INTEGRATED WASTEWATER MASTERPLANNING FOR WANGANUI CITY

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ABSTRACT

Overflows and spilling during rain events, coupled with pressure from developers, have caused the Wanganui District Council (WDC) to evaluate the existing wastewater network and develop an integrated masterplan for their wastewater reticulation. The purpose of the masterplan is to act as a decision making tool in relation to Capex and Opex spending for these assets within the wider framework of its 30-year Infrastructure Strategy.

At the commencement of this project, a “Roadmap” for the integrated masterplanning and hydraulic analysis of WDC’s wastewater system was created that showed how different asset information could be linked together in a coordinated way. The roadmap informed WDC of the required sequence of tasks, likely outcomes, required resources, timeframes and costs associated with the implementation of such an integrated masterplanning project prior to their commitment of resources and funds.

As part of the masterplanning process, a hydraulic model of WDC’s entire wastewater network was built and calibrated using InfoWorks CS software. This model was used to identify the constraints within the networks and to create a programme of associated remedial works.

This paper focuses on the development of the masterplan, the results of the wastewater model and development of the Programme of Works and outcomes. It serves as a case study on the benefits of the adopted roadmap and future implications.

KEYWORDS

Wastewater masterplan; masterplanning roadmap; infrastructure strategy; hydraulic modelling.

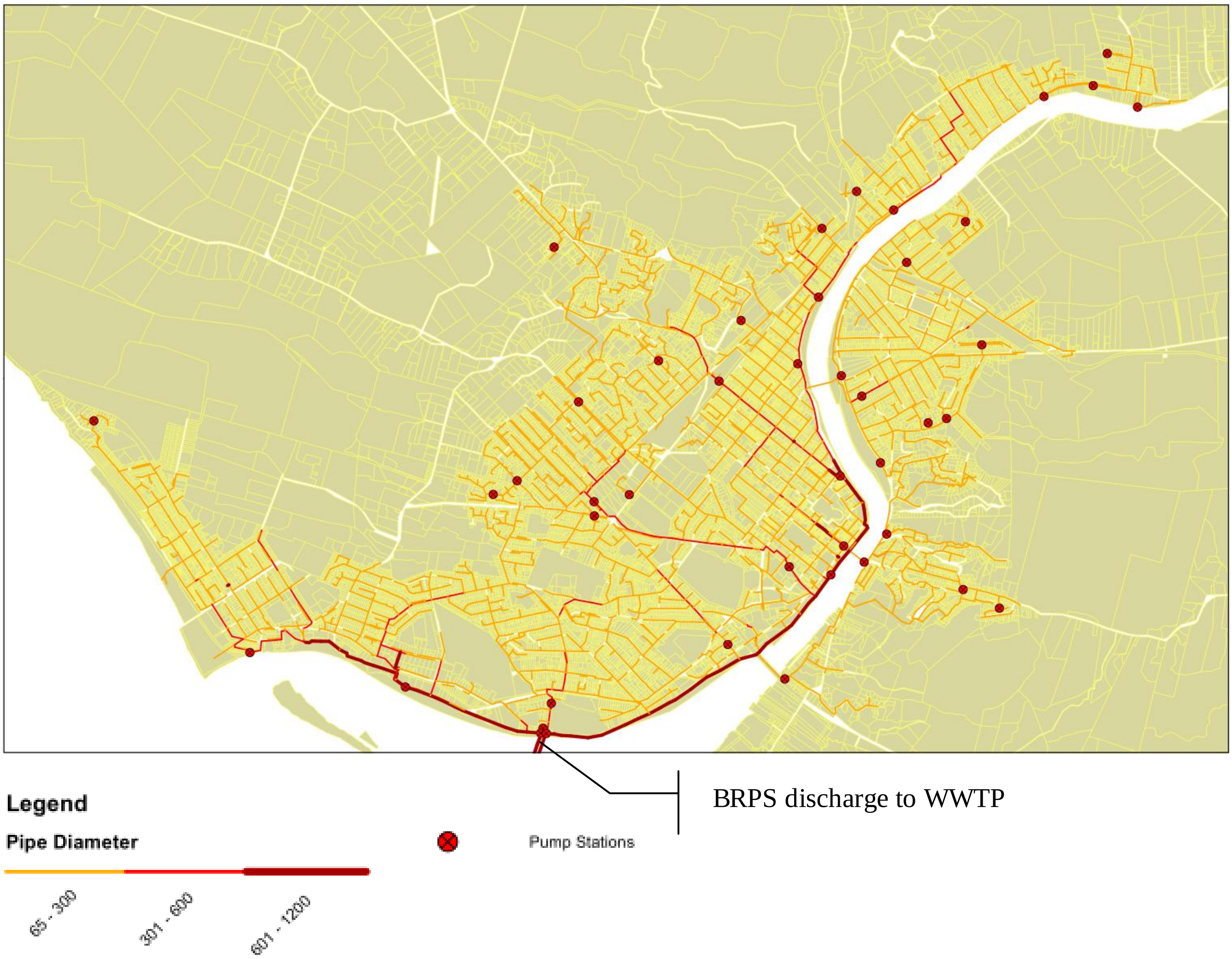
1 INTRODUCTION

The Wanganui wastewater collection system serves a population of approximately 36,324 people over an area of 2,730 ha. The wastewater network consists of 286 kms of gravity sewers and 29 pump stations. All flow is directed to the main pump station at Beach Road, which pumps wastewater under the Whanganui River to the wastewater treatment plant (WWTP) located near the airport in the south east of the city.

Originally constructed as a combined system in the late 1800's, the public network has been separated to 90% complete over the last 20 years. Despite the works of the separation projects, high levels of inflow and infiltration (I/I) have been observed in the gravity network. In addition, overflows and spilling are observed during wet weather, indicating the network is still running at/near full capacity.

Figure 1 below provides an overview of the existing wastewater network. The pipes are categorized by diameter.

