Developing a Corrosion Strategy to Protect New Zealand's Largest Wastewater Asset – the Central Interceptor

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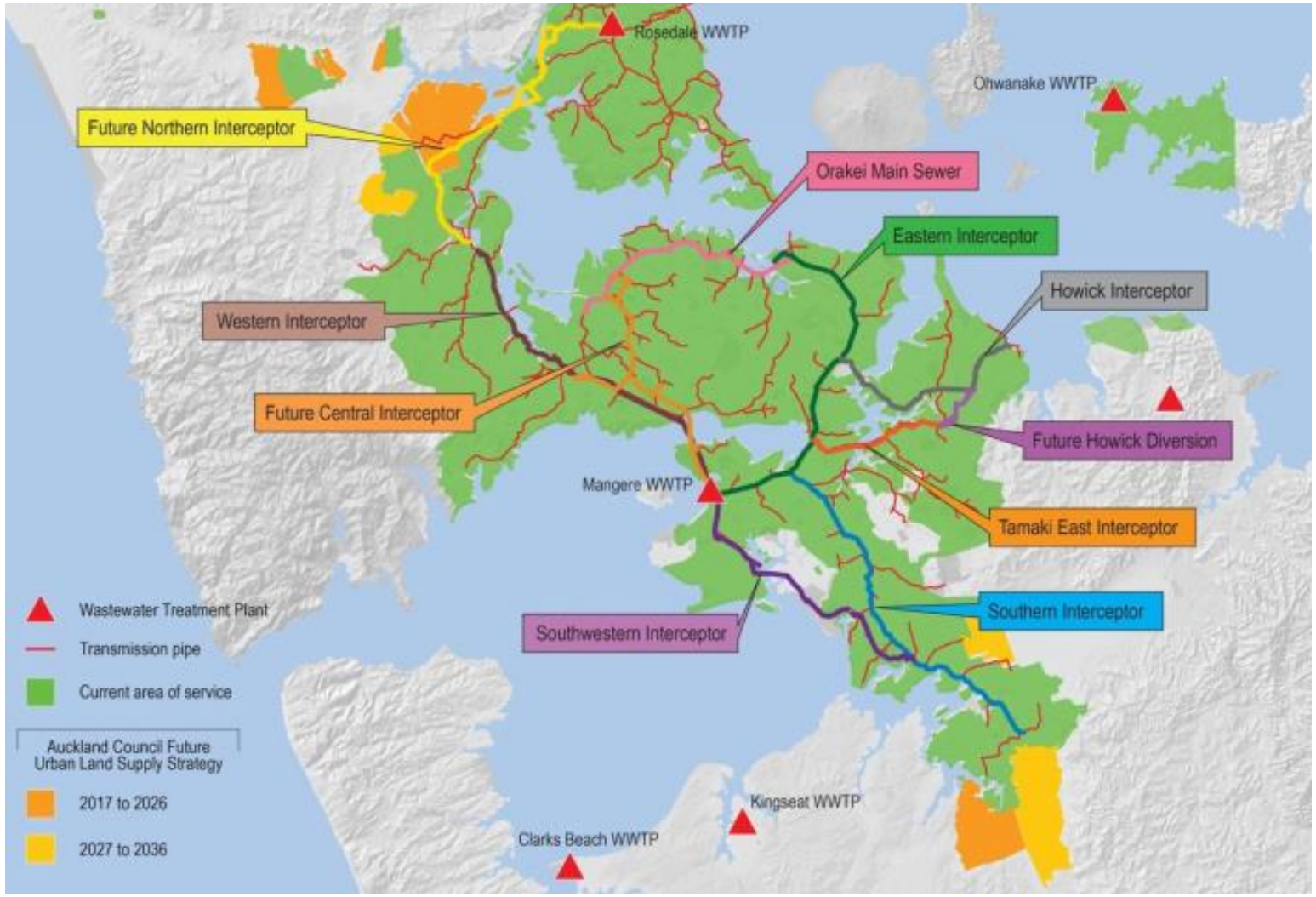
Presentation Outline

- Project Overview
- Corrosion
  - Mechanism
  - Modelling/Sampling
  - Material Testing Programme
- Relevance to CI
  - Predicted Corrosion Rates
  - Available Solutions
- Solutions
  - Strategy: hydraulics/ventilation/odour management, material selection,
  - Material Selection
  - Quality/Monitoring/Maintenance
- Lessons Learned

