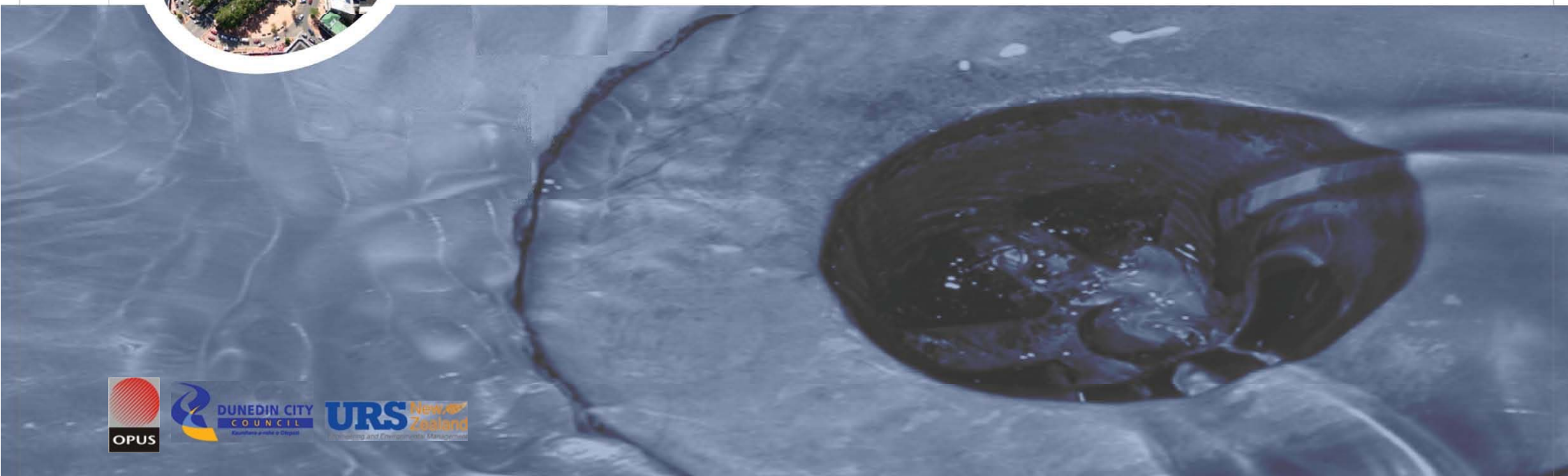
Dunedin 3 Waters Strategy

ICMP Summary Report

Appendix A – ICMP Summaries



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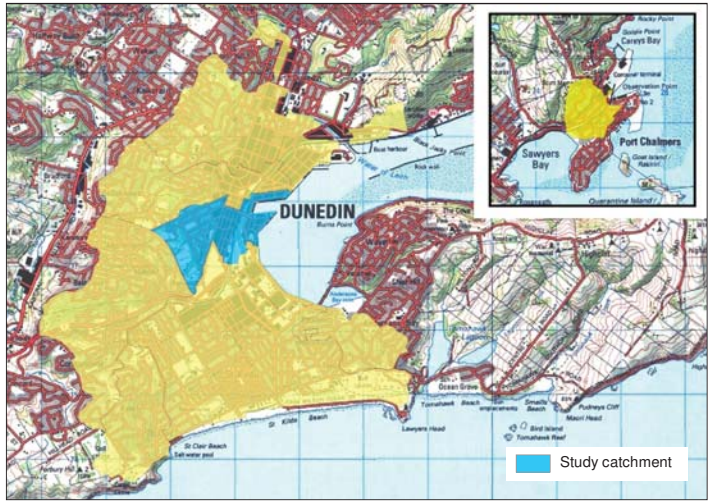
Kitchener Street Catchment



Overview

Size: 137 ha

Land Use: Mixed (47 % residential, 28 % industrial, 15 % commercial, 11 % port)

Imperviousness: 69 %

Stormwater Pipe Age: 43 % greater than 90 years old

No. of Outfalls: 11

Receiving Environment: Otago Harbour

Length of Pipe:

Stormwater: 10 km
Wastewater: 13 km
Water Supply: 20 km

The Kitchener Street catchment is located near the centre of the Dunedin city urban area. The residential area lies on the hilly upper part of the catchment to the west, whereas the industrial, commercial and port zones span the flat, low-lying portion of the catchment, most of which is situated on reclaimed land. The town belt runs along the western boundary, while the Otago Harbour bounds the catchment to the east.

The stormwater network in the catchment is characterised by ageing pipes, laid at steep grades in the upper catchment, and flat grades east of princes Street. Flooding occurs at relatively few locations in the catchment, due mainly to insufficient pipe capacity and localised depressions in the topography. Stormwater quality in the catchment is typical of the land use, however effects on the harbour environment are difficult to establish.

Issues Summary

Limited Confidence in the Knowledge of Effects on Harbour Environment and Variability of Stormwater Quality Results

- High variability of stormwater quality results, any trends in stormwater contaminant levels remain unclear, however results to date indicate typical contaminant concentrations in stormwater discharge.
- Poor information on actual effects of stormwater on harbour environment.
- Lack of data to assess linkages between pipe discharge and harbour environment quality.

Potential Wastewater Discharges

- Single stormwater measurement in 2010 indicating potential wastewater contamination. No ongoing effects or discharge recorded.

Deep Flooding

- Model results indicate 2 parcels affected by deep flooding during 1 in 10 yr ARI rainfall event; rises to 16 during 1 in 50 yr ARI rainfall event in current, and 21 land parcels in future planning scenarios.
- The only significant location of deep flooding predicted during the 2010 1 in 50 yr ARI event is surrounding the industrial block next to The Oval, in particular the western side of Princes Street from Lees Street to Jones Street, and in car parks within the associated industrial block.
- Based on modelling results, it is possible that floodwaters will enter a small number of buildings during large events, due to breaks in the kerb and doorsteps flush with the pavement.

Low Level of Service in Lower Catchment

- Significant proportion of the lower network is predicted to surcharge during a modelled 1 in 2 yr ARI rainfall event, with 11.2 % of catchment manholes overflowing, however most are in the wharf area near to a harbour outfall. During a 1 in 10 yr ARI rainfall event, 43 % of catchment manholes are predicted to overflow.

Network Maintenance

- Flooding extents and durations in the Kitchener Street catchment are potentially exacerbated by variations in the frequency and standards of catchpit and inlet screen cleaning and maintenance.
- City-wide inconsistencies in frequency and standards of cleaning and maintenance of stormwater structures (inlets and catchpits) can lead to discrepancies in level of service.

Flood Hazard (current and future) 1 in 100 yr ARI

- Flood hazard issues in this catchment are considered to be fairly minor, with hazard being identified in areas predicted to have deep flooding during a number of events.
- Transport routes are not predicted to be severely affected – inundation across roads is predicted to be shallow or confined to the sides of the road.
- Small parts of lower catchment at risk of direct tidal inundation.

Nuisance Flooding

- Nuisance flooding predicted and confirmed during small events in two main areas; South Road at the intersections of Maitland Street, Lees Street and Jones Street, and near Crawford Street at the intersections with Jervois Street and Police Street.
- Not expected to inundate roads or be experienced for long periods of time.

Ongoing Stormwater Discharge

- Could exacerbate historical contaminant issues in the harbour. Extent to which this is likely to occur is unconfirmed.
- Key stakeholder issue.
- Based on available data, consequence currently believed to be minor.

Fryatt Street Wharf

Catchment Specific Approaches	SMART Targets
Quantity	
• Design new pipes with capacity to convey a 1 in 10 yr ARI rainfall event (including climate change allowances). • Enhance understanding of effects of deep flooding, particularly on private property. • Ensure cleaning and maintenance schedules and contracts are sufficiently robust. • Ensure consistency city-wide of stormwater structure cleaning and maintenance. • Ensure new development does not increase potential habitable floor flooding due to the stormwater system in events up to a 1 in 50 yr ARI rainfall event. • Ensure new development does not increase the number of properties predicted to flood due to the stormwater system in a 1 in 100 yr ARI rainfall event. • Identify areas in catchment where more regular stormwater structure cleaning and maintenance could reduce flooding risk. • Maintain or improve existing level of service in network. • Monitor customer complaints and / or undertake site visits to confirm locations of flooding. • Protect key and vulnerable infrastructure (e.g. pump stations, works depots, schools, hospitals, electricity supply etc) from flood hazard. Avoid development of vulnerable sites / critical infrastructure in flood prone areas. • Undertake pipe renewals programme as scheduled (with older pipes prioritised). • Use customer complaints and ROS to gauge satisfaction with the stormwater system performance.	• < 16 properties at risk of deep flooding (> 300 mm) during a 1 in 50 yr ARI rainfall event by 2060. • > 68 % of pipes to convey a 1 in 10 yr ARI rainfall event by 2060. • > 60 % resident's satisfaction with the stormwater collection service (ongoing). • Develop consistent cleaning and maintenance criteria for all stormwater inlet assets (city-wide) by 2012. • Develop list of key stormwater assets in Kitchener Street catchment requiring additional cleaning and maintenance checks by 2013. • Document cleaning and maintenance responsibilities for all stormwater inlet assets (city-wide) by 2013. • Provide modelled flood predictions to DCC Climate Change Adaptation Group to ensure information is taken into account during the development of a city-wide climate change adaptation plan. • Undertake habitable floor survey and / or damage assessment of potentially flooded properties.
Quality	
• Consider the cost / benefit of stormwater quality treatment as part of flood mitigation works where practicable. • Develop method for determining linkages between stormwater management and harbour environment. • Enforce the Trade Waste Bylaw, and educate occupiers of high-risk sites with respect to stormwater discharge quality. • Incorporate a feedback process to the ICMP if / when monitoring indicates potential adverse effects from stormwater discharges. • Redesign DCC's monitoring programme to ensure stormwater quality and receiving environment data is collected within a robust framework. • Require source control of stormwater contaminants in new development of high- contaminant generating land uses. • Undertake monitoring to ensure stormwater quality does not deteriorate over time. • Use improved monitoring programme to enable better understanding of potential catchment contamination.	• Implement an education / enforcement programme targeting stormwater discharges from high risk land uses by 2015. • Implement management options to remediate problem where necessary. • Improve confidence in data supporting analysis of stormwater discharge quality and effects on harbour environment, with improved confidence in data by 2013. • Improve data relating to levels microbial contamination and potential sources of contamination within the catchment by 2012. • No deterioration of stormwater quality due to land use change or development in the catchment. • Robust city-wide monitoring framework developed and implemented by 2012.

Recommendations

Further Study

- Redesign the city-wide framework for stormwater quality and harbour environment monitoring.
- Utilise stormwater complaints and ROS information to continuously gauge customer satisfaction with the stormwater service.
- Identify and undertake floor level survey and damage assessment of properties potentially internally affected by deep flooding (up to a 1 in 50 yr ARI).

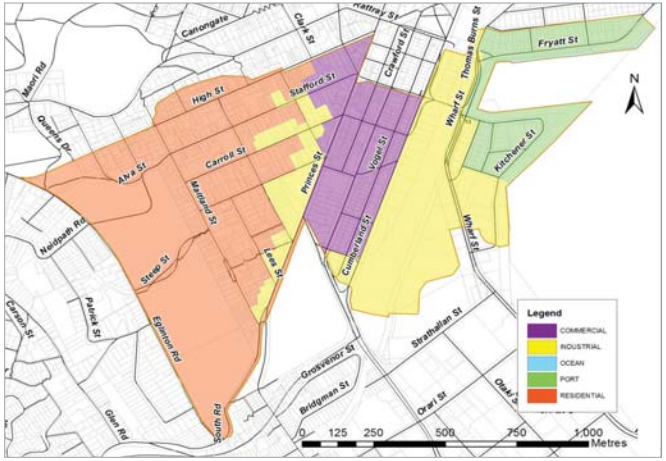
Planning and Education

- Review business processes to ensure subdivision and development incorporates catchment specific requirements per the relevant ICMP.
- Contribute information to a city-wide climate change adaptation plan.
- Work with ORC to develop a plan for education programmes in relation to best practice site management of industrial premises.

Operation and Maintenance

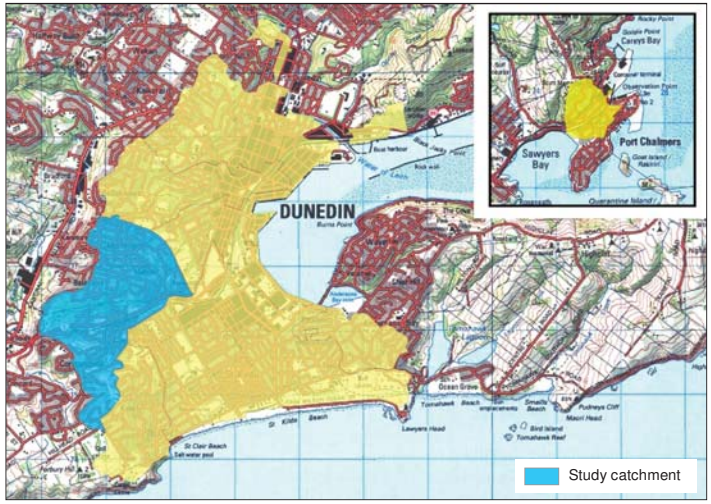
- Implement the revised city-wide monitoring framework.
- Compile an inventory of all stormwater structures including asset condition, ownership and identify key locations for more frequent cleaning and maintenance.
- Undertake a city-wide review of all current contracts for maintenance of stormwater structures; documenting scope and standards

Catchment Harbour Outfall at Kitchener Street



Catchment Land Use Zones

Port between Kitchener Street and Fryatt Street



Overview

Size: 341 ha

Land Use: Predominantly residential (99 %)

Imperviousness: 47 %

Stormwater Pipe Age: 17 % greater than 90 years old

No. of Outfalls: 1

Receiving Environment: Otago Harbour

Length of Pipe:

Stormwater: 20 km
Wastewater: 52 km
Water Supply: 57 km

The Orari Street catchment is a large, relatively steep catchment that includes three main stream gullies surrounding Caversham Valley Road, Corstorphine Road and Glen Road. The stormwater network is characterised by a mixture of piped and open watercourses, with a single large outfall pipe that is sealed for approximately 1.3 km, from Wilkie Road to the outfall. The Glen Valley discharges to a large intake structure at the base of Glen Road.

