LESSONS LEARNT FROM RETROFITTING EXISTING WASTEWATER CATCHMENTS WITH VACUUM SEWER SYSTEMS POST-EARTHQUAKE

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Beca. Creative people striving together to transform our world

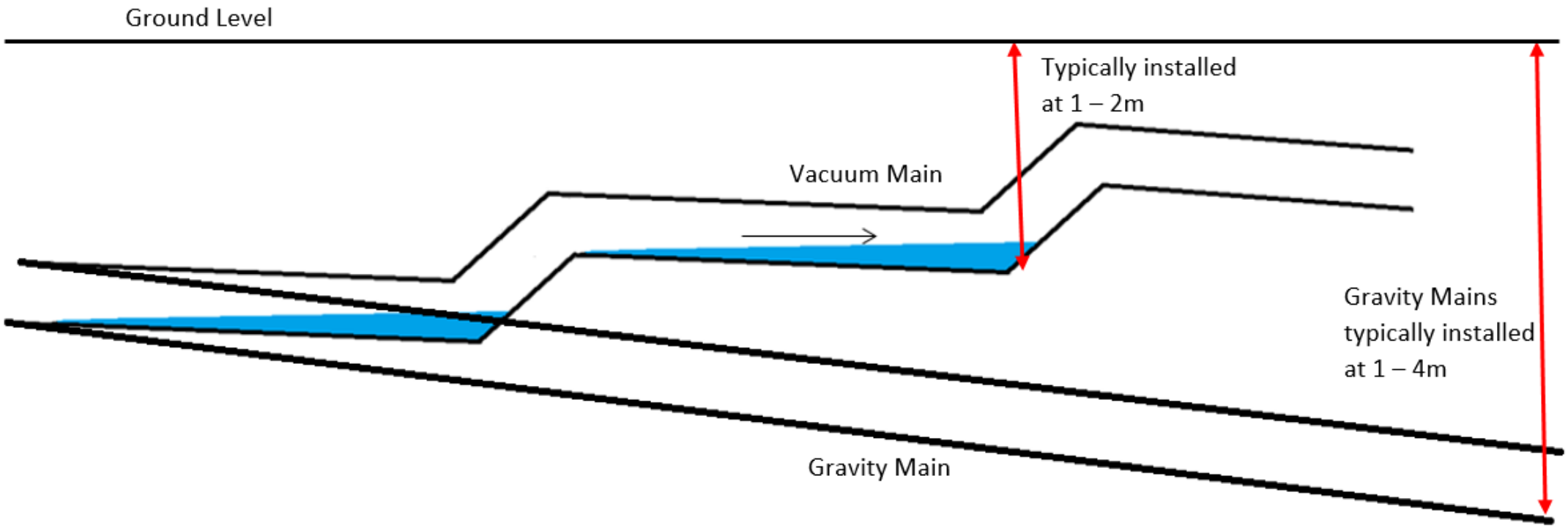
Agenda

- Introduction
- How a Vacuum Sewer System Works (VSS)
- Why Vacuum Sewer Systems were Considered
- Challenges and Lessons Learnt
- Conclusion
- Questions

Introduction

- The Stronger Christchurch Infrastructure Rebuild Team (SCIRT)
- Three Clients:
  - Christchurch City Council (CCC)
  - The New Zealand Transport Authority (NZTA)
  - Canterbury Earthquake Recovery Authority (CERA)
- Five head contractors:
  - City Care
  - Fulton Hogan
  - Downers
  - Fletchers and
  - MacDow

Why Vacuum Sewer Systems

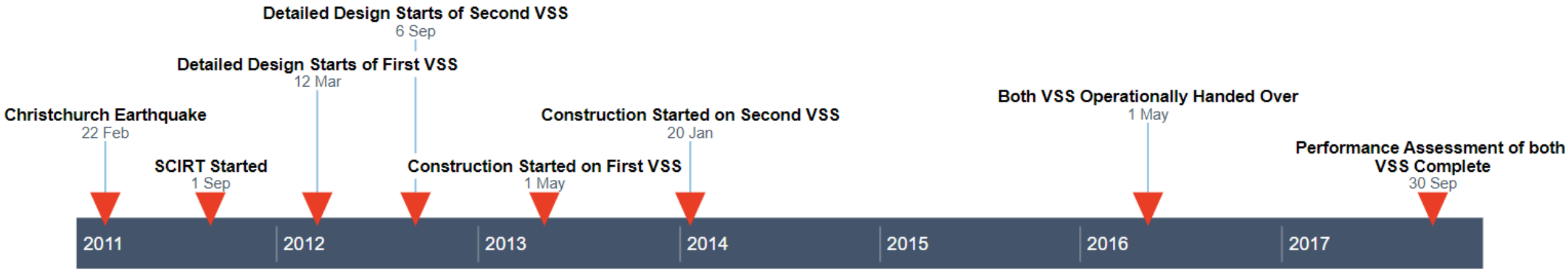


Vacuum Main and Gravity Main Cross
Long Section Comparison

VSS Experience in NZ

- One VSS in NZ prior to the earthquake
- Limited NZ experience
- Christchurch City Council had no experience in VSS
- No known experience in a retrofit situation

