MAYORAL FLOOD TASKFORCE

Final Report
Part C - Appendix C: Wastewater Overflows in Flood Events

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List of Contributors

Mike Gillooly	Christchurch City Council	Stuart Sandy	Aecom
Terry Howes	Christchurch City Council	Andy Gibson	Aecom
John Mackie	Christchurch City Council	Peter Christensen	Aurecon
Helen Beaumont	Christchurch City Council	Jeanette White	Aurecon
Leah McBey	Christchurch City Council	Regan Smith	Aurecon
Dean Ewen	Christchurch City Council	Anna Lindgren	Aurecon
Tim Ayers	Christchurch City Council	Thomas Chabanne	Aurecon
Peter Wehrmann	Christchurch City Council	Irfon Jones	Aurecon
Paul Dickson	Christchurch City Council	Jan Kupec	Aurecon
Stephen Adam	Christchurch City Council	Zoe Pletz	Aurecon
Graham Harrington	Christchurch City Council	Tom Revell	Aurecon
Paul Cottam	Christchurch City Council	Leon Gerrard	Aurecon
Luke Merryweather	Christchurch City Council	Cameron Irvine	Aurecon
Lisa Perry	Christchurch City Council	Camilla Gibbons	Aurecon
Dave Rowlands	Christchurch City Council	Richard Simpson	Aurecon
Tony Liu	Christchurch City Council	Jonathan Broome	Bond Construction Management
David Pinkney	Christchurch City Council	Vance Perrin	City Care
Tom Parsons	Innovate Consulting Ltd	Brian Keown	City Care
Sylvia Maclaren	Jacobs	Helen Shaw	Environment Canterbury
Gareth Taylor	Jacobs	Matt Thomas	Garage Consulting Company
Ben Fountain	Jacobs	Kate Dawkings	GHD
Matt Shepherd	Jacobs	Jalan McGrory	GHD
Matt Bot	Jacobs	Julia Riding	GHD
AJ Weir	Jacobs	Matt van der Peet	GHD
Jim Bell	Jacobs	Stephen Bensberg	L G Consulting Limited
Dave Compton-Moen	Jacobs	Chris Maguire	MWH
Ramana Sonthi	Jacobs	Simon Dellis	Opus
Matt Prosser	Jacobs	Mark Groves	Opus

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Appendix C Wastewater Overflows in Flood Events

Background information

The Christchurch wastewater network drains to a single wastewater treatment plant (WWTP) at Bromley near the Heathcote Estuary. All wastewater within Christchurch drains to this point either under gravity via pipework, or pumped via pressure pipes.

Three key trunk mains, the Western Interceptor, Southern Relief and Northern Relief, convey flows to Pump Station 1 (PS1) and PS11, the two largest terminal pump stations, and from here onto the WWTP. As the names of these trunk sewers suggest, they were constructed at various points to deal with population growth, more stringent regulation and ever increasing wastewater flows. PS20, PS36 and PS15 are also key terminal pump stations which convey flows to the WWTP.

All Banks Peninsula settlements have separate wastewater systems draining to their respective WWTP's. Little River has no reticulation system or WWTP, as the residents use septic tanks.

Existing wastewater studies

The Christchurch wastewater system has been modelled a number of times over the years. More recently the Council has developed a post-quake hydraulic model of the Christchurch wastewater network. This model was calibrated to numerous flow monitors and provides good data on network performance. The post-quake model build, calibration and network performance are well documented, and are being refined and updated as the Stronger Christchurch Infrastructure Rebuild Team (SCIRT) work is captured and system knowledge is enhanced by additional flow monitoring. Full recalibration of the post-SCIRT model will be done over the winter of 2016 as the SCIRT part of the sewer rebuild nears completion.

The Lyttelton and Akaroa systems are not as well documented, but are being modelled hydraulically to improve understanding of each network.

The Council automatically and continuously monitors 20 overflow sites. These sites are the most likely to operate in larger storm events. The monitoring systems provide alarms and data on the overflows.

