Christchurch City Council

Urban Development and Transport Committee
MINUTES ATTACHMENTS

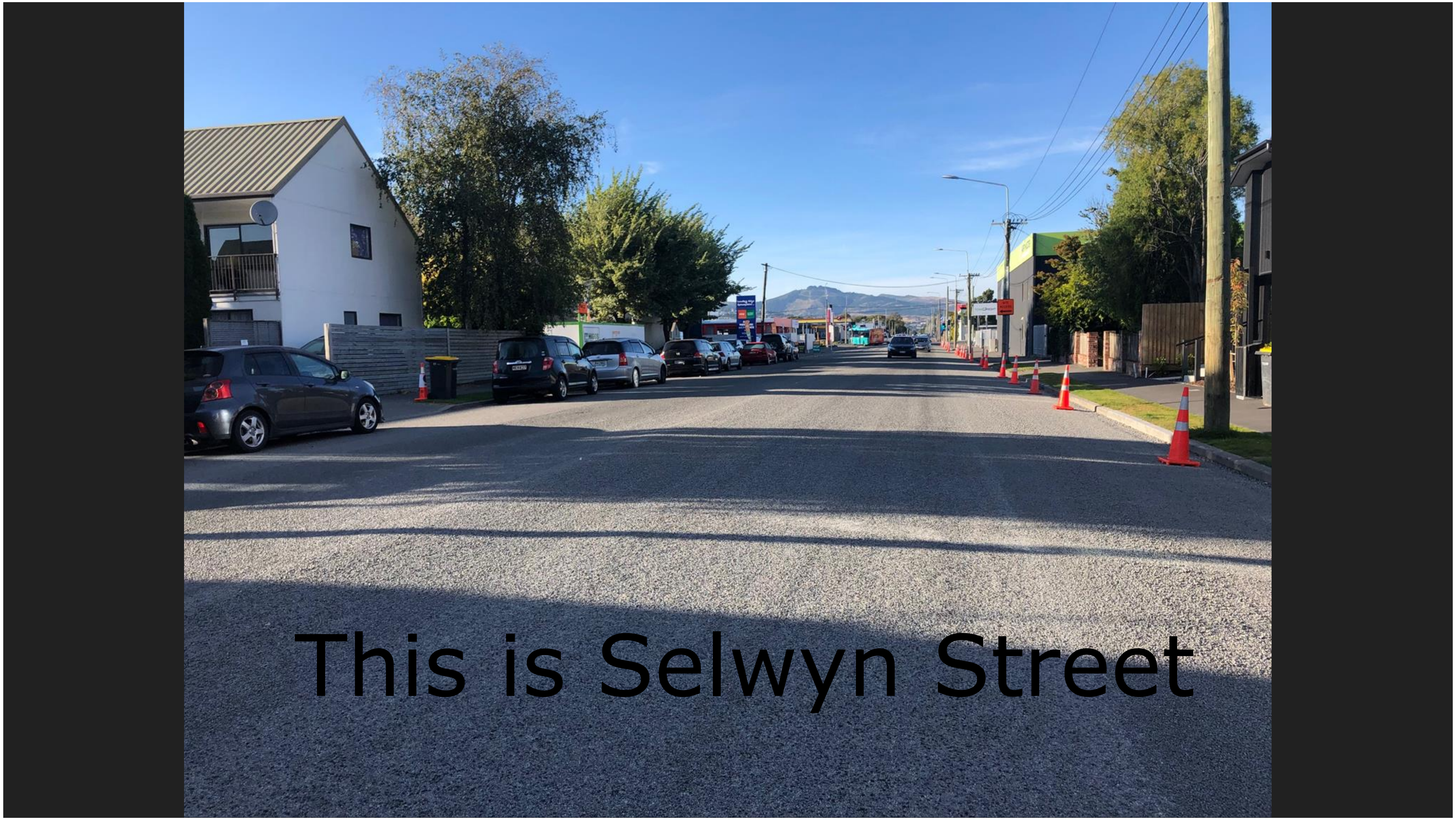
Date: **Thursday 31 March 2022**
Time: **9.30am**
Venue: **Held by Audio/Visual Link**

TABLE OF CONTENTS **PAGE**


Attractive
Christchurch
streets

Attachment A Item 4.1


Huanui Ln


This is Selwyn Street


NO ENTRY
select
TYRE & AUTO SERVICE
Christchurch Hospital
BRAKES
SUSPENSION
ALIGNMENT
NITROGEN
BATTERIES
It’s busy, especially being a route to hospital

Selwyn Street would be perfect for Streets for People, traffic calming

It’s used day and night

Different modes: cars/trucks/ambulances; buses; bikes (unprotected); scooters; pedestrians

Residents are growing

It’s by a school - and a preschool

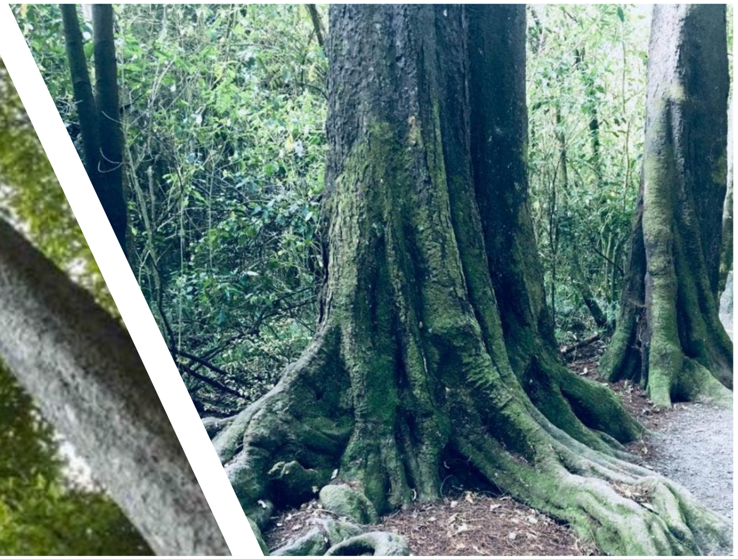
A facility for bone marrow cancer patients is being built, who need R&R


Selwyn Street is neglected
"You are pretty much in a high traffic CBD area but with none of the street concessions that come along with that status. Namely asphalting, a 30km speed limit and buildouts."
Please help!

Riccarton Bush Kilmarnock Residents' Association







CCC Vacuum Sewer System Capacity Constraints

Prepared: March 2022

Michele McDonald

Team Leader Asset Planning Water & Wastewater

Christchurch City Council

Contents

- SCIRT background
- SCIRT decision process
- Local pressure and vacuum design considerations
- Vacuum system performance issues
- Way forward
- Conclusion
- References

SCIRT background

- Stronger Christchurch Infrastructure Rebuild Team (SCIRT) was formed to manage the infrastructure rebuild following the earthquakes – including planning, design and construction phases
- The SCIRT Client Governance Group (CGG) was advised by several committees. Decisions were mostly made by the **Scope and Standards committee** in particular consisting of both Council and CERA representatives
- The **Infrastructure Rebuild Technical Standards and Guidelines (IRTSG)** developed by Council engineers and approved by the owner participants to issue to SCIRT through the Scope and Standards committee. Objectives included:
  - To return the infrastructure networks to a condition that meets the levels of service prior to the 4th September 2010 earthquake within the timing constraints of the rebuild
  - Where restoration work is undertaken, and where reasonably possible and economically viable , greater resilience is to be incorporated into the network
  - 'Like for like' restoration ONLY funded – betterment if economically favourable and required for the rebuild **had to be funded by Council**