Flooding is a significant issue in the Orari Street catchment, with properties and roads predicted to experience flooding from as little as a 1 in 2 yr ARI rainfall event, including surface overflows into the South Dunedin catchment during extreme events. Historical flooding of South Road near the Glen Valley intake is more likely related to the local topography and outfall pipe capacity rather than issues with the intake itself. Blockage of stream intakes and poor catchpit maintenance is considered to be a major contributor to the predicted flooding in this catchment.

Issues Summary

Deep Flooding

- Model results indicate 10 parcels affected by deep flooding during 1 in 2 yr ARI rainfall event; rises to 85 land parcels during 1 in 50 yr ARI rainfall event in current and 99 land parcels in future planning scenarios.
- Large number of properties affected during extreme climate change scenario.
- A large amount of deep flooding is predicted to be exterior to buildings (although surveys not yet undertaken).

Limited Confidence in the Knowledge of Effects on Harbour Environment and Variability of Stormwater Quality Results

- High variability of stormwater quality results, any trends in stormwater contaminant levels remain unclear, however results to date indicate moderately low contaminant concentrations in stormwater discharge.
- Poor information on actual effects of stormwater on harbour environment, although not considered significant with respect to this catchment.
- Lack of data to assess linkages between pipe discharge and harbour environment quality.

Blocking / Maintenance of Intake Structures

- Intake structures on a number of open channels (the majority of which are privately owned) are undersized and / or sensitive to blockage, and overland flow from blocked or overflowing screens is exacerbating flooding in critical areas.

Low Confidence in Hydraulic Model

- There is low confidence in hydraulic model results in areas where flooding is not validated by photographic or anecdotal evidence.
- The current hydraulic model is suitable for planning purposes, but not for preliminary design.

Flood Hazard (current and future) 1 in 100 yr ARI

- Significant / extreme flood hazard during large rainfall events. Predicted in a number of areas, particularly on South Road at the base of the Glen Valley, and on Glen Road.

Network Maintenance

- Flooding extents and durations in the Orari Street catchment are potentially exacerbated by variations in the frequency and standards of catchpit and inlet screen cleaning and maintenance.
- City-wide inconsistencies in frequency and standards of cleaning and maintenance of stormwater structures (inlets and catchpits) can lead to discrepancies in level of service.

Ongoing Stormwater Discharge

- Could exacerbate historical contaminant issues in the harbour. Extent to which this is likely to occur is unconfirmed.
- Key stakeholder issue.
- Based on available data, consequence currently believed to be minor.

Nuisance Flooding

- Nuisance flooding is predicted and confirmed in three main areas; South Road beneath the Motorway overbridge, in the South Road commercial area, and on the northern part of the Caversham Bypass Motorway.
- Flooding not significant during small events, but becomes progressively worse with larger events.

Low Level of Service in Upper Catchment

- Small diameter pipes in the upper reaches of the network only have capacity to convey 1 in 2 yr ARI rainfall events. Overflow causes overland flow and exacerbates flooding in other locations.

Overland Flow into the South Dunedin Catchment

- Overland flow is predicted to enter the South Dunedin catchment from the South Road commercial area, and Corstorphine area, during large events.

Catchment Specific Approaches	SMART Targets
Quantity	
• Design new pipes with capacity to convey a 1 in 10 yr ARI rainfall event (including climate change allowances). • Develop a better understanding of the likely effects and magnitude of climate change. • Enhance understanding of effects of deep flooding, particularly on private property. • Ensure cleaning and maintenance schedules and contracts are sufficiently robust. • Ensure consistency city-wide of stormwater structure cleaning and maintenance. • Ensure damaged screens are replaced / fixed. • Ensure new development does not increase potential habitable floor flooding due to the stormwater system in events up to a 1 in 50 yr ARI rainfall event. • Ensure new development does not increase the number of properties predicted to flood due to the stormwater system in a 1 in 100 yr ARI rainfall event. • Ensure transport routes around flooding areas will be available. • Identify areas in catchment where more regular stormwater structure cleaning and maintenance could reduce flooding risk. • Improve model confidence by seeking flood related information in areas predicted to flood by the model (but unconfirmed). • Improve model confidence by undertaking local survey and flow calibration wherever capital works are proposed and preliminary design is necessary. • Investigate effects on South Dunedin catchment, and re-prioritise issue if significant. • Maintain or improve existing level of service in network. • Protect key and vulnerable infrastructure (e.g. pump stations, works depots, schools, hospitals, electricity supply etc) from flood hazard. Avoid development of vulnerable sites / critical infrastructure in flood prone areas. • Undertake an inspection of all open channel sections, to record status of intake structures. • Undertake pipe renewals programme as scheduled (with older pipes prioritised). • Use customer complaints and ROS to gauge satisfaction with the stormwater system performance. • Work with property owners to ensure screens and intakes are properly maintained.	• < 0.1 % of catchment surface area predicted to flood during a 1 in 2 yr ARI rainfall event by 2060. • < 85 properties at risk of deep flooding (> 300 mm) during a 1 in 50 yr ARI rainfall event. • > 60 % resident's satisfaction with the stormwater collection service (ongoing). • > 70 % of pipes to convey a 1 in 10 yr ARI rainfall event by 2060. • Assess the effects of overland flooding from Orari Street catchment on South Dunedin catchment. • Develop consistent cleaning and maintenance criteria for all stormwater inlet assets in the catchment (in conjunction with city-wide criteria) by 2012. • Develop consistent cleaning and maintenance criteria for all stormwater inlet assets (city-wide) by 2012. • Develop list of key intake structures in Orari Street catchment requiring additional cleaning and maintenance checks by 2013. • Develop list of key stormwater assets in the Orari Street catchment requiring additional cleaning and maintenance checks by 2013. • Document cleaning and maintenance responsibilities for all stormwater inlet assets (city-wide) by 2013. • Ensure all damaged, poor performing, or missing screens are replaced (if appropriate) by 2013. • Improve level of confidence in the Orari Stormwater Hydraulic model to 'moderate' by 2014. • Provide modelled flood predictions to agencies responsible for transport routes. • Provide modelled flood predictions to DCC Climate Change Adaptation Group to ensure information is taken into account during the development of a city-wide climate change adaptation plan. • Undertake habitable floor survey and / or damage assessment of potentially flooded properties.
Quality	
• Consider the cost / benefit of stormwater quality treatment as part of flood mitigation works where practicable. • Develop method for determining linkages between stormwater management and harbour environment. • Enforce the Trade Waste Bylaw, and educate occupiers of high-risk sites with respect to stormwater discharge quality. • Incorporate a feedback process to the ICMP if / when monitoring indicates potential adverse effects from stormwater discharges. • Redesign DCC's monitoring programme to ensure stormwater quality and receiving environment data is collected within a robust framework. • Require source control of stormwater contaminants in new development of high- contaminant generating land uses. • Undertake monitoring to ensure stormwater quality does not deteriorate over time.	• Implement an education / enforcement programme targeting stormwater discharges from high risk land uses by 2015. • Improve confidence in data supporting analysis of stormwater discharge quality and effects on harbour environment, with improved confidence in data by 2013. • No deterioration of stormwater quality due to land use change or development in the catchment. • Robust city-wide monitoring framework developed and implemented by 2012.

Recommendations

Further Study

- Identify and undertake floor level survey and damage assessment of properties potentially internally affected by deep flooding (up to a 1 in 50 yr ARI).
- Redesign the city-wide framework for stormwater quality and harbour environment monitoring.
- Increase hydraulic model confidence in The Glen Valley, South Road commercial area and around the Caversham Bypass Motorway, via survey, data collection and / or flow monitoring and calibration.
- Utilise stormwater complaints and ROS information to continuously gauge customer satisfaction with the stormwater service.

Planning and Education

- Review the education / advice provided to property owners responsible for watercourses to ensure adequate information and assistance is provided.
- Contribute information to a city-wide climate change adaptation plan.
- Develop an emergency response plan to re-route traffic during extreme rainfall events, and identify vulnerable properties.
- Review business processes to ensure subdivision and development incorporates catchment specific requirements per the relevant ICMP.
- Review flood hazard in South Dunedin catchment, incorporating effects from the Orari Street catchment.

Operation and Maintenance

- Ensure damaged screens and / or intake structures on open channels and watercourses are replaced or repaired.
- Implement the revised city-wide monitoring framework.
- Compile an inventory of all stormwater structures including asset condition, ownership and identify key locations for more frequent cleaning and maintenance.
- Undertake a city-wide review of all current contracts for maintenance of stormwater structures; documenting scope and standards.

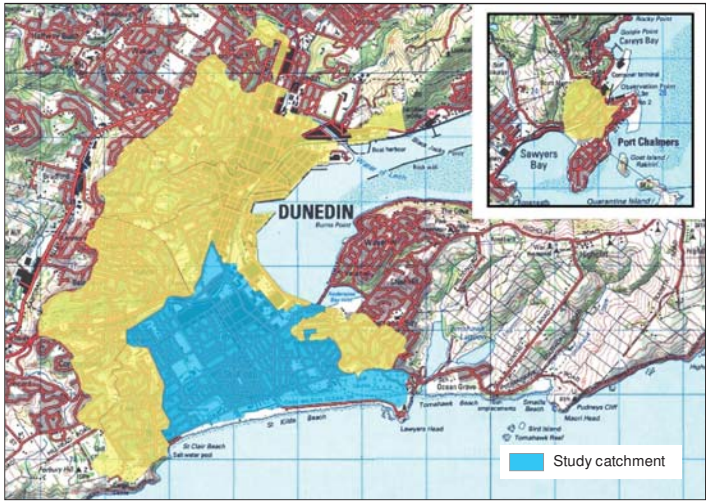
Capital Works

- Undertake local pipe and catchpit upgrades in South Road / Leckhampton Court area.

Land Parcel Imperviousness (lighter = more pervious)

Flooding on South Road (Feb, 2005)

Catchment Topography (lighter = lower elevation)



Overview

Size: 590 ha

Land Use: Predominantly residential
(81 % residential, 18 % industrial, 2 % commercial)

Imperviousness: 60 %

Stormwater Pipe Age: 12 % greater than 90 years old

No. of Outfalls: 1

Receiving Environment: Otago Harbour, via Portobello Pumping Station

Length of Pipe:

Stormwater: 63 km
Wastewater: 76 km
Water Supply: 125 km

The South Dunedin catchment is generally flat, and covers approximately 10-15 % of the central urban area of Dunedin. The stormwater network in the catchment comprises chiefly of shallow pipes laid at flat gradients, all of which discharge to the harbour via the Portobello pump station.

The majority of the stormwater network in the catchment only has capacity to convey small rainfall events, with shallow ponding predicted to occur in many locations (primarily in road channels) throughout the catchment during storms as small as a 1 in 2 yr ARI rainfall event. Soils in the area are generally well drained, however high groundwater limits drainage opportunities. A number of other stormwater catchments either connect directly to South Dunedin (St Clair), or contribute to flooding in the catchment via overland flow (Shore Street, Orari Street and St Clair).

Contamination of harbour sediments adjacent to the South Dunedin catchment has occurred historically, due to industrial land uses in the catchment. As the catchment is now predominantly residential, with fewer high-risk industries in the area, the quality of stormwater discharged is improving, however PAH and potentially heavy metal contamination has been detected in some stormwater samples, and will be the subject of further investigation.

Issues Summary

Hydraulic Bottlenecks

- A number of 'bottlenecks' in the system may be exacerbating flood potential, and create a lower overall level of service in the network.

Blocking / Maintenance of Intake Structures

- Blocking of intake screen leads to backwater effects throughout catchment.

Deep Flooding

- Model results indicate 8 parcels at risk of deep flooding during a current 1 in 10 yr ARI rainfall event, and 31 during 1 in 50 yr ARI rainfall event.

Pump Station Operation

- Pump station operation is key to performance of infrastructure. Future upgrades are dependent on the optimisation of pump stations.

Cross Connection with St Clair Network

- Limited knowledge of the effects of the cross connection due to independent modelling of catchments.
- Stormwater exchange between the South Dunedin and St Clair networks may be reducing the available capacity of the receiving network.

Overland Flow from other Catchments

- Overland flow is predicted to move into the South Dunedin catchment area from the Shore Street, St Clair and Kitchener Street catchments.
- The effects of the Shore Street catchment are particularly significant.

Low Level of Service

- 44 % of the network cannot accept rainfall from a 1 in 10 yr ARI rainfall event, driving by network capacity.
- Network 99 % surcharged during a 1 in 2 yr ARI rainfall event.

Flood Hazard –Current and Future 1 in 100 yr ARI

- 'Moderate' to 'significant' flood hazard predicted in both current and future scenarios.
- Mainly affecting properties already at risk of deep flooding. Due to flatness of catchment, high velocity flows not predicted.

