Under the Resource Management Act 1991

And

In the matter of Proposed Plan Change 2 to the Rotorua District Plan

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JOINT WITNESS STATEMENT - STORMWATER
Date 01 September 2020

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EXPERT CONFERENCING – STORMWATER AND FLOODING

Introduction

1. In accordance with the Hearing Panel's Direction #2 dated 21 August 2020, the stormwater/flood modelling experts have taken part in facilitated caucusing and have prepared a Joint Witness Statement – Stormwater / Flood Modelling (JWS – SW).

2. Details of the planning expert conferencing are as follows:

   Facilitated by Greg Hill.

   Held online via video conferencing.

   Date: 25 August 2020

   Attendance:

   Liam Foster (LF)
   Peter Blackwood (PB)
   Peter West (PWest)
   Kathy Thiel-Lardon (KTL)
   Phil Wallace (PW)
   Greg Manzano (GM)
   Sean Finnigan (SF)
   Mark Townsend (MT)
   Mark Pennington (MP)

3. Subsequent to the caucusing, Greg Manzano and Mark Townsend have withdrawn from this process. Neither of these participants expressed any concern with the proceedings.
4. All participants confirmed that they have read and abide by the Environment Court Practice Note, as it applies to expert conferencing.

5. LF prepared and presented a series of slides to describe modelling undertaken by WSP on behalf of RLC (attached).

Factual background

6. The Greater Utuhina Catchment Model (GUCM) is the name used to refer to the suite of hydrological and hydraulic models that cover the stream and catchment of the Utuhina Stream, which drains to Lake Rotorua, developed by Bay of Plenty Regional Council. This model has been developed for the purpose of flood simulation.

7. The GUCM contains rainfall-runoff assessment covering all of the Utuhina catchment, which includes the Pukehangi plan change area, but does not have complete coverage in hydraulic model results over all of the area potentially affected by changes to rainfall-runoff behaviour that could result from Pukehangi land use change.

8. WSP have used a combination of modelling by themselves and that from the GUCM to assess the likely flood effects in the area downstream of the Pukehangi Plan Change.

9. A 72-hour nested rainfall pattern provided by BoPRC was used for these assessments.

10. To undertake the above, WSP prepared inputs to the GUCM that were representative of
    a. The current catchment, which includes undeveloped land in the Pukehangi Plan Change area
    b. The proposed catchment, which includes developed land in the Pukehangi Plan Change area together with proposed stormwater/flood mitigation, implemented via a series of detention ponds upstream of Pukehangi Road.

11. After WSP provided the above to BoPRC, the GUCM and WSP model were both used to assess the difference in flood behaviour that could be attributed to the proposed development (which includes development and its proposed mitigation). For clarity, the proposed mitigation is comprised of a series of flood attenuation ponds located upstream of Pukehangi Road (on site).

Matters agreed by the experts

12. All experts agreed that:

    a. The WSP report referred to the analyses as being "overly conservative". The experts agree that the analyses are appropriately conservative. The stormwater report is to be amended accordingly.
    b. Apart from the pond drain-down time issues addressed in 17 and 18 below, the parameters used in the modelling described in points 9, 10 and 11 above were appropriate for the assessment undertaken.
    c. For the scenarios modelled, the assessments described in points 9, 10 and 11 above showed that maximum flood depth and flood velocity in the areas downstream of the proposed plan change area was likely to change by the amounts shown in the figures presented by WSP (attached). However, it was noted that scenario 3 is now outdated and that scenario 14 was unlikely to be acceptable because of point 17 below.

Discussion

13. There was discussion on the degree to which the analyses undertaken could be considered conservative. BoPRC produced some analysis that supported the case for these analyses to be considered "appropriately conservative" and this was agreed by WSP.

14. PB noted shortcomings in the flood frequency analysis presented in Appendix C to the WSP SW report dated 19 August 2020. PB demonstrated that the WSP analysis overlooked a previous period of available data and therefore underestimated the design flows. PWest pointed out that the correct design flows supported the hydrological modelling results. Appendix C's incorrect conclusions were expressed in the body of the SW report and then again in the s42A report. It was discussed that this would misrepresent the hydrological situation unless these reports were updated.

15. PWest presented hyetographs of two storms occurring in 2018 and 2019 presented in the WSP SW report dated 19 August 2020. These showed the rainfall occurring at least one day before the peak was slightly higher than assumed in the 72h-nested design hyetograph.

16. PB referenced the occurrence of several documented heavy ended storms. These were major storm events. PB explained that heavy ended storms are expected to generate larger peak flows as the most intense rain falls on a more saturated catchment.

17. PWest raised the matter of the drain-down time necessary in the system of ponds proposed by WSP for effects mitigation. It was suggested that, if these ponds took a period of several days to drain following a rainfall event, that they may not be empty for a subsequent event. This could affect their ability to mitigate effects of development in response to a subsequent rainfall event.

18. Taking the above into account, the mitigation solution proposed could not be endorsed by all experts, requiring that additional analyses be conducted to confirm the assessment.

Matters in dispute between the experts

19. There were no matters of disagreement between the experts, although it was noted that further assessment was required to advance these discussions and to reach agreement on the effects assessment.

Agreed way forward

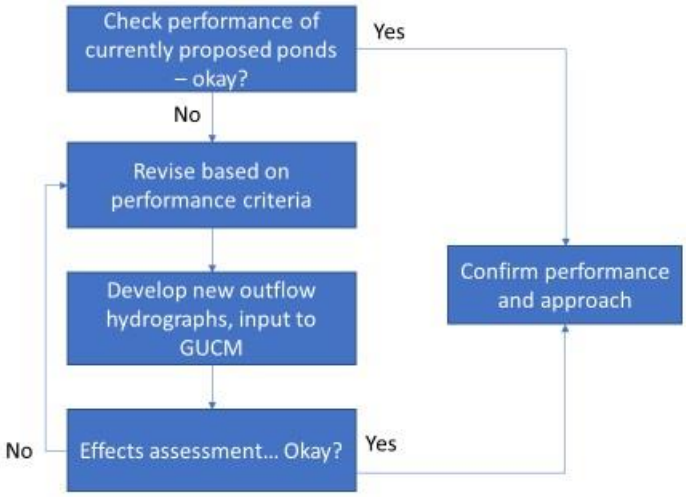
20. The experts caucused and agreed an approach to the position reached. This approach is summarised in the attached page of notes, and can be described as follows:
    a. The drain-down performance of proposed ponds needs to be checked against relevant criteria. Several criteria were proposed, as shown in the notes, with the following performance agreed as the most appropriate:
        i. 50% of the volume stored within detention ponds that can only drain via the lowest outlet, shall drain within 24 hours. This criterion is highlighted in yellow in the attached notes.

b. Should the proposed ponds not meet the above performance criterion, then the pond configuration shall be re-designed.
c. Following such re-design, the revised outlet analysis (as described in 10.b above) shall be provided to BoPRC for input to the GUCM.
d. The GUCM and the WSP models shall be used to assess the performance as described in 11 above.
e. Should the revised ponds meet the required performance criterion, then the approach can be confirmed and the results accepted.
f. An amended stormwater report is required that addresses the re-analysis described in the points (a) to (e) above, and also the language changes outlined in items 12.aand 13 above.

21. For the above analyses the experts agreed that for the initial analyses, only the 1%AEP event need be used. Once the pond performance has been confirmed for this event, then 2%AEP and 0.2%AEP shall also be checked.

Signed:

Notes from caucusing on the way forward (dated 25 August 2020)



Events
Post only – event based (not long term sequence)
Iterate (if needed) using 1%AEP
2% and 0.2% to follow
Start with existing level of development (% impervious)
Will need to examine "city future" scenario too

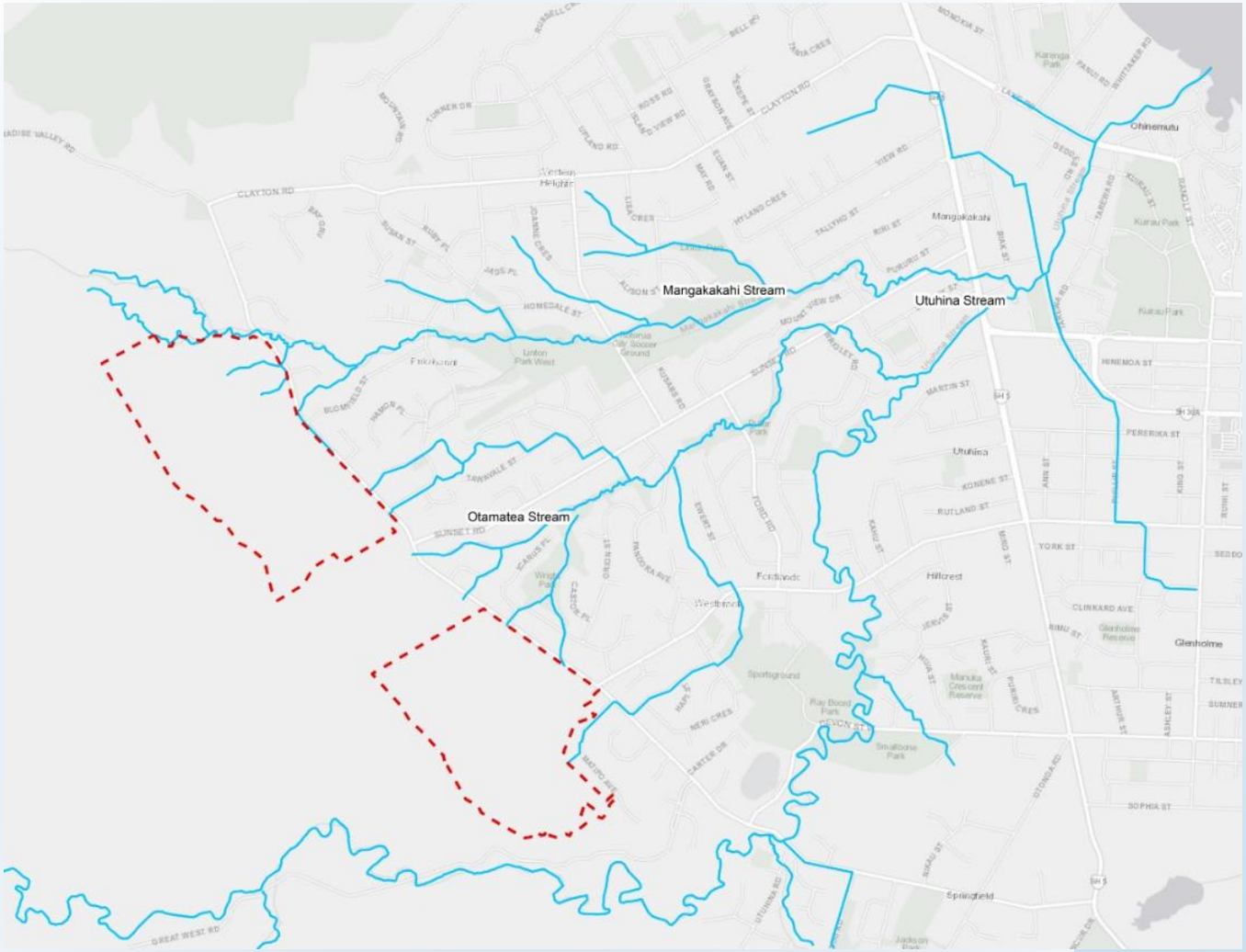
Notes
GUCM model takes about 1.5 days to run
Can do several runs in parallel
No need to change models or modelling approach

Performance criteria
Size/volume
Safety
Drain down time

- 50% of volume in 24 hours after end of event, total drain maximum 4 days from end of event
- Maybe from time of when pond level starts dropping
- Or from time that lower orifice only operates
- 50% of volume only served by lower orifice must drain in 24 hours

Dams?
Geotech?

