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Modelling Assessment

Thomas Street Catchment Attenuation

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CONFIDENTIAL



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1	Updated based on client feedback
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Disclaimers and Limitations

This report ('**Report**') has been prepared by WSP exclusively for Gore District Council ('**Client**') in relation to Thomas Street Catchment Attenuation Assessment ('**Purpose**') and in accordance with the Short form Agreement with the Client dated 22 June 2021. The findings in this Report are based on and are subject to the assumptions specified in the Report and Offer of Services dated 22 June 2021. WSP accepts no liability whatsoever for any reliance on or use of this Report, in whole or in part, for any use or purpose other than the Purpose or any use or reliance on the Report by any third party.

1 Summary

Gore District Council (GDC) have been contacted regarding development of land at the top of the Thomas Street catchment. This has recently been purchased by a new landowner and they have plans to subdivide this property for residential development.

WSP previously provided a report where stormwater attenuation in this catchment was explored. GDC would like to explore this further in relation to this proposed development.

This report presents the findings of this further assessment, which has considered:

- Existing catchment performance.
- Catchment performance post stormwater separation.
- Attenuating the runoff from the proposed development catchment (pre-development) and limiting the peak discharge rate where it enters the stormwater network.

The existing system is a combined sewer system. There are plans to separate the stormwater from the foul, and this is represented in a separate model scenario. The stormwater network represented in the stormwater separation model scenario has been sized to accept flows from a 5-year rainfall event, including an allowance for climate change.

The results of this assessment indicate that attenuating flow from the site improves the catchment performance with regards predicted flood depth and Richmond Street pump station peak flow. However, there is little benefit with regards peak flow predictions at Ardwick Street stormwater pump station, Broughton Street wastewater main, or the wastewater treatment plant (WWTP) inflow.

After discussions with Matt Bayliss (GDC) about the initial findings of this project, the following assessment is recommended:

- Assess the potential benefit with complete removal of the development subcatchment. This will indicate the potential maximum benefit of limiting the flows from the site. This analysis can then quickly inform if more detailed analysis of further flow limiting will likely provide value.
- The assessment should consider reduction in flood depths when compared to the existing system.
- The assessment should consider potential reduction in pipe sizes and construction costs of the stormwater separation project.

Revision two of this report includes the results of these recommended investigations. The results show that removing the storm flows from the development site:

- Reduce flood depths downstream, but with only a small reduction in flood extent.
- Reduce the amount of new stormwater assets required in the Richmond Street pump station. This gives an estimated cost reduction of 4% to construct these assets.

Based on these results, there is potential benefit for GDC in further flow attenuation from the development site. The main benefit will be with regards costs savings when constructing the stormwater assets in the Richmond Street pump station area as part of the stormwater separation project. Recommendations from this further assessment are:

- The cost savings are compared against the potential costs of any flow attenuation scheme on the development site.
- Further catchment attenuation, and/or flow re-direction within the catchment, is investigated.

Following these results, discussions were had with GDC on the potential of directing the stormwater from the northern end of Broughton Street into the Thomas St attenuation basin. The aim would be to reduce peak flows in the network to a point where stormwater pipe upgrades in Devon Street can be avoided. Having interrogated the model, flow down the Broughton Street pipeline in the 5-year 1-hour event is predicted to have a peak of 370 L/s and total volume of 900 m³. Based on these flows it is considered unlikely to get to a point where the downstream upgrades aren't required. However, it may reduce pipe sizes required and improve constructability.

2 Assessment Approach

Prior the Thomas Street catchment attenuation assessment, model updates (addition of the Bupa development) and model validation were undertaken. See *Model Validation Memorandum, WSP, 8 July 2021*.

To assess the Thomas Street catchment attenuation, the following methodology was followed:

- Model updated to incorporate the Elizabeth Street SW separation and attenuation basin details, as per report and drawings provided: “7060 - Elizabeth St - Detailed Design Report Rev 1” and “200817 - 7060 - Elizabeth St Detailed Design - FOR REVIEW”.
- Modify the development subcatchment, as shown Figure 1, to separate area of recent low-density development. This area has been applied to the model downstream of the development assessment point. Impermeable area for this low-density development area has been set as 20%.
- Runoff from development subcatchment assumed to be based on it being undeveloped, i.e. no impermeable area.

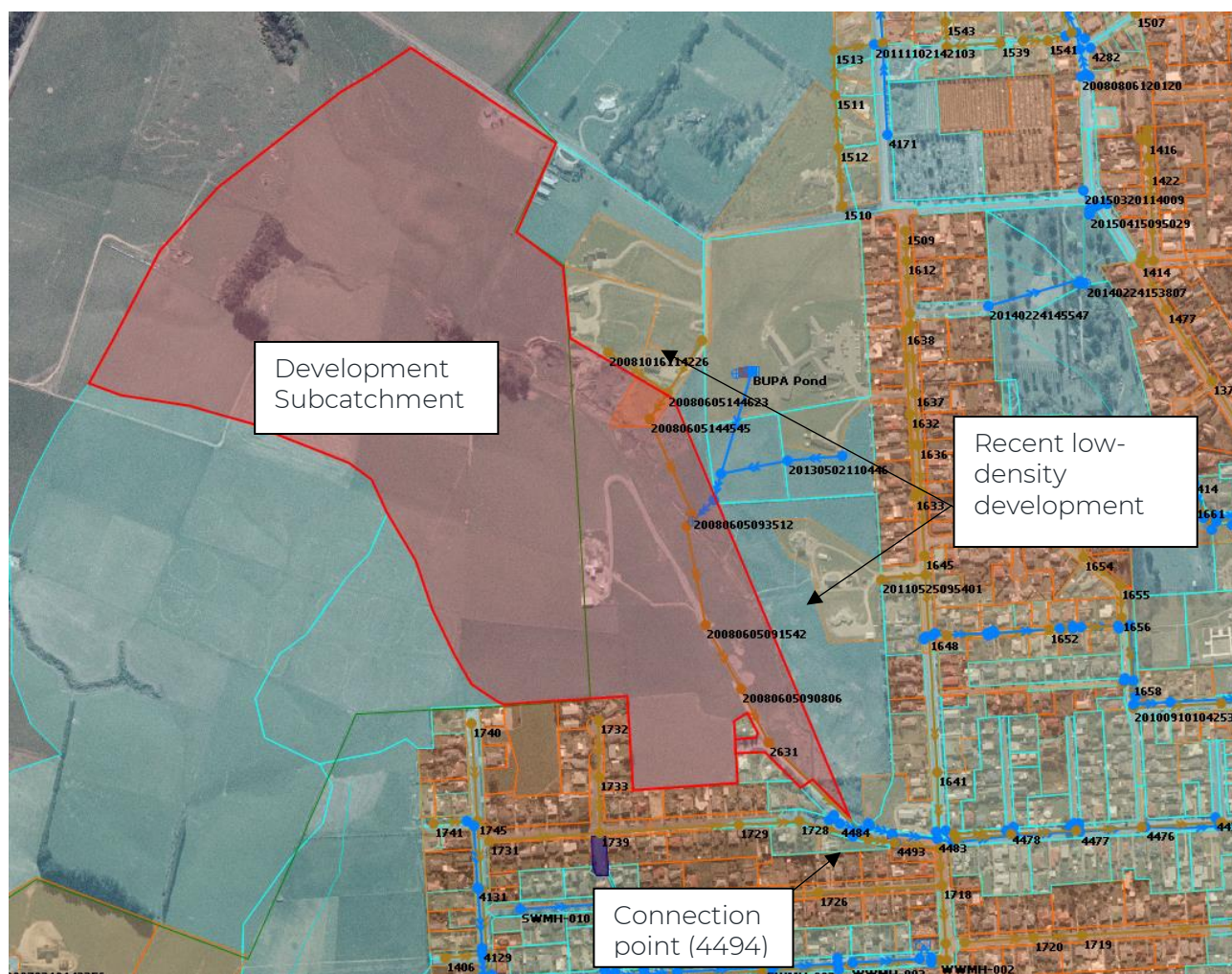


Figure 1 Development Area

- Scenarios created to assess the catchment performance before and after attenuation, scenarios run were:
 - 1 Base model (existing system – no separation) and no attenuation – run with 5 yr and 10 yr events.

- 2 Base model (existing system – no separation) (with attenuation. Limit to 100 L/s) – run with 5 yr events.
 - 3 Base model (existing system – no separation) (with attenuation. Limit to 350 L/s) – run with 10 yr events.
 - 4 Base model (with separation) and no attenuation – run with 5 yr and 10 yr events.
 - 5 Base model (with separation) (with attenuation. Limit to 100 L/s) – run with 5 yr events.
 - 6 Base model (with separation) (with attenuation. Limit to 350 L/s) – run with 10 yr events.
- Attenuation represented by applying the development subcatchment to an oversized manhole. This manhole was then connected to the network at manhole 4494 using an orifice with a limiting discharge.

3 Assumptions

In preparing this report WSP has relied on the following assumptions and qualifications:

- Design rainfall, including an allowance for climate change, from the Gore Design Rainfall Analysis Report (Opus International Consultants, 2012) has been used. It should be noted that this rainfall is not based on the latest MfE guidance.
- Elizabeth Street SW separation and attenuation basin - phase 2 (full solution) has been added to the model.
- Separation scenarios will be based on the Master Plan 20% AEP upgrade option.
- Catchment parameters for the development area as per the plan provided by GDC, i.e. assumed no further development in the catchment.

5 Results

Model results were assessed to:

- Provide volume of attenuation storage required for each attenuation scenario assessed, see section 5.1.
- Provide flood maps showing reduction in flooding in the downstream network (see section 5.2), using the following comparisons:
 - Compare scenarios 2 and 3 with scenario 1.
 - Compare scenarios 5 and 6 with scenario 1 and 4.
- Determine reduction in peak flows (see section 5.3) at the Ardwick Street pump station, the Broughton Street main and the WWTP inflow, using the following comparisons:
 - Compare scenarios 2 and 3 with scenario 1.
 - Compare scenarios 5 and 6 with scenario 1 and 4.

5.1 Attenuated Storage Volume

Table 1 provides the volume of attenuation storage required attenuation scenarios 2 and 3. Attenuation volumes for scenarios 5 and 6 are equal to scenarios 2 and 3 respectively. This is because the development catchment parameters do not alter between scenarios.

The storage volume required will increase when the land is developed, and a percentage of the land is impermeable.

Table 1 Attenuation Volumes¹

Scenario	Attenuation Volume (m ³) in 1-hour event	Attenuation Volume (m ³) in 2-hour event
2. Base model (existing system – no separation) (with attenuation. Limit to 100 L/s) – run with 5 yr events.	1,920	2,050
3. Base model (existing system – no separation) (with attenuation. Limit to 350 L/s) – run with 10 yr events.	2,820	2,960

5.2 Flood Depth

The comparison of scenarios 2 and 3 with scenario 1 are shown in Figure 2, to Figure 5. These show that there is a reduction in predicted flood depth due to attenuating flow from the development site.

