonshine fault for which there is limited data on its time of last movement or recurrence interval. However suitable dam types can be designed for each site to resist the earthquake induced ground shaking. The GNS studies indicate that there is no displacement hazard through the recommended dam sites due to active faulting.
- A suitable dam site was recommended for each catchment with a dam layout developed using an RCC gravity dam. Site access requirements were also determined. Preliminary cost estimates have been prepared for all three sites, which include the costs of all the project elements such as the dam, access requirements, pipelines, roading upgrades and water treatment facilities, where applicable. s7(2)(h), s7(2)(i) [redacted]
- The proposed dam locations were:
    - Skull Gully – On Skull Gully Stream some 600m upstream of the confluence with the Wainuiomata River;
    - Whakatikei - On the Whakatikei River some 2500 m upstream of the confluence with the Wainui stream;
    - Pakuratahi- On the Pakuratahi River at Ladle Bend.

[1] *Live Storage Assessment Phase 2- Engineering Assessment*, MWH, June 2007.

3. Whakatikei Storage Optimisation

3.1 LSA Phase 2 Storage

The MWH report *Live Storage Assessment Phase 2 – Engineering Assessment* recommended a total storage volume of 8,400 ML, broken down as follows:

Table 1 LSA Phase 2 Storage Volume for Whakatikei

Design requirement to provide 36 MLD for 90 days	4,900ML
Volume below base water level	500ML
Allowance for sedimentation over 100 years	700ML
Allowance for flushing flows	200ML
Allowance for climate change	1,000ML
Allowance for modelling and survey error	1,000ML
Rounding to nearest 0.5 m level	100ML
TOTAL	**8,400ML**

GWRC assessments have determined that when this storage is added to the storage of the upgraded existing storage at Stuart Macaskill lakes that this storage can supply a total regional population of approximately 486,000.

GWRC have determined that 2100 is adopted as the future date at which the storage dam supply capabilities would be exceeded. This was based on expected useful life of the storage and distribution infrastructure. GWRC have linearly extrapolated the Statistics New Zealand Medium Population Projection over this period to arrive this corresponds to a population of approximately 550,000[2].

This optimisation study considers the following scenarios that have been modelled in GWRC's Sustainable Yield Model (SYM) to determine the 2% ASP each will support:

- Current proposed storage volume of 8,400 ML;
- A storage volume and treatment capacity sufficient to supply a population of 500,000;
- A storage volume and treatment capacity sufficient to supply a population of 550,000.

3.2 SYM Modelling Results

GWRC's SYM was used to determine the required storage volume for the higher population projections. The outputs from this modelling work are shown in table 2.

Table 2 Storage volume requirements from SYM analysis

	500,000 population	550,000 population
Live Storage Volume Required	6,300 ML	11,000 ML
WTP Capacity Requirement	70 MLD	100 MLD

[2] Whakatikei Storage Reservoir – Optimisation Studies Discussion and Outline plan, GWRC November 2011.

3.3 Required Storage Volume

The required storage volumes for the LSA Phase 2 work together with the two higher population projections are summarised in table 3.

The output from GWRC's SYM analysis provided live storage requirements. Allowances were made for dead storage, sedimentation, flushing and modelling and survey error that were consistent with LSA Phase 2.

Table 3 Required Total Storage Volumes

	LSA Phase 2	500,000 population	550,000 population
WTP Capacity Requirement	36 MLD	70 MLD	100 MLD
Live Storage Volume Required	4,900 ML	6,300 ML	11,000 ML
Volume below base water level	500 ML	500 ML	500 ML
Allowance for sedimentation over 100 years	700 ML	700 ML	700 ML
Allowance for flushing flows	200 ML	200 ML	200 ML
Allowance for climate change	1,000 ML	N/A[3]	N/A
Allowance for modelling and survey error	1,000 ML	1,000 ML	1,000 ML
Subtotal	8,300 ML	8,700 ML	13,400 ML
Top Water level (TWL) at Spillway Crest	143.5 m	144 m	150.3 m
TOTAL VOLUME at TWL	8,400 ML	8,758 ML	13,500 ML

3.4 Storage Curves

Figure 3.1 presents the reservoir storage curve versus reservoir height from the LSA Phase 2 preferred dam location. This curve was prepared during the LSA Phase 2 works and it was agreed with GWRC that this would not be recreated for the new alternatives identified during this study.

The curve was derived from LIDAR survey contours at 2 m intervals.

A calculation was carried out to determine the storage curve for the largest dam case of 550,000 population, TWL of RL150m, at approximately 250m upstream. It was found that the storage volume reduced by approximately 2.7% when moving the dam 250m upstream. For the purposes of this exercise this was not considered significant in the analysis of the option locations and determination of the preferred site.

[3] Allowance for climate change for 500,000 and 550,000 population projections was included in the live storage figures provided from the GWRC SYM modelling work.

Fig 6.2 Whakatikei Reservoir Storage Curve

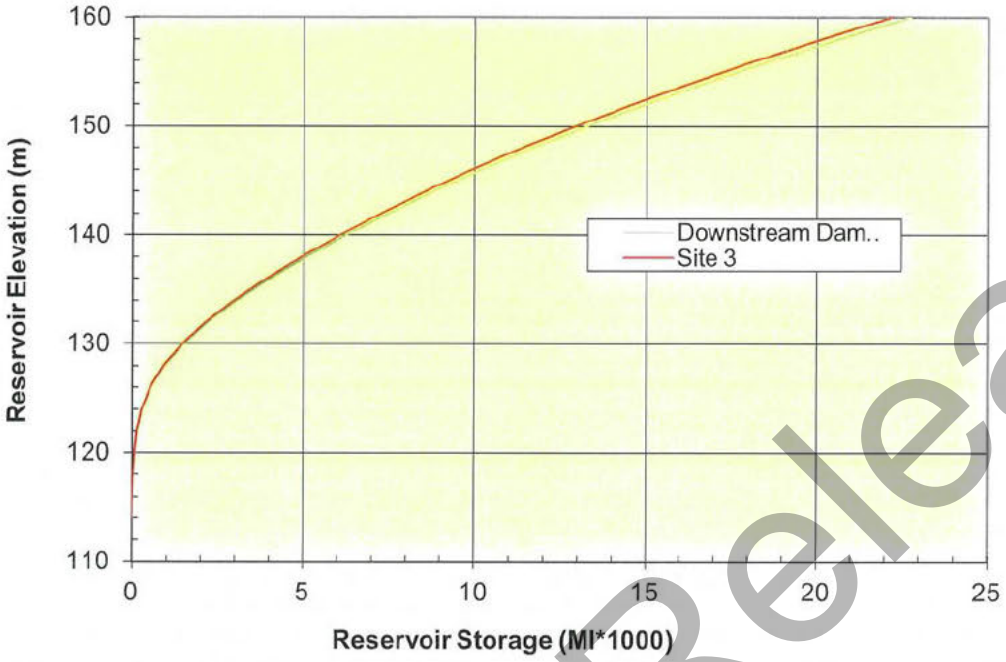

Figure 3-1: Reservoir Storage Curve

The top water level (TWL) for each option was determined using this storage curve. These volumes fall within the allowance for modelling and survey error .

Table 4 shows the TWL elevation for the dam options.

Table 4 TWLs and Dam Crest Levels

	LSA Phase 2	500,000 population	550,000 population
TWL Elevation (RL)	143.5m	144.0m	150.3m
Dam Crest level	151.0 m	151.5 m	157.5 m

4. Alternative Dam Locations

4.1 Identification Process

The process of selecting alternative dam sites was based on selecting locations that appeared to give similar foundation conditions to the LSA Phase 2 location so was approached from both Engineering, and Landscape/Visual perspectives. Three possible dam locations were chosen; the first being the original LSA Phase 2 location (Option 1), the second approximately 90m upstream from the original LSA Phase 2 location (Option 2) and third some 250m upstream from the original LSA Phase 2 location (Option 3). These are discussed below.

4.2 Option 1 – LSA Phase 2 Location

The first task was to review the location of the LSA Phase 2 Option recommended in 2007. This was moved approximately 10m downstream in order to allow a possible increase in crest height to the order of RL 158 m to accommodate the 550,000 population requirements. the dam axis needed to shift downstream by some 10 metres so as to not be following the 156 m contour along a high level valley. The original axis was chosen for estimating the relative cost of the project but in 2007 it was noted that detailed design may involve a shift of the axis upstream or downstream within a range of 100 m.

For the Whakatikei catchment, two potential dam site areas were initially considered in the Phase 1 study. Dam Site 1 was preferred and is at the lower end of the gorge that exits near Bulls Run Road. This is the site that was also included in Mandeno Chitty and Bell (1980). A second dam site was located at the upper end of the gorge, but was discounted from detailed study due to its proximity to the Moonshine fault, and the risk of surface rupture through the site.

In the Phase 1 Engineering Assessment report it was considered that a dam lower down the gorge is a preferred location for the following reasons:

- The dam is located further from the Moonshine fault. This reduces the risk of displacement at the dam site or the access to it.
- Less access distance is required up the gorge to the dam site making it easier and less costly
- Less pipe length is required to take the water down the gorge to the water treatment plant.

The LSA Phase 2 study focussed on Dam Site 1 location shown in Figure 1.

4.2.1 Advantages:

The main advantages of Option 1 are:

- Shorter access roads and pipelines resulting in a reduced cost for these items;
- Maximised available storage volume by better utilisation of the Whakatikei valley.

4.2.2 Disadvantages:

- There is potential for significant adverse visual impacts given the location of the dam;
- This location would destroy sections of the lower gorge that potentially have significant recreational values such as the lower rock pools.

4.3 Option 2 – Upstream of Deep Gorge Section

The desktop investigation identified the first alternative site selected as part of this optimisation study. This site is shown in Figure 2.

The first alternative site (Option 2) that appears feasible is a shift of the dam axis upstream by 95 metres to the next spur on the right abutment. This site would reduce the visual prominence of the dam as viewed from the ridgeline off the end of Bulls Run Road and may potentially retain the lower rock pools.

This site retains as many of the advantages of the original site as possible and whilst being located approximately 95 m upstream it potentially protects the deep gorge section of the valley which has been raised as possibly having significant recreational benefits for use as a swimming/bathing area. However

the proximity of a required stilling basin and cofferdam and diversion requirements may result in the pools being lost or significantly altered by construction activities.

4.3.1 Advantages:

The main advantages of Option 2 are:

- Less adverse visual impacts when compared to Option 1;
- Greater likelihood of retaining recreation values of lower gorge rock pools.

4.3.2 Disadvantages:

- Adverse visual impacts compared to upstream location options;
- Long pipeline and access routes when compared to Option 1.

4.4 Option 3 – Upstream of Bend

The second alternative site was initially narrowed to be within an acceptable area spanning approximately 50m beyond the sharp bend.

Geomorphic evidence indicated a number of inferred scarps on each side of the valley upstream of Option 2 until the dam axis was moved upstream by some 160 m and around a 90 degree bend in the river. For the next 70 m upstream, the valley is of fairly uniform shape and the alternative site (Option 3) could be accommodated within this reach approximately 250m upstream of the original LSA preferred site discussed in Option 1. For the purpose of comparison with the other sites, Option 3 was selected as far downstream as practicable, but with allowance for a stilling basin to reduce the energy of flood flows before these flows need to follow the 90 degree bend in the river.

This site significantly reduces the visual prominence of the dam and retains more of the downstream river bed including the location of the deep pools. Diversion tunnels are shorter relative to sites further upstream, and the distance of the low level access and pipeline route is shorter.

As noted previously the site is located with sufficient flexibility to accommodate a stilling basin at the toe of the dam before spill flows need to flow around the bend. Distances for low level access, pipeline route and diversion tunnel length are also minimised. There remains flexibility to move the dam axis upstream or downstream in the order of 30 m in final design if site investigations dictate the need.

4.4.1 Advantages:

The main advantages of Option 3 are:

- Less adverse visual impacts when compared to Options 1 and 2;
- Will retain recreation values of lower gorge rock pools.

4.4.2 Disadvantages:

- Longer pipeline and access routes when compared to Options 1 and 2.

5. Site Inspections

A site visit to inspect the three potential dam site locations was undertaken on 7th February 2012.

The objective was to make a comparison between the previous investigation work on the preferred LSA Phase 2 site with the new alternatives with a view to recording the physical attributes relevant to each discipline and identifying any significant potential flaws with these new sites.

The site inspection confirmed that there were no obvious fatal flaws to founding a dam at any of the sites i.e. Options 1, 2 or 3 as shown on drawing C01.Preliminary interpretation of the structural data collected demonstrates a broad geological correlation between Option 1 and 2,-. Minor variation in stratigraphic orientation of the rock strata was found but were not seen as show stoppers at any of the dam sites.

6. Discipline Assessments

6.1 Flood Routing

Given the new alternative sites were considered to be reasonably close to the original LSA Phase 2 site, the previous flood routing work from this LSA Phase 2 study was adopted and was assumed to be adequate for the purposes of this work.

Preliminary flood routing from the previous LSA Phase 2 Hydrological Assessment indicated that a 1 in 100 AEP flood would have a peak inflow of 229 m^3/s. If it is assumed that the reservoir is full at the start of the flood then the reservoir would rise by 2.2 m with a peak spill flow of 200 m^3/s, assuming a spillway width of about 30 metres. Under PMF conditions the inflow is 1085 m^3/s, the reservoir rise is 6.4 m and the peak spill flow is 1024 m^3/s.

For the purpose of estimating the dam volume a freeboard of 5.5 m has been assumed. This assumes some limited overtopping of the dam crest can occur at the PMF. For this study it was considered that stilling basin widths be limited to some 20 m, and that the crest length would more likely not exceed 25 m when allowance for a pier was provided to support access across the dam crest. The narrower spillway means that a flood range of 7 to 7.5 m should be applied above spillway crest to define the dam crest for the non-oveflow dam blocks. Table 4 TWLs and Dam Crest Levels provides the TWL and Dam Crest levels for all options.

Alternative spillway crest widths can be considered during final design, it was considered that there is a practical limit of around 30 m, due to the width of stilling basin that can be accommodated to return the flow to the river and the flow convergent angles typically used for flow down the spillway face.

6.2 Geotechnical Assessment

The preliminary geological assessment of the 2007 site indicates the dam would be founded on greywacke rock comprising interbedded sandstone and argillite. In this previous assessment, the greywacke is confirmed as being at relatively shallow depth across the dam site.

The geotechnical assessment at the new sites (Options 2 and 3) was undertaken to identify any significant discrepancies between the outputs from the previous Phase 2 assessment, as outlined in the MWH document; Phase II Geotechnical Assessment Report (February 2007).

6.2.1 Regional Geology

The regional geology surrounding the Whakatikei River is well described in the GNS Science publication *'Assessment of potential fault surface rupture at three proposed Wellington water storage dam sites*, Begg et.al (2006).

Additional geological detail can also be found in the *Phase II Geotechnical Assessment Report (February 2007) as well as the* GNS QMAP publication #22: Geology of the Wellington Area (1996).

The nearest active faults to the proposed sites are the Wellington Fault (4.2 km SE) and the Moonshine Fault (860m NE).

6.2.2 Walkover Reconnaissance

During the site visit, a preliminary basic mapping traverse was completed that investigated the outcropping geology at sites Options 2, 3 and 4.

Rock types noted are summarised in section 6.2.3 of this report. Basic structural measurements of the exposed rocks were also taken so that an evaluation of prior work would be completed.

Other geomorphic and landscape features were also recorded as outlined under Section 6.2.5.2.

6.2.3 Geological Observations

The main rock type dominating the exposure at river level is an alternating siltstone and sandstone sedimentary sequence known as the 'Torlesse Supergroup'. Common to the Wellington region, it is known as 'Greywacke'.

The rocks exposed have been described according to the NZ Geotechnical Society guidelines as the following:

> *A light brown grey, strong-very strong, slightly weathered medium-fine grained sandstone-siltstone GREYWACKE.*

In most outcrops they aredense, and have multiple opposing joint sets that are close to very closely spaced.

No significant fault or crush / breccia zones were observed during the site visit.

The hillside above the river environment has an angle of 45° and rises from river level +100m to the top of the slope. In some places the slopes are blanketed with very loose, angular, sand bound gravel otherwise known as landslide scree debris. Capping the surrounding hillsides is a variable thickness of colluvium, loess and silty organic soil.

6.2.4 Structural Geology

All basic structural measurements collected during the site visit were analysed with the DIPS computer program, for geological irregularities. This method provides the most accurate comparison of the observations made during the recent site visit with those made during the previous assessment.

Bedding and joint orientation data gathered during the site visit is provided in Appendix A.

6.2.5 Geological Assessment

6.2.5.1 Geological Interpretation

Preliminary interpretation of the structural data collected demonstrates a broad geological correlation between the original 2007 site Option 1 when compared to Options 2 & 3 upstream. Minor variation in stratigraphic orientation of the rock strata was found but no evidence of major faults or crush zones were found at the sites.

Stereoplots for site Options 2 and 3 are found in Appendix B.

6.2.5.2 Geomorphic Interpretation

Topographic and aerial photographic interpretation reveals several landslide or rock slide features present along all sides of the river gorge. The development of these features is likely related to the undercutting nature of the river itself. These features were confirmed during the site visit with the observation of landslide debris deposits near the river edge. Landslide scarps responsible for these rock debris deposits are located further above.

It is highly likely that these slopes will continue to shed material as part of the Whakatikei gorge geomorphic development. These loose shallow scree deposits will need to be accounted for during the preliminary dam design process, i.e.: the provision for minor shallow scaling of the slopes adjacent to the dam and reservoir to remove this loose rock material.

6.2.5.3 Geohydrology

During the site visit some minor isolated water seepage was noted from between the jointed sandstones at site Option 2. It was unclear where the source of the water originates, though it is likely to stem from significantly further above the river gorge in the hillside catchment above. Further investigation would be required to determine the extent of seepage but at this stage it is believed that this feature would not have any detrimental effect on a proposed dam structure.

6.3 Dam Features

The dam features are common to all 3 sites and are based around the following:

1. A concrete gravity dam. Either roller compacted concrete (RCC) or faced symmetrical hardfill dam (FSHD), as an alternative.
2. A central ungated spillway over the dam crest leading to a stilling basin at the dam toe
3. An intake structure to the right of the spillway supplying a pipeline to the water treatment plant and bypass valve direct to the river that can therefore handle minimum flows
4. From a dam geometry perspective it was believed that Option 3 appeared to be slightly more favourable due to the increased overall width of the gorge at this location and therefore provides more options with regard to stream diversion during construction, i.e. it offers a sluice diversion option.

6.3.1 Alternative Construction Techniques

An alternative to the RCC dam option adopted across the Skull Gully, Pakuratahi and Whakatikei site options considered in 2007 is the Faced Symmetrical Hardfill Dam (FSHD). Hardfill dams are built from a relatively low-grade roller compacted concrete without joints, with a sloping upstream and downstream face with an impermeable membrane on the upstream face. The strength of the hardfill need not be as high as RCC which allows reduced cement contents and or by using as-dug river gravels and/or quarry waste equivalent materials.

Advantages of FSHD include:

- Low compressive and shear strength requirements for the hardfill
- Reduced cement quantities, which result in lower unit costs – partially offset by greater material volumes
- Even spread of stress across the foundation
- Little requirement for tensile strength
- Excellent seismic resistance
- Capable of construction on weaker foundations
- Little or no requirement for joint preparation between placed layers
- Minimum foundation treatment
- Ability to over-top during construction and when complete.

Disadavatages of FSHD include

- Require a greater foundation footprint
- Require a greater volume of materials
- Construction duration likely to increase

There is well established precedence for FSH dams in the 40 to 60 m range, with the highest being in excess of 100 m being the 107 m high Cindere dam located in the west Anatolia Region of Turkey, in the highest seismic zone area in the Seismic Zone map of Turkey.

6.4 Seismic Hazard

As part of the Phase 2 studies, GNS (reference GNS *Assessment of potential fault surface rupture at three proposed Wellington water storage sites*) has reviewed the faulting in the vicinity of the Whakatikei dam site and examined in the field areas around the dam site. This work has better defined the location of the NE-SW striking Moonshine Fault through more detailed aerial photograph interpretation, field investigation and study of high resolution LIDAR data. The fault crosses the Whakatikei River obliquely some 860m upstream of the proposed dam site, and passes some 500m to the north west of the dam site. The site itself is inferred to be free from surface rupture hazard. At the upstream site, which was discounted during the Phase 1 study due to proximity to the Moonshine fault, GNS has noted the presence of shearing at the site during this Phase 2 assessment. This observation of shearing suggested a surface rupture hazard at this site and justified the earlier decision to discount this site.

The Whakatikei dam site is located approximately 4.5 km from the active Wellington Fault. Other nearby faults include the Akatarawa Fault, that passes within 2 km of the dam site and the Moonshine Fault that passes within 500 m of the site.

The detailed design of the dam will need to account for the significant ground shaking that will occur with rupture of the active faults, including the Wellington, Akatarawa or Moonshine faults.

6.5 Baseline Recreational Assessment

Isthmus were engaged to provide landscape input to the selection of a preferred dam site and a baseline landscape assessment of the existing environment. The full report is included in Appendix G.

This section summarises the key findings.

6.5.1 Existing landscape features and significance

Landscape values of the proposed reservoir site were evaluated in the context of the wider Whakatikei catchment, with reference to those parts of Section 6 and 7 of the RMA relevant to landscape matters. Moderate to high natural character values were identified across the area that would be affected by the proposal and two natural features were identified in the area that warrant consideration as 'Outstanding Natural Features': the 'Tawa Terraces' along the eastern side of the river basin and the 'Upper Whakatikei Gorge' at the head of the reservoir.

6.5.2 Potential landscape issues, opportunities and design strategies

Landscape issues identified relate primarily to potential adverse effects on (1) natural character of the Whakatikei River and its margins, (2) the two 'Outstanding Natural Features' (ONF) identified, and (3) landscape aspects of amenity values including visual amenity and recreation. Most adverse effects were assessed as potentially moderate, moderate-high or high as would be expected given the nature of the project and the relatively natural character of the catchment. Additional adverse effects were also identified with the 150.3 RL inundation (550,000 population) option with respect to: (1) flooding of the Tawa Terraces ONF and, to a lesser extent, the 'Upper Whakatikei Gorge' ONF (2) natural character values, (3) natural landforms, vegetation and terrestrial habitats, and (4) visual amenity.

However, the preferred dam site is likely to moderate some of these adverse effects compared to the other alternative dam locations, and, while it will have some adverse effects, the proposed reservoir will also be a 'naturalistic' feature with its own aesthetic amenity and a degree of natural character. Recommended design measures to address earthworks, access tracks, ecological restoration and offset planting, reservoir management regimes and structures design would also help to avoid, remedy and mitigate for these effects. Further opportunities to provide for potential positive effects include a possible network of cycle (mountain bike), walking and bridleway tracks. A best practice approach would be to establish a design 'Framework' to address these matters as part of the NoR application given effect by Condition. This Framework can then developed into an integrated Landscape Management Plan at the Outline Plan stage of works.

6.5.3 Key Assumptions

- The assessment was based on field and aerial survey by helicopter and desktop study and relied on information provided in the 2007 Phase 2 Feasibility Study, GWRC staff and the MWH Optimisation Study team.
- Landscape opportunities identified are based on the assumption that strategies can be put in place to avoid permanent exclusion zones around the reservoir and in the wider catchment.
- This appraisal takes account of matters addressed by Section 6(c)-(f) in the RMA to the extent that they influence landscape values but does not take the place of specialist discipline assessments such as ecology, heritage and tangata whenua matters.
- This is a preliminary assessment for the purpose of determining the viability of the project in terms of landscape matters and refining the design. Such assessments would be developed in more detail once the project description is confirmed.

6.6 Ecology

6.6.1 Terrestrial Ecology

In assessing the impacts of the preferred Whakatikei dam option for the 550,000 population base the 2007 terrestrial ecology assessment has been reviewed with a focus on the vegetation classification plan with a RL150.3m reservoir level overlay. Recent higher definition aerial photography has also been analysed.

While it is difficult to discern any difference spatially between the two reservoir levels one can determine the vegetation types affected with a reasonable degree of certainty.

It is apparent that the reservoir level at RL 150.3m would impinge on more cut over podocarp-broadleaved forest and regenerating broadleaved scrub and low forest associated with the steep hillsides upstream of the preferred dam sites (Options 2 and 3). The steep terrain ensures though that the additional area of forest and scrub vegetation affected represents only a small portion of the overall extent of these vegetation types present in this reach of the valley.

Other indigenous vegetation types affected by a higher reservoir level are riparian vegetation associated with the bluffs, rocky outcrops and steep banks bordering the river within the gorged section at the head of the reservoir and an area of cut over podocarp-broadleaved forest associated with a broad terrace that abuts the true left bank of the river downstream from the gorged section. In the case of the riparian vegetation, the steeper gradient of the river within this confined reach ensures that a metre increase in the reservoir level would affect only a small area of riparian vegetation comprising of mainly woody shrubs and herbaceous species of a low stature. However the cut over beech-podocarp-broadleaved forest that exists further downstream would be inundated to a greater degree relative to the overall extent of this forest (as mapped in the 2007 assessment) owing to the lower relief of the terrace landform.

Option 3 would result in less cut over podocarp-broadleaved forest and broadleaved scrub and low forest being inundated in the lower gorged section due to the upstream position of the dam site.

Based on this high level assessment it is expected that no new vegetation types and by inference wildlife habitats would be affected by the RL150.3m reservoir level.

6.6.2 Aquatic Ecology

The differences between the LSA Phase 2 site and the options have been considered with regard to the aquatic ecology. The largest dam site located 250m upstream of the LSA Phase 2 site would have a TWL that would increase from 143.5 RL to 150m RL. The reservoir area would increase from approximately 68 Ha to 83Ha and its length would increase from approximately 4.9 km to 5.4 km. Thus the scheme furtherest from the 2007 site would convert an additional 0.5 km length of flowing river into lake.

The upstream extent of the reservoir lake would reach 20m beyond the Paddys Creek confluence, nearly 800m further upstream than the upper extent of the LSA Phase 2 lake. These differences are relatively neutral with respect to the aquatic ecology because the additional length of affected river is small and because the loss of riverine habitat would be partially compensated by the gain in lacustrine habitat. This change would tend to benefit some fish species over others, for instance it has been suggested that a lake may benefit trout at the expense of dwarf galaxias populations (Joy 2006). Nevertheless, the difference between the two lake options is considered to be negligible. Similarly, the potential loss of migratory fish access into the upper catchment, which will be one of the more substantive issues associated with the scheme, would be similar for both options. (The Whakatikei catchment supports at least five diadromous fish species which would be prevented from accessing habitat upstream of the dam).

Another potentially significant issue, the impact of flow regulation on the lower river, might be influenced by the proposed increase in total storage volume from 8,400 ML to 13,400 ML. A larger volume has a greater potential to dampen the natural flow regime in the lower river by storing a greater proportion of small to moderate freshes. However there may also be a greater ability to mitigate such effects, by increasing the allocation for flushing flows.

In summary, there is little difference between the options in respect of their potential adverse effects on the aquatic ecology. Both include substantial issues that would need to be comprehensively assessed and mitigated through the consent application process.

7. Construction Issues

7.1 Permanent and Temporary Access Roads

As discussed in the 2007 reports an upgrade of Bulls Run Road and Moonshine Road is required to manage construction and traffic to/from the dam and WTP.

The project will also require access roads to the dam from the end of Bulls Run Road and possibly a haul road to retrieve aggregate from within the valley upstream of the dam.Drawings for the proposed Whakatikei access and haul roads are contained in Appendix B of the *Live Storage Assessment Phase 2, Engineering Assessment (Final), May 2007*.

The access and haul road quantities were increased/decreased to allow for the different site locations as can be seen in the spreadsheets in Appendix F.

However, on deciding a preferred option the access and haul roads were amended to cover the following:

- Lowering of the lower access road to allow for a closer correlation with the indicative water supply pipeline route to the WTP from chainage 520m as indicatively shown in drawing C02
- Adjusting the haul road from the dam to merge in with the 2007 route in order to evaluate quantities of cut relating to the haul road finishing at the dam crest level for the 500,000 population, RL152m. It is envisaged that the haul road will need to be altered as the project proceeds to allow for dam construction
- An additional small road to the WTP has been allowed for as can be seen in drawing C02

The lower access road does not tie in with the indicative water supply pipeline at the lower reach where the pipeline goes under the spur. The final pipeline route to the WTP is something that needs to be further considered as part of a detailed design. It is still assumed at this stage that the temporary haul road of 3m in width with passing bays every 100m (average overall width 4.0m) from the dam site to a gravel source is approximately 1km upstream of the dam site. This gravel source location as it stands may not prove to be the final location to source materials required for dam construction. It is envisaged that this temporary road will be under the dam lake at the completion of the dam construction. At this stage a temporary haul road has been assumed for the purpose of establishing a project cost estimate. However, alternatives may produce lesser costs if aggregate supplies are from alternative sources and no haul road is constructed.