SCIRT VSS Timeframes



VSS Catchment Overview

- 700 dwell
some large
commercial
- Max. flow
- 200 colle
chamber

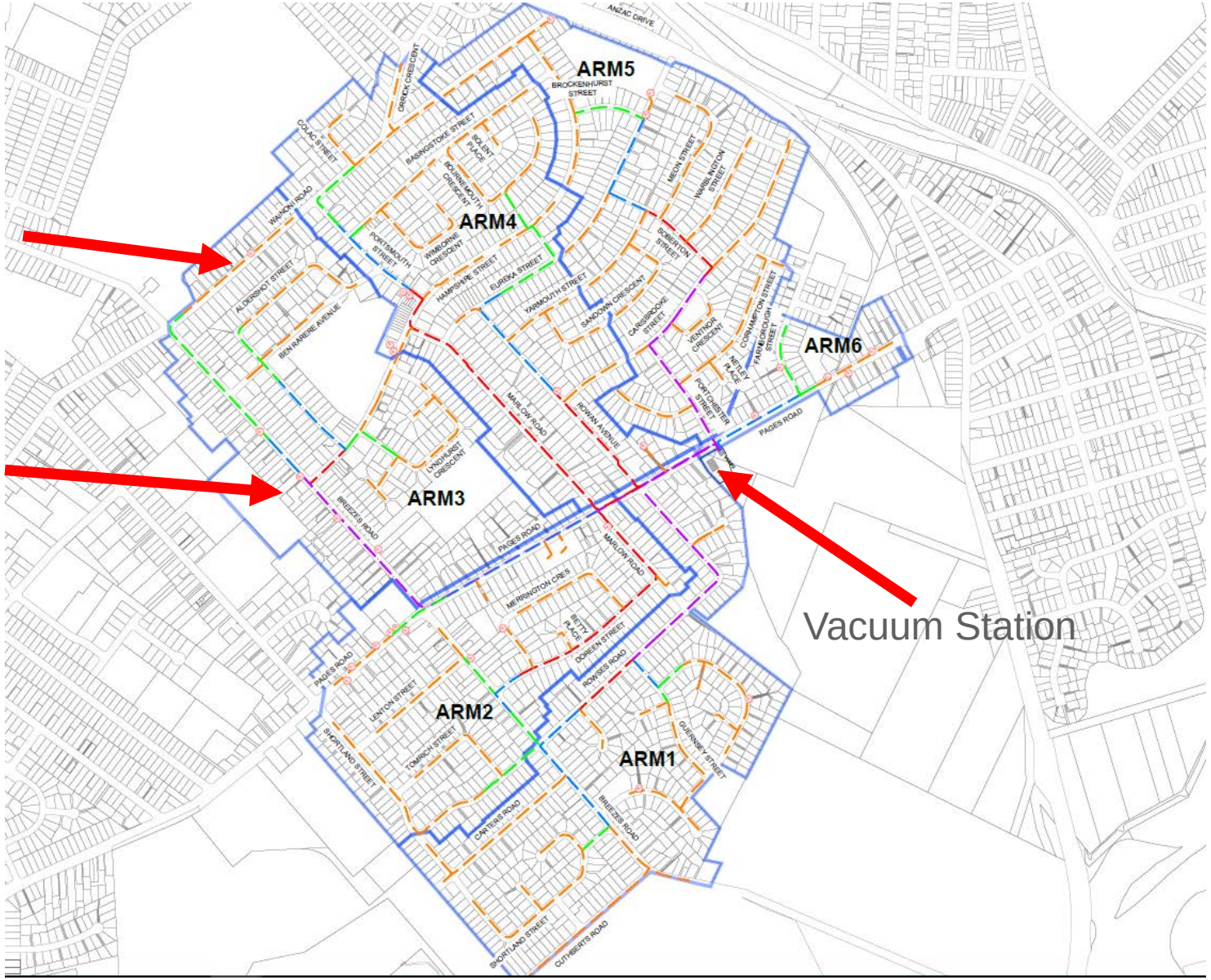
wellings
all
s of
rcial lots
w of 120

800
on
rs

How a Vacuum Sewer System Works

Vacuum Mains

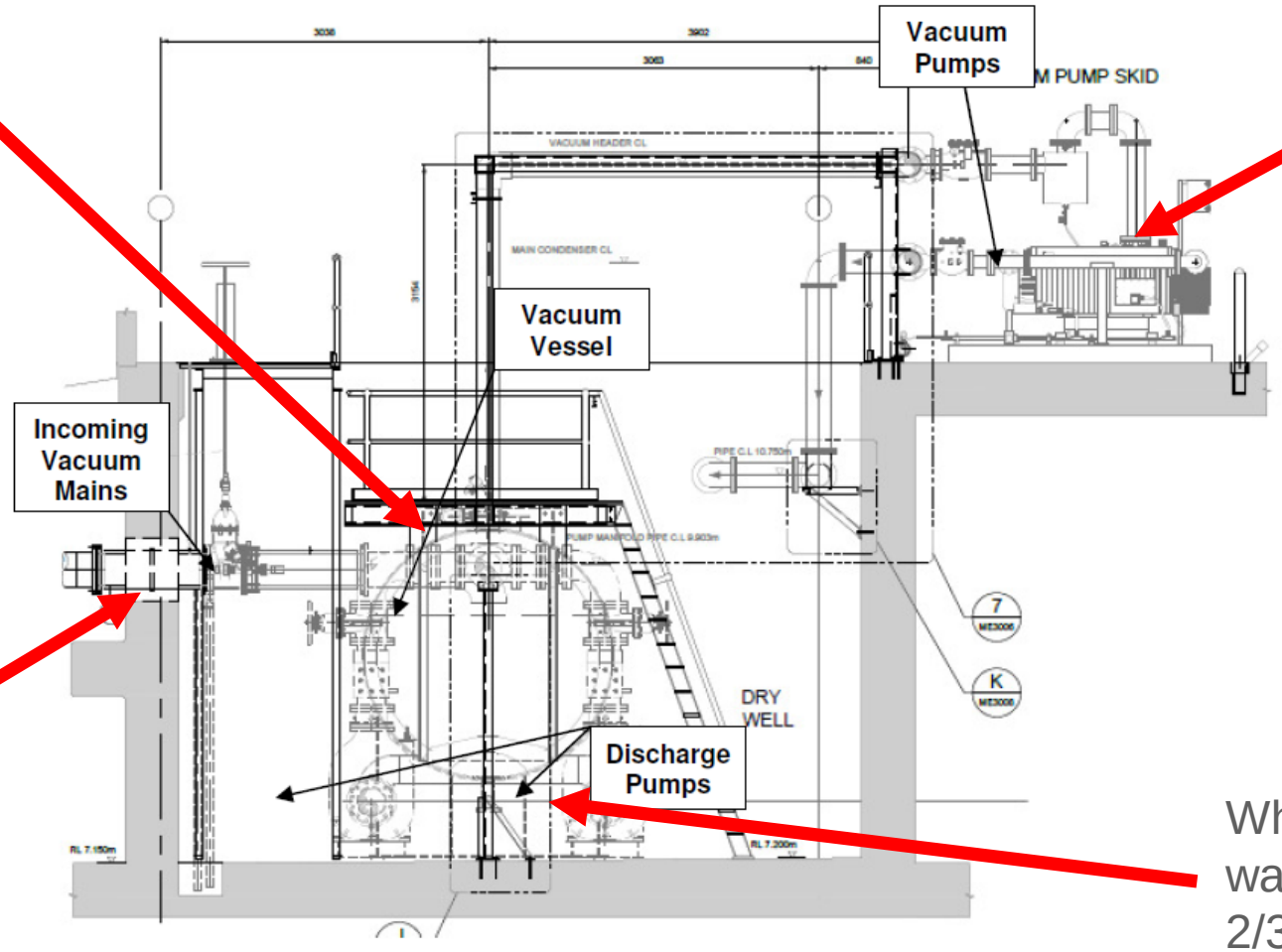
Collection Chambers



