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Asset Management of Brownfield Reservoirs – Opportunities/lessons from a comprehensive condition assessment and remediation programme

WSP & Beca-HunterH20



water
NEW ZEALAND
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Tākina, Te Whanganui-a-Tara Wellington

Overview of Presentation

- Quick recap of the Wellington Water's 'Very High Criticality' asset assessment program
- 2021 Reservoir external condition assessment using a 'Digital Workflow'
- 2022-2023 Design of required work and roof leakage testing
- 2023-2027 Delivery of a three-year program of works
- Data capture to inform re-inspection and 'Whole of life' asset management

Proactive Asset Management Preventing Asset Failure

Dixon Street, Wellington CBD, wastewater trunk main failure
– 20 December 2019

Case Study: Proactive Asset Management Preventing Asset Failure

Very High Criticality Asset:

“An asset whose failure has an unacceptable and extensive impact on the livelihoods of people and our environment and where time to restore service would be greater than 1 day”.

Very High Critical Assets were determined by assessing an assets Failure Mode against the resulting customer service impacts:

- H&S
- Public health
- Environmental impact
- Cost
- Service outage & duration

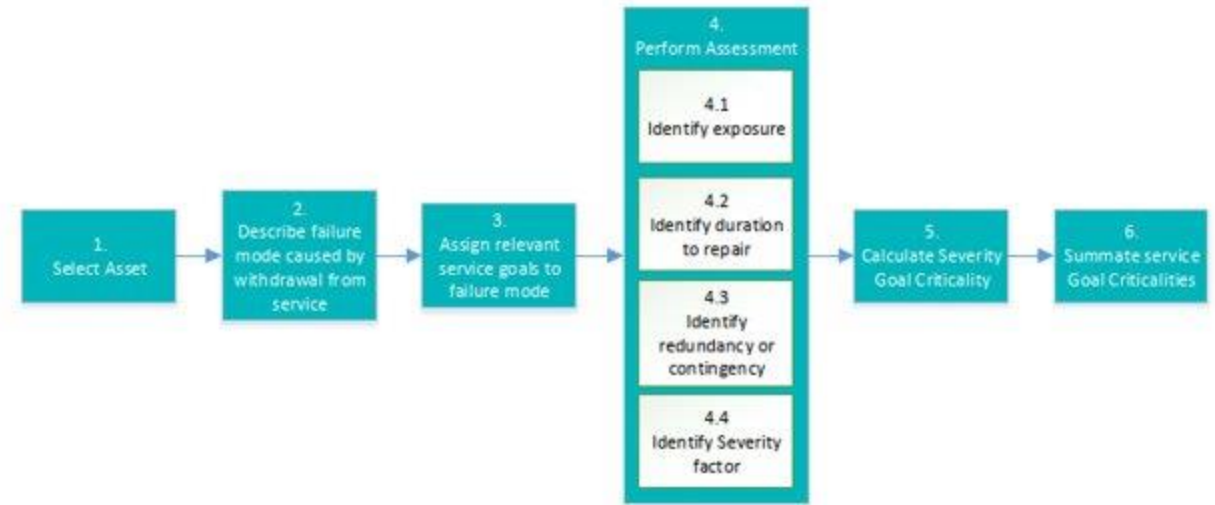
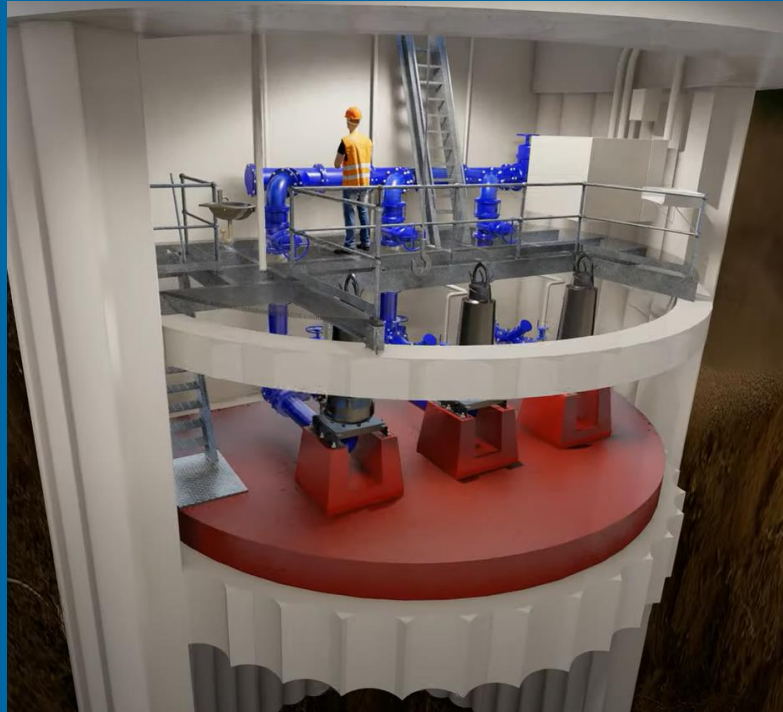