7.2 Access Road Assumptions

- Access roads are 4m in width with a 1m side drain on one side
- The access roads are designed such that they will remain in use for the same expected life as the dam
- All bridges shall be single lane and have guardrails
- Side protection guardrail is required for 20m either side of each bridge in both directions
- Cut material disposed of within 2km radius
- Transverse culverts, to facilitate stormwater runoff, are installed every 60m to reduce the risk of overtopping, scouring and undermining of the road
- The access roads are conceptually designed to ensure that no part of the upper access route will be under water during a 1 in 100 year flood event
- All cut batters are benched with a maximum envisaged cut being approximately 35m at this stage. There has been no detailed geotechnical investigation to verify if this cut slope if feasible at all locations
- The minimum horizontal radius adopted is 20m
- The maximum vertical grade adopted is 15%
- Pavement depth – 300mm.
- Chipseal wearing surface is used.

7.3 Aggregate and Cement Supply

The Phase 2 Geotechnical Assessment Report indicates that aggregate sources are available in the reservoir area upstream of the dam site. Testing of the aggregate source will be required to ensure that suitable quantities of aggregate and sand can be produced. It is likely that some crushing and grinding will be required to produce enough fines to allow reduction in cement volumes in the RCC mix.

An alternative source of aggregate for the RCC mix is to utilise some of the cut to waste volumes from the haul road construction or supply from the Hutt River. Some 90,000m^3 is expected from digger and truck operations, compared to a dam volume of approximately 35,000m^3. At this stage it has not been confirmed whether supply from the Hutt River can be guaranteed, as it would be subject to separate consents which was outside the scope of the Phase 2 investigations. Material from around the site may well suit the FSHD option.

Depending on the aggregate source the concrete could be batched either upstream or downstream of the dam site. Sites for batching downstream of the dam will need to be located clear of the contractors area for construction of the water treatment plant. Final aggregate sources are a matter of detailed investigation, and material testing that would be undertaken in subsequent phases of detailed dam design.

Approximately 5000 tonnes of cement will need to be transported to the concrete batching plant for an RCC dam, and approximately 4000m3 for a FSH dam.

7.4 Water Supply – Dam to Water Treatment Plant

From the dam it is necessary to deliver the water to the treatment plant at the end of Bulls Run Road. The minimum operating level at the dam is set at elevation 126 m and the inlet to the water treatment plant is approximately 115m. It is envisaged that the pipeline is to be located under the lower access road where possible. An indicative alignment has been chosen with a conservative fall, with the final alignment to be determined through design to avoid unnecessary height differences between the road and top of pipe. At this stage the lower access road has attempted to follow the RL128m contour to minimise where possible the depth to invert but final lower access road and pipeline levels will need to be co-ordinated through detailed design.

Once out of the Whakatikei Gorge there are alternate pipeline routes to get to Bulls Run Road and the WTP. Option 1 is to tunnel through the ridge and lay the pipe in the tunnel. Option 2 is to follow the Whakatikei River down to the confluence of the Wainui stream and then follow the Wainui stream back up to Bulls Run Road and the WTP. The latter is a longer and more circuitous route. The more economic route should be considered as part of any final design process. For cost estimating purposes at this stage Option 1 has been assumed.

8. Construction Staging

It is possible to stage the construction of either an RCC dam or FSH dam to build the crest to RL 151 m initially and then to RL 157.5 m at a later date as the population demand increases. The concept of the staging is indicated in drawing Z1990400 C01 in Appendix C.

For the staged approach it is recommended that the excavation and stilling basin be sized for the ultimate design and grout and drainage curtains are constructed at the first stage of construction. The staging then becomes a more straight forward concrete placing project with the old and new concrete being dowelled together. It would be advisable to partially lower the reservoir during the construction of the Stage 2 works so that both new and old concrete act together when the raised reservoir force is re-applied to the dam. In constructing the second stage i.e. 550,000 population size it is advisable to construct a high capacity bypass from the intake back to the river.

Broad costings have been completed for a staged approached and are outlined in Section 11.

9. Cost Comparisons (2007 Storage Volumes)

9.1 Costing Estimating Process

The site option costing process adopted for this work followed the following key stages:

- Dam and roading cost estimates have been worked up for all the options considered for a dam size equivalent to the 2007 size i.e. equivalent TWL of RL143.5m;
- The dam pricing only considers RCC construction
- For Option 1 (the 2007 Whakatikei site), cost escalation factors will be applied to bring this site into December 2011 costs;
- Water treatment plant costs will be factored up on a per MLD basis based on similar WTP in New Zealand where appropriate.

9.1.1 Limitations and Assumptions

In performing the cost estimating work it is important to keep in mind the following limitations and assumptions:

- The contract procurement model is critical – competitive design & construct can be substantially cheaper than Alliance or public-private partnership.
- With regard to water treatment the allocation of process risk is important, as risk often equates to extra cost. Refer to section 11.1.5.
- In terms of limitation any cost estimating is time dependent, and is subject to change as the market conditions change (e.g. construction boom time or lean time, changes in commodity prices etc.).

9.2 Methodology

The dam site option cost estimating was based on the revision of the costing spreadsheets for LSA Phase 2 as outlined in the costing report titled "*Live Storage Assessment Phase Two – Cost Estimate Report Final*" dated June 2007.

As quantities for the RCC dam and roads changed according to their location these quantities were recalculated from a bottom-up basis. New rates were updated to December 2011 using the Capital Goods Price Index (CGPI), from the Department of Statistics, New Zealand for the relevant item, i.e. pipelaying, general civil etc. s7(2)(h), s7(2)(i) [redacted]

s7(2)(h), s7(2)(i) [redacted]

9.3 Option 1 – 2007 Location

Option 1 is the 2007 site for the Whakatikei dam. This was very slightly adjusted to produce a more accurate fit between spurs but does not significantly affect s7(2)(h), s7(2)(i) [redacted]. Hence, the cost estimate involved updating the existing spreadsheets using the CGPI for the RCC dam, roading, water treatment plant and GWRC works. As requested by GWRC, the item titled "*Common GWRC ancillary work on distribution system*" was removed for this phase of the project s7(2)(h), s7(2)(i) [redacted]

s7(2)(h), s7(2)(i) [redacted]

9.4 Option 2 – Upstream of Deep Gorge Section

s7(2)(h), s7(2)(i) [redacted]

While the diversion works for Option 2 are less than for Option 1 the dam volume is slightly greater and there is an additional 90m of water supply pipeline to the WTP, however the costs of these generally balance out overall. The primary element that increases the cost of Option 2 is the additional cost of the access roads and in particular the required cut from the steep hillside. The road costs are based on the

slightly reduced length of haul road being constructed at the same level as indicated in Option 1 in the 2007 report, with the upper access road being constructed to the 550,000 population level of RL158.

s7(2)(h), s7(2)(i) [redacted]

9.5 Option 3 – Upstream of Bend

Option 3 is located approximately 250m upstream of Option 1.

In similar fashion to Option 2 the main cost increase relates to the increased access roading required i.e. additional 250m of lower and upper access roads and there is an additional 250m of water supply pipeline to the WTP. There is a negligible difference in the cost of the RCC dams in all three options, Option 3 has the lowest RCC dam cost. s7(2)(h), s7(2)(i) [redacted] and this is primarily due to the greater volume of cut required through the steeper hillside as the dam is located upstream of the bend. Again the road costs are based on the slightly reduced haul road being constructed at the same level as indicated in Option 1 in the 2007 report with the upper access road being constructed to the 550,000 population level of RL158 as stated above.

s7(2)(h), s7(2)(i) [redacted]

9.6 Discussion

s7(2)(h), s7(2)(i) [redacted]

A factor causing this is because when the slightly reduced dam cost for Option 3 is offset with the increased roading cost the overall cost increase is minimal. From an RCC dam perspective there is very little difference between dams, again there are gains and offsets such as increased quantities relating to the RCC dam quantities offset with an increase/decrease in the diversion tunnel lengths.

s7(2)(h), s7(2)(i) [redacted] The WTP cost was based on the 2007 breakdown with the major items factored up using the CGPI. s7(2)(h), s7(2)(i) [redacted] For this stage the cost of the WTP does not play a major role in the cost decision making of a preferred site as its size is constant for all three options.

10. Preferred Site Selection

A preferred site selection process was completed with the intention of addressing the main points of difference between the three site options. The process followed was not a full MCA but rather a mechanism for the project team to assess the three sites with the key project drivers in mind of engineering acceptability and landscape/recreational benefits.

The list of attendees were:

- s7(2)(a) [redacted]

10.1 Criteria

The agreed criteria were determined through a collaborative exercise involving the attendees. The expectation was that the criteria would focus on the project drivers as well covering the key points of difference as identified through the various discipline assessments.

Table 5 Preferred Site Selection Criteria

Criteria	Description	Elemental Weighting	Total Criteria Weighting
Geology	General geotechnical suitability of site	s7(2)(h), s7(2)(i) [redacted]	
Environmental Effects	Retaining natural character incl. native veg, terrestrial habitat		
	Minimising adverse landform amenity (incl. earthworks)		
	Retaining outstanding natural features		
Social	Retaining public access to rivers		
	Minimising adverse visual amenity		
	Retaining existing recreational values		
	Potential for positive recreational benefits		
Constructability	Dam geometry required due to gorge shape & ability to construct differing dam types		
Capital Cost	Low, Medium or High comparison.		
TOTAL			

10.2 Scoring

It was agreed that an assessment would be undertaken on all three sites. This was to confirm that the Options 2 and 3 were superior, or otherwise to the original LSA Phase 2 site (Option 1).

During the assessment the scoring given to each criteria was reached through a consensus with the possible values given ranging from 0 to 5. The scoring was not ranking based meaning that sites that compared closely on any given criteria could be given identical scores. A score of 0 represented a site containing a fatal flaw whereas a score of 5 represented the best with respect to that particular criteria.

10.3 Outcome

The completed scoring and commentary from the assessment is included in Appendix H. Table 6 shows the summary scores for each option.

Table 6 Summary of Scores for Preferred Site Selection

Greater Wellington Regional Council
Whakatikei Storage Optimisation Study
Preferred Site Discussion
Project: Z1990400

		Criteria				
		Geology	Environmental Effects	Social	Constructability	Capital Cost
	Site	s7(2)(h), s7(2)(i)				
Whakatikei	Phase 2 Preferred Site					
	Option 2					
	Option 3					

This assessment has identified that Option 3 is the preferred site for the potential Whakatikei Storage Dam. The second best site is Option 2 and the least preferred site is Option 1.

For the Geology criteria assessment the sites could not be separated. The desktop geology assessment combined with the limited site observations has concluded that the foundation requirements are very similar for this site when compared to the other two sites.

With the dam being located further upstream for Option 3, this had less adverse environmental effects and provided for greater potential recreational benefits due to access to the lower reaches of the river, therefore Option 3 scored higher in the Environmental Effects and Social criteria.

It proved difficult to separate the scoring of the sites for the Constructability criteria as the required geometry is similar and all are suitable for RCC and hardfill dam construction techniques.

There was also insufficient justification to separate the site scoring of the Capital Cost criteria. Although Option 3 would have a longer access road and pipeline, the shape of the valley at this point enables the volume of concrete to be slightly less than Options 1 and 2. The potential diversion tunnel would also be shorter. These have the effect of pulling the Option 3 cost estimate back in line with the other two sites.

11. Preferred Site Costings

From the preferred site selection meeting discussed under Section 10 above Option 3 was chosen to be the overall preferred site.

The assumptions and cost development methodology are outlined in the sections below. It should be noted that as there is little difference between the 2007 population and 500,000 population dam sizes that therefore the RCC dam quantities are very similar. This is due to the assumptions made in 2007 about the expected demand compared to the demand figures used in 20012.

11.1 Cost Estimate (500,000 Population Projection)

s7(2)(h), s7(2)(i)

11.1.1 Dam Costing

The spreadsheet titled 'Option 3 – 500,000 Pop Size' contained in Appendix E highlights quantities (in blue) that have been adjusted for this size of dam. The RCC quantities for the dam volume have increased from 34,500m^3 as per the 2007 population to 35,600m^3 indicating very little difference in dam size. The supply pipeline to the WTP has increased by approximately 250m. The area for lake clearing was calculated by tracing the spillway level (TWL) at the RL144 and multiplying by the average width over the inundation area. This equates to an area of approximately 70 Ha. For the purposes of this study the topography adjustment is assumed to be within the estimating limits.

11.1.2 Moonshine and Bulls Run Road Upgrade

This cost was factored up using the CGPI index with no change in quantity from GWRC.

11.1.3 Main Access Roads

This item comprises a variety of elements as broken down in the elemental roading spreadsheets contained in Appendix F. All the assumptions remain as outlined in the "*Live Storage Assessment Phase Two, Cost Estimate Report- Final, June 2007*". It should be noted there have been two major areas where roading deviates slightly from the 2007 report. The first is the lower access road has been refined slightly to try and align more with an indicative water supply pipeline route.

Some further assumptions to note when carrying out the concept design of the extension of the lower access road are:

- 8m rigid truck used for tracking, one way traffic, minimum horizontal curve is 20m.
- Vertical curve length based on approx 50km/h (50m).
- New maximum cut is approximately 26m.
- Design road level is approximately 2m above the invert of the indicative route of the supply pipeline from chainage 520 to the dam.
- Design road is all in cut, no fill or retaining is required.

Additional design and refinement would be required to determine final road and pipeline alignments and levels.

The items altered are highlighted in blue and relate to quantities of both lower and upper access roads as well as the road to the WTP. With regard to the upper access road the road rise has been taken to RL158m which is the level of the ultimate dam size (550,000 population) with regards to this phase of work. Detailed design will be required to align this road to a final dam level. At this stage the tie in of the access roads to the dam is considered an issue that should be resolved during subsequent design stages.

Erosion and sediment control measures have also been increased on a pro rata basis to allow for the increased length of access road being constructed.

Overall, the quantities of cut have significantly increased due to both the increased length of access road to get to this site and because the dam has moved to a location past a steeper part of the gorge requiring greater cut faces.

11.1.4 Haul Road

Similarly to the "*Live Storage Assessment Phase Two, Cost Estimate Report- Final, June 2007*", it is envisaged that material will be taken from upstream. The haul road has been slightly altered over 250m

from the dam to allow for the haul road to rise to the height of the dam where cut is likely to be the greatest. Again, the cut has been limited to about 35m in height to align with the maximum cut heights for the access roads. The exact level of the haul road for the purposes of this exercise is not vital as it does not greatly alter the quantities for the purpose of estimating.

11.1.5 Whakatikei -Water Treatment Plant

The water treatment plant (WTP) is one of the major items within the overall estimate. It was agreed that this would be estimated on a per MLD basis. As a 'top down' estimate is being carried out it is acknowledged that there are significant issues that need to be highlighted when reviewing the top down numbers contained in the Whakatikei WTP item in Appendix D:

- Process costs are a significant portion of the overall WTP. This part of the work has not considered treatment options as part of this pricing exercise. s7(2)(h), s7(2)(i) .
- A number of WTP costs have been gathered for reference both within New Zealand and overseas in the case where it has been difficult to find a large WTP
- Cost of WTP's have been updated to December 2011 costings and then plotted on a graph to obtain a crude cost curve, this has then been checked using a smaller WTP to gain some level of correlation.

Advice has been sought from MWH colleagues in Australia and Canada who have been/are involved in the construction of larger WTP's. s7(2)(h), s7(2)(i) .

In New Zealand, MWH has been involved in a number of WTP's over the last decade, these include the Southern WTP, 40MLD in Dunedin in 2005 with the option of increasing size to 70MLD, Nelson WTP, 42MLD in 2001 and the Levin WTP 20MLD, 2010. In addition to this, MWH are currently working on a 116MLD WTP in British Columbia, Canada. The Southern and Nelson WTPs were based on actual final capital costs, all others were based on estimates at various stages of design.

The methodology used was to bring all these WTP costs up to December 2011 prices using the CGPI and plot these costs on a graph. For the 116MLD and 100MLD the cost range was plotted as commonally adopted in practice for this stage of estimating. An indicative costing curve was used to estimate high level costs for 70 and 100MLD WTP's

s7(2)(h), s7(2)(i)

11.1.6 GWRC Distribution Downstream of WTP

s7(2)(h), s7(2)(i)

11.2 Cost Estimate (550,000 Population Projection)

s7(2)(h), s7(2)(i)

11.2.1 Dam Costing

The spreadsheet titled 'Option 3 – 550,000 Pop Size' contained in Appendix E highlights quantities (in blue) that have been adjusted for this size of dam. Similar to 11.1.1 the RCC quantities for the dam volume have increased from 35,600m3 to 51,000m3, likewise the foundation quantities have increased . Quantities related to the other RCC dam components such as grout curtain and drain holes were increased on a pro rata basis. The water supply pipeline to the WTP has increased as discussed in Section 11.1.1. The area for lake clearing was calculated by tracing the spillway level (TWL) at the RL150. This equates to an area of approximately 82Ha.

11.2.2 Moonshine and Bulls Run Road

This cost was factored up using the CGPI index with no change in quantity from GWRC.

11.2.3 Main Access Road

This item comprises a variety of elements as broken down in the elemental roading spreadsheets contained in Appendix F. s7(2)(h), s7(2)(i)

s7(2)(h), s7(2)(i) The cost estimate for the access roads is discussed in 11.1.3 and is virtually the same as for the lower dam. The primary difference will be that the final upper access road will need to be shaped into the final dam crest level which in this case is approximately RL158.

11.2.4 Haul Road

This is as discussed under Section 11.1.4. While the haul road at this stage only rises to the RL152m this would need to be adjusted for the higher dam but for the purposes of this exercise exact final levels are not critical as the purpose of this exercise is the estimation of quantities for optioneering.

11.2.5 Whakatikei -Water Treatment Plant

The WTP is one of the major items within the overall estimate and aspects and methodology relating to costing has been discussed as per section 11.1.5 above.

s7(2)(h), s7(2)(i)

11.2.6 GWRC Distribution Downstream of WTP

These costs were provided by GWRC via a memo dated 15 March 2012 and have been updated as a line item in the Total Project Cost Estimates for the 550,000 population s7(2)(h), s7(2)(i) .

11.3 Staged Cost Estimate (450,000 - 550,000 Population Projection)

s7(2)(h), s7(2)(i)

11.3.1 Methodology

GWRC wished to investigate the option of constructing a dam that can be increased in size at a later date to accommodate the proposed increased population of 550,000. A brief meeting was held with GWRC to discuss the proposal and the following was agreed:

- The base estimate to be used would be based on the 2007 population size
- The base estimate would comprise all RCC dam elements that would be required at the 2007 population but with a larger foundation to be constructed as part of the smaller dam
- The Total Project Cost is formatted similarly to the Total Project Cost spreadsheets above but contains two columns one with the total base cost and the other containing costs relating to the staged increase in size of the dam to obtain the 550,000 population size.

11.3.2 Dam Costing

The spreadsheet titled 'Option 3 – Staged Costing' contained in Appendix E highlights quantities (in blue) that have been adjusted for this size of dam. The difference here is that the dam costs all relate to the 2007 population with the exception being item 5 in the RCC Dam breakdown spreadsheet contained in Appendix E. Item 5.00 will require the quantities as used in the dam for the 550,000 population with the exception of item 5.03 being the "RCC Concreting incl facing". One further item is included here called "Excavation to Stockpile" and will account for the preliminary stockpile of materials from the end of the haul road to the proposed WTP for use in RCC work at a later stage.

In the staged column the primary task is increasing the height of the concrete dam, item 5.03. This rate has been increased by a nominal 20% to account for preparation of the surface and take of materials from a stockpile by the WTP. s7(2)(h), s7(2)(i) Additional lake clearing will be required and s7(2)(h), s7(2)(i) of setting up batching plants, temporary works, compliance with Resource Consents and other bulk one off items required for a full dam construction.

11.3.3 Moonshine and Bulls Run Road

This cost will not change for the staged option.

11.3.4 Main Access Road

This item will have a nominal 100m of the upper access road that will need to be relevelled to accommodate the new dam height. There is an amount allowed for Stage 2 to account for the maintenance and repair of the access road during and after construction, as during this phase of work the access roads will be used for hauling materials.

11.3.5 Haul Road

As the haul road which was constructed for the main dam construction will be under water, materials will need to be hauled along the access road, therefore there will be no dedicated haul road.

11.3.6 Whakatikei -Water Treatment Plant

The WTP is one of the major cost items and this has been discussed under 11.1.5 above.

For a 550,000 population a 100MLD WTP is required s7(2)(h), s7(2)(i) [redacted]

11.3.7 GWRC Distribution Downstream of WTP

These costs were provided by GWRC via a memo dated 15 March 2012 and have been updated as a line item s7(2)(h), s7(2)(i) [redacted]

12. Summary of Parameters

Table 7 summarises the key parameters for the LSA 2 site and the preferred site from this Optimisation Study.

Table 7 Summary of Key Parameters

	LSA Phase 2	Preferred Site	
		500,000 population	550,000 population
Estimated stream bed level	111 m RL	112 m RL	112 m RL
BWL – Minimum operating level	126m RL	126 m RL	126 m RL
TWL – Spillway level	143.5 m RL	144.0 m RL	150.3 m RL
Dam crest level	151 m RL	151.5 m RL	157.5 m RL
Total Storage Volume	8,400 ML	8,760 ML	13,400 ML
Lake Area	68 Ha	70 Ha	82 Ha
Dam height above stream bed level	40 m	39.5 m	45.5 m
Dam height including embedment below stream bed level	45 m	44.5 m	50.5 m
Freeboard (spillway crest to dam crest)	7.5 m	7.5 m	7.2 m

13. Conclusions

It was found that Option 3 provided the preferred location with the most favourable points relating to landscape and recreational opportunities, with cost and construction issues comparable with the other option locations looked at. Below is an outline of conclusions for the various disciplines.

13.1 Geology

The aim of the site visit was to check and map the rock exposures found in the river for any possible features that may influence dam site location and to understand whether any geological change existed between Option 1 and Options 2, 3 as geological details were patchy in this upstream region.

Based on observational results only, no evidence of major faults or crush zones that may affect the stability of a dam structure was found in the bedrock exposure along the river.

Structural data and rock bedding orientation measurements were found to generally agree with those taken in previous mapping work. Therefore the geological properties of Option 1 are contemporaneous to that of Options 2, 3.

Based on observations and data gathered during the site visit of the 7th February, Options 2 and 3 have no significant geological features that would eliminate them from further consideration for a dam structure.

13.2 Dam

From a dam construction perspective there are a number of dam site options which are equally viable between the site selected in 2007 and within the reach of the river extending upstream some 350m which includes the alternative options. The RCC and FSHD types could be constructed at any of the sites looked at within this stage of the project.

13.3 Ecology

13.3.1 Aquatic Ecology

The preferred dam site would be located a short distance upstream of the LSA Phase 2 proposed dam site. The reservoir for the 550,000 population would be larger and would affect a longer reach of river. There is little difference between the 2007 location and preferred option in respect of their potential adverse effects on the aquatic ecology. Both include substantial issues that would need to be comprehensively assessed and mitigated through the consent application process.

13.3.2 Terrestrial Ecology

The 550,000 reservoir would be larger and would affect a greater area of indigenous vegetation cover, particularly cut over podocarp-broadleaved forest. Nevertheless there is little difference between the 2007 location and preferred option in respect of their potential adverse effects on terrestrial ecology values. Both include substantial issues that would need to be comprehensively assessed and mitigated through the consent application process.

13.4 Landscape and Recreational Assessment

Preferred Option 3 is located approximately 250m upstream of Option 1. Option 3 is situated around a tight bend in the gorge and therefore significantly reduces the visual impacts when viewed from the ridgeline off the end of Bulls Run Road. Option 3 would also completely protect the lower gorge rock pools.

13.5 Capital Cost Estimate

There is little difference in the cost estimates between the sites for the 2007 population size. s7(2)(h), s7(2)(i) [redacted] The items with the greatest influence in the total base estimate are the RCC dam cost, WTP and GWRC distribution costs. While there is some understanding of WTP costs for smaller WTP's more detailed investigation is required around costings for larger WTP's to get more accurate costings. s7(2)(h), s7(2)(i) [redacted]

14. References

Sources of reference for this report include:

1. Begg. J.G, Mazengarb. C. 1996: Geology of the Wellington Area, scale 1:50 000. Institute of Geological and Nuclear Sciences Geological Map 22. 1 sheet + 128p. Lower Hutt, New Zealand: Institute of Geological and Nuclear Sciences Limited.
2. Burns. D, Farqhuar. G, Mills. M, Williams. A., 2005. Field Description of Soil and Rock, Guideline for the Field Classification of Soil and Rock for Engineering Purposes. New Zealand Geotechnical Society Inc.
3. Suneson. Neil. H. 1993: The geology of the Torlesse Complex along the Wellington area coast, North Island, New Zealand. *New Zealand Journal of Geology and Geophysics, Vol.36:369-384.*
4. Varnes, D.J. (1978): Slope Movement Types and Process. In special report 176: *Landslides: Analysis and Control.* Schuster, R.L. and Krizek, R.J. (eds), TRB, National Research Council, Washington D.C: 11-33.
5. MWH, Phase II Geotechnical Assessment Report, February 2007, Greater Wellington Regional Council
6. GNS,Assessment of potential fault surface rupture at three proposed Wellington water storage dam sites, November 2006, Greater Wellington Regional Council
7. MWH, Live Storage Assessment Phase 2 Hydrology Report, March 2007, Greater Wellington Regional Council
8. MWH, Live Storage Assessment Phase 2, Dam Break Assessment, September 2006, Greater Wellington Regional Council
9. MWH, Live Storage Assessment Phase 2, Engineering Assessment (Final), May 2007, Greater Wellington Regional Council
10. MWH, Live Storage Assessment Phase Two, Cost Estimate Report- Final, June 2007, Greater Wellington Regional Council
11. MWH, Whakatikei Water Treatment Plant: Outline Design & Build Budget, May 2007, Greater Wellington Regional Council
12. MWH, Live Storage Assessment, Phase 2 Planning Supplementary Report, May 2007, Greater Wellington Regional Council
13. MWH, Phase 2 Live Storage AssessmentConsultation Summary, May 2007, Greater Wellington Regional Council
14. MWH, Live Storage Assessment, Phase 2 Planning Review Construction Issues, May 2007, Greater Wellington Regional Council
15. MWH, Live Storage Assessment - Phase 2 Environmental Investigations, March 2007, Greater Wellington Regional Council
16. MWH, Assessment of Terrestrial Ecology Values (Part of Phase II Investigations) Investigation of Three Potential Water Supply Reservoir Sites within the Whakatikei, Pakuratahi and Wainuiomata Catchments, March 2007, Greater Wellington Regional Council
17. Native Fish Survey
18. MWH, LSA Phase II, Pests: Plants & Animals, May 2007, Greater Wellington Regional Council

MWH

Appendix A: GWRC SYM Modelling Results and Distribution Costings

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21 December 2011

File No: B/01/14/12

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Dear s7(2)(a)

Whakatikei Dam Optimisation - Storage Volumes for 500,000 and 550,000 population

The SYM (Sustainable Yield Model) modelling work for Whakatikei has been completed and the results are set out below. This modelling work is based on a climate model adjusted for climate change, so no further allowance for climate change is required.

Population of 500,000

Usable storage volume required:	6,300 million litres
Maximum flow through WTP:	70 million litres per day

Population of 550,000

Usable storage volume required:	11,000 million litres
Maximum flow through WTP:	100 million litres per day

The total storage volume will need to include provision for dead water, sedimentation and flushing as previously, but not climate change.

Please do not hesitate to contact me if you need clarification or additional information.

Yours sincerely

s7(2)(a)
s7(2)(a)
s7(2)(a)

WGN_DOCS-#1003083-V1

15 March 2012

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Dear s7(2)(a)

Whakatikei Dam Optimisation studies -Estimated costs for delivery pumping station and pipeline for populations of 500,000 and 550,000

s7(2)(h), s7(2)(i)

In summary, and rounded to the nearest one million dollars these costs are as set out below. Note that engineering costs have been included but **no** allowance for contingencies has been made.

