A STEP FORWARD IN THE WELLINGTON REGION'S WATER MODELLING JOURNEY

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ABSTRACT

In September 2014, Wellington Water was created following the merger of the Water Supply Group of Greater Wellington Regional Council with Capacity Infrastructure Services Limited. The decision to amalgamate was part of a wider push by councils in the region to realise the benefits of shared services across the region.

Wellington Water is a shared service, council-controlled organisation jointly owned by Hutt, Porirua, Upper Hutt and Wellington City Councils, and the GWRC. Wellington Water manages the drinking water, stormwater and wastewater networks on behalf of its client councils and provides advice about how best to invest in their future development.

In 2014/15 Wellington Water along with MWH embarked on a water model build project on behalf of Hutt City Council. The model is a key planning activity to:

- understand how systems operate under various scenarios now and in the future,
- assess system performance under normal conditions and critical asset failure scenarios,
- assess implications of developments, upgrades, renewals and operational modifications, and
- produce supporting information for planning studies.

Wellington Water wishes to improve the quality of its asset data information (including water network models) by using the economies of scale enabled by the amalgamation of the water service utilities. In this context, Wellington Water is rationalising its modelling work so that outcomes are consistent and comparable. This involves developing consistent tools in terms of software package, data schemes, calibration standards and documentation. Consequently, the first element of the project was to update the previous *Regional Water Modelling Specification* to bring it in line with national best practice. A modelling report template was also prepared for consistency in documentation. This is a corner stone of the modelling strategy as it allows, if required in the future, the possibility to combine all water models into a combined model and a better integration with the asset data system, GIS and live SCADA.

Innovation was encouraged within this project. Paper plans were abandoned in favour of a single online Google Map for the planning, execution and documentation of the field test. This simple but efficient change saved time and money and improved significantly the communication between the parties involved in the field test (Wellington Water, Council, contractor, consultant, fire service, operations).

The project also highlighted the benefits of further preliminary analysis work of SCADA information: discrepancies were found in the balance between inflow, outflow and water level for several reservoirs or for flow meters in series with one another. These could have been identified earlier in the project through reservoir balance checks, complete demand disaggregation and preliminary model run. This would have allowed to flag potential significant discrepancies or gaps, allowing enabling works to be undertaken prior to the field test and possibly a finer demand allocation to be achieved.

This paper demonstrates the step change in water modelling practice within the Wellington region following the water services amalgamation.

1 INTRODUCTION

1.1 WELLINGTON WATER LIMITED

Wellington Water Ltd (WWL) created in September 2014 and is a shared service, council-controlled organisation jointly owned by Hutt (HCC), Porirua, Upper Hutt and Wellington City Councils, and the Greater Wellington Regional Council (GWRC). The amalgamation was part of a wider push by Councils in the region to realise the benefits of shared services.

Wellington Water manages the three water networks (drinking water, stormwater and wastewater) on behalf of its client councils and provides advice about how best to invest in their future development. Wellington Water's purpose is to create excellence in regional water services for healthy communities.

Wellington Water manages expenditure on behalf of the five Wellington councils of approximately $175 million, to maintain and develop water assets worth $2.7 billion. Each shareholding council owns its respective water services assets (pipes, pump stations, reservoirs and treatment plants). After considering advice from Wellington Water, and in consultation with their respective communities, councils then decide the service levels, policies and investment they will set for each network. Wellington Water works with councils, the community, regulatory authorities, contractors and consultants to deliver activities aimed at maintaining and improving the infrastructure that is essential to human life and the growth of the regional economy.

1.2 CONTEXT AND VISION

Wellington Water's three strategic outcomes are: the provision of safe drinking water, respect for the environment and providing resilient systems now and in the future. Modelling projects are undertaken to meet the strategic outcome of providing resilient systems.

