RENEWALS – SPEND SOME MONEY ON INVESTIGATIONS OR JUST REPLACE IT?

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ABSTRACT

The Park Road Rising Main services approximately 17% of Hastings. It has a conglomeration of six different sewer pump stations all competing against one another to discharge into a single DN375 concrete rising main.

This paper outlines how by taking a more holistic approach to renewal projects and time spent in the investigation phase, a more robust multifaceted solution can be found. This has the potential to save the Client thousands of dollars in construction and operation costs, while also addressing growth and minimizing community disruption.

Rather than diving into a capital works intensive solution of replacing like-for-like, which has often been the historical approach, the project team worked with the Council to step back and invest time and money in the investigation stage. By doing this, the team were able to significantly reduce the capital investment required.

Following rising main bursts, pipe samples were taken and we identified that the Park Road rising main had minimal service life remaining and needed replacing. This coupled with desire from the Council's roading team to carry out a full road reconstruction, meant that there was strong pressure just to get in and replace the rising main.

By undertaking extensive investigations and strategic planning, we developed the master plan. We looked at the impacted and surrounding catchments. We assessed the surrounding catchments because there were interconnections and complications not readily understood without in-depth assessments. By using a combination of GIS, network modelling, real-time flow monitoring and piezometers we discovered that the main servicing problem could be narrowed down to a single catchment. This catchment had a wet weather peaking factor of approximately 15, three times the accepted limit. In addition the pump stations were in an arms race with one another pushing pumps off their curves in wet weather resulting in a poor level of service.

Our master plan has now been refined and is entering the detailed design phase. It sets out the best way to stage the ultimate goals given the budget and time available while still remaining flexible due to the continuing inflow and infiltration investigations.

KEYWORDS

Renewal, Investigations, Master Plan, Asset Management, Network Planning

PRESENTER PROFILE

James has 15 years' experience in many multi-disciplinary projects that required careful inter-agency liaison with local council and government departments to gain project approvals. He has experience dealing with environmentally sensitive areas, indigenous and non-indigenous heritage sites and presenting to community interest groups and community information sessions.

1 INTRODUCTION

The Hastings District Council (HDC) engaged Stantec under the Alliance Professional Services Contract to create a Master Plan for the future of the Park Road Rising Main and associated infrastructure. This paper summarizes the process involved to create a Master Plan and program of capital investment. The proposed Master Plan was based on a Level of Service (LoS) removing spillage to the environment under a 1:5 year 24 hour Average Recurrence Interval (ARI) storm which is approximately a 20% Annual Exceedance Probability (AEP) event.

2 THE PROBLEM

Hastings is predominantly flat, with an average grade across the city of approximately 1:400 making draining the city's sewage by gravity while still achieving minimum grades difficult. The result of this is a network with numerous small interconnected pump stations located throughout.

The Park Road rising main services the Akina and Parkvale areas within HDC's sewer renewal strategy classifies the rising main as Category A – a high priority pipeline critical to the HDC sewer network.

The rising main and six associated pump stations have a history of operational and maintenance issues, due to the complex arrangement and interdependency of the pump stations. The area is also known to suffer inflow and infiltration (I+I) which is an ongoing level of service issue within the catchment. Because of this the residents towards the upstream end of the catchment have a poor level of service in wet weather with difficultly flushing toilets etc.

The last few hundred metres of the rising main on Victoria Street experienced multiple pipe failures and was identified as requiring renewal.

Due to the many complex issues associated with the Park Road Rising Main, proposed developments within the catchment area, and the significant investment required to renew the Victoria Street rising main section, HDC and Stantec identified the need for a Master Plan.

3 THE MASTER PLAN

3.1 STUDY AREA

The study area included all wastewater catchments associated with the Park Road rising main within the Akina and Parkvale suburbs in Hastings. Pump Stations **directly linked** to the Park Road Rising Main were as follows:

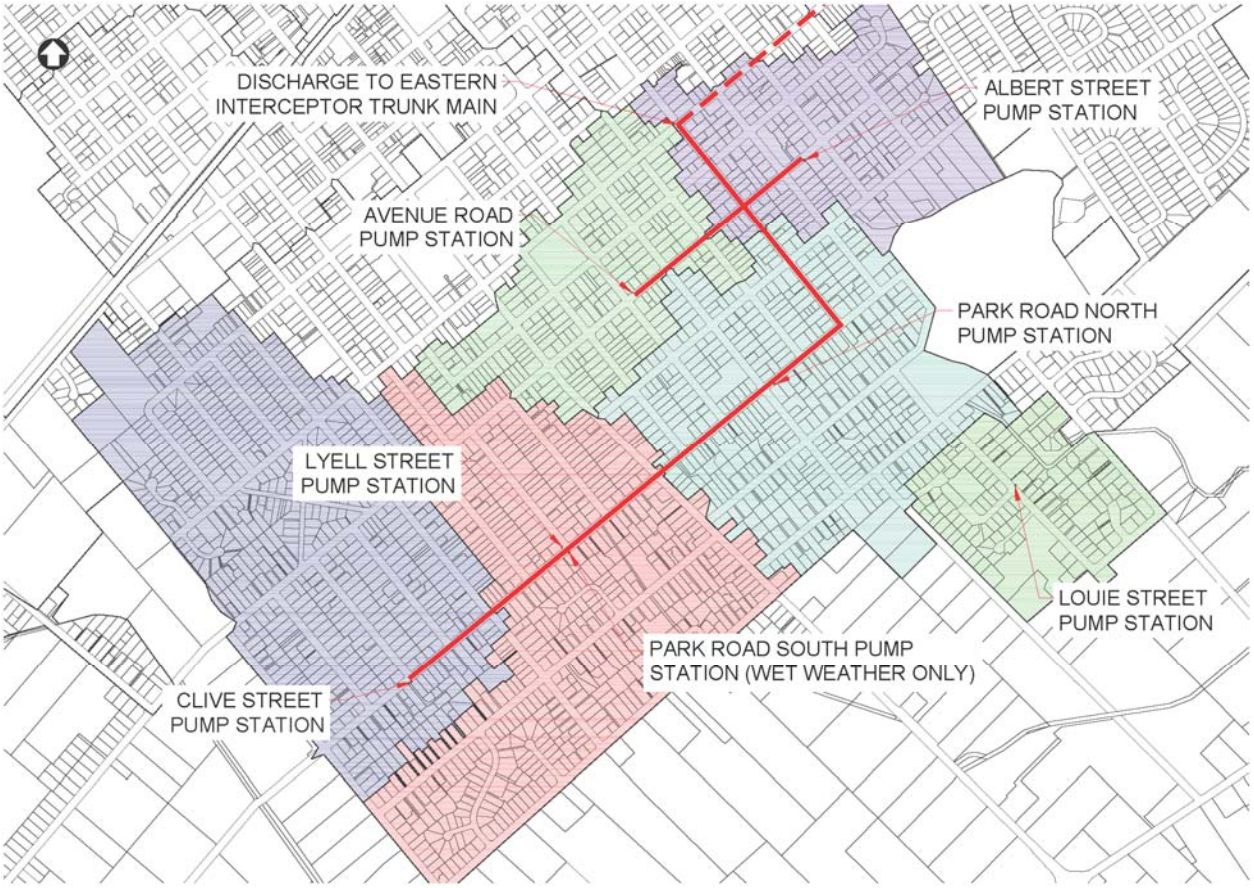
- Clive Street Pump Station
- Lyell Street Pump Station
- Park Road South Pump Station (operates during wet weather only)
- Park Road North Pump Station

- Albert Street Pump Station
- Avenue Road Pump Station.

A further catchment (Louie Street Pump Station) was also included in the assessment but was not directly linked to the Park Road Rising Main. This was included as a potential catchment realignment to remove the rising main passing through private property and to reduce flows to the Hood Street pump station that was experiencing a very poor level of service.

The rising mains all converge on a single DN525 trunk sewer known as the Eastern Interceptor. This was also included in the study area through to its connection into the large inland sewers.

Figure 1: Park Road Rising Main Catchment Overview



3.2 PRELIMINARY INVESTIGATIONS

The first phase of the Master Plan involved a gathering of all the information available on the existing wastewater and stormwater infrastructure within the Park Road rising main catchment and downstream Eastern Interceptor trunk main. In addition to this site investigations, where deemed critical, were also carried out (e.g. CCTV, pipe samples). Each pump station, rising main and trunk service in the network was initially assessed based on the following:

- Operational Assessment
    - Blockages, sediment odour
    - Slower flows or dips
    - Damage from other services
    - Access to infrastructure (maintenance hole spacing, protection slabs)
    - Isolation capability
- Condition Assessment
    - Results from laser profiling
    - Exposed reinforcing bars
    - Pipe samples and cores

3.2.1 KEY PRELIMINARY FINDINGS

Some of the findings from this preliminary investigation are listed below. It is not an extensive list but rather a sample of key issues raised.

Most of the pump stations were built in 1969 with 10-20 years of remaining life expected. All had less than the required 6 hours storage at average dry weather flow required.

