Jacobs Challenging today. Reinventing tomorrow.

Sewer Symphony – An investigation of Hydraulic Phenomena in a falling main through acoustics

Presenter: Joe Allen (Jacobs)

Photo Credit: Colin Monteath

Agenda

LWW Scheme Overview

Hydraulic Challenges of Open Pipe

Pinch Valve Station Overview

Testing and Investigations

Hypothesis and Likely Cause

Control Solution

Conclusions

Questions

Acknowledgements

Christchurch City Council

Patrick Cantillon

Jess Carruthers

Fulton Hogan

Laurence Da Silva

Darath Ng

Jacobs

Kevin Neilson

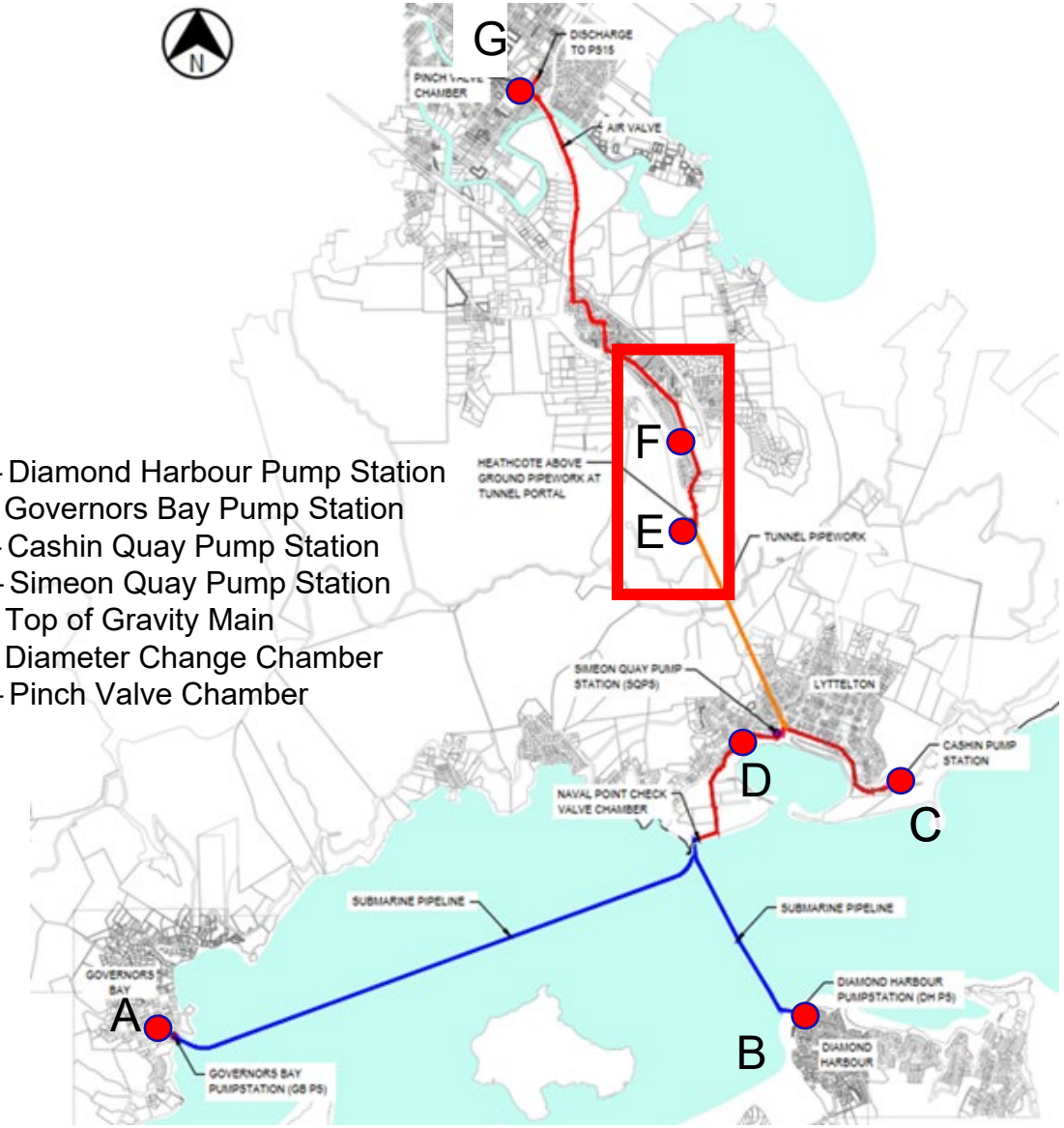
Daniel Morse

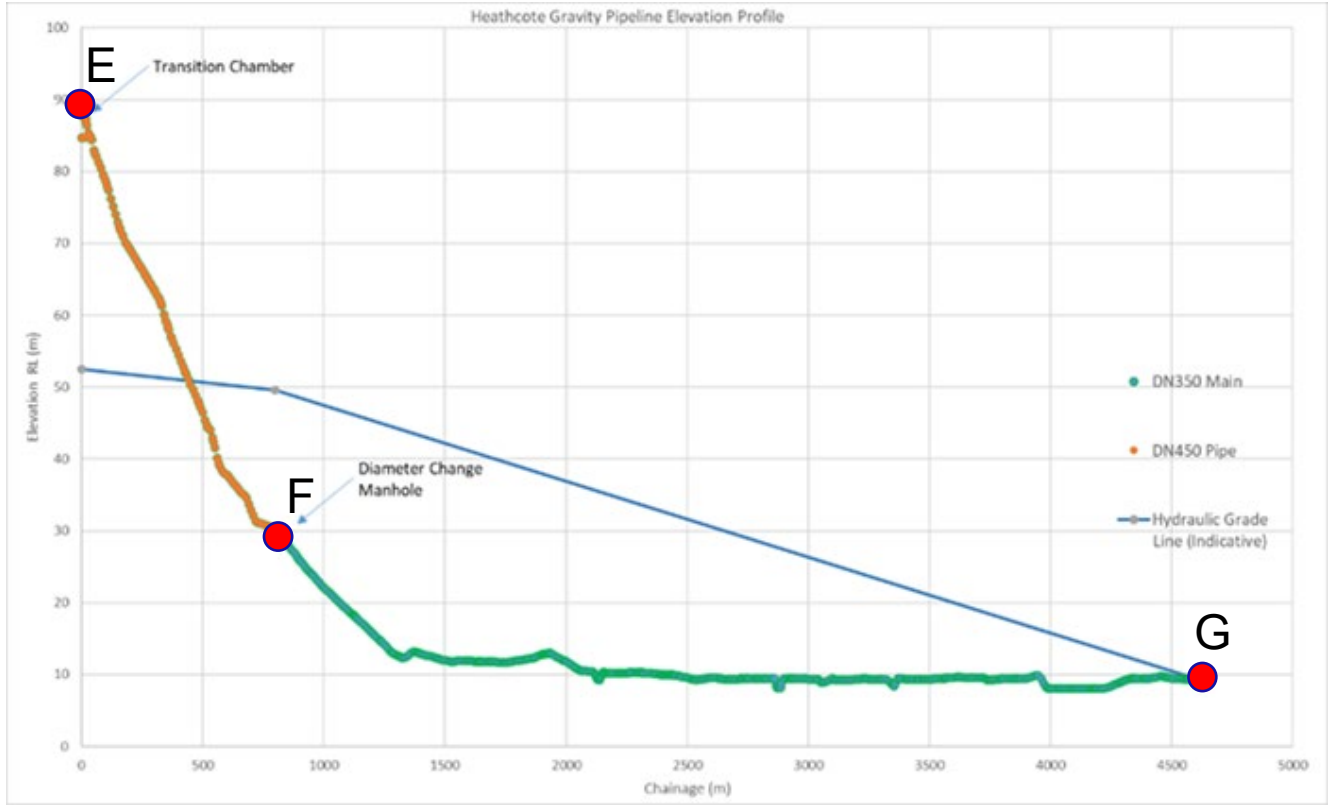
Doug Franklin

Bruce Lade

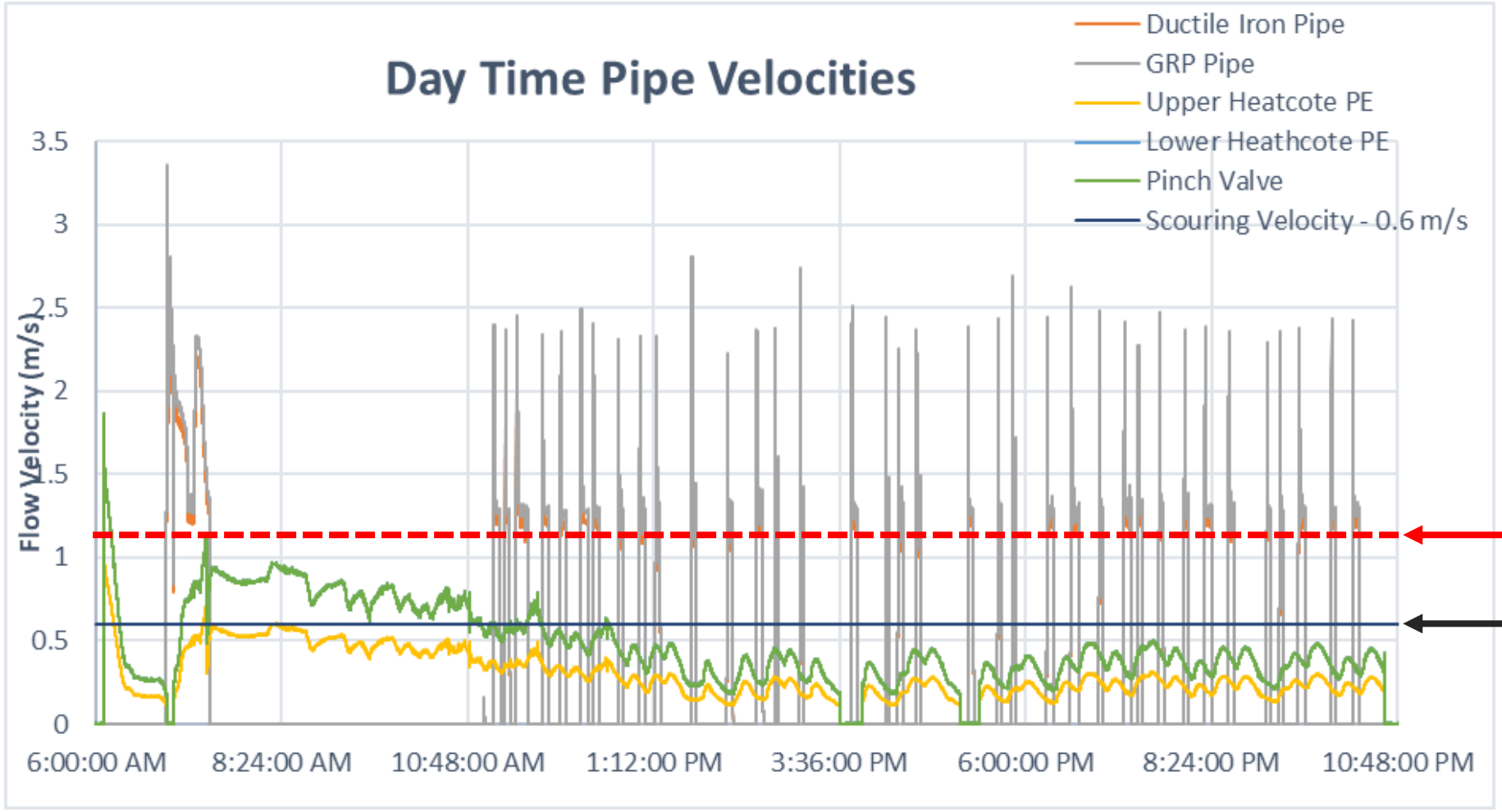
LWW Scheme Layout and Description

A – Diamond Harbour Pump Station
B - Governors Bay Pump Station
C – Cashin Quay Pump Station
D – Simeon Quay Pump Station
E – Top of Gravity Main
F – Diameter Change Chamber
G – Pinch Valve Chamber