Network Condition and Age

- The age of the assets could be a concern for several reasons; impedance of flow (poor condition), leakage (in or out), and contaminant ingress.

Nuisance Flooding

- Nuisance flooding is predicted on a regular basis throughout the catchment due to hydraulic restrictions throughout the network.

Network Maintenance

- Flooding extents and durations are potentially exacerbated by variations in the frequency and standards of catchpit and inlet screen cleaning and maintenance.
- City-wide inconsistencies in frequency and standards of cleaning and maintenance of stormwater structures (inlets and catchpits) can lead to discrepancies in level of service.

Limited Confidence in the Knowledge of Effects on Harbour Environment and Variability of Stormwater Quality Results

- High variability of stormwater quality results, any trends in stormwater contaminant levels remain unclear.
- Poor information on actual effects of stormwater on harbour environment.
- Lack of data to assess linkages between pipe discharge and harbour environment quality.

Ongoing Stormwater Discharge

- Could exacerbate historical contaminant issues in the harbour. Extent to which this is likely to occur is unconfirmed.
- Based on available data, there may be some ongoing contamination of stormwater.

Point Source Contamination

- 'Spikes' of high PAH in stormwater quality sampling, combined with historical (and potentially recent) PAH contamination of sediment indicates a point source may exist in the catchment.
- Old gasworks site in catchment. Additionally, ageing pipes may be allowing ingress of contaminated groundwater.

Catchment Specific Approaches	SMART Targets
Quantity	
• Design new pipes with capacity to convey a 1 in 10 yr ARI rainfall event (including climate change). • Develop method for determining linkages between stormwater management and harbour environment. • Enhance understanding of effects of deep flooding, particularly on private property. • Ensure cleaning and maintenance schedules and contracts are sufficiently robust. • Ensure consistency city-wide of stormwater structure cleaning and maintenance. • Ensure new development does not increase potential habitable floor flooding due to the stormwater system in events up to a 1 in 50 yr ARI rainfall event. • Ensure new development does not increase the number of properties predicted to flood due to the stormwater system in a 1 in 100 yr ARI rainfall event. • Ensure that the Portobello Road Pumping Station is running optimally, and has capacity to adjust for future flows, and potential upgrades to the overall South Dunedin network. • Identify areas in catchment where more regular stormwater structure cleaning and maintenance could reduce flooding risk. • Incorporate a feedback process to the ICMP if / when monitoring indicates potential adverse effects from stormwater discharges. • Investigate local upgrade options. • Investigate options for reducing habitable floor flooding during frequent events. • Maintain or improve existing level of service in network. • Monitor customer complaints and / or undertake site visits to confirm locations of flooding. • Prioritise Portobello screens for early and regular attention during storms. • Prioritise study into the effects of the Shore Street / South Dunedin / St Clair catchment interaction. • Protect key and vulnerable infrastructure (e.g. pump stations, works depots, schools, hospitals, electricity supply etc.) from flood hazard. Avoid development of vulnerable sites / critical infrastructure in flood prone areas. • Quantify and investigate effects of overflows through the bypass structure between the two networks. • Quantify and investigate the effects of overland flow from other catchments. • Reducing the backwater effect caused by blocking Portobello Pump Station intake screens. • Undertake pipe renewals programme as scheduled (with older pipes and hydraulic bottlenecks prioritised). • Undertake pipe renewals programme as scheduled (with older pipes prioritised). • Use customer complaints and ROS to gauge satisfaction with the stormwater system performance.	• < 31 properties at risk of deep flooding (> 300 mm) during a 1 in 50 yr ARI rainfall event by 2060. • > 60 % residents' satisfaction with the stormwater collection service (on-going). • > 56 % of pipes to convey a 1 in 10 yr ARI rainfall event by 2060. • Develop consistent cleaning and maintenance criteria for all stormwater inlet assets (city-wide) by 2012. • Develop consistent cleaning and maintenance criteria for all stormwater inlet assets (city-wide) by 2012. Specifically include action plan for cleaning the Portobello screens. • Develop list of key stormwater assets in the South Dunedin catchment requiring additional cleaning and maintenance checks by 2013. • Document cleaning and maintenance responsibilities for all stormwater inlet assets (city-wide) by 2013. • Document cleaning and maintenance responsibilities for all stormwater inlet assets in the catchment by 2013. • Ensure Portobello Road Pump Station is running optimally. • Feasibility studies undertaken of upgrades to relieve hydraulic bottlenecks by 2014. • Further characterisation of South Dunedin stormwater by 2012. • Implement an education / enforcement programme targeting stormwater discharges from high risk land uses by 2015. • Measure frequency and effectiveness of manual cleaning of screens. • Portobello Road Pump and Tainui pump stations to convey a 1 in 10 yr ARI rainfall event by 2060. • Prioritise or develop options for mitigating flooding effects by 2015. • Provide modelled flood predictions to agencies responsible for transport routes. • Provide modelled flood predictions to DCC Climate Change Adaptation Group to ensure information is taken into account during the development of a city-wide climate change adaptation plan. • Quantify and assess the effects of overflows from St Clair on South Dunedin, and / or vice versa by 2013. • Quantify and assess the effects of overland flow from other catchments on South Dunedin, prioritising Shore Street and St Clair interactions. • Robust city-wide monitoring framework developed and implemented by 2012. • Test Portobello Road Pump Station, and document capacity. • Undertake habitable floor survey and / or damage assessment of potentially flooded properties.
Quality	
• Consider the cost / benefit of stormwater quality treatment as part of flood mitigation works where practicable. • Develop solutions to remove key contaminants at-source, or implement stormwater treatment. • Enforce the Trade Waste Bylaw, and educate occupiers of high-risk sites with respect to stormwater discharge quality. • Further characterise the stormwater quality from the catchment to confirm key contaminants. • Locate and remove point source Contamination of PAHs. • Redesign DCC's monitoring programme to ensure stormwater quality and receiving environment data is collected within a robust framework. • Require source control of stormwater contaminants in new development of high- contaminant generating land uses. • Undertake an investigation to identify the primary sources of key contaminants. • Undertake monitoring to ensure stormwater quality does not deteriorate over time.	• Confirmation of key contaminants and primary sources by 2012. • Implementation of measures to reduce contaminants in stormwater by 2013. • Improve confidence in data supporting analysis of stormwater discharge quality and effects on harbour environment, with improved confidence in data by 2013. • Lower the contaminant levels in sediment adjacent to the Portobello Road Outfall to below ANZECC 'high' trigger values within 20 years. • No deterioration of stormwater quality due to land use change or development in the catchment.

Recommendations

Further Study

- Redesign the city-wide framework for stormwater quality and harbour environment monitoring.
- Undertake further stormwater monitoring to investigate the extent of potential PAH and heavy metal contamination and likely sources within the catchment.
- Combine the South Dunedin, Shore Street, Orari Street and St Clair 1-D and 2-D stormwater models.
- Identify and undertake floor level survey and damage assessment of properties potentially internally affected by deep flooding (up to a 1 in 50 yr ARI).
- Utilise stormwater complaints and ROS information to continuously gauge customer satisfaction with the stormwater service.

Planning and Education

- Work with ORC to develop a plan for education programmes in relation to best practice site management of industrial premises.
- Review business processes to ensure subdivision and development incorporates catchment specific requirements per the relevant ICMP.
- Contribute information to a city-wide climate change adaptation plan.

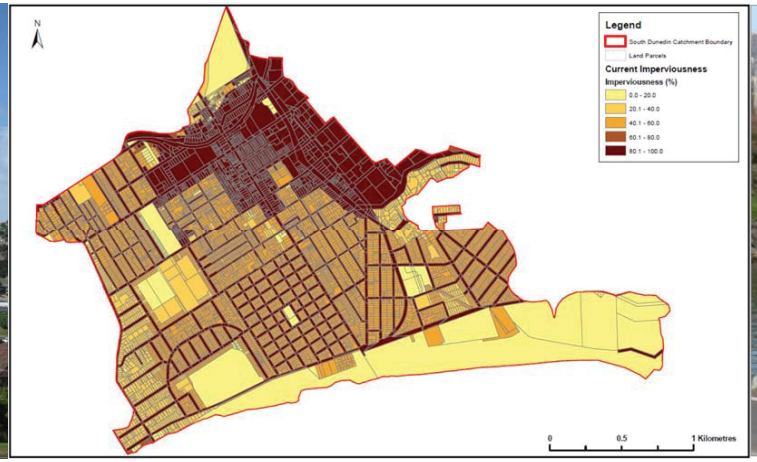
Operation and Maintenance

- Implement the revised city-wide monitoring framework.
- Compile an inventory of all stormwater structures including asset condition, ownership and identify key locations for more frequent cleaning and maintenance.
- Undertake a city-wide review of all current contracts for maintenance of stormwater structures; documenting scope and standards.
- Ensure planned renewals are designed to accommodate a 1 in 10 yr ARI rainfall event and incorporate allowances for climate change.

Capital Works

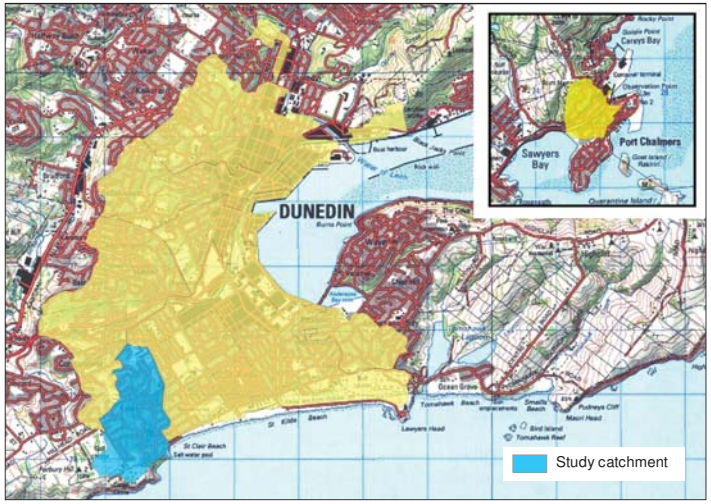
- Progressively develop and implement Infrastructural upgrades to reduce critical location flooding in 1 in 10 years through to 1 in 50 years.

View of South Dunedin looking down Surrey Street from Orari Street Catchment



South Dunedin Current Imperviousness

South Dunedin Catchment Harbour Outfall



Overview

Size: 164 ha

Land Use: Predominantly residential
(90 % residential, 10 % rural)

Imperviousness: 41 %

Stormwater Pipe Age: 20 % greater than 90 years old

No. of Outfalls: 3

Receiving Environment: Second Beach and St Clair Beach

Length of Pipe:

Stormwater: 11 km
Wastewater: 19 km
Water Supply: 23 km

The St Clair catchment is characterised by steep gullies along the head of the catchment in the west, with the low lying areas of South Dunedin and St Kilda in the east.

The stormwater network consists of both open channel (streams) and piped sections, and is based on the catchment's natural watercourses, with ten branches convening in three main gullies, before discharging to a large 'interceptor' pipeline running north to south, along Forbury Road. Outfalls discharge stormwater to Second Beach, via the Bell Chamber outfall, or directly to St. Clair Beach.

The Forbury Road pipe dictates the overall system capacity and currently surcharging leads to surface flooding and overflows into the South Dunedin catchment during extreme events. There is also a direct connection between the South Dunedin and St Clair stormwater systems at the intersection of Hillside Road and Forbury Road.

The stormwater discharges into a high-energy environment, and as such, the quality of the stormwater (typical of the residential land use) is not considered to be having an adverse effect on the receiving environment. Wastewater has been detected in the stormwater, however, and investigations are recommended to identify the source and remove this contamination. This is particularly important as St Clair beach is a popular bathing and surfing beach.

Issues Summary

Potential Wastewater Contamination

- Single stormwater measurement in 2010 indicating potential wastewater contamination. Possibility of manhole overflows from the wastewater system supported by 3 Waters Wastewater Study and stream assessments.

Cross Connection with the South Dunedin Stormwater Network

- Limited knowledge of the effects of the cross connection due to independent modelling of catchments.
- Stormwater exchange between the South Dunedin and St Clair networks may be reducing the available capacity of the receiving network during extreme events.

Low Level of Service in Lower Catchment

- While network capacity in the upper catchment is in excess of the 1 in 10 yr ARI rainfall event, the capacity of the Forbury Road interceptor stormwater line (leading to the outfalls) is insufficient to convey the flows from the catchment.

Network Maintenance

- Flooding extents and durations in St Clair are potentially exacerbated by variations in the frequency and standards of catchpit and watercourse inlet screen cleaning and maintenance.
- City-wide inconsistencies in frequency and standards of cleaning and maintenance of stormwater structures (inlets and catchpits) can lead to discrepancies in level of service.

Nuisance Flooding

- Nuisance flooding is predicted and confirmed during small events in two main areas: along Forbury Road, from Wilson Avenue to approximately 80 m north of Macandrew Road; and surrounding an intake screen at 30 Middleton Road.
- Not expected to inundate roads or be experienced for long periods of time.

Flood Hazard (current and future) 1 in 100 yr ARI

- Flood hazard issues in this catchment are considered to be fairly minor, with hazard being identified in areas predicted to have deep flooding during a number of events.
- Transport routes are not predicted to be severely affected – inundation across roads is predicted to be shallow or confined to the sides of the road.

Ongoing Stormwater Discharge

- Stormwater discharged contains relatively low levels of stormwater contaminants; no measurable adverse effects on the receiving environment.
- Key stakeholder issue.
- Based on available data, consequence currently believed to be minor.