The comparison of scenarios 5 and 6 with scenario 1 are shown in Figure 6 and Figure 7. These show a significant reduction in predicted flood depth due to catchment wide stormwater separation and upgrades.

The comparison of scenarios 5 and 6 with scenario 4 are shown in Figure 8 and Figure 9. These show no reduction in predicted flood depth in the 5-year event as there is no existing flooding predicted due to catchment wide surface water separation. There is some reduction in predicted flood depth in the 10-year event.

¹ The critical duration was found to be either 1-hour or 2-hour depending on the return period. Therefore, the results for both are presented.

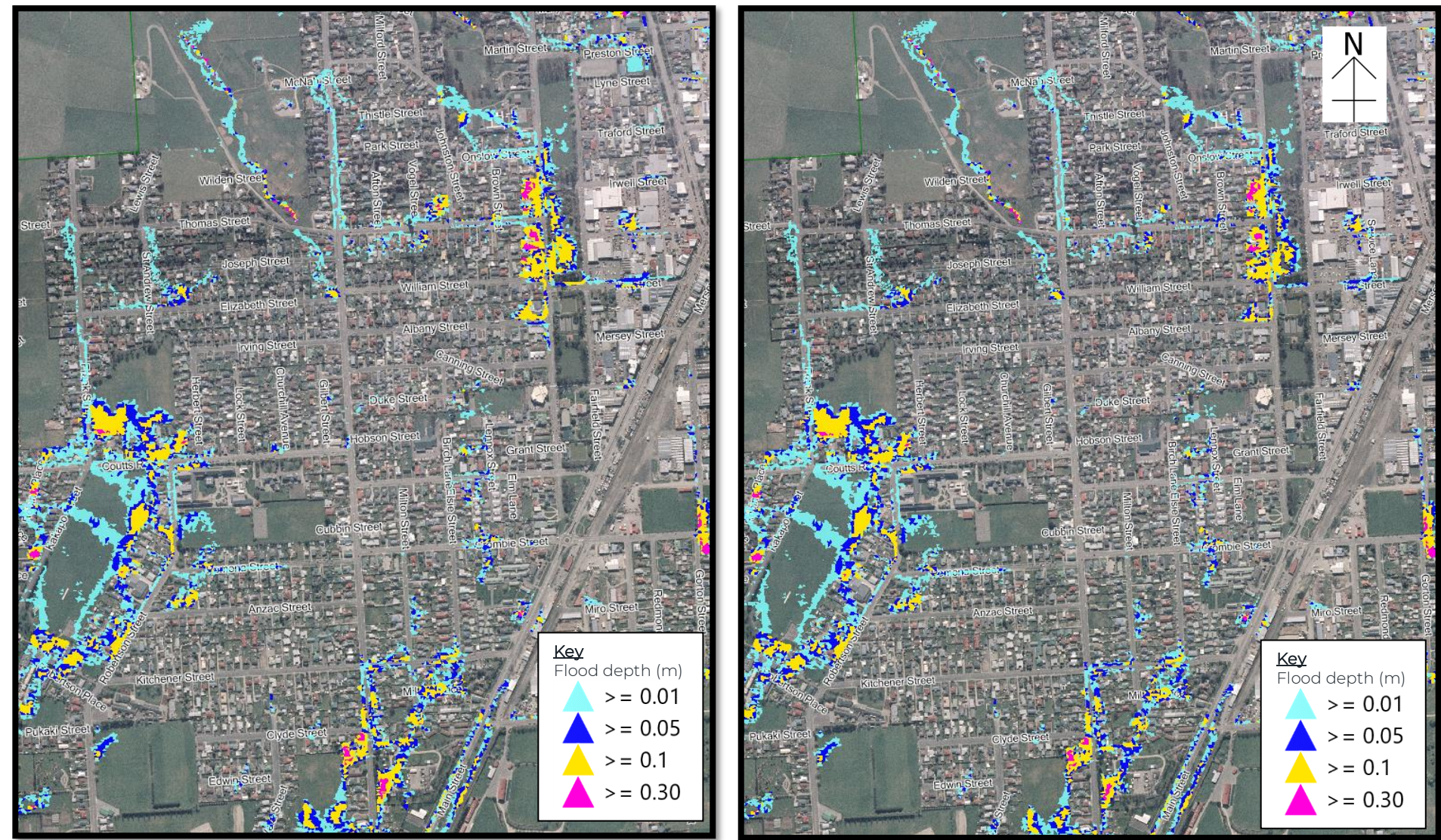


Figure 2 Scenario 1 flood map (left) and scenario 2 flood map (right) (5-yr, 2-hr)

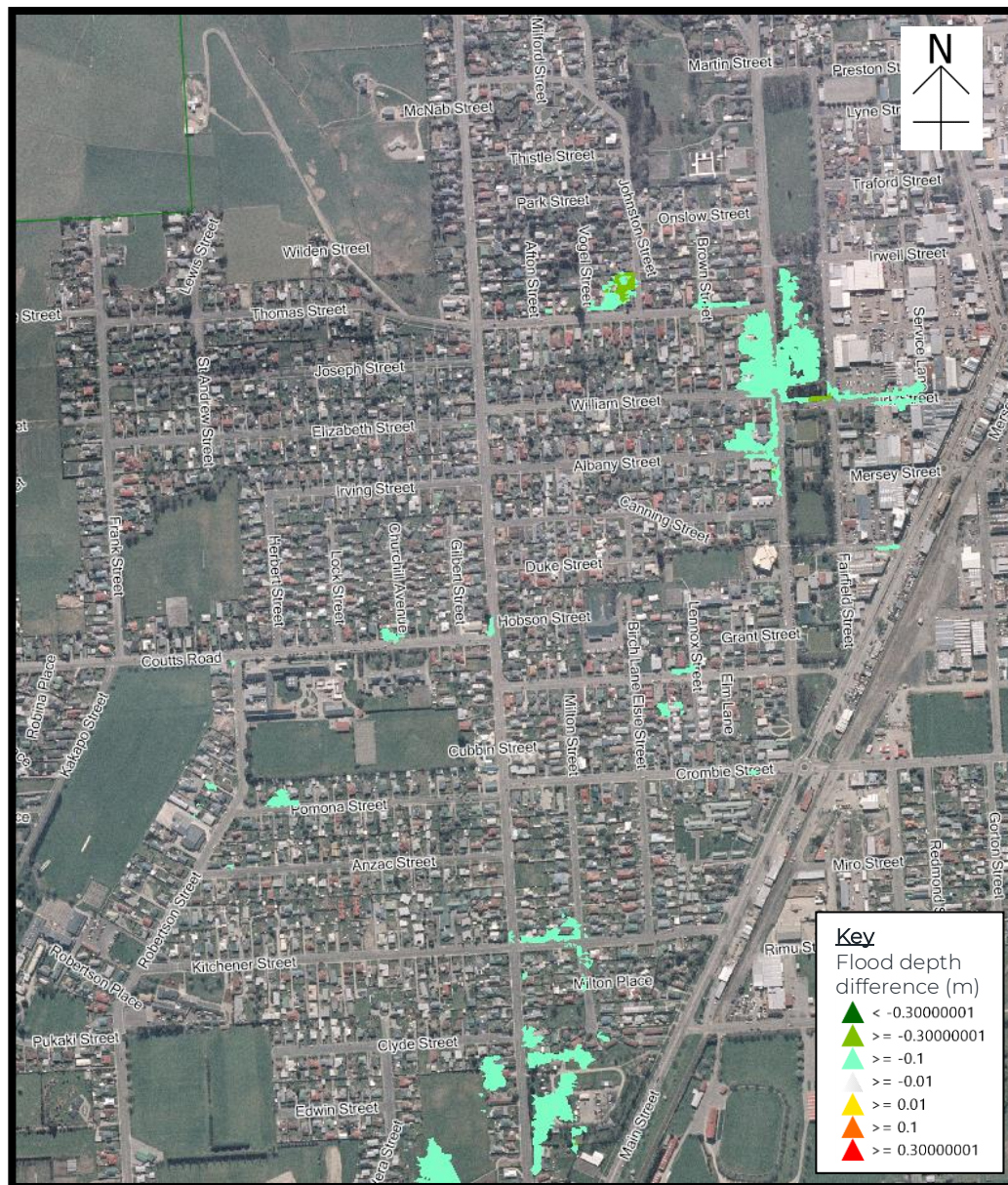


Figure 3 Scenario 1 v scenario 2 flood difference map (5-yr, 2-hr)

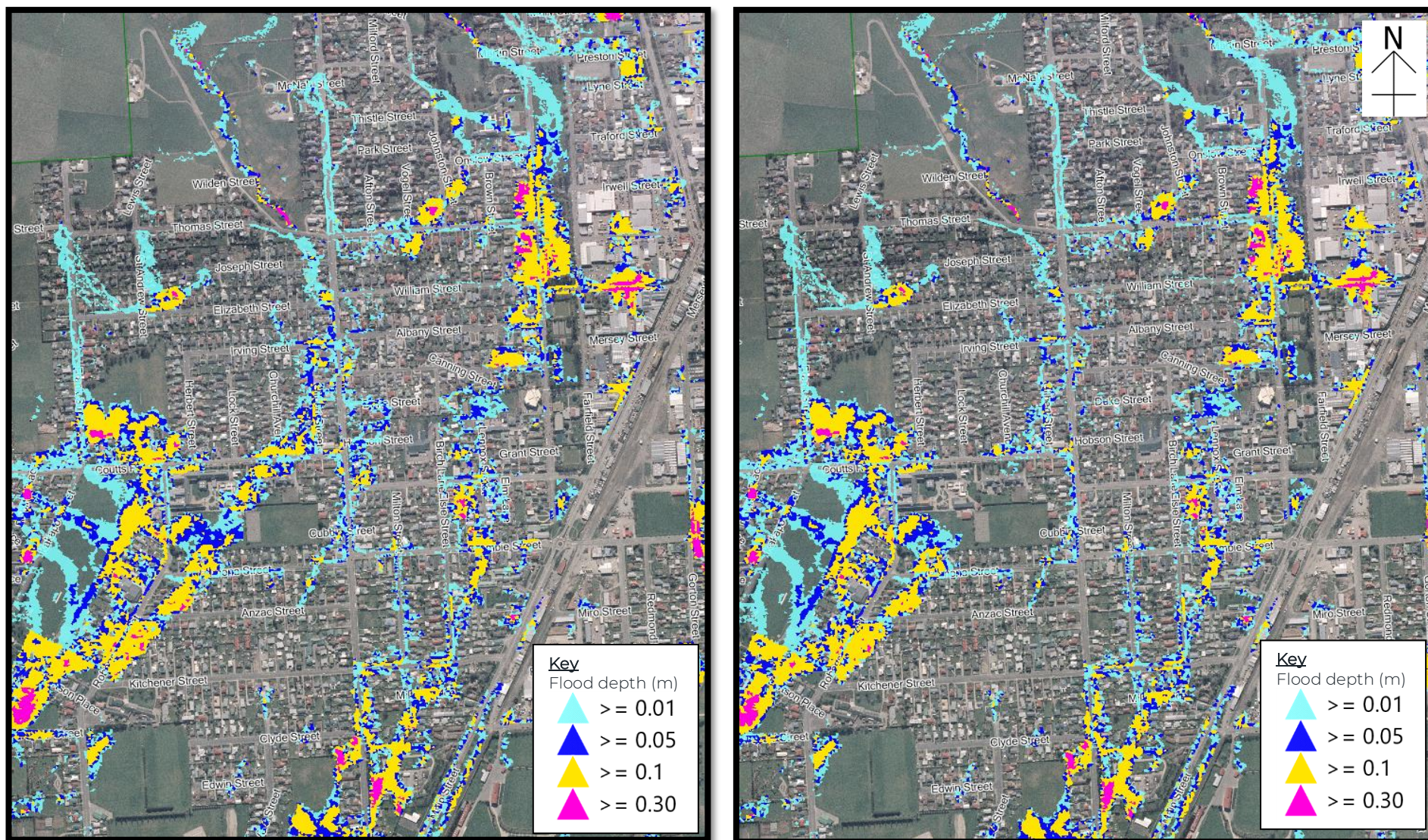


Figure 4 Scenario 1 flood map (left) and scenario 3 flood map (right) (10-yr, 2-hr)