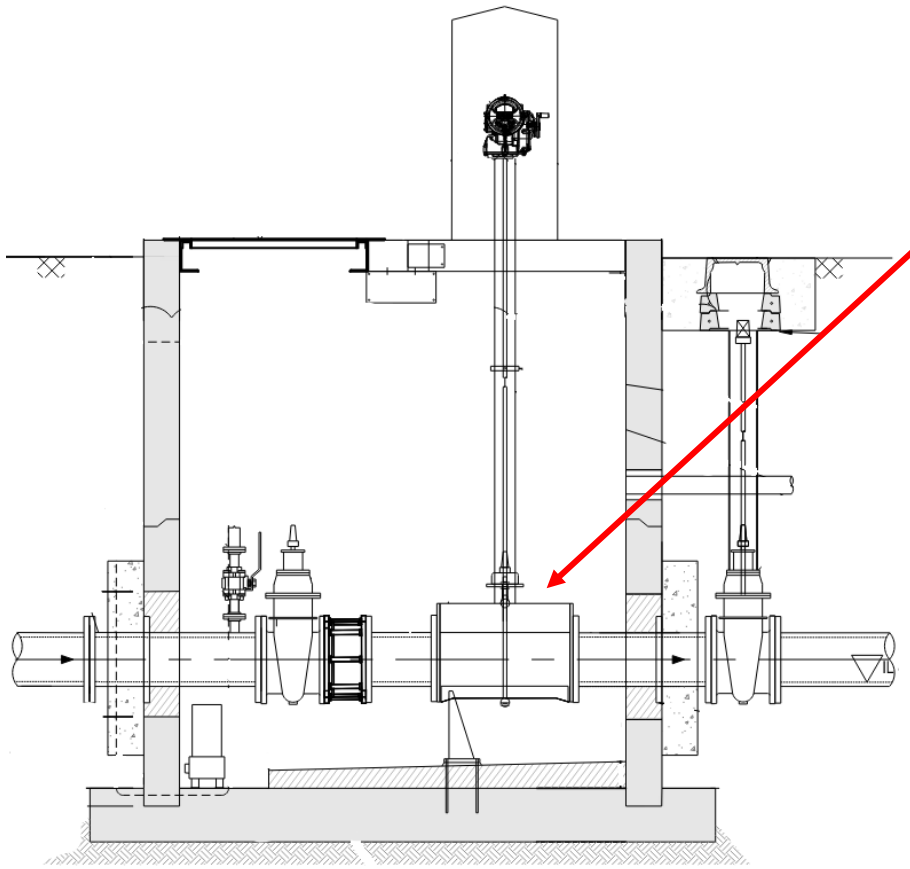
Hydraulic Challenges of Open Gravity Main



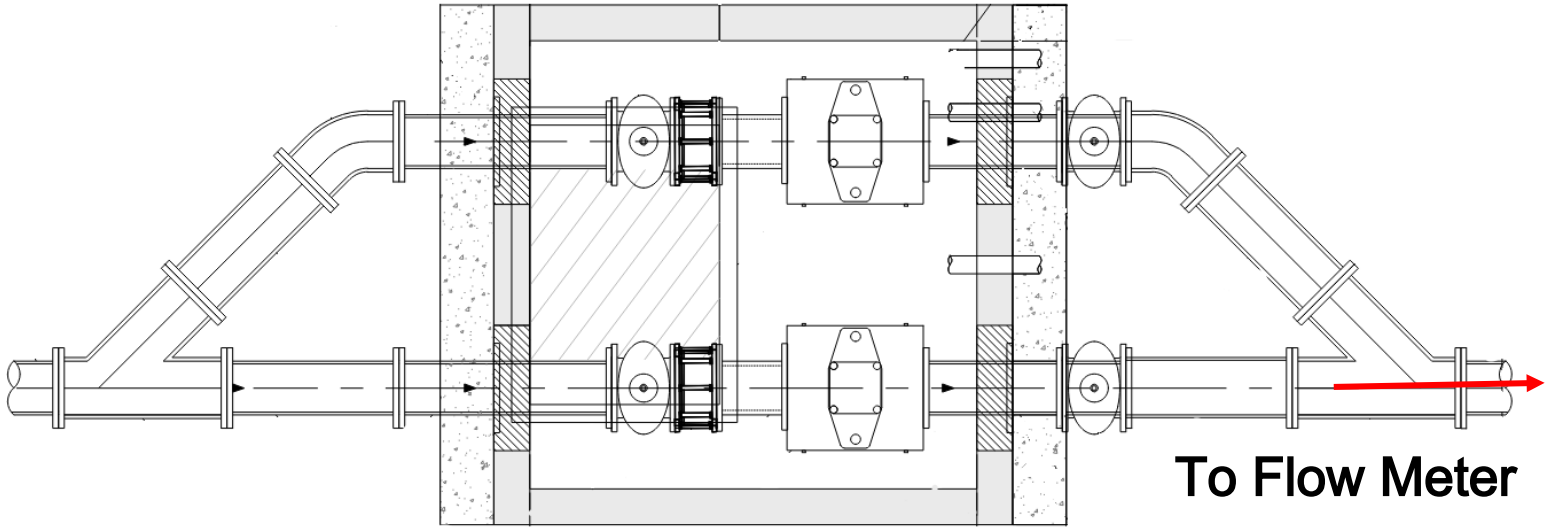
Project Specific target = 1.1m/s

CCC IDS Min Design Requirement = 0.6m/s

Pinch Valve Station



Pinch Valve



To Flow Meter

Elevation

Plan

Commissioning Challenges….