WSP presentation



PC2 - Pukehāngī Heights

Stormwater Caucus – Key Information (as of 21st August 2020)

Purpose

- To share the:
  - Council modelling parameters
  - Outputs from the Council modelling
  - Outputs from the Regional Council model

To cover

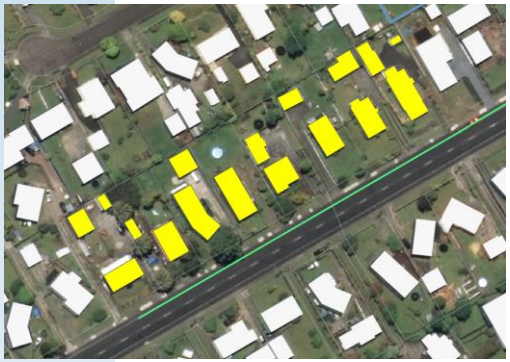
- Modelling Approach
  - Parameters (reference Stormwater Report for more details).
- Difference Maps (depth and velocity)
  - 1%
  - 2%
  - 0.2%
- Works not completed to date

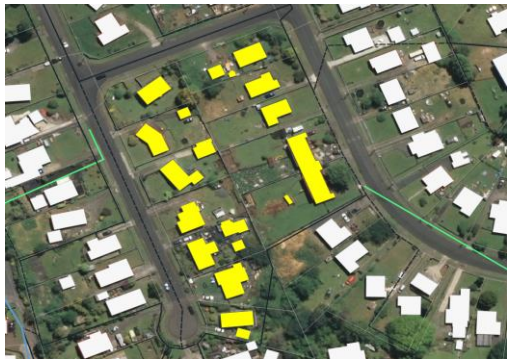
Modelling Approach

The Council models

- Catchment 14 (Otamatea) and Catchment 15 (Mangakakahi) – 2017 & 2018.
  - Integrated 1d/2d urban stormwater models
  - Infoworks ICM modelling software
  - Predominant model build focus – urban stormwater system performance.
  - Two consultants built the models.
  - Models terminate at confluence with Utuhina
- 2019 – models amended to be similar in nature:
  - Same software version
  - Amended C15 runoff model to be like C14.
    - SCS curve model – "City Now"
      - Current residential areas CN 61 and 66.
      - I.e. 45-54% imperviousness (see overleaf)

Sample of existing Residential zone imperviousness (Western Area)

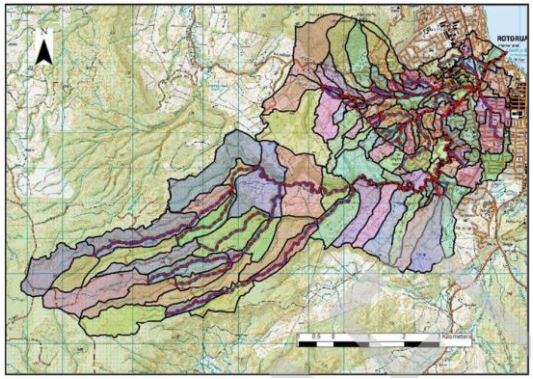


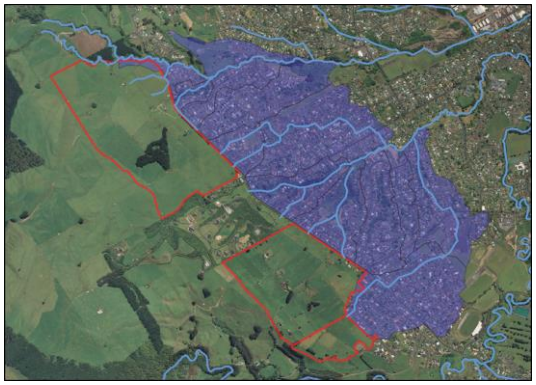


	Areas (ha)				Percentages				
Subcatchment	Total	Road	Roof	Paved	Road	Roof	Paved	Total impermeable	Permeable
DI008264	0.803	0.107	0.157	0.105	13%	20%	13%	46%	54%
Ewert_Sump1	1.296	0.12	0.19767	0.054	9%	15%	4%	29%	71%
DI008169	0.386	0.034	0.0871	0.027	9%	23%	7%	38%	62%
MAX					**13%**	**23%**	**13%**	**46%**	**54%**
Weighted Average					**11%**	**18%**	**7%**	**36%**	**64%**
AVERAGE					**10%**	**19%**	**8%**	**38%**	**62%**

The Regional Council Model

- Greater Utuhina Catchment model (GUCM) - No overall document on the model available in relation to model build / assumptions (bottom left image), but our approach has been:
  - Work on model architecture in November 2019 to share the Plan Change subcatchment representation.
  - Agree point sources to pass results (Time varying inflow hydrographs) from Council models to route through the GUCM:
    - Base situation (2130) with 'City Now'
    - Post development
- The GUCM would provide the overarching comparative assessment of effects through Utuhina (except for the area in purple in image bottom right)





Hydrological Parameters used

- Rainfall – received from Regional Council:
  - 'fully centred' 72 hour nested synthetic time series.
  - Distributed across catchment - 'dummy' rain gauges.
  - Hirds V4 depth duration frequency.
  - Current conditions – 0 degrees.
  - Future condition (2130) – 3.68 degrees (equivalent to RCP 8.5).
- Boundary Condition for the Utuhina
  - Received from Regional Council for each AEP event.

Hydrological Parameters used

- Rainfall Runoff routing:
  - SCS runoff model
  - 5mm/hour exfiltration from basin wetted area

Table 3-1: Curve numbers for sub-catchments – Affected by the potential plan change area ONLY – Scenario 14[*1]

Cover Description	Impervious Area (%)	Impervious CN	Pervious Area (%)	Pervious CN	Blended Curve Number
	1	2	3	4	= ((1*2) + (3*4))/100
Rural - Pre-Development	0	98	100	21	21
Rural – Post Development[*2]	0	98	100	29	29
Rural 2 Residential[*3]: Min. Average lot size 4000 m^2	20	98	80	29	43
Residential 1 – Average lot size 600 m^2	70	98	30	29	77
Residential Medium Density: Average lot size 450 m^2	80	98	20	29	84
Commercial and business	85	98	15	29	88
Streets/roads: sealed	62.5	98	37.5	29	72

[*1] *Existing urban areas use SCS CN numbers identified as part of previous hydraulic model build works.*

[*2] *To represent improved hydrological efficiency from amendments to the current rural land topography.*

[*3] *Planned landscaping of this area to include increased revegetation to support visual and nutrient work.*

The Plan Change representation

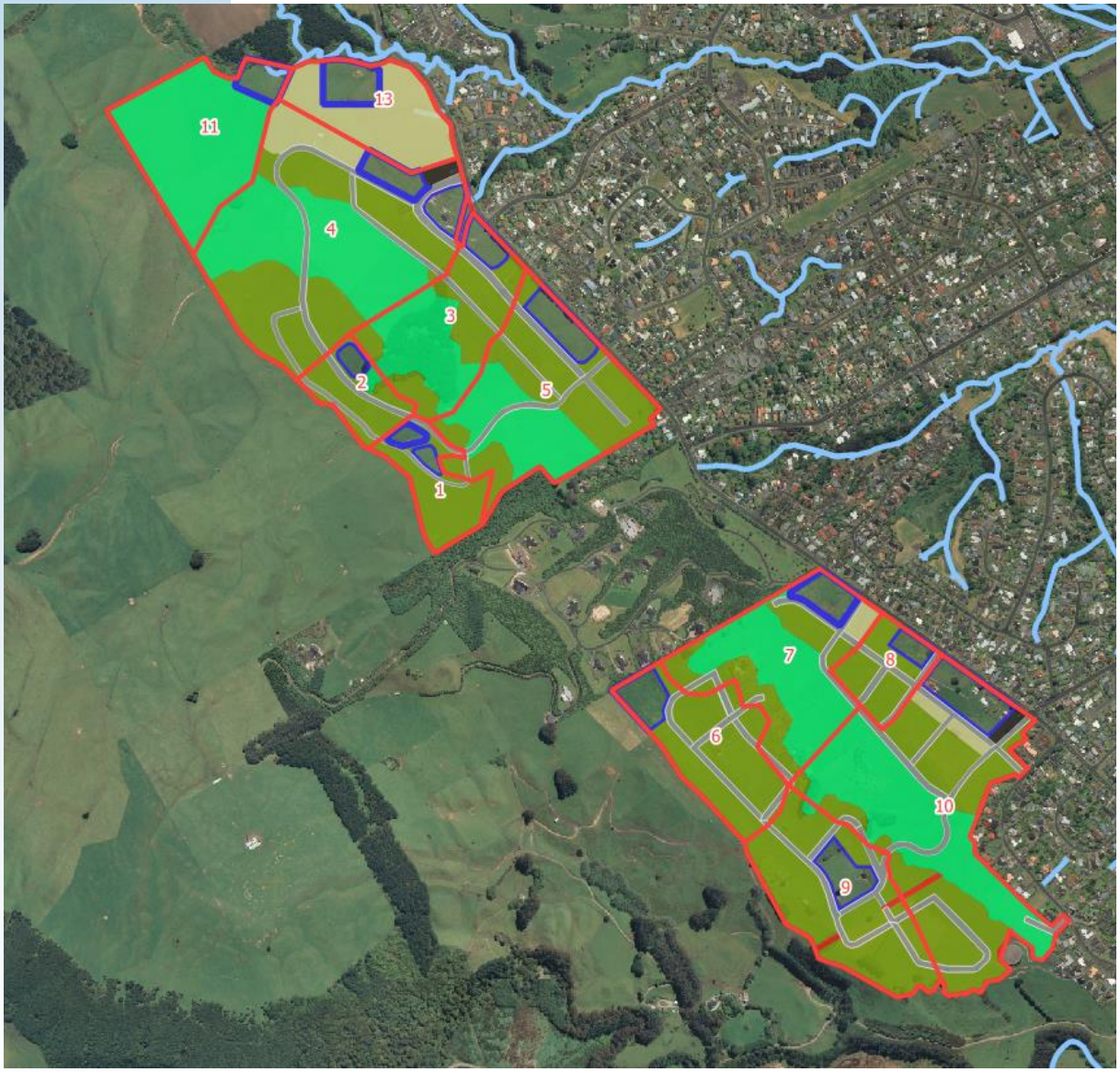
- Conceptual SW Masterplan

- Modelling simplicity, based on Structure Plan:
  - End of system, offline, 'dry' attenuation basins distributed across the development.

  - Outlets included to control discharge:
    - Sized using 24 hour NI-PMP temporal pattern,
    - Reduce discharge rates higher than pre-development,
    - No overtopping for all durations from 20mins to 1 day.

  - Maintained these settings throughout ALL modelling.

Structure Plan – used for modelling



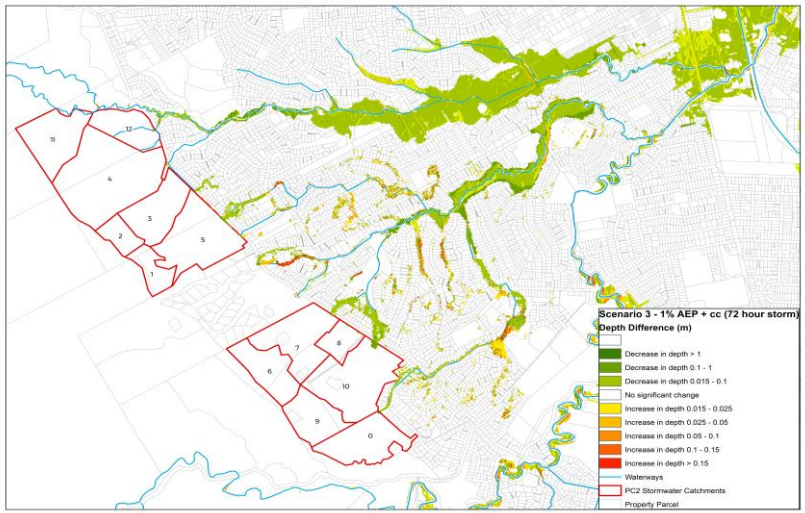
Commercial
Medium Density
Pond
Residential
Roads
Rural 2
Full Boundary

