HAMILTON CITY 3-WATERS INFRASTRUCTURE STRATEGIES – MASTER PLANNING IN THE FACE OF UNCERTAINTY

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ABSTRACT

Hamilton City is one of New Zealand's fastest growing metropolitan centres with population increasing at around 2.3% per annum. Strategic infrastructure planning and delivery is critical to enabling growth in a manner that protects and enhances the Waikato River and the natural environment whilst being affordable.

Hamilton City Council (Council) has recently delivered Master Plans for water, waste water and storm water infrastructure. These Master Plans provide roadmaps for future investments in Hamilton's 3-Waters infrastructure. They are keystone documents for short and long-term funding decisions involving a combined capital investment of more than $670 million over the next 10 years.

The Master Plans seek to recognise the social and cultural significance of the Waikato River and acknowledge the importance of the Waikato River to Hamilton City including in the provision of water services. In delivering the master planning programme, tools and methodologies have been developed from which to base future Master Plan revisions thus supporting agile strategies and investment plans.

This paper offers insight into the methods and tools used to support delivery and implementation of the Master Plans and recommended capital works programme. The challenges and uncertainties faced are presented along with tactics employed to achieve nimble infrastructure strategies able to accommodate change in key inputs and assumptions such as growth projections, environmental targets, levels of service and organisational structure.

KEYWORDS

3-waters infrastructure, strategic planning, master planning

PRESENTER PROFILE

Jackie Colliar is an Infrastructure Engineer – Waters at Council. She has over 15 years' engineering experience having worked as a consultant engineer, project manager and researcher in both the public and private sectors. Jackie has project managed the Wastewater Master Plan in parallel with several strategic wastewater infrastructure projects since joining Council in late 2015.

Andrea Phillips is an Infrastructure Engineer – Waters at Council, where she has worked in various roles over the last 12 years'. She has project managed the Stormwater Master Plan, is programme manager for Integrated Catchment Management Plans along with being involved in various updates to Hamilton stormwater guidelines.

Glenn Boyd is an Infrastructure Engineer – Waters at Council, where he was worked for the last 13 years in different roles including project managing Version 2 of the Water Master Plan. Previously Glenn has also worked in the construction and surveying industry, for the Thames Coromandel District Council (3 years) and MWH (5 years).

1 INTRODUCTION

Hamilton City is one of New Zealand's fastest growing metropolitan centres with population increasing at around 2.3% per annum. Along with this growth comes an increased demand on the City's infrastructure. This requires the city to plan well and to make sure that cost effective and productive infrastructure is available to enable it to function and prosper.

Hamilton manages its growth through several key landuse and financial documents:

- The Hamilton Urban Growth Strategy (HUGS): sets out the future growth of the city.

- The Hamilton City District Plan: Council's urban planning response that locks in the growth strategy through the Resource Management Act 1991.

- Growth Funding Policy: enables developers to provide infrastructure ahead of time so Council's inability to debt fund infrastructure does not unduly restrict development.

- The 10-Year Plan: provides the budget and clarity on what and when projects will be funded by Council and is prepared in accordance with the Local Government Act 2002 (LGA).

The 10-Year Plan is largely informed by a combination of the following two documents:

- **Activity Management Plans (AMPs):** AMPs are prepared for each infrastructure type. The AMPs contain the strategies and approaches (both financial and technical) used over the whole life of assets to manage them in the most cost-effective manner to provide a specific level of service.

- **30-Year Infrastructure Strategy:** In addition to a 10-Year Plan the LGA requires Council to prepare a 30-year Infrastructure Strategy. Councils Infrastructure Strategy is an indicative estimate of Hamilton's future infrastructure needs, a statement of current assumptions and thinking on what infrastructure issues Hamilton is likely to face in the future and how Council is currently planning to respond. Conceptualising what infrastructure may be required beyond the 10-Year Plan provides decision-makers with robust information for considering Council's infrastructure and finances sustainable over the long term.

Alongside the need to respond to faster than planned and unplanned growth, legislative and community needs and expectations are changing. Infrastructural and environmental resilience, reliability, improvement and enhancement are required and expected. Reliable and sustainable water supply and wastewater systems are vital to the social, economic and environmental well-being of Hamilton.

There is greater recognition of the importance of the Waikato River and ensuring healthy waterways, driven by the Regional Policy Statement, Regional Plan (including the Healthy Rivers Plan Change), Vision and Strategy for the Waikato River, and the National Policy Statement for Freshwater Management.

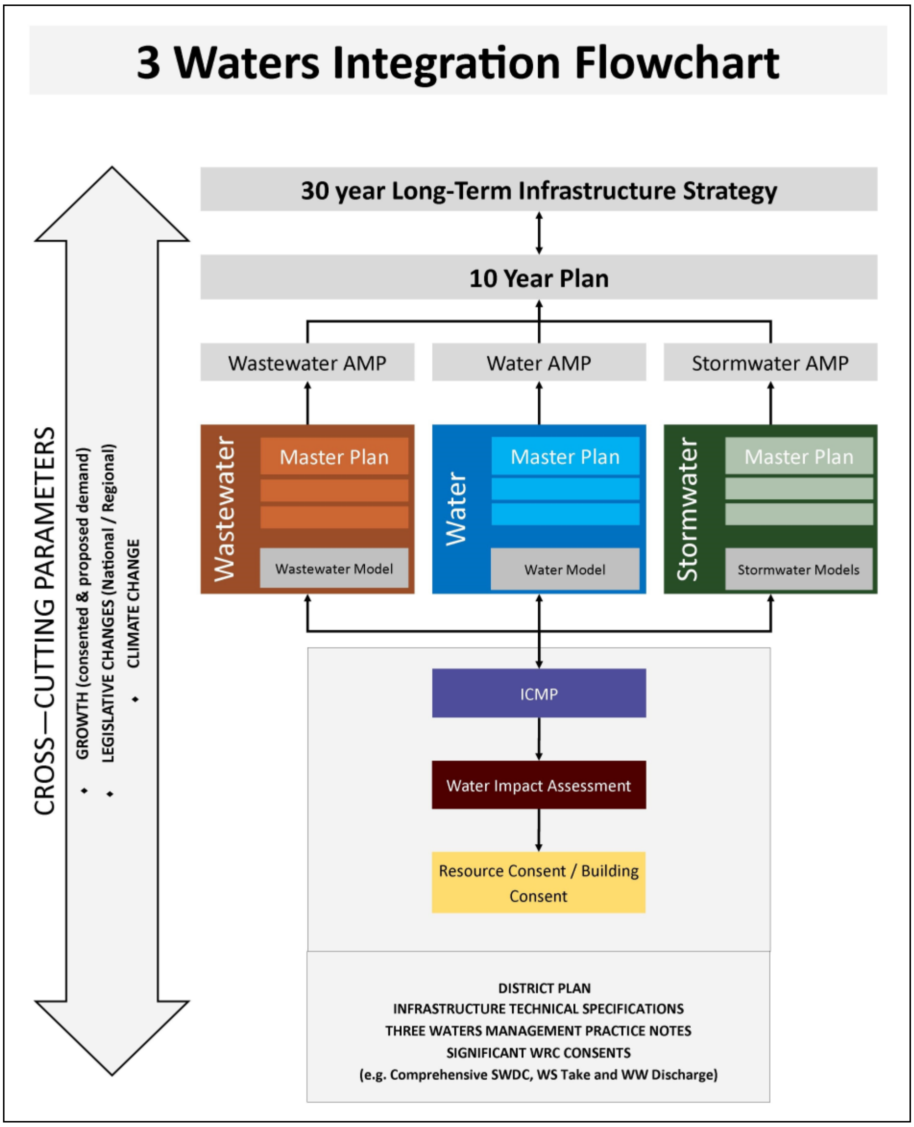
The pressures to service growth, respond to legislative drivers, inform the 10-Year Plan, 30-Year Infrastructure Strategy, and maintain levels of service to existing and new customers has led to the development of the Master Plans for water, wastewater and stormwater.