Figure 1: Wanganui Wastewater Network

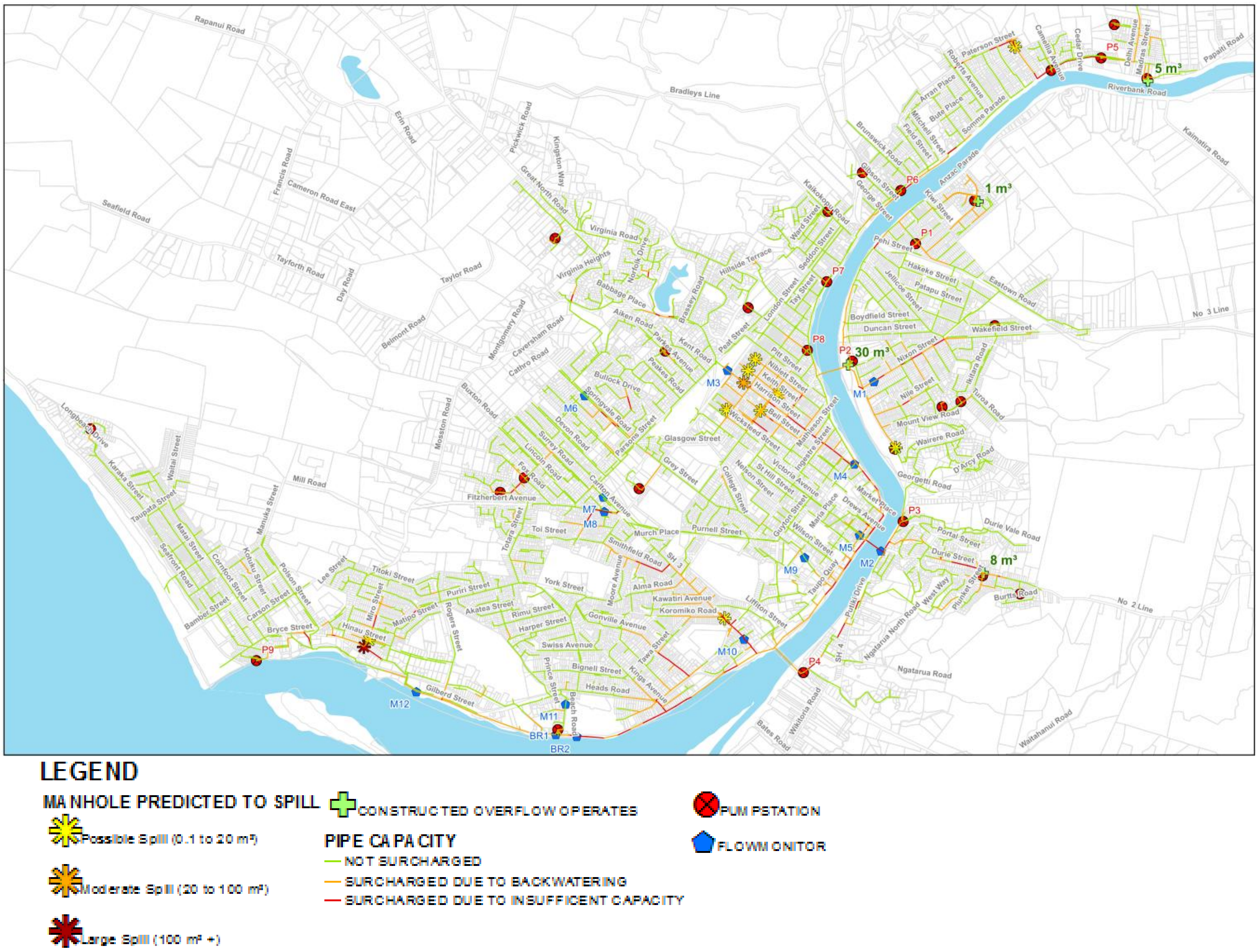


2 MASTERPLANNING ROADMAP

2.1 KEY DRIVERS

The Wanganui wastewater network is prone to spilling in events with an ARI greater than 1 in 6 months. This occurs partly due to the capacity of the network, but also because of I/I. Figure 2 below provides an overview of the system performance of the network during a 1 in 6 month rain event.

Figure 2: 6 Month ARI System Performance



Certain areas of the network, including the main interceptor, are at full capacity and experience surcharging. Determining the source of I/I to eliminate overflows and spilling is therefore a key driver for development of the masterplan.

There is also pressure from developers to build new subdivisions outside of the residential zone. The impact these new developments would have on the existing system is fundamental for determining the feasibility, as well as financial contribution, of these developments.

Finally, the central government requires a 30-year Strategy to be submitted. Previous wastewater and stormwater infrastructure upgrades/projects have shown that the asset renewals and upgrades were done on an ad hoc basis, instead of taking a more holistic approach and considering the needs of the entire system. Being able to logically define the critical assets, how they relate to each other as a whole, and choose a realistic Level of Service (LOS) is fundamental in developing a 30-year Strategy.

2.2 DEVELOPING THE ROADMAP

At the commencement of this project, a “Roadmap” for the integrated masterplanning and hydraulic analysis of WDC’s stormwater and wastewater systems was created. This roadmap showed how the following information could be linked together in a coordinated way:

- SCADA,
- CCTV data,

- rehabilitation/renewal planning and implementation,
- knowledge of sewer separation extents,
- related understanding of wastewater inflow and infiltration in the system, and
- system hydrologic and hydraulic modelling data.

The roadmap was tailored specifically to suit WDC's needs and informed the Council of the required sequence of tasks, likely outcomes, required resources, timeframes, and costs associated with the implementation of such an integrated masterplanning project prior to their commitment of resources and funds. Development of the roadmap can be broken down as follows:

- Identify the starting point – where are we now?
- Identify the finish line – where do we want to be?
- Identify the route – how are we going to get there?

2.2.1 THE STARTING POINT – EXISTING CONDITIONS AND INFORMATION

The first phase was to analyse the existing data and determine what was useful and what additional information needed to be collected.

GIS data for the wastewater network was available via Online Mapping. Prior to commencement of this project, programs were not in place to ensure assets were updated following renewals/works, so extensive data verification was required.

Four permanent flow meters are located in the Wanganui wastewater network, and SCADA is set up at all 29 pump station sites. In general the flow meters and level data was useful, however additional flow metering sites were requested to aid in the model build and calibration.

Constructed overflows were not monitored, and their operational status was not well documented. As the model was developed, multiple overflow sites had to be verified to accurately replicate the performance of the wastewater network.

2.2.2 THE FINISH LINE – APPLICATIONS OF THE MASTERPLAN

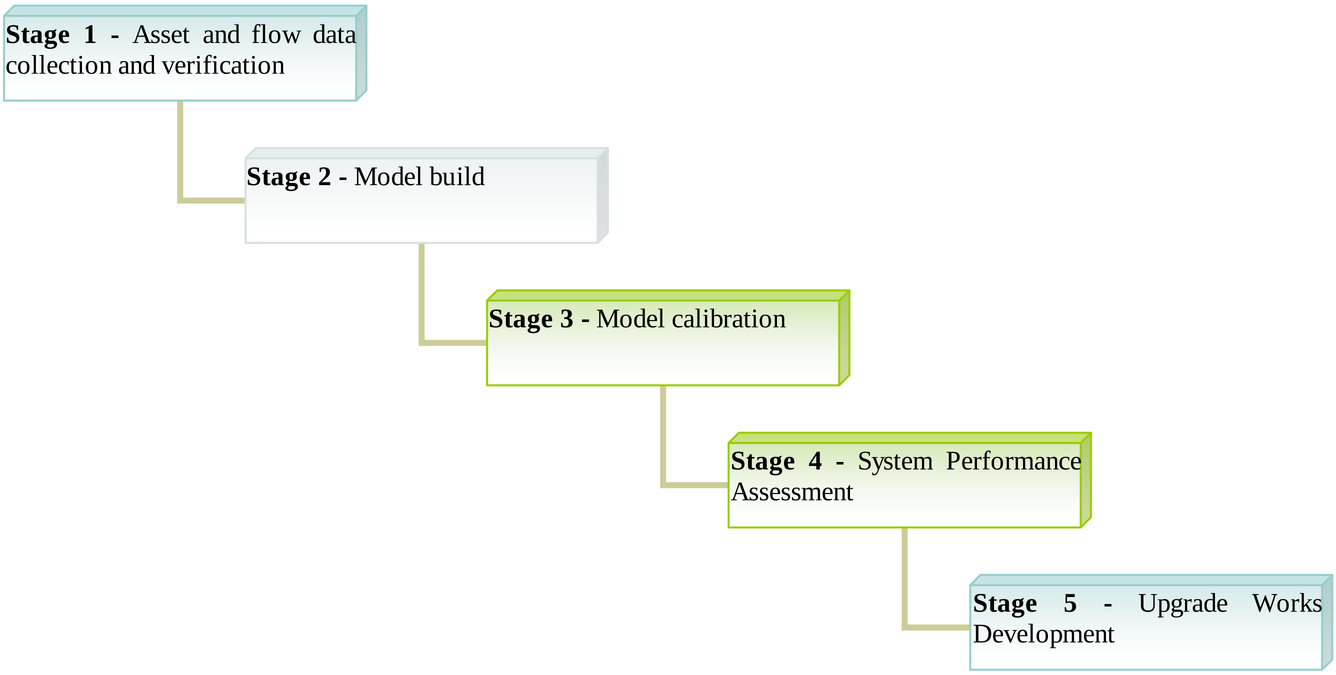
WDC decided that there were four key elements that they would want to use the masterplan for:

- Growth – Identify parts of the network that have spare capacity
- I/I Improvements and System Upgrades – Develop a Programme of Works to reduce suspected high I/I responses and eliminate spilling/overflows
- Level of Service – Understand the effectiveness of the separation project and define the level of service of the existing system
- 30-year Strategy – Use the results to focus expenditures and assist in developing a 30-year Infrastructure Strategy

2.2.3 THE ROUTE – PROCESS AND DEVELOPMENT OF THE MASTERPLAN

After understanding WDC's needs and the purpose of their specific masterplan, the following roadmap was developed.

Figure 3: WDC Roadmap



The following sections detail each of the different stages.

3 STAGE 1 – ASSET AND FLOW DATA COLLECTION

Stage 1 involved the collection and assessment of asset data. As previously mentioned, GIS wastewater pipe and manhole data was provided. In general the spatial accuracy was good, although some minor connectivity issues were found that had to be resolved. The pipe diameters were reasonably reliable, although the reliability of the invert levels was poor.

Data verification was carried out by an external consultant, during which the GIS data was assessed against local knowledge, as-builts, and other documentation (such as manhole assessments). This provided improved data for modelling.

A flow monitoring plan was developed to break up each of the catchments into manageable sub-catchments for calibration. Flow data was collected between October 2013 and February 2014, and consisted of four existing permanent flow meters and twelve temporary flow monitors in total.

Pump station capacity was unknown, however level data from each of the pump stations was available. Pump flow rates were calculated based on this data.

Constructed overflows were incorporated into the model and verified throughout the model build and calibration stage. Blanked off overflows were modelled as closed valves to provide WDC the option of running different scenarios with them open in the future.

4 STAGE 2 – MODEL BUILD

The wastewater model was built using InfoWorks CS. The network was divided into sub-catchments averaging between 2 to 4 hectares. Industrial sites, commercial, and non-residential areas were identified so appropriate diurnal patterns and base flows could be applied. The updated GIS information was then imported into the model. The screenshot in Figure 4 provides an overview of the network.

Figure 4: WDC Wastewater InfoWorks CS Model

The model was validated to highlight any connectivity issues or negative grades, and each of these was addressed. As new information about the network was collected (via site visits, as-builts, etc.) the model was updated accordingly.

Not all of the data was available, however. Nearly 50% of the manhole inverts were either interpolated based on GIS information from surrounding assets, or were assigned a default value of ground level minus 1 m. Areas that were found to be critical to the modelling were verified on site. It was not cost-effective, nor was it necessary, to ascertain the invert levels for the entire network.

5 STAGE 3 – MODEL CALIBRATION

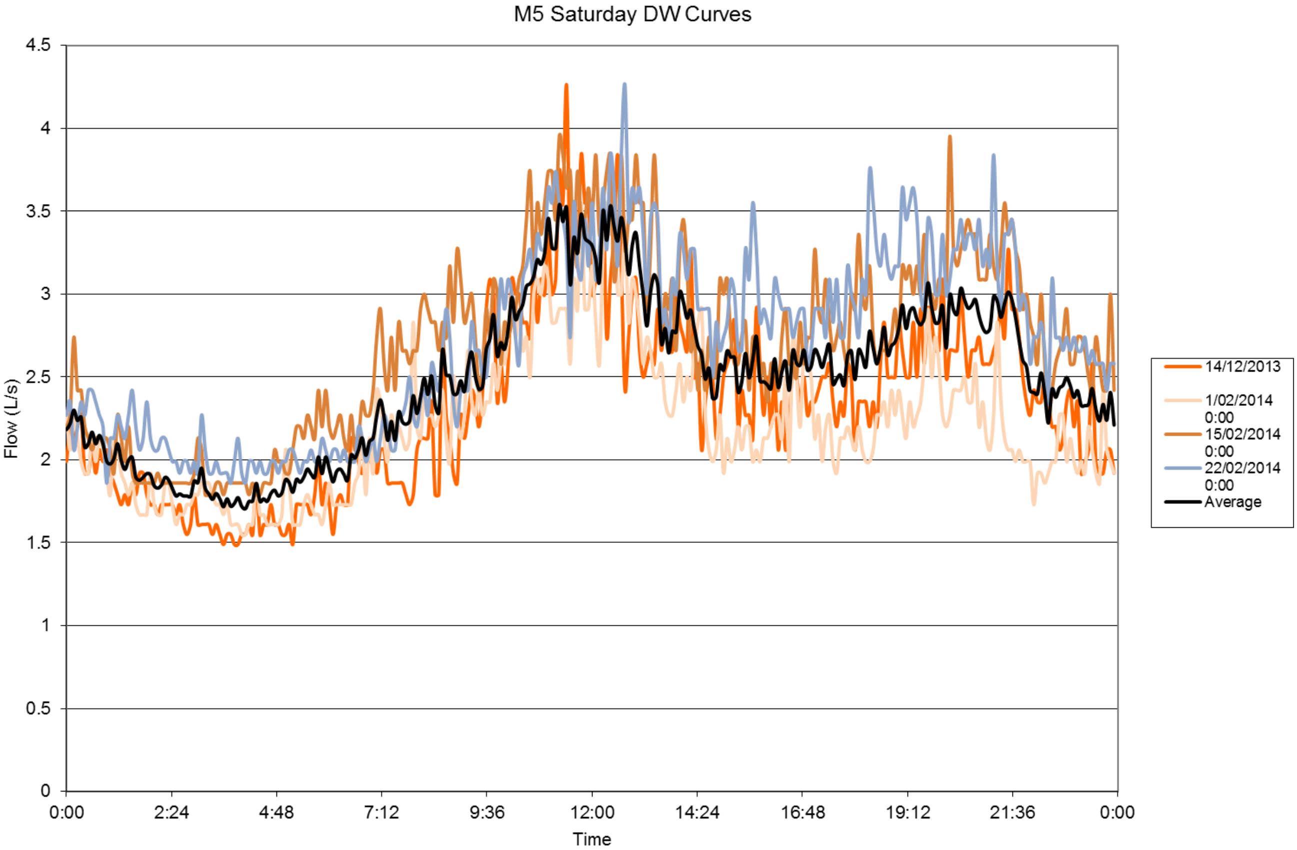
Both dry and wet weather flow and depth calibration was conducted using flow data from:

- 9 large pump stations
- 12 temporary flow monitors
- 3 permanent flow monitors
- Trade waste records
- Historical spill records

5.1 DRY WEATHER FLOW

Dry weather curves were derived from the flow monitoring data for each catchment by averaging a number of dry day hydrographs. Figure 5 below is an example of a dry weather curve for one of the catchments.

