HILLSBOROUGH WATER SUPPLY ZONE MASTER PLAN –A COMPREHENSIVE SOLUTION

Marcel Bear (Opus International Consultants), Anna Hadfield (Metrowater)

ABSTRACT

In 2007/8 Metrowater engaged Opus International Consultants to undertake the master planning of the Hillsborough water supply zone in Auckland. This paper presents a case study of the project, focusing on the management tools used and the links to other water supply initiatives within Metrowater and the Auckland region. It demonstrates an integrated approach to water supply planning.

The master plan was guided by the asset management objectives of Metrowater. These were given in the request for proposals and carried through the project to direct the issues identification and option development and selection. This ensured the long term optimal solutions were synchronized with *all* the company objectives.

Metrowater's risk matrix was used to establish the level of risk that is acceptable in key areas (e.g. security of supply) and to assist with the selection of a preferred option. A team approach was adopted at the project outset, involving Watercare and people from across the business including operations and maintenance, planning, modeling and GIS to gain buy-in and support at the project planning stage. This improved the understanding and acceptance of the solutions so they can be more easily implemented.

Metrowater, its maintenance contractor, consultants and Watercare the bulk water provider are improving the management, planning and operation of the water supply system on many fronts, applying a concerted and coordinated effort to raise the standard of service and deliver robust complete solutions.

KEYWORDS

Water supply, planning, modeling, asset management objectives, security of supply, risk, levels of service, management

1 INTRODUCTION

The Hillsborough water supply zone (displayed in Figure 1) is one of the 11 zones that make up the Metrowater reticulation, a reticulation that carries water to over 400,000 people in Auckland City.

The age of the water supply network ranges from pre-1900 to present day, with the usual pipe materials employed in Aotearoa; steel, cast iron, cement lined cast iron, asbestos cement and plastics, plus the ubiquitous "unknown" material. Developing a master plan for the future system development requires the reticulation condition and performance to be assessed, projected into the future and designed for. Completing this task requires consideration of the many facets of network performance, such as;

- providing for the effects of growth,
- providing the necessary fireflows,
- system security of supply and pipe criticality,
- water quality,
- pipe condition and renewal and
- leakage management.

Of the 11 water supply zones within the Auckland Isthmus, previous master plans were completed for all zones between 1993 and 1996, and new master plans were completed for two zones in 2006/07.

The Hillsborough zone has approximately 240 km of watermains with two pressure reduced subzones, two pumped subzones and one gravity fed subzone, all supplied by the regional bulk water supplier, Watercare. It has a current population of approximately 50,000 which is expected to rise to around 80,000 within the 50 year planning horizon.

The master plan for Hillsborough was developed using the asset management objectives of Metrowater as the primary drivers to direct the process. The objectives were translated into system performance measures, which were used to inform option development and assessment. Aiming to satisfy these objectives has addressed (to a greater or lesser degree) all facets of network performance listed above. This is the art of engineering - design based on the best available information.

Figure 1: The Hillsborough Water Supply zone (Hillsborough Water Supply Zone Master Plan, Opus International Consultants, September 2008)

2 OVERVIEW OF THE MASTER PLANNING PROCESS

The Hillsborough water supply zone master plan was completed in two key phases:

- **Phase 1 - Model update, calibration and peer review**

  The existing H_2OMap model was updated with as-builts and asset corrections. Model connectivity and data checks were carried out. A field test plan was prepared and key asset checks carried out, followed by field testing of pressure and flow at 53 locations for a period of two weeks. The model was updated with recent billing (water consumption) information, followed by model calibration**.** An independent model peer review confirmed that the model was robust and fit-for-purpose.

- **Phase 2 - Master plan**

  The model was updated with future demand information with demand horizons of 2007, 2017, 2027 and 2051. Issues were identified within the zone under existing conditions and future demand horizons. Initial options were identified, followed by final options based on a cost-benefit and multi-criteria analysis where required. Four workshops were held on project start-up, and at the end of the issues identification, initial options and final options stages of the project. These communicated the relevant results to the wider team involved with the project.

3 ALIGNING INVESTMENT DECISIONS WITH ASSET MANAGEMENT OBJECTIVES

To maintain performance across all levels of service and optimize zone-wide solutions, investment decisions were linked to Metrowater's asset management objectives (Asset Management Plan, 2007 to 2027, Metrowater). This allowed the identification and prioritization of both planning projects and asset solutions in a consistent manner. The benefits of this approach were as follows:

- To optimize zone-wide solutions based on multi-driver analysis to meet all levels of service and reduce costs in the long term.

- To negate the need for single driver studies through which it is possible to make incorrect asset investment decisions (undersized, oversized or unnecessary assets) and/or compromise levels of service now or in the future.

- To continue to meet levels of service while catering for growth.

Aligning investment decisions with asset management objectives was undertaken at two levels:

- **Prioritizing water supply zones for master planning:** water supply zones were ranked based on the known issues in each zone which were individually scored against Metrowater's asset management objectives (AMP07).

- **Identifying and prioritizing asset solutions based on asset management objectives:** capital and operational solutions for the Hillsborough water supply zone were determined and prioritized based on Metrowater's asset management objectives (AMP07) and targets.

3.1 PRIORITIZING WATER SUPPLY ZONES FOR MASTER PLANNING

3.1.1 REQUIRED FREQUENCY OF MASTER PLANNING

Metrowater adopts a 20 year asset management plan and a 10 year capital works program as its standard deliverables from asset planning investigations. The frequency for updating this information is largely driven by the rate of change or growth within each water supply zone. Metrowater has a rolling program to review (and update as required) the capital investment plans it has developed based on the age of previous plans, significant changes in the water supply zone, changes in the growth forecasts utilized in the master planning as well as business drivers (resources and budget).