Overflow Point

Overflow Capture

Viewing Port

Testing Plan

1. Initial Testing

Verify Key Design Factors

2. Discovery Testing

What effect variables had

Learn about the issue

3. Investigation Testing

Focus on specific variable

Inform the solution

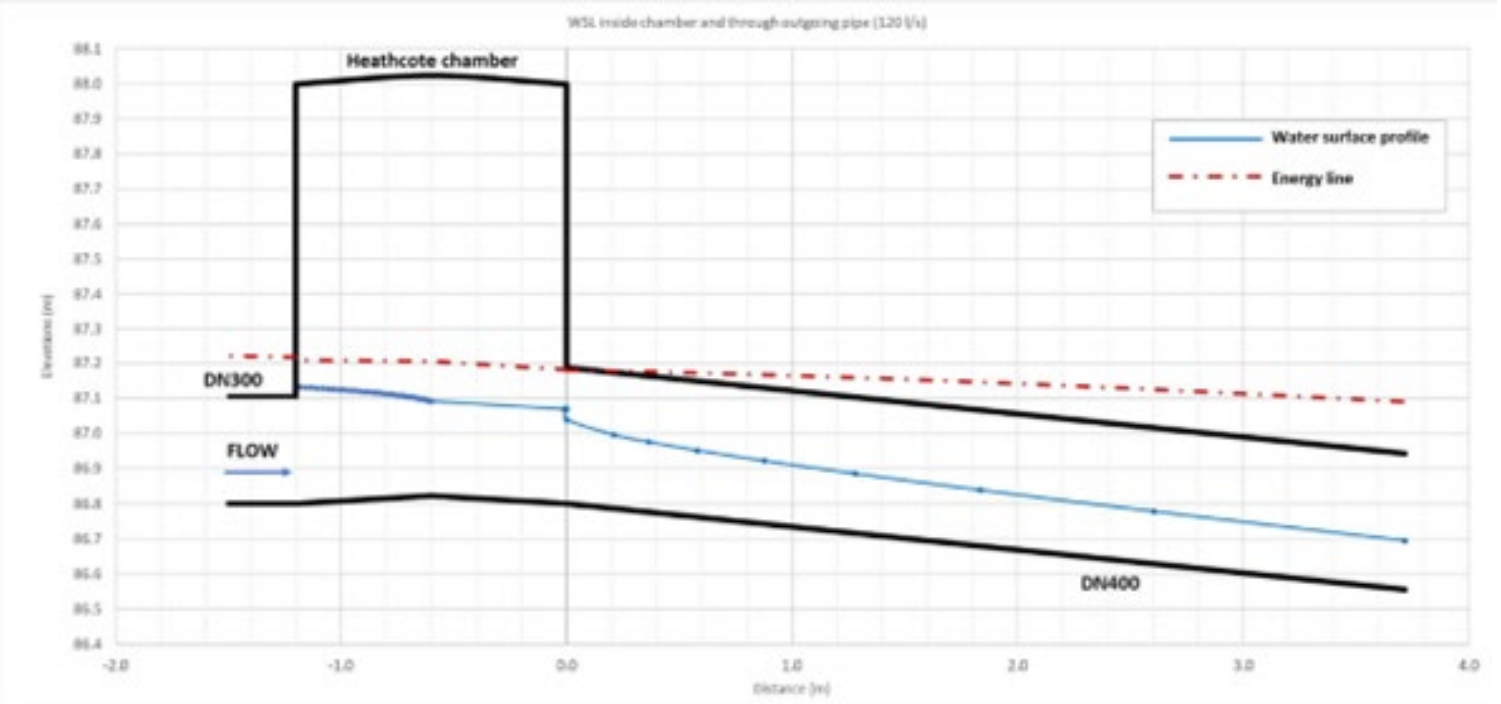
4. Acceptance Testing

Prove the Solution

Initial Testing

Objectives

- ❑ Verify the hydraulic performance of the transition chamber
- ❑ Verify pump flow rates at selected pump speeds against the design basis



Outcomes

No Hydraulic issue observed in chamber

Pump rates consistent with design

Problem downstream of Transition Chamber

What was going on?

Critical Analysisfrom Initial Testing

We must have Air Entrainment bulking the flow

How can air be getting in??

Where could it be??

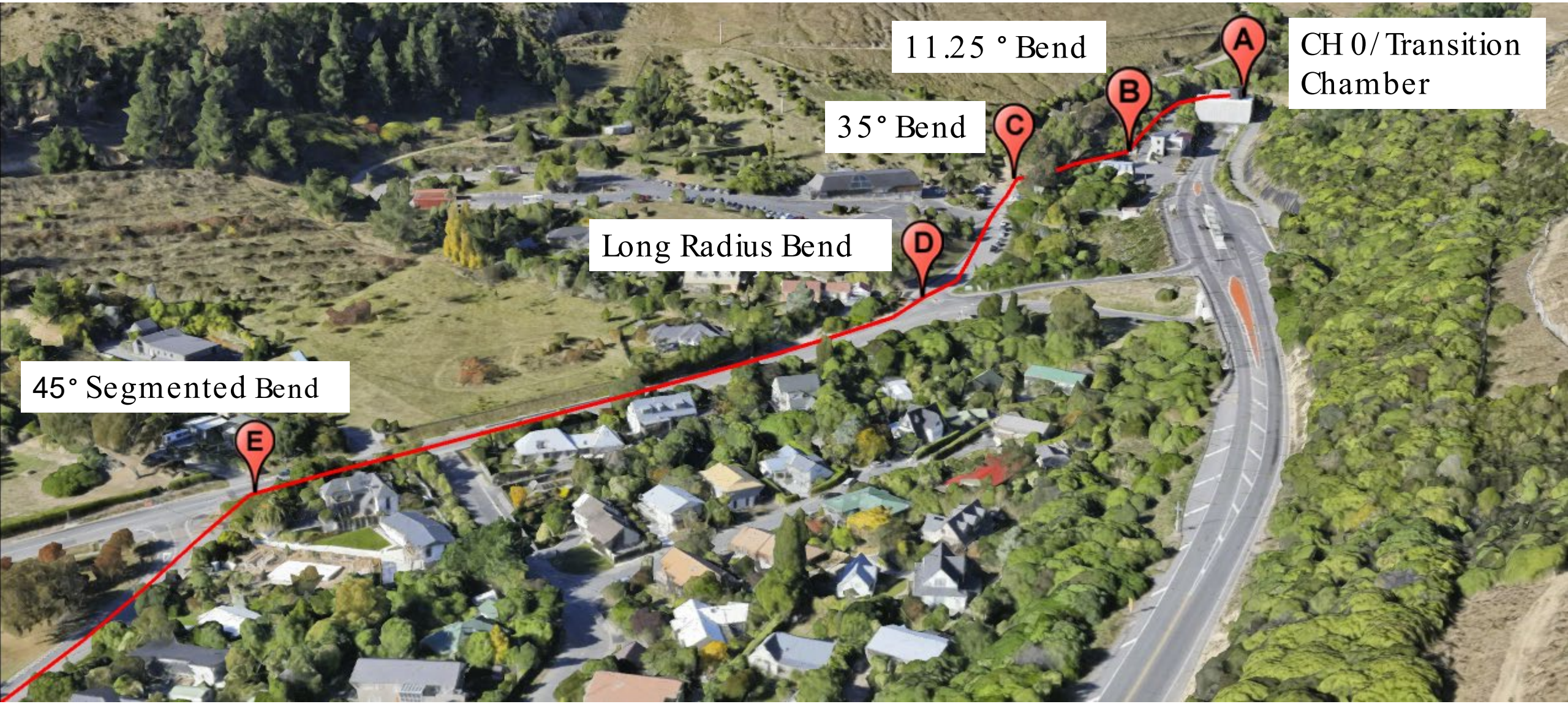
If we can't see it… Can we hear it??