2 CONTEXT

2.1 DOCUMENT INTEGRATION

The flowchart provided in Figure 1 illustrates how the Master Plans fit within the wider land-use, infrastructure, and funding plans, consents or standards that are prepared, held by, or administered by Council. The relationships shown in Figure 1 are complex, evolving, and are influenced significantly by national and regional requirements, growth demands, and a changing physical and natural environment (including climate change).

Figure 1: Integration of 3 Waters Documents



2.2 MASTER PLANNING OBJECTIVES

Common objectives for all three Master Plans include:

- Delivering user-friendly, fit for purpose, agile and defendable Master Plans (and supporting implementation tools) to an suitable level of detail to satisfy Council

Business Case requirements and inform future 10-Year Plan, 30 Year Infrastructure Strategy, and AMP updates;

- Establishing a framework for strategic infrastructure planning and development that provides for revision and evolution of the Master Plans to ensure they remain relevant in the future e.g. can be adapted to respond to actual growth rates, revised growth projections, regulatory and consenting compliance, and changes to and level of service and legislative ;
- Providing a platform to record assumptions and provide clarity around infrastructure proposals developed to support the 10-Year Plan and 30 Year Infrastructure Strategy, including associated uncertainties, risks and any further investigation and verification actions required; and
- Influencing all levels of our water infrastructure business by involving appropriate internal stakeholders at the right times and at the right levels to ensure the Master Plans are relevant to them and that they reflected (or acknowledge) their respective experiences and needs.

Objectives specific to the Water Master Plan (WMP) include:

- Decoupling the water treatment plant (WTP) from day to day network operations to improve network resilience and simplify operations;
- Optimising energy use;
- Integrating with the other water network management strategies, e.g. Water Loss Strategy & Operational strategies;
- Optimising and fully automating the current reservoir control approach; and
- Exploring synergies between the WMP and the WTP capacity to minimise WTP flow fluctuations for each design horizon by maximising network reservoir use and de-coupling the plant from daily demand.

Objectives specific to the Stormwater Master Plan (SMP) include:

- Providing a high level understanding of existing and potential future stormwater quantity and quality characteristics and associated effects ; and
- Enabling efficiencies in carrying out stormwater management activities including supporting the development of stormwater catchment management plans.

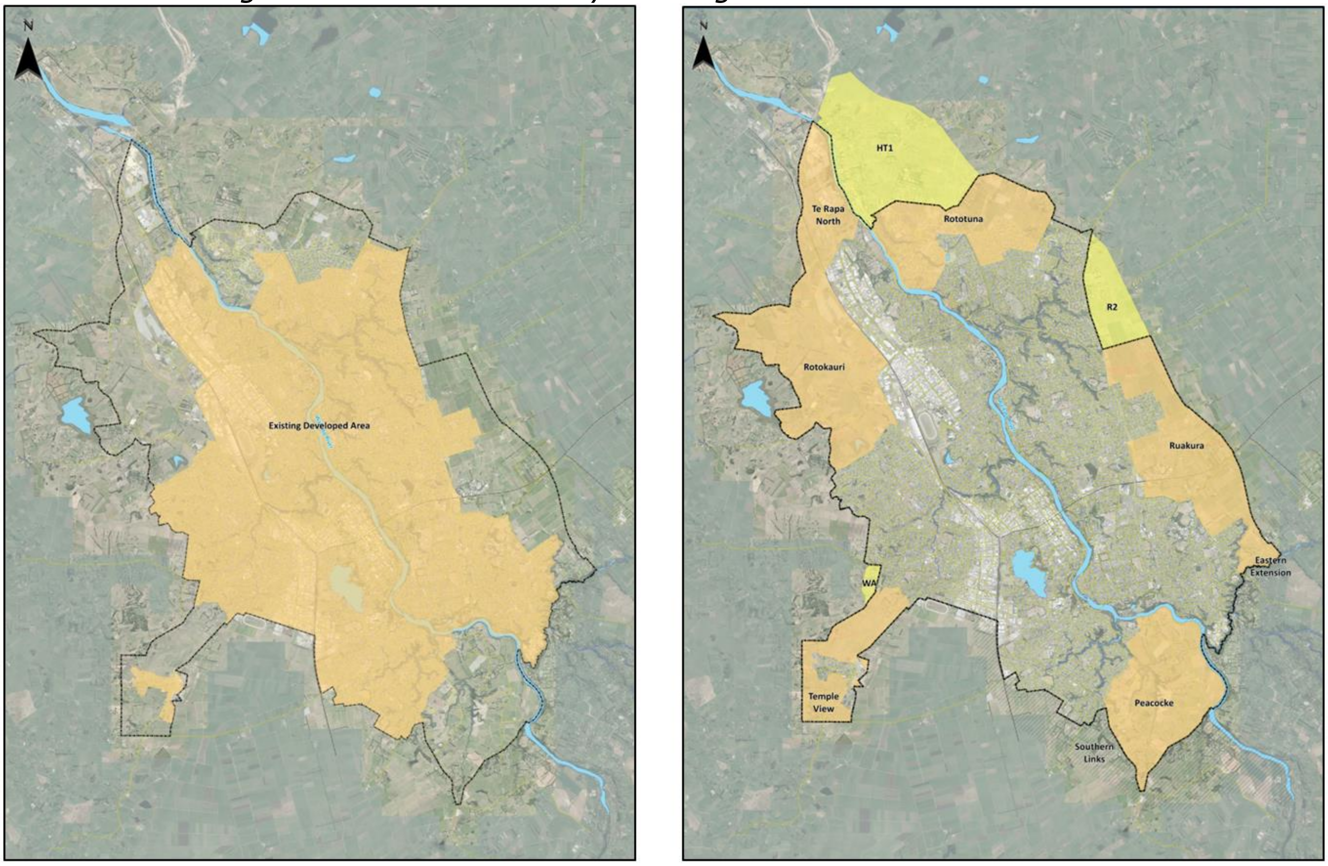
Objectives specific to the Wastewater Master Plan (WWMP) include:

- Extending network planning from the strategic interceptor level to include trunk network performance and interventions; and
- Applying new methods to evaluate and prioritise capital works.

2.3 POPULATION GROWTH

The 3-Waters Master Plans provide strategies for servicing existing and projected growth. Existing and future growth areas of Hamilton City are shown in Figure 2. A summary of the design horizons and population equivalent figures that the Master Plans are based on is shown in Table 1.

Figure 2: Hamilton City Existing and Future Growth Areas



R2 – Ruakura Stage 2, HT 1 – Horotiu Stage 2, and WA growth cells are located outside the current Council jurisdictional boundary. A strategic agreement with Waikato District Council is in place to provide for the future boundary adjustments.