Wellington Water has in place a Strategic Modelling Framework for developing three waters models (stormwater, wastewater and drinking water). The framework is a generic process to guide and record model development, listing key processes and documents including:

- identification of model objectives,
- stocktake of existing models,
- modelling specifications,
- model management plan, and
- implementation (activity) plan.

Significant time, experience and money are invested in developing models. The framework is in place to ensure that models achieve the required objectives and that their integrity is maintained in the future.

A second document, the Regional Water Model Strategy, applies the framework to water supply networks modelling and contains the actual information (objectives, stocktake, management plan and implementation plan). A number of models already exist and therefore the strategy focuses on their management and development. Some early gains from the strategy have been identified as:

- reduced licence requirements,
- standardisation in process resulting in more efficient model builds,
- standardisation in reporting resulting in better documentation, and
- opportunities for model integration projects.

Developing the HCC model forms part of the implementation plan of the strategy for water supply network modelling.

1.3 WATER MODELLING OBJECTIVES

The objective of the water modelling programme is to develop hydraulic models for the distribution network of each city that will enable Wellington Water to:

- undertake Zone Management Plans (ZMPs) to prepare a staged programme of upgrades and replacements for inclusion in the Long Term Plan (LTP),
- understand how the system operates under various scenarios now and in the future,

- assess the system performance under normal conditions and critical asset failure scenarios,
- identify critical assets and required resilience upgrades,
- assess the implications of new developments and operational modifications, and
- produce supporting information for planning studies (e.g. when a new reservoir is needed).

1.4 HUTT CITY COUNCIL WATER SYSTEM

The Hutt City water supply network supplies a population of approximately 100,000. It is fed from the Te Marua and Wainuiomata water treatment plants via the transmission network formerly operated by Greater Wellington Regional Council, and 10 bulk supply points from the transmission network. The distribution network comprises 24 storage reservoirs, 14 pump stations and approximately 680km of pipes. The gross per capita usage for HCC is 345 litres/head/day averaged over the last five years.

Figure 1-1: System overview, District Metered Areas and reservoirs

2 PROJECT WORK

2.1 PROJECT STAGES

Wellington Water commissioned MWH to undertake the modelling work, and organised the overall project in several stages. Each stage was scoped at the completion of the previous one.

2.1.1 REGIONAL MODELLING SPECIFICATIONS

Each council in the Wellington region manages its asset data, and therefore the network information varies greatly in form, detail and reliability between councils. Several models have been built over the years using different software packages and achieving varying levels of accuracy. The first element of work was to update and complete the Regional Water Model Specification, which sets processes and quality standards for all water supply modelling works.

MWH compiled national best practice for model build and calibration and adapted the specification to Wellington Water's needs. The specification recognises the differences in asset data and existing models between councils,

and sets non-prescriptive guidelines, to be met where the base data allows. It details the procedures to follow for all stages of the modelling work, for example:

- key checks to undertake on the base data supplied by Wellington Water,
- asset data mapping,
- naming conventions,
- assumptions for pipe internal diameters and roughness,
- demand analysis methodology,
- deliverables for each phase of work,
- calibration criteria, and
- setup of working models.

2.1.2 STOCKTAKE AND IMPLEMENTATION PLAN

MWH undertook a stocktake of the existing water supply network model by reviewing the available documentation and model performance. The existing model was incomplete, uncalibrated and not fit for the purpose set out in the Regional Water Model Strategy. Different approaches were assessed for bringing the model to the required standard. As is often the case, a model rebuild was found to deliver a more reliable and efficient product at a cost comparable to that of a complete update. The rebuild was therefore preferred and different funding scenarios were compared (from all in one year to spread over six years). Undertaking the model build and calibration in a single package of work was found to be more cost-effective but, to meet budget and resource requirements, it was decided to undertake it over two financial years.