Vacuum Station

How a Vacuum Sewer System Works

Vacuum pressure in vacuum vessel and pipework



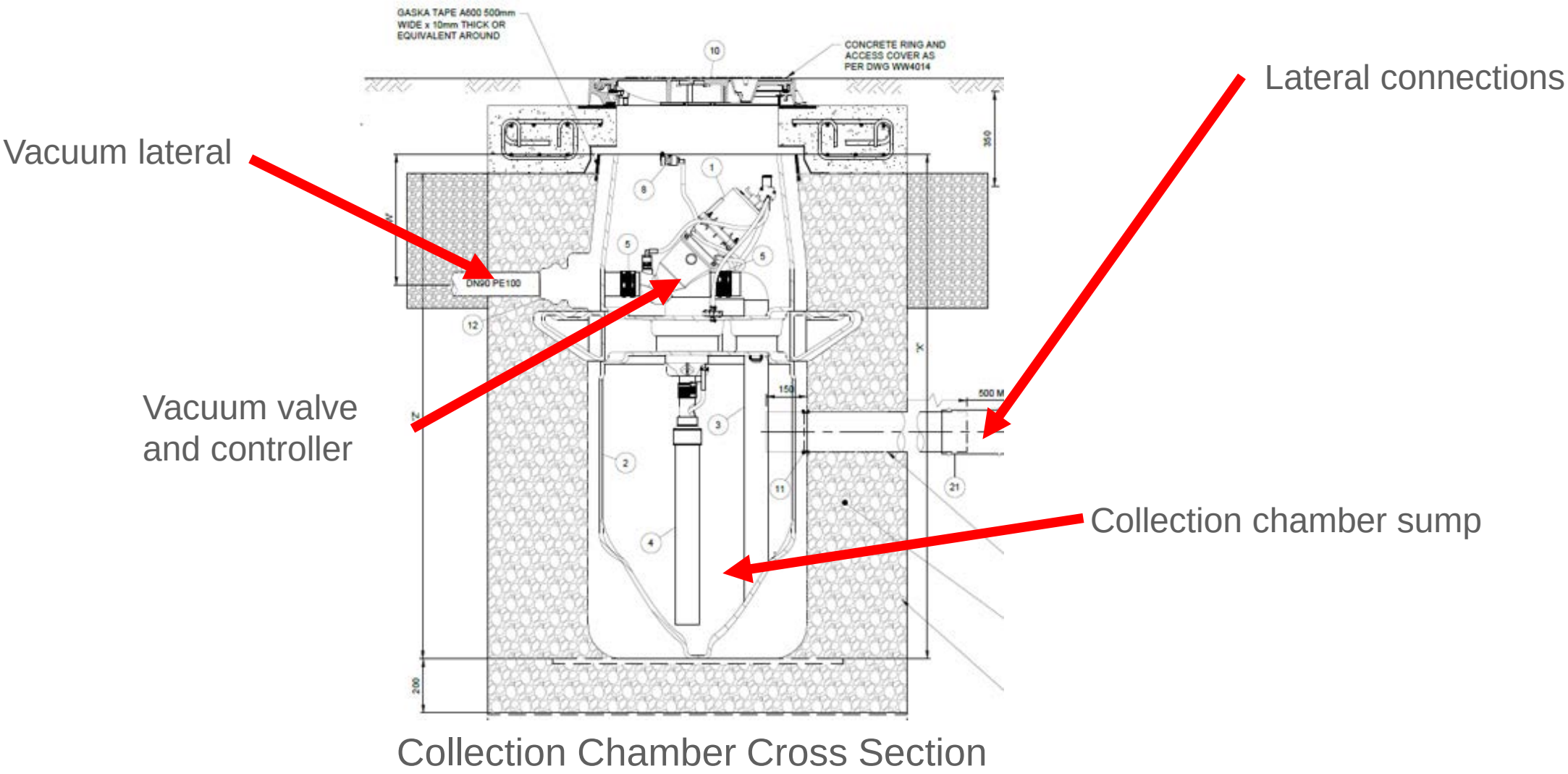
Vacuum pumps generate vacuum

Wastewater and air enter the vacuum vessel

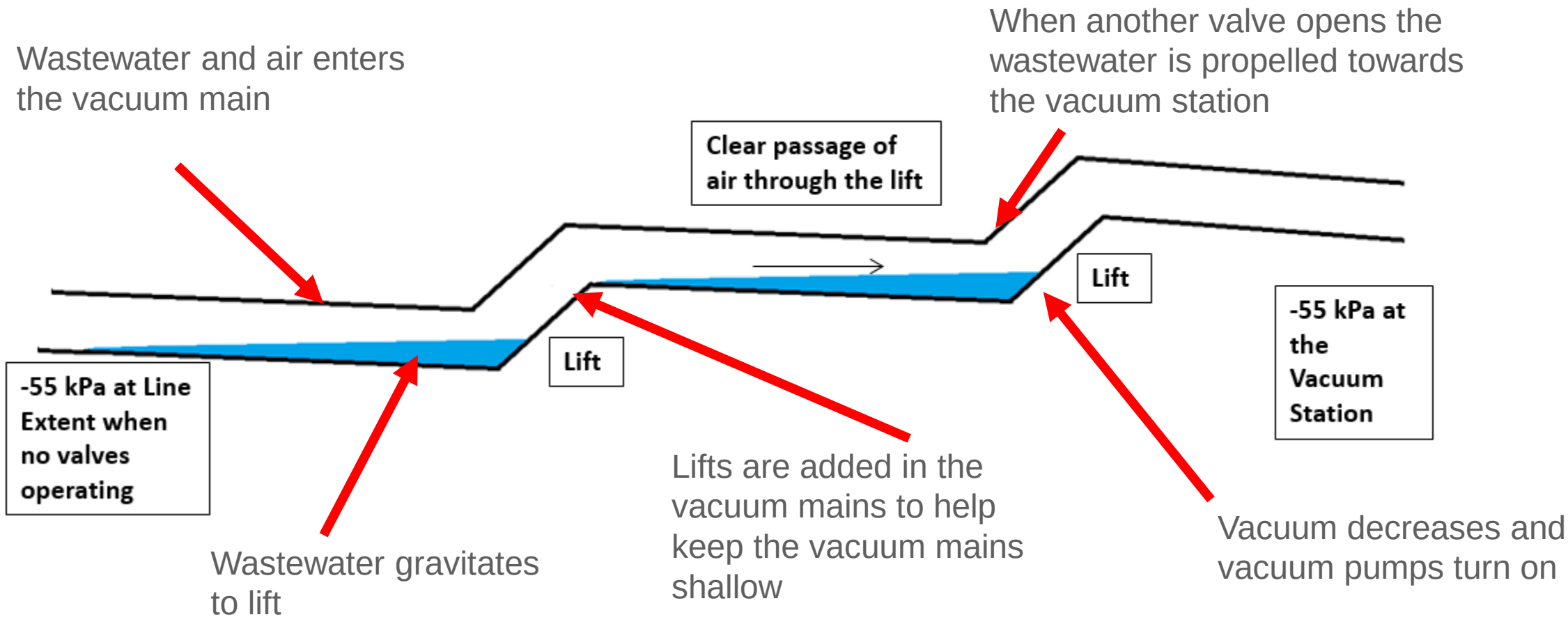
When the wastewater reaches 2/3 full the discharge pumps turn on

