Regional Floodplain Database:

2014 Model Maintenance Report - Burpengary Creek (BUR)

Moreton Bay Regional Council

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1 Introduction

Aurecon has been commissioned by Moreton Bay Regional Council (MBRC) to upgrade the Burpengary Creek (BUR) hydrologic and hydraulic models as part of the Regional Floodplain Database (RFD) 2014 Maintenance Project.

The key aspects of the RFD 2014 Maintenance Project updating process involved:

- Amendments to the sub-catchment parameterisation and discretisation in the WBNM hydrologic model based on latest LiDAR survey
- Testing of various rainfall loss permutations within the WBNM model to identify a preferred loss value going forward
- Incorporation of latest LiDAR survey within the 2D domain of the TUFLOW model
- Incorporation of latest bathymetric survey in the TUFLOW model
- Updating of TUFLOW material roughness layers in line with Councils current requirements
- Inclusion of break-lines to define channels where necessary in the TUFLOW domain
- Completion of historical validation for the January 2011 event
- In corporation of the Dale Street Bund design and associated drainage infrastructure (eg detention basins, culverts, etc)
- Incorporation of latest structure data within TUFLOW model pertaining to recent development areas in the TUFLOW domain
- Incorporation of underground trunk drainage within the TUFLOW 1D model domain at specific 'investigation areas'
- Generating outputs in multiple formats as per Council's requests, and using latest TUFLOW version for all simulations
- Running updated storm tide and sensitivity modelling scenarios as per Council's requirements

These updates are described in further detail in the following sections of this report.

2 2014 model maintenance details

2.1 WBNM model

The existing WBNM model was provided to Aurecon by MBRC. This was reviewed and amended in agreement with Council. The principal alterations that were made are described in the following bullet points.

- The 2014 LiDAR data was used to cross-check sub-catchment discretisation throughout the model. This led to changes in the sub-catchment discretisation in a small number of areas, most notably where development had obviously since taken place when compared against the previous LiDAR dataset
- In particular the sub-catchment discretisation of the catchment areas upstream of the Dale Street bund was incorporated into the BUR model (ie with the bund acting as a sub-catchment boundary). This was required so as to accurately represent the hydrologic and hydraulic behaviour/interaction of the local and regional flood sources

- Aurecon also incorporated amendments as provided by Council to the fraction impervious percentages of the WBNM sub-catchments
- An initial loss of 15mm was adopted for events up to 20% AEP. For events greater in magnitude than 20% AEP no initial loss was applied. For all events a 2.5 mm/hr continuous loss rate was applied
- Where previous modelling had not accounted for certain event magnitudes these were generated in accordance with Council and industry requirements (ie 0.02% and 0.01% AEP events)
- Quality checks against the previous WBNM modelling was carried out to ensure consistency across both model outputs, notwithstanding any differences that were owing to the aforementioned changes that were made to the model set-up/parametrisation

2.2 TUFLOW model

In conjunction with Council, Aurecon made a number of changes to the BUR TUFLOW model. These modifications are outlined in the following bullet points. Refer also to Figure 2-1:

- The TUFLOW 2013-12-AD-iSP-w64 executable was used for all simulations. This TUFLOW version includes Councils hazard categories as a default output
- All TUFLOW model files were named as per Council's RFD naming convention (Run ID: 002c)
- Results were generated in multiple formats as per Council's requests – this includes XMDF, FLT and WRB outputs types. In summary the outputs coding is as follows:
  - For rivers/creeks:
    - Map Output Format == XMDF | FLT | WRB
    - WRB Map Output Data Types == h d v
    - XMDF Map Output Data Types == h v d ZMBRC Z0 ZQRA SP
    - FLT Map Output Data Types == h v d ZMBRC Z0 ZQRA
  - For storm tide:
    - Map Output Format == XMDF | FLT |
    - XMDF Map Output Data Types == h v d ZMBRC Z0 ZQRA SP Z9
    - FLT Map Output Data Types == h v d ZMBRC Z0 ZQRA Z9
- Incorporation of 2014 LiDAR survey within the 2D domain of the TUFLOW model
- Incorporation of 2009 bathymetric survey (Z-points) in the TUFLOW model in the creeks
- Updating of TUFLOW material roughness layer in line with Councils current requirements – this includes use of the most up to date waterbody layer, and also accounts for a number of specific areas of development within the 2D domain
- Inclusion of break-lines to define channels where necessary in the TUFLOW domain – this was undertaken as per Council's standard methodology using 'z-shape' gully lines based on streamline data provided
- Inclusion of the Dale Street Bund design – the 3D design of the bund, floodplain excavation and detention basins was stamped into the model topography to represent the future conditions in this part of the floodplain. Also included were the culverts that run through the bund which were modelled as non-return structures within TUFLOW. This reflects flap valves/gates being employed at the culvert outlets to prevent backwater flooding from Burpengary Creek surcharging through the culverts into the detention basins

- Incorporation of latest structure data within TUFLOW model pertaining to recent development areas in the TUFLOW domain. These locations were outlined in the project brief and data pertaining to each was provided by Council – this comprised design drawings, onsite survey, photographs, etc. Over the course of the project, and following Aurecon's ongoing review of the model, a small number of additional structures were also added
- Incorporation of underground trunk drainage within the TUFLOW 1D model domain at specific 'investigation areas'. These investigation areas were outlined in the project brief, of which there were 33 discrete locations in total. The data was typically obtained from Council's stormwater GIS layer which was also provided as part of this project. '2d SA pits' were used to control the application of the flow within the 2d domain such that it would be subsequently conveyed by the underground network, yet could still surcharge and show overland flooding where the pipe network capacity was exceeded
- A review of the modelling of buildings was also conducted to ensure the BUR model met with current industry practices. Of note is that the Deception Bay Shopping Centre in the lower reaches of the BUR model was explicitly modelled as combination of a higher roughness coefficient, and also a z-shape with an elevation matching the finished floor level of 4.5 mAHD
- PO lines were reviewed and amended where necessary
- Storm tide and sensitivity modelling scenarios were simulated as per Council's brief requirements