Figure 5: Example Dry Weather Curve



Loading rates for residential and non-residential customers and base flows were determined by taking into consideration:

- the water consumptions and associated return to sewer ratio (RTSR),
- trade waste metering data, and
- a flow balance equation.

Base flow was applied to the model where the minimum night flow exceeded any flows assigned to non-residential discharges.

The model was then calibrated for the following parameters:

- Peak flow rate
- Minimum and maximum flow
- Volume of flow (daily)
- Timing of peaks and troughs
- General shape of the predicted and observed hydrographs

5.2 WET WEATHER FLOW

Wet weather calibration was undertaken by developing runoff surfaces for each catchment to simulate wet weather response. A single hydraulic model simulation covering the entire flow monitoring period was run using rainfall and evaporation data. This enabled the wetting and drying of the catchment over the course of the monitoring period to be modelled.

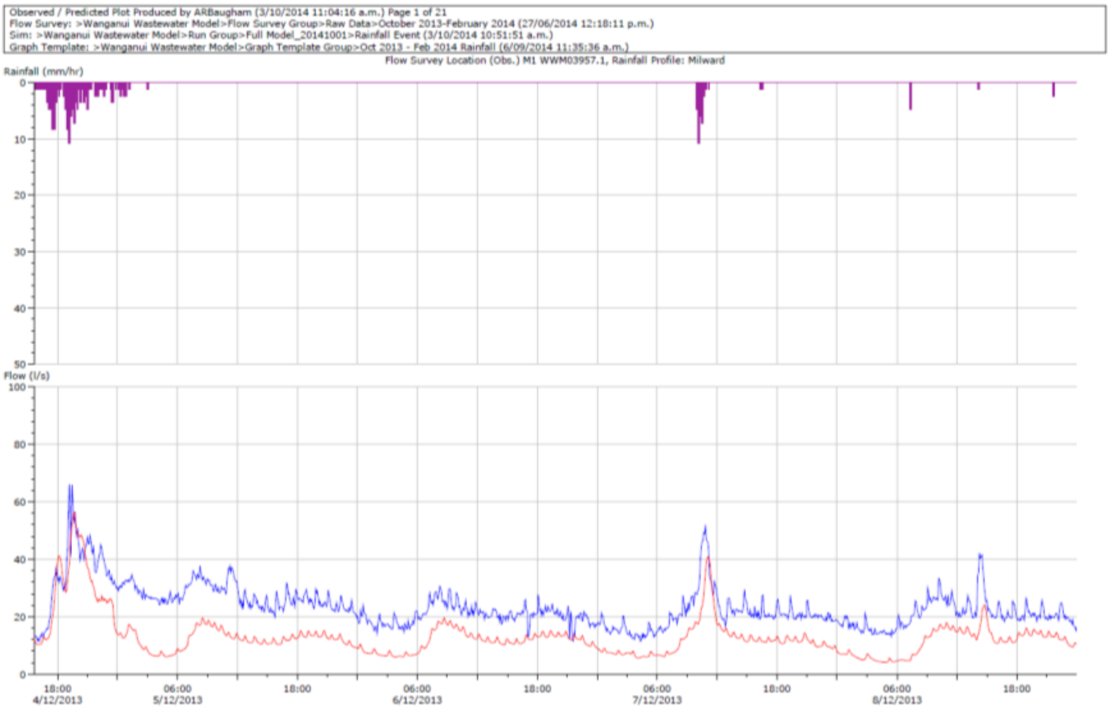
The model was calibrated for the following parameters:

- Peak flow rate
- Volume of flow
- Peak depth
- Timing of peaks
- General shape of the predicted and observed hydrographs

The calibration statistics for each calibration event were obtained by comparing the model predicted and observed results over time periods specific to the individual events. A single design parameter set was developed for each catchment to enable the model to accurately represent the selected calibration events, taking into consideration any bias between the events. Generally the averaged per cent matching (bias) for each calibration parameter was reduced to the smallest average possible, without affecting the model predicted shape of the wet weather response.

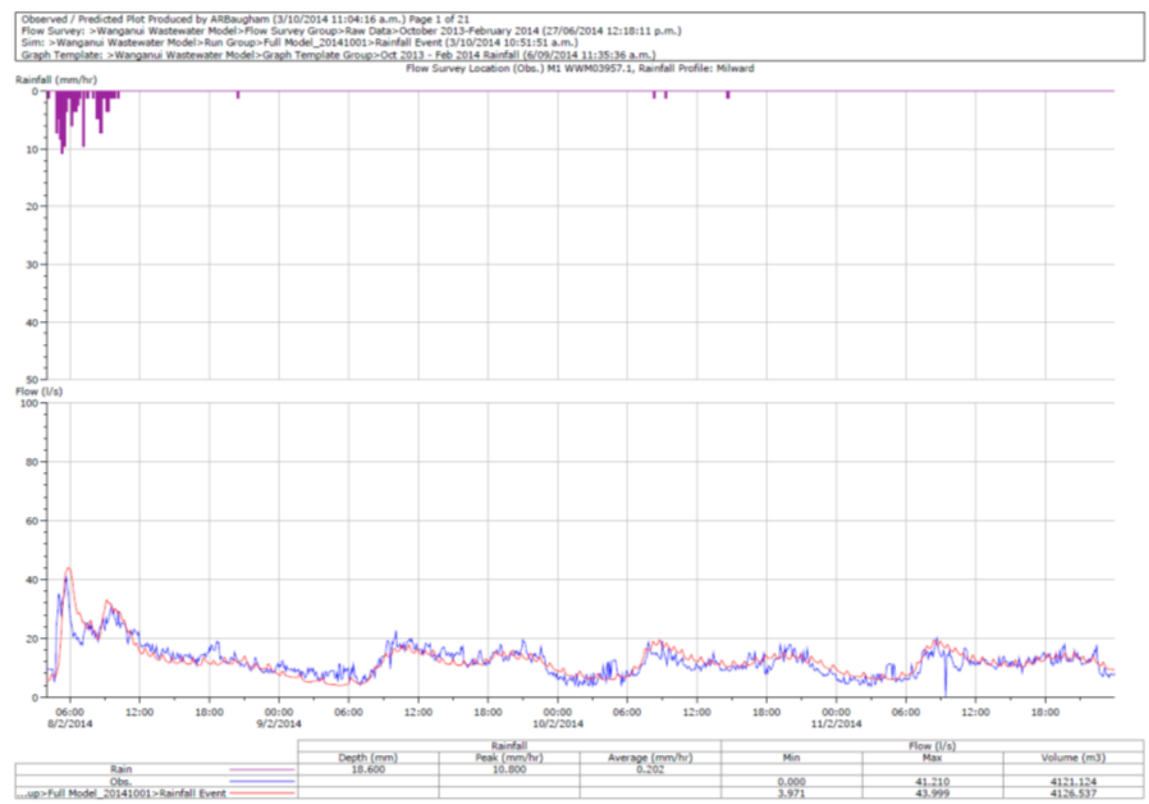
One catchment revealed a data anomaly, in which only some rainfall events showed a large slow response in the network. Events with similar rain profiles did not result in the same hydrograph, indicating an external source of flow is likely. Figure 6 and Figure 7 provide examples of this slow response. Because a cross connection with an adjacent stream is the likely source of this slow response, this could not be modelled and was flagged for further investigation for system improvements.