Vacuum Station Cross Section

How a Vacuum Sewer System Works



How a Vacuum Sewer System Works



Vacuum Main Long Section

How a Vacuum Sewer System Works

Collection Chamber Installation

How a Vacuum Sewer System Works

Vacuum Lateral Connection to a Vacuum Main

How a Vacuum Sewer System Works

Vacuum Main and Lift Installation

VSS Standards

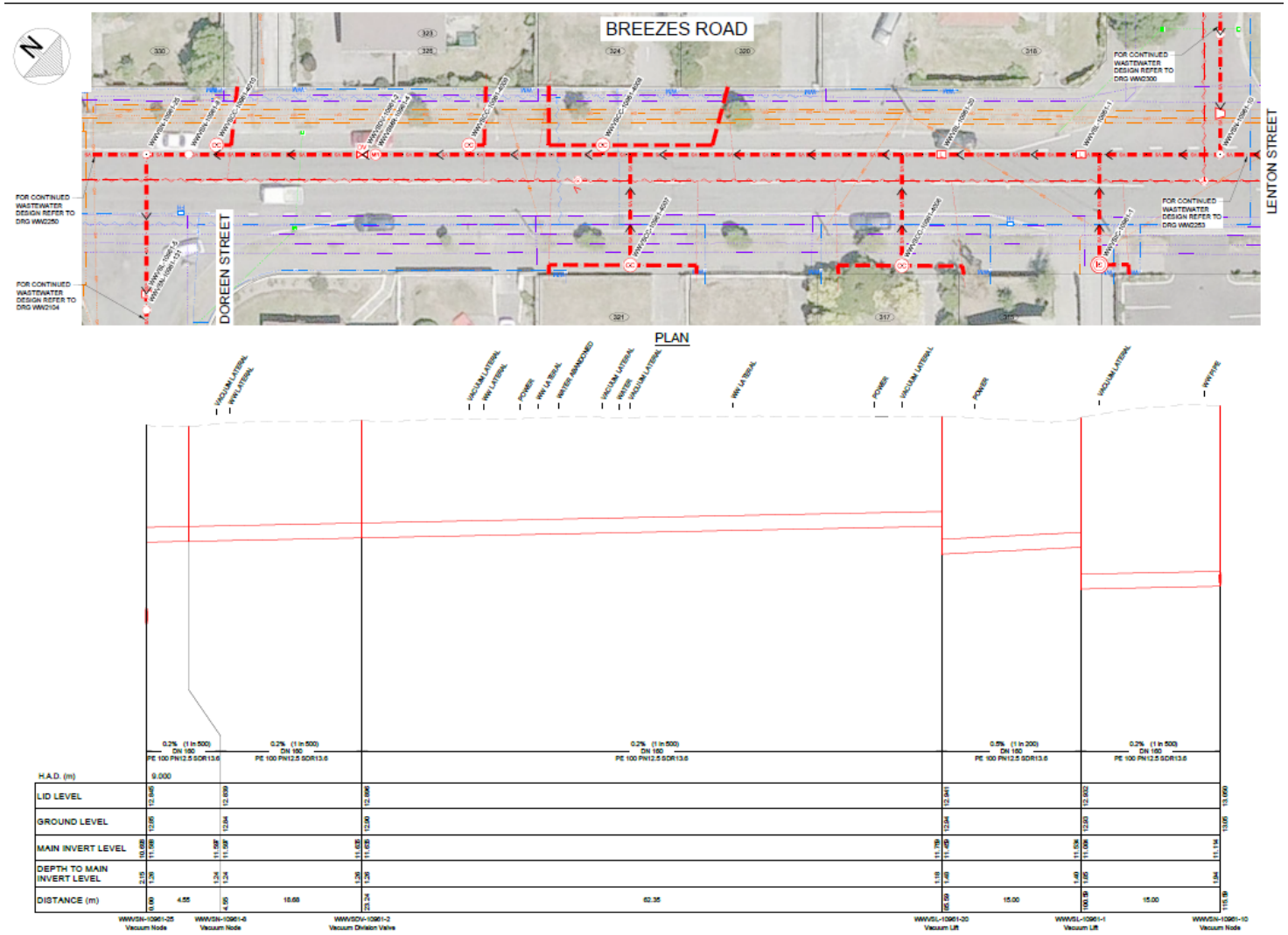
Both catchments were designed and constructed using the following standards:

- Water Services Association of Australia WSA-06, Vacuum Sewerage Code of Australia
- Airvac Design Manual
- Water Environment Federation (WEF), Alternative Sewer Systems
- Christchurch City Council (CCC) Infrastructure Design Standards (IDS) for flowrates
- Christchurch City Council (CCC) Construction Standard Specifications (CSS)
- Vacuum Sewer System supplier guidance

Challenges and Lessons Learnt

- Vacuum mains
- Collection chambers
- Existing Services
- Inflow and Infiltration
- Air to Liquid Ratio
- Automatic Air Admittance Systems
- Operation

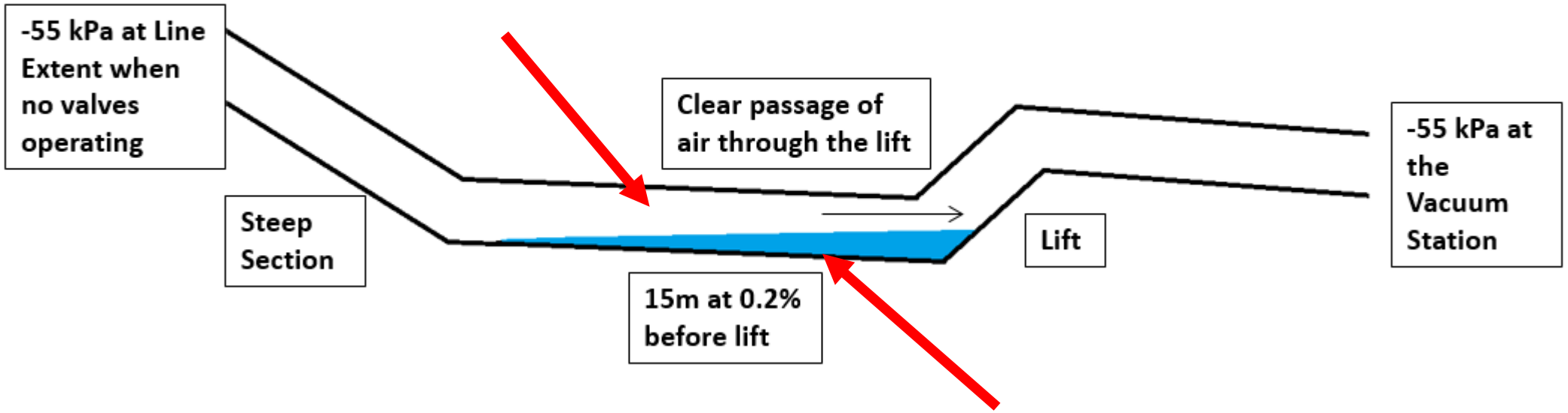
Vacuum Mains



Plan and Long Section of a Vacuum Main

Vacuum Mains

The air gap is critical to the systems performance



Vacuum Main Long Section

If the section of vacuum main is to steep before a lift the lift can become waterlogged

