PLANNING TO REDUCE FLOOD RISK – TAKANINI NORTH

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ABSTRACT

Over 30km^2 of rural land in south Auckland has been earmarked for development. The area has the potential to allow for approximately 50,000 new homes, or four years of Auckland's housing supply. Approximately 6.5 km^2 of this growth area lies within the Greenfield area of Takanini North. The Takanini North area has some promising features including flat topography, close proximity to the CBD, and existing rail and motorway corridors. However flood risk, existing downstream development and the underlying geology are major constraints in the Takanini area. The topography and historic farm practices have also limited the primary drainage network. Therefore considerable investment in bulk stormwater infrastructure is needed to maximise development opportunities.

Greenfield development provides an opportunity to take a holistic design approach to flood risk. An early and integrated planning approach across multiple properties allows a consolidated response to flood risk management as part of the overall strategic planning process. This enables future growth while providing protection from flooding for established urban areas downstream. Other flood management benefits include integrating stormwater infrastructure across ecological and park amenities and multimodal transport. This leads towards high quality social, economic and environmental outcomes for these growth areas. This approach has been followed and is being realised in a similar Greenfields development area in Takanini South.

The Takanini South scheme represents an innovative stormwater management approach applied to a live zoned development area. The Takanini South project has highlighted issues that will need early consideration for any potential development of other rural zoned areas such as Takanini North and the wider south Auckland growth area, including:

- Early, integrated planning.
- Protection of strategic land from subdivision and development.
- Impact of land value as a result of land use changes.
- Importance of comprehensive framework planning.
- Adapting existing or introducing alternative funding models.

This paper explores, from a stormwater planning perspective, the challenges and solutions associated with developing bulk stormwater infrastructure to service Takanini North and mitigate the existing flood risk downstream.

KEYWORDS

Planning, Wai Ora, Flood Management

PRESENTER PROFILE

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1 INTRODUCTION

In today's environment of rapid urban expansion causing development of rural areas, bulk stormwater infrastructure is sometimes the most practical option to service Greenfields development areas.

At 56 km^2, the Papakura Stream catchment produces 10,600,000 m^3 of runoff, resulting in a 5,600,000 m^2 floodplain. A Greenfield area in Takanini North is zoned for future development within the Papakura Stream catchment which is 6.5 km^2 in area and will almost double the urban area within the catchment. The proposed growth area has poor ground conditions and already suffers from significant flooding issues. The growth and associated increase in runoff from the proposed development area also creates a considerable flood risk management challenge. Creative planning of development infrastructure is required to optimise conflicting priorities and to manage the flood risk both in the proposed development area and the already built urban areas downstream.

This paper explores, from a stormwater planning perspective, the challenges and solutions associated with developing bulk stormwater infrastructure to service Takanini North and mitigate the existing flood risk downstream.

2 BACKGROUND

Auckland is the fastest growing city in New Zealand, with population projections exceeding 2.4 million people by 2047 (Auckland Council, 2017) and pressure being placed on the existing infrastructure across the region. Auckland Council's key role is to identify and deliver development opportunities to meet the growing needs of the region. Auckland Council's Healthy Waters Department operates and maintains the existing stormwater network, while planned extensions and enhancements to the stormwater network serve to manage flood risk and facilitate growth (Nitsche et al, 2016).

The Auckland Unitary Plan (operative in part) outlines the development rules that support the aspirations for Auckland that are documented in the Auckland Plan and proposes the development time frames for the next 30 years in the Auckland Region. The Unitary Plan rezoned some areas in the region for growth in 2016, and also includes "Future Urban Zones" (FUZ) areas which will be live zoned and developed in future years. It is essential to proactively plan development of these FUZ areas in order to maximise the development opportunities as these areas come forward for development. Taking a consolidated design approach that incorporates flood risk management as part of the strategic planning process will maximize Auckland's ability to cater for future growth while providing protection from flooding.

Auckland's Future Urban Land Supply Strategy (FULSS) governs when which areas earmarked for growth are to be brought forward for development. The scale and

timeframes required to develop the necessary supporting infrastructure are a key input into the FULSS. The Strategy ensures a continuous supply of land is brought forward over the next 30 years to meet Auckland's growth demands (Auckland Council, 2017).