Christchurch City Council

Attachment A Item 7

SCIRT decision process

- Concept designs were prepared for both the Shirley (PS25 and PS40) and Aranui (PS36) catchment areas
- Factors considered in the concept design phase:
  - Land damage and ground conditions as demonstrated by observed liquefaction, liquefaction resistance index, DBH technical categories (TC1, TC2, TC3), groundwater table
  - Asset age, maintenance history, condition assessments
  - Retention of existing assets with residual life or full replacement – demonstrable benefits required to justify replacement of compliant , functioning infrastructure – <u>if not economically favourable and required for rebuild it could be considered betterment</u>
  - Sites currently serviced towards the back of properties
  - Geographical context, catchment reshaping, optimisation
  - <u>Use of alternate technologies as economic alternatives or to provide greater resilience</u>
- Pipe rehabilitation and/or relining was always considered but for the above catchments, not possible due to the extensive damage

Vacuum Sewer System Briefing 16 March 2022 Slide 4

Christchurch City Council

SCIRT decision process

- Options were evaluated in terms of:
  - Constructability
  - Resilience
  - Planning / communication
  - Estimated life cycle costs
- Life cycle cost comparison included consideration of:
  - capital cost
  - operational cost
  - inflow & infiltration savings
  - further seismic damage costs

Table 8 – Comparison Costs (Costs based on Concept Design are +/- 25 %)

	Option 0 Replacement	Option 1 Enhanced Gravity	Option 2 Vacuum ABCE + Gravity D	Option 3 Vacuum ABCDE	Option 4 Pressure ABCDE	Option 5 Vacuum ABCE + Pressure D
a. Replacement cost[1]	$46.9 m	-	-	-	-	-
b. Like for Like[1]	-	$56.4 m	-	-	-	-
c. Betterment cost[2]	-	-	-	-	-	-
d. EQ Resilience cost[2]	-	-	$49.6 m	$50.7 m	$59.0 m	$49.1 m
e. Operational cost (NPV)[3]	$0.2 m	$0.9 m	$1.6 m	$1.9 m	$5.0 m	$2.2 m
f. Inflow/infiltration savings (NPV)	-$1.06 m	-$1.11 m	-$1.4 m	-$1.5 m	-$1.7 m	-$1.6 m
g. First Response and Network Rebuild (NPV)[4]	$17.0 m	$14.7 m	$7.6 m	$7.1 m	$6.4 m	$6.7 m
Comparison cost (a+b+c+d+e+f+g)	**$63.0 m**	**$70.8 m**	**$57.5 m**	**$58.2 m**	**$68.7 m**	**$56.4 m**

SCIRT decision process

Aranui Options

Option	System	Capital Cost ($million)	Life Cost ($million)	Multi-criteria Score
0	Replacement	$46.9	$63.0	45%
1	Enhanced Gravity	$56.4	$70.8	41%
2	Vacuum ABCE + Gravity D	$49.6	$57.5	58%
3	Vacuum ABCDE	$50.7	$58.2	67%
4	Pressure ABCDE	$59.0	$68.7	63%
5	**Vacuum ABCE + Pressure D**	**$49.1**	**$56.4**	**75%**

Shirley Partial Options (150 houses)

Option	System	Capital Cost ($million)	Life Cost ($million)	Multi-criteria Score
1	Gravity	$4.7	$6.3	
2	Pressure	$4.5	$5.1	
3	**Vacuum**	**$3.4**	**$4.3**	

Shirley Full Options (610 houses)

Option	System	Capital Cost ($million)	Life Cost ($million)	Multi-criteria Score
1	Enhanced Gravity (involving 3 new pump stations + 4 lift stations + some pressure)	$12.0	$12.5	29%
2	**Vacuum**	**$9.5**	**$9.9**	**50%**

SCIRT decision process

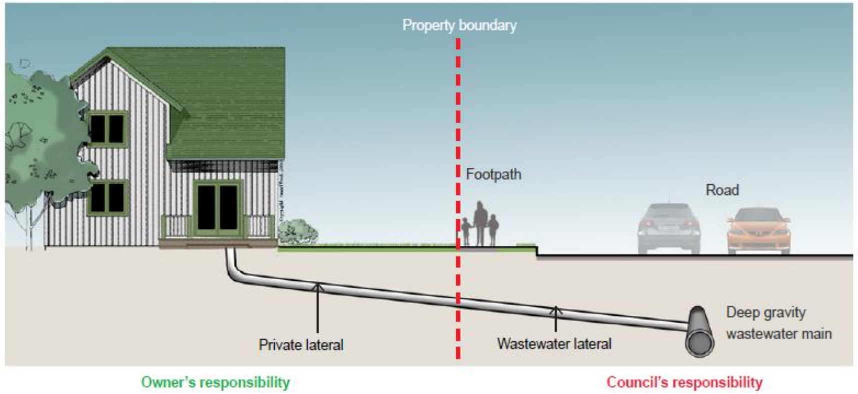
- Several meetings were convened during the concept planning phase with the Council's Wastewater Asset Owner Representative as well as with SCIRT and City Care experts
- Workshops were held with Asset Owner Representatives and Technical Leads to discuss options and confirm acceptance of the concept design direction
- This was followed with presentations to the Asset Owners
- Finally, the decision was approved by the SCIRT Scope and Standards Committee
- During the SCIRT decision process, Ngai Tahu independently concluded that Prestons should be developed as a vacuum sewer catchment - it was therefore understood by the Asset Owner Representatives at that time, that vacuum sewer technology would be introduced in due course

SCIRT decision process

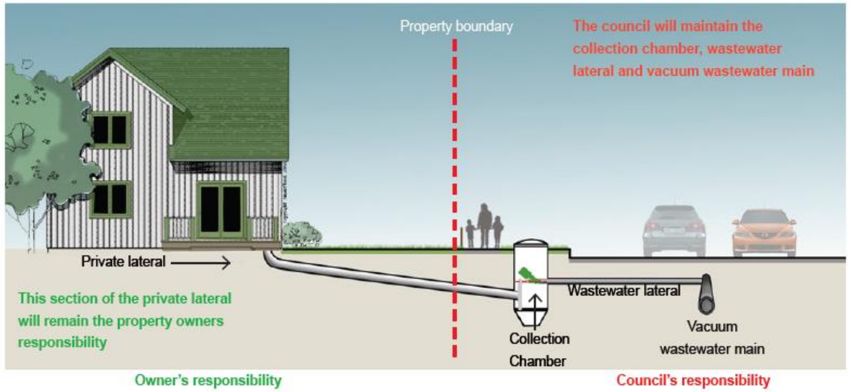
- Why not Pressure Sewer Systems:
  - Works on private property requires property owner consent
  - Delays to obtain property owner agreement on location of pump chamber
  - Social impacts – systems were regarded negatively by the community
  - Aesthetic issues were raised
  - Construction on private property
  - Legal arrangements – agreement needed / vesting of infrastructure
  - Works on private property highly susceptible to abuse or misuse
  - Ongoing maintenance accessibility issues
  - Flotation of tanks in liquefied ground (can be mitigated)
  - Higher initial capital costs / higher life cycle cost
- The above resulted in the decision that pressure sewers to be used only in areas with the greatest risk of land damage or where required to move services to the front of the property