Population	Pumping Station cost	Pipeline cost	Total cost
500,000	s7(2)(h), s7(2)(i)		
550,000	s7(2)(h), s7(2)(i)		

Regards

s7(2)(a)

Whakatikei Dam Optimisation Study
Pumping station and delivery pipeline estimated costs for populations of 500,000 and 550,000 people

Asumptions:
1. Base estimates taken from reports #392895 and #381067
2. Design flow for 500,000 population 70 MLD, pipe size 850 mm dia.
3. Design flow for 550,000 population 100 MLD, pipe size 950 mm dia.
4. No allowance included for contingencies

Update of 2006 estimate

	Base estimate September 2006			Updated estimate Dec 2011		
Option	**CGPI**		**Estimated**	**CGPI**		**Estimated**
450,000 population option	**Class**	**Value**	**Cost**	**Class**	**Value**	**Cost**
Pipeline	S2CB	1386	s7(2)(h)	S2CB	1770	s7(2)(h), s7(2)(i)
Pumping station	S2CG	1310	s7(2)(i)	S2CG	1630	
Total						

Estimate of larger capacity Pumping Station and Pipeline

500,000 population option

850 mm pipeline

Laying cost increase say	s7(2)(h), s7(2)(i)	Assumed to be s7(2)(h), s of total cost
Pipe cost increase		Proportional to diameter. Assumed to be s7(2)(h), s7 of cost
Weighted cost increase		
Estimated cost for pipeline		

Pumping station

Electrical equipment and motors	Cost increase prortional to flow increase =	s7(2)(h), s7(2)(i)
Pipework and civil component	Cost increase prortional to sq root of flow increase =	
Weighted cost increase	s7(2)(h), s7(2)(i)	
Estimated cost for pumping station		
Total		

550,000 population option

950 mm pipeline

Laying cost increase say	s7(2)(h), s7(2)(i)	
Pipe cost increase		
Weighted cost increase		
Estimated cost for pipeline	s7(2)(h), s7(2)(i)	

Pumping station

Electrical equipment and motors	Cost increase prortional to flow increase =	s7(2)(h), s7(2)(i)
Pipework and civil component	Cost increase prortional to sq root of flow increase =	
Weighted cost increase	s7(2)(h), s7(2)(i)	
Estimated cost for pumping station		
Total		

28 MAR 2012

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26 March 2012

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Dear s7(2)(a)

Whakatikei Dam optimisation study - Staged construction of pumping station and delivery pipeline

As discussed this afternoon I have estimated the cost of staging the construction of a facility to service a total population of 550,000 people.

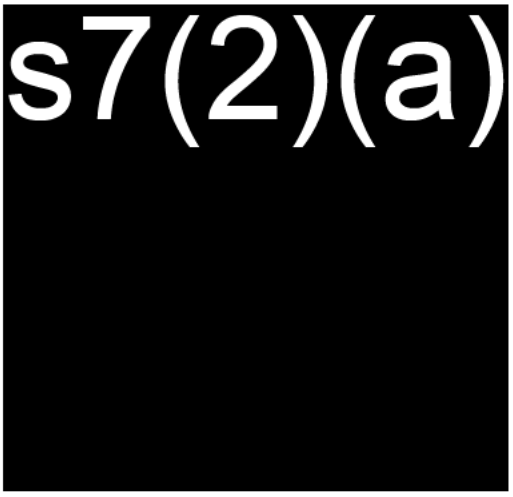
Assumptions:

1. Upgrade from 450,000 population (40 MLD) to 550,000 population (100 MLD)
2. Install full size pipeline (950 mm diameter) as part of stage 1.
3. Construct pump station civil and building works to full size as part of stage 1.
4. Install three 20 MLD pumps initially (two duty and one standby).
5. Install three additional 20 MLD pumps in stage 2 to give five duty and one standby.

Estimated costs:

The attached spreadsheet shows the way in which the costs for the pumping station and the delivery pipeline have been calculated. Below is a summary of the costs for stage construction.

	Pipeline	Pumping station	Total
Stage 1	s7(2)(h), s7(2)(i)		
Stage 2			
Total			



Whakatikei Dam Optimisation Study
Pumping station and delivery pipeline estimated costs for populations of 500,000 and 550,000 people

Assumptions:
1. Base estimates taken from reports #392895 and #381067
2. Design flow for 500,000 population 70 MLD, pipe size 850 mm dia.
3. Design flow for 550,000 population 100 MLD, pipe size 950 mm dia.
4. No allowance included for contingencies

Update of 2006 estimate

	Base estimate September 2006			Updated estimate Dec 2011		
Option	**CGPI**		**Estimated**	**CGPI**		**Estimated**
450,000 population option (40 MLD)	**Class**	**Value**	**Cost**	**Class**	**Value**	**Cost**
Pipeline	S2CB	1386	s7(2)(h), s7(2)(i)	S2CB	1770	s7(2)(h), s7(2)(i)
Pumping station	S2CG	1310		S2CG	1630	
Total						

Estimate of larger capacity Pumping Station and Pipeline
500,000 population option (70 MLD)
850 mm pipeline
Laying cost increase say s7(2)(h), s7(2)(i)
Pipe cost increase
Weighted cost increase
Estimated cost for pipeline s7(2)(h), s7(2)(i)
Pumping station
Electrical equipment and motors Cost increase proortioned to flow increase =
Pipework and civil component Cost increase proortioned to sq root of flow increase = s7(2)(h), s7(2)(i)
Weighted cost increase s7(2)(h), s7(2)(i)
Estimated cost for pumping station
Total

550,000 population option (100 MLD)
950 mm pipeline
Laying cost increase say s7(2)(h), s7(2)(i)
Pipe cost increase
Weighted cost increase
Estimated cost for pipeline
Pumping station
Electrical equipment and motors Cost increase proportioned to flow increase =
Pipework and civil component Cost increase proportional to sq root of flow increase = s7(2)(h), s7(2)(i)
Weighted cost increase s7(2)(h), s7(2)(i)
Estimated cost for pumping station
Total

#1027027

Staged Development (450,000 population to 550,000)
Assumptions:

1. Pipeline will be laid at full size (950 mm dia.)
2. Pump station building and civil work will be sized for full development (100 MLD flow rate)
3. Initial pump installation 2 duty and one standby @ approx 20 MLD each.
4. Upgrade requires 3 additional pump giving 5 duty and 1 standby @ approx 20 MLD each

Stage 1
Pipeline
Pump station civil
Pump station electrical and pumps
Total for pumping station
Total for pipeline & pumping station

Stage 2
Upgrade pumping station

Total for staged construction

s7(2)(h), s7(2)(i)

surcharge for working on existing live structure

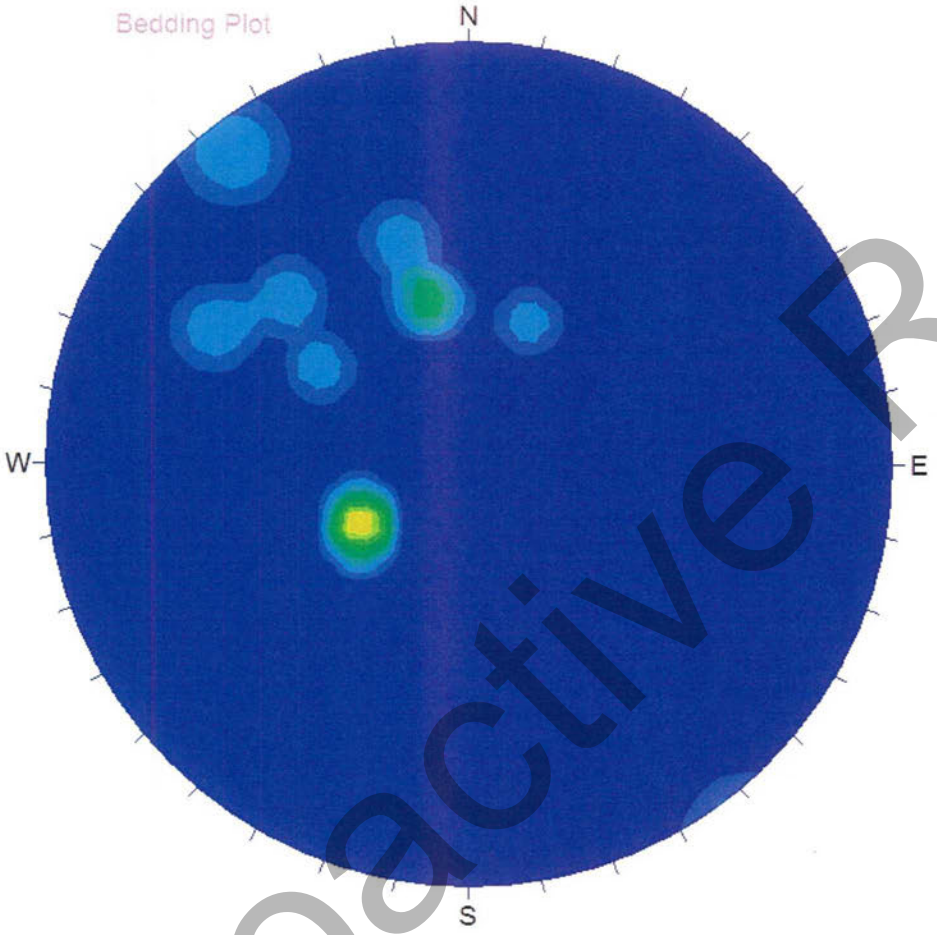
Appendix B: Stereo pole plots

NB: These stereoplots of data collected at Sites (Options) 2,3 &4 must be examined with data presented in the document; *MWH, Phase II Geotechnical Assessment Report (February 2007)*

(Please note that Option 4 originally referred to the extent of Option 3)

Observation summary

1) Some variation in bedding attitude between Option 1 and Option 2,3,4.
2) Strong correlation of joint subset 2a between Option 1 and Option 2,3,4.
3) Loose correlation of joint sets 1a, 2 and 3 between Option 1 and Option 2,3,4.

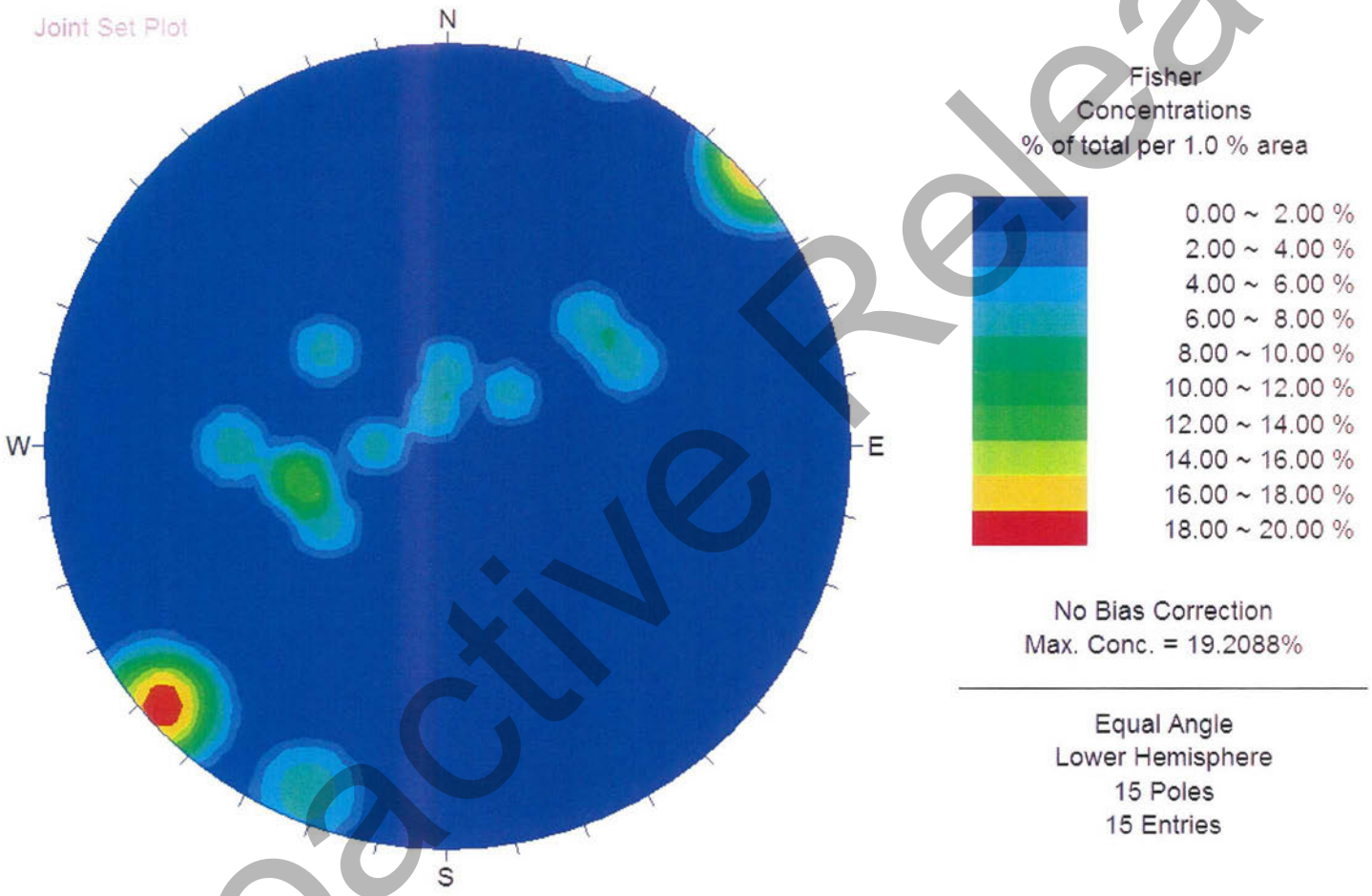


Fisher
Concentrations
% of total per 1.0 % area

0.00 ~ 3.50 %	
3.50 ~ 7.00 %	
7.00 ~ 10.50 %	
10.50 ~ 14.00 %	
14.00 ~ 17.50 %	
17.50 ~ 21.00 %	
21.00 ~ 24.50 %	
24.50 ~ 28.00 %	
28.00 ~ 31.50 %	
31.50 ~ 35.00 %	

No Bias Correction
Max. Conc. = 30.6116%

Equal Angle
Lower Hemisphere
12 Poles
12 Entries

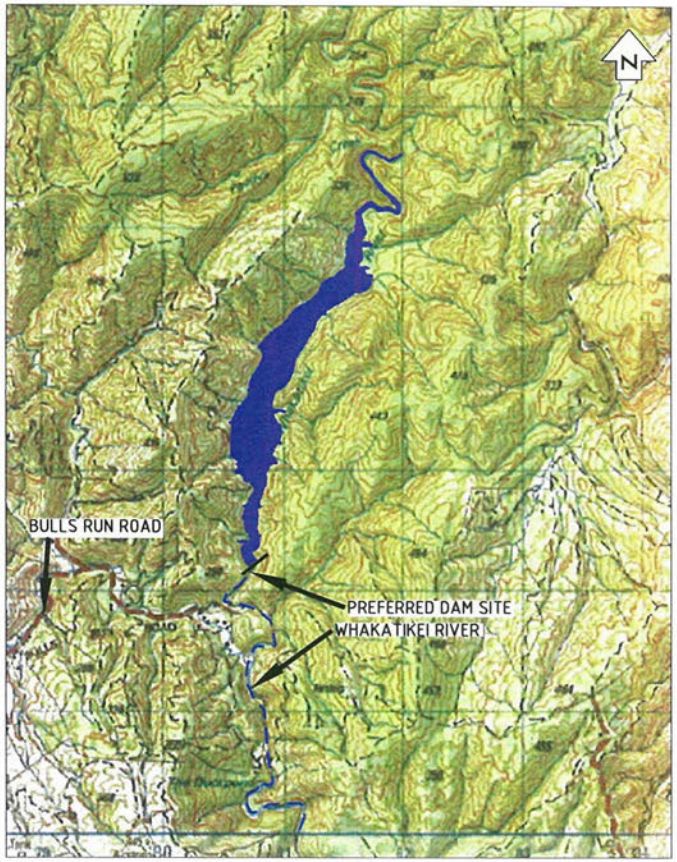


Structural orientation data gathered 7th Feb 2012

waypoint	Dip	Azi (dip direction)	type
16	20	90	Joint
16	56	90	Joint
16	42	78	Joint
17	23	230	Joint
17	22	180	Joint
17	42	128	Joint
18	52	245	Joint
18	10	160	Joint
18	86	50	Joint
19	40	77	Joint
19	50	228	Joint
19	90	48	Joint
20	39	57	Joint
20	85	22	Joint
20	85	45	Joint
16	34	32	Bed
16	32	45	Bed
17	85	120	Bed
17	45	100	Bed
18	44	140	Bed
18	58	140	Bed
18	68	95	Bed
19	60	110	Bed
19	30	41	Bed
20	34	33	Bed
20	40	180	Bed
20	42	146	Bed

Waypoint	S	E
16	41 04'47.9"	175 01'53.2"
17	41 04'47.1"	175 01'54.2"
18	41 04"46.5"	175 01"54.2"
19	41 04'45.7"	175 01'54.4"
20	41 04'41.0"	175 01'55.0"

Appendix C: Drawings



INUNDATION PLAN @ RL – 144m

LAYOUT PLAN WITH SITE OPTIONS

NOTES

1. OUTLINE SHOWING FOOTPRINT OF RCC DAMS
2. CREST WIDTH DRAWN TO 550,000 POPULATION SIZE

NOT FOR CONSTRUCTION

REV	REVISIONS	DRAWN	CHECKED	APPROVED	DATE
A	PRELIMINARY – FINAL DRAFT TO CLIENT	NB	GS	DH	30/03/12

	Name	Date
SURVEYED	-	-
DESIGNED	PF	-
DESIGN CHECK	EW	-
DRAWN	NB	06/03/2012
DRAWING CHECK	JH	-
APPROVED	DH	-

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WHAKATIKEI STORAGE OPTIMISATION

OPTIONS CONCEPT LAYOUT PLAN

Status Stamp: PRELIMINARY

Date Stamp: 28/03/2012

SCALES (A1) NOT TO SCALE

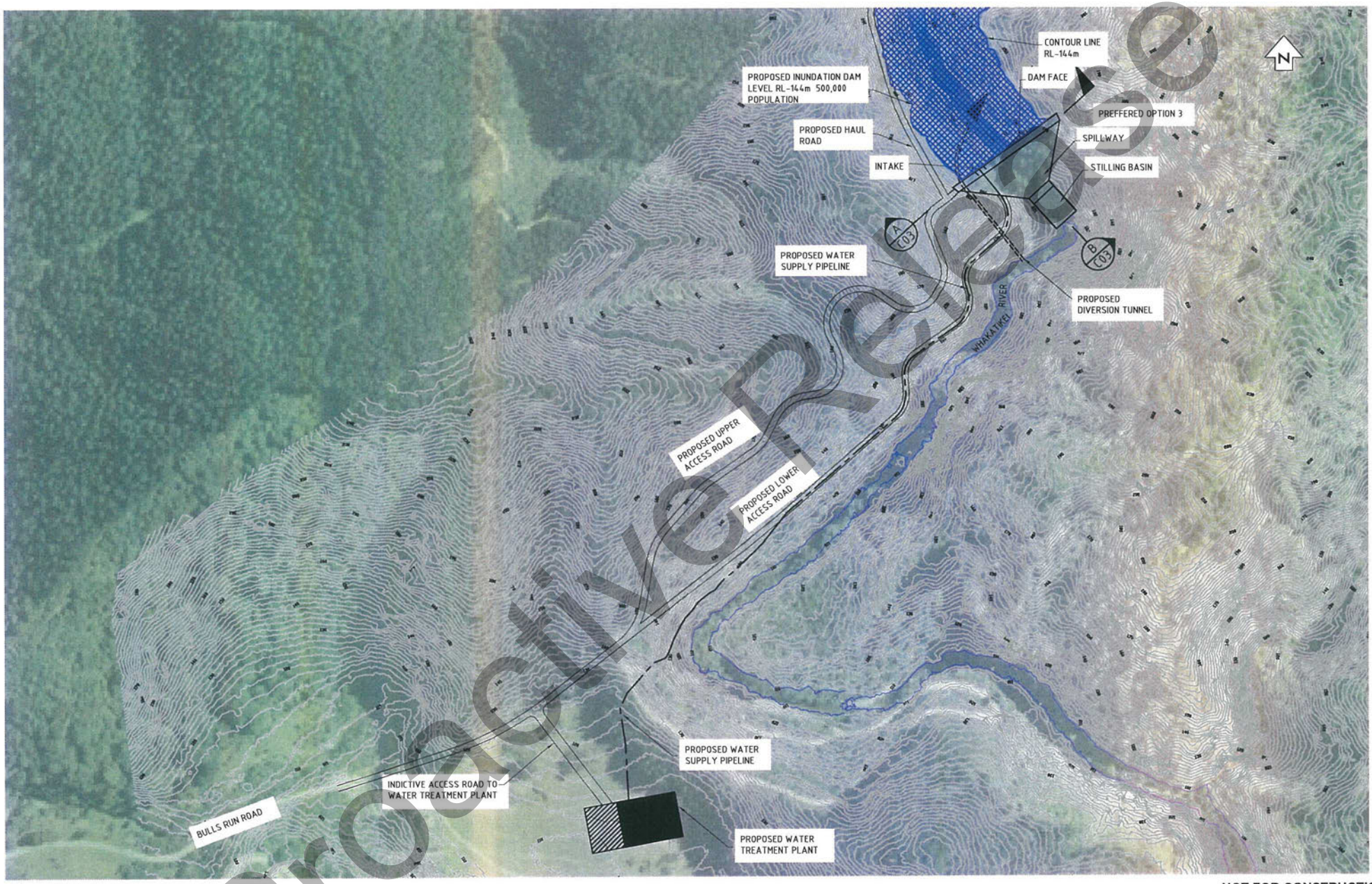
Drawing No.: C01 | Sheet No. | Rev: A

XREFS : Dam locations, Whakatiki Contours, Inundation Plan

\\nzwgn1s01\projects\Z19508up\Z1990400 – GWRC Whakatikei Storage Optimisation\2 Technical_Deliverables\8109 Drawings\Cad\C01.dwg

DO NOT SCALE – IF IN DOUBT, ASK

ORIGINAL SIZE A1



NOT FOR CONSTRUCTION

REV	REVISIONS	DRAWN	CHECKED	APPROVED	DATE
A	PRELIMINARY - FINAL DRAFT TO CLIENT	NB	GS	DH	16/03/12

	Name	Date
SURVEYED	-	-
DESIGNED	PF	28/03/12
DESIGN CHECK	SW	28/03/12
DRAWN	NB	28/03/12
DRAWING CHECK	JH	28/03/12
APPROVED	DH	28/03/12

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WHAKATIKEI STORAGE OPTIMISATION

LAYOUT OF PREFERRED SITE

Status Stamp: PRELIMINARY

Date Stamp: 06/03/2012

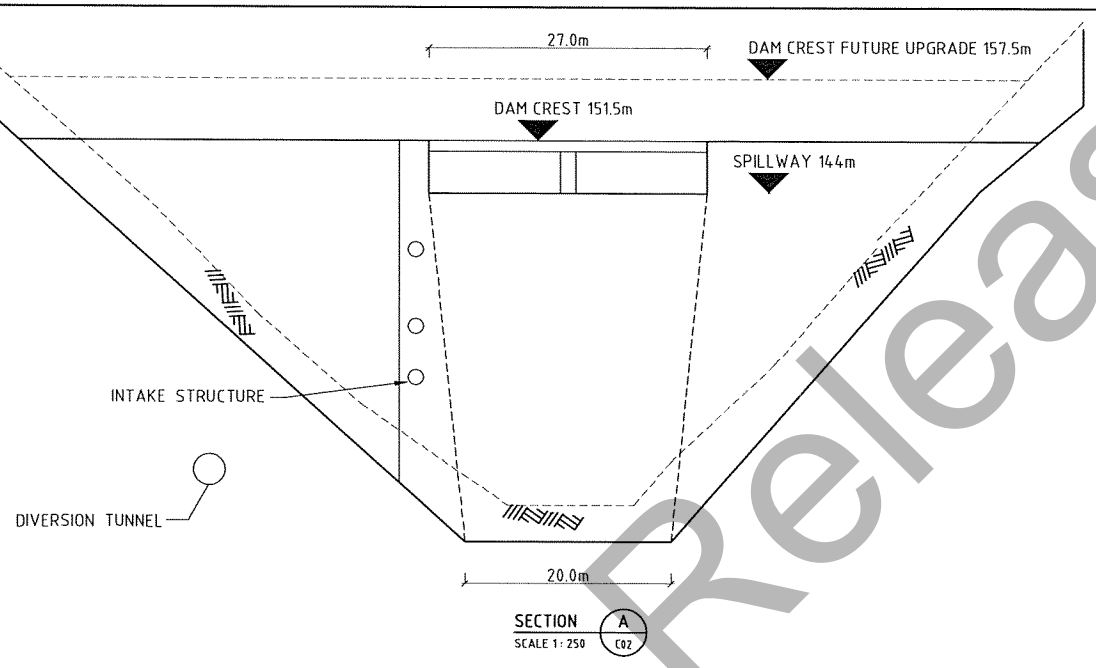
SCALES (A1) 1:-1000(A1)

Drawing No.: C02 | Sheet No. | Rev.: A

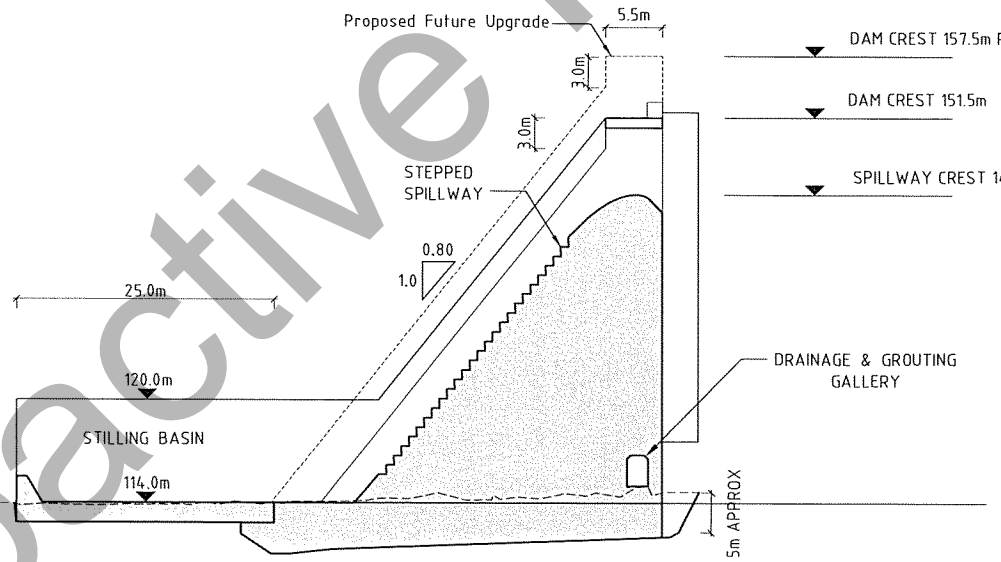
XREFS - PART Whakatikei Contours, existing roads, Whakatikei Contours, Dam locations, C01, Inundation Plan

\\nzwgn1s01\projects\Z19580up\Z1990400 - GWRC Whakatikei Storage Optimisation\2 Technical_Deliverables\6109 Drawings\Cad\C02.dwg

ORIGINAL SIZE A1 — DO NOT SCALE - IF IN DOUBT, ASK



SECTION A
SCALE 1 : 250 C02



SECTION B
SCALE 1 : 250 C02

NOT FOR CONSTRUCTION

REV	REVISIONS	DRAWN	CHECKED	APPROVED	DATE
A	PRELIMINARY - FINAL DRAFT FOR CLIENT	NB	PF	DH	30/03/12

	Name	Date
SURVEYED	-	-
DESIGNED	PF	28/03/12
DESIGN CHECK	GS	28/03/12
DRAWN	NB	06/03/2012
DRAWING CHECK	JH	28/03/12
APPROVED	DH	30/03/12

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WHAKATIKEI STORAGE OPTIMISATION

CROSS-SECTION DETAIL OF SITE 3

Status Stamp: PRELIMINARY

Date Stamp: 28/03/2012

SCALES (A1) AS SHOWN

Drawing No.: C03 | Sheet No.: | Rev: A

XREFS : Dam Sections

\\nzwgnts01\projects\Z19500up\Z1990400 - GWRC Whakatikei Storage Optimisation\2 Technical_Deliverables\0109 Drawings\Cad\C03.dwg