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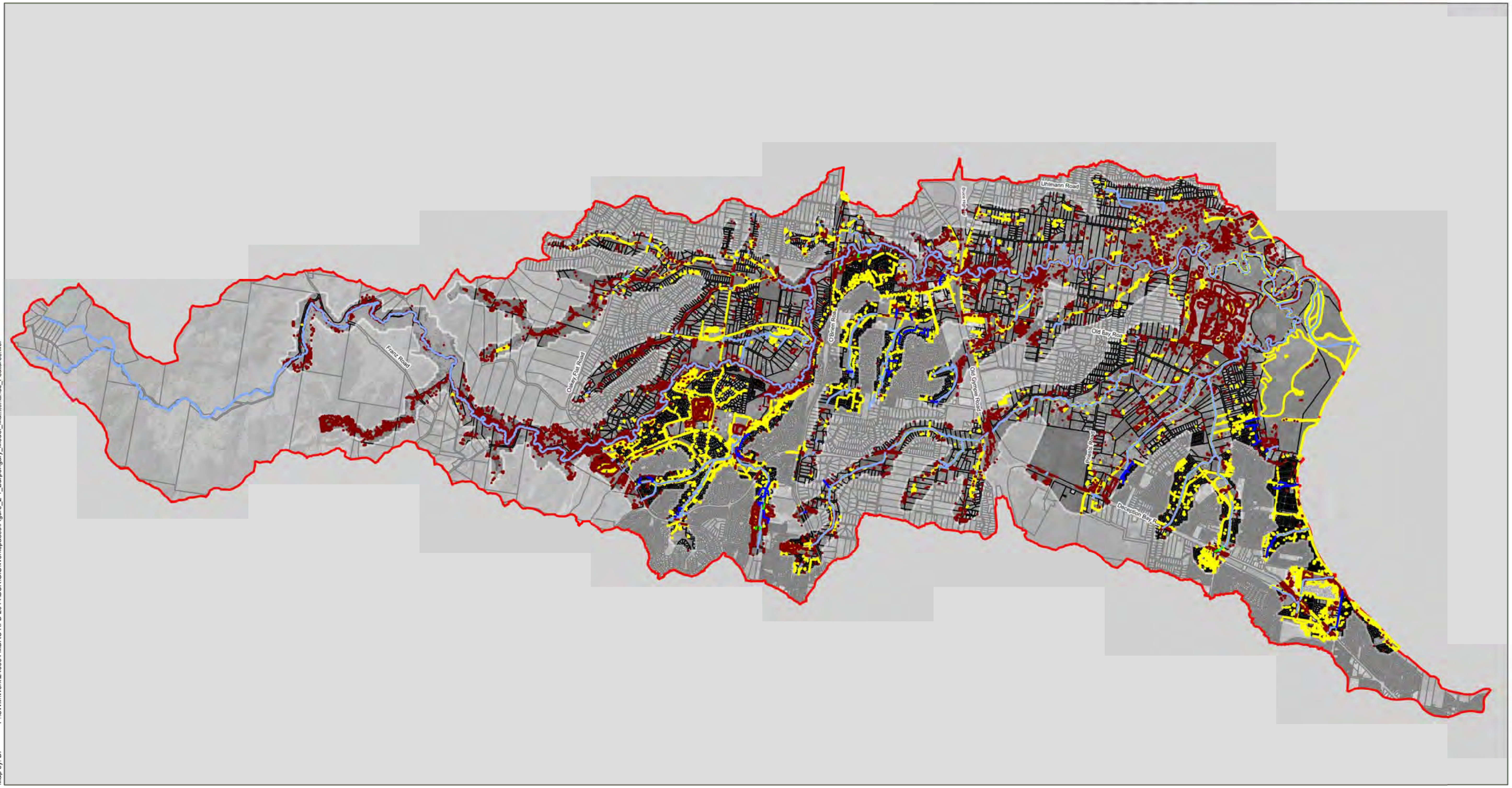

Map by: DF

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Legend

- Burpengary Catchment Boundary
- Hydraulic Model Boundary
- Cadastral Bondaries

Additional Features

- Change in Landuse Roughness
- Change in Topography/Bathymetry
- Bridge
- Open Drain/Channel
- Underground Drainage
- Additional Culvert

Notes:

A3 scale 1:50,000

0 1,250 m 2,500 m

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Projection: MGA Zone 56

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Figure 2-1: Hydraulic Model Maintenance Features

3 Model simulations

3.1 Verification

The January 2011 storm generated a significant flood event on Burpengary Creek for which gauge and survey data was available. Accordingly, a historical validation was undertaken using the TUFLOW model, noting that the 2011 rainfall event was first modelled in the WBNM model to determine the necessary inflows for the TUFLOW model. The January 2011 event was estimated as being close to a 1% AEP event.

Refer to Section 4.2 where the results of the verification simulation are discussed in detail.

3.2 Design flood events

This section describes the design storm conditions used in the hydrodynamic modelling tasks. Design storm events are synthesised events used to estimate design flood conditions. They are based on a probability of occurrence, usually specified using the Average Exceedance Probability (AEP) nomenclature. For events less than the 50% AEP, the terminology Exceedances per Year (EY) is used (eg 0.5EY for the 2yr ARI event).

3.2.1 River and creek critical duration assessment

For the RFD 2014 Maintenance Project the Critical Duration Analysis (CDA) undertaken utilised the 1% AEP and 0.1% AEP events. Results from the CDA are shown in Figure 3-1 to Figure 3-2.

Critical durations selected from the 1% AEP event CDA were applied to all events ranging from the 1EY to the 1% AEP. Critical durations selected from the 0.1% AEP event CDA were applied to all events ranging from the 0.5% AEP to the PMF event.

The critical durations selected from the CDA is shown in Table 3-1.

Table 3-1 Critical duration assessment

Assessment event	Durations	Selected durations	Adopted event(s)
1% AEP	½, 1, 1½, 2, 3, 4½, 6, 9, 12, and 24 hour storm	1, 2 and 6 hour storm	1EY, 0.5EY, 20%, 10%, 5%, 2% and 1% AEP
0.1% AEP	½, 1, 1½, 2, 3, 4, 5, 6, 12, and 24 hour storm	1, 3 and 6 hour storm	0.5%, 0.2%, 0.1%, 0.05%, 0.02%, 0.01% AEP and PMF

To determine the critical storm durations, the following methodology was adopted:

1. Hydrologic and hydraulic modelling for the range of storm durations as listed in Table 3-1
2. Mapping of the peak flood levels for the “maximum envelope” of all the storm durations
3. Mapping of the peak flood levels for the “maximum envelope” of the selected storm durations as listed in Table 1
4. Difference comparison between the mapped peak flood levels for the selected storm durations (iii) and the mapped peak flood levels from all storm durations (ii)
5. Selection of the critical storm durations was based on the storm durations generating the highest flood levels across the most of the minor basin area

The difference comparison for the 1% and 0.1% AEP peak flood levels determined from above methodology is shown in Figure 3-3 and Figure 3-4. These figures illustrate that the selected critical durations (see Table 3-1) generally represents the peak flood levels throughout the minor basin.

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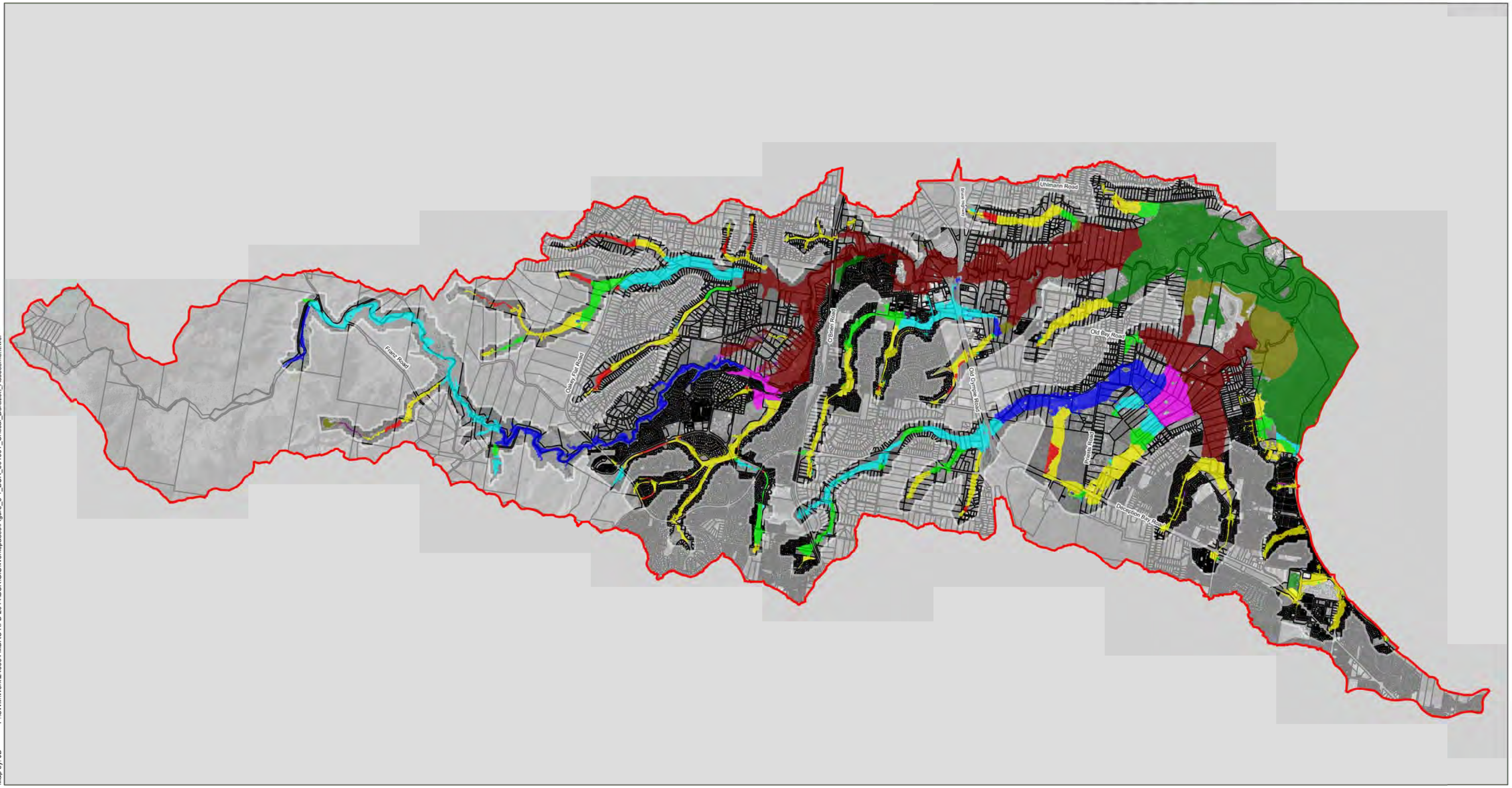