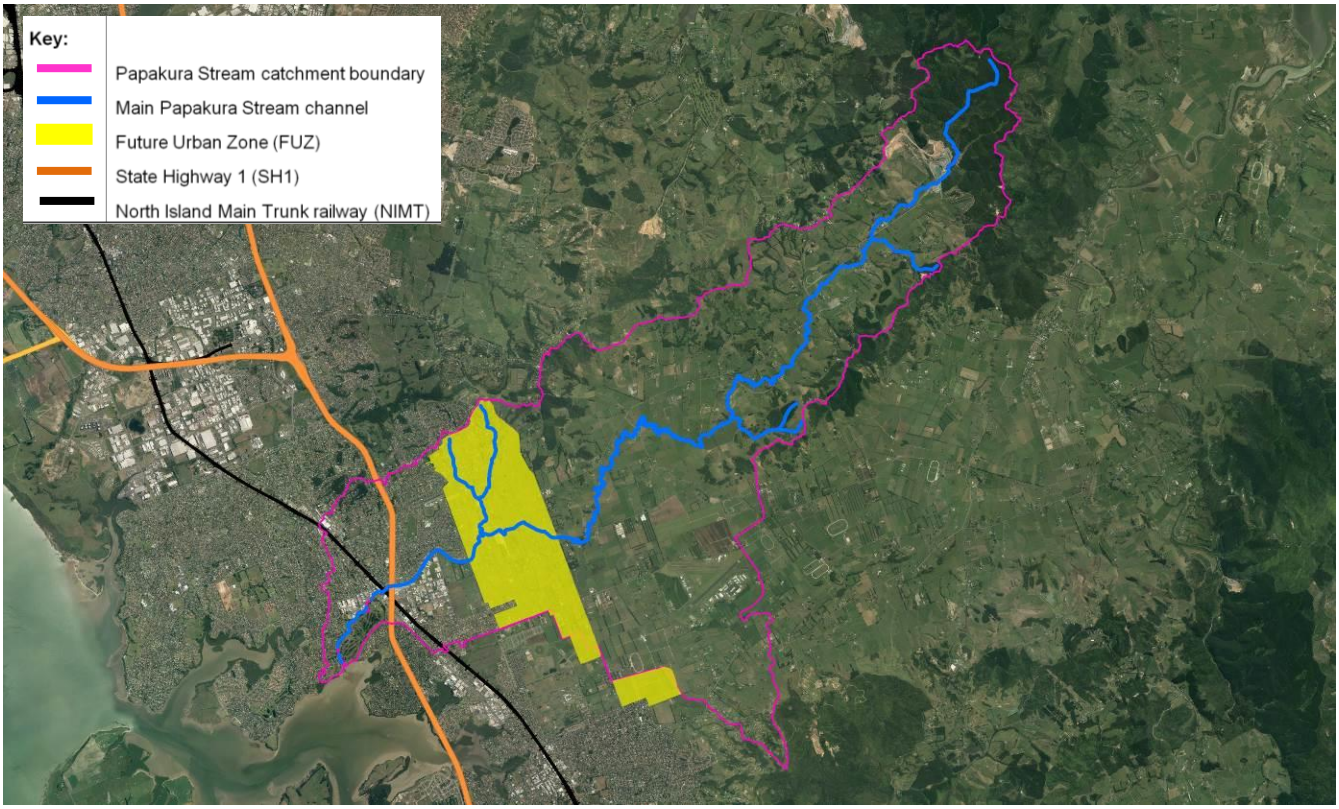
The Unitary Plan identifies extensive areas of rural land in the southern Auckland Region as FUZ. A pre-feasibility options study was carried out for the Takanini North FUZ in the south of the region and was utilised to inform Auckland's FULSS and define the appropriate development timing for the FUZ.

3 TAKANINI NORTH FUTURE URBAN ZONE

Due to existing major transport corridors in the area, a FUZ of 6.5km^2, is proposed in Takanini North, which lies within the Papakura Stream Catchment. The Papakura Stream's headwaters are located in the Clevedon Hills and the predominantly rural stream catchment (Figure 1) drains through the township of Takanini before discharging into the Manukau Harbour.