Local Pressure and Vacuum Design Considerations

The existing wastewater system



The new vacuum wastewater system

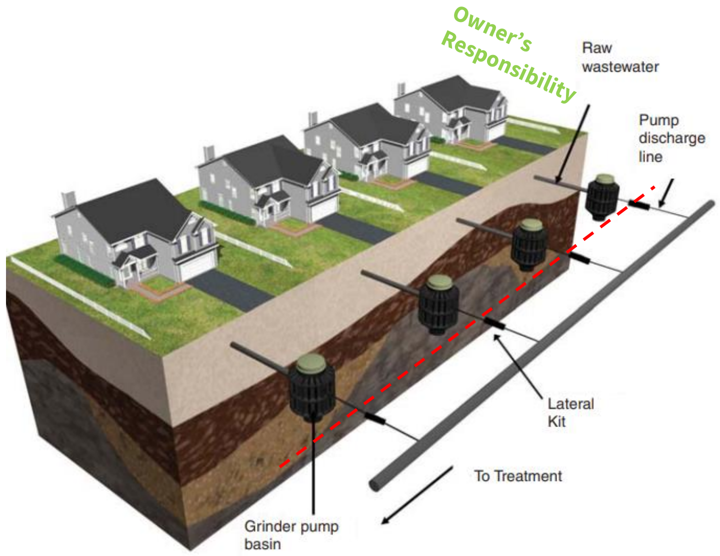


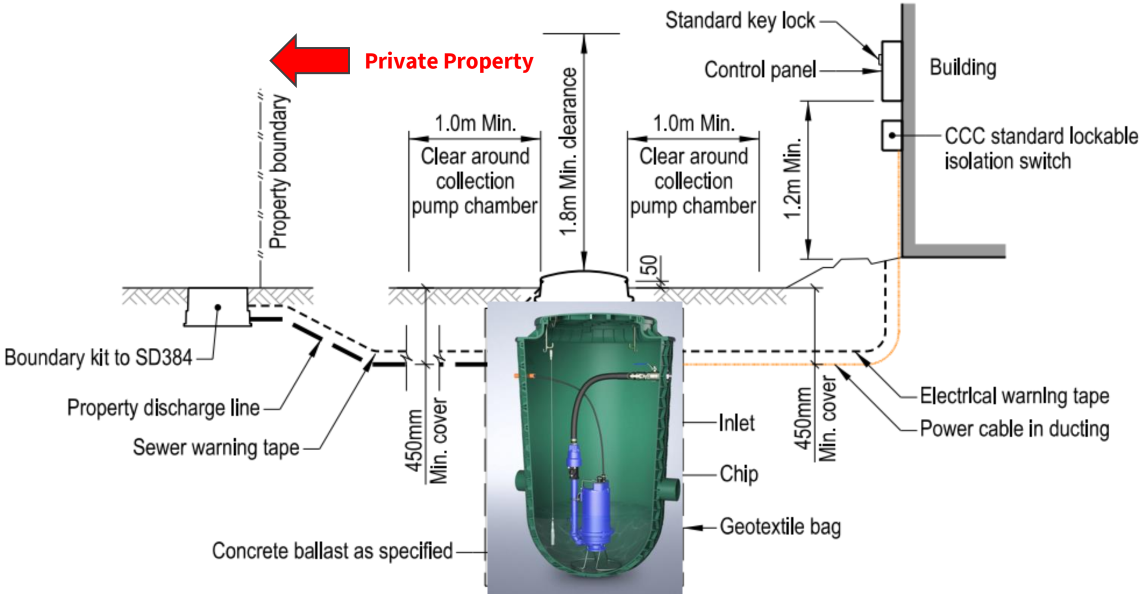
In a conventional gravity wastewater system, private sewer laterals are connected to deep gravity wastewater mains which convey wastewater to the wastewater treatment plant.

In a vacuum system, **4 (preferred) number of houses** are connected to a vacuum valve/collection chamber. The vacuum pump station establishes a vacuum in the pipes and the valves open pneumatically to allow wastewater to be sucked out of the chamber towards the vacuum pump station.

Local Pressure and Vacuum Design Considerations

The local pressure sewer system





On street pressure is a potential alternative but has major power installation costs and administration burden attached to it

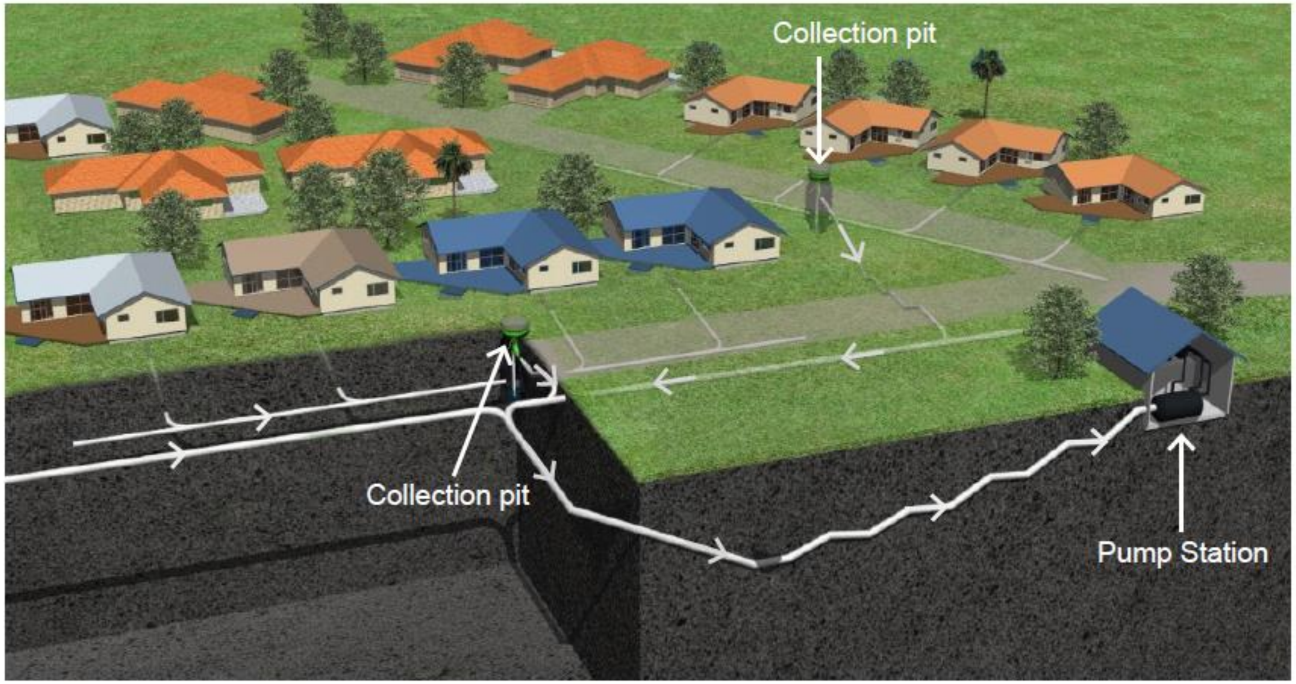
Council's Responsibility

Item 7

Attachment A

Local Pressure and Vacuum Design Considerations

Vacuum Sewer Network



Network of vacuum mains from small to large

Separate vacuum arms

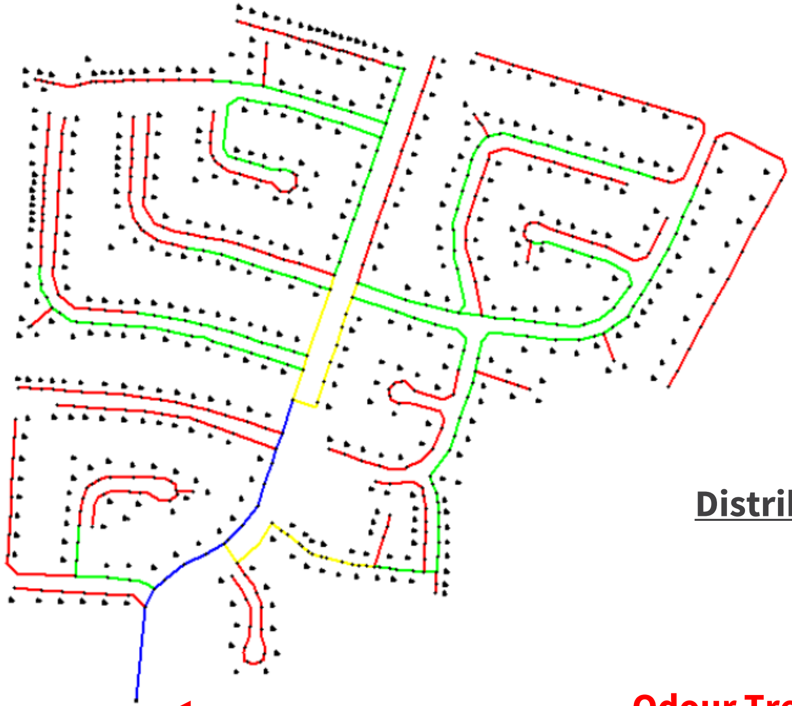
Shirley - 3 vacuum mains enter PS but single pipe creates vacuum in all arms