2.1.3 DATA REVIEW

Wellington Water subsequently tasked MWH to undertake a review to determine if the available data was sufficient to enable a working model to be prepared to the standard set out in the Specification. The review covered:

- GIS data (which physical elements are captured in GIS? Which information fields are available? What information is missing?),
- operational information (pump types and settings, valve types and settings, reservoir size and levels), and
- SCADA (what is captured on SCADA? Does it appear reliable?).

The review found that the network data was sufficient but concerns were raised regarding the accuracy of SCADA information. The flow information for key flow meters was missing in places, or polling intervals were insufficient to derive accurate demand profiles for some District Metered Areas (DMAs). This led to prioritising DMAs with realistic demand profiles derived for the first stage of the calibration while keeping those with less reliable demand derivation for the following year. This provided Wellington Water an opportunity to improve the flow data in the interim. While the initial driver for undertaking the calibration work over two years was budget limitations, it proved to be a technically beneficial for the Hutt City project.

2.1.4 STAGE 1 OF MODELLING WORK

The first stage of the modelling work included:

- the model build from GIS and operational information for the entire Hutt City network,
- preparing a Field Test Plan for the entire Hutt City network,
- a field test for the DMAs where a good demand derivation was achieved from available SCADA (approximately half the system), and
- calibration for those DMAs.

Following calibration, the model accurately replicates the measured system performance (flow, pressure, water level in reservoirs, pump operation). Several assumptions were made to match model predictions with field measurements. To check these assumptions, a series of field checks were recommended in the calibration report.

Most of the issues are believed to originate from inaccurate SCADA information. In particular, discrepancies were identified for flows in and out of reservoirs (which are expected to be similar over a long period of time) and

between reservoir flow balance and change in water level. These suggest that some flow meter readings are inaccurate.

