SEEING THE UNSEEN – OPPORTUNITIES FROM A HOLISTIC NATIONAL VIEW OF STORMWATER ASSETS AND FUNCTIONS

H Shaw - Beca, A Allan – WSP, P Christensen - Storm Environmental,
T McCartney - Praxus, K Hill - Tauranga City Council

ABSTRACT

The 2022 Water Services Reform Legislation required Territorial Local Authorities (TLA's) to create asset & function allocation schedules. Both the physical assets (such as pipes) and non-physical functions (such as overland flow paths) were included in the requirements for the allocation schedules. These would enable newly formed Water Entities and TLAs to deliver their legislative responsibilities. To facilitate the holistic management of stormwater, critical information about catchments, including piped networks, natural drainage systems, wider conveyance pathways, and water quality treatment, was vital for the Water Entities. The approach taken remains an invaluable case study for the future delivery model being developed for Local Water Done Well.

TLAs shared their geospatial stormwater network data with the Department of Internal Affairs for analysis. The legislation in place at the time required the identification of stormwater assets that would transfer to new entities (i.e. the core urban networks) and those that would remain with TLAs (e.g. transport stormwater assets).

The automated analysis of 3.1 million stormwater assets from 66 TLAs, using a standardised approach, unveiled, for the first time, a comprehensive national overview of New Zealand's stormwater networks and assets. This included 820,000 privately owned stormwater assets, 570,000 transport-related stormwater assets, 63,000 assets in rural areas, 44,000 waterway features, 6,000 dedicated stormwater treatment devices, and 4,000 mixed-use stormwater treatment devices, primarily concentrated in Auckland, Tauranga, and Christchurch.

The data standardisation and result validation processes revealed large differences in nomenclature and information detail between council datasets.

The initial TLA data upload generally included hard assets, limited to engineered structures and piped networks, with significant gaps relating to 'soft' infrastructure and mixed-use assets including watercourses and wetlands that form part of the managed catchments.

Gaps in information about natural urban watercourses and overland flow paths were significant. Watercourses serve an important conveyance function within catchments and are part of the management story for both water quality and flooding outcomes, but are complex due to unclear ownership between TLAs, Regional Authorities and private landowners. Similarly, unformed overland flow paths for stormwater were generally not included in data sets; information on these exists to differing levels across the country, both in hydraulic modelled extents and as records of observed flooding.

Data gaps were more apparent once the data was visualised, and able to be compared across datasets; feedback from council staff was positive regarding the ability to notice gaps and update information. Having standardised data and automated tools to analyse datasets also meant that the update of information was fast and efficient.

The findings and processes outlined in this paper provide a transformative perspective on stormwater infrastructure management. The identification and comprehensive analysis of 3.1 million stormwater assets, including privately owned, transport-related, and rural assets, offer a groundbreaking national overview. The standardised approach to data and the utilisation of automated tools addresses critical challenges within the industry, such as discrepancies in nomenclature and information detail among council datasets. The ability to visualise and compare data across diverse datasets facilitates the identification and rectification of significant gaps in information, particularly related to 'soft' infrastructure and mixed-use assets like watercourses and wetlands. By enabling benchmarking on a national scale, this work contributes to the establishment of consistent regulations and efficient stormwater management practices, ultimately optimising the limited resources available in the New Zealand stormwater industry.

KEYWORDS: NETWORKS, CLASSIFICATION, WATER REFORM

1 INTRODUCTION

During 2022 and 2023, preparation for the three waters' reform was focused on setting up four, then ten, Water Services Entities to own and manage wastewater, water supply, and stormwater networks and services.

In order for the Entities to commence operation, the assets and functions to be transferred required identification, scheduling and agreement for transfer. This meant that they all needed to be identified and catalogued. In the case of stormwater, there was additional complexity around the definition of the assets to be transferred; assets providing drainage for roads were to remain with local councils or transport network owners; and land providing a stormwater function. For example, serving as stormwater detention ponds, were also to remain with council, subject to formal agreements with the Entities around operation and maintenance.

The Three Waters National Transition Unit (a team within the Department of Internal Affairs) was set up to support the establishment of the entities. The stormwater technical workstream was tasked with identifying stormwater assets to be transferred, and establishing the relationship agreements between entities, councils and other parties relating to stormwater services. The digital services workstream was responsible for collecting digital three waters asset data from all territorial local authorities in New Zealand.

As part of this work, the stormwater workstream accessed the geospatial and asset management system data relating to the stormwater networks, collected by the digital team. These data were standardised, analysed and presented on a digital platform.

Analysis of the data involved interpreting the new legislation and developing an automated geospatial analysis tool. Results of analysis were then presented digitally for validation by TLAs. Figure 1 below provides an example from Lincoln of the tool provided to councils to enable validation of the results to be recorded.