Figure 6: M1 Catchment Showing Slow Response



	Rainfall			Flow (l/s)		
	Depth (mm)	Peak (mm/hr)	Average (mm/hr)	Min	Max	Volume (m3)
Rain	32.000	10.800	0.307			
Obs.				11.440	66.020	8799.715
...up>Full Model_20141001>Rainfall Event				4.093	56.557	4905.130

Figure 7: M1 Catchment with No Slow Response



6 STAGE 4 – SYSTEM PERFORMANCE ASSESSMENT

System Performance was conducted by running both a dry period (no rainfall) and design rainfall events. This was ultimately done to identify the current LOS in terms of frequency and volumes of spills/overflow, as well as identify areas with spare capacity available for growth.

System performance was broken into two separate assessments: overall network assessment and I/I analysis.

6.1 NETWORK ASSESSMENT

The system performance of the Wanganui Wastewater System was assessed using the following two flow conditions:

- Dry Weather Performance
- Wet Weather Performance

6.1.1 DRY WEATHER PERFORMANCE

The key outcome of dry weather performance is an estimate of the maximum velocity in each of the gravity pipes during dry weather. This is an indicator that pipes have been laid with sufficient grades to achieve self-cleansing velocity on a regular basis.

During dry weather flow 30% of the pipes in the network did not achieve the minimum dry weather velocity required. Potential performance issues such as blockages may occur in these locations.

6.1.2 WET WEATHER PERFORMANCE

The performance of the gravity system is reported in terms of pipe surcharging, manhole spills and constructed overflows that operate.

The performance of rising mains is reported in terms of rising main velocity for both one pump and two pumps running. High velocities indicate that the rising mains are undersized and may be causing inefficiencies at the pump station. Low velocities indicate issues around self-cleansing / slime shear.

The performance of the pump stations is reported in terms of maximum inflow versus pump capacity.

The modelling showed that multiple spills occur in the network during a 1 in 6 month rain event and that the number and volume of spills increases as the ARI of the rainfall increases. These issues are caused by a combination of pump station and/or gravity main capacity issues. Excessive inflow and infiltration is likely to be a contributing factor to the capacity of the system being exceeded.

6.2 I/I ANALYSIS

Prior to development of the masterplan, WDC suspected significant I/I issues throughout the city and its impact on pump stations, the WWTP capacity, and associated operational costs. Part of system performance was to quantify the wet weather flow impacts and develop an I/I management strategy for the wastewater system.

Infiltration and Inflow was assessed using a range of key performance indicators (KPIs) as per the practice described in the Water Services Association of Australia (WSAA), *Management of Wastewater System Infiltration and Inflow, Good Practice Guideline*. These were:

- Groundwater Infiltration (GWI)
- Direct Inflow or Stormwater Inflow (SWI)
- Rainfall Dependent Infiltration and Inflow (RDII)

This assessment was completed prior to the publication of Water NZ *Infiltration and Inflow Control Manual* (GHD Ltd., 2015).

6.2.1 GROUNDWATER INFILTRATION

The assessment found that over half of the catchments have a high level of ground water infiltration where the base flow exceeds 40% of the average dry weather flow. This was also reflected in the loading rates, where almost all catchments had loading rates greater than 220 litres per person per day, indicating a high level of infiltration. The WDC loading rates were also found to be above the upper bound of the design loading provided in *NZS:4404: Land Development and Subdivision Infrastructure* (2010).

6.2.2 STORMWATER INFLOW

The assessment found that over half of the catchments had an SWI (or Peaking Factor) exceeding that stated in NZS:4404 for design. The following was found to contribute the most significant wet weather inflow/peak wet weather flows:

- Un-separated portions of the wastewater network
- Stormwater cross connections and/or illegal connections to the wastewater network
- Possible Matarawa Stream cross connection (as identified at flow metering site M1)

The assessment also found that the peak wet weather flows exceeded the pipe capacity in several areas.

6.2.3 RAINFALL DEPENDENT INFILTRATION AND INFLOW

With the exception of the un-separated portion of the network, almost all of the catchments had RDII parameter values within or below the range expected for an older network in good condition. Given what was known about the system from the calculation of the KPI’s and through assessment of the shape of the response to wet weather in the flow monitoring data it was suggested that:

- While ground water infiltration does exist it does not appear to be rainfall dependent as there is marginal increase in infiltration during and after a rainfall event.
- The network appears to be more susceptible to stormwater inflow and almost all of the rainfall dependent flow in the network comes from direct inflow.
- This is seen in the flow monitoring data by short sharp peaks during the rainfall with the system quickly returning to normal once the rainfall has concluded.

7 STAGE 5 – UPGRADE WORKS DEVELOPMENT

A system improvements plan/programme of works was developed to resolve the issues identified in the System Performance assessment. System improvements/upgrades were made to the model to eliminate spilling and overflows at a target level of service. Options considered for each of the issues addressed in the improvement plan included:

- Reduction in spilling through I/I reduction or catchment diversion,
- Upgrade of conveyance systems such as pipes, pumps, etc.,
- Attenuation through storage, and
- Modification of pump station operation to minimise overflow frequency, but also keep the WWTP inlet within required operational parameters.

7.1 I/I REDUCTION

I/I reduction is considered one of the most effective options to resolve localised overflows and treatment plant capacity exceedance (GHD Ltd., 2015). An I/I reduction programme has the potential to reduce and/or resolve capacity issues not only in the target catchment, but also in the downstream receiving systems. For this reason the I/I improvement options were considered first in upgrade works.

7.1.1 SPECIAL LOCALISED I/I IMPROVEMENTS

Two locations were identified for I/I improvements that fall outside what would be considered normal I/I reductions:

- Possible cross connection with the Matarawa Stream inflow
- Separation of the remaining un-separated sewer catchment

7.1.2 LEVEL 1 INFLOW REDUCTION

There are three levels of I/I management programmes available:

- Level 1 – rectification of inflow defects in sewers, laterals and manholes
- Level 2 – Level 1 plus complete sewer sealing/rehabilitation including public part of house laterals
- Level 3 – Level 2 plus complete lateral sealing/rehabilitation including all of the public and private parts of the laterals

It was recommended that Level 1 inflow reduction focus on catchments with the highest SWI, overflows, and capacity constraints. Level 1 reductions are generally the most cost effective I/I reduction method to reduce peak flows and therefore reduce the frequency of spills. Selection of the catchment was based on SWI thresholds provided by the Water NZ *Infiltration and Inflow Control Manual* (GHD Ltd., 2015). Eight of the twenty-two catchments were selected for Level 1 reductions.

Although I/I is significant, due to the nature of the wastewater network and the relatively small amount of pumping required (mostly small lift stations) the operational cost of this infiltration and inflow is relatively small. On this basis I/I reduction was found to be only worthwhile when considered together with other drivers such as:

- Management of risk associated with I/I induced:
    - Sewer deterioration, which can lead to pipe collapses
    - Sinkholes
- A reduction in overflows;
- A reduction in wastewater pumped to sea from Beach Road during high flow periods, and/or
- The creation of available capacity in the network.

I/I reduction should also be balanced with:

- Other system potential system improvements, and
- The criticality of the network.