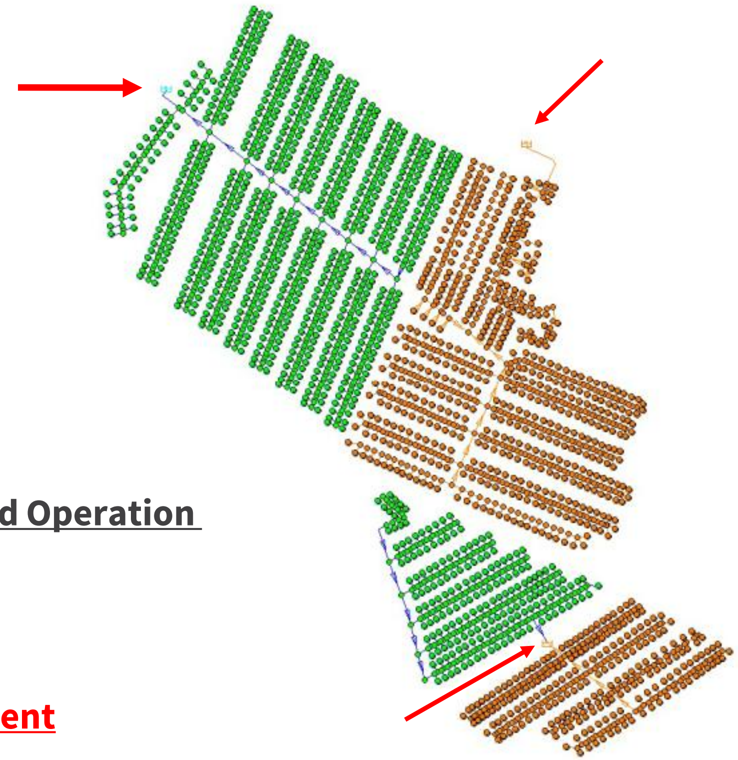
Aranui/Prestons – 6 vacuum mains enter PS but single pipe creates vacuum in all arms

Centrally Operated

Local Pressure and Vacuum Design Considerations

Pressure Sewer Network





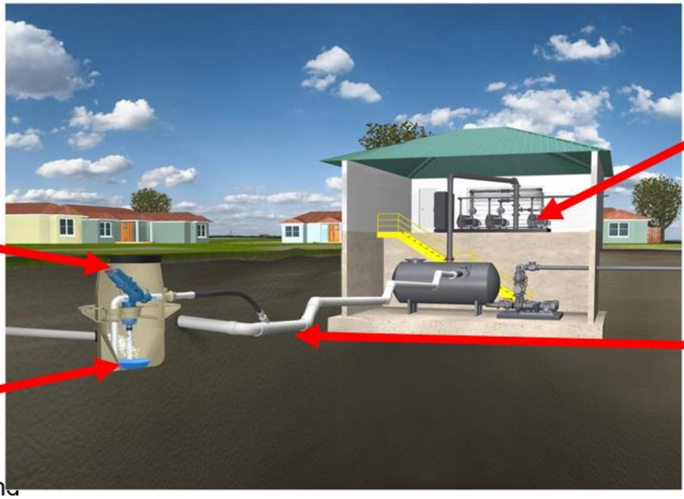
Distributed Operation

Odour Treatment

Local Pressure and Vacuum Design Considerations

Vacuum Pump Station

3) A normally closed interface valve in the valve pit keeps vacuum on the main



1) Vacuum pumps create a vacuum on the collection tank & then shut off

2) Vacuum mains connected to the tank extend the vacuum to each valve pit

4) Interface valve opens, contents sucked out, followed by atmospheric air and differential pressure propels sewage toward vacuum station

5) As valves open and admit atmospheric air, vacuum levels will drop. This is sensed at the vacuum station & the vacuum pumps come on to restore vacuum.

OR several satellite pump stations and rising mains

What would an upgrade entail?

- increased size of vacuum pipes where they have reached the maximum flow capacity or duplicate pipes
- upgrade of the pump station including the vacuum pumps, the vacuum collection tank, the wastewater pumps and the rising main or more pump stations
- more vacuum sewer valve chambers to be added - BUT a redesign may be needed as well as adding more chambers only will alter the air-to-liquid ratio

Local Pressure and Vacuum Design Considerations

Design Codes:

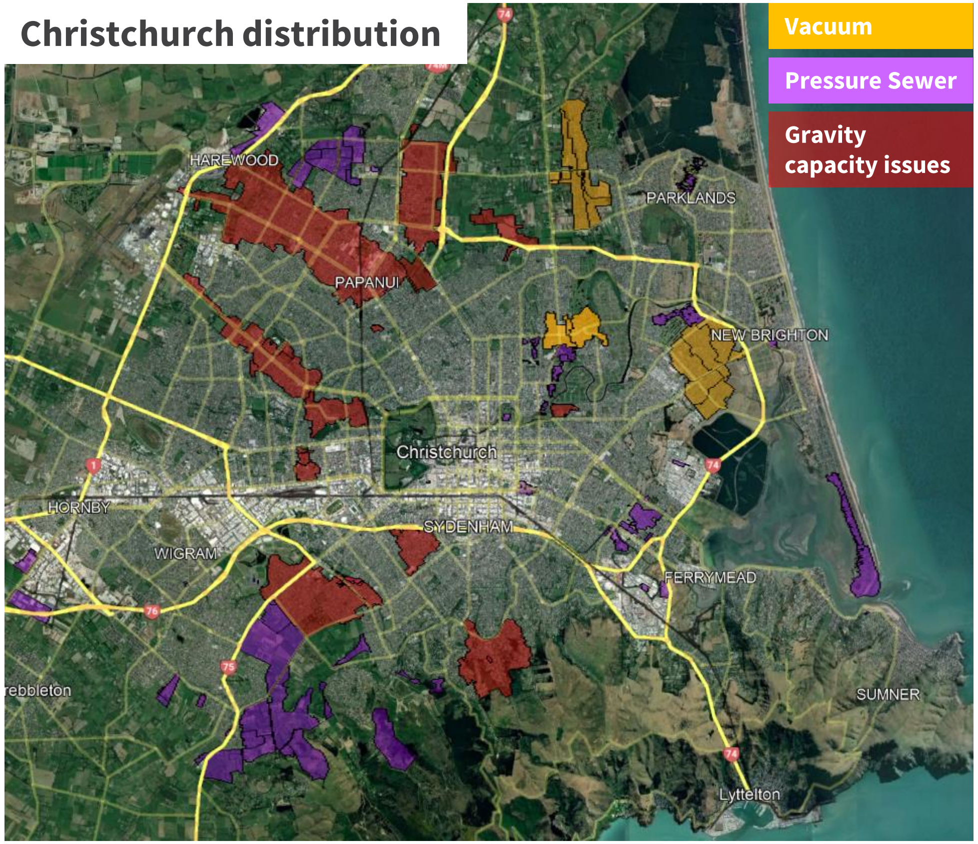
- Vacuum Sewerage Code of Australia WSA 06-2008
- Pressure Sewerage Code of Australia WSA 07-2007
- AS/NZS - pipe manufacture and design codes
- Council Infrastructure Design Standard (IDS)

The vacuum design code states that because PE welded pipes are used for the vacuum pipes, that inflow and infiltration should only be recognized for the gravity part of the system but that an allowance must still be made for stormwater and groundwater infiltration.

