3. STORM REPORT: 11–13 OCTOBER 2000

Officer responsible Water Services Manager	**Author** Ken Couling, DDI 371-1388
Corporate Plan Output: Utilities Maintenance (Vol II pp 9.3.31-34)	

The purpose of this report is to describe the storm experienced by Christchurch between 11-13 October 2000, to review how the waterways and drainage system coped with the event and to identify further investigations and remedial action to improve the functioning of the waterways and drainage system should another similar storm event occur in future. The report focuses on Christchurch's waterways and drainage system not the City Council's storm emergency response which was the subject of an internal review reported elsewhere.

This agenda item is an executive summary of the technical report which has been separately circulated to Councillors.

THE STORM

Rain began falling about 10pm on Wednesday 11 October over the whole Christchurch area but within a few hours the rain intensity began to increase in the south-east sector of the city. Sustained heavy rain fell for a 12 hour period in the south-east from 3am to 3pm on Thursday 12 October.

The total rainfall depth for the storm increased markedly from approximately 40 mm near the airport to 190 mm recorded in Bowenvale Valley just below the Summit Road. (See rainfall depths map attached.)

The rainfall was accompanied by strong winds from the south. At the airport winds reached gale force by 6am 12 October with the strongest gust of 106 km/hour recorded at 3pm. Maximum wind gusts experienced on the Port Hills and over Banks Peninsula undoubtedly exceeded this recording at the airport.

With the 'epicentre' of the storm over the eastern Port Hills hill waterways discharging into the middle reaches of the Heathcote River (i.e. Waimea/Eastern Terrace reach) surcharged the middle reach which peaked between 1–2pm 12 October. Waimea and Eastern Terraces were impassable for several hours. A number of residents were evacuated as a precautionary measure. The maximum flood level was within 100 mm of the lowest house floor levels.

The storm was an extreme event for hill waterways from Bowenvale Valley to Sumner. Elsewhere throughout the city rivers, waterways and the piped drainage system generally satisfactorily. In the Bexley area, the amount of rainfall overwhelmed the capacity of the two stormwater pumping stations discharging to the Avon River. Water ponded on streets up to a maximum depth of about 400 mm and on private properties until water levels were gradually drawn down by the pumps.

The highest ever peak discharge of 6 cubic metres/second was recorded at the flume at Bowenvale Valley. Many hill waterways overtopped their banks which caused flooding, debris and sediment deposition on private property. The specific cause of overtopping was generally debris blockages at culvert and pipeline inlets, especially those with inlet gratings. Blockages with serious consequences occurred in Barnett Park, Redcliffs; Nayland Street at Richmond Hill Road, Sumner; and Upper Sumnervale Drive, Sumner. Reports of water entering eight houses in Redcliffs and up to 12 houses and commercial premises in Sumner village resulted from these overflows.

The October storm was an extreme event in terms of wind and rain depth and intensity falling in the south-east sector of the city. The wind generated a lot of debris which was available to block waterways at pipe inlets and gratings resulting in overflows.

SYSTEM OPERATION

Christchurch people awoke on 12 October to a lot of damage to trees on private property and on public streets. Initially the City Council response through its roading contractors in particular concentrated on restoring road access blocked by fallen trees. The drainage contractor responded in accordance with normal wet weather procedures which involve inspection, clearing and monitoring of critical inlet and debris grates throughout the waterways and drainage system. With the exception of hill waterways the waterways and drainage system assisted by normal wet weather procedures by the contractor performed satisfactorily. Even in the Bexley area where prolonged ponding of stormwater occurred the pumps operated as expected throughout the event.

Problems arose in some hill waterway catchments where the contractors normal wet weather resources became overwhelmed by the quantity of debris building up on critical inlet grates resulting in waterway overflows. Procedures for dealing with critical locations are spelt out clearly in the maintenance contract documents. However, by the time it was realised that the problem areas were concentrated in Redcliffs and Sumner and additional men and machinery were diverted from elsewhere by City Care, some significant overflows had already occurred.

It should be noted that many gratings performed well (for example the pipe inlet grating in Basil Place, McCormacks Bay) and men and machinery were on hand at many critical grates successfully clearing debris to avert greater overflows and more serious flood damage (for example the Sumner flood relief pipeline inlet grating at Wakefield Avenue from which 3.5 tonnes of debris was removed).

DISCUSSION OF MAJOR ISSUES

Storm Return Period

A stormwater drainage system is designed to a certain standard often expressed as Annual Exceedence Probability (AEP). This is expressed as the probability in percentage terms that an event will be equalled or exceeded in any one year. For example, our stormwater piping system and artificial waterways are designed to a 20% AEP standard on the flat. This means that there is a 1 in 5 chance in any one year that the drainage system will be overtopped. This design event is often called the five year storm. Waterways and pipelines on the Port Hills are designed to a 5% AEP standard, ie a 20 year design storm standard in terms of capacity. However, because steep hill waterways are prone to erosion, slips, blockage etc the effective design standard is similar to on the flat. Under more extreme storm conditions the waterways and drainage system is expected to overtop. Designers should ensure that a safe secondary flow path exists for system overflows where they are likely to occur. The performance of the waterways and drainage system during a storm needs to be judged against the expected design standard of the system.