DO NOT SCALE - IF IN DOUBT, ASK

ORIGINAL SIZE A1

MWH

Appendix D: Total Project Base Cost

Total Project Cost Base Estimate 2012
Whakatikei
RCC Dam - Option 1 2007 size

	s7(2)(h), s7(2)(i)	Comments
Dam Construction		
Preliminary & General		From item 1 Appendix E
Diversion Works / Cofferdams/		From item 2 Appendix E
Spillway		From item 3 Appendix E
Intake/Rising Main		From item 4 Appendix E
RCC Dam		From item 5 Appendix E
Reservoir Clearing		From item 6 Appendix E. Very uncertain as depends on recoverability, access, price of timber, logging costs, [illegible] condition of trees -to be determined during detail phase
Electricity to Dam Site WTP & Pump Station		Included in GWRC Distribution downstream of WTP estimates
Sub Total		
Unspecified Items s7(2)(h)		
Total Construction		
Consenting Process		
Engineering Fees/Resource Consents/Bldg Permit Levy		From item 8 Appendix E exluding item 8.03
Land Purchase		From item 9 Appendix E
Environmental Mitigation & Compensation		From item 10 Appendix E
Total Base Estimate for Dam Construction		
Upgrade Moonshine & Bulls Run Rd		
(Full upgrade & Property mitigation)		
Construction Cost includes fees		GWRC costs updated using CGPI
Unspecified Items		GWRC memo "Unspecified items & @RISK accuracy bounds" FILE B/01/12/31, 12/4/07
Total		
Main Access Road		
Preliminary & General		s7(2)(h), s7(2)(i)
Construction Cost		Refer Appendix K less site monitoring & Preliminary & General Item to give base construction cost
Unspecified Items s7(2)(h)		
Sub Total		
Investigation & Engineering Fee		s7(2)(h), s7(2)(i)
Total		
Haul Road		
Preliminary & General		s7(2)(h), s7(2)(i)
Construction Cost		Refer Appendix F less site monitoring & Preliminary & General Item to give construction cost
Unspecified Items s7(2)(h),		
Sub Total		
Investigation & Engineering Fee		s7(2)(h), s7(2)(i)
Total		
Whakatikei Water Treatment Plant		
Design, Construction & commissioning		Estimate appears high compared to similar size plant built so no unspecified items added
Unspecified Items s7(2)(h)		
Total		
GWRC Distribution Downstream of WTP		
Distribution Works downstream WTP		Refer Appendix F in 2007 Cost estimate report updated to Dec 2011 prices - Takapu Booster Not included
Unspecified Items s7(2)(h)		s7(2)(h), s7(2)(i) items
Total		
TOTAL		

Total Project Cost Base Estimate 2012
Whakatikei
RCC Dam - Option 2 2007 size

s7(2)(h), s7(2)(i)

	Comments
Dam Construction	
Preliminary & General	From item 1 Appendix E
Diversion Works / Cofferdams/	From item 2 Appendix E
Spillway	From item 3 Appendix E
Intake/Rising Main	From item 4 Appendix E
RCC Dam	From item 5 Appendix E
Reservoir Clearing	From item 6 Appendix E. Very uncertain as depends on recoverability, access, price of timber, logging costs, amount of merchantable condition of trees -to be determined during detail phase
Electricity to Dam Site WTP & Pump Station	Included in GWRC Distribution downstream of WTP estimates
Sub Total	
Unspecified Items s7(2)(h)	
Total Construction	
Consenting Process	
Engineering Fees/Resource Consents/Bldg Permit Levy	From item 8 Appendix E exluding item 8.03
Land Purchase	From item 9 Appendix E
Environmental Mitigation & Compensation	From item 10 Appendix E
Total Base Estimate for Dam Construction	
Upgrade Moonshine & Bulls Run Rd	
(Full upgrade & Property mitigation)	
Construction Cost includes fees	GWRC costs updated using CGPI
Unspecified Items	GWRC memo "Unspecified Items & @RISK accuracy bounds" FILE B/01/12/31, 12/4/07
Total	
Main Access Road	
Preliminary & General	s7(2)(h), s7(2)(i)
Construction Cost	Refer Appendix F less site monitoring & Preliminary & General Item to give base construction cost
Unspecified Items s7(2)(h),	
Sub Total	
Investigation & Engineering Fee	s7(2)(h), s7(2)(i)
Total	
Haul Road	
Preliminary & General	s7(2)(h), s7(2)(i)
Construction Cost	Refer Appendix F less site monitoring & Preliminary & General Item to give construction cost
Unspecified Items s7(2)(h)	
Sub Total	
Investigation & Engineering Fee	s7(2)(h), s7(2)(i)
Total	
Whakatikei Water Treatment Plant	
Design, Construction & commissioning	Estimate appears high compared to similar size plant built so no unspecified items added
Unspecified Items s7(2)(h)	
Total	
GWRC Distribution Downstream of WTP	
Distribution Works downstream WTP	Refer Appendix F in 2007 Cost estimate report updated to Dec2011 prices - Takapu Booster Not included
Unspecified Items s7(2)(h)	s7(2)(h), s7(2)(i) items
Total	
TOTAL	

Total Project Cost Base Estimate 2012
Whakatikei
RCC Dam - Option 3 2007 size

s7(2)(h), s7(2)(i)

		Comments
Dam Construction		
Preliminary & General		From item 1 Appendix E
Diversion Works / Cofferdams/		From item 2 Appendix E
Spillway		From item 3 Appendix E
Intake/Rising Main		From item 4 Appendix E
RCC Dam		From item 5 Appendix E
Reservoir Clearing		From item 6 Appendix E. Very uncertain as depends on recoverability, access, price of timber, logging costs, actual [illegible] condition of trees -to be determined during detail phase
Electricity to Dam Site WTP & Pump Station		Included in GWRC Distribution downstream of WTP estimates
Sub Total		
Unspecified Items s7(2)(i		
Total Construction		
Consenting Process		
Engineering Fees/Resource Consents/Bldg Permit Levy		From item 8 Appendix E exluding item 8.03
Land Purchase		From item 9 Appendix E
Environmental Mitigation & Compensation		From item 10 Appendix E
Total Base Estimate for Dam Construction		
Upgrade Moonshine & Bulls Run Rd		
(Full upgrade & Property mitigation)		
Construction Cost includes fees		GWRC costs updated using CGPI
Unspecified Items		GWRC memo "Unspecified items & @RISK accuracy bounds" FILE B/01/12/31, 12/4/07
Total		
Main Access Road		
Preliminary & General		s7(2)(h), s7(2)(i)
Construction Cost		Refer Appendix F less site monitoring & Preliminary & General Item to give base construction cost
Unspecified Items s7(2)(i		
Sub Total		
Investigation & Engineering Fee		s7(2)(h), s7(2)(i)
Total		
Haul Road		
Preliminary & General		s7(2)(h), s7(2)(i)
Construction Cost		Refer Appendix F less site monitoring & Preliminary & General Item to give construction cost
Unspecified Items s7(2)(i)		
Sub Total		
Investigation & Engineering Fee		s7(2)(h), s7(2)(i)
Total		
Whakatikei Water Treatment Plant		
Design, Construction & commissioning		Estimate appears high compared to similar size plant built so no unspecified items added
Unspecified Items s7(2)(i		
Total		
GWRC Distribution Downstream of WTP		
Distribution Works downstream WTP		Refer Appendix F in 2007 Cost estimate report updated to Dec2011 prices- Takapu Booster Not included
Unspecified Items s7(2)(i		s7(2)(h), s7(2)(i) items
Total		
TOTAL		

Total Project Cost Base Estimate 2012
Whakatikei
RCC Dam - Option 3 - 500,000 Population

s7(2)(h), s7(2)(i)

		Comments
Dam Construction		
Preliminary & General		From item 1 Appendix E
Diversion Works / Cofferdams/		From item 2 Appendix E
Spillway		From item 3 Appendix E
Intake/Rising Main		From item 4 Appendix E
RCC Dam		From item 5 Appendix E
Reservoir Clearing		From item 6 Appendix E. Very uncertain as depends on recoverability, access, price of timber, logging costs, [illegible] condition of trees -to be determined during detail phase
Electricity to Dam Site WTP & Pump Station		Included in GWRC Distribution downstream of WTP estimates
Sub Total		
Unspecified Items s7(2)(h)		
Total Construction		
Consenting Process		
Engineering Fees/Resource Consents/Bldg Permit Levy		From item 8 Appendix E exluding item 8.03
Land Purchase		From item 9 Appendix E
Environmental Mitigation & Compensation		From item 10 Appendix E
Total Base Estimate for Dam Construction		
Upgrade Moonshine & Bulls Run Rd		
(Full upgrade & Property mitigation)		
Construction Cost includes fees		GWRC costs updated using CGPI
Unspecified Items		GWRC memo "Unspecified items & @RISK accuracy bounds" FILE 8/01/12/31, 12/4/07
Total		
Main Access Road		
Preliminary & General		s7(2)(h), s7(2)(i)
Construction Cost		Refer Appendix F less site monitoring & Preliminary & General Item to give base construction cost
Unspecified Items s7(2)(h)		
Sub Total		
Investigation & Engineering Fee		s7(2)(h), s7(2)(i)
Total		
Haul Road		
Preliminary & General		s7(2)(h), s7(2)(i)
Construction Cost		Refer Appendix F less site monitoring & Preliminary & General Item to give construction cost
Unspecified Items s7(2)(h)		
Sub Total		
Investigation & Engineering Fee		s7(2)(h), s7(2)(i)
Total		
Whakatikei Water Treatment Plant		
Design, Construction & commissioning		Cost obtained from cost curve developed using existing costs for recent WTP's and a range for 116MLD WTP's
Unspecified Items s7(2)(h)		
Total		
GWRC Distribution Downstream of WTP		
Distribution Works downstream WTP		Refer Appendix A for updated to Dec2011 prices - Takapu Booster Not included
Unspecified Items s7(2)(h)		s7(2)(h), s7(2)(i) items
Total		
TOTAL		

Total Project Cost Base Estimate 2012
Whakatikei
RCC Dam - Option 3 - 550,000 Population

s7(2)(h), s7(2)(i)

		Comments
Dam Construction		
Preliminary & General		From item 1 Appendix E
Diversion Works / Cofferdams/		From item 2 Appendix E
Spillway		From item 3 Appendix E
Intake/Rising Main		From item 4 Appendix E
RCC Dam		From item 5 Appendix E
Reservoir Clearing		From item 6 Appendix E. Very uncertain as depends on recoverability, access, price of timber, logging costs, actual size of trees, condition of trees -to be determined during detail phase
Electricity to Dam Site WTP & Pump Station		Included in GWRC Distribution downstream of WTP estimates
Sub Total		
Unspecified Items s7(2)(h)		
Total Construction		
Consenting Process		
Engineering Fees/Resource Consents/Bldg Permit Levy		From item 8 Appendix E exluding item 8.03
Land Purchase		From item 9 Appendix E
Environmental Mitigation & Compensation		From item 10 Appendix E
Total Base Estimate for Dam Construction		
Upgrade Moonshine & Bulls Run Rd		
(Full upgrade & Property mitigation)		
Construction Cost includes fees		GWRC costs updated using CGPI
Unspecified Items		GWRC memo "Unspecified items & @RISK accuracy bounds" FILE B/01/12/31, 12/4/07
Total		
Main Access Road		
Preliminary & General		s7(2)(h), s7(2)(i)
Construction Cost		Refer Appendix F less site monitoring & Preliminary & General Item to give base construction cost
Unspecified Items s7(2)(h)		
Sub Total		
Investigation & Engineering Fee		s7(2)(h), s7(2)(i)
Total		
Haul Road		
Preliminary & General		s7(2)(h), s7(2)(i)
Construction Cost		Refer Appendix F less site monitoring & Preliminary & General Item to give construction cost
Unspecified Items s7(2)(h)		
Sub Total		
Investigation & Engineering Fee		s7(2)(h), s7(2)(i)
Total		
Whakatikei Water Treatment Plant		
Design, Construction & commissioning		Cost obtained from cost curve developed using existing costs for recent WTP's and a range for 116MLD WTP's
Unspecified Items s7(2)(h)		
Total		
GWRC Distribution Downstream of WTP		
Distribution Works downstream WTP		Refer Appendix A for updated to Dec2011 prices - Takapu Booster Not included
Unspecified Items s7(2)(h)		s7(2)(h), s7(2)(i) items
Total		
TOTAL		

Total Project Cost Base Estimate 2012
Whakatikei
RCC Dam - Option 3 - Staged 2007 size - 550,000 Population

	s7(2)(h), s7(2)(i)	Comments
Dam Construction		
Preliminary & General		From item Preliminary & General Appendix E
Diversion Works / Cofferdams/		From item Diversion Works / Cofferdams/ Appendix E
Spillway		From item Spillway Appendix E
Intake/Rising Main		From item Intake/Rising Main Appendix E
RCC Dam		From item RCC Dam Appendix E
Reservoir Clearing		From item Reservoir Clearing Appendix E. Very uncertain as depends on recoverability [illegible] ongoing costs actual size of trees, conditon of trees -to be determined during detail phase
Electricity to Dam Site WTP & Pump Station		Included in GWRC Distribution downstream of WTP estimates
Sub Total		
Unspecified Items s7(2)(h)		
Total Construction		
Consenting Process		
Engineering Fees/Resource Consents/Bldg Permit Levy		From item Engineering Fees/Resource Consents/Bldg Permit Levy Appendix E excluding item [illegible]
Land Purchase		From item Land Purchase Appendix E
Environmental Mitigation & Compensation		From item Environmental Mitigation & Compensation Appendix E
Total Base Estimate for Dam Construction		
Upgrade Moonshine & Bulls Run Rd		
(Full upgrade & Property mitigation)		
Construction Cost includes fees		
Unspecified Items		
Total		
Main Access Road		
Preliminary & General		s7(2)(h), s7(2)(i)
Construction Cost		Refer Appendix F less site monitoring & Preliminary & General Item to give base construction cost
Unspecified Items s7(2)(h)		
Sub Total		
Investigation & Engineering Fee		s7(2)(h), s7(2)(i)
Total		
Haul Road		
Preliminary & General		s7(2)(h), s7(2)(i)
Construction Cost		Refer Appendix F less site monitoring & Preliminary & General Item to give construction cost
Unspecified Items s7(2)(h)		
Sub Total		
Investigation & Engineering Fee		s7(2)(h), s7(2)(i)
Total		
Whakatikei Water Treatment Plant		
Design, Construction & commissioning		s7(2)(h), s7(2)(i) [illegible]
Unspecified Items s7(2)(h)		
Total		
GWRC Distribution Downstream of WTP		
Distribution Works downstream WTP		Refer Appendix A for updated to Dec2011 prices - Takapu Booster Not included
Unspecified Items s7(2)(h)		s7(2)(h), s7(2)(i) [illegible]
Total		
TOTAL		

MWH

Appendix E: Breakdown RCC Dam Costs

GWRC - LSA Project
Whakatikei Dam Construction
Detailed Cost Schedule
Option 1 - 2007 Size

Updated for Dec

s7(2)(h), s7(2)(i)

Item	Quantity	Unit		Comment
1.00 Preliminary & General				
s7(2)(h), s7(2)(i)	[redacted]	%	[redacted]	
2.00 Diversion Works / Cofferdams/				
2.01 5.5 m dia tunnel	180.00	m	$	s7(2)(h), s7(2)(i)
2.02 Inlet structure	60.00	m3	$	
2.03 Inlet gate	20.00	tonne	$	
2.04 Tunnel plug	140.00	m3	$	
2.05 Coffer dams	2	ea	$	s7(2)(h), s7(2)(i)
3.00 Spillway				
3.01 Spillway Reinforced Concrete	2,150.00	m3	$	
3.02 Spillway Bridge	165.00	m2	$	
3.03 Stilling Basin Reinforced Concrete	1,755.00	m3	$	
3.04 Stilling basin Slab Anchor Drilling	700.00	m	$	
3.05 Anchor Install and Grout	900.00	m	$	
4.00 Intake/Rising Main				
4.01 RC Intake Structure	130.00	m3	$	Rate derived from previous project & factored up due to small quantities
4.02 Main Intake Pipe and Associated Valving for take-off	1.00	LS	$	s7(2)(h), s7(2)(i)
4.03 Scour Valve	1.00	ea	$	Approximated from GWRC
4.04 Pipework to treatment plant	1,000.00	m	$	900 mm main allowed
4.05 Tunnels through ridge	60.00	m	$	Drill, Blast + shotcrete, 4 m diameter tunnel
5.00 RCC Dam				
5.01 Foundation Excavation	16,600.00	m3	$	New RCC dam moved slightly so quantities adjusted
5.02 Foundation Preparation	3,700.00	m2	$	New RCC dam moved slightly so quantities adjusted
5.03 RCC Concreting incl facing	34,686.00	m3	$	New RCC dam moved slightly so quantities adjusted
5.04 Grout Curtain Drilling	1,225.00	m	$	Rate derived from 2007 costing report
5.05 Grouting - cement	86.00	tonne	$	Rate derived from 2007 costing report
5.06 Drain holes in dam	309.00	m	$	Based on diamond tipped drill through RC excludes scaffolding,generators,dust control,slurry disposal and setting out
5.07 Drain holes to foundation	400.00	m	$	As above
6.00 Reservoir Clearing				
6.01 Lake Clearing	68.00	ha	$	Costings very dependant on accessibility, size and girth. Approximate rates gained from Barry Leonard of GWRC and from Ministry of Agriculture and Forestry. Assumed 1/3 of native is recoverable
7.00 Electicity to WTP & Pump Station				s7(2)(h), s7(2)(i)
				Included in GWRC Distribution Downstream of WTP estimate
Sub Total				
s7(2)(h), s7(2)(i)				
Total Construction				
8.00 Engineering Fees/Resource Consents/Bldg Permit Levy				s7(2)(h), s7(2)(i)
8.01 Investigations				
8.02 Civil Design				
8.03 Environmental/Resource Consents/Env Crt Hearings, etc				
8.04 Project management / Const Supervision				
8.05 Building Consent Levy	1 to 5			
9.00 Land Purchase				
9.01 Land Purchase outstanding				
10.00 Environmental Mitigation & Compensation				
Total Dam Project Cost				

GWRC - LSA Project
Whakatikei Dam Construction
Detailed Cost Schedule
Option 2 2007 size

Updated for Dec 2011 rates
CGPI Index

Item	Quantity	Unit	Rate $	Total	Comment
1.00 Preliminary & General					
s7(2)(h), s7(2)(i)					
2.00 Diversion Works / Cofferdams/					
2.01 5.5 m dia tunnel		m	$		s7(2)(h), s7(2)(i)
2.02 Inlet structure	60.00	m3	$		
2.03 Inlet gate	20.00	tonne	$		
2.04 Tunnel plug	140.00	m3	$		
2.05 Coffer dams	2	ea	$		s7(2)(h), s7(2)(i)
3.00 Spillway					
3.01 Spillway Reinforced Concrete	2,150.00	m3	$		
3.02 Spillway Bridge	165.00	m2	$		
3.03 Stilling Basin Reinforced Concrete	1,755.00	m3	$		
3.04 Stilling basin Slab Anchor Drilling	700.00	m	$		
3.05 Anchor Install and Grout	900.00	m	$		
4.00 Intake/Rising Main					
4.01 RC Intake Structure	130.00	m3	$		Rate derived from previous project & factored up due to small quantities
4.02 Main Intake Pipe and Associated Valving for take-off	1.00	LS	$		s7(2)(h), s7(2)(i)
4.03 Scour Valve	1.00	ea	$		Approximated from GWRC
4.04 Pipework to treatment plant	1,090.00	m	$		900 mm main allowed, additional length allowed
4.05 Tunnels through ridge	60.00	m	$		Drill, Blast + shotcrete, 4 m diameter tunnel
5.00 RCC Dam					
5.01 Foundation Excavation	22,500.00	m3	$		New RCC dam moved slightly so quantities adjusted
5.02 Foundation Preparation	4,500.00	m2	$		New RCC dam moved slightly so quantities adjusted
5.03 RCC Concreting incl facing	38,100.00	m3	$		New RCC dam moved slightly so quantities adjusted
5.04 Grout Curtain Drilling	1,225.00	m	$		Rate derived from 2007 costing report
5.05 Grouting - cement	86.00	tonne	$		Rate derived from 2007 costing report
5.06 Drain holes in dam	309.00	m	$		Based on diamond tipped drill through RC excludes scaffolding,generators,dust control,slurry disposal and setting out
5.07 Drain holes to foundation	400.00	m	$		As above
6.00 Reservoir Clearing					
6.01 Lake Clearing	68.00	ha	$		Costings very dependant on accessibility, size and girth. Approximate rates gained from Barry Leonard of GWRC and from Ministry of Agriculture and Forestry. Assumed 1/3 of native is recoverable.
					s7(2)(h), s7(2)(i)
7.00 Electicity to WTP & Pump Station					Included in GWRC Distribution Downstream of WTP estimate
Sub Total					
s7(2)(h), s7(2)(i)					
Total Construction					
8.00 Engineering Fees/Resource Consents/Bldg Permit Levy					
8.01 Investigations					
8.02 Civil Design					
8.03 Environmental/Resource Consents/Env Crt Hearings, etc					
8.04 Project management / Const Supervision					
8.05 Building Consent Levy	1 to				
9.00 Land Purchase					
9.01 Land Purchase outstanding					
10.00 Environmental Mitigation & Compensation					
Total Dam Project Cost					

s7(2)(h), s7(2)(i)

s7(2)(h), s7(2)(i)

GWRC - LSA Project
Whakatikei Dam Construction
Detailed Cost Schedule
Option 3 2007 size

Updated for Dec 2011 rates CGPI Index

Item	Quantity	Unit	Rate $	Total	Comment
1.00 Preliminary & General					
s7(2)(h), s7(2)(i)					
2.00 Diversion Works / Cofferdams/					
2.01 5.5 m dia tunnel		m	$		s7(2)(h), s7(2)(i)
2.02 Inlet structure	60.00	m3	$		
2.03 Inlet gate	20.00	tonne	$		
2.04 Tunnel plug	140.00	m3	$		
2.05 Coffer dams	2	ea	$		s7(2)(h), s7(2)(i)
3.00 Spillway					
3.01 Spillway Reinforced Concrete	2,150.00	m3	$		
3.02 Spillway Bridge	165.00	m2	$		
3.03 Stilling Basin Reinforced Concrete	1,755.00	m3	$		
3.04 Stilling basin Slab Anchor Drilling	700.00	m	$		
3.05 Anchor Install and Grout	900.00	m	$		
4.00 Intake/Rising Main					
4.01 RC Intake Structure	130.00	m3	$		ate derived from previous project & ctored up due to small quantities
4.02 Main Intake Pipe and Associated Valving for take-off	1.00	LS	$		s7(2)(h), s7(2)(i)
4.03 Scour Valve	1.00	ea	$		pproximated from GWRC
4.04 Pipework to treatment plant	1,250.00	m	$		00 mm main allowed. Additional 250m llowed
4.05 Tunnels through ridge	60.00	m	$		rill, Blast + shotcrete, 4 m diameter tunnel
5.00 RCC Dam					
5.01 Foundation Excavation	16,600.00	m3	$		ew RCC dam moved so quantities djusted
5.02 Foundation Preparation	3,700.00	m2	$		ew RCC dam moved so quantities djusted
5.03 RCC Concreting incl facing	34,500.00	m3	$		ew RCC dam moved so quantities djusted
5.04 Grout Curtain Drilling	1,421.00	m	$		ate derived from 2007 costing report
5.05 Grouting - cement	100.00	tonne	$		ate derived from 2007 costing report
5.06 Drain holes in dam	358.00	m	$		ased on diamond tipped drill through RC xcludes scaffolding,generators,dust ontrol,slurry disposal and setting out s above
5.07 Drain holes to foundation	464.00	m	$		
6.00 Reservoir Clearing					
6.01 Lake Clearing	68.00	ha	$		ostings very dependant on accessibility, ze and girth. Approximate rates gained om Barry Leonard of GWRC and from inistry of Agriculture and Forestry. ssumed 1/3 of native is recoverable. s7(2)(h), s7(2)(i)
7.00 Electicity to WTP & Pump Station					ncluded in GWRC Distribution Downstream f WTP estmate
Sub Total					
s7(2)(h), s7(2)(i)					
Total Construction					
8.00 Engineering Fees/Resource Consents/Bldg Permit Levy					
8.01 Investigations					
8.02 Civil Design					
8.03 Environmental/Resource Consents/Env Crt Hearings, etc					
8.04 Project management / Const Supervision					
8.05 Building Consent Levy	1 to				
9.00 Land Purchase					
9.01 Land Purchase outstanding					
10.00 Environmental Mitigation & Compensation					
Total Dam Project Cost					

s7(2)(h), s7(2)(i)

s7(2)(h), s7(2)(i)

GWRC - LSA Project
Whakatikei Dam Construction
Detailed Cost Schedule
Option 3 - 500,000 Pop Size

Updated for Dec 2011 rates CGPI Index

Item	Quantity	Unit	Rate $	Total	Comment
1.00 Preliminary & General					
s7(2)(h), s7(2)(i)					
2.00 Diversion Works / Cofferdams/					
2.01 5.5 m dia tunnel		m	$		
2.02 Inlet structure	60.00	m3	$		
2.03 Inlet gate	20.00	tonne	$		
2.04 Tunnel plug	140.00	m3	$		
2.05 Coffer dams	2	ea	$		
3.00 Spillway					
3.01 Spillway Reinforced Concrete	2,150.00	m3	$		
3.02 Spillway Bridge	165.00	m2	$		
3.03 Stilling Basin Reinforced Concrete	1,755.00	m3	$		
3.04 Stilling basin Slab Anchor Drilling	700.00	m	$		
3.05 Anchor Install and Grout	900.00	m	$		
4.00 Intake/Rising Main					
4.01 RC Intake Structure	130.00	m3	$		Rate derived from previous project & factored up due to small quantities
4.02 Main Intake Pipe and Associated Valving for take-off	1.00	LS	$		s7(2)(h), s7(2)(i)
4.03 Scour Valve	1.00	ea	$		Approximated from GWRC
4.04 Pipework to treatment plant	1,250.00	m	$		900 mm main allowed. Additional 250m to location of dam allowed for here
4.05 Tunnels through ridge	60.00	m	$		Drill, Blast + shotcrete, 4 m diameter tunnel
5.00 RCC Dam					
5.01 Foundation Excavation	16,600.00	m3	$		New RCC dam moved slightly so quantities adjusted
5.02 Foundation Preparation	3,700.00	m2	$		New RCC dam moved slightly so quantities adjusted
5.03 RCC Concreting incl facing	35,600.00	m3	$		New RCC dam moved 250m so quantities adjusted
5.04 Grout Curtain Drilling	1,421.00	m	$		Rate derived from 2007 costing report
5.05 Grouting - cement	100.00	tonne	$		Rate derived from 2007 costing report
5.06 Drain holes in dam	360.00	m	$		Based on diamond tipped drill through RC excludes scaffolding,generators,dust control,slurry disposal and setting out
5.07 Drain holes to foundation	465.00	m	$		As above
6.00 Reservoir Clearing					
6.01 Lake Clearing	70.00	ha	$		Costings very dependant on accessibility, size and girth. Approximate rates gained from Barry Leonard of GWRC and from Ministry of Agriculture and Forestry. Assumed 1/3 of native is recoverable.
7.00 Electicity to WTP & Pump Station					Included in GWRC Distribution Downstream of WTP estimate
Sub Total					
s7(2)(h), s7(2)(i)					
Total Construction					
8.00 Engineering Fees/Resource Consents/Bldg Permit Levy					
8.01 Investigations					
8.02 Civil Design					
8.03 Environmental/Resource Consents/Env Crt Hearings, etc					
8.04 Project management / Const Supervision					
8.05 Building Consent Levy	1 to				
9.00 Land Purchase					
9.01 Land Purchase outstanding					
10.00 Environmental Mitigation & Compensation					
Total Dam Project Cost					

s7(2)(h), s7(2)(i)

GWRC - LSA Project
Whakatikei Dam Construction
Detailed Cost Schedule
Option 3 - 550,000 Pop Size