Focused on Upper Steep Section

Ground Microphone

Theoretical assessment of upper steep section ~~n~~ Suggested issues should not occur

Hydraulic Features of the Steep Upper Section



Discovery Testing – What can we Learn?

Variables Changed	Flowrates
	Starting Pinch Valve position
	Pipe full level
Acoustic Sensing	Useful/reliable to identify free surface
	Used under a variety of operational conditions
	Didn't work as intended

Lack of additional noise at bends ➡ No hydraulic jumps/Air lock at these features

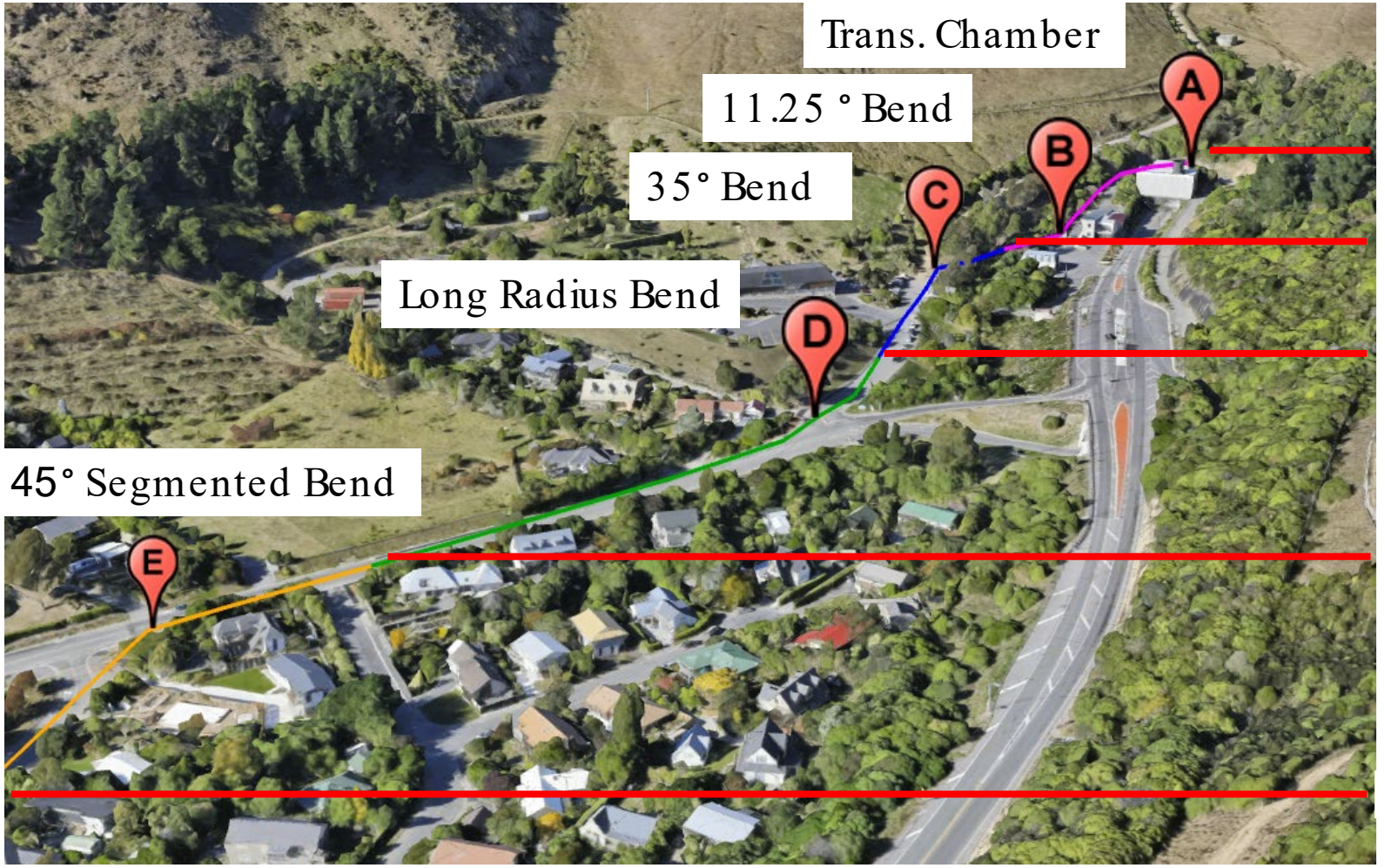
Investigation Testing - Focus on Key Areas

Objectives

- Characterise/ Locate Hydraulic Blockage or Flow Bulking
- Bends suspected of being significant

Development of Testing

- Broke pipe into segments
- Reduce Variables:
  - Constant Pump Flowrate
  - Valve Closed
  - Varied pipe full level