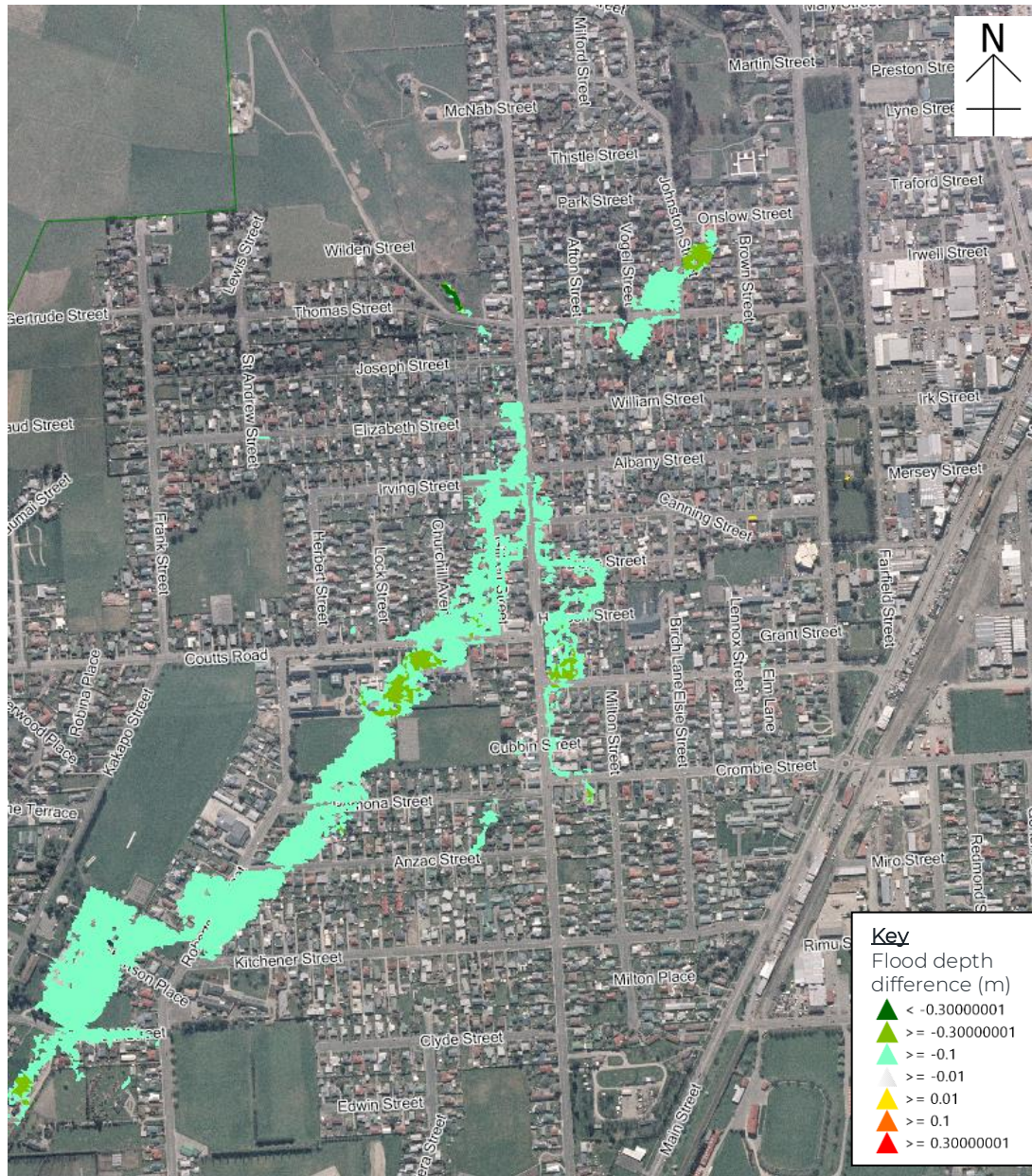


Figure 5 Scenario 1 v scenario 3 flood difference map (10-yr, 2-hr)

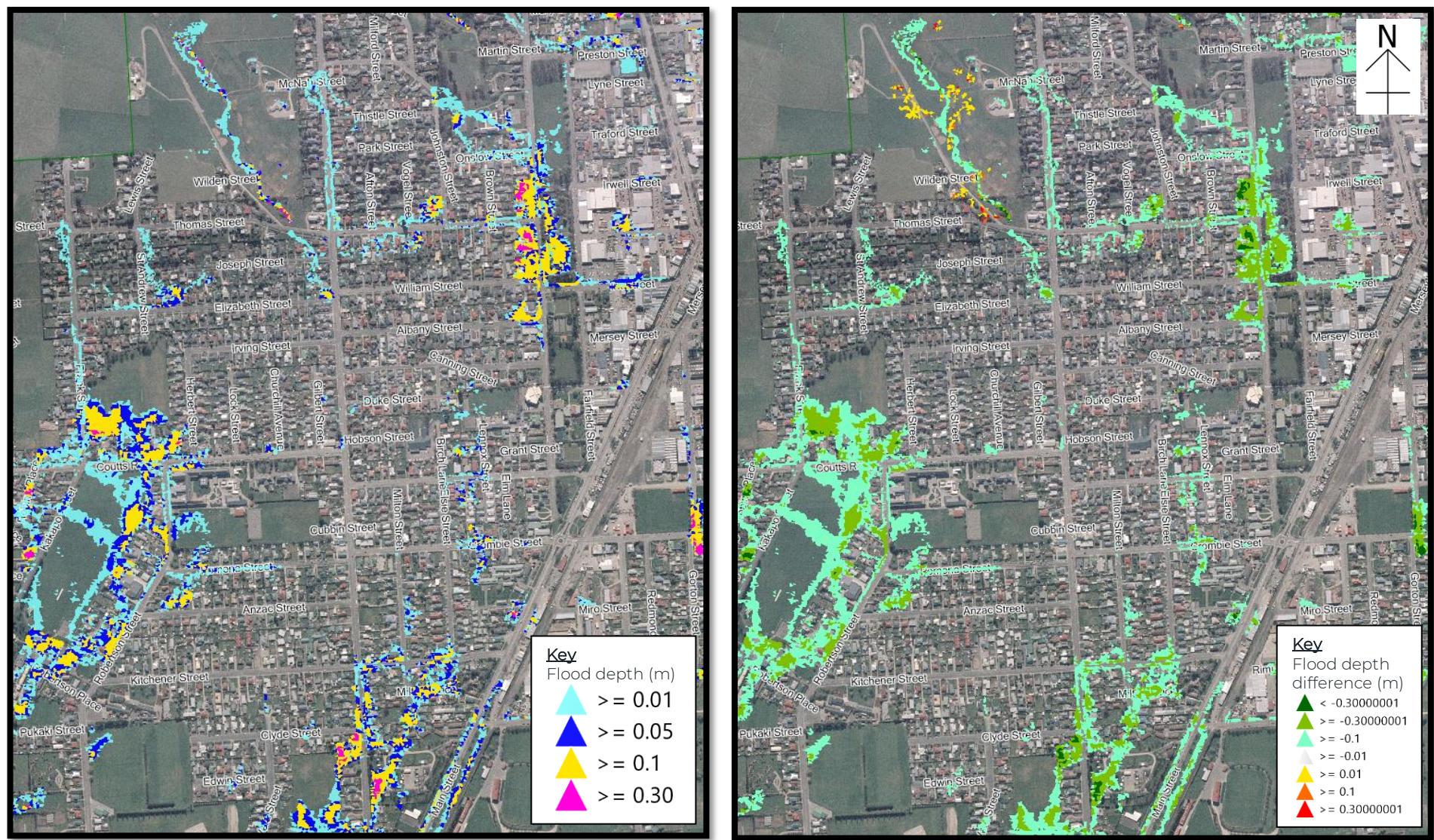


Figure 6 Scenario 1 flood map (left) and Scenario 1 v scenario 5 flood difference map (right) (5-yr, 2-hr)

