Watercare Services Limited

Motions Catchment Improvement

Flood Risk Assessment

August 2025

Jacobs

Watercare


Ki te ora te wai, Ka ora te whenua, Ka ora te tangata

Document Control

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1 Introduction

1.1 Watercare

Watercare Services Limited (Watercare) is a lifeline utility responsible for the planning, maintenance, and operation of wastewater services to communities in Auckland. Its activities and programmes are funded through user charges and borrowings. Watercare is required by the local authority, by the Local Government (Auckland Council) Act 2009, to be a minimum-cost, cost-efficient service provider.

Watercare collects wastewater from 1.7 million people's homes including trade waste from industry, through approximately 8,700 Km of pipelines. It pumps through 534 pump stations, treats approximately 410 million litres of wastewater daily through 18 treatment plants and disposes in environmentally responsible ways to protect the public health, the local environment and coasts and harbours.

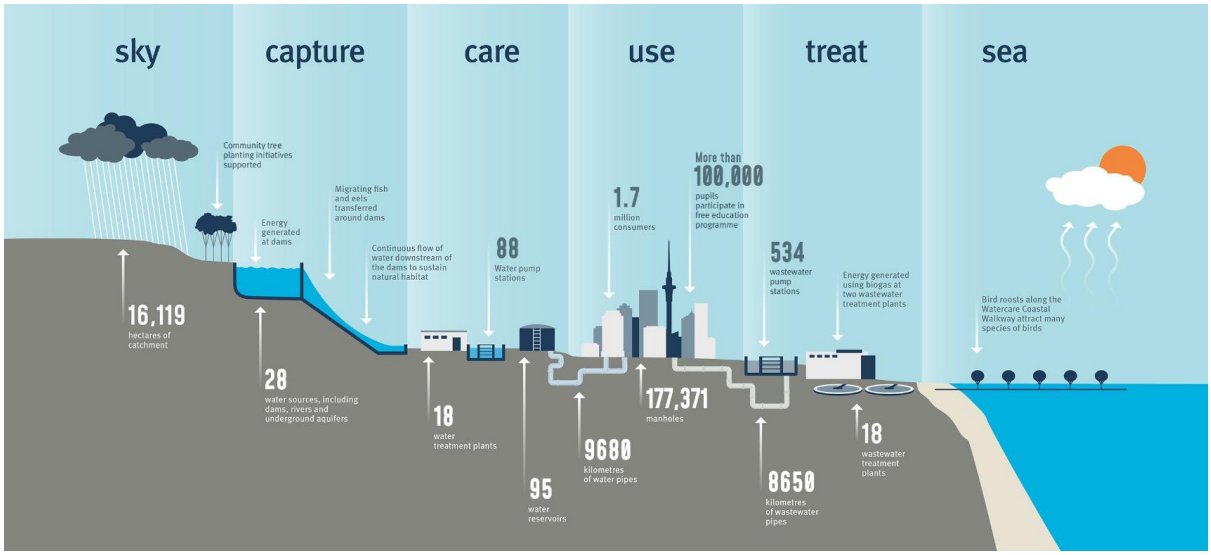


Figure 1: Overview of Watercare's assets and operations.

Watercare's activities are intrinsically linked to the health of people and the natural environment. Auckland's wastewater sources must be sufficient volume and reliability to improve the quality of beaches and waterways.

Watercare carries out significant work to upgrade and build infrastructure, to maintain levels of service and provide capacity for a fast-growing population. Watercare ensures Auckland and its people continue to enjoy dependable services by upgrading its assets, planning, building, and delivering new infrastructure in cost-efficient ways.

1.2 Project background and description

The Western Isthmus Water Quality Improvement Programme (WIWQIP) Motions Catchment Improvements Project (the Project) involves the construction of a new collector sewer approximately 3.2 kilometres in length from Canada Street in Auckland's Central Business District (CBD) to Western Springs Park in Western Springs. The collector sewer is proposed to be a diameter ranging from 2.4m up to 4.5m and will have three branch connections. Two

branch connections will go under State Highway 16 connecting the Newton Catchment to Suffolk Reserve and connecting Arch Hill Scenic Reserve and southern parts of Grey Lynn to Nixon Park. The third branch connection will connect Suffolk Reserve to Basque Park. There will also be 16 Engineered Overflow Points (EOPs) and 16 local network connections. The Project will tie into the Central Interceptor at Western Springs Park.

The Project is part of the WIWQIP which aims to significantly reduce wastewater overflows into the Waitematā Harbour in order to improve stream and beach water quality across the City's Central Western Isthmus. The aim of the Project is to build a new pipeline to collect combined wastewater and stormwater flows from the Motions Catchment and convey these to the Central Interceptor at Point Erin Park, where they can then be safely conveyed to the Māngere Wastewater Treatment Plant. The WIWQIP is a joint initiative between Watercare and Auckland Council's Healthy Waters that was established in 2017 and has been identified in Watercare's Asset Management Plan 2021 – 2041 as a key programme to further protect the environment and provide clean harbours and waterways. At a high level, the three main goals of the WIWQIP are:

- To reduce risks to public health by alleviating uncontrolled discharges into local catchments;
- To remove the permanent health warning status of both Meola Reef and Cox's Bay; and
- To reduce intermittent beach closures in the area over the next 10 years.

The Project is a critical component of the wider WIWQIP which will enable Watercare to bring about considerable environmental benefits, reduce risks to public health and improve the amenity of the Motions catchment. For further detail regarding the proposed works and the Project's objectives, please refer to Section 4 of the Assessment of Effects on the Environment.

1.3 Purpose of this report

The purpose of this report is to support the resource consent application for the construction of a new collector sewer approximately 3.2 kilometres in length from Canada Street in Auckland's Central Business District (CBD) to Western Springs Park in Western Springs where the Project ties into the Central Interceptor. The Project also involves the construction of three branch connections and 16 Engineered Overflow Points (EOPs).

As detailed in the assessment of effects on the environment, the required resource consents include land use consent for earthworks under sections 9(2) and 9(3) of the Resource Management Act 1991. In particular, land use consent is required for earthworks under the land disturbance rules of Chapter E26 of the Auckland Unitary Plan (Operative in Part).

Of specific relevance to this assessment are the general standards and related assessment criteria for earthworks associated with infrastructure works. Those relevant to flooding and overland flow paths are:

E26.5.5.2. General standards

18. Earthworks (including filling) within a 1% AEP flood plain (excluding road network activities): must not raise ground levels more than 300mm, to a total fill volume up to

$10m^3$ which must not be exceeded through multiple filling operations; and must not result in any adverse changes in flood hazard beyond the site.

19. Earthworks (including filling) within overland flow paths (excluding road network activities) must maintain the same entry and exit point at the boundaries of a site and not result in any adverse changes in flood hazards beyond the site, unless such a change is authorised by an existing resource consent.
20. Temporary land disturbance and stockpiling of soil and other materials within 1% AEP flood plain and/or overland flow path for up to a maximum of 28 days in any calendar year may occur as part of construction or maintenance activities.

E26.5.7.2. Assessment criteria

d) whether the earthworks and final ground levels will adversely affect overland flow paths or increase potential volume or frequency of flooding within the site or surrounding sites.

i) the extent of risks associated with natural hazards and whether the risks can be reduced or not increased.

These standards and associated assessment criteria have been employed to focus this flood assessment memorandum.

2 Project Inputs

Error! Reference source not found. below lists the input data collected and used to complete this flood risk assessment.

Table 2-1 Project Input Data Overview

Component	Details	Data Sourced Date	Source	Comments
GIS layers	• Overland Flow Paths with Peak Flow Rate and Run off Volumes • Flood prone areas • Floodplains and Model Results 1% AEP with climate change (WaterRIDE online)	21st July 2025	Auckland Council	• Data from AC Geomaps • Projection – NZTM2000
Model results	• Healthy Waters catchment model results, including 100-year ED without climate change (CC) and 100-year MPD with 2.1°C and 3.8°C CC	21st July 2025	Auckland Council	• Projection – NZTM2000 • Datum – AKVD1946 • Catchment Model Converted by Woods in 2023
Constructability Report	• Motions Collector Sewer Constructability Report – Rev 1 (McConnel Dowell, March 2025)	16th July 2025	McConnell Dowell	• This report provided the shaft site area extents
Concept Design Report	• Western Isthmus Water Quality Improvement Project: Motions Catchment Improvements - Concept Design Report Revision A01 (Aurecon 19/12/2024)	14th July 2025	Aurecon	• Concept design report for the Motions Catchment Improvements project

3 Flood Assessment

3.1 Method

Potential for flooding at the sites

This assessment is based on the Auckland Council published geographic information systems (GIS) layers for OLFP, FPA and FP. Below is a short description of the layers and how the data has been interpreted for the assessment. Flooding is primarily assessed for the 1% Annual Exceedance Probability (AEP) since this defines the floodplain as referenced in the general standards and assessment criteria of the Auckland Unitary Plan.

- **Overland Flow Paths (OLFP)** – This is a GIS layer produced based on Auckland Council's latest LiDAR flown in 2016. It predicts the natural flow paths of water over the ground without a stormwater drainage network. Peak flow data for 39%, 10% and 1% AEP storm events without climate change (**CC**) and with 2.1°C and 3.8°C CC were calculated following Auckland Council Technical Publication No. 108 (**TP108**) (Auckland Regional Council (ARC), 1999) and attributed to each overland flow path line segment. The peak flow data provides a high-level indication of the severity of flooding at each shaft site.
- **Flood prone areas (FPA)** – This layer shows topographical depressions produced based on Auckland Council's latest LiDAR flown in 2016. The flood prone areas extent is the area where water will pond before spilling, assuming any drainage outlet to the topographical depression is blocked. The flood prone area data includes the spill elevation and flood prone elevation in 1% AEP future event assuming MPD and 2.1°C CC. It also provides maximum flood elevation and maximum flood extent. Flood levels are referenced to Auckland Vertical Datum 1946.
- **Floodplains (FP)** – This is a GIS layer produced based on the 1% AEP storm event with 3.8°C CC assuming maximum probable development (MPD) (or 2.1°C CC if 3.8°CC is not available). For the Motions Creek catchment, the Auckland Council stormwater model results represent the MPD 100-year with 3.8°C CC stormwater model results. Maximum flood flow rate, flood depth and flood level were used to analyze the flood risk at each shaft site. Note flood depths less than 50 mm are not shown in the mapping and so are not considered in our assessment.

Flood hazard classification

Flood hazard is a function of the depth and velocity of flood waters at a particular location. It provides a measure of the severity of the impacts of flooding on people and property. Flood hazards are low in shallow slow-moving water and increase with increasing water depth and velocity.

The flood hazard class reported in this assessment is from the stormwater model results provided by Auckland Council. The flood hazard classification is based on the product of the modelled maximum flood depth (**D**) and velocity (**V**) (**DxV**), following the Auckland Council flood hazard classification method as shown in Figure 3-1.

Potential flood impact areas

This is a high-level assessment to identify the areas which may be subject to an increase in the depth or the extent of flooding because of the proposed works and any overland flow management or shaft protection works which may be required as part of the temporary or permanent works. The extent of the potential flood impact areas are indicative and have been defined using engineering judgement and the current modelled flood extent, maximum flow rate, flood levels and ground contours to estimate the areas of land likely to be affected.