Map by: JD

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Legend

- Burpengary Catchment Boundary
- Hydraulic Model Boundary
- Cadastral Bondaries

Critical Durations

30 minute	270 minute
60 minute	360 minute
90 minute	540 minute
120 minute	720 minute
180 minute	1440 minute

Notes:

A3 scale 1:50,000

0 1,250 m 2,500 m

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Figure 3-1: Critical Duration Assessment - 1% AEP

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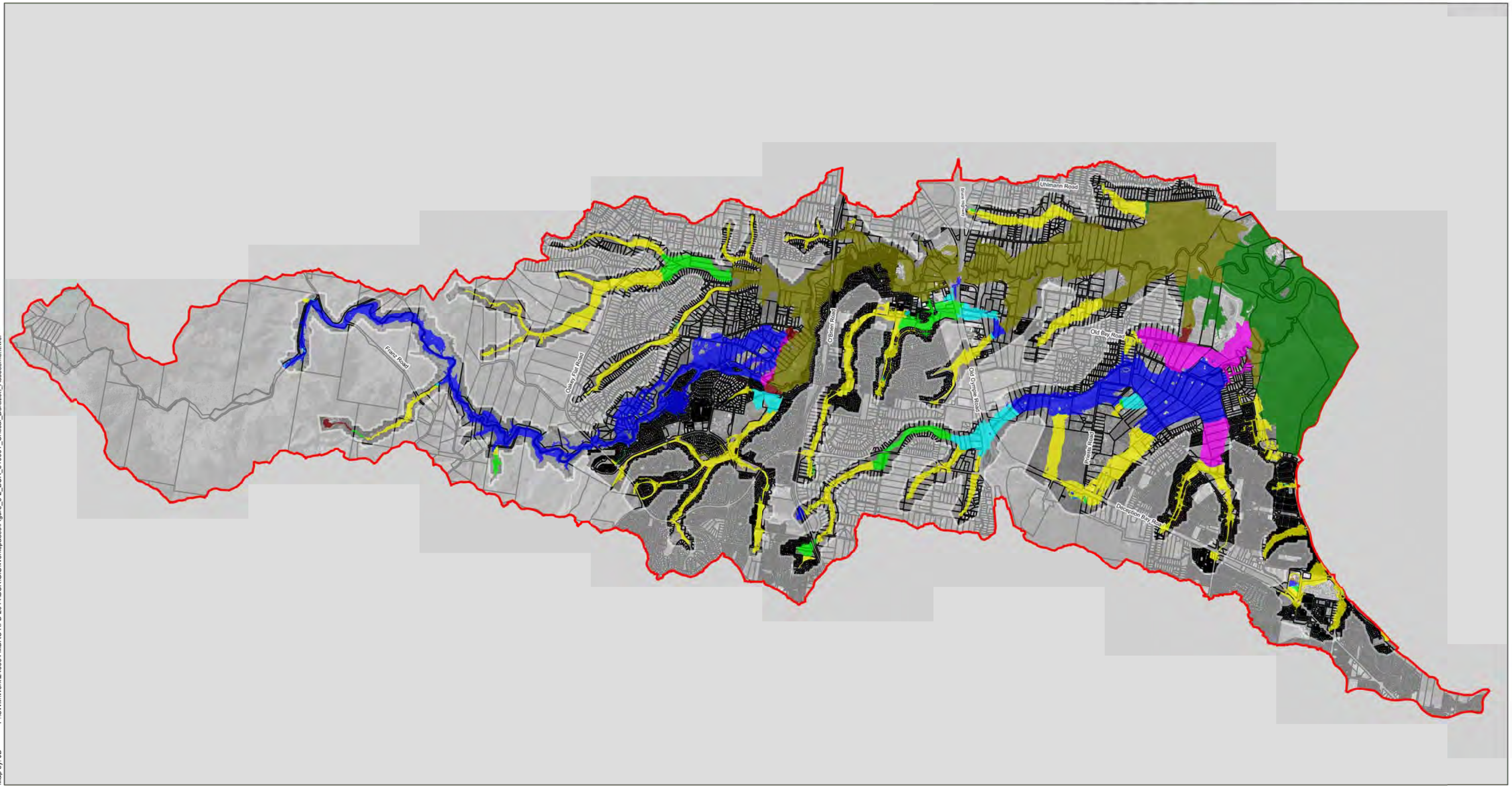

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Map by: JD

Legend

Burpengary Catchment Boundary

Hydraulic Model Boundary

Cadastral Bondaries

Critical Duration

30 minute	240 minute
60 minute	300 minute
90 minute	360 minute
120 minute	720 minute
180 minute	1440 minute

Notes:

A3 scale 1:50,000

0 1,250 m 2,500 m

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Figure 3-2: Critical Duration Assessment - 0.1% AEP

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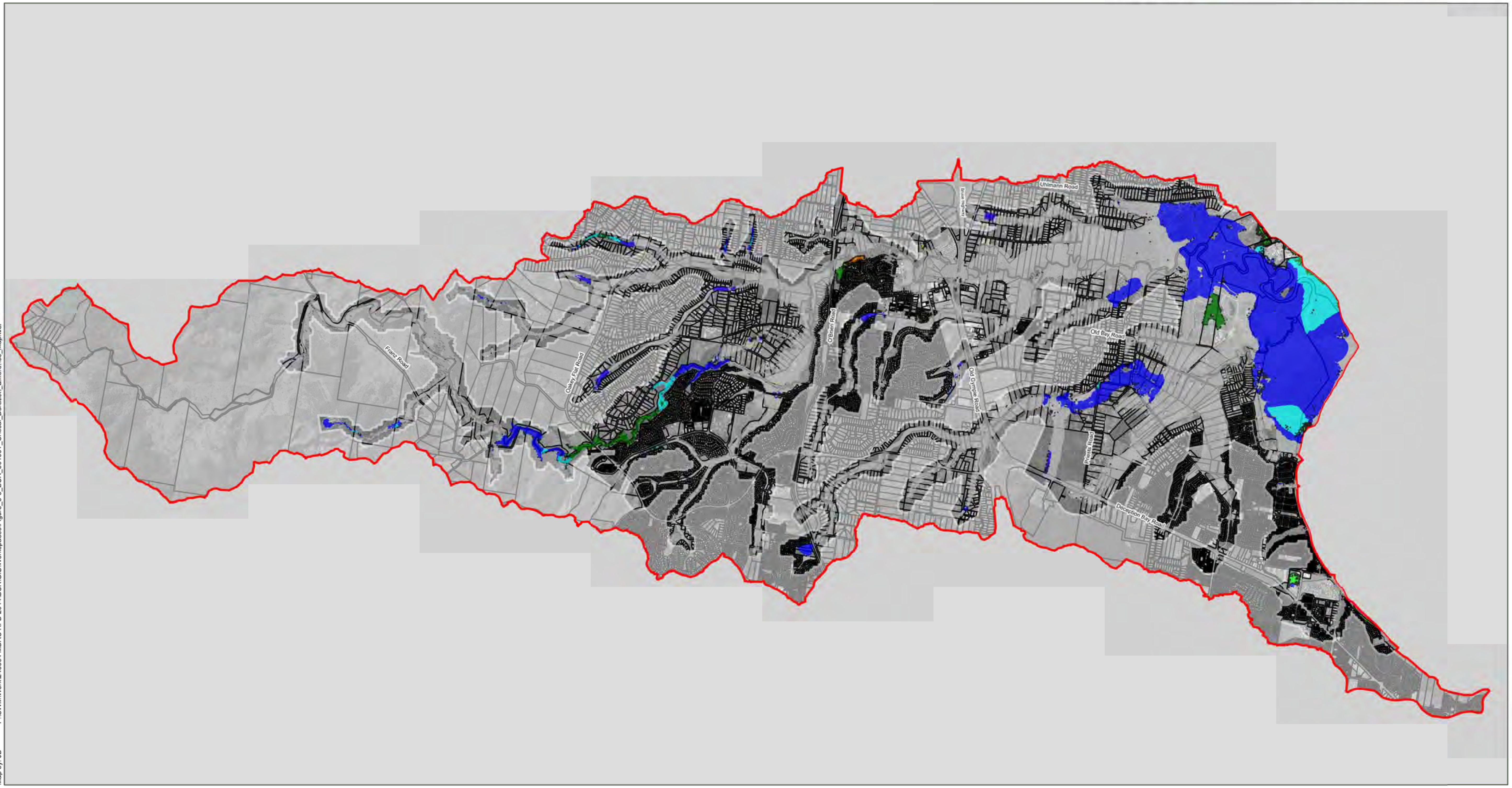