The Council Infrastructure Design Standard states that :

- *for pressure sewer systems, the maximum flow (MF) factor is not used because the 24 hour storage chamber and pump dampen the peak flows*
- *for vacuum sewer systems, use a maximum flow (MF) factor as per gravity systems i.e. 2.78 of peak design flow*

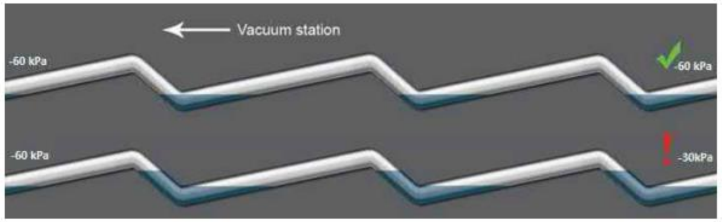
Christchurch distribution



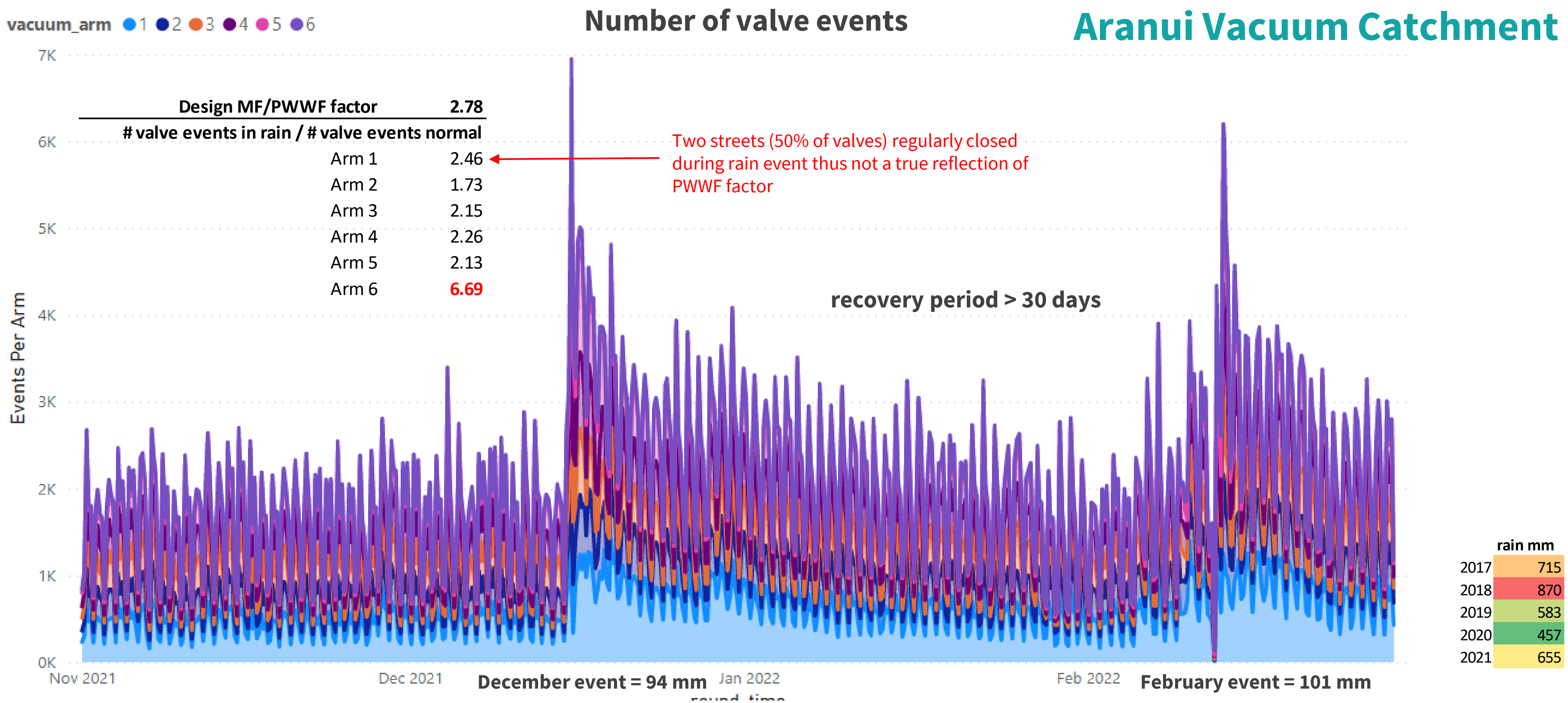
Vacuum System Performance Issues

1. Inflow and infiltration flow (MF/PWWF) exceeds the design allowance

- **The risk of high I&I from damaged private property laterals was highlighted in the Shirley and Aranui design phase**
- The approach adopted was to perform CCTV inspections of private laterals as part of the SCIRT project and to advise the property owner that it is their responsibility to repair damaged pipes, and to recover costs from EQC or their insurers.
- Vacuum system performance is dependent on maintaining the balance between air and liquid in the pipes (air-to-liquid ratio) – this requires regular checking and setting of individual valve controls and ensuring that the vacuum mains do not become waterlogged
- Where flows exceed the design allowance into the collection chamber and through the vacuum valves, the system responds as follows:
  - Waterlogging of the vacuum mains causing reducing vacuum pressure in the network
  - Potential loss of service to parts of the catchment
  - Higher vacuum pump runtimes
  - Irregular air to liquid ratio
  - Sluggish system performance