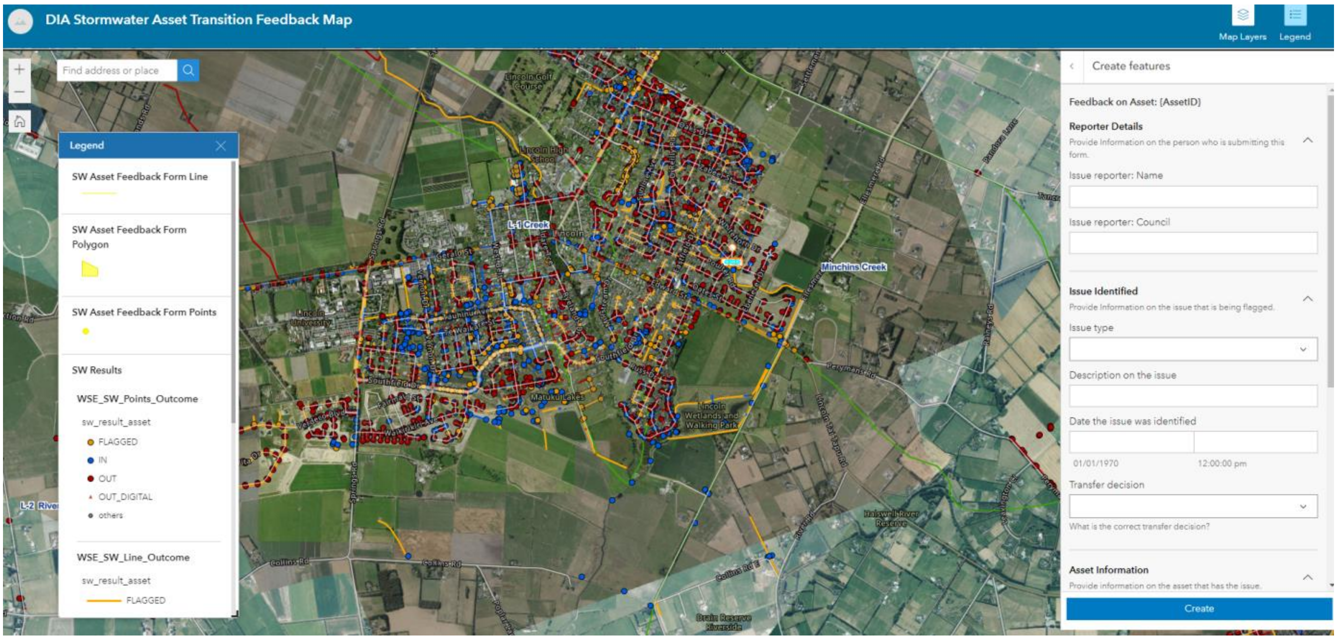


Figure 1: Results viewer with feedback form

Following the general election in October 2023, legislation requiring the set-up of Water Services Entities was repealed, meaning that assets were no longer required to transfer. New legislation expected during 2024 will support the set-up of locally-controlled organisations for water services. Legislation requiring the regulation of water services remains in place.

An overview of all the stormwater assets in New Zealand to a common data standard has never been this comprehensive; benchmarking undertaken in the past has been done using voluntarily provided datasets, and consequently has not been complete. There are many insights that we can take from these data, to be used at various scales.

2 DISCUSSION

2.1 NATIONAL STATISTICS

The development of the tool is the first example of a comprehensive national overview of New Zealand's stormwater networks and assets, and an approach that mapped data to a common standard. Data sets uploaded to the NTU included a wide variation in nomenclature and information detail. During the initial risk assessment for developing the tool the worst case scenario of utilising 66 unique data sets was considered, however in practice there was some commonality in nomenclature between councils that had previously collaborated, or where asset management services had been engaged from the same provider across multiple councils.

There were considerable differences in the quality of data between councils, with large data gaps apparent in some areas. Backlogs of as-built data were not uncommon, with some councils under-resourced to add this to the asset management system or in some instances records existing only in paper format. Data gaps were more apparent once the data was visualised, and able to be compared across datasets; feedback from council staff was positive regarding the ability to notice gaps and update information. Having standardised data and automated tools to analyse datasets also meant that the update of information was fast and efficient.

The initial TLA data upload generally included hard assets, limited to engineered structures and piped networks, with significant gaps relating to 'soft' infrastructure and mixed-use assets including watercourses and wetlands that form part of the managed catchments. In many cases this information was available from sources outside of the traditional asset management system, or was in the process of being digitised, but in other cases it was not available.

This analysis identified 820,000 privately owned stormwater assets, 570,000 transport-related stormwater assets, 63,000 assets in rural areas, 44,000 waterway features, 6,000 dedicated stormwater treatment devices, and 4,000 mixed-use stormwater treatment devices, primarily concentrated in Auckland, Tauranga, and Christchurch.