Development of the FUZ would double the urban area in the catchment and if zoned for residential development, could allow for the development of up to 4,400 new dwellings. The extent of the FUZ area is shown in Figure 1. The Takanini North FUZ is bordered by Mill Road on the upstream boundary and Porchester Road at the downstream boundary.

Figure 1: Location of the Takanini North FUZ within the Papakura Stream



Considerable investment in bulk stormwater infrastructure is needed to maximise development opportunities in the Takanini North FUZ. An advanced design approach, with integration across ecological and parks amenities and multimodal transport options, will result in further benefits being realised. This growth area provides a potential opportunity for a consolidated response that incorporates flood risk management as part of the strategic planning process, thus enabling future growth while providing protection from flooding for the established urban area of Takanini downstream.

3.1 PAPAKURA STREAM CATCHMENT AND FLOODING HISTORY

The Papakura Stream catchment is 56 km^2 in area and produces over 10,000,000 m^3 of runoff in a 1% Annual Excedence Probability (AEP) event (TP108 100 year 24 hour rainfall depths of 200-230mm). The stream is highly constrained through the urbanised area of Takanini at the downstream end of the catchment where the stream channel is heavily engineered and further constrained by the three bridges of the SH1 motorway, the North Island Main Trunk railway line and Great South Road, all falling within a 500 m long reach of the main stream channel.

The engineered channel conveyance capacity through the urban area is in the order of 90 m^3/s. Detailed hydrological analysis, indicates the 1% AEP peak flow (including an allowance for climate change) is approximately 240 m^3/s. Neither the engineered channel nor the three bridge structures has the capacity to convey the 1% AEP flows. As a result, there has been widespread flooding of the existing urban area, including residential, commercial and industrial buildings, most notably in 1953, 1965, 1985, 2011 and 2017 (Figure 2).

Figure 2: Flooding in the Papakura Stream Catchment, March 2017

Flooding downstream of Mill Road, in the Takanini North FUZ area

The flat areas of the urban Takanini area, the Takanini North FUZ area and the rural area upstream of the FUZ are all affected by extensive areas of floodplain. Within the FUZ area, the northern side of the channel is steep and includes two significant tributaries to the Papakura Stream. The southern part of the FUZ area is flat, underlain by peat soils and does not include any stream channels of note.

Management of flooding and minimizing effects on others is therefore an important consideration for development located in this future growth area.

3.2 OTHER CONSTRAINTS TO DEVELOPMENT

As well as flooding constraints, the Takanini North FUZ area is affected by a number of other constraints that will pose technical challenges to the development of bulk infrastructure to service this growth area. These are described below and illustrated in Figure 3.

3.2.1 PEAT SOILS

Parts of urban Takanini and the rural FUZ are underlain by extensive areas of deep peat soils, up to 50 m in depth in place. These peat soils have fluctuating ground water levels, up to or above ground level during winter, and up to 4 m below ground level in the summer months. Large areas of low-lying land are inundated for the majority of the winter months. The poor ground conditions limit development intensity and decrease the feasibility of installing above and below ground infrastructure, primarily due to the potential risk of ground settlement. Large pipe fittings are buoyant in these ground conditions, and this may cause pipes to lift due to high groundwater pressure.

3.2.2 DOWNSTREAM CONSTRAINTS

The Papakura Stream passes through the Mill Road and Porchester Road bridges at the up and downstream boundaries of the FUZ. Both of these bridges are sized to take less than the 1% AEP peak flow.