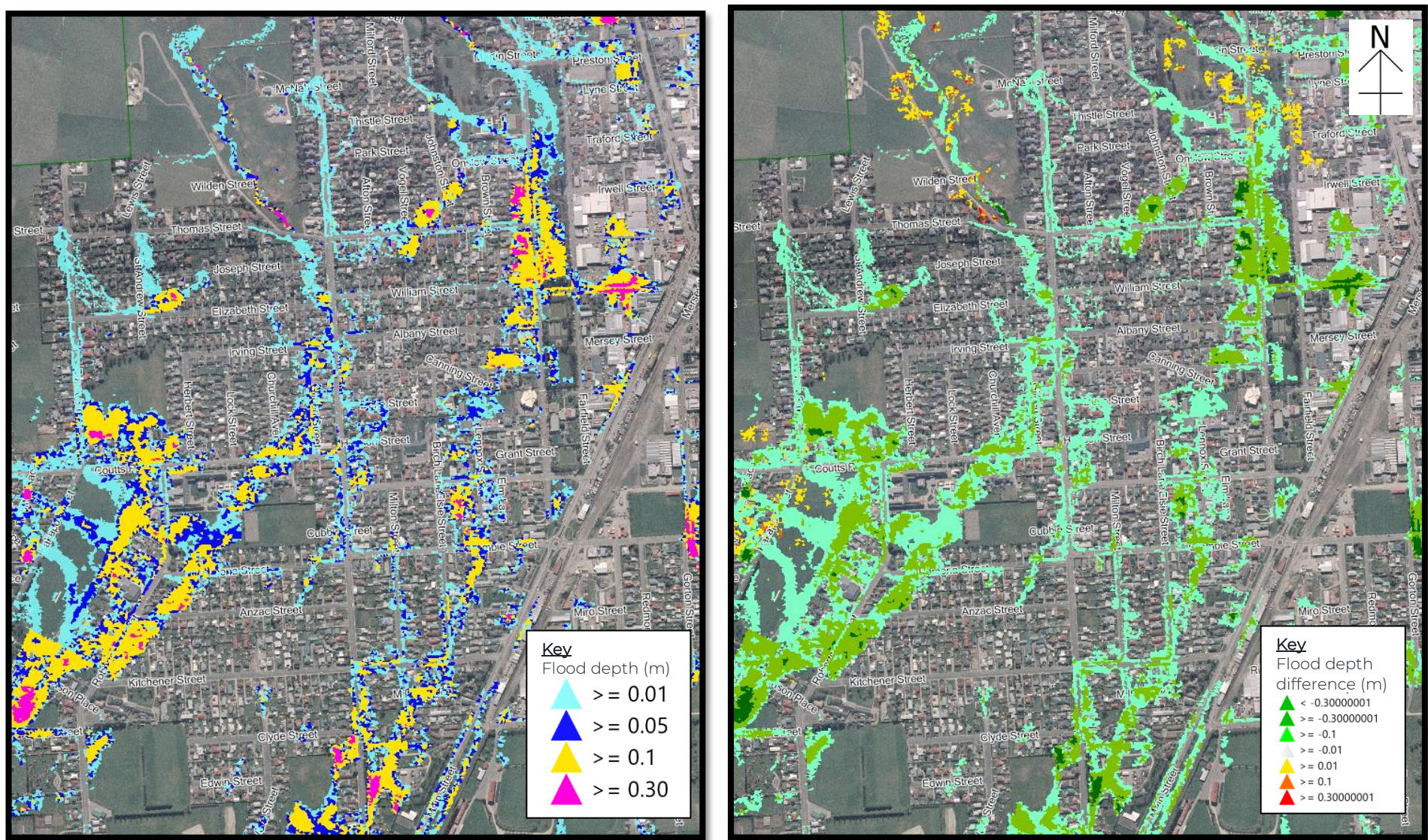


Figure 7 Scenario 1 flood map (left) and Scenario 1 v scenario 6 flood difference map (right) (10-yr, 2-hr)

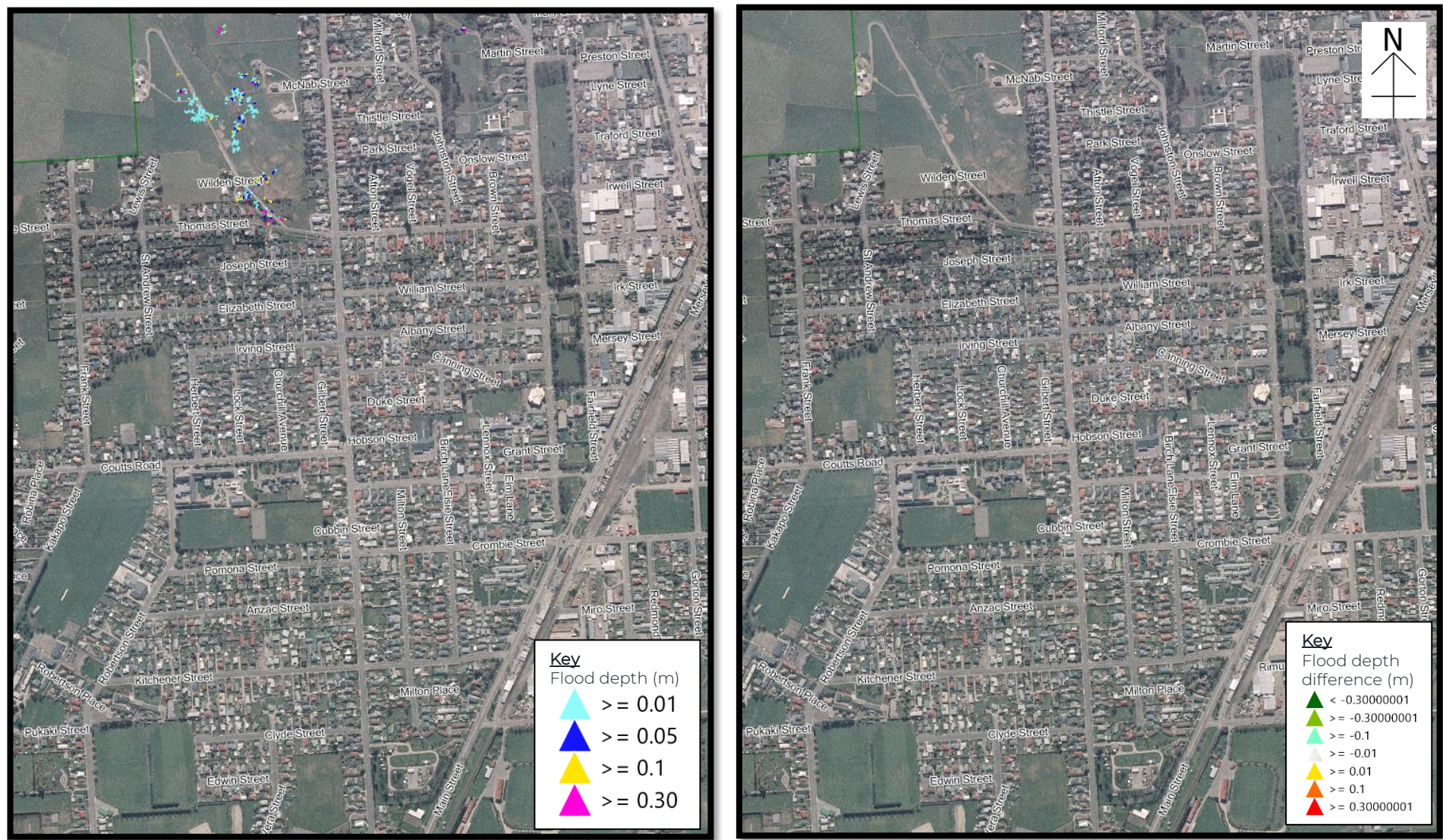


Figure 8 Scenario 4 flood map (left) and Scenario 4 v scenario 5 flood difference map (right) (5-yr, 2-hr)

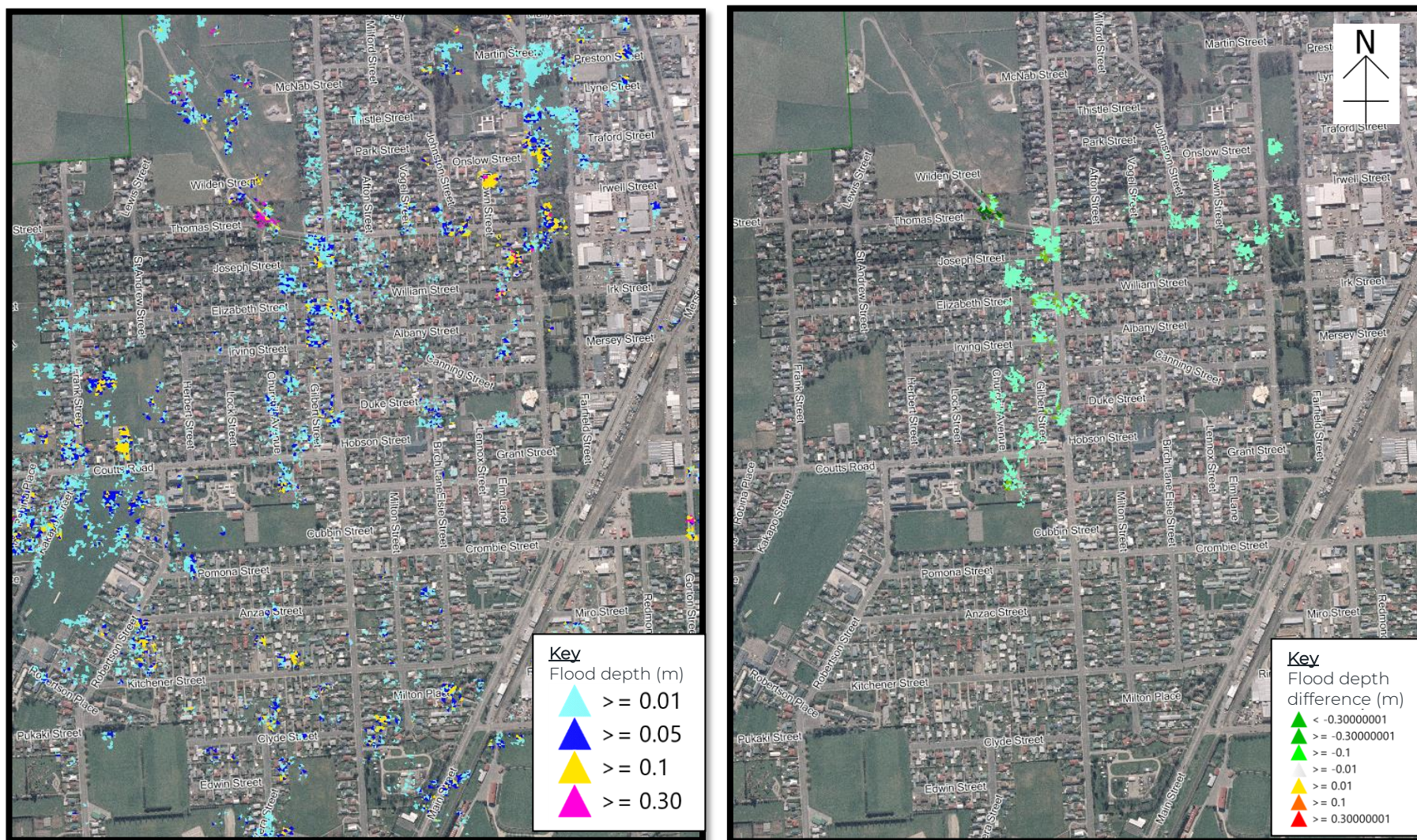


Figure 9 Scenario 4 flood map (left) and Scenario 4 v scenario 6 flood difference map (right) (10-yr, 1-hr²)

² Very little predicted flooding in the 2-hr event. Therefore, 1-hr event shown here.

5.3 Catchment Peak Flows

Peak flow from the Thomas Street catchment is shown Table 2 below.

Table 2 Thomas Street Catchment Flows

Event	Peak Catchment Flow (L/s)	Flow Restricted To (L/s)
5-yr, 1-hr	668	100
5-yr, 2-hr	531	100
10-yr, 1-hr	1,265	350
10-yr, 2-hr	1,020	350

The reduction in peak flows at the Ardwick Street pump station (see Table 3), Richmond pump station (see Table 4) the Broughton Street main (see Table 5), and the WWTP inflow (see Table 6) was determined.