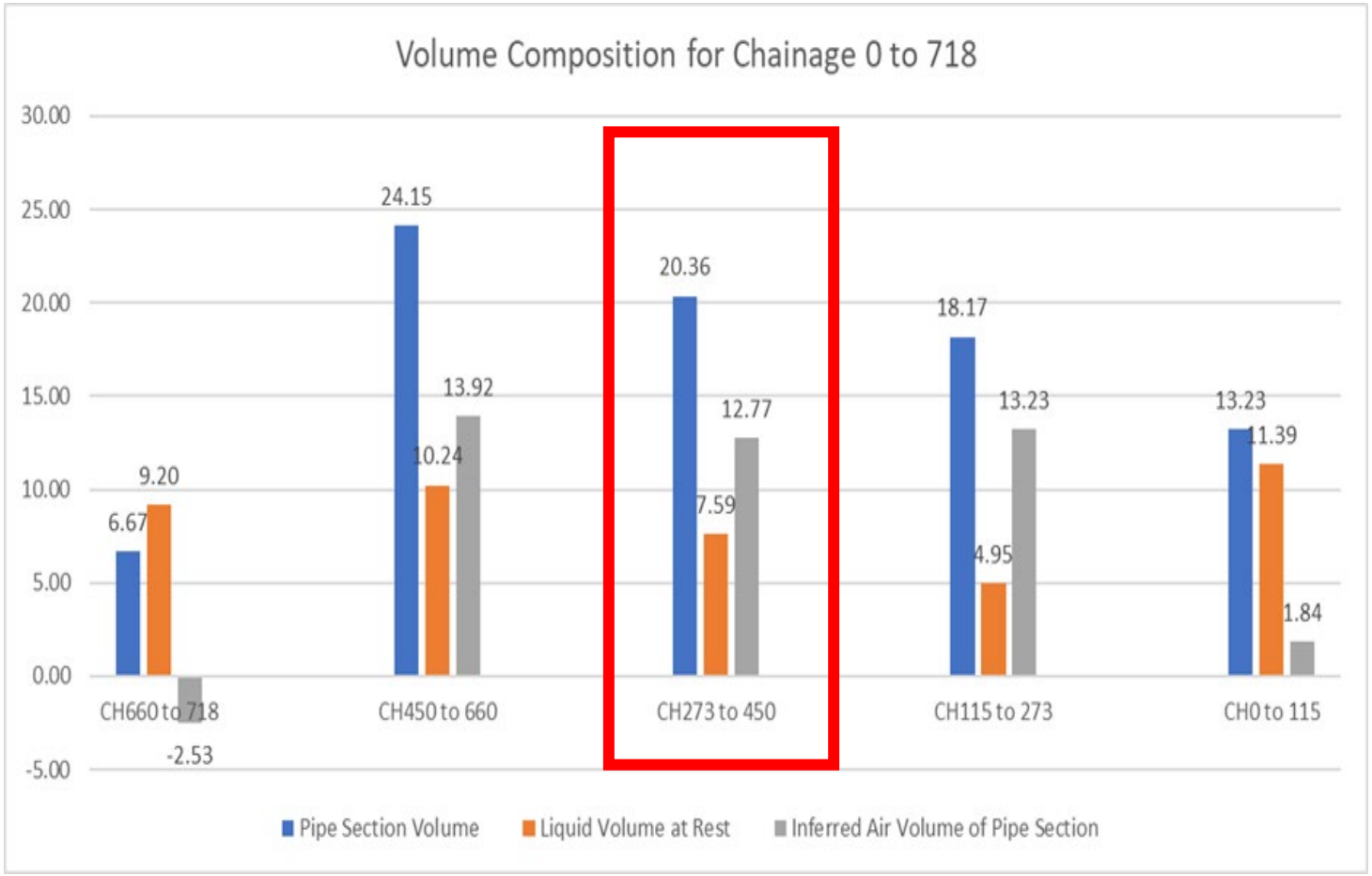
Investigation Testing

Objective:

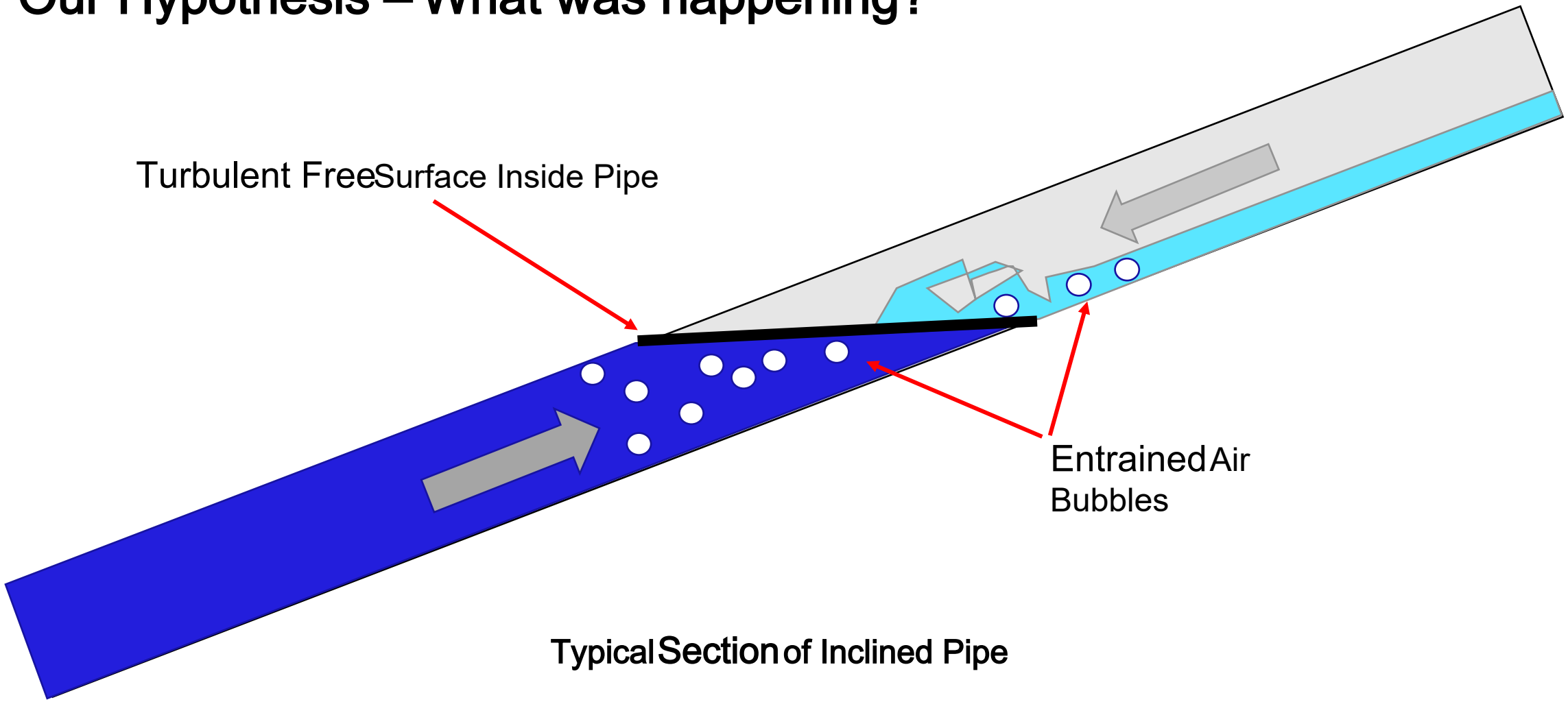
- Determine if flow bulking was occurring
- Isolate specific locations where it was occurring

Observations

- CH000 - 115 – 16% (11.25° Bend)
- CH115 - 273 – **267% (35° Bend)**
- CH273 - 450 – **168% (LR Bend)**
- CH450 - 660 – **136% (45° Bend)**



Our Hypothesis – What was happening?