Overland Flow to the South Dunedin Catchment

- Overland flow is predicted to move into the South Dunedin catchment from the St Clair catchment, along Forbury Road during small events, as well as Beach Street during large storm events.

Deep Flooding

- Model results indicate 2 parcels affected by deep flooding during a 1 in 10 yr ARI rainfall event; rises to 5 during 1 in 50 yr ARI rainfall event in current, and d 7 land parcels in the mean climate change future planning scenarios.

Outfall Pipe to Bell Chamber at Second Beach

Catchment Specific Approaches	SMART Targets
Quantity	
• Design new pipes with capacity to convey a 1 in 10 yr ARI rainfall event (including climate change allowances). • Enhance understanding of effects of deep flooding, particularly on private property. • Ensure cleaning and maintenance schedules and contracts are sufficiently robust. • Ensure consistency city-wide of stormwater structure cleaning and maintenance. • Ensure damaged screens are replaced / fixed. • Ensure new development does not increase potential habitable floor flooding due to the stormwater system in events up to a 1 in 50 yr ARI rainfall event. • Ensure new development does not increase the number of properties predicted to flood due to the stormwater system in a 1 in 100 yr ARI rainfall event. • Identify areas in catchment where more regular stormwater structure cleaning and maintenance could reduce flooding risk. • Investigate effects on South Dunedin, and re-prioritise issue if significant. • Maintain or improve existing level of service in network. • Monitor customer complaints and / or undertake site visits to confirm locations of flooding. • Protect key and vulnerable infrastructure (e.g. pump stations, works depots, schools, hospitals, electricity supply etc) from flood hazard. Avoid development of vulnerable sites / critical infrastructure in flood prone areas. • Quantify and investigate effects of overflows through the bypass structure between the two networks. • Undertake an inspection of all open channel sections, to record status of intake structures. • Undertake pipe renewals programme as scheduled (with older pipes prioritised). • Use customer complaints and ROS to gauge satisfaction with the stormwater system performance. • Work with property owners to ensure screens and intakes are properly maintained.	• < 16 properties at risk of deep flooding (> 300 mm) during a 1 in 50 yr ARI rainfall event. • > 60 % resident's satisfaction with the stormwater collection service (ongoing). • > 66 % of pipes to convey a 1 in 10 yr ARI rainfall event by 2060. • > 84 % of pipes to convey a 1 in 10 yr ARI rainfall event by 2060. • Assess the effects of overland flooding from St Clair catchment on South Dunedin catchment. • Develop consistent cleaning and maintenance criteria for all stormwater inlet assets (city-wide) by 2012. • Develop list of key stormwater assets in St Clair catchment requiring additional cleaning and maintenance checks by 2013. • Ensure all damaged, poor performing, or missing screens are replaced (if appropriate) by 2013. • Provide modelled flood predictions to DCC Climate Change Adaptation Group to ensure information is taken into account during the development of a city-wide climate change adaptation plan. • Quantify and assess the effects of overflows from St Clair on South Dunedin, and / or vice versa by 2013. • Undertake habitable floor survey and / or damage assessment of potentially flooded properties.
Quality	
• Enforce the Trade Waste Bylaw, and educate occupiers of high-risk sites with respect to stormwater discharge quality. • Require source control of stormwater contaminants in new development of high contaminant generating land uses. • Support further investigation into overflows in catchment. • Use improved monitoring programme to enable better understanding of potential catchment contamination.	• Implement an education / enforcement programme targeting stormwater discharges from high risk land uses by 2015. • Implement management options to remediate problem where necessary. • Improve data relating to levels microbial contamination and potential sources of contamination within the catchment by 2012. • No deterioration of stormwater quality due to land use change or development in the catchment.

Recommendations

Further Study

- Combine the South Dunedin and St Clair 1-D and 2-D stormwater models.
- Undertake further stormwater monitoring to investigate the extent of potential wastewater contamination and likely sources within the catchment.
- Undertake comprehensive watercourse inspections.
- Utilise stormwater complaints and ROS information to continuously gauge customer satisfaction with the stormwater service.
- Identify and undertake floor level survey and damage assessment of properties potentially internally affected by deep flooding (up to a 1 in 50 yr ARI).

Planning and Education

- Review business processes to ensure subdivision and development incorporates catchment specific requirements per the relevant ICMP.
- Review the education / advice provided to property owners responsible for watercourses to ensure adequate information and assistance is provided.
- Contribute information to a city-wide climate change adaptation plan.
- Review flood hazard in South Dunedin catchment, incorporating effects from the St Clair catchment.

Operation and Maintenance

- Compile an inventory of all stormwater structures including asset condition, ownership and identify key locations for more frequent cleaning and maintenance.
- Ensure damaged screens and / or intake structures on open channels and watercourses are replaced or repaired.
- Undertake a city-wide review of all current contracts for maintenance of stormwater structures; documenting scope and standards.

Capital Works

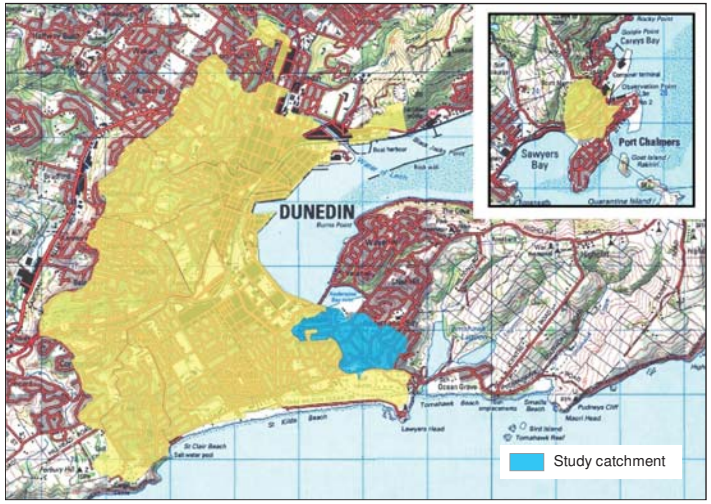
- Provide input into wastewater investigation and subsequent upgrade to reduce manhole overflows.

St Clair Beach

Bell Chamber Outfall Ceiling

Cross-connection with South Dunedin Stormwater Network

Bell Chamber Outfall at Second Beach



Overview

Size: 101 ha

Land Use: Predominantly residential
(99 % residential, 1 % commercial)

Imperviousness: 49 %

Stormwater Pipe Age: 21 % greater than 90 years old

No. of Outfalls: 1

Receiving Environment: Andersons Bay

Length of Pipe:

Stormwater: 4.6 km
Wastewater: 13 km
Water Supply: 13 km

he Shore Street catchment is characterised by steep gullies at the head of the catchment in the east and the Musselburgh Rise in the west of the catchment. There is a large area of reclaimed land adjacent to the Andersons Bay Inlet, some of which is included in the Shore Street catchment.

The stormwater network has two main branches running south to north; one along Tainui Road, picking up flow from the Musselburgh Rise area, with the second following Bayfield Road draining the balance of the catchment. These branches meet at Shore Street before discharging into the Andersons Bay Inlet. The network is predominantly piped, but includes several lengths of open channel in the upper reaches. There are a number of areas in the catchment where deep flooding is predicted to occur, either due to tidal influence on the network, or at watercourse intakes.

The Andersons Bay Inlet has evidence of historical contamination; the enclosed nature of the inlet means that contaminants discharged with stormwater are more likely to remain in the inlet. While the stormwater quality is thought to be typical of the residential land use, more information is required in order to determine the effects current stormwater discharges are having on the receiving environment. Wastewater contamination is suspected in one location, but not confirmed and further monitoring and investigation of the likely source is recommended.

Issues Summary

Blocking / Maintenance of Intake Structures

- A number of catchpits and intake structures in the Chisholm Place and Tahuna Road area are prone to blockage, resulting in small areas of deep flooding in these areas.

Potential Wastewater Contamination

- Known emergency discharge into the Andersons Bay Inlet from Marne Street pumping station.
- Suspected overflow in Tainui Street area, although no evidence in stormwater sampling to date.

Limited Confidence in the Knowledge of Effects on Harbour Environment and Variability of Stormwater Quality Results

- High variability of stormwater quality results, any trends in stormwater contaminant levels remain unclear, however results to date indicate moderately low contaminant concentrations in stormwater discharge.
- Poor information on actual effects of stormwater on harbour environment.
- Lack of data to assess linkages between pipe discharge and harbour environment quality.

Network Maintenance

- Flooding extents and durations in the Shore Street catchment are potentially exacerbated by variations in the frequency and standards of catchpit and inlet screen cleaning and maintenance.
- City-wide inconsistencies in frequency and standards of cleaning and maintenance of stormwater structures (inlets and catchpits) can lead to discrepancies in level of service.

Tidal Influence on Network

- Tidal influence on the network results in reduced capacity in lower network.
- May be exacerbating nuisance flooding issues in some locations.
- Will be affected by climate change, resulting in increased extent of flooding in lower catchment.

Nuisance Flooding

- Nuisance flooding is predicted and confirmed in two areas in the catchment – in the vicinity of Lochend Street in the lower catchment, and from Tainui Road, causing flooding into the South Dunedin catchment.
- Flooding is affected by tidal influence, and may be causing an issue on private properties. The resolution of the ground model, however, means that the exact location of the flooding is not confirmed.

Flood Hazard (current and future) – 1 in 100 yr ARI

- Flood hazard issues in this catchment are considered to be fairly minor, with hazard being identified in areas predicted to have deep flooding during a number of events. The majority of these locations are near or within watercourses in the upper catchment.
- Transport routes are not predicted to be severely affected – inundation across roads is predicted to be shallow.
- Small parts of lower catchment at risk of direct tidal inundation.

Ongoing Stormwater Discharge

- Could exacerbate historical contaminant issues in the harbour. Extent to which this is likely to occur is unconfirmed.
- Key stakeholder issue.
- Based on available data, consequence currently believed to be minor.

Low Level of Service

- 15 % of network manholes overflow during a 1 in 5 yr ARI rainfall event.
- Low level of service in some locations contributing to nuisance (and deep) flooding.

Deep Flooding

- Model results indicate 21 parcels affected by deep flooding during 1 in 10 yr ARI rainfall event; rises to 40 during 1 in 50 yr ARI rainfall event in current, and 43 land parcels in future planning scenarios.
- Deep flooding is in small 'pockets', and likely to be mostly exterior to buildings (however surveys not yet undertaken).

Overland Flow into Other Catchments

- Overland flow is predicted to move into the South Dunedin catchment area ('the Flat') from the Shore Street catchment from the Tainui Road area during small events, and from the Lochend Street area during large rainfall events.

Catchment Specific Approaches	SMART Targets
Quantity	
• Design new pipes with capacity to convey a 1 in 10 yr ARI rainfall event (including climate change allowances). • Develop a better understanding of the likely effects and magnitude of climate change. • Enhance understanding of effects of deep flooding, particularly on private property. • Ensure cleaning and maintenance schedules and contracts are sufficiently robust. • Ensure consistency city-wide of stormwater structure cleaning and maintenance. • Ensure damaged screens are replaced / fixed. • Ensure new development does not increase potential habitable floor flooding due to the stormwater system in events up to a 1 in 50 yr ARI rainfall event. • Ensure new development does not increase the number of properties predicted to flood due to the stormwater system in a 1 in 100 yr ARI rainfall event. • Identify areas in catchment where more regular stormwater structure cleaning and maintenance could reduce flooding risk. • Investigate effects on the South Dunedin catchment, and re-prioritise issue if significant. • Maintain or improve existing level of service in network. • Monitor customer complaints and / or undertake site visits to confirm locations of flooding. • Protect key and vulnerable infrastructure (e.g. pump stations, works depots, schools, hospitals, electricity supply etc) from flood hazard. Avoid development of vulnerable sites / critical infrastructure in flood prone areas. • Undertake an inspection of all open channel sections, to record status of intake structures. • Undertake pipe renewals programme as scheduled (with older pipes prioritised). • Use customer complaints and ROS to gauge satisfaction with the stormwater system performance. • Work with property owners to ensure screens and intakes are properly maintained.	• < 40 properties at risk of deep flooding (> 300 mm) during a 1 in 50 yr ARI rainfall event. • > 60 % resident's satisfaction with the stormwater collection service (ongoing). • > 66 % of pipes to convey a 1 in 10 yr ARI rainfall event by 2060. • Assess the effects of overland flooding from Shore Street catchment on South Dunedin catchment. • Develop consistent cleaning and maintenance criteria for all stormwater inlet assets in the catchment (in conjunction with city-wide criteria) by 2012. • Develop consistent cleaning and maintenance criteria for all stormwater inlet assets (city-wide) by 2012. • Develop list of key intake structures in Shore Street catchment requiring additional cleaning and maintenance checks by 2013. • Document cleaning and maintenance responsibilities for all stormwater inlet assets (city-wide) by 2013. • Document cleaning and maintenance responsibilities for all stormwater inlet assets in the catchment by 2013. • Ensure all damaged, poor performing, or missing screens are replaced (if appropriate) by 2013. • Provide modelled flood predictions to DCC Climate Change Adaptation Group to ensure information is taken into account during the development of a city-wide climate change adaptation plan. • Undertake habitable floor survey and / or damage assessment of potentially flooded properties.
Quality	
• Consider the cost / benefit of stormwater quality treatment as part of flood mitigation works where practicable. • Develop method for determining linkages between stormwater management and harbour environment. • Enforce the Trade Waste Bylaw, and educate occupiers of high-risk sites with respect to stormwater discharge quality. • Incorporate a feedback process to the ICMP if / when monitoring indicates potential adverse effects from stormwater discharges. • Redesign DCC's monitoring programme to ensure stormwater quality and receiving environment data is collected within a robust framework. • Require source control of stormwater contaminants in new development of high- contaminant generating land uses. • Undertake monitoring to ensure stormwater quality does not deteriorate over time. • Use improved monitoring programme to enable better understanding of potential catchment contamination.	• Implement an education / enforcement programme targeting stormwater discharges from high risk land uses by 2015. • Implement management options to remediate problem where necessary. • Improve confidence in data supporting analysis of stormwater discharge quality and effects on harbour environment, with improved confidence in data by 2013. • Improve data relating to levels microbial contamination and potential sources of contamination within the catchment by 2012. • No deterioration of stormwater quality due to land use change or development in the catchment. • No discharges from the Marne Street pumping station during 1 in 10 yr ARI rainfall event or less. • Robust city-wide monitoring framework developed and implemented by 2012.

