LYTTELTON WASTEWATER PROJECT

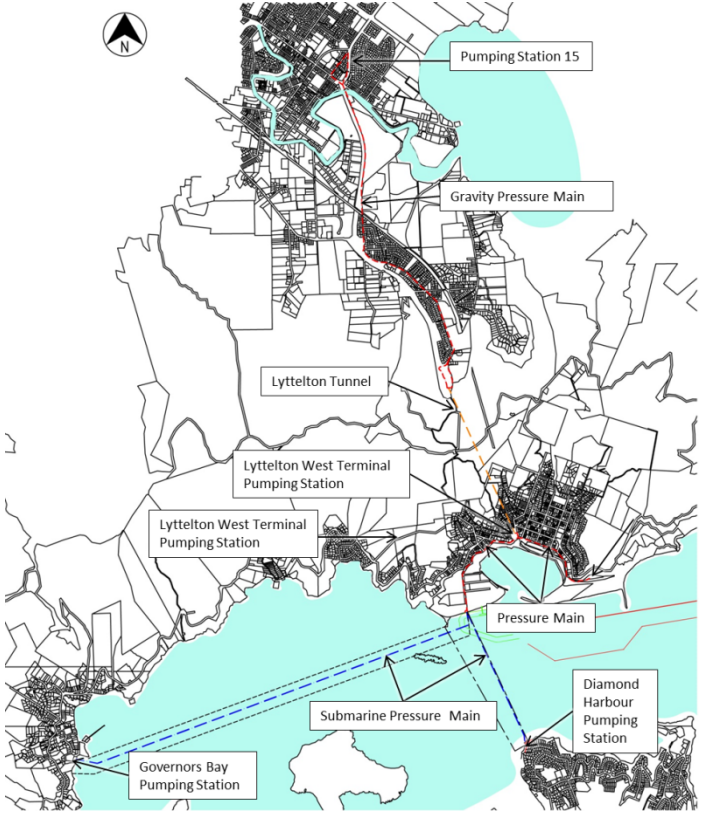
OPTIMISATION OF PUMP / STORAGE TO IMPROVE CULTURAL, ENVIRONMENTAL AND ECONOMIC OUTCOMES

The Lyttelton Wastewater Project

Christchurch City Council long term strategy is to remove all wastewater discharges from Lyttelton Harbour

The project is to decommission wastewater treatment plants at Governors Bay, Diamond Harbour and Lyttelton and convey all wastewater to Christchurch

This project has a history going back more than 10-years



Project Constraints

Time – existing consents require cessation of Governors bay discharge by December 2018

Environment – 7km of submarine pipelines, 7km of pipe in road, 2km of pipe in tunnel, 60m static head and 130m pump head on tunnel pressure main, 3 rail crossings, a river crossing and construction through the Lyttelton Port entrance

Capacity – The receiving pump station has a capacity limit of 120 L/s, while present day peak wet weather flows are in the order of 250 L/s

This presentation focuses on the development and optimisation of the pump / storage philosophy adopted

Pump / Storage Design Philosophy

Flow buffering and storage was required due to the capacity limit at the receiving pump station

Lyttelton WWTP is the easiest and most cost effective place to provide bulk storage, BUT

Providing storage at each WWTP enables reduction in pumping and pressure main size and cost, AND

Provides emergency storage in case of pump station failure

The principal philosophy agreed was to provide distributed storage

Factors Influencing Design of Pump / Storage Facilities

Diamond Harbour and Governors Bay sites are constrained by small land area cut into hill and difficult access for construction

Diamond Harbour and Governors Bay existing treatment tanks in good condition and suitable for re-purposing

The head of the harbour identified as the most sensitive receiving environment

Lyttelton site has land available for storage and large treatment tank that can be reused

Design Philosophy for Pump / Storage Facilities

The following were identified as key design objectives:

1. Re-purpose existing treatment tanks and build as large a storage as sensibly achievable at Governors Bay (350 m^3) and Diamond Harbour (700 m^3), to avoid costly future storage capacity upgrade
2. Identify future capacity upgrade method for all sites, increased pump rate for Governors Bay and Diamond Harbour and increased storage for Lyttelton
3. Prioritise overflow risk mitigation for Governors Bay
4. Prioritise Lyttelton as recipient of surplus flows, as reuse of existing treatment tank provides a large storage (1400 m^3)
5. Construct additional smaller and easily cleaned storage tank at Lyttelton for more frequent overflows (700 m^3)