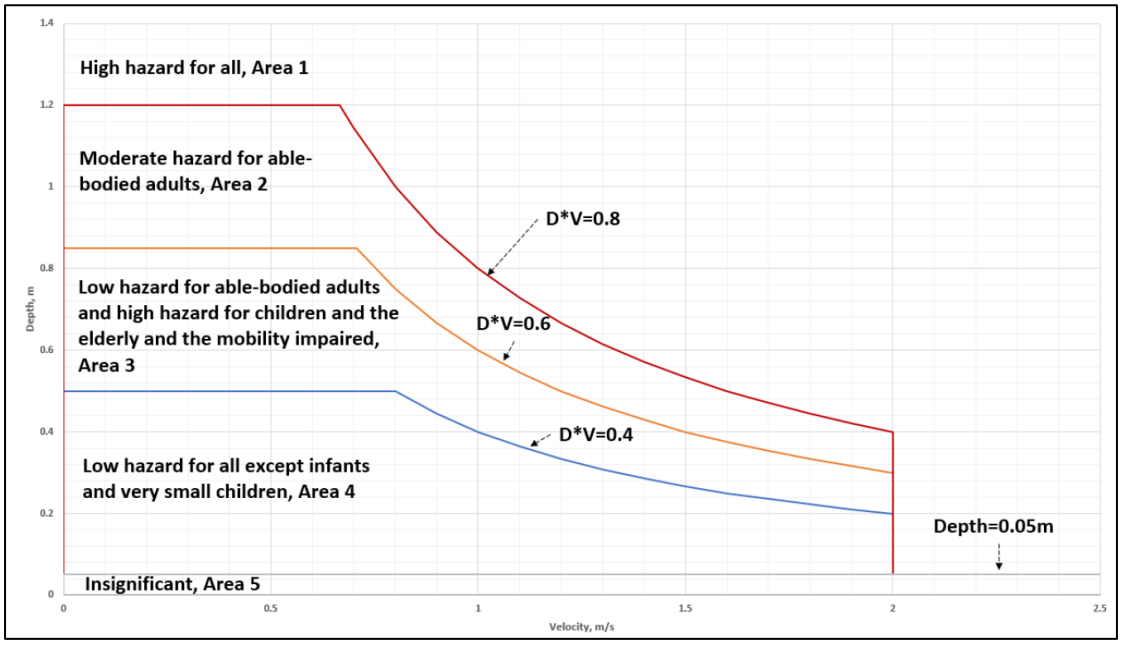


Figure 3-1 Auckland Council 2D Flood Hazard Classification

3.2 Results

Based on the available data, all the sites are exposed to at least one type of flood hazard in the 1% AEP. Table 3-1 below provides a summary of the potential for flooding at each shaft site, the flood hazard and the potential for impact on flooding at adjacent properties. Further details of the flood risk at each site, and recommendations for managing flood risk are provided in Table 3-2. No detailed information on the proposed site layouts is available so our comments and recommendations are general in nature. The potential flood impact areas, as estimated from the available data, are shown on the flood map for each shaft site in Table 3-2.

Flood risk during construction of the proposed works

Given the relatively short construction period at each shaft site (several weeks), the likelihood of a flood event of a magnitude of the 1% AEP occurring during construction is relatively small (i.e., much less than 1%). Nonetheless, there is the potential for damage to the works during construction and injuries. Suitable measures should therefore be included in the site layouts and site management plans to reduce the potential consequences of a flood event to the site.

Whilst Standard E26.5.5.2 (20) allows temporary stockpiling of earthworks in the 1% AEP floodplain for up to 28 days, the proposed works at all sites, which include other activities as well as earthworks, are likely to extend beyond that period and have the potential to obstruct or displace flood water in an event of a magnitude of the 1% AEP . At most of the sites this could

increase flood hazard at adjacent properties. Suitable mitigation measures should therefore be included in the design of the temporary work to reduce the potential for adverse effects.

These could include:

- Provision of safe, unobstructed flow paths for flood water through the site to control speed and direction of flow to reduce any increase in upstream flooding and the potential for erosion.
- Provision of a temporary channel or swale to divert flow around the site works while maintaining the entry and exit points at the boundary as required under section E26.5.5.2 19.
- Placing equipment, containers or cabins on raised formwork which allow water to flow or pond underneath.
- Orientating containers, stockpiles or equipment in line with flow directions.
- Limiting the volume of material stockpiled at any time within the site
- Arranging the site layout to take account of expected locations of flow paths or ponding and avoiding storage of materials and equipment or stockpiles in those areas.
- Protection of the tunnel shaft by temporary works such as a bund or by channeling stormwater runoff away from the shaft area to protect against water ingress.

It is recommended that these measures are incorporated within the certified ESCP (Erosion and Sediment Control Plan) for the sites. Their effectiveness in managing flooding should be demonstrated in relation to criteria d) and i) of E26.5.7.2.

Post-construction flood risk

Since the permanent works are largely below ground, the impact of the works on flooding following completion of construction is likely to be less than during construction. To reduce the impact on flooding, ground levels should be restored to the pre-construction levels. This can help reduce any changes to existing overland flow paths, as well as the spill levels and storage capacity in flood-prone areas, ultimately lowering the impact on the performance of other stormwater infrastructure.

Table 3-1 Overview of potential for flooding, flood hazard and potential for impact on flooding at adjacent properties at each shaft site

Shaft ID	Locations	OLFP1	FPA2	FP3	Flood Hazard Classification	Potential properties impacted
SH01	Corner Canada/ East Streets	Moderate	Deep	Shallow	Insignificant	31 Mercury Lane Newton; 29 East Street Newton;17 South Street Newton
SH02	Suffolk Reserve	Moderate	Deep	Deep	High hazard for all	9 Suffolk Street, Eden Terrace;14 Suffolk Street, Eden Terrace;16 Suffolk Street, Eden Terrace
SH03	Mostyn Street Reserve	Fast	Deep	Deep	High hazard for all	28 Buchanan Street Kingsland; 30 Buchanan Street Kingsland; 20 Mostyn Street Kingsland; 22 Mostyn Street Kingsland; 23 Mostyn Street Kingsland; 25 Mostyn Street Kingsland; 17 Richbourne Street Kingsland; 19 Richbourne Street Kingsland;
SH04	Fourth Avenue Car Park (adjacent to Nixon Park)	Moderate	N/A	Shallow	Low Hazard for all except infants and very small children	4 Fourth Avenue Kingsland; 6 Fourth Avenue Kingsland; 8 Fourth Avenue Kingsland 9 Fourth Avenue Kingsland; 11 Fourth Avenue Kingsland; 13 Fourth Avenue Kingsland; 15 Fourth Avenue Kingsland; 19 Fourth Avenue Kingsland; 19A Fourth Avenue Kingsland; 24 Central Road Kingsland; 1 Third Avenue Kingsland; 3 Third Avenue Kingsland; 5 Third Avenue Kingsland
SH05	Kingsland Avenue	Fast	N/A	Deep	Low hazard for able-bodied adults and high hazard for children and the elderly and the mobility impaired	39 Kingsland Avenue Kingsland; 48 Kingsland Avenue Kingsland; 50 Kingsland Avenue Kingsland; 50B Kingsland Avenue Kingsland; 2/39A Fourth Avenue Kingsland; 4/39A Fourth Avenue Kingsland
SH06	Finch Street	Fast	Deep	Deep	Low hazard for all except infants and very small children	44 Don Croot Street Western Spring; 65 Finch Street Western Springs; 67 Finch Street Western Springs; 1 Levonia Street Western Springs; 3 Levonia Street Western Springs; 5 Levonia Street Western Springs; 7 Levonia Street Western Springs; 9 Levonia Street Western Springs
SH07	Myrtle Street	Fast	Deep	Deep	Moderate hazard for able-bodied adults	23 Levonia Street Western Springs; 30 Levonia Street Western Springs; 25 Warwick Street Western Springs; 27 Warwick Street Western Springs; 20 Warwick Street Western Springs; 9 Myrtle Street Western Springs; 9A Myrtle Street Western Springs; 10 Myrtle Street Western Springs; 1/8 Myrtle Street Western Springs; 2/8 Myrtle Street Western Springs; 32 Cardigan Street Western Springs; 2/32 Cardigan Street Western Springs
SH08	Southeast of Western Springs Park	Moderate	N/A	Shallow	Low hazard for all except infants and very small children	Northeast of Western Springs Outer Fields
SH09	Ophir Street/ Edinburgh Street	Moderate	N/A	Shallow	Insignificant	16 Edinburgh Street Newton; 23 Edinburgh Street Newton; 27 Edinburgh Street Newton; 13 Ophir Street Newton
SH10	Gundry Street Cul de Sac	Moderate	N/A	Shallow	Low hazard for all except infants and very small children	24 Gundry Street Newton; 19 Gundry Street Newton; 6 Winchester Street Newton
SH11	Burgoyne Street	Moderate	N/A	Shallow	Low hazard for all except infants and very small children	13 Burgoyne Street Grey Lynn; 15 Burgoyne Street Grey Lynn; 16 Nixon Street Grey Lynn
SH12	Basque Park	Moderate	Deep	Shallow	Low hazard for all except infants and very small children	11 Fleet Street Eden Terrace; 12 Fleet Street Eden Terrace; 13 Fleet Street Eden Terrace; 14 Fleet Street Eden Terrace; 15 Fleet Street Eden Terrace; 22 Fleet Street Eden Terrace; 19-35 Fleet Street Eden Terrace; 24 Fleet Street Eden Terrace
SH13	Cooper Street Cul de Sac	Moderate	N/A	Shallow	Low hazard for all except infants and very small children	50 Cooper Street Grey Lynn; 41 Cooper Street Grey Lynn; 43 Cooper Street Grey Lynn
SH14	Arch Hill Reserve	Moderate	N/A	Shallow	Low hazard for all except infants and very small children	No
SH15	Arch Hill Reserve	Moderate	N/A	Shallow	Low hazard for all except infants and very small children	No

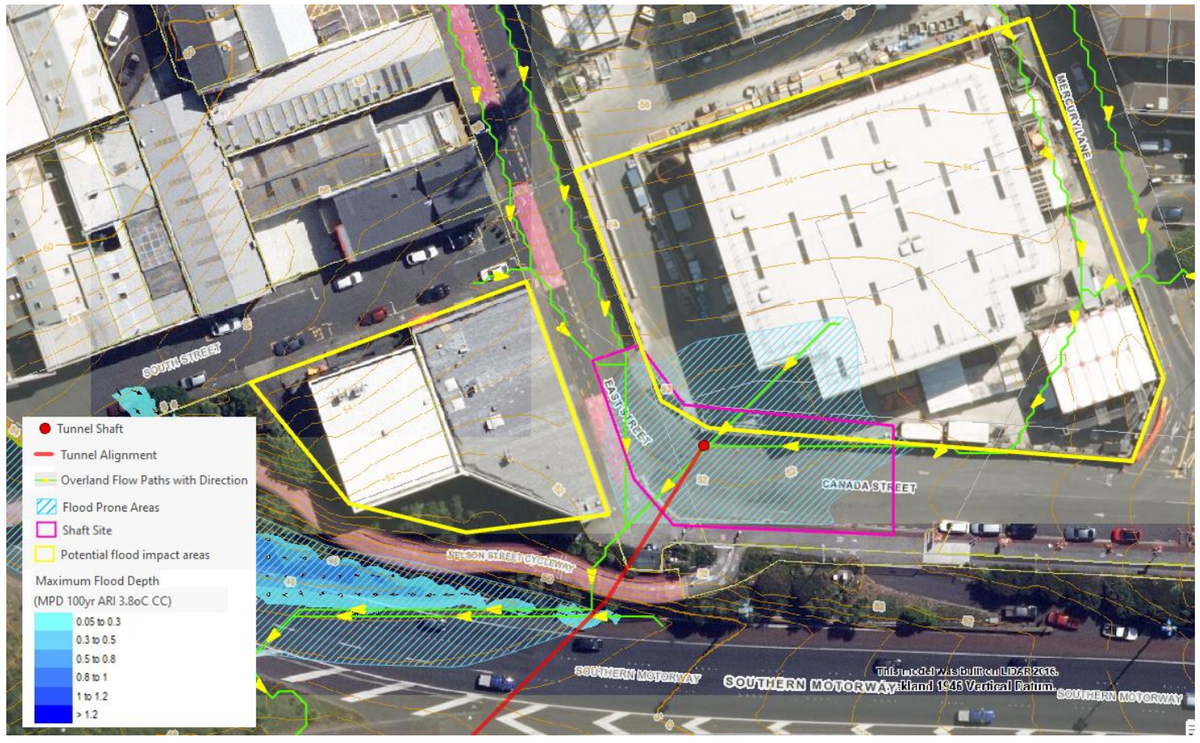
Note:

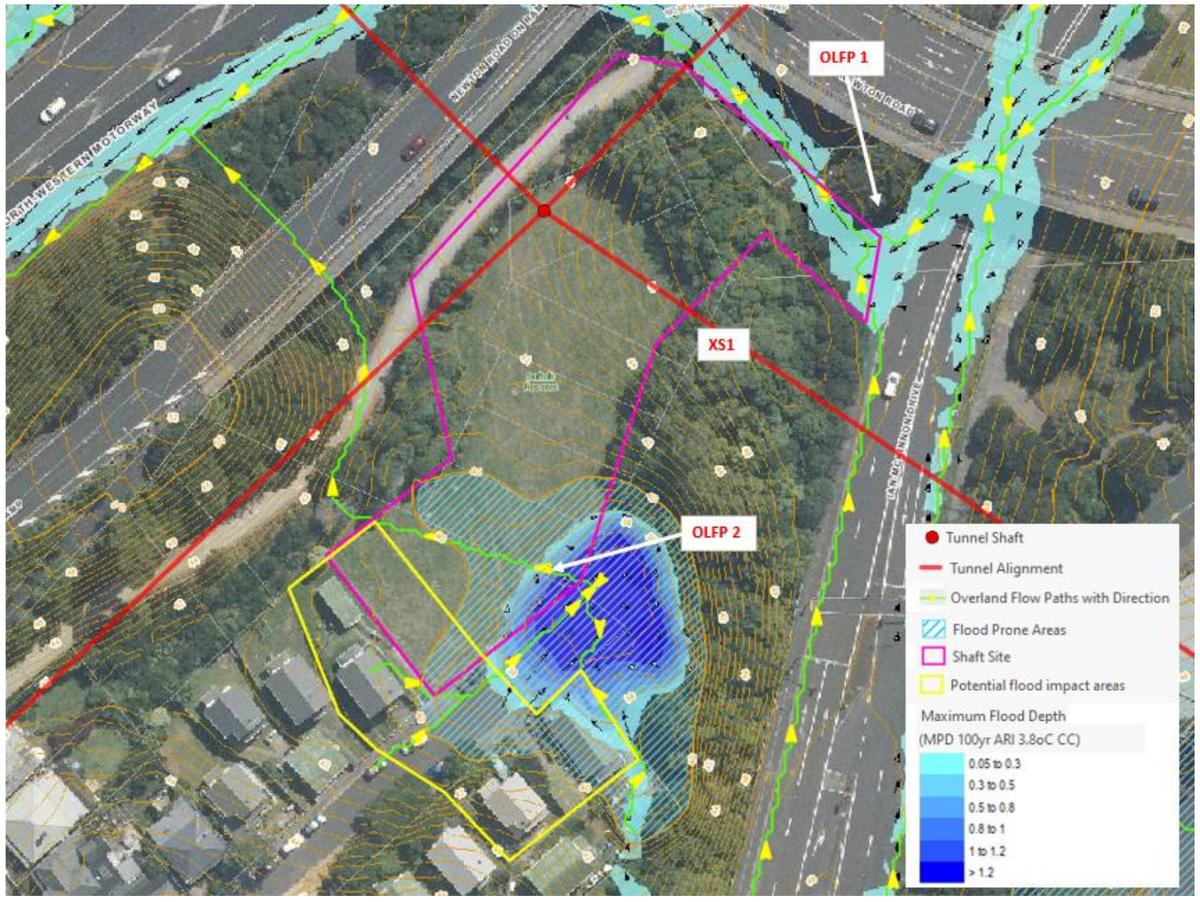
[1] For overland flow paths (OLFP), “fast” means maximum flow rate from model result is equal to or greater than 2 m^3/s. and “moderate” means maximum flow rate less than 2 m^3/s.

[2] For flood prone areas (FPA), “deep” means flood prone area spill ponding depth is equal to or greater than 500 mm and “moderate” means spill ponding depth is less than 500 mm.

[3] For floodplains (FP), “deep” means maximum flood depth is equal to or greater than 500 mm.

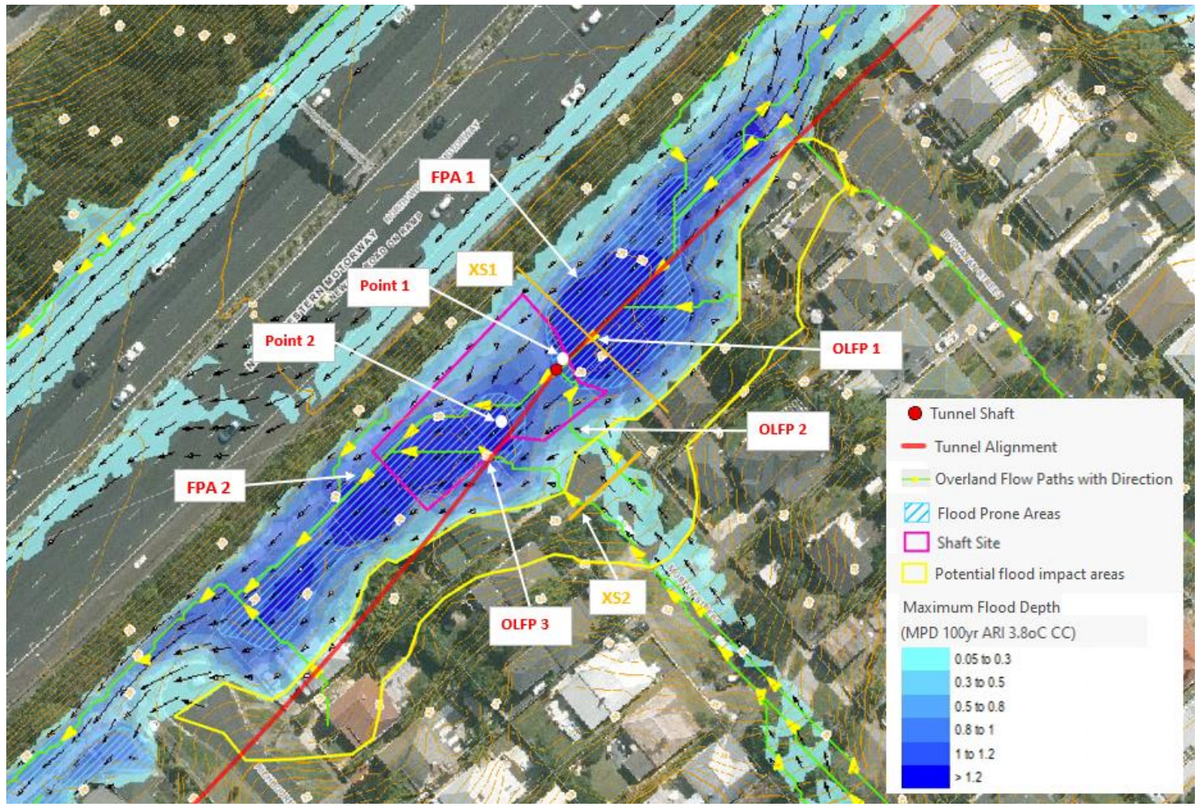
Table 3-2 Flood Risk Assessment Results

<table>
<tr><th>Shaft ID</th><th>Locations</th><th>Shaft Site Map with Flood Information (Flood Depth during MPD 1% AEP 3.8oC CC event)</th><th>Findings and Conclusions</th></tr>
<tr><td>SH01</td><td>Corner of Canada/ East Streets</td><td> 
</td><td>1. Overland flow path
<table><tr><th rowspan="2">Location</th><th rowspan="2">Catchment Area (ha)</th><th colspan="3">Peak Flow (m^3/s)</th></tr><tr><th>ED 1% AEP No CC</th><th>MPD 1% AEP 2.1°C CC</th><th>MPD 1% AEP 3.8°C CC</th></tr><tr><td>OLFP 1</td><td>1.54</td><td>0.30</td><td>0.59</td><td>070</td></tr><tr><td>OLFP 2</td><td>7.64</td><td>1.86</td><td>2.58</td><td>3.07</td></tr></table>2. Flood Prone Area (FPA)
<table><tr><th>Minimum Elevation (m RL)</th><th>Spill Elevation (m RL)</th><th>Spill Ponding Depth (m)</th><th>Flood prone elevation in MPD 1% AEP event (m RL)</th></tr><tr><td>51.56</td><td>52.24</td><td>0.689</td><td>N/A</td></tr></table>3. Floodplains
• The floodplain / model results indicate there is no flooding during the MPD 1% AEP 3.8°C CC event at the shaft site.
Conclusions
• Two overland flow paths from the northern side of East St and the eastern side of Canada St converge at the corner of Canada and East Street. The shaft site covers both overland flow paths just upstream where they converge.
• Shaft site intersects with a FPA. The spill elevation is 52.24m RL and ponding depth is 689mm.
• Catchment model results show flooding within the shaft site has maximum flood depths less than 50mm. The flood hazard is classified as ‘insignificant’.
• The adjacent properties on both sides of East St could be adversely impacted by blockage of the overland flow and removal of flood storage within the flood prone area due to temporary site works.
• We recommend managing the overland flow paths during construction, controlling speed and direction of flow to minimize flooding at adjacent properties (highlighted). Measures such as a temporary bund or wall are needed to protect the shaft site from water ingress, and diverting flow along the shaft site boundary, additional bunding may be required to prevent flooding into potentially impacted properties.</td></tr>
</table>

SH02	Suffolk Reserve		1. Overland flow **Location** / **Catchment Area (ha)** / **Peak Flow (m^3/s)**: ED 1% AEP No CC; MPD 1% AEP 2.1°C CC; MPD 1% AEP 3.8°C CC OLFP 1: 35.0 ha; 8.00; 11.00; 13.13 OLFP 2: 1.3 ha; 0.34; 0.47; 0.55 2. Flood Prone Area (FPA) **Minimum Elevation (m RL)** / **Spill Elevation (m RL)** / **Spill Ponding Depth (m)** / **Flood prone elevation in MPD 1% AEP event (m RL)** 36.45; 41.46; 5.01; 39.97 3. Floodplains • Model results indicate flood ponding at the end of Suffolk Street; maximum flood depth is up to 2 meters and maximum flood elevation of the ponding area is 38.4m RL. There is a DN1500 pipe that drains the ponding to the northwest • The model results indicate overland flow enters the shaft site at the northeastern corner and flows along the boundary leaving the shaft site to the northwest under the Newton Road on-ramp, the maximum flow rate at cross-section XS1 is 0.47m^3/s and maximum velocity is 0.9m/s during the MPD 1% AEP with 3.8°C CC event. **Conclusions** • We recommend that the overland flow path in the northeastern corner be maintained and any earthworks at this entrance to the site should take care not to divert flows towards the tunnel shaft. A temporary channel or swale could be used to divert flow around the northeast shaft site boundary. • The adjacent properties at the end of Suffolk Street could be adversely impacted by blockage of the overland flow and removal of flood storage within the flood prone area due to temporary site works. • For the shaft site area adjacent to the end of Suffolk St, model results indicate significant ponding in a depression with an overland flow path once the depression spills. We recommend preventing any blockage of the existing stormwater outlet with debris from site and maintaining the overland flow path through the site to the outlet. This could be achieved by temporary works such as a bund to keep stormwater runoff away from the shaft area.