Figure 1: WWL flow chart for assessment of assign asset criticality.

Very High Criticality Assets
Identified across the
Wellington region:

- 77km of drinking water pipes
- 230km of wastewater pipes
- 164 km of stormwater pipes
- 140 reservoirs
- 84 pump stations
- 560 water treatment plant assets



140 Drinking Water Reservoirs External Visual Condition Assessment

Failure Modes assessed:

1. Health and Safety – Preventing falls from height
2. Structural Durability Failure – Identification of immediate risks and longer-term vulnerabilities. Excludes Seismic.
3. Water Quality – Assessment of contamination resilience.



Condition Assessment – Visual Assessment Guidelines

Page 1

IMMEDIATELY SAFE		Grade 1 Condition	Grade 2 Condition	Grade 3 Condition	Grade 4 Condition	Minor remedial work	Major remedial work
1	Reservoir - No Action Required (or minor action)	...	...	...	...	...	...
2	Reservoir - Minor Priority for Ongoing Reservoir Rehabilitation	...	...	...	...	...	...
3	Reservoir - Repair	...	...	...	...	...	...
4	Reservoir - Replace	...	...	...	...	...	...
5	Reservoir - Decommission	...	...	...	...	...	...



Foundation of the project

Water Quality / Contamination

Failure Mode: Contaminants entering the reservoir via roof leakage through the roof surface area via diffusion, or localised leakage at formed construction joints or cracks in the roof slab

Failure Mechanism: ...

Failure State	Water Quality / Contamination	Example Assessment / Key considerations
Very low risk of contamination
Low risk of contamination
Medium risk of contamination
High risk of contamination
Very High risk of contamination

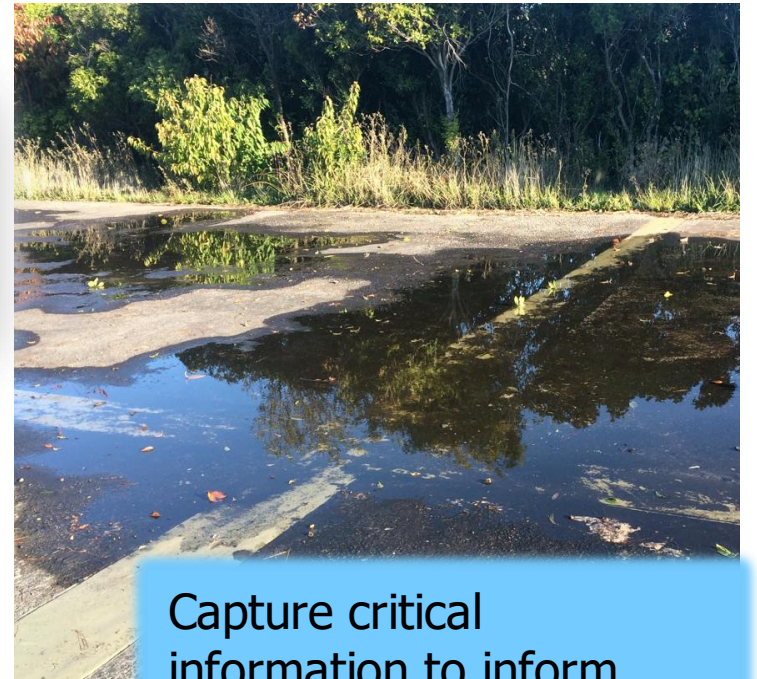
Preserves knowledge from technical specialists