Factors Influencing Development of Design Flows

Flow records available for more than 10-years for each site, however some uncertainty on reliability and Lyttelton flow recorder located on outlet from WWTP

Flow records identify that Lyttelton and Diamond Harbour have very high inflow and infiltration

Population projections predict significant growth for Governors Bay and Diamond harbour

Uncertainty of consentable wet weather overflow frequency, with a 2-year return frequency identified as a minimum target

Suitability of Flow Records for Use for Design

The flow records for each of the sites were assessed including:

- Flow meter location – to check if it recorded all incoming flows
- Flow variation with wet weather – to check timing and scale of response
- Evidence of calibration of flow meters

This established the following:

- No evidence of meter calibration
- Diamond Harbour has high inflow and record appropriate for use
- Governors Bay record appropriate for use
- Lyttelton has high inflow and peak flows bypass the flow meter, so further assessment required and a 20% factor applied for design

It was recognised that some conservatism should be applied due to flow meters being uncalibrated

Development of Design Flows

The duration and accuracy of the flow record was considered suitable for determination of storage requirements using statistical means

Use of historical records was considered a better design method than using per-capita flow rates and population projections

The flow records where adjusted to present day population, then scaled to projected 2041 populations

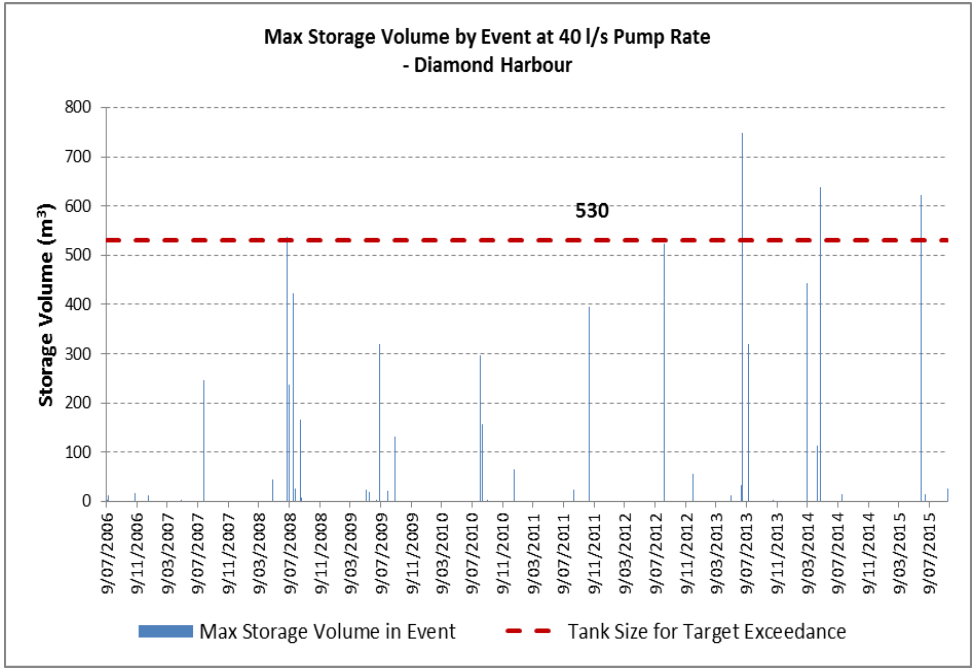
Flow records with high inflow and infiltration where left unadjusted, as reduction of inflow and infiltration cannot be relied upon and provides Council an ongoing opportunity to manage capacity