3.1.2 PRIORITIZATION OF WATER SUPPLY ZONES

The 11 Metrowater water supply zones were prioritized for master planning based on key drivers reflecting Metrowater's asset management objectives (AMP07). The purpose of this exercise was to identify the 'worst performing' zones based on known issues in the zones.

Hillsborough water supply zone received the highest ranking (poorest performance) due to the comparatively high number of water quality complaints, a large number of critical assets, significant non revenue water issues and

some pressure complaints. The relevant key driver scores for the Hillsborough zone against the Metrowater asset management objectives are given in Table 1.

3.2 IDENTIFYING AND PRIORITIZING ASSET SOLUTIONS BASED ON ASSET MANAGEMENT OBJECTIVES

The development of the Hillsborough master plan was guided by the asset management objectives of Metrowater through incorporating these objectives into the project brief and decision making tools.

3.2.1 PROJECT BRIEF

Table 1 shows the format of the objectives and required outcomes as provided in the Hillsborough project brief to consultants. These were provided to direct thinking and decisions at critical stages of the project as follows:

- To reinforce objectives and 'need for project' at project start-up.
- To focus the issues identification stage to ensure that the issues identified cover all asset management objectives and target areas.
- To direct the option development and solutions to ensure that these resolve all issues and meet Metrowater targets in the long term.

Table 1: Metrowater Objectives (Asset Management Plan 2007-2027, Metrowater) – Hillsborough water supply zone key driver scores, and required outcomes of master plan

<table>
<tr><th>Business Objective</th><th>Metrowater Target</th><th>Hillsborough Zone key driver scores (1-5)*</th><th>Required Outcomes</th></tr>
<tr><td>Objective 1 (Improve public health risk management)</td><td>• Maintain Ministry of Health "a" grading
• 100% compliance with NZ Drinking Water Standards determinants</td><td rowspan="2">5 (Water Quality – Complaints and FACE)</td><td rowspan="2">Water Quality
• Identify areas with potential water quality issues (complaint areas compared with simulation) within the network.
• Review and report on monitoring regime and results and compare with water-age simulation results.
• Identify solutions to water quality issues (both 2007 and 2051) to achieve targets (including system optimization/ configuration).</td></tr>
<tr><td>Objective 2 (Reduce nuisance impact of water quality problems)</td><td>• Fewer than 5.7 complaints per 1,000 customers per year by 2007/08 and 3.5 by 2011/12</td></tr>
<tr><td>Objective 3 (Reduce nuisance impact from water asset failures)</td><td>• <60 breaks per 100 km of watermain per year
• <150 unplanned service interruptions per year by 2007/08 and <130 by 2009/10</td><td rowspan="2">5 (Security of Supply and Criticality Assessment)</td><td rowspan="2">Security of Supply and Criticality
• Identify and confirm security of supply issues and critical assets.
• Identify solutions (both 2007 and 2051) taking into consideration Watercare bulk network criticality issues and proposed changes.

Asset Condition
• Make recommendations on the future requirements for the out of service assets (pump stations and reservoirs) – e.g. return to service or remove based on cost-benefit analysis.
• Review the break history and renewal program and compare against the assets confirmed for upgrade. Confirm assets for renewal under the current and future scenarios.</td></tr>
<tr><td>Objective 4 (Reduce response times)</td><td>• 98% of priority one incidents responded to in less than 75 minutes
• Average duration of an unplanned water supply interruption <3 hrs by 2007/08 and <2 hrs by 2009/10
• >95% of unplanned service interruptions restored within five hours by 2007/08 and >97% by 2009/10</td></tr>
</table>

Business Objective	Metrowater Target	Hillsborough Zone key driver scores (1-5)*	Required Outcomes
Objective 5 (Reduce risk and nuisance impact from low pressure and flow)	• >95% of all pressure and flow tests comply with NZFS requirements (at 100 kPa residual pressure during peak demand times) • 100% of flow tests from a 20 mm service connection are more than 25 l/min and 200 kPa during peak demand times	3 (Fire Flow Deficiency) 5 (Low Pressure Complaints)	Fire flow • Identify areas that do not comply with the fire flow requirements under existing and future demand scenarios. • Identify solutions to fire flow compliance issues and present together with thematic maps. • Consider localized solutions (e.g. on-site sprinklers and reduction in fire hazard and therefore reduced requirement from reticulation) during cost/benefit analysis. Pressure • Identify assets that operate outside the desired criteria for the four peak flow analysis horizons. • Identify solutions for peak flow and pressure compliance requirements. • Consider changes to zone boundaries and location of bulk supply meters as alternative solutions.
Objective 6 (Improve water conservation including by leakage control)	• Reduce citywide leakage to 5,972,000 m^3 by June 2009	4 (Unaccounted-for Water)	Unaccounted-for Water • Consider the potential for pressure management and its effects on burst rates and loss reduction.
Population Growth	n.a.	3 (Population Growth Impacts)	Growth • Consider growth in the assessment and analysis of future system performance, including areas that are not highlighted as growth nodes but may have the potential for development.

Metrowater uses a 1-5 performance grading assessment, where 1 is a minimal and 5 a significant deficiency.