Recommendations

Further Study

- Undertake comprehensive watercourse inspections.
- Redesign the city-wide framework for stormwater quality and harbour environment monitoring.
- Identify and undertake floor level survey and damage assessment of properties potentially affected by deep flooding (up to a 1 in 50 yr ARI).
- Utilise Residents' Opinion Survey information to continuously gauge customer satisfaction with the stormwater service.

Planning and Education

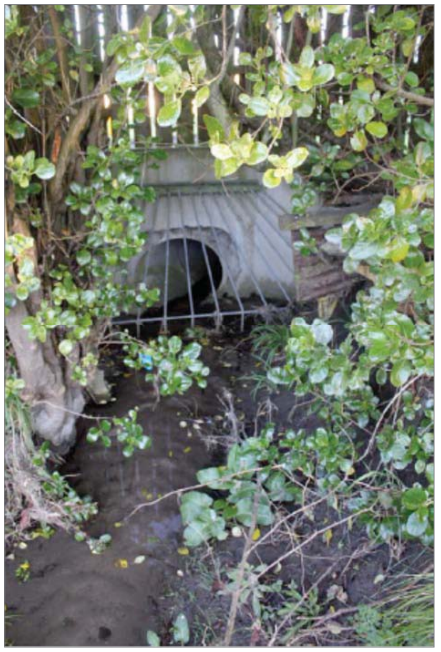
- Review the education / advice provided to property owners responsible for watercourses to ensure adequate information and assistance is provided.
- Review business processes to ensure subdivision and development incorporates catchment specific requirements per the relevant ICMP.
- Contribute information to a city-wide climate change adaptation plan.
- Review flood hazard in South Dunedin catchment, incorporating effects from the Shore Street catchment.

Operation and Maintenance

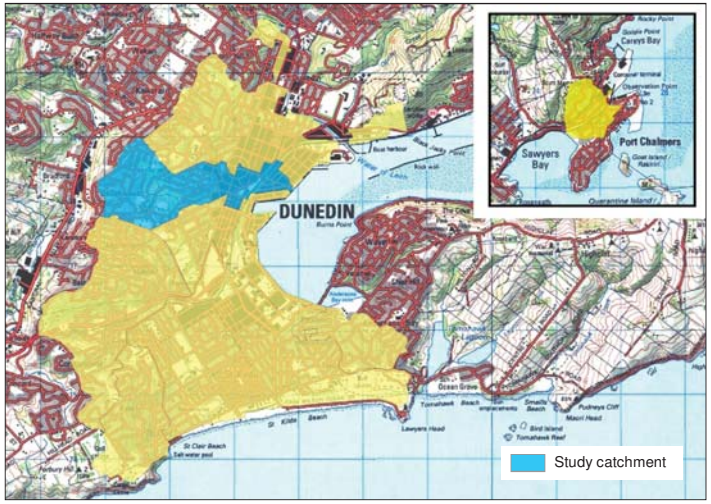
- Ensure damaged screens on watercourses are replaced or repaired (where not imposing a threat to stream health).
- Implement the revised city-wide monitoring framework.
- Undertake a city-wide review of all current contracts for maintenance of stormwater structures; documenting scope and standards.
- Develop list of key stormwater structures for more regular cleaning as part of existing and/or future maintenance contracts, incorporating key Shore Street catchment structures.

Open Channel at Top of Chisholm Place

View of Portobello Road across Andersons Bay Inlet



Culvert Intake at 71 Tahuna Road



Overview

Size: 209 ha

Land Use: Mixed (74 % residential, 16 % commercial, 10 % industrial, 1 % port)

Imperviousness: 56 %

Stormwater Pipe Age: 36 % greater than 90 years old

No. of Outfalls: 1

Receiving Environment: Otago Harbour

Length of Pipe:

Stormwater: 17 km
Wastewater: 32 km
Water Supply: 41 km

The topography of the Mason Street catchment is characterised by low lying relatively flat areas in the eastern areas which are occupied by industrial and urban land uses, with the topography increasing in steepness towards the residential-zoned west of the catchment. The catchment includes part of the central business district in Dunedin.

In general, the majority of the pipe network in the catchment has capacity to accept flows from a 1 in 10 yr ARI rainfall event. System restrictions do exist, however, and in the upper catchment, these result in high velocity overland flow down the catchment. Deep flooding is predicted to occur in a small number of properties, predominantly in the lower catchment and during larger events.

High microbial readings in the limited stormwater quality samples taken indicate possible wastewater contamination, and further monitoring and investigation of the likely source is recommended.

Issues Summary

Limited Confidence in the Knowledge of Effects on Harbour Environment and Variability of Stormwater Quality Results

- High variability of stormwater quality results, any trends in stormwater contaminant levels remain unclear.
- Poor information on actual effects of stormwater on harbour environment.
- Lack of data to assess linkages between pipe discharge and harbour environment quality.

Deep Flooding

- Model results indicate 7 parcels affected by deep flooding during 1 in 10 yr ARI rainfall event; rises to 24 properties during 1 in 50 yr ARI rainfall event in current and future planning scenarios.
- Large number of properties affected during extreme climate change scenario.
- Flooding during low frequency events mostly predicted exterior to buildings (although surveys not yet undertaken).

Flood Hazard – Current and Future 1 in 100 yr ARI

- Areas of 'significant' flood hazard in roadways, mostly in central city, predicted during current event.
- 'Significant' flood hazard in roadways in central city, with increased flood extent, predicted in the future (2060) event predominantly due to tidal inundation, exacerbated by predicted climate change effects.

Potential Wastewater Contamination

- High microbial contamination of stormwater, particularly in 2010, may be cause for concern.

Network Maintenance

- Flooding extents and durations in the Mason Street catchment are potentially exacerbated by variations in the frequency and standards of catchpit and inlet screen cleaning and maintenance.
- City-wide inconsistencies in frequency and standards of cleaning and maintenance of stormwater structures (inlets and catchpits) can lead to discrepancies in level of service.

Blocking / Maintenance of Intake Structures

- Potential blockage of inlet screens at Queens Drive / Serpentine Avenue and Canongate Road could exacerbate downstream flooding.

Low Level of Service

- General low level of service of stormwater network (less than 1 in 10 yr ARI), driven by both pipe capacity and tidal influence.
- 18 % of manholes predicted to overflow during a current 1 in 10 yr ARI rainfall event, pipes flowing full throughout a large part of system.
- Overflows currently occurring, no capacity for climate change effects.
- Effects mainly nuisance flooding, affecting approximately 1 % of the catchment currently, and 2 % of catchment in future 1 in 10 yr ARI rainfall event.

Nuisance Flooding

- Nuisance flooding on regular basis in a small number of areas, particularly tidally influenced locations. Causes some partial road blockages.
- Affects < 0.05 % of catchment during 1 in 2 yr ARI rainfall event, and 1 % of catchment during a 1 in 10 yr ARI rainfall event.

Ongoing Stormwater Discharge

- Could exacerbate existing/historical contaminant issues. Extent to which this is likely to occur is unconfirmed.
- Key stakeholder issue.
- Based on available data, consequence currently believed to be minor.

Canongate Intake

Catchment Specific Approaches	SMART Targets
Quantity	
• Design new pipes with capacity to convey a 1 in 10 yr ARI rainfall event (including climate change allowances). • Enhance understanding of effects of deep flooding, particularly on private property. • Ensure cleaning and maintenance schedules and contracts are sufficiently robust. • Ensure consistency city-wide of stormwater structure cleaning and maintenance. • Ensure new development does not increase potential habitable floor flooding due to the stormwater system in events up to a 1 in 50 yr ARI rainfall event. • Identify areas in catchment where more regular stormwater structure cleaning and maintenance could reduce flooding risk. • Maintain or improve existing level of service in network – ensure no increase in the number of stormwater manholes predicted to overflow in a 1 in 10 yr ARI rainfall event. • Reduce number of properties predicted to flood during a current 1 in 10 yr ARI rainfall event. • Undertake pipe renewals programme as scheduled (with older pipes prioritised). • Use ROS to gauge city wide satisfaction with the stormwater system performance	• < 0.02 % of catchment surface area predicted to flood during a 1 in 2 yr ARI rainfall event by 2060. • < 1 % of catchment surface predicted to flood during a 1 in 10 yr ARI rainfall event by 2060. • < 18 % manholes predicted to overflow during a 1 in 10 yr ARI rainfall event by 2060. • < 24 properties at risk of deep flooding (> 300 mm) during a 1 in 50 yr ARI rainfall event by 2060. • > 60 % resident's satisfaction with the stormwater collection service (ongoing). • > 65 % of pipes to convey a 1 in 10 yr ARI rainfall event by 2060. • Develop consistent cleaning and maintenance criteria for all stormwater inlet assets (city-wide) by 2012. • Develop list of key stormwater assets in Mason Street catchment requiring additional cleaning and maintenance checks by 2013. • Document cleaning and maintenance responsibilities for all stormwater inlet assets (city-wide) by 2013. • Undertake habitable floor survey and / or damage assessment of potentially flooded properties.
Quality	
• Consider the cost/benefit of stormwater quality treatment as part of flood mitigation works where practicable. • Develop appropriate management options to remediate problem where necessary. • Develop method for determining linkages between stormwater management and harbour environment. • Enforce the Trade Waste Bylaw, and educate occupiers of high-risk sites with respect to stormwater discharge quality. • Incorporate a feedback process to the ICMP if/when monitoring indicates potential adverse effects from stormwater discharges. • Investigate potential sources of wastewater contamination.	• Implement an education / enforcement programme targeting stormwater discharges from high risk land uses by 2015. • Implement management options to remediate problem where necessary. • Improve confidence in data supporting analysis of stormwater discharge quality and effects on harbour environment, with improved confidence in data by 2013. • Improve data relating to levels microbial contamination and potential sources of contamination within the catchment by 2012. • No deterioration of stormwater quality due to land use change or development in the catchment. • Robust city-wide monitoring framework developed and implemented by 2012.

Recommendations

Further Study

- Redesign the city-wide framework for stormwater quality and harbour environment monitoring.
- Undertake further stormwater monitoring to investigate the extent of potential wastewater contamination and likely sources within the catchment.
- Utilise stormwater complaints and ROS information to continuously gauge customer satisfaction with the stormwater service.
- Improve quality of stormwater network data (through level survey, GIS confirmation, CCTV).
- Undertake feasibility study to optimise capital works and enable design of the most robust, long term solution for resolving catchment flooding.
- Identify and undertake floor level survey and damage assessment of properties potentially internally affected by deep flooding (up to a 1 in 50 yr ARI).

Planning and Education

- Develop a city-wide climate change adaptation plan, including ongoing monitoring of climate change predictions, incorporating damage assessment of the vulnerable infrastructure.
- Develop an emergency response plan for the catchment to ensure evacuation from flooded areas is possible during a large storm event.
- Review business processes to ensure subdivision and development incorporates catchment specific requirements per the relevant ICMP.
- Work with ORC to develop a plan for education programmes in relation to best practice site management of industrial premises.

Operation and Maintenance

- Implement the revised city-wide monitoring framework.
- Compile an inventory of all stormwater structures including asset condition, ownership and identify key locations for more frequent cleaning and maintenance. Include the Queens Drive / Serpentine Avenue and Canongate intake screens.
- Undertake a city-wide review of all current contracts for maintenance of stormwater structures; documenting scope and standards.

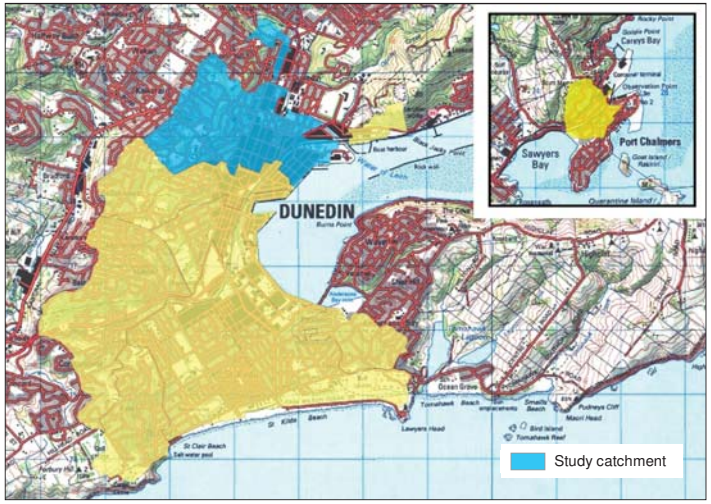
Capital Works

- Include additional or improved catchpits in all stormwater capital works.