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Map by: JD

Legend

- Burpengary Catchment Boundary
- Hydraulic Model Boundary
- Cadastral Bondaries

Peak Flood Level Differnce (m)

- <-1.00
- -1.00 to -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- No Change

Difference in Flood Extent

- Decrease in Innundation Extent
- Increase in Innundation Extent

Notes:

A3 scale 1:50,000

0 1,250 m 2,500 m

Date: 02/07/2015 Version: 0 Job No: 243304

Projection: MGA Zone 56

Regional Floodplain Database **2014 Model Maintenance Report - Burpengary (BUR)**

Figure 3-3: Critical Duration Assessment
Peak Flood Level Difference - 1% AEP

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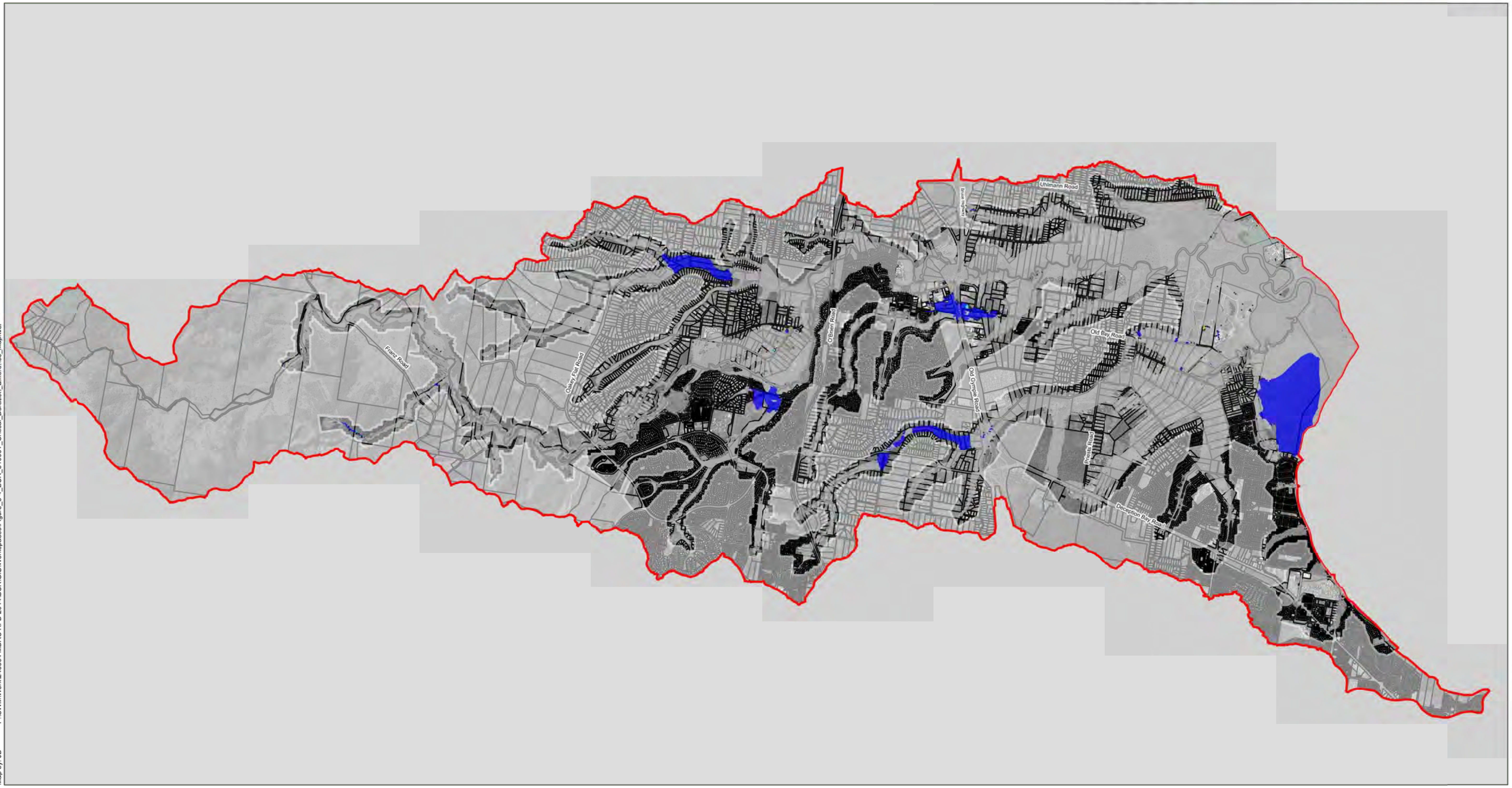

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Map by: JD

Legend

- Burpengary Catchment Boundary
- Hydraulic Model Boundary
- Cadastral Bondaries

Peak Flood Level Differnce (m)

- <-1.00
- -1.00 to -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- No Change

Difference in Flood Extent

- Decrease in Innundation Extent
- Increase in Innundation Extent

Notes:

A3 scale 1:50,000

0 1,250 m 2,500 m

Date: 02/07/2015 Version: 0 Job No: 243304

Projection: MGA Zone 56

Regional Floodplain Database **2014 Model Maintenance Report - Burpengary (BUR)**

Figure 3-4: Critical Duration Assessment
Peak Flood Level Difference - 0.1% AEP

3.2.2 River and creek design event simulations

The BUR model was simulated for a range of AEPs and storm durations as detailed in Section 3.2.1, as well as the MBRC Design Storm (MDS). Councils adopted design storm (ie the MDS) is a 1% AEP 15 minute event embedded within a 270 minute design storm. The MDS is useful for general investigations into changes in model parameters and catchment characteristics, as it reduces the number of model runs required (ie one run instead of multiple storm durations).

The BUR model was simulated for the following design events:

- The 1EY, 0.5EY, 20%, 10%, 5%, 2%, 1%, 0.5%, 0.2%, 0.1%, 0.05%, 0.02%, 0.01% AEP events and the PMF event for the three selected critical durations
- The Moreton Bay Design Storm – 1% AEP 15 minute in 270 minute embedded design storm

3.2.3 Storm tide design event simulations

The coastal (downstream) boundary was modified for the storm tide runs to allow for accurate modelling of the inundation propagation/extents.

