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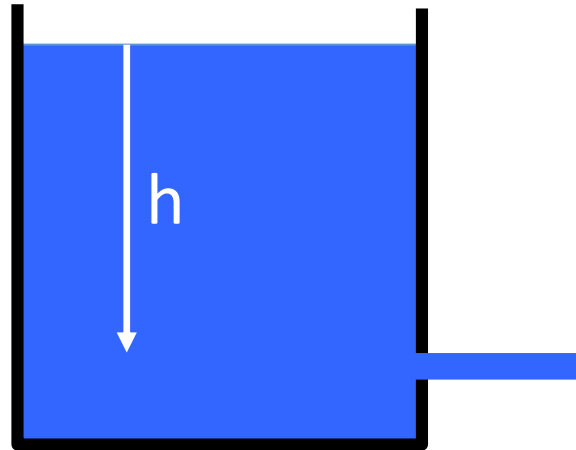
# **PRESSURE-BASED LEAKAGE CHARACTERISATION OF BULK WATER PIPES**

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THE UNIVERSITY OF  
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Te Whare Wānanga o Tāmaki Makaurau  
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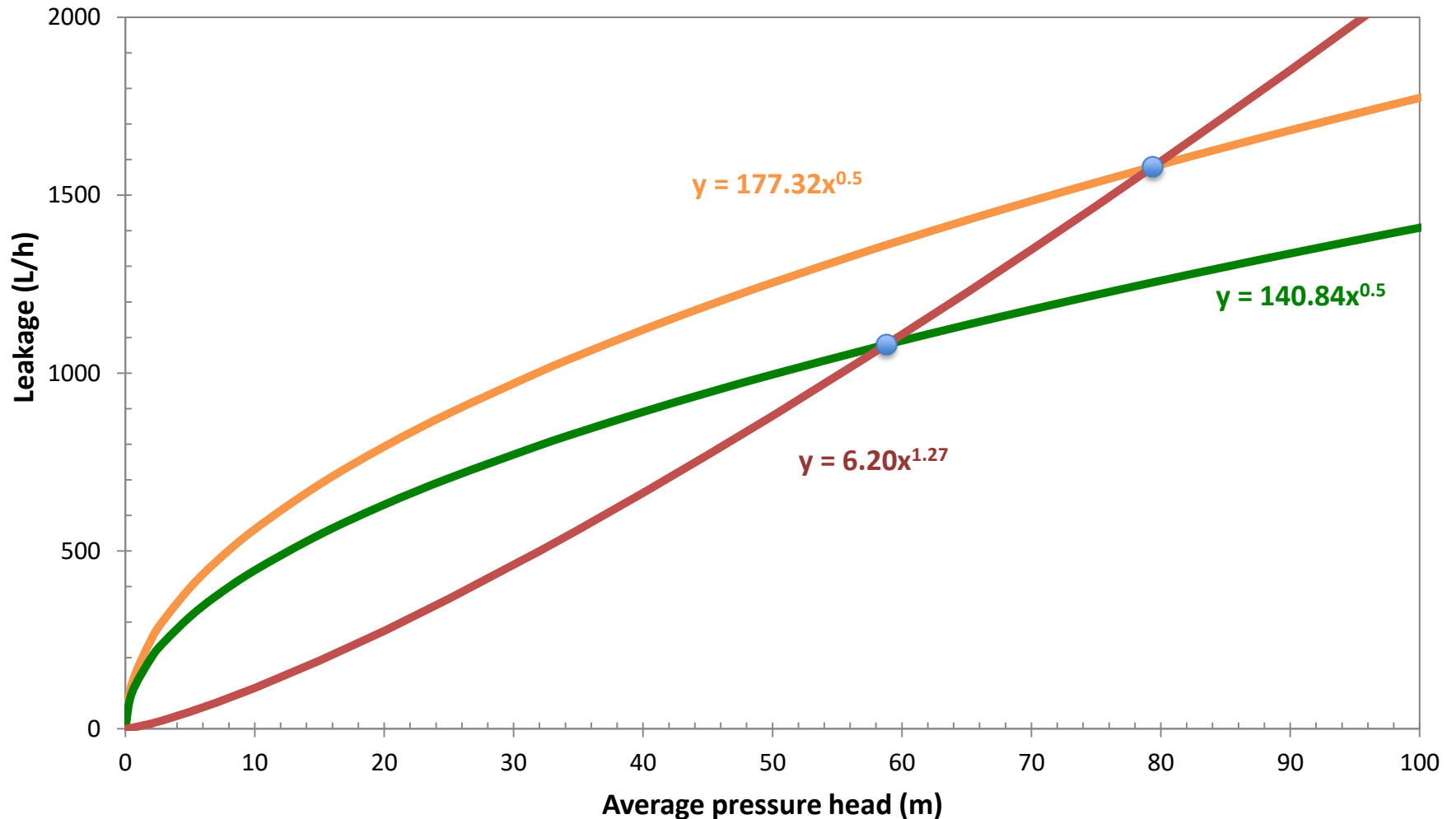
# Orifice Equation



- From conservation of energy:

$$Q = C_d A \sqrt{2gh}$$

# Pressure management DMA in Durban, South Africa



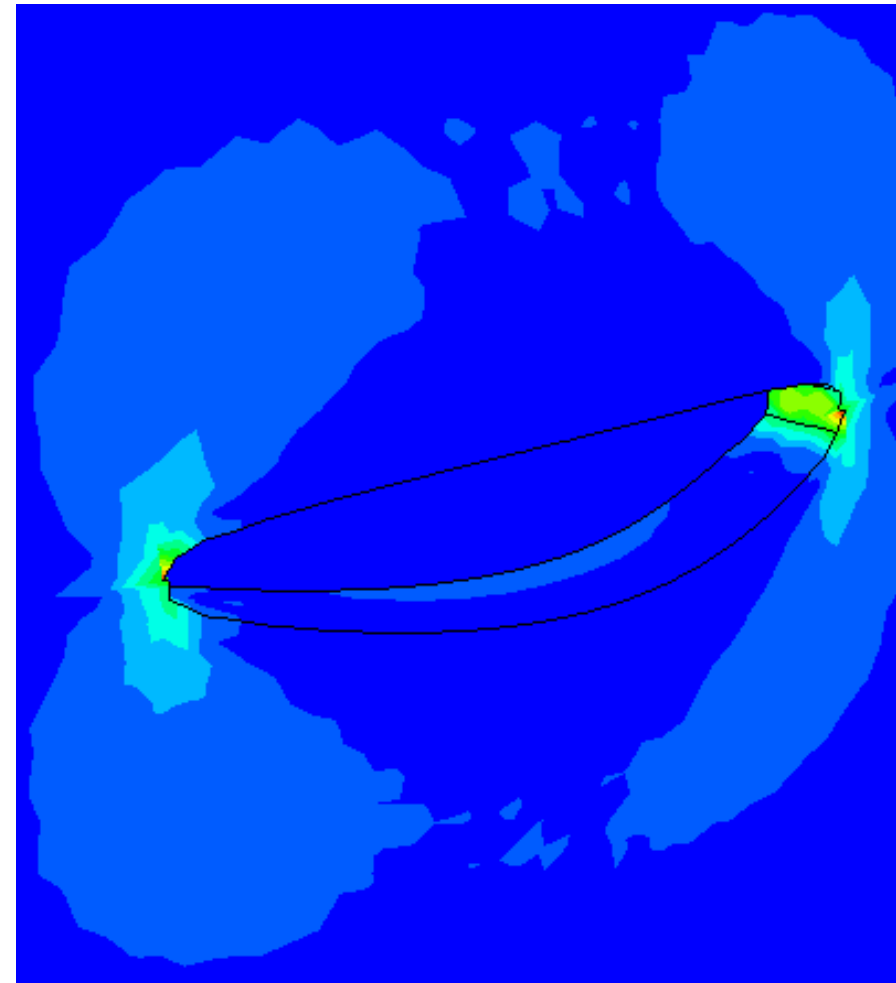
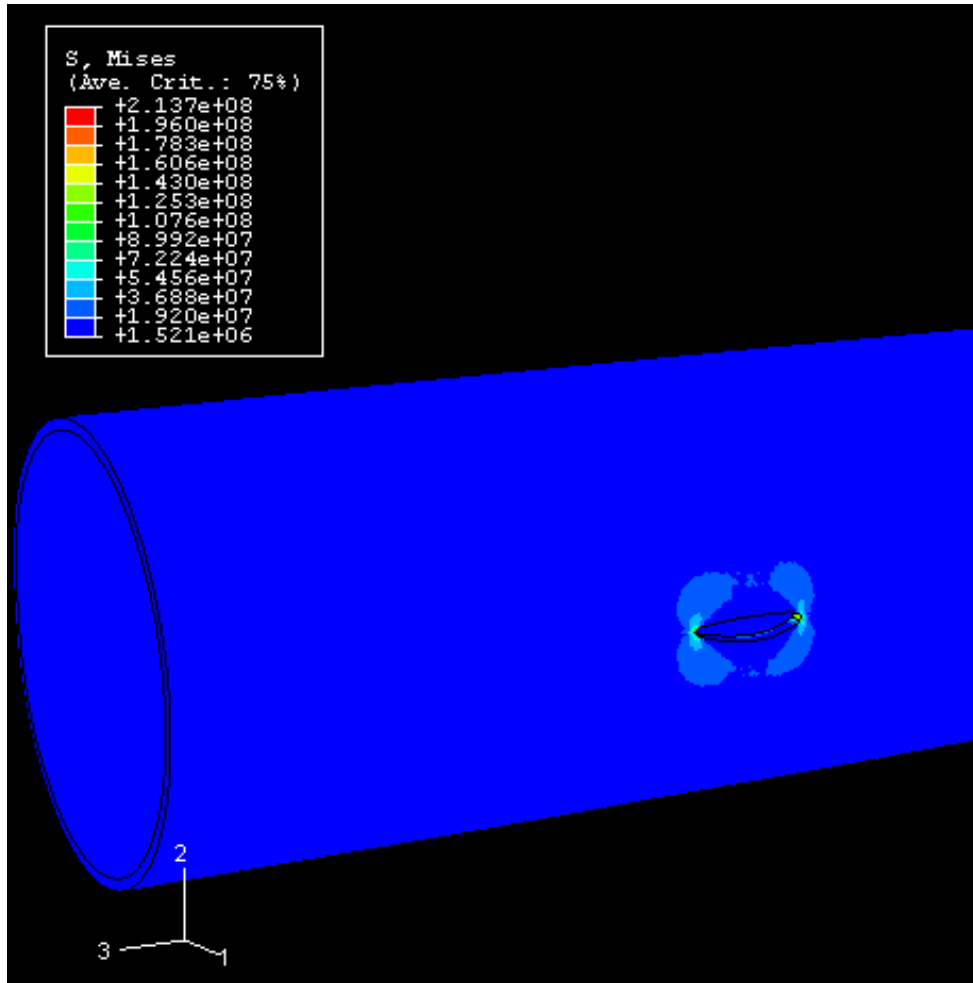
# Modelling leakage in practice