Collection Chambers

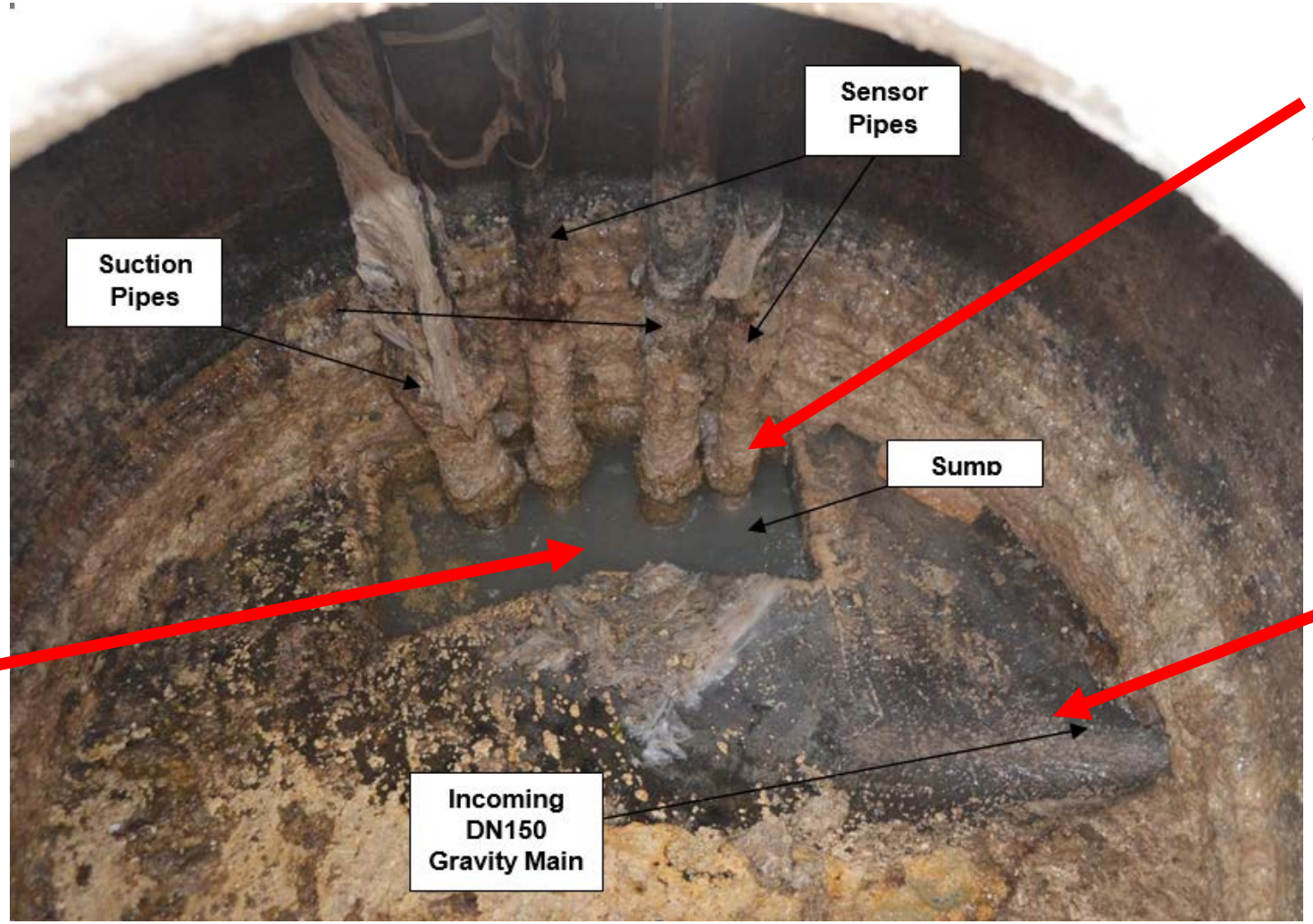
Collection Chamber Installation

Collection Chambers

Infiltration through ducting penetrations and over the top of the collection chamber