Flooding along Water Street (Feb, 2005)

Modelled Catchment Imperviousness (lighter = more pervious)

Flooding along Bond Street (Feb, 2005)



Overview

Size: 334 ha

Land Use: Predominantly residential
(65 % residential, 11 % industrial, 10 % commercial, 8 % campus, 6 % port)

Imperviousness: 60 %

Stormwater Pipe Age: 33 % greater than 90 years old

No. of Outfalls: 6

Receiving Environment: Otago Harbour

Length of Pipe:

Stormwater: 32 km
Wastewater: 47 km
Water Supply: 60 km

The Halsey Street catchment is relatively large, covering an area of approximately 390 ha, characterised by relatively low lying flat land in the lower reaches with increasing steepness towards the head of the catchment. The catchment is predominantly urban with areas of residential, commercial and industrial land use as well as areas of bush cover and grass playing fields.

The natural stream network in this catchment comprises three streams with natural channels located within the Town Belt. The stream channels are piped upstream receiving flow from an urban residential area. Downstream, at the edge of the Town Belt, the flow within the stream channels is diverted via pipework a piped network, discharging via six outfalls into the Otago harbour.

A large part of the stormwater network can accept a 1 in 10 yr ARI rainfall event (84 %), however this is primarily in the upper parts of the catchment. Hydraulic restrictions in the upper catchment also result in high velocity stormwater flowing down the catchment. Tidal influence affects system capacity in the lower catchment. Flooding in commercial areas of the catchment is predicted, and has caused issues in the past for local business owners.

Limited stormwater sampling in the catchment has shown variable levels of contaminants in stormwater. This, combined with a historically contaminated receiving environment, has prompted recommendations for further monitoring and investigation.

Issues Summary

Potential Wastewater Contamination

- High microbial contamination of stormwater, particularly in 2007, 2009 and 2010, may be cause for concern.

Limited Confidence in the Knowledge of Effects on Harbour Environment and Variability of Stormwater Quality Results

- High variability of stormwater quality results, any trends in stormwater contaminant levels remain unclear.
- Poor information on actual effects of stormwater on harbour environment.
- Lack of data to assess linkages between pipe discharge and harbour environment quality.

Nuisance Flooding

- Nuisance flooding is predicted on a regular basis in a number of locations in due to hydraulic restrictions throughout the catchment and tidal influence on the lower catchment. Of significance are the effects on London Street and in the central city (vicinity of St Andrew Street). Nuisance flooding may pose a risk to building interiors on George Street.
- Affects 0.05 % of catchment during 1 in 2 yr ARI rainfall events, and 0.8 % of catchment during a 1 in 10 yr ARI rainfall event.

Blocking / Maintenance of Intake Structures

- Intake structures are undersized and/or inadequately maintained and/or prone to blockage.
- Blocked or overflowing screens will exacerbate predicted overland flows and flooding in critical areas.

Flood Hazard – Current and Future 1 in 100 yr ARI

- Areas of significant flood hazard in roadways, including State Highway, mostly in central city, predicted during current event.
- Significant flood hazard in roadways in central city, with increased flood extent, predicted in the future (2060) event predominantly due to tidal inundation, exacerbated by predicted climate change effects.

Network Maintenance

- Flooding extents and durations in Halsey Street are potentially exacerbated by variations in the frequency and standards of catchpit and inlet screen cleaning and maintenance.
- City-wide inconsistencies in frequency and standards of cleaning and maintenance of stormwater structures (inlets and catchpits) can lead to discrepancies in level of service.

Low Level of Service

- 16 % of stormwater network cannot accept rainfall from a 1 in 10 yr ARI, driven by both network capacity and tidal influence.
- Manholes predicted to overflow with pipes flowing full throughout approximately 57 % of system.
- This low level of service is currently occurring with no capacity for climate change effects.
- Flooding results in certain locations during a current 1 in 10 yr ARI rainfall event.

Ongoing Stormwater Discharge

- Could exacerbate existing / historical contaminant issues. Extent to which this is likely to occur is unconfirmed.
- Key stakeholder issue.
- Based on available data, consequence currently believed to be minor.

Deep Flooding

- Model results indicate 2 land parcels affected by deep flooding during 1 in 5 yr ARI rainfall event; rises to 32 parcels during 1 in 50 yr ARI rainfall event in current and 56 parcels in future planning scenarios.
- Large number of properties affected during extreme climate change scenario.
- A proportion of the deep flooding predicted during high frequency events is predicted exterior to buildings (although surveys not yet undertaken).

Bute Street Intake

Catchment Specific Approaches	SMART Targets
Quantity	
• Design new pipes with capacity to convey a 1 in 10 yr ARI rainfall event (including climate change allowances). • Develop a better understanding of the likely effects and magnitude of climate change. • Enhance understanding of effects of deep flooding, particularly on private property. • Ensure cleaning and maintenance schedules and contracts are sufficiently robust. • Ensure consistency city-wide of stormwater structure cleaning and maintenance. • Ensure damaged screens are replaced / fixed. • Ensure new development does not increase potential habitable floor flooding due to the stormwater system in events up to a 1 in 50 yr ARI rainfall event. • Ensure new development does not increase the number of properties predicted to flood due to the stormwater system in a 1 in 100 yr ARI rainfall event. • Ensure transport routes around flooding areas will be available. • Identify areas in catchment where more regular stormwater structure cleaning and maintenance could reduce flooding risk. • Maintain or improve existing level of service in network – ensure no increase in the number of stormwater manholes predicted to overflow in a 1 in 10 yr ARI rainfall event. • Prioritise the renewals programme to focus on poorly performing areas of the catchment • Protect key and vulnerable infrastructure (e.g. pump stations, works depots, schools, hospitals, electricity supply etc) from flood hazard. Avoid development of vulnerable sites / critical infrastructure in flood prone areas. • Reduce the number of properties predicted to flood during a current 1 in 10 yr ARI rainfall event. • Undertake an inspection of all open channel sections, to record status of intake structures. • Undertake pipe renewals programme as scheduled (with older pipes prioritised). • Use ROS to gauge city wide satisfaction with the stormwater system performance • Work with property owners to ensure intakes and screens are properly maintained.	• < 0.05 % of catchment surface area predicted to flood during a 1 in 2 yr ARI rainfall event by 2060. • < 0.8 % of catchment surface predicted to flood during a 1 in 10 yr ARI rainfall event by 2060. • < 16 % manholes predicted to overflow during a 1 in 10 yr ARI rainfall event by 2060. • < 32 properties at risk of deep flooding (> 300 mm) during a 1 in 50 yr ARI rainfall event by 2060. • > 60 % resident's satisfaction with the stormwater collection service (ongoing). • > 66 % of pipes to convey a 1 in 10 yr ARI rainfall event by 2060. • Develop a catchment specific emergency response plan by 2012. • Develop consistent cleaning and maintenance criteria for all stormwater inlet assets in the catchment (in conjunction with city-wide criteria) by 2012. • Develop consistent cleaning and maintenance criteria for all stormwater inlet assets (city-wide) by 2012. • Develop list of key stormwater assets in Halsey Street catchment requiring additional cleaning and maintenance checks by 2013. • Develop list of key stormwater intake structures in Halsey Street catchment requiring additional cleaning and maintenance checks by 2013. • Document cleaning and maintenance responsibilities for all stormwater inlet assets (city-wide) by 2013. • Document cleaning and maintenance responsibilities for all stormwater inlet assets in the catchment by 2013. • Ensure all damaged, poor performing, or missing screens are replaced (if appropriate) by 2013. • Provide modelled flood predictions to DCC Climate Change Adaptation Group to ensure information is taken into account during the development of a city-wide climate change adaptation plan. • Undertake habitable floor survey and/or damage assessment of potentially flooded properties. • Undertake survey of property owners to determine any occurrence of flooding during high frequency events.
Quality	
• Consider the cost / benefit of stormwater quality treatment as part of flood mitigation works where practicable. • Develop appropriate management options to remediate problem where necessary. • Develop method for determining linkages between stormwater management and harbour environment. • Enforce the Trade Waste Bylaw, and educate occupiers of high-risk sites with respect to stormwater discharge quality. • Include Halsey Street as a priority catchment in the monitoring programme. • Incorporate a feedback process to the ICMP if/when monitoring indicates potential adverse effects from stormwater discharges. • Investigate potential sources of wastewater contamination. • Redesign DCC's monitoring programme to ensure stormwater quality and receiving environment data is collected within a robust framework. • Require source control of stormwater contaminants in new development of high- contaminant generating land uses. • Undertake monitoring to ensure stormwater quality does not deteriorate over time. • Undertake targeted monitoring to enable better understanding of potential catchment contamination.	• Implement an education / enforcement programme targeting stormwater discharges from high risk land uses by 2015. • Implement management options to remediate problem where necessary. • Improve confidence in data supporting analysis of stormwater discharge quality and effects on harbour environment, with improved confidence in data by 2013. • Improve data relating to levels microbial contamination and potential sources of contamination within the catchment by 2012. • No deterioration of stormwater quality due to land use change or development in the catchment. • Robust city-wide monitoring framework developed and implemented by 2012.

Recommendations

Further Study

- Undertake further stormwater monitoring to investigate the extent of potential wastewater contamination and likely sources within the catchment.
- Redesign the city-wide framework for stormwater quality and harbour environment monitoring.
- Improve quality of stormwater network data through (level survey, GIS confirmation, CCTV).
- Undertake feasibility study to enable preparation of an action plan of stormwater capital works in the catchment.
- Utilise stormwater complaints and ROS information to continuously gauge customer satisfaction with the stormwater service.
- Identify and undertake floor level survey and damage assessment of properties potentially affected by deep flooding up to a 1 in 50 yr ARI event. (Include properties in George Street commercial area).

Planning and Education

- Review the education / advice provided to property owners responsible for watercourses to ensure adequate information and assistance is provided.
- Develop a city-wide climate change adaptation plan, including ongoing monitoring of climate change predictions, incorporating damage assessment of the vulnerable infrastructure.
- Develop an emergency response plan for the catchment to ensure evacuation from flooded areas is possible during a large storm event.
- Review business processes to ensure subdivision and development incorporates catchment specific requirements per the relevant ICMP.

Operation and Maintenance

- Implement the revised city-wide monitoring framework.
- Ensure damaged screens and / or intake structures on open channels and watercourses are replaced or repaired.
- Compile an inventory of all stormwater structures including asset condition, ownership and identify key locations for more frequent cleaning and maintenance.
- Undertake a city-wide review of all current contracts for maintenance of stormwater structures; documenting scope and standards.

Capital Works

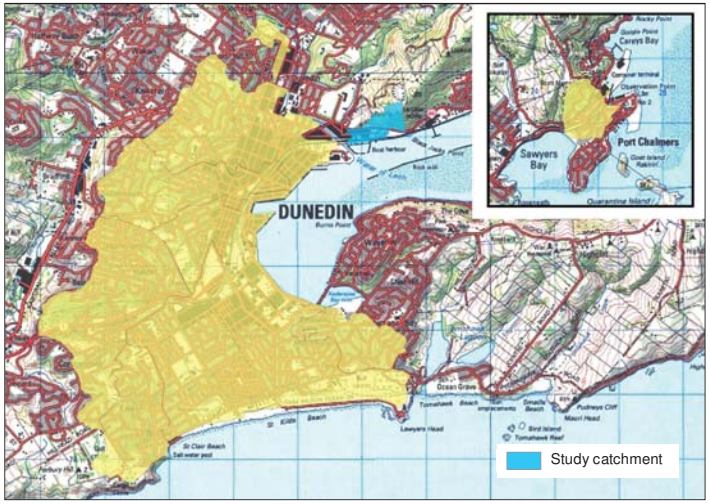
- Include additional or improved catchpits in all stormwater capital works.

Logan Road Intake

Brick Arch Stormwater Pipe on Hanover Street

Flooding on George Street (Feb, 2005)

Catchment Harbour Outfall at Bauchop Street



Overview

Size: 31 ha

Land Use: Predominantly rural and industrial (48 % industrial, 52 % rural)

Imperviousness: 48 %

Stormwater Pipe Age: All installed between 1941 and 1960

No. of Outfalls: 3

Receiving Environment: Otago Harbour

Length of Pipe:

- ***Stormwater:*** 0.5 km
- ***Wastewater:*** 2 km
- ***Water Supply:*** 1 km

The Ravensbourne Road catchment is a small, primarily industrial, catchment to the east of the Dunedin CBD. The industrial area of the catchment is located on flat reclaimed land adjacent to the harbour, with steep bush covered hillside to the north.

A singly small gully drains the busy hillside, and natural flow is intercepted at Ravensbourne Road and diverted via pipework and an open channel to an outfall discharging to the Otago harbour. The flat industrial area and roads are drained via two stormwater pipe networks which discharge to the harbour via two further harbour outfalls.

The stormwater network is predicted to overflow during relatively small events, however flooding duration is predicted to be short and localised. This flooding is not considered to be a significant issue for the catchment. The catchment stormwater network is tidally influenced, however during climate change scenarios, flood risk is likely to be related to sea level and storm surge, rather than the reticulation.

Limited stormwater monitoring information gathered to date indicates that the stormwater quality discharged from this catchment is at the low end of the typical range of expected stormwater quality for the catchment's industrial land use. Similarly, harbour sediment contaminant levels adjacent to the catchment were found to be low.

Issues Summary

Limited Confidence in the Knowledge of Effects on Harbour Environment and Variability of Stormwater Quality Results

- High variability of stormwater quality results, any trends in stormwater contaminant levels remain unclear.
- Poor information on actual effects of stormwater on harbour environment.
- Lack of data to assess linkages between pipe discharge and harbour environment quality.