- Practitioners adopted a power equation:

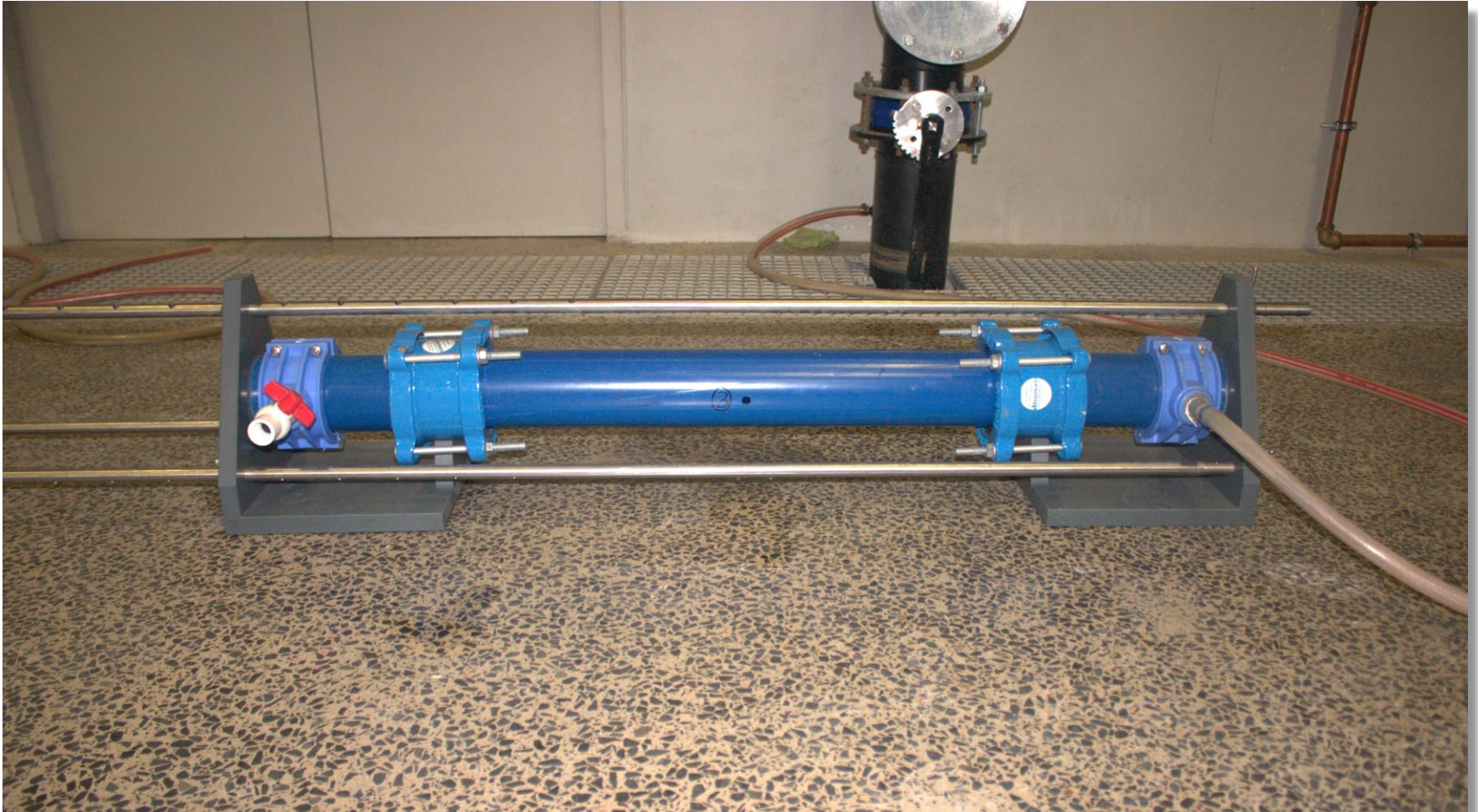
$$Q = ch^{N1}$$

- According to theory:  $N1 = 0.5$
- In practice:  $0.4 \leq N1 \leq 2.95$

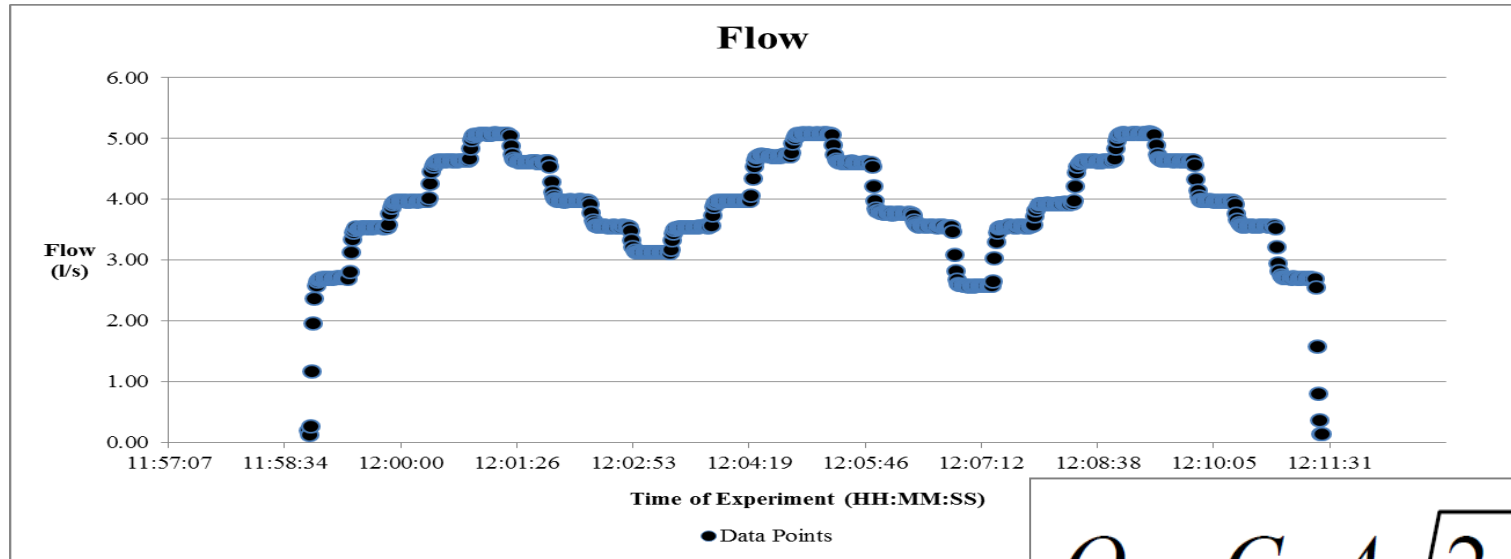
# FEM Modelling – Longitudinal crack



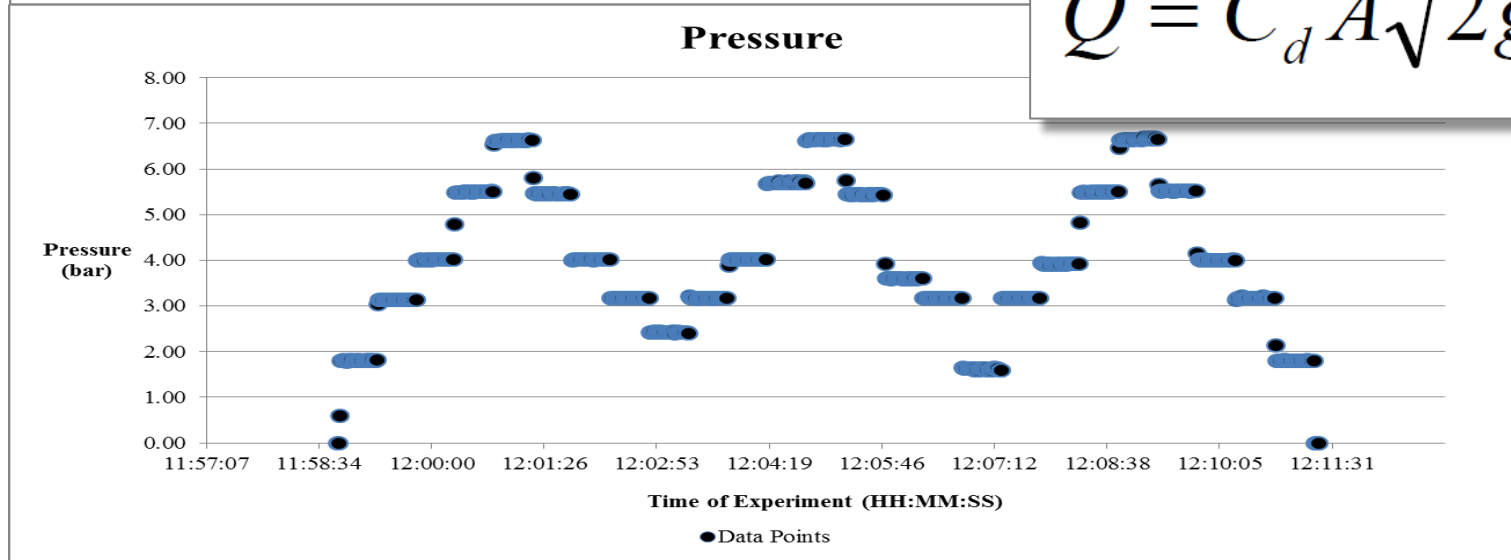