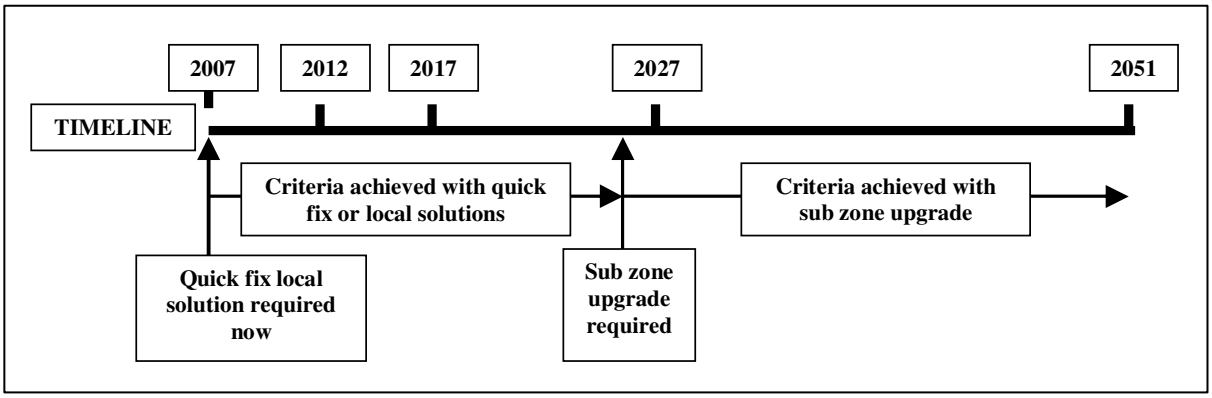
3.2.2 APPROACH TO STAGING OPTIONS

Through the process of developing the zone model and using it to analyze the water supply, an understanding of the issues facing the supply were developed, including when these issues were expected to eventuate. The timing of these issues was used to develop 'just in time' solutions to achieve the most realistic staging of future options, using the following process;

1. Current system deficiencies were identified,
2. Current system deficiencies were analyzed to identify if there were any possible quick fix or local solution that could achieve compliance, without implementing a sub-zone wide option,
3. These quick fix local solutions were recommended,
4. Future horizon scenarios were analyzed with all quick fix local solutions in place, to identify the year that further issues would arise and therefore when an upgrade would be needed,
5. Options for upgrades were developed, considering each sub zone independently, using a cost benefit multi-criteria analysis to identify the optimal solution,
6. The options developed in 5 above were assembled and modified if necessary, to address security of supply considering the zone as a whole.

This process is illustrated in Figure 2.

Figure 2: Option staging example – 'just in time'



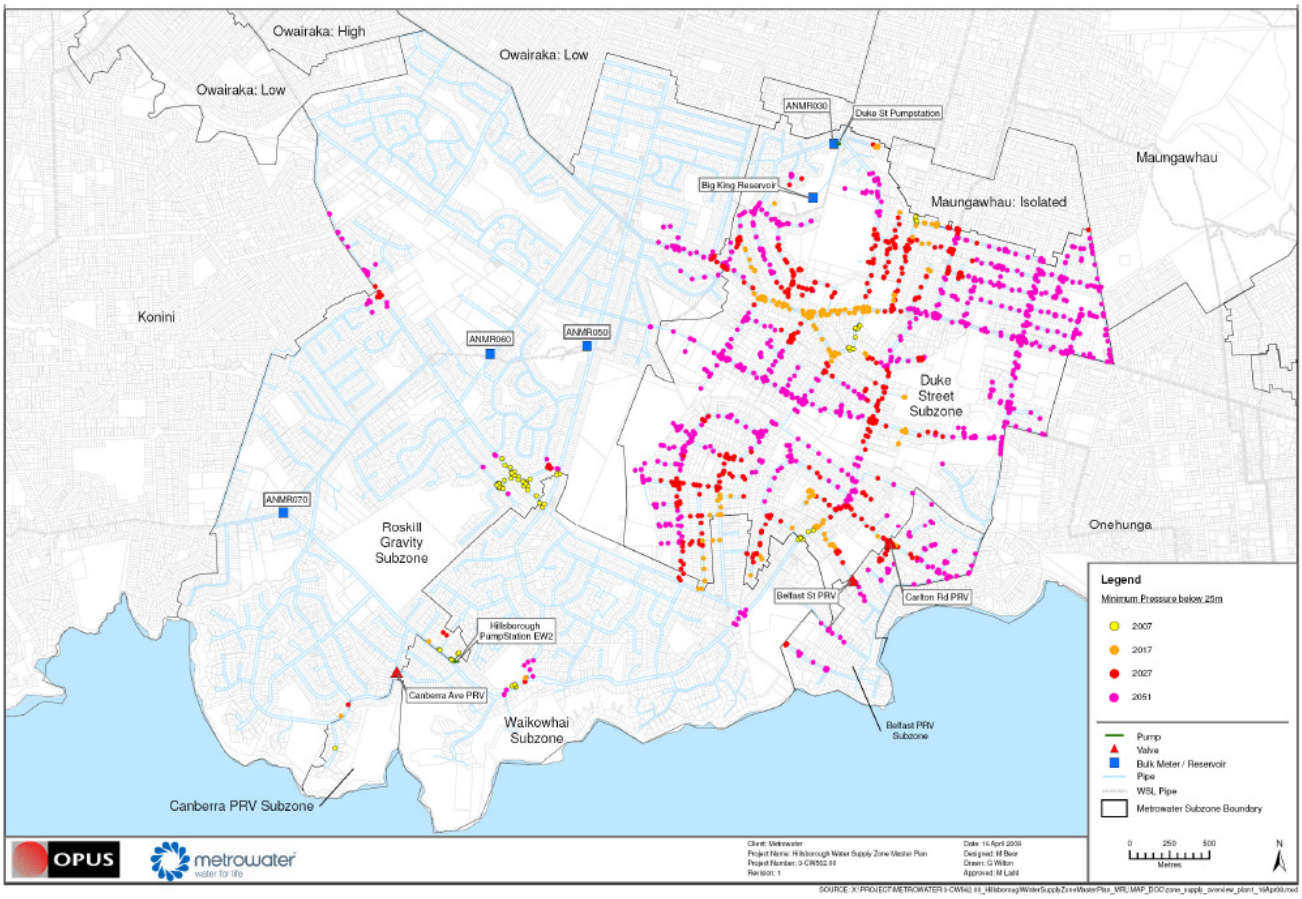
3.2.3 DECISION MAKING TOOLS

The Metrowater Optimized Decision Making (ODM) tool and 10 year investment program link the decision making (options analysis) and project prioritization to the asset management objectives. The ODM tool was used where there was more than one solution to a particular issue based on a benefit-cost and multi-criteria approach. An example of how these tools were used during the Hillsborough study follows:

OPTIMIZED DECISION MAKING TOOL

In the issues phase of the project the Duke Street subzone was found to experience low pressures and fire flow failures over a large proportion of the zone. Pressures of 10 m were recorded during peak demand times in 2017, degrading over time with 'no water' failures by 2027. Figure 3 shows the areas of the zone recording pressures less than 25 m over the planning horizons analyzed in the project.