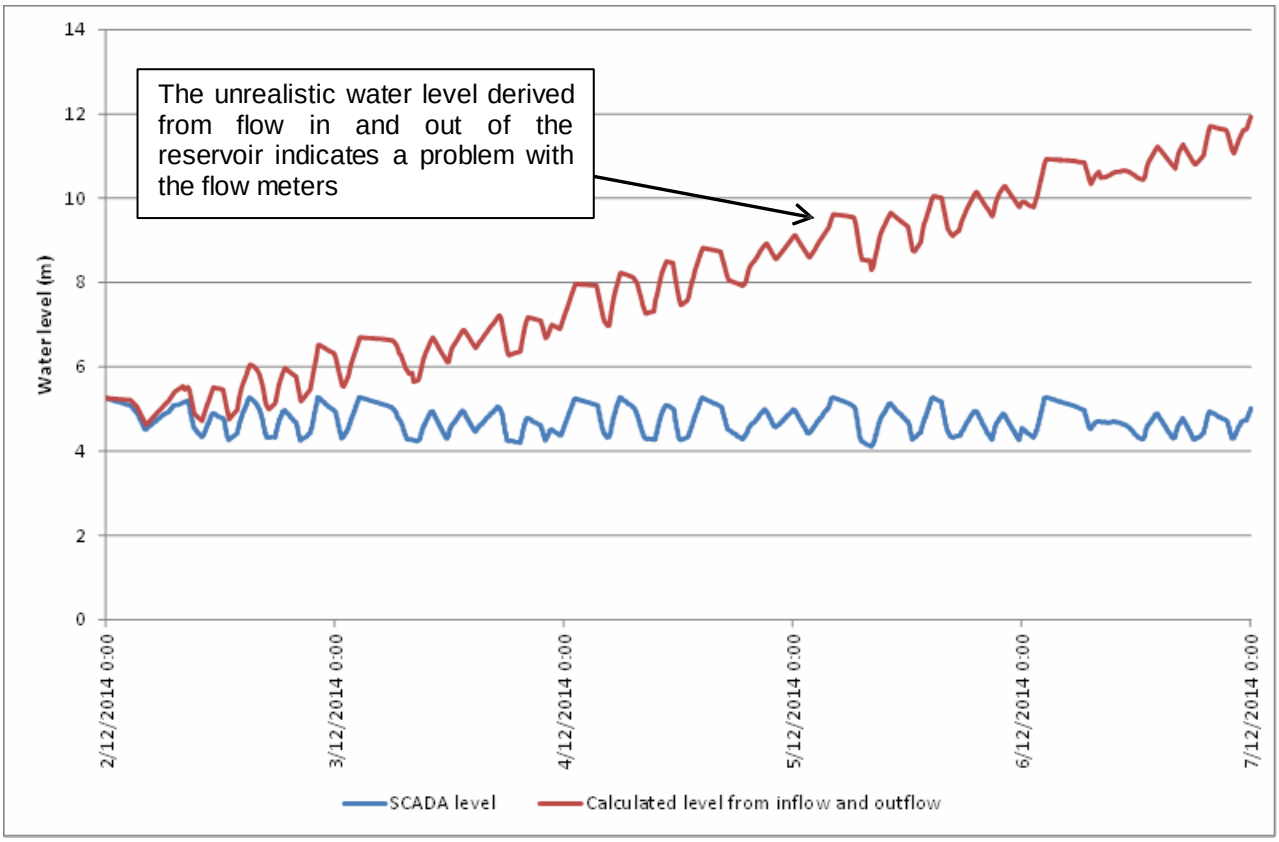

Figure 2-1: Water level in reservoir derived from flow data and observed

At the time of writing, field checks for Stage 1 are being undertaken to confirm calibration assumptions. These investigations have so far confirmed some GIS errors in pipe diameter and connectivity. Additional field checks are currently programmed to confirm these, by running known flows through the flow meters and comparing with SCADA values. This may point to equipment that will need recalibration.

2.1.5 STAGE 2 OF MODELLING WORK

Stage 2 of the modelling work is scheduled for the 2015-16 financial year. This stage will include completing further investigation to improve the reliability of flow data, field testing and calibration of those DMAs where SCADA data was found to be less reliable.

2.2 PROJECT OUTCOMES

At the time of writing, the project has delivered:

- a calibrated model for approximately half of the Hutt City water supply network,
- network schematics clarifying the operation of the system and the relation between the various DMAs,
- a breakdown of the water demand in residential, commercial and leakage components, with a list of the DMAs with significant leakage,
- a list of flow meters and water level transducers with suspected inaccurate readings,
- a list of valves suspected to be closed when they should be open, leading to unnecessary pressure losses, and
- a list of GIS improvement activities.