# Laboratory leakage tests



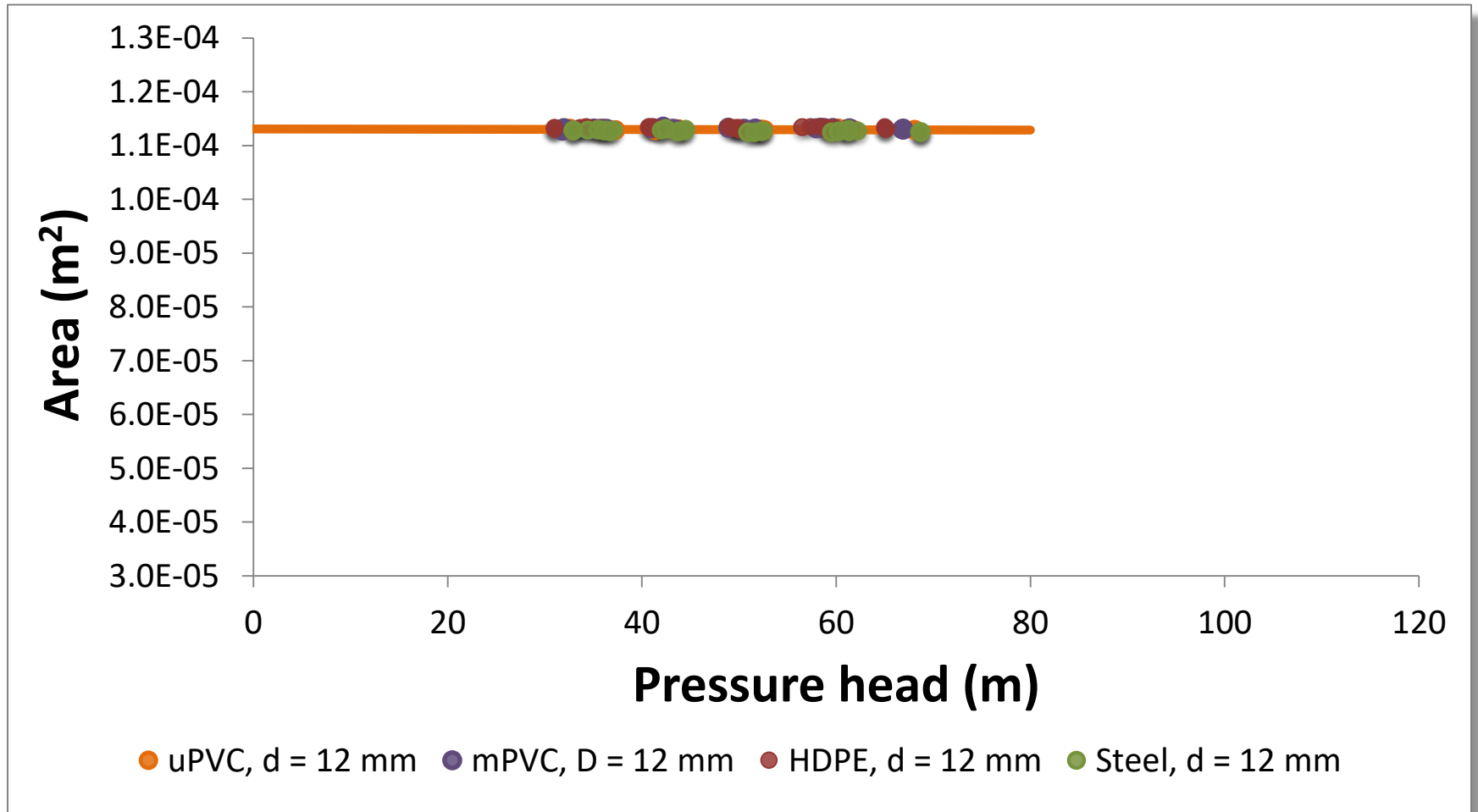
# Lab Testing



$$Q = C_d A \sqrt{2gh}$$

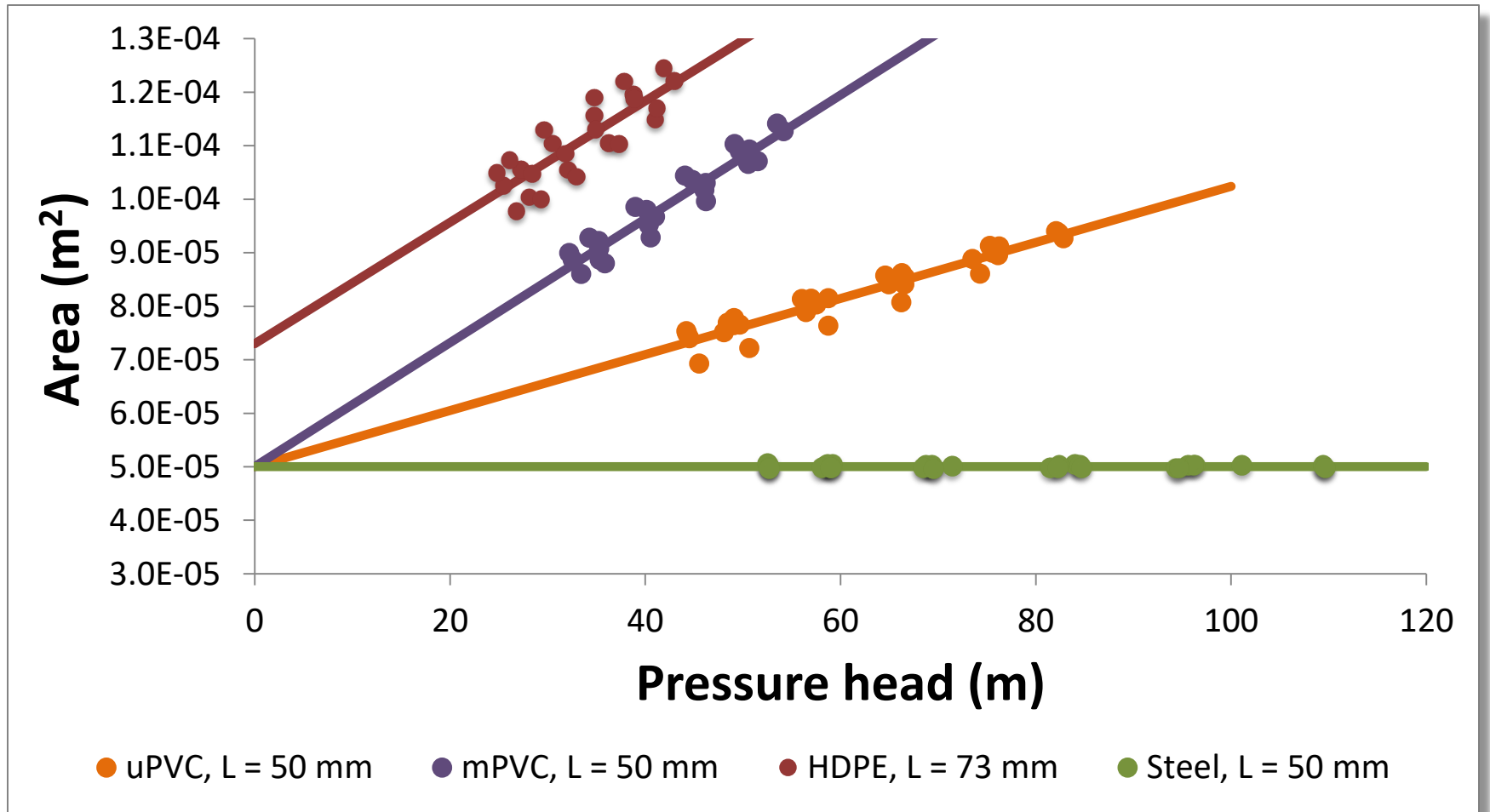


# Round Holes (d = 12 mm)

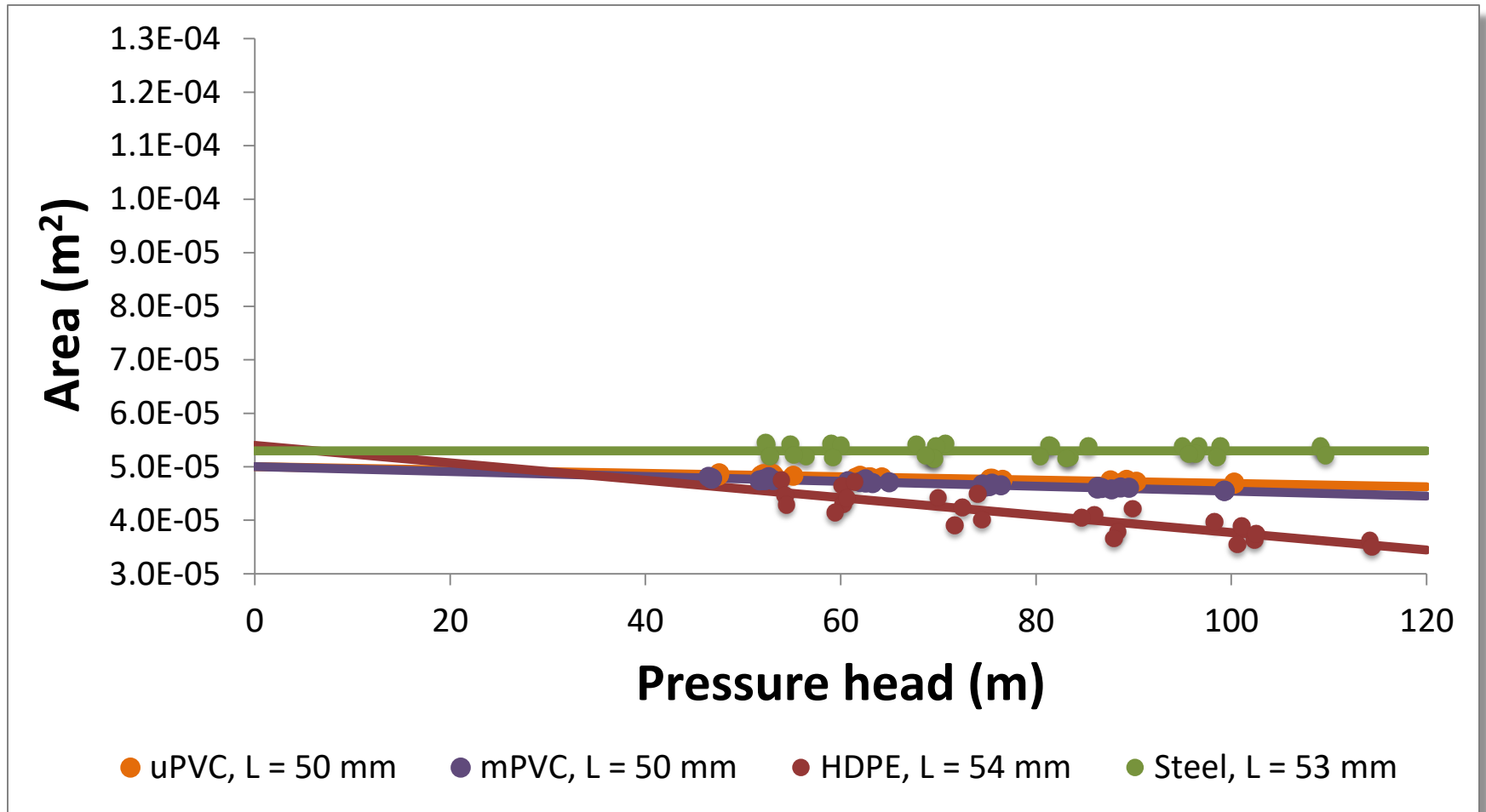




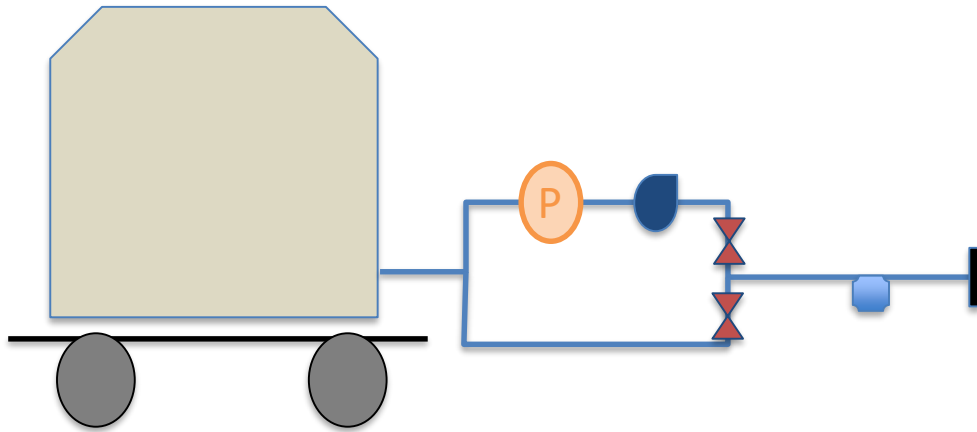
# Longitudinal cracks ( $L \cong 50$ mm)