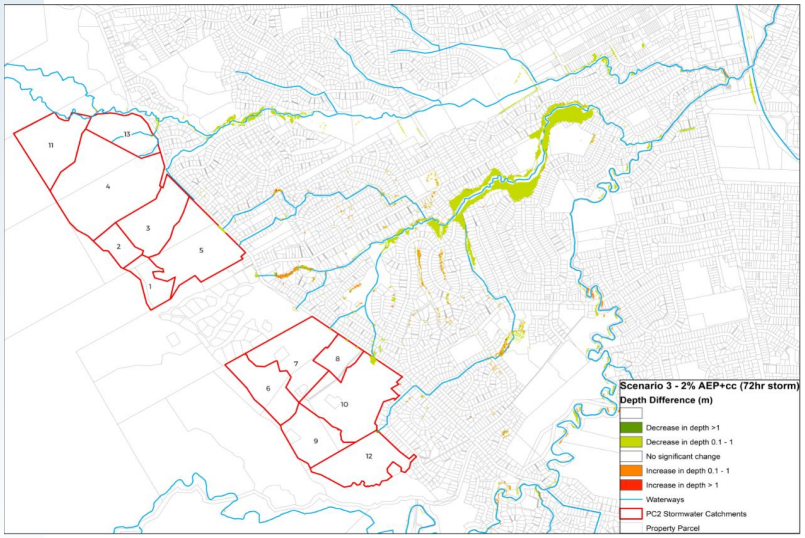
Area Reference	Scenario 14 (**Error! Reference source not found.**)	
	Catchment Area (ha)	Weighted CN
1	8.2	49.81
2	3.9	74.09
3	10.5	60.40
4	29.4	59.59
5	16.2	64.22
6	12.3	60.63
7	14.3	56.66
8	4.0	76.04
9	12.7	76.16
10	25.5	62.47
11	11.6	42.80
13	7.6	84.2
Totals	**156.3**	

The Difference Maps

(as per Report Scenario 3)

Before you read on – note the scale (and impact of the 'noise')





We can produce the GIS to either scale. The choice for the series of maps produced is the bottom set, which has:

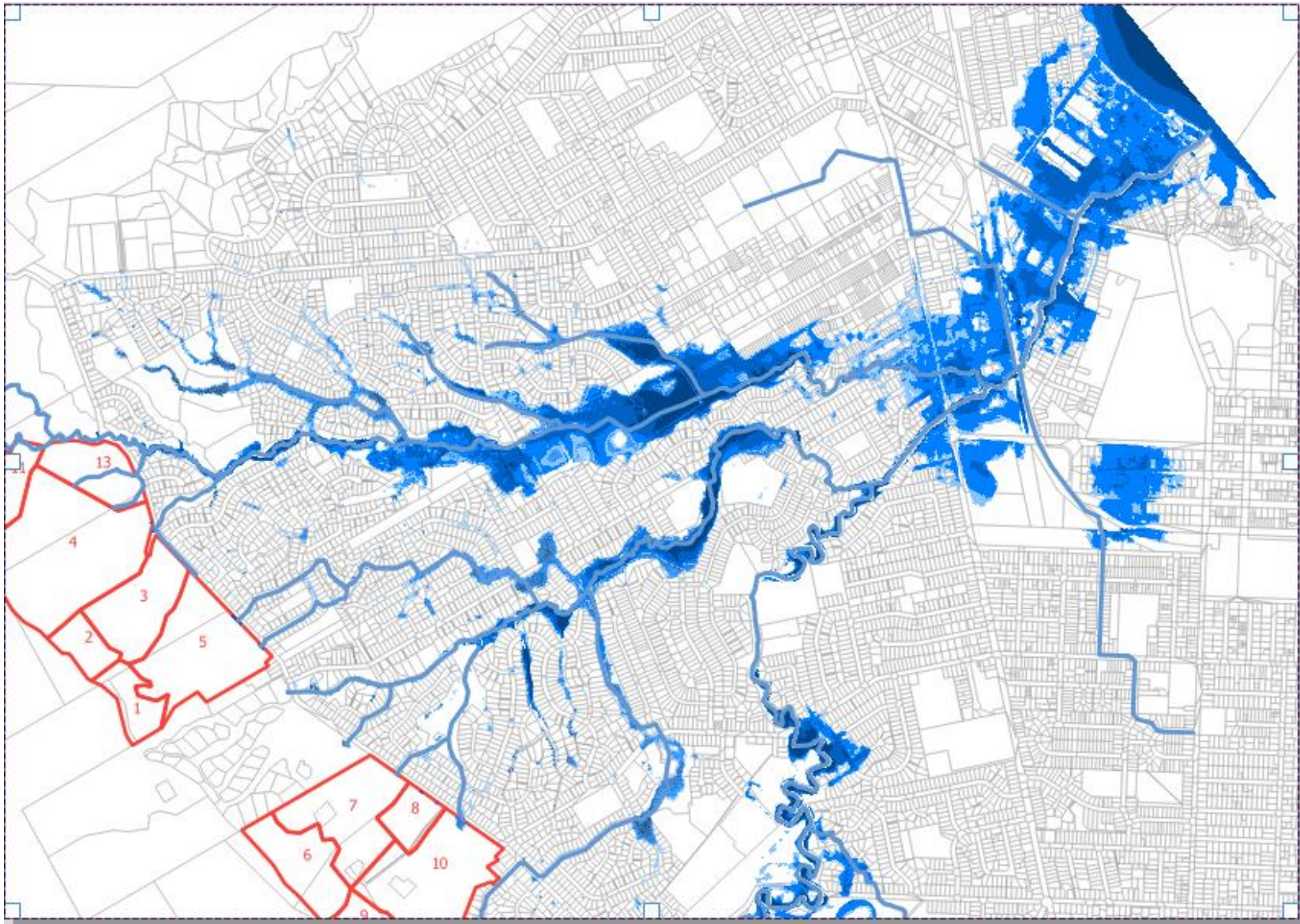
- Less classes to show the effects range.
- Amended the 'No significant change' class
  - Top - +/- 15mm
  - Bottom - +/- 100mm

Reason

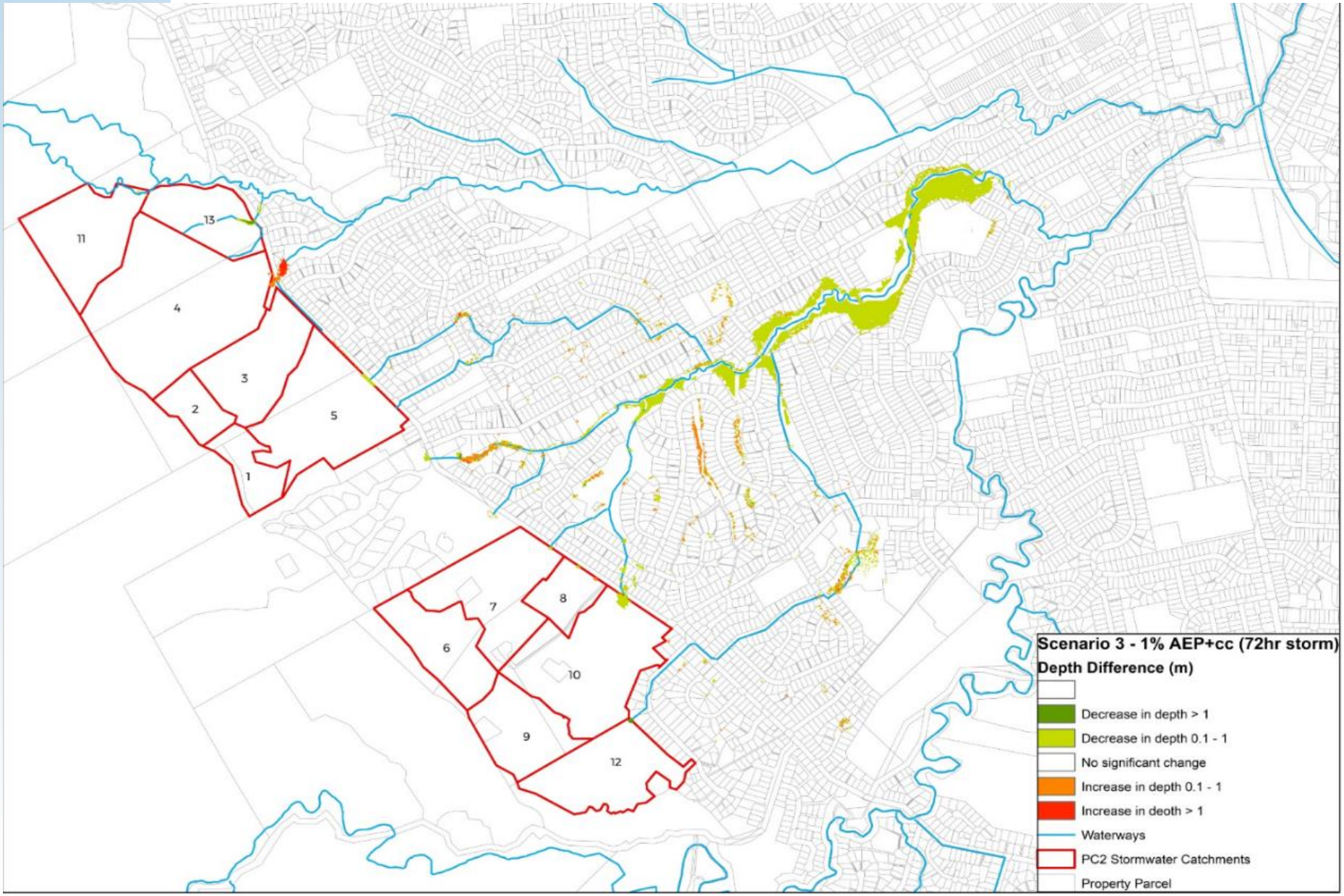
- A limitation of ICM software - 2d ground model re-meshes differently so in the top image you see 'noise' - plus and minuses adjacent to each other (a meshing artefact).

Happy to discuss this choice. We have the set as per the top image for comparison for S3 results.

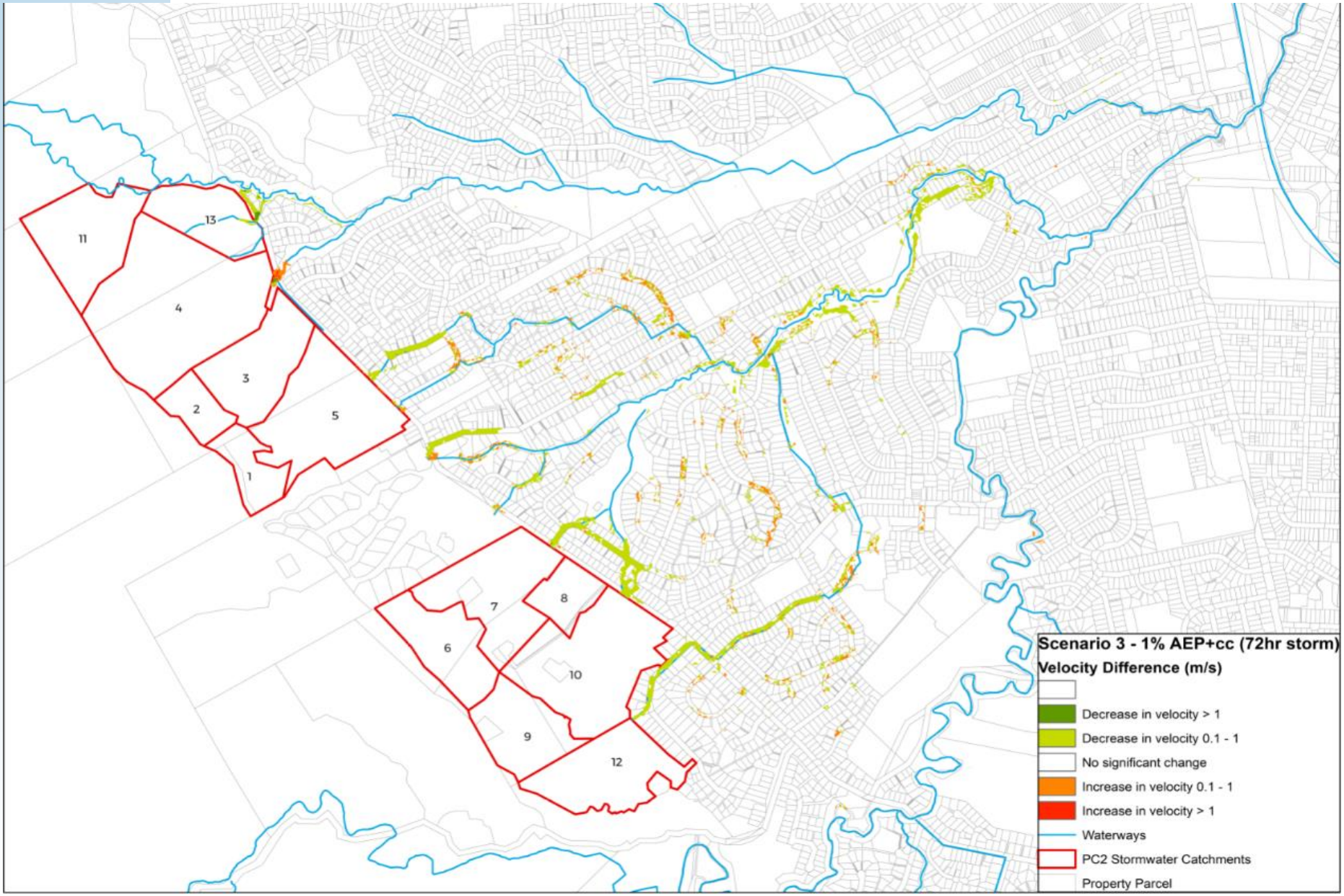
1% AEP plus CC event – 'City Now'