Updated for Dec 2011 rates CGPI Index

Item	Quantity	Unit	Rate $	Total	Comment
1.00 Preliminary & General					
s7(2)(h), s7(2)(i)	[redacted]	[redacted]	[redacted]	[redacted]	s7(2)(h), s7(2)(i) [redacted]
2.00 Diversion Works / Cofferdams/					
2.01 5.5 m dia tunnel	[redacted]	m	$		s7(2)(h), s7(2)(i) [redacted]
2.02 Inlet structure	60.00	m3	$		
2.03 Inlet gate	20.00	tonne	$		
2.04 Tunnel plug	140.00	m3	$		
2.05 Coffer dams	2	ea	$		s7(2)(h), s7(2)(i) [redacted]
3.00 Spillway					
3.01 Spillway Reinforced Concrete	2,150.00	m3	$		
3.02 Spillway Bridge	165.00	m2	$		
3.03 Stilling Basin Reinforced Concrete	1,755.00	m3	$		
3.04 Stilling basin Slab Anchor Drilling	700.00	m	$		
3.05 Anchor Install and Grout	900.00	m	$		
4.00 Intake/Rising Main					
4.01 RC Intake Structure	130.00	m3	$		Rate derived from previous project & factored up due to small quantities
4.02 Main Intake Pipe and Associated Valving for take-off	1.00	LS	$		s7(2)(h), s7(2)(i) [redacted]
4.03 Scour Valve	1.00	ea	$		Approximated from GWRC
4.04 Pipework to treatment plant	1,250.00	m	$		950 mm main allowed. Additional 250m to location of dam allowed for here
4.05 Tunnels through ridge	60.00	m	$		Drill, Blast + shotcrete, 4 m diameter tunnel
5.00 RCC Dam					
5.01 Foundation Excavation	19,000.00	m3	$		New RCC dam moved so quantities adjusted
5.02 Foundation Preparation	3,800.00	m2	$		New RCC dam moved so quantities adjusted
5.03 RCC Concreting incl facing	51,000.00	m3	$		New RCC dam moved so quantities adjusted
5.04 Grout Curtain Drilling	1,650.00	m	$		Rate derived from 2007 costing report
5.05 Grouting - cement	115.00	tonne	$		Rate derived from 2007 costing report
5.06 Drain holes in dam	415.00	m	$		Based on diamond tipped drill through RC excludes scaffolding,generators,dust control,slurry disposal and setting out
5.07 Drain holes to foundation	540.00	m	$		As above
6.00 Reservoir Clearing					
6.01 Lake Clearing	82.00	ha	$		Costings very dependant on accessibility, size and girth. Approximate rates gained from Barry Leonard of GWRC and from Ministry of Agriculture and Forestry. Assumed 1/3 of native is recoverable.
					s7(2)(h), s7(2)(i) [redacted] calculated on plan area
7.00 Electicity to WTP & Pump Station					Included in GWRC Distribution Downstream of WTP estimate
Sub Total					
s7(2)(h), s7(2)(i)					
Total Construction					
8.00 Engineering Fees/Resource Consents/Bldg Permit Levy					
8.01 Investigations					
8.02 Civil Design					
8.03 Environmental/Resource Consents/Env Crt Hearings, etc					
8.04 Project management / Const Supervision					
8.05 Building Consent Levy	1				
9.00 Land Purchase					
9.01 Land Purchase outstanding					
10.00 Environmental Mitigation & Compensation					
Total Dam Project Cost					

s7(2)(h), s7(2)(i) [redacted]

GWRC - LSA Project
Whakatikei Dam Construction
Detailed Cost Schedule
Staged 2007 size-550,000 Pop

Updated for Dec 2011 rates CGPI Index

Item	Quantity	Unit	Rate $	Total	Comment
1.00 Preliminary & General					
s7(2)(h), s7(2)(i)	20.00%	%	[redacted]	[redacted]	To account for same establishment but decreased quantities
2.00 Diversion Works / Cofferdams/					
2.01 5.5 m dia tunnel	-	m			Approximated from a similar 2006 overseas tunnelling contract
2.02 Inlet structure	-	m3			
2.03 Inlet gate	-	tonne			
2.04 Tunnel plug	-	m3			
2.05 Coffer dams and diversion	1	ea			To allow for some temporary diversion
3.00 Spillway					
3.01 Spillway Reinforced Concrete	-	m3			
3.02 Spillway Bridge	-	m2			
3.03 Stilling Basin Reinforced Concrete	-	m3			
3.04 Stilling basin Slab Anchor Drilling	-	m			
3.05 Anchor Install and Grout	-	m			
4.00 Intake/Rising Main					
4.01 RC Intake Structure	-	m3			
4.02 Main Intake Pipe and Associated Valving for take-off	-	LS			
4.03 Scour Valve	-	ea			
4.04 Pipework to treatment plant	-	m			
4.05 Tunnels through ridge	-	m			
5.00 RCC Dam					
5.01 Foundation Excavation	-	m3			
5.02 Foundation Preparation	-	m2			
5.03 RCC Concreting incl facing	16,500.00	m3			s7(2)(h), s7(2)(i)
5.04 Grout Curtain Drilling	-	m			
5.05 Grouting - cement	-	tonne			
5.06 Drain holes in dam	-	m			
5.07 Drain holes to foundation	-	m			
6.00 Reservoir Clearing					
6.01 Lake Clearing	16.00	ha			s7(2)(h), s7(2)(i)
7.00 Electicity to WTP & Pump Station					Included in GWRC Distribution Downstream of WTP estimate
Sub Total					
s7(2)(h), s7(2)(i)					
Total Construction					
8.00 Engineering Fees/Resource Consents/Bldg Permit Levy					
8.01 Investigations					
8.02 Civil Design					
8.03 Environmental/Resource Consents/Env Crt Hearings, etc					Decreased by half as assuming similar process but less work
8.04 Project management / Const Supervision					
8.05 Building Consent Levy	1 to $				
9.00 Land Purchase					
9.01 Land Purchase outstanding					
10.00 Environmental Mitigation & Compensa					
Total Dam Project Cost					

s7(2)(h), s7(2)(i)

s7(2)(h), s7(2)(i)

s7(2)(h), s7(2)(i)

GWRC - LSA Project
Whakatikei Dam Construction
Detailed Cost Schedule
Staged Base 2007 size

Updated for Dec 2011 rates CGPI Index

Item	Quantity	Unit	Rate $	Total	Comment
1.00 Preliminary & General					
1.01 s7(2)(h), s7(2)(i)	[redacted]	[redacted]	[redacted]	[redacted]	
2.00 Diversion Works / Cofferdams/					
2.01 5.5 m dia tunnel	[redacted]	m	$		Approximated from a similar 2006 overseas tunnelling contract
2.02 Inlet structure	60.00	m3	$		
2.03 Inlet gate	20.00	tonne	$		
2.04 Tunnel plug	140.00	m3	$		
2.05 Coffer dams	2	ea	$		s7(2)(h), s7(2)(i) [redacted]
3.00 Spillway					
3.01 Spillway Reinforced Concrete	2,150.00	m3	$		
3.02 Spillway Bridge	165.00	m2	$		
3.03 Stilling Basin Reinforced Concrete	1,755.00	m3	$		
3.04 Stilling basin Slab Anchor Drilling	700.00	m	$		
3.05 Anchor Install and Grout	900.00	m	$		
4.00 Intake/Rising Main					
4.01 RC Intake Structure	130.00	m3	$		Rate derived from Project B & factored up due to small quantities
4.02 Main Intake Pipe and Associated Valving for take-off	1.00	LS	$		s7(2)(h), s7(2)(i) [redacted]
4.03 Scour Valve	1.00	ea	$		Approximated from GWRC
4.04 Pipework to treatment plant	1,250.00	m	$		950 mm main allowed. Additional 250m to location of dam allowed for here
4.05 Tunnels through ridge	60.00	m	$		Drill, Blast + shotcrete, 4 m diameter tunnel
5.00 RCC Dam					
5.01 Foundation Excavation	19,000.00	m3	$		550,000 population foundation size
5.02 Foundation Preparation	3,800.00	m2	$		550,000 population foundation size
5.03 RCC Concreting incl facing	34,500.00	m3	$		450,000 population RCC quantity
5.04 Grout Curtain Drilling	1,650.00	m	$		550,000 population size
5.05 Grouting - cement	115.00	tonne	$		550,000 population size
5.06 Drain holes in dam	415.00	m	$		550,000 population size
5.07 Drain holes to foundation	540.00	m	$		550,000 population size
6.00 Reservoir Clearing					
6.01 Lake Clearing	66.00	ha	$		Costings very dependant on accessibility, size and girth. Approximate rates gained from Barry Leonard of GWRC and from Ministry of Agriculture and Forestry. Assumed 1/3 of native is recoverable. s7(2)(h), s7(2)(i) [redacted] site. Area calculated on plan area
7.00 Electicity to WTP & Pump Station					Included in GWRC Distribution. Downstream of WTP estimate
Sub Total					
s7(2)(h), s7(2)(i) [redacted]					
Total Construction					
8.00 Engineering Fees/Resource Consents/Bldg Permit Levy					
8.01 Investigations					
8.02 Civil Design					
8.03 Environmental/Resource Consents/Env Crt Hearings, etc					
8.04 Project management / Const Supervision					
8.05 Building Consent Levy	1 to 5				
9.00 Land Purchase					
9.01 Land Purchase outstanding					
10.00 Environmental Mitigation & Compensation					
Total Dam Project Cost					

s7(2)(h), s7(2)(i) [redacted]

Appendix F: Breakdown Roading Costs

GWRC Live Storage Assessment - Whakatikei - Option 1 -2007 size
Elemental Breakdown for Construction Costs

Item	Description	Unit	Quantity	Rate	Sub-Element Totals	Sub-Element Totals to Dec 2011	Element Totals 07	Element Totals Dec 11
1	**Site Monitoring**							
1.1	MSQA and consent monitoring fees	LS	1					
	Physical Works							
2	**Environmental compliance**							
2.1	Construct permanent erosion and sediment control measures, maintenance and monitoring - access roads	LS	1					
2.2	Construct permanent erosion and sediment control measures, maintenance and monitoring - tempeary haul road	LS	1					
3	**Earthworks**							
3.1	Site Clearance - access roads	m^2						
3.2	Site Clearance - temperary haul road	m^2						
3.3	Strip topsoil and dispose within site - access roads	m^3						
3.4	Strip topsoil and dispose within site - temporary haul road	m^3						
3.7	Cut to fill - digger and truck operation - access roads	m^3						
3.8	Cut to fill - digger and truck operation - tempoary haul road	m^3	204					
3.11	Cut to waste on site - digger and truck operation - access roads	m^3						
3.12	Cut to waste on site - digger and truck operation - temporary haul road	m^3						
3.13	Undercut to waste (Previsional Sum)	m^3	3,000					
3.14	Ongoing maintenance to haul read	LS	1					
4	**Ground Improvements**							
4.1	Geotextile to soft areas	m^2	1900					
4.2	Geogrid to soft areas	m^2	1900					
5	**Drainage**							
5.1	Form drainage channel at edge of road threugh cut batters	m	950					
5.2	Install 300mm dia transverse concrete culverts at 60m spacings with scour protection at outlet	ea	16					
5.3	Rip Rap protection	m^2	190					
6	**Pavement and Surfacing**							
6.1	AP40 Basecourse	m^3	2000					
6.2	Grade 4 chipseal	m^2	6700					
7	**Bridges**							
7.1	Single lane bridge 10m in length (1 No.)	m^2	0					
7.2	Single lane bridge 15m in length (1 No.)	m^2	0					
7.3	Single lane bridge 20m in length (1 No.)	m^2	120					
8	**Retaining walls**							
8.1	Not used							
9	**Traffic services**							
9.1	Safety Barrier Shoulder	m	120					
9.2	Safety Barrier end treatments	No	4					
9.4	Road markings and signs	LS	1					
10	**Service relocations**							
10.1	Not used							
11	**Landscaping and urban design**							
11.1	Hydroseed batters as environmental mitigation	m^2	13700					
12	**Traffic Management and temporary works**							
12.1	Not used							
13	**Preliminary and general**							
13.1	Preliminary and General (Site Establishment)	LS	1					
14	**Extraordinary construction costs**							
14.1	Not used							
	Base estimate							

s7(2)(h), s7(2)(i)

Date of Estimate: 29/05/07	Cost index
Estimate prepared: s7(2)(a)	Signed
Estimate internal peer s7(2)(a)	Signed
Estimate external peer review by: N/A	Signed N/A

GWRC Live Storage Assessment - Whakatikei - Option 2-2007 size
Elemental Breakdown for Construction Costs

Item	Description	Unit	Quantity	Rate	Sub-Element Totals	Sub-Element Totals to Dec 2011	Element Totals 07	Element Totals Dec 11
1	**Site Monitoring**							
1.1	MSQA and consent monitoring fees	LS	1					
	Physical Works							
2	**Environmental compliance**							
2.1	Construct permanent erosion and sediment control measures, maintenance and monitoring - access roads	LS	1					
2.2	Construct permanent erosion and sediment control measures, maintenance and monitoring - tempoary haul road	LS	1					
3	**Earthworks**							
3.1	Site Clearance - access roads	m²						
3.2	Site Clearance - temporary haul road	m²						
3.3	Strip topsoil and dispose within site - access roads	m³						
3.4	Strip tepsoil and dispose within site - temporary haul road	m³						
3.7	Cut to fill - digger and truck operation - access roads	m³						
3.8	Cut to fill - digger and truck operation - tempoary haul road	m³	204					
3.11	Cut to waste on site - digger and truck operation - access roads	m³						
3.12	Cut to waste on site - digger and truck operation - temperary haul road	m³						
3.13	Undercut to waste (Provisional Sum)	m³	3,000					
3.14	Ongoing maintenance to haul road	LS	1					
4	**Ground Improvements**							
4.1	Geotextile to soft areas	m²	2200					
4.2	Geogrid to soft areas	m²	2200					
5	**Drainage**							
5.1	Form drainage channel at edge of road through cut batters	m	1100					
5.2	Install 300mm dia transverse concrete culverts at 60m spacings with scour protection at outlet	ea	19					
5.3	Rip Rap protection	m²	220					
6	**Pavement and Surfacing**							
6.1	AP40 Basecourse	m³	2300					
6.2	Grade 4 chipseal	m²	7700					
7	**Bridges**							
7.1	Single lane bridge 10m in length (1 No.)	m²	0					
7.2	Single lane bridge 15m in length (1 No.)	m²	0					
7.3	Single lane bridge 20m in length (1 No.)	m²	120					
8	**Retaining walls**							
8.1	Not used							
9	**Traffic services**							
9.1	Safety Barrier Shoulder	m	120					
9.2	Safety Barrier end treatments	No	4					
9.4	Road markings and signs	LS	1					
10	**Service relocations**							
10.1	Not used							
11	**Landscaping and urban design**							
11.1	Hydroseed batters as environmental mitigation	m²	19500					
12	**Traffic Management and temporary works**							
12.1	Not used							
13	**Preliminary and general**							
13.1	Preliminary and General (Site Establishment)	LS	1					
14	**Extraordinary construction costs**							
14.1	Not used							

s7(2)(h), s7(2)(i)

Base estimate	
Date of Estimate: 29.05.07	Cost index
Estimate prepared by: s7(2)(a) [redacted] Feb 2012	Signed
Estimate checked: s7(2)(a) [redacted]	Signed
Estimate external peer review by: N/A	Signed N/A

GWRC Live Storage Assessment - Whakatikei - Option 3 2007 size
Elemental Breakdown for Construction Costs

Item	Description	Unit	Quantity	Rate	Sub-Element Totals	Sub-Element Totals to Dec 2011	Element Totals 07	Element Totals Dec 11
1	**Site Monitoring**							
1.1	MSQA and consent monitoring fees	LS	1					
	Physical Works							
2	**Environmental compliance**							
2.1	Construct permanent erosion and sediment control measures, maintenance and monitoring - access roads	LS	1					
2.2	Construct permanent erosion and sediment control measures, maintenance and monitoring - tempoary haul road	LS	1					
3	**Earthworks**							
3.1	Site Clearance - access roads	m^2	[illegible]					
3.2	Site Clearance - temporary haul road	m^2	[illegible]					
3.3	Strip topsoil and dispose within site - access roads	m^3	[illegible]					
3.4	Strip topsoil and dispose within site - temporary haul road	m^3	4 100					
3.7	Cut to fill - digger and truck operation - access roads	m^3	5 100					
3.8	Cut to fill - digger and truck operation - tempoary haul road	m^3	204					
3.11	Cut to waste on site - digger and truck operation - access roads	m^3	95 200					
3.12	Cut to waste on site - digger and truck operation - temporary haul road	m^3	30 000					
3.13	Undercut to waste (Provisional Sum)	m^3	3,000					
3.14	Ongoing maintenance to haul road	LS	1					
4	**Ground Improvements**							
4.1	Geotextile to soft areas	m^2	2600					
4.2	Geogrid to soft areas	m^2	2600					
5	**Drainage**							
5.1	Form drainage channel at edge of road through cut batters	m	1300					
5.2	Install 300mm dia transverse concrete culverts at 60m spacings with scour protection at outlet	ea	22					
5.3	Rip Rap protection	m^2	230					
6	**Pavement and Surfacing**							
6.1	AP40 Basecourse	m^3	2700					
6.2	Grade 4 chipseal	m^2	9100					
7	**Bridges**							
7.1	Single lane bridge 10m in length (1 No.)	m^2	0					
7.2	Single lane bridge 15m in length (1 No.)	m^2	0					
7.3	Single lane bridge 20m in length (1 No.)	m^2	120					
8	**Retaining walls**							
8.1	Not used							
9	**Traffic services**							
9.1	Safety Barrier Shoulder	m	120					
9.2	Safety Barrier end treatments	No	4					
9.4	Road markings and signs	LS	1					
10	**Service relocations**							
10.1	Not used							
11	**Landscaping and urban design**							
11.1	Hydroseed batters as environmental mitigation	m^2	26000					
12	**Traffic Management and temporary works**							
12.1	Not used							
13	**Preliminary and general**							
13.1	Preliminary and General (Site Establishment)	LS	1					
14	**Extraordinary construction costs**							
14.1	Not used							

s7(2)(h), s7(2)(i)

Base estimate

Date of Estimate: 29/05/07	Cost index
Estimate prepared by: s7(2)(a)	Signed
Estimate internal peer review s7(2)(a)	Signed
Estimate external peer review by: N/A	Signed N/A

GWRC Live Storage Assessment - Whakatikei - Option 3 -500,000 Population
Elemental Breakdown for Construction Costs

Item	Description	Unit	Quantity	Rate	Sub-Element Totals	Sub-Element Totals to Dec 2011	Element Totals 07	Element Totals Dec 11
1	**Site Monitoring**							
1.1	MSQA and consent monitoring fees	LS	1	s7(2)(h), s7(2)(i)				
	Physical Works							
2	**Environmental compliance**							
2.1	Construct permanent erosion and sediment control measures, maintenance and monitoring - access roads	LS	1					
2.2	Construct permanent erosion and sediment control measures, maintenance and monitoring - tempoary haul road	LS	1					
3	**Earthworks**							
3.1	Site Clearance - access roads	m²	[illegible]					
3.2	Site Clearance - temporary haul road	m²	22 200					
3.3	Strip topsoil and dispose within site - access roads	m³	6 000					
3.4	Strip topsoil and dispose within site - temporary haul road	m³	4 440					
3.7	Cut to fill - digger and truck operation - access roads	m³	4 000					
3.8	Cut to fill - digger and truck operation - tempoary haul road	m³	160					
3.11	Cut to waste on site - digger and truck operation - access roads	m³	91 500					
3.12	Cut to waste on site - digger and truck operation - temporary haul road	m³	46 700					
3.13	Undercut to waste (Provisional Sum)	m³	3,000					
3.14	Ongoing maintenance to haul road	LS	1					
4	**Ground Improvements**							
4.1	Geotextile to soft areas	m²	2600					
4.2	Geogrid to soft areas	m²	2600					
5	**Drainage**							
5.1	Form drainage channel at edge of road through cut batters	m	1300					
5.2	Install 300mm dia transverse concrete culverts at 60m spacings with scour protection at outlet	ea	22					
5.3	Rip Rap protection	m²	260					
6	**Pavement and Surfacing**							
6.1	AP40 Basecourse	m³	2400					
6.2	Grade 4 chipseal	m²	5300					
7	**Bridges**							
7.1	Single lane bridge 10m in length (1 No.)	m²	0					
7.2	Single lane bridge 15m in length (1 No.)	m²	0					
7.3	Single lane bridge 20m in length (1 No.)	m²	120					
8	**Retaining walls**							
8.1	Not used							
9	**Traffic services**							
9.1	Safety Barrier Shoulder	m	120					
9.2	Safety Barrier end treatments	No	4					
9.4	Road markings and signs	LS	1					
10	**Service relocations**							
10.1	Not used							
11	**Landscaping and urban design**							
11.1	Hydroseed batters as environmental mitigation	m²	23000					
12	**Traffic Management and temporary works**							
12.1	Not used							
13	**Preliminary and general**							
13.1	Preliminary and General (Site Establishment)	LS	1					
14	**Extraordinary construction costs**							
14.1	Not used							

Base estimate	
Date of Estimate: 29 05 07 - Updated March 2012	Cost index
Estimate prepared by: s7(2)(a)	Signed
Estimate internal peer review: s7(2)(a)	Signed
Estimate external peer review by: N A	Signed N A

GWRC Live Storage Assessment - Whakatikei - Option 3 - 550,000 Population
Elemental Breakdown for Construction Costs

Item	Description	Unit	Quantity	Rate	Sub-Element Totals	Sub-Element Totals to Dec 2011	Element Totals 07	Element Totals Dec 11
1	**Site Monitoring**							
1.1	MSQA and consent monitoring fees	LS	1	s7(2)(h), s7(2)(i)				
	Physical Works							
2	**Environmental compliance**							
2.1	Construct permanent erosion and sediment control measures, maintenance and monitoring - access roads	LS	1					
2.2	Construct permanent erosion and sediment control measures, maintenance and monitoring - tempoary haul road	LS	1					
3	**Earthworks**							
3.1	Site Clearance - access roads	m^2	[illegible]					
3.2	Site Clearance - temporary haul road	m^2	[illegible]					
3.3	Strip topsoil and dispose within site - access roads	m^3	[illegible]					
3.4	Strip topsoil and dispose within site - temporary haul road	m^3	4 440					
3.7	Cut to fill - digger and truck operation - access roads	m^3	4 000					
3.8	Cut to fill - digger and truck operation - tempoary haul road	m^3	160					
3.11	Cut to waste on site - digger and truck operation - access roads	m^3	91 500					
3.12	Cut to waste on site - digger and truck operation - temporary haul road	m^3	46 700					
3.13	Undercut to waste (Provisional Sum)	m^3	3,000					
3.14	Ongoing maintenance to haul road	LS	1					
4	**Ground Improvements**							
4.1	Geotextile to soft areas	m^2	2600					
4.2	Geogrid to soft areas	m^2	2600					
5	**Drainage**							
5.1	Form drainage channel at edge of road through cut batters	m	1300					
5.2	Install 300mm dia transverse concrete culverts at 60m spacings with scour protection at outlet	ea	22					
5.3	Rip Rap protection	m^2	260					
6	**Pavement and Surfacing**							
6.1	AP40 Basecourse	m^3	2400					
6.2	Grade 4 chipseal	m^2	5300					
7	**Bridges**							
7.1	Single lane bridge 10m in length (1 No.)	m^2	0					
7.2	Single lane bridge 15m in length (1 No.)	m^2	0					
7.3	Single lane bridge 20m in length (1 No.)	m^2	120					
8	**Retaining walls**							
8.1	Not used							
9	**Traffic services**							
9.1	Safety Barrier Shoulder	m	120					
9.2	Safety Barrier end treatments	No	4					
9.4	Road markings and signs	LS	1					
10	**Service relocations**							
10.1	Not used							
11	**Landscaping and urban design**							
11.1	Hydroseed batters as environmental mitigation	m^2	23000					
12	**Traffic Management and temporary works**							
12.1	Not used							
13	**Preliminary and general**							
13.1	Preliminary and General (Site Establishment)	LS	1					
14	**Extraordinary construction costs**							
14.1	Not used							
	Base estimate							

Date of Estimate: 29.05.07 > Updated March 2012	Cost index
Estimate prepared by: s7(2)(a)	Signed
Estimate internal peer review by: s7(2)(a)	Signed
Estimate external peer review by: N A	Signed N A

GWRC Live Storage Assessment - Whakatikei - Staged
Elemental Breakdown for Construction Costs

Item	Description	Unit	Quantity	Rate	Sub-Element Totals	STAGED - TO 550,000 POP	Element Totals Dec 11
1	**Site Monitoring**						
1.1	MSQA and consent monitoring fees	LS	1	s7(2)(h), s7(2)(i)			
	Physical Works						
2	**Environmental compliance**						
2.1	Construct permanent erosion and sediment control measures, maintenance and monitoring - access roads	LS	1				
2.2	Construct permanent erosion and sediment control measures, maintenance and monitoring - tempoary haul road	LS	1				
3	**Earthworks**						
3.1	Site Clearance - access roads	m²	2 400				
3.2	Site Clearance - temporary haul road	m²	22 290				
3.3	Strip topsoil and dispose within site - access roads	m³	460				
3.4	Strip topsoil and dispose within site - temporary haul road	m³	4 440				
3.7	Cut to fill - digger and truck operation - access roads	m³	310				
3.8	Cut to fill - digger and truck operation - tempoary haul road	m³	160				
3.11	Cut to waste on site - digger and truck operation - access roads	m³	7 100				
3.12	Cut to waste on site - digger and truck operation - temporary haul road	m³	46 700				
3.13	Undercut to waste (Provisional Sum)	m³	3,000				
3.14	Ongoing maintenance to haul road	LS	1				
4	**Ground Improvements**						
4.1	Geotextile to soft areas	m²	200				
4.2	Geogrid to soft areas	m²	200				
5	**Drainage**						
5.1	Form drainage channel at edge of road through cut batters	m	100				
5.2	Install 300mm dia transverse concrete culverts at 60m spacings with scour protection at outlet	ea	2				
5.3	Rip Rap protection	m²	24				
6	**Pavement and Surfacing**						
6.1	AP40 Basecourse	m³	190				
6.2	Grade 4 chipseal	m²	410				
7	**Bridges**						
7.1	Single lane bridge 10m in length (1 No.)	m²	0				
7.2	Single lane bridge 15m in length (1 No.)	m²	0				
7.3	Single lane bridge 20m in length (1 No.)	m²	120				
8	**Retaining walls**						
8.1	Not used						
9	**Traffic services**						
9.1	Safety Barrier Shoulder	m	120				
9.2	Safety Barrier end treatments	No	4				
9.4	Road markings and signs	LS	1				
10	**Service relocations**						
10.1	Not used						
11	**Landscaping and urban design**						
11.1	Hydroseed batters as environmental mitigation	m²	1800				
12	**Traffic Management and temporary works**						
12.1	Not used						
13	**Preliminary and general**						
13.1	Preliminary and General (Site Establishment)	LS	1				
14	**Extraordinary construction costs**						
14.1	Not used						
Base estimate							0

Date of Estimate: 29/05/07	Cost index
Estimate prepared by: s7(2)(a)	Signed
Estimate internal peer review by: s7(2)(a)	Signed
Estimate external peer review by: N/A	Signed N/A

GWRC Live Storage Assessment - Whakatikei - Option 3 Staged base size
Elemental Breakdown for Construction Costs