Figure 3: Hillsborough Water Supply zone low pressure issue areas (Hillsborough Water Supply Zone Master Plan, Opus International Consultants, 2008)



Four options were presented in the initial options phase to resolve all issues such that Metrowater can meet all levels of service now and in the future. Each of these options included a set of solutions, appropriately phased to align with the timing of the issues observed.

The ODM tool was used to direct decision-making based on scoring each option against seven 'effect categories'. The options and scoring is displayed below in Table 2.

Table 2: ODM analysis, Duke Street Options

Option	Levels of Service	Socio-Cultural, Amenity Public Impact	Overall Business Risk	Ownership Management Consenting	Technical Performance Issues	Environmental	Economic Financial	Totals
Max possible score	38	6	13	17	18	8	20	120
Do nothing	23	2	3	17	8	8	20	80
Option 1 – Upgrade delivery main (Arterial Level 2 road), upgrade pump station, retain reservoir.	38	1	10	7	18	8	2	84
Option 2 – Upgrade delivery main (Local road), upgrade pump station, retain reservoir.	38	2	10	7	18	8	2	85
Option 3 – Upgrade delivery main (Local road), upgrade pump station, abandon reservoir.	38	3	13	13	17	8	2	93
Option 4 – Return to service Watercare reservoir, new BSP, new pump station, abandon existing pump station and reservoir.	38	2	13	8	17	8	0	86

The 'Do nothing' option was discarded due to the inability to supply water in the long-term or to meet the Metrowater minimum pressure requirement. The main differentiators between the options were as follows:

- Socio-cultural, amenity, public-impact – Option 3 received the highest score as the Duke Street reservoir will be removed, improving the amenity value of the adjacent park, and watermain construction in the local road will be less disruptive to public.
- Overall business risk – Options 1 and 2 received a lower score due to the higher risk (contamination and leakage) associated with retaining the reservoir.
- Ownership, management and consenting – Option 1 and 2 received lower scores as it was considered that ongoing access to maintain and upgrade the reservoir would be more difficult to obtain than consent to remove the reservoir. Option 4 received a lower score due to the consenting issues associated with Watercare reservoir and new pump station.
- Economic/Financial – Option 4 had the highest cost and hence the lowest score.

Option 3, involving upgrading the reticulation on a local road and abandoning the reservoir, received the highest score and hence is the optimal solution for this sub-zone. Option 3 is displayed in Figure 4 below.