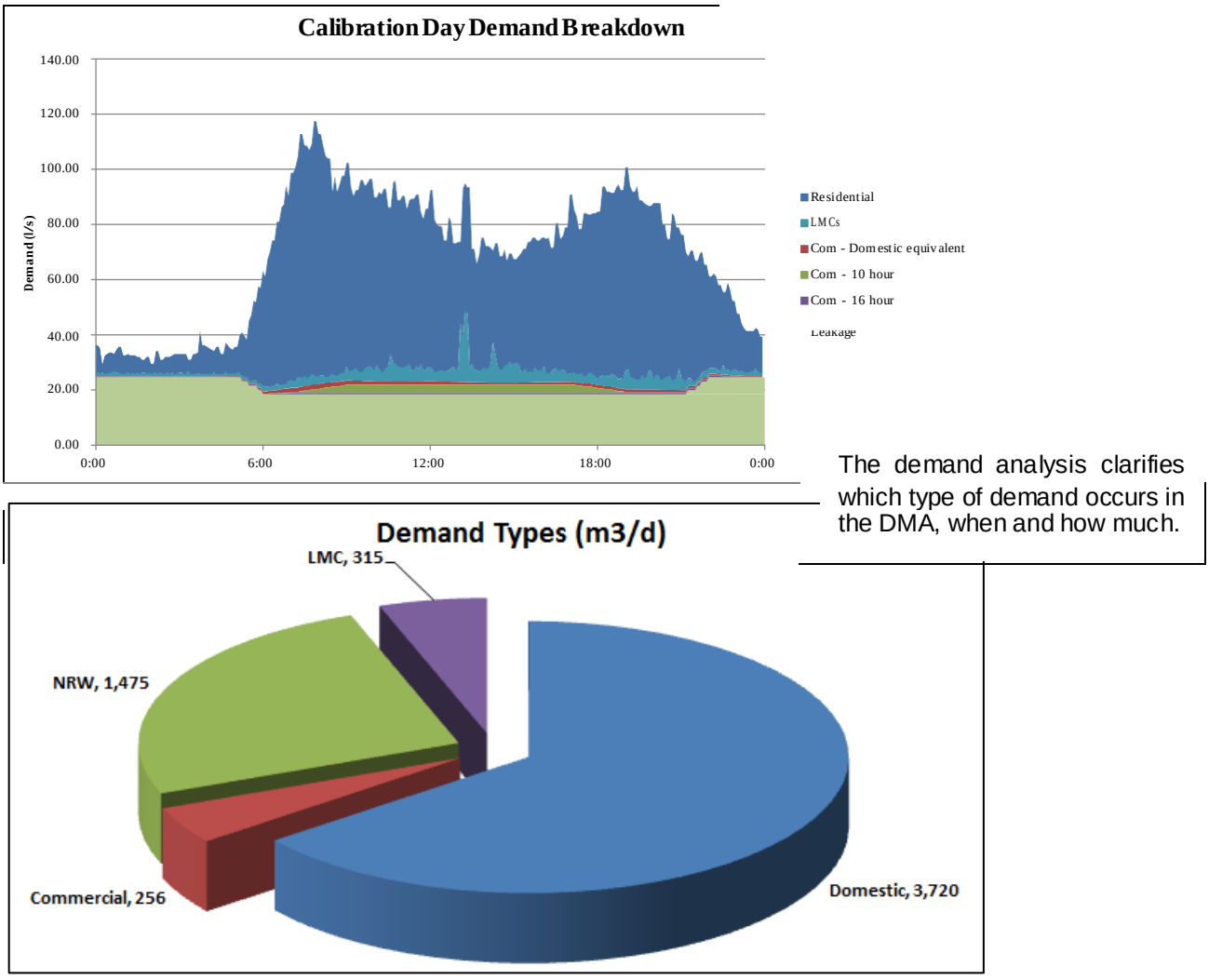

Figure 2-2: Example of demand breakdown for a DMA

3 INNOVATION

In the process of delivering the Hutt City model, a number of time-saving and error-management innovations were trialled.

3.1 ONLINE MAP FOR FIELD TEST

The Field Test Plan comprised the installation of approximately 50 pressure loggers on hydrants and pump station pressure tappings. This required preparing a Field Test Plan to indicate to a contractor where to install logging equipment. Conventionally this is done using paper plans which is time-consuming, costly, and impractical, and does not allow keeping track of the frequent location changes required when a hydrant is found to be faulty. Subsequent communication between the consultant and the contractor is critical to ensure the final logging locations will provide sufficient data to understand the system performance. Such communication is difficult when paper plans are used as a medium for information.

After discussion with the logging contractor (Asset Monitoring Limited – AML), paper plans were abandoned for the Hutt City modelling work in favour of a single online Google Map for to plan, execute and document the field test. MWH prepared a preliminary online map and distributed it to interested parties (Wellington Water, CityCare, fire services, contractor, Council) as an early indication of possible logger locations. Access to the map is free and does not require any proprietary software. The contractor had constant access to the map via a laptop in his

vehicle, and captured information on the go, eliminating the need for paperwork at their end. This information included:

- hydrants not suitable for logging because they were leaking, silted, buried or had other issues,
- time, date and location of logger installation, and
- identification and depth of the logger.

