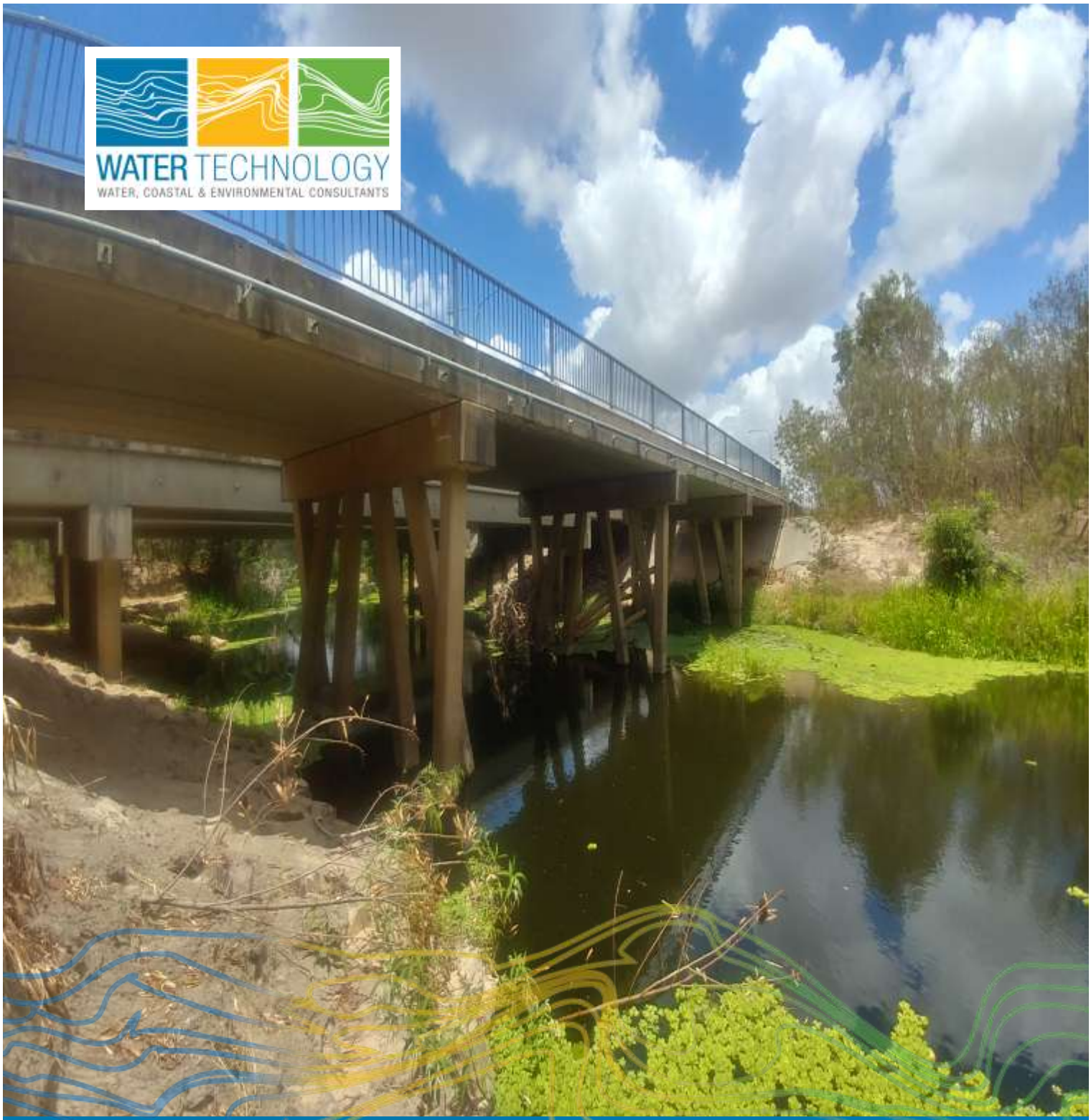


Flood Study Update Addendum

Bohle River Flood Study (Update) 2025

Townsville City Council

18 March 2026

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ACKNOWLEDGEMENT OF COUNTRY

The Board and employees of Water Technology acknowledge and respect the Aboriginal and Torres Strait Islander Peoples as the Traditional Custodians of Country throughout Australia. We specifically acknowledge the Traditional Custodians of the land on which our offices reside and where we undertake our work.