Note that this event utilises a dynamic (temporally varying) downstream boundary condition without any rainfall over the catchment. The downstream boundary condition was generated using MBRC's Storm Tide Hydrograph Tool as supplied by Council ('20140620 Storm Tide Hydrograph Tool.xlsx').

In total there were four (4) storm tide reference points that were used to develop the storm tide dynamic profile. They included MBC_011, MBC_012, MBC_013, and MBC_014.

Table 3-2 outlines the various storm tide runs that were undertaken as part of the BUR RFD project.

Table 3-2 Summary of storm tide events

ID	Description
BUR_S_002c_E_00020Y	No rainfall, dynamic Storm Tide (5% AEP current)
BUR _S_002c_E_00100Y	No rainfall, dynamic Storm Tide (1% AEP current)
BUR _S_002c_E_01000Y	No rainfall, dynamic Storm Tide (0.1% AEP current)
BUR _S_002c_E_10000Y	No rainfall, dynamic Storm Tide (0.01% AEP current)
BUR _S_002c_F_00100Y	No rainfall, dynamic Storm Tide (1% AEP future incl. Climate Change + 0.8m SLR)

3.3 Sensitivity analysis

The BUR model was used to assess a total of ten (10) sensitivity simulations in order to evaluate the response of the model to changes in key parameters. Each scenario test is outlined in Table 3-3.

Note that each test was undertaken using the 1% AEP MDS storm.

Table 3-3 Sensitivity analysis summary

ID	Scenario Test	Section
R01	Roughness	3.3.1
R02	Blockage	3.3.2
R03	Climate Change – Rainfall	3.3.3
R04	Climate Change – Sea level rise	3.3.3
R05	Climate Change – Rainfall and sea level rise	3.3.3
R06	Storm tide – current storm tide with current rainfall	3.3.3
R07	Storm tide – future storm tide with future rainfall and sea level rise	3.3.3
R08	Vegetated floodplain	3.3.4
R09	Future catchment development	3.3.4
R10	Vegetated floodplain and future catchment development	3.3.4

3.3.1 Hydraulic roughness analysis

All Manning's 'n' values in the TUFLOW models 2D domain were increased by 20%.

3.3.2 Structure blockage analysis

For the blockage scenario a blockage factor was only applied to all culverts in the BUR model (noting that this does not apply to underground pipe networks).

For culverts the blockage scenario was adopted from the SKM *Floodplain Parameterisation* report (2012b), and includes:

- A full blockage is applied if the culvert diagonal is less than 2.4 m
- A 15% blockage is applied if the culvert diagonal is greater than 2.4 m

3.3.3 Climate change and downstream boundary conditions analysis

Simulations R03 to R07 involved the testing of the models sensitivity to climate change. This involved investigation of effects associated with increased rainfall, sea-level rise and storm tide activity. The following five (5) scenarios were assessed:

- R03: Investigation of the impact of an increase in rainfall intensity of 20% (as per SKM (2012a) *Boundary Conditions, Joint Probability and Climate Change Report*)
- R04: Investigation of the impact of an increased tailwater level of 0.8 m due to predicted sea level rise
- R05: Investigation of the impact of a 20% increase in rainfall intensity and an increased tailwater level of 0.8 m due to predicted sea level rise. This test combines scenarios R03 and R04
- R06: Investigation of the impact of a 1% AEP current static storm tide level with concurrent 1% AEP MDS rainfall event
- R07: Investigation of the impact of a 20% increase in rainfall intensity and an increase in sea level rise (ie a static storm tide level (1% AEP GHG) + 0.8 m)

3.3.4 Future land-use analysis

Three future landuse scenarios were assessed using the 1% AEP MDS. These tests did not incorporate any changes to rainfall intensity or tailwater conditions from those assumed in the design runs. Instead they focused on altering the fraction impervious within the sub-catchment domain, as well as modifying the vegetative cover within the floodplain.

In line with anticipated future catchment development the WBNM hydrologic model was modified to reflect an increase in the fraction impervious within each subcatchment. This leads to increased run-off and higher peak discharges. These discharges were in turn incorporated into the TUFLOW model as inflow boundary conditions.

The floodplain vegetation was altered in line with the brief requirements. This was done by developing specific TUFLOW material layers to increase the roughness within the 1% AEP floodplain.

The following three (3) scenarios were assessed:

- R08: Investigation of the impact of increased vegetation in the floodplain. This involved changing the 'medium dense vegetation' material class to a 'high dense vegetation' class and changing the 'low grass/grazing' material class to a 'medium dense vegetation' class
- R09: Investigation of the impact of increased residential development. The WBNM model was updated to reflect an increase in the fraction impervious within each subcatchment. The increased discharges were then incorporated into the TUFLOW model as inflow boundary conditions
- R10: Investigated the impact of increased residential development and increased vegetation in the floodplain. This test combines scenarios R08 and R09

4 Model results and outcomes

4.1 2014 model maintenance

Figures 4-1 and 4-2 show the difference between the 2012 BUR model and the updated 2014 BUR model for the 5% and 1% AEP events respectively. The storm durations used in creating a combined envelope for the two models and events are shown in Table 4-1.

Table 4-1 Storm duration comparison for 5% and 1% AEP events

Event	Storm durations for 2012 model	Storm durations for 2014 model
5% AEP	1, 3 and 6 hour	1, 2 and 6 hour
1% AEP	10, 15, 30, 45 minutes, 1, 1½, 2, 3, 4½, 6, 9, 12, 18, 24, 36, 48 and 72 hour	½, 1, 1½, 2, 3, 4½, 6, 9, 12, and 24 hour

Negative values in Figures 4-1 and 4-2 show where the 2014 BUR model flood levels are lower than those of the 2012 BUR model results and vice versa. These differences were investigated and satisfactorily understood. Aspects contributing to the differences included updated topography, alterations in the hydrologic model outputs that act as inflow boundary conditions to the TUFLOW model, and changes to local drainage infrastructure (eg new pipes, embankments, earthworks, etc).