SH03

Mostyn Street Reserve



1. Overland flow

Location	Catchment Area (ha)	Peak Flow (m^3/s)		
		ED 1% AEP No CC	MPD 1% AEP 2.1°C CC	MPD 1% AEP 3.8°C CC
OLFP 1	59.95	11.53	16.26	19.27
OLFP 2	0.28	0.07	0.10	0.12
OLFP 3	1.6	0.45	0.60	0.70

2. Flood Prone Area (FPA)

Location	Minimum Elevation (m RL)	Spill Elevation (m RL)	Spill Ponding Depth (m)	Flood prone elevation in MPD 1% AEP event (m RL)
FPA 1	25.44	26.24	0.8	26.24
FPA 2	25.3	26.13	0.84	26.13

3. Floodplains

- Model results indicated the maximum flood elevation listed in the table below.

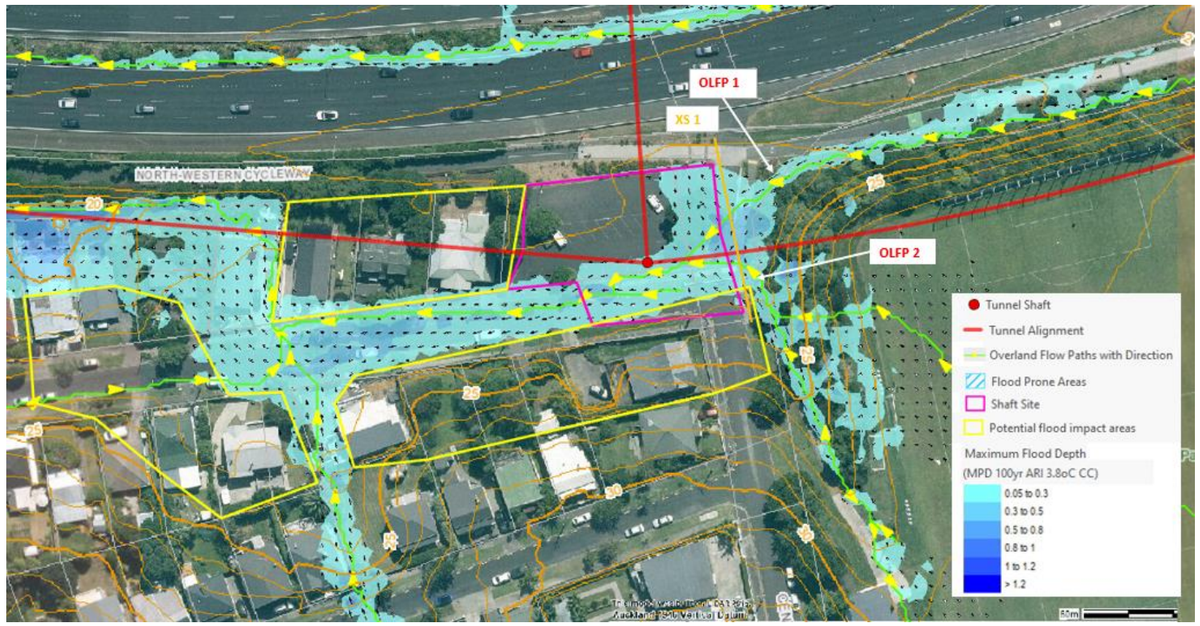
Stormwater (SW) event	Point 1	Point 2
MPD 1% AEP with 3.8°C CC	27.28	27.18

- Model results indicate the maximum flow through cross-sections listed in the table below.

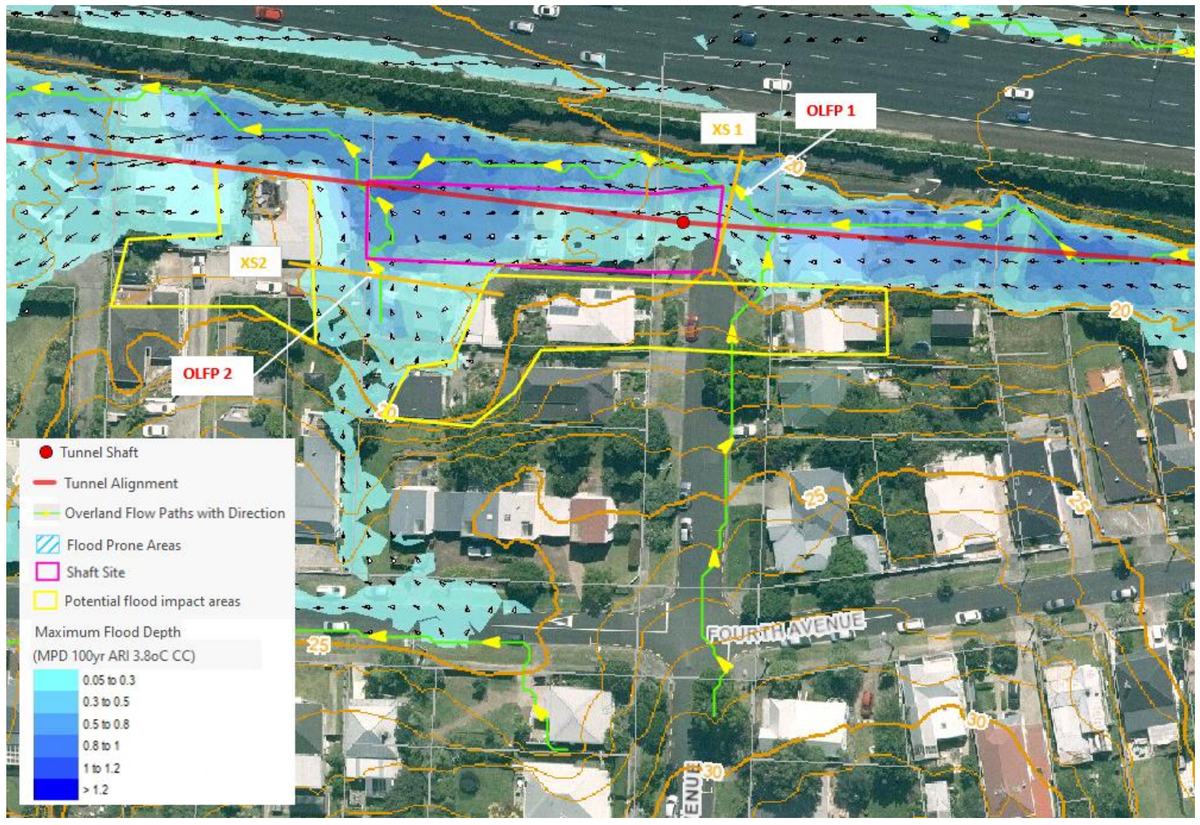
Stormwater (SW) event	XS 1 (m^3/s)	XS 2 (m^3/s)
MPD 1% AEP with 3.8°C CC	9.75	0.35

Conclusions

- The model results show a significant overland flow with a peak flow rate of 9.75 (m^3/s) coming from the northeast, entering the shaft site with a maximum flood elevation of 27.28m RL during the MPD 1% AEP with 3.8°C CC event. A second overland flow from the southeast has a peak flow rate of 0.35 (m^3/s) based on the model results during MPD 1% AEP with 3.8°C CC event.
- The model results indicate the maximum flood levels at point 1 and 2 are 27.28m RL and 27.18m RL respectively. The model results show maximum flood depths within the shaft site of up to 1.9m.
- Based on the model results, the flood hazard at the shaft site was classified as 'High hazard for all'.
- The adjacent properties at the end of Buchanan, Mostyn and Richbourne Streets could be adversely impacted by blockage of the overland flow and removal of flood storage within the floodplain due to temporary site works.
- There is a high risk of water ingress into the shaft tunnel and protection measures will be required to prevent this. We recommend maintaining the overland flow paths through the site and a stormwater management plan to manage flows. A temporary channel or swale could be used to divert flow around the site works, with a bund to protect the shaft site and any other vulnerable equipment from water ingress.

SH04	Fourth Avenue Car Park (adjacent to Nixon Park)		1. Overland flow **Location** / **Catchment Area (ha)** / **Peak Flow (m^3/s)**: **ED 1% AEP No CC** / **MPD 1% AEP 2.1°C CC** / **MPD 1% AEP 3.8°C CC** OLFP 1 — 1.52 — 0.38 — 0.54 — 0.65 OLFP 2 — 4.06 — 1.10 — 1.50 — 1.78 2. Flood Prone Area (FPA) – No FPA intersect or around the shaft site 3. Floodplains • Model results indicate the maximum flood elevation around the tunnel shaft is approximately 22.66m RL. • Model results indicated the maximum flow through cross-sections (XS 1) during MPD 1% AEP with 3.8°C CC event is 0.68 m^3/s. **Conclusions** • Two overland flow paths flow through the site, from the east and the south and converge within the site. The overland flow through cross-section (XS 1) at the eastern boundary of the site is 0.68 m^3/s. The model results show flood depths ranging from 50 to 300mm within the shaft site area. The maximum flood elevation around the tunnel shaft is approximately 22.66m RL. • The model results indicate the flood hazard at the shaft site is classified as 'Low hazard for all except infants and very small children'. • The adjacent properties along Fourth Avenue could be adversely impacted by blockage of the overland flow and removal of flood storage within the floodplain due to temporary site works. • We recommend maintaining the overland flow paths through the site including the site entry and exit. A temporary channel or swale could be used to divert flow around the site works, with measures such as a bund to protect the shaft site from water ingress.

SH05 | Kingsland Avenue



1. Overland flow

Location	Catchment Area (ha)	Peak Flow (m^3/s)		
		ED 1% AEP No CC	MPD 1% AEP 2.1°C CC	MPD 1% AEP 3.8°C CC
OLFP 1	18.09	4.609	6.193	7.341
OLFP 2	0.21	0.055	0.077	0.092

2. Flood Prone Area (FPA) - No FPA intersect or around the shaft site

3. Floodplains

- Model results indicated the maximum flood elevation around the tunnel shaft is approximately 19.62m RL. The flood was ponded at the west side of the shaft site with a maximum flood level of 19.08m RL.
- The maximum flow through cross-sections from the model results during MPD 1% AEP with 3.8°C CC event listed in the table below.

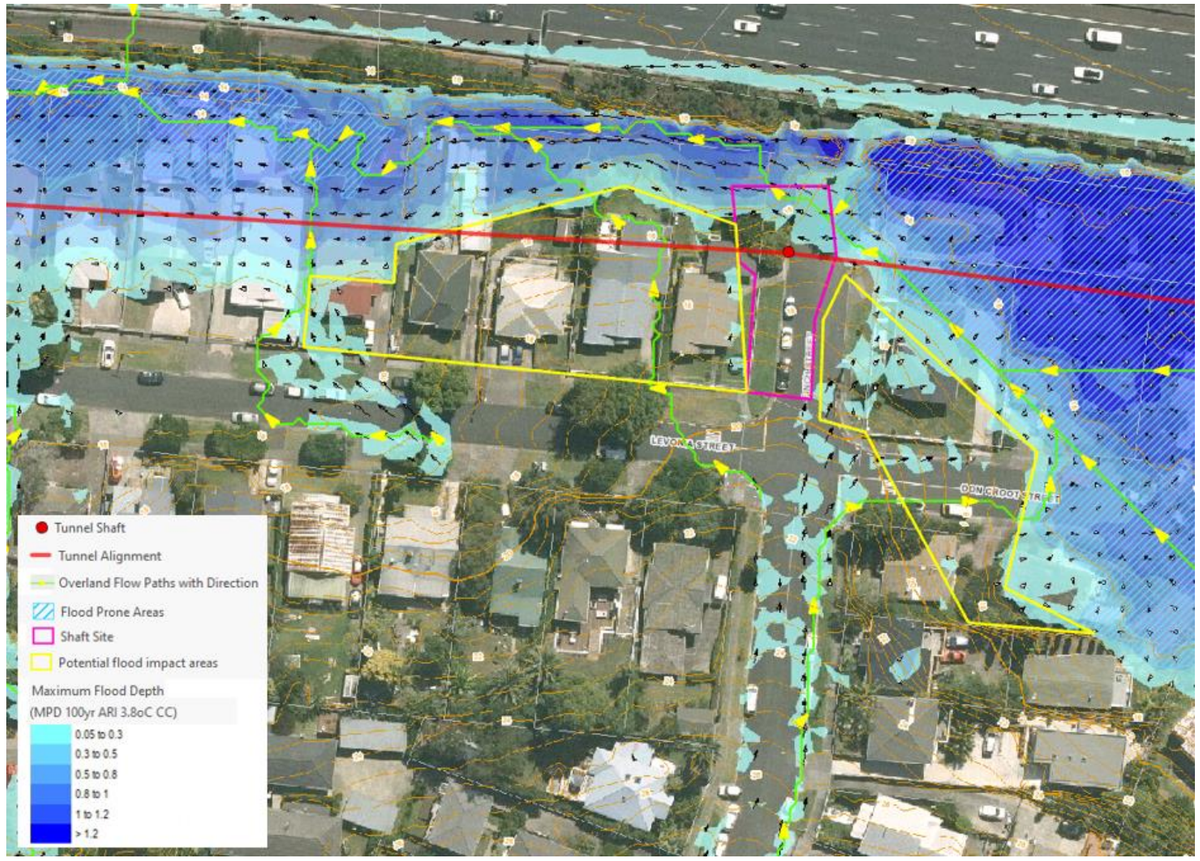
Stormwater (SW) event	XS 1 (m^3/s)	XS 2 (m^3/s)
MPD 1% AEP with 3.8°C CC	2.53	0.19