Development of Storage Requirements

Flow records were converted to an average hourly flow rate

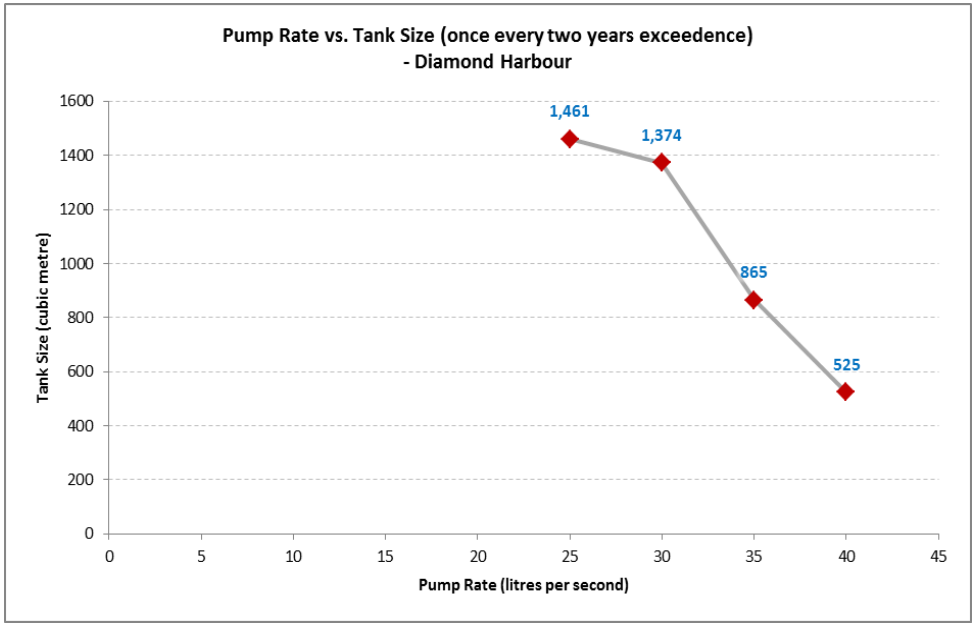
A pump rate - overflow volume model was developed to determine the overflow volume during a storm event for a given pump rate

The 2-year return period overflow volume was then determined to establish the minimum storage required



Determining Pump / Storage Relationship

This process was repeated for a range of pump rates to establish a pump rate vs storage volume relationship for each site for a 2-year ARI



Optimising Pump / Storage at Each Site

Pump flow rates and required storage at each site were adjusted to achieve the design philosophy as follows:

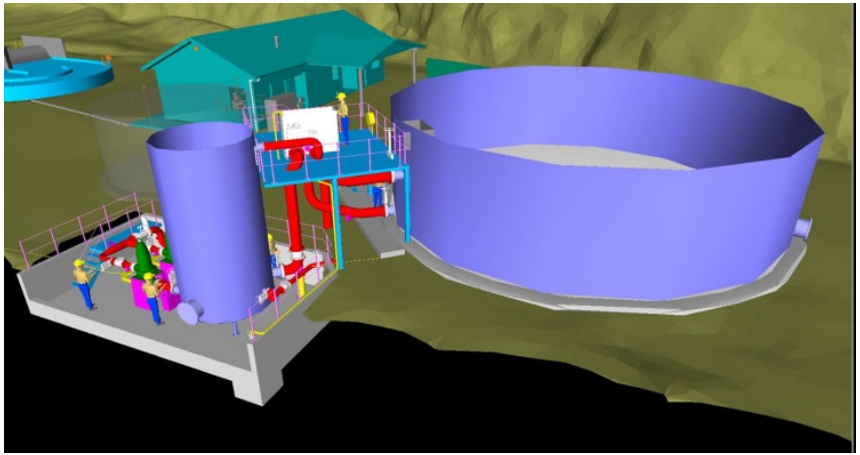
- Governors Bay – build maximum sensibly achievable storage
- Diamond Harbour – build maximum sensibly achievable storage
- Lyttelton – build new storage tank, convert existing treatment tank to storage and enable control of transfer pump rate to enable other pumps to continue without restriction

Scheme Area	Pump Rate (L/s)	Storage Required (m^3)	Storage Provided (m^3)
Lyttelton	65	850	2,100
Diamond Harbour	40	525	700
Governor's Bay	15	120	350
Totals	120	1,495	3,150

Pump / Storage Facility General Arrangement

Flows all sites have arrive via elevated gravity or pressure, enabling development of overflow storage with gravity inflow and outflow

