URBAN INTENSIFICATION – THE WASTEWATER IMPLICATIONS

Brayden Barnett, Harrison Grierson Ltd

ABSTRACT

It is well publicised that the demand for housing in growing urban centres significantly outstrips the current supply. The demand is progressively being catered for with a mix of new greenfield subdivisions and redevelopment of brownfield sites. This intensification will only place additional stress to an already overloaded network.

This paper will discuss implications observed on the existing wastewater network as a result of this widespread urban intensification and the effects on relevant stakeholders. In general we will be referring to areas where a greater percentage of residential and commercial lots are being developed or construction of multi-story buildings on previously underdeveloped land.

The way in which new wastewater assets are designed and constructed continue to evolve to ensure robust solutions to the additional constraints of an intensified city are provided. We will discuss in depth the major constraints in reference to two general scenarios which are relatively common:

- Connections to a wastewater network that is currently at capacity
- Renewals and upgrading of existing infrastructure in an intensified or soon to be intensified land.

We will explore some of the constraints and corresponding learnings from the perspective of asset owners, developers and the community as a whole.

KEYWORDS

Wastewater, capacity, constraints, augmentation

1 INTRODUCTION

Defining infrastructure of an urban centre includes: transport, water, energy, telecommunications and social. All five of these pillars are critical in the successful operation of a functioning city. As cities work towards visions of becoming more liveable areas, the provision of this infrastructure is essential to achieving growth and reaching this vision.

It is well reported that population growth provides economic benefits for the community's that the growth occurs in. Cities are currently undergoing unprecedented urban growth fuelled by record migration, high business confidence, record low interest rates and reports of record building consents being approved.

Wastewater is one aspect seldom discussed, usually hidden underground and kept out of sight, but is one of the fundamental issues which constant investment needs to be prioritised. This paper explores some of the challenges that are becoming more common during the design and construction phases of new developments, and the renewal and rehabilitation of existing wastewater networks. We will explore these from the perspective of the asset owner, developer and third parties/the community.

2 IMPACT OF INTENSIFICATION

Auckland's wastewater infrastructure, like many other urban centres, is not getting any younger. With the majority of the wastewater networks value being below the ground, ongoing tender love and care to service the continual developments and change being carried out above ground. As in Aucklands case, the existing network asset base of 7900km of pipelines and 165,000 manholes with an approximate replacement value of $6 billion. As outlined in Watercares recently published Asset Management Plan, a forecast of $6 billion has been derived for wastewater infrastructure over the next 20 years.

An example, the number of people in Auckland to grow by 1 million people in the next 30 years. The PAUP proposes significant intensification across Auckland with three quarters of a million people to be located within the existing urban area. Utility organisations around New Zealand, are under constant pressure to provide additional capacity to their communities and address the renewal of the ageing existing infrastructure. Increasing costs arise particularly through specific requirements for renewals of extensive aging asset bases and to service growth in rapidly growing areas. These organisations require innovative approaches and the use of robust construction methodologies to live up to their missions, demonstrate cost effective solutions while adhering to relentless cost pressures.

Infill housing, terraced housing and multi-storey apartments within existing urban extents will form the majority of the additional demand on the aging infrastructure. As in most cases, the oldest infrastructure is in the central portions of the city, with new infrastructure typically added around the fringes as required.

Implications of this intensification can be generally put into the follow categories:

- Reduced level of service
- Increased risk of overflows
- Poor local growth

The following case studies provide a high level review of two situations which are occurring and will continue to occur at the intensification within the urban limits continue to develop.

Case Study 1 – A new development where the current network is at or nearing capacity

Case Study 2 –Robust rehabilitation and replacement of existing infrastructure to ensure high levels of service.

3 CASE STUDY – DESIGN IMPLICATIONS

3.1 THE PROJECT

A new multi-storey development complex consisting of 250 residential apartments and approximately 5000m^2 of commercial/retail space was proposed on a large section, previously utilised for cark parking during events, conferences and overflow car parking from the surrounding businesses.