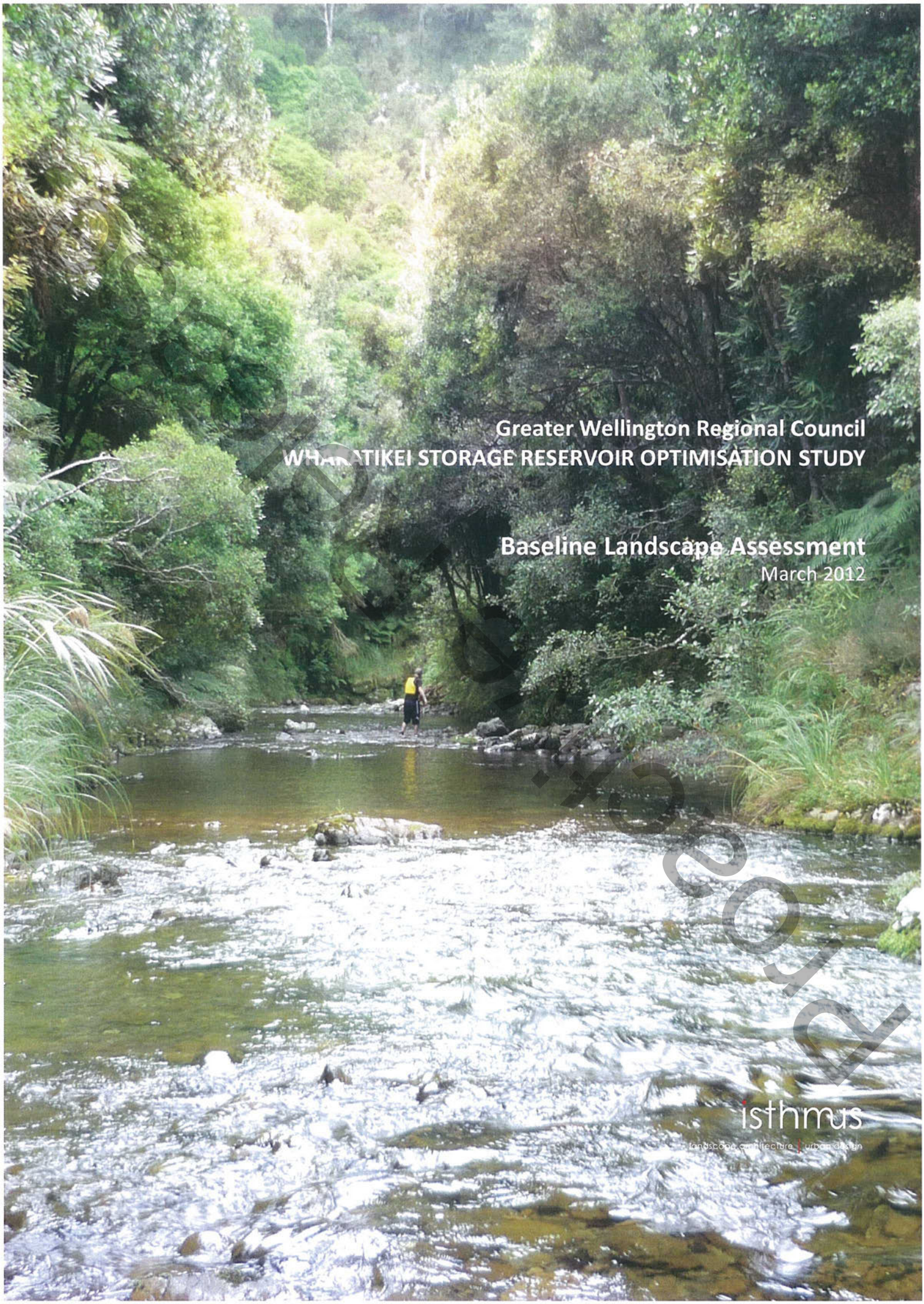
Item	Description	Unit	Quantity	Rate	Sub-Element Totals	Sub-Element Totals to Dec 2011	Element Totals 07	Element Totals Dec 11
1	**Site Monitoring**							
1.1	MSQA and consent monitoring fees	LS	1					
	Physical Works							
2	**Environmental compliance**							
2.1	Construct permanent erosion and sediment control measures, maintenance and monitoring - access roads	LS	1					
2.2	Construct permanent erosion and sediment control measures, maintenance and monitoring - tempoary haul road	LS	1					
3	**Earthworks**							
3.1	Site Clearance - access roads	m^2	[illegible]					
3.2	Site Clearance - temporary haul road	m^2	[illegible]					
3.3	Strip topsoil and dispose within site - access roads	m^3	6 000					
3.4	Strip topsoil and dispose within site - temporary haul road	m^3	4 440					
3.7	Cut to fill - digger and truck operation - access roads	m^3	4 000					
3.8	Cut to fill - digger and truck operation - tempoary haul road	m^3	160					
3.11	Cut to waste on site - digger and truck operation - access roads	m^3	91 500					
3.12	Cut to waste on site - digger and truck operation - temporary haul road	m^3	46 700					
3.13	Undercut to waste (Provisional Sum)	m^3	3,000					
3.14	Ongoing maintenance to haul road	LS	1					
4	**Ground Improvements**							
4.1	Geotextile to soft areas	m^2	2600					
4.2	Geogrid to soft areas	m^2	2600					
5	**Drainage**							
5.1	Form drainage channel at edge of road through cut batters	m	1300					
5.2	Install 300mm dia transverse concrete culverts at 60m spacings with scour protection at outlet	ea	22					
5.3	Rip Rap protection	m^2	260					
6	**Pavement and Surfacing**							
6.1	AP40 Basecourse	m^3	2400					
6.2	Grade 4 chipseal	m^2	5300					
7	**Bridges**							
7.1	Single lane bridge 10m in length (1 No.)	m^2	0					
7.2	Single lane bridge 15m in length (1 No.)	m^2	0					
7.3	Single lane bridge 20m in length (1 No.)	m^2	120					
8	**Retaining walls**							
8.1	Not used							
9	**Traffic services**							
9.1	Safety Barrier Shoulder	m	120					
9.2	Safety Barrier end treatments	No	4					
9.4	Road markings and signs	LS	1					
10	**Service relocations**							
10.1	Not used							
11	**Landscaping and urban design**							
11.1	Hydroseed batters as environmental mitigation	m^2	23000					
12	**Traffic Management and temporary works**							
12.1	Not used							
13	**Preliminary and general**							
13.1	Preliminary and General (Site Establishment)	LS	1					
14	**Extraordinary construction costs**							
14.1	Not used							
Base estimate								

s7(2)(h), s7(2)(i)

Date of Estimate: 29 05 07	Cost index
Estimate prepared by: s7(2)(a)	Signed
Estimate internal peer review: s7(2)(a)	Signed
Estimate external peer review by: N A	Signed N A

MWH

Appendix G: Isthmus Report



Greater Wellington Regional Council
WHARATIKEI STORAGE RESERVOIR OPTIMISATION STUDY

Baseline Landscape Assessment

March 2012

isthmus

landscape architecture | urban design

CONTENTS

1.0 INTRODUCTION

Isthmus have been engaged by Greater Wellington Regional Council (GWRC) to provide a baseline landscape assessment for the proposed water storage reservoir in the Whakatikei River near the end of Bulls Run Road (as shown in Figure 1 - 4) as part of a wider optimisation study. The optimisation study follows on from the 2007 Phase 2 Feasibility Study of three potential reservoir sites: on (1) Whakatikei River, (2) Pakuratahi River and (3) Skull Gully Stream respectively and an additional Feasibility Study conducted in 2011 considering a site on the Kaitoke Stream.

In the initial phases of the Whakatikei Optimisation Study, a preferred dam site (Option 3) was selected (as shown in Figure 3) through the consideration of geological, environmental, social, constructability and capital cost, as described in more detail in the main body of the Optimisation Study report. Isthmus' appraisal of the potential adverse and positive environmental effects of each dam site was provided in a separate report (February 2012). A summary of that appraisal is attached as Appendix 1. The Optimisation Study will be used to inform the selection of the preferred reservoir site and the more detailed assessment of landscape and visual effects in the Notice of Requirement (NoR) phases of the project.

This report follows on from the preferred dam site appraisal and provides a baseline landscape assessment of the overall project as one of the discipline assessments in the Optimisation Study Report.

The baseline landscape assessment includes a description and appraisal of the:

- Site context - existing landscape features and significance
- Description of Whakatikei Reservoir proposal's main parameters[1];
- Landscape issues - potential adverse effects [1];
- Landscape and recreation opportunities - potential positive effects of the proposal[1]; and
- Design strategies

Note:

- The appraisal of landscape matters is based on desktop study and field survey. The desktop study relies in part on the information provided by other disciplines in the Phase 2 Feasibility reports along

[1] including the impact of increasing the storage capacity for a future population size from the Phase 2 study baseline of 450,000 to 500,000 and 550,000

6.6 EROSION AND SEDIMENT CONTROLS

- **Environment Management Plan (EMP) and Construction Management Plan (CMP)** - landscape architecture (and ecology) input/coordination with landscape strategies. For example, to coordinate construction cut face stabilisation techniques with long term revegetation /rehabilitation techniques.

6.7 SUPPORTING POLICY FRAMEWORKS

- **Exclusion zone -** policy and management protocols to ensure existing and proposed recreational activities can be implemented.
- **Access management -**to ensure existing use of the area by motorised recreation is retained/limited to organised events.

In the subsequent phases of this project, an integrative **Landscape Management Plan**, could provide an effective mechanism to articulate the way in which landscape matters (opportunities and strategies to avoid, remedy and mitigate effects) have been addressed[11]. A best practice approach would be to establish a design 'Framework' early which is developed into a comprehensive plan as the design is developed in more detail. A **Landscape Management Plan Framework** could be developed as part of the Notice of Requirement application and given effect by a Condition that requires a subsequent Landscape Management Plan consistent with the Framework. This Framework would establish overall design principles and key parameters for the components of the proposal that impact on landscape effects (earthworks, ecological restoration etc) along with the process for development and degree of detail required in the subsequent **Landscape Management Plan. It** would detail and graphically illustrate specific implementation strategies to achieve the design parameters, and could form part of the Outline Plan of Works. It would include measurable performance criteria and monitoring and reporting requirements to ensure certainty of effects. In addition, it would also indicate the integration of landscape with other disciplines such as ecology, recreation and engineering.

[11] As supported by recent Environment Court decisions, for example, MfE, Board of Inquiry (2011) Final Report and Decision of the Board of Inquiry into the Hauāuru mā Raki Wind Farm and Infrastructure Connection to Grid. ISBN 978-0-478-37225-0

6.4 RESERVOIR MANAGEMENT

- **Operation levels -** typical/flood/drought management regimes and their impact on proposed recreation opportunities/need for pontoons etc) and options to establish constructed wetlands.
- **Flow management -**strategies to limit the duration of low/residual flows and appropriate flushing regimes as they impact on recreation values, fish habitat, visual amenity and natural character.

6.5 STRUCTURES DESIGN

- **Reservoir edge treatment -** materials (gravels or alternative) to reduce adverse effects on natural character and to support proposed recreation activities (access to the waters edge), mitigation planting-wetlands and fish habitat.
- **Dam structures -**abutment returns, RCC, spillway and stilling basin treatment to provide visual amenity.
- **Water take off pipeline -** location and alignment along the contours to minimise earthworks, surface materials/colours and support structures/screening to reduce adverse visual effects.
- **Diversion tunnel -** downstream construction area configuration and rehabilitation strategies to reduce adverse effects on natural character values and visual amenity.
- **Bridges** - typology to complement regional park setting/bush areas with simple clean lines, include consideration of abutment areas, vehicle barriers (where required) and balustrades to support proposed recreation activities; access across the crest of the dam.
- **Water Treatment Plant -** location against vegetation/landform, to minimse earthworks and to provide for maintenance vehicle requirements, height, roof profile and other appropriate articulation strategies to reduce apparent bulk and scale, materials and colours and fencing options to reduce adverse visual impact and complement Park setting.
- **Informal carpark areas -**location to reduce earthworks, permeable paving and informal edges to complement Park setting.
- **Visual mitigation/amenity planting** - as required to screen or integrate structures into the surrounding landscape (including dam structures, water treatment plant, fences, carparks) to include site preparation, appropriate species selection, planting technologies, monitoring and pest and weed control requirements.

6.2 ACCESS TRACKS

- **Alignment** - in relation to topography and existing forestry roads including opportunities to develop long section alternatives that would limit earthworks/cut face heights.
- **Size and extent of cut and fill batters** - as above and with options to investigate optimal batter/bench profiles to reduce adverse effects on visual amenity and enhance opportunities for revegetation/rehabilitation.
- **Drainage and sediment control** - post construction measures such as edge bunds to reduce erosion.
- **Road width controls** and post construction verge treatments to reduce apparent widths.
- **Stream crossings** - location to minimise earthworks/sedimentation, culvert alignment and additional structures to reduce erosion and provide for fish passage.

6.3 ECOLOGICAL RESTORATION AND OFF-SET MITIGATION

- **Reservoir habitats** - edge contouring/treatment to support fish habitat including spawning areas, trout management/exclusion mechanisms (if required to prioritise native fish).
- **Down stream habitats** - flow and discharge management regimes/requirements to support fish habitat, enrichment strategies (river morphology) to mitigate for loss of migration where fish passage structures are unlikely to be successful/may not be warranted.
- **Constructed wetlands** (to mitigate for the loss of those at Drapers Flat) - location as supported by existing contours, soil type, natural runoff and reservoir edge treatment and operation levels, to include additional contouring/earthworks, appropriate species selection, planting technologies, monitoring and pest and weed control requirements and opportunities for pedestrian access.
- **Offset planting** - strategies to offset for the loss of river bed vegetation types through retirement of exotic forestry areas in the basin, to include site preparation, appropriate species selection, planting technologies, monitoring and pest and weed control requirements.
- **Edge sealing** - planting to protect/provide shelter along newly exposed edges of existing indigenous vegetation, to include site preparation, appropriate species selection, planting technologies, monitoring and pest and weed control requirements.
- **Wider catchment initiatives** - to protect water quality in the reservoir including additional bridges, riparian buffers and improved spawning/nursery habitat strategies (river morphology) to mitigate for the loss of fish migration.

6.0 DESIGN STRATEGIES

In addition to the potential recreation opportunities discussed above, there is considerable scope to avoid, remedy and mitigate (reduce) adverse effects of the proposal through the detailed design, particularly with respect to natural character and landscape amenity. Such matters may be relevant as part of an overall judgement of the NoR and consenting process.

Design opportunities include the following:

6.1 EARTHWORKS

- **General principles** - a cut and fill balance to reduce sedimentation and erosion risks, strategies to minimise the overall volume of earthworks, loss of native vegetation, impact on ecological and important geological features and adverse visual effects along with opportunities to enhance rehabilitation.
- **Cut batter** (access roads, dam abutments) - face gradients and height and bench profiles, edge and surface treatments required to enhance revegetation/rehabilitation opportunities (such as native hydroseeding), minimise sedimentation and tie cuts back into surrounding topography.
- **Fill batter -** (access roads, dam abutment) "" and in particular, appropriate location to minimise sedimentation risk including soil stabilisation techniques if required, such as MSE walls.
- **Cut and fill revegetation/rehabilitation strategies** - to include site/soil preparation, seed/eco sourcing requirements, appropriate planting technologies such as native hydroseeding along with traditional small grade revegetation methods, monitoring and pest control requirements.
- **Reservoir edge treatment -** contouring and gradients to tie back into the natural contours, to support proposed recreational uses (tracks to the reservoir edge and swimming), minimise further losses to the remaining tawa forests through soil saturation and include opportunities for mitigation planting- constructed wetlands and fish spawning sites.
- **Disposal of surplus material** - location, height and depth to avoid adverse effects on waterways, visual effects and enhance opportunities for rehabilitation/revegetation. Including consideration of appropriate removal/disposal of existing vegetation in the inundation area.
- **Stockpiling areas for construction-**location, height and duration of storage to prevent adverse effects on waterways and visual effects.

5.0 LANDSCAPE OPPORTUNITIES

In addition to the potential positive visual effects of the reservoir, there are opportunities to provide for additional recreation activities in the vicinity of the proposed reservoir, which would help offset landscape values that might otherwise be lost. Such opportunities include a potential network of cycle (mountain bike), walking and bridleway tracks that would provide access to the reservoir and improved access to the river bed below the dam (illustrated in Figure 2 and 3 and proposed Design Strategies Figure 9).

Opportunities include:

- An informal carpark area near the proposed water treatment plant on Dude Ranch Flat.
- Improvements to the existing river access track off Bulls Run Road aligned with a possible [pedestrian and bike] swing bridge and easy crossing point for horses.
- A potential CWB track along the eastern ridgeline to the Karapoti Pramline track with a connecting track down to the head of the reservoir and possible constructed wetlands.
- A CWB trail along the upper access road with connections to the wider network of existing forestry roads and improved links to the reservoir area including a constructed 'beach' or pontoon for swimming.
- Pedestrian access over the dam crest via the vehicle maintenance bridge and a loop track back to the swing bridge.
- Pedestrian access along the lower access road and tracks down to the river aligned with swimming holes and beach areas including a view point below the dam. A second swing bridge, near the deep pools, could provide views of the gorge and a shorter loop track.
- Potential 4WD access off Cooks/Cleary Rd to an informal carpark above the reservoir along improved forestry roads. [Limited] potential for non motorised boat access to the reservoir; where enthusiasts are prepared to negotiate the 4WD roads and then carry their craft some distance to the waters edge.
- Access to varied landscape types including elevated vantage points, natural river bed landforms including shallow/riffled areas and the lower incised gorge, open water, constructed wetlands and indigenous and exotic forests.

Note:

This appraisal assumes subsequent design phases will prioritise appropriate remediation and mitigation strategies, as discussed further below, and implement policy and management frameworks that avoid permanent exclusion zones within the catchment.

Adverse Landscape Effects	450,000 population (inundation 143.5 RL)	500,000 population (inundation 144 RL)	550,000 population (inundation 150.3 RL)
	access road and the water treatment plant. Effects moderated by preferred dam location and with opportunities to mitigate/reduce the duration of effects through design strategies-discussed below. Flow management will have an impact on visual amenity. In particular, un-seasonal /extended residual flow periods will increase adverse effects. The aesthetic qualities/positive visual effects of the reservoir will moderate for some of these effects. Changes to the aesthetic quality of the area can also be anticipated in the next 5-10 years due to pine forest harvest.		
-existing recreational values (s7c)	*low* Existing uses off the end of Bulls Run Road will be largely unaffected. Access across the river in the inundation area will be impacted; currently used by a small number of hunters/fisherman	*low* Similar effects	*low* Similar effects

Adverse Landscape Effects	450,000 population (inundation 143.5 RL)	500,000 population (inundation 144 RL)	550,000 population (inundation 150.3 RL)
	platform require significant cuts with terraced benches up to 30m but with fill predominantly located away from the river bed. Disposal sites for additional/unsuitable fill will need to be considered in subsequent planning stages along with potential remediation/mitigation strategies reduce extent and duration of effects; as discussed below. Some of these effects could be anticipated as a result of planned forest harvesting activities where existing tracks would be upgraded/new tracks formed to set up haulers etc		
-visual amenity (s7c)	*high* Adverse effects predominantly associated with the scale and the design of the dam structures, and the earthworks and native and exotic vegetation removal required to establish	*high* similar effects	*high* Additional adverse effects due to loss of river terrace features in the inundation area.

Adverse Landscape Effects	**450,000 population** (inundation 143.5 RL)	**500,000 population** (inundation 144 RL)	**550,000 population** (inundation 150.3 RL)
	the site of least impact in the Phase 2 assessment.		
-historic heritage (s6f)	*low to moderate* No registered archaeological or other historic sites. Possible tram line embankments observed along the river terraces that would be inundated. Water treatment plant area site of bachs built by WWII American soldiers. To be reviewed following further consultation with key stakeholders, such as the Historic Places Trust, and survey where required in subsequent assessment stages.	*low to moderate* Similar effects	*low to moderate*
-natural landforms (s7f)	*high* River bed landforms impacted by inundation, dam wall and downstream structures including spilling basin and diversion tunnel construction area. Additional earthworks required to construct upper and lower access roads and establish water treatment plant	*high* Similar effects	*high* Adverse effects increased; greater extent of river terrace and gorge landforms included in the inundation area.

Adverse Landscape Effects	**450,000 population** (inundation 143.5 RL)	**500,000 population** (inundation 144 RL)	**550,000 population** (inundation 150.3 RL)
	discharge from the water treatment plant will also need to be considered in subsequent assessment stages particularly where diversity of native fish species below the dam site is recognised.		
-public access to rivers (s6d)	*low* Existing access largely retained with potential for additional tracks off access roads-see below	*low* Similar effects	*low* Similar effects
-values to tangata whenua (s6e)	*low to moderate* To be reviewed following further consultation with Iwi in subsequent assessment stages. It is assumed that the area would have formed part of a wider mahinga kai/food gathering area, but there are no known sites of significance. Values associated with the mauri or life force of water will need to be considered through flow management/treatment and discharge regimes. Whakatikei site identified as	*low to moderate* Similar effects	*low to moderate* Similar effects

Adverse Landscape Effects	**450,000 population** (inundation 143.5 RL)	**500,000 population** (inundation 144 RL)	**550,000 population** (inundation 150.3 RL)
	uncommon in the Park. Downstream works predominantly effect revegetating broad leaf scrub and lowland forest species including groups of emerging rewarewa and occasional podocarp specimens . Mitigation and offset opportunities are discussed further below.		
-in stream ecological values (s6c)	*moderate* Dam structures would block migration of native fish and trout species. Overall aquatic habitat values and loss of instream habitat assessed as low-moderate. Further survey required to confirm native fish population levels in the inundation area and the quality of the trout fishery/spawning ground as advised by Fish & Game. Mitigation opportunities discussed further below. Effects on downstream values due to flow management and consented	*moderate* Similar effects	*moderate* Similar effects

Adverse Landscape Effects	**450,000 population** (inundation 143.5 RL)	**500,000 population** (inundation 144 RL)	**550,000 population** (inundation 150.3 RL)
-outstanding natural features and landscapes (s6b)	'Tawa terraces' *moderate to high* Representative areas retained including part of the broadest terrace at the head of the reservoir. 'Upper gorge' *low-moderate* At peak operational capacity the water level would be a maximum of 4m above the river bed over approx 1/3rd of the feature submerging natural river bed landforms and minor areas of vegetation along the banks	'Tawa terraces' *moderate to high* Similar effects 'Upper gorge' *low-moderate* Similar effects	'Tawa terraces' *high* Majority loss of the feature 'Upper gorge' *moderate-high* Inundation extends along more than half of the gorge with capacity water levels a maximum of 10m above the existing river bed affecting a much greater area of vegetation. This includes a narrow terrace near the inundation extent for the lower population levels.
-native vegetation and terrestrial habitat (s6c)	*moderate to high* Moderate to high ecological values identified within the inundation area (see Figure 2). Raupo wetland at Drapers Flat and majority area of tawa dominated forest on river terrace landforms lost with remnant podocarp specimens left after logging. Vegetation types considered to be significant; are	*moderate to high* similar effects	*moderate to high* Increased inundation would impact on remaining terraces with tawa dominated forest. Inundation area extends a further 700m upstream and up to 4m above the natural river bed with further impact on the vegetation along the margins of the gorge.

Adverse Landscape Effects	**450,000 population** (inundation 143.5 RL)	**500,000 population** (inundation 144 RL)	**550,000 population** (inundation 150.3 RL)
-natural character (s6a)	*high* The proposal requires significant modification to the river bed landforms and hydrology and vegetation patterns to establish the reservoir and further vegetation removal and large scale earthworks to construct the dam and access roads. Dam structures, pipelines and water treatment plant introduce prominent built forms into this area. Effects on natural character will be partially moderated by the introduction of the reservoir as a 'natural' feature and selection of the preferred dam site. Adverse effects on natural character would also result from anticipated forest harvest. Mitigation opportunities discussed further below .	*high* Similar effects	*high* Effects increased slightly by loss of remaining river terrace forest areas and small area of beech-podocarp-broadleaf in the gorge. Options to mitigate for loss of wetland areas may also be affected.

- low effects on existing recreation values; the area impacted by the proposal is not regularly used for recreation by members of the public. There are however a number of additional recreation opportunities and potential positive effects that could integrated into the project through a possible network of cycle (mountain bike), walking and horse riding tracks; as discussed in the next section of this report.

Overall, this assessment considers the adverse effects of the project on landscape matters to be moderate to high but with considerable opportunities to avoid, remedy and mitigate for these effects through detail design and the potential to integrate positive effects in terms of recreation values. This assessment also distinguishes the effects of inundation levels required to provide for a population level of 550,000. Additional adverse effects are identified at the 150.3 RL inundation level with respect to: the Tawa Terraces Outstanding Natural Feature and, to a lesser extent, the 'Upper Whakatikei Gorge' Outstanding Natural Feature, natural character values, native vegetation and terrestrial habitats, natural landforms and visual amenity. The higher inundation level may also impact on options to mitigate for the loss of the raupo wetland at Drapers Flat by removing the remaining flat areas with soils that would be suitable.

Most of the adverse landscape effects were assessed as potentially moderate, moderate-high or high as would be expected given the nature and extent of the project and the site context. A number of potential positive landscape effects were also identified along with design strategies to avoid, remedy and mitigate for these effects; as discussed in more detail in the following sections of this report.

In summary, adverse effects on:

- Natural Character will be high due to the inundation of indigenous vegetation and existing river bed landforms along with access road earthworks and the introduction of the dam structure. Some of these effects have been avoided by the selection of the preferred dam site and will be moderated by the introduction of the reservoir as a 'naturalistic' feature. In addition, there are a range of detail design strategies that can be used to avoid, remedy and mitigate for these effects such as edge treatment to ensure the reservoir ties back into the natural contours and minimises 'soil saturation dieback' of the adjacent indigenous forest.
- the 'Tawa Terrace' Outstanding Natural Feature will be moderate to high at the 450-500,000 population level and high at the 550,000 population level due to increased inundation. Whilst this feature is not at the upper end of the scale in terms of landscape values, effects of the lower inundation levels have been distinguished due to the opportunity they provide to retain a representative and distinct part of this feature near the head of the reservoir. Other matters to consider in terms of the overall effects of the project on landscape include opportunities to offset for the loss of the values of this feature through retirement/revegetation of adjacent exotic forestry areas after harvest.
- the 'Upper Whakatikei Gorge' would be low to moderate at the 450,000-500,000 population level with the inundation levels extending along approximately 1/3rd of river bed landforms and likely to impact on minor areas of riparian vegetation. Effects of the 550,000 population level are considered to be of a different order, where the inundation would impact on the majority length and additional areas of cut over beech-podocarp forest. Offset planting treatments could also be relevant in the overall consideration of these effects.
- Landscape amenity relate to:

  - effects on visual amenity which will be high, particularly during the construction period and the time taken to revegetate areas impacted by earthworks (3+ years). Some of these effects have been avoided by the selection of the preferred dam site and will be moderated or offset by the aesthetic qualities and potential positive visual effects of the reservoir. Along with planting treatments, a range of detail design strategies, such as cut batter profiles and structure finishes will be important in terms of determining the long term adverse visual effects of the project.

Section 7 requires that particular regard to given to:

"(c) the maintenance and enhancement of amenity values"

(f) "the maintenance and enhancement of the quality of the environment"

The following table addresses the impact of the proposed Whakatikei Reservoir and the varying inundation levels on each of these matters as they contribute to landscape values.

Note:

- These are preliminary assessments for the purpose of determining the viability of the project in terms of landscape matters and refining the design. Such assessments would be developed in more detail once the project description is confirmed.

-There is an overlap between landscape and other disciplines dealing with such matters as ecology, heritage and tangata whenua values. This report takes such matters into account to the extent that they influence landscape values, but does not take the place of those specialist disciplines. At the Notice of Requirement stage of the project, Section 6c)-f) and Section 7f) matters would also be assessed by a specialist ecologist, recreation, Iwi representatives and cultural/heritage advisors.

-This appraisal has relied on information provided in the Phase 2 reports and by GWRC staff, as appropriate to this stage of the project.

A five point scale was used to rank effects as follows:

1=low
2=low to moderate
3=moderate
4=moderate to high
5=high

4.0 LANDSCAPE ISSUES

Potential adverse landscape effects of the proposal include the following:

- effects on natural character resulting from the inundation of the river and its margins;
- effects resulting from inundation of native vegetation and habitat;
- effects on historical associations resulting from inundation of historical features;
- effects on visual amenity resulting from the dam and associated structures / access;
- effects on visual amenity resulting from the reservoir itself (positive and negative) including the appearance of the margins resulting from fluctuating water levels;
- effects on recreation use (positive and negative) as a result of inundation of the valley;

Such effects are relevant to the following section 6 and 7 matters of the RMA.

Section 6 requires as a matter of national importance the recognition and provision for:

> *"(a) the preservation of the natural character of the coastal environment (including the coastal marine area), wetlands, and lakes and rivers and their margins, and the protection of them from inappropriate subdivision, use, and development:*
>
> *(b) the protection of outstanding natural features and landscapes from inappropriate subdivision, use, and development:*
>
> *(c) the protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna:*
>
> *(d) the maintenance and enhancement of public access to and along the coastal marine area, lakes, and rivers*
>
> *(e) the relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga:*
>
> *(f) the protection of historic heritage from inappropriate subdivision, use, and development"`*

DESIGN ATTRIBUTES	All populations	450,000 population	500,000 population	550,000 population
-construction	upstream blast technique probable with earthworks/ vegetation clearance required to establish platform for works near river bed			
Batch plant				
-location	As per water treatment plant			
Water treatment plant				
- foot print (m^2)	150+ earthworks assumed			
- height (m)	Less than 8m			
- construction and operation	Additional paved roads to service. Discharge of treated and backwash water and sludge, onsite stormwater and wastewater to land			

DESIGN ATTRIBUTES	All populations	450,000 population	500,000 population	550,000 population
- materials				
- construction area (inch coffer dam)	assume works effect 60m downstream of dam face			
Access Roads				
- width	4m, 1m side drain			
- lower access road location	130m contour			
- lower access road est. (m)	700			
- maximum cuts (m), no fill along bed	32			
- upper access road location	158-160m contour			
- upper access road est. (m)	600			
-maximum cuts (m), fill across tributary	28			
- cut face profiles	1:2, 10m face, 2+m bench			
- materials	chipseal			
Water take off pipeline				
- location	126 m contour			
- diameter (m)	tbc			
- length (m) est. only	600			
- construction	Tunnelled through ridgeline to plant			
Diversion tunnel				
- diameter (m)	5.5			
- length (m)	130			

DESIGN ATTRIBUTES	All populations	450,000 population	500,000 population	550,000 population
Reservoir/inundation area				
Storage volume (ML)		8400	8760	13400
Lake Area (Ha)		66	68	83
Dam components				
- crest RL		151	151.5	157.5
- crest width (m)	5			
- crest length (m)		92	94	100
- spillway RL		143.5	144	150.3
- standard operating RL	1-2m below the spillway			
- overall height (m)		40	40.5	45.5
- materials/features	RCC, stepped spillway			
- spill way length (m)	25			
- spill way width (m)	18-25			
Residual flow m^3/s (90% mean annual flow)	0.291			
Vehicle Access Bridge				
- length (m)		92	94	100
- width (m)	3-4			
- construction options	balustrade palisade/mesh			
Stilling Basin				
- width (m)	15			
- length (m)	25			
- depth (m	10			

Forest and the region as an inland Tawa dominant forest also recognised as a food source and nesting ground for kereru. Patterns of landform and vegetation cover establish moderate to high natural character values with other aesthetic qualities relating to the unique qualities of the Tawa canopy and browsed under-storey of ferns and the sequence of enclosed views that are punctuated by more open vantage points along the river. Historical associations are marked by remnant mature trees and possible tram line formations with the potential for further archaeological survey and consultation with Iwi to complement and add to these values. The terraces are also valued by a [small number] of pig and deer hunters where the exclusion of motorised activities, remoteness, gentle terrain and proximity to the river make it favourable for game (camp sites and deer observed during the field survey).