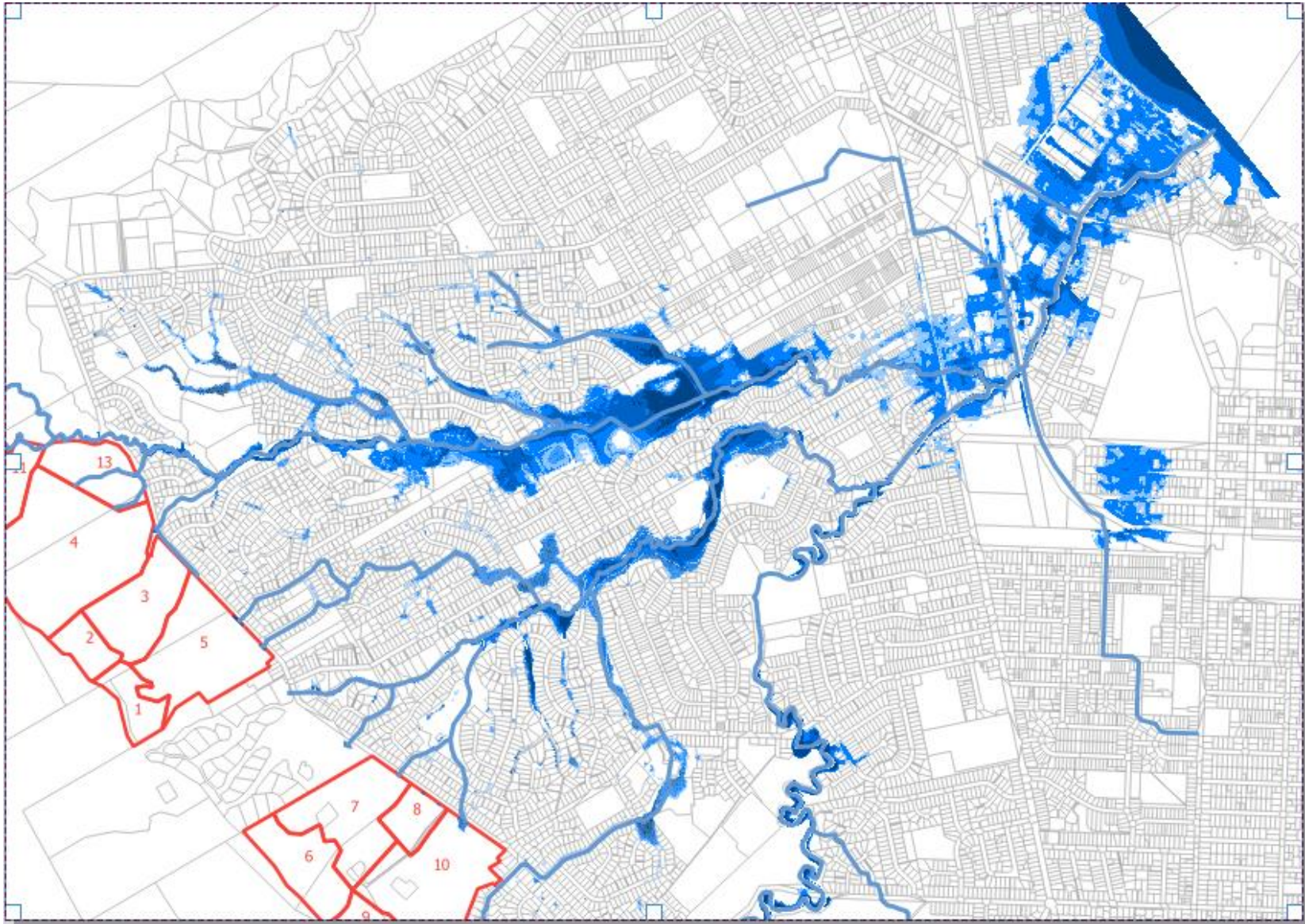
CN21 – 1% & CC
Depth Difference



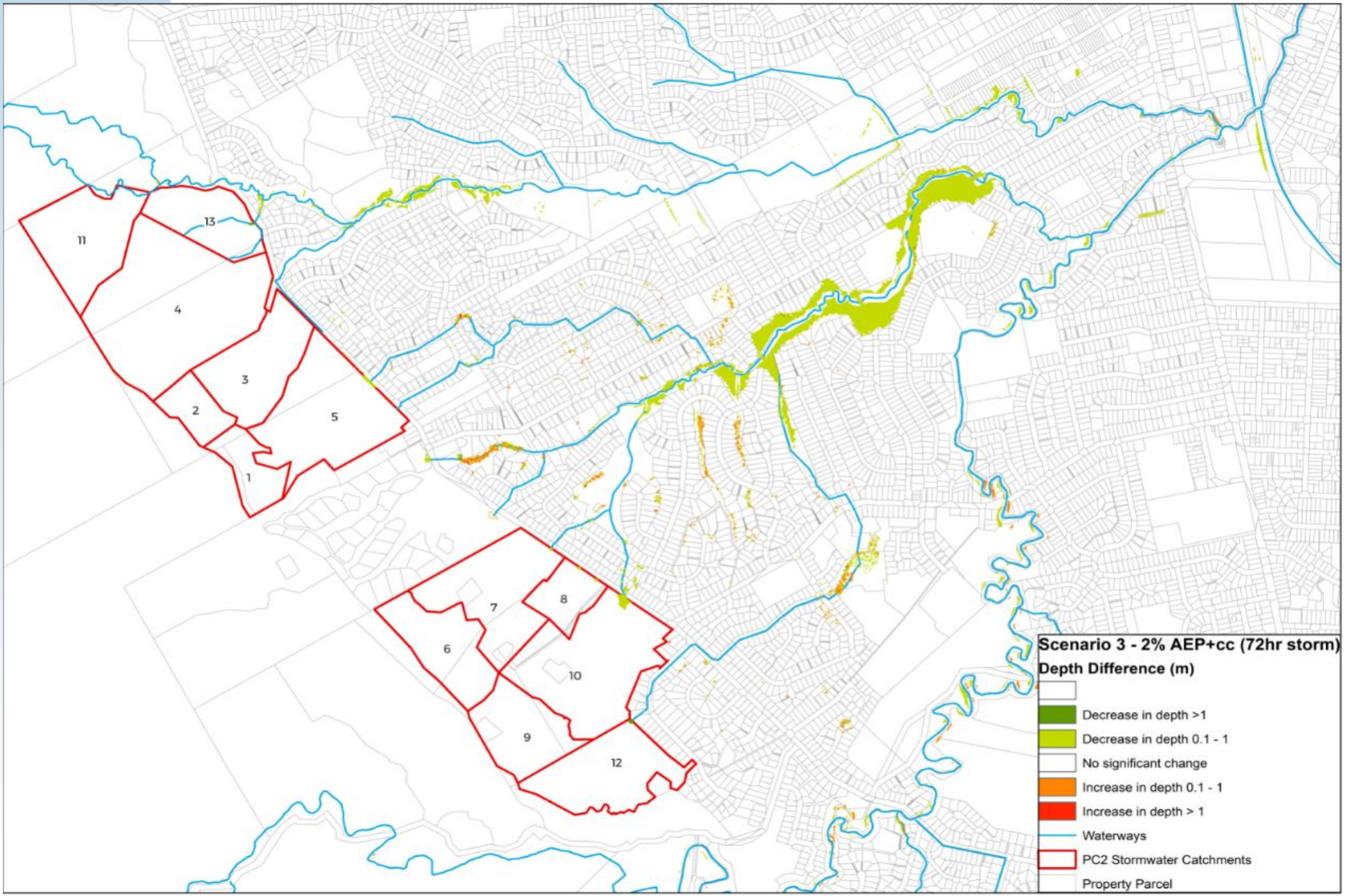
CN21 – 1% & CC
Velocity Difference



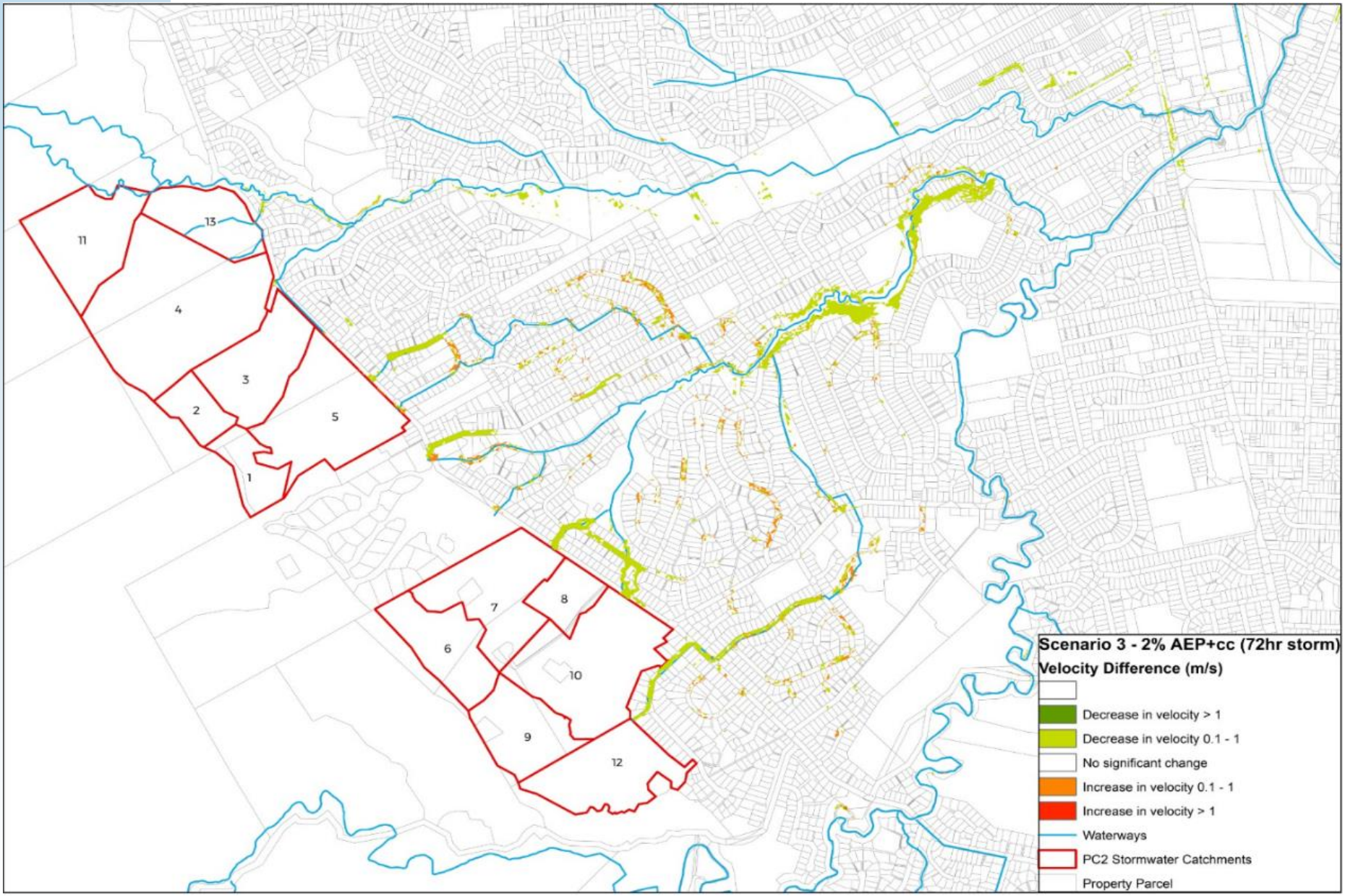
2% AEP plus CC event – 'City Now'