Collection Chamber and Vacuum Valve

Collection Chambers



Fat build up around the suction and sensor pipes

No isolation between sumps

No fall through incoming main

Bespoke Collection Chamber

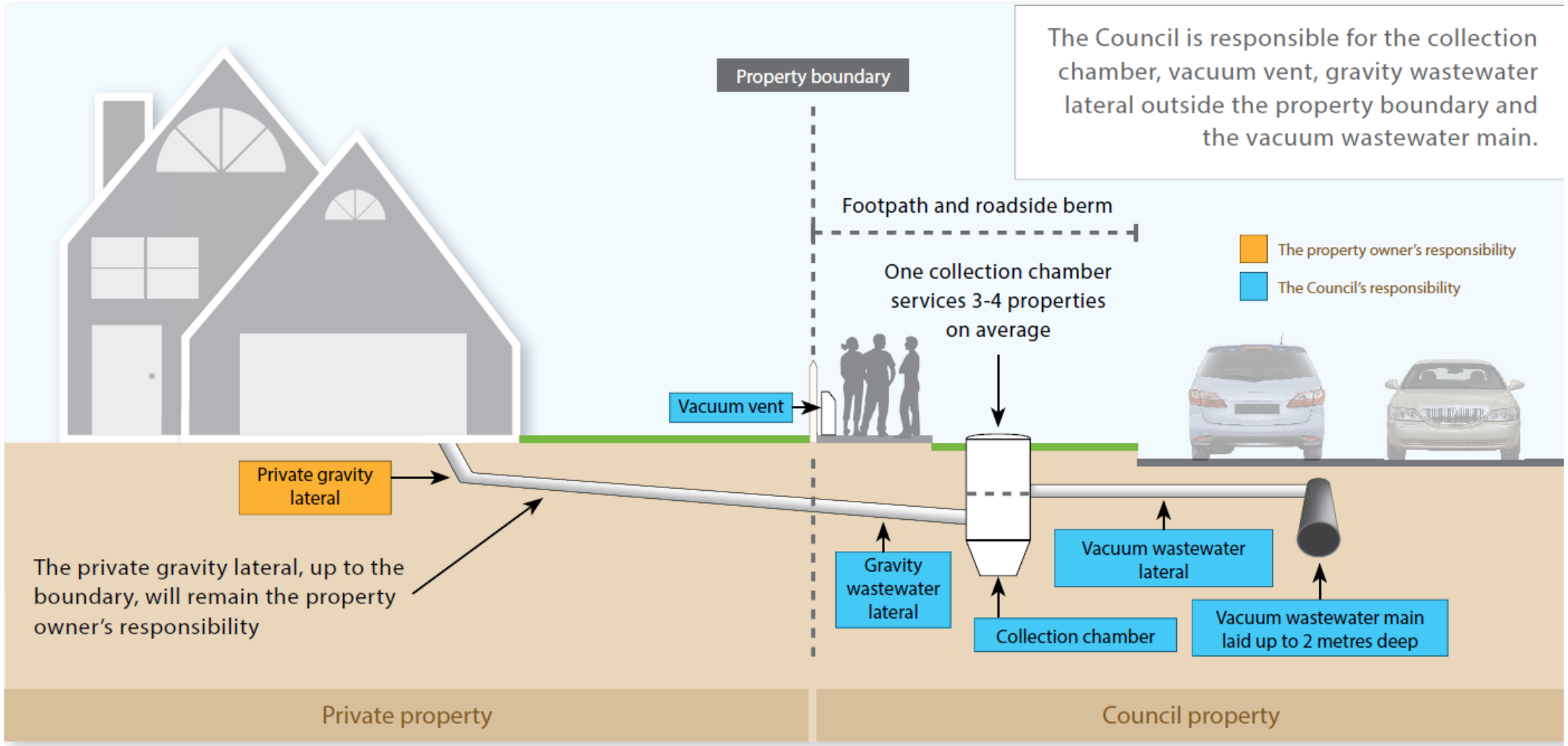
Existing Services

Vacuum Main Installation

Existing Services

Slot Trench in a Berm

Inflow and Infiltration



Long Section of Laterals, Collection Chamber and Vacuum Main

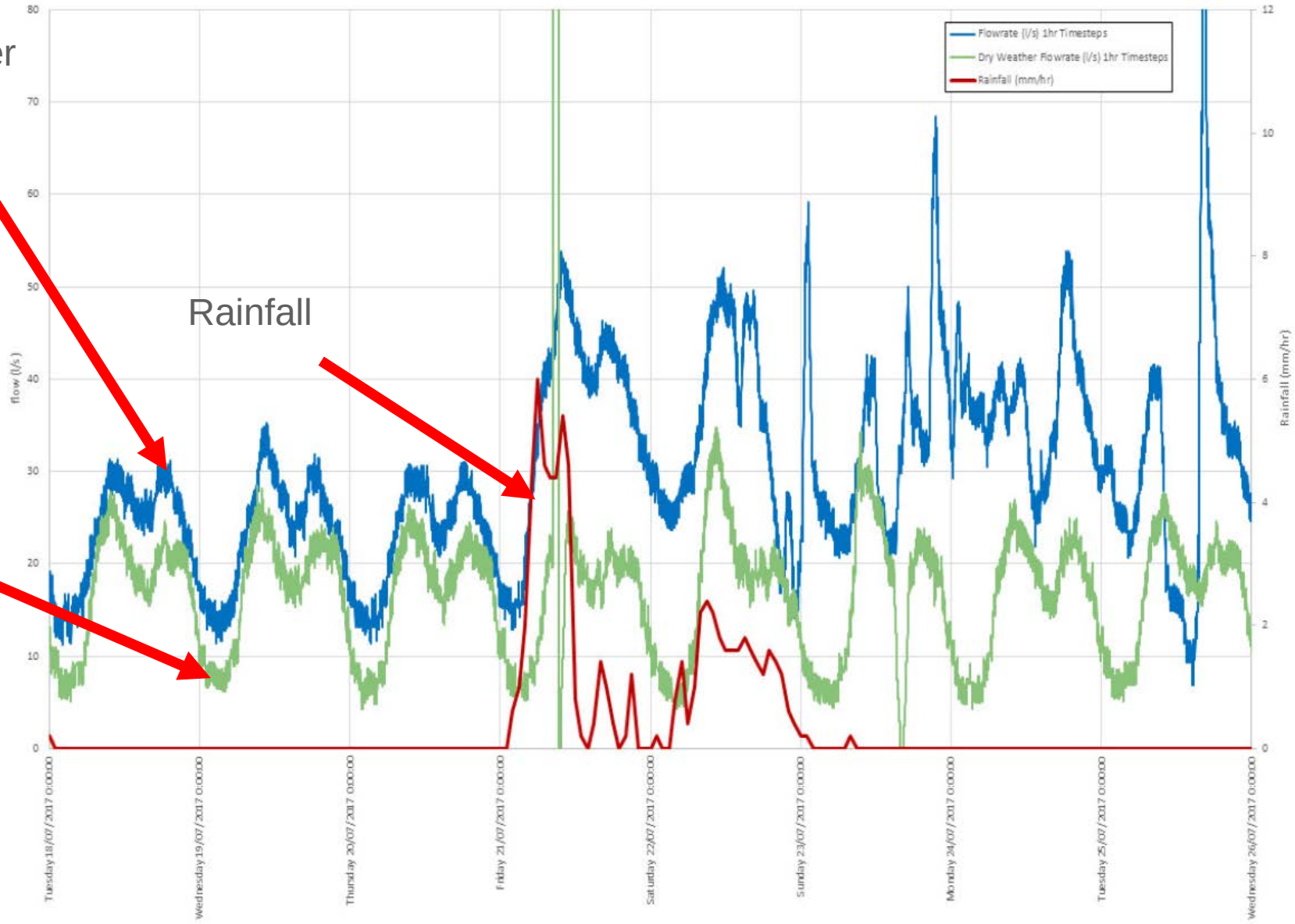
Inflow and Infiltration

- CCTV Laterals
- Inflow and infiltration unknown
- Wet weather flow rates - Capacity
- Distribution of calculated versus reality WWF