The ' Upper Whakatikei Gorge' at the head of the reservoir and its immediate banks beyond the Tawa Terraces is also considered to be outstanding due to physical and perceptual aspects. This feature would share an eastern boundary with the broader [Whakatikei/Akatarawa/Maungakotukutuku/Waikanae catchment] outstanding natural landscape. This incised section of the river features a particularly pronounced meander sequence with steep bluffs, exposed rock outcrops and narrow gravel banks expressive of the underlying greywacke geomorphology. Patterns of vegetation are distinct from the infill terraces and, although modified, represent a coherent pattern of beech-podocarp-broadleaf forest on highly leached soils. Aesthetic qualities relate primarily to the legibility of the landforms and high natural character values that are linked to the both physical qualities and the areas remoteness/wilderness qualities. Distinct [historical or contemporary] associations are unknown and are probably unlikely, given the areas inaccessibility.

3.0 WHAKATIKEI RESERVOIR PROPOSAL

The key parameters for each of the options for the proposed dam and reservoir are summarised in the table below. See Figure 3 for indicative locations.

Note: this description assumes the haulage road proposed in Phase 2 would not be included in the final design.

recreational values and that the landscapes of the Whakatikei catchment should be managed under that premise.

Natural character values within Whakatikei catchment, as described above, range from moderate -high to high[8] and are considered to meet the 'naturalness' test for an ONF/L in line with case law[9] and the proposed Regional Policy Statement, that is: where the '*natural components [clearly] dominate over the influence of human activity*'.

It is considered that an area in the north east Park (see Figure 5) should be regarded as an ONL. The area is outside that impacted by the proposed reservoir site. This landscape includes areas in the Whakatikei and the Akatarawa catchments that flow to the south (to the east of Titi Stream and the Whakatikei River from the head of the reservoir) and the Maungakotuktuku and Waikanae catchments that flow to the north[10]. The forest areas in this landscape are some of the least modified in the Park and represent a range of forest types and habitats across distinct altitudinal zones and establish links to the Rimutakas and the Tararuas. Patterns of landcover and landform contribute to a highly legible landscape with strong picturesque qualities and high natural character values. Historic associations are a further feature, including use as an important food gathering area and pathway through the ranges by Maori, native timber milling with relics such as the Pram [line] track and diverse recreational use with international recognition.

The area to be impacted by the proposed reservoir is not considered to be an ONL, however there are two features in this area that are warrant recognition as ONFs as follows: (see Figure 6-8).

The 'Tawa Terraces' along the eastern banks of the river are considered to be outstanding due to a combination of physical, perceptual and associative factors. The terrace landforms are distinct, intact and representative hydrological patterns of alluvial deposition and uplift within the wider catchment. Whilst modified by logging, the vegetation patterns on these terraces are unique in the Akatarawa

[8] Using a 5 point scale: low | low to moderate | moderate | moderate | moderate to high | high

[9] The court has determined that naturalness is a cultural construct, rather than a scientific term, influenced by context and perception. A natural landscape is not necessarily pristine or completely unmodified and can be consistent with extensive agricultural activities including exotic forestry. For example, in the Mount Cass case, the commissioners:

"[did] *not accept that the only truly natural landscape is a pristine landscape-that is to set the bar too high*"

Mainpower NZ Limited v Hurunui District Council. Decision No. [2011] NZEnvC 384. 9 December 2011 [338]

[10] The boundary of this landscape could be determined (and is beyond the scope of this study) through more detailed analysis of changes in the quality of indigenous vegetation patterns and corresponding landforms (rivers, streams and spurs

Significant or Special Amenity Landscapes (SAL) are a classification that can help give effect to Sections 7(c), although Sections 7(c) and 7(f) apply to all landscapes. Special Amenity Landscapes are often identified where the patterns of landform and landcover have been modified by various human activities over time but where aesthetic qualities or cultural attributes of the area are still considered to be significant to the District. Under the Act, the status of significant amenity or visual amenity landscapes is related to amenity values; as defined in the Interpretation section of the Act:

> *"those natural or physical qualities and characteristics of an area that contribute to people's appreciation of its pleasantness, aesthetic coherence, and cultural and recreational attributes."*

Policy 26 of the proposed Greater Wellington Regional Policy Statement defines an SAL as:

> *"distinctive and widely recognised by the community for the contribution its landscape amenity values make to the pleasantness, aesthetic coherence, cultural and recreational attributes of the district, city or region, and may be dominated by either natural elements or human activity"*

The operative Kapiti Coast District Plan identifies the upper reaches of the Whakatikei Catchment, including the slopes of Mt Wainui, as an outstanding natural landscape. Outstanding Natural Landscapes and Features and Significant Amenity Landscapes have not been identified or mapped in the Upper Hutt City District to date, although some of the ridgelines encircling the city have been identified on the District Planning Maps as having special visual amenity significance.

An assessment of the significance of the landscapes and features in the Whakatikei catchment has been carried out in this appraisal to identify the matters of national importance that need to be considered in future stages of the project and to provide the greatest opportunity to integrate design solutions that are commensurate with an appropriate development.

Landscape Significance Findings

It is considered, following field and desktop survey, that the entire Akatarawa Forest Park has special amenity values because of its prominent topography, diverse and unmodified patterns of hydrology, remnant and regenerating indigenous vegetation and diversity of habitats, historical associations and

Landscape Significance

The determination of landscape significance relates to Part 2 of the Act and the three main types of landscape that are distinguished for the purpose of resource management[6]. Identification and differential management of the three 'tiers' of landscape is also provided for by the proposed Greater Wellington Regional Policy Statement.

Outstanding natural features and landscapes (ONF/ONL) are addressed under Section 6(b) which requires, as a matter of national importance:

> *"the protection of outstanding natural features and landscapes from inappropriate subdivision, use, and development."*

Environment Court decisions establish the general principle that outstanding natural landscapes and features can be identified where the physical, perceptual and associative aspects or values of a landscape are, on balance:

> *"conspicuous, eminent, especially because of excellence, remarkable"* [7].

Policy 24 of the proposed Regional Policy Statement District defines an ONF/ONL as:

> *"exceptional or out of the ordinary and that its natural components dominate over the influence of human activity..."* [see Appendix 2]

Section 7(c) requires that particular regard that should be had to:

> *"the maintenance and enhancement of amenity values"*

And, Section 7(f) which requires that particular regard should be had to:

> *"the maintenance and enhancement of the quality of the environment"*

6 Wakatipu Environment Society Inc. v Queenstown Lakes District Council, C180/99, para [92]
7 Wakatipu Environment Society Inc. v Queenstown Lakes District Council, C180/99 para [82]

Landscape Values	Whakatikei Catchment	Proposed Reservoir Area
Associative	The Whakatikei catchment would have formed part of a wider food gathering area for Maori historically. There are few known sites of significance to tangata whenua in the catchment but with the need for further consultation and survey to confirm and address continuing values related to the mauri or life force of water and appropriate management. Historical associations are linked to native timber logging efforts across the Akatarawas/Tararuas in the late 19th Century/early 20th century with a number of relics located throughout the Park. Tram line formations (unsurveyed) are a feature of many of the ridgelines and prominent spurs in the Whakatikei catchment. Further consultation/survey with Historic Places Trust would be required to determine the nature and extent of heritage matters. Shared and recognised values strongly linked to the Parks primary management focus: water collection and supply with the majority of the catchment designated in the Hutt District Plan for water collection. Secondary objectives recognised in the Forest Management Plan include: native forest regeneration; production forestry; and 'back country' recreational activities. Ecological values in the Whakatikei catchment contribute to a regionally significant resource including wetland areas in the headwaters that are recognised as threatened environments by the Department of Conservation. The Regional Freshwater Plan, identifies the Whakatikei River as a trout fishery and habitat. Recreational activities within the Whakatikei catchment are diverse and strongly associated with the network of forestry roads and tracks that are accessible to organised 4WD groups, trail bikes and mountain bikes (the catchment includes part of the Karapoti Classic). Hunting is a feature in the more remote areas in the north east with horse riding, walking, running and trout fishing more common in close proximity to the access points off the Hutt River and the Karapoti tracks in the Akatarawa catchment.	Area contributes to the wider historic values of the catchment and with further survey/consultation required to confirm any sites of significance to tangata whenua/linked with native timber logging. Probable tramline formations located along the river terraces on the eastern side of the river during the field survey. Other historical associations may be linked to the use of the Dude Ranch Flat as a holiday destination and the bachs (all but one removed) constructed by American soldiers during WWII. Recreational activities in the reservoir area are more limited than in other areas of the Whakatikei catchment. Access up the river bed from the end of Bulls Run Road is controlled by a locked gate and limited by the deep pools in the lower gorge. Hunters and trout fishing enthusiasts occasionally make their way up to the inundation area via forestry roads/ unmarked walking tracks. Existing forestry tracks along the western banks of the river are used by permitted horse riders and for 4WD/trail bike events only. 4WD/ trail bike access to the reservoir area is discouraged through liaison with ARAC and track maintenance programs. The valley floor is identified as one of 6 areas in the Park with particular environmental values in GWRC ARAC guidance publications. The area is recognised as the 'best tawa forest in the area' with 'good areas of black beech and regenerating rimu and hinau' and giant kokupu in the streams.

Landscape Values	Whakatikei Catchment	Proposed Reservoir Area
Perceptual	The Whakatikei catchment has strong picturesque qualities due to the way in which a number of elements come together. Prominent topography, coherent patterns of indigenous and exotic vegetation cover and the extent and diversity of the hydrological network provide a range of landscape experiences and framed views with a sense of depth and distinct planes of fore, mid and background. Areas of open space, along accessible valley floors and ridgelines, are contrasted with more intimate enclosed spaces in gorge and forested areas. Mt Wainui and, Mt Titi provide distinct landmarks at the northern edge of the catchment and the sequence of ridgelines and the Whakatikei River bed are clearly expressive of the underlying geomorphology and are reinforced by indigenous vegetation patterns. Broad areas of exotic forest contribute further to the coherent patterns of landform and landcover as can be appreciated from elevated vantage points. Natural character values range from moderate to high to high[4]; from areas of exotic forestry and early sucessional indigenous forests impacted by motorised recreation to unmodified riverbeds and hillsides with dense indigenous forest and remnant specimens and limited access. Built structures are relatively uncommon and more typical of rural/uninhabited areas (unsealed forestry tracks, huts, transmission lines). Patterns of landform and landcover are clearly expressive of continuing and regenerating natural processes and contrast strongly with nearby residential/urban areas. Hydrological systems are largely unmodified and of high visual quality. A wide range of terrestrial and aquatic habitats are supported with native bird and fish species easily observed. Exotic forest cover enhances the sense of enclosure and isolation and contributes to perceptions[5] of natural character.	Strongly picturesque and memorable landscape; prominent ridgelines and indigenous/exotic landcover provide a strong sense of enclosure and establish varying landscape types with a sequence of framed views from accessible tracks and the river bed. Coherent patterns of vegetation reflect distinct soil and microclimate zones. River terrace tawa dominant forests provide a more intimate landscape experience with light filtered through the characteristic pale green canopy and a sequence of views afforded along deer tracks and natural clearings at the rivers edge. A moderate to high degree of natural character can be associated with the coherent patterns of vegetation including the plantation forest, the unmodified landforms, the prominence of water and varying river flow patterns along with the areas lack of public access/remoteness.

[4] Using a 5 point scale: low | low to moderate | moderate | moderate | moderate to high | high

[5] The court has determined that naturalness is a cultural construct, rather than a scientific term, influenced by context and perception. A natural landscape is not necessarily pristine or completely unmodified and can be consistent with extensive agricultural activities including exotic forestry. For example, in the Mount Cass case, the commissioners:

"[did] *not accept that the only truly natural landscape is a pristine landscape-that is to set the bar too high*"

Mainpower NZ Limited v Hurunui District Council. Decision No. [2011] NZEnvC 384. 9 December 2011 [338]

Landscape Values	Whakatikei Catchment	Proposed Reservoir Area
Physical	Landforms that are representative of the Wellington ranges and largely unmodified. A distinct sequence of uplifted and dissected SW-NE tending ridgelines and spurs underlain by Torlesse supergroup greywacke. Named peaks feature along the northern edges of the catchment including Mt Wainui (722m) and Mt Titi (613m). Land formation processes are associated with several named faultlines including the Moonshine Fault which runs through the Whakatikei Valley. Hydrological patterns are characteristic of the regions steep lands with numerous tributaries to the main river. Named features (NZTopo50 map) include Wainui Stream near the end of Bulls Run Rd. The main river bed features a typical sequence of incised gorges with greywacke outcrops and deep pools and broader infill basins with shifting gravel banks and narrow uplifted terraces. Wetland areas are located in the headwaters of the river and the proposed reservoir area; not found in the rest of the Park. Landcover is predominantly indigenous and diverse. Most areas have been modified by native timber logging but with patterns more intact on the eastern side of the river and northern half of the catchment. Lowland to montane forest types are represented including rare high species on Mt Wainui. Terrestrial and aquatic habitats contribute to important links between the Rimutaka and Orongorongo ranges in the south to the Tararua Ranges in the north and feature a diverse range of forest bird species, invertebrates and native fish species.	Representative landform sequence. Majority area part of a narrow basin enclosed by distinct ridgelines and a sequence of spurs. Distinct uplifted river terraces are a particular feature of the basin area. Incised gorges with characteristic rock outcrops and deeper pools mark the upper and lower extent of the proposed reservoir site. Coherent patterns of cut over podocarp and broadleaf forest and revegetating lowland scrub along with substantial areas of plantation forestry. Beech-podocarp forest near the head of the reservoir features mature specimens. Cut over tawa dominant forest is located on the terraces along much of the eastern side of the basin with a broader area near the head. A number of small ox-bow lakes are located along these terraces marking past river courses across the basin. A raupo wetland (perched swamp) is located on the western banks near Drapers Flat derived from colluvial sediment and surface runoff. The tawa river terrace forest and wetland vegetation types are uncommon in the rest of the Park and with lowland forest and wetland areas recognised as threatened habitats nationally. Collectively, these vegetation patterns provide a high diversity of indigenous trees and shrubs with various successional phases represented. Terrestrial and aquatic habitats for native fish, invertebrate and forest bird species, contribute to the wider ecological values of the Park. Tawa forests form an important seasonal food source for kereru in the area and nesting site. Note: further survey/analysis of NIWA fish database would be required to confirm native fish populations upstream of the proposed dam site and the absence of trout recorded in the Phase 2 study.

- **associative**

The relationships that have been established in an area through patterns of landuse over time and contribute to amenity, sense of place and identity.

More detailed assessment factors, in line with this tripartite definition of landscape values, are detailed in landscape policies in the proposed Greater Wellington Regional Policy Statement (see Appendix 2).

Following on from this framework and the desktop review and field survey, the key aspects of the Park within the Whakatikei catchment and the proposed reservoir area that contribute to landscape values are outlined in the table below:

A diverse range of recreation activities are supported in the Park with the most popular entrances being Karapoti Rd (from Upper Hutt) and Maungakotukutuku Rd (from Kapiti). The Akatarawa Forests, mainly to the west of Whakatikei River, provide one of the main venues for registered 4WD and trail bike users in the region. Whilst Bulls Run/Cooks Road is one of the least popular entry points to the Park, it provides access to a large network of vehicle tracks in the catchment with connections through to Maungakotukutuku. Club Motor Cross on GWRC land and private motorised sports also feature in the vicinity on the block known as Rallywoods accessed through the GWRC 'Cooks Block'. The Park is also well known for its mountain biking tracks and hosts the annual international Karapoti Classic. More remote parts of the Park are used for hunting. Areas adjacent to the Hutt River are popular for walking, running, swimming and trout fishing due to their proximity to urban areas and the well formed tracks. In contrast, public access to the areas around the Whakatikei Reservoir site is relatively uncommon. GWRC issues permits/keys for organised motorised sports events based at the Dude Ranch Flat and a small number of horse riders who use the forestry tracks in Cleary Road and Cooks Block all year round. Trout fishing enthusiasts can access the area by walking in from the end of Bulls Run Road or via the Duck Pond track up from the Riverstone Terrace subdivision, but are largely confined to areas below the proposed dam site due to the deep pools in the lower gorge. Determined four wheel drive and trail bike enthusiasts can access the proposed reservoir area along forestry tracks that terminate near Drapers Flat. However, GWRC discourages them from doing so to protect the ecology of the area and limits maintenance on these tracks. GWRC staff also report that the inundation area is used for trout fishing and hunting occasionally.

2.2 LANDSCAPE VALUES AND SIGNIFICANCE

Whilst landscape is not directly defined in the RMA, it is common practice[3] to assess landscape under three primary components as follows:

- **natural and physical**

Including the geological, topographical, ecological, dynamic and built components of the landscape.

- **perceptual**

The areas aesthetic qualities including naturalness and legibility.

[3] For example, Mainpower NZ Limited v Hurunui District Council. Decision No. [2011] NZEnvC 384. 9 December 2011 para [301].

Landform

Patterns of landform in the Park are underlain by uplifted and dissected Torlesse greywacke and argillite landforms influenced by several faults. The Moonshine Fault can be distinguished along the Moonshine and Bulls Run Rd valleys and to the north of the proposed reservoir site. Patterns of uplift, erosion and alluvial deposits have established a sequence of incised gorges and broader valley basins and south-west to north-east tending ridgelines with steep spurs which are characteristic of many of the ranges in the Wellington Region.

Landcover

Pockets of original and larger areas of regenerating podocarp, beech and broadleaf forest have been retained in the Park following a significant period of native timber milling. Indigenous flora and fauna values of the Akatarawas are considered to be significant[2] in the context of the lower North Island and provide links between the Kapiti Coast and the Tararua Ranges. In the proximity of the Whakatikei reservoir site, most of the bush has been cut over but includes remnants of beech - podocarp, kamahi and tawa dominated forests. The tawa forests on river terraces and areas of wetland in the proposed reservoir area (as shown in Figure 2) are uncommon elsewhere in the Park. Terrestrial and river habitats in the Whakatikei River catchment and other areas of the Park provide for a high diversity of bird and insect life, and native fish and introduced trout species.

There are approximately 3,000 ha of plantation forests managed by GWRC in the Park. Most of these forests are located in the south part of the Park and are accessed off Valley View Road, Bulls Run Road and Cooks Road. Areas of plantation forest feature along much of the western slopes above the proposed reservoir site.

Landuse

Historically, the Akatarawa ranges provided an important area for food gathering by Maori and transportation routes to and from the Hutt Valley and the Kapiti Coast along what is now Akatarawa Road. However, there are very few registered archaeological sites in the Park or sites of known significance to Iwi. Relics of native timber logging are a feature of the Akatarawa Forest with tramline formations identified by GWRC staff along many ridgelines and prominent spurs in the proposed reservoir area.

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2 GWRC (2011) Greater Wellington Parks Network Plan

with further input from the Optimisation Study Engineering team MWH, in relation to project parameters and the implications of the storage capacity options. GWRC staff also provided further information in relation to the existing features and uses of the Park and the base files used for mapping. Field work consisted of a ground survey of the alternative dam sites along the river bed and the proposed reservoir area. An aerial survey by helicopter was used to view less accessible areas of the catchment.

-This assessment assumes strategies can be put in place to avoid permanent exclusion zones around the reservoir and in the wider catchment. That is: members of the public will be able to swim/use non motorised craft on the reservoir and that 4WD/Quad/Trail bike access in the Akatarawa Forest Park (the 'Park') will remain largely unchanged including the continuation of controlled/event only access to areas immediately adjacent to the reservoir.

2.0 SITE CONTEXT

2.2 BACKGROUND

Policy context

The proposed water storage reservoir is located in steep hill country of the Akatarawa Forest Park (15,000 ha) managed by GWRC. The Park is administered under the Local Government Act 2002 and the Wellington Regional Water Board Act 1972 as a water collection area for the future demands of the region. Significant areas of the Park are designated for water collection in both the Upper Hutt City Council and Kapiti Coast District Council District Plans, including the proposed Whakatikei Reservoir site.

Akatarawa Forest Park-specific management initiatives and policies in the GWRC Regional Park Network Plan (2011) prioritise management for water collection and supply with a focus on the lower Whakatikei River area. A second tier of objectives address the protection of native forest vegetation, forestry production, 'back country' recreational experiences and motorised recreation and the provision for future wind energy development. Recreational opportunities and access protocols are further promoted and coordinated through the community organisation 'The Akatarawa Access Committee' (ARAC).

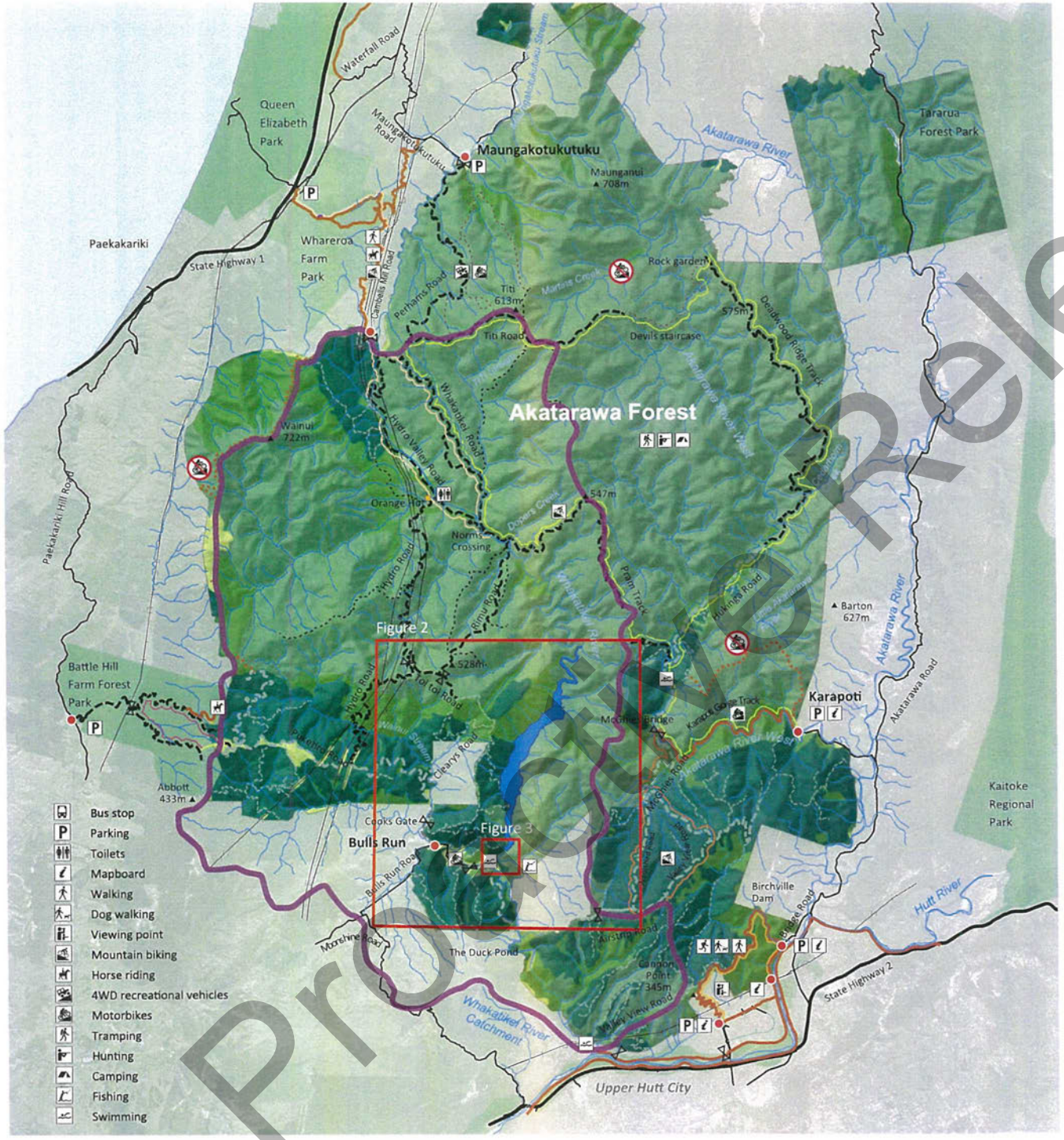

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Figure 1: Akatarawa Forest Park

Whakatikei Baseline Landscape Assessment - Optimisation Study

30/03/12

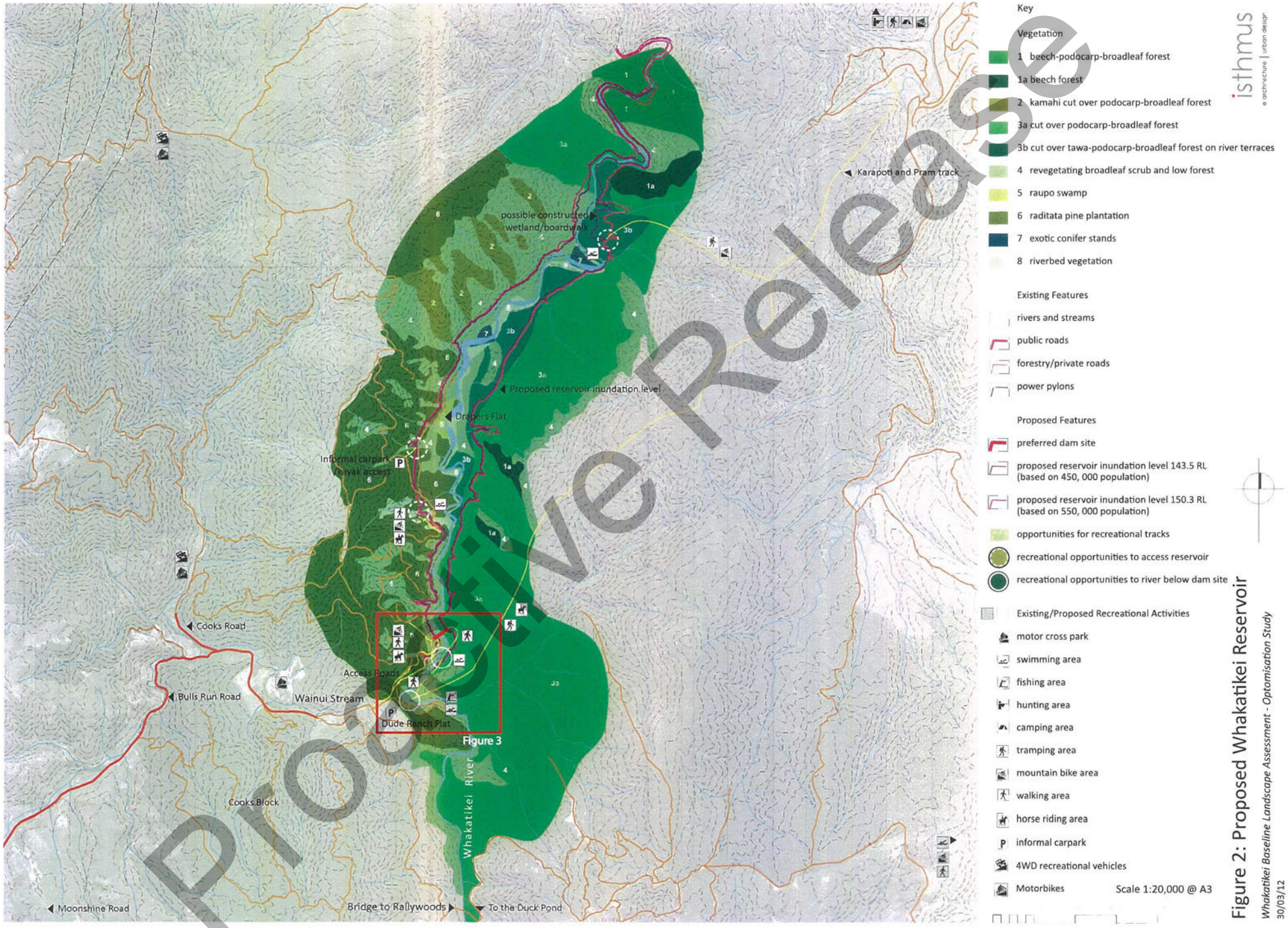

Figure 2: Proposed Whakatikei Reservoir

Whakatikei Baseline Landscape Assessment - Optomisation Study

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Key

Vegetation

- 3a cut over podocarp-broadleaf forest
- 4 revegetating broadleaf scrub and low forest
- 6 raditata pine plantation