Table 1: Hamilton City Future Population Projections

Area Name	**Current Development PE**	**Projected Population Equivalent (PE)**				**Development**	
		2021	**2041**	**2061**	**City Full**	**Start**	**End**
Existing	145,700	140,200	151,700	163,100	163,100		
2015 Intensification	3,500	4,800	9,000	9,900	23,000		
ROTOTUNA	1,300	24,800	30,200	30,200	30,200	2011	2029
RUAKURA (STAGE 1)	200	2,900	8,500	17,000	18,500	2011	2066
NORTHERN EXTENSION	1,000	1,100	1,800	2,600	8,000	2011	2185
PEACOCKES	300	1,000	14,500	25,400	25,400	2013	2055
ROTOKAURI	400	3,200	9,800	18,200	27,300	2014	2100
EASTERN EXTENSION			100	200	700	2016	2185
TEMPLE VIEW FUTURE	100	600	2,100	3,700	15,500	2016	2210
R2 - RUAKURA STAGE 2	100	100	100	1,200	9,100	2058	2090
HT 1 - HOROTIU STAGE 2	400	400	400	400	32,300	2073	2115
WA					1,000		
TOTAL	**153,000**	**179,100**	**228,200**	**271,900**	**354,100**		

All population projections have been rounded. The population projections and timing for growth cells are sourced from the 2015 Wastewater Model. Council is currently updating population projections.

3 METHODS & TOOLS – WHAT WE DID & WHY WE DID IT

3.1 COMMON APPROACHES

3.1.1 MASTER PLANNING PROGRAMME TEAM

The Council staff members leading the development of the Master Plans are a tight knit team with complementary skill sets and an acute understanding of the needs of the various internal and external stakeholders. Each has experience across all 3-waters infrastructure. Delivering the three Master Plans concurrently as part of a single team has ensured consistency with assumptions and inputs (e.g. growth and land use assumptions), cost assessments, and messaging to key stakeholders and decision-makers. The programme team structure has also delivered efficiencies through joint development and implementation of common methods to collect, manage and maintain data.

The team structure and approach has also enabled engagement with key internal stakeholders to be planned and timed to be more manageable for those stakeholders who are dealing trying to balance significant workloads and commitments.

3.1.2 INTERNAL STAKEHOLDER ENGAGEMENT

Internal stakeholders play an important role throughout the process. A range of Council staff were involved throughout the process, from formulation of objectives to obtaining data, endorsement and implementation. As an example of the value added, during initiation work it was apparent that not all necessary data was available (e.g. private device mitigation). This led to internal workshops to form a new process to collect this information through the building consent process. In another situation some data was not available in the required format, leading to updates and new processes to collect the data in a meaningful way, such as the new geospatial layers and schemas for information on publically vested devices.

Workshops were held with staff to ensure there was a 'human eyes' element that confirmed findings and helped with prioritisation. In some cases, various Council units were working on projects with similar objectives (such as proposed riparian planting or culvert upgrades requiring fish passage).

It was also important that all stakeholders understood the scope of the master planning projects and what was not being considered as part of the project. This ensures we avoid duplication of effort and missed opportunities achieving multiple outcomes and benefits.

3.1.3 EXTERNAL STAKEHOLDER ENGAGEMENT

Direct external stakeholder engagement was not carried out as part of developing these Master Plans due to the timeframes involved. The Master Plans are 'living' documents that recommends active engagement with the Regional Council, development community, tangata whenua and the public for future revisions.

3.1.4 INDEPENDENT PEER REVIEW

Independent peer reviewers contributed to the development of each Master Plan. This included providing input and direction from project initiation to delivery of the final Master Plan documents and recommended works programmes.

Having independent peer reviewers involved throughout the process was a way to ensure the Master Plans produced are, robust, defendable and fit for purpose.

3.2 WATER

The Water Master Plan (WMP) looks at three strategic milestones (2021, 2041, and 2061) and a fourth "city full" scenario. These will be used to plan peak flow and storage upgrades at the WTP and all major water network developments within Hamilton. Servicing opportunities for neighbouring Councils are also identified.

Version 2 of the WMP further develops high level assumptions, objectives and recommendations provided by Version 1 (Mott MacDonald 2015), specifically to provide the necessary detail for the creation and implementation of a zone based operation that decouples the WTP from network demand.

The zone creation is a key component of the overall WMP philosophy and allows the Water Loss Strategy and other initiatives to be implemented.

Most (93%) of the Hamilton water supply network is operated as a single area (called the Blue Zone). The Blue Zone is serviced by the WTP, five reservoirs and three pump stations. This approach means that the WTP has to be operated to match the immediate demands of connected water customers. This creates a complex operational system making it difficult to fix any problems that arise, undertake significant maintenance, and provide a consistent level of service across the city.

Separating (decoupling) the WTP from day to day network operations by isolating the reservoirs and pump stations is the best methodology to achieve the WMP objectives.

Decoupling is done by splitting the Blue Zone reservoirs and associated pump stations into discrete supply zones. A dedicated bulk main fills the reservoirs in each zone. Isolating each reservoir will provide Council operations ultimate control of each zone and help identify where water loss is happening.

The phases of work to develop and implement the WMP were:

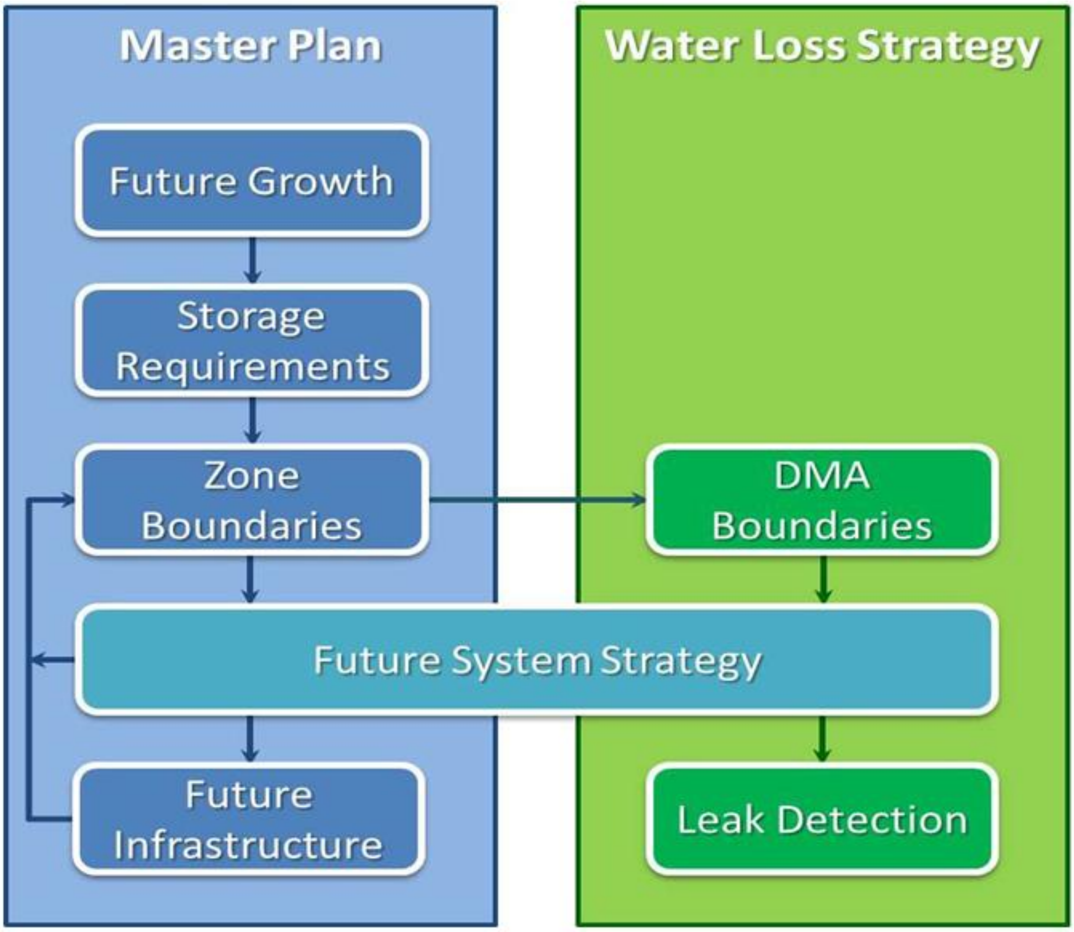
1. Defining assumptions to use for future growth and projected demands
2. Outlining a plan for additional storage requirements
3. Reviewing the issues and available options
4. Preparing a conceptual design of Zone Boundaries and Future System Strategy
5. Preparing a conceptual design of future infrastructure
6. Verifying the WMP
7. Maintaining the WMP
8. Preparing an Implementation Plan for each Water Supply Zone
9. Outlining Assumptions and Limitations

Councils detailed water network hydraulic model is used to guide various master planning phases. The overall work flow diagram of the WMP document and how it is linked to Councils Water Loss Strategy is shown in the Figure 3 below.