It was ultimately recommended that only one catchment undergo I/I improvements first in order to test the effectiveness of Level 1 works. The selected catchment is a typical residential catchment and can easily be isolated and monitored. It also showed a significant response to Level 1 improvements in the model in terms of the reduction of the total spill volumes. Once the improvements have been made in this catchment it can be determined if the results were as expected and if it is worth moving ahead with the other identified catchments.

7.2 PIPE UPGRADES

Upgrading pipes was considered when spilling occurred due to available pipe capacity. In several instances spilling occurred due to constrictions where the sewer reduced in diameter downstream.

Table 1 below summarises the upgrades required for each LOS. Pipe diameters range in size from 150 mm to 750 mm.

Table 1: Pipe Upgrades

Level of Service Target	Pipe Upgrades (km)
1 in 6 Month	1.4
1 in 1 Year	4.8
1 in 2 Year	6.8

7.3 STORAGE

Storage was generally only considered where the downstream receiving system did not have capacity to accept additional flows from alternatives such as pump and pipe upgrades. As the discharge consent requirements at BRPS and capacity constraints of the main interceptor were found to be significant limitations, storage was primarily used to mitigate the peak flows in these areas. In addition, constructability was considered to ensure that the proposed location could facilitate the required storage size.

Table 2 below summarises the total amount of storage required for each LOS.

Table 2: Pipe Upgrades

Level of Service Target	Storage Required (m³)
1 in 6 Month	1,656
1 in 1 Year	2,875
1 in 2 Year	5,132

7.4 PUMP CONTROLS/PUMP STATION CAPACITY

Existing pump station operation and pumping capacity had been determined from level data obtained from WDC. Where the pump station control philosophy or pump capacity was found to be the constraint these were generally changed/increased as this is a relatively low cost option compared to alternatives such as storage. This was only considered when there was sufficient downstream capacity.

7.4.1 BEACH ROAD PUMP STATION CONTROL PHILOSOPHY

One control philosophy change recommended was for the Beach Road Pump Station (BRPS), which is the terminal pump station that receives all flows from the Wanganui wastewater network and conveys them to the WWTP. It consists of four pumps operating on variable speed drives.

The control philosophy was optimised to maximize storage within the interceptor, as well as minimise spilling in the upstream catchments. The recommended solution reduced spilling in the upstream catchments as much as possible while not exceeding the ocean outfall discharge consent condition, which is fixed. The solution involved pumping the maximum flow rate that the WWTP could handle earlier, which alleviated surcharging in the main interceptor. Controls were also adjusted to pump to sea earlier during extreme wet weather events. During the 1 in 6 month rain event the pump station only pumped to sea for less than an hour, well below the consented duration.

7.5 CRITICALITY ASSESSMENT

A criticality analysis of WDC's wastewater assets was also carried out to help direct their renewal program. This was done in addition to network improvements to prevent spilling and overflows.

The term "critical assets" in the assessment was defined as those assets with a high consequence of failure. The criticality of each asset was defined using a number of weighted criteria. A grade of 0 to 3 was assigned for each criteria. The overall criticality score of the asset was calculated using the product of the weighting and the criteria grade.

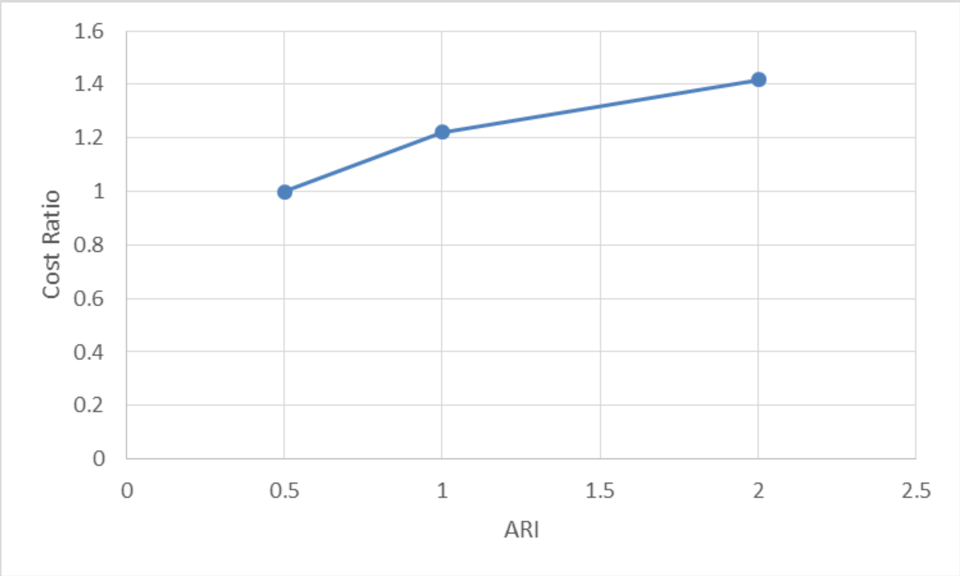
The purpose of the criticality assessment was to prioritise the assets for CCTV inspection. Information obtained from the CCTV inspections would then be used to refine the likelihood of failure score, and therefore determine where preventive maintenance and/or renewal is required. This will aid in the development of the renewal program once completed.

Detailed methodology and findings of this assessment can be found in 2014 Water NZ Conference paper 'Risk-Based Asset Inspection Prioritisation Programme' (Toy, 2014).

7.6 ESTIMATED CONSTRUCTION COSTS

Preliminary cost estimates were provided for the recommended system improvements. The major contributor in cost was found to be the combined sewer separation, which accounted for 60% of the cost for the 1 in 6 Month LOS target. Figure 8 below provides a graphical comparison of the total costs for the different LOS targets as a ratio to the lowest 1 in 6 Month LOS.