Ardwick Street Stormwater Pump Station

The peak inflows to Ardwick Street stormwater pump station are predicted to reduce very slightly due to the development catchment attenuation. However, the peak flows are predicted to increase significantly due to catchment wide stormwater separation.

Table 3 Ardwick Street PS peak flow comparison

Scenario 1 Peak Flows (L/s)	Scenario 2 Peak Flows (L/s)	Scenario 3 Peak Flows (L/s)	Increase (L/s)
5-yr, 1-hr = 899 5-yr, 2-hr = 884 10-yr, 1-hr = 1,026 10-yr, 2-hr = 962	5-yr, 1-hr = 897 5-yr, 2-hr = 873	10-yr, 1-hr = 1,027 10-yr, 2-hr = 962	5-yr, 1-hr = -2 5-yr, 2-hr = -11 10-yr, 1-hr = +1 10-yr, 2-hr = 0
Scenario 1 Peak Flows (L/s)	Scenario 5 Peak Flows (L/s)	Scenario 6 Peak Flows (L/s)	Increase (L/s)
5-yr, 1-hr = 899 5-yr, 2-hr = 884 10-yr, 1-hr = 1,026 10-yr, 2-hr = 962	5-yr, 1-hr = 4,893 5-yr, 2-hr = 3,336	10-yr, 1-hr = 6,789 10-yr, 2-hr = 5,077	5-yr, 1-hr = +3,994 5-yr, 2-hr = +2,452 10-yr, 1-hr = +5,763 10-yr, 2-hr = +4,115
Scenario 4 Peak Flows (L/s)	Scenario 5 Peak Flows (L/s)	Scenario 6 Peak Flows (L/s)	Increase (L/s)
5-yr, 1-hr = 4,893 5-yr, 2-hr = 3,336 10-yr, 1hr = 6,789 10-yr, 2-hr = 5,077	5-yr, 1-hr = 4,893 5-yr, 2-hr = 3,336	10-yr, 1-hr = 6,789 10-yr, 2-hr = 5,077	5-yr, 1-hr = 0 5-yr, 2-hr = 0 10-yr, 1-hr = 0 10-yr, 2-hr = 0

Richmond Stormwater Pump Station

The development catchment attenuation is predicted to have no effect on the peak flows here when compared with the existing system. This is because the network is surcharged, and a reduction in peak flows causes a reduction in flooding rather than peak pipe flow.

However, peak flows here are predicted to be reduced when compared with the catchment wide stormwater separation scenario.

Table 4 Richmond PS inflow

Scenario 1 Peak Flows (L/s)	Scenario 2 Peak Flows (L/s)	Scenario 3 Peak Flows (L/s)	Increase (L/s)
5-yr, 1-hr = 918 5-yr, 2-hr = 861 10-yr, 1-hr = 996 10-yr, 2-hr = 929	5-yr, 1-hr = 918 5-yr, 2-hr = 860	10-yr, 1-hr = 996 10-yr, 2-hr = 929	5-yr, 1-hr = 0 5-yr, 2-hr = -1 10-yr, 1-hr = 0 10-yr, 2-hr = 0
Scenario 1 Peak Flows (L/s)	Scenario 5 Peak Flows (L/s)	Scenario 6 Peak Flows (L/s)	Increase (L/s)
5-yr, 1-hr = 918 5-yr, 2-hr = 861 10-yr, 1-hr = 996 10-yr, 2-hr = 929	5-yr, 1-hr = 4,576 5-yr, 2-hr = 3,231	10-yr, 1-hr = 6,005 10-yr, 2-hr = 5,160	5-yr, 1-hr = +3,659 5-yr, 2-hr = +2,370 10-yr, 1-hr = +5,009 10-yr, 2-hr = +4,231
Scenario 4 Peak Flows (L/s)	Scenario 5 Peak Flows (L/s)	Scenario 6 Peak Flows (L/s)	Increase (L/s)
5-yr, 1-hr = 4,837 5-yr, 2-hr = 3,420 10-yr, 1hr = 6,008 10-yr, 2-hr = 5,407	5-yr, 1-hr = 4,576 5-yr, 2-hr = 3,231	10-yr, 1-hr = 6,005 10-yr, 2-hr = 5,160	5-yr, 1-hr = -261 5-yr, 2-hr = -189 10-yr, 1-hr = -3 10-yr, 2-hr = -247

Broughton Street Wastewater Main

The development catchment attenuation is predicted to have no effect on the peak flows here (asset ID 2153-2138, 44-56 Broughton Street). There is a reduction of peak flows further up the catchment when comparing scenario 1 with scenarios 2 and 3, as the discharge of stormwater to the wastewater system via the cross-connection on Thomas Street is reduced/eliminated. However, this affect is reduced as you move downstream.

Peak flows here are predicted to be significantly reduced by the catchment wide stormwater separation.

Table 5 Broughton Wastewater Main peak flow comparison

Scenario 1 Peak Flows (L/s)	Scenario 2 Peak Flows (L/s)	Scenario 3 Peak Flows (L/s)	Increase (L/s)
5-yr, 1-hr = 744 5-yr, 2-hr = 724 10-yr, 1-hr = 788 10-yr, 2-hr = 742	5-yr, 1-hr = 744 5-yr, 2-hr = 722	10-yr, 1-hr = 788 10-yr, 2-hr = 742	5-yr, 1-hr = 0 5-yr, 2-hr = -2 10-yr, 1-hr = 0 10-yr, 2-hr = 0
Scenario 1 Peak Flows (L/s)	Scenario 5 Peak Flows (L/s)	Scenario 6 Peak Flows (L/s)	Increase (L/s)
5-yr, 1-hr = 744 5-yr, 2-hr = 724 10-yr, 1-hr = 788 10-yr, 2-hr = 742	5-yr, 1-hr = 113 5-yr, 2-hr = 83	10-yr, 1-hr = 152 10-yr, 2-hr = 117	5-yr, 1-hr = -631 5-yr, 2-hr = -641 10-yr, 1-hr = -636 10-yr, 2-hr = -625
Scenario 4 Peak Flows (L/s)	Scenario 5 Peak Flows (L/s)	Scenario 6 Peak Flows (L/s)	Increase (L/s)
5-yr, 1-hr = 113 5-yr, 2-hr = 83 10-yr, 1hr = 152 10-yr, 2-hr = 117	5-yr, 1-hr = 113 5-yr, 2-hr = 83	10-yr, 1-hr = 152 10-yr, 2-hr = 117	5-yr, 1-hr = 0 5-yr, 2-hr = 0 10-yr, 1-hr = 0 10-yr, 2-hr = 0

WWTP Inflow

The development catchment attenuation is predicted to have no effect on the peak flows here. However, peak flows here are predicted to be significantly reduced by the catchment wide stormwater separation.

Table 6 WWTP peak inflow comparison

Scenario 1 Peak Flows (L/s)	Scenario 2 Peak Flows (L/s)	Scenario 3 Peak Flows (L/s)	Increase (L/s)
5-yr, 1-hr = 849 5-yr, 2-hr = 862 10-yr, 1-hr = 858 10-yr, 2-hr = 867	5-yr, 1-hr = 849 5-yr, 2-hr = 862	10-yr, 1-hr = 858 10-yr, 2-hr = 867	5-yr, 1-hr = 0 5-yr, 2-hr = 0 10-yr, 1-hr = 0 10-yr, 2-hr = 0
Scenario 1 Peak Flows (L/s)	Scenario 5 Peak Flows (L/s)	Scenario 6 Peak Flows (L/s)	Increase (L/s)
5-yr, 1-hr = 849 5-yr, 2-hr = 862 10-yr, 1-hr = 858 10-yr, 2-hr = 867	5-yr, 1-hr = 141 5-yr, 2-hr = 145	10-yr, 1-hr = 209 10-yr, 2-hr = 200	5-yr, 1-hr = -708 5-yr, 2-hr = -717 10-yr, 1-hr = -649 10-yr, 2-hr = -667
Scenario 4 Peak Flows (L/s)	Scenario 5 Peak Flows (L/s)	Scenario 6 Peak Flows (L/s)	Increase (L/s)
5-yr, 1-hr = 141 5-yr, 2-hr = 145 10-yr, 1hr = 220 10-yr, 2-hr = 200	5-yr, 1-hr = 141 5-yr, 2-hr = 145	10-yr, 1-hr = 209 10-yr, 2-hr = 200	5-yr, 1-hr = 0 5-yr, 2-hr = 0 10-yr, 1-hr = -17 10-yr, 2-hr = 0

6 Further Analysis

The first revision of this report included recommendations for further analysis, these were:

- Assess the potential benefit with complete removal of the Thomas Street rural sub-catchment. This will indicate the potential maximum benefit of limiting the flows from the site. This analysis can then quickly inform if more detailed analysis of further flow limiting will likely provide value.
- The assessment should consider reduction in flood depths when compared to the existing system.
- The assessment should consider potential reduction in pipe sizes and construction costs of the stormwater separation project.

This section provided the methodology and results of this further analysis.

6.1 Methodology

- Two new scenarios were created in the model:
 - Scenario 7 - Base with Thomas Street rural sub-catchment removed.
 - Scenario 8 - SW separation with Thomas Street rural sub-catchment removed.
- These were run with the, 2-year, 5-year and 10-year storm events.
- Flood depth maps and flood depth difference maps have been produced.
- Stormwater pipe sizes, in the SW separation scenario, downstream of the Thomas Street catchment connection were re-assessed based on the predicted reduction in flow.
- Cost estimates of these stormwater pipes/manholes were calculated and compared to the original cost estimates.

6.2 Attenuation Storage Volume

Table 7 provides the volume of attenuation storage required when not allowing any flow to pass forward during the storm event.

The storage volume required will increase when the land is developed, and a percentage of the land is impermeable.

Table 7 Attenuation Volumes³

Scenario	Attenuation Volume (m ³) in 1-hour event	Attenuation Volume (m ³) in 2-hour event
7. Base model (existing system – no separation) (with attenuation. Limit to 0 L/s) – run with 5yr events.	2,570	2,850

³ The critical duration was found to be either 1-hour or 2-hour depending on the return period. Therefore, the results for both are presented.

6.3 Flood Depth Maps

The comparison of scenarios 1 and scenario 7 in the 2-year event are shown in Figure 10 and Figure 12, in the 5-year event are shown in Figure 13 and Figure 14, and in the 10-year event are shown in Figure 14 and Figure 15.

These show that there is some reduction in predicted flood depth due to removing flow from the development site. However, there is minimal difference in flood extent, based on a visual inspection of the maps.

The comparison of scenarios 4 and 8 are shown in Figure 16 and Figure 17. The flood depth maps show the results for the 10-year event only, as there is no predicted flooding during the 5-year event. This is because the SW separation network has been sized to accept the 5-year flows. These maps also show that there is some reduction in predicted flood depth due to removing flow from the development site. However, there is minimal difference in flood extent, based on a visual inspection of the maps.