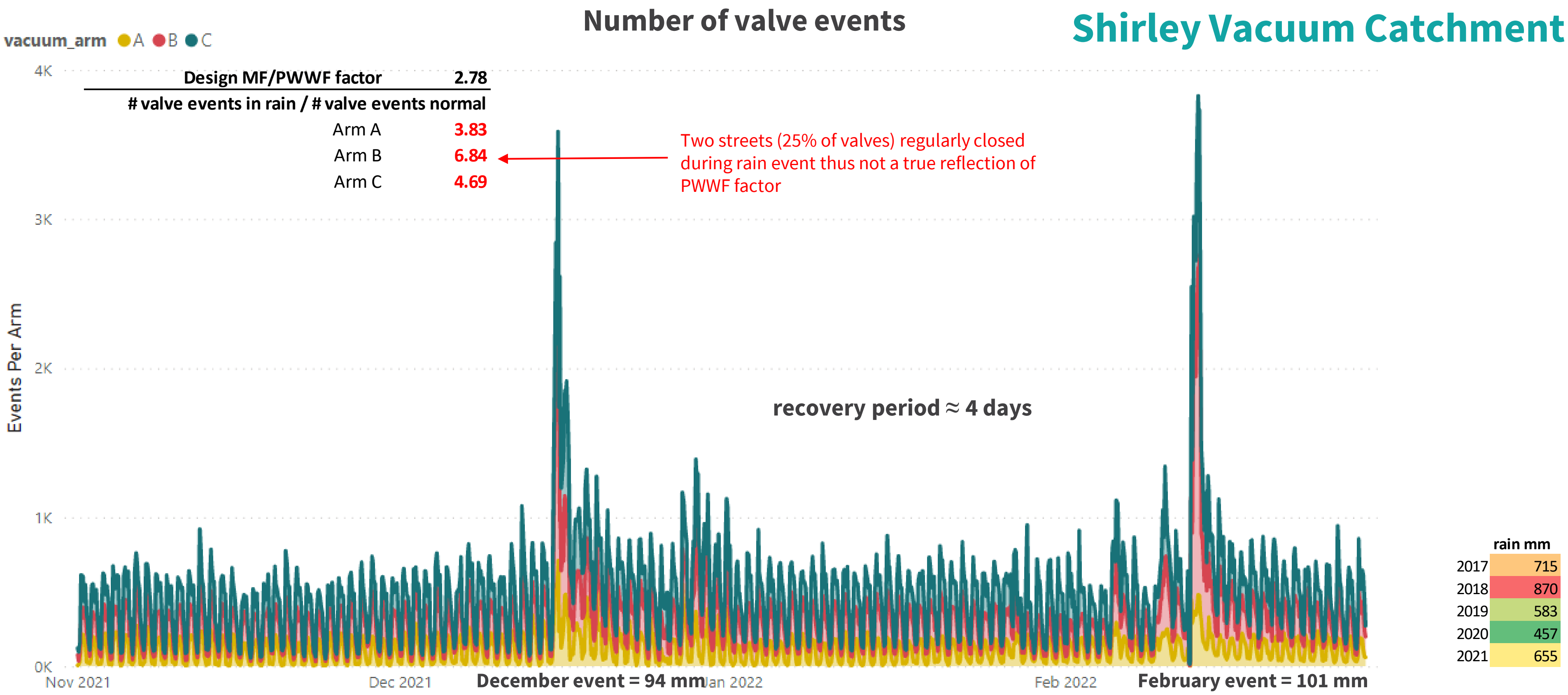


Vacuum System Performance Issues



Vacuum System Performance Issues

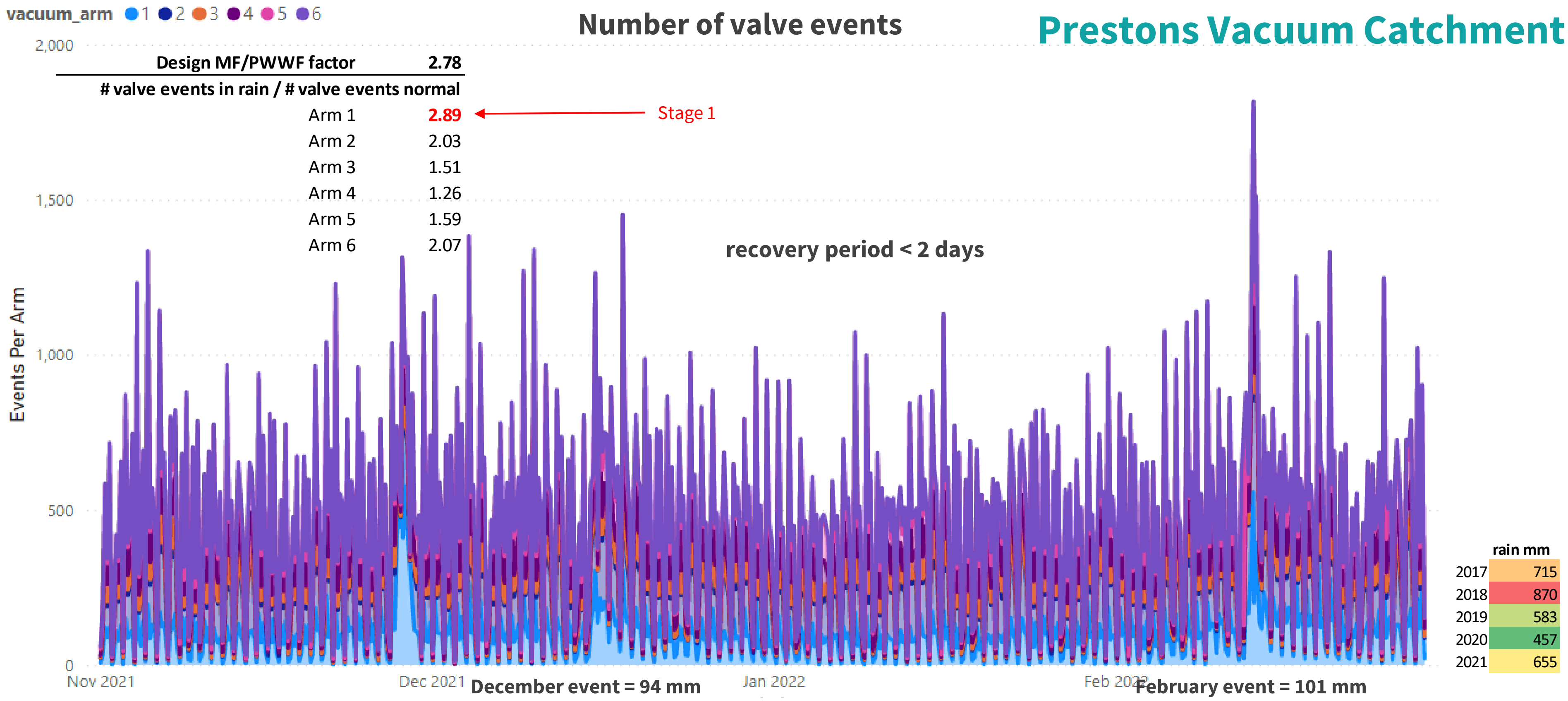
Shirley Vacuum Catchment



Item 7

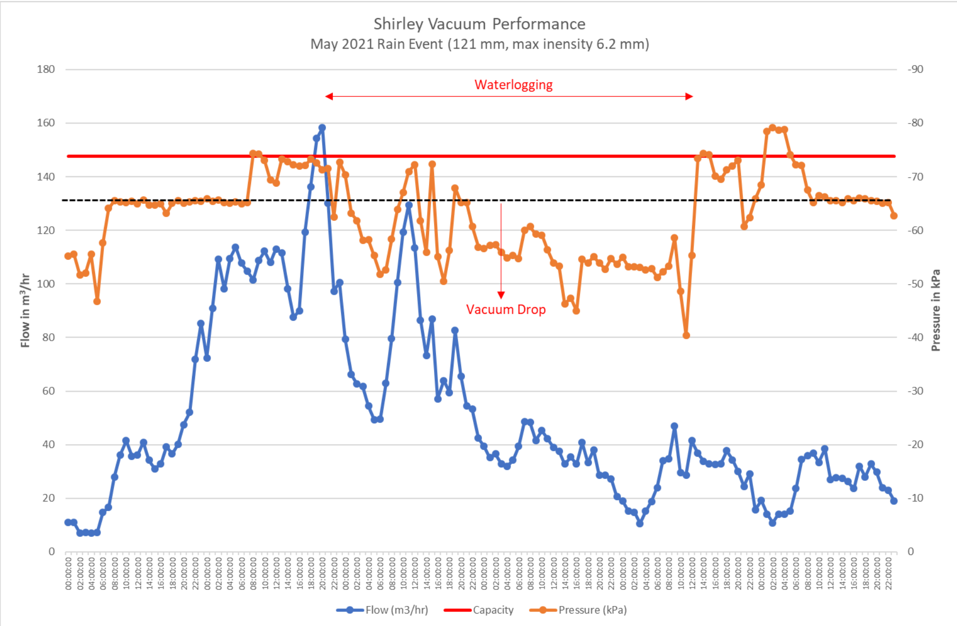
Attachment A

Vacuum System Performance Issues

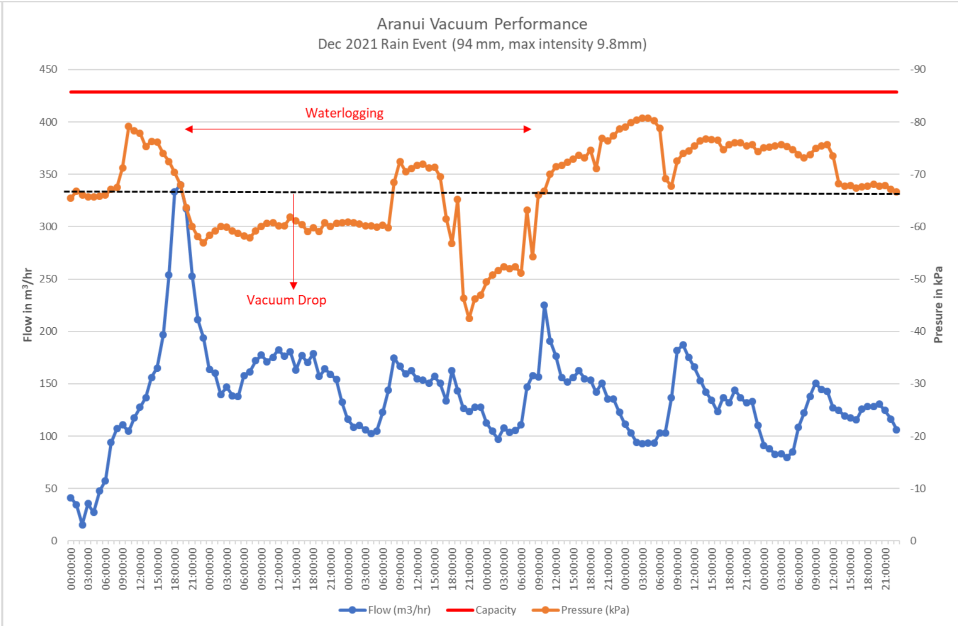


Vacuum System Performance Issues

Shirley – May 2021 Rain Event

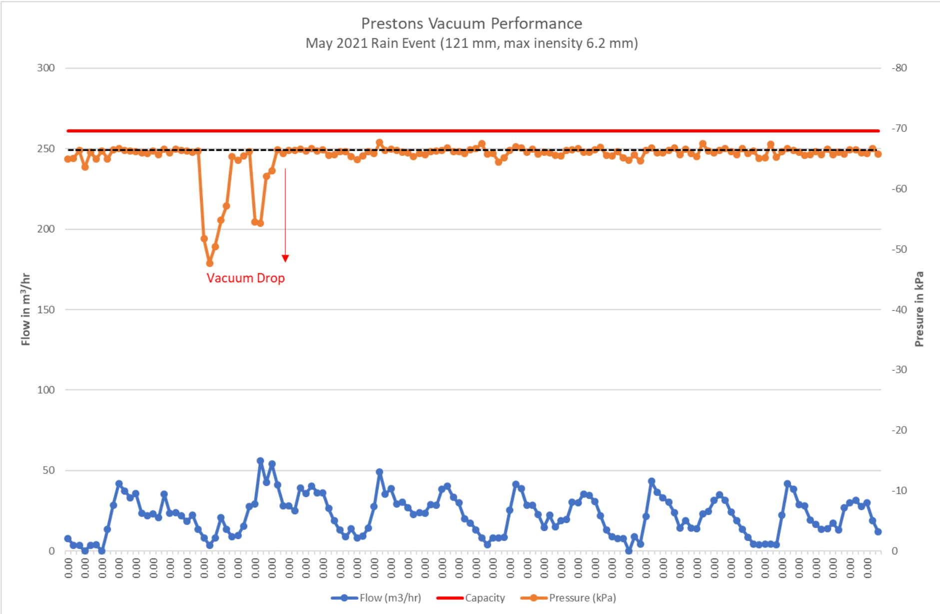


Aranui – December 2021 Rain Event

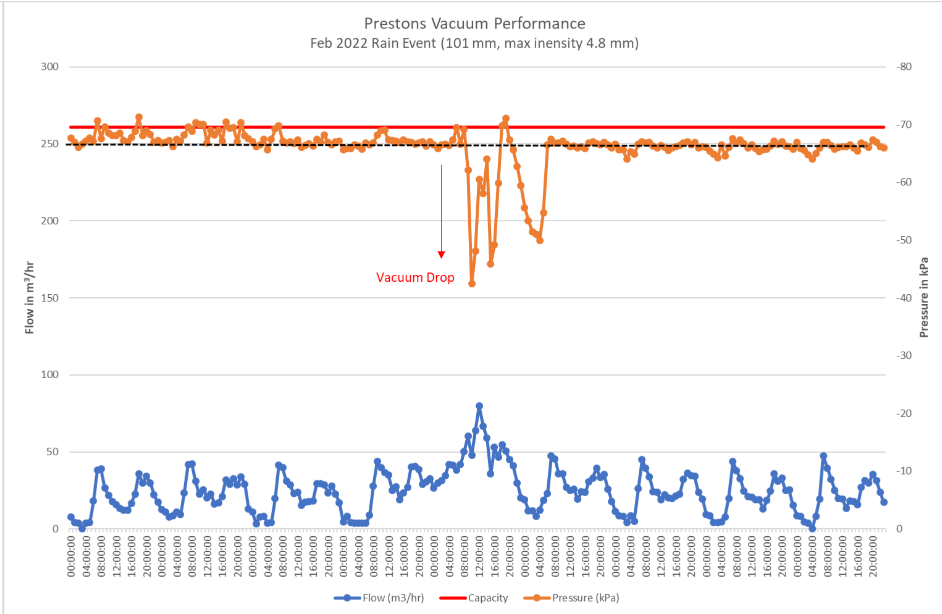


Vacuum System Performance Issues

Prestons – May 2021 Rain Event



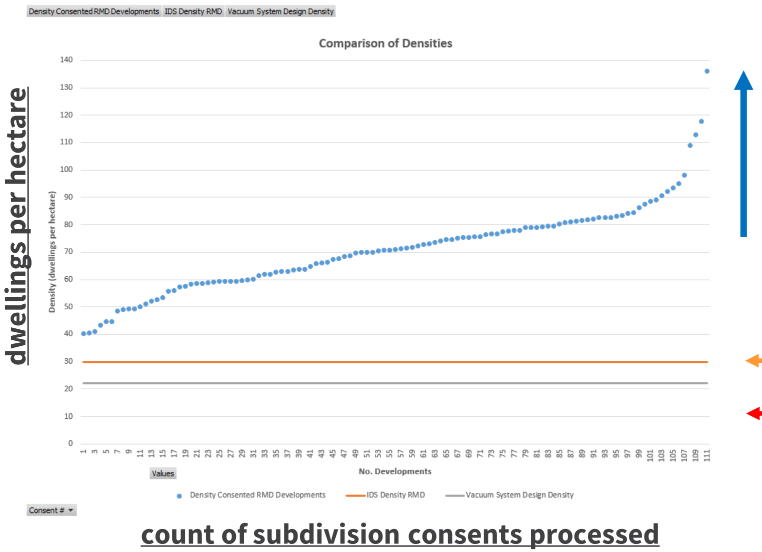
Prestons – February 2022 Rain Event



Vacuum System Performance Issues

2. Design flow rates based on CCC Living 1 Zone requirements in Shirley and Aranui

- Pipe sizing provided for properties to be subdivided into parcels of 450 m^2 per dwelling, plus an allowance for a driveway
- Vacuum pits were designed and placed for the current number of dwellings only



Medium Density Residential Standards

Minimum Density for Residential Medium Density (current District Plan)

Aranui Design 11 - 29 houses per hectare

Shirley Design at 10 - 16 houses per hectare

Vacuum System Performance Issues

3. RMD zone in Shirley enabled based on many assumptions

RMD = Residential Medium Density