Central Interceptor Project



Central Interceptor Project

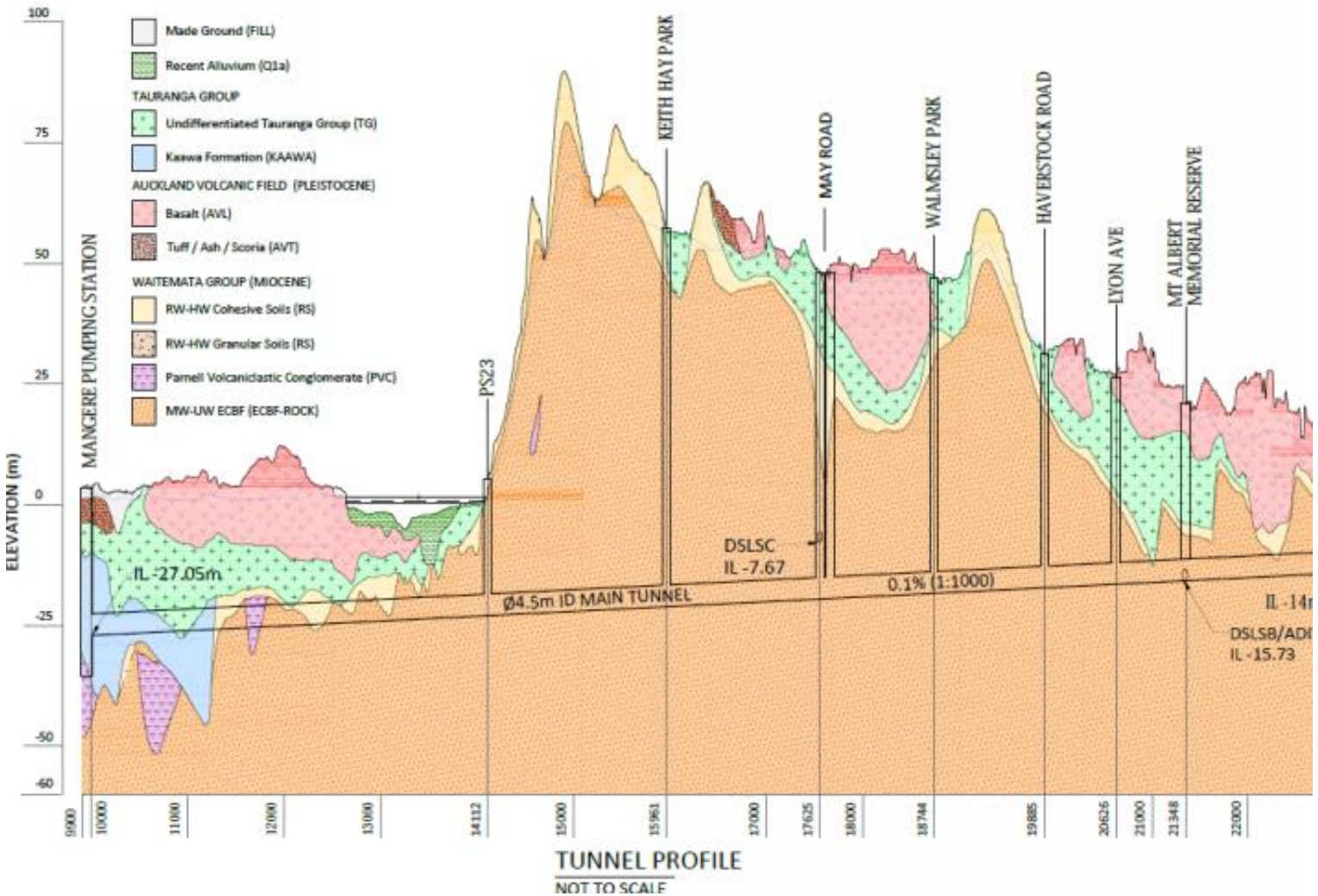
- 4.5m ID, 13 km long main tunnel
- 2.4m ID, 1.1 km long link sewer
- 2.1m ID, 3.2 km long link sewer
- 16 shafts, up to 78 m deep, 10 m dia

