Hamilton City Council

HAMILTON CBD WATER SUPPLY ZONE

WATER SUPPLY RESERVOIR UPGRADE LOCATION ASSESSMENT

29 MAY 2025

PUBLIC

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Hamilton City Council

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ABBREVIATIONS

CBD	Central Business District
CWT	Clear Water Tank
HCC	Hamilton City Council
HLPS	High Lift Pump Station
PC12	Plan Change 12
PS	Pump Station
RES	Reservoir
TWL	Top Water Level
WSZ	Water Supply Zone
WTP	Water Treatment Plant

EXECUTIVE SUMMARY

The Ruakiwi Water Supply Zone (WSZ) services the central city area of Hamilton. The current Ruakiwi Reservoir volume is 15 ML (Mega/Million Litres). Forecast development in the WSZ is currently estimated by HCC to require a future storage volume of 40-60 ML. As the existing Ruakiwi reservoir is planned to be decommissioned once the new reservoir/s are in service, the future reservoir/s must provide for the full 40 – 60 ML of storage.

Funding has been secured from the Central Government Infrastructure Acceleration Fund (IAF) for strategic water supply upgrades within the central city. The IAF is intended to enable more housing development to occur more quickly. Also, the New Zealand Government's Medium Density Residential Standards (MDRS) will permit more intensive development in the central city (currently being considered as Plan Change 12).

Hamilton City Council (HCC) engaged WSP to assess potential locations for a reservoir site to service future growth within the central city area. In the context of the reservoir location assessment, the site would house new reservoirs and all association discharge booster pump infrastructure. HCC subsequently engaged WSP to undertake an assessment of potential locations for an associated booster pump station (see 'High Level Booster Pump Station Location Assessment') for the preferred reservoir site.

The key objectives of this assessment are as follows:

- Identify potential sites and assess them at a high level (desktop only) to determine the most appropriate reservoir location. This will be achieved by providing input into the identification of suitable locations for a new drinking water reservoir as part of the IAF Reservoir and Booster Pump Station project.
- Understand the difference in energy costs for a selection of representative sites and the baseline scenario (i.e. the existing Ruakiwi Reservoir site).

The following methodology has been applied for this assessment:

- Identify a long list of potential sites based on several criteria that a potential reservoir site must have in order for it to be viable for reservoir operations
- Select five sites that can broadly represent the identified long list of sites by identifying key common attributes (e.g. elevation, distance to supply zone, proximity to WTP etc.). Then, undertake a comparative energy cost assessment of these five representative sites. The difference in energy costs was one of the criteria that was assessed in the fatal-flaws assessment (see below).
- Assess the long list of sites utilising a fatal flaws-based approach – eliminating any sites from the long list that have any fatal flaw attributes. Then, refine the list further based on additional criteria (e.g. the conclusions drawn from the comparative energy assessment, discussions with HCC etc.). Recommend a short list of sites for further assessment.
- Undertake a Multi Criteria Assessment (MCA) of the short-listed sites to identify a preferred site for a new reservoir.

SITE SELECTION/ LONG LIST DEVELOPMENT

A total of 30 sites were identified for inclusion into the initial long list. The long list sites are generally open greenspace sites (reserves, sports fields, schools) within several kilometres of the

CBD. However, some additional sites were included on private industrial land, or further away from the CBD so that a broad representation of sites could be considered.

Other sites could have been included, but the main objective was to assess a representative sample of sites that meet the minimum size requirements, at various distances and elevations relative to the CBD, the WTP and the existing Ruakiwi reservoir site. The long list of sites, in relation to the supply zone, can be seen in the figure below.

REPRESENTATIVE ENERGY ASSESSMENT

The representative energy assessment involved the high-level assessment of energy use based on a single average day and averaged flow rates and volumes. It was not possible to account for variability in a simple assessment therefore static parameters were adopted to provide a comparative energy use scenario only. Actual power use and costs will vary significantly due to the complex and dynamic nature of the infrastructure, but the outputs were suitable to compare the likely relative energy use of the sites.

Five representative sites were selected that could broadly represent the energy properties of all the long list sites, instead of assessing all the long list sites separately. The representative sites were then compared to the baseline scenario (i.e. the existing Ruakiwi site with the reservoir at a higher elevation). The representative sites varied from the short-listed sites that were identified in the fatal flaws assessment. This is because the representative energy assessment was intended to be a

comparative energy assessment of sites with key varying attributes to understand how energy usage changes because of different site attributes (e.g. elevation compared to WTP, distance from WTP/ supply zone etc.).

The representative sites identified for the comparative energy assessment can be seen in the figure below.

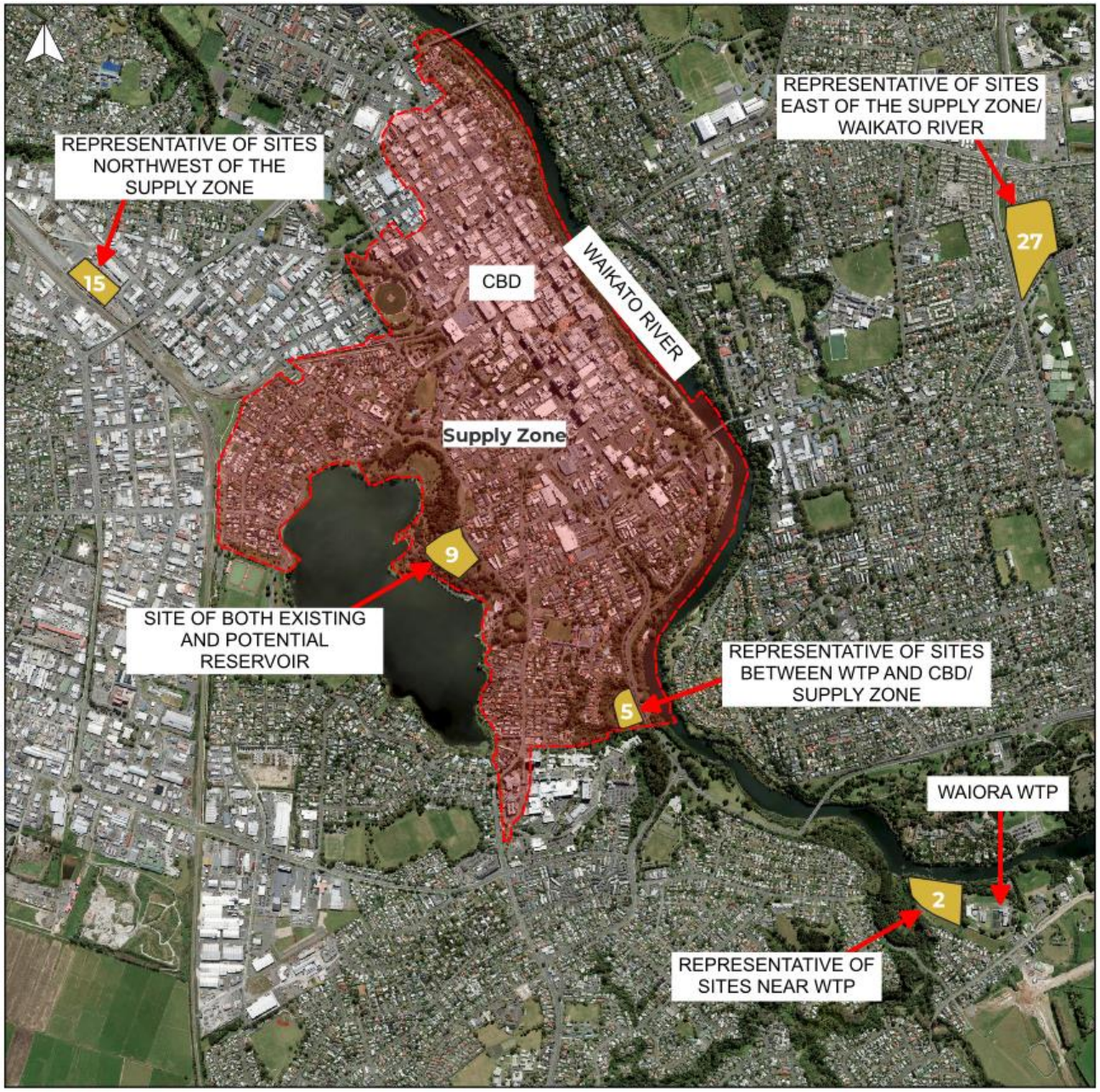


Figure 1 Representative sites for energy assessment

The representative sites are as follows:

- Ruakiwi (site 9) – The existing reservoir site was included as the baseline for comparison because it is already in use.
- WTP (representing sites 1 and 2) – A potential site near the existing Water Treatment Plant was included due to its proximity to treatment infrastructure and potential efficiencies associated with reservoir filling.

- Graham Park (representing sites 3, 4, 5 and 6) – This site is located approximately mid-way between the existing WTP and the CBD, so was included to represent potential sites along the WTP-CBD corridor which is thought to be the area in which the least amount of new capital infrastructure would be required (shortest route between the WTP and the CBD).
- Kent Street (representing sites 10, 11, 12, 13, 14, 15, 16 and 17) – This site was adopted as a representative site northwest of the CBD. Sites to the northwest are further away from the WTP than the existing Ruakiwi site, requiring more energy to fill them from the WTP. This site was included to see if energy costs for sites north/northwest of the CBD would be higher than sites between the WTP and the CBD.
- Marist Park (representing sites 21, 22, 23, 24, 25, 26, 27, 28 and 29) – This site was adopted as a representative site east of the CBD. Sites to the east are further away from the CBD than the existing Ruakiwi site, requiring more energy to boost pressure and convey water to the CBD. Eastern sites will also require one or two Waikato River crossings (although this does not affect the energy assessment). This site was included to see if energy costs would be higher than sites between the WTP and the CBD.

The assessment showed that the existing Ruakiwi reservoir site is likely the most energy efficient provided the existing reservoir levels and the supply zone is optimised by introducing gravity and booster pumped sub-zones.

The existing Ruakiwi Reservoir is very tall (approximately 19 m – an RL of 84.5 m) and when full, is high enough to service the entire current red zone by gravity. However, to achieve this, water is pumped to a higher elevation than is needed to service much of the supply zone (approximately 70%) by gravity. This results in a higher overall energy use than is optimal.

Constructing a new reservoir at a lower elevation at the same site will retain gravity supply to most current and future zones. This should result in lower overall energy use at the expense of having to boost pump to higher elevations around Ruakiwi Road (estimated at about 30% of the future zone area subject to assessment and optimisation).

The WTP site has a comparable (but slightly higher) energy use compared to the optimised Ruakiwi site. If the Ruakiwi site cannot be optimised, then the WTP site would become the favoured site from an energy use perspective. The WTP site is the preferred back-up site. However, for a new reservoir to be viable, a new dedicated supply main would need to be constructed to the CBD now (instead of in the future for the existing Ruakiwi Reservoir site).

All other representative sites (regardless of current land-use) that have an elevation less than the existing Ruakiwi site are predicted to require more energy to operate than the existing reservoir site and the WTP site and are therefore not preferred.

The conclusions drawn from this comparative energy assessment formed a criteria item for the traffic light fatal flaws assessment.

FATAL FLAWS ASSESSMENT

A fatal flaw assessment was undertaken to refine the identified long list of sites down to a short list that could be assessed in more detail. The assessment considered the following aspects:

- Land ownership
- Proximity to the bulk water network
- Proximity to the Waiora WTP
- Proximity to the CBD
- Site elevation
- Site area (scale)
- Relative energy use
- Underlying site geology

The fatal flaw assessment was not scored. The assessment was based on a simple traffic light system applied on a relative basis for each item, as follows:

RED	Significant issues / fatal flaw
ORANGE	Potential issues / challenges
GREEN	No significant issues

The traffic light assessment was not intended to differentiate individual sites. Rather, the assessment provides a simple visual appreciation of sites with a higher chance of being suitable. It refined the long list by removing sites from contention that have obvious fatal flaws. The list was then refined further based on non-fatal criteria such as the conclusions drawn from the comparative energy assessment, and discussions with HCC.

Six sites were short-listed to be progressed through to the Multi Criteria Analysis (MCA) assessment. Three representative abandoned sites were added to the assessment as a check of the fatal flaw assessment (nine sites in total). These sites can be seen in the figure below.

Table 1 Short list of reservoir sites

SITE NO.	LOCATION / NAME	COMMENT
2	Peacocke / Waiora WTP	Integrated inlet pumping beside the WTP site could be done independent to the High Lift Pump station (sans pipework).
4	Melville Park	Site availability is subject to proposed use for Wet Weather Wastewater Storage. Not a preferred site due to the possibility of being required for wastewater.
5	Graham Park (or other viable sites between the WTP and CBD)	Only as a backup site because the site may need to be filled, and the reservoir elevated to optimise energy use. However, it is retained as it is likely to have a lower capital cost than other more remote sites as it is in the efficient corridor between the WTP and the CBD.
9	Ruakiwi Reservoir Site	Has an existing designation for water infrastructure purposes and can be optimised to be more energy efficient than the current reservoir. The designation would need to be increased to accommodate the footprint area for two reservoirs.
10	Lake Domain Reserve	Potential backup / additional area to be used in conjunction with the existing Ruakiwi Site. This site represents any area of the lake domain reserve that is outside of the designation for the existing Ruakiwi reservoir. The existing designated and elevated site remains preferred over this site.

SITE NO.	LOCATION / NAME	COMMENT
12	Hinemoa Park (Rostrevor Street)	Less favourable than other locations as it is at the northern extent of the CBD (less energy efficient, more costly due to longer pipelines) but potentially a viable alternative if other sites have fatal flaws. Not a preferred site due to low-medium likelihood of being required for wastewater and located further north than the existing reservoir site.

Figure 2 Short listed reservoir sites

MCA ASSESSMENT AND CONCLUSIONS

A detailed MCA assessment was undertaken for the six shortlisted sites plus three representative sites from the discarded options. The representative sites were included in the MCA to validate

their elimination in the earlier fatal flaw assessment. The scores were collated into an average score for each criterion resulting in a final 'group' score and MCA ranking.

The MCA was scored by WSP and reviewed by HCC and personnel from key project disciplines after which, the Ruakiwi (existing) reservoir site was adopted as the preferred location. The MCA scores and rankings are presented in Table 2.

Table 2 MCA outcome scores and ranking

SITE NO.	LOCATION / NAME	WEIGHTED SCORE	RANKING	COMMENT / PRIMARY INFLUENCE IN SCORE AND RANKING
1	Gully Reserve Near 300 Peacockes Road	3.261	8	Low ranking due to the infrastructure required to service the remote site with new connection back to both the WTP and the CBD.
2	Peacocke / Waiora WTP	3.778	2	High ranking due to proximity to the existing WTP requiring less future strategic infrastructure to fill the reservoir. Ranked lower than Ruakiwi due to lower energy efficiency and infrastructure required to outlet to the CBD.
4	Melville Park	3.579	3	Middle-high ranking due to the location in the efficient infrastructure corridor between the WTP and the CBD. Lower than the top two options due to the potential loss of high use reserve areas and slightly lower energy efficiency.
5	Graham Park	3.519	4	
9	Ruakiwi Reservoir Site	4.155	1	Ranked the highest due to proximity to the CBD, energy efficiency and the existing designation status (acknowledging that the future works will likely require the designation to be extended).
10	Lake Domain Reserve	3.303	6	Middle-low ranking made favourable due to proximity to the CBD but adversely affected by being north of the current reservoir site and requiring the extension of strategic infrastructure, and due to the potential loss of high use reserve areas and lower energy efficiency that options along the WTP-CBD corridor.
12	Hinemoa Park (Rostrevor Street)	3.409	5	
15	Kent Street Industrial Area	3.278	7	Low ranking due to the infrastructure required to service the remote site with a new connection back to both the WTP and the CBD.