We respect the knowledge, skills and lived experiences of Aboriginal and Torres Strait Islander Peoples, who we continue to learn from and collaborate with. We also extend our respect to all First Nations Peoples, their cultures and to their Elders, past and present.



Artwork by Maurice Goolagong 2023. This piece was commissioned by Water Technology and visualises the important connections we have to water, and the cultural significance of journeys taken by traditional custodians of our land to meeting places, where communities connect with each other around waterways.

The symbolism in the artwork includes:

- *Seven circles representing each of the States and Territories in Australia where we do our work*
- *Blue dots between each circle representing the waterways that connect us*
- *The animals that rely on healthy waterways for their home*
- *Black and white dots representing all the different communities that we visit in our work*
- *Hands that are for the people we help on our journey*

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1 INTRODUCTION

Water Technology (WT) previously delivered the Bohle River Flood Study 2023 (document no. 22020246 R01 V02 Final dated 28/08/2023) which includes the main body of the technical report and documents the methodology and results for the study. Townsville City Council (Council) have requested WT update the model as part of a broader flood risk management project across the Local Government Area (LGA).

This Bohle River Flood Study (Update) 2025 report is considered an addendum to the Bohle River Flood Study 2023 report, and documents the additional modelling undertaken for the catchment, including:

1. Application of revised IFDs.
2. Revision of TUFLOW model boundary.
3. Inclusion of recent development and Stage 5 of the Townsville Ring Road.

The updated version of the Bohle River flood model was simulated for a comparable selection of design events and temporal patterns as per the Bohle River Flood Study (2023) report, as described in Table 1.1.

Table 1.1 Simulated Design Events, Durations, and Temporal Patterns

Design Event	Durations and Temporal Patterns	Temporal Pattern Bin
Current Climate 2020		
50% AEP, 20% AEP, 10% AEP, 5% AEP	30-min TP6, 45-min TP7, 60-min TP6, 90-min TP6, 120-min TP7, 180-min TP2, 360-min TP8, 540-min TP6, 1440-min TP10	Intermediate
2% AEP, 1% AEP, 0.5% AEP, 0.2% AEP, 0.05% AEP	30-min TP6, 45-min TP7, 90-min TP1, 120-min TP4, 180-min TP7, 270-min TP10, 360-min TP4, 1080-min TP1	Rare
PMF	15-min, 30-min, 45-min, 60-min, 90-min, 120-min, 150-min, 180-min, 240-min, 300-min, 360-min, 720-min, 1080-min	GSDM
Future Climate 2090 (RCP 8.5%)		
2% AEP, 1% AEP	30-min TP6, 45-min TP7, 90-min TP1, 120-min TP4, 180-min TP7, 270-min TP10, 360-min TP4, 1080-min TP1	Rare

Figure 1.1 shows an overview of the hydraulic model boundary including updates incorporated into this study.