Wastewater flooding history

Wastewater overflow issues are caused by stormwater and increased groundwater getting into the network. This can result in wastewater overflowing at designed overflow points, or if these designed overflow points are no longer of sufficient capacity surcharging of the sewers occurs and overflow into the street occurs, and beyond that overflow on to private property may occur. With extensive surface flooding in a long duration rain event most of the excess water entry into the sewer system occurs through vented manholes and flooded property discharging down gulley traps that are below the flood level.

Wastewater overflows were built to provide the least adverse effect when the system surcharges in an emergency of excess flow situation. These overflows are a formal point of overflow to a stormwater pipe, for example, to stop flooding into the street or private properties, particularly in an emergency. The primary goal is to protect people from coming into to contact with wastewater by preventing discharge onto private property or on to public road.

The Christchurch wastewater network suffers overflows during longer rainfalls, such as the event on 5 March where rainfall depths were significant. The network shows little to no response to shorter, higher intensity rainfalls. Several factors drive the response to longer events:

- Deep surface ponding can cover vented manholes and private gulley traps.
- Longer events saturate the catchment's upper soils and raise groundwater levels. This increases pressure on deep gravity lines and more water leaks into them increasing flows
- The scale and extent of the network is such that in shorter rainfalls extensive ponding and ground saturation do not occur.

Earthquake damage to the wastewater network

The Christchurch earthquakes resulted in significant damage to the wastewater system, including to some pumping stations and a large amount of pipework. Large sections of network were also inundated with sand and silt through soil liquefaction, which reduced pipe capacity, blocked pipes and wore out pumps.

Elevated groundwater or reduced land levels combined with widespread pipe damage also increased average flows in the network by up to 60%. . This has greatly reduced capacity in wet weather events and has increased overflow volume and frequency.

Differential land settlement has reduced pipe gradients or created dips in the network which have adversely affected flow capacity and increased maintenance needs through more sedimentation in the lines and increased blockage.

Key drainage infrastructure

Wastewater infrastructure relevant to Christchurch floods are wastewater overflows, manhole covers (particularly if vented) and private gully traps. They are sources of flood water entering and exiting the wastewater system. There are about 260 vented manholes within the documented extent of the 5 March flood.

There are over 100 wastewater overflow points designed into the wastewater network, mostly for emergencies and will not operate during a flood. However, there are some 20 to 40 that are known to operate and are a source of stormwater contamination. In severe rain events such as experienced this year there will also have been overflows at street level through manhole tops and vents due to surcharging. In a small number of cases there will also be overflows from gulley traps onto private property.

Overflows in the areas assessed by the Taskforce are below in Table J.1.

Table J.1 Key wastewater overflows

Area	Overflows
Flockton Basin	PS6 and PS53 overflows operated during the 5 March 2014 flood and are likely to have operated for the 18 March and 29 April events. PS1/21, known as Grassmere, is a large overflow upstream on a trunk sewer and also operated during the 5 March, 18 March and 29 April rainfall events as well as earlier even events such as August 2012 and June 2013.
Heathcote Valley	All overflows are downstream of reported 5 March flooding
Lower Heathcote Valley	Overflows known to have operated on 5 March include PS60/1, PS23/1, PS18/1 and PS18/2. These overflows also operated for the 18 March and 29 April rainfall events as well as earlier events such as August 2012 and June 2013.
Sumner & Redcliffs	PS34/1 and PS33/1 overflows are known to have operated on 5 March. It is not known if they overflowed on the 18 March or 29 April events. Other overflows along coast line and in the Avon and Heathcote river catchments will also contribute to water quality in the Heathcote Estuary.
Lower Avon	During the 5 March, 19 March and 29 April events PS1/21, PS40/1, PS1/11 and PS36/2 operated. Overflows PS1/20 and PS1/19 in Riccarton may also have operated. Further, overflows PS6 and PS53 are also likely to have operated.
South Shore	PS37/1 is the only overflow in the area and is not known to have operated. However the estuary may be contaminated from all the overflows upstream (see Lower Avon and Flockton Basin above).
Lyttelton, Little River and Akaroa	Lyttelton WWTP is known to overflow after heavy rainfall, as is Akaroa's WWTP, with both operating during the March 5th event. Little River has no reticulated wastewater, being on septic tanks.