Flow splitter boxes were developed to enable flow between wet-well and storage in a failsafe manner without need for process control or valve actuation

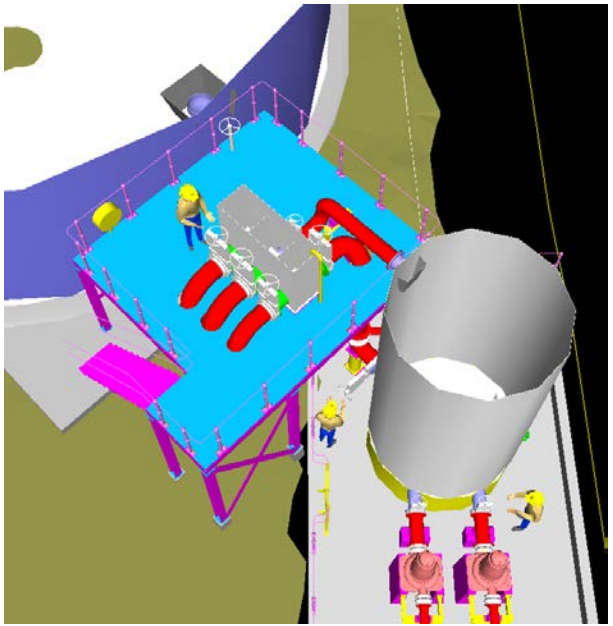


Additional Scheme Optimisation

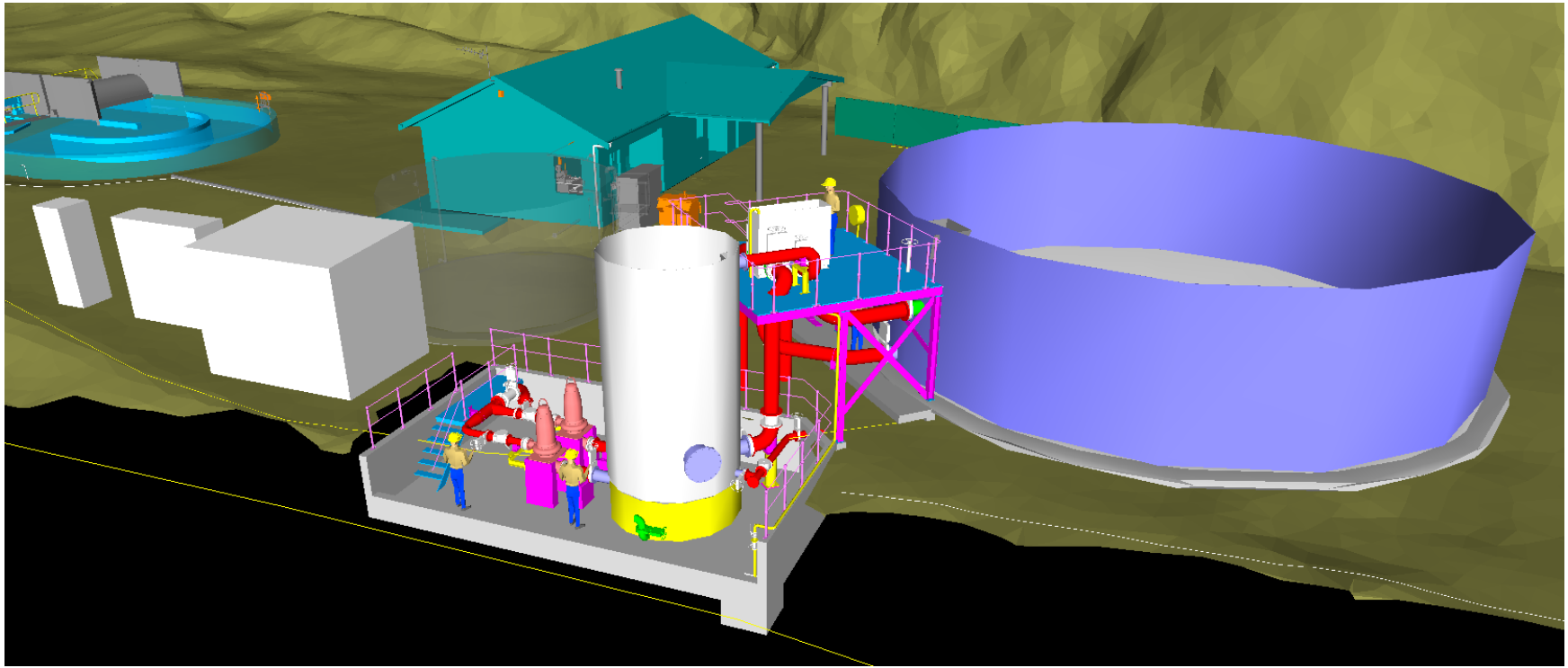
Application of a “fail safe” philosophy led to the development of flow splitter boxes that enable flows to cascade to storage without operator intervention in the event pump failure