SITE NO.	LOCATION / NAME	WEIGHTED SCORE	RANKING	COMMENT / PRIMARY INFLUENCE IN SCORE AND RANKING
27	Marist Park	2.948	9	Lowest ranking due to the amount of infrastructure required to service the remote site with a new connection back to both the WTP and the CBD including crossing the Waikato River.
The sites assessed in the MCA are classed as per the shading below:				
Short listed site - preferred	Other short-listed site retained from the traffic light assessment.	Representative site (discarded in the traffic light assessment) included in the MCA.		

The preferred Ruakiwi Reservoir Site option (site 9) was adopted due to the following:

a The existing Ruakiwi Reservoir site ranked 1st by a significant margin in the MCA. Sensitivity testing of individual criterion scores by WSP did not change the outcome because the existing site is favourable in many criteria.

b The detailed MCA scoring outcome closely matched the outcome of the traffic light assessment that preceded it (e.g. the top two preferred sites were the same in both assessments).

c The existing reservoir site has the highest elevation of all the sites in proximity to the CBD. The existing site has the lowest energy use potential based on the high-level energy assessment which is consistent with its high elevation (e.g. even though the energy assessment was coarse, confidence is high that the existing site will be the most efficient). The elevated site is also the most resilient in an emergency as it supplies water by gravity to most of the zone.

d The existing reservoir site provides the most adaptable location because the new reservoir(s) can be built alongside the existing one making the transition to new infrastructure easier.

e The existing reservoir site is likely to be a more resilient supply due to the vicinity of the reservoir to the customers (distant locations result in longer pipework, which increases the supply risk).

f It is acknowledged that this assessment has not undertaken a detailed and thorough assessment of any planning and consultation aspects (e.g. cultural, visual, and loss of amenity reserve area). Some inputs into the MCA were sought from the relevant parties to address some of these aspects at a very high-level. However, there is already a water infrastructure designation and an existing reservoir at the site so the works may not be perceived as such a significant change of use compared to an alternate site.

The Ruakiwi Reservoir site (Site 9) is the preferred site based on the high-level energy assessment and the MCA. The existing site has the benefit of an existing designation and use for water infrastructure and proximity to the CBD, resulting in lower outlet pipeline construction costs. Most of the future CBD zone can also be serviced by gravity which is good for resilience.

1 PROJECT BACKGROUND

1.1 INTRODUCTION

The Ruakiwi Water Supply Zone (WSZ) (also known as the Red Zone) services the central city area of Hamilton. The current Ruakiwi Reservoir volume is 15 ML (Mega/Million Litres).

Funding has been secured from the Central Government Infrastructure Acceleration Fund (IAF) for strategic water supply upgrades within the central city. The IAF is intended to enable more housing development to occur more quickly. Also, the New Zealand Government's Medium Density Residential Standards (MDRS) will permit more intensive development in the central city (currently considered as Plan Change 12).

Forecasted development in the 'Red Zone' and the potential future extension to some (or all) of PC12 Stage 1 is currently estimated by HCC to require a future storage volume of 40-60 ML. As the existing Ruakiwi reservoir is planned to be decommissioned once the new reservoir/s are in service, the future reservoir/s must provide for the full 40 – 60 ML of storage.

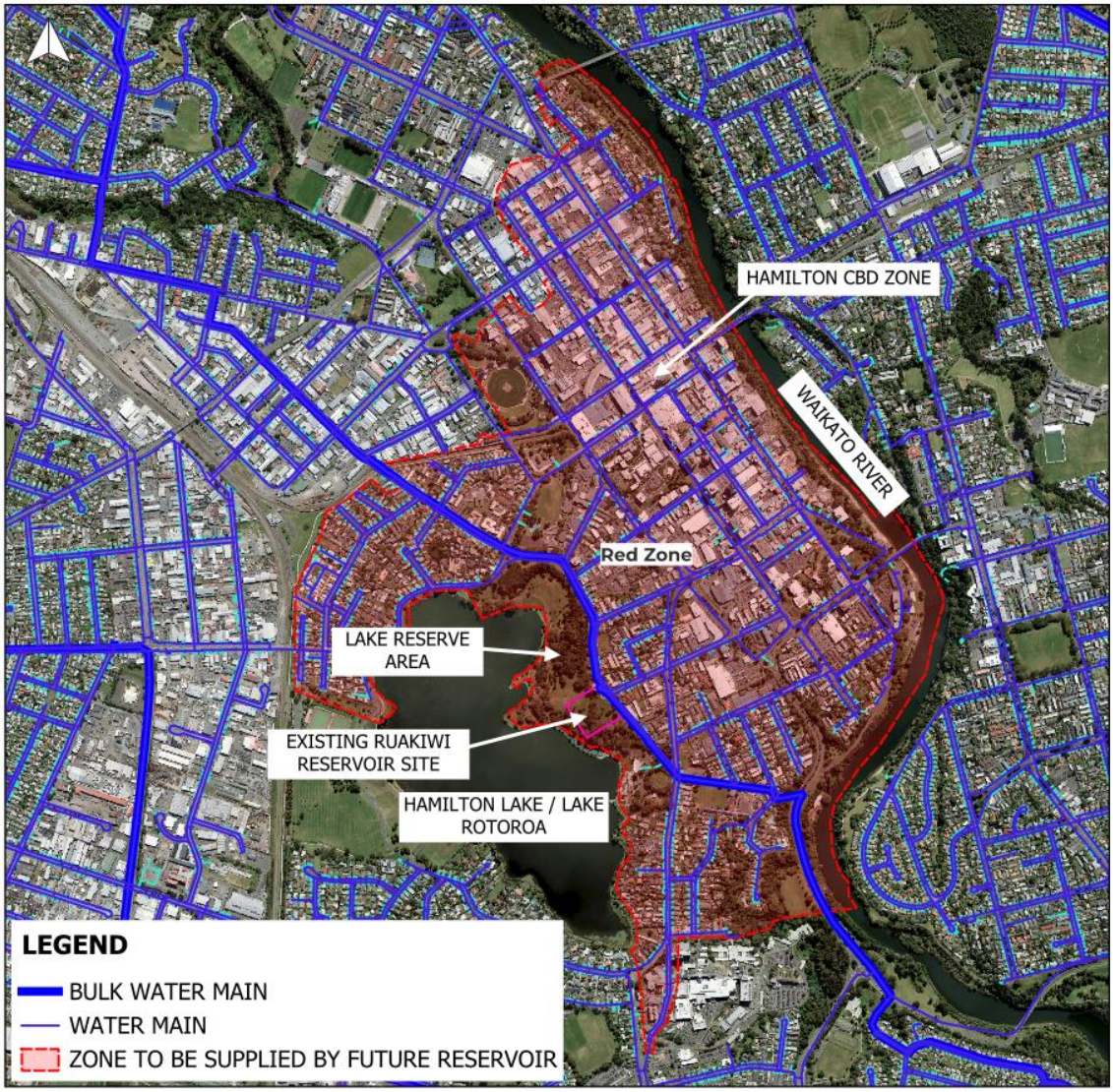


Figure 3 Ruakiwi Water Supply Zone (the Red Zone) (source: Mott Macdonald)

Hamilton City Council (HCC) engaged WSP to assess potential locations for a reservoir site to service future growth within the central city area as part of the IAF programme.

HCC subsequently engaged WSP to undertake an assessment of potential locations for an associated booster pump station (see '*High Level Booster Pump Station Location Assessment*') for the preferred reservoir site.

1.2 ASSESSMENT OBJECTIVES AND METHODOLOGY

The key objectives of this assessment is to:

1. Identify potential sites and assess them at a high level (desktop only) to determine the most appropriate location for a new reservoir and integrated booster pump infrastructure as part of the IAF Reservoir and Booster Pump Station project.
2. Understand the difference in energy costs for a selection of representative sites and the baseline scenario (i.e. the existing Ruakiwi Reservoir site).

The following methodology has been applied for this assessment:

STAGE 1

Identify a long list of potential sites based on several criteria that a potential reservoir site must have for it to be viable for reservoir operations.

STAGE 2

Select five sites that can broadly represent the identified long list of sites by identifying key common attributes (e.g. elevation, distance to supply zone, proximity to WTP etc.). Then, undertake a comparative energy cost assessment of these five representative sites. The difference in energy costs will be one of the criteria that is assessed in the fatal flaws assessment.

STAGE 3

Assess the long list of sites utilising a fatal flaws-based approach – eliminating any sites from the long list that have any fatal flaw attributes. Then, refine the list even further based on some further soft criteria (e.g. the conclusions drawn from the comparative energy assessment, discussions with HCC etc.). Recommend a short list of sites for further assessment.

STAGE 4

Undertake a Multi Criteria Analysis (MCA) assessment of the short-listed sites from Stage 3 considering a broader range of criteria and recommend a preferred site.

1.3 THE RUAKIWI WSZ AND PLAN CHANGE 12

1.3.1 ZONE EXTENTS

A 'Stage 1' area was identified by HCC as part of the Plan Change 12 (PC12) process. This area is targeted for priority growth intensification and higher density development to align with creating a more walkable city. Part of the current Ruakiwi WSZ is contained within the identified PC12 Stage 1 area – as seen in Figure 4. below.

Figure 4 PC12 Stage 1 priority development area

HCC planning staff note that the Ruakiwi WSZ may someday be expanded to service a larger area than currently indicated – encompassing some (or all) of the proposed Stage 1 area.

1.3.2 MODELLED STORAGE VOLUMES

The Water Supply Network Master Plan projected that a total storage volume of 60 ML would be required to service the Ruakiwi WSZ to meet the predicted growth through to 2061.This estimate was based on modelling conducted in 2018. However, since May 2021, a significant reduction in outflow from the existing Ruakiwi reservoir had been observed, primarily due closing boundary connections that were incorrectly open between the existing high-pressure Red Zone and the surrounding medium-pressure zones. These improvements were estimated to significantly reduce the per capita water consumption in the Red Zone, and therefore an updated modelling assessment conducted by Mott Macdonald in 2024 adjusted the Red Zone demand accordingly. The revised storage assessment for the 2061 population estimate indicates that a total storage volume of 40 ML would be sufficient to meet future service levels in the Ruakiwi WSZ.

As outlined in Section 1.3.1, HCC planning staff anticipate expanding the Ruakiwi WSZ to include some of the adjacent suburbs. However, the exact extent of this expansion remains undefined and will only be defined once population growth patterns are more understood. These potential expansions were not included in Mott Macdonald's 2024 model run. An extension to the Ruakiwi WSZ beyond its current boundaries would render the projected storage volume of 40 ML inadequate to meet the service-level and water-security requirements.

To ensure capacity flexibility, accommodating both additional zone area and population increases, HCC has proposed increasing the total future storage volume for new reservoir/s to 50 ML. The existing Ruakiwi reservoir has a physical storage volume of 9.9 ML and it does not meet current seismic resilience standards. Strengthening the structure could further reduce its storage volume, making it insufficient to meet the anticipated short-term demands. The existing reservoir is planned to be decommissioned once the new infrastructure and 25 ML reservoir is in service by 2031. In-line with current growth projections, a second 25 ML reservoir is expected to be planned for by 2040, with operations commencing by 2046.

Providing two 25 ML reservoirs gives the flexibility to:

- Ensure water turnover is appropriately timed
- Maximise the usage age of the investment
- Reconfirm the size of the future reservoir if the modelling or water usage behaviour changes over time

Although the 2061 time-horizon is used as a baseline in the Master Plan, growth will continue beyond this point. Any further growth and additional expansion will require ongoing management and consideration across the wider network.

2 ASSESSMENT APPROACH

2.1 OVERVIEW

In consultation with HCC a total of 30 potential reservoir sites were identified for inclusion within an initial long list. These initial sites were selected to represent a sample of sites covering various scenarios such as distance and elevation relative to the CBD, the Waiora WTP, the existing Ruakiwi reservoir, and existing land-use.

An assessment of the long list sites was then undertaken to remove sites with obvious fatal flaws, and refine down to a short list of sites that could be progressed to more detailed assessment/s.

Concurrently, a representative energy assessment was undertaken to comparatively assess the variability of energy usage for several representative sites. The results from the energy assessment were one of the assessment criteria that was considered in the short-listing process.

Note that the small subset of representative sites assessed in the representative energy assessment may vary from the short-listed sites that are identified following the fatal flaws assessment of the long list. This is because the representative energy assessment is intended to be a comparative energy assessment of six sites with key varying attributes to understand how energy usage changes as a result of different site attributes (e.g. elevation compared to WTP, distance from WTP/ supply zone etc.).

Following this, a multi-criteria-analysis (MCA) assessment was undertaken for the sites identified within the short list.

This methodology can be seen in Table 3 below.

Table 3 Methodology and report section references

TASK NO.	DESCRIPTION	REPORT SECTION REFERENCE
1	Identify the initial long list of sites	3.2
2	Undertake a representative energy assessment to compare the existing reservoir site to several representative sites chosen from the long list. The conclusion/s drawn from this assessment will inform one of the criteria to undertake the long list fatal flaws assessment.	4
3	Undertake a fatal flaw assessment using readily available information to refine the long list to an initial short list.	5
4	Refine the short list in consultation with HCC. Confirm that sites other than the existing elevated Ruakiwi Site represent realistic alternatives worthy of investigation.	5.2
5	Undertake a multi-disciplinary desktop assessment and MCA of the final short list resulting in a list of viable sites	6
6	Recommend a preferred site	6.2

3 SITE SELECTION APPROACH

3.1 SELECTION CRITERIA

Potential reservoir sites were identified by HCC and WSP and assessed at a desktop level against the following ideal reservoir site criteria:

- Site characteristics:
  - Medium-large undeveloped open green space
  - Favourable topography (i.e. gradual slope; stable ground conditions)
  - Easily accessible by maintenance/ operations staff
  - Elevated topography (compared to WSZ)
  - Ideally Council/publicly owned, but other ownership types are included in the long list for completeness even if they are dismissed early for that reason.
- Proximity to services:
  - Ideally within 1 km of the PC12 Stage 1 area, but not necessarily limited to this distance where open space is present, or elevated topography exists further away.
  - Near to an existing bulk water main, or, near a possible future bulk main identified in the Master Plan.

3.2 LONG LIST OF POTENTIAL RESERVOIR SITES

Table 4 is the long list of sites included in the initial assessment. Figure 5 on the next page shows the site locations and site numbers related to the table.

Table 4 Long list sites

SITE NO.	LOCATION / NAME	SITE NO.	LOCATION / NAME
1	Gully Reserve near 300 Peacockes Road	16	Railway Park
2	Peacockes Reserve near the Waiora WTP	17	Swarbrick Park
3	Reserve land at 66 Bader St	18	Tui Ave, Minogue Park, Recreation Reserve
4	Melville Park	19	Claudelands Field
5	Graham Park	20	Kitchener Park
6	Hamilton West School	21	Steele Park
7	Gower Park	22	Hamilton East Primary School
8	Innes Common	23	Galloway Park
9	Ruakiwi Reservoir Site	24	Hamilton Boys High School Ground 1

SITE NO.	LOCATION / NAME	SITE NO.	LOCATION / NAME
10	Lake Domain Reserve	25	Hamilton Boys High School Ground 2
11	Hamilton Girls High School	26	Peachgrove Intermediate School
12	Hinemoa Park (Rostrevor Street)	27	Marist Park
13	Fraser Tech Rugby Ground Reserve	28	Clyde Park
14	Beside FMG Stadium	29	Hillcrest Stadium
15	Kent Street Industrial Area	30	Forest Lake Hill (existing reservoir site)
Non-specific sites (See note)			
31	Frankton Industrial (Ellis Street, Higgins Rd)	35	Fred Jones Park (Ulster Street)
32	Brymer Road	36	Kent Street Industrial (non-specific location)
33	Fairfield Park (Clarkin Road)	37	Crawford Street Industrial (non-specific location)
34	CBD Commercial (non-specific location)	38	South of Kahikatea Drive / Kahikatea Park (rural)

Note: Non-specific sites are represented as general areas and are not shown in Figure 5. A traffic light assessment was not undertaken for all these areas, but they were considered and are commented on in Table 15 on page 26.

Figure 5 Long list sites

4 COMPARATIVE ENERGY ASSESSMENT

This section outlines the approach and outcome of a static energy assessment undertaken to compare energy and cost implications of different site elevations.

The assessment does not seek to represent the actual energy use under variable conditions that will occur. To do so would require a complex dynamic model established off the entire system – which currently does not exist and would not be cost-effective to develop. Instead, the assessment is based on a single static scenario for the purpose of estimating the relative difference in energy use as a percentage.

4.1 COMPARISON SITES

4.1.1 BASELINE SCENARIO

The baseline scenario for the comparative assessment is the existing reservoir located at the existing designated Ruakiwi Reservoir site. Note that this differs from the proposed reservoir site (see 'Site 9' in Section 4.1.2) which is next to the existing reservoir but at a different elevation.

The suitability of the Ruakiwi site from an engineering aspect is only affected by other considerations due to the required scale of the new reservoir and the prominent location.

4.1.2 REPRESENTATIVE ALTERNATIVE SITES

Instead of assessing all the long list sites separately, five representative sites were selected that could broadly represent the energy properties of all the long list sites. These representative sites were then compared to the baseline scenario (i.e. the existing Ruakiwi site with the reservoir at a higher elevation).

The representative sites may vary from the short-listed sites that will be identified in the fatal flaws assessment (Section 5.5). This is because the representative energy assessment is intended to be a comparative energy assessment of sites with key varying attributes to understand how energy usage changes because of different site attributes (e.g. elevation compared to WTP, distance from WTP/ supply zone etc.).

The outcomes from this comparative energy assessment was used as one of the criteria to refine the long list down to the short list.

These representative sites are listed in Table 5 below.

Table 5 Energy assessment representative sites for comparison

SITE	NAME	RESPRESENTATIVE OF	COMMENT
2	Peacocke Reserve / WTP	Sites located near the WTP	A representative site near the WTP was identified for the assessment for the following reasons: — A site here has a high chance of being a viable alternative due to its proximity to the WTP and relatively low pumping costs to fill the reservoir.

SITE	NAME	RESPRESENTATIVE OF	COMMENT
			— Incoming pipework would be a short distance from the WTP meaning only one pipeline (the outgoing pipeline to the CBD) would need to be constructed. — The supply side booster pumping system could be integrated with the WTP to allow direct servicing to the CBD if the reservoir is out of action.
5	Graham Park	Sites between the WTP and CBD – at distance from WTP	A representative site between the WTP and CBD. The corridor between the WTP and CBD is likely the most efficient in terms of the quantity of new infrastructure and capital construction costs, not including the existing Ruakiwi Site. The Graham Park site was selected as a representative site as it has the lowest elevation. This assessment would therefore have a degree of conservatism compared to other sites along the corridor.
9	Proposed Ruakiwi Site	Site within existing Ruakiwi designation	A new but lower reservoir on the current Ruakiwi reservoir site. It was included within the assessment because it is the site with the highest elevation in the city. It has efficiencies in terms of energy to fill and resilience in that it can gravitate to the CBD during a pump or power outage.
15	Kent Industrial Area	Sites to the northwest of the CBD	A representative site to the northwest of the CBD. These sites are further away from the WTP than the existing Ruakiwi site. This representative site was included to confirm that more energy would be required and therefore energy costs would be higher than sites between the WTP and the CBD.
27	Marist Park	Sites to the east of the CBD	A representative site to the east of the CBD. These sites are further away from the CBD than the existing Ruakiwi site. This representative site was included to confirm that more energy would be required and therefore energy costs would be higher than sites between the WTP and the CBD. Sites east of the CBD will also need one or two Waikato River crossings (although this does not affect the energy assessment).

4.1.3 LOCATION OF SITES FOR COMPARISION

The sites selected for the comparative energy assessment can be seen in Figure 6 below.

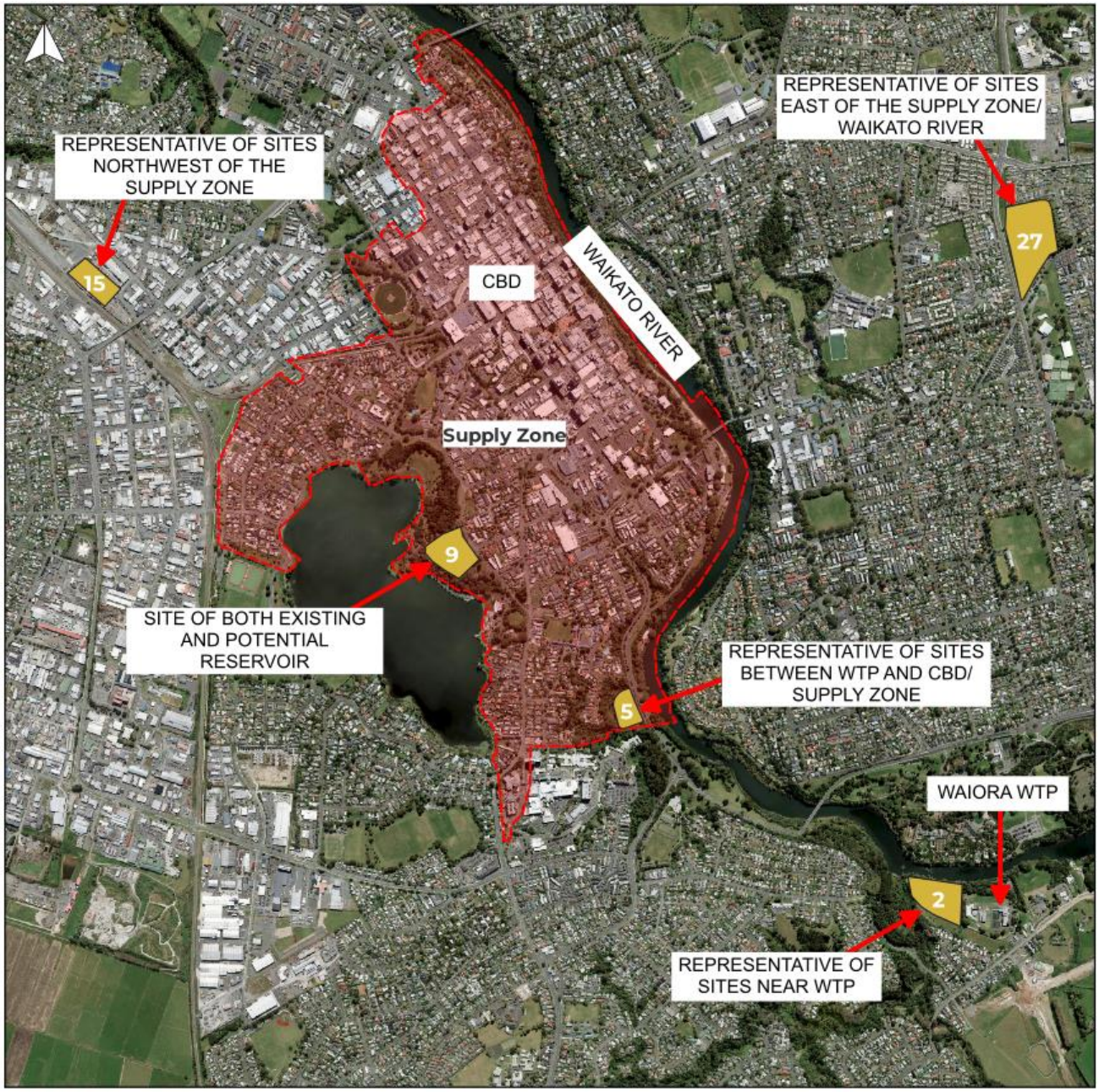


Figure 6 Location of comparative energy assessment sites

4.2 ENERGY ASSESSMENT METHODOLOGY

The assessment objective is to provide a comparison of the cost of energy inputs for the five representative sites and the existing Ruakiwi site (i.e. the baseline scenario).

The current working assumption is that the new Ruakiwi reservoir will require a booster pump station (BPS) to service the higher elevation areas located within the current Ruakiwi WSZ (the final zone area could be different – see Section 1.3.1).

In Figure 7 below, the green area indicates the low elevation zone, meanwhile the red area is the high elevation zone. These two zones are relevant to the pumping aspect of this assessment. A BPS is required to boost pressure and supply customers in the red area in a resilient and cost-effective manner.

Figure 7 Potential future Ruakiwi Supply Zone

The representative static energy cost model has been calculated considering the energy needed to:

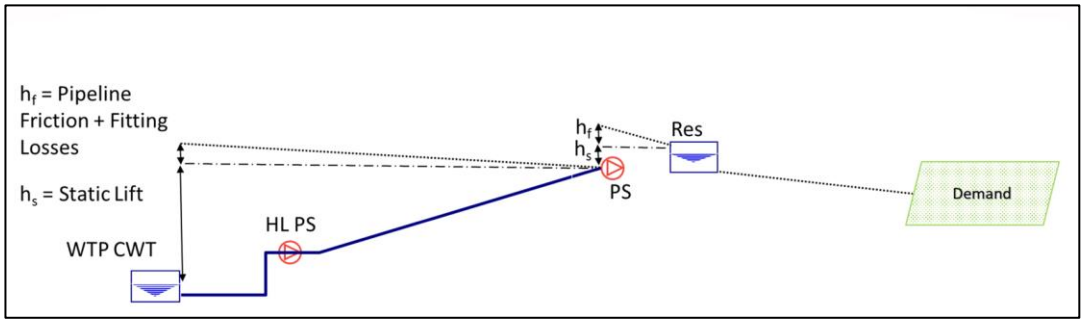
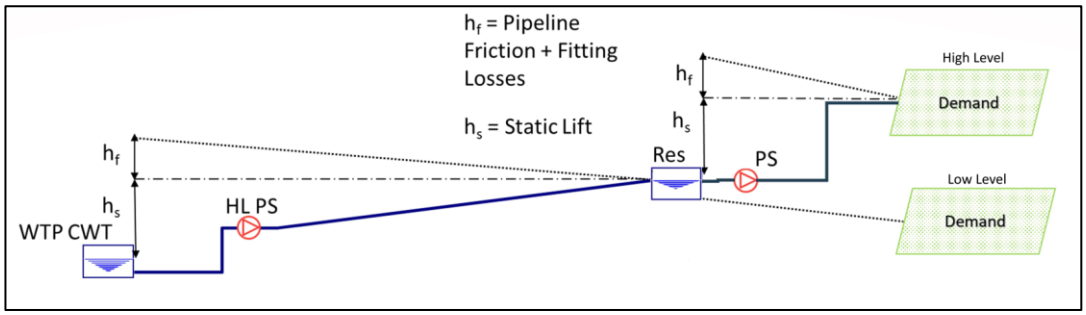
- Pump treated water from the Waiora WTP to the Reservoir over 18 hours.
- Supply water from the Reservoir to the network based on demand at the required pressure (constant pressure 24 hours a day via either pumping and/or gravity – as required).
- Overcome network friction and fittings losses in the bulk transmission network to and from the Reservoir, plus static head requirements up to the reservoir elevation, and the network operating pressure elevation.

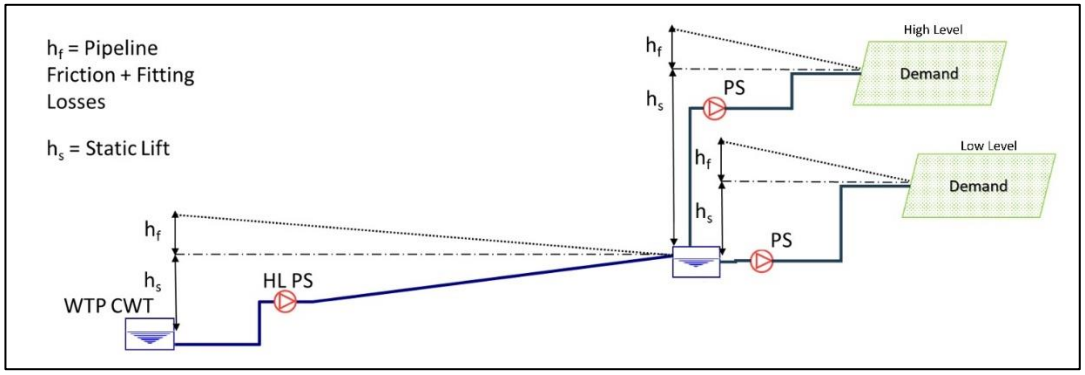
The model estimates an energy cost per day by multiplying the hourly power cost by the system's daily operation hours, representing the overall expense of operating the hydraulic system.

4.2.1 SCHEMATIC REPRESENTATION

The baseline scenario and five representative sites can be grouped into three scenarios in terms of the properties and energies of the bulk supply and network. Schematic representations of the three scenarios are presented in Table 6 below.

Table 6 Schematic representations of different scenarios

SCENARIO	ENERGY SCHEMATIC
Existing Ruakiwi site and high elevation reservoir (i.e. baseline scenario)	 This is the current scenario. Water is pumped from the Waiora WTP to the Ruakiwi site using the high-lift pumps located at the WTP site. Due to the elevation of the existing reservoir, additional boosted pumping is required to fill the reservoir. Implications: — The water is pumped twice before being supplied to the customers — Water is pumped to a high elevation to supply 100% of the supply zone – which is unnecessary considering approximately 70% of the supply zone is at an elevation much lower than the reservoir
Future Ruakiwi site and lower level reservoir	 This scenario would utilise the current Ruakiwi site, with a reservoir located at a lower elevation than the current reservoir. If the reservoir is constructed at an optimised level, the high-lift pumps at the Waiora WTP can be used to fill the reservoir. A new booster pump station can then be used to only pump water, for a second time, to the portion of the supply zone that needs it (i.e. the 'high-level / low pressure'). Implications: — Water is only pumped once for 70% of the supply zone (i.e. the 'low level or high-pressure zone') — 70% of the supply zone can be supplied via gravity without booster pumping — Double-pumping is used to supply 30% of the supply zone, compared to 100% (in the baseline scenario)

All other representative sites	 The Ruakiwi site is the highest-elevated site in the city (with space for a new reservoir). This means that all the other representative sites are at lower elevations, and therefore the high-lift pumps at the Waiora WTP can be used to fill the reservoir. However, boosted pumping is required to 100% of the supply zone. Implications: — Water is pumped twice before being supplied to the customers — Two new booster pump stations will be required – one to pump to the high elevation (low pressure) zone and one to pump to the low elevation (high pressure) zone — The static lift required for the high zone booster pump station will be large

4.2.2 HYDRAULIC PARAMETERS

The following key hydraulic assumptions in Table 7 have been used in the energy assessment and apply to all sites.

Table 7 Hydraulic parameters and assumptions

ITEM	PARAMETER	COMMENT
Transmission network pipe losses	2 m/km	HCC standard network target
Demand flow	170 L/s	This is based on the median demand flow from the current Ruakiwi Reservoir, supplied by HCC
Maximum demand flow	340 L/s	Based on two times the median flow above
Reservoir filling flow	225 L/s	Theoretical inflow rate over 18 hours, to replace demand volume out of the reservoir over 24 hours
Maximum reservoir filling flow	450 L/s	Based on two times the filling flow above
High/low zone demand flow ratio	30% high / 70% low	Based on the ratio of areas from Figure 7. This is applied to discharges from the reservoirs to the supply zone
Pump efficiency	77%	Assumed

Pumped vs gravity relationships	-	A new reservoir at the Ruakiwi site could supply 70% of the demand by gravity (e.g. to the low zone) with the balance boosted by pumping 24 hours per day. A new reservoir at any of the other sites would have to be 100% pumped to a low-level and high-level zone.

4.2.3 ELEVATION PARAMETERS

The following general elevation parameters in Table 8 have been used in the energy assessment and apply to all sites.

Table 8 General elevation parameters

ITEM	PARAMETER	COMMENT
WTP pump station elevation	30 m RL	Based on the WTP site level of ~ 33 m RL less 3 m to the pump / clear water tank elevation.
Low zone pressure elevation target	67 m RL	Approximated to provide about 20-30 m head within the highest part of the zone.
High zone pressure elevation target	85.5 m RL	Approximated to provide about 20-30 m head within the highest part of the zone.

The site-specific parameters in Table 9 have been used for the respective sites in the energy assessment.

Table 9 Site specific parameters

ITEM	PARAMETER	COMMENT
EXISTING RUAKIWI SITE – BASELINE SCENARIO		
Existing reservoir elevation	67 m RL base level 91 m RL TWL	
SITE 2 – PEACOCKES RESERVE / WTP		
WTP future reservoir elevation	34 m RL base level 39 m RL TWL	Based on the existing site level of 34 m RL.
WTP reservoir pump level	34 m RL	The assumed pump level is equal to the base level of the reservoir (the worst case).
SITE 5 – GRAHAM PARK		
Graham future reservoir elevation	20 m RL base level 25 m RL TWL	Based on the existing park level of ~22 m RL and assuming a partially compensated foundation and 5 m deep reservoir. Pumping energy from the WTP to this site is governed by pipeline losses and higher pipeline levels along the route as the reservoir will be at or below the WTP.
Graham reservoir pump level	20 m RL	The assumed pump level is equal to the base level of the reservoir (the worst case).
SITE 9 – FUTURE RUAKIWI		
Ruakiwi future reservoir elevation	60 m RL base level 67 m RL TWL	
SITE 15 – KENT INDUSTRIAL AREA (NORTHWEST REPRESENTATIVE SITE)		
Kent future reservoir elevation	37 m RL base level 42 m RL TWL	Based on the existing site level of 37 m RL.
Kent reservoir pump level	37 m RL	The assumed pump level is equal to the base level of the reservoir (the worst case).
SITE 27 – MARIST PARK (EASTERN REPRESENTATIVE SITE)		
Marist future reservoir elevation	40 m RL base level 45 m RL TWL	Based on the existing site level of 40 m RL.
Marist reservoir pump level	40 m RL	The assumed pump level is equal to the base level of the reservoir (the worst case).

Table 10 Total pumping head yielded in the energy assessment

PARAMETER	EXISTING RUAKIWI	FUTURE RUAKIWI	WTP	GRAHAM	KENT	MARIST
Total Operating Head (WTP to Reservoir) (m)	67.2	43.2	9.5	8.8	23.3	22.4
Head Boosting to High Elevation Zone (m)	N/A	28.7	60.2	67.3	54.2	51.0
Change in Elevation to Low Elevation Zone (m)	N/A	N/A	38.5	51.3	34.9	33.5

4.2.4 ASSUMPTIONS AND LIMITATIONS

It is important to note that the modelling assessment is static and is only suitable for a comparative assessment of the sites. The assessment is suitable for comparison provided the same parameters are used for all sites.

In addition to any assumptions outlined in Table 7, 8 and 9 above, the following additional assumptions are noted:

- The analysis has not considered the diurnal pattern of flows (i.e. changing water use throughout the day where there are two peaks of water demand – one in the morning and one in the evening). This was done because:
  - During actual operation, pumping speeds and inflow and outflow rates will be variable.
  - It is not possible to account for variability in a simple assessment. Therefore, single static parameters have been adopted to provide a comparative energy use scenario only, based on assumed average conditions.
  - Actual power use and costs will vary significantly, but the outputs can be compared to appreciate the relative energy use.
- The cost of power is assumed to be $0.20/kWh.
- Filling from the WTP assumes the following:
  - All sites that are not elevated (e.g., all apart from Ruakiwi) will not be fed from the current WTP as the existing HLPS delivers significantly more head than is required to fill a reservoir at lower-level sites (i.e. wasted energy).
  - The existing bulk water supply pipeline from the WTP to the existing Ruakiwi site does not have capacity to service ultimate development in the Ruakiwi Zone. A new dedicated bulk water supply system is likely to be required. As such, this assessment assumes a new low lift pump station will be required at the WTP with a new filling pipeline to all sites (and a Water Masterplan typical transmission head loss of ≤2 m/km).
- All assumed reservoir levels and top water levels are expected to differ in the final solution. Also, it is acknowledged that water levels in the reservoir will also be variable and TWL and normal operating levels could differ.

4.3 ASSESSMENT RESULTS

4.3.1 RESULTS

Table 11 shows the results from the energy assessment calculations. The stated percentage changes compare the energy usage of each of site to the energy usage of the existing Ruakiwi baseline scenario.

A cost comparison is presented which uses the median flows to yield a comparative yearly cost.

Table 11 Energy assessment results

PARAMETER	EXISTING RUAKIWI	FUTURE RUAKIWI (OPTMISED TWL)	PEACOCKES RESERVE/ WTP	GRAHAM PARK	KENT INDUSTRIAL AREA	MARIST PARK
Median Flows	$693/day	$535/day -26%	$565/day -18%	$674/day -3%	$664/day -4%	$633/day -9%
2 x Flow	$1,387/day	$1,071/day -26%	$1,114/day -20%	$1,348/day -3%	$1,327/day -4%	$1,266/day -9%
Median Annual Energy Cost	$252,945	$195,275	$206,225	$246,010	$242,360	$231,045

4.3.2 DISCUSSION

FUTURE RUAKIWI RESERVOIR (OPTIMISED LOWER)

An assessment based on a new Ruakiwi reservoir at a lower TWL than the existing scenario has shown the following:

- The levels for the future reservoir can be optimised to avoid the energy inefficiencies that exist at the existing reservoir. Although the existing reservoir can service the entire red zone via gravity, much of the zone does not need a reservoir as elevated as it is, and higher pressures also increase leakage. Only the higher elevations in the zone (about 30% of the future zone) benefit from the high elevation of the reservoir resulting in the additional energy use.
- Provided a new reservoir can be constructed at a near optimal elevation to balance gravity and boosted sub-zones, the Ruakiwi site is estimated to be the most efficient. If optimised efficiently, approximately 70% of the Ruakiwi WSZ can be serviced by gravity. An optimised elevation should minimise the energy costs associated with filling.
- Filling the Ruakiwi Reservoir to an optimised elevation over 18 hours appears more efficient than boosting from a lower elevation site 24 hours a day.
- Only the WTP site is comparable and is a possible viable alternative if the Ruakiwi site is found to be fatally flawed in further investigations – or if it cannot be optimised (see below).

There would be significant visual impacts associated with a larger reservoir of the same height as the existing Ruakiwi Reservoir. The site topography and the likely need to maintain a lower profile height means that the new reservoir at Ruakiwi would likely have a lower TWL.

PEACOCKE RESERVE / WTP

The WTP site appears to be the most favourable alternative from an energy aspect:

- The Peacocke Reserve/WTP site is ~21% more efficient than the existing Ruakiwi reservoir system. The other assessment sites are only approximately 5-11% more efficient.
- The Peacocke Reserve/ WTP site is ~7% less efficient than the optimised (future) Ruakiwi reservoir system. The other assessment sites are >20% less efficient.

The WTP reservoir site likely benefits from its proximity to the WTP and lower pumping costs into the reservoir. This benefit is seen in comparison to the existing Ruakiwi Reservoir site and the alternative sites.

Further efficiencies are gained from pumping to a lower elevation for about 70% of the CBD demand, compared to pumping the entire demand to the current high elevation Ruakiwi Reservoir.

The WTP site is the furthest of all the representative sites from the Ruakiwi WSZ that it would service. Whilst the pumping cost into the reservoir would be lower, pumping costs associated with supplying the intended service zone would be much higher than the alternative sites.

GRAHAM PARK

The Graham Park site appears disadvantaged (compared to the WTP site) because its elevation is approximately 14 m below the WTP. Pumping energy is still required to deliver water to the lower Graham Park site (it cannot be gravitated due to topographical constraints) but must lift a higher static head to the respective zones, due to its lower elevation. This has resulted in the Graham Park site having a comparable energy use to the more distant sites (see below) at higher elevations.

The cost of boosting the entire zone from Graham Park 24 hours a day is higher than the optimised Ruakiwi Reservoir which would only need to boost to about 30% of the zone, and from a higher elevation (i.e., lower boost pressure).

The Graham Park site and Reservoir height would probably need to be built up significantly to negate the additional energy. A lift of at least 10 m is anticipated to elevate the typical minimum reservoir water level (the absolute low water level could be lower provided it is a rare occurrence). This is expected to be prohibitively costly.

REPRESENTATIVE NORTHWEST (KENT) AND EASTERN (MARIST) SITES

Both representative sites are potentially more energy efficient than the current Ruakiwi Reservoir. However, there is potential to make the Ruakiwi future reservoir more efficient which would see these sites 20-30% less efficient.

The representative sites have also shown that they are not as efficient as sites located in a corridor between the WTP and the CBD (e.g., Site 2 – WTP). Note that Graham Park is between the WTP and the CBD and is not as efficient because it is lower than the WTP – the previous statement holds only for sites along the corridor at or above the existing WTP elevation.

4.4 ENERGY ASSESSMENT CONCLUSION

The assessment has shown potential scenarios where an alternative reservoir site (to Ruakiwi) could be more energy efficient – e.g. if the existing reservoir levels gravity regime is retained.

The assessment results appear to indicate that the most significant influencing parameter is reservoir elevation (e.g. as opposed to lengths of pipework). The proposed Ruakiwi site is shown to be the most energy efficient because it can service some or all the zone by gravity. However, it will be important to retain similar levels to that used in this assessment so that this efficiency is realised. This assessment indicates it is not beneficial to service the entire zone by gravity, but a partial gravity solution from a lower reservoir should be more energy efficient than a wholly boosted solution from a lower reservoir located elsewhere.

A general trend is concluded that indicates the most efficient sites are any site within the corridor between the WTP and the CBD (provided it has an elevation above the WTP). Locations outside of this corridor will require longer pipelines – resulting in more hydraulic losses, higher pumping costs, and higher capital and operational costs. This is particularly relevant if the WTP High Lift Pump Station cannot efficiently service the new reservoir, and a new dedicated pump set, and bulk filling main is required.

Table 12 lists the key conclusions for each of the assessed sites in order of the resulting site suitability (more suitable sites first). Note that the recommendations are wholly based on the energy assessment and no other considerations such as cost, constructability, resilience etc.

Table 12 Energy assessment conclusions

SITE	COMMENT	RECOMMENDATION
2 – Peacocke Reserve/ WTP	The WTP site is the second most energy-efficient site. If the proposed Ruakiwi site is found to be fatally flawed or cannot be optimised, then the WTP site would become the favoured site from an energy use perspective.	Not recommended due to distance from the supply zone. This site should only be considered further if the proposed Ruakiwi site is found to be fatally flawed.
5 – Graham Park	Graham Park is a depressed reserve which might be able to accommodate a reservoir with little visual impact on the surrounding area. It is also located between the WTP and the CBD. However, the assessment has shown that a site below the WTP elevation is not as efficient due to increased pumping requirements back up to the CBD level.	Not recommended because of lower site elevation and likely higher energy use. If the site was at a higher elevation, it would likely be comparable to the WTP site.
9 – Proposed Ruakiwi Site	This site has the highest elevation of all other identified sites – meaning it has efficiencies in terms of energy and resilience in that it can gravitate to the CBD during a pump or power outage.	Recommended as the preferred site as it is likely the most energy efficient – particularly if the reservoir levels are optimised by introducing gravity and booster pumped sub-zones.
15 – Kent Industrial Area	The assessment showed that the more distant sites could be favourable if the Ruakiwi site cannot be optimised, or if sites closer to the WTP/CBD are not	Not recommended as there are sites with lower estimated energy use (typically those

SITE	COMMENT	RECOMMENDATION
27 - Marist Park	viable. However, they are only marginally better than the existing Ruakiwi Reservoir system so a more detailed assessment would be required if the existing site can only be partially optimised or not at all.	closer to the WTP and the CBD).

5 FATAL FLAWS ASSESSMENT

WSP undertook a traffic light fatal flaws assessment of the 38 sites identified within the long-list to reduce the number of sites from 38 to a provisional shortlist.

5.1 ASSESSMENT CRITERIA

This section summarises the assessment items and approach. Table 13 lists the items considered in the fatal flaws assessment.

Table 13 Fatal flaws assessment criteria

ITEM	RESERVOIR SITE ASSESSMENT CRITERIA
Apparent ownership and zoning	Considers the likely ownership status based on land use – e.g., Council/public, Ministry of Education or similar (Crown), Private.
Proximity to the bulk water network and the existing WTP	Distance from the bulk network which needs to be connected to, for reservoir filling.
Proximity to the CBD	Distance from the CBD which needs to be connected to for supplying water to the CBD trunk network. Considers each location in relation to the Waikato River where bridge (or under river) crossings will be required.
Underlying geology	Considers the typical underlying geology from NZ Geological Maps.
Site elevation	Considers the elevation of the site relative to the CBD. Higher requires less pumping energy and lower requires more (i.e., higher is better).
Site area	Consider the available site area against the required area.

The fatal flaws assessment was not scored. The assessment was based on a simple traffic light system applied on a relative basis for each item, as follows:

RED	Significant issues/fatal flaw
ORANGE	Potential issues/challenges
GREEN	No significant issues

The traffic light assessment was not intended to differentiate individual sites. Rather, the assessment provides a simple visual appreciation of sites that have a higher chance of being suitable. The traffic light assessment refines the initial long list by removing sites from contention that have fatal flaws. The list is then refined further based on non-fatal criteria – such as the results from the comparative energy assessment (Section 4) and discussions with HCC.

The final short list identified at the end of this initial assessment will be progressed into a more detailed MCA assessment (Section 6).

Further discussion related to the traffic light application is presented in Section 5.2.

5.2 TRAFFIC LIGHT APPLICATION

This section provides additional context to how the traffic light system was applied. As stated in Section 2.1, the traffic lights are intended to differentiate within items, not necessarily across different items. This approach results in a visual picture of which sites might be more favourable to shorten the initial list.

The application scale is relative to the parameter range of a particular item and is not related to other items. For example, the range of proximity to the bulk network is typically less than proximity to the CBD so the distances at which the colours apply do not match. A similar scale for each would have resulted in no differentiation for the bulk network distance parameter.

5.2.1 APPARENT OWNERSHIP

Three ownership types were identified and applied as follows:

- Council/public – green (already owned, subject to designation etc.)
- Private – orange (can be purchased but lacks certainty)
- Schools – red (unlikely to be accepted and has significant community impacts if used for other purposes)

5.2.2 PROXIMITY TO THE BULK WATER NETWORK

An approximate measurement was made from each site to the closest bulk network pipeline, along roads or within public reserve. This would be relevant where there is capacity within the existing bulk network and WTP high lift pump system to supply the new reservoir.

The traffic lights were applied as follows:

- Short distance (< 200 m) – green
- Medium distance (500 m – 200 m) – orange
- Long distance (> 500 m) – red

5.2.3 PROXIMITY TO THE WTP

An approximate measurement was made from each site to the Waiora WTP, along roads or within public reserve. This would be relevant where there is not enough capacity within the existing bulk network and WTP high lift pump system to supply the new reservoir, so a new dedicated pump system and pipeline are required. HCC has advised that this is likely to be the case due to existing constraints at the WTP high lift pump station.

The traffic lights were applied as follows:

- Short distance (generally <1 km) – green
- Long distance (generally > 1 km) but closer to the WTP than the current Ruakiwi site – orange
- Long distance (generally > 1 km) including a Waikato River crossing (on the bridge or under river) or further from the WTP than the current Ruakiwi site – red

5.2.4 PROXIMITY TO THE CBD

An approximate measurement was made from each site to the CBD fringe, along roads or within public reserve. The traffic lights were applied as follows:

- Short distance (generally <1 km) – green
- Long distance (generally > 1 km) – orange
- Long distance (generally > 1 km) including a Waikato River crossing – red

5.2.5 UNDERLYING GEOLOGY

The broad underlying geology was taken from NZ Geological Maps for each site. This was used to infer the likely site suitability or complexity of the structure foundation.

Table 14 Geology initial assessment basis

SOIL TYPE	DESCRIPTION	COMMENT
Walton Subgroup	Alluvium dominated by primary and reworked, non-welded ignimbrite	Typically, higher more competent ground. Construction and foundations are not expected to be significant (for a structure of this size and criticality).
Piako Subgroup	Soft, dark brown to black, organic mud, muddy peat, and woody peat	Typically, low-lying poor ground with low bearing capacity and high water tables. Complex construction and deep foundations may be required.
Hinuera Formation	Cross-bedded pumice sand, silt, and gravel with interbedded peat.	Typical alluvial soils are present in the Waikato. Good bearing capacity and variable water tables. Some foundation improvement may be required compared to the Walton subgroup, but less so than the Piako Subgroup.
Taupo Pumice Alluvium	Predominantly pumice sand, silt, and gravel alluvium with charcoal fragments.	
Pakihi Supergroup	Alluvial and colluvial sand, silt, mud and clay with local gravel and peat beds	

5.2.6 SITE ELEVATION

The HCC GIS was used to determine the approximate elevation of each site relative to the CBD, taken as the level of Anglesea Street midway along its length in the vicinity of Ward Street.

- Full gravity or lower energy booster pumping – >10 m above the CBD – green
- Neutral – ±10 m relative to the CBD – orange
- Significant booster pumping required – >10 m below the CBD – red

5.2.7 SITE AREA

The required site area was approximated at 6,600 m^2 based on the area needed to accommodate a 40 ML circular reservoir 10 m tall, with a minimum 5 m perimeter buffer to the structure.

- Area requirement exceeded, low risk of shortfall (> 125% of the area) – green

- Area requirement met, medium risk of shortfall (80% - 125% of the area) – orange
- Site area requirement not met (< 80% of the area) – red

5.3 TRAFFIC LIGHT ASSESSMENT AND REVIEW

The following sections outline some key aspects that resulted in the shortlist being reduced.

5.3.1 ENERGY ASSESSMENT

The energy assessment showed that whilst the most significant influencing parameter for energy usage appears to be reservoir elevation, the length of pipework does have some impacts. Although the assessment is high level / low detail, this conclusion fits with what would be expected (where pumping energy increases with additional pipe length).

The energy assessment broadly showed that the most efficient location for a new reservoir would be anywhere along a direct line between the Waiora WTP and the CBD – provided the site is at or above the existing WTP elevation (e.g., Graham Park is not). Locations outside this general alignment would require longer pipelines resulting in more frictional energy losses, higher pumping costs, plus higher capital construction and operational costs.

5.3.2 DISCUSSION WITH HCC

The initial traffic light assessment was discussed with HCC and the following key outcomes were applied to the short list assessment.

5.3.2.1 ENERGY ASSESSMENT AND PROXIMITY OF SITES TO THE WTP AND THE CBD

Sites outside of the corridor between the Waiora WTP and the CBD will have higher capital works construction and operational costs (longer pipelines), and higher energy costs (as concluded in Section 5.3.1).

It is acknowledged by WSP and HCC that developed design and more detailed estimates of capital and operational costs would provide greater certainty, particularly when comparing sites a similar distance from the CBD/WTP. However, it was agreed that there is enough confidence to recommend that sites outside the ideal corridor are not progressed based on likely capital and operational costs.

5.3.2.2 WAIKATO RIVER CROSSING (EASTERN SITES)

All sites east of the Waikato River will require a river crossing to service the CBD. Another river crossing will be required for all eastern sites if the WTP High Lift Pump Station cannot provide water to the new reservoir (which according to HCC is probable without a major upgrade). River crossings for eastern sites will be costly to implement compared to western sites and an increased resilience risk relative to western sites.

River crossings are acknowledged by WSP and HCC as being broadly feasible subject to further investigation and feasibility design of drilled solutions, or aerial crossings on existing bridges. Short listing one or two eastern sites was considered so that more detailed assessment could be undertaken to increase certainty. However, this in association with the discussion in Section 5.3.2.1, reinforces the omission of all eastern sites from the short list.

5.3.3 SCHOOLS AND OTHER PRIVATE SITES

It was agreed that all school sites could not be progressed due to the low likelihood that land could be secured, and approvals obtained. School sites are high-use areas benefitting students and the wider community. The impact of a large structure would also significantly affect the operation and amenity of schools.

Private sites within industrial and commercial areas do not have the same use and benefit as school reserves. It may be possible to gain approvals for a reservoir to be built in an industrial / commercial area without adversely affecting adjacent businesses. However, land purchase would still need to be negotiated which will displace business and require the demolition of existing facilities.

It was agreed that all school sites would be omitted from the short list where other viable publicly owned sites exist.

Industrial / commercial sites can be revisited if all other short-listed sites are proven to be unsuitable.

5.3.4 PROXIMITY OF SITES TO ONE ANOTHER

Two sites within the ideal corridor were highlighted by HCC during discussions as follows:

- Site 1 (in Peacocke) and Site 2 (beside the WTP) would both be short listed based on the traffic light assessment and the energy assessment. However, HCC noted that there is little benefit including both sites, so the more favourable site is Site 2 which is closer to the WTP. Site 1 was therefore omitted from the short list but could be revisited if needed.
- Site 9 (existing Ruakiwi) and Site 10 (Lake Domain) are like Site 1 and 2 in that they are close to each other with the existing reservoir site being preferred as it is already designated. However, rather than omitting Site 10 it is included in the short list as a supplementary site.

  The existing reservoir site is constrained by the available designated boundaries so while it is the most favourable site, it may need to be supplemented to accommodate ancillary infrastructure (e.g., high level zone booster pump station).

5.4 INITIAL SITE ASSESMENT OUTCOME

Table 15 shows the outcome of the fatal flaw traffic light assessment. Refer to Appendix A for the complete traffic light table and input parameters.

Table 15 Long list sites and outcome

SITE NO.	LOCATION / NAME	PRIMARY REASON TO INCLUDE OR NOT INCLUDE (refer to the appendix tables for all reasons)
1	Gully Reserve near 300 Peacockes Road	Not included as site No. 2 is closer to the to the existing WTP so the more favourable of the two.
2	Peacockes Reserve near the Waiora WTP	**Included** as it is beside the existing WTP and is located along the energy-efficient zone between the WTP and the CBD.
3	Reserve land at 66 Bader St	Not included due to site shape constraints and access issues at the rear of private properties and amidst adjacent gully arms.

SITE NO.	LOCATION / NAME	PRIMARY REASON TO INCLUDE OR NOT INCLUDE (refer to the appendix tables for all reasons)
4	Melville Park	**Included** as it is located along the energy-efficient zone between the WTP and the CBD (note: subject to use for wastewater storage purposes).
5	Graham Park	**Included** as it is located along the energy-efficient zone between the WTP and the CBD, albeit with potential inefficiencies caused by its elevation below the WTP (refer to Table 16 for additional context to this inclusion)
6	Hamilton West School	Not included as it is a school ground with potential significant community and land acquisition issues.
7	Gower Park	Not included due to known poor ground conditions – peat soils, potential significant foundation issues.
8	Innes Common	Not included due to known poor ground conditions – peat soils, potential significant foundation issues.
9	Ruakiwi Reservoir Site	**Included** as it is the existing designated site and can be optimised for energy efficiency and is located within the CBD. There are noted spatial constraints with this site (the existing designation would need to be extended).
10	Lake Domain Reserve	**Included** as it is beside the existing Ruakiwi Reservoir site and may be required where the existing site does not have enough space (e.g., for a booster pump station to be located).
11	Hamilton Girls School	Not included as it is a school ground with potential significant community and land acquisition issues.
12	Hinemoa Park (Rostrevor St)	**Included** as it is located along the energy-efficient zone between the WTP and the CBD, albeit at the northern extent of the apparent energy-efficient zone.
13	Fraser Tech Rugby Ground Reserve	Not included as the site is too small.
14	Beside FMG Stadium	
15	Kent Street Industrial Area	Not included as it is located north of the energy efficient zone between the WTP and the CBD requiring additional capital cost, for longer pipelines and higher energy use.
16	Railway Park	
17	Swarbrick Park	
18	Tui Ave, Minogue Park, Recreation Reserve	
19	Claudelands Field	Not included as it is located east of the energy efficient zone between the WTP and the CBD requiring additional capital cost, for longer pipelines, a Waikato River crossing, and higher energy use.
20	Kitchener Park	

SITE NO.	LOCATION / NAME	PRIMARY REASON TO INCLUDE OR NOT INCLUDE (refer to the appendix tables for all reasons)
21	Hamilton East School	Not included as it is a school ground with potential significant community and land acquisition issues. Not included as it is located east of the energy efficient zone between the WTP and the CBD requiring additional capital cost, for longer pipelines, a Waikato River crossing, and higher energy use.
22	Steele Park	Not included as it is located east of the energy efficient zone between the WTP and the CBD requiring additional capital cost, for longer pipelines, a Waikato River crossing, and higher energy use.
23	Galloway Park	
24	Hamilton Boys High School Ground 1	Not included as it is a school ground with potential significant community and land acquisition issues. Not included as it is located east of the energy efficient zone between the WTP and the CBD requiring additional capital cost, for longer pipelines, a Waikato River crossing, and higher energy use.
25	Hamilton Boys High School Ground 2	
26	Peachgrove Intermediate School	
27	Marist Park	Not included as it is located east of the energy efficient zone between the WTP and the CBD requiring additional capital cost, for longer pipelines, a Waikato River crossing, and higher energy use.
28	Clyde Park	
29	Hillcrest stadium	
30	Frankton Industrial (Ellis Street, Higgins Rd)	Not included as it is privately owned land located west of the energy efficient zone between the WTP and the CBD which needs additional capital cost, for longer pipelines and higher energy use.
NON-SPECIFIC SITES		
31	Brymer Road	Not included as it is located north of the energy efficient zone between the WTP and the CBD requiring additional capital cost, for longer pipelines and higher energy use.
32	Fairfield Park (Clarkin Road)	Not assessed – Further than Claudelands (so not added)
33	CBD Commercial (non-specific location)	Not assessed – High land cost, would need to be underground to be able to use air space above, resulting in high energy costs
34	Fred Jones Park (Ulster Street)	Similar location and status as the FMG site – consider the wider area in association with the FMG assessment
35	Kent Street Industrial (non-specific location)	Refer to site No. 15 above.
36	Crawford Street Industrial (non-specific location)	Not assessed - more remote than Kent St and similar status, wrong side of the railway tracks.

SITE NO.	LOCATION / NAME	PRIMARY REASON TO INCLUDE OR NOT INCLUDE (refer to the appendix tables for all reasons)
37	South of Kahikatea Drive / Kahikatea Park (rural)	Not assessed - same ground issues as Gower and currently outside the city boundary, further away
38	Forest Lake Hill (existing reservoir site)	Not assessed - existing reservoir site is too small unless a tall reservoir is built ~70 m high which is not feasible. No open sites on the hill area.

A total of six sites are listed to be taken through to the short list.

5.5 SHORT LISTED SITES FOR MCA

The short-listed sites that were identified for further assessment in the MCA can be seen in Figure 8 below.

Figure 8 Short listed reservoir sites

Table 16 below discusses the key features of each short-listed site. Three representative abandoned sites were added to the assessment as a check of the fatal flaw assessment (nine sites in total).

Table 16 Short listed reservoir sites

SITE NO.	LOCATION / NAME	COMMENT
1	Reserve near 300 Peacockes Road	This site is like site 2 in that it is very close to the WTP (approximately 1.2 km). It is not as preferential as site 2 since it is not as close.

SITE NO.	LOCATION / NAME	COMMENT
		This site was included as a representative site to the south of the WTP. This representative site was included to confirm that southern sites were not misrepresented in the fatal flaw assessment and would not be favourable in a detailed MCA.
2	Peacocke / Waiora WTP	Integrated inlet pumping beside the WTP site could be done independently to the High Lift Pump Station with a new pump set and pipework.
4	Melville Park	Site availability is subject to proposed use for Wet Weather Wastewater Storage. Not a priority site due to possibly being required for wastewater
5	Graham Park	Only as a backup site because the site may need to be filled, and the reservoir elevated to optimise energy use. Retained, however, as it is likely to have a lower capital cost than other more remote sites as it is in the efficient corridor between the WTP and the CBD. Note: Investigations could be carried out on other viable sites between the WTP and CBD in the vicinity of Graham Park.
9	Ruakiwi Reservoir Site	Has an existing designation (see note) for water infrastructure purposes and can be optimised to be more energy efficient than the current reservoir. Note: The existing designation is too small for the proposed reservoir/s and additional designation area will need to be sought.
10	Lake Domain Reserve	Potential backup / additional area to be used in conjunction with the existing Ruakiwi Site (e.g. for the second reservoir, booster pump station or ancillary buildings). This site represents any area of the lake domain reserve distant from the existing designated site. The existing designated and elevated site remains preferred over this site.
12	Hinemoa Park (Rostrevor Street)	Less favourable than other locations as it is at the northern extent of the CBD (less energy efficient, more costly due to longer pipelines) but potentially a viable alternative if other sites have fatal flaws. Not a priority site due to a low-medium likelihood of being required for wastewater and located further north than the existing reservoir site.
15	Kent Street Industrial Area	This site was included as a representative site to the north of the CBD. This representative site was included to confirm that northern sites were not misrepresented in the fatal flaw assessment and would not be favourable in a detailed MCA. Private land would need to be purchased, and existing facilities (e.g. buildings) demolished. This site is further from the WTP than the existing Ruakiwi reservoir, which is less ideal than some other sites (less energy efficient, more costly due to longer pipelines required).
27	Marist Park	This site was included as a representative site to the east of the CBD across the Waikato River. This representative site was included to confirm

SITE NO.	LOCATION / NAME	COMMENT
		that eastern sites were not misrepresented in the fatal flaw assessment and would not be favourable in a detailed MCA. Located on the other side of the river from both the WTP and the Ruakiwi WSZ, meaning the water will have to cross over two bridges before reaching the customer. Not ideal to have the storage facilities located at such a far distance from the customer (increase in resilience risk).

6 ASSESSMENT OF SHORT LIST (MCA)

A more detailed assessment of the short-listed sites was undertaken in the form of a scored Multi Criteria Assessment (MCA).

6.1 CORE CRITERIA AND WEIGHTINGS

The MCA items and weighting was discussed and agreed at a workshop with HCC and other discipline sub-consultants on 13 June 2024. The assessment criteria and weightings are shown in Table 17.

Table 17 MCA criteria and weightings

CORE CRITERIA & WEIGHTING	SUB-CORE CRITERIA		SUB WEIGHTING
Financial 20%	Cost (Construction)	Anticipated relative cost – qualitative	100.0%
Carbon 10%	Carbon Emissions	Anticipated relative whole of life carbon emissions - qualitative indicator	100.0%
Cultural 5%	Archaeology and Cultural Sites	Presence of archaeological sites / heritage sites	100.0%
Technical 35%	Construction	Terrain and site topography	5.0%
		Presence of existing utilities (such as electricity, gas, telecommunications etc)	10.0%
		Ground conditions, soil erodibility issues, and contamination	5.0%
		Land acquisition issues (such as delays in the planning phase due to ownership of land) (also considered proxy for costs)	5.0%
		Current district planning zone allocation (difficulties during the planning phase)	5.0%
	Operation	Site elevation relative to the CBD (and therefore pumping requirements)	10.0%
		Relative energy cost per day (based on the hourly power cost by the system's daily operation hours) compared to the existing reservoir site at Ruakiwi	10.0%
		Opportunity for new technology - based on conversations with HCC	2.5%

CORE CRITERIA & WEIGHTING	SUB-CORE CRITERIA		SUB WEIGHTING
		Simplicity of operation (pumping facilities, remoteness, complexity of pumping and boosting)	2.5%
		Compliance and complexity - based on conversations with HCC	5.0%
	Infrastructure and Associated Assets	Proximity to Waiora WTP (especially compared to the existing Ruakiwi reservoir location) (also considered a proxy for construction costs)	10.0%
		Proximity to CBD (also considered a proxy for construction costs)	15.0%
		Proximity to the bulk network (also considered a proxy for construction costs)	10.0%
		Access during isolation events	2.5%
		Facilitates transfer across reservoir zones (opportunities for rezoning in high-pressure areas and systems with trunk mains supply between reservoirs)	2.5%
Resilience 10%	System Resilience	Proximity to natural hazards	20.0%
		Redundancy and inter-connectivity	40.0%
		Adaptability	40.0%
Environment 10%	Impacts on Environment	Endangered ecological communities (EECs) - such as indigenous and at-risk species (also considered a proxy for costs)	50.0%
		Vicinity to watercourses (and extent of ESC controls)	50.0%
Social 10%	Impact on Community	Impacts during construction (location of assets / infrastructure and noise, odour, traffic, visual impacts etc during construction)	30.0%
		Impacts during O&M (location of assets / infrastructure and noise, odour, traffic, visual impacts etc. during O&M)	20.0%
		Stakeholder acceptability (location of assets / infrastructure, impacts on residents, communities and environmental groups etc.)	50.0%

Table 18 provides a brief description of how each criterion was scored. Refer to the MCA scoring sheet in Appendix C for additional descriptions of the scoring range and basis.

Table 18 MCA basis of scoring

CRITERIA	BASIS OF SCORING
FINANCIAL – COST	
Anticipated relative construction cost	This criterion was scored based on the likely relative cost of the reservoir and associated pipelines between to/from the CBD and the WTP. Sites along the corridor between the WTP and the existing reservoir site are likely to have lower costs, and more distant sites, particularly those on the east of the Waikato River, are likely to have a higher capital cost.
CARBON – CARBON EMISSIONS	
Anticipated relative whole of life carbon emissions	This criterion was scored neutral (3) for all options because there is not enough information to differentiate between options, particularly given that operational energy and the reservoir structures are not likely to differ much.
CULTURAL – ARCHAEOLOGY AND CULTURAL SITES	
Presence of archaeological sites / heritage sites	This criterion was scored based on the presence of sites in readily available mapping. Sites at the reservoir locations were more critical (scored lower) than sites along pipelines with a higher chance of being avoided. Note: wider cultural aspects were not considered as HCC is undertaking separate cultural consultation and impact assessments.
TECHNICAL – CONSTRUCTION	
Terrain and site topography	This criterion was scored based on the relative complexity of building a reservoir on the site (e.g. a mostly flat site with minimal earthworks versus a steep complex site).
Presence of existing utilities	This criterion was scored based on services within the reservoir site. No services scored high, some non-critical services scored neutral, and critical services (e.g. high-pressure gas) scored low.
Ground conditions	This criterion was scored based on soil information from readily available geological maps. Sites with good ground score high, sites on alluvial soils score slightly lower, and sites on poor ground (e.g. peat) score low.
Land acquisition issues	This criterion was scored based on the ownership and status of the land where Council owned open space scores higher than privately owned land or public land already in use for a specific purpose (e.g. sports parks, schools).
Current district planning zone allocation	This criterion was scored based on the district plan zoning where designated land or open space zoned land scored higher than land zoned for a specific use (e.g. industrial, commercial, residential).

CRITERIA	BASIS OF SCORING
TECHNICAL – OPERATION	
Site elevation relative to the CBD	This criterion was scored based on the elevation relative to the CBD where a higher site will need less infrastructure, and a lower site would require more infrastructure to operate (e.g. pump station).
Relative energy cost per day	This criterion was scored based on a high-level energy assessment with sites scored higher where they have a lower relative energy use.
Opportunity for new technology	This criterion was scored neutral (3) for all options because there is not enough information available to differentiate between options at this stage and level of design detail.
Simplicity of operation	This criterion was scored based on the relative location of the key infrastructure elements (reservoir, pump station). Sites where pumping equipment could be located at or close to the reservoir site, or the existing WTP site scored higher. Remote sites with long pumping distances were scored lower.
Compliance and complexity	This criterion was scored neutral (3) for all options because there is not enough information available to differentiate between options at this stage and level of design detail.
TECHNICAL – INFRASTRUCTURE AND ASSOCIATED ASSETS	
Proximity to Waiora WTP	This criterion was scored based on proximity to the WTP where sites closer to the WTP would require less new pipe infrastructure to service long term demand (e.g. lower costs for strategic pipeline upgrades from the WTP to the reservoir).
Proximity to CBD	This criterion was scored based on proximity to the CBD where sites closer to the CBD would require less new pipe infrastructure to service long term demand (e.g. lower costs for strategic pipeline upgrades from the reservoir to the CBD).
Proximity to bulk network	This criterion was scored based on proximity to the existing strategic bulk water network where sites closer would require less new pipe infrastructure to connect the new reservoir, particularly in the short term before strategic pipeline upgrades are required.
Access during isolation events	This criterion was scored neutral (3) for all options because there is not enough information available to differentiate between options at this stage and level of design detail.
Facilitates transfer across reservoir zones	This criterion was scored neutral (3) for all options because there is not enough information available to differentiate between options at this stage and level of design detail.

CRITERIA	BASIS OF SCORING
RESILIENCE – SYSTEM RESILIENCE	
Proximity to natural hazards	This criterion was scored neutral (3) for all options because there is not enough differentiation between the sites (e.g. no sites are within major flood areas).
Redundancy and inter-connectivity	This criterion was scored based on the ability of the site to operate in full or part during an outage. Higher elevation sites score higher based on being able to service more area by gravity during a major outage.
Adaptability	This criterion was scored based on the ability of the site to adapt to unknowns in the future. Sites with excess open green space and the ability to adapt to network changes (e.g. the site beside the WTP) scored highest.
ENVIRONMENT – IMPACTS ON ENVIRONMENT	
Endangered ecological communities (EECs)	This criterion was scored based on total avoidance of EEC's (high score) through to significant clearing of EEC's (low score). Most sites involve varying degrees of vegetation clearance and tree removal so scored in the mid-range.
Vicinity to watercourses	This criterion was scored based on proximity to watercourses and the Waikato River, typically accompanied by steeper topography in the form of gully sides and river terraces. Sites away from these features, or close to only minor features, scored higher.
SOCIAL – IMPACT ON COMMUNITY	
Impacts during construction	This criterion was scored based on the potential impact of construction including noise, odour, traffic, and visual ranging from no impact (high score) to significant impacts (low score). Areas away from high use residential and park areas (e.g. commercial and industrial) scored higher.
Impacts during O&M	This criterion was scored based on the potential impact of operation and maintenance including noise, odour, traffic, and visual ranging from no impact (high score) to significant impacts (low score). Areas away from high use residential and park areas (e.g. commercial and industrial) scored higher. This criterion was scored more neutral than the construction item above as O&M is less frequent and lower impact.
Stakeholder acceptability	This criterion was scored based on stakeholder perception and acceptability where locations involving a significant loss of public space or amenity scored lower than private sites in industrial or commercial areas.

6.2 MCA OUTCOME

6.2.1 MCA SCORING

The MCA was scored by WSP and reviewed by HCC and personnel from key project disciplines after which, the Ruakiwi (existing) reservoir site was adopted as the preferred location. The MCA scores and rankings are presented in Table 19.

Table 19 MCA outcome scores and ranking

SITE NO.	LOCATION / NAME	WEIGHTED SCORE	RANKING	COMMENT / PRIMARY INFLUENCE IN SCORE AND RANKING
1	Gully Reserve Near 300 Peacockes Road	3.261	8	Low ranking due to the infrastructure required to service the remote site with a new connection back to both the WTP and the CBD.
2	Peacocke / Waiora WTP	3.778	2	High ranking due to proximity to the existing WTP requiring less future strategic infrastructure to fill the reservoir. Lower ranked than Ruakiwi due to lower energy efficiency and infrastructure needed to outlet to the CBD.
4	Melville Park	3.579	3	Middle-high ranking due to the location in the efficient infrastructure corridor between the WTP and the CBD. Lower than the top two options due to the potential loss of high use reserve areas and slightly lower energy efficiency.
5	Graham Park	3.519	4	
9	Ruakiwi Reservoir Site	4.265	1	Ranked the highest due to proximity to the CBD, energy efficiency and the existing designation status (acknowledging that works will likely require the designation to be extended).
10	Lake Domain Reserve	3.303	6	Middle-low ranking made favourable due to proximity to the CBD but adversely affected by being north of the current reservoir site requiring an extension of strategic infrastructure, and due to the potential loss of high-use reserve areas and lower energy efficiency that options along the WTP-CBD corridor.
12	Hinemoa Park (Rostrevor Street)	3.409	5	
15	Kent Street Industrial Area	3.278	7	Low ranking due to the amount of infrastructure required to service the remote site with a new connection back to both the WTP and the CBD.

SITE NO.	LOCATION / NAME	WEIGHTED SCORE	RANKING	COMMENT / PRIMARY INFLUENCE IN SCORE AND RANKING
27	Marist Park	2.948	9	Lowest ranking due to the amount of infrastructure required to service the remote site with a new connection back to both the WTP and the CBD including crossing the Waikato River.
The sites assessed in the MCA are classed as per the shading below:				
Short listed site - preferred	Other short-listed site retained from the traffic light assessment.	Representative site (discarded in the traffic light assessment) included in the MCA.		

6.2.2 DISCUSSION

As previously stated, WSP presented and discussed the initial scoring with HCC. HCC accepted the MCA outcome after reviewing the scoring, and the Ruakiwi (existing) reservoir site was adopted as the preferred location.

The basis for the preferred option is as follows:

- The detailed MCA scoring outcome closely matched the outcome of the traffic light assessment that preceded it (e.g. the top two preferred sites were the same in both assessments).
- The existing Ruakiwi Reservoir site ranked 1st by a significant margin in the MCA. Sensitivity testing of individual criterion scores by WSP did not change the outcome because the existing site is favourable in many criteria.
- The existing reservoir site has the highest elevation of all the sites in proximity to the CBD. The existing site has the lowest energy use potential based on the high-level energy assessment, consistent with its high elevation (e.g. even though the energy assessment was coarse, confidence is high that the existing site will be the most efficient). The elevated site is also the most resilient as it supplies water by gravity to most of the zone.
- The existing reservoir site provides the most adaptable location because the new reservoir(s) can be built alongside making the transition to new infrastructure easier.
- It is acknowledged that this assessment has not addressed planning and consultation aspects in detail, such as cultural, visual, and loss of amenity reserve area. However, there is already a water infrastructure designation and an existing reservoir at the site so the works may not be perceived as such a significant change of use compared to an alternate site.
- All alternate sites will result in the same or similar impacts. While individual stakeholders may favour one site over another, this was not envisaged by HCC as likely to outweigh the technical benefits of the existing site.

7 SUMMARY AND CONCLUSION

The findings from the static energy assessment and initial traffic light assessment showed enough separation between sites to recommend a short list of six sites.

The energy assessment generally found that any viable site between the WTP and the CBD is likely to have a similar energy profile (provided the elevation is higher than the WTP). However, the existing elevated Ruakiwi reservoir site with optimised levels (lower top water level than the existing) was found to be the most energy efficient of all the sites that were assessed. More remote sites along the corridor between the CBD and the WTP only appeared viable if the Ruakiwi site could not be adopted and the reservoir's top water level optimised lower than the existing Ruakiwi Reservoir.

The fatal flaw traffic light assessment considered aspects such as land ownership, proximity to the bulk water network/ WTP/ CBD, site elevation and site area, energy use (from the energy assessment), and site geology. This assessment indicated six sites that were considered most suitable to be included within the short list – one of which was the existing Ruakiwi reservoir site.

A detailed MCA assessment was then undertaken on the six shortlisted sites and three representative sites from the discarded options. The representative sites were included in the MCA to validate their elimination in the earlier fatal flaw (traffic light) assessment.

Like the energy assessment and fatal flaw assessment, the existing Ruakiwi reservoir site scored higher than all other assessed sites. As such, the Ruakiwi reservoir site was identified as being the preferred site. The existing site has the benefit of an existing designation and use for water infrastructure and proximity to the CBD which will result in lower outlet pipeline construction costs. Most of the future CBD zone can also be serviced by gravity which is good for resilience.

It was concluded that no other sites should be considered for further analysis, and any subsequent investigations can focus on the preferred site only. Further work needs to be undertaken in subsequent design stages to address any limitations this site might have (e.g. no detailed planning investigations, ecological investigations, geological investigations, or consultations had been undertaken at the time of writing).

8 LIMITATIONS

This report ('Report') has been prepared by WSP exclusively for Hamilton City Council ('Client') in relation to the provision or additional water storage for the future CBD Supply Zone ('Purpose') and in accordance with the Waikato LASS IFS PSP00002218-2023 dated 15 September 2023. The findings in this Report are based on and are subject to the assumptions specified in the Report. WSP accepts no liability whatsoever for any reliance on or use of this Report, in whole or in part, for any use or purpose other than the Purpose or any use or reliance on the Report by any third party.

In preparing this Report, WSP has relied upon data, surveys, analyses, designs, plans and other information ('Client Data') provided by or on behalf of the Client. Except as otherwise stated in this Report, WSP has not verified the accuracy or completeness of the Client Data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in this Report are based in whole or part on the Client Data, those conclusions are contingent upon the accuracy and completeness of the Client Data. WSP will not be liable for any incorrect conclusions or findings in the Report should any Client Data be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to WSP.

APPENDIX A

LONG LIST FATAL FLAW (TRAFFIC LIGHT) ASSESSMENT

HCC IAF CBD (Ruakiwi) Potential Reservoir Location Assessment - Long List Assessment

Significant issues / fatal flaw	Potential issues / challenges	No signficant issue

CBD = 40 m RL 6,620 m2

Location Number	Location Name	Traffic light score these items: District Plan Zoning	Likely Ownership	Proximity to bulk network (in)	Proximity to WTP (in)	Proximity to CBD (out)	Geotech (soils maps only)	Elevation above / below CBD (Reference elevation above)	Site Area (m²)	Other	Continue to short list?	Comments / reasoning
1	300 Peacocks Rd - Gully	Open Space Zone - Peacocke Sports and Active Recreation	Hamilton City Council	500 m	1200 m	3675 m	Hinuera Formation	43 m = 3 m above	140,278	Similar to Site 2 but further from the WTP	NO	This site is viable but site 2 is closer so site 2 is preferentially included.
2	12 Waterford Rd - Near Waiora Treatment Plant - Peacocks Reserve	Open Space Zone - Peacocke Natural Open Space	Hamilton City Council	Bulk main crosses over this site	200 m	2944 m	Taupo Pumice Alluvium	34.5 m = 5.5 m below	32,190	Ideal location right next to the WTP	YES	Overall site stability will need to be considered in close proximity to the Waikato Rver but otherwsie viable.
3	66 Bader Street	Community Facilities Zone	Hamilton City Council	100 m	>1000 m Closer to the WTP than the current Ruakiwi Site	2000 m	Hinuera Formation	39.5 m = 0.5 m below	8,723	Site shape is narrow and long and access is limited by gully systems	NO	Site shape and limited access
4	Melville Park - Near Hamilton Skating	Open Space Zone - Sports and Recreation Open Space Zone - high use	Hamilton City Council	150 m	>1000 m Closer to the WTP than the current Ruakiwi Site	1000 m	Hinuera Formation	36.5 m = 3.5 m below	14,180	Earmarked for use as a possible Wastewater Wet Weather Storage Tank location (2025+)	YES	Dependant on wastewater Master Plan solution going ahead, but otherwise viable
5	Graham Park	Open Space Zone - Sports and Recreation Open Space Zone	Hamilton City Council	55 m	>1000 m Closer to the WTP than the current Ruakiwi Site	400 m	Pakihi Supergroup	21.5 m = 8.5 m below	28,821	Nil identified	YES	Archery Club use would be affected, but otherwsie viable
6	Hamilton West School Ground	Community Facilities Zone	Ministry of Education	20 m	>1000 m Closer to the WTP than the current Ruakiwi Site	Within the CBD fringe	Walton Subgroup	41 m = 1 m above	8,253	Nil identified	NO	School
7	Gower Park	Open Space Zone - Sports and Recreation Open Space Zone - high use Melville FC	Hamilton City Council	200 m	>1000 m Closer to the WTP than the current Ruakiwi Site	1050 m	Piako Subgroup	40 m = 0 m above	109,188	Nil identified	NO	Known ground conditions
8	Innes Common	Open Space Zone - Sports and Recreation Open Space Zone - high use Cricket	Hamilton City Council	900 m Western rail trail	>1000 m Further from the WTP than the current Ruakiwi Site	1500 m	Piako Subgroup	38.5 m = 1.5 m below	66,107	Nil identified	NO	Known ground conditions
9	Current Ruakiwi Res	Water infrastructure designation	Hamilton City Council	Bulk main crosses over	>1000 m	Within the CBD	Walton Subgroup	67 m = 27 m above	5,289	Nil identified	YES	Site area is limited (known constraint) but the current status overrides this and it is retained noting a higher or deeper founded strucuture could be built
10	Lake Domain Reserve	Open Space Zone - Destination Open Space Zone	Hamilton City Council	75 m	>1000 m Further from the WTP than the current Ruakiwi Site	200 m	Walton Subgroup	39 m = 1 m below	11,978	Nil identified	YES	Retained as a close proximity backup site to the current reservoir site, that could be used for ancilliary purposes (e.g., booster pumpstation, additional storage volume). NOT favoured over the exisitng site as a full standalone solution.
11	Hamilton Girls School	Open Space Zone - Neighbourhood Open Space Zone	Ministry of Education	190 m	>1000 m Further from the WTP than the current Ruakiwi Site	Within the CBD	Walton Subgroup & Hinuera Formation	40 m = 0 m above	8,592	Nil identified	NO	School
12	Hinemoa Park / Rostrevor Street	Open Space Zone - Sports and Recreation Open Space Zone	Hamilton City Council	600 m	>1000 m Further from the WTP than the current Ruakiwi Site	Within the CBD	Hinuera Formation	37.5 m = 2.5 m below	15,216	Earmarked for use as a possible Wastewater Wet Weather Storage Tank location (2060+)	YES	Further from the WTP than the existing site but still witihn the CBD area. Dependant on wastewater Master Plan solution going ahead, but otherwise viable.
13	Fraser Tech Rugby Ground Reserve	Open Space Zone - Sports and Recreation Open Space Zone - High use Waikato Rugby	Hamilton City Council	400 m	>1000 m Further from the WTP than the current Ruakiwi Site	Within the CBD fringe	Hinuera Formation	37 m = 3 m below	9,611	Nil identified	NO	Reserve use and distance from WTP compared to other sites
14	Beside FMG Stadium	Open Space Zone - Sports and Recreation Open Space Zone - High use Waikato Rugby	Hamilton City Council	900 m	>1000 m Further from the WTP than the current Ruakiwi Site	Within the CBD fringe	Hinuera Formation	34 m = 6 m below	9,583	Nil identified	NO	Reserve use and distance from WTP compared to other sites
15	Kent Street Industrial Area	Industrial zone - private land	Unknown / Private	400 m	>1000 m Further from the WTP than the current Ruakiwi Site	1200 m road distance to CBD	Hinuera Formation	37.5 m = 2.5 m below	14,790	Nil identified	NO	Private land would need to be purchased and facilities demolished, distance from WTP compared to other sites
16	Railway Park	Open Space Zone - Sports and Recreation Open Space Zone	Hamilton City Council	900 m	>1000 m Further from the WTP than the current Ruakiwi Site	1500 m including major rail crossing	Hinuera Formation	37.5 m = 2.5 m below	14,698	Nil identified	NO	Distance from CBD, distance from WTP compared to other sites, energy use
17	Swarbrick Park	Open Space Zone - Sports and Recreation Open Space Zone	Hamilton City Council	400 m	>1000 m Further from the WTP than the current Ruakiwi Site	2000 m including major rail crossing	Hinuera Formation	36 m = 4 m below	63,836	Nil identified	NO	Distance from WTP compared to other sites, energy use
18	Tui Ave, Minogue Park, Recreation Reserve	Open Space Zone - Destination Open Space Zone	Hamilton City Council	650 m	>1000 m Further from the WTP than the current Ruakiwi Site	2800 m road distance to CBD	Hinuera Formation	36.5 m = 3.5 m below	83,948	Nil identified	NO	Distance from WTP compared to other sites, energy use
19	Claudelands Field	Open Space Zone - Destination Open Space Zone	Hamilton City Council	670 m	>1000 m Waikato River Crossing	1250 m Waikato River Crossing	Hinuera Formation	37 m = 3 m below	51,361	Nil identified	NO	Distance from CBD, distance from WTP compared to other sites, energy use, bridge crossing
20	Kitchener Park	Open Space Zone - Sports and Recreation Open Space Zone	Hamilton City Council	1500 m	>1000 m Waikato River Crossing	1080 m Waikato River Crossing	Hinuera Formation	38 m = 2 m below	2,108	Nil identified	NO	Distance from CBD, distance from WTP compared to other sites, energy use, bridge crossing
21	Steele Park	Open Space Zone - Sports and Recreation Open Space Zone - high profile reserve	Hamilton City Council	1200 m	>1000 m Waikato River Crossing	550 m Waikato River Crossing	Hinuera Formation	38 m = 2 m below	32,422	Earmarked for use as a possible Wastewater Wet Weather Storage Tank location (2025+)	NO	Distance from CBD, distance from WTP compared to other sites, energy use, bridge crossing
22	Hamilton East School Playground	Community Facilities Zone	Ministry of Education	900-1200 m	>1000 m Waikato River Crossing	800 m Waikato River Crossing	Pakihi Supergroup	23 m = 17 m below	5,021	Nil identified	NO	Distance from CBD, distance from WTP compared to other sites, energy use, bridge crossing
23	Galloway Park	Open Space Zone - Sports and Recreation Open Space Zone	Hamilton City Council	200 m	>1000 m Waikato River Crossing	1700 m Waikato River Crossing	Hinuera Formation	42.5 m = 2.5 m above	50,535	Nil identified	NO	Distance from WTP compared to other sites, energy use, bridge crossing
24	Hamilton Boys High School Ground 1	Community Facilities Zone	Ministry of Education	600 m	>1000 m Waikato River Crossing	2000 m Waikato River Crossing	Hinuera Formation	40 m = 0 m above	54,695	Nil identified	NO	Distance from CBD, distance from WTP compared to other sites, energy use, bridge crossing, school
25	Hamilton Boys High School Ground 2	Community Facilities Zone	Ministry of Education	900 m	>1000 m Waikato River Crossing	1700 m Waikato River Crossing	Hinuera Formation	40 m = 0 m above	68,123	Nil identified	NO	Distance from CBD, distance from WTP compared to other sites, energy use, bridge crossing, school
26	Peachgrove Intermediate School playground	Community Facilities Zone	Ministry of Education	160 m (incl. crossing private properties)	>1000 m Waikato River Crossing	1500 m Waikato River Crossing	Hinuera Formation	39.5 m = 0.5 m below	41,503	Nil identified	NO	Distance from CBD, distance from WTP compared to other sites, energy use, bridge crossing, school
27	Marist Park	Open Space Zone - Sports and Recreation Open Space Zone	Hamilton City Council	50 m	>1000 m Waikato River Crossing	2030 m Waikato River Crossing	Hinuera Formation	39.5 m = 0.5 m below	60,793	Nil identified	NO	Distance from WTP compared to other sites, energy use, bridge crossing
28	Clyde Park	Open Space Zone - Sports and Recreation Open Space Zone	Hamilton City Council	50 m	>1000 m Waikato River Crossing	1020 m Waikato River Crossing	Hinuera Formation	40.5 m = 0.5 m above	47,453	Nil identified	NO	Distance from WTP compared to other sites, energy use, bridge crossing
29	Hillcrest stadium	Open Space Zone - Sports and Recreation Open Space Zone	Hamilton City Council	50 m	>1000 m Waikato River Crossing	1900 m Waikato River Crossing	Walton Subgroup & Hinuera Formation	41.5 m = 1.5 m above	36,585	Nil identified	NO	Distance from WTP compared to other sites, energy use, bridge crossing
30	Forest Lake Hill	Water infrastructure designation	Hamilton City Council	Bulk main crosses over	>1000 m Further from the WTP than the current Ruakiwi Site	2800 m road distance to CBD	Hinuera Formation		2,100	No open sites - existing reservoir site too small unless a tall reservoir is built - ~70m high	NO	
31	Frankton Industrial (Ellis Street, Higgins Rd)	Industrial zone - private land	Unknown / Private	0-400 m	>1000 m Further from the WTP than the current Ruakiwi Site	2000 m	Piako Subgroup	37 m = 3 m below	131,021	Nil identified	NO	Distance from CBD, distance from WTP compared to other sites, energy use, private land
32	Brymer Road	Open Space Zone - Sports and Recreation Open Space Zone	Hamilton City Council	1215 m	>1000 m Further from the WTP than the current Ruakiwi Site	6500 m	Walton Subgroup	61.5 m = 21.5 m above	13,694	Nil identified	NO	Distance from CBD, distance from WTP compared to other sites, energy use
33	Fairfield Park - clarkin road	NON-SPECIFIC SITES NOT ASSESSED - SEE COMMENT / REASONING									NO	Further than claudelands (so not added)
34	CBD land - building or carpark on top										NO	Land cost, would need to be underground to be able to use air space above, resulting in high energy costs
35	Fred Jones Park Ulster										NO	Similar FMG
36	Kent St industrial could be anywhere along that length										NO	Consider exact location if it makes it to the short list
37	Crawford Street industrial area										NO	But more remote than Kent St and similar status, wrong side of the tracks
38	Southern Links (south of Kahikatea Drive) / Kahikatea Park										NO	Same ground issues as Gower and currently outside city boundary, further away

APPENDIX B

ENERGY ASSESSMENT TABLES

SCENARIO - BASEFLOW	Ruakiwi Existing			Ruakiwi Future			Graham Park			300 Peakcocks (2)			Kent Street (15)			Marist Park (27)		
	WTP Pump to Base of Reservoir	Base of Reservoir To TWL	Pump RL to Target delivery point	WTP Pump to Base of Reservoir	Base of Reservoir To TWL	Pump RL to Target delivery point	WTP Pump to Base of Reservoir	Pump RL to Target delivery point	Pump RL to Target delivery point	WTP Pump to Base of Reservoir	Pump RL to Target delivery point	Pump RL to Target delivery point	WTP Pump to Base of Reservoir	Pump RL to Target delivery point	Pump RL to Target delivery point	WTP Pump to Base of Reservoir	Pump RL to Target delivery point	Pump RL to Target delivery point
Parameters	Boost from WTP to Ruakiwi Base level	Boost from RL to filling level of Ruakiwi	Boost to High Pressure Zone	Boost from WTP to Ruakiwi Base level	Boost from RL to filling level of Ruakiwi	Boost to High Pressure Zone	Boost from WTP to Graham Park Reservoir Base level	Boost to High Pressre Zone	Boost to Low Pressure Zone	Boost from WTP to 300 Peakcocks Base Level	Boost to High Pressure Zone	Boost ot Low Pressure Zone	Boost from WTP to Kent Street Base level	Boost to High Pressure Zone	Boost ot Low Pressure Zone	Boost from WTP to Marist Park Base Level	Boost to High Pressure Zone	Boost ot Low Pressure Zone
Pump RL (m) - Either at WTP or Reservoir Base Level	30	67	67	30	60	60	20	20	20	30	34	34	30	37	37	30	40	40
Target delivery point (m)	67	91	85.5	60	67	85.5	25	85.5	67	39	85.5	67	42	85.5	67	45	85.5	67
Length (km)	3.1	0	1.60154	3.1	0	1.60154	1.9	0.9156	2.1364	0.22238	4.32827	2.7611	5.65271	2.84253	2.45824	3.6798	2.73272	3.2322
Pipe Losses (m)/km	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Total losses in pipe	6.2	0	3.20308	6.2	0	3.20308	3.8	1.8312	4.2728	0.44476	8.65654	5.5222	11.30542	5.68506	4.91648	7.3596	5.46544	6.4644
Head (m)	43.2	24	21.70308	36.2	7	28.70308	8.8	67.3312	51.2728	9.44476	60.15654	38.5222	23.30542	54.18506	34.91648	22.3596	50.96544	33.4644
Density (kN/m3)	9.81	9.81	9.81	9.81	9.81	9.81	9.81	9.81	9.81	9.81	9.81	9.81	9.81	9.81	9.81	9.81	9.81	9.81
Flow (m3/s)	0.225	0.225	0.000	0.225	0.225	0.051	0.225	0.051	0.119	0.225	0.051	0.119	0.225	0.051	0.119	0.225	0.051	0.119
Flow (m3/h)	810.00	810.00	0.00	810.00	810.00	183.60	810.00	183.60	428.40	810.00	183.60	428.40	810.00	183.60	428.40	810.00	183.60	428.40
Head (m)	43.2	24	21.70308	36.2	7	28.70308	8.8	67.3312	51.2728	9.44476	60.15654	38.5222	23.30542	54.18506	34.91648	22.3596	50.96544	33.4644
Overall Efficiency	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
Input power (kW)	123.835	68.797	0.000	103.769	20.066	18.650	25.226	43.749	77.734	27.074	39.087	58.403	66.806	35.207	52.937	64.095	33.115	50.735
Power cost ($/kW.h)	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Specific energy (kWh/m3)	0.152883	0.084935		0.128110	0.024773	0.101579	0.031143	0.238282	0.181452	0.033425	0.212892	0.136329	0.082477	0.191759	0.123568	0.079130	0.180365	0.118429
Cost per hour	$ 24.77	$ 13.76		$ 20.75	$ 4.01	$ 3.73	$ 5.05	$ 8.75	$ 15.55	$ 5.41	$ 7.82	$ 11.68	$ 13.36	$ 7.04	$ 10.59	$ 12.82	$ 6.62	$ 10.15
Pumping hours per day	18	18	24	18	18	24	18	24	24	18	24	24	18	24	24	18	24	24
Cost per day	$ 445.81	$ 247.67		$ 373.57	$ 72.24	$ 89.52	$ 90.81	$ 209.99	$ 373.12	$ 97.47	$ 187.62	$ 280.34	$ 240.50	$ 168.99	$ 254.10	$ 230.74	$ 158.95	$ 243.53
Cost per year	$ 162,720	$ 90,400		$ 136,353	$ 26,367	$ 32,675	$ 33,147	$ 76,648	$ 136,190	$ 35,575	$ 68,480	########	$ 87,784	$ 61,683	$ 92,745	$ 84,221	$ 58,017	$ 88,888
	1-year	1-year	1-year	1-year	1-year	1-year	1-year	1-year	1-year	1-year	1-year	1-year	1-year	1-year	1-year	1-year	1-year	1-year

APPENDIX C

MCA ASSESSMENT TABLES

Multi-Criteria Analysis (MCA) of Reservoir Location Options - Long-List Options

Grey Items from Template and to be Discussed with HCC in Workshop

OPTION SCORING (MCA)

Populate values / rating of options listed below

Items Scored w/ 0 to be Discussed/ Scored After Discussion w/ HCC

CORE CRITERIA	WEIGHTING	SUB-CORE CRITERIA	SUB WEIGHTING	Description / Indicator for Assessment	Score	Scoring Guide	Reservoir Location Options - Short-List AND Representative North and South Sites: Option 1 (Gully Reserve Near 300 Peacockes Rd)	Option 2 (Peacockes Reserve Near Waiora WTP)	Option 4 (Melville Park)	Option 5 (Graham Park)	Option 9 (Existing Ruakiwi Reservoir Site)	Option 10 (Lake Domain Reserve)	Option 12 (Hinemoa Park)	Option 15 (Kent Street Industrial Area)	Option 27 (Marist Park)	Weighted Score: Option 1 (Gully Reserve Near 300 Peacockes Rd)	Option 2 (Peacockes Reserve Near Waiora WTP)	Option 4 (Melville Park)	Option 5 (Graham Park)	Option 9 (Existing Ruakiwi Reservoir Site)	Option 10 (Lake Domain Reserve)	Option 12 (Hinemoa Park)	Option 15 (Kent Street Industrial Area)	Option 27 (Marist Park)
Financial	20%	Cost (Construction)	100.0%	Relative (high-level) cost comparison of reservoir location options - incl. construction, land acquisition, protection of ecological areas, site clearance etc. Qualitative indicator	5 4 3 2 1	Very low-low relative cost Low-medium relative cost Medium relative cost Medium-high relative cost High-very high relative cost	3.00	4.00	4.00	4.00	4.00	3.00	3.00	2.00	2.00	0.800	1.000	1.000	1.000	1.000	0.800	0.800	0.600	0.600
Carbon	10%	Carbon Emissions	100.0%	NPV of GHG emissions costs from construction energy use and material use, and operational energy. Relative and qualitative indicator	5 4 3 2 1	Very low-low carbon emissions Low-medium carbon emissions Medium carbon emissions Medium-high carbon emissions High-very high carbon emissions	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
Cultural	5%	Archaeology and Cultural Sites	100.0%	Presence of archaeological sites/ heritage sites	5 4 3 2 1	Archaeological/ heritage sites completely avoided Possible archaeological/ heritage site/ known site nearby - easily avoidable Known archaeological/ heritage site - impacts can be completely avoided Known archaeological/ heritage site - impacts may occur but acceptable for approval Known archaeological/ heritage site - significant impact to site would occur	4.00	1.00	5.00	1.00	4.00	5.00	4.00	5.00	5.00	0.210	0.090	0.250	0.090	0.210	0.250	0.210	0.250	0.250
Technical	35%	Construction	5.0%	Terrain and site topography	5 4 3 2 1	No terrain or topography issues Minor terrain or topography issues Some terrain or topography issues Difficult terrain or steep topography impossibly difficult terrian/ criticality steep topography	5.0	4.0	5.0	5.0	4.0	4.0	5.0	5.0	5.0	0.088	0.070	0.088	0.088	0.070	0.070	0.088	0.088	0.088
			10.0%	Presence of existing utilities (such as electricity, gas, telecommunications etc)	5 4 3 2 1	No utilities present Presence of a few minor utilities Precense of many minor utilities Presence of major utilities Presence of many major utilities	2.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	0.070	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
			5.0%	Ground conditions, soil erodibility issues, and contamination	5 4 3 2 1	No ground condition issues Minor ground conditions issues Moderate ground conditions issues Major ground conditions issues Critical ground conditions issues	5.0	4.0	4.0	4.0	4.0	2.0	4.0	4.0	5.0	0.088	0.070	0.070	0.070	0.070	0.035	0.070	0.070	0.088
			5.0%	Land acquisition issues (such as delays in planning phase due to ownership of land) (also considered proxy for costs)	4 3 2 1	Land owned by HCC - reserve/ open space Land owned by HCC - recreation/ sports zone Private property Government owned site	2.0	4.0	3.0	3.0	5.0	3.0	3.0	2.0	3.0	0.035	0.070	0.053	0.053	0.088	0.053	0.053	0.035	0.053
			5.0%	Current district planning zone allocation (difficulties during the planning phase)	4 3 2 1	Zoned for water infrastructure Open space zone/ natural zone Sport and recreation zone/ industrial zone/ communities facilities zone / commercial-industrial High use sport and recreation zone / residential	1.0	4.0	3.0	3.0	4.0	3.0	3.0	2.0	3.0	0.018	0.070	0.053	0.053	0.070	0.053	0.053	0.035	0.053
		Operation	10.0%	Site elevation relative to the CBD (and therefore pumping requirements)	5 4 3 2 1	Elevation much higher than the CBD Elevation higher than the CBD Elevation lower than the CBD Elevation much lower than the CBD	3.0	3.0	3.0	3.0	5.0	3.0	3.0	3.0	3.0	0.105	0.105	0.105	0.105	0.175	0.105	0.105	0.105	0.105
			10.0%	Relative energy cost per day (based on the hourly power cost by the system's daily operation hours) compared to the existing reservoir site at Ruakiwi	5 4 3 2 1	Much less than current energy cost Less than current energy cost No difference More than current energy cost Much more than current energy cost	2.0	3.0	2.0	2.0	3.0	2.0	2.0	1.0	1.0	0.070	0.105	0.070	0.070	0.105	0.070	0.070	0.035	0.035
			2.5%	Opportunity for new technology - based on conversations with HCC	5 4 3 2 1	High opportunity Moderate opportunity Limited opportunity	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0.026
			2.5%	Simplicity of operation (pumping facilities, remoteness, complexity of pumping and boosting)	5 4 3 2 1	Integrated solution (e.g. at WTP, at Reservoir) v Pumping to one CBD zone, but from a remote site Pumping to both the high and low zone from close site (WTP or Reservoir) Pumping to both the high and low zone from remote site Pumping long distances both to and from	2.0	3.0	2.0	2.0	5.0	3.0	2.0	1.0	1.0	0.018	0.026	0.018	0.018	0.044	0.026	0.018	0.009	0.009
			5.0%	Compliance and complexity - based on conversations with HCC	5 4 3 2 1	Minimal Costs Moderate Costs High Cost	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053
		Infrastructure and Associated Assets	10.0%	Proximity to Waiora WTP (especially compared to the existing Ruakiwi reservoir location) (also considered proxy for construction costs)	5 4 3 2 1	Less than 1000m from WTP Closer to WTP than current reservoir site (but greater than 1000m) Further from the WTP than current reservoir site (greater than 1000m)	4.0	5.0	3.0	3.0	2.0	2.0	1.0	1.0	1.0	0.140	0.175	0.105	0.105	0.070	0.070	0.035	0.035	0.035
			15.0%	Proximity to CBD (also considered proxy for construction costs)	5 4 3 2 1	Within the CBD/ CBD fringe Within 1000m to the CBD Moderate road distance from CBD Moderate road distance from CBD and major railway crossing Major distance and/or Waikato River crossing	2.0	2.0	3.0	3.0	5.0	4.0	5.0	2.0	1.0	0.105	0.105	0.158	0.158	0.263	0.210	0.263	0.105	0.053
			10.0%	Proximity to bulk network (also considered proxy for construction costs)	5 4 3 2 1	At bulk main Less than 100m from existing bulk main Less than 500m from existing bulk main Less than 1000m from existing bulk main More than 1000m from existing bulk main	3.0	5.0	5.0	5.0	5.0	5.0	2.0	3.0	5.0	0.105	0.175	0.175	0.175	0.175	0.175	0.070	0.105	0.175
			2.5%	Access during isolation events	5 4 3 2 1	Good Moderate Very difficult	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0.026
			2.5%	Facilitates transfer across reservoir zones (opportunities for rezoning in high pressure areas and systems with trunk mains supply between reservoirs)	5 4 3 2 1	Trunk transfers between reservoirs (No New Trunk transfers between reservoirs a with Pumping to reservoirs and limited new reservoirs Pumping to reservoirs and new reservoirs	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0.026

Multi-Criteria Analysis (MCA) of Reservoir Location Options - Long-List Options

Grey Items from Template and to be Discussed with HCC in Workshop

OPTION SCORING (MCA)

Populate values / rating of options listed below

Items Scored w/ 0 to be Discussed/ Scored After Discussion w/ HCC

CORE CRITERIA	WEIGHTING	SUB-CORE CRITERIA	SUB WEIGHTING	Description / Indicator for Assessment	Score	Scoring Guide	Reservoir Location Options - Short-List AND Representative North and South Sites: Option 1 (Gully Reserve Near 300 Peacockes Rd)	Option 2 (Peacockes Reserve Near Waiora WTP)	Option 4 (Melville Park)	Option 5 (Graham Park)	Option 9 (Existing Ruakiwi Reservoir Site)	Option 10 (Lake Domain Reserve)	Option 12 (Hinemoa Park)	Option 15 (Kent Street Industrial Area)	Option 27 (Marist Park)
Resilience	10%	System Resilience	20.0%	Proximity to natural hazards	5	Avoided	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
					4										
					3	Moderate									
					2										
					1	Poor									
			40.0%	Redundancy and inter-connectivity - based on ability to service during outage	5	Full gravity and stored volume	2.0	3.0	2.0	3.0	5.0	2.0	2.0	2.0	2.0
					4	Partial gravity and stored volume									
					3	Emergency power and capacity (e.g. at WTP)									
					2	Stored volume only (remote supply point)									
					1	No resilience									
			40.0%	Adaptability	5	Good adaptability with staging	3.0	5.0	3.0	3.0	5.0	3.0	4.0	2.0	1.0
					4										
					3										
					2										
					1	Provide least adaptability									
Environment	10%	Impacts on Environment	50.0%	Endangered ecological communities (EECs) - such as indigenous and at-risk species (also considered proxy for costs)	5	All EECs avoided	3.0	2.0	3.0	3.0	3.0	2.0	3.0	4.0	3.0
					4	Removal of individual trees									
					3	Removal of vegetation from small area									
					2	Removal of vegetation from large area									
					1	Significant clearing of EECs									
			50.0%	Vicinity to watercourses (and extent of ESC controls)	5	No watercourses nearby	3.0	2.0	3.0	3.0	5.0	3.0	5.0	5.0	4.0
					4	Heavily modified urban channel nearby									
					3	Minor watercourse in vicinity/ flat topography and minimal ESC controls									
					2	Moderate watercourse nearby/ moderate topography and ESC controls									
					1	Major watercourse nearby/ steep topography and major ESC controls required									
Social	10%	Impact on Community	30.0%	Impacts during construction (location of assets / infrastructure and noise, odour, traffic, visual impacts etc during construction)	5	No impacts	2.0	4.0	1.0	3.0	4.0	1.0	1.0	4.0	1.0
					4	Minor impacts									
					3	Moderate impacts									
					2	Major impacts									
					1	Significant impacts									
			20.0%	Impacts during O&M (location of assets / infrastructure and noise, odour, traffic, visual impacts etc during O&M)	5	No impacts	3.0	4.0	3.0	3.0	3.0	3.0	3.0	4.0	3.0
					4	Minor impacts									
					3	Moderate impacts									
					2	Major impacts									
					1	Significant impacts									
			50.0%	Stakeholder acceptability (location of assets / infrastructure and impacts on residents and communities and environmental groups etc)	5	No stakeholder issues	2.0	4.0	1.0	1.0	3.0	1.0	1.0	4.0	1.0
					4	Minor stakeholder issues									
					3	Moderate stakeholder issues									
					2	Major stakeholder issues									
					1	Significant stakeholder issues									

Weighted Score: Option 1 (Gully Reserve Near 300 Peacockes Rd)	Option 2 (Peacockes Reserve Near Waiora WTP)	Option 4 (Melville Park)	Option 5 (Graham Park)	Option 9 (Existing Ruakiwi Reservoir Site)	Option 10 (Lake Domain Reserve)	Option 12 (Hinemoa Park)	Option 15 (Kent Street Industrial Area)	Option 27 (Marist Park)	
0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	
0.080	0.120	0.080	0.120	0.200	0.080	0.080	0.080	0.080	
0.120	0.200	0.120	0.120	0.200	0.120	0.160	0.080	0.040	
0.150	0.100	0.150	0.150	0.150	0.100	0.150	0.200	0.150	
0.150	0.100	0.150	0.150	0.250	0.150	0.250	0.250	0.200	
0.060	0.120	0.030	0.090	0.120	0.030	0.030	0.120	0.030	
0.060	0.080	0.060	0.060	0.060	0.060	0.060	0.080	0.060	
0.100	0.200	0.050	0.050	0.150	0.050	0.050	0.200	0.050	
3.261	***3.778***	***3.579***	***3.519***	***4.265***	***3.303***	***3.409***	***3.278***	***2.948***	Total
0.260	***0.380***	***0.260***	***0.300***	***0.460***	***0.260***	***0.300***	***0.220***	***0.180***	Resilience
0.919	***1.155***	***1.076***	***1.076***	***1.313***	***1.050***	***1.006***	***0.805***	***0.875***	Technical
0.210	***0.090***	***0.250***	***0.090***	***0.210***	***0.250***	***0.210***	***0.250***	***0.250***	Carbon
0.800	***1.000***	***1.000***	***1.000***	***1.000***	***0.800***	***0.800***	***0.600***	***0.600***	Financial
0.300	***0.200***	***0.300***	***0.300***	***0.400***	***0.250***	***0.400***	***0.450***	***0.350***	Environment
0.220	***0.400***	***0.140***	***0.200***	***0.330***	***0.140***	***0.140***	***0.400***	***0.140***	Social
0.210	***0.090***	***0.250***	***0.090***	***0.210***	***0.250***	***0.210***	***0.250***	***0.250***	Cultural

8	**2**	**3**	**4**	**1**	**6**	**5**	**7**	**9**	

Option 1 (Gully Reserve Near 300	**Facockes Reserve Near**	**tion 4 (Melville Par**	**5 (Grahaming Ruakiwi I**	**(Lake Domain R**	**12 (Hinemo**	**cent Street Ind**	**option 27 (Marist Park)**	
8	**2**	**3**	**4**	**1**	**6**	**5**	**7**	**9**	Total
5	**2**	**5**	**3**	**1**	**5**	**3**	**8**	**9**	Resilience
7	**2**	**3**	**3**	**1**	**5**	**6**	**9**	**8**	Technical
5	**8**	**1**	**8**	**5**	**1**	**5**	**1**	**1**	Carbon
5	**1**	**1**	**1**	**1**	**5**	**5**	**8**	**8**	Financial
5	**9**	**5**	**5**	**2**	**8**	**2**	**1**	**4**	Environment
4	**1**	**6**	**5**	**3**	**6**	**6**	**1**	**6**	Social
5	**8**	**1**	**8**	**5**	**1**	**5**	**1**	**1**	Cultural

Assumptions (operations and maintenance, design and construction, energy price escalation and reliability factors)