Improves data capture consistency

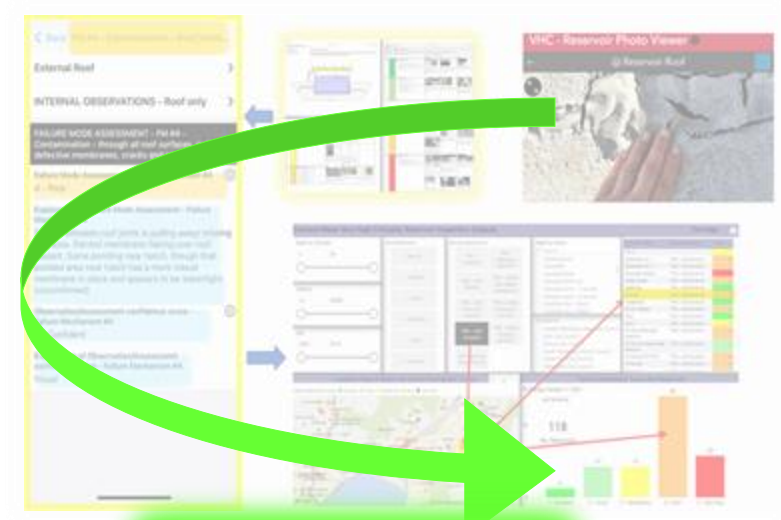
Condition Assessment - Mobile App



Focus on the end user experience



Capture critical information to inform technical assessment



Know the full Information workflow



Log outputs from other inspection activities

The Digital Workflow

Back FM #4 - Contamination - Roof joints...

External Roof >

INTERNAL OBSERVATIONS - Roof only >

FAILURE MODE ASSESSMENT - FM #4 - Contamination - through all roof surfaces, including, defective membranes, cracks and joints

Failure Mode Assessment - Failure Mechanism #4
4 - Poor

Explanation of Failure Mode Assessment - Failure Mechanism #4
Sealant between roof joints is pulling away/ missing in places. Painted membrane flaking over roof sealant. Some ponding near hatch, though that ponded area near hatch has a more robust membrane in place and appears to be watertight. (unconfirmed)

Observation/Assessment confidence score - Failure Mechanism #4
2 - Confident

Explanation of Observation/Assessment confidence score - Failure Mechanism #4
Visual



Assessment scoring



Phone App:
Digitally record assessment score and supporting evidence



Auto-generated summary reports

Reservoir Name	Failure Mechanism	Score
Gloaming Hill	FM4 - roof structure	4
Gracefield	FM4 - roof structure	4
Grenada North	FM4 - roof structure	4
Grenada North H.L.	FM4 - roof structure	4
Grenada South - 1 (south)	FM4 - roof structure	4
Grenada South - 2 (north)	FM4 - roof structure	4
Greyfriars No. 1 (East)	FM4 - roof structure	4
Greyfriars No. 2 (West)	FM4 - roof structure	4
Sunville	FM4 - roof structure	4
Sveastores	FM4 - roof structure	3
Sylvan Heights	FM4 - roof structure	3
Tata	FM4 - roof structure	3
Tawa	FM4 - roof structure	3
Ta Marua Backwash Reservoir	FM4 - roof structure	2
Ta Marua Process Water Reservoir	FM4 - roof structure	2
Upper Hutt City Council	FM4 - roof structure	2
Timeberlea	FM4 - roof structure	2
Waikanae	FM4 - roof structure	2