Conclusions

- An overland flow path flows through the site, from the east to west. The model results indicate a significant overland flow through cross-section (XS 1) of 2.53 m^3/s and flood depths ranging from 50 to 300mm within the shaft site area.
- The model results indicate the flood hazard at the east of the shaft site is classified as “Low hazard for all except infants and very small children’, where the west shaft site is defined as ‘Low hazard for able-bodied adults and high hazard for children and the elderly and the mobility impaired’.
- The adjacent properties along Kingsland and Fourth Avenues could be adversely impacted by blockage of the overland flow and removal of flood storage within the floodplain due to temporary site works.
- The tunnel shaft is at high risk of water ingress and protection measures will be required to prevent this. We recommend maintaining the overland flow path through the site. A temporary channel or swale with bunding could be used to divert flow around the site works, with a bund to protect the shaft site and other vulnerable equipment from water ingress. The tunnel shaft should be protected by temporary works such as a bund or channeling stormwater runoff away from the shaft area.

SH06

Finch Street



1. Overland flow

Location	Catchment Area (ha)	Peak Flow (m^3/s)		
		ED 1% AEP No CC	MPD 1% AEP 2.1°C CC	MPD 1% AEP 3.8°C CC
OLFP 1	48.10	9.93	13.48	15.99

2. Flood Prone Area (FPA)

Minimum Elevation (m RL)	Spill Elevation (m RL)	Spill Ponding Depth (m)	Flood prone elevation in MPD 1% AEP event (m RL)
14.59	16.66	2.07	16.66

3. Floodplains

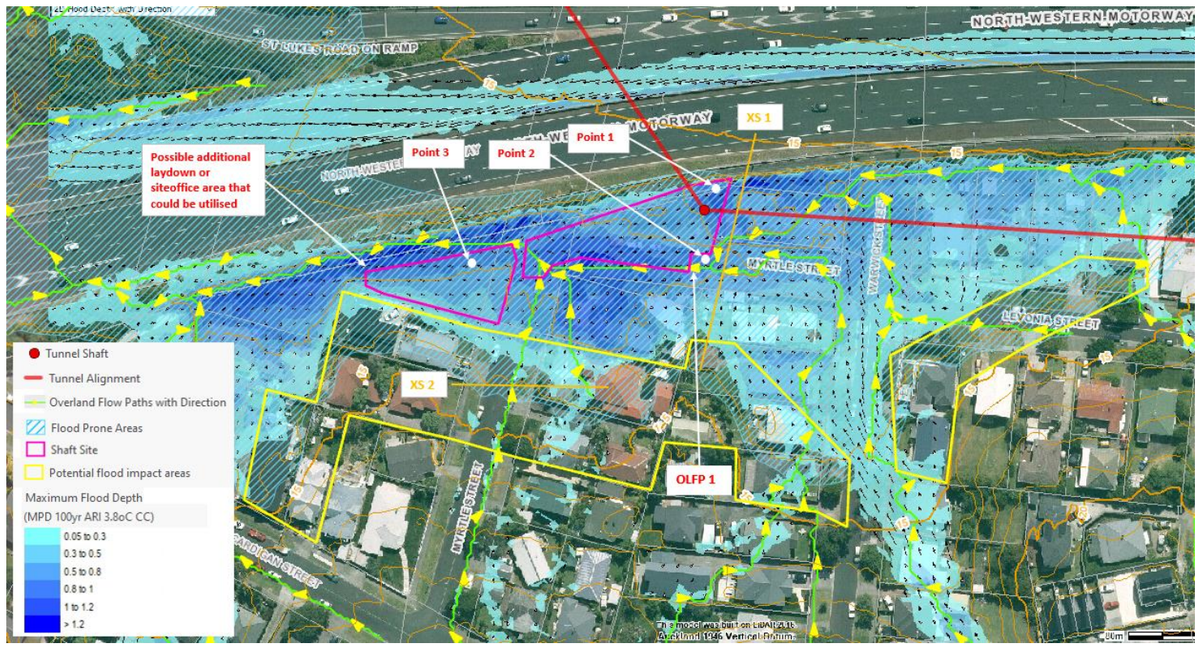
- Model results indicate the maximum flow through cross-sections (XS 1) for MPD 1% AEP with 3.8oC CC event is 3.92m^3/s.
- Model results show the flood will impact the north side of the shaft site; the maximum flood depths range from 50mm to 300mm. The shaft is outside the flood extent, or the flood depth is less than 50mm.

Conclusions

- One overland flow path flow across the northeastern corner of the site. The model results show a flood depth ranging from 50 to 300mm at the north shaft site areas close to the tunnel shaft, then getting deeper at the north shaft site boundary.
- The model results indicate a significant overland flow through cross-section (XS 1) at 3.92 m^3/s.
- The model results indicate the flood hazard at the north shaft site areas is classified as ‘Low hazard for all except infants and very small children’.
- The adjacent properties on Finch, Levonia and Don Croot Streets could be adversely impacted by blockage of the overland flow and removal of flood storage within the floodplain due to temporary site works.
- We recommend maintaining the overland flow path through or around the site. A temporary channel or swale with bunding could be used to divert flow around the site works, with a bund to protect the shaft site and other vulnerable equipment from water ingress.

SH07

Myrtle Street



- Overland flow

Location	Catchment Area (ha)	Peak Flow (m^3/s)		
		ED 1% AEP No CC	MPD 1% AEP 2.1°C CC	MPD 1% AEP 3.8°C CC
OLFP 1	65.85	12.333	16.728	19.825
OLFP 2	0.48	0.135	0.179	0.214
OLFP 3	0.49	0.144	0.19	0.226

- Flood Prone Area (FPA)

Minimum Elevation (m RL)	Spill Elevation (m RL)	Spill Ponding Depth (m)	Flood prone elevation in MPD 1% AEP event (m RL)
11.15	14.27	3.11	14.27

- Floodplains
- Model results indicated the maximum flood elevation listed in the table below.

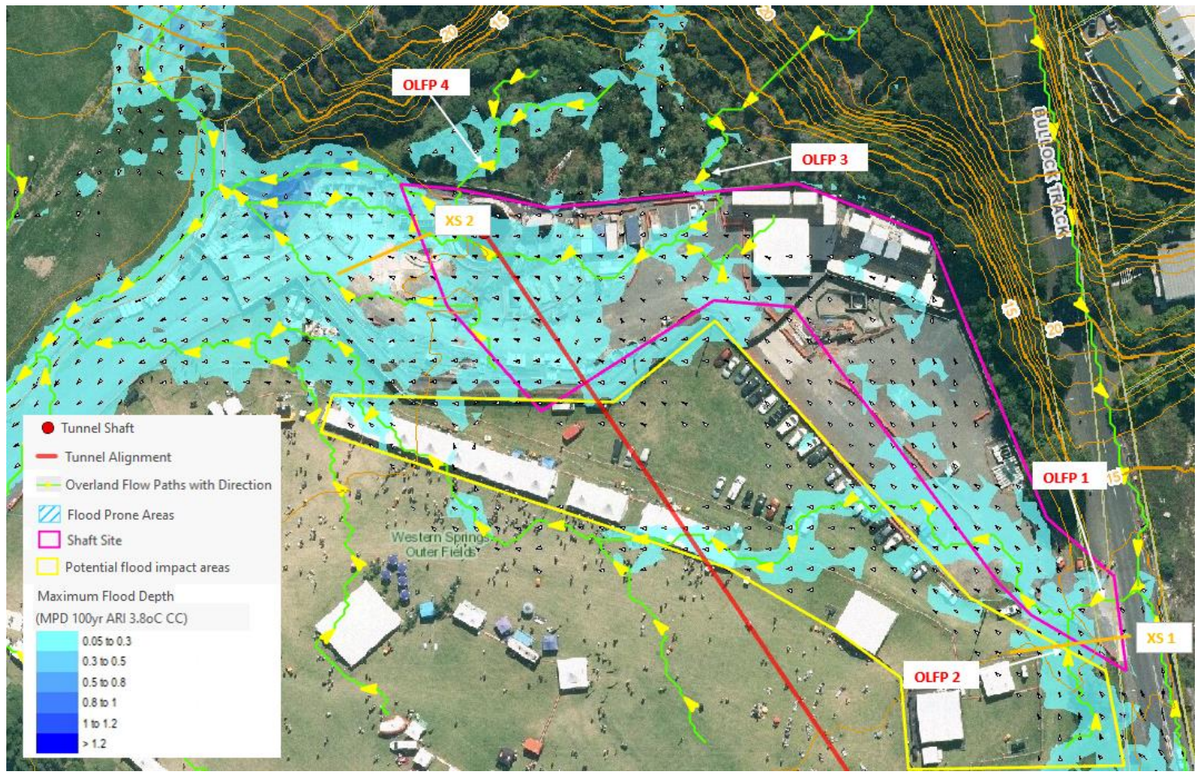
Stormwater (SW) event	Point 1	Point 2	Point 3
MPD 1% AEP with 3.8°C CC	13.72	13.72	13.71

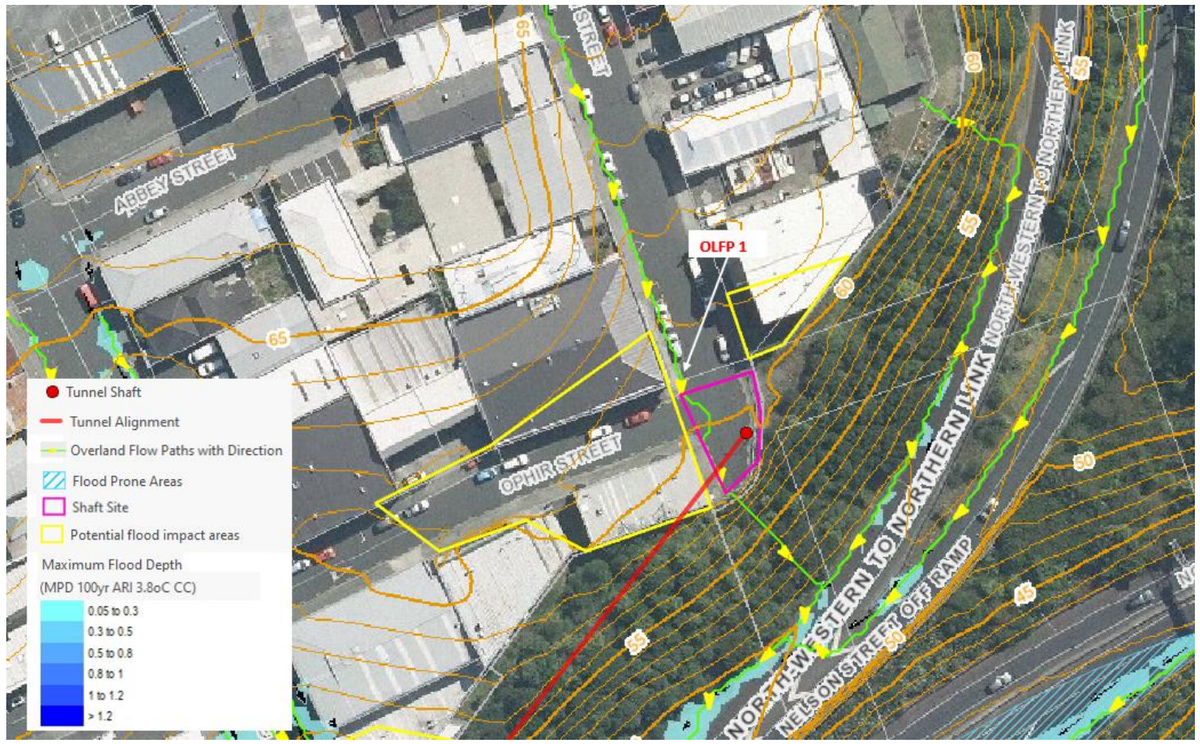
- The maximum flow through cross-sections from the model results during MPD 1% AEP with 3.8oC CC event listed in the table below.