The downstream section of the Park Road rising main along Victoria Street had suffered a number of failures over the past few years. Pipes samples were taken where the rising main has been repaired and where access chambers have been cut in. The mechanism for pipe failure in this section appeared to be air pockets forming along the soffit of the pipe, which had collected hydrogen sulphide gas, and allowed biogenic corrosion to occur. Over time these air pockets have corroded through the concrete pipe wall. The cause of the air pockets was unknown, but possibly poor construction control, settlement of the ground supporting the pipe, or accumulation initially at pipe joints. There was also no means along the pipeline to remove entrapped air/gas.

Photograph 1: Section through a failed concrete pipe from Victoria Street

Damage to the pipe infrastructure was also evident with services having been drilled through the side of the Eastern Interceptor.

Photograph 2: 11 kV cable ducts drilled through the Eastern Interceptor

Access to the infrastructure throughout was limited and the ability to isolate sections of the mains for operations and maintenance was poor. The section of Park Road South rising main between Lyell Street and Heretaunga Street East was exceptionally difficult to access with construction of a precast interlocked concrete slab panels located directly above the rising main. The panels were 1700 mm wide x 1400 mm long x 150 mm thick. This concrete slab would have posed a significant problem if the modelling indicated that

the pipe needed to be upsized to cater for ultimate flows because of costs involved to access. It was believed that the concrete slab was installed to protect the pipeline from traffic loadings, when the road level was reduced.

In the 90's, HDC slip lined a series of the existing gravity pipes throughout the gravity sections of the network. Unfortunately this has caused reoccurring blockages and capacity issues. It was also suspected that since the PE slip lines were not grouted around the annulus and maintenance hole connections then a direct infiltration point was likely to have formed.

3.3 MASTER PLAN ANALYSIS

The model was calibrated through a process of flow monitoring and model calibration before any modelling was undertaken. We installed a series of flow meters inside the gravity network just upstream of the pump stations and compared this actual data to the predicted modelling outcomes.

3.3.1 GRAVITY NETWORK MODELLING

Initial modelling of the catchments identified vast upgrades required across the network to cater for the future predicted flow rates. However, The Lyell Street catchment was identified as having the greatest inflow and infiltration issues within the system. With wet weather flows 'peaking factors' up to 15 times the peak dry weather flow rates, three times the accepted limit. The surrounding catchments peaking factors were all indicated to be around 5 times the peak dry weather flows, on the high side but acceptable.

We recommended that stormwater improvements are focused in the Lyell Street area to yield the greatest return in investment and overall operational improvements for the sewer.

Because of this, two modelling scenarios were investigated based on the preferred ultimate servicing strategy. The first modelling run assumed that no inflow and infiltration improvements to the Lyell Street Pump Station catchment is achieved. The second assumes that the inflow and infiltration reductions in the Lyell Street catchment is equal to that of Clive Street catchment.

The rough order costs of the two potential upgrade options to the gravity network indicated that if the inflow and infiltration analysis in Lyell Street catchment was successful in reducing the I+I to that of the surrounding catchments. The Council could save approximately $1.1M in capital investment to the gravity network.

3.3.2 PUMP STATION MODELLING

The Park Road South pump station only operates in wet weather when Lyell Street is inundated. From an analysis of the model built of the Park Road system it appeared that when Park Road South pump station cuts in, the high flow rate and resulting total head generated within the rising main was then high enough to push the other pump stations off their duty point curves. This effect exacerbated the surcharge problems within the other pump station catchments as they were unable to pump at the required flow rates. The most impacted catchment in this situation appeared to be Clive Street due to being located at the furthest point and the highest point on the hydraulic profile. The Albert and

Avenue pump stations are near the discharge point so the hydraulic profile is not significantly impacted when Park Road South is in operation.

Based on this, we recommended that when Victoria Street was upgraded in the next year or so, to install two additional separate rising mains alongside the existing main. These two new mains would be sized to simplify and improve the hydraulics within the system. Of the two new rising mains, one would take the Albert and Avenue pump stations off the existing Park Road rising main. The second rising main would only take the Park Road North catchment. The Park Road North pump station could then also be sized to:

- Take the proposed 16.4Ha, 310 property Howard Street development, and
- Divert the Louie Street pump station away from the Hood Street catchment.

This will ease flow conditions and defer capital upgrade requirements at the Hood Street pump station.

The remaining three pump stations upstream in the network (Lyell, Clive and Park Road South) would still operate on the existing rising main. However, due to reduction of the flows now entering the existing rising main this meant the existing pipeline could be slip lined rather than exhumed and replaced. The design also allows flexibility in capital upgrades with the Park Road South pump station able to be decommissioned once the Lyell Street pump station is upgraded.