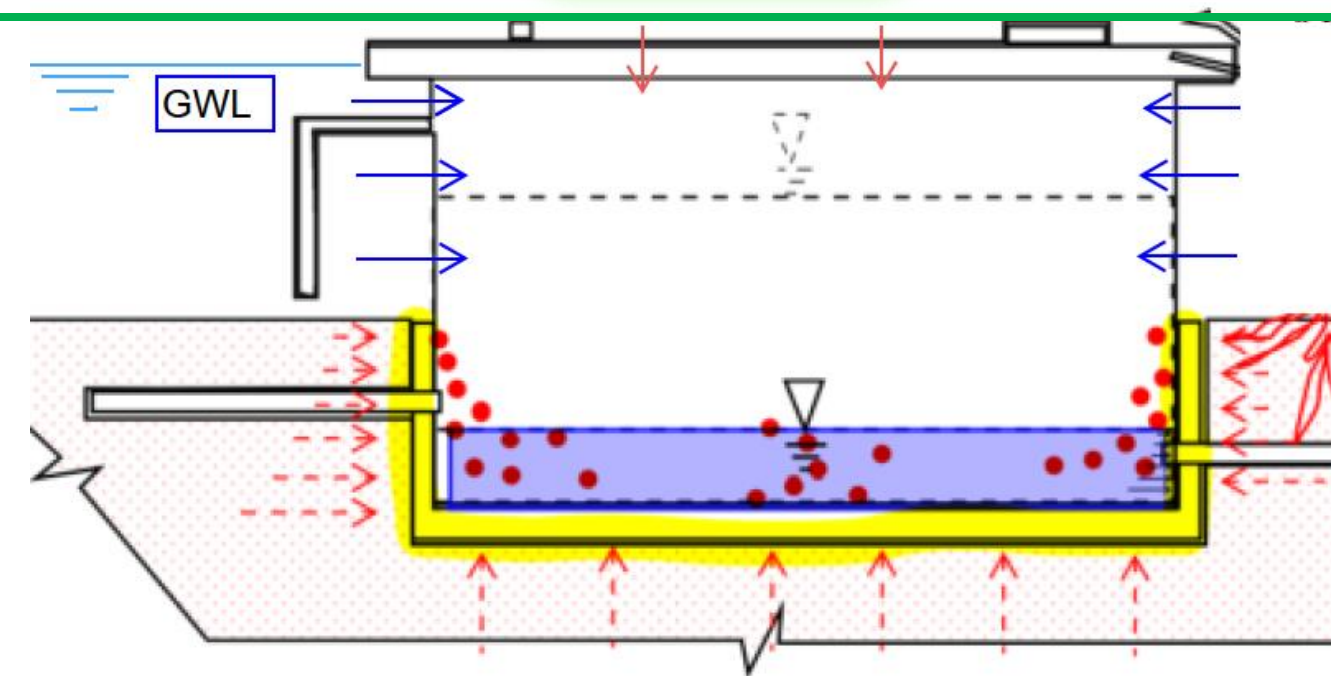
Work Type	No. Items	Cost	Total No. Items	Cost
Contamination Works2	1	\$18,500	1	\$18,500
Other Works	1	\$18,500	1	\$18,500
Roof Membrane - PVC	1	\$10,500	1	\$10,500
Roof Sealant Replacement	1	\$500	1	\$500
Roof Membrane - Epoxy	1	\$500	1	\$500
Roof Membrane - PVC	1	\$500	1	\$500
Roof membrane repairs, wall to roof r...	4	\$49,500	4	\$49,500