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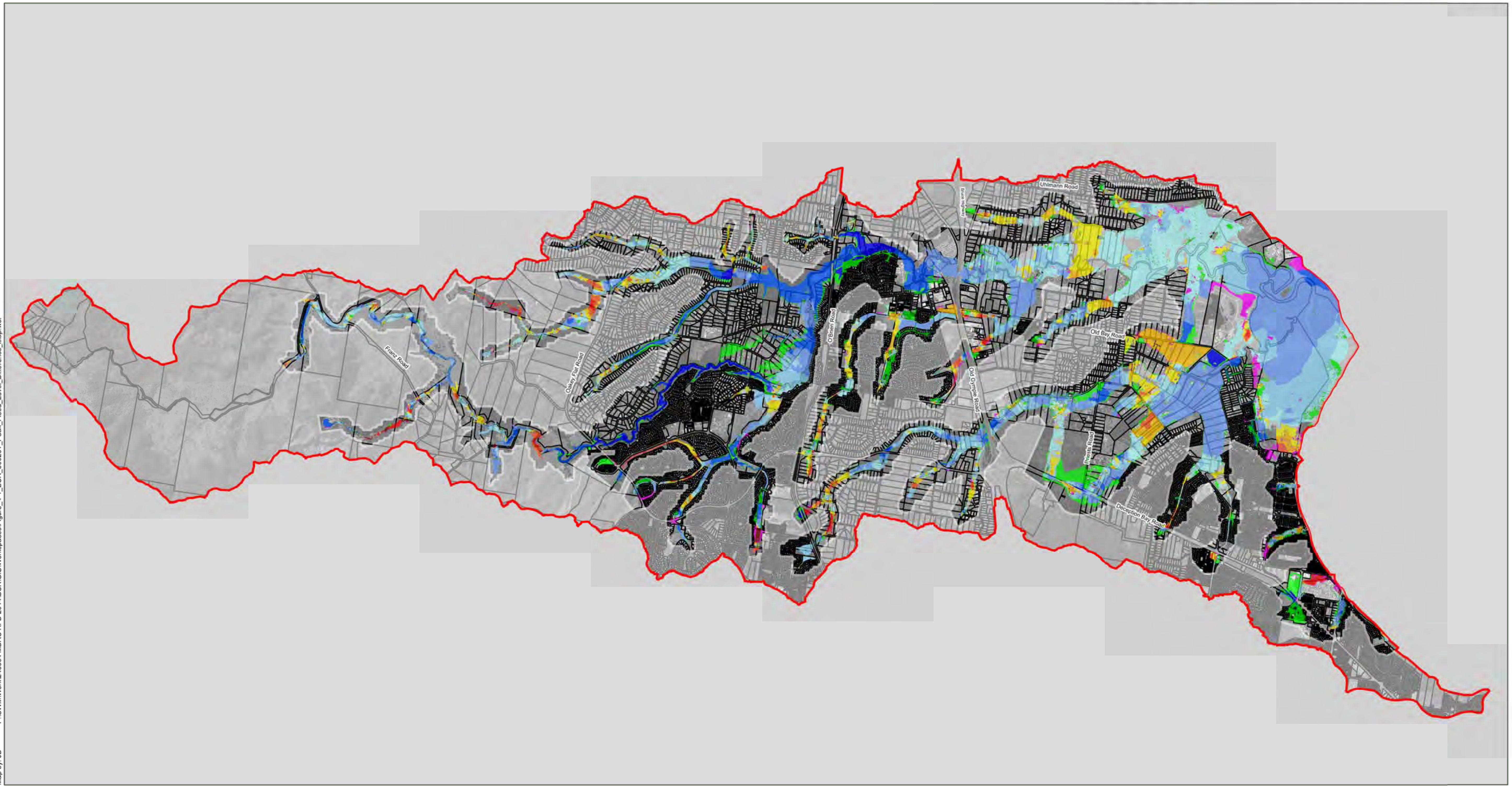
Map by: JD P:\SWM\Work\243304 MBRC RFD 2014\BUR\GIS\Workspaces\Figure_4-1_BUR_00020Y_Peak_Flood_Level_Difference_Map.wor



Legend

- Burpengary Catchment Boundary
- Hydraulic Model Boundary
- Cadastral Bondaries

Difference in Peak Flood (m)

- <-0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- >0.50

Differnce in Flood Extent

- Decrease in Inundation Extent
- Increase in Inundation Extent

Notes:

A3 scale 1:50,000

0 1,250 m 2,500 m

Date: 26/06/2015 Version: 0 Job No: 243304

Projection: MGA Zone 56

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Figure 4-1: 2014 BUR Model Versus 2012 BUR Model
Peak Flood Level Difference - 5% AEP

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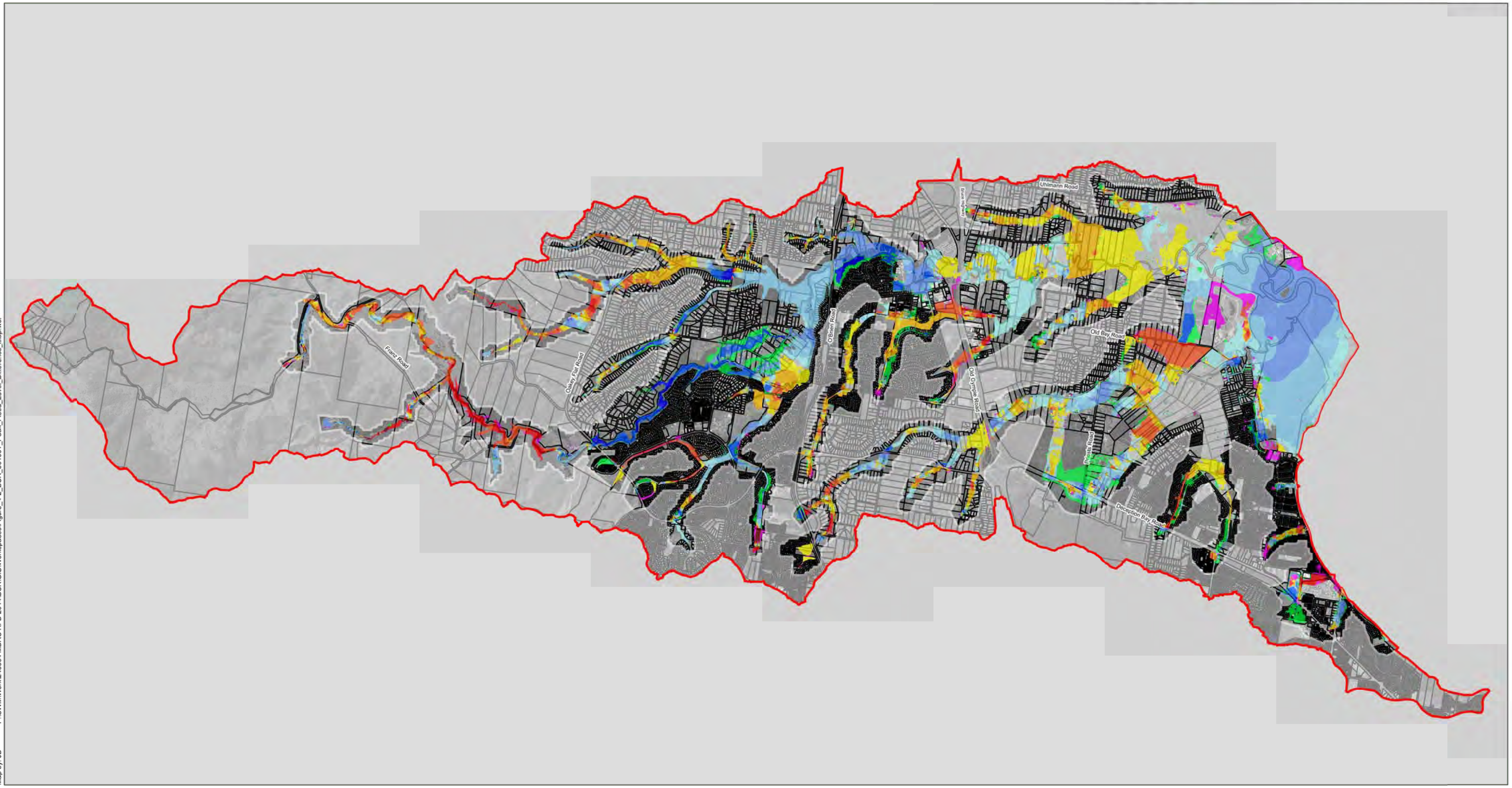

Map by: JD

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Legend

Burpengary Catchment Boundary

Hydraulic Model Boundary

Cadastral Bondaries

Difference in Peak Flood (m)

- <-0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- >0.50

Differnce in Flood Extent

- Decrease in Innundation Extent
- Increase in Innundation Extent

Notes:

A3 scale 1:50,000

0 1,250 m 2,500 m

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Projection: MGA Zone 56

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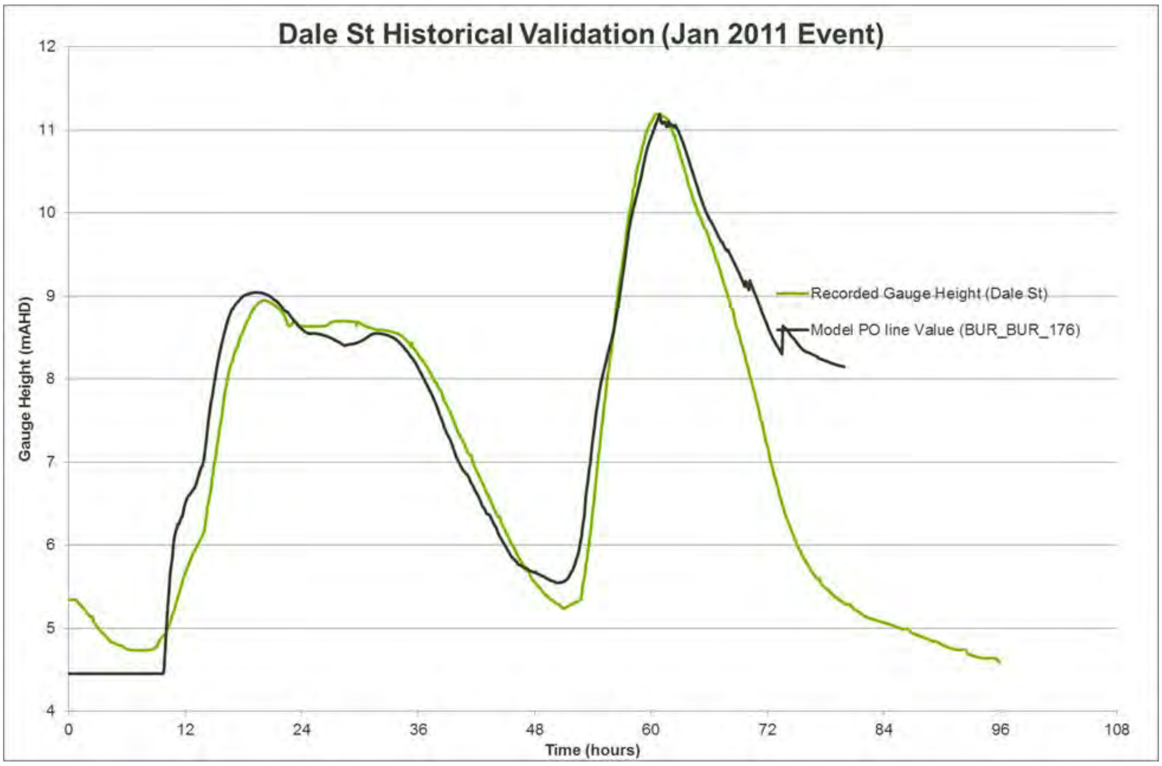
Figure 4-2: 2014 BUR Model Versus 2012 BUR Model Peak Flood Level Difference - 1% AEP

4.2 Verification

Verification against recorded rainfall and surveyed flood marks was undertaken for the January 2011 event for the BUR model. The January 2011 event was estimated as being close to a 1% AEP event.

This included a single gauge comparison at Dale Street (note that the gauge at Rowley Road malfunctioned during this event) and 54 recorded flood marks. The flood marks covered a wide expanse of the floodplain comprising Burpengary, Deception Bay, Morayfield, and Narangba.

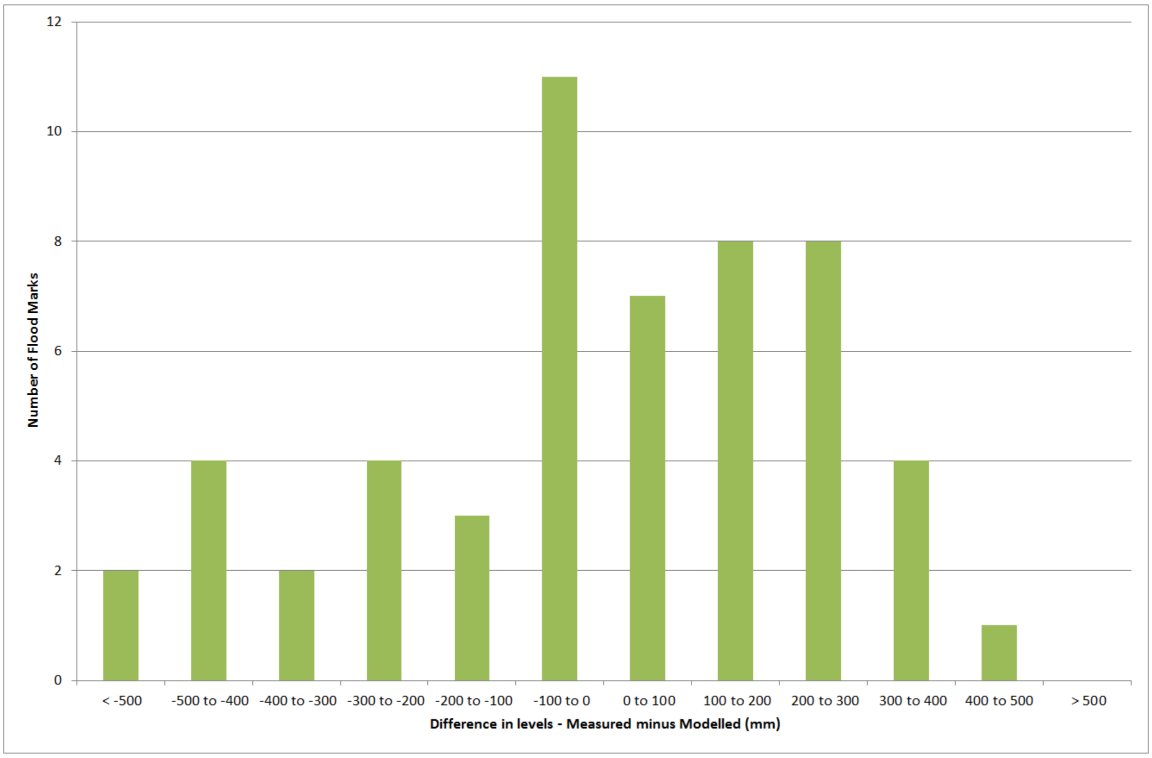
Graph 4-1 below shows the correlation between the recorded and predicted stage hydrographs at the Dale Street gauge. Excellent agreement is achieved both in terms of peak flood levels and general timing/shape.



Graph 4-1 Recorded stage hydrograph cf. TUFLOW stage hydrograph for January 2011 event

The 54 recorded flood marks were surveyed on 11 January 2011. These typically included debri lines and high water marks that remained on surfaces following the flood recession. Note that when measuring flood lines/debris marks there is often an appreciable margin of error in estimating the exact flood level. This can be caused by wave action on the flood surface and also stagnation of the flow at immersed objects (eg at a bridge pier). In addition, human and mechanical error relating to the measurement/surveying process can also occur.

Graph 4-2 below shows a histogram distribution of the flood mark correlation.



Graph 4-2 Histogram of flood mark correlation for the January 2011 event

The key observations that can be derived from interrogating the data are:

- Generally speaking a good correlation was observed
- The average of the sum of the absolute differences is approximately 200 mm
- The maximum positive difference between the measured and modelled (ie measured minus modelled) was 470 mm, while the maximum negative difference between the measured and modelled (ie measured minus modelled) was -670 mm (excluding one assumed erroneous outlier value of -1.54 m at 118 Forest Ridge Drive)
- The standard deviation of the sum of the differences is approximately 300 mm – this implies that approximately 70% of the 54 surveyed marks are within 300 mm, a typical tolerance/target in verification exercises of this nature)
- There was an almost even split between marks that were greater than the predicted TUFLOW levels (28) and marks that were less than the predicted TUFLOW levels (26) – accordingly no single trend of over-prediction/under-prediction was present across the model

Overall, the verification simulation has shown good correlation with recorded field data including the gauge at Dale Street and 54 surveyed flood marks. The model can therefore be expected to provide relatively accurate flood predictions for design flood events of a similar magnitude.

4.3 Design flood behaviour

Results were generated in multiple formats as per Council's requests – this includes XMDF, FLT and WRB outputs types. The following outputs were generated both on an interval (time varying) and peak value basis:

- Flood level (h)
- Flood depth (d)
- Flow velocity (v)
- Four Hazard Classifications (ZBMRC, Z0, ZQRA, Z9)
- Stream Power (SP)

4.3.1 River and creek

A max-max function was used to derive the envelope of all critical storm durations (Section 3.2.1) for each event and all the TUFLOW outputs listed in Section 4.3 above. Results for the 5%, 1% and 0.1% AEP events are available on Council's website (www.moretonbay.qld.gov.au/floodcheck) as PDF suburb maps or in the Flood Explorer interactive mapping tool.