During the standardisation of the data, datasets were able to be simplified, enabling useful key asset types to be identified – the preparation of draft allocation schedules has allowed us to compare datasets across councils, and gives us useful insights (an example of which is in the next section). Figure 2 below shows one of the allocation schedules (the lists of assets that would be transferred to the Water Service Entity) drafted for Entity A, with a summary of all the assets. The ability to view all the council data in a consistent format can lead to powerful insights and provides an opportunity for councils to adopt a national approach based on this work.

Asset Class	Asset Type	Number of assets	Examples of asset types in category
Chambers and Manholes	Catchpit/Sump	13,129	Core urban stormwater network assets
	Chamber	183,840	
	Catchpit/Sump	123,751	Stormwater assets in rural areas or roads, or owned by other parties
	Chamber	4,528	
Control Structures	Basin	138	
	Bund	21	
	Dam Wall	3	
	Erosion Control	462	Structures and control features critical to the stormwater network.
	Inlet	4,496	
	Outlet	14,157	
	Spillway	11	
	Wall	34	
	Basin	164	
	Bund	31	
	Dam Wall	7	
	Erosion Control	325	Structures and control features owned by other parties or in rural areas
	Inlet	589	
	Outlet	1,219	
	Spillway	28	
	Wall	5	
Land	Vegetation/Planting	48	Planting associated with primary stormwater treatment facilities
	Vegetation/Planting	26	Owned by other parties or in rural areas
Pipes and Conduits	Culvert	1,277	
	Main	252,311	Core urban stormwater assets
	Service Line	155,199	
	Culvert	10,567	Stormwater assets in rural areas or roads, or owned by other parties
	Main	44,100	
	Service Line	78,483	
Site Services	Fence	50	Fencing associated with primary stormwater treatment facilities
	Fence	37	Owned by other parties or in rural areas
Treatment Devices	Treatment Device	6,597	Primary stormwater treatment devices
	Treatment Device	3,981	Stormwater treatment devices in rural areas or owned by other parties

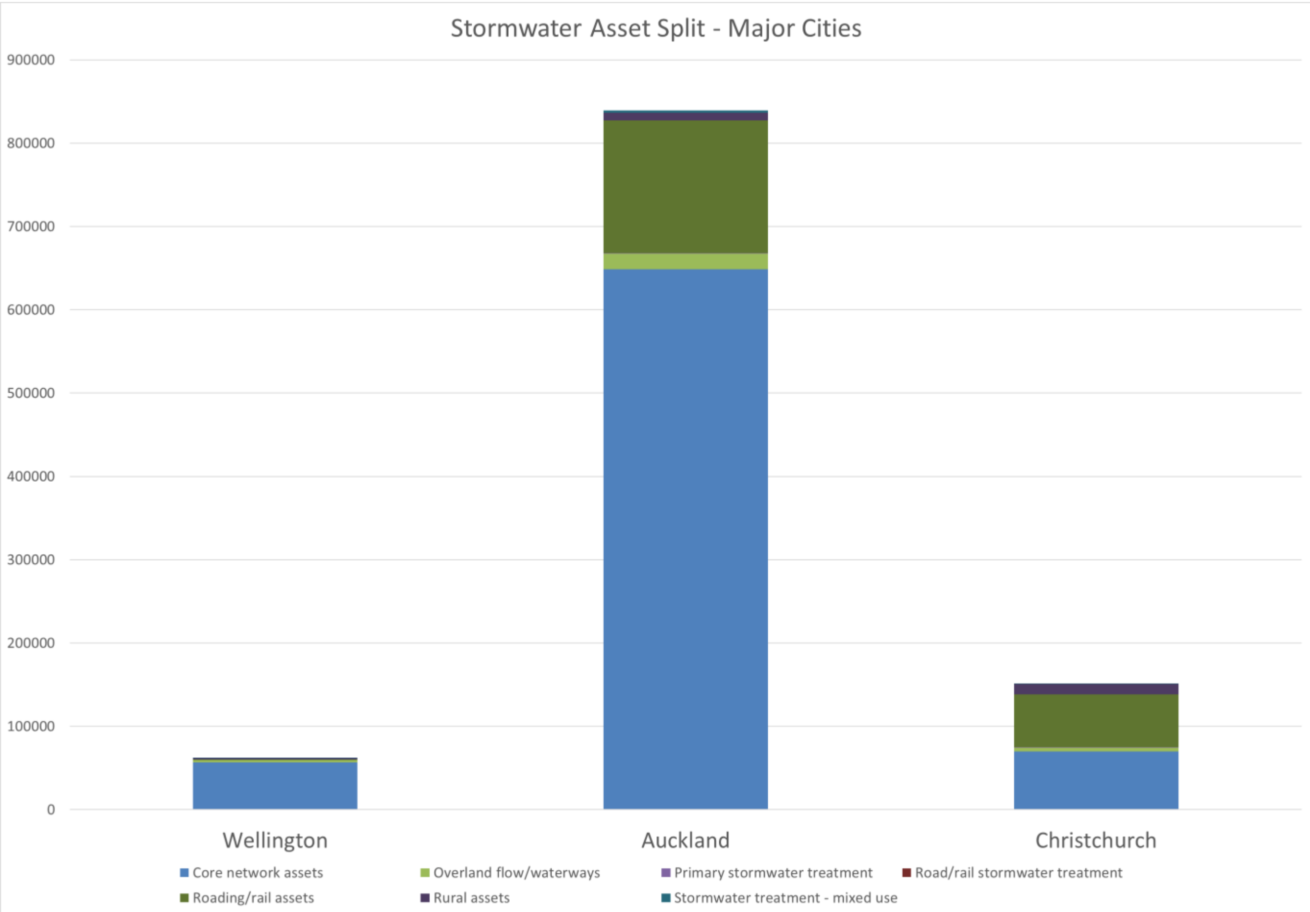
Figure 2: Example Allocation Schedule for Stormwater Asset Transfer