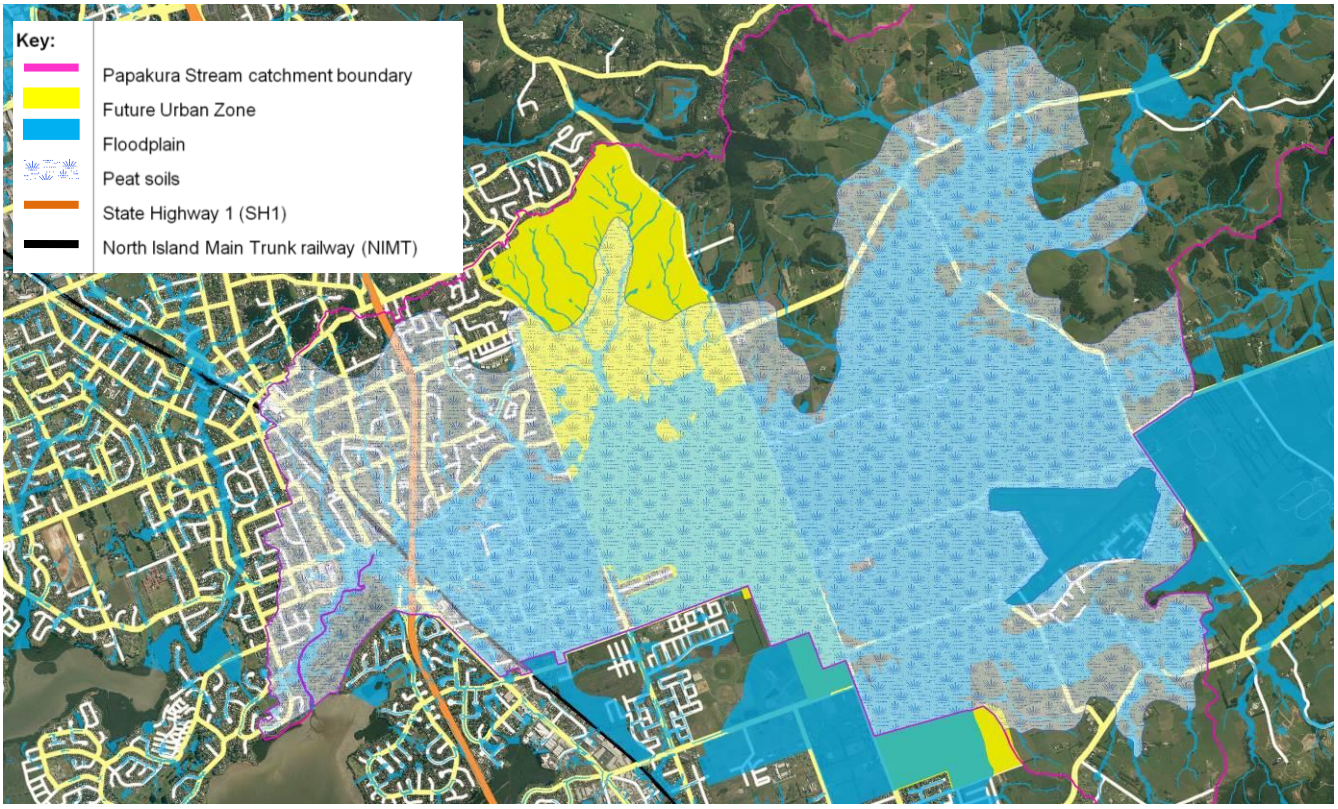
Further downstream in urban Takanini, three major bridges (SH1 motorway, NIMT rail and Great South Road) further constrain flows in the Papakura Stream. These bridges are located close together along a 500 m reach of the Papakura Stream.

3.2.3 LACK OF LOCAL DRAINAGE

The area of the FUZ south of the Papakura Stream does not include any tributaries to the Papakura Stream. This flat rural area is typically serviced by open road-side drains. Many of these drains have no discernable grade. Whilst some of these drains are connected to the Papakura Stream, others are isolated with no outlet. Many of these drains are affected by ground water infiltration, and may have no capacity to provide stormwater drainage during periods when ground water levels are high. The area is therefore subject to surface water flooding and local flooding as well as the flooding from the main Papakura Stream channel.

Parts of the northern FUZ are steeper than the south part of the FUZ with well-defined tributaries. These tributaries are generally incised with grassed banks. However, the area is still affected by extensive floodplain from the Papakura Stream and underlying peat soils in places.

Figure 3: Floodplain and peat soil extents within the Takanini North FUZ



4 LESSONS FROM TAKANINI SOUTH

A Greenfield residential zoned growth area is located to the south of the Takanini North. The southern Takanini growth area shares many of the same characteristics as the Takanini North FUZ, including extensive areas of peat and floodplain.