In summary the output coding for all design fluvial flooding is as follows:

- Map Output Format == XMDF | FLT | WRB
- WRB Map Output Data Types == h d v
- XMDF Map Output Data Types == h v d ZMBRC Z0 ZQRA SP
- FLT Map Output Data Types == h v d ZMBRC Z0 ZQRA

4.3.2 Storm tide

Outputs were generated for each storm tide event (Section 3.2.3) and all the TUFLOW outputs listed in Section 4.3 above. The outputs for the 5%, 1% and 0.1% AEP events are available on Council's website (www.moretonbay.qld.gov.au/floodcheck) as PDF suburb maps or in the Flood Explorer interactive mapping tool.

In summary the output coding for all storm tide flooding is as follows:

- Map Output Format == XMDF | FLT |
- XMDF Map Output Data Types == h v d ZMBRC Z0 ZQRA SP Z9
- FLT Map Output Data Types == h v d ZMBRC Z0 ZQRA Z9

4.4 Sensitivity analysis results

The 1% Moreton Bay Design Storm (MDS) was used in all the sensitivity analyses, avoiding the need to run multiple durations. The results of these analyses are summarised in Sections 4.4.1 to 4.4.4.

Note also that in comparing the 1% MDS against the 1% AEP design event (the envelope of all durations), both results generally correlated well. Towards the lower reaches of the model the 1% AEP design event was approximately 100mm higher than the 1% MDS but this is to be expected considering that longer duration events are critical in these parts of the floodplain.

4.4.1 Hydraulic roughness analysis

A comparison of the results showed the increase in Mannings 'n' to raise water levels by approximately 200 mm at a few localised areas. Generally though the increase was in the order of 30 mm to 80 mm.

4.4.2 Structure blockage analysis

Blockage of the structures in line with the details set out in Section 3.3.2 resulted in maximum increases in flood level of 200 mm immediately upstream of the structure. Decreases in peak flood levels of up to 80 mm were observed downstream of a number of blocked structures.

4.4.3 Climate change and downstream boundary conditions analysis

The climate changes analyses involved testing the response of the model to changes in rainfall intensity and sea-level rise (ie increased tailwater levels) both individually and in combination.

Investigation of the impact of an increase in rainfall intensity of 20% (R03)

An increase in rainfall intensity resulted in flood levels being raised by up to 100 mm on average throughout the catchment. Isolated increases of up to 500 mm were observed in certain areas where channels were very defined and narrow. The corresponding increase in flood extent is minimal in most areas.

Investigation of the impact of an increased tailwater level of 0.8 m SLR (R04)

An increase in the downstream tailwater to simulate the effects of sea level rise increases the flood levels in the downstream model reaches by up to 800 mm- this corresponds to a relatively minimal increase in the extent of flooding. The increased tailwater level does not affect the flood levels in the model reaches 3 km upstream of the model outlet.

Investigation of increase in rainfall intensity of 20% and 0.8 m SLR (R05)

Combining the two previous scenarios, flood levels in the downstream reaches of the model (in close proximity to the downstream boundary) were observed to increase by a maximum of up to 1400 mm. The upper reaches which are beyond the influence of the tailwater did not show any significant differences when compared to the R03 results. However in the areas where the effects of both the higher tailwater and increased discharge are experienced, flood levels were observed to increase by up to 300 mm – generally speaking this corresponds to a relatively minimal increase in the extent of flooding.

Investigation of 1% AEP current static storm tide with concurrent 1% AEP MDS rainfall event (R06)

The impact of a 1% AEP storm tide principally affects only the lower model reaches. Close to the models downstream boundary increases in flood level of up to 1600 mm are observed. Further upstream where the tailwater effect is still present but reduced in magnitude, increases of 200 mm are experienced. No increases are predicted to occur 4 km upstream of the outlet model boundary.

Investigation of increase in rainfall of 20% combined with a static storm tide level (1% AEP GHG) + 0.8 m sea level rise (R07)

The impact of a 1% AEP future storm tide combined with an increase in rainfall intensity and 0.8 m sea level rise has a significant impact on flood levels and extents in the catchment. This is essentially a ‘worst case’ scenario with three components being tested in combination. Flood levels in the downstream reaches of the model (in close proximity to the downstream boundary) were observed to increase by up to 2500 mm while in the upstream reaches increases of up to 100 mm were observed. In the areas where the effects of both the higher tailwater and increased discharge are experienced, flood levels were observed to increase by up to 700 mm. Generally speaking this corresponds to a significant increase in the extent of flooding throughout the catchment.

4.4.4 Future landuse analysis

Investigation of increased vegetation in the floodplain (R08)

The increased roughness parameters that were applied to the floodplain vegetation was observed to only cause increases in flood levels by 50 mm. In some locations isolated increases of up to 200 mm were observed but in general it is not observed to significantly alter flood conditions when compared to the existing/base-case scenario.

Investigation of increased catchment development (R09)

Increased catchment development has no significant impact on peak flood levels throughout the model. Maximum increases of up to 10 mm are observed to occur.

Investigation of increased vegetation in the floodplain and increased catchment development (R10)

Testing the combination of increased vegetation and increased catchment development has no significant effect compared to the individual testing carried out in Scenarios R08 and R09.

4.5 Model limitations and quality

The following model limitations apply to the BUR 2014 model upgrade:

- The 5 m grid resolution within the 2D domain may not be able to accurately represent localised channels/drains that have a total width of approximately 10 m or less. Typically TUFLOW recommends that at least 3-4 grid cells be used when modelling a channel as being fully 2D
- The extent of the underground pipe network that is modelled is focused on trunk drainage infrastructure and does not contain the full network extent
- The application of inflow boundaries (SA polygons) may not fully represent the extent of localised overland flooding that can occur in each sub-catchment
- The accuracy of the various datasets provided for use in the model development cannot be verified by Aurecon. This applies to topographic data, underground network data, structural survey/dimensions, etc
- The model reflects the catchment conditions at a particular point in time. This is captured in the LiDAR survey and aerial imagery/catchment urbanisation. This is obviously subject to change due to additional catchment development, and changes in topography that may be either man-made (eg cutting/filling), or natural (eg bathymetric alterations to channel profiles following major flood events). Accordingly, periodic updates of the models are recommended to ensure they reflect any significant changes to the catchment and floodplain conditions

4.6 Model specification and run times

The BUR TUFLOW model has a total model domain area of 44 km^2. Table 4-2 provides details on runtimes and memory requirements for various design events and the MDS.

Table 4-2 Model specification and approximate run times for selected events

Event	Model grid size	Model duration (hours)	Model run time (CPU hours)	Model memory (RAM Gb)
1 EY (6 hours)	5m	16	31	3.2
10% AEP (6 hours)	5m	16	41	3.2
1% AEP (6 hours)	5m	16	45	3.2
0.1% AEP (6 hours)	5m	16	38	3.2
0.01% AEP (6 hours)	5m	16	39	3.2
PMF (6 hours)	5m	16	44	3.2
MDS	5m	15	36	3.2
1% AEP storm tide	5m	60	100	3.1
0.1% AEP storm tide	5m	60	108	3.1

5 Conclusion

The BUR hydrologic and hydraulic models have been updated successfully in line with Councils brief requirements for the RFD 2014 Maintenance Project. An assessment of the hydraulic model outputs shows the simulations to be both robust and stable across the spectrum of event magnitudes that were run. This spans from the 1EY event right through to the PMF.

The data management and modelling has been undertaken in line with Councils naming conventions and modelling approaches/techniques. Close liaison was maintained with Council personnel over the course of the project to ensure a successful outcome.

6 References

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