The development is located in a well-established suburb. The central location makes it a premier choice due to the close vicinity to supermarkets, public transport, school zones, parks and even a hospital. The developers mandate is to create a well-planned, connected and small community atmosphere. As there is further land that could be potentially developed, consideration to the future proofing of any proposed scheme needed to be considered as part of any solution.

3.2 CONSTRAINTS

Generally, demonstrating that capacity exists or that the development won't have adverse effects on the existing infrastructure is required to enable the proposed connection to be accepted. During the initial phase of the project, an infrastructure assessment was carried out to assess the current infrastructure in the catchment and the likely flows to be generated by the development. It was promptly identified that the adjacent gravity wastewater network serving the catchment was at or nearing capacity at peak times.

A further assessment and review of the downstream catchment was taken place to identify any capacity restraints in the network which could be resolved to potentially provide additional capacity. A review of the GIS information showed a decrease in the pipe size at several locations along the pipeline. During this phase, engagement with local utility provider was carried out to develop a range of servicing solutions in a transparent manner. As part of this process, the utility provider carried out several site visits to confirm the sizing of the downstream network and updated their hydraulic models. This did not result in any change to the initial capacity constraints.

As a result of these initial options assessments and working alongside the utility provider, an agreement was reached to determine a maximum level of flow that was acceptable to be discharged into the existing network. These flows could only be pumped at nominal times throughout the day during low flow periods and continuous discharge overnight up to the maximum level of flow.

Also, with high density developments, allocation of land to be used for the pumping station, maintenance and odour issues are also big constraints and specific design solutions have been carried out to address these additional constraints which are included as part of the holistic solution.

- Odour Control – Cafes, apartments in the vicinity
- Overflows – not acceptable
- Emergency Generator
- Access for maintenance

Obviously such infrastructure requires a significant site foot print, robust odour control and not to mention provision for storage capacity and making the system flexible enough for potential future stages.

3.3 OUTCOME

Following a rigorous options assessment process based on the constraints of the network, the design of a private pump station was the most robust solution. This pump station was designed to take the following into account:

- Sufficient storage for a day's wastewater storage
- Future proofing for additional development
- Continuous pumping overnight and intermittent pumping at selected times throughout the day
- Emergency generator onsite to reduce size of emergency storage tank footprint

This is a site specific solution developed for a particular set of constraints and given the size of the project, the value resulting from a private pump station far exceeds the reduction in size of the development, contribution to the upgrading of downstream infrastructure or delaying the construction. The pump station was successfully designed and optimised to work within the flow constraints agreed on.

The upgrade is part of the medium term planning for the utility provider, so the flows could be potentially be increased as hydraulic capacity is increased downstream once network augmentation is carried out in the future.

3.4 STAKEHOLDERS

Asset Owner: Levels of service for the existing users could not be comprised, as the current network services a critical area. This is also a form of “sweating the asset” to optimise the existing network performance as much as possible in order to gain efficiency of the asset. This also delays significant capital expenditures in the short term which can be elsewhere in the system.

Developers: The developer has had the cost of additional up front capital expenditure before any of the apartments are connected. Also the owners will need to contribute to the ongoing maintenance of such a system.

Body Corporate/Owners: costs for operating and maintenance will need to be incurred. Risks also associated with odour if the system is poorly maintained.

Community: Level of service for existing users should not be compromised. Flows from this development will not impact any users in the catchment.

4 CASE STUDY – CONSTRUCTABILITY IMPLICATIONS

4.1 THE PROJECT

This particular case study explores a selection of constraints incurred in the construction and rehabilitation process of urban pipeline. This section of paper will not focus on a particular project, but elaborate on observations made during a selection of similarly scoped projects throughout an urban region. Typically these projects involve either upgrading or rerouting pipelines, or rehabilitating existing pipelines.

Typically the thought of carrying out pipeline replacement/renewals involves shutting down a section of road for a period of time and installing a pipelines. This is also the case with many residents who are barely aware of the infrastructure within their boundaries.