The Takanini South catchment has recently been rezoned for development as the Takanini Strategic Housing Area (SHA). Similarly to the Takanini North area, there is an existing urban area downstream that is also prone to flooding. The Takanini South development includes the construction of the Takanini Cascades which comprises of a man-made stream with a width of 25-50 m to cater for flood flows. The channel intercepts and diverts flood flows and additional runoff due to development via a large box culvert and tunnelled pipeline to Pahurehure Inlet and into the Manukau Harbour which is approximately 3.5 km south from the Papakura Stream estuary. The Takanini Cascades project represents a quite radical intervention in flood risk management and growth facilitation for Auckland.

The Takanini Cascades concept, with an area of 8 ha of land, represents a pilot scheme which so far has highlighted a number of issues that will need early consideration for the wider Papakura Stream catchment and the Takanini North FUZ including:

- Early, integrated planning.
- Protection of the strategic land from subdivision and development.
- Impact of land value as a result of land use changes.
- Importance of comprehensive framework planning.
- Utilising and enhancing existing or possibly introducing alternative funding models.

Due to the close proximity and similar characteristics of the Takanini South growth area to the Takanini North FUZ, it has been assumed that many of the same design principals can be similarly applied to the Takanini North FUZ.

5 TAKANINI NORTH OPTIONS

A typical approach for new developments is to attenuate only the differential flows between pre and post development. This approach does not resolve existing local flood risk within the FUZ, and will not resolve the existing flood risk in the already developed area downstream.

The scale of the Takanini North FUZ provides a very real opportunity to proactively plan this development area early and maximize the potential benefits. By following a whole catchment approach, rather than allowing for piecemeal development, the potential opportunity to reduce flood risk in both the FUZ and the urban area of Takanini, downstream is maximised.

Auckland Council's Healthy Waters department is proactively considering high level options for the Takanini North area to test whether the following are feasible:

1. Management of post development flows.

2. Reduction of local flood risk within the Takanini North FUZ to facilitate development of this proposed growth area.

3. Reduction of the existing flood risk at properties and key infrastructure downstream.

A range of options for each of these mitigation approaches were investigated by Mott MacDonald (2017) and are discussed at a high level below.

5.1 MANGEMENT OF DEVELOPMENT FLOWS

Potential development of the FUZ is likely to increase local runoff by approximately 40 m^3/s and 190,000 m^3 in the 1% AEP event. Development of this area has the potential to significantly increase the existing flood risk downstream in urban Takanini for localised or short duration storms.

Local site attenuation and/or flow management requirements and the associated land take will therefore be critical when zoning of this growth area is planned.

There are very limited approaches for the management of development runoff in Takanini North.

1. Taken from the Takanini Cascades to the south, the potential concept of open, wetland channels for conveying both the 10% and 1% AEP flows from the site was considered. This approach has been shown to work in Takanini South, which shares similar flat topography and existing widespread shallow flooding.

2. Stormwater Conveyance for the northern FUZ through formalisation of the existing flow paths and streams.

The scale of the FUZ area to the south of the Papakura Stream is so large that any conveyance channels would need to be in the order of 30 m wide at the upstream

extents, widening to an 80m wide channel top width at the downstream extent. The overall land take for these conveyance channels is therefore significant. However, there is the opportunity to provide the local community with shared space and amenity adjacent through these channels whilst providing additional riparian habitat.

The steeper topography of the northern side of the Takanini North FUZ area requires a different approach to those considered for the southern FUZ. The northern FUZ also has different underlying soils (silty loams and clays) and a more confined floodplain. Local stormwater conveyance from the northern FUZ to the main Papakura Stream can be made by utilising the existing stream network. However, the existing channels would require formalization, possible channel extensions, and the creation of esplanade reserve areas. The work requirement will be dependent on the outcomes of detailed site investigation and careful consideration of the FUZ as a whole.

5.2 MITIGATION OF PAPAKURA STREAM FLOODING

The Takanini North FUZ is impacted by flooding associated with the Papakura Stream due to locally flat topography and the large upstream contributing catchment area. Mitigation options considered:

1. Mitigating the effects of the proposed development only (no increase in flooding).
2. Decreasing the flooding extents from the Papakura Stream within the FUZ.
3. Decreasing flood risk in the already developed area of Takanini, downstream of the FUZ.