Inflow and Infiltration

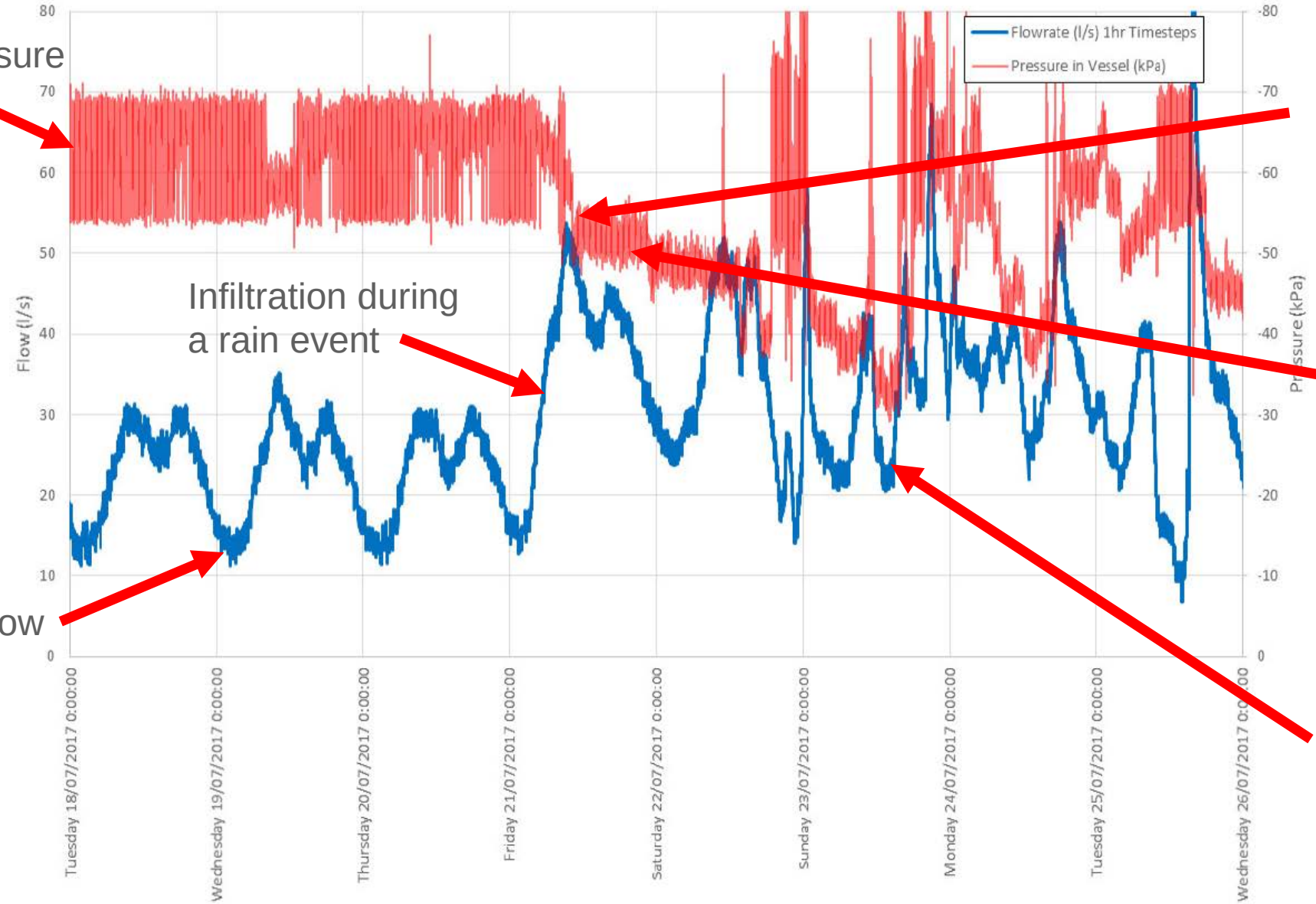
Wet weather wastewater flow

Typical dry weather wastewater flow



Inflow and Infiltration

Vacuum Pressure



Infiltration during a rain event

Wastewater flow

Vacuum pressure drops due to high flow into the system

As the vacuum pressure drops part of the catchment at the end of the lines will not have enough vacuum to operate

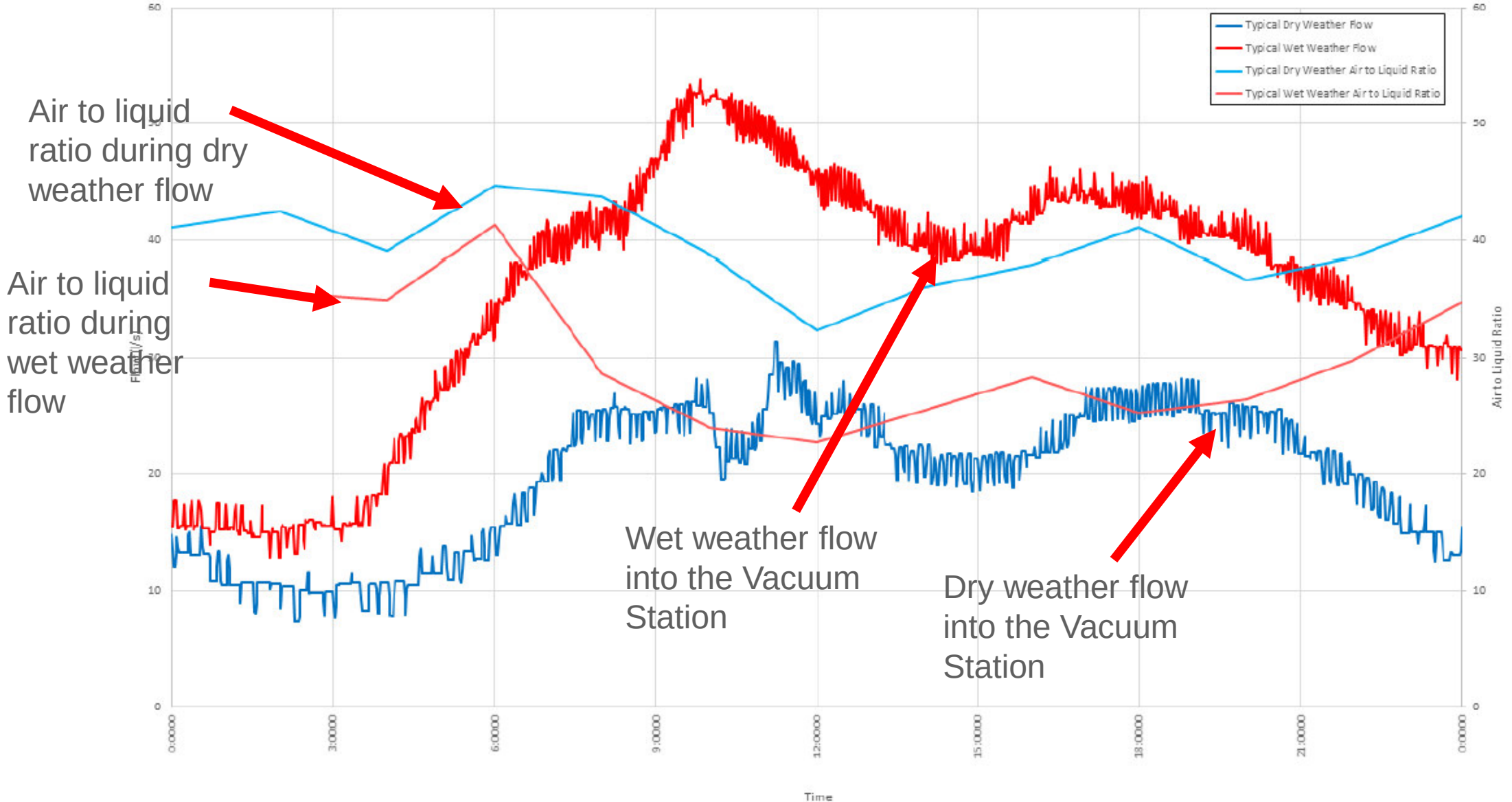
The system try's to self recover although high flow inhibits this