Changes are visible online immediately after map updates, making it convenient for the contractor to discuss alternative logging locations with MWH while on site. At the end of the deployment the online map represented the actual locations of the loggers and all interested parties were advised. The online map also provided clear information for Wellington Water to prepare a work order for the maintenance contractor (CityCare) to fix all the hydrants identified as faulty. Hydrants, which are paint-marked and far apart, lend themselves well to this technique.

This simple but efficient change saved time and money and significantly improved the communication between the parties involved in the field test. It was particularly useful in situations where:

- spatial information is required while on site,
- locations are spread over a large area,
- the user does not have a GIS software licence,
- various organisations need to communicate through a common platform , and
- an accuracy of +/- 5m is sufficient to locate the assets on site.

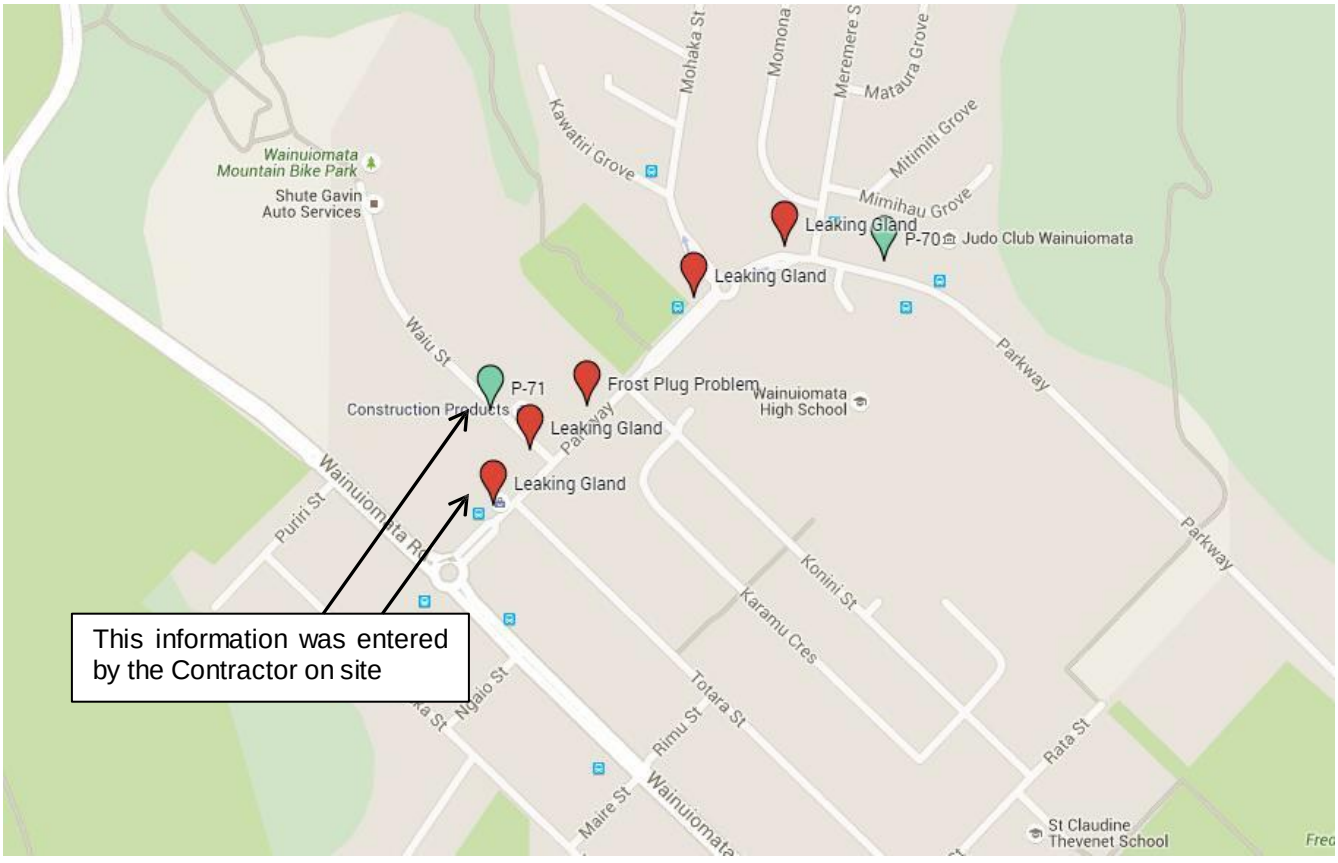

Figure 3-1: Example of the online Google Map field test plan execution

3.2 ONLINE SCHEMATICS

MWH prepared a series of four network schematics (one for each water supply zone). Wellington Water also commissioned MWH to prepare “strategic schematics” of the Hutt City network to provide a general understanding of the network operation in a single document, intended to be viewed online. The vision is to

provide a future single document for the entire region that can be examined at various levels of detail, from the general architecture to the SCADA tag of each flow meter supplying a given DMA.

The solution of choice would be a web-based application, with a GIS feel. However, sourcing or developing such a product would not have been practical within this project. Instead, a pragmatic decision was made to prepare a first version with a smart PDF document which comprises:

- a schematised map of the network,
- layers showing DMAs, meters, SCADA tags and reservoirs levels, and
- links to elevation and plan schematics, presenting each water supply zone in greater detail.

This schematic was developed and is currently under review by planning and operations engineers within Wellington Water. The content and format of the schematic will be improved following their feedback.

4 LEARNINGS

Breaking down the programme of work into several stages enabled problem solving and scope optimisation between hold points. Those stages comprised the following tasks:

- review of objectives and standards,
- stocktake of existing and implementation plan,
- data review,
- build and calibration, and
- field checks.