- 110 m at its deepest point
- 15 m below Manukau Harbour seabed

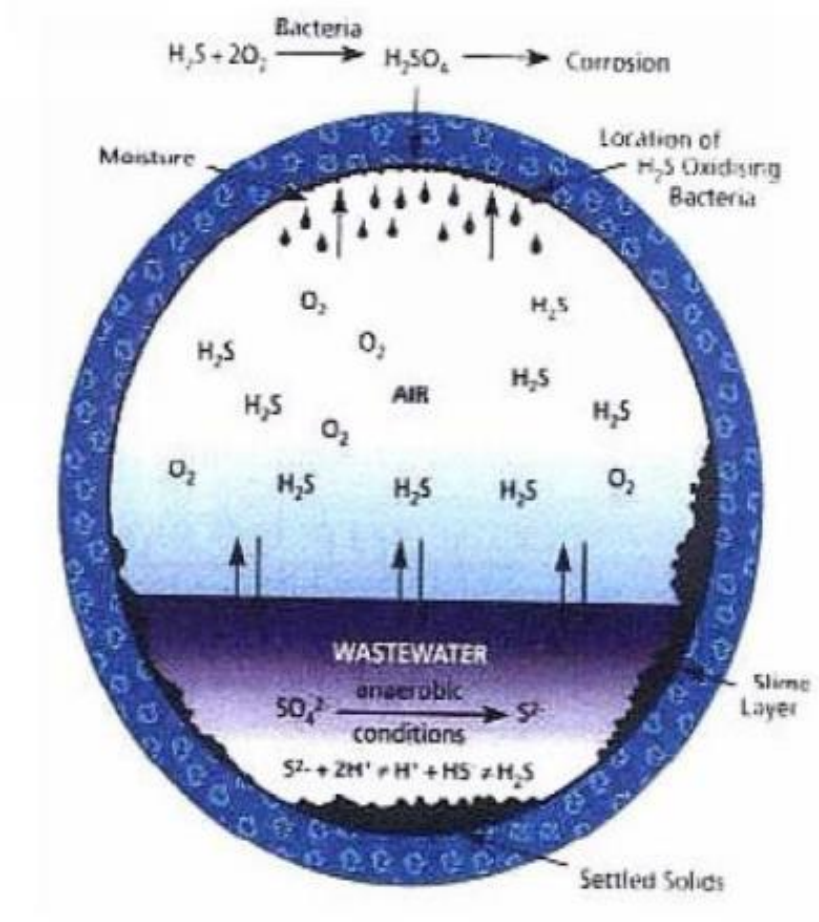
- 200,000 m^3 of storage capacity
- The pump station at Mangere will lift up to 6 m^3/s storm flow into the plant

Project challenges

- Large scale linear project – many sites
- Long design life - 100 year asset life
- Difficult to access – shafts up to 4km apart
- Challenging surface geology drives the tunnel deep under the ground