As well as identifying assets to be transferred to an entity (IN), to remain with council or the existing owner (OUT), or to be discussed (FLAGGED), the automated tool categorised data, enabling the following to be identified:

- Council stormwater networks
- Roading stormwater networks (catchpits, leads, soakholes)
- Private stormwater networks
- Waterways *(overland flowpath functions were unable to be consistently mapped)*
- Mixed use stormwater facilities

2.2 DISTRIBUTION OF ASSET TYPES

Data analysis across all datasets enabled a large number of comparisons to be made. Figure 3 below provides an example, with a comparison of both the total number of stormwater network assets in each city, but also the split between core network assets, waterways and stormwater treatment. While missing data may skew these results (particularly for waterways and open drains), the usefulness of having data in the same format and able to be queried for benchmarking purposes is evident. It also allows the differences in asset distribution between localities to be readily identified, something which is important as a more consistent national approach to stormwater asset management and reporting is developed, creating opportunity for clearer reporting and assessment against investment targets aimed at particular asset or function types.



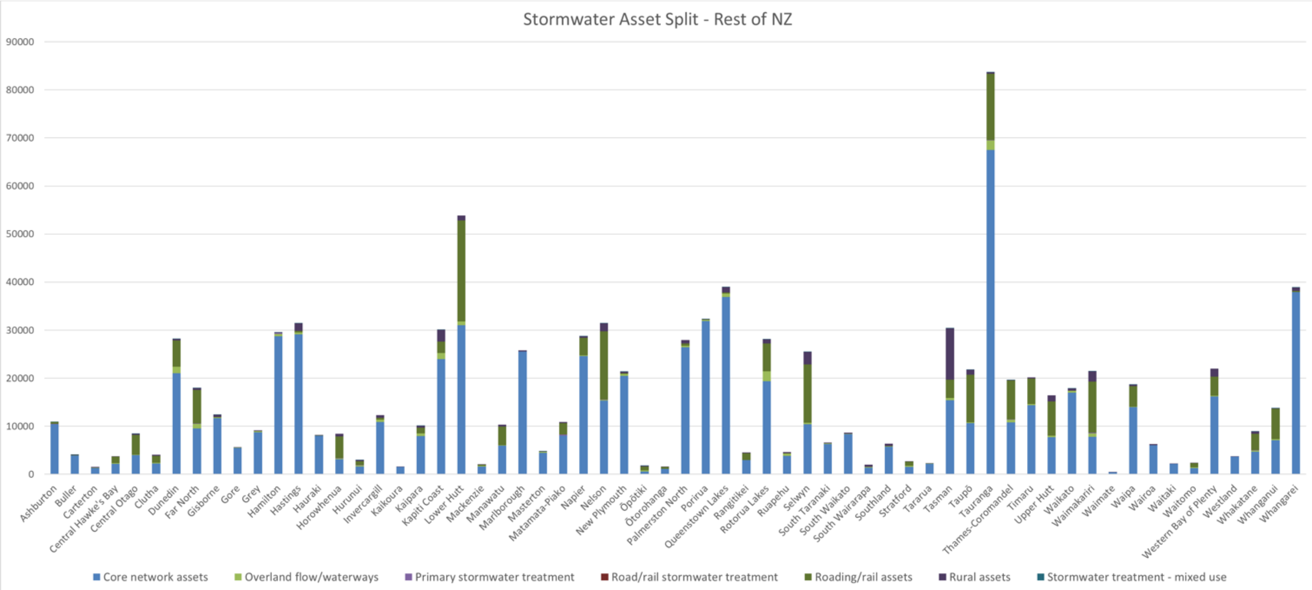


Figure 3: Stormwater asset type distribution; major cities, and rest of New Zealand

When preparing the allocation schedule drafts for Entity A, the variability of asset types making up the council stormwater networks is clear, and the variability is repeated throughout the country.