Figure 8: System Improvements Estimate Cost Comparison

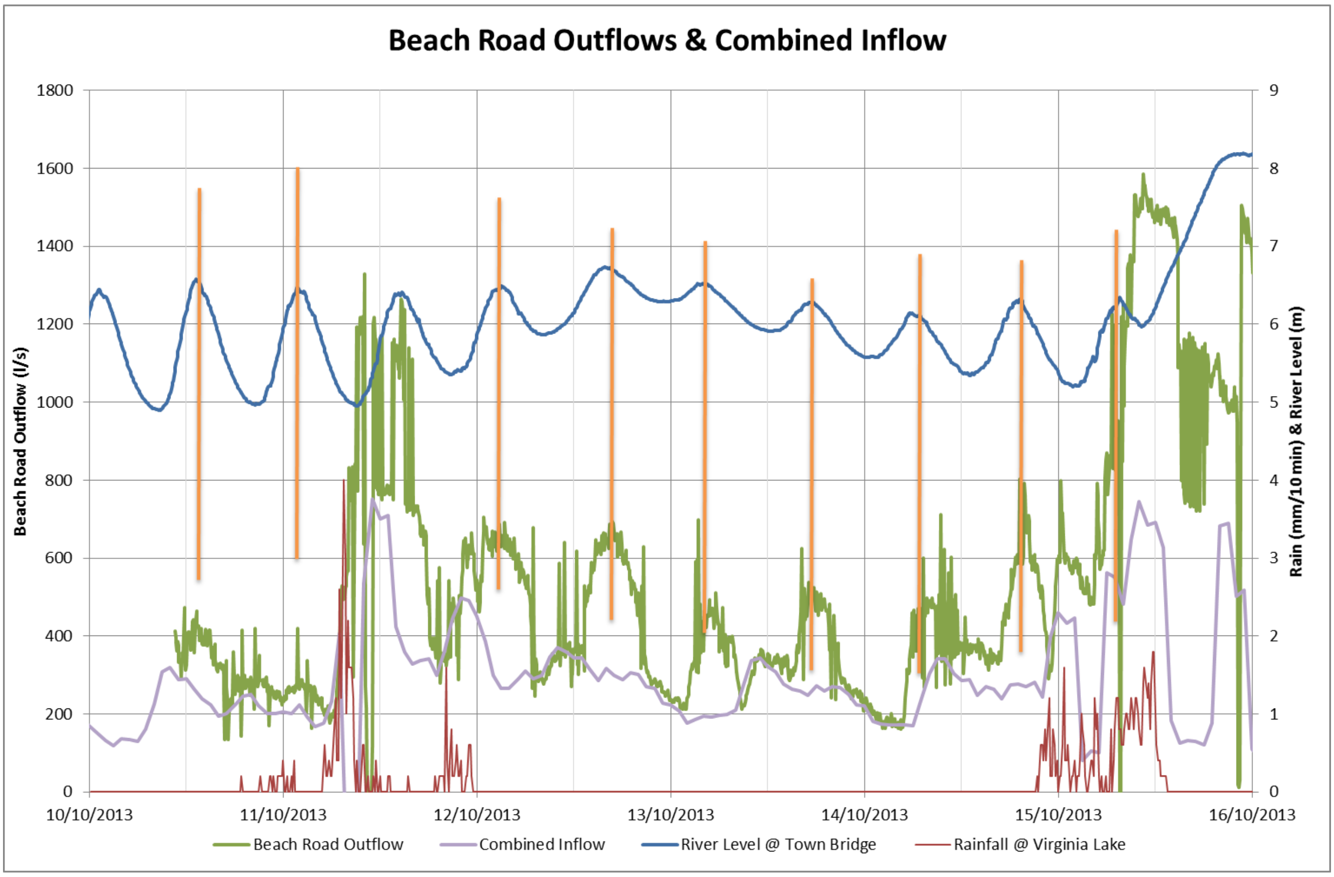


8 KEY FINDINGS

8.1 BEACH ROAD PUMP STATION

One very large finding concerned the performance of the Beach Road Pump Station. During review of the historic flow data before flow monitoring commenced, it was found that there was a large inflow from the Whanganui River into the main Beach Road Pump Station. Figure 9 below shows the Beach Road Pump Station discharge in comparison with the inflow and river level.

Figure 9: Beach Road Pump Station Flow Comparison



What was discovered from this data was that when the river reaches a certain level, it backflows through the constructed overflow into the pump station and ends up being pumped to the WWTP. The orange lines on the graph demonstrate how the peaks line up with the high tide in the river. Maintenance crew were sent to the pump station during a rain event and confirmed that there was indeed a large amount of water entering the pump station from the overflow.

WDC was able to remedy this and an approximate calculation was made to determine the implications of the river inflow. It was estimated that an additional daily volume of 6,500 m³ was being pumped to the WWTP to be treated. Assuming a rate of $0.20/m³ to treat this extra flow (including additional wear on the plant and equipment), eliminating this excess flow results in an annual savings of $312,000.

This finding was also important because this inflow was discovered and remedied before the start of flow monitoring, so more accurate data could be collected and used for the calibration of the model. Otherwise the model would not have been able to be calibrated.

8.2 MATARAWA STREAM

As discussed previously during the wet weather flow calibration, inflow from the Matarawa Stream was suspected due to the slow response found only during some rainfall events. The cross connection has been narrowed down to two different possibilities:

- A cross connection with the stormwater network, in which the stream flows back up into a stormwater pipe and into the wastewater network, or

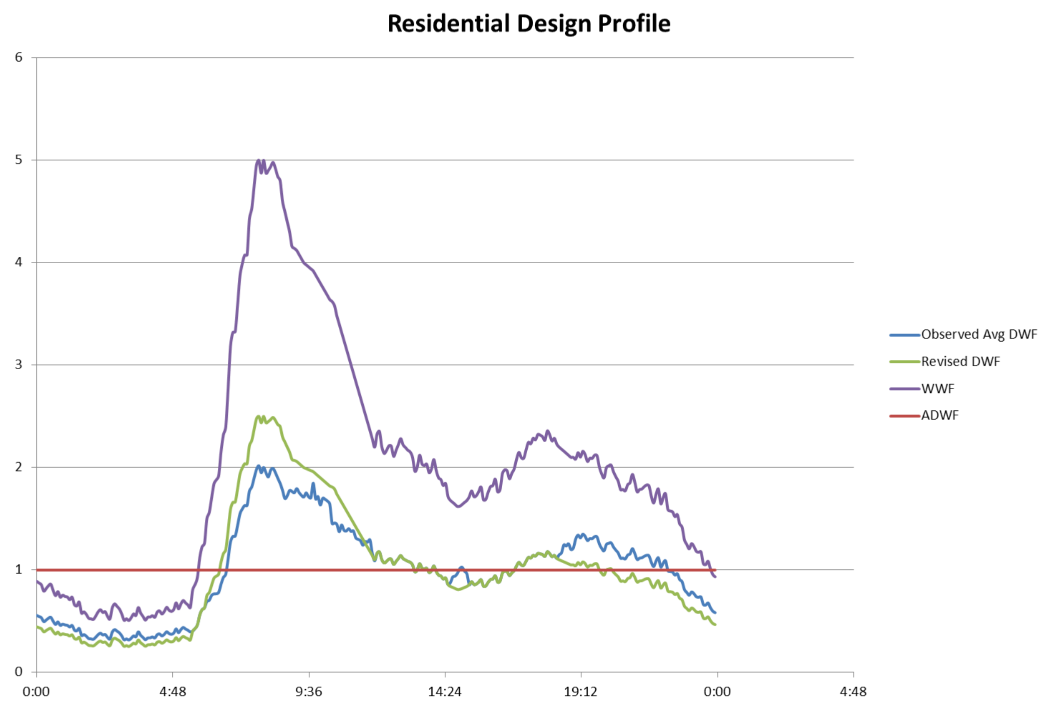
- A connected overflow into the stream.

Investigations are currently underway to locate this connection.