Auto-updated Interactive Dashboards

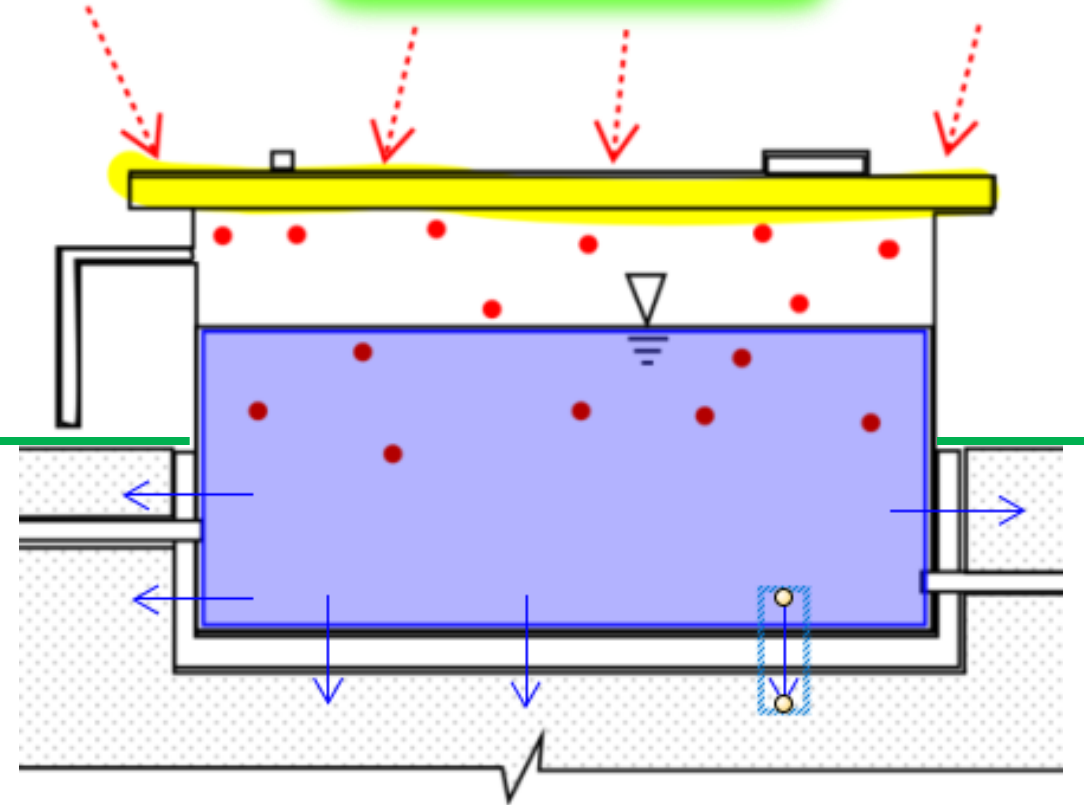
Costings based on recent installations

Contamination Resilience – Above ground vs Buried

Buried Reservoir



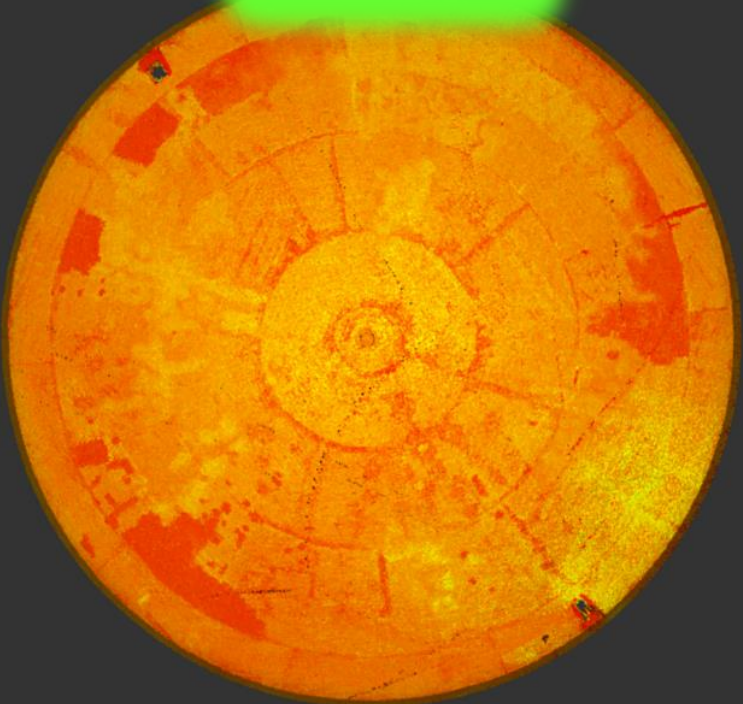
Above ground Reservoir



Offline Roof Leakage Testing

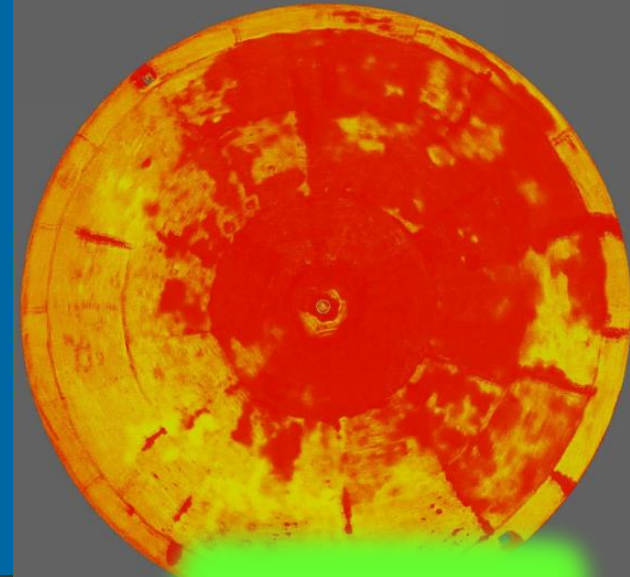
- Industry best practice to demonstrate water tightness
- Can be difficult and expensive to take reservoirs offline