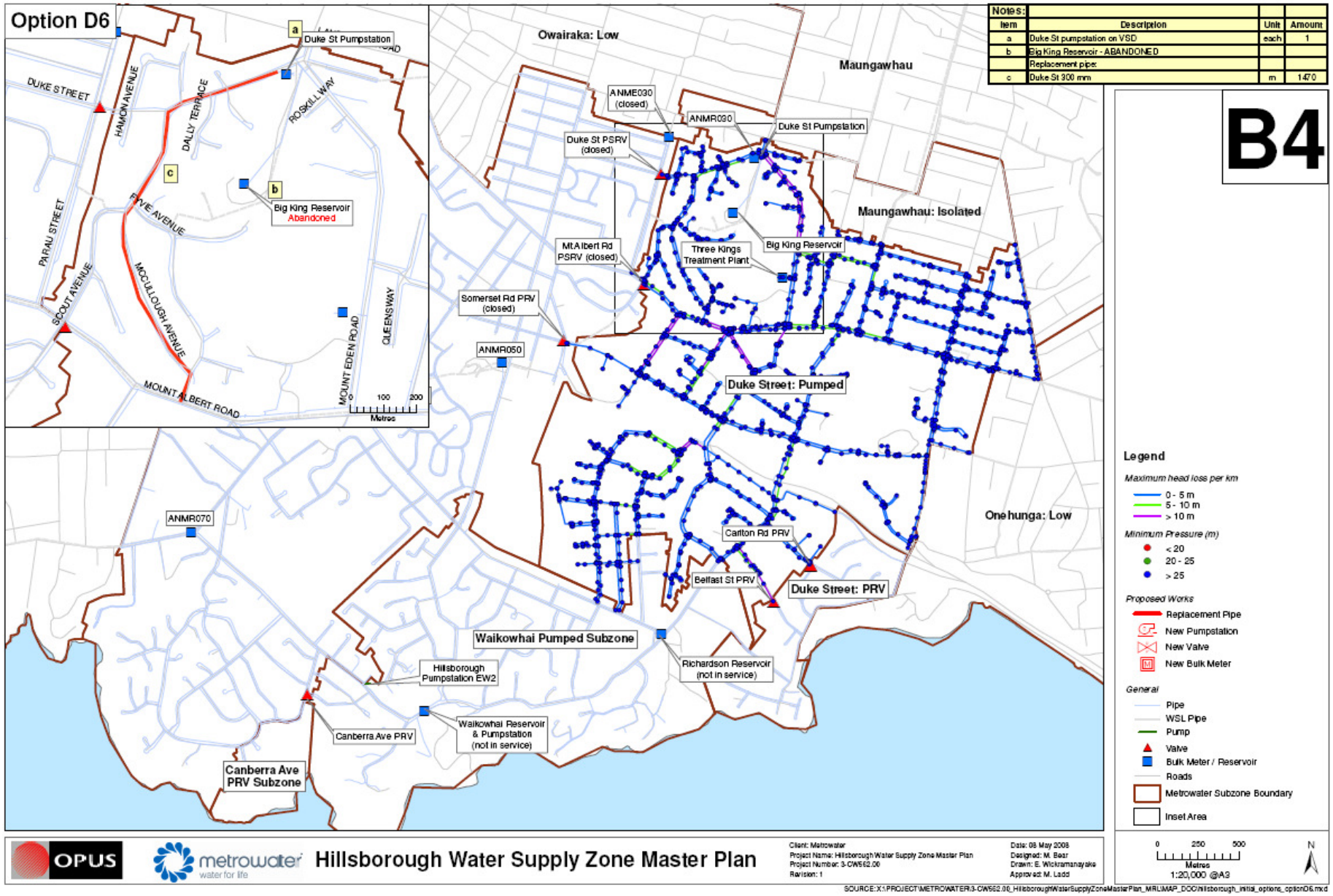


Figure4: Solution Option 3 for the Duke St subzone (Hillsborough Water Supply Zone Master Plan, Opus International Consultants, 2008)

10 YEAR INVESTMENT PROGRAMME

The 10 year investment program summarizes key information for each solution to allow prioritization of the Hillsborough solutions as well as allowing these to be prioritized against solutions for other water supply zones. The information collected allowed for a rudimentary cost-benefit calculation (undertaken through the 10 year investment program) to provide a prioritization of the projects. The information collected included:

- Number of customers water pressure issue resolved
- Number of customers fire flow issue resolved
- Number of customers with improved security of supply
- Enables development
- Linked to a growth node
- Project cost information
- Scheduling factors (dependencies, consent-ability, date required, readiness)

The ODM tool was developed by Metrowater in August 2006 based on the National Asset Management Steering (NAMS) Group guidelines. The Metrowater 10-year investment program tool was last updated in December 2006. Metrowater is currently improving the process and tools by which options are evaluated and capital works are prioritized against asset management objectives, as discussed in Section 5.

4 RISK-BASED ASSESSMENT OF ASSET SOLUTIONS

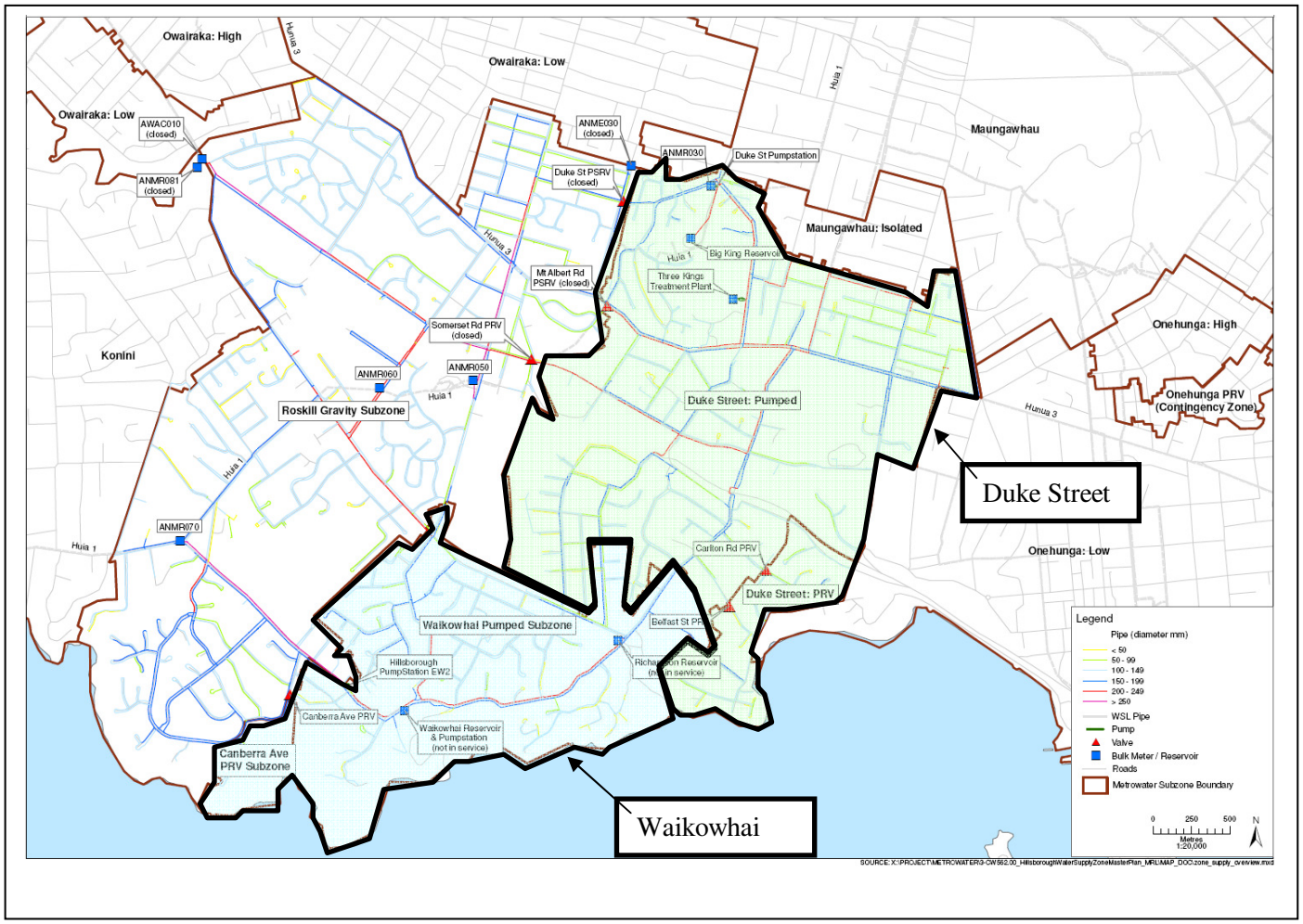
In many cases there is one obvious solution to any given issue and the solution needs to be implemented, for example to meet the Metrowater requirements for supply pressure or fire flow. Other issues, such as providing security of supply (SoS), are more complex and we need to ask the question "how much security is enough"? To provide security of supply to the two pumped subzones within Hillsborough, the Metrowater risk matrix and ODM tools were used to answer this question.