The types of projects generally fall into at least one of these categories, these generally require specific consideration in engineering design and are not routine in nature:

- Significant disruption if breakage occurs
- Deep pipelines
- Pipeline with private properties and/or under buildings
- Critical function in the network (rising mains)
- Services hospitals
- Service large catchments (large diameter/large flows)
- Difficult access

4.2 CONSTRAINTS

As part of these types of work, the job site vary, from locations, to pipe sizes to pipeline renewals and pipe bridge replacements. But some of the biggest constraints with carrying out these work in an efficient manner include some of the following:

1) Restricted Access:

Typically as a result of infilling residential lots in suburbs with large sections. Figure 1 illustrates a typical example of the access restrictions due to the infilling of lot. Often, these situations can occur during the lead times between design, tendering and to construction commencing.

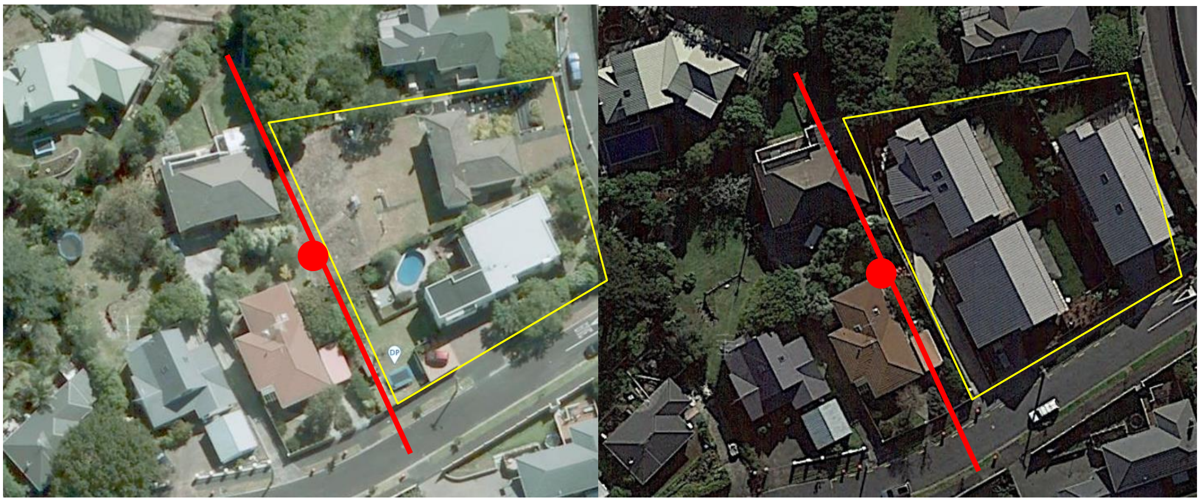

Figure 1: Typical changes in access to the network

As the majority of cities are generally serviced by gravity, the depths at which excavations are required, constructability using trenchless techniques and size of machinery required, these access restrictions can result in additional risks that need to be address and subsequent costs being incurred.

Alternative routes of access may cause significant disruption to the land owner and significant financial cost to the asset owner. Where available, pipelines should be constructed close to boundaries. Communication with landowners also needs to be had to there future plans with the property and how the pipeline may affect these plans. The long term needs to be considered.

2) Landowner approvals:

Determining the actual owners of the properties. A lot of these propoerties are owned by trusts, therefore it is difficult to make contact with owners. Permissions can also be significantly influenced on the political beliefs and previous interactions with utilities companies or Councils organisations.

3) Flows:

Significant flows need to be bypassed during cut-ins and cut-overs. Risks of overflows

It is now becoming more common to plan and design the proposed works, put it out to tender, and find that the on-site conditions have changed significantly from the original methodology initially planned during the tendering process.

4.3 OUTCOME

Below are a brief outcomes and strategies used to overcome these constraints. Different consruction methodologies are extensively covered in other papers, we will focus on the higher level outcomes of these technologies to meet stakeholder expectations.