Post upgrade



- Consider utilising rainfall events
- Hatch mounted fans assist drying reservoir interior

Prior to upgrade



Online Leakage Testing

- Use of drones, boats & selfie sticks
- Experience required to differentiation between condensation and leakage
- Observations inform the 'Visual Assessment Guidelines'

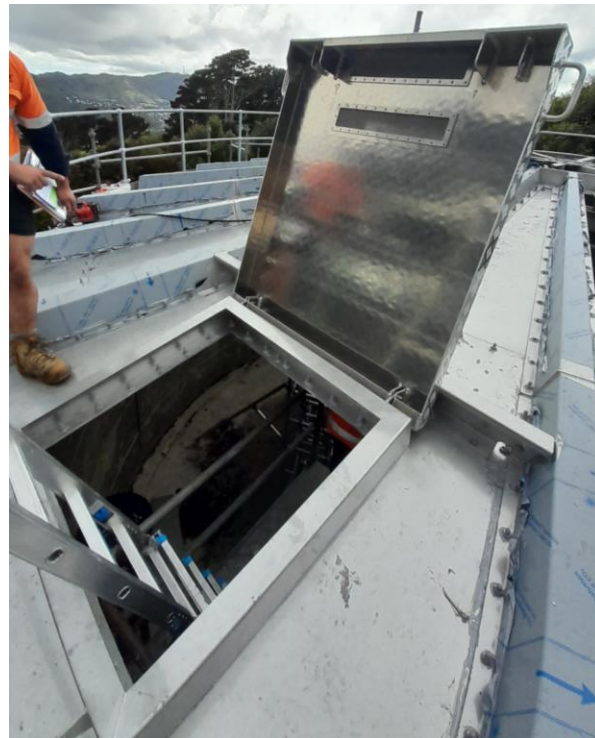
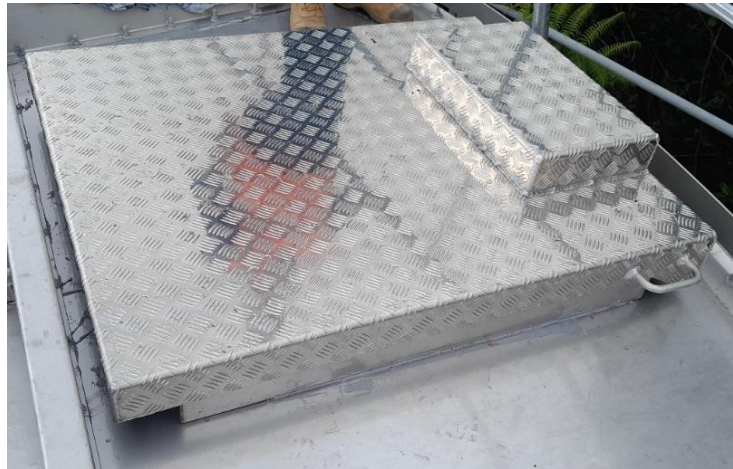


Remedial Program of Works

- Four-year \$14 million program of works covering 6 different client councils.
- Juno Civil Ltd allocated as the contractor under Wellington Water's contractor.
- All work on above ground reservoirs designed to be completed without taking the tank offline
- Economies of scale providing design optimisation and delivery efficiencies.

Hatch & Hatch nib Replacement

- Hatch Design
- Protected Hinges and locks
- Rubber seal to prevent vermin entry
- Robust construction to prevent vandalism
- Lightweight lid for ease of lifting
- Integrated air venting
- Methodology to undertake replacement while reservoir is online



Online Hatch nib replacement

Air vents & Overflow pipes– Rodent protection

- Warm blooded animals – Very High risk
- Insects – lower risk
- Venting capacity requirements need to be considered when using flap gate valves on overflow pipes

Air Vent Mesh installation



Internal Overflow pipe



External overflow pipe flap gate valve

Membranes – Physical vs Epoxy



Physical membranes

More expensive.