3.3.3 INFLOW AND INFILTRATION

An earlier report 'HDC Infiltration and Inflow Strategy' (Stantec, May 2016) relevant to the Park Road rising main nominated some key findings:

- The low-lying areas in Lumsden Place (Lyell Street pump station catchment), which have the potential to flood, are now developed and could be a source of stormwater inflow if the gullies are not raised high enough above ground level
- The Park Road rising main catchments have the worst inflow sources due to known overflow incidents and/or wastewater overflows predicted by hydraulic modelling, and I+I analysis yielding high peaking factors in comparison with threshold values
- Infiltration and inflow (I+I) analysis recorded high rainfall dependent infiltration (RDI) and higher than threshold groundwater infiltration (GWI), a sign of possible leaky pipe joints within the system
- The catchments were predicted by network modelling to have dry weather flow surcharges/spills.

Using this information and the initial modelling analysis it was clear that the focus on infiltration and inflow needed to be on the Lyell Street catchment. Stantec and HDC then installed and monitored the groundwater in the catchment via piezometers to identify if the area suffered from a high water table and was the source of some of the infiltration issues present.

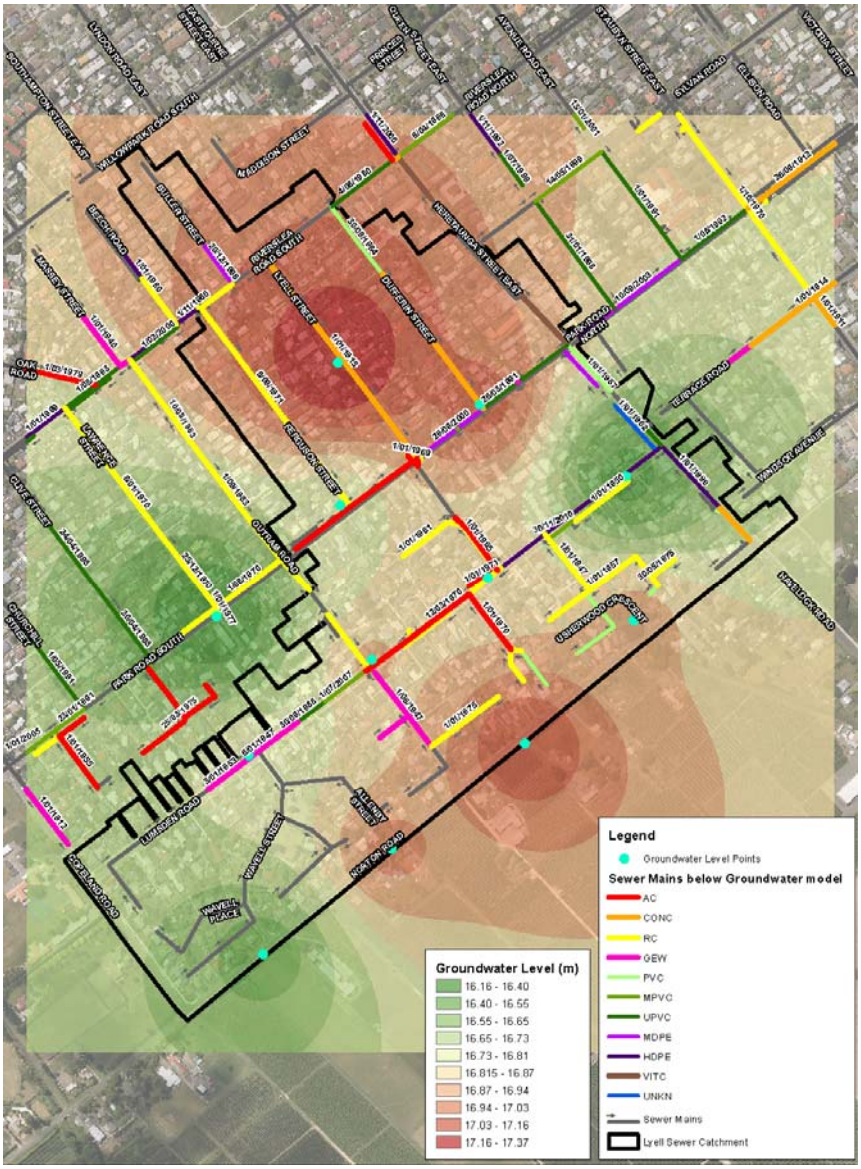
INFILTRATION FOCUS

To assist in focusing the limited resources in key areas we agreed with HDC that the water table should be looked into. Twelve piezometers were installed evenly spaced throughout the catchment to establish an indicative water table within the problem Lyell

Street catchment. The piezometers were monitored over a period of approximately 2 months. This data was then used to create a 3D map of the water table that could be compared to known pipe depths, install dates and material types.