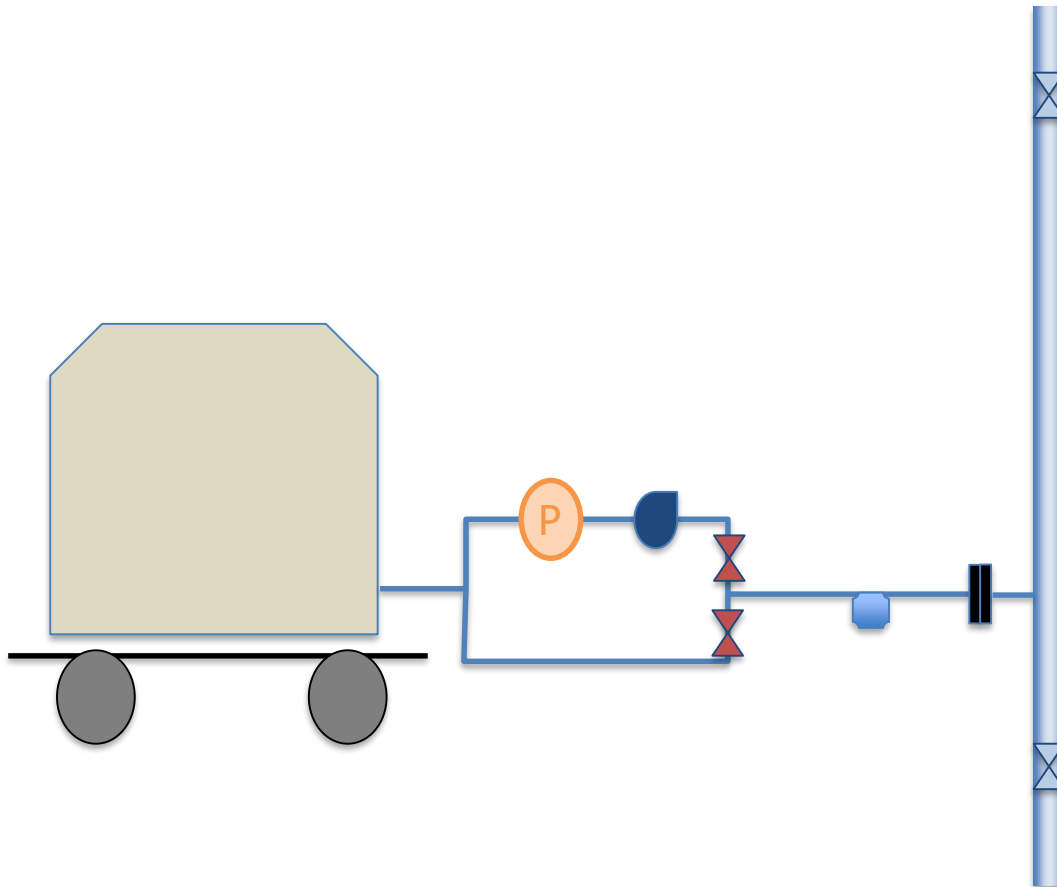
# Circumferential cracks ( $L \cong 50$ mm)