Air to Liquid Ratio

- Air-to-liquid ratio is critical
- Too much air can result in long runtimes of the vacuum pumps
- Too little air results in waterlogging and loss of service
- In operation the air-to-liquid ratio can be calculated by using the formula below:

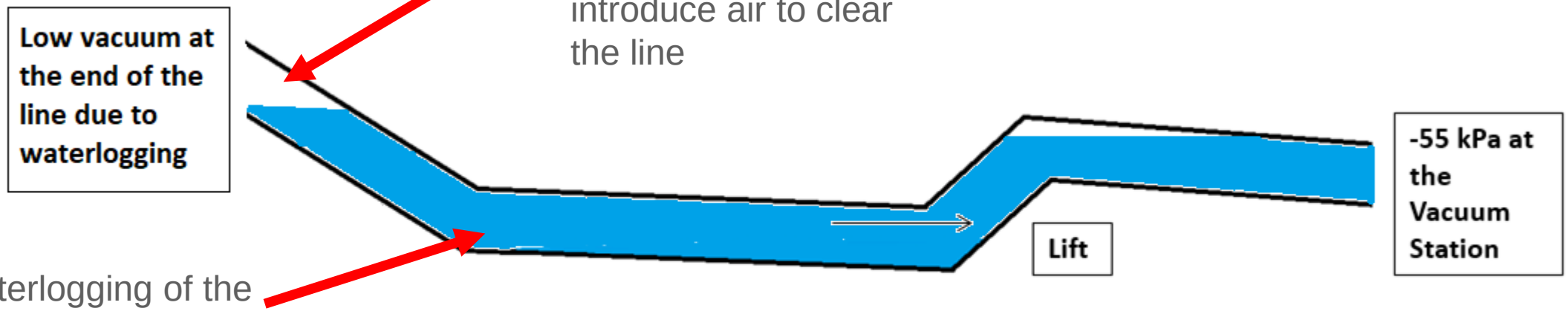
$$\text{Air/Liquid} = \frac{m^3/hr \text{ of air}}{m^3/hr \text{ of wastewater}}$$

Air to Liquid Ratio



Automatic Air Admittance System (AAAS)

An AAAS can detect low vacuum at the end of the line and introduce air to clear the line



Waterlogging of the vacuum main

Operation

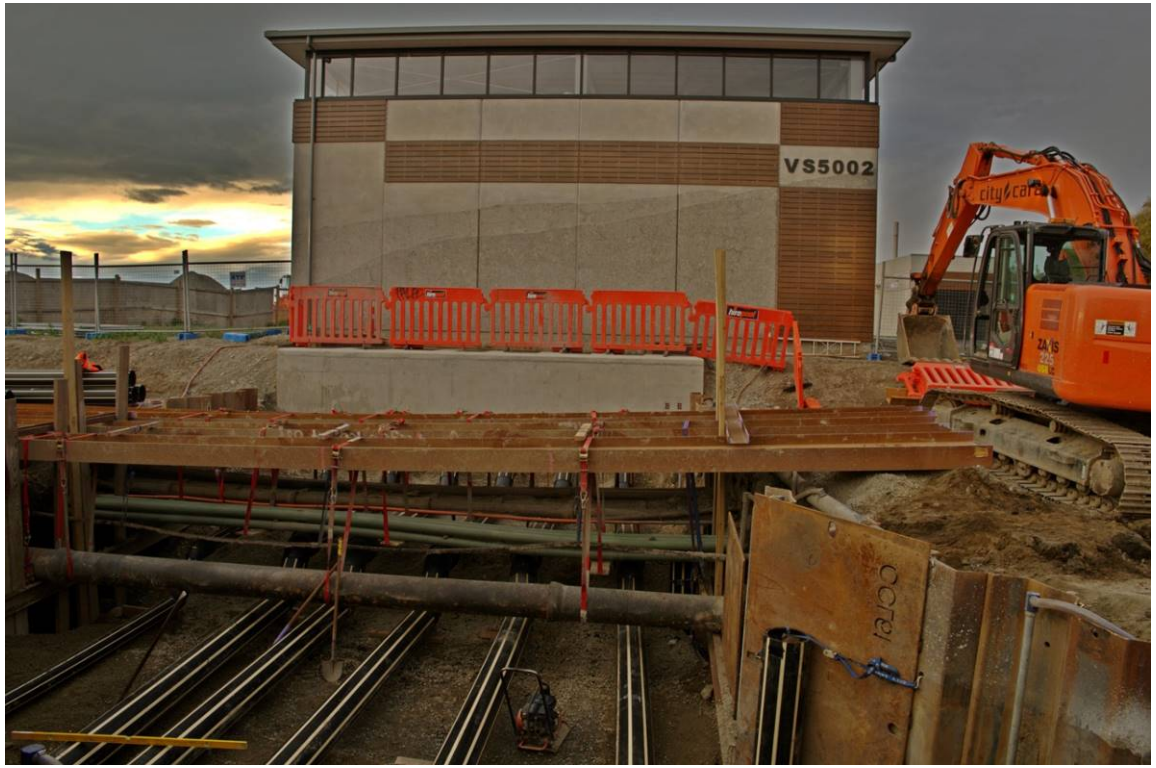
Anecdotal evidence as provided by the operational and maintenance contractor can be seen below:

- Higher call outs for valves failing open
- Fats build up in collection chambers
- Fats blinding the air water separators (between the vacuum pumps and vessel)
- Long vacuum pump runtimes
- Inflow and Infiltration
- Failed controllers (that operate the valve)

Conclusion

- VSS supplier input is critical
- Actual costs
- Air-to-liquid ratio
- Inflow and infiltration
- Automatic Air Admittance Systems (ASSS)
- Monitoring systems

Questions



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