Utilisation of sedimentation and baffles in wet-well and storage tanks to provide primary treatment and eliminate need for mechanical screens

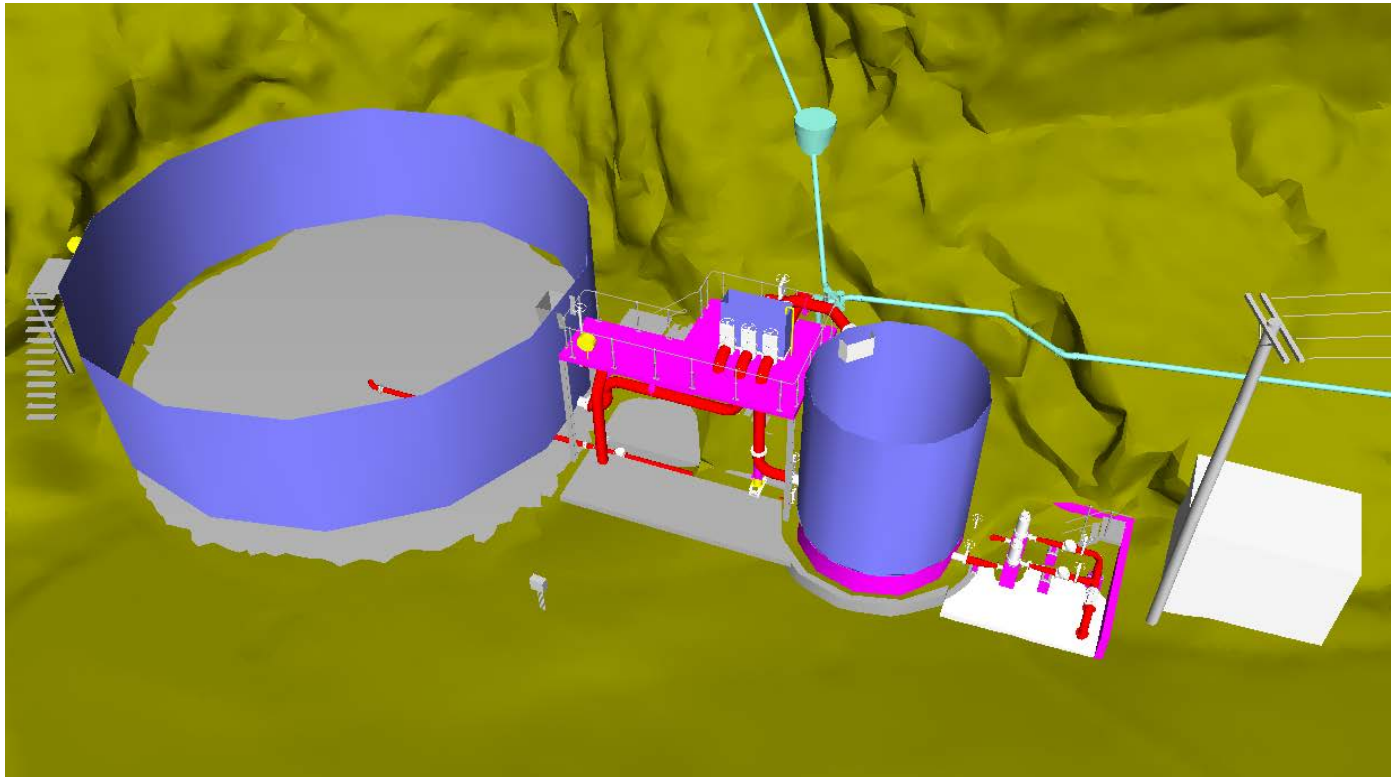
Incorporation of scheme capacity upgrade options, including planning for increase pump size (power supply, piping arrangement)