8.3 WASTEWATER NETWORK DESIGN

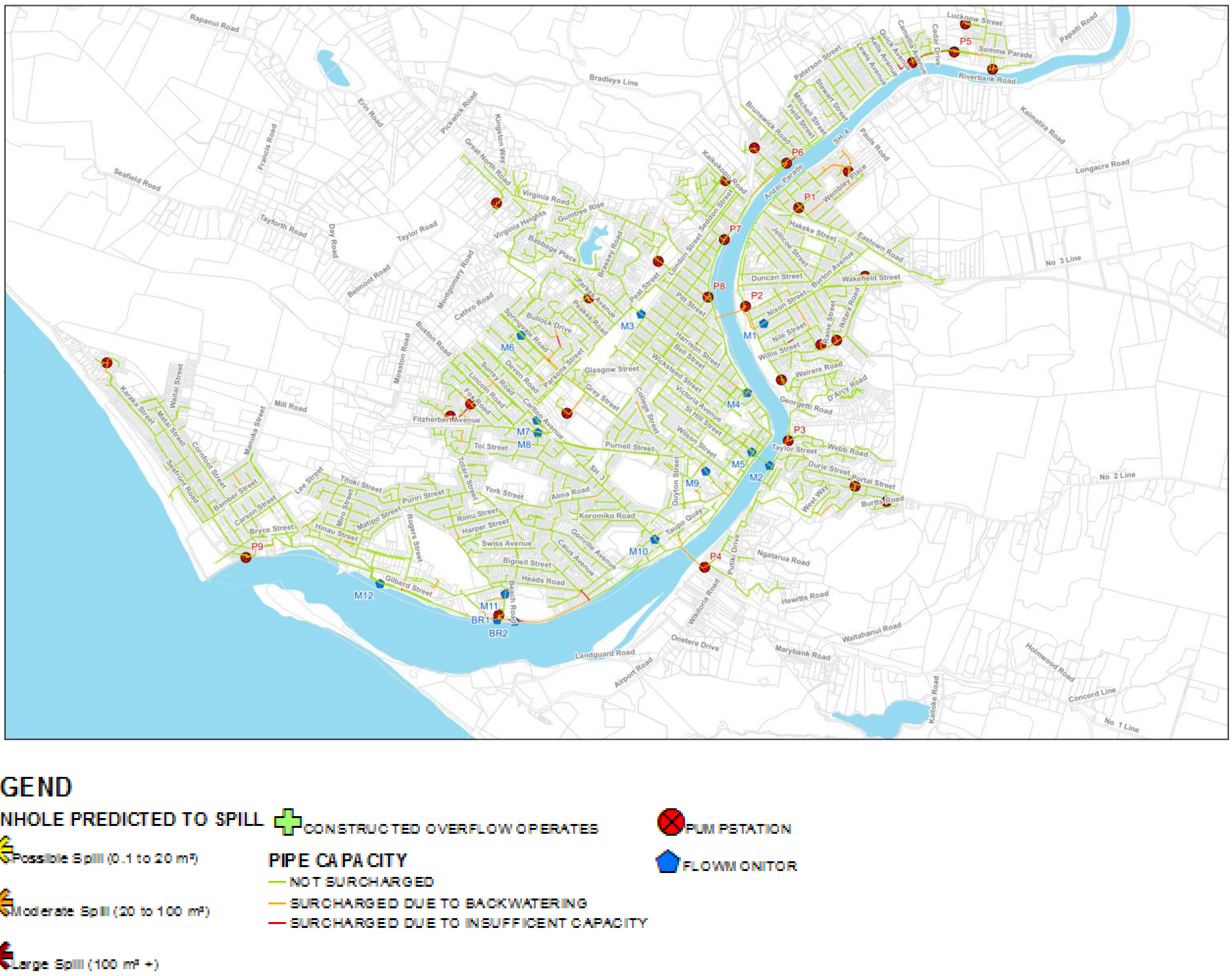
Due to the amount of spilling both modelled and observed, the wastewater network was also evaluated using design DWF curves from NZS 4404:2010 to serve an indicative comparison to typical design parameters. An "observed" average DWF curve was calculated by averaging each catchment's DWF curve used in the model. This average was then adjusted to create a DWF peaking factor of 2.5 in accordance with NZS:4404. The WWF curve was then 2 times the revised DWF curve. Figure 10 below compares the three different curves.

Figure 10: Residential Design Profile



These curves were then imported into the model for residential catchments (industrial and commercial profiles remained unchanged) and the existing wastewater network was evaluated. Figure 11 shows the results of the simulation for a 1 in 6 month rain event.

Figure 11: System Performance of Typical Diurnal WWF



NZS:4404 loading rates are designed such that no surcharging should occur in the system. Excluding the rising mains which are supposed to be full, the model showed that there is minimal surcharging in the Wanganui wastewater network. This is in contrast to the results using the observed DWF curves (refer Figure 2).

It should be noted that the simplified WWF curve used for this analysis provides a peaking factor of 5 for 1 hour and 4+ for 2 hours. The peak flow could be extended, however this corresponds to previous system performance analysis that showed the critical storm to be approximately 2 hours for the 1 in 6 month event. Based on the performance of the system during the 1 in 6 month 2 hour duration storm, no additional analyses were performed.

Results from using the design DWF and WWF curves show that the network appears to be designed in accordance with NZS:4404. Any failings in the system are a result of the network having a larger base flow and wet weather response than is specified in NZS:4404.

8.4 GROWTH AND DEVELOPMENT

Evaluation of the existing wastewater network revealed that there is no capacity for further urban rezoning without specific capex. The model is now being used to determine what upgrades are required for proposed development areas.

8.5 ENVIRONMENTAL IMPACT

WDC is consented to pump directly to the sea a maximum of 32 hours per year. A long term simulation using four years of actual rain data showed that the system upgrades will result in this consent limit being met.

With a calibrated model, it is also possible to determine the volume being spilled and volume/duration of overflow occurring for design events. The long term analysis showed that the amount of overflows/spilling will be reduced by the system improvements plan, the extent of which is dependent on the LOS target selected.

The model outcomes were used to communicate the arising issues to the consent regulator and local Iwi.

8.6 INFLOW AND INFILTRATION

The model revealed that there may be a number of cross connections between the stormwater and wastewater networks that were previously unknown. These became apparent when a high SWI ratio was required in certain catchments in order to achieve calibration. As previously discussed, high SWI ratios also help identify which catchments may benefit the most from I/I reductions. These catchments can undergo smoke testing to confirm the extent of direct stormwater connections and then be remediated.

Investigations are currently being done in some of these catchments, however inflow reduction will not be able to cost-effectively resolve all of these issues.

8.7 UNEXPLAINED SWI

In order to calibrate the model to the flow monitoring data in one of the catchments, a significant wet weather response was required. This resulted in significant spilling during system performance, which is not actually observed in reality. The discrepancy between the model and observed behaviour of the system upstream of the flow monitoring location indicates there could be a cross connection with the stormwater network at the downstream end of the catchment.

This is currently being investigated, and once the location of the connection is known and it is closed, the catchment will need to be monitored and re-calibrated. This will reduce the level of works required to eliminate spilling in the catchment and downstream of the catchment. The system improvements plan will be modified once the outcome of these investigative works is known.

8.8 COMBINED SEWER SEPARATION

The model indicated separation of the remaining combined sewer in Wanganui would significantly reduce the volume spilling/overflowing. However this work is estimated to cost approximately 60% of the total upgrade costs. This cost allows for the construction of an entire stormwater network to service the un-separated area, which has minimal fall available and therefore requires large diameter pipes.

Alternative solutions (i.e., leaving the network un-separated and storing excess flows) are currently being investigated.

9 CONCLUSIONS

The following conclusions were made following development of the Wanganui Wastewater Masterplan:

- Network modelling is an indispensable tool for utility providers.
- The cost for developing the masterplan and a working model is an excellent value since it helps direct future expenditures that will have a positive impact on the network.
- The masterplan helps direct renewals and capital upgrades.
- The model significantly reduces the level of uncertainty of the network, which aids in the development of a 30-year Strategy.

- The masterplan enables well informed technical decision making by governance.
- The network model can be used to determine the most cost effective way to service a growth area, and allows the Council to make decisions on whether or not those areas should be developed.
- The network model requires on-going refinement and a specialist dedicated resource.
- A roadmap is key for development of an effective masterplan.
- Development of a masterplan is valuable in that it not only improves knowledge about the existing network, but also helps identify any operational issues that may not have been known previously.

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