Sewer Corrosion



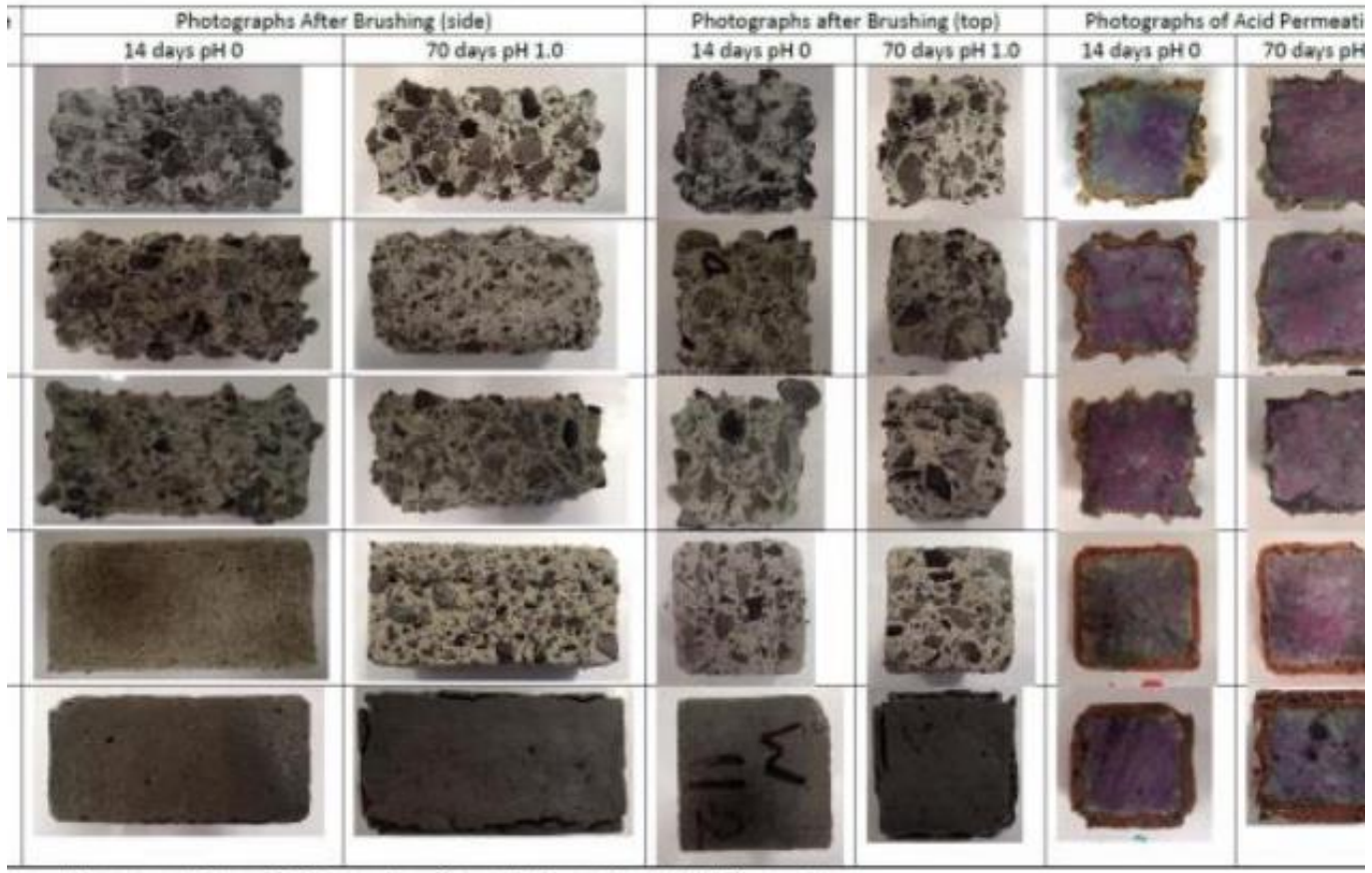
Modelling and Sampling for Corrosion Prediction

- Sewage sampling and characterisation (March 2015 to May 2016)
  - 3 campaigns, including seasonal variation
  - Baseline field coupon testing

- Sulphide generation and corrosion modelling
  - Gas and liquid phase characterisations
  - Variable design parameters:
    - Sewage characteristics (As Sampled vs. Normal),
    - Method of analysis (USEPA and SCORe methods),
    - Seasonal effect (summer vs. winter),
    - Ventilation efficiency (for benefits of forced ventilation accounting for when system is shut down and for reduced efficiency at distant points), and
    - Factor of safety (considering criticality of each section, climate change, and uncertainty of relative humidity)