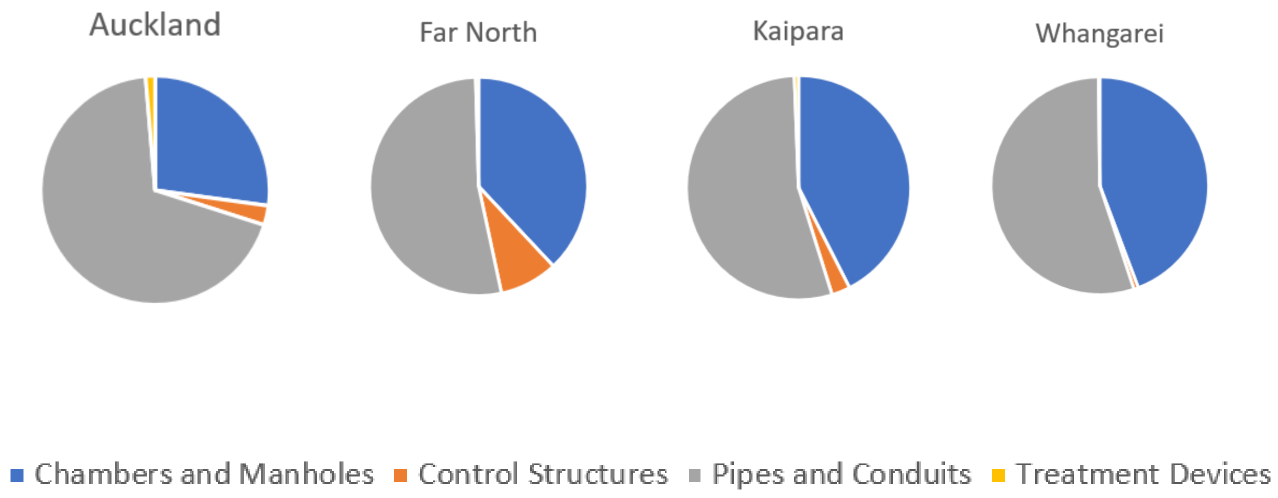


Figure 4: Variation in stormwater asset types owned by Councils in Entity A area

2.3 URBAN WATERWAYS

The handling by the tool of urban waterways, including ephemeral streams, and overland flow paths which form a core component of urban stormwater management was a challenging and much debated topic. Stormwater networks, under modern design standards, target design storm event capacities. In many areas reviewed during the development of the tool the upper limit for this target capacity was found to be a 1-in-10 year return period event. Where set, target design service levels vary nationally, and there were many areas of legacy stormwater networks where there were unclear target service levels. The consequence of this is a reliance, formally or informally, on other means for conveyance of the flows that exceed this capacity.

Waterway and overland flowpath identification challenged the process of scheduling of assets and functions. The data for this fell mostly into the function category rather than asset category. Records included in asset databases included locations where engineered channels for conveyance had been created but the data sets lacked consistent data for natural or semi-natural channels, channels in private property, and routes of overland flow. In general, natural form watercourses were not included in uploaded data sets.

Overland flowpaths had, in very few instances, been identified in asset data, and as a result a decision was made to exclude these from the assessment. It was acknowledged that in some parts of the country this information existed, either in stormwater models or in observed or anecdotal records. The mapping of these overland flow paths would therefore need to form part of a Day 1 activity for the Water Service entities and were included as a core part of development of Stormwater Management Plans required by the legislation. Where models existed for a catchment and had been uploaded to the asset database, these were tagged as a digital asset within the tool to enable future teams to connect with potential sources of overland flow path and watercourse mapping. Investment in this area remains an area where councils could make rapid improvement in knowledge about flood risk if Stormwater Management Plans are not included in future legislation.

Urban waterways, identified as part of the stormwater network painted a complex but incomplete picture. This picture raised challenging questions about the need for their inclusion of waterways in the schedules. However a review of case studies of urban streams highlighted the importance of oversight and co-ordinated management of waterway functions, in particular due to flood risk impacts on people and property, erosion risk impacts to property, erosion risk to other 3 waters infrastructure and impacts on the operation of the transport network.

The example shown in Figure 4 included areas of unidentified overland flow paths, natural or semi natural watercourses, disconnected sections of stormwater network, and pipe networks that were registered as having private ownership but acting as conveyance for significant stormwater flows and providing a flood risk reduction benefit to the wider catchment area.