At the Botanic Gardens rain gauge the October storm was a 25% AEP event (ie four year event) for a duration of 15 hours. The waterways and drainage system is expected to cope effectively with an event of this magnitude or slightly greater and it did except in the south-east. The rainfall recorded at the Bowenvale Avenue flume during the most intense 12-15 hours during the storm is assessed as a 2.5% AEP occurrence (ie 40 year rainfall event). The peak discharge measured was also assessed to have a similar probability of occurrence.

Peak flood discharge along the Waimea/Eastern Terrace reach of the Heathcote River reached approximately 10% AEP (i.e. 10 year flood) but observed maximum water levels were higher than expected for this discharge. The surcharge caused by the six cubic metres/second peak inflow into the river from Bowenvale Valley and restriction to flow caused by fallen trees across the river downstream are considered the most likely explanations for this circumstance. Storm runoff exceeded the design capacity of the stormwater and drainage system in some catchments in the south-east of the city, especially in hill catchments from Bowenvale to Sumner. Some overflows of sediment and debris laden stormwater must be expected in these circumstances but improvements can be made to inlet structures and storm procedures to reduce the frequency of overflows. This is discussed in following sections.

Inlet Structures on Hill Waterways

The drainage design concept on most of our hill waterways presents some fundamental difficulties for the designer. Steep open channels on the Port Hills convey stormwater at high velocity to a pipe inlet structure located at or about the point of change of grade at the foot of the hills. Stormwater is then conveyed by the outfall pipeline on a flat grade to a river, estuary or sea outlet. Outlets affected by high tide require flapgates or other backflow prevention devices. Fundamental problems with such a system include: bypass and overtopping of the pipeline inlet structure due to bank erosion by high velocity water or debris blockage, sedimentation deposition in the outfall pipeline because of quiescent conditions resulting from flat gradients and submerged outlets during high tide and street flooding during extreme high tides caused by backflow through faulty or obstructed outlet flapgates.

An open waterway extending from the hills to the receiving waters crossed by generously sized culverts and bridges with a generous buffer between the waterway and urban development is a much more effective and reliable design concept. Or course, an outlet gate structure would still be required at outfalls affected by high tide.

This concept should be followed where possible. However, in the common situation where urban development has occurred over existing outfall pipelines satisfactory functioning will be reliant on well-designed inlet structures, well-organised storm emergency procedures and the provision of safe secondary flow paths away from critical locations such as pipeline inlet structures. Further investigations and improvements in these three aspects are recommended later in this report. (Refer to sections 3.1 to 3.5 of the technical report for more details.)

Bexley

The two stormwater pumping stations at Bexley located in Waitahi and Wairoa Streets were overwhelmed by storm runoff. However, unlike some previous events both pumps operated throughout the storm without blockage.

Stormwater ponding is inevitable during an extreme storm. Pumping capacity needs to be sufficient to significantly reduce serious flood damage and is considered adequate. Some controlled flood storage capacity has been provided recently in the Waitahi Street catchment by Knights Pond immediately west of the expressway corridor. Wairoa Street catchment would also benefit from some controlled flood storage capacity if a suitable ponding site can be found.

Backflow prevention devices on all pipe outfalls from Bexley to the Avon River should also be checked. (Refer to section 3.8 of the technical report for more details.)

Heathcote River Middle Reaches

According to a flow gauging carried out on the Heathcote River at Buxton Terrace by Environment Canterbury staff at approximately 1pm on 12 October the observed flood water level was approximately 300 mm higher than expected for the discharge calculated.

Fallen trees across the river downstream are considered to be the most likely cause for this elevation in flood level. However, this conclusion needs to be confirmed by ongoing investigations. Alternative hypotheses are that the river bed level may have risen during the recent years, Environment Canterbury miscalculated the discharge or denser planting on the riverbanks over recent years has increased the 'roughness' of the flood channel.

This issue is being investigated thoroughly because the risk of flood water entering low-lying houses along this reach of the river would be increased significantly if this situation is repeated during future major storms. (Refer to section 3.6 of the technical report for more details.)

Operational Procedures

Discussions are ongoing with the drainage contractor to improve our storm emergency procedures related to keeping inlet structures on hill waterways clear of debris. Earlier identification of problem areas and the diversion of additional men and machinery to those locations is the key to a more effective response in future. The collection and dissemination of reliable up-to-date information amongst City Council and contracting personnel is an important ingredient of the improvements to operational procedures under consideration. Discussions are also continuing over whether there should be a role for local wardens.