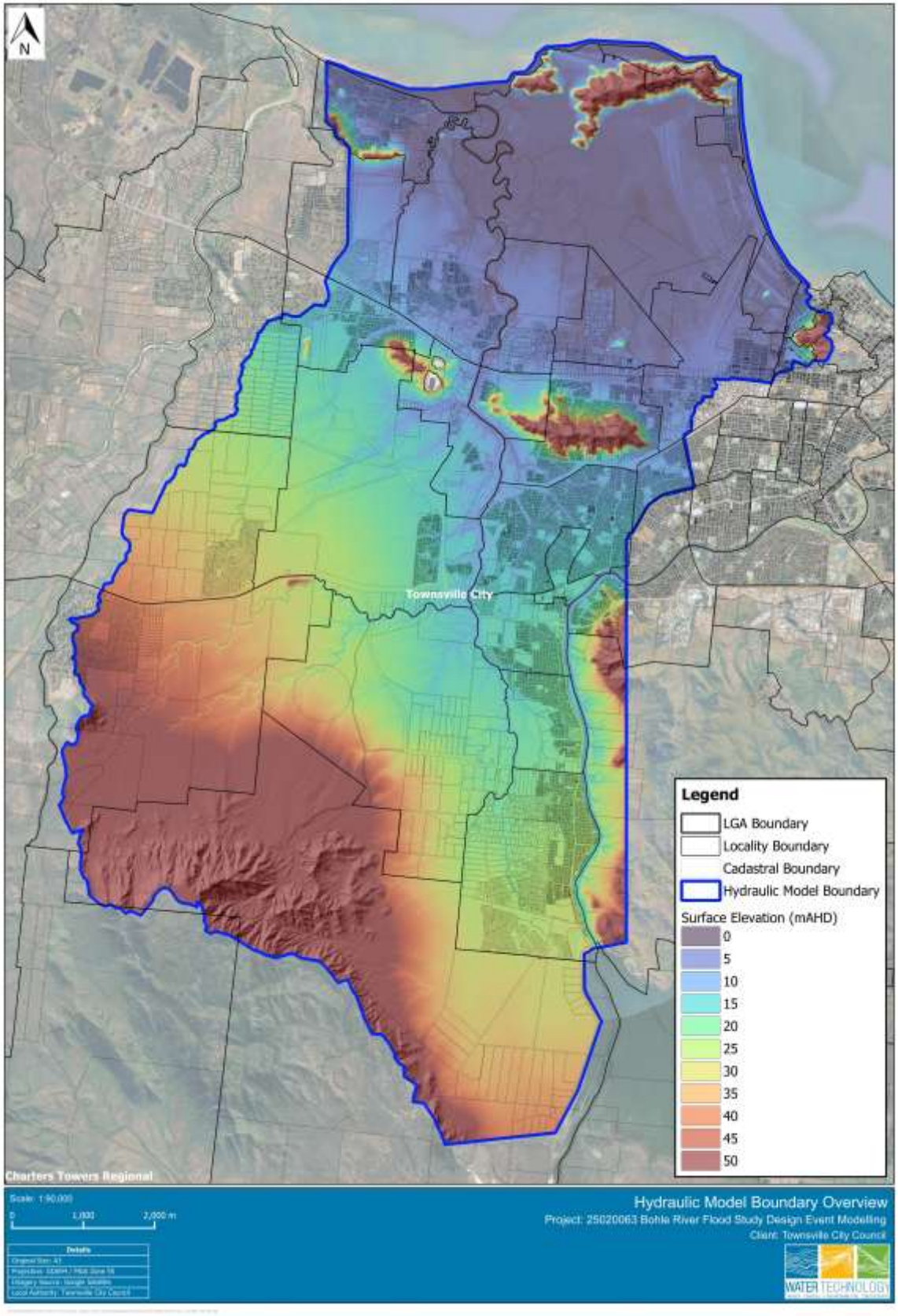


Figure 1.1 Hydraulic Model Boundary Overview

2 HYDROLOGIC AND HYDRAULIC MODEL UPDATES

The following updates were requested by Council as part of this Bohle River Flood Study (Update) 2025 report:

1. Application of revised IFDs.
2. Revision of TUFLOW model boundary.
3. Inclusion of recent development and Stage 5 of the Townsville Ring Road.

The following sections provide more detail on the model updates.

2.1 Application of Revised IFDs

As part of the updated flood study, a supplementary report was considered, which assessed the suitability of existing Intensity-Frequency-Duration (IFD) estimates for the Bohle catchment. The supplementary report, prepared by Don Carrol (2022, attached as an appendix to the former 2023 study) examined pluviograph and ALERT station data provided by Townsville City Council, extending rainfall intensity statistics beyond the 2012 cut-off of the Bureau of Meteorology (BoM) ARR 2016 analysis.