- The 2016 District Plan change that zoned 30% of the Shirley vacuum catchment as Residential Medium Density was **enabled by a SCIRT technical memo in September 2014 (before the vacuum system was commissioned)**
- The advice concluded that a potential increase of 341 dwellings could be accommodated **if** the peak wet weather flow component assumed in the design is reduced by 15% (i.e. PWWF of 2.4). The following risks were highlighted:
  - Exceeding the vacuum station capacity could result in pumps failing to cope and temporary shut down of the vacuum reticulation. Continued flows in excess of the maximum design flow could be accommodated if the sewage pumps were modified or upgraded. Vacuum pumps may have to be upgraded.
  - Additional flow in excess of the designed maximum flow could result in reduced air-to-liquid ratio in the vacuum mains and loss of vacuum in the reticulation resulting in vacuum valves having insufficient vacuum to operate
- It was recommended that:
  - CCC should monitor the actual capacity and ensure that new developments do **not exceed the design maximum flow**
  - Where existing dwellings develop under the District Plan, CCC to ensure that additional flow rate and storage conform with the requirements of the IDS and WSA-06 vacuum code
  - **CCC to assess the wet weather response in the system after commissioning to quantify spare capacity**
  - **CCC ensure repair or renewal of private property laterals where infiltration is identified**