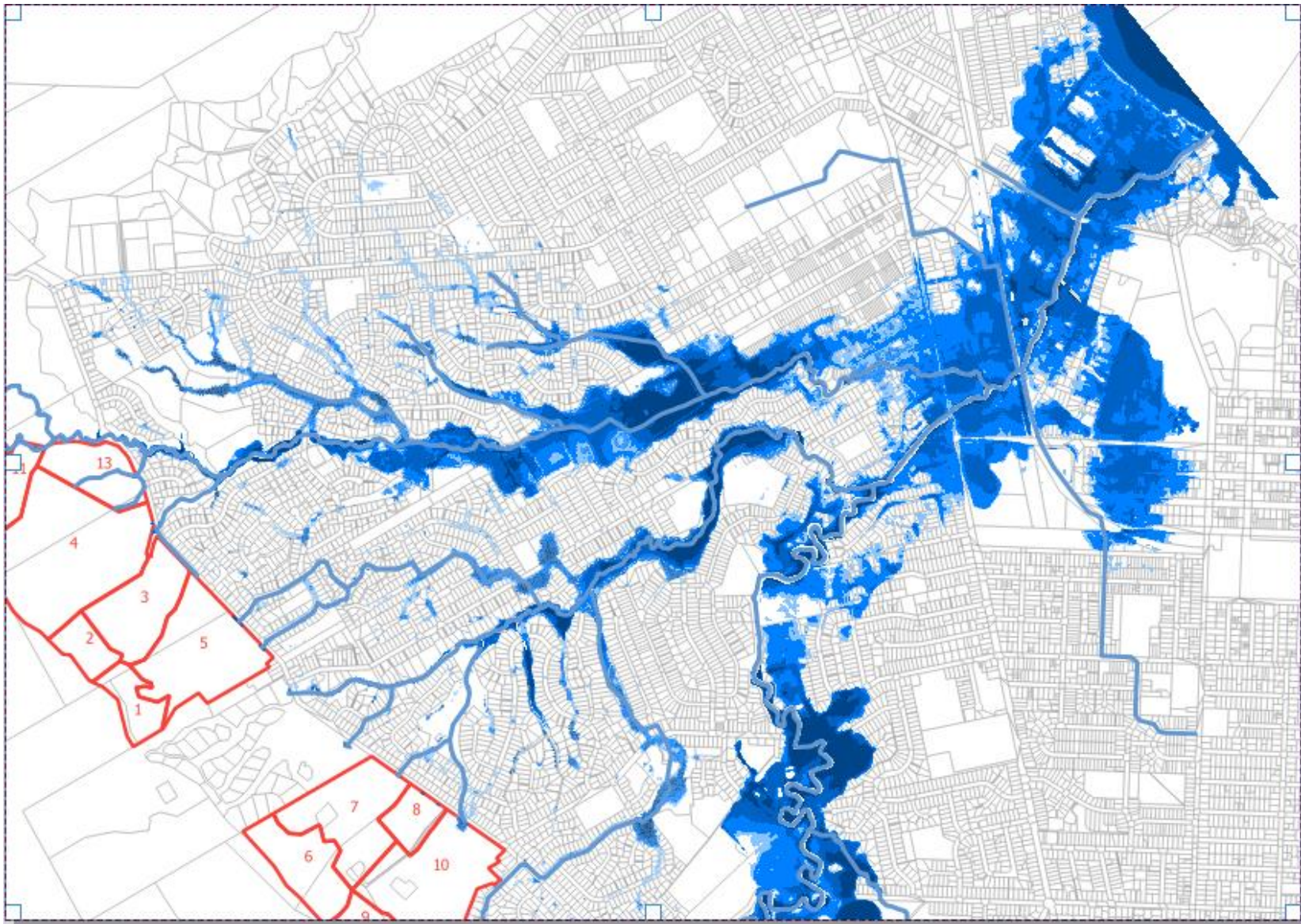
CN21 – 2% & CC
Depth Difference



CN21 – 2% & CC
Velocity Difference



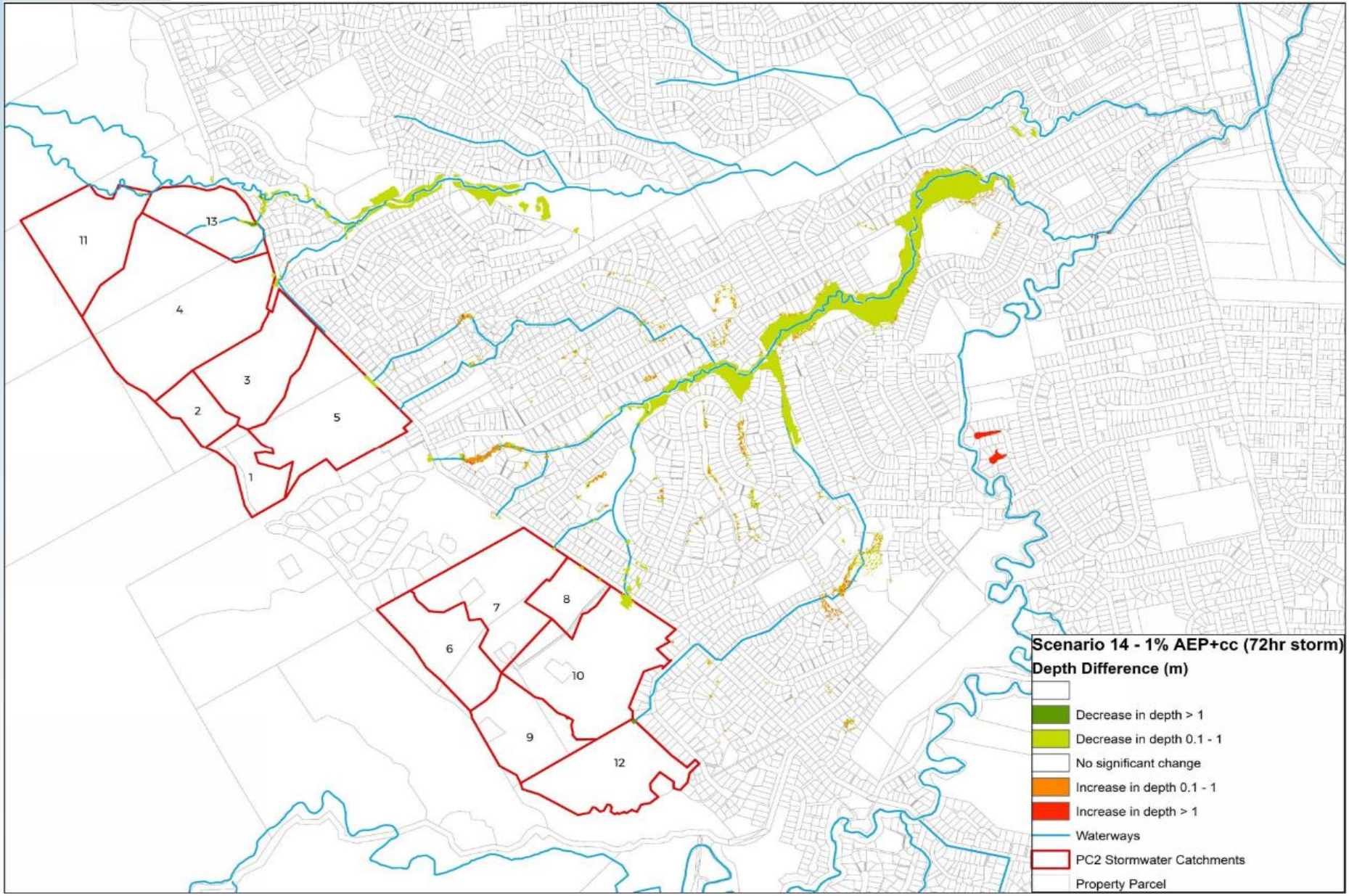
0.2% AEP plus CC event – 'City Now'



The Difference Maps

(Scenario 14)

CN21 – 1% & CC
Depth Difference



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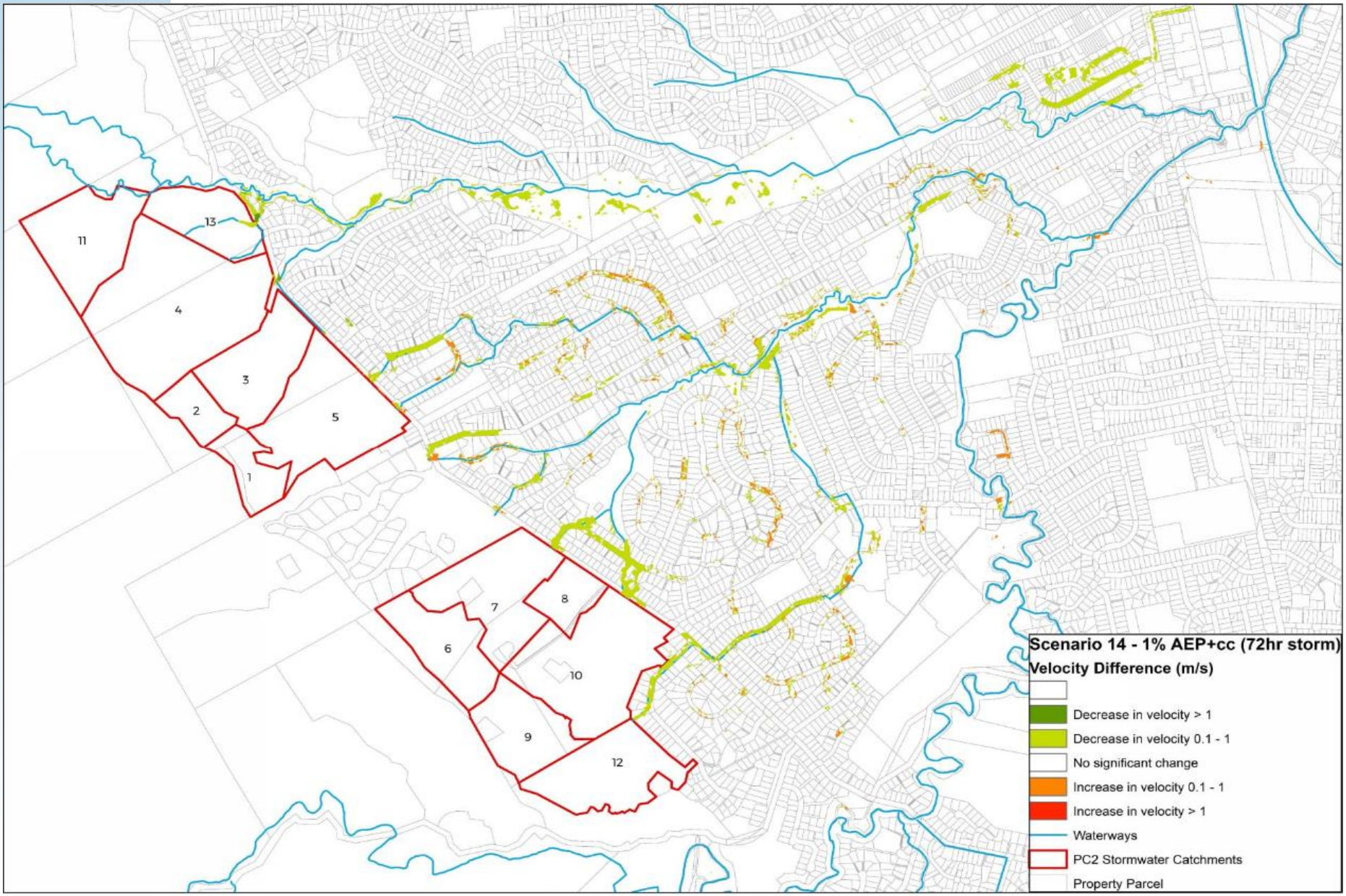
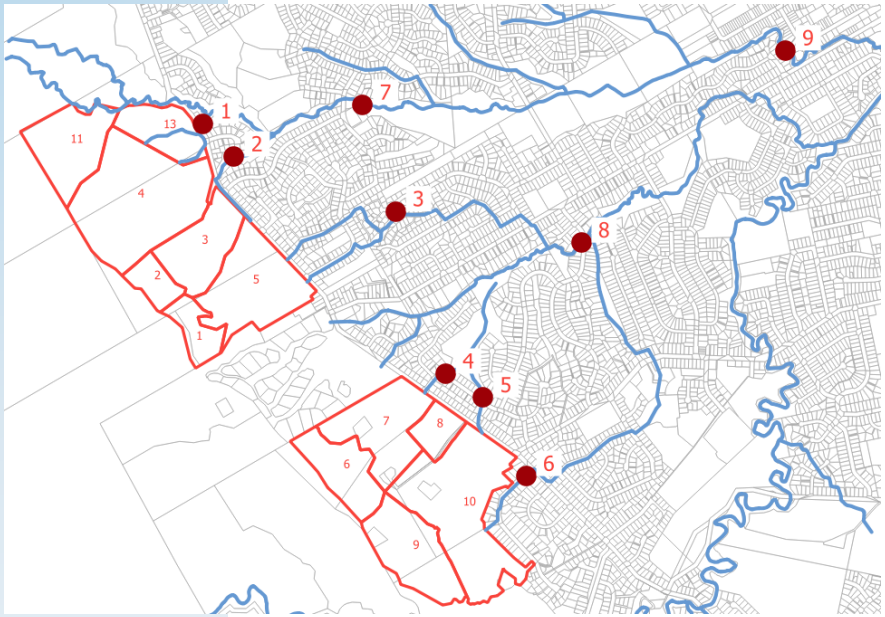
Velocity Difference