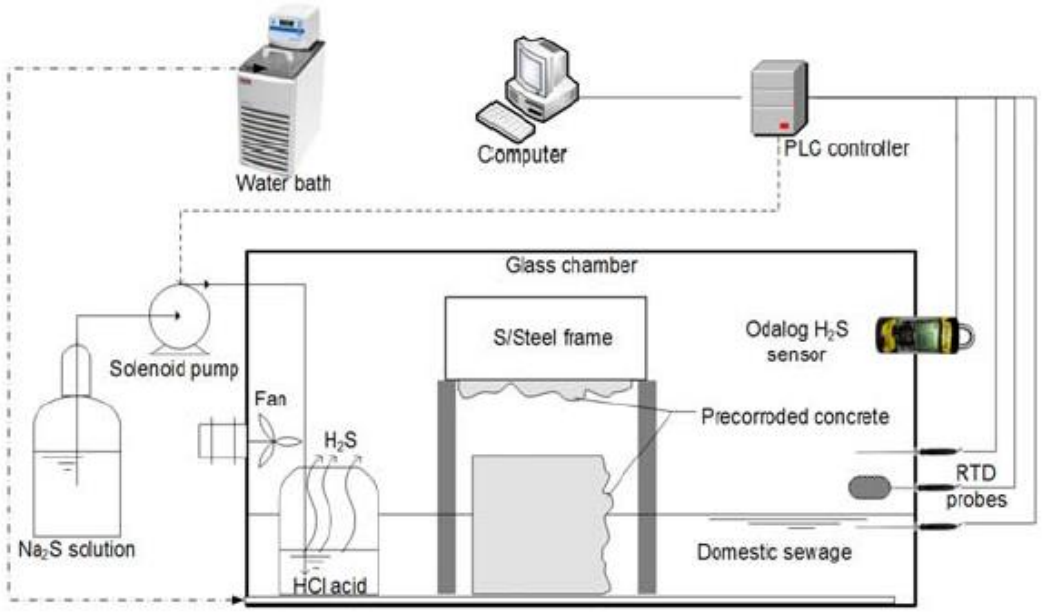
Material Testing Programme

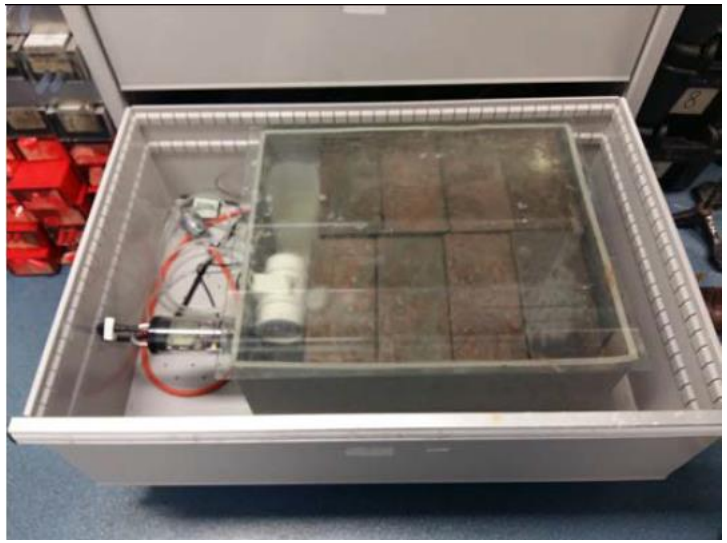
- Desktop study of potential suppliers of ARC material
- Material coupon exposure to the in-situ environment
- Request for Information for the supply of ARC for linings
- Independent laboratory testing study on pre-qualified suppliers
  - Physical tests (WSP Opus)
  - Acid bath tests (University Sydney)
  - Biogenic chamber tests (University of Queensland)
- Assessment of approved suppliers
  - 4 tested (plus control)
  - 2 approved