Restricted Access: New pipelines should be designed with the future instensification in mind.

It is easy to just say that all future pipelines shall be located within the road reserve or within public land, but as we know with gravity pipelines, we are constrained by the topography and the depths that are tolerable to the asset owner. Diverting pipelines through parks and schools becomes a much more appealing option for areas more intensified areas. For the most part, the grades cannot be changed significantly within a gravity network, particularly for a well-established cities as a change in grade at one point changes the hydraulics while the utmost is done to not install pipelines within private properties, we are governed by the invert levels of the upstream and downstream manholes.

During rehabilitation and renewals works there is a lot more uncertainty and risk therefore contractors and asset owners/operators must be agile with the methodologies used to enable robust innovate solutions to be developed and implemented. These include traditional open cut, directional drilling and other trenchless techniques.

Landowner approvals: Collaboration during construction- one of the key component to meeting the project objectives is the active collaboration between all stakeholders, whether it is the asset owner, contractor, designer, environmental compliance, iwi down to individual homeowners. Meetings, site visits, risk workshops, etc.

Flows: flow monitoring data in the network is essential, this includes the storage capacities of pump stations. It is also important to assess the upstream catchment of the system. In one particular case, the upstream catchment is a main hospital. The consequences of poor construction and bypassing methodologies would be catastrophic compared to that of several residential dwellings that could not be used for two days.

It is understanding the constraints, all stakeholders' expectations and determining an economic solution to work within the parameters to achieve the desired outcome.

4.4 STAKEHOLDERS

Asset owners - these organisations are serving their respective communities. Eventual Operators, and those that a responsible for the level of service to the respective communities. Restricted access to sites and their assets is becoming a significant burden for the asset owner in terms of maintenance and more importantly, the renewal or replacement of the asset particularly cost implications and the risks asscociated with the works.

Landowner – Landowners need to be fully educated as to why access is required on their properties and realistic programmes must be provided to ensure a successful working relationship. If the landowners have special requests, these should try to be accommodating to the best of all stakeholders abilities.

Contractor – Although the methodology of works origninally tendered for has changed, the Contractor needs to be realitively agile and solution oriented. Need to work in a collaborative manner with the designers and asset owner such as early contractor involvement.

Communities - directly affected by decisions, construction programmes, operational and costs. The community is impacted in terms of ongoing maintenance, overflows and potentially loss of income. Communication and tolerance to these works are different areas of the city, therfore the approach and ongoing liasion stratigies need to be modified. Any type of physical works can be stressful for the general public. This may be in the form of traffic delays, reduced car parking, and perceived excessive timeframes.

5 KEY LEARNINGS

While it is not foreseeable to prevent intensification occurring, there are implications to all stakeholders. Below are a summary of the key learnings derived over a brief period of time based on works carried out in the case studies outlined above:

- Setting of expectations. One of the main constraints to solving these problems is setting the expectations at the start. This enables a much more transparent process. With all parties aware of the goals that need to be accomplished.

- Operators of the need to be involved at the start of the projects

- For any solution, the engagement of all stakeholders is required.
- There are always risks to any solution. These must be identified and dealt with in a transparent manner.
- Compromising the level of service to existing users is not acceptable
- Active collaboration by all parties is critical in the success of reaching the desired outcomes.
- The procurement model for the work must be used to drive best value for all stakeholders.

ACKNOWLEDGEMENTS

Infrastructure & Networks team at Harrison Grierson.

REFERENCES

Patterson Horner, A. and James, D. (2015) 'A Journey from Age Based Renewals towards Optimised Long Term Condition Based Renewals'

The Auckland Long Term Plan. http://theplan.theaucklandplan.govt.nz

Asset Management Plan 2016 to 2036, Watercare Services Limited, https://www.watercare.co.nz/SiteCollectionDocuments/AllPDFs/Watercare-Asset-Management-Plan-2016-2036.pdf

Map data: Google, DigitalGlobe