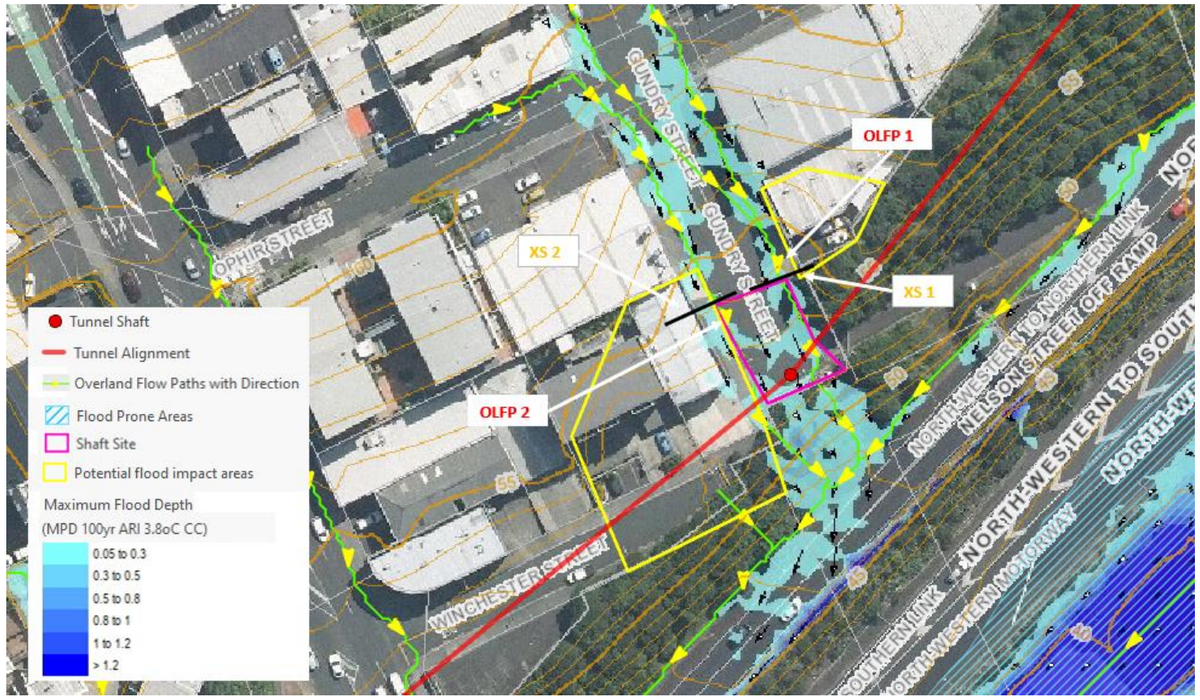
Stormwater (SW) event	XS 1 (m^3/s)	XS 2 (m^3/s)
MPD 1% AEP with 3.8°C CC	6.91	0.08

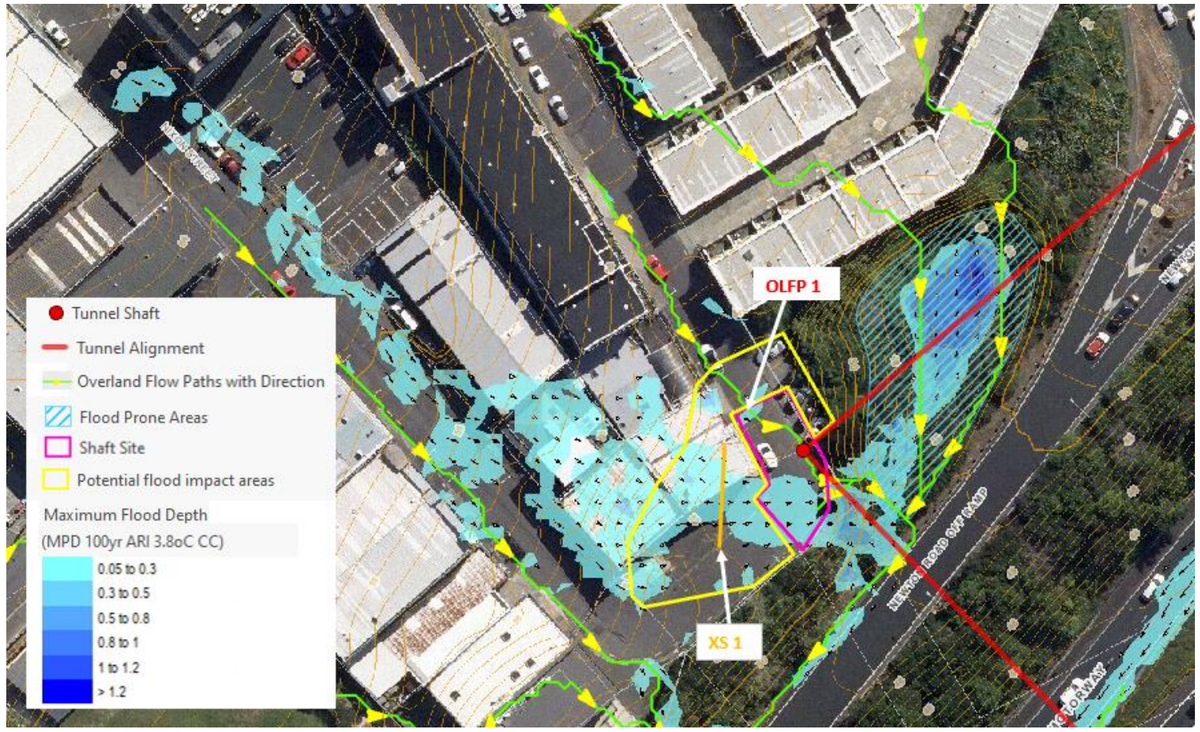
Conclusions

- Two overland flow paths flow through or adjacent to the site, from the east and the south and converge within the site and exit the site flowing to the west. The model results show a significant overland flow with a value of 6.91 m^3/s (XS 1) coming from the east, entering the shaft site with a maximum flood elevation of 13.72m RL during MPD 1% AEP with 3.8°C CC event. The overland flow from the south has a flow rate of 0.08 m^3/s (XS 2) based on the model results during MPD 1% AEP with 3.8°C CC event.
- The model results indicated the maximum flood levels at around and within the site are 13.72m R. The model results show the maximum flood depths within the shaft site of up to 1.3 meters
- Based on the model results, the flood hazard at the shaft site was classified as 'Moderate hazard for able-bodied adults'
- The adjacent properties on Warwick, Levonia, Myrtle and Cardigan Streets could be adversely impacted by blockage of the overland flow and removal of flood storage within the floodplain due to temporary site works.
- We recommend maintaining the overland flow paths through the site. A temporary channel or swale could be used to divert flow around the site works. In addition, we recommend protecting the tunnel shaft and equipment within the shaft site area by temporary works such as a bund to keep stormwater runoff away from the shaft area.

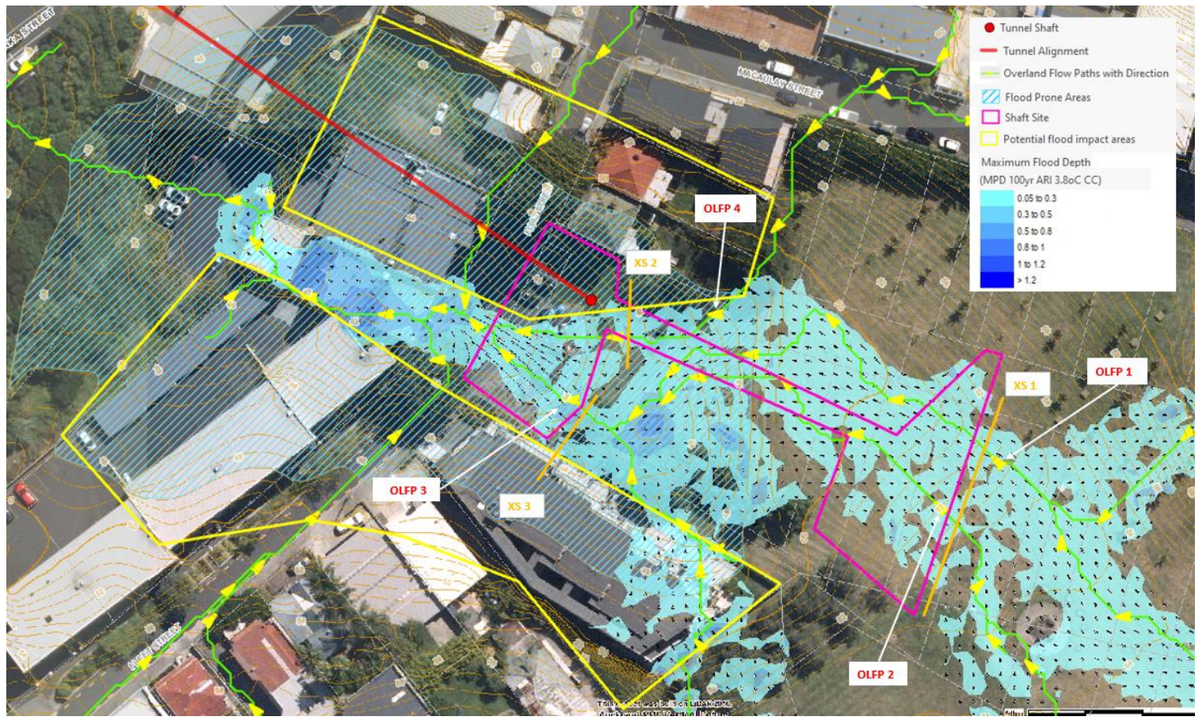
SH08	Southeast of Western Springs Park		1. Overland flow **Location** / **Catchment Area (ha)** / **Peak Flow (m^3/s)**: **ED 1% AEP No CC** / **MPD 1% AEP 2.1°C CC** / **MPD 1% AEP 3.8°C CC** OLFP 1 — 15.55 — 3.75 — 5.04 — 5.98 OLFP 2 — 0.26 — 0.05 — 0.10 — 0.12 OLFP 3 — 0.43 — 0.10 — 0.17 — 0.20 OLFP 4 — 0.50 — 0.12 — 0.20 — 0.23 2. Flood Prone Area (FPA) - No FPA intersect or around the shaft site 3. Floodplains • The maximum flow through cross-sections from the model results during MPD 1% AEP with 3.8oC CC event listed in the table below. **Stormwater (SW) event** / **XS 1 (m^3/s)** / **XS 2 (m^3/s)** / **XS 3 (m^3/s)** MPD 1% AEP with 3.8°C CC — 0.21 — 0.02 — 0.049 **Conclusions** • The model results show an overland flow with a value of 0.21m^3/s (XS 1) coming from the south end of Bullock Track, entering the shaft site and flowing toward tunnel shaft. • A minor overland flow coming from the north of the shaft site (XS 2) with a flow rate of 0.02 (m^3/s) is expected not to impact the tunnel shaft. And the overland flow though XS 3 is less than 0.05 (m^3/s). • The model results indicate flood depths within the shaft site area ranging from 50 to 200mm. • Based on the model results, the flood hazard at the shaft site was classified as ‘Low hazard for all except infants and very small children’. • The adjacent part of Western Springs Outer Field could be adversely impacted by blockage of the overland flow and removal of flood storage within the floodplain due to temporary site works. • We recommend maintaining the overland flow paths. A temporary channel or swale could be used to divert flow around the site works, with a bund to protect the shaft site from water ingress.