1% - Difference Maps



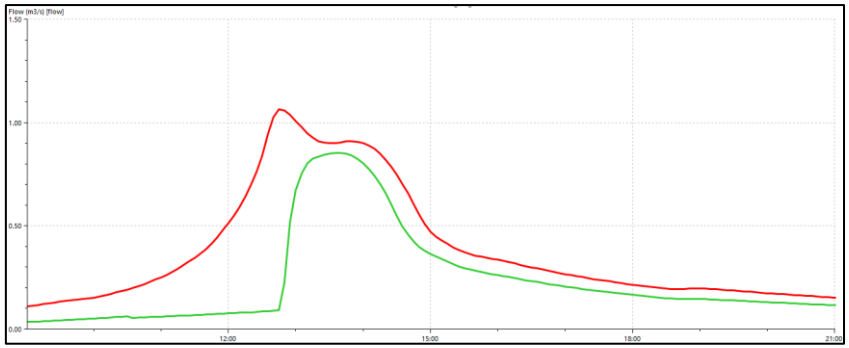
Legend

- 2 Comparison Hydrograph
- Watercourse
- PC2 Basin Sub-catchments

Legend

- Pre-Development Flows
- Post-Development Flows

1



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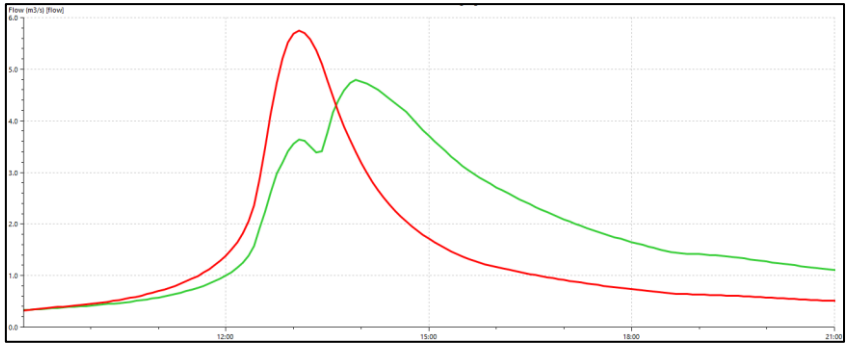

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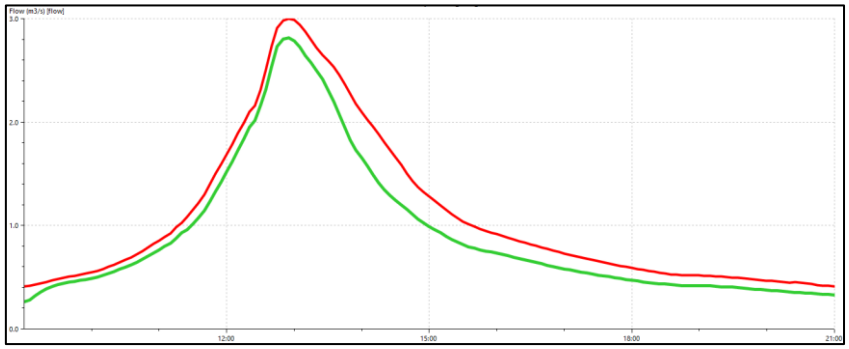
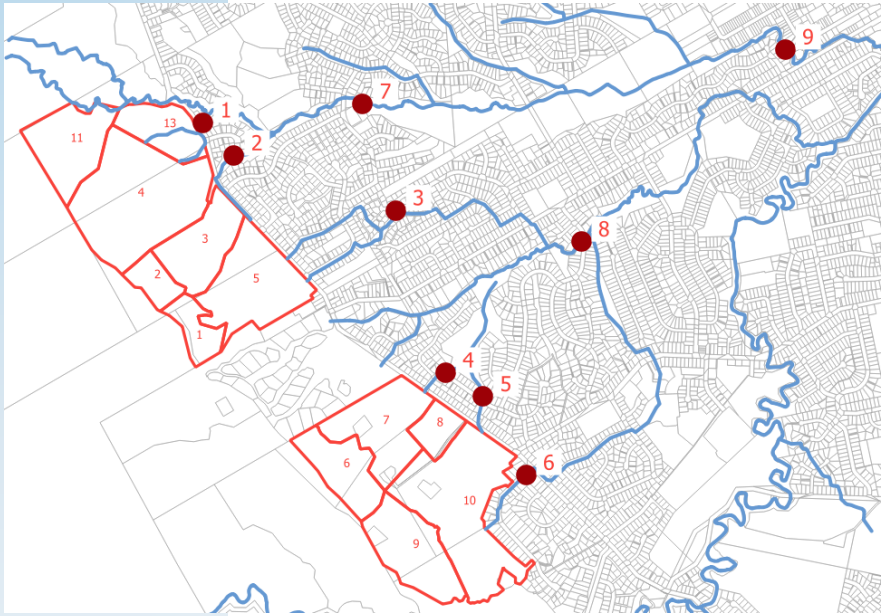


1% - Difference Maps



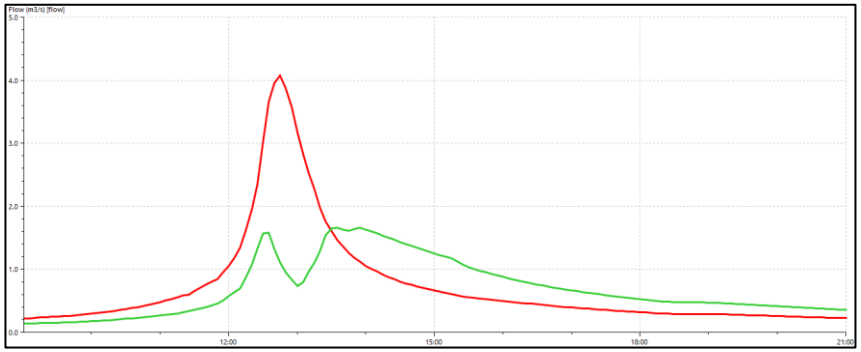
Legend

- 2 Comparison Hydrograph
- Watercourse
- PC2 Basin Sub-catchments

Legend

- Pre-Development Flows
- Post-Development Flows

4



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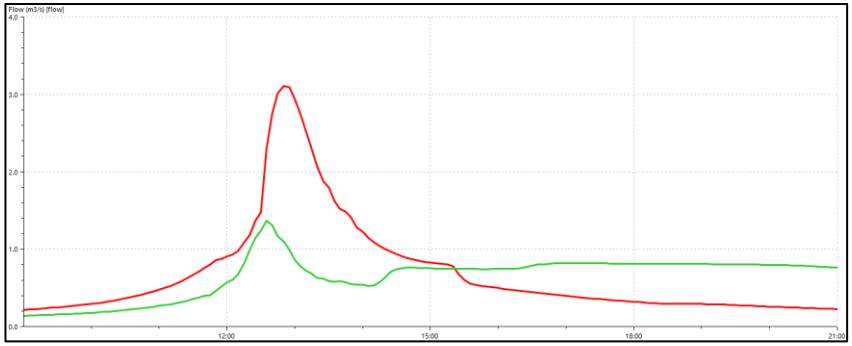

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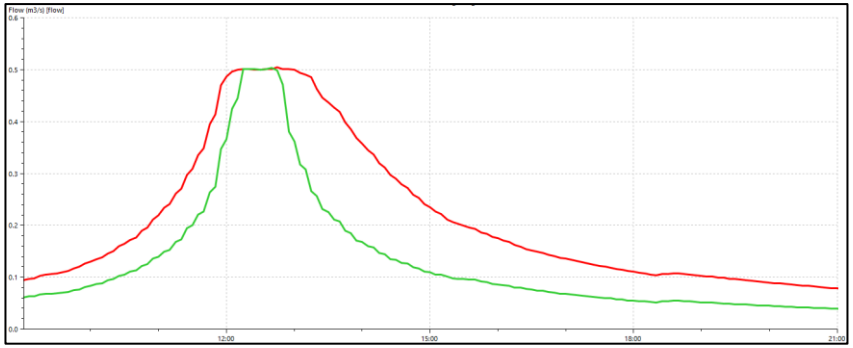
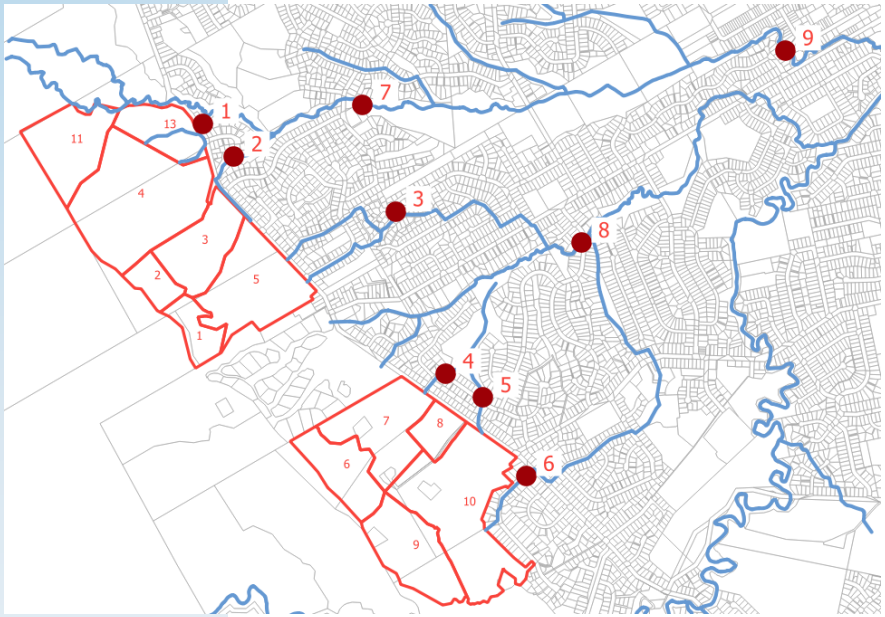


1% - Difference Maps



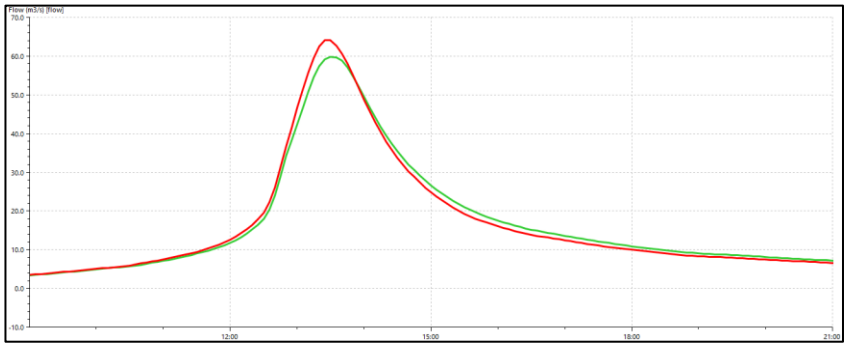
Legend

- 2 Comparison Hydrograph
- Watercourse
- PC2 Basin Sub-catchments

Legend

- Pre-Development Flows
- Post-Development Flows

7



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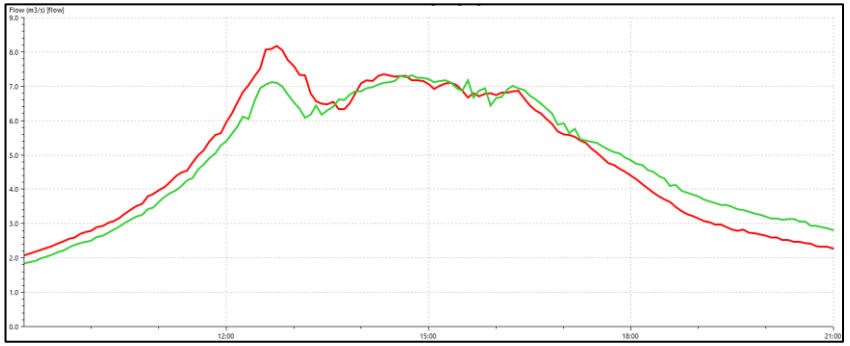