The demand management area (DMA) boundaries proposed in the Water Loss Strategy are largely based on the zone delineation recommended in the WMP and any changes to the delineation of these zones impacts on both documents.

The future system strategy needs to be common for the two documents to ensure consistency in the projects approach and in their outcome.

Figure 3: Water Master Plan Methodology and Synergies with DMAs.



3.3 STORMWATER

The process for preparing the Stormwater Master Plan (SMP) has been significantly different to the WMP and Wastewater Master Plans (WWMP). This is because:

- The WMP and WWMP were version 2 documents with existing citywide models, methods and tools to draw from. The SWP is the first version, so methods and tools were developed in parallel to data was collation and interrogation.

- Rather than having a single existing treatment facility (e.g. WTP for Water), there are 16 hydrological catchments with a variety of receiving environments with different values, and hundreds of existing or proposed management devices.

- Unlike water and wastewater which are very dependent on population demand assumptions, stormwater is very dependent on impervious cover and landuse types. These datasets, along with others, needed to be collated and refined as key inputs.

The SMP project developed five key peer reviewed methodologies to allow analysis of data and inform outputs. These related to: the geometric network, contaminant load and treatment, watercourse management, overland flowpath and flooding, and network management. These are briefly described in the following sections.

3.3.1 GEOMETRIC NETWORK

The geometric network was built from existing Council drainage network features with additional drainage lines extracted from a digital elevation model. The majority of the analysis of the SMP was done using the geometric network (also known as a connectivity network) in GIS. The rationale for using a geometric network is to take advantage of its connectivity and directionality functions. These allow attributes to be accumulated along the network, in the downstream direction, so that impacts on receiving environments and the effects of mitigation measures can be better evaluated.

3.3.2 CONTAMINANT LOAD AND TREATMENT

A citywide contaminant load model was developed using the geometric network and hydrology tools. This defined the total annual loads and relative annual average concentrations to target locations where water quality treatment should be investigated and/or implemented.

The stormwater generated from development in greenfield areas in Hamilton are expected to be treated to at least the minimum of HCC Infrastructure Technical Specifications (ITS) standards and are generally reviewed and amended in response to catchment management planning and consenting application findings. Particular focus was therefore given to the brownfield areas of which less than 20% receives some level of treatment. Brownfield areas with commercial and industrial land use areas, highly trafficked roads and isolated catchments at the headwaters of watercourses were considered. Over 35 sites were identified as opportunities for improvement and requiring further assessment, with the intention of verifying and implementing new water quality improvement projects.

3.3.3 WATERCOURSE MANAGEMENT

The Watercourse Management of the SMP describes Hamilton City's streams and defines management priorities and principles. The network of open watercourses within the city limits has been compiled into a continuous network that takes into account stormwater pipes and culverts that convey stormwater. this creates a new geospatial information dataset for Council. This was achieved by compiling disparate existing datasets, modifying where appropriate and adding catchment context from outputs and analysis derived from the Geometric Network, such as connected impervious.

This part of the SMP found that the streams in Hamilton City range from rural drains through to minor disturbed natural channels which still retain high biodiversity values. Seventeen native and nine exotic fish species have been recorded and MCI quality thresholds range from Poor (severe enrichment) to Good (mild pollution), with no sample results indicating Excellent water quality. In response, potential projects were identified including riparian improvement, naturalisation, bank erosion remediation and fish barrier remediation.

3.3.4 OVERLAND FLOWPATHS AND FLOODING

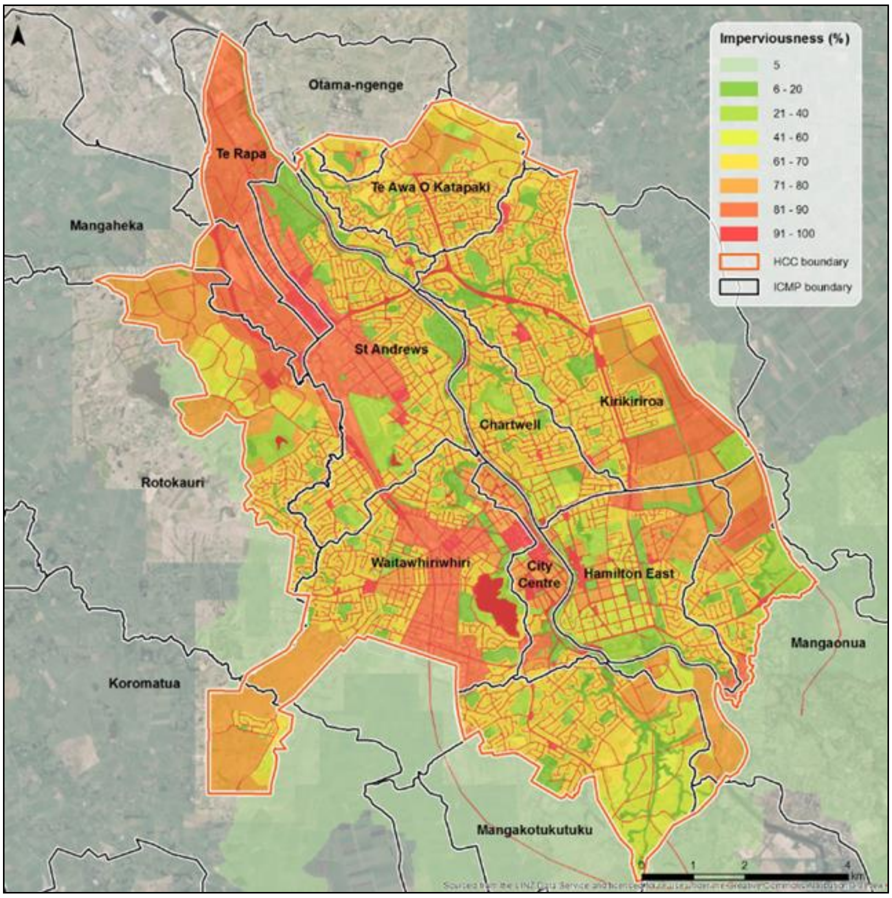
A number of citywide datasets were developed as part of the SMP to aid in the understanding of flooding. These include a Digital Elevation Model, Overland Flowpaths (OLFPs), a Future Impervious Surface Layer, and Building Footprint Layer.

At a coarse city wide level 12% of buildings within the City intersect with an OLFP, and 28% are within in the extent of a 1% AEP flood event. This analysis provides a conservative estimate which, through detailed modelling, is expected to reduce significantly. Detailed modelling will continue through the development of Integrated Catchment Management Plans (ICMP) aligning with Councils updated Stormwater Modelling Methodology (version 2, draft) and will begin to consider mitigation options. The SMP recommendations include the need to define level of service and policy positions regarding flood hazards and risk.