SH09	Ophir Street/ Edinburgh Street		1. Overland flow **Location** / **Catchment Area (ha)** / **Peak Flow (m^3/s)**: ED 1% AEP No CC; MPD 1% AEP 2.1°C CC; MPD 1% AEP 3.8°C CC OLFP 1 | 7.87 | 0.23 | 0.30 | 0.36 2. Flood Prone Area (FPA) - No FPA intersect or around the shaft site 3. Floodplains – Model results show no flood at the shaft site, or the flood depths is less than 50mm. **Conclusions** • Overland flow paths GIS layer shows the peak flow rate for the MPD 1% AEP with 3.8°C CC event is 0.36 m^3/s. Street catchpits and a DN600 pipe drain the flooding to the east. • Based on the model results, the flood hazard at the shaft site was classified as 'Insignificant'. • The adjacent properties on Ophir and Edinburgh Streets could be adversely impacted by blockage of the overland flow due to temporary site works. • We recommend maintaining the overland flow paths. A temporary bund could be used to divert flow around and toward the northeast side of the shaft site and protect the shaft site from water ingress.

SH10	Gundry Street Cul de Sac		1. Overland flow **Location** / **Catchment Area (ha)** / **Peak Flow (m^3/s)**: ED 1% AEP No CC; MPD 1% AEP 2.1°C CC; MPD 1% AEP 3.8°C CC OLFP 1 — 1.53 — 0.45 — 0.59 — 0.70 OLFP 2 — 0.47 — 0.14 — 0.18 — 0.22 2. Flood Prone Area (FPA) - No FPA intersect or around the shaft site 3. Floodplains • The maximum flow through cross-sections from the model results during MPD 1% AEP with 3.8°C CC event listed in the table below. **Stormwater (SW) event** / **XS 1 (m^3/s)** / **XS 2 (m^3/s)** MPD 1% AEP with 3.8°C CC — 0.14 — 0.18 **Conclusions** • Overland flow paths GIS layer shows peak flow of 0.70 and 0.22 m^3/s at OLFP 1 and OLFP 2 respectively during MPD 1% AEP with 3.8°C CC event. • Based on the model results, the flood hazard at the shaft site was classified as 'Low hazard for all except infants and very small children'. • The adjacent properties on Gundry and Winchester Streets could be adverse impacted by blockage of the overland flow due to temporary site works. • We recommend maintaining the overland flow paths at the shaft site, and measures to protect the tunnel shaft from overland flow. A temporary bund could be used to divert flow around and toward the east side of the shaft site and protect the shaft site from water ingress.

SH11	Burgoyne Street		1. Overland flow **Location** / **Catchment Area (ha)** / **Peak Flow (m^3/s)**: ED 1% AEP No CC; MPD 1% AEP 2.1°C CC; MPD 1% AEP 3.8°C CC OLFP 1 | 0.35 | 0.11 | 0.14 | 0.16 2. Flood Prone Area (FPA) - No FPA intersect or around the shaft site 3. Floodplains • The maximum flow through cross-sections (XS 1) from the model results is 0.38 (m3/s) during MPD 1% AEP with 3.8oC CC event. **Conclusions** • The Overland flow paths GIS layer shows peak flow of 0.16 m^3/s at OLFP during MPD 1% AEP with 3.8°C CC event. • Model results show minor overland flow coming from the north with a flow rate of 0.38 m^3/s at XS 1. It also indicated there is unlikely to have flood at the tunnel shaft or the flood depth is less than 50mm. • Based on the model results, the flood hazard at the shaft site was classified as 'Low hazard for all except infants and very small children'. • The adjacent properties on Burgoyne and Nixon Streets could be adversely impacted by blockage of the overland flow and removal of flood storage within the floodplain due to temporary site works. • We recommend maintaining the overland flow paths through the shaft site, and measures to protect the tunnel shaft from overland flow. A temporary bund could be used to divert flow around and toward the east side of the shaft site and protect the shaft site from water ingress.

SH12 | Basque Park



1. Overland flow

Location	Catchment Area (ha)	Peak Flow (m^3/s)		
		ED 1% AEP No CC	MPD 1% AEP 2.1°C CC	MPD 1% AEP 3.8°C CC
OLFP 1	6.97	1.72	2.45	2.92
OLFP 2	0.95	0.24	0.33	0.39
OLFP 3	10.37	2.46	3.47	4.19
OLFP 4	0.60	0.16	0.22	0.26

2. Flood Prone Area (FPA)

Minimum Elevation (m RL)	Spill Elevation (m RL)	Spill Ponding Depth (m)	Flood prone elevation in MPD 1% AEP event (m RL)
41.69	48.47	6.78	48.47

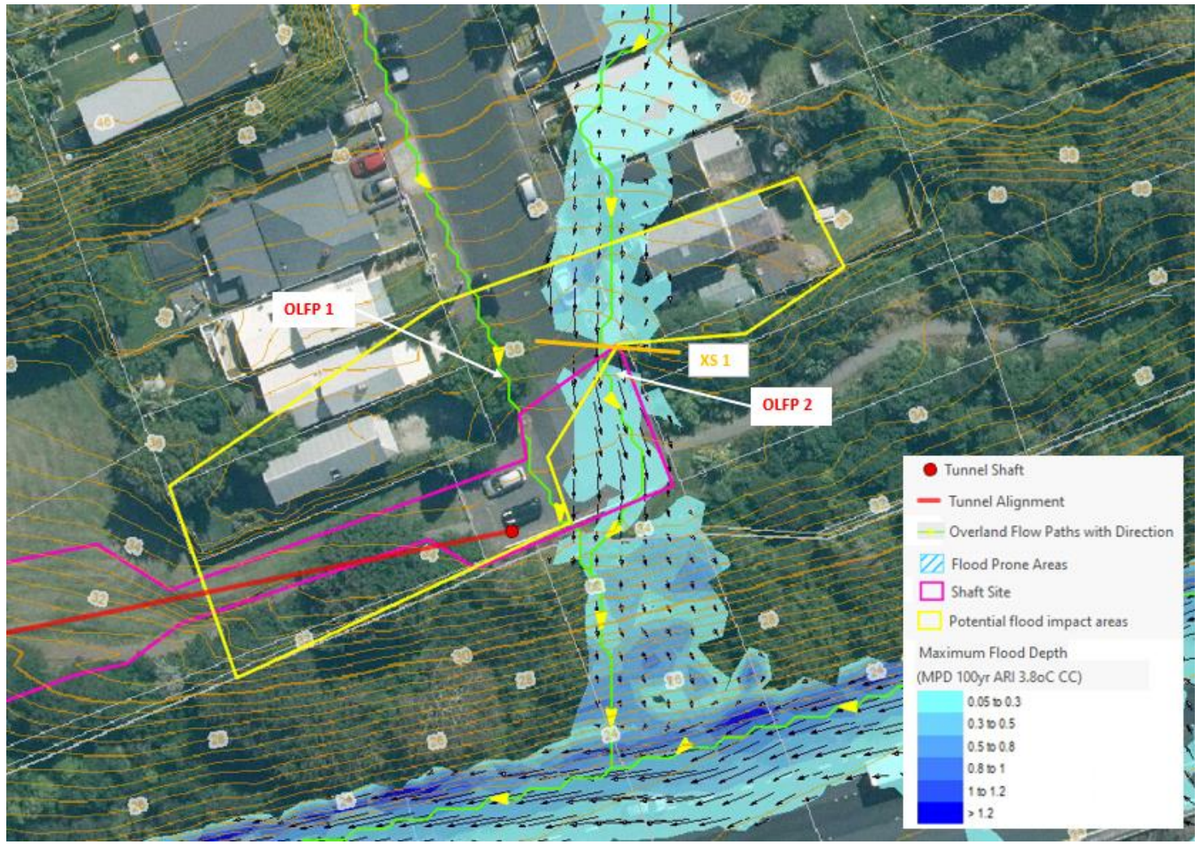
3. Floodplains

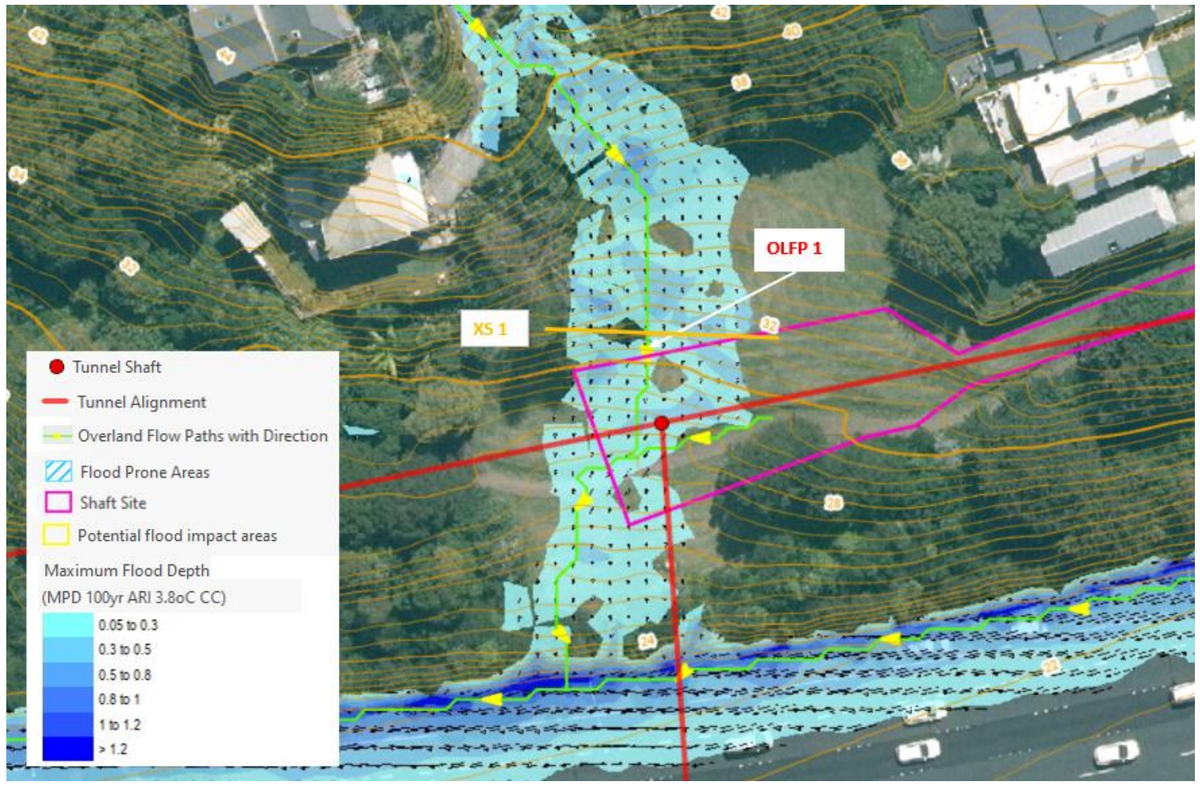
- The maximum flow through cross-sections from the model results during MPD 1% AEP with 3.8°C CC event listed in the table below.