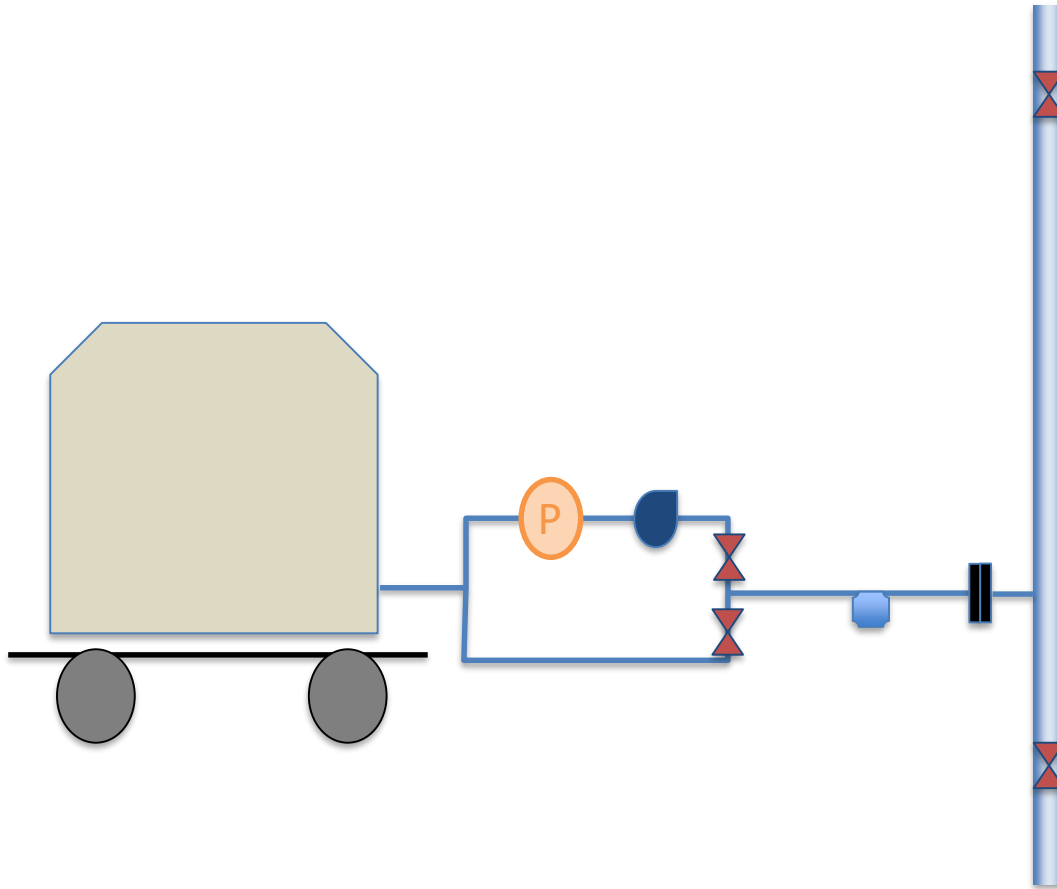
# Pipe Condition Assessment Device



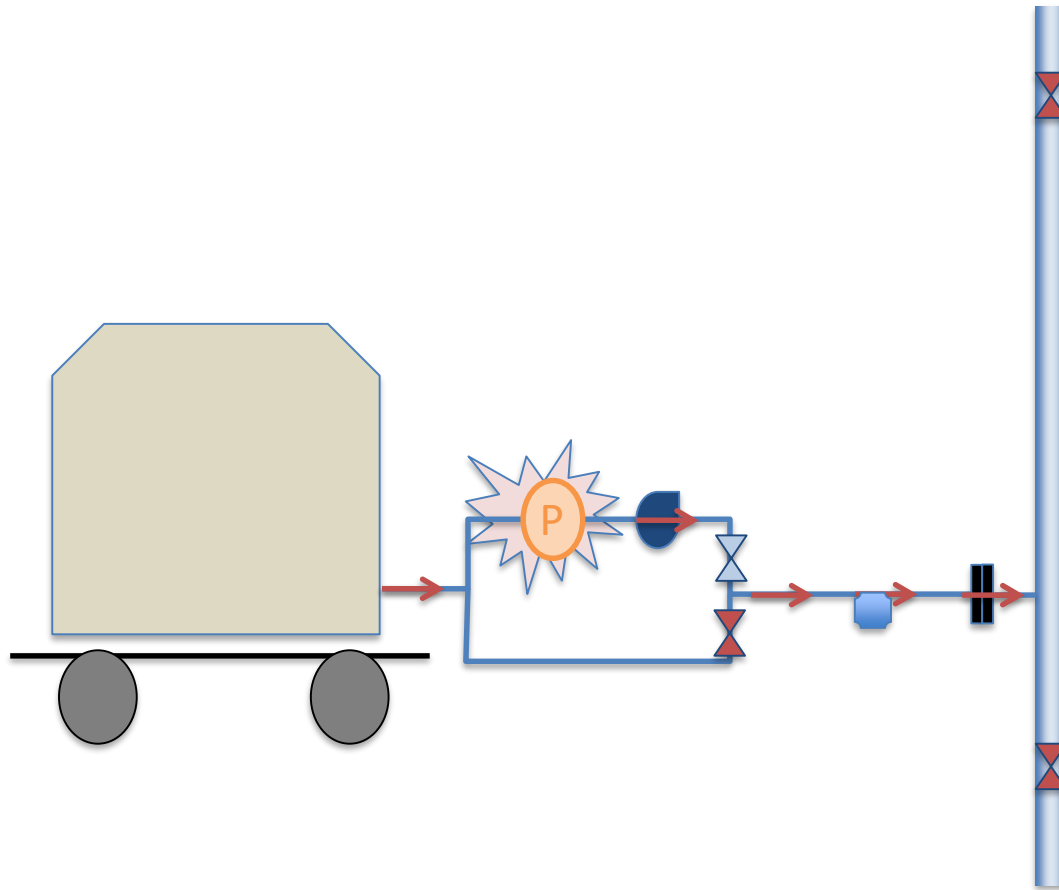
# Connect to pipe



# Isolate pipe

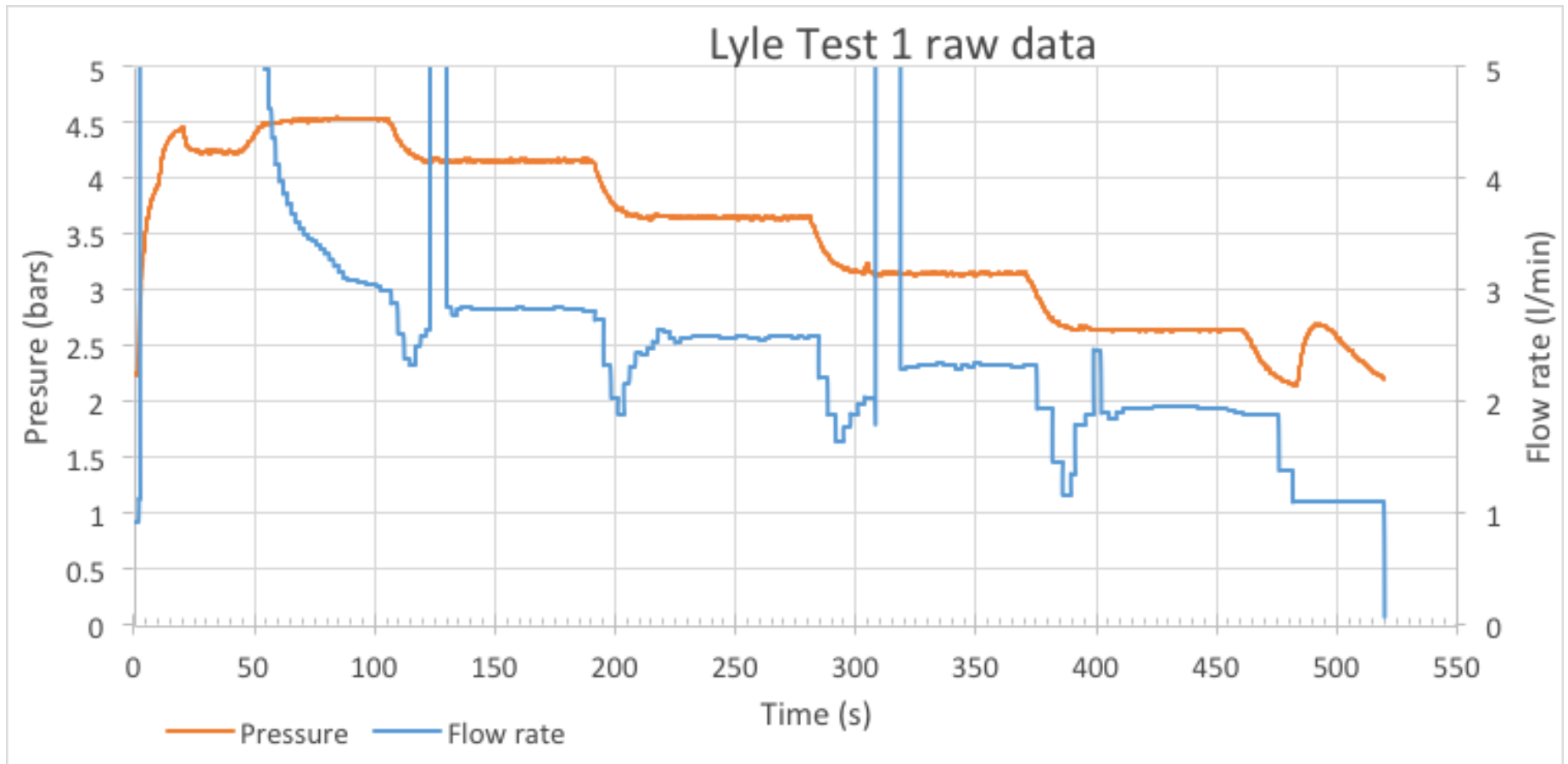