Typical Section of Inclined Pipe

Revised Operational Control

- Pinch Valves changed from Normally Closed to Normally Open

- Implemented a periodic scouring cycle

- Introduced scouring operational mode at Simeon Quay PS

- Included communications between Pinch Valve and Simeon Quay PS

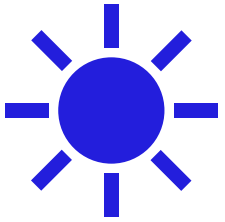
- Established preconditions for initiating a Scour Cycle

Acceptance Testing

Peak Design Flowrate Steady State Test (Open Pipe)

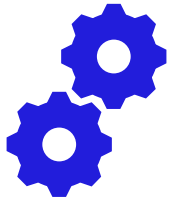
Account for flow bulking at peak design flow

Dry Weather Operation (Open Pipe)



Inform Scour Frequency

Operational Handover

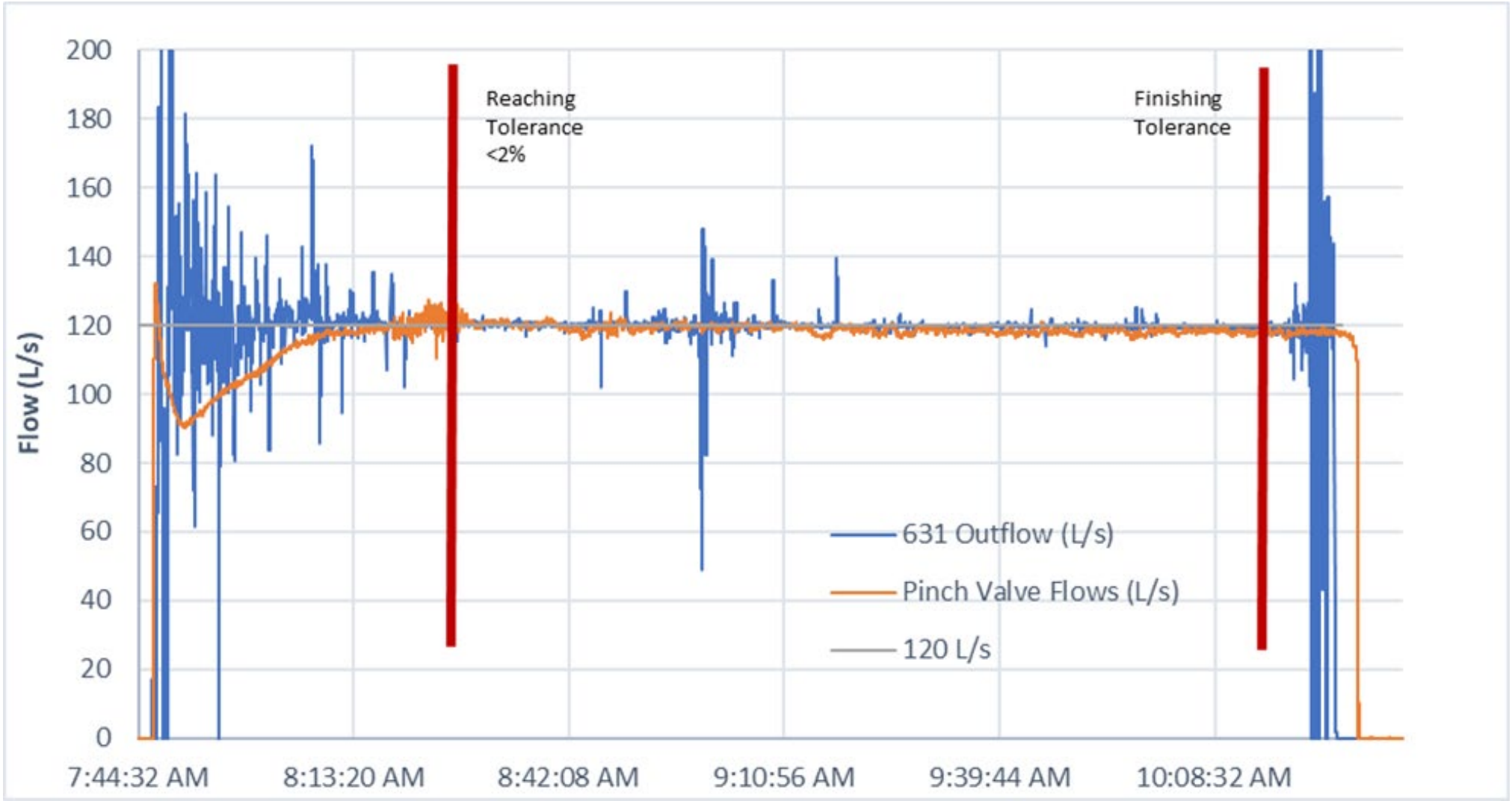


Recommission under revised operational philosophy

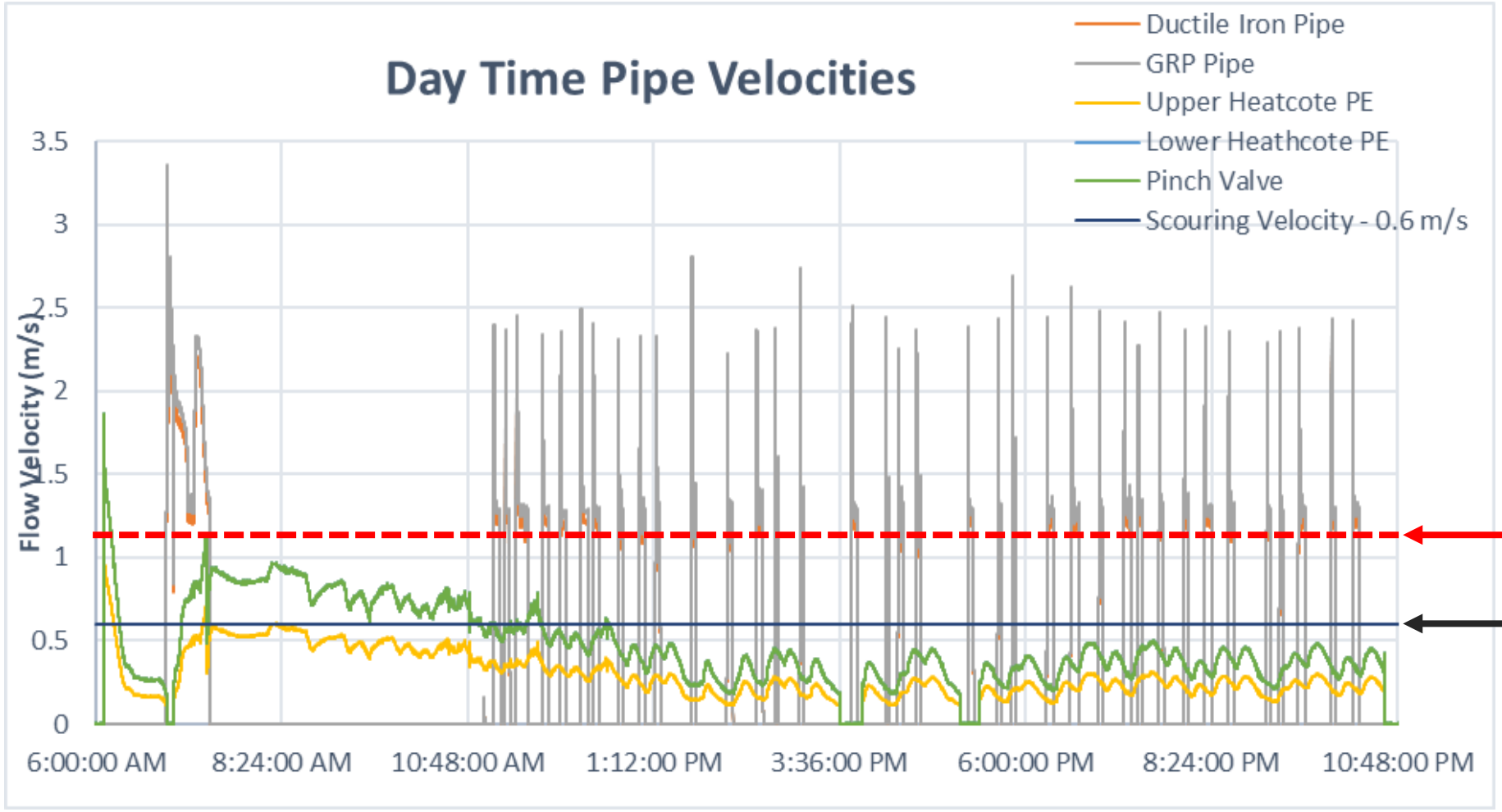
Operational & Wet Weather Proving

Prove reliability of revised Control Philosophy