Figure 10 Scenario 1 (base) flood map (left) and scenario 7 (base with Thomas Street rural sub-catchment removed) flood map (right) (2-yr, 1-hr)



Figure 11 Scenario 1 (base) v scenario 7 (base with Thomas Street rural sub-catchment removed) flood difference map (2-yr, 1-hr)

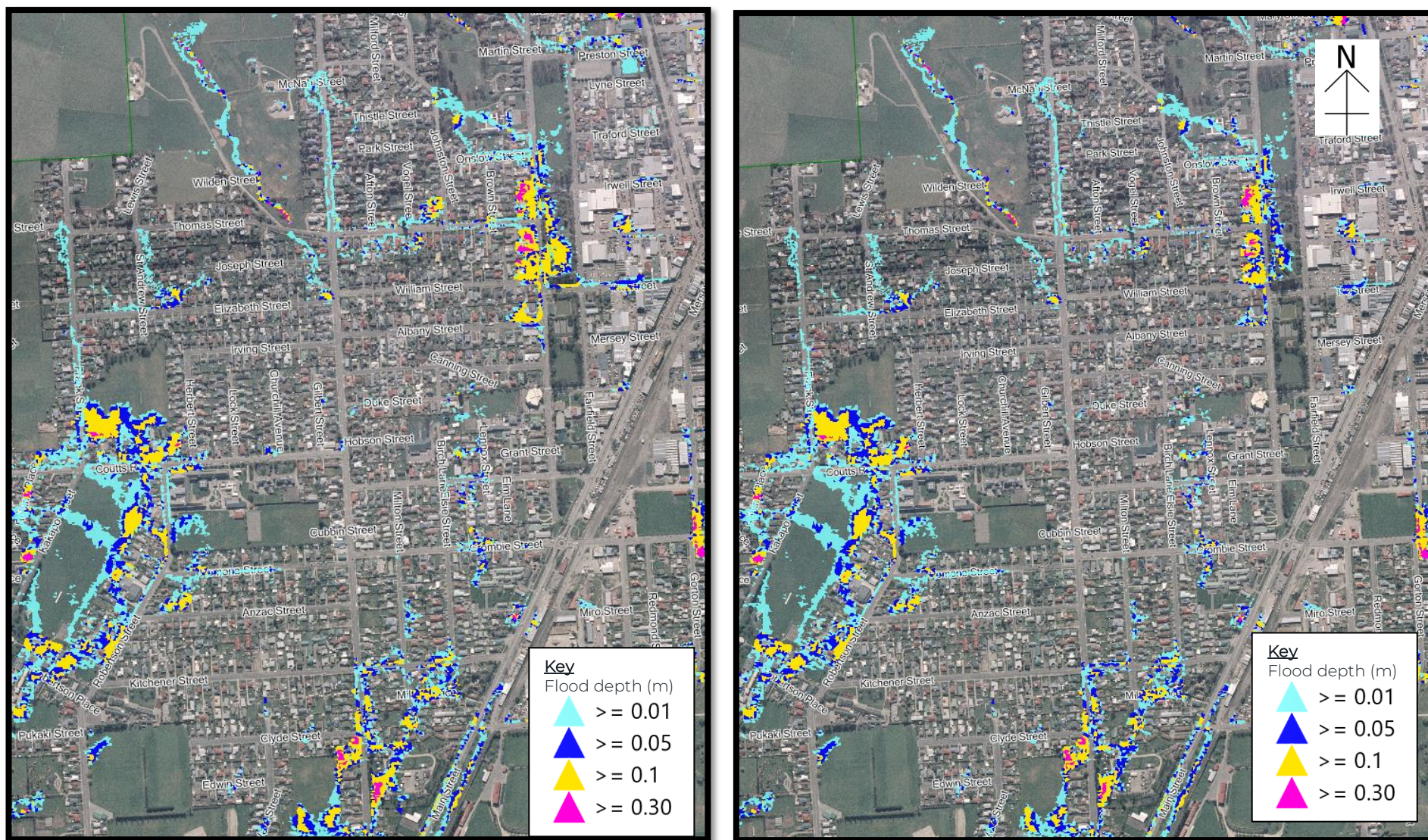


Figure 12 Scenario 1 (base) flood map (left) and scenario 7 (base with Thomas Street rural sub-catchment removed) flood map (right) (5-yr, 2-hr)

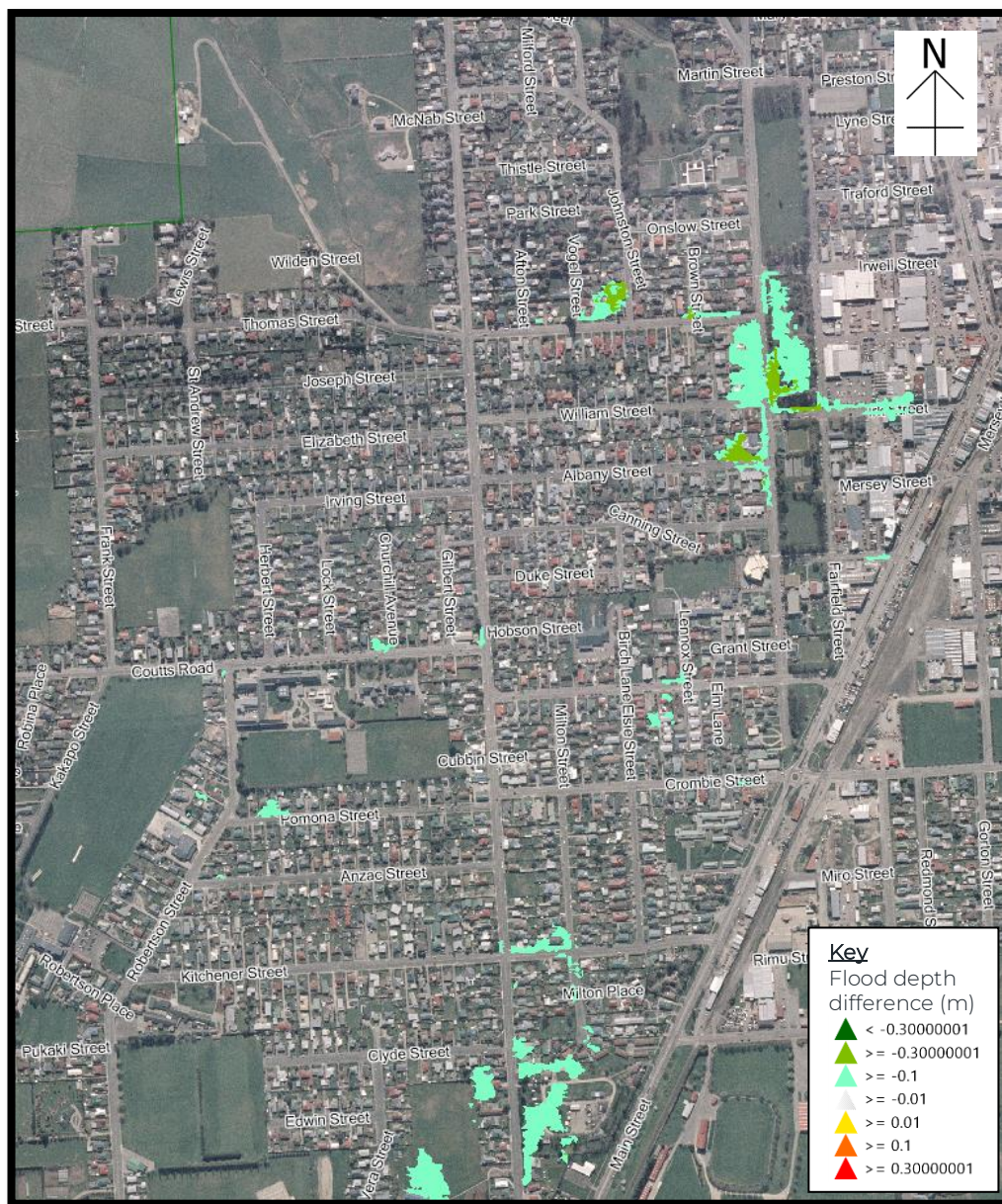


Figure 13 Scenario 1 (base) v scenario 7 (base with Thomas Street rural sub-catchment removed) flood difference map (5-yr, 2-hr)

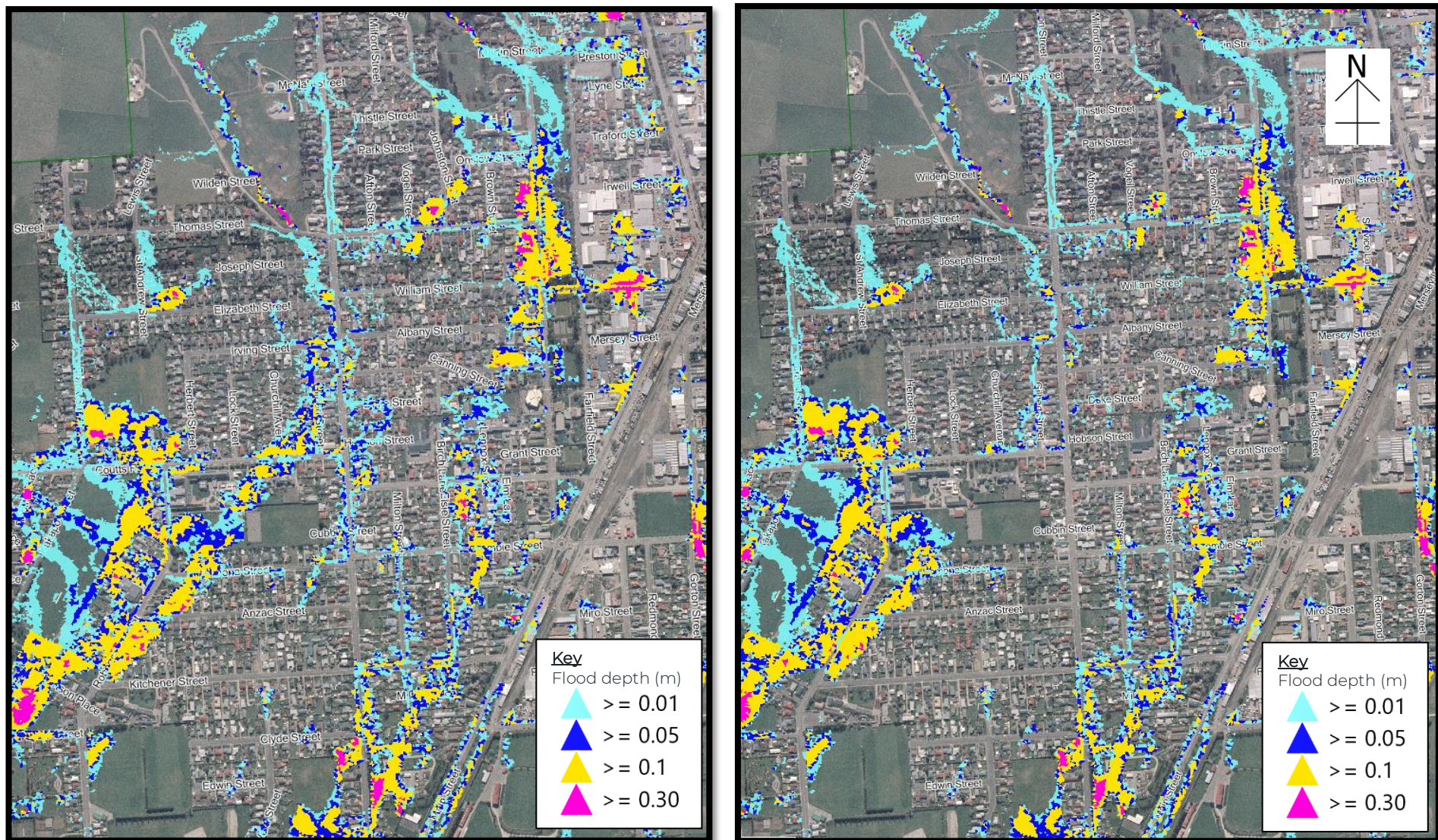


Figure 14 Scenario 1 (base) flood map (left) and scenario 7 (base with Thomas Street rural sub-catchment removed) flood map (right) (10-yr, 2-hr)