3.3.5 NETWORK MANAGEMENT

Hamilton City is serviced by an estimated 14,565 underground pipes and culverts with a total pipe length of more than 675 km designed to collect and convey surface waters. Understanding and protecting the function and performance of these networks is important. Geospatial layers including curve number overlays and a future impervious layer (as shown in Figure 4) were developed to aid with future citywide scale assessments.

Figure 4: Network Management Geospatial information example - Future Impervious Layer



3.3.6 PROJECTS DATABASE TOOL

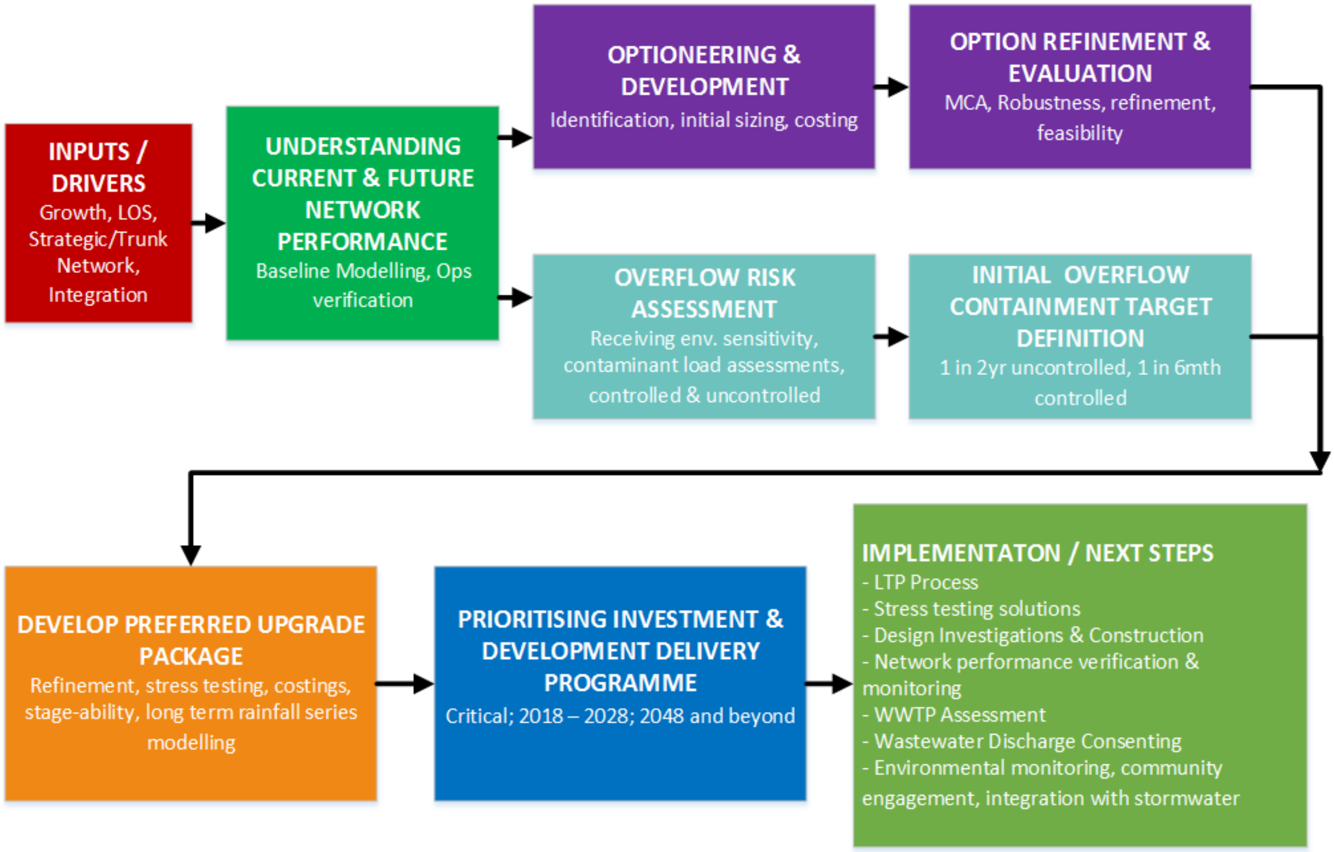
The main tool emerging from the SMP is a Projects Database representing how (and where) Council can better manage the stormwater network and its associated impacts. The data was analysed by reviewing the spatial layers together to look for these opportunities. The projects identified include growth requirements, stream enhancement works (to improve ecological function), treatment improvements, and investigations into flooding. The actions assigned to each of these projects range in status from scoping to options assessment and detailed concept design components. To manage this information and provide a robust reporting platform, a Projects Database has been designed and populated. The Projects Database has a spatial reference (to an associated polygon) indicating the site or area related to the project record.

3.4 WASTEWATER

The Wastewater Master Plan (WWMP) builds on an earlier version of the WWMP (AECOM, 2015) that was developed to help inform high level long term funding decision making. The earlier work provided a precursor to a fuller technical assessment of future network and strategic infrastructure needs i.e. WWTP, interceptors and associated pump stations.

The overall methodology used to deliver the 2nd Generation WWMP is illustrated in Figure 5 below. Key tools and approaches used are further described in the following sections.

Figure 5: Wastewater Master Planning Process



3.4.1 MODELLING CURRENT & FUTURE NETWORK PERFORMANCE

Councils calibrated wastewater model is a key asset used to understand network capacity deficiencies over specified future design horizons and to test and develop potential upgrade options.

The detailed hydraulic model of the wastewater collection system was developed in two stages as part of an earlier four-year project. The most recent version of the model is an all-of-pipe model that has been calibrated and verified to a network of flow meters and rain gauges to confirm parameters for both dry and wet weather flow generation.

The current level of accuracy for the model is considered appropriate for WWMP purposes, and was used to identify and understand network capacity deficiencies during the current (2015), 2041, and 2061 planning horizons.

3.4.2 OPTIONEERING & OPTIONS DEVELOPMENT

Over 100 initial upgrade options were developed as part of the WWMP process. The Optioneering process was carried out in parallel to a risk based assessment. Options were developed to mitigate high-risk overflows and manage projected growth. The initial upgrade options considered interceptor extensions, pipe and pump upgrades, diversion and duplicate sewers, bulk storage facilities, overflow screening and gross pollutant removal systems, and wet weather management at the WWTP. The potential benefits of large scale Inflow and Infiltration (I/I) reduction programmes and alternative reticulation methods (i.e. systems with reduced design I/I parameters) were also considered as part of the WWMP project.

The WWMP options were modelled through an iterative process, using single-event simulation to develop initial sizing. Modelling scenarios were then developed to compare the performance of different upgrade options and to refine the sizing and extent of infrastructure to address the high risk overflows. The modelling was initially undertaken based on City Full design horizon to assess the maximum population/development condition of Hamilton City, and to develop preferred upgrades and phasing with consideration of long term infrastructure planning outcomes.

3.4.3 OVERFLOW RISK ASSESSMENT

The impacts of wastewater overflows were analysed to inform the WWMP process. This approach is consistent with recent industry trends and best practice, and increases the likelihood that capital investments yield an appropriate level of benefit for the community. Watercare and Sydney Water have both utilised overflow risk assessments to inform their wet-weather overflow mitigation strategies. In addition, aligning the wastewater capital works programme with the overflow risk assessment approach enables Council to manage overflows in a more effective manner.