Flood Hazard – Future 1 in 100 yr ARI (Extreme Event)

- Current: area of 'Low' Flood Hazard in roads and some industrial locations.
- Future extreme events: areas of 'Moderate' Flood Hazard in roads and some industrial locations resulting from stormwater. Areas of 'Significant/Extreme' Flood Hazard on harbour front predominantly due to tidal effects.

Network Maintenance

- Flooding extents and durations in Ravensbourne Road are potentially exacerbated by variations in the frequency and standards of catchpit cleaning and maintenance.
- City-wide inconsistencies in frequency and standards of cleaning and maintenance of stormwater structures (inlets and catchpits) can lead to discrepancies in level of service.

Blocking / Maintenance of Intake Structures

- Accumulation of debris at the intake screen on Ravensbourne and blocking of catchpits on Parry Street is predicted to exacerbate nuisance flooding and overland flow.

Low Level of Service

- Most of the network has a low level of service between 1 in 2 yr ARI and 1 in 5 yr ARI rainfall event driven by network hydraulic capacity. Effect is nuisance flooding within the road.
- Currently occurring, no capacity for climate change effects.

Nuisance Flooding

- Currently occurring at locations within road during 1 in 5 yr ARI rainfall event. Extent is minor affecting < 0.1 % of the catchment.
- Effects rise to approximately 0.4 % of the catchment during a future 1 in 10 yr ARI rainfall event.

Ongoing Stormwater Discharge

- Could exacerbate existing / historical contaminant issues. Extent to which this is likely to occur is unconfirmed.
- Key stakeholder issue.
- Based on available data, consequence currently believed to be minor.

Catchment Harbour Eastern Outfall

Catchment Specific Approaches	SMART Targets
Quantity	
• Design new pipes with capacity to convey a 1 in 10 yr ARI rainfall event (including climate change allowances). • Develop a better understanding of the likely effects and magnitude of climate change. • Ensure cleaning and maintenance schedules and contracts are sufficiently robust. • Ensure consistency city-wide of stormwater structure cleaning and maintenance. • Ensure damaged screens are replaced / fixed. • Ensure new development does not increase potential habitable floor flooding due to the stormwater system in events up to a 1 in 50 yr ARI rainfall event. • Ensure new development does not increase the number of properties predicted to flood due to the stormwater system in a 1 in 100 yr ARI rainfall event. • Ensure transport routes around flooding areas are available. • Identify areas in catchment where more regular stormwater structure cleaning and maintenance could reduce flooding risk. • Maintain or improve existing level of service in network – ensure no increase in the number of stormwater manholes predicted to overflow in a 1 in 10 yr ARI rainfall event. • Protect key and vulnerable infrastructure (e.g. pump stations, works depots, schools, hospitals, electricity supply etc) from flood hazard. Avoid development of vulnerable sites / critical infrastructure in flood prone areas. • Survey local ratepayers' satisfaction with current level of service. • Undertake an inspection of all open channel sections, to record status of intake structures. • Work to avoid significant disruption to people and services during a large rainfall event. • Work with property owners to ensure intakes and screens are properly maintained.	• < 0.1 % of catchment surface area predicted to flood during a 1 in 5 yr ARI rainfall event by 2060. • < 0.2 % of catchment surface area predicted to flood during a1 in 10 yr ARI rainfall event by 2060. • < 25 % manholes overflowing during a 1 in 10 yr ARI rainfall event by 2060. • > 60 % resident's satisfaction with the stormwater collection service (ongoing). • Develop a catchment specific emergency response plan by 2012. • Develop consistent cleaning and maintenance criteria for all stormwater inlet assets in the catchment (in conjunction with city-wide criteria) by 2012. • Develop consistent cleaning and maintenance criteria for all stormwater inlet assets (city-wide) by 2012. • Develop list of key stormwater assets in Ravensbourne Road catchment requiring additional cleaning and maintenance checks by 2013. • Develop list of key stormwater intake structures in Ravensbourne Road catchment requiring additional cleaning and maintenance checks by 2013. • Document cleaning and maintenance responsibilities for all stormwater inlet assets (city-wide) by 2013. • Document cleaning and maintenance responsibilities for all stormwater inlet assets in the catchment by 2013. • Ensure all damaged, poor performing, or missing screens are replaced (if appropriate) by 2013. • Provide modelled flood predictions to DCC Climate Change Adaptation Group to ensure information is taken into account during the development of a city-wide climate change adaptation plan.
Quality	
• Consider the cost / benefit of stormwater quality treatment as part of flood mitigation works where practicable. • Develop method for determining linkages between stormwater management and harbour environment. • Enforce the Trade Waste Bylaw, and educate occupiers of high-risk sites with respect to stormwater discharge quality. • Incorporate a feedback process to the ICMP if/when monitoring indicates potential adverse effects from stormwater discharges. • Redesign DCC's monitoring programme to ensure stormwater quality and receiving environment data is collected within a robust framework. • Require source control of stormwater contaminants in new development of high- contaminant generating land uses. • Undertake monitoring to ensure stormwater quality does not deteriorate over time.	• Implement an education / enforcement programme targeting stormwater discharges from high risk land uses by 2015. • Improve confidence in data supporting analysis of stormwater discharge quality and effects on harbour environment, with improved confidence in data by 2013. • No deterioration of stormwater quality due to land use change or development in the catchment. • Robust monitoring framework developed and implemented by 2012.

Recommendations

Further Study

- Redesign the city-wide framework for stormwater quality and harbour environment monitoring.
- Utilise stormwater complaints and ROS information to continuously gauge customer satisfaction with the stormwater service.

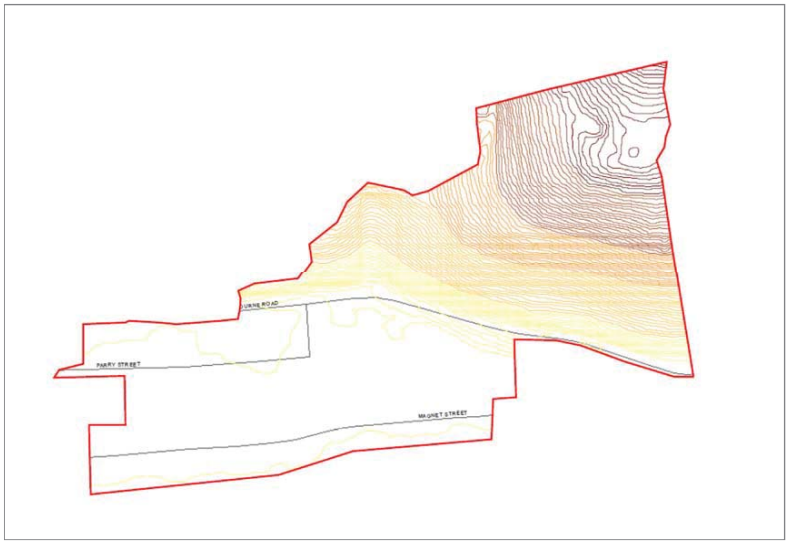
Planning and Education

- Develop a city-wide climate change adaptation plan, including ongoing monitoring of climate change predictions, incorporating damage assessment of the vulnerable infrastructure.
- Review business processes to ensure subdivision and development incorporates catchment specific requirements per the relevant ICMP.
- Work with ORC to develop a plan for education programmes in relation to best practice site management of industrial premises.

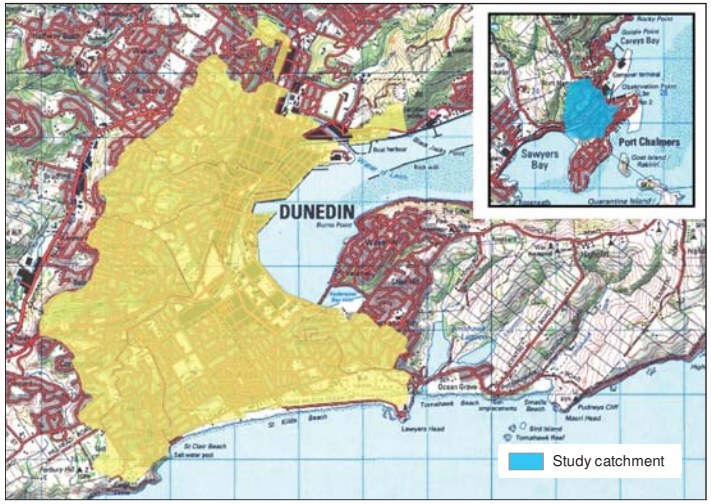
Operation and Maintenance

- Implement the revised city-wide monitoring framework.
- Compile an inventory of all stormwater structures including asset condition, ownership and identify key locations for more frequent cleaning and maintenance. Include Parry Street catchpits and the Ravensbourne Road stormwater intake structure.
- Undertake a city-wide review of all current contracts for maintenance of stormwater structures; documenting scope and standards.

Modelled Stormwater Network; Tidally Influenced (green) and Non-tidally Influenced (blue)



Catchment Topography (lighter = lower elevation)



Overview

Size: 58 ha

Land Use: Predominantly residential and rural (6 % commercial, 2 % industrial, 1 % port, 45 % residential, 45 % rural)

Imperviousness: 34 %

Stormwater Pipe Age: 83 % greater than 90 years old

No. of Outfalls: 3

Receiving Environment: Otago Harbour

Length of Pipe:

Stormwater: 4 km
Wastewater: 6 km
Water Supply: 5 km

The Port Chalmers catchment is relatively small, covering an area of approximately 58 ha, bounded by coastline to the south-west, a rural area of significant bush cover to the north and the Otago port to the north-east. Land use within the catchment is predominantly residential and rural with areas of commercial, industrial and port land uses.

The stormwater system is entirely piped, and discharges via three main outfalls; one to the east into the Lower Otago Harbour, and two to the west, into the Upper Otago Harbour.

Hydraulic modelling predicts that approximately 67 % of the network can accept stormwater from events up to a 1 in 10 yr ARI rainfall event, however flooding resulting from under-capacity or larger events is not predicted to cause significant issues.

Wastewater overflows have been constructed from two pump stations in the catchment into the stormwater system, however these are not predicted to occur during frequent rainfall events. Stormwater quality and receiving environment data for this area is limited.

Issues Summary

Limited Confidence in the Knowledge of Effects on Harbour Environment and Variability of Stormwater Quality Results

- High variability of stormwater quality results, any trends in stormwater contaminant levels remain unclear.
- Poor information on actual effects of stormwater on harbour environment.
- Lack of data to assess linkages between pipe discharge and harbour environment quality.

Network Maintenance

- Flooding extents and durations in Port Chalmers catchment are potentially exacerbated by variations in the frequency and standards of catchpit cleaning and maintenance.
- City-wide inconsistencies in frequency and standards of cleaning and maintenance of stormwater structures (inlets and catchpits) can lead to discrepancies in level of service.

Nuisance Flooding

- Nuisance flooding is predicted on a regular basis in a number of locations due to limited network capacity and restrictions throughout the catchment. Flooding is not significant during small events but becomes progressively worse with larger events.
- Affects 0.04 % of catchment area during 1 in 2 yr ARI events, and 0.7 % of catchment during a 1 in 10 yr ARI event.

Low Level of Service

- General low level of service of stormwater network (less than 1 in 10 yr ARI), driven predominantly by network capacity.
- 33 % of manholes predicted to overflow during a current 1 in 10 yr ARI rainfall event, with pipes flowing full throughout a large proportion of system.
- This low level of service is currently occurring with no capacity for climate change effects.

Flood Hazard – Current and Future 1 in 100 yr ARI

- Areas of moderate to significant flood hazard in roadways, including State Highway predicted during current event.
- Moderate to significant flood hazard extent predicted in the future (2060) event.

Ongoing Stormwater Discharge

- Could exacerbate existing / historical contaminant issues. Extent to which this is likely to occur is unconfirmed.
- Key stakeholder issue.
- Based on available data, consequence currently believed to be minor.

Potential Wastewater Contamination

- High microbial contamination of stormwater in 2007, may be cause for concern.

Deep Flooding

- Model results indicate 4 land parcels affected by deep flooding during 1 in 10 yr ARI rainfall event; rises to 9 parcels during 1 in 50 yr ARI rainfall event in current and 12 parcels in future planning scenarios.
- A proportion of the deep flooding predicted during high frequency events is predicted exterior to buildings.

Wastewater Emergency Overflows

- Potential for wastewater contamination of stormwater should overflows operate. Analysis to date suggests infrequent operation.