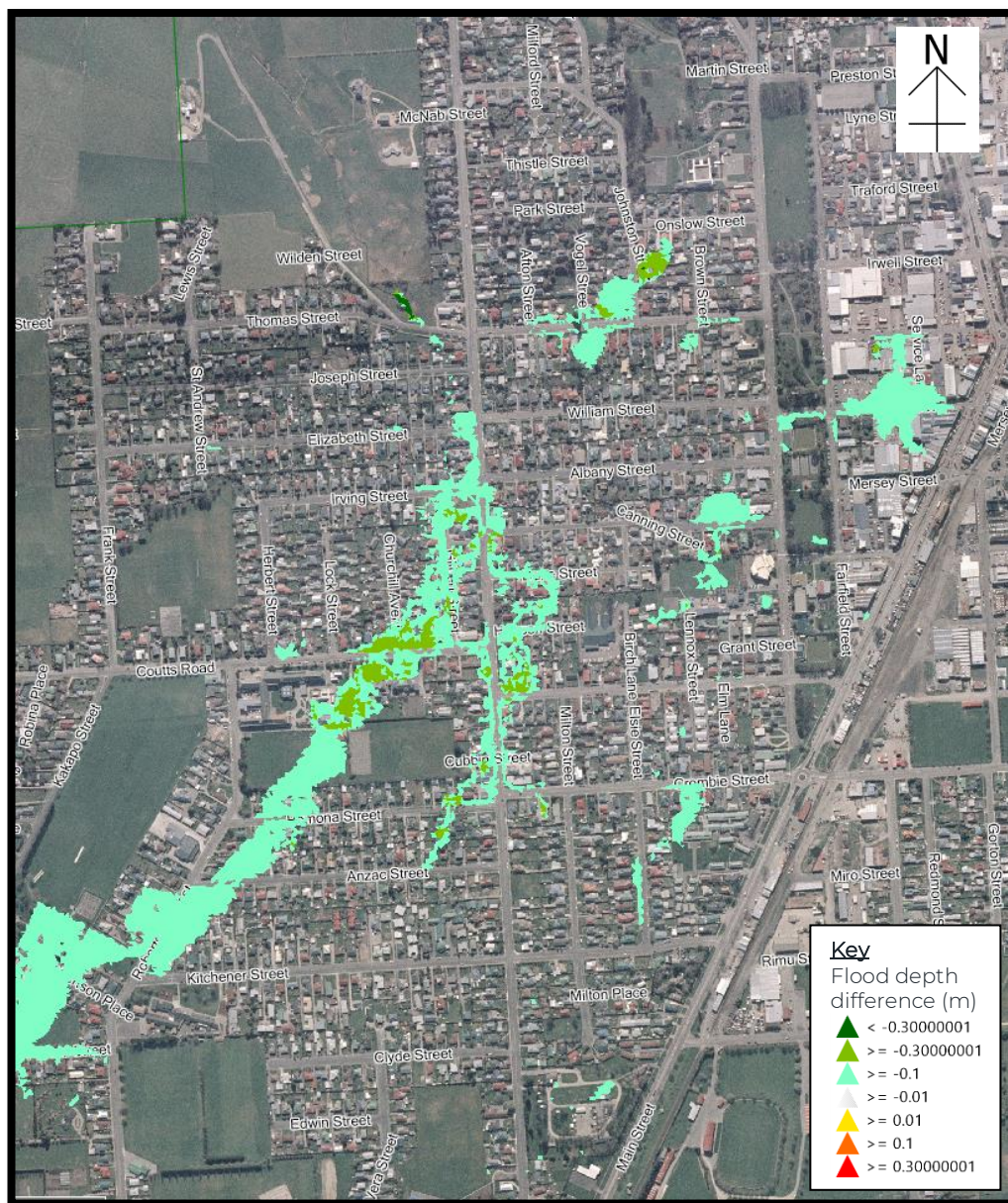


Figure 15 Scenario 1 (base) v scenario 7 (base with Thomas Street rural sub-catchment removed) flood difference map (10-yr, 2-hr)

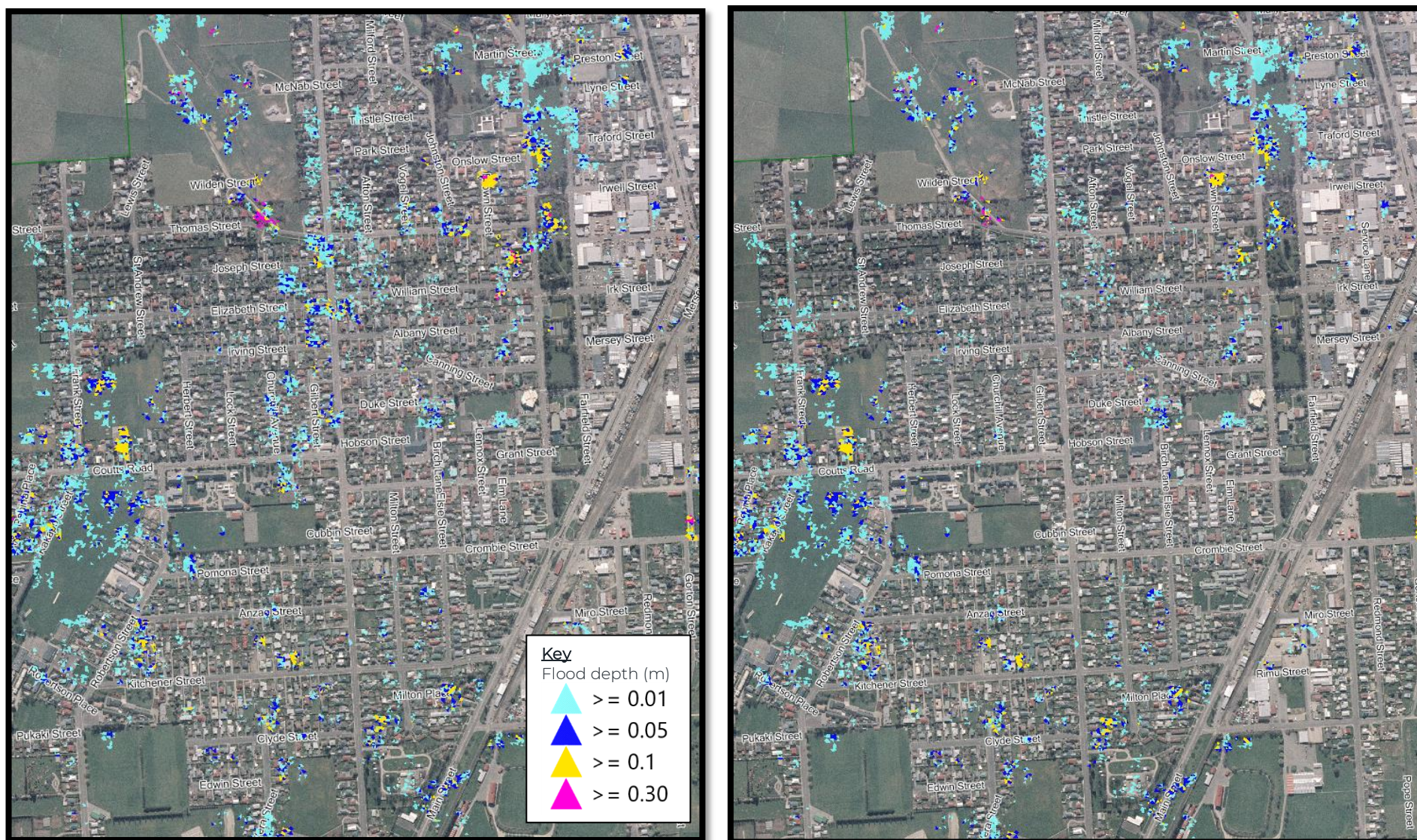


Figure 16 Scenario 4 (SW Separation scenario) flood map (left) and scenario 8 (SW Separation scenario with Thomas Street rural sub-catchment removed) flood map (right) (10-yr, 1-hr)