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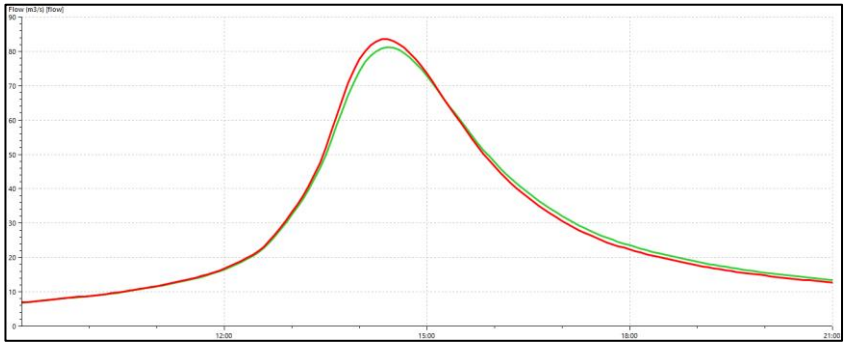
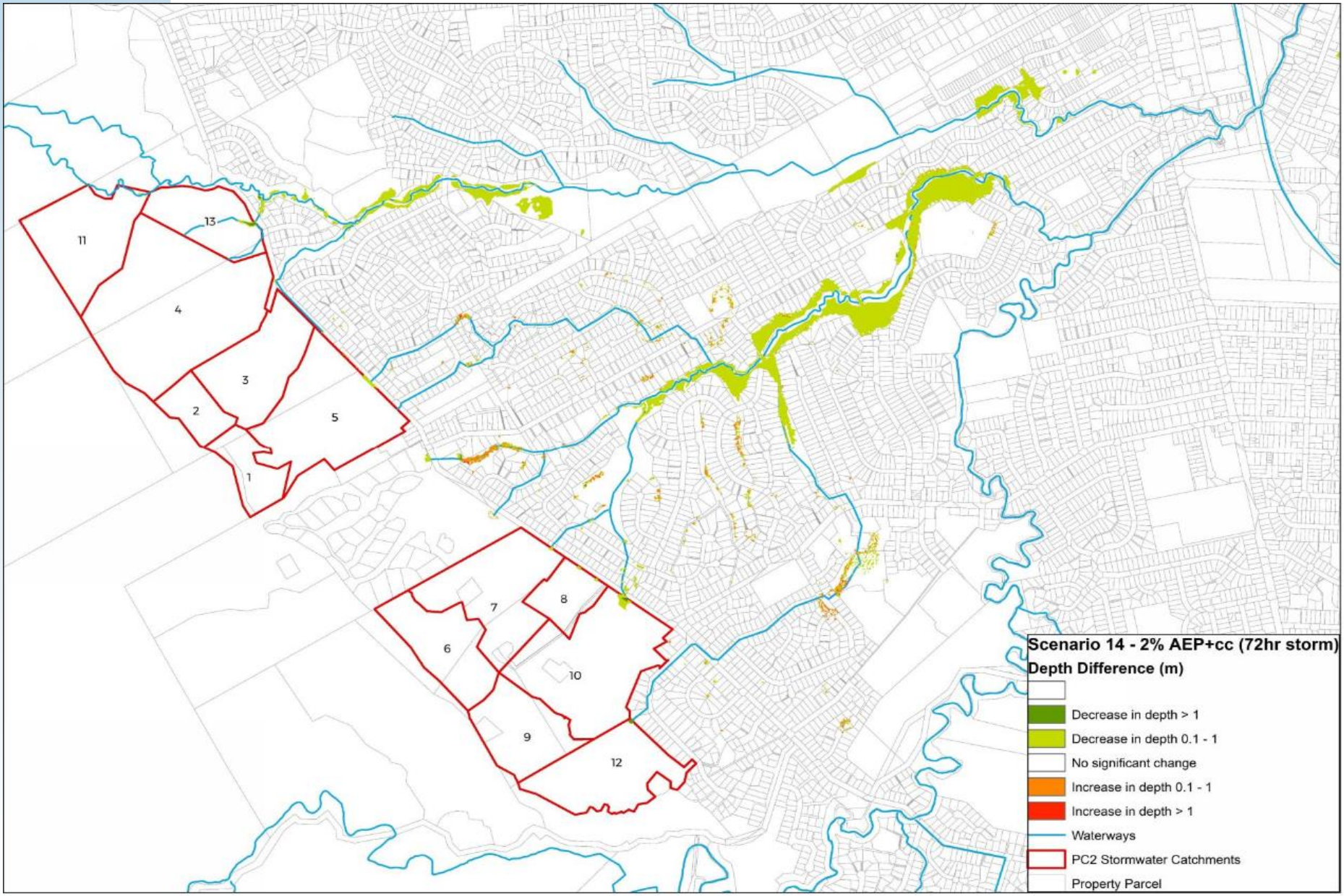
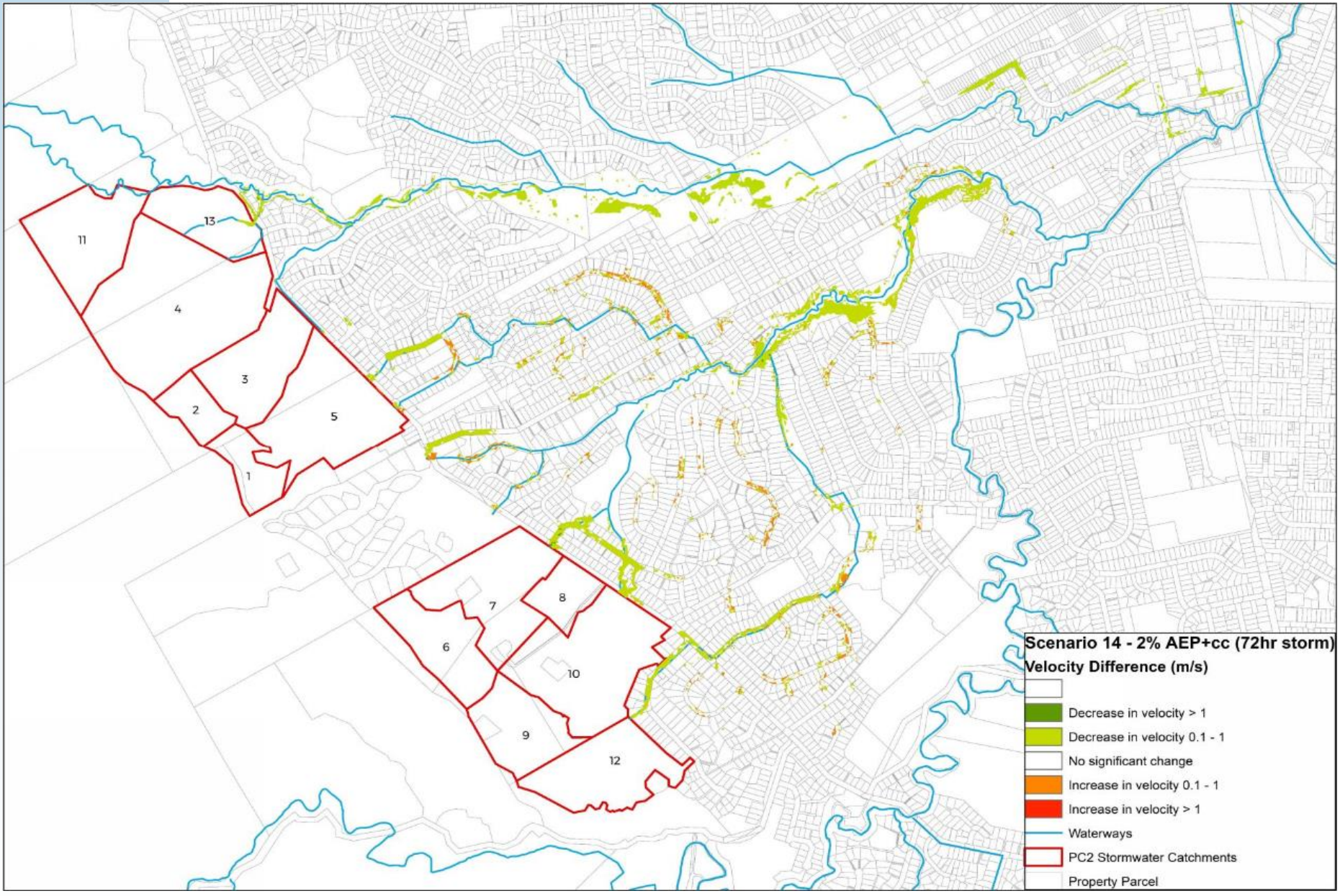