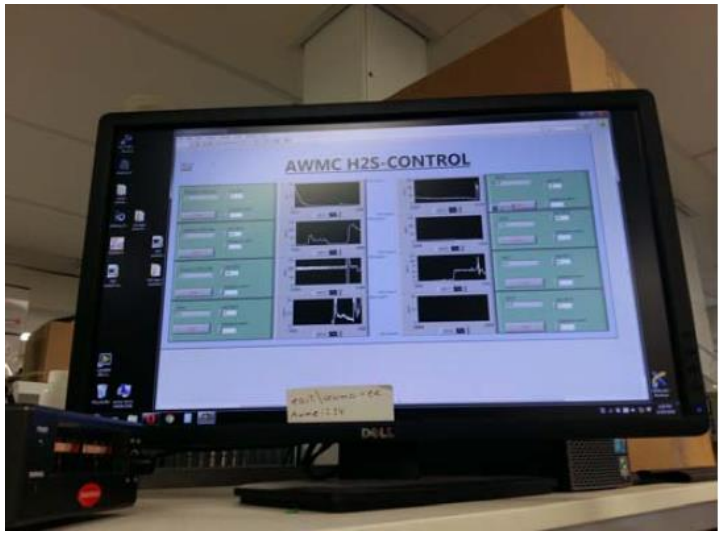


igure 1 Summary of Example Photographs of Corroded Concretes and Acid Permeation

Biogenic Testing

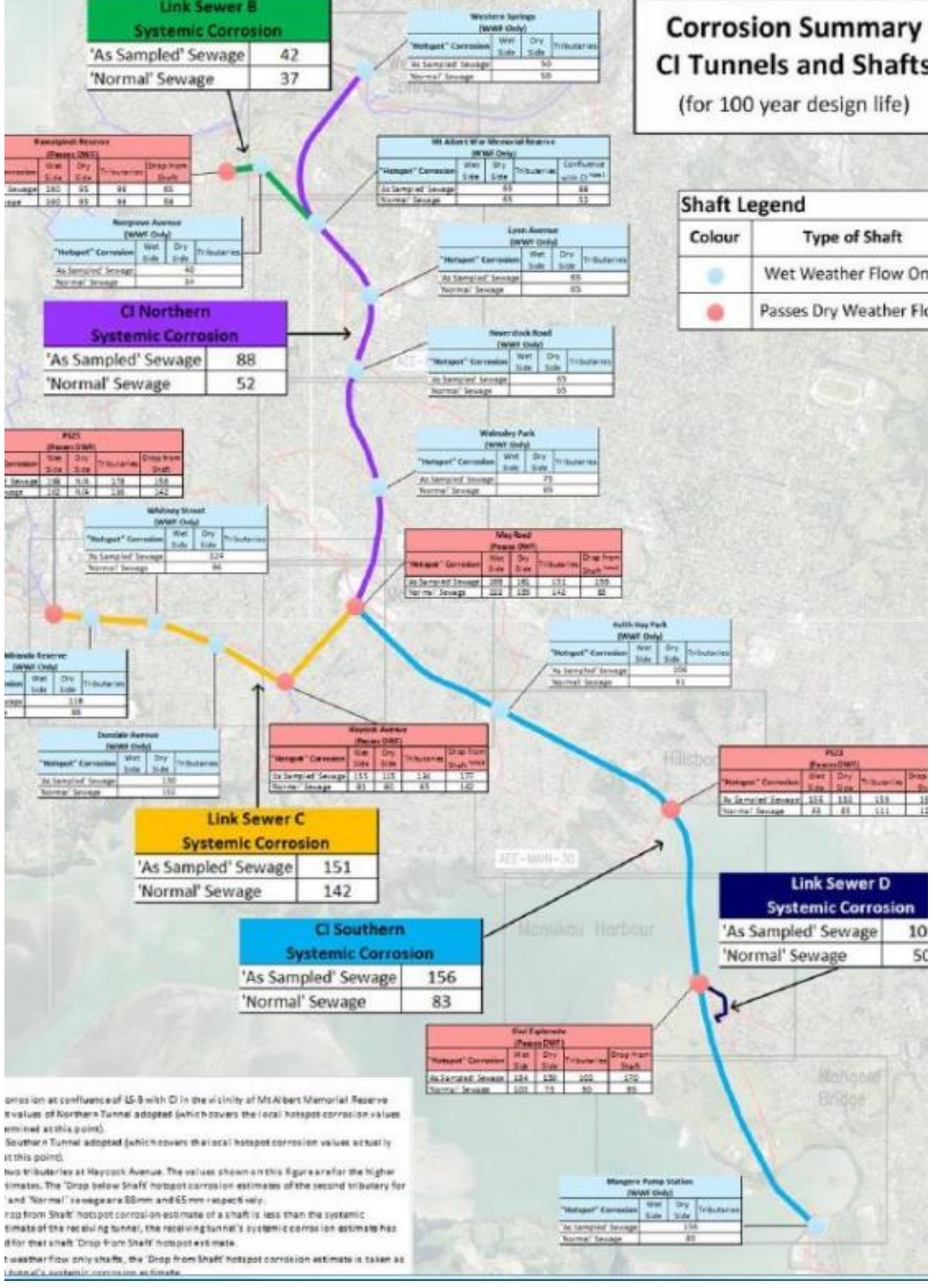






Predicted corrosion over 100 year design life

- 42 to 156 mm generally
- 50 to 268 mm at hot spots (areas of localised turbulence)
- 88 and 156 mm for northern and southern tunnel sections



Corrosion Protection Solutions

Need for robust solution due to lack of accessibility

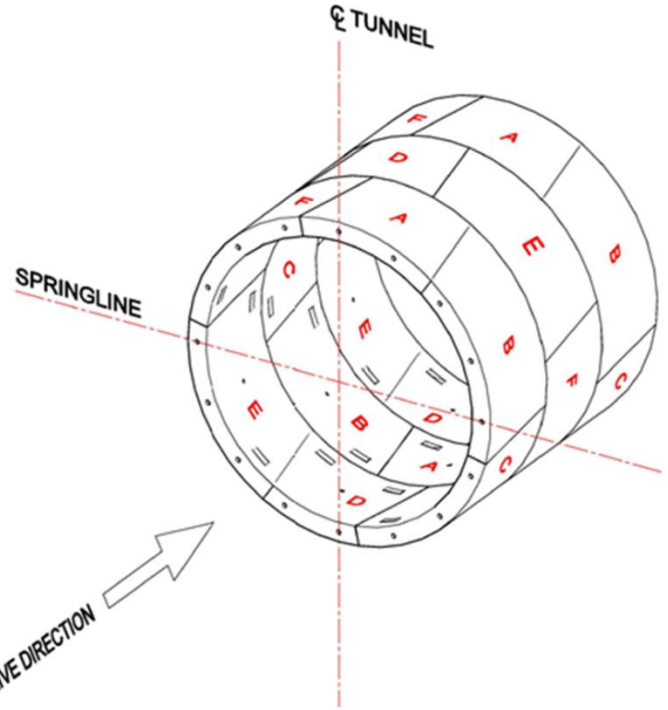
- Hydraulic design: vortex and cascade drops to minimise air entrainment
- Ventilation: forced ventilation (exhausting and treatment of air from sewer air space) to reduce H2S gas concentrations
- Odour management: only exhausting at shafts with air treatment facilities
- Options: OPC, ARC, HDPE, GRP, stainless steel, hybrid solution