Existing Features

- rivers and streams
- rock pools
- forestry roads/paths

Opportunities for Recreational Activites

- fishing areas
- swimming areas
- mountain biking
- hiking track
- walking track
- lookout point
- parking
- bridle trail

Proposed Features

- prefered dam site
- other dam site options
- inundation level for preferred dam (143.5m RL, for population estimate 450,000)
- inundation level for 550,000 population (150.3m RL, for population estimate 550,000)
- proposed inundation level (143.5m RL, for population estimate 450,000)
- indicative location of diversion tunnel
- dam access roads
- walking tracks
- CWB tracks (cycle, walkway and bridle track)
- indicative underground pipeline route
- swing bridge

Scale 1:2,500 @ A3

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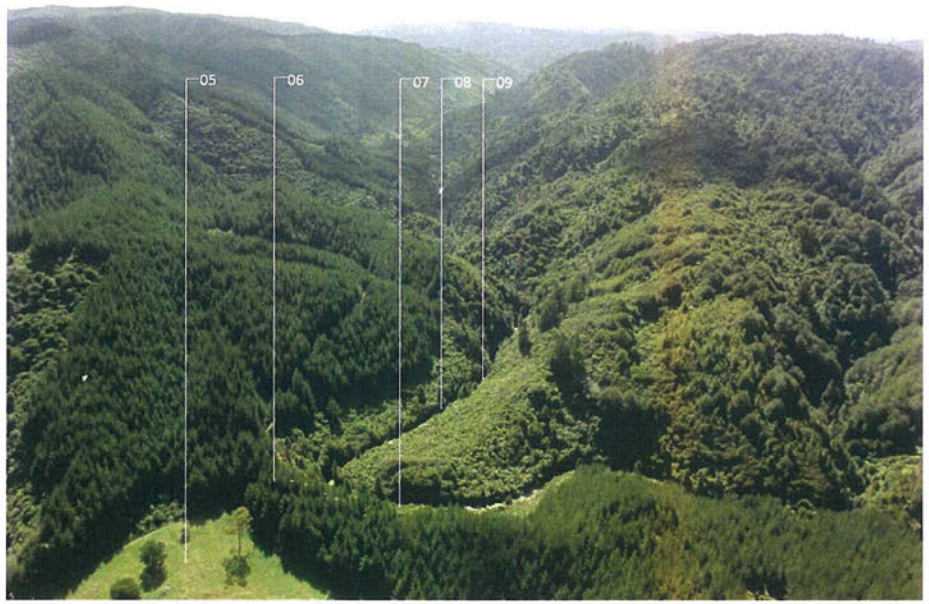
Figure 3: Preferred Dam Site

Whakatikei Baseline Landscape Assessment - Optimisation Study

30/03/12



01 Aerial View upstream from Dude Ranch Flat

02 Aerial View upstream from preferred Dam site

03 Aerial View upstream from Drapers Flat

04 Aerial View downstream near the extent of the basin

Orientation Markers
(located at the same point in all images)

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Figure 4 Site Context Photographs A

Whakatikei Baseline Landscape Assessment - Optomisation Study

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05 Open grass area at Dude Ranch Flat proposed site of Water Treatment Plant

06 View up Whakatikei River Valley from 'Dude Ranch' Ridgeline

07 View up Whakatikei River from existing forestry track river access

08 View downstream to existing river access and ridgeline to Dune Ranch Flat

09 Rock Pools in Whakatikei River above dam site option 1

10 Beach on bend below preferred dam site

Figure 4 Site Context Photographs B

Whakatikei Baseline Landscape Assessment - Optimisation Study

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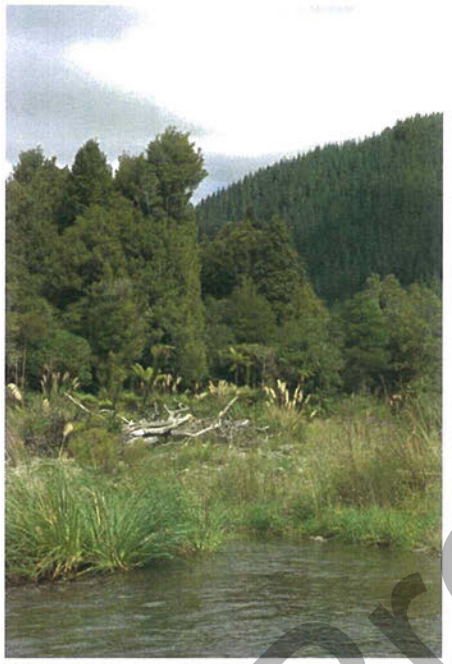
11 View Upstream of the Whakatikei River from beach below preferred Dam Site

12 View near Drapers Flat towards the Tawa Terraces

13 View from an existing forestry track above Drapers Flat



14 View downstream near Drapers Flat

15 View downstream mid basin

16 View downstream mid basin

17 View downstream near the upper extent of the basin

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Figure 4 Site Context Photographs C

Whakatikei Baseline Landscape Assessment - Optomisation Study

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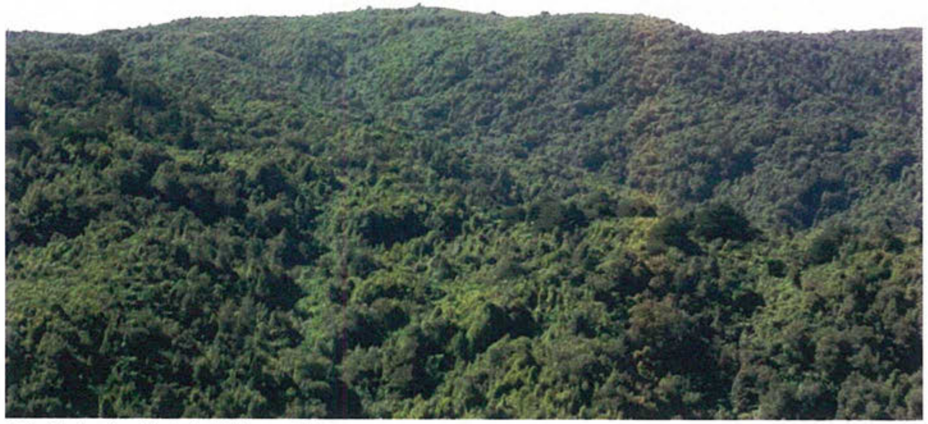
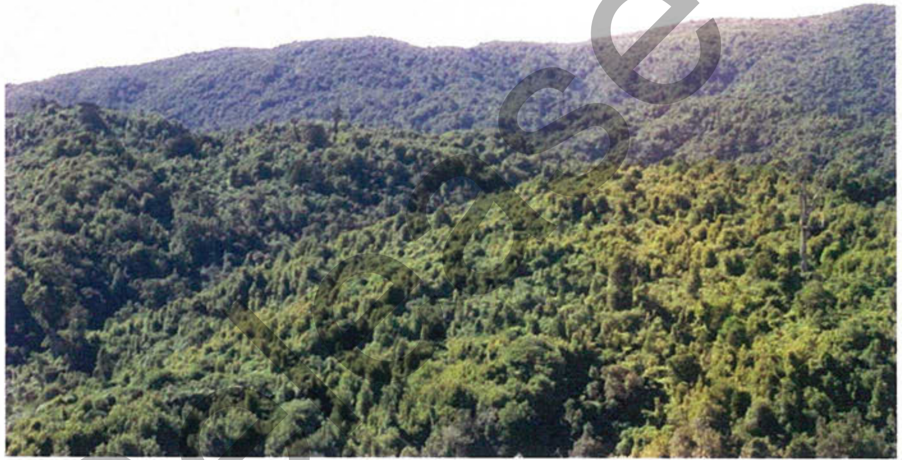


18 Aerial view from Whakatikei Valley near Titi Stream



19 Aerial view from Whakatikei Valley near Titi Stream

20 Aerial view from Whakatikei Valley with Mt Deadwood in the background

Figure 5 Outstanding Natural Landscape - Akatarawa Forest

Whakatikei Baseline Landscape Assessment - Optimisation Study

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Key

Outstanding Natural Features

Tawa Terraces

Upper Whaketikei Gorge

Existing Features

rivers and streams

public roads

forestry /private roads

power pylons

Proposed Features

preferred dam site

proposed reservoir inundation level 143.5 RL (based on 450, 000 population)

proposed reservoir inundation level 150.3 RL (based on 550, 000 population)

Scale 1:20,000 @ A3

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Figure 6 Outstanding Natural Features - Whakatikei Reservoir Area

Whakatikei Baseline Landscape Assessment - Optomisation Study

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Figure 7 Outstanding Natural Feature - Tawa Terraces

27 Aerial view of upper gorge near the upstream extent

28 View upstream near the start of the gorge feature

29 Aerial view of upper gorge vegetation patterns

Figure 8 Outstanding Natural Feature - Upper Whakatikei Gorge

Whakatikei Baseline Landscape Assessment - Optomisation Study

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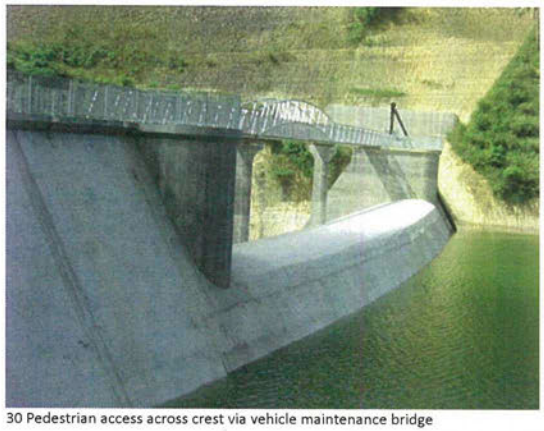

30 Pedestrian access across crest via vehicle maintenance bridge

31 Pedestrian access across crest via vehicle maintenance bridge

32 Tracks with open views and lookouts across reservoir

33 CWB tracks connecting to existing system of tracks (Cycle, Walk and Bridle paths)

34 Boardwalk areas adjacent to the reservoir and constructed wetlands

35 Enclosed pathways through bush clad areas adjacent to reservoir

36 Potential for swing bridge across Whakatikei River below proposed dam to provide alternative loop track and views up river

37 Access to existing beach areas/swimming holes below the proposed dam

38 CWB tracks (Cycle, Walk and Bridle paths)

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Figure 9 Possible Design Strategies

Whakatikei Baseline Landscape Assessment - Optimisation Study

30/03/12

APPENDIX 1: PREFERRED DAM SITE APPRAISAL			
ALTERNATIVE DAM SITES	**OPTION 1**	OPTION 2	**OPTION 3**
Environmental Effect Factors			
- native vegetation and terrestrial habitat (s6c)	▪ greatest loss of native vegetation values and terrestrial habitat through inundation ▪ additional vegetation lost between option 1 and 2 has reduced values-predominately regenerating broadleaf scrub and is reduced by steep topography ▪ effects partially offset by reduced access roads	▪ area inundated between option 2 and 3 includes remnant podocarps and greater diversity of species ▪ additional access road and pipeline earthworks effect increased area of regenerating scrub including tributary	▪ least native vegetation and terrestrial habitat loss through inundation-regenerating scrub/cut over broadleaf and podocarp forest on eastern banks of lower gorge retained ▪ additional access road and pipeline earthworks effect tributary and greater area of regenerating scrub over the spur
- in stream ecological values (s6c)	▪ effects localised, loss of habitat (90m) between option 1 and 2 would have little impact on the overall catchment	▪ effects localised, additional 150m of the river bed retained (compared to option 1) would have little impact of the overall catchment	▪ least effects on in stream ecological values, additional 200m of the river bed retained (compared to option 2)
- natural character (6a)	▪ greatest loss of natural character -dam structure viewed in closest proximity to public viewpoints, riverbed and regenerating scrub further modified by stilling basin and coffer dam including loss of incised gorge/deep pools	▪ dam location reduces effects on natural character values (compared to option 1); structures form a mid ground element and deep pools and incised gorge will be retained ▪ natural character gains offset by increased access road and pipeline earthworks /removal of regenerating scrub	▪ dam location has the least effects on natural character; majority of the dam face screened from the main public viewpoints and landform features (incised gorge) and native vegetation retained on the western banks ▪ gains offset by increased access road earthworks/extent of cut required
- outstanding natural features and landscapes (s6b) Note: this area has not been identified as an outstanding natural landscape (onl) in the Upper Hutt District Plan. A conservative approach has been used in this assessment (where it is assumed part of the lower gorge may contribute to an onl) to be confirmed by further assessment in the next stages of the optimisation study.	▪ inundation areas include incised gorge with distinct physical and perceptual/experiential characteristics and areas of native vegetation that include canopy species/ greater diversity	▪ inundation areas include minor areas of incised gorge and areas of native vegetation that include canopy species/greater diversity	▪ effects are in dependant of the dam location
- public access to rivers (s6d) assumes downstream areas of the river bed will be exempt from any exclusion zone requirements	▪ greatest extent of the lower gorge inundated/ in the exclusion zone ▪ effects partially offset by lower access road/potential tracks down to the river	▪ greater extent of the lower gorge retained for trout fishing/ swimming ▪ extended access roads provide potential for additional tracks down to the river bed	▪ greatest area of the river bed retained for trout fishing and swimming ▪ acccess roads provide potential for improved/easy access e.g. tracks off the road to beach areas/deep pools ▪ public access effects independent of dam-due to reservoir exclusion zone requirements
- values to tangata whenua/relationship (s6e)	▪ independent of the dam site/any effects will be related to the broader inundation area/management of water	▪ independent of the dam site/any effects will be related to the broader inundation area/management of water	▪ independent of the dam site/any effects will be related to the broader inundation area/management of water

Environmental Effect Factors (cont'd)	OPTION 1	OPTION 2	OPTION 3
- historic heritage values (s6f)	▪ least effects on possible tramline embankments (not surveyed)-unlikely to be impacted by inundation area/ access roads	▪ additional access road and pipe line earthworks may impact on tramline embankments (not surveyed)	▪ additional access road and pipe line earthworks may impact on remaining tramline embankments (not surveyed)
- landform /topography (s7f)	▪ greatest effects on the landforms of the riverbed through inundation including distinct incised gorge ▪ effects partially offset by reduced access road earthworks (no fill profile for lower access road to avoid impact on riverbed) ▪	▪ effects on landforms in the river reduced (compared to option 1) but with most of the deep pools/incised gorge impacted by spillway/coffer dam structures ▪ increased access road and pipeline earthworks including 20m+ cuts (benched) and fill areas with potential impact on river bed	▪ least effects on the landforms of the river/ lower section of the gorge visible from the main public view points (fill effects will need to be managed) ▪ greatest length and extent of access roads required including 30m+ cuts (benched) and fill areas with potential impact on river bed
- visual amenity (s7c)	▪ dam has greatest visual prominence as a fore-ground element from the main public view points ▪ prominence increased by dam crest length-14m greater than option 2 ▪ greatest modification of river bed landforms ▪ adverse effects partially offset by reduced extent of access roads but with cuts on the lower access road up to 14m	▪ visual prominence from Bulls Run Rd reduced (compared to option 2); Dam forms a background element from the main public viewpoint and has reduced crest length. ▪ views along the lower section of the gorge retained and downstream vegetation may provide partial screening of dam edges ▪ extended access roads require removal of additional pine forest and regenerating scrub with 30m+ cuts (benched), fill limited to tributary area. Revegetation of cut and fill areas will require 3 years+	▪ dam crest may still be visible from the ridgeline/main public viewpoint but as a background element with the majority of the dam obscured by behind the spur and intervening vegetation ▪ views along the lower section of the gorge/river bed maintained ▪ extended access roads will be visually prominent/require the removal of substantial areas of pine forest with 32m+ cuts (benched), fill limited to tributary area. Revegetation will require 3 years+
- existing recreational values (s7c) assumes no exclusion zone requirement downstream of the dam	▪ greatest effects on existing recreation values/loss of river bed available for trout fishing/swimming including deep pools in the incised gorge (between option 1 and 2) ▪ least effect on river bed backdrop through access road earthworks	▪ access to lower sections of the gorge retained/may include some of the deep pools but majority impacted by downstream structures ▪ existing backdrop of native vegetation partially retained on the eastern banks of the lower gorge ▪ backdrop on the western bank impacted by access road earthworks - reduces recreation values (vegetation largely retained below the lower access road)	▪ least impact on existing recreational values, lower section of the gorge retained for trout fishing and swimming including deep pools ▪ existing backdrop of native vegetation retained on the eastern banks of the lower gorge ▪ backdrop on the western banks impacted by access road construction - reduces recreational values (vegetation largely retained below the lower access road)
- potential for recreational benefits (S7c)	▪ lower access road provides potential for additional access point to the river bed for trout fishing/swimming ▪ upper access road would upgrade existing forestry track/provide access to the dam crest and vehicle bridge with potential loop track along the eastern bank ▪ long term options include development of tramline track along eastern ridgeline to connect with Karapoti network	▪ lower access road provides potential for 2+ access points to the river and alternative swing bridge crossing downstream of the dam ▪ upper access road would upgrade existing forestry track/ provide access to the dam crest and vehicle bridge crossing and a potential loop track along the eastern banks ▪ long term options include development of tramline track along eastern ridgeline to connect with Karapoti network	▪ lower access road provides potential for several access points to the river including deep pools, beach area near the spur and alternative swing bridge crossing ▪ upper access road would upgrade existing forestry track/provide access to the dam crest and vehicle bridge crossing with potential loop track along the eastern banks ▪ potential development of (assumed) tramline track along western ridgeline to connect with existing forestry tracks/extending walking/ cycling/horseriding network within the Park- long term ▪ long term options include development of tramline track along eastern ridgeline to connect with Karapoti network

APPENDIX 2: LANDSCAPE ASSESSMENT POLICIES - GWRC Proposed Regional Policy Statement

Policy 24: Identifying outstanding natural features and landscapes – district and regional plans

District and regional plans shall identify outstanding natural features and landscapes having determined that the natural feature or landscape is exceptional or out of the ordinary and that its natural components dominate over the influence of human activity, taking into account the following factors:

(a) Natural science values: these values relate to the geological, ecological, topographical and natural process components of the natural feature or landscape:

- Representativeness: the combination of natural components that form the feature or landscape strongly typifies the character of an area.

-Research and education: all or parts of the feature or landscape are important for natural science research and education.

-Rarity: the feature or landscape is unique or rare within the district or region, and few comparable examples exist.

-Ecosystem functioning: the presence of healthy ecosystems is clearly evident in the feature or landscape.

(b) Aesthetic values: these values relate to scenic perceptions of the feature or landscape:

- Coherence: the patterns of land cover and land use are in harmony with the underlying natural pattern of landform and there are no significant discordant elements of land cover or land use.

-Vividness: the feature or landscape is visually striking and is widely recognised within the local and wider community for its memorable and sometimes iconic qualities.

-Naturalness: the feature or landscape appears largely unmodified by human activity and the patterns of landform and land cover appear to be largely the result of intact and healthy natural systems.

(c) Expressiveness (legibility): the feature or landscape clearly shows the formative processes that led to its existing character.

(d) Transient values: the consistent and noticeable occurrence of transient natural events, such as seasonal change in vegetation or in wildlife movement, contributes to the character of the feature or landscape.

(e) Shared and recognised values: the feature or landscape is widely known and is highly valued for its contribution to local identity within the immediate and wider community.

(f) Tangata whenua values: Maori values inherent in the feature or landscape add to the feature or landscape being recognised as a special place.

(g) *Historical associations: knowledge of historic events that occurred in and around the feature or landscape is widely held and substantially influences and adds to the value the community attaches to the natural feature or landscape.*

Policy 26: Identifying significant amenity landscapes – district and regional plans

District and regional plans shall identify significant amenity landscapes taking into account the following factors:

(a) *Natural science values: these values relate to the geological, ecological, topographical and natural process components of the landscape:*

-Representativeness: the combination of natural components that form the landscape strongly typifies the character of an area.

-Research and education: all or parts of the landscape are important for natural science research and education.

-Rarity: the landscape is unique or rare within the district or region, and few comparable examples exist.

-Ecosystem functioning: the presence of healthy ecosystems is clearly evident in the landscape.

(b) *Aesthetic values: these values relate to scenic perceptions of the feature or landscape:*

- Coherence: the patterns of land cover and land use are in harmony with the underlying pattern of landform and there are no significant discordant elements of land cover or land use.

-Vividness: the landscape is visually striking and is widely recognised within the local and wider community for itsmemorable and sometimes iconic qualities.

-Naturalness: the patterns of landform and land cover appear to be largely the result of intact and healthy natural systems.

(c) *Expressiveness (legibility): the landscape clearly shows the formative processes that led to its existing character.*

(d) *Transient values: the consistent and noticeable occurrence of transient natural events, such as seasonal change in vegetation or in wildlife movement, contributes to the character of the landscape.*

(e) *Shared and recognised values: the landscape is widely known and is highly valued for its contribution to local identity within the immediate and wider community.*

(f) *Tangata whenua values: Maori values inherent in the landscape add to the landscape being recognised as a special place.*

(g) *Historical associations: knowledge of historic events that occurred in and around the landscape is widely held and substantially influences and adds to the value the community attaches to the landscape.*

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Appendix H: Site Comparison Discussion

Comments from Preferred Site Discussion

Attributes	Description	LSA Phase 2 Preferred Site	Option 2	Option 3
Geology	General Geotechnical suitability of site.	Sound dam foundation. Acceptable site. No fatal flaws. However no subsurface information is available at this stage. Site is not compromised by Moonshine Fault. Very good as far as Wellington region goes for dam sites.	No discernible difference. No justification to change score.	Orientation of joints differs slightly but is not considered to be significant to warrant change in score.
Environmental Effects	Retaining natural character incl. native veg, terrestrial habitat	FOCUS ON NATIVE VEGETATION. Lower site - greater inundation	FOCUS ON NATIVE VEGETATION. Slight improvement on Option 1. However there will be more effects from access road than with Option 1 but these are seen to be able to be mitigated through design solutions.	FOCUS ON NATIVE VEGETATION. Greater area of native vegetation retained with more diversity upstream of Option 2 (on east bank) . However there will be more effects from access road than with Options 1 & 2 but these are seen to be able to be mitigated through design solutions.
	Minimising adverse landform amenity (incl. earthworks)	This criteria is an aspect of overall natural character. This assessment considers modification of RIVER BED & BANKS. Minimises effects on bank (less cuts for access roads) but with greatest impact on the riverbed landforms. Rock pools are lost with this option.	This criteria is an aspect of overall natural character. This assessment considers modification of RIVER BED & BANKS. Cuts up to 28m in places for access roads. No guarantee on retaining the pools.	This criteria is an aspect of overall natural character. This assessment considers modification of RIVER BED & BANKS. Cuts for access roads up to 32m in places, but can be mitigated somewhat with design. Minimised effects on the river bed - maintains rock pools and beach. Longer term assessment considers the river bed positive effects (saving pools & beach) outweighs cuts which can be designed out and planted.
	Retaining outstanding natural features	Not currently identified as outstanding natural landscape (onl). If this area was considered to have onl features it could include the deep pools and native vegetation along the edges of the river. Option 1 removes the pools and is considered the worst option in this criteria.	Not currently identified as outstanding natural landscape. Better than 1 but not enough to improve score from option 1.	Not currently identified as outstanding natural landscape. Effects for this option more related to the lake as more stream bed, beach and pools are retained.
	Retaining public access to rivers	Assume that all river below dam is accessible. Discussion on H & S issue of spillway operation with public access downstream. Provides least access to river of all three options. Access to river will be accounted for in +ve recreational effects. Current access is difficult and this will not be made any worse in terms of existing public access. For this reason all three options given same score.	Assume that all river below dam is accessible. Discussion on H & S issue of spillway operation with public access downstream. This option provides greater access than 1 but less than 3. Will be accounted for in +ve recreational effects. Current access is difficult and this will not be made any worse in terms of existing public access. For this reason all three options given same score.	Assume that all river below dam is accessible. Discussion on H & S issue of spillway operation with public access downstream. This option provides access to greater length of river. Will be accounted for in +ve recreational effects. Current access is difficult and this will not be made any worse in terms of existing public access. For this reason all three options given same score.
	Minimising adverse Visual amenity	Considered visual effects from top of ridgeline looking along river. Most visually prominent. Discussion on potential for positive visual effects to be addressed through detail design	Considered visual effects from top of ridgeline looking along river. Still visually prominent, reducing as dam moves upstream. Gains partially offset by extended access road requirements but with options to reduce/mitigate through detailed design	Considered visual effects from top of ridgeline looking along river. Moving around the bend provides a significant improvement to visual prominence.Gains partially offset by extended access road requirements but with options to reduce/mitigate through detailed design and screening provided by intervening topography
	Retaining existing Recreational Values:	Some access to the lower gorge from Bulls Run Road. Some swimming and fishing possible. Can gain permit for riding horse and off road events. Main issue is what exclusion zones will be in effect. All three sites will be similar in effect.	Some access to the lower gorge from Bulls Run Road. Some swimming and fishing possible. Can gain permit for riding horse and off road events. Main issue is what exclusion zones will be in effect. All three sites will be similar in effect.	Some access to the lower gorge from Bulls Run Road. Some swimming and fishing possible. Can gain permit for riding horse and off road events. Main issue is what exclusion zones will be in effect. All three sites will be similar in effect.
	Potential for positive recreational benefits	Assuming that recreational benefits of LAKE are consistent for all three options. Focus here is on the potential benefits of the dam location. Assumes than non-motorised public access is possible to the lower gorge, up to the dam and across the dam crest. More options to access the river bed will be provided. Could include a swing bridge. The further up the gorge the dam site is, the more opportunities exist for positive recreational benefits. All options could include a loop track(s) and potential for long term development of tram line track through to Karapoti network.	More potential than Option 1 but less than 3.	This location has the greater potential. Retains rock pools, more access points to river, with potential links to existing forestry tracks off the upper access road through to the dam lake.
Constructability	Dam geometry required due to gorge shape & ability to construct differing dam types;	Lower valley has steeper sides making abutment excavation potentially more difficult. All three sites can incorporate a staging or raising approach. Option 1 has easiest access road to construct. All three can incorporate RCC and Hardfill construction techniques. Positive and negative aspects cancel each other out for all three options. All three options too close to separate from one another.	Lower valley has steeper sides making abutment excavation potentially more difficult. All three sites can incorporate a staged construction approach as well as both RCC and Hardfill construction options. Access road construction more difficult than Option 1 but easier than Option 3. Positive and negative aspects cancel each other out for all three options. All three options to close too separate from one another.	This site has less steep abutment slopes potentially making abutment excavation easier. All three sites can incorporate a staged construction approach as well as both RCC and Hardfill construction options. Long and more difficult access road required. Positive and negative aspects cancel each other out for all three options. All three options too close to separate from one another.
Capital Cost	Low, Medium or High comparison.	Looking at main cost drivers - s7(2)(h), s7(2)(i) [redacted] In this case it is the WTP s7(2)(h), s7(2)(i) [redacted] A total of 34,600m3 of concrete required. Longest diversion tunnel but shortest access roads. Very small cost difference across all sites.	A total of 38,000m3 of concrete is required. Shortest diversion tunnel but largest volume plus additional pipe & road costs on top of Option 1.	34,500m3 of concrete. s7(2)(h), s7(2)(i) [redacted] The current cost estimates for all three options do not justify a difference in scores.

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BUILDING A BETTER WORLD

Greater Wellington Regional Council
Whakatikei Storage Optimisation Study
Prefferred Site Discussion
Project: Z1990400

	Site	Criteria					
		Geology	Enviromental Effects	Social	Constructability	Capital Cost	s7(2)(h), s7(2)(i)
Whakatikei	Phase 2 Preferred Site						
	Option 2						
	Option 3						

Criteria Scoring Assessment

Attributes	Description	Elemental Weighting	Total
Geology	• General geotechnical suitability of site.	s7(2)(h), s7(2)(i)	
Environmental Effects	• Retaining natural character incl. native veg, terrestrial habitat		
	• Minimising adverse landform amenity (incl. earthworks)		
	• Retaining outstanding natural features		
Social	• Retaining public access to rivers		
	• Minimising adverse visual amenity		
	• Retaining existing recreational values;		
	• Potential for positive recreational benefits		
Constructability	• Dam geometry required due to gorge shape & ability to construct differing dam types;		
Capital Cost	• Low, Medium or High comparison.		

Scoring	0	Unacceptable - Contains 'show stopper' issue and no longer considered in selection;
	1	Worst in respect of the particular criteria;
	2	
	3	Average neither particularly good nor bad in respect of the particular criteria;
	4	
	5	Best in respect of the particular criteria;

NOTES:

1 The intention of this assessment is to identify and score points of difference between the sites being assessed.
2 The assessment is not intended to identify all possible assessment criteria.
3 Refer to comments sheet for background on how each score assessment was completed.
4 Assessment was carried out by undertaking a comparison of the LSA Phase 2 Preferred Site (updated to 2012 costs) against the same storage volume dam moved to the optimised sites known as Option 2 & Option 3.