This procurement approach is recommended for projects of this size in the Wellington region. The approach is particularly successful when there are unknowns and limitations with asset data and SCADA information.

More preliminary data assessment is recommended for future water model calibration projects. In particular, the following activities should be undertaken as early as possible in the project, and before the preparation of a Field Test Plan:

- A complete demand breakdown between residential, commercial and leakage. This may highlight errors or limitations with the SCADA flow data (through abnormal demand profiles or abnormal average values) that may otherwise go unnoticed.
- A complete demand allocation and model run. This may highlight errors or limitations with the customer points, zone boundaries or network configuration.
- A comparison of flows in and out of each reservoir (which are expected to be similar over a long period of time) and a comparison of reservoir flow balance and change in water level.

The use of online Google Maps was very successful in improving the communication between parties during the field test and is recommended for future projects, in particular those involving the location of hydrants or other easily identifiable assets.

5 PERSPECTIVES

Wellington Water has programmed completing Stage 2 of the calibration of the Hutt City network for the 2015-2016 financial year, along with preparing working models. This will follow the same structure of field test, calibration, field checks and taking on board lessons learned.

Over the next few years we expect that existing water supply models in the Wellington Region will be brought to the standard of the specification, either via updates, rebuild or recalibration, and that working models will be prepared and subsequently maintained.

While the asset data varies between councils in format, completeness and accuracy, Wellington Water aims at delivering water models with sufficient accuracy to meet the calibration criteria, benchmarking their quality and usefulness.

The Hutt City water model calibration is seen as a first step on the journey to bring the region's water models to a consistent level of quality and confidence, through embedding the processes and learnings into Wellington Water practices. These models will be useful for:

- long term planning including growth and resilience,
- operational improvements (pump and reservoirs optimisation, pressure reduction),
- renewal planning and sizing, and
- possibly, in the long term, integrating the models with other systems that deal with the same physical asset, eg SCADA, GIS and asset management systems.

The key outcomes of such a journey will be to maximise the usefulness of the models to, in turn, get as much value as possible from the water network assets.

KEYWORDS

Water supply modelling, Hutt City, Wellington region, shared services