Material Selection for Corrosion Protection

- Materials to meet 100-year design life must first meet structural requirements, then durability requirements:
  - Sacrificial material
  - Corrosion resistant material
  - Corrosion protection membrane
- One-pass vs. two-pass systems
- Different materials for different elements
  - Portland cement concrete, polycrete, geopolymer concrete, GRP, HDPE

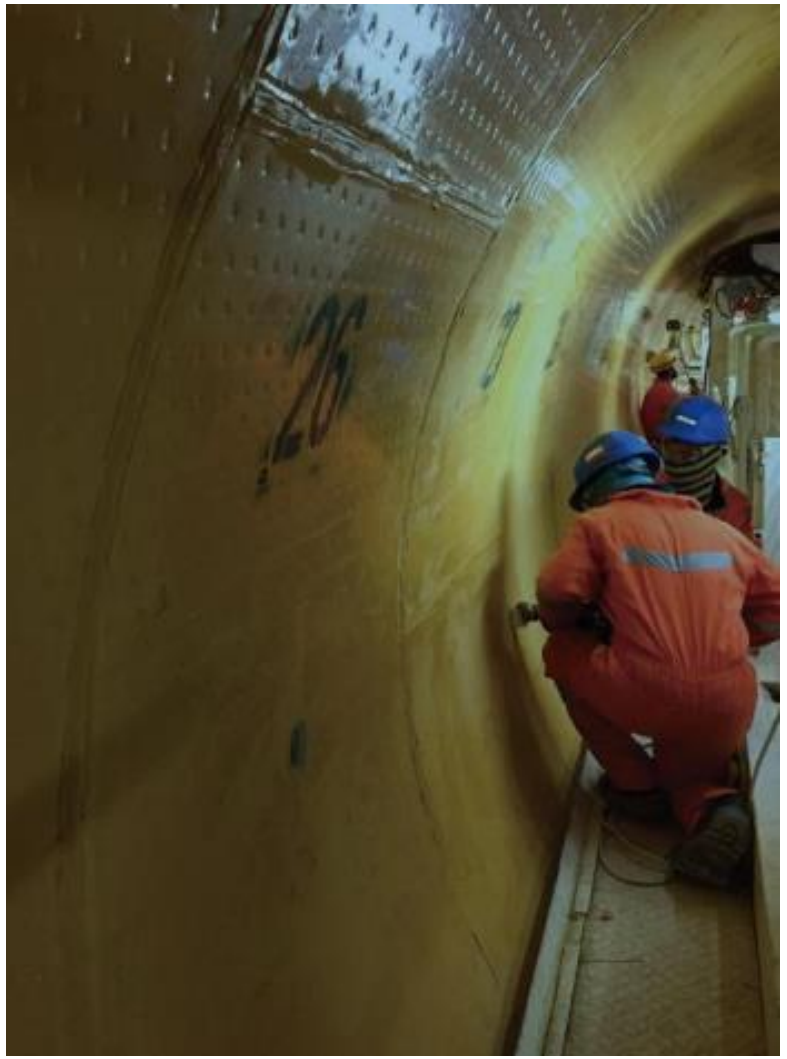
What is a segmental tunnel lining?

A ring of concrete segments that the TBM will launch off to sequentially build the lining