Issues

The main wastewater issue in floods is contamination. As a public health risk it can contaminate properties and sections and is an unpleasant experience for those affected. NIWA[1] studied health risks from wastewater overflows, concluding that overflows elevate risk, and noting that the rivers themselves also become health risks. Flooding of watercourses can also prevent wastewater overflows from operating, causing upstream manholes to surcharge into the street.

Flood waters can contain visible waste 'solids' such as tissue or sanitary products, which are then left on the ground or on properties as flood waters recede.

Key issues are:

- Long rainfall events saturate the catchment leading to heavier flows
- Surface flooding enters the wastewater network and increases flow rates
- Parts of the wastewater network cannot cope with the increasing flows, resulting in surcharging of the network and overflow operation
- Most flood-affected areas contain or are downstream of wastewater overflows that may be operating
- Contamination of waterways and flood waters due to wastewater overflows operating
- Flood waters are not safe for human contact regardless of wastewater contamination
- Wastewater overflows sometimes cannot operate due to flooded waterways causing wastewater manholes to surcharge
- Surcharging wastewater manholes pushing wastewater into the street and flood waters
- Surcharging private gully traps pushing wastewater into private sections,
- Visible solids in flood waters that are left on the ground as flood water recedes
- Health risk to those returning home or coming into contact with flood waters
- Public distress over contamination, particularly if solids are visible
- Health risks to the public, particularly the more vulnerable members of the community

March 2014 flood event

During the 5 March event 20 overflows are known to have operated and several others may also have operated, though this was not observed. Further, there would have been several manhole and gully trap overflows triggered due to surcharging. While some were recorded during the March event, it is likely that many more actually occurred, but were not reported or were hidden by flood waters.

While wastewater contamination itself doesn't necessarily cause physical damage, it does create a public health risk, particularly to vulnerable people.

It can also leave sections and properties contaminated after the flood and may leave wastewater solids in parts of the catchment. Visible fragments of toilet paper for example, were reported by the media in a later flood.

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[1] *Quantitative Microbial Risk Assessment associated with sewer discharges to the Avon and Heathcote River catchments,* NIWA Client Report HAM2009-158, October 2009.

Contamination adds to residents' distress as they are trying to cope with flooding. It makes the return home less appealing, knowing the house may be contaminated with wastewater. If homeowners are less likely to return home or continue living in a flood prone area, this in turn damages the community.

In addition, overflows and flood water contamination also affect the environment, amenity, recreational value and food gathering in an area, and is culturally offensive.

Current Response Procedures

Council operates its overflows under an operative consent which until earthquake repairs are completed and enforcement agreement is in place with Ecan.. A part of the consent is an Overflow Response Plan agreed with Community and Public Health and Ecan. Along with this, it has invested in a system to allow real time monitoring of key overflows and is continuing to expand its understanding of the network hydraulics, and the impact of stormwater flooding on unmonitored overflows.

Council procedures focus on monitored overflows or Customer Service Requests (CSRs). The response plan includes putting up contamination warning signs, sampling water quality and clean-up once the wastewater overflow has stopped. The clean-up comprises a walkover along affected waterways removing offending material and disinfecting areas where solids have been present. The Council web site is also updated with overflow information when they occur.

Where a ratepayer has reported wastewater on their property, a clean-up crew is sent out to clean and disinfect the property / section. Council notifies a list of stakeholders, including some community groups. Call centre staff are also advised and the communication team is notified when any overflows occur.