A number of options were considered including:

1. Increasing the channel conveyance of the main Papakura Stream right through to the estuarine receiving environment.
2. Local attenuation to mitigate the effects of increased runoff from the FUZ only.
3. Attenuation upstream of the FUZ to mitigate flows through the FUZ and further downstream.
4. Floodplain consolidation, to maximize developable area without increasing flood risk.
5. Within FUZ floodplain excavation to mitigate existing flood risk downstream.
6. Diverting flood flows via flood tunnels.

The works associated with all of these options are large scale and carry inherent risks, including dewatering and associated settlement, potential for increased sediment loads, damage to existing habitats and poor ground conditions. The costs associated with earthworks on this scale are high and the landtake required to achieve these options is extensive.

6 DISCUSSION

As expected, the options work found that the creation of additional storage through excavation works is inefficient due to the large volume of runoff from the upstream

contributing catchment. Large scale storage options are only likely to achieve a reduction of flows from over 250 m^3/s to 165-215 m^3/s in the 1% AEP at the downstream FUZ boundary. However, the channel and bridge constraints downstream cannot convey more than $90m^3/s$ of flow, so flood risk in the downstream urban area would only be partially reduced. The local increase in runoff that will be associated with the development of the FUZ would also still require mitigation.

All options considered within this study have significant technical challenges associated with them, primarily due to the constraints imposed by the underlying peat soils. This includes both Health and Safety risk during construction and the risks associated with settlement of the adjacent land over the longer term.

Development of the Northern FUZ only is potentially a way to avoid the risks and construction costs associated with the peat soils in the southern part of the FUZ. However, development in the steeper northern area only will still increase flood flows and levels in the 1% AEP event, resulting in larger flood extents and depths. An extensive land take area will still be required for the management of this increase in runoff as the cumulative effect of piecemeal development will be significant. A consolidated stormwater management plan will be required to prevent piecemeal development from resulting in increased flood risk both within the FUZ and in the urban areas downstream.

The excavation of large scale attenuation areas is potentially problematic. Due to the flat grade, only a relatively shallow excavation is possible, so the associated land take required will be correspondingly larger.

The scale of the infrastructure required to service the Takanini FUZ area is well beyond that considered for stormwater management elsewhere in the Auckland Region. While large scale attenuation features such as those proposed here have been implemented in New Zealand, these generally utilize existing stormwater features where the land is vested as reserve area. The cost of the infrastructure and the cost of the associated land take will be important considerations for zoning of this FUZ area in the future. An early strategic planning approach will be required to secure up to 167Ha of land for stormwater management purposes.

If the cost of the required infrastructure is adequately offset by the value of the unlocked developable area, Structure Planning will be an important mechanism to protect the strategic land from subdivision and development. At this stage, the Takanini North FUZ area has not been brought forward for Structure Planning. This is because other extensive areas in south Auckland identified for growth have been earmarked for development sooner. Auckland Council will have to manage the issue of Private Plan Change applications by developers seeking to bring their land holdings forward for development early. Piecemeal development without consideration for the whole growth area will reduce the development potential of the FUZ as a whole. Early planning will also identify which areas of land are required for stormwater management and theoretically limit the escalation of land costs by speculators.

The high cost of the bulk infrastructure required to service the Takanini North growth area is likely to require alternative funding models. Delaying development in this area through the sequencing plan laid out in the Auckland FULSS will ensure there is adequate time to plan the infrastructure required to service this area. Early planning and community engagement will allow this development area to achieve improved social, economic and environmental outcomes.

7 CONCLUSION

The early pre-feasibility work described in this paper was used to inform Auckland's FULSS, which governs when which areas earmarked for growth are to be brought forward. The Strategy ensures a continuous supply of land is brought forward over the next 30 years to meet Auckland's growth demands (Auckland Council, 2017). The scale of the required bulk infrastructure, cost estimates and timeframes required to develop the infrastructure are a key input into the Land Supply Strategy.

While the options work described in this paper was undertaken at a high level, the work outlined here provided a key input into the sequencing for Takanini North. In this case, the outcomes of the project highlighted the significant flooding challenges associated with developing the Takanini North FUZ. As a result, the proposed development sequencing of the Takanini North area has been moved back by a further five years to 2043-2047 in the FULSS.

ACKNOWLEDGEMENTS

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