Impacts were assessed for both designed (pump station overflows) and uncontrolled (Manhole overflows) discharge locations using traditional metrics of spill frequency and volume, as well as an assessment of the risk of effects (e.g. proximity to a watercourse). The assessment was conducted for both existing (2015 population) and future (2061 population) conditions using the following:

- Calibrated/verified hydraulic model;
- Operational knowledge;
- An initial desktop assessment of the risk of effects of pump station overflows for:
    - Public health impacts
    - Environmental impacts
    - Aesthetic impacts
    - Cultural impacts
- The potential for benefit of reducing pump station overflows as compared to other sources of pollution from stormwater runoff;
- An Initial desktop assessment of the risk of community impacts of uncontrolled overflows (e.g. Manholes); and
- An assessment of the relationship between annual spill frequency and annual overflow volumes (for both pump station overflows and uncontrolled overflows).

The purpose of this holistic assessment was to inform:

- The development/refinement of overflow mitigation options including:
    - assurance that options will deliver targeted outcomes/agreed community benefits
    - agreed basis of concept designs
    - prioritization/timing of options implementation
    - staging
    - cost estimates
- Council's strategy for consultation and consenting of wastewater overflows.

The completed analysis represents an initial high level assessment sufficient for development of WWMP options. More detailed assessments will be conducted to support Council's journey toward obtaining network discharge consent(s), and the detailed designed of preferred upgrades. Going forward Council will look to refine and optimise wastewater overflow mitigation measures against other pollution control options to maximise benefits to the community.

3.4.4 OVERFLOW TARGET DEFINITION

As a result of the baseline network performance modelling, optioneering (particularly initial upgrade sizing) and overflow risk assessment Council adopted a conservative target level of service (commonly referred to as "containment target) of one overflow every two years for both designed and uncontrolled overflow points. This conservative level of service was adopted to ensure that feasibility assessments of options like bulk storage facilities are using an appropriate factor of safety and that funding requests through the 10-Year Plan process are sufficient (given the uncertainty around future discharge consent requirements and the results of stakeholder engagement).

As Council further develop a discharge consent strategy and progresses to detailed design for preferred solutions, the final targeted levels of service may vary substantially from a 2-year containment standard, particularly for sites where the risk and potential for benefits are determined to be low. It is likely that in many cases an alternative discharge frequency target may be adopted based on the level of risk and the potential for benefit. More detailed investigations are required to determine this, and will be prioritised on the basis of the initial risk assessment.

3.4.5 OPTION REFINEMENT & EVALUATION

Multi-Criteria Assessment (MCA) was used to evaluate individual options and upgrade strategies (combinations & sequencing of options) and identify the preferred works programme to inform 10-Year Plan decision making. The MCA was used to score each option against a set of 16 key non-price criteria. The criteria included community/social impacts, constructability/operability, flexibility, ability to stage the upgrade and future system resilience.

The results of the MCA were plotted with preliminary cost estimates on one axis and non-price on the other axis. The preferred upgrades were generally identified as the options with the highest non-price score and lowest cost estimate. The preliminary cost estimates were developed from the initial sizes from the previous options development phase.

3.4.6 DEVELOPMENT OF A PREFERRED UPGRADE PACKAGE

The sizing of upgrades was arrived at through iteratively modelling a design rainfall event that was predicted to cause no more than one overflow every two years from the high-risk overflow locations.

The preferred upgrades were modelled further for the 2028 and 2061 design horizons. This work determined the sizing of the preferred upgrades at the 2028 and 2061 horizons, and further facilitated the assessment of stage-ability for the upgrades.

The preferred options were analysed using Long-term Simulation (LTS) modelling, with 10 years of actual rainfall, to further refine the sizing. The LTS modelling output includes overflow results covering the 10-year time series. These results were used to check the hydraulic performance of the upgrades i.e. the actual overflow mitigation (e.g. locations, frequencies). The 2028 design horizon was used for the LTS analysis because it is the upcoming, short-term horizon. This analysis provides an additional level of investigation of the 2028 preferred package of upgrades.

The refined 2028 package of upgrades will be used to inform Council's 2018 – 2028 10-Year Plan review.

3.4.7 CAPITAL WORKS PROGRAMME DEVELOPMENT & PRIORITISATION

The cost estimates were revised for the preferred upgrades using the modified sizes from the LTS modelling work. The prioritisation of the works in the 10-Year Plan Capital Works Programme is based on several key objectives as follows:

1. To mitigate high-risk and high volume overflows in a cost-effective manner. This places priority on works that are good value for money (as measured in dollars per m3 of overflow mitigated);
2. To initiate low-cost upgrades first. This enables the mitigation of multiple overflow locations in a short timeframe for a relatively low cost;
3. To place priority on overflow mitigation at locations that are known to be problematic. These are locations that have been field-verified in the past and receive regular customer complaints;
4. To manage and enable growth within the City. This aligns with Council's strategy regarding housing supply and growth;
5. To consider the interdependencies of individual works. This looks to complete critical path works first to enable the implementation of subsequent works; and
6. To mobilise long lead-time works, such as the larger works and I/I reduction works.

The prioritised list of works, works staging and timing, and cost estimates were combined to develop the capital works programme from 2018 through to City Full design horizons.

The initial risk assessment provides a basis for identifying locations where detailed investigations are warranted. The detailed investigations would include a more refined and detailed analysis of the risks at the locations of concern.

3.4.8 PUKETE WASTEWATER TREATMENT PLANT

The Pukete WWTP is an essential component of the entire Council wastewater system, and therefore options to address wastewater collection system needs must be carefully balanced against interactions with the WWTP. This includes issues and options associated with growth and development, and management of peak wet weather flows.

In parallel to the WWMP (which focuses on collection and conveyance) Council has developed an upgrade strategy for the Pukete WWTP. This includes a series of future upgrades to accommodate growth, as well as changes to peak wet weather flows resulting from recommended options in the collection system master plan such as pipe capacity upgrades, and storage tanks which will mitigate the effects of wastewater overflows.

Council will continue to coordinate and refine options for the collection system and the WWTP as targeted improvements are taken through design and implementation stages.

4 CHALLENGES, RISKS & UNCERTAINTY

Delivering relevant and useful strategic level plans over medium and long-term timeframes is challenging. Dealing with uncertainty is an inherent component of the process. Examples of the key challenges, risks and uncertainties faced in delivering the 3-waters Master Plans and the tactics used to produce nimble infrastructure strategies able to accommodate changing circumstances, objectives and drivers are presented in Table 2 below.

Table 2: Key challenges, risks and uncertainties and management strategies

Population growth, land use changes and timing	
<u>Examples</u>	**<u>Management Strategies</u>**
Population and land-use changes and timing assumptions are fundamental to the master planning process but present significant uncertainty, including: • Potential land use intensification • Uncertainty of land acquisition and/or development scheme plans • Growth pattern and timing changes • Interdependencies with other work streams outside the Master Planning process	Use best available information for modelling activities and document assumptions and limitations Stress testing proposed solutions based on maximum probable development (MPD) / City full / Intensified development scenarios Regularly update / review population assumptions, models, Master Plans and capital works programmes Preparation of ICMPs that are evidence based documents, adopting best practical options for larger developments
Levels of service, environmental standards and legislated requirements	
Wastewater Network Overflow Frequency Target – Council do not have a defined level of service (or containment target) for overflows in the wastewater network target	Adopting reasonably conservative containment targets to inform analysis and funding prioritisation Taking a Risk Management / Effects based approach to prioritisation of investment Providing for external stakeholder engagement – e.g. Waikato Regional Council, Tangata Whenua, as part of implementation programme
Water Pressure at Point of Supply - Council is required (through the ITS) to provide 10m minimum water pressure at ground level at the point of supply but aims to deliver normal operating minimum pressure of 20m (set by the Council bylaw)	Adopting a minimum pressure target of 20m in the WMP process to meet existing customer expectations
Statutory Requirements - Legislation is being updated, such as National Policy Statement – Freshwater, and Heathy Rivers Plan Change 1 to the Regional Plan	Creating an overarching objectives and targets document summarising requirements has been created and can be reviewed as legislation is updated ICMPs and Master Plans are regularly updated
Costs	
The strategic nature of the Master Plans often requires capital estimates to be evaluated at a conceptual level. The concept level estimates are then used to inform 10-Year Plan funding decisions As a result considerable uncertainty exists around the potential costs of recommended works	Where possible conducting a reasonable level of investigation to inform Master Plan updates or project scopes Including reasonable contingencies in the cost estimates Clearly documenting assumptions used to estimate costs Programming work with sufficient lead in time to fully understand technical issues and costs and optimise solutions Grouping of recommended solutions geographically for the 10-Year Plan to enable flexibility in the form of solutions delivered
Affordability	
Agreed 10-Year Plan funding does not match proposed Master Plan timing and the target Level of Service is compromised Affordability and best use of limited funds	Where possible, identifying interim solutions or interventions to manage level of service issues Staging the capital works programmes so they can be adapted to reflect changing circumstances