This supplementary work was prompted by inconsistencies between design flood levels estimated using BoM ARR 2016 IFDs and direct flood frequency analyses, which indicated systematically higher flood levels than those simulated in the hydraulic model. Previous investigations (Water Technology, 2023) found that design rainfall intensities needed to be increased by 15-20% to reconcile with historical flood frequency results. The supplementary analysis, drawing on rainfall records up to November 2022, confirmed that significant increases in rainfall intensities (20-40% for durations from 6 to 120 hours) may be required to align design rainfall with observed flood behaviour.

While these findings highlight the limitations of existing IFD estimates for Townsville, they are subject to large error bounds due to the relatively short length of records and the influence of extreme events such as the 1998 and 2019 floods. The supplementary report therefore recommended interim use of scaling factors to adjust rainfall inputs until such time that a BoM-led update of IFDs is undertaken using state-of-the-art methods.

The supplementary analysis has been used to justify interim adjustment (factoring) of design rainfall intensities. These factors bridge the gap between ARR 2016 baseline estimates and observed flood frequency behaviour. Derived design flood surfaces have been enveloped with historical events (1998 and 2019) under ultimate development conditions to ensure that projected design levels exceed known historical flood levels.

This approach recognises the limitations of short-term and non-WMO compliant datasets but provides a defensible interim solution until a comprehensive BoM-led IFD update can be undertaken for the Townsville region.

These factors were originally adopted as part of the direct rainfall modelling for the Bohle River catchment, as document in the previous report (Water Technology, 2023 – reference 22020246_R01_V02) which modelled the revised IFDs for the 1% AEP design event. This flood study update considers the factored IFDs across all assessed design flood events.

2.2 Revision of TUFLOW Model Boundary

The recent update to the Bohle River flood model provided an opportunity to refine the hydraulic model boundary to address identified limitations and improve both accuracy and computational efficiency. These revisions were guided by a combination of industry best practice, alignment with adjacent models, and observed inefficiencies within the existing model setup. Collectively, the changes strengthen the defensibility of the updated flood model and provide greater confidence in the results.

The revisions to the model boundary included the following:

- Western boundary realignment - The western model boundary was adjusted to remove isolated instances of glass-walling that had been observed in the previous configuration. Glass-walling can produce unrealistic localised flood behaviour, introducing artificial constraints that reduce the accuracy of results. In addition, the boundary was realigned to coincide with the Rupertswood hydraulic model boundary. This ensures consistency between neighbouring models, reducing potential discontinuities in predicted flood behaviour at the interface and enabling a more coherent floodplain assessment across the broader catchment.

  Due to the reduced overall catchment area, and the introduced outflow boundary to allow overflow from the Bohle River catchment into the adjacent catchment, there is less discharge into the creeks which flow along the western-most boundary of the updated model. That is, it is acknowledged that this adjustment will reduce flow and levels (among other hydraulic attributes) in this area.

  The previous and updated model western boundary is shown in Figure 2.1, with the resultant flood depth results compared in Figure 2.2.

- Internal boundary realignment around mine pits in the Shaw locality - The internal model boundary surrounding the Shaw mine pits was realigned to better reflect the physical topography of the embankments. In the previous model, the boundary was placed marginally inside the crest of the mine pit embankment. This configuration allowed rainfall to accumulate in the narrow space between the boundary and the embankment, creating deep, stagnant water bodies with no outflow pathways. Such artefacts are not hydraulically realistic, and the resulting slow-draining water masses were found to increase computational demands, leading to inefficiencies in model runtime. By revising the boundary to match the embankment crest, the updated model more accurately represents site conditions, prevents the accumulation of artificial ponding, and ensures improved model stability and performance.

  The previous and updated model boundary around the mine pits in the Shaw locality is shown in Figure 2.3, with the resultant flood depth results compared in Figure 2.4.

These refinements address both technical and practical considerations: they reduce sources of error, improve consistency across adjoining studies, and removed behaviour that previously undermined efficiency. In turn, this contributes to a more robust and transparent basis for modelling of the Bohle River catchment.