Figure 4: Dunedin's stormwater network, with 'private' watercourses in red.

2.4 MIXED USE ASSETS, STORMWATER TREATMENT & SOFT INFRASTRUCTURE

The nature of stormwater management lends itself to co-existing with other activities and land use. In many areas of New Zealand, large open space including recreation grounds are ideal locations for temporary storage of surplus water that would otherwise pose a flooding hazard. Likewise, wetlands are increasingly being built with amenity and biodiversity functions, as well as serving stormwater treatment and flood management purposes. The number of stormwater treatment devices and mixed use assets ranged significantly (from none to a large number). We found that areas with new development or major streetscape works (such as Waimakariri, Wānaka, Kāpiti, Tauranga, Christchurch post-earthquake) had a significant number of stormwater treatment devices and soft infrastructure, while other areas such as Wellington, Dunedin, and small district towns had very few.

Mixed use assets formed a key subset of the databases processed by the tool, needing a separate category to flag the assets as complex due to having multiple parties interested in their function, even if there was only a single asset owner (refer Figure 4). The tool through its gateway assessments identified shared functions within a space as well as asset ownership. Flagging and recording these owners and functions set the foundation for development of Service Level Agreements that would enable delivery of the stormwater outcome but also establish the other requirements for use of the space. These service level agreements also enabled consideration of shared delivery models where multiple maintenance outcomes had defined requirements that could then be contracted to a single delivery agency, and a mechanism for cost apportionment based on the target performance for each function.

This approach also addressed a key concern raised by TLA's that emerged during the development of the water reform legislation relating to land ownership. It ensured that there was a pathway for land to remain owned by councils, but the functions that occupied that land that would sit with the water service entity or other organisation.

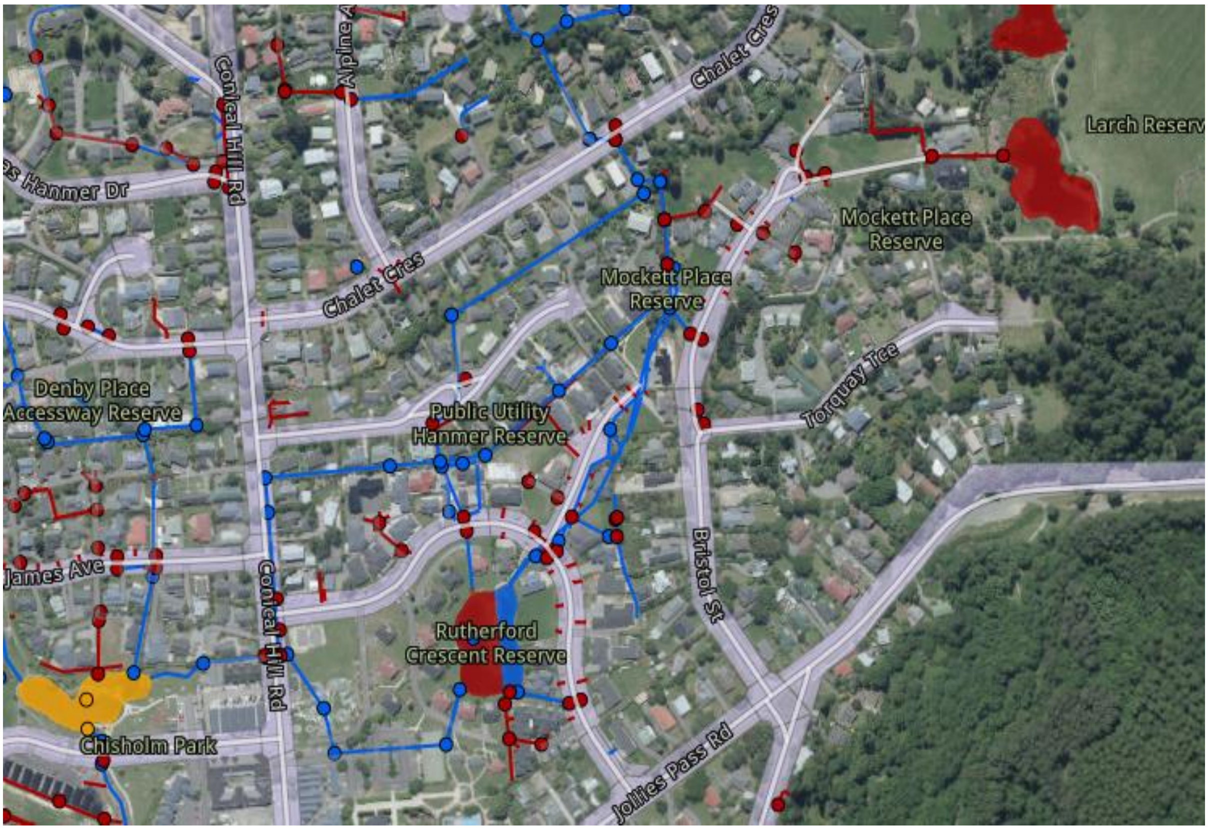


Figure 4: Hanmer, showing mixed ownership of stormwater detention and treatment areas (red = private, blue = public, orange = unknown)