Vacuum System Performance Issues

3. RMD zone in Shirley enabled based on many assumptions

RMD = Residential Medium Density

- Issues with the advice provided:
  - **Assumed that the additional growth would be assigned proportionate to the theoretical spare capacity for each arm**
  - **Assigned the theoretical PS spare capacity as additional spare capacity and thereby exceeded the design code for the individual arms (as recommended should not be allowed by CCC)**
  - Relied on dry weather flow monitoring taken immediately after the earthquakes, when many of the properties were vacant
  - Assumed that the wet weather peak factor would be less than the design allowance because the WSA06-2008 code states that groundwater infiltration, and inflow and infiltration should only apply to the gravity part of the sewer system
  - Assumed ZERO I&I contribution from new, intensification houses i.e. no additional inflow issues for these sites
  - **Assumed that high flows after the commissioning can be quickly identified and causes be easily dealt with**
  - **Assumed that I&I flow rate would be evenly distributed throughout the catchment**
  - **Assumed that density for the RMD zone would not exceed the minimum level i.e. 30 houses per hectare**

Way forward: Actions Already Implemented

1. **Vacuum Sewer System Monitoring** – installed 1,494 vacuum monitoring devices plus dashboard ($1,700,000)

2. As advised by the Suppliers, CCC installed 13 off **Automatic Air Inlet Systems (AAIS)** at the end of arms which are prone to waterlogging. The AAIS detect low vacuum within a vacuum main, and allows additional air to be introduced into the system to reduce the risk of vacuum loss. But noted that while the AAIS will reduce the risks to the system during wet weather, the introduction of additional air may reduce the vacuum pumps ability to handle the maximum flow($910,000)

3. Draft **Water Supply and Wastewater 2022 Bylaw** – Clause 32 strengthens the Council's rights in terms of the Local Government Act, 1974

   If the Council believes that wastewater drains on private property are deficient, damaged, blocked, receiving excessive inflow and infiltration, are leaking, or are otherwise not in a satisfactory operating state; the Council may require the property owner to investigate the drain and rectify any issues, at the owner's cost.

   Where the Council requires a property owner to investigate and rectify any issues, a property owner must:

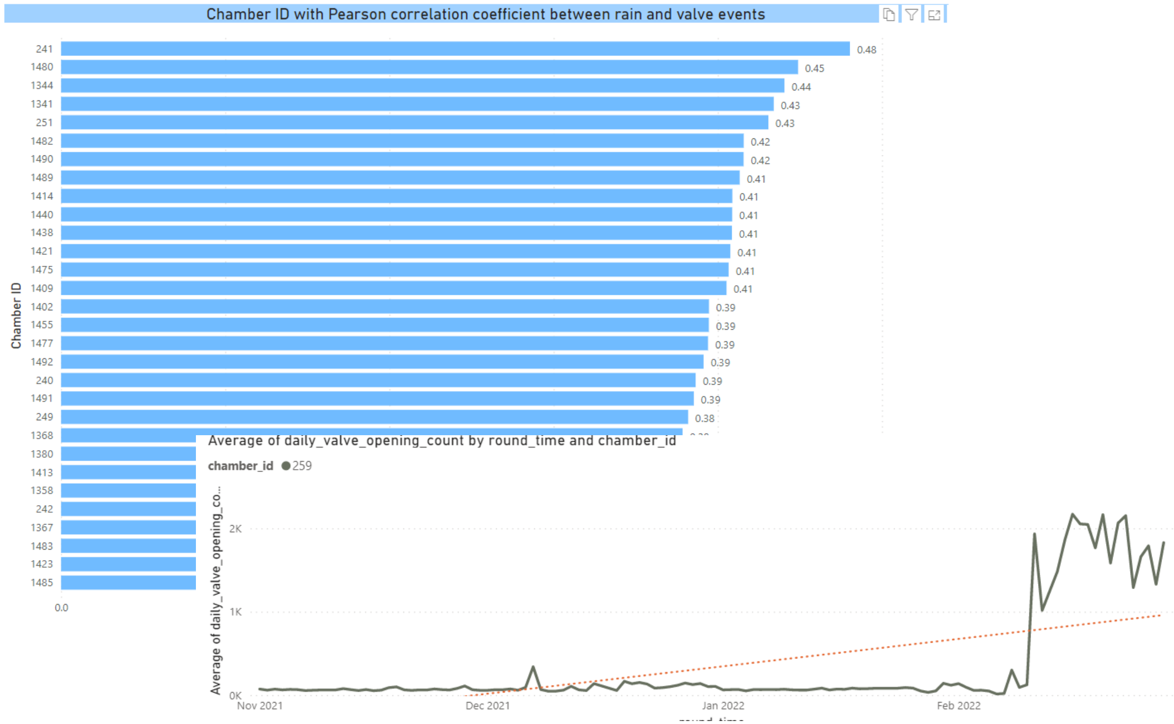
   - *Engage a qualified person*
   - *Submit report to Council*
   - *Demonstrate that repairs done*

   Where the Council requires a property owner to investigate and rectify a drain under subclauses (3) and (4), the investigation and any repairs or replacements must be completed within timeframes as specified and agreed by the Council

Way forward: What can still be done

1. Use the Vacuum Sewer Monitoring System to **identify the valve chambers most susceptible to I&I**

Shirley



Way forward: What can still be done

2. Use the Water Supply and Wastewater 2022 Bylaw to **require properties identified as high I&I contributors to inspect their drains and repair if found faulty** (additional resources needed to manage)
3. **Seal vacuum chambers** to reduce inflow and infiltration into the chambers (surface flooding, etc.) (funding needed)
4. Expand the Vacuum Sewer Monitoring System functionality (in progress) to:
   - monitor pressure at ends of vacuum mains and integrate into vacuum monitoring dashboard
   - enable remote control of the AAIS and integration into the vacuum monitoring dashboard
5. Upgrade? Duplicate systems? **(rough calculation if considering only the replacement cost of vacuum systems – non-engineered)**

SHIRLEY				ARANUI			
70 houses/ha	100 houses/ha	70 houses/ha	100 houses/ha	70 houses/ha	100 houses/ha	70 houses/ha	100 houses/ha
50% I&I reduction		No I&I reduction		50% I&I reduction		No I&I reduction	
Capacity x 3	**Capacity x 4**	**Capacity x 5**	**Capacity x 8**	**Capacity x 2**	**Capacity x 3**	**Capacity x 5**	**Capacity x 7**
≈ $35 million	≈ $50 million	≈ $60 million	≈ $100 million	≈ $75 million	≈ $115 million	≈ $200 million	≈ $280million

Attachment A Item 7

Conclusion

- SCIRT Vacuum System Decision
    - Robust decision making – multi-criteria analysis
    - Life cycle cost – 25% of decision
    - Collective decision
    - Positive outlook that the I&I flow factor would be less than the IDS design factor (2.78)
    - Supported by Prestons decision
- Performance of the systems improved since 2017/2018 (or just less rain?)
- I&I reduction will further improve systems performance
- **HOWEVER** still not able to accommodate the proposed MDRS enabled development
    - at best a density of 20 houses per hectare (Shirley) and 25 houses per hectare (Aranui) if 50% I&I reduction is achieved BUT assuming that both I&I reduction and new development will be uniformly distributed
- The decision to upgrade or duplicate should be made in the context of the wider growth strategy i.e. how best to invest limited funds to achieve the highest return (more houses)

References

- trim://12/314392: 2012 SSC Meeting 23 May - Item 41 PS25 - Application for Use of Vacuum Sewer, SCIRT, 05/05/2012
- trim://17/400675: Concept Design Report Catchment Study – PS36 Catchment, Area NE4 (WW), SCIRT, 30/07/2012
- trim://17/1281759: Aranui VSS Masterplan Hydraulic Performance Assessment, SCIRT, 26/09/2017 including Appendix A: HNZC & LURP Implications for Aranui VSS, Appendix B: Inclusion of Automatic Air Admittance Systems into the Vacuum Sewer Systems
- trim://17/1281766: Shirley VSS Masterplan Hydraulic Performance Assessment, SCIRT, 27/09/2017 including Appendix A: HNZC & LURP Implications for Shirley VSS, Appendix B: Inclusion of Automatic Air Admittance Systems into the Vacuum Sewer Systems
- Inputs from Council staff involved in SCIRT either directly as Technical Leaders or as Council representatives