# Run variable pressure test



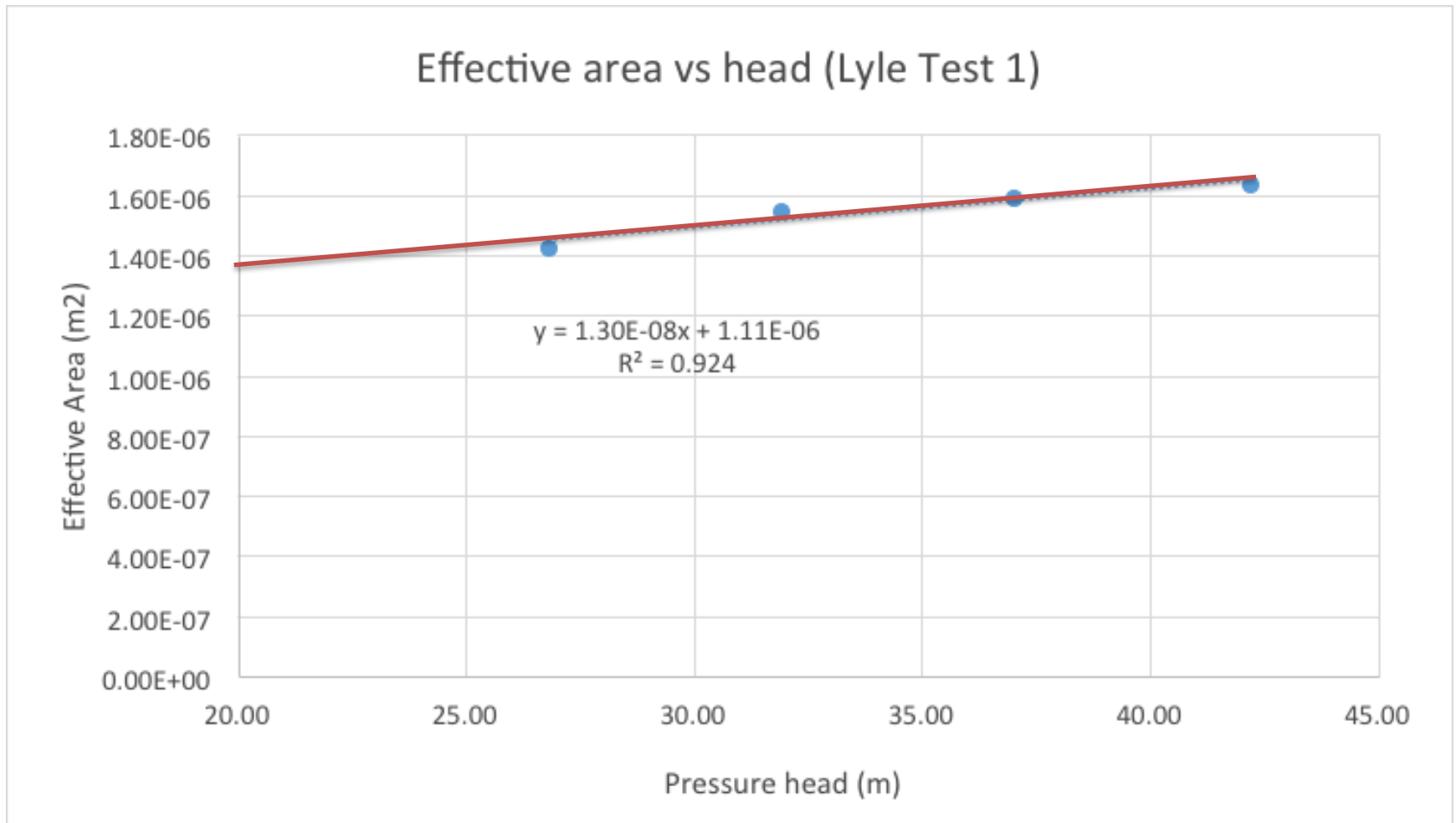


# Field test results





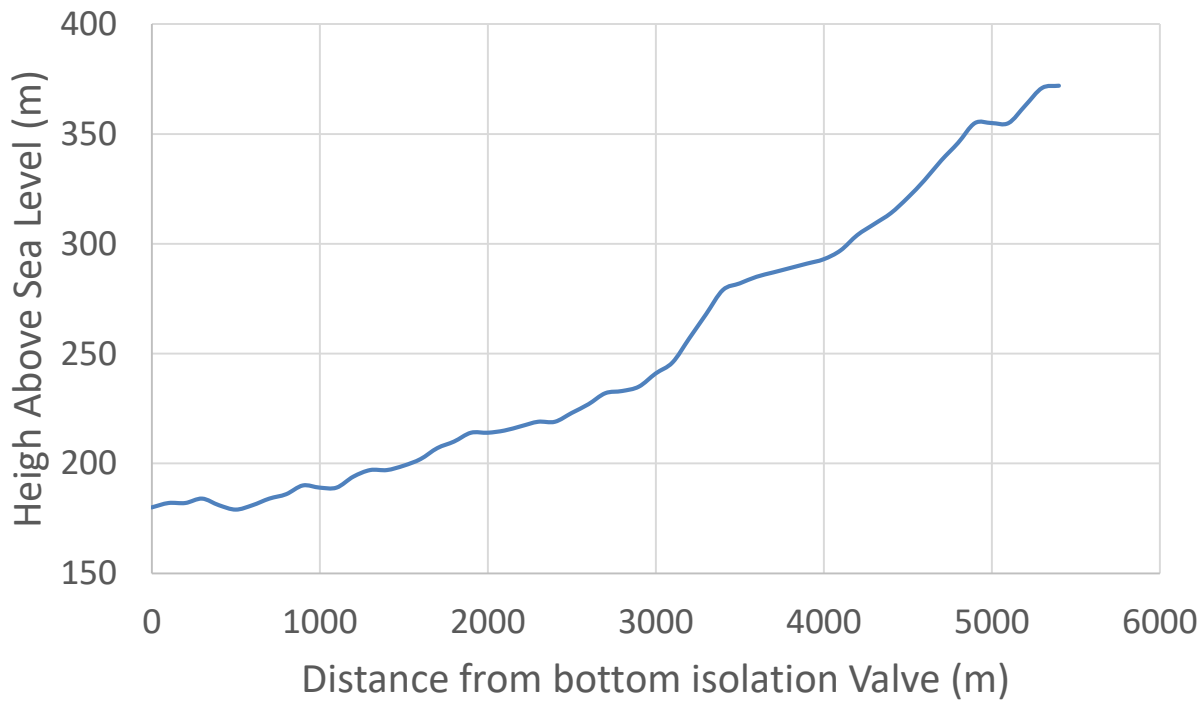
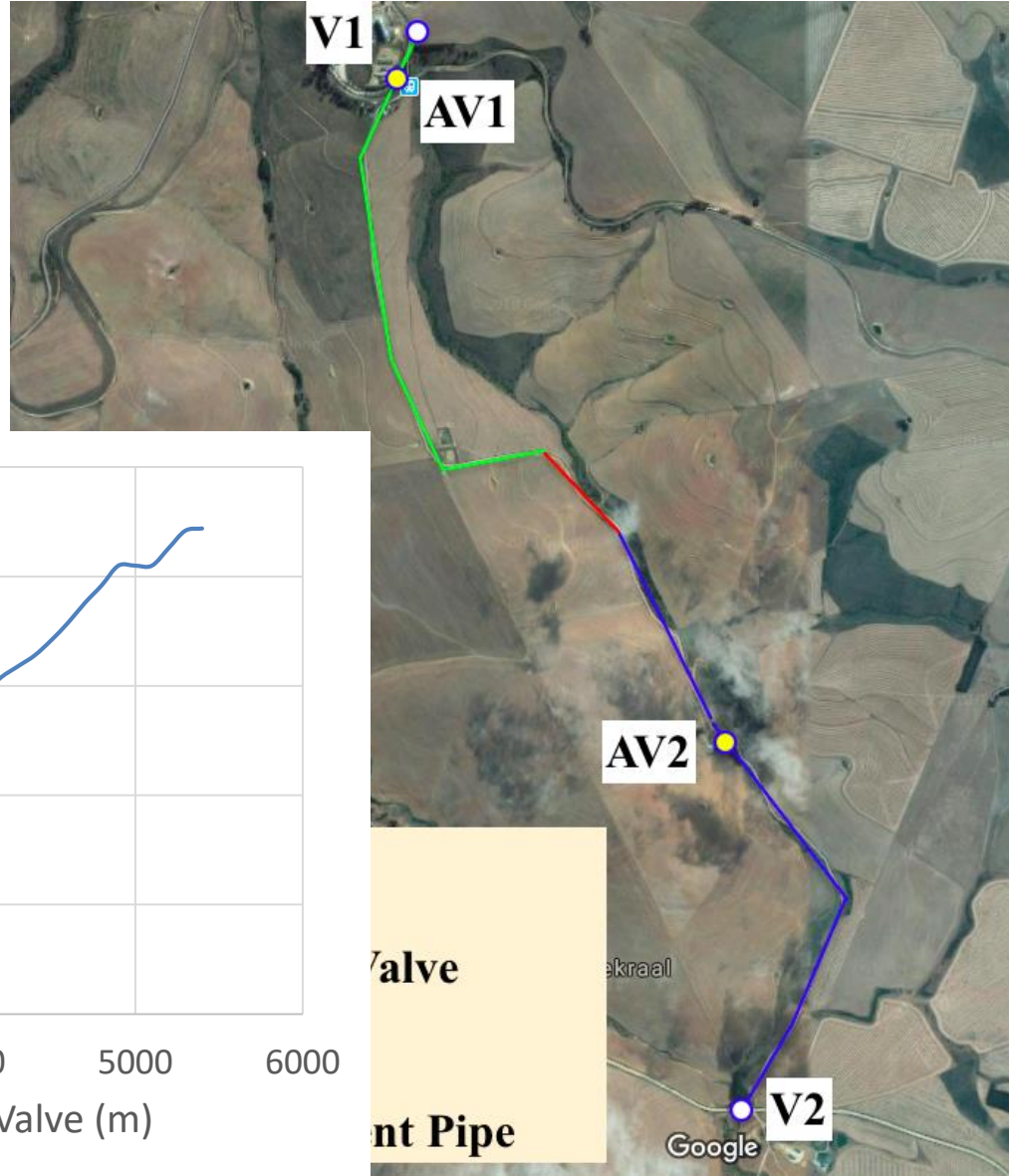
# Field test leak properties