4.1 ASSESSING SECURITY OF SUPPLY USING THE RISK MATRIX

The Hillsborough zone has two pumped subzones; Duke St and Waikowhai. (see Figure 5). These subzones are supplied by pumpstations that provide about 30 m boost to deliver adequate pressure to the elevated areas of the zones. The Duke St pumpstation consists of two pumpsets in a duty/standby configuration, located in an above-ground pumphouse adjacent to a busy arterial road. It has a secure power supply with backup available from the electricity network. There is no onsite standby generation and the associated Big King reservoir provides about 12 hours storage based on the current annual average flow. The Hillsborough pumpstation supplies the Waikowhai subzone via three pumpsets in a duty/duty/standby configuration. These are located in an underground chamber with an adjacent switchboard and control panel above ground, located on a busy arterial road. The site is within the road reserve in a residential area. It has a single power supply from the electricity network and site constraints preclude onsite standby generation. Backup power is provided from a mobile generator located some 8 km away, which is transported to site when required.

Assessing the security of supply (SoS) requirements of the pumpstations was done using the risk matrix, which defined risk as likelihood times consequence. A range of possible events was developed for each pumpstation, considering historical events. These include power outage, low suction pressure at the pump inlet, mechanical failure and accident/truck impact into the pumpstation. Each of these events was assessed and an impact defined using the model and a likelihood developed based on historical performance. From this, the acceptability of these events was defined using the risk matrix.

Figure 5 – Pumped subzones within the Hillsborough zone



4.1.1 THE METROWATER RISK MATRIX

The Metrowater risk matrix is shown in Figure 6. The risk of an event is defined as a combination of likelihood and impact. The likelihood was derived from the expected frequency of the event. The impact of an event was defined using model outputs to establish areas with low or no water and the impact definitions associated with the risk matrix, which categorized the impacts into; negligible, minor, moderate, major and catastrophic. The risk matrix was used to establish the acceptability of these events.

Figure6 Metrowater Risk Matrix

LIKELIHOOD	Minor	Moderate	Major	Extreme
Every month				
2-4 times a year				
Once a year				
One every 2-3 years				
Once a decade				
	IMPACT			

Key	
	Acceptable level of Risk
	Acceptable level of Risk as long as specific controls and monitoring are in place to manage Risk
	May be acceptable level of Risk - Depends on conscious executive decision to accept and acknowledgment risk and implement appropriate controls and monitoring to manage Risk
	Not acceptable and we must try and stop/reduce/minimise Risk

A risk analysis of the events was carried out, and event acceptability was defined using the risk matrix. See Table 3. Events that would not be acceptable (mechanical failure or power outage at Hillsborough pumpstation) were considered further, and options developed to mitigate the effect of these events. Four options were developed, as shown in Figure 7, including standby pumps and standby generation (SoS4), a dedicated pipeline between the pumpstations so they could provide backup for each other (SoS3) or a third pumpstation in the zone as backup, with associated supply pipelines (SoS2 and SoS1). In developing these options the aim was to provide full security of supply (i.e. pressure never drops below 200 kPa). In an extreme event a lesser level of service may be acceptable (e.g. 150kPa). This is identified as a future improvement (Section 5).

Table 3 – Assessment of event acceptability

Event	Impact	Likelihood	Acceptability
Power outage across the city	Extreme	Once a decade	May be acceptable
Power outage at Hillsborough pump station	Major	2-4 times per year	Not acceptable
Low suction pressure at Hillsborough pumpstation	Moderate	2-4 times per year	Acceptable – requires attention
Power outage at Duke Street pumpstation	Major	One every 2-3 years	Acceptable – requires attention
Mechanical failure at either pumpstation	Extreme	One every 2-3 years	Not acceptable
Accident/Truck impact into either pumpstation	Extreme	Once a decade	May be acceptable

Each option was considered using the model, and the residual risk remaining in the zone with each option in place was considered. Again the risk matrix was used to define the acceptability of the remaining risk, as shown in Table 4. Table 4 also includes the cost for providing SoS, and was used to decide between the options that would have an acceptable risk remaining. Option SoS4 was selected.