Operational procedures for opening and closing the gates of the Woolston Tidal Barrage need to be confirmed and communicated to all personnel involved. The circumstances in which the gates should be closed against an incoming tide during an extreme high tide cycle needs to be identified. (Refer to sections 2.1 and 2.2 of the technical report for more details.)

Cost Implications

Some additional costs will be incurred against this year's operations budget directly related to the October storm. Additional planning and investigations costs up to approx $50,000 are anticipated. Additional costs for storm response will be payable to the drainage contractor. Some of the storm-related cost may be able to be met by under-expenditure in other activities this financial year.

The waterways and drainage system suffered little damage during the October storm which necessitates renewals and replacements. However, many drainage improvements are recommended in this report and recommendations for additional works will result from planning and investigations underway. Fortuitously the catchments where most of the flood damage occurred—Barnett Park/Rifle Range Drain, Redcliffs and Richmond Hill Road waterway, Sumner were already subject to drainage improvement planning and design. Capital works have not begun on either scheme. We now have the opportunity to review both schemes in the light of a volume of information gathered during the October storm. It is hoped that additional capital works recommended can be funded largely by substitution for other projects of lower priority.

FUTURE ACTION

In respect of Christchurch's waterways and drainage system and its planning, design and operation in the light of the October 2000 storm, the following actions are proposed:

Planning, Investigation and Design:

(a) Debris trapping and pipeline inlet grating design for hill waterways will be reviewed and revised design criteria will be included in the new Waterways, Wetlands and Drainage Guide.

(b) All critical existing debris traps, inlet structures and grates on hill waterways will be audited in terms of the design review above and a prioritised schedule of improvement works prepared.

(c) The reason for elevated flood levels along the Waimea/Eastern Terrace reach of the Heathcote River will be determined by further investigation.

System Operation:

(a) Storm emergency procedures (including communication protocol) for critical inlet structures and grates will be reviewed. Consideration will also be given to what role, if any, suitably experienced local residents should have in keeping critical structures free from blockage and providing early warning of trouble.

(b) The operating procedures for opening and closing the Woolston Tidal Barrage will be confirmed and all personnel involved will be acquainted with the procedures.

Site Specific Proposals:

(a) Sumner—Sumnervale, Sumner waterway and flood relief pipe:

(i) The feasibility of installing a debris trap on the Sumner waterway in Sumnervale Reserve will be investigated and installed if the results of the investigation are favourable.

(ii) Investigation into a cost effective technique for removing sediment from the Sumner flood relief pipe will be continued and reported by June 2001.

(b) Sumner—Richmond Hill Road waterway:

(i) Stormwater pipelines in the flooded area will be inspected for sediment accumulation and methods for sediment removal be investigated if necessary.

(ii) The planning, investigation and design already underway for joint Richmond Hill Road and waterway improvements will include a range of options which will mitigate the flood damage caused by an event similar to the October storm. (Options involving a suite of planning, system operation and maintenance and improvement works will be developed in consultation with the community.)

(c) Redcliffs—Barnett Park and Rifle Range Drain:

(i) The planning measures and drainage improvements identified in the 1999 report and budgeted for this financial year will be implemented.

(ii) A debris trap on Rifle Range Drain in Barnett Park at or above Bayfield Avenue will be investigated and installed if the results of the investigation are favourable.

(iii) The bunding between the pipeline inlet grating beside the Scout Den in Barnett Park will be raised and the secondary flow path from the inlet grating west into Barnett Park car park will be reshaped to reduce the risk of the diversion swale overflowing east into private properties on Wakatu Terrace.

(iv) The feasibility of installing drain plugs in the Estuary seawall for private properties opposite Barnett Park will be investigated. (If the results of the investigation are favourable the City Council may offer to meet a share of the cost of installation.)

(d) Other Port Hills catchments:

(i) A debris trap on Bridle Path waterway above Bridle Path Road will be investigated and installed if the results of the investigations are favourable.

(ii) A formal secondary flow path will be formed between Bridle Path Road and the Heathcote Domain play area.

(iii) Additional trash racks located upstream from the inlet grating on Alderson Avenue will be investigated and installed if the results of the investigation are favourable.

(e) Bexley:

(i) The 225 mm diameter pipeline connecting the Waitaki Street pumping station catchment to the Wairoa Street pumping station catchment along Pages Road will be disconnected at its high point to restrict flood overflows from the Waitaki Street catchment ponding in the Wairoa Street catchment.

(ii) The effectiveness of backflow prevention (i.e. pipe outlet flapgates to the Avon River) will be checked and any improvements, including maintenance procedures necessary, carried out. Opportunities for control of ponding within the Wairoa Street pumping station catchment be investigated.

Recommendation: That the Parks and Recreation Committee note that some additional operational expenditure which may not be able to be funded by substitution is likely to be incurred this financial year on investigations and emergency response directly related to the October storm. Capital expenditure on improvements necessary in the light of what happened during the storm are likely to be funded by substitution in place of lower priority projects.

Chairman's Recommendation: That the above recommendation be adopted.