Knowledge Gaps / Accuracy of Tools / Reliability of data	
As with any modelling exercise, the options modelling for the WWMP has its limitations and a degree of uncertainty including : • Reliability of modelling predictions, including predicted wastewater overflows • How wastewater from undeveloped areas will be serviced and enter the network • The population projections and future increase in I/I The recently completed Initial Overflow Risk Assessment is considered an initial assessment that needs field verification, 'ground-truthing', and refinement to confirm the high-risk overflow sites Changes to the overflow risk scores could affect the composition and prioritisation of the works programme	Utilising calibrated wastewater model as the starting point. Developing trunk wastewater network designs for greenfield development areas. Programming capital works to reflect the confidence in the modelling predictions and overflow risk assessments. Where predicted overflows are not supported by operational observations or data, a programme of network monitoring is the critical next step toward confirming a) if there is a network deficiency that needs to be addressed and b) the scale and form of an appropriate intervention/solution. Progressing investigations and discussions regarding network overflows. Investing in continuous improvement and maintenance of the wastewater model through routine updates and regular re-calibration and network monitoring programmes
The quality and scope of some existing data is not fit for purpose e.g. stormwater monitoring info, device efficiency, rain/flow gauge information	Gather new data or adjustment or reconfiguration of existing data so that it is fit for purpose
Uncertainty of actual flood hazard and risk versus predicted (modelled) scenarios	Ground truthing of modelling predictions including survey field work
Climate Change	
The level of climate change is uncertain but expected to result in more extremes in weather, including increased frequency and intensity of precipitation, and longer dry spells/drought conditions which in turn will impact on water resources Environmental changes the nature and scale of water quality and water quantity effects	Climate change is considered for Stormwater in post development scenarios by applying increased rainfall based on 2.1 Degree Celsius temperature increase Sensitivity of identified wastewater solutions to increased rainfall frequency and intensity is planned as part of implementation of the WWMP Measures that help supplement water sources (e.g. rain tanks) to help alleviate potable water scarcity during dry periods
Internal Resources	
Delivery of three separate Master Plans in parallel placed significant pressure on internal resources, particularly with respect to internal stakeholders ability to meaningfully engage, critique and contribute to developing the recommendations made in each Master Plan	Staggering the various Master Plans key stakeholder engagement dates/meetings to not overload internal staff

5 IMPLEMENTATION / NEXT STEPS

5.1 WASTEWATER

The WWMP identifies $270 million of capital investment in the wastewater reticulation network over the next 30 years. A further $125 million is identified to upgrade and expand the WWTP.

The recommended network upgrades include new interceptors and strategic pump stations, bulk storage facilities, pre-treatment and controlled discharge systems, trunk pipeline and pump station upgrades and flow diversions.

Other recommendations critical to implementing the overall Master Plan strategy (but not included in the capital cost estimates) include:

- Commissioning more detailed risk assessments (including external stakeholder engagement) to optimise overflow mitigation options, confirm appropriate level of service targets and ensure that benefits yielded from capital investments are significant enough to warrant the cost;
- Integrating Wastewater and Stormwater management strategies to optimise community and environmental benefits;
- Expanding I/I reduction works and aligning I/I reduction with asset renewals;
- Providing a policy framework and technical specifications to allow for alternative reticulation methods where appropriate, and to deliver reduced I/I to the overall system;
- Setting funding for upgrading of local reticulation;
- Verifying predicted wastewater overflows through network monitoring (e.g. field observations, such as monitoring surcharge activity at manhole locations where the model indicates current day capacity issues; additional flow monitoring focused in high priority areas; examination of available telemetry data (e.g. pump station operations);
- Model maintenance, verification and sensitivity analysis (using different climate change and population projections) including refining, updating and recalibrating the wastewater model; and
- Regularly reviewing to the WWMP.

5.2 STORMWATER

The SMP makes multiple recommendations covering the following:

- Data investments and procurement;
- Process, policy or procedure development;
- Implementation of operating procedures;
- Monitoring based data collection;
- Development of methodologies in future SMP versions;
- Educating staff in data management processes; and
- Stormwater resources.

The recommendations vary in nature, some are long term projects that need focused project management or significant funding. Over 220 projects are identified, most of which were included within the indicative stormwater funding programme to inform discussion for the 10-Year Plan funding process. Some examples include flow gauging and rainfall data, overland flowpath, creation of a prioritisation matrix to guide project investigation and implementation.

The SMP provides a list of items to work through as funding, resourcing and time allow, which will take some years. Prioritisation of some projects may occur in response to emerging or immediate needs, for example in response to storm damage. The overall stormwater management approach is expected to take several years to embed.

5.3 WATER

The WMP will ultimately drive over $250 million of capital works programmes over the next 50 years with $83 million planned for the next 10 years. Key recommendations include:

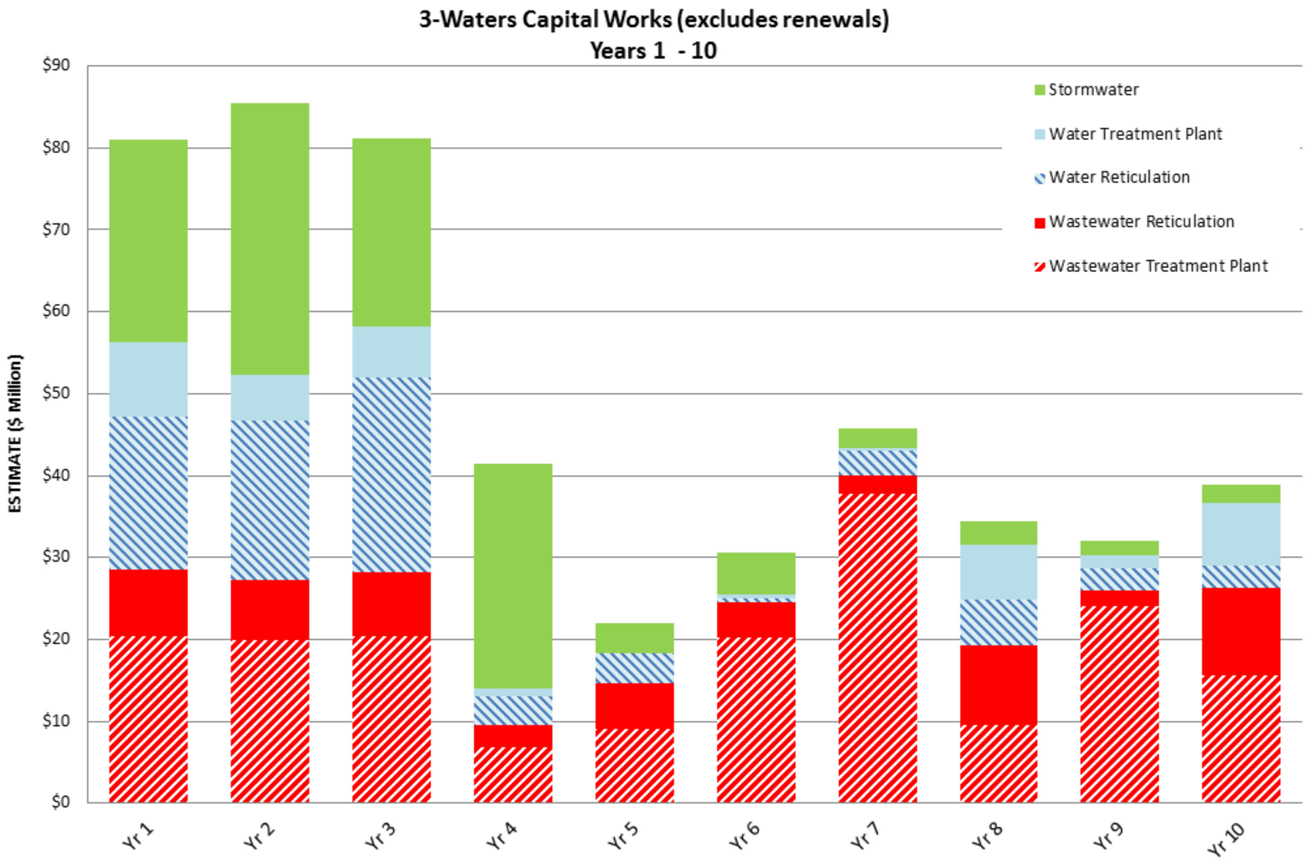
- Implementing a zone based operation to decouple the water treatment plant from network demand by splitting the Blue Zone reservoirs and associated pump stations into discrete supply zones with a dedicated reservoir bulk main;
- Developing a strategic valve check plan identifying key valves that need to be automated and other important valves that need their status tracked (through SCADA or Internet);
- Verifying that the existing pumps are capable of delivering the proposed flow rates and head requirements in the new zones;
- Nominating a dedicated WMP implementation team led by a specified "owner" to meet the tight timeframe provided and to support the delivery of the programme;
- Verifying the status of all key infrastructure before and during the implementation of the proposed zoning;
- Maintaining and reviewing implementation plans before and after the establishment of each proposed zone;
- Providing a detailed project lifecycle breakdown as a separate delivery programme document aligned with the high level strategy to inform the 10-Year Plan. For the purpose of this WMP the project lifecycle has been combined into a single line item associated with a given operational time horizon. These time horizons have been provided and agreed within Council;
- Reviewing the location and feasibility of all proposed brownfield infrastructure; including bulk supply mains, service mains, isolation valves and reservoirs;
- Exploring the feasibility of joint projects with Waikato District Council to rationalise the reservoir network (e.g. eastern reservoirs placement and northern treatment plant planning);
- Exploring synergies between the WMP and the WTP capacity to minimise WTP flow fluctuations for each design horizon by maximising network reservoir use and de-coupling the plant from daily demand;
- Developing a more detailed business case for a new northern treatment plant prior to any further consideration; and
- The Water Demand Management Plan recommendations should be implemented to reduce peak demands and optimise future infrastructure sizing e.g. universal water metering (UWM) and demand restrictions;

5.4 LONG TERM PLAN & 30-YEAR INFRASTRUCTURE STRATEGY

The Master Plans are keystone documents for short-term and long-term funding decisions and recommend a combined capital investment of more than $670 million over the next 10 years (refer to Figure 6).

Affordability constraints and opportunities to smooth out recommended expenditure over the 10-Year Plan period are currently being considered.

Figure 6: Master Plans - Recommended expenditure



6 CONCLUSIONS

The 2nd generation Water and Wastewater Master Plans and first generation Stormwater Master Plan provides a significant amount of background information relevant to the ongoing development and management of 3-waters infrastructure within Hamilton City.

The Master Plans sets out the strategy, priorities and programme of works required to sufficient levels of detail necessary to inform and support preparation of the 10-Year Plan and 30-year Infrastructure Strategy and details the capital investment required to improve system performance and to meet the significant expected growth in the city.

The plans and technical information that the Master Plans are based on provide a solid foundation for further investigation to support future revisions, refinement and evolution of the Master Plans.

The recommended works in each of the Master Plans represent a significant capital investment for Council and ensuring that the basis of those recommendations are sound is critical for meeting the needs of the growing city in an environmentally and financially responsible manner.

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Stormwater Master Plan: Damian Young, Emily Reeves & Barry Carter (Morphum Environmental Limited); Graham Levy (Beca Ltd) – Overall Stormwater Master Plan Project Peer Reviewer

REFERENCES

AECOM, Hamilton City Council (2015) *"Infrastructure Master Plan – Wastewater"*

AECOM (2015) *"Hamilton City Wastewater Model – Model Development and System Performance Report"* for Hamilton City Council

GHD Ltd, Hamilton City Council (2017) "Wastewater Master Plan – Version 2.0"

GHD Ltd (2017a) "*Wastewater Master Plan Version 2 – Overflow Risk Assessment and Containment Target Report*" for Hamilton City Council

GHD Ltd (2017b) "*Wastewater Master Plan Version 2 – Masterplan Investigations Report*" for Hamilton City Council

Hamilton City Council (2012) *"City Waters - Water Conservation and Demand Management Plan"*

Hamilton City Council (2015a) *"2015-25 10-Year Plan - Long-term Infrastructure Strategy 2015-2045"* Volume 2

Hamilton City Council (2015b) *"Activity Management Plans – Water/Wastewater/Stormwater/Solid Waste"*

Hamilton City Council (2015c) *"Hamilton's 10-Year Plan 2015-25"*

Hamilton City Council (2016a) *"Growth Funding Policy"* Version 2

Hamilton City Council (2016b) *"Partly Operative District Plan"*

Hamilton City Council (2016c) *"Three Waters Management Practice Notes"*

Hamilton City Council (2017) *"Infrastructure Technical Specifications"*

Harland Environmental Ltd - Hart R, Hamilton City Council (2017) *"Rotokauri – Integrated Catchment Management Plan"*

Morphum Environmental Ltd, Hamilton City Council (2016a) "Stormwater Master Plan"

Morphum Environmental Ltd, Hamilton City Council (2016b) *"Standard Stormwater Modelling Methodology Version 2 Draft"*

Mott MacDonald Ltd, Hamilton City Council (2016) *"Hamilton City Water Supply – City Wide Strategic Master Plan"*

National Policy Statement for Freshwater Management (2014) Wellington, New Zealand

Thomas Civil and Environmental Consultants (2011) *"Water Loss Strategy for Hamilton City Council"*

Waikato Regional Council (2011), Resource Consent 105279 to Hamilton City Council, *"Comprehensive Stormwater Discharge Consent"*

Waikato Regional Council (2012) *"Waikato Regional Plan"*

Waikato Regional Council (2016a) *"Operative Waikato Regional Policy Statement - Te Tauākī Kaupapa here ā-Rohe"*

Waikato Regional Council (2016b) *"Proposed Regional Plan Change 1 - Healthy Rivers"*

Waikato River Authority (2011) *"Vision and Strategy for the Waikato River"*

Waikato-Tainui Te Kauhanganui Incorporated (2013) *"Tai Tumu, Tai Pare, Tai Ao - Waikato Tainui Environmental Plan"*