Catchment Outfall at Watson Park

Catchment Specific Approaches	SMART Targets
Quantity	
• Design new pipes with capacity to convey a 1 in 10 yr ARI rainfall event (including climate change allowances). • Develop a better understanding of the likely effects and magnitude of climate change. • Enhance understanding of effects of deep flooding, particularly on private property. • Ensure cleaning and maintenance schedules and contracts are sufficiently robust. • Ensure consistency city-wide of stormwater structure cleaning and maintenance. • Ensure new development does not increase potential habitable floor flooding due to the stormwater system in events up to a 1 in 50 yr ARI rainfall event. • Ensure new development does not increase the number of properties predicted to flood due to the stormwater system in a 1 in 100 yr ARI rainfall event. • Ensure transport routes around flooding areas will be available. • Identify areas in catchment where more regular stormwater structure cleaning and maintenance could reduce flooding risk. • Maintain or improve existing level of service in network – ensure no increase in the number of stormwater manholes predicted to overflow in a 1 in 10 yr ARI rainfall event. • Protect key and vulnerable infrastructure (e.g. pump stations, works depots, schools, hospitals, electricity supply etc) from flood hazard. Avoid development of vulnerable sites / critical infrastructure in flood prone areas. • Undertake pipe renewals programme as scheduled (with older pipes and poorly performing network areas prioritised). • Undertake pipe renewals programme as scheduled (with older pipes prioritised). • Use ROS to gauge city wide satisfaction with the stormwater system performance.	• < 0.7 % of catchment surface predicted to flood during a 1 in 10 yr ARI rainfall event by 2060. • < 33 % manholes predicted to overflow during a 1 in 10 yr ARI rainfall event by 2060. • < 9 properties at risk of deep flooding (> 300 mm) during a 1 in 50 yr ARI rainfall event by 2060. • > 20 % of pipes to convey a 1 in 10 yr ARI rainfall event by 2060. • > 60 % resident's satisfaction with the stormwater collection service (ongoing). • Develop consistent cleaning and maintenance criteria for all stormwater inlet assets (city-wide) by 2012. • Develop list of key stormwater assets in Port Chalmers catchment requiring additional cleaning and maintenance checks by 2013. • Document cleaning and maintenance responsibilities for all stormwater inlet assets (city-wide). • Provide modelled flood predictions to DCC Climate Change Adaptation Group to ensure information is taken into account during the development of a city-wide climate change adaptation plan. • Undertake habitable floor survey and / or damage assessment of potentially flooded properties.
Quality	
• Consider the cost / benefit of stormwater quality treatment as part of flood mitigation works where practicable. • Continued stormwater monitoring to enable better understanding of potential catchment contamination. • Develop appropriate management options to remediate problem where necessary. • Develop method for determining linkages between stormwater management and harbour environment. • Enforce the Trade Waste Bylaw, and educate occupiers of high-risk sites with respect to stormwater discharge quality. • Incorporate a feedback process to the ICMP if/when monitoring indicates potential adverse effects from stormwater discharges. • Investigate potential sources of wastewater contamination. • Redesign DCC's monitoring programme to ensure stormwater quality and receiving environment data is collected within a robust framework. • Require source control of stormwater contaminants in new development of high- contaminant generating land uses. • Undertake monitoring to enable better understanding of frequency and cause of operation and risk of potential stormwater contamination. • Undertake monitoring to ensure stormwater quality does not deteriorate over time. • Undertake to disconnect all known cross connections.	• Develop management approaches and ongoing monitoring protocols by 2015 where appropriate. • Disconnect known cross connections by 2015. • Implement an education / enforcement programme targeting stormwater discharges from high risk land uses by 2015. • Implement management options to remediate problem where necessary. • Improve confidence in data supporting analysis of stormwater discharge quality and effects on harbour environment, with improved confidence in data by 2013. • Improve data relating to levels microbial contamination and potential sources of contamination within the catchment by 2012. • Improve understanding of frequency and cause of operation and risk to stormwater quality by 2015. • No deterioration of stormwater quality due to land use change or development in the catchment. • No pump station overflows due to capacity during a 1 in 10 yr ARI rainfall event. • Robust city-wide monitoring framework developed and implemented by 2012.

Recommendations

Further Study

- Redesign the city-wide framework for stormwater quality and harbour environment monitoring.
- Utilise stormwater complaints and ROS information to continuously gauge customer satisfaction with the stormwater service.
- Identify and undertake floor level survey and damage assessment of properties potentially internally affected by deep flooding (up to a 1 in 50 yr ARI).

Planning and Education

- Develop a city-wide climate change adaptation plan, including ongoing monitoring of climate change predictions, incorporating damage assessment of the vulnerable infrastructure.
- Review business processes to ensure subdivision and development incorporates catchment specific requirements per the relevant ICMP.

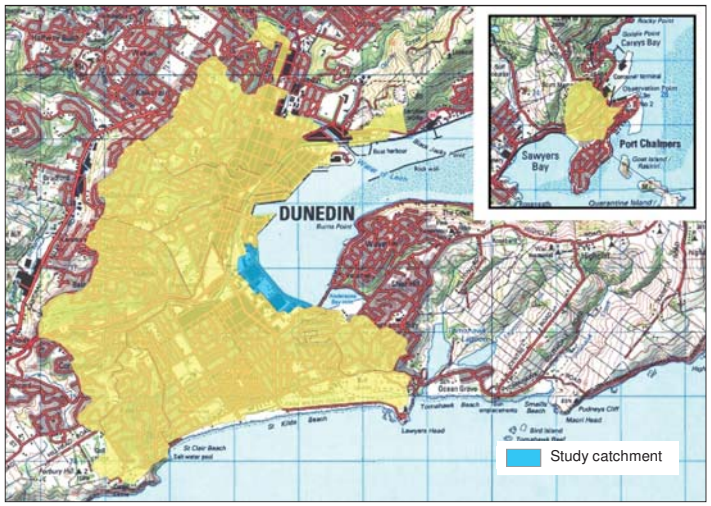
Operation and Maintenance

- Implement the revised city-wide monitoring framework.
- Compile an inventory of all stormwater structures including asset condition, ownership and identify key locations for more frequent cleaning and maintenance.
- Undertake a city-wide review of all current contracts for maintenance of stormwater structures; documenting scope and standards.
- Ensure planned renewals are designed to accommodate a 1 in 10 yr ARI rainfall event and incorporate allowances for climate change.
- Implement programme to monitor wastewater emergency overflows.

Modelled Pipes; Tidally Influenced (green) and Non-tidally Influenced (blue)

Ajax Road Intake

Catchment Geology



Overview

Size: 39 ha

Land Use: Industrial (100 %)

Imperviousness: 98 %

Stormwater Pipe Age: All installed between 1940 and 2000

No. of Outfalls: 4

Receiving Environment: Otago Harbour

Length of Pipe:

Stormwater: 2 km
Wastewater: 2 km
Water Supply: 4 km

The Portsmouth Drive catchment is a small, flat catchment adjacent to the Upper Harbour Basin. The catchment land use is entirely industrial, and the area is on reclaimed land.

The stormwater network is piped, and discharges via four outfalls into the Upper Otago Harbour Basin. The level of service of the pipe network is generally low, however predicted flooding is expected to be primarily 'nuisance' flooding. Tidal influence is significant, however, and Portsmouth Drive is known to be flooded during high tides and storm events. However, during climate change scenarios, flood risk is likely to be related to sea level and storm surge, rather than the reticulation.

The catchment is adjacent to a historically contaminated part of the harbour, however limited information on the current stormwater quality means that conclusions regarding current contaminant inputs cannot be made.

Issues Summary

Limited Confidence in the Knowledge of Effects on Harbour Environment and Variability of Stormwater Quality Results

- High variability of stormwater quality results, any trends in stormwater contaminant levels remain unclear.
- Poor information on actual effects of stormwater on harbour environment.
- Lack of data to assess linkages between pipe discharge and harbour environment quality.

Flood Hazard – Future 1 in 100 yr ARI (Extreme Event)

- Areas of extreme flood hazard in roadways, and south eastern parts of the catchment predicted in the future (2060) predominantly due to tidal influence, exacerbated by predicted climate change effects.

Network Maintenance

- Flooding extents and durations in Portsmouth Drive are potentially exacerbated by variations in the frequency and standards of catchpit cleaning and maintenance.
- City-wide inconsistencies in frequency and standards of cleaning and maintenance of stormwater structures (inlets and catchpits) can lead to discrepancies in level of service.

Blocking / Maintenance of Intake Structures

- Potential blockage of the tidally influenced catchpits on Teviot Street and Midland Street intersections with Portsmouth Drive could exacerbate flooding.

Low Level of Service

- General low level of service of stormwater network (approximately 1 in 2 yr), driven by both pipe capacity and tidal influence.
- 65 % of manholes predicted to overflow during a current 1 in 10 yr ARI rainfall event.
- Currently occurring, no capacity for climate change effects.
- Effects are mainly nuisance flooding, affecting approximately 3.3 % of the catchment currently, and 6 % of catchment in future 1 in 10 yr ARI rainfall event.

Nuisance Flooding

- Nuisance flooding on regular basis in a small number of areas, particularly tidally influenced locations. Causes some partial road blockages.
- Affects < 1 % of catchment during 1 in 2 yr ARI rainfall event, and 3.3 % of catchment during a 1 in 10 yr ARI rainfall event.

Deep Flooding

- Model results indicate 2 parcels affected by deep flooding during 1 in 5 yr ARI rainfall event; rises to 6 properties during 1 in 50 yr ARI rainfall event in current and future planning scenarios.
- Large number of properties affected during extreme climate change scenario.
- Flooding mostly predicted exterior to buildings (although surveys not yet undertaken).

Ongoing Stormwater Discharge

- Could exacerbate existing/historical contaminant issues. Extent to which this is likely to occur is unconfirmed.
- Key stakeholder issue.
- Based on available data, consequence currently believed to be minor.

Harbour Outfall Structure at Teviot Street

Catchment Specific Approaches	SMART Targets
Quantity	
• Design new pipes with capacity to convey a 1 in 10 yr ARI rainfall event (including climate change allowances). • Develop a better understanding of the likely effects and magnitude of climate change. • Enhance understanding of effects of deep flooding, particularly on private property. • Ensure cleaning and maintenance schedules and contracts are sufficiently robust. • Ensure consistency city-wide of stormwater structure cleaning and maintenance. • Ensure new development does not increase potential habitable floor flooding due to the stormwater system in events up to a 1 in 50 yr ARI rainfall event. • Ensure new development does not increase the number of properties predicted to flood due to the stormwater system in a 1 in 100 yr ARI rainfall event. • Ensure transport routes around flooding areas will be available. • Identify areas in catchment where more regular stormwater structure cleaning and maintenance could reduce flooding risk. • Maintain or improve existing level of service in network – ensure no increase in the number of stormwater manholes predicted to overflow in a 1 in 10 yr ARI rainfall event. • Protect key and vulnerable infrastructure (e.g. pump stations, works depots, schools, hospitals, electricity supply etc) from flood hazard. Avoid development of vulnerable sites / critical infrastructure in flood prone areas. • Undertake pipe renewals programme from 2040. • Use ROS to gauge city wide satisfaction with the stormwater system performance.	• < 1 % of catchment surface area predicted to flood during a 1 in 2 yr ARI rainfall event by 2060. • < 3.3 % of catchment surface area predicted to flood during a 1 in 10 yr ARI rainfall event by 2060. • < 6 properties at risk of deep flooding (> 300 mm) during a 1 in 50 yr ARI rainfall event by 2060. • < 65 % manholes predicted to overflow during a 1 in 10 yr ARI rainfall event by 2060. • > 43 % of pipes to convey a 1 in 10 yr ARI rainfall event by 2060. • > 60 % resident's satisfaction with the stormwater collection service (ongoing). • Develop consistent cleaning and maintenance criteria for all stormwater inlet assets (city-wide) by 2012. • Develop list of key stormwater assets in Portsmouth Drive catchment requiring additional cleaning and maintenance checks by 2013. • Document cleaning and maintenance responsibilities for all stormwater inlet assets (city-wide) by 2013. • Provide modelled flood predictions to DCC Climate Change Adaptation Group to ensure information is taken into account during the development of a city-wide climate change adaptation plan. • Undertake habitable floor survey and / or damage assessment of potentially flooded properties.
Quality	
• Consider the cost / benefit of stormwater quality treatment as part of flood mitigation works where practicable. • Develop method for determining linkages between stormwater management and harbour environment. • Enforce the Trade Waste Bylaw, and educate occupiers of high-risk sites with respect to stormwater discharge quality. • Incorporate a feedback process to the ICMP if / when monitoring indicates potential adverse effects from stormwater discharges. • Redesign DCC's monitoring programme to ensure stormwater quality and receiving environment data is collected within a robust framework. • Require source control of stormwater contaminants in new development of high- contaminant generating land uses. • Undertake monitoring to ensure stormwater quality does not deteriorate over time.	• Implement an education / enforcement programme targeting stormwater discharges from high risk land uses by 2015. • Improve confidence in data supporting analysis of stormwater discharge quality and effects on harbour environment, with improved confidence in data by 2013. • No deterioration of stormwater quality due to land use change or development in the catchment. • Robust city-wide monitoring framework developed and implemented by 2012.

Recommendations

Further Study

- Redesign the city-wide framework for stormwater quality and harbour environment monitoring.
- Identify and undertake floor level survey and damage assessment of properties potentially internally affected by deep flooding (up to a 1 in 50 yr ARI).
- Utilise stormwater complaints and ROS information to continuously gauge customer satisfaction with the stormwater service.

Planning and Education

- Develop a city-wide climate change adaptation plan, including ongoing monitoring of climate change predictions, incorporating damage assessment of the vulnerable infrastructure.
- Review business processes to ensure subdivision and development incorporates catchment specific requirements per the relevant ICMP.
- Work with ORC to develop a plan for education programmes in relation to best practice site management of industrial premises.

Operation and Maintenance

- Implement the revised city-wide monitoring framework.
- Undertake a city-wide review of all current contracts for maintenance of stormwater structures; documenting scope and standards.
- Compile an inventory of all stormwater structures including asset condition, ownership and identify key locations for more frequent cleaning and maintenance. Include Teviot Street and Midland Street catchpits.

Capital Works

- Assess the feasibility of installing tide gates / flap valves on tidally influenced outfalls (Kitchener Street, Midland Street and Teviot Street)

Power Substation on Otaki Street

Catchment Geology

Looking South-East along Portsmouth Drive (Otago Harbour at Left)