The figure below shows the results of the GIS analysis with a map of the water table relative to the pipe depths. Only pipes lower than the water table were highlighted. From this it was quickly noted that the two oldest mains located in Dufferin Street and Lyell Street should be the first to be investigated. Both had high water tables, very old concrete mains and were known to flood easily in wet weather.

Figure 2: Lyell Groundwater Level Analysis



INFLOW FOCUS

The second focus point was trying to establish direct inflows into the sewer network. HDC was keen to speak to ratepayers directly and gain an understanding on their wet weather experiences. However, timing was key, being able to get to site and get feedback from resident over the whole catchment in a matter of days before information was forgotten

was challenging. To assist in refining key areas, we again used GIS. This time we used LiDAR of the area to assign a level to the property based on the lowest level located within each site. This was then compared to the road stormwater levels to confirm if the property could actually drain away in wet weather.

The figure below shows the outcome of the analysis, properties in red are an indication that they cannot drain to the existing road stormwater network and should be first to be questioned.

Figure 3: Lyell Properties Below Road Level

3.4 OUTCOMES / RECOMMENDATIONS

The summary of the Master Plan outcomes and recommendations are:

- A staged and prioritized capital investment program over the next ten years. The Long Term Plan (LTP) takes into account a tight construction market, aligning with

other planned HDC infrastructure investments, allows for developer works to commence unimpeded and minimizes shutdown and over-pumping of mains.

- Key changes to the network recommended were:
    - Two existing pump stations remain on the existing relined rising main
    - One pump station is decommissioned
    - One existing pump station empties to a new rising main with the ability to take on flows from proposed developments and diverting flows away from an already overloaded catchment
    - Two existing pump stations empty to a new rising main
- Once the master plan is implemented HDC will meet its 1:5 year no spill policy for all six catchments.
- The stormwater inflow and infiltration reduction investigations were focused on a few streets within the Lyell Street catchment instead of the entire catchment. From the results of the wastewater modelling work completed the potential savings in the order of $1.1M estimated in capital expenditure could offset stormwater improvements within the Lyell Street catchment.
- By investing approximately $120k in initial investigations (Stantec and subcontractor fees) HDC is potentially able to save $1.1M in capital costs and further ongoing operational savings due to the resulting smaller pump stations from I+I reductions.

4 INFLOW AND INFILTRATION REFINEMENT

HDC then split the recommendations resulting from the Master Plan into two directions. Stantec was engaged to complete the detailed design of the pipework and infrastructure, while the I+I investigations were refined in a series of HDC subcontracts. The following sections summarize those subcontracts and the outcomes.

4.1 DISTRIBUTED TEMPERATURE SENSING (DTS)

City Care Ltd was engaged by HDC to complete an I+I assessment of the areas identified in the Master Plan. Distributed Temperature Sensing (DTS) technology was utilized. This technology involved installing fibre optic cable throughout the identified catchment pipes and monitoring of the water temperature differences before, during, and after rainfall events.

4.2 CUSTOMER SURVEYS

HDC and Opus developed a questionnaire that could be given to residents to complete following a large wet weather event. Follow up site visits were then completed if required.

They have now developed a GIS platform to hold the information collected via questionnaire and subsequent site visits. HDC's plan is to merge the information from the DTS survey with the site visits to identify any focus areas for further investigation.

4.3 OUTCOMES

The above processes are still underway at the time of writing this paper. The initial outcomes from the further refinement process have indicated that the initial Master Plan estimate focus areas were correct ensuring that resources focused on areas that would prove to provide the biggest returns in terms of investment.

5 CONCLUSIONS

So, what did HDC end up with at the end of this Master Planning process we undertook over a series of months? Effectively, it was a verified Master Plan complete with step by-step infrastructure upgrade requirements to help fix this multi-faceted problem. This Master Plan then enabled the Council to stagger the capital investment over a number of years.

The analysis behind the Master Plan wasn't a perfect representation of the network – in places it is fairly course. However, it was a cost effective way for focusing resources on the infrastructure investments that would prove to have the biggest returns and impact on fixing the poor level of service experienced by the ratepayers.

At the time of writing this paper we are about to complete the first phase of detailed design with construction expected to commence at the start of 2019.

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