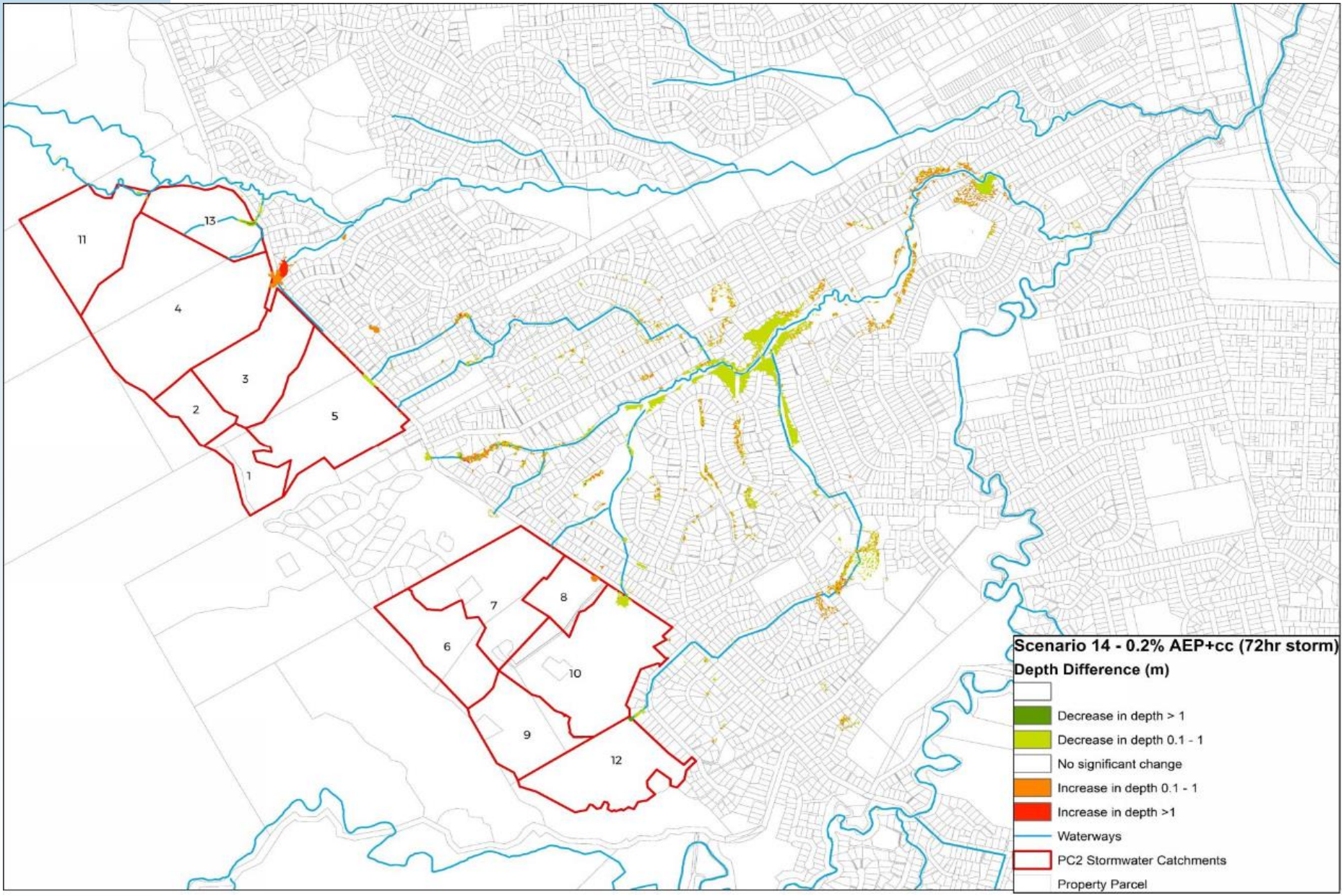
CN21 – 2% & CC
Depth Difference



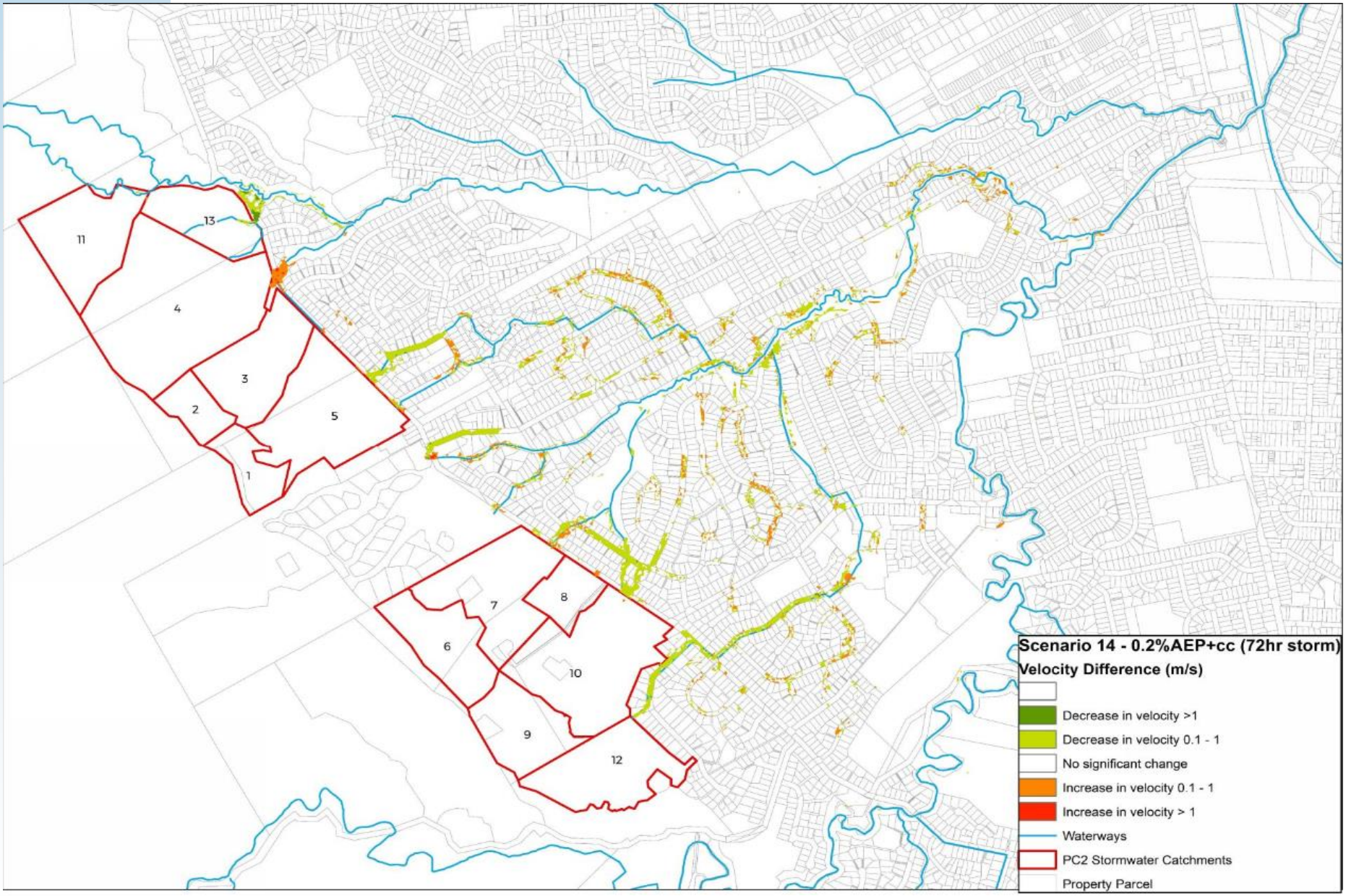
CN21 – 2% & CC
Velocity Difference



CN21 – 0.2% & CC
Depth Difference



CN21 – 0.2% & CC
Velocity Difference



The Difference Maps

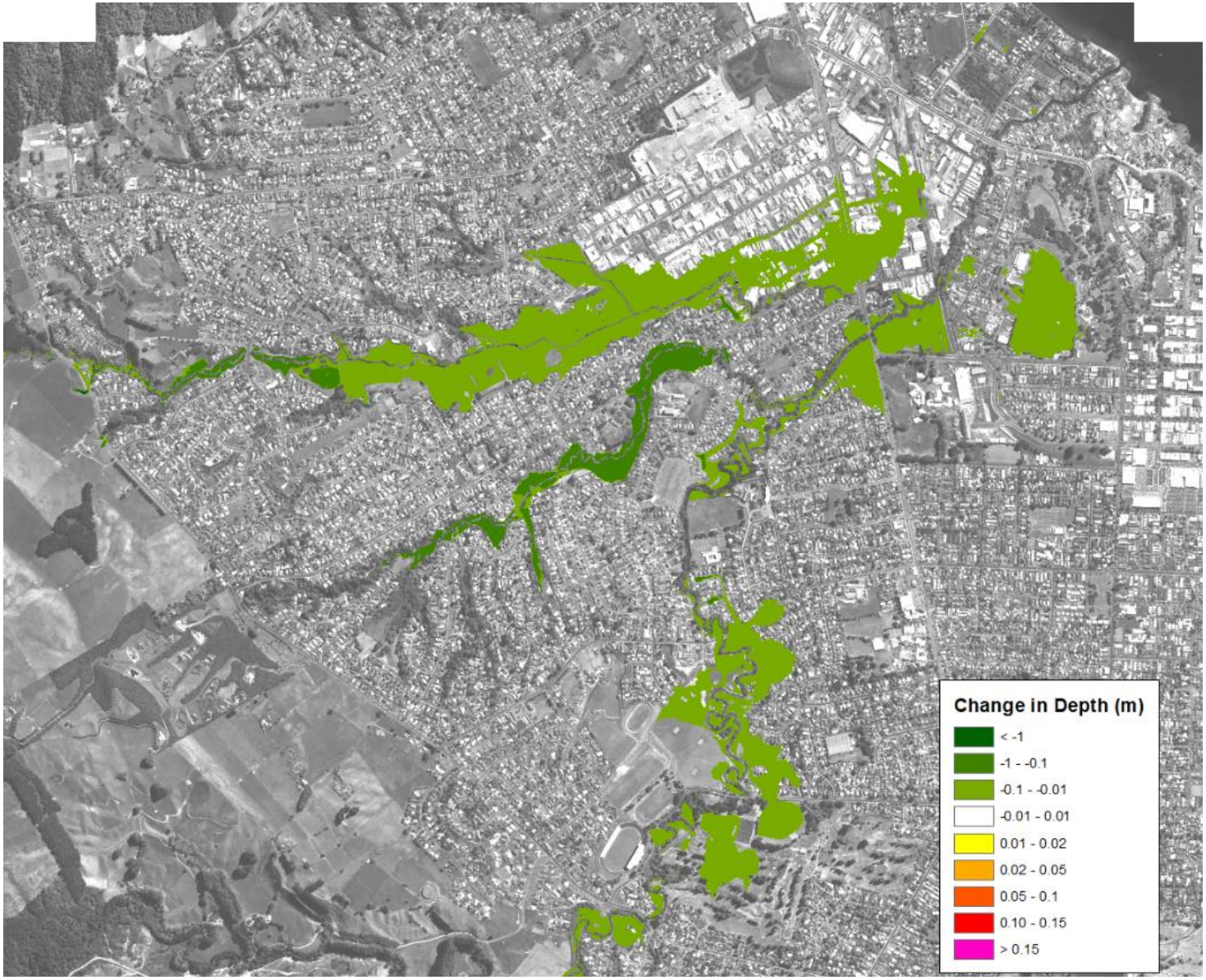
City Future Result

GUCM only

CN21 – 1% & CC

Depth Difference

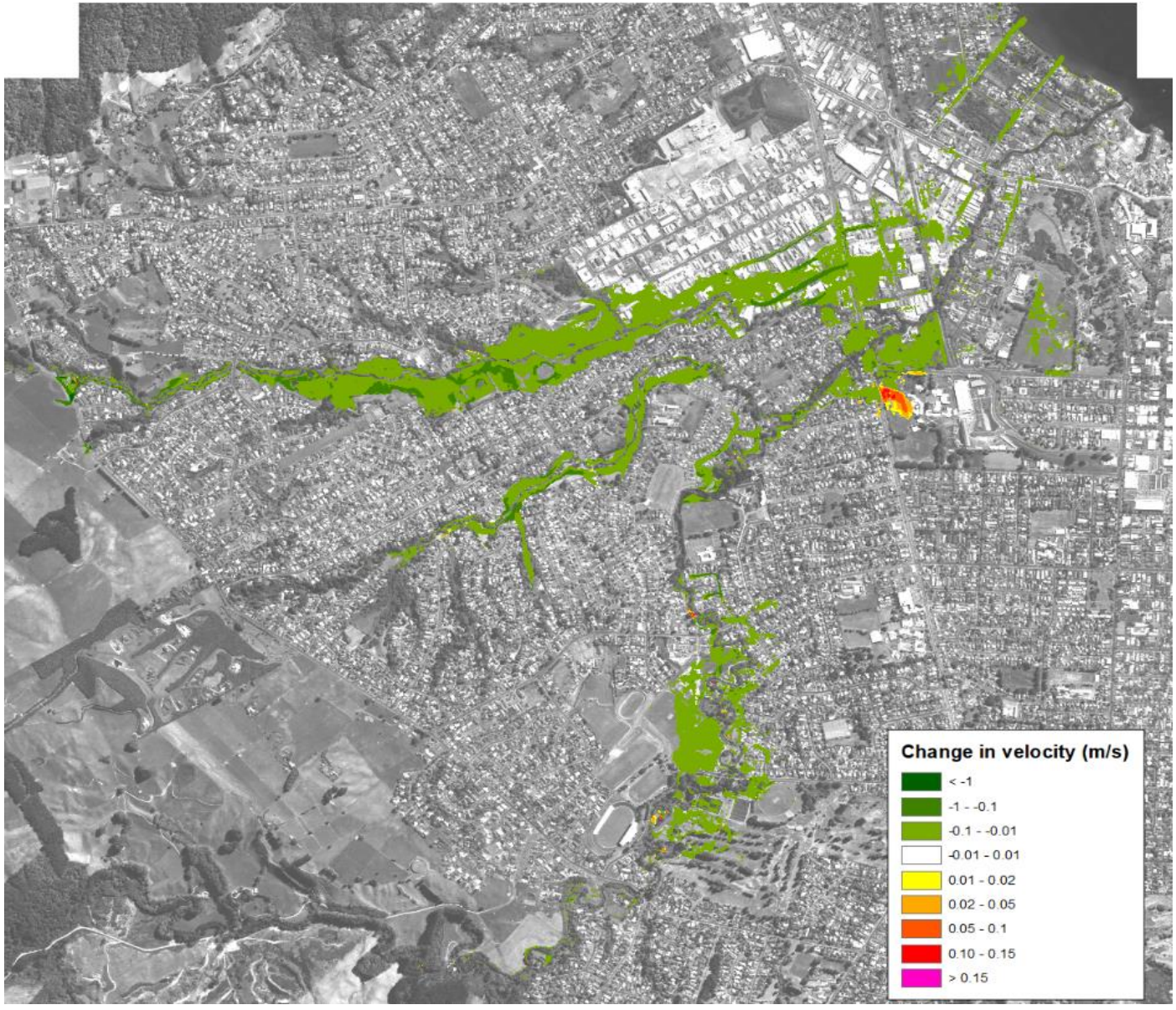
City Futures – GUCM outputs ONLY



CN21 – 1% & CC

Velocity Difference

City Futures – GUCM outputs ONLY



Elements not completed (underway) at present

Works remaining ?

- City Future simulations in the Council Models

S3 – Mapping – more classes.