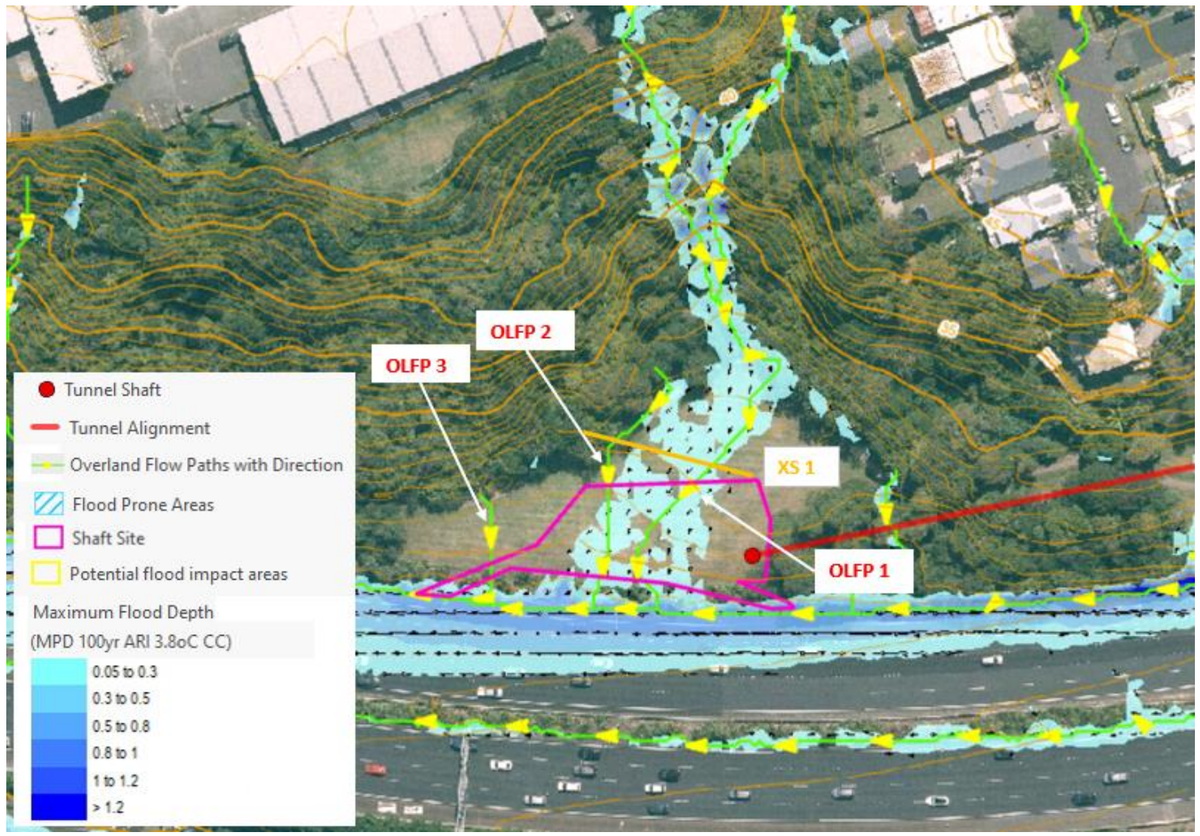
Stormwater (SW) event	XS 1 (m^3/s)	XS 2 (m^3/s)	XS 3 (m^3/s)
MPD 1% AEP with 3.8°C CC	0.54	0.09	0.86

Conclusions

- The model results show a shallow overland flow coming from southeast covering most of the shaft site area and leaving the site toward the northwest and conveyance through DN2550 and DN1500 pipes.
- The overland flow from the south has a flow rate of 0.54 m^3/s at XS 1 based on the model results during MPD 1% AEP with 3.8oC CC event.
- The tunnel shaft is not within the flood extent based on the model results or the flood depth is less than 50mm.
- Based on the model results, the flood hazard at the shaft site areas were classified as ‘Low hazard for all except infants and very small children’.
- The adjacent properties on Fleet Street could be adversely impacted by blockage of the overland flow and removal of flood storage within the floodplain due to temporary site works.
- We recommend maintaining the overland flow paths at the shaft site, including measures to protect the tunnel shaft and equipment within the shaft site from flooding. A temporary channel or swale could be used to divert flow around the site works, with a bund to protect the shaft site from water ingress. The tunnel shaft should be protected by temporary works such as a bund or channeling stormwater runoff away from the shaft area.

SH13	Cooper Street Cul de Sac		1. Overland flow **Location** / **Catchment Area (ha)** / **Peak Flow (m^3/s)**: **ED 1% AEP No CC** / **MPD 1% AEP 2.1°C CC** / **MPD 1% AEP 3.8°C CC** OLFP 1 — 3.16 — 0.916 — 1.19 — 1.411 OLFP 2 — 0.25 — 0.062 — 0.084 — 0.1 2. Flood Prone Area (FPA) - No FPA intersect or around the shaft site 3. Floodplains • Model results indicated the maximum flow through cross-section (XS 1) is 0.48 m^3/s. **Conclusions** • The model results show an overland flow path from north to south with a peak flow rate of 0.48 m^3/s, maximum flood depths within the site area range from 50 to 200mm. These areas are classified as 'Low hazard for all except infants and very small children'. • The tunnel shaft is not within the flood extent based on the model results, or the flood depth is less than 50mm. • The adjacent properties at the end of Cooper Street could be adversely impacted by blockage of the overland flow and removal of flood storage within the floodplain due to temporary site works. • We recommend maintaining the overland flow path through the site. A temporary channel or swale could be used to divert flow around the site works, with a bund to protect the shaft site from water ingress.

SH14	Arch Hill Reserve		1. Overland flow **Location** / **Catchment Area (ha)** / **Peak Flow (m^3/s)**: ED 1% AEP No CC; MPD 1% AEP 2.1°C CC; MPD 1% AEP 3.8°C CC OLFP 1 | 1.40 | 0.406 | 0.527 | 0.625 2. Flood Prone Area (FPA) - No FPA intersect or around the shaft site 3. Floodplains • Model results indicated the maximum flow through cross-section XS 1 is 0.21 m^3/s. **Conclusions** • An overland flow path flows across the western end of the shaft site. The model results show that overland flow from the north has a flow rate of 0.21 m^3/s, and maximum flood depths within the site area range from 50 to 200mm. These areas are classified as 'Low hazard for all except infants and very small children'. • The shaft site entrance is located at eastern end of the site off Cooper Street, and the shaft site footprint runs through Arch Hill Reserve connecting tunnel shaft SH13 to the entrance. The model results show the entrance and the eastern part of shaft site area are not flooded or the flood depth is less than 50mm. • There are no adjacent properties that could be adversely impacted due to the temporary site works. • We recommend maintaining the overland flow path through the shaft site. A temporary channel or swale could be used to divert flow around the site works, with a bund to protect the shaft site from water ingress.

SH15	Arch Hill Reserve		1. Overland flow **Location** / **Catchment Area (ha)** / **Peak Flow (m^3/s)**: ED 1% AEP No CC; MPD 1% AEP 2.1°C CC; MPD 1% AEP 3.8°C CC OLFP 1 — 3.16 — 0.916 — 1.19 — 1.411 OLFP 2 — 0.25 — 0.062 — 0.084 — 0.1 OLFP 3 — 0.25 — 0.055 — 0.078 — 0.095 2. Flood Prone Area (FPA) - No FPA intersect or around the shaft site 3. Floodplains • Model results indicate the maximum flow rate through cross-section (XS 1) is 0.25 m^3/s. **Conclusions** • The model results show overland flow from the north has a flow rate of 0.25 m^3/s, the maximum flood depths within the site range from 50 to 200mm. These areas are classified as 'Low hazard for all except infants and very small children'. The shaft site blocks the overland flow from the north. • The tunnel shaft is not within the modelled flood extent. The tunnel shaft should be protected from flooding as it is located on a sloping area with an overland flow above. • The shaft site entrances at both the western and eastern ends of the site are within and require crossing of flood hazard areas classified as 'High hazard for all'. • There are no adjacent properties that could be adversely impacted due to the temporary site works. • We recommend maintaining the overland flow path through the site and ensuring it is directed away from the tunnel shaft. A temporary channel or swale could be used to divert flow around the site works, with a bund to protect the shaft site from water ingress.

4 Comments on AUP Assessment Criteria

As noted previously, the following assessment criteria are relevant given the land use consent triggers and the application's restricted discretionary activity status:

E26.5.7.2. Assessment criteria

d) whether the earthworks and final ground levels will adversely affect overland flow paths or increase potential volume or frequency of flooding within the site or surrounding sites.

i) the extent of risks associated with natural hazards and whether the risks can be reduced or not increased.

Regarding these criteria, we provide the following comments:

Whether the earthworks and final ground levels will adversely affect overland flow paths or increase potential volume or frequency of flooding within the site or surrounding sites.

There is potential for overland flow paths to be adversely affected at all shaft sites. At shaft sites 3, 5, 6 and 7, all or much of the site is flooded and provides conveyance of overland flows. At these sites, the impact on overland flow is expected to be more significant.

At shaft site 2, 3, 5, 6,7 and 12, there is ponding within the shaft site area and temporary works could increase the volume of flood storage, and therefore flood depths on the site or adjacent properties.

The frequency of flooding is not expected to increase within the sites or surrounding sites as due to the sloping nature of the sites the removal of flood storage is expected to raise the flood level rather than increasing flood extents.

The extent of risks associated with natural hazards and whether the risks can be reduced or not increased

At site 1, 4, 8, 9, 10, 11, 12, 13, 14 and 15, the risk is relatively low, and it is expected that diversion of flow though the site will result in no change to current flood risk.

At site 2, 3, 5, 6, and 7, there is currently high flood risk, and diversion of overland flow paths and site protection using bunds, channelling stormwater and other mitigation may not be able to reduce the current level of risk.

5 Limitations and Assumptions

The limitations and assumptions of this flood risk assessment work are summarized below:

- The Motions catchment stormwater model results of ED 1% AEP without CC and MPD 1% AEP with 2.1 and 3.8 °C CC were provided by Auckland Council. The model and model results are assumed to be suitable for the flood risk assessment in this work.
- The limitations and assumptions of the stormwater model and model results in the Motions Model Update Report completed by Woods in 2024 are considered as part of this work.
- Overland flow path information with peak flow data and flood prone areas data is generated based on LiDAR flown in 2016 following the TP108 (Auckland Regional Council (ARC), 1999) method and other Auckland Council guidance. Limitations and assumptions in TP108 and other Auckland Council guidance are considered as part of this work. Changes to the ground surface since 2016 will not be represented in the flood layers so the impacts of recent developments should also be considered
- The shaft sites extent GIS layer is not provided. The digitized shaft site extent is based on the figures in the Motions Collector Sewer Constructability Report – Rev 1. We assume the digitized shaft site extent matches the proposed construction site extent.
- We did not have any additional information on the proposed site layout at each site, so we assume that the entire site footprint has the potential to impact on overland flows and flooding within the footprint.
- The potential flood impact areas were created based on engineering judgement. Further modelling work is recommended to confirm which properties may be affected, maximum flood depth and levels, and maximum flow rates. This should be completed once further details about potential site arrangements have been agreed.

6 References

Auckland Regional Council (ARC). (1999). *Guidelines for Stormwater Runoff Modelling in the Auckland Region. Technical Publication No.108 (TP108).* Auckland, New Zealand.