Current schemes in progress

There are several schemes underway or being investigated to:

- reduce overflow operation
- respond to wet weather
- repair quake damage
- accommodate growth
- improve safety

These include:

- The Stronger Christchurch Infrastructure Rebuild Team (SCIRT) rebuild – the worst hit areas are being rebuilt, in some cases with more resilient systems less prone to groundwater infiltration, and other less damaged areas are being repaired. The SCIRT rebuild is expected to significantly reduce network overflows and volumes however it is unlikely that repairs and renewal will reduce the overflow frequency and volume to pre-earthquake levels.
- Manhole covers – some manholes prone to lifting are being fixed closed or fitted with a safety grill. This is a safety measure to reduce the risk of someone falling into a manhole with a dislodged cover.
- Manhole vents – workers are identifying vented manholes in areas of potential flooding and are trialling blocking them with plastic to reduce inflow and a more permanent program of blocking vents in known flood prone areas is being implemented. However, vents are there to release hydrogen sulphide, and there may be long term financial costs if there is increased damage from hydrogen sulphide attacks on infrastructure.
- Upgrades recently completed that have reduced the overflows include the Colombo Street Diversion, PM 105, and the Wairakei Diversion which is under construction.

- Planned upgrades – there are several upgrade projects underway or planned through SCIRT or the Council to improve network performance or accommodate growth. These are projects such as the Riccarton Sewer Upgrade, and Grassmere Overflow Storage.
- Gully traps –Council intends to trial a form of non-return valve on gully traps that allows wastewater to overflow out, necessary to protect the inside of the property when there is a blockage, but that greatly reduces flood water flowing into the wastewater network.
- Full wet weather and dry weather flow calibration of the post SCIRT model will be carried out in 2016 as the SCIRT rebuild of the network nears completion.
- Flap gates – new internal rubber check valves have been installed on many of the key wastewater overflow pipes to replace older flap valve and prevent reverse flow of flood waters into the network when debris becomes lodged under the flap. The programme is still on-going and aims to eventually cover all wastewater overflows.

Options

Constraints

The key constraint is the scale of the work needed to eliminate stormwater entry into the wastewater network and the consequent wastewater overflows. Every large city in the world that has developed over 100 years or more has sewer overflows or combined sewer overflows (CSO's). It is not possible for Christchurch to achieve a "no overflow" situation given the city's topography and history as a swamp. There will always be some overflow in extreme events. Some overflows will always operate during rainfall as significant as that on 5 March 2014, as that exceeded the wastewater network planned level of service. There may always be contamination of flood waters from other sources as well, such as flood water surcharging private connections via gully traps or flowing through manhole covers, if that excess flow entering the network subsequently exits the network further downstream

Costly upgrades are needed to resolve the network-wide issues and their implementation would take years due to the scale of work required. Therefore in the short term it has to be accepted that flood waters are always likely to become contaminated. However, there are some options that could reduce the inflow of flood waters into the wastewater network and make the experience less distressing for residents of flood prone areas.

Opportunities

The Council emergency response policy could consider:

- Reviewing current procedures for post-flooding cleanup of wastewater solids. In areas facing large insurance excesses and until longer term solutions are in place, Council may consider providing guidance and advice about access to funding for post-flooding clean-up
- Include methods to reduce significant inflow such as sealing manhole vents and flood prone gulley traps to reduce the stormwater entry into the sewer network and thereby reduce the potential for flood waters to become contaminated
- Screen solids at the overflows to aid the clean-up once floodwaters have receded. Note that Council is required under the current consent to "assess" each overflow site for potential screening. Council has agreement with ECan to delay this until after the flow calibration in 2016 as by then there will be a better picture of overflow frequency volume and location. Screens are under consideration at some sites already but are a complex matter as blinding of screens can cause significant other issues.

Potential solutions

The following options have been identified.

Canterbury District Health Board FAQs

The Canterbury District Health Board has published on its website advice on avoiding risks from contaminated flood waters.