2.5 PRIVATE ASSETS AND PSEUDO PRIVATE ASSETS

Large sections of data uploaded included private stormwater infrastructure. In most instances it was possible for the tool to quickly identify these as private lateral connections to the stormwater network, or private land drainage that had been captured within TLA data. However, there were several locations where stormwater pipes of significant capacity were flagged as private while also providing a wider catchment flood reduction benefit. These assets were of a size and scale that it would be unlikely for multiple land owners to be able co-ordinate to address maintenance or replacement issues that would eventuate during the asset life cycle. In some cases (e.g. Dunedin) this is a known issue, but in other cases these pipes and their significance was not known.

How private pipes, particularly laterals, are managed varies throughout the country, particularly the identification of where an asset becomes a public asset. This makes a consistent approach to asset identification and management challenging. A national standard for this would assist in asset management into the future.

Similarly there were a number of assets captured in the uploaded data that related to the operation of other public or private benefit for a specific function or land use. These included stormwater management systems for council owned and private landfill sites, drainage for sports and recreation facilities and stormwater infrastructure associated with drinking water, wastewater and administrative facilities. These assets were treated by the tool as pseudo private assets and attached to the delivery of the functions of those sites and excluded from the assets identified for transfer. This will remain relevant if a CCO model is developed, as these assets are not 'public' in the sense of draining commonly managed areas, and therefore are likely to remain as an asset for continued TLA management. In many cases the identification of these assets through this process has helped in clarifying asset management responsibilities within TLAs between separate parts within the organisation.

2.6 TRANSPORT ASSETS

Under the water reform legislation, transport assets were to remain in the ownership of the transport agency currently responsible (either a department of council, or a separate organisation). Relationship agreements were to be developed to help provide levels of service across each area. Figure 5 shows a map of central Auckland, where transport owned stormwater soakpits provide all stormwater management for the area.

Figure 5: Large area of Auckland, served by transport owned soak pits (red dots)

The challenges arising with the incorporation of the transport data in the model were three-fold.

Firstly, there was a need to establish criteria to determine what assets in the road corridor fulfilled a drainage function and what were there to protect roading assets. These criteria would then be used to select assets to be transferred and those that should remain with the Road Controlling Authorities (RCA). Most councils have ad hoc arrangements around this separation of responsibility between the roading and drainage teams arbitrarily determined on budget and/or funding conditions, or historical accidents of ownership. Overcoming this inconsistency required a lot of engagement with both asset and operational staff (who in themselves were often at odds) as well as consideration of the quality and quantity objectives of the program.

The criteria developed and generally agreed by RCA and the New Zealand Transport Agency (NZTA) were as follows.

- Kerb and channel, catchpit grates and catchpit leads connecting to an 'engineered' stormwater drainage system were to remain with the RCA.
- Conveyance and disposal assets solely dedicated to the road (e.g. rural water tables, rain gardens or urban soak holes disposing of road runoff) remained with the RCA.
- Culverts over 300mm diameter remained with the RCA.

These criteria were the most prevalent across the councils and were the most practical to apply. As with all the section conditions these criteria were able to be overridden by the Council for general or specific requirements.

The second problem pertained to data and data set veracity. While all Road Controlling Authorities (RCA) have reasonable attribute data sets in the Road Asset Maintenance Management (RAMM) system, they do not have good geospatial representation data to migrate to the decision tool. There was also a lack of connectivity across linear assets such as RCA designated pipes and drains so even after there was a visual representation there was no asset intelligence associated to help show 'what is connected to what.' To add to the complexity, whilst many councils have some form of geospatial representation of their RAMM data, the exchange of data is manual or at best batch loaded when specific demands arise. This meant that data was often out of date or simply missing.

To overcome this, the tool employed a mix of attribute analysis, asset proximity conditions and multiple runs of the model. If asset description, ownership and location met the criteria identified above they were assigned transfer status based upon those criteria. The tool also used some smart location-based testing to determine the most likely system connectivity. After each iteration of the model, the team would then discuss the results with council representatives and refine the selection conditions to arrive at a best fit. It should be noted that this best fit requirement was for a national based result meaning some councils would need to amend the in or out conditions to meet the specific requirements once they had the standardised model results for their jurisdiction.

The third challenge the team encountered was not in data quality but the impacts of change. This was not only at the technical level. The changing financial position impacted the scale of resourcing and viability of continuing service delivery due to potential reduction or increase in scale and/or complexity.