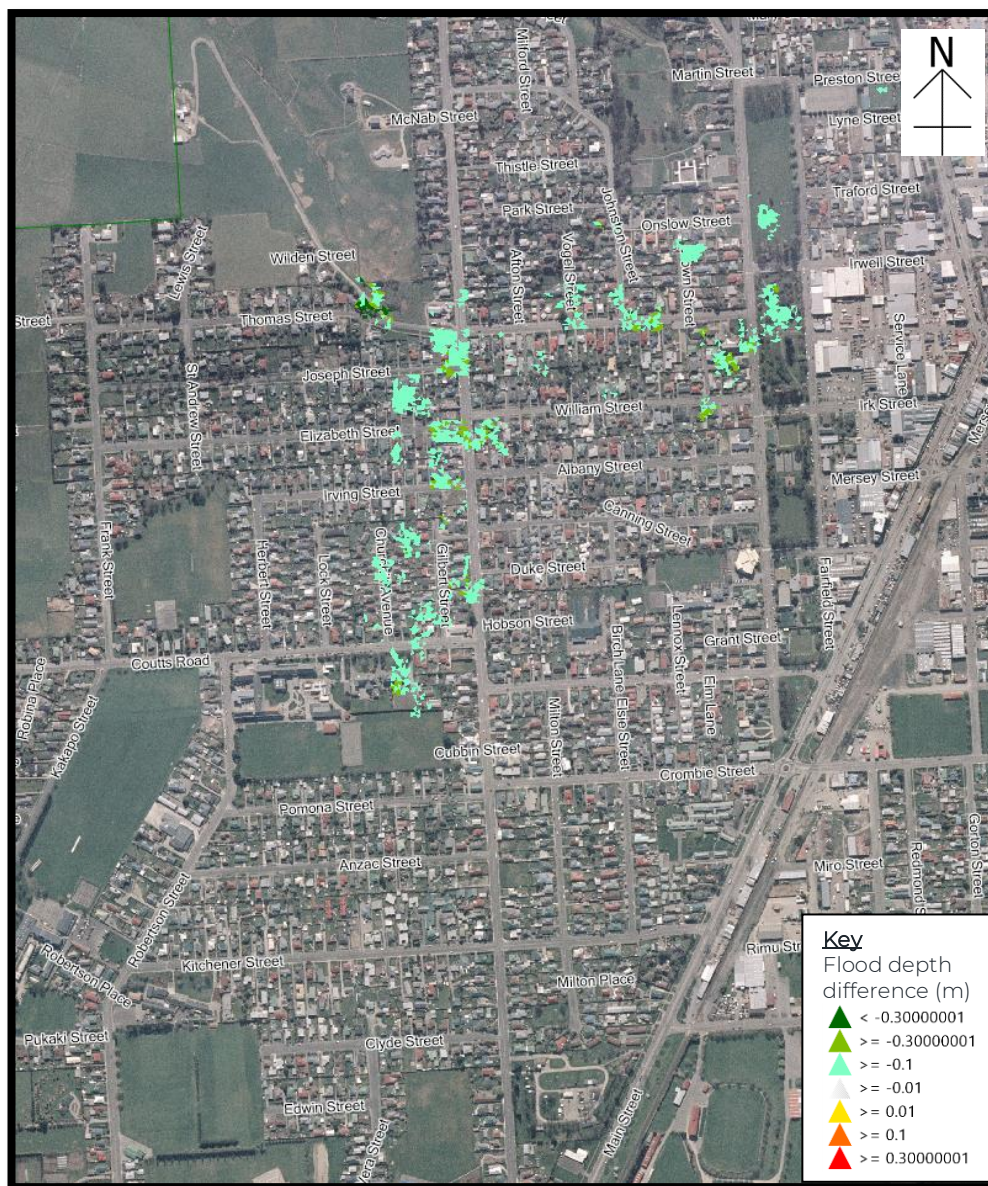


Figure 17 Scenario 4 (SW Separation scenario) v scenario 8 (SW Separation scenario with Thomas Street rural sub-catchment removed) flood difference map (10-yr, 1-hr)

6.4 Richmond Street PS Flows

The removal of the Thomas Street rural catchment flows is predicted to have no effect on the peak flows here when compared with the existing system. This is because the network is surcharged, and a reduction in peak flows causes a reduction in flooding rather than peak pipe flow.

However, peak flows here are predicted to be reduced when compared with the catchment wide stormwater separation scenario.

Table 8 Richmond Street PS Flows

Scenario 1 Peak Flows (L/s)	Scenario 7 Peak Flows (L/s)	Increase (L/s)
5-yr, 1-hr = 918 5-yr, 2-hr = 861 10-yr, 1-hr = 996 10-yr, 2-hr = 929	5-yr, 1-hr = 917 5-yr, 2-hr = 859 10-yr, 1-hr = 996 10-yr, 2-hr = 929	5-yr, 1-hr = -1 5-yr, 2-hr = -2 10-yr, 1-hr = 0 10-yr, 2-hr = 0
Scenario 4 Peak Flows (L/s)	Scenario 8 Peak Flows (L/s)	Increase (L/s)
5-yr, 1-hr = 4,837 5-yr, 2-hr = 3,420 10-yr, 1-hr = 6,008 10-yr, 2-hr = 5,407	5-yr, 1-hr = 4,493 5-yr, 2-hr = 3,141 10-yr, 1-hr = 5,977 10-yr, 2-hr = 4,821	5-yr, 1-hr = -343 5-yr, 2-hr = -279 10-yr, 1-hr = -31 10-yr, 2-hr = -586

6.5 Stormwater Separation Optimization

With the removal of the Thomas Street rural subcatchment, the predicted flows downstream are reduced. Therefore, the stormwater capacity required to be provided in the SW separation scenario is also reduced. Figure 18 shows the change in predicted surcharge levels in the stormwater network downstream of the connection point to Richmond St PS.

Based on these results, the pipe sizes and network extent required directly downstream of the connection point to Richmond St PS has been re-assessed. The pipes sizes required are summarized in Table 9, and the cost estimates of these stormwater assets are:

- Previous cost was estimated as **\$37,100,000**
- The new cost is estimated as **\$35,800,000**

This is a 4% decrease in costs for the new stormwater assets in the Richmond St PS area.

These costs have been developed by:

- Following the same methodology and assumptions as described in *Gore Stormwater Master Plan Development, Stage 1, WSP Opus, August 2018*.
- Using the 20% AEP concept design plan costs.
- Calculating the change in total pipe length per pipe size, because of the reduction in predicted flows. Flows determined using 5-year, 1-hour event.
- Re-calculating costs for the whole of the Richmond St PS area using these new total pipe lengths per pipe size.
- No change has been made to the PS costs included due to the small percentage decrease in predicted peak flows here.
- No change has been made to the constructability issues factor, as there are still large diameter dual pipes required on Irwell Street. Therefore, it is recommended that further catchment attenuation, and/or flow re-direction within the catchment, is investigated.

Table 9 Pipe Upgrade Summary

Link Ref	Existing	Scenario 4 Pipe Size (mm)	Scenario 8 Pipe Size (mm)
4494.1	750	750	750
4495.1	600	750	600
4483.1	600	825	675
New MH RPS42.2		825	825
4486.1	600	825	825
4481.1	600	900	825
4477.1	600	900	900
4476.1	600	Dual pipes; 1050 & 600	1050
4475.1	600	Dual pipes; 1050 & 600	1050
4145.1	450	Dual pipes; 2 x 1200	Dual pipes: 1050 & 1200
4448.1	450	Dual pipes; 2 x 1200	Dual pipes: 1050 & 1200
4146.1	750	Dual pipes; 2 x 1200	Dual pipes: 1050 & 1200
4147.1	750	Dual pipes; 2 x 1200	Dual pipes: 1050 & 1200
4447.1	750	Dual pipes; 2 x 1350	Dual pipes: 1050 & 1200
4446.1	750	Dual pipes; 2 x 1350	Dual pipes: 1350 & 1200
4435.1	750	Dual pipes; 2 x 1350	Dual pipes: 1350 & 1200
4434.1	750	Dual pipes; 2 x 1350	Dual pipes: 1350 & 1200
4438.1	750	Dual pipes; 2 x 1350	Dual pipes: 1350 & 1200
4437.2	750	1500	1500
20111115145241.1	750	1500	1500
4404.1	750	1500	1500
20060504110628.1	750	1500	1500
4217.1	750	1500	1500

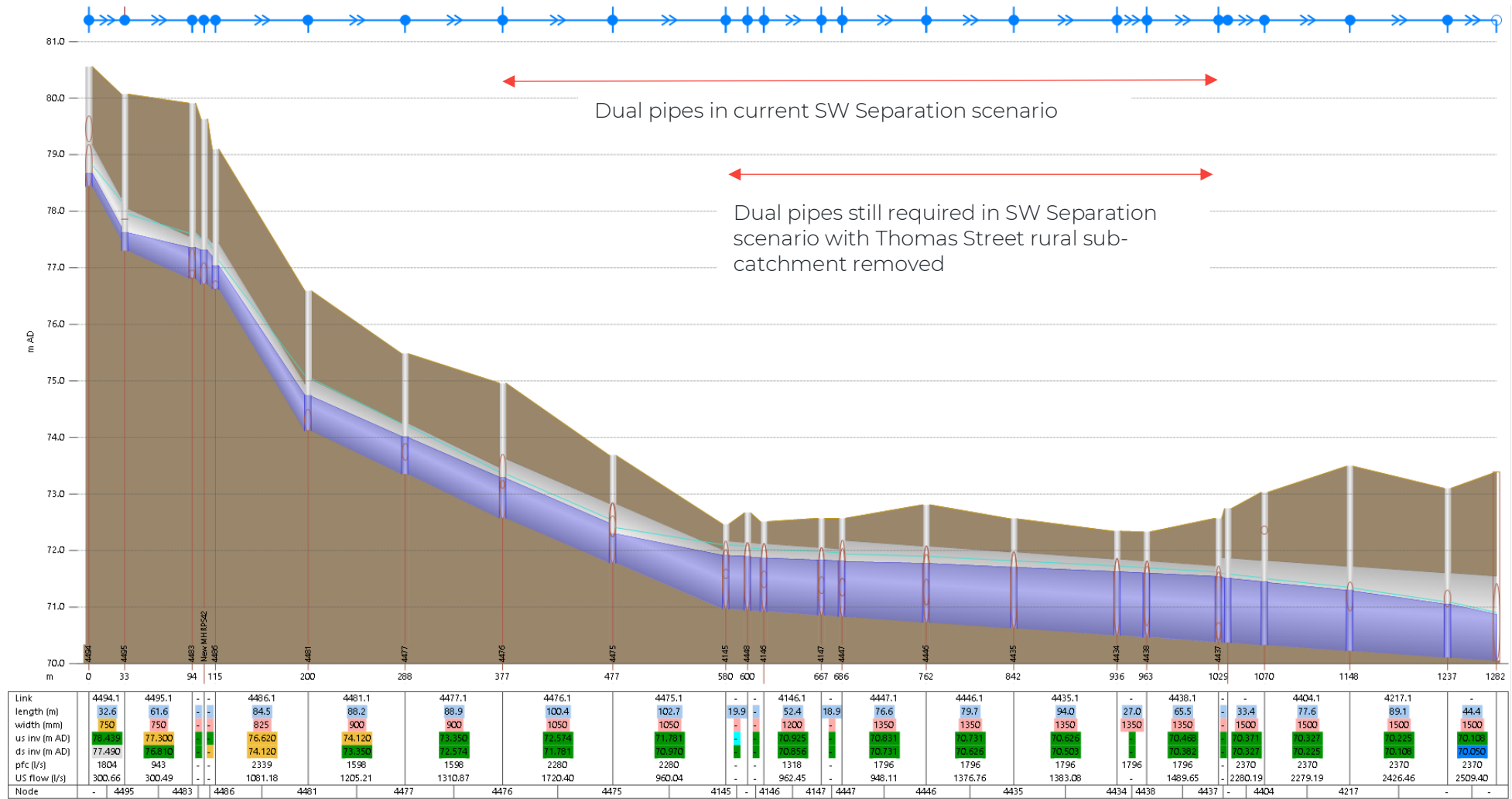


Figure 18 Long Section from Thomas Street rural catchment connection point to Richmond St PS

Light blue shows the results for the SW separation, 5-year, 1-hour. Dark blue shows the results for the SW separation with Thomas Street catchment removed, 5-year, 1-hour

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