Figure 7 – Security of supply upgrade options

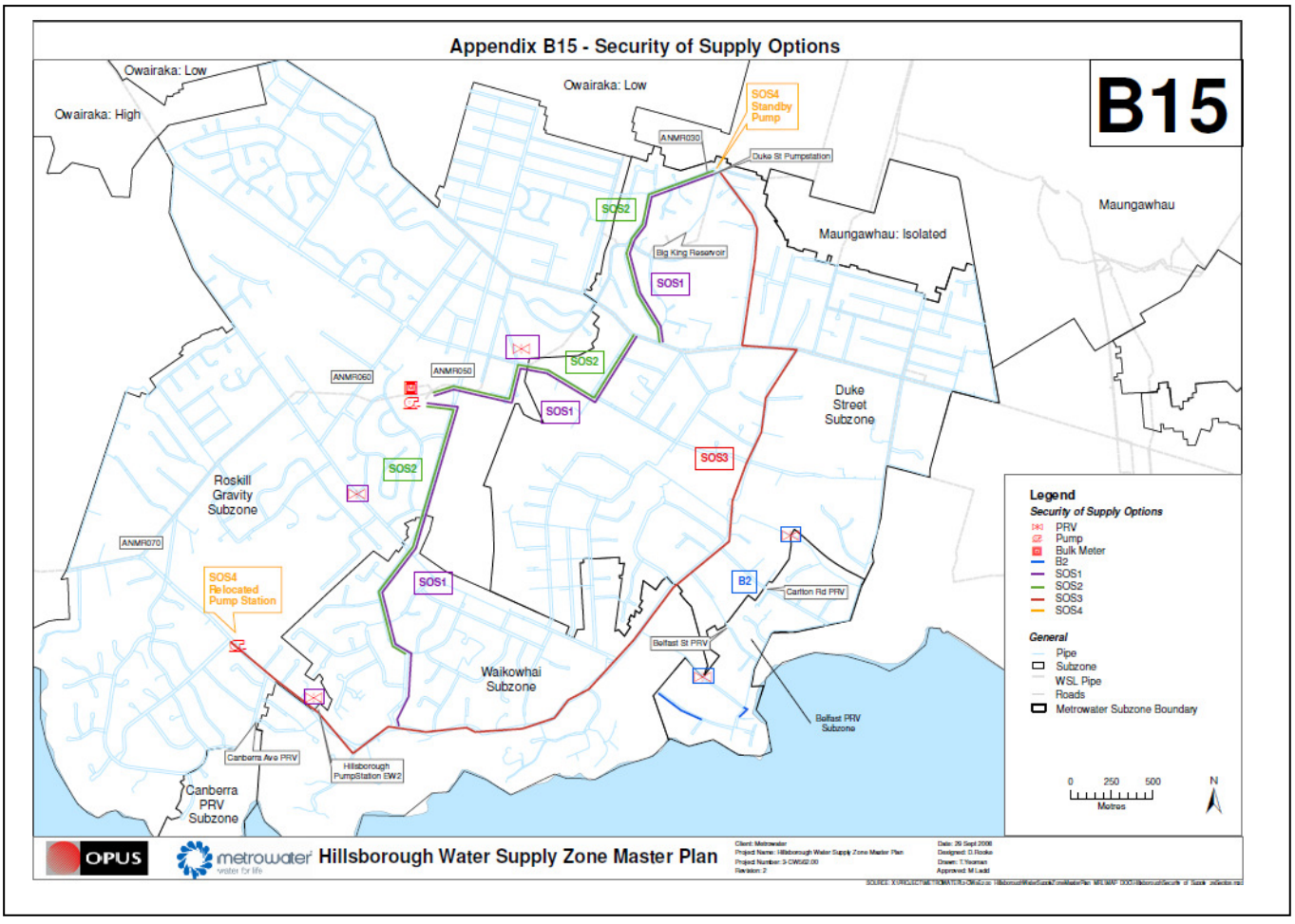


Table 4 Acceptability of remaining risk

SoS Option	Cost ($000)[1]	Risk remaining	Acceptability
SoS1 New Mt Roskill pumpstation	2,460	Nil	N/A
SoS2 New Mt Roskill pumpstation	1,910	Nil	N/A
SoS3 Pipeline between pumpstations	3,495	Accident/truck impact into either pumpstation	May be acceptable
SoS4 Standby pumps and generation	1,110	Accident/truck impact into either pumpstation	May be acceptable
Standby pumps only	300[2]	Power outage at Hillsborough pumpstation	Not acceptable
Standby generation only	500[2]	Mechanical failure at Hillsborough pumpstation	Not acceptable

[1] NPV Operation and Capital cost for providing SoS only

[2] NPV Capital cost

5 IMPROVEMENTS TO THE PLANNING PROCESS

The master planning process is subject to ongoing improvement as asset information, processes and tools are improved within Metrowater, as well as through an increasing level of coordination with Watercare on projects at all levels.

Prior to undertaking the Hillsborough Master Plan, Metrowater had been through a period of undertaking single-driver studies. These included:

- Available fire flow modeling study (Opus International Consultants, 2006)
- Growth planning project (GHD, 2006)
- Water quality complaint reduction strategy (Metrowater, 2006)
- Unplanned interruptions strategy (Metrowater, 2006)
- Water criticality project – stage II (GHD, 2007)

The information gained through these studies was utilized in prioritizing water supply zones for master planning, as well as for checking issues and options through the development of the master plan. Most of the solutions from these studies have been further analyzed and implemented where possible. While these projects provided a good understanding of issues against these key drivers, uncertainties remained in many areas when attempting to implement solutions from these studies without undertaking a thorough multi-driver analysis.

Detailed below are the improvements that have been made to the planning process, both before, during and as a result of the lessons learned through the Hillsborough master plan.

Project Phase	Lesson Learned/Process Improvement
Field testing	***Field testing – internal and external communications*** It is vital that during the two week field testing period, construction and maintenance works are deferred or minimized within the zone. Construction or maintenance works can significantly affect the operation of the zone and adversely impact the ability to calibrate. A process of internal communication and close cooperation with the Metrowater operations team was adopted to minimize these disruptions.