3 FEEDBACK ON THE TOOL

Once the tool had been developed it was released to a pilot group of TLA's for further refinement. This refinement process provided full access to the tool for these TLA's and used an inbuilt feedback function to capture areas where the tool was not functioning as intended or where there were unique examples within the stormwater network that had not been accommodated into the rules behind the tool. Following the refinement stage the tool was released to all TLA's that had uploaded data for use and feedback.

The feedback about the tool was positive and help from council staff led to iterative improvement of the tool. The tool provided both a mechanism to visually display and interact with stormwater asset data and was able to output draft lists of assets identified for transfer that could be worked through as the TLA's prepared for the water service entity establishment. The tool achieved its aims of reducing workload required by councils and their asset management organisations in meeting the requirements of the legislation.

One of the unexpected outcomes of the tool and its feedback function was an opportunity for TLA's to find data issues during their tool review and address these within their own data sets, effectively performing an unintended but beneficial data improvement function. The review process involved gathering a range of asset managers (Three Waters, Parks, Facilities, Roading), planners and managers to look at the results together using the webmap viewer. The benefit of gathering a diverse range of stakeholders to look at the stormwater system together was often significant. There was usually plenty of discussion as to why things were the way they were, identification of opportunities for improvement, and actions noted for improvement of asset management. While the webmap only shows a TLA their own data, having a facilitated viewing of the asset data enabled conversations to be had for which there is usually not time in the busyness of day-to-day work.

Subsequent to repeal of the Act requests were made to the NTU for copies of the tool to enable TLA's to continue to use it for data assessment and improvement

4 FUTURE USES OF DATA AND PROCESS

The consolidation of datasets will likely be required for any type of water reform over the coming years. Benchmarking at a national scale will be a valuable tool for regulation, and the formation of CCOs under the current water reform programme will require aggregation of data from multiple councils. The processes applied to the stormwater dataset could be re-purposed to other datasets to assist with nationalised aggregation of data.

The limited resources available to stormwater management in New Zealand means that any efficiencies gained in the data and asset management space will lead to clearer and more robust prioritisation of issues, and better use of resources in addressing outcomes.

5 CONCLUSIONS / RECOMMENDATIONS

1. **Data standardisation is essential.** The only way that asset data such as these can be benchmarked or aggregated is by standardising the data. The project undertaken by the NTU in preparation for the reform mapped stormwater asset datasets from 66 councils into a common format (for a select set of parameters while retaining unique asset ID's). For future water service organisations, regardless of their scale or composition, this will also be an essential step. Methodologies adopted for this project can be very efficiently modified and used for this purpose, and the process was designed to be applied repeatedly as new datasets became available.
2. **Stormwater asset management requires a flexible, collaborative approach** between all parties. While it may be possible to 'split' ownership across multiple agencies, responding to flooding events, maintenance issues and making the best use of opportunities for stormwater treatment requires all parties to work together to achieve common outcomes. The regulatory environment for operation of stormwater networks has also matured over time, bringing in new and sometimes challenging additional value considerations that were not factored into original decision making.
3. **Stormwater treatment has occurred due to 'opportunity'**. It is very difficult to retrofit stormwater treatment, and TLA's have taken opportunities to do so where they can. Christchurch, for example, has had the opportunity to rebuild following a major earthquake. Auckland and Hawke's Bay TLA's are now looking to take an opportunity following major floods. Fast growth in areas such as Queenstown and Wānaka has resulted in 'pockets' of treated subdivisions, enabled via developer requirements. Inclusion of identified opportunity areas during catchment planning enables quick response to major disruption events to build back better, including treatment and blue/green infrastructure choices.
4. **Stormwater planning using an integrated catchment approach** is essential for managing stormwater. Stormwater cannot be contained within imposed boundaries of a closed network asset management that focuses solely on hard assets owned by a single party. This becomes particularly evident when the capacity of that network is exceeded by large storm events or that network is reliant on other features, and natural watercourses for conveyance of flows. The management of the conveyance function of urban water ways and overland flow paths forms part of integrated stormwater planning and building knowledge of these assets and functions through a standardised approach to modelling and recording data. Its interface with existing asset data for hard assets supports the use of a nationally consistent approach for stormwater management.

ACKNOWLEDGEMENTS

The team would like to acknowledge and thank the staff in the now dis-established National Transition Unit within the Department of Internal Affairs. Tight timeframes and an enormous task were met with considerable dedication and hard work.

Council staff who were already very busy brought their expert skills and institutional knowledge to the table, providing data and supporting the project on top of their day jobs, during a stressful time of change.

The multi-organisation consortia team and Entity Leads worked together collaboratively, leaving their affiliations at the door to achieve the best outcome for the project.

Ngā mihi nui ki a koutou.