**BIG BO**  
REFRIGERATED  
CONTAINER  
SOLUTIONS

# Field Test: Overberg



Valve

nt Pipe

AV2

V1

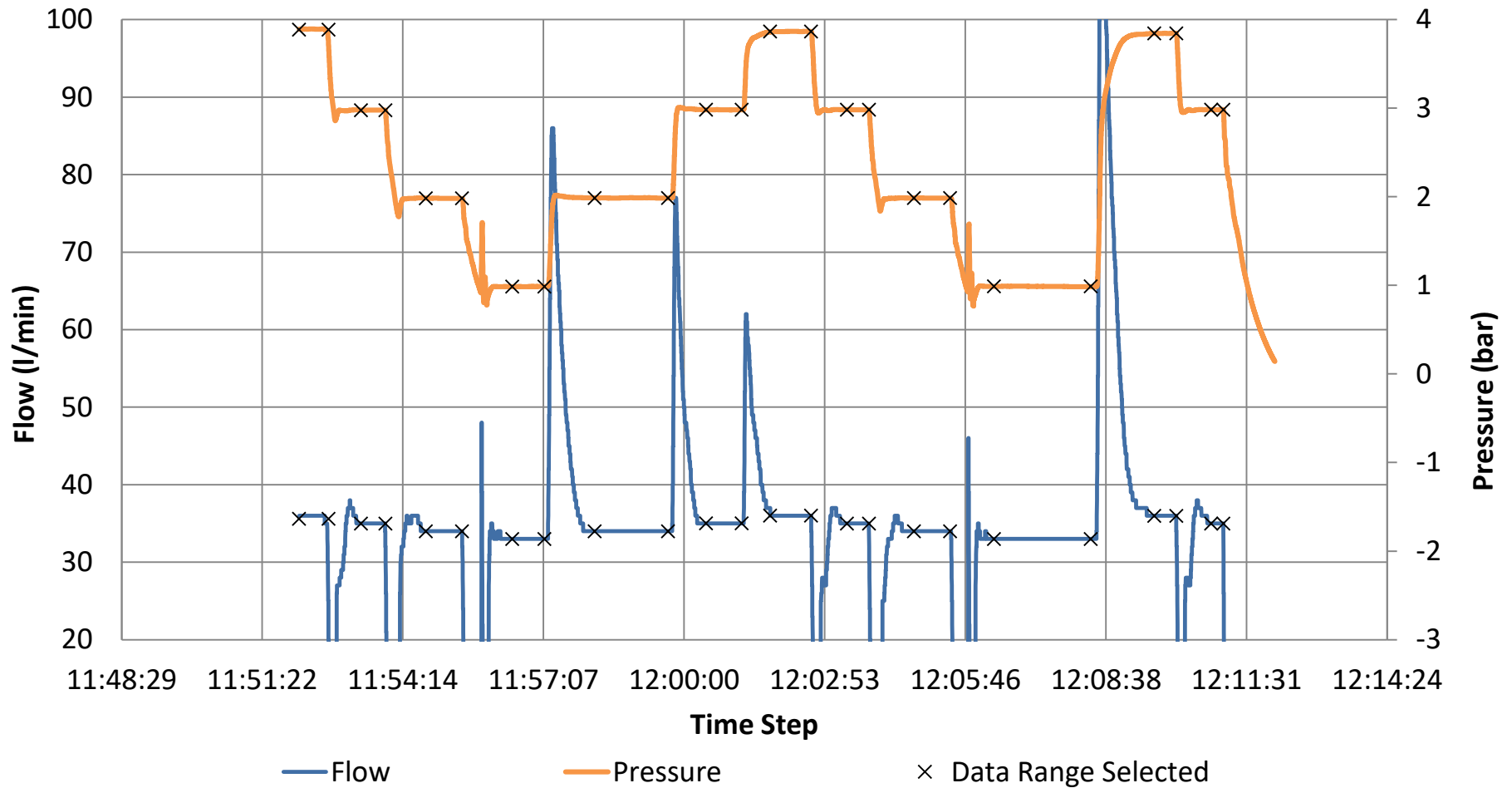
AV1

V2

Google



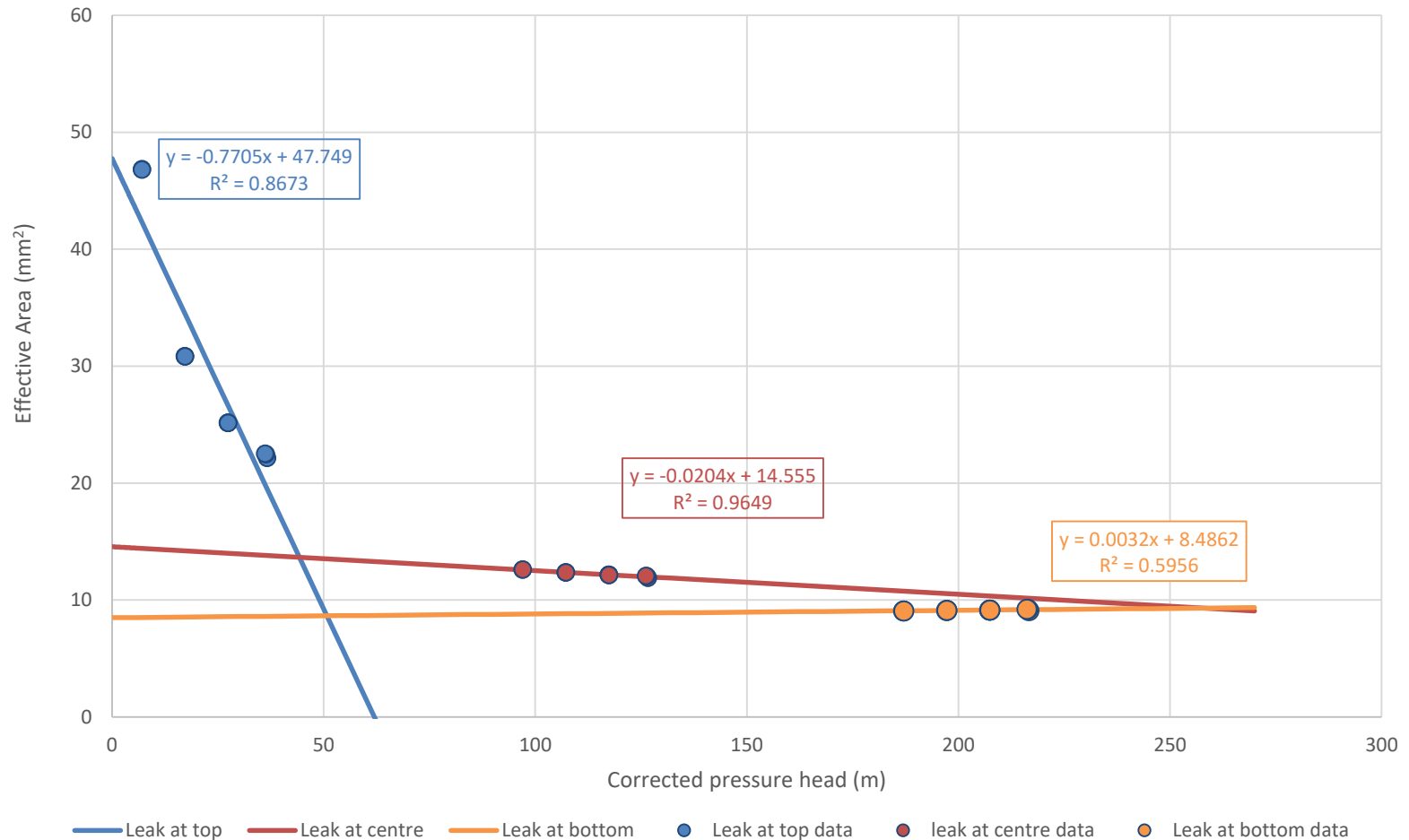
# Overberg: Field Test Results



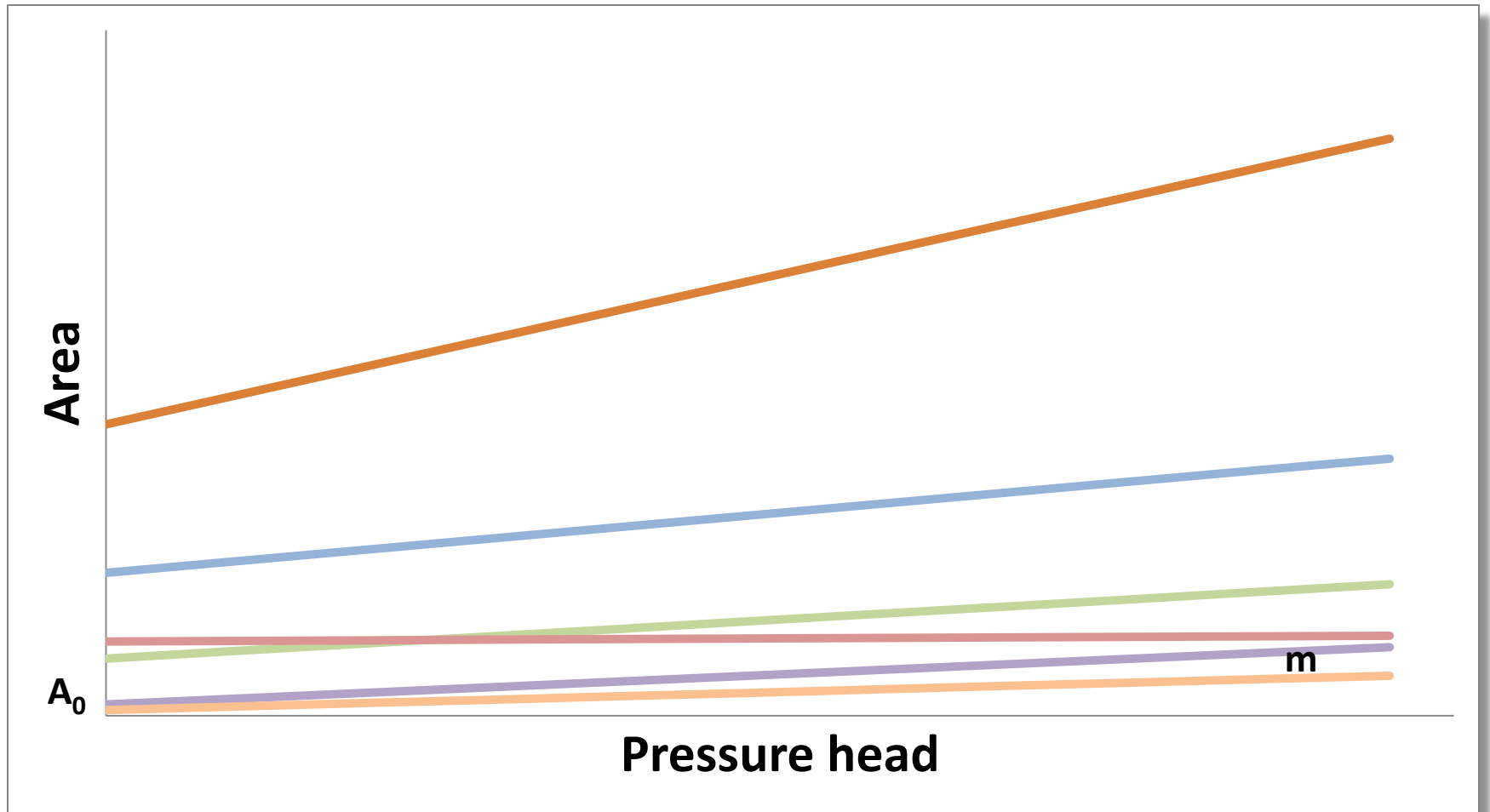


# Leak Area vs Pressure

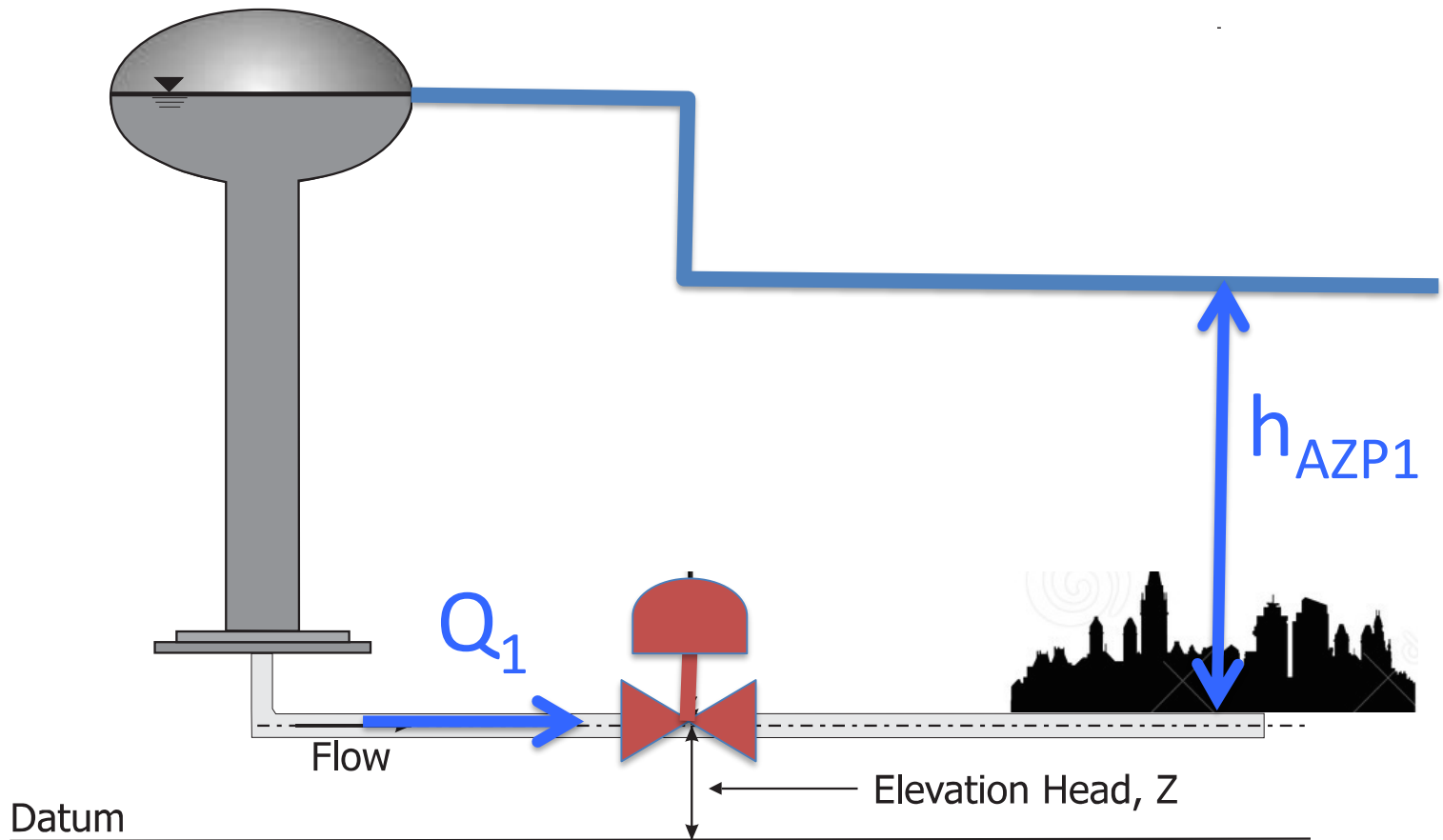
MOE Results



# DMA with many Leaks

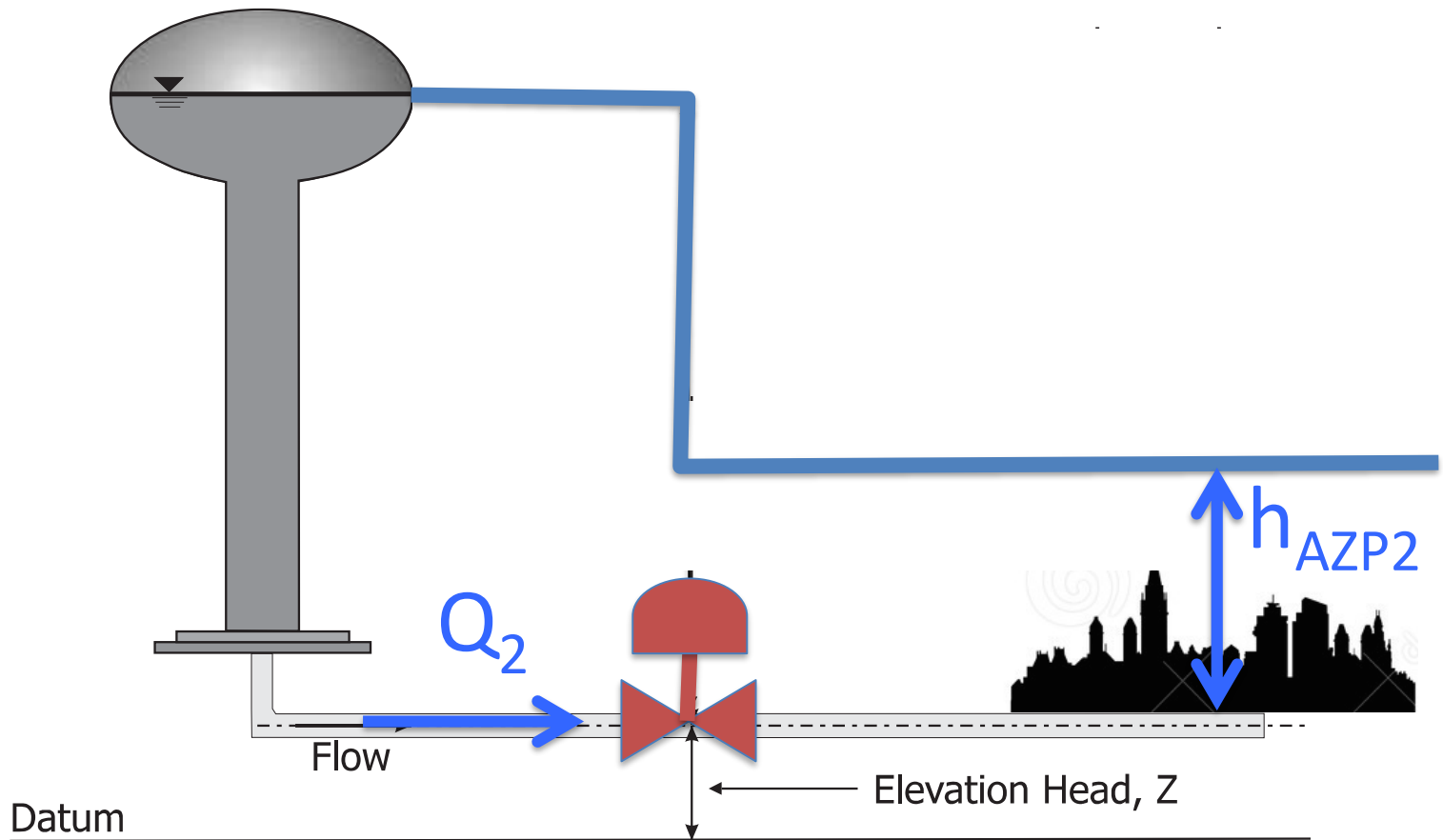