Peak Design Flow Steady State Testing (Open Pipe)



Dry Weather Operation (Open Pipe)



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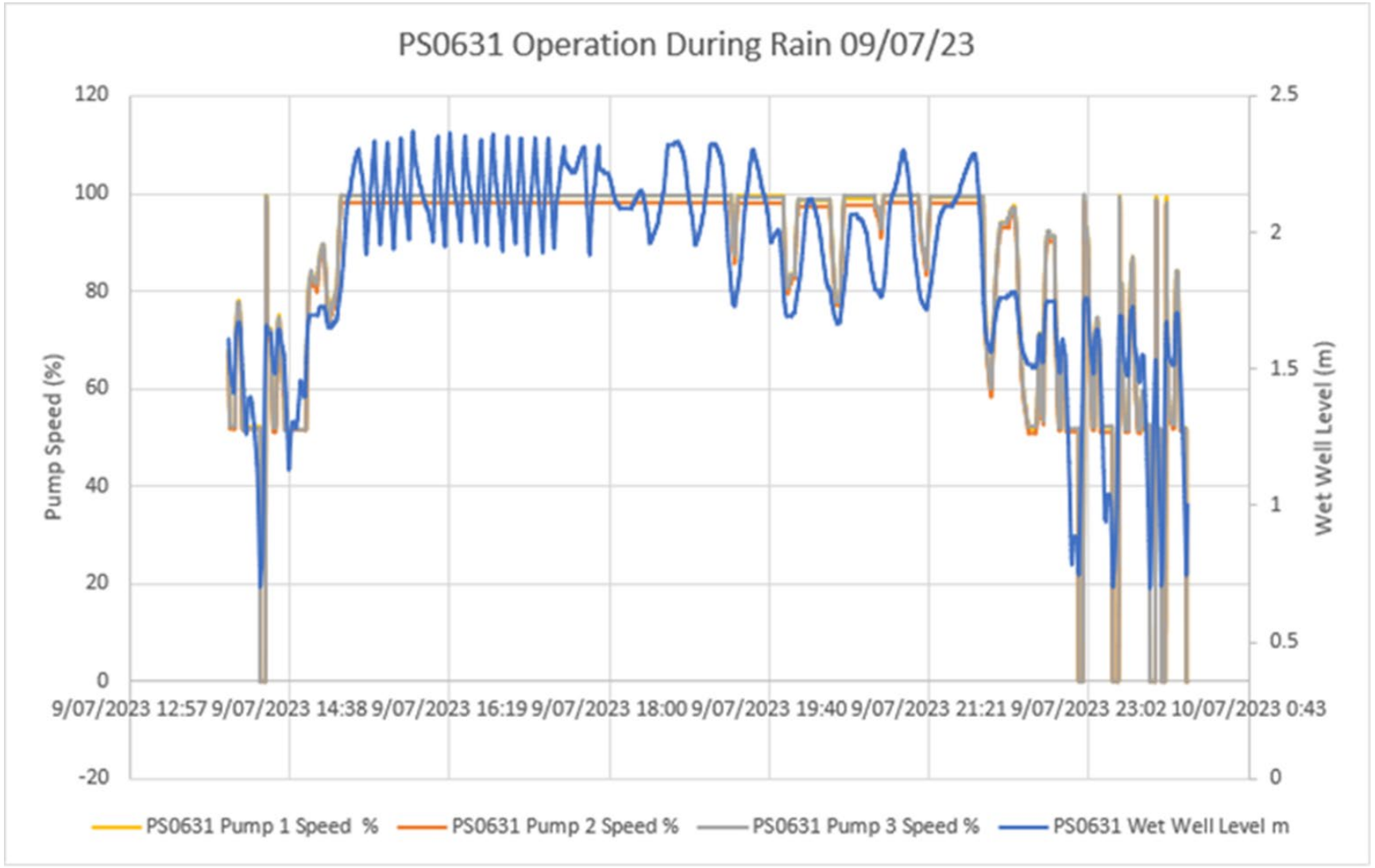
Operational & Wet Weather Proving



Conclusions

- Theory indicated low risk of hydraulic issues
- No Single hydraulic jump forming
- Overflows caused by flow bulking due to entrained air
- Peak design flowrate sustainable without overflow (with flow bulking)
- Demonstrated reliability of revised operational mode during both dry and wet weather
- Solution involved changes to automation software only
- Original intent of the Pinch Valve Control was maintained
- Added benefit of reduced valve movements = longer valve life

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Important

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Thank you

Questions?