Project Phase	Lesson Learned/Process Improvement
Field testing	***Valve checking prior to field testing*** On calibration of the model for the Hillsborough water supply zone, many system anomalies were discovered requiring field investigation and resolution before model calibration could be achieved. Many of these anomalies were due to closed or partially closed valves. While these closed valves can be simulated in the model to achieve calibration it is more effective to have the system under normal operating conditions (i.e. no closed valves). A process for targeted valve checking on large and critical mains prior to the field testing period was identified as a method to reduce the number of anomalies and improve the model calibration. This is coordinated with other valve checking programs where possible for efficiency savings, and has been implemented on subsequent planning studies.
Model update	***Asset data – link model update to updated GIS*** For the Hillsborough model update phase the existing Metrowater model of the Hillsborough water supply zone was updated with new as-builts and asset changes/corrections. A process of model data checks was then carried out within the model. Metrowater has been undertaking an asset data improvement project; a concentrated program to update all existing asset information in the corporate GIS (MapInfo) system. The GIS is now sufficiently more up-to-date to allow models to be created directly from the GIS. This allows coordination of the data sets and improves efficiency in the long term. Some additional data improvement is still required to streamline this process; however this has been undertaken in subsequent projects.
Model calibration	***Calibration criteria, model build specification, model maintenance strategy*** At the commencement of the Hillsborough master plan process, Metrowater required the consultant to indicate the level of calibration that would be achieved through the project. Metrowater would then review and accept/reject this proposal. Metrowater have subsequently developed a calibration criteria and model build specification. This allows significantly more consistency between the models and ensures the Metrowater standards are met. Metrowater is in the process of developing a model maintenance strategy to assign a structure to the methodology and frequency of model updates and alert when calibration criteria are breached to a level requiring re-calibration.
	Model peer review An independent peer review was carried out on the calibrated model, to ensure that calibration was achieved prior to continuing into the master plan phase of the project. This ensured the model was robust and fit for purpose prior to committing additional expenditure on master planning and solution development.
Master plan	***Master plan solutions*** Improvements were achieved through the definition of 'quick-fix' and long-term solutions and in linking solutions to asset management objectives and the risk matrix for decision making.

Project Phase	Lesson Learned/Process Improvement
Master plan	***Water quality solutions*** Water quality analysis was based on water age compared to water quality complaints records and a review of the water quality sampling regime. Recommendations centered around improving water age and ensuring other solutions did not worsen water age and recommendations on the sampling regime. It is thought that further improvement can be achieved in these solutions through: • Ensuring the water quality testing regime is 'representative' of the zone. • Improving circulation around stagnation points and poor-performing sampling points through local as well as zone-wide solutions.
	Pressure management solutions Pressure management solutions were high level only and in future master plans will require a more detailed level of analysis, including identifying parts of the zone that are suitable for pressure management, and a cost-benefit assessment (cost of control valves, monitoring, system augmentation; reduction in bursts, leakage).
	10 year investment program/ODM tool and process for implementing solutions Following the completion of the Hillsborough master plan issues have been encountered with the information collected for the 10 year investment program and the implementation of the solutions from the plan. The information collected through the planning study needs to be sufficient to allow a business case to be produced for each solution or set of solutions. The 10 year investment program tool needs to be more closely aligned with the asset management objectives of Metrowater. Work is currently underway in this respect.
	Scenario analysis Following completion of the Hillsborough study, Metrowater have identified the need to undertake further scenario analysis to understand the cost of providing different levels of service and inform community consultation (if required or deemed necessary). An example of this is understanding the cost of providing full security of supply or higher pressure to large industrial/commercial customers.
Entire project	***Need to adopt a team approach*** A team approach was viewed as a critical factor in determining the optimal solutions for the water supply zone, to gain buy-in and support at the project planning phase. Team input was required on project selection and at critical stages through the project program including: model update and calibration, master plan start-up, issues workshop, initial options workshop, final options workshop, review of final report and presentation of solutions. The team involved key people from across Metrowater including: modeling, asset planning, project planning, asset information (GIS), operations and maintenance, development. Watercare were included at key stages to gain feedback on options affecting the Watercare network. This improved the understanding and acceptance of the solutions so they can be more easily implemented.

Project Phase	Lesson Learned/Process Improvement
Entire project	***Improving coordination with Watercare through input to study process and outcomes, joint model development.*** Watercare were involved/consulted in the field testing and master plan phases of the project and meetings to discuss solutions affecting or future utilization of the Watercare network assets. Future Hydraulic Grade Lines (HGLs) for the study were based on the minimum BSP (Bulk Supply Point) HGLs given in the Bulk Water Agreement between Metrowater and Watercare, based on the assumption that these HGLs would continue to be available in the future. Planned upgrading of one BSP was realized late in the project and further analysis confirmed that this would alter a significant solution for the zone, saving over $300,000 in planned expenditure. A process for improved coordination with Watercare, through feedback on future available HGLs and the creation of joint Watercare-Metrowater models has been initiated to resolve this potential issue.

6 CONCLUSIONS

The Hillsborough water supply zone master plan produced a set of solutions for the zone, optimized and prioritized to ensure that Metrowater will meet its levels of service into the future. The process of incorporating the Metrowater asset management objectives into; the zone selection, issues identification, option development and option selection ensured that the solutions were synchronized with these objectives. $2.7 million worth of capital and operational upgrading for the 50 year planning period was identified, a figure which was reduced to $2.4 million through improved coordination with Watercare.

The 'just in time' future upgrades have been staged based on expected development. This will be monitored over the planning period to ensure the development assumptions are valid, to maintain the currency of the masterplan.

Through the master planning process a number of improvements were identified which have been carried through into subsequent master plans. This streamlines the process and solution development to ensure Metrowater does the right project at the right time and produces efficiency gains in the long term.

The upcoming amalgamation of the local network operators into Watercare enables a wider approach to water planning. It will give the opportunity, not previously available, to develop solutions that may solve regional issues, e.g. defining water supply zone boundaries based on hydraulics rather than political jurisdiction. The ongoing improvement to the master planning process enables this wide view, as there is always a bigger picture.

ACKNOWLEDGEMENTS

The authors thank the reviewers of this paper; Brian Sharman (Metrowater), Stephen Grace (Metrowater) and Dan Stevens (Opus International Consultants).

REFERENCES

GHD (2006) 'Growth Planning Project, Final Report'
GHD (2007) 'Water Criticality Project – Stage II'
Metrowater (2006) 'Water Quality Complaint Reduction Strategy'
Metrowater (2007) 'Asset Management Plan July 2007 to June 2027'
Opus International Consultants (2006) 'Available Fire Flow Modeling, Final Report'
Opus International Consultants (2008) 'Hillsborough Water Supply Zone Master Plan'
Opus International Consultants (2009) 'Metrowater Water Modeling Specification