# Minimum Night Flow Conditions (Point 1)

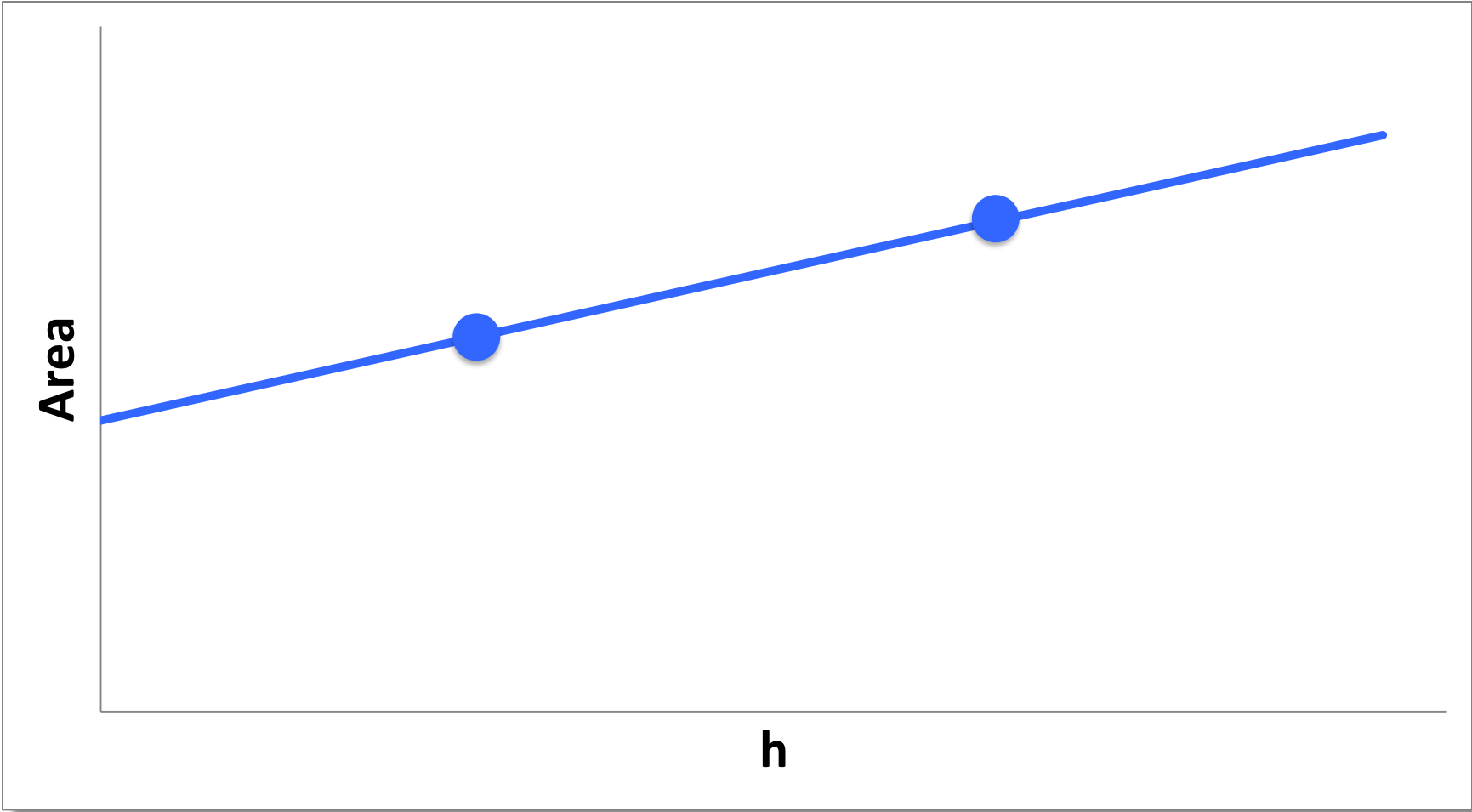




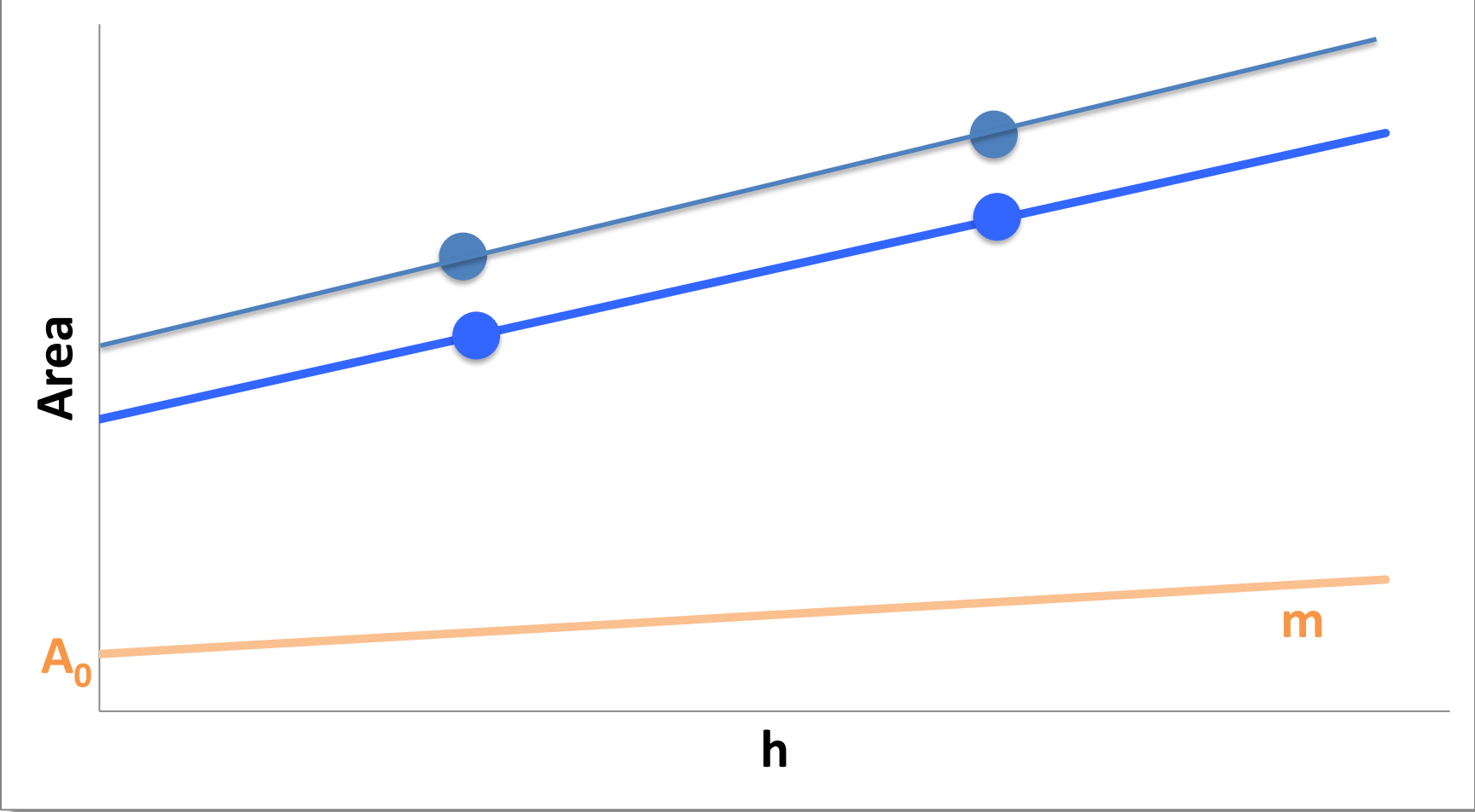
# Minimum Night Flow Conditions (Point 2)



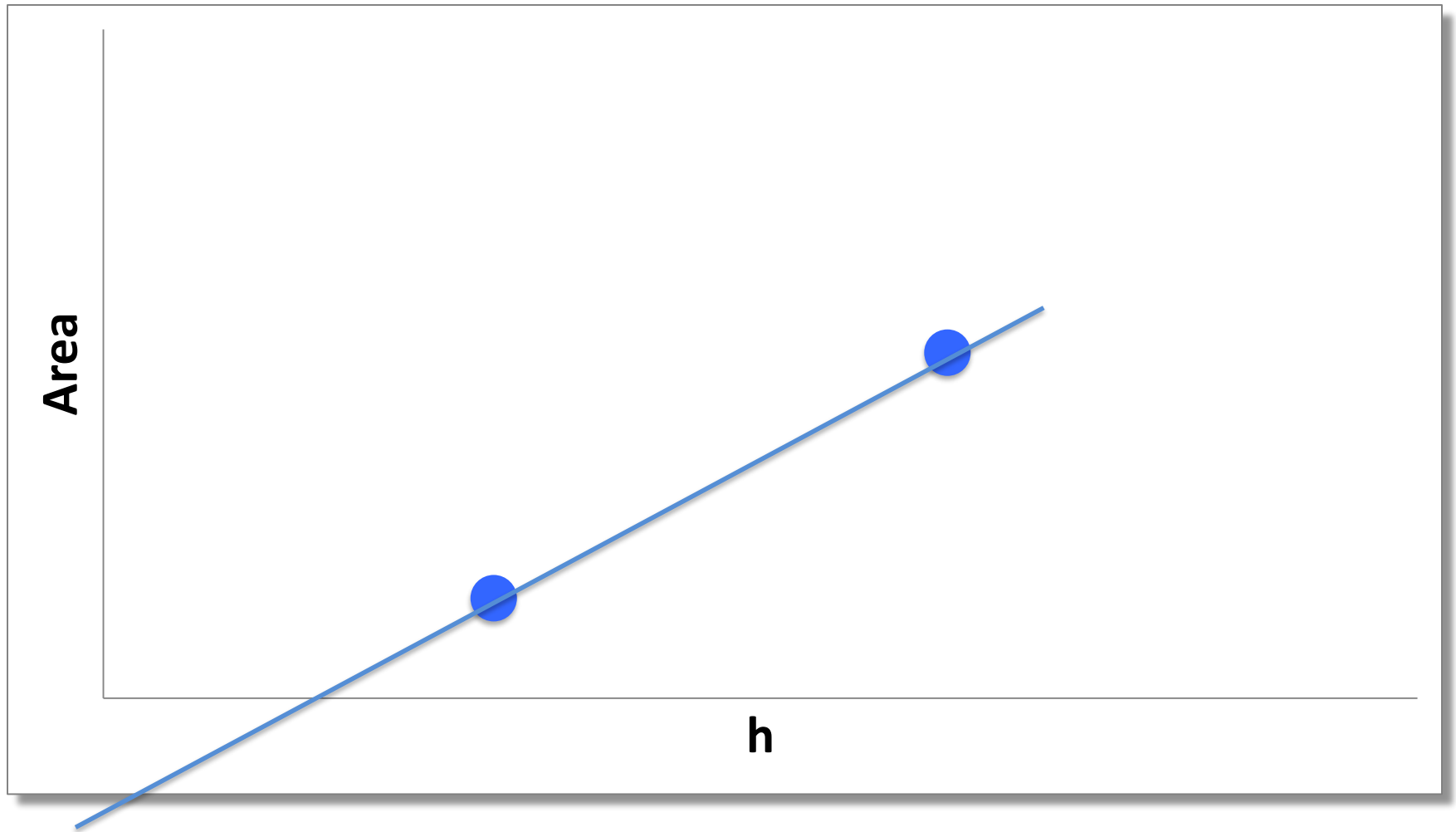
# DMA with Unknown Leaks



# DMA with Unknown Leaks



# DMA with Open Boundary Valve



Thank You!

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