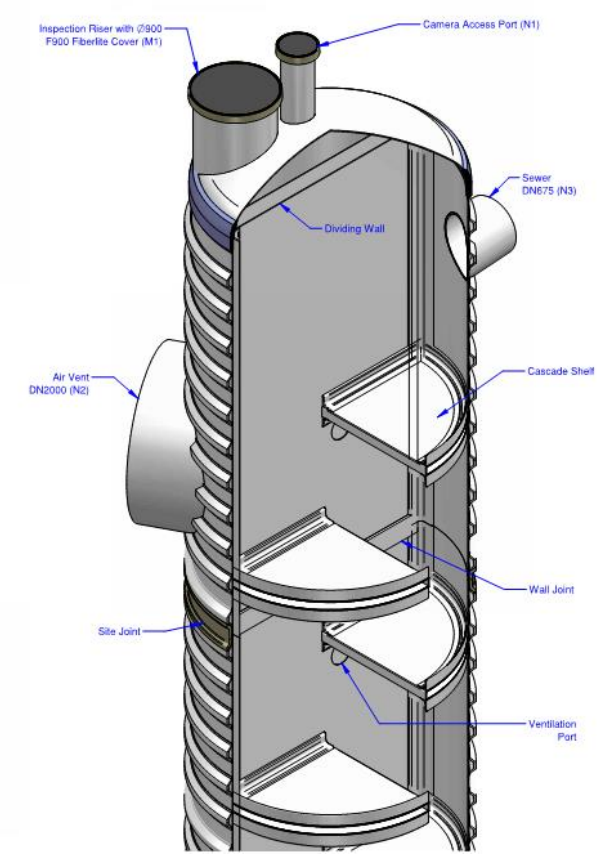
Material Selection for Tunnel Lining

- One-pass system
  - Precast concrete (OPC) +
  - Corrosion protection lining (HDPE) +
  - 50-year sacrificial thickness
- Upcoming challenges:
  - Drainage (8.7 bar)
  - Quality



Material Selection for Shafts

- 16 shafts total
- Diameters from 3 m to 10.8 m
- Depths from 12 m to 78 m
- Variable construction methods
- Variable predicted corrosion rates



Material Selection for Shafts

- Small diameter: GRP
- Corrosion rates sufficiently low: OPC
- High corrosion rates: ARC

Quality, Monitoring and Maintenance

Quality

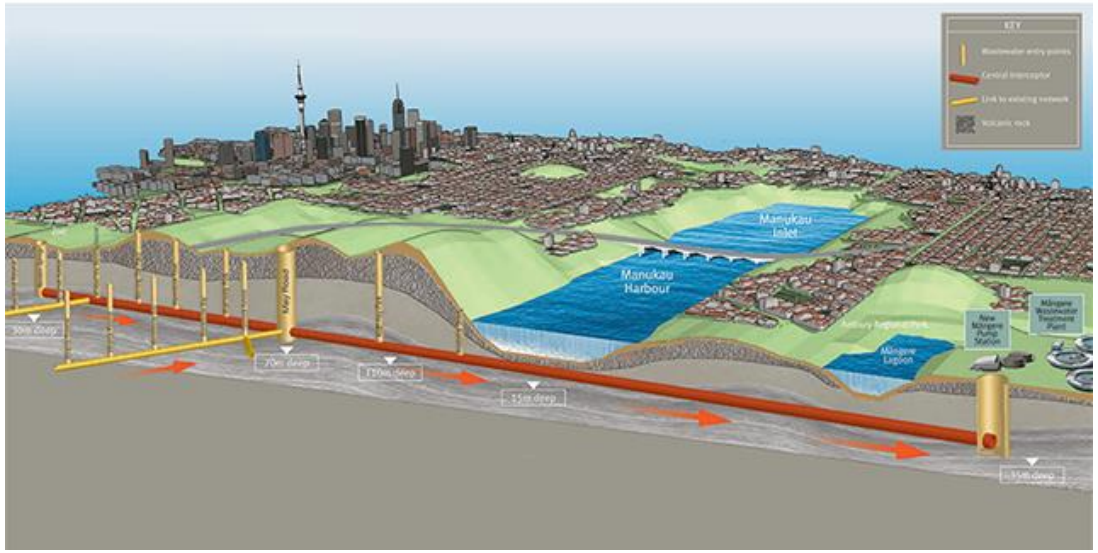
- Testing and inspection plans
- Material submittals
- Method statements
  - Welding of seams
  - Patch repair methods
  - Insert capping

Monitoring and Maintenance

- CCTV port in shaft roof slab
- Man cage access via shafts
- Clear PE membrane?
- Warning layer?
- Fibre optics?
- Lining deterioration pins?

Lessons Learned

- Project scale and risk mandates a robust solution
- Current material testing is not application specific
- Supply to NZ and economies of scale need to be considered
- Preferred technical solution not always commercially viable
- Project timeline matters
- Get the experts
- Learn from other projects



Conclusion

- Multi-prong approach
- Hydraulic and ventilation considerations
- Actual sewer concentrations considered
- International expertise and experiences
- Technical and commercial factors

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