Longer design life, more durable with less maintenance

Epoxy Membranes:

Effective solution for roof surfaces with minimal thermal movement and few construction joints.

Decay quickly with roof ponding

Sealant Replacements

- Replace all sealants – future asset management
- Pay extra attention to sealants covering critical post tensioning elements.
- Consider the security of sealants with direct access to the water supply beneath



Structural Durability Repairs



- Specification of staircases and security upgrades that are robust, vandal proof and earthquake resilient.



Staircase and Handrail installation

- Undertake preventative structural durability repairs before they compromise the structural integrity.

Predictive Maintenance & Whole of Life Asset Management

End Of Asset Life

	Material selection	Design Life	Condition Score	Remain Design Life	Replacement Year	Estimate of Cost	0 to 5 years					6 to 20 years															20+ years					
							2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043			
PLANNED INSPECTIONS/ASSESSMENTS							\$4,600	\$4,600	\$4,600	\$4,600	\$34,600	\$4,600	\$4,600	\$4,600	\$4,600	\$14,600	\$4,600	\$4,600	\$4,600	\$4,600	\$34,600	\$4,600	\$4,600	\$4,600	\$4,600	\$4,600	\$4,600	\$4,600	\$14,600	\$4,600	\$4,600	\$4,600
monthly, external, general inspections						\$3,000	\$3,000	\$3,000	\$3,000	\$3,000	\$3,000	\$3,000	\$3,000	\$3,000	\$3,000	\$3,000	\$3,000	\$3,000	\$3,000	\$3,000	\$3,000	\$3,000	\$3,000	\$3,000	\$3,000	\$3,000	\$3,000	\$3,000				
annual, external, general inspections						\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000				
5 yearly, offline, ROV Drone																																
5 yearly, Engineering Condition and Re-assessment																																
10 yearly, offline, internal cleanout, Engineering																																
RESERVOIR - STRUCTURE							\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0			
Roof	concrete	100	2	65	2086																											
walls	concrete	100	2	65	2086																											
columns	concrete	100	2	65	2086																											
floor slab	concrete	100	2	65	2086																											
2 Roof surface - membrane	membrane	50	2	26	2047	\$31,400																										
2 External Roof joints / bandages	sealant	25	2	18.25	2037	\$15,000																										
2 Internal Wall joints / bandages	sealant	0		0	0	0																										
2 Internal Floor joints / bandages	sealant	0		0	0	0																										
RESERVOIR - ANCILLARY							\$0	\$0	\$0	\$0	\$3,000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$700	\$0	\$0		
3 Air vent	steel	50	3	20	2041	\$700																										
2 Hatch lid	steel	50	2	32.5	2054	\$30,000																										
2 Hatch upstand nib	concrete	50	2	32.5	2054	\$7,000																										
1 Roof handrails	aluminium	50	1	45	2066	\$15,700																										
2 External vertical access ladder / steel	steel	50	2	32.5	2054	\$3,000																										
3 Overflow vermin barrier	steel	15	3	4	20	\$3,000																										
2 Internal vertical access ladder / steel	steel	20	3	20	2011	\$3,000																										

Conclusion & Key points

- Condition assessment provides visibility of asset condition to ensure intervention can be undertaken prior to failure.
- Consider investing in a digital workflow for sizable condition assessments or data capture exercises.
- Site inspection specifications with photographic examples are a great tool to inform visual assessments.
- Assessment and remediation at scale provides better outcomes and consistency.
- Water tightness testing underpins the contamination resilience of reservoirs. The cost of testing should be balanced against the cost of a remediation. Prioritise testing on larger tanks and those you are unfamiliar with.
- Many contamination improvements can be implemented cheaply and will mitigate some of the most significant risks (mesh installation, sealant replacement, flap gate valves, epoxy membranes)
- Do not underestimate the operational effort and cost to take tanks offline.
- Consider 'whole of life' maintenance and upgrade requirements when specifying upgrades. Consider when the next drain down is likely to occur.
- Consultant collaboration draws on the strengths of both organisations.

Acknowledgements & References & Questions:

- Wellington Water – John Scott, Rob Blakemore, Paul Winstanley
- WSP & Beca design teams
- EPA presentation; 'Understanding the significance of breaches to and sediment buildup in finished drinking water storage tanks' – Bob Clement, 2019