Reduce Inflow

Reducing the flow of floodwaters into the wastewater network may reduce the potential for contaminating flood waters. This can be done in a reasonable time and cost using these methods:

- Installation of non-return valves at gully traps in flood prone areas.. This allows gully traps to overflow in emergencies to protect the internal property and prevents high rates of flood water flowing into the wastewater network.
- Blocking of vented manholes – in Christchurch approximately half the manholes have vents to allow air in and out of the network as it fills and drains and to ensure low levels of hydrogen sulphide. However, once roads are flooded, the vents allow water to flow into the network. The Council has already tried blocking flood-prone vents by placing plastic sheeting under the vent grate. Proposals are being developed to more permanently block the vents subject to inundation. However, vents are there to release hydrogen sulphide, and there may be long term financial costs if there is increased damage from hydrogen sulphide attacks on infrastructure.
- Continue with the installation of flap valves on wastewater overflows

Reduce solids

Wastewater solids, such as sanitary products, tissue paper, fat, faeces and other such material are a highly visible indicator of contamination. Such material upsets residents and makes for a more difficult and costly clean up after the flood. Therefore any measures that could reduce solids would be of benefit and would upset residents less. To reduce solids the Council should continue to assess the suitability of the larger overflow points for automatic screening devices realising that until the inundation of some areas is resolved there will also be the informal overflows through manhole tops that will not be screened.

In general the floatable solids are trapped in manhole tops when the system becomes surcharged and the heavier settleable solids remain at pipe level while overflow discharge level is normally below the water surface but well above pipe invert. The use of manually raked screens or CopaSac's is not considered an appropriate solution in small over locations as the blinding of the screens and filling of the CopaSacs can quickly result in overflow out the top of nearby manholes rather than discharge to the waterway.

Council Response Procedures

The Council currently has an agreed, documented and comprehensive procedure for responding to overflows, which are generally followed well. However, they relate to waterways affected by overflows known to have operated. They do not extend to areas that have been flooded away from the immediate vicinity of the waterway, such as Flockton Basin, Sumner and Redcliffs or other areas without monitored overflows.

For individual property clean-ups Council relies on residents calling in with a Customer Service Request (CSR) about wastewater contamination, at which a clean-up crew is sent out.

However many residents do not call the Council and the wastewater operations team may not be aware of properties that have been internally flooded. The scale of clean-up is also limited, with inside the house clean-up jobs being left to insurers. However insurers may not be able to respond quickly enough to decontaminate a house in a reasonable time, or the most flood-prone properties are now subject to large excesses.

From reviewing overflow response procedures it is evident that:

- land drainage and wastewater operations teams need to be notified of flooded properties,
- it should be assumed that all flood waters could be contaminated whether there is visible evidence of sewage contamination or not,
- relying on insurance companies to clean up properties may be difficult where people now have large excesses.

To strengthen the current procedures we have identified the following options:

- The list of notified parties should be extended to include flood prone communities not currently included including the Flockton Basin Residents Association.
- Dedicating a person at City Care to manage the post overflow / flooding clean-up and disinfection work.

Council may wish to consider being more active cleaning up properties in the most vulnerable areas. Instead of waiting for a CSR to come in, clean-up should be directly offered to those known to have been affected. This could be done by liaising with the community spokesperson for each area, or via direct contact if the Council holds their contact details. A rapid and active response would be seen positively and may make life more bearable for those affected. It may be worth discussing this with insurance companies for less vulnerable properties. However in areas such as the Flockton Basin where large insurance excesses are being applied or where people are uninsured and unable to pay Council may consider providing guidance and advice about access to funding for post-flooding clean-up.

Internal property flooding should be the first priority, particularly for vulnerable families, followed by section clean-up and then waterway corridors.

Changing the overflow response procedures as proposed would add responsibilities to the wastewater operations team, which has limited financial and human resources. Therefore management and funding need to be considered. It may be best managed by the land drainage team or a joint response team in the short term until longer term solutions are actioned.

A Council staff member and contractor could be assigned to a specific catchment. They would liaise between the land drainage and wastewater operations teams within Council and manage the response. This should ideally go beyond wastewater contamination and include evacuation, temporary flood alleviation measures, road closures and subsequent clean up, including litter and wastewater solids. Each catchment manager needs training and a check list of actions so they have a clear plan in order of priority. This would need to be considered in conjunction with the policy and procedures for specific catchments being developed with this report, which will propose similar measures.