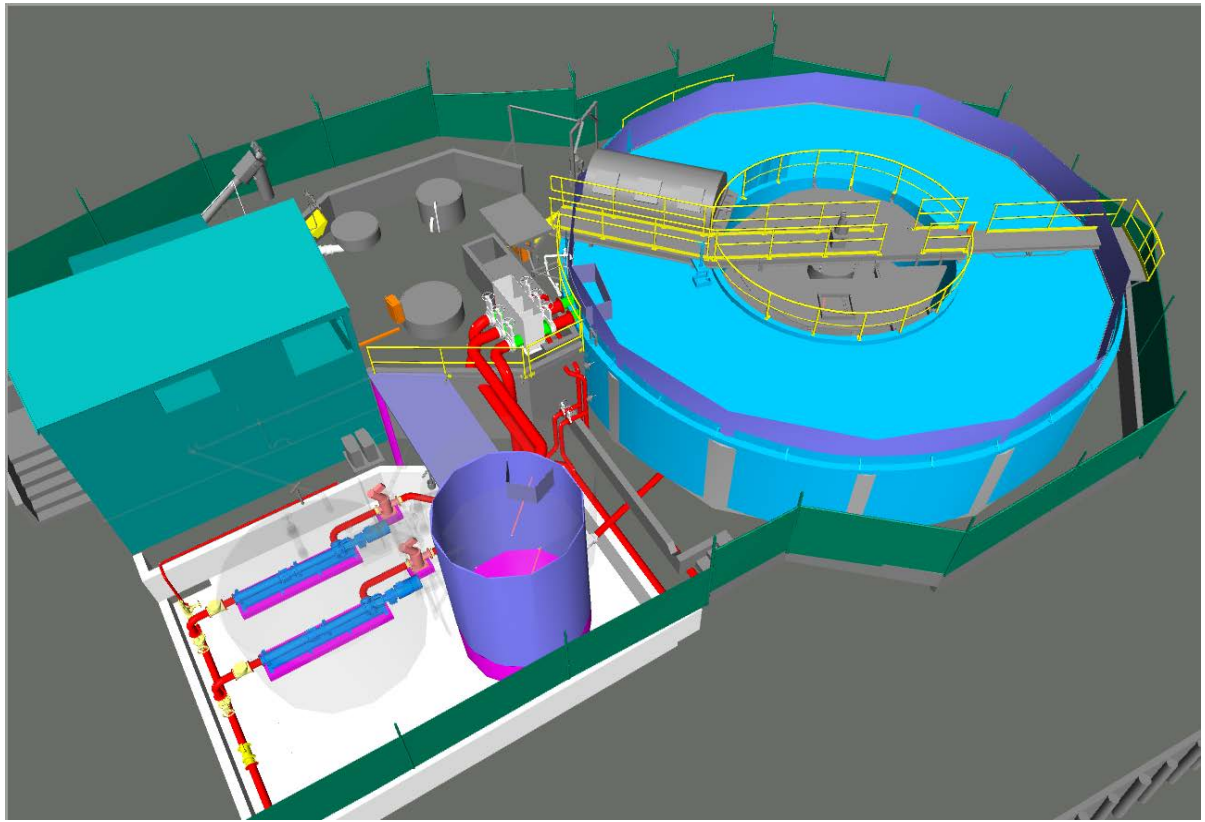
Lyttelton Pump / Storage Facility



Diamond Harbour Pump / Storage Facility



Governors Bay Pump / Storage Facility



Conclusion

Key outcomes that improve cultural, environmental and economic outcomes include:

- Provision of greater storage than the minimum required, on the basis that it is sensible and cost effective to do so now
- Application of increased conservatism in the most sensitive environments
- Development of Lyttelton as the long term bulk storage facility, due to its size and the ability to divert Lyttelton flows to storage
- Development of “fail-safe” operation of pump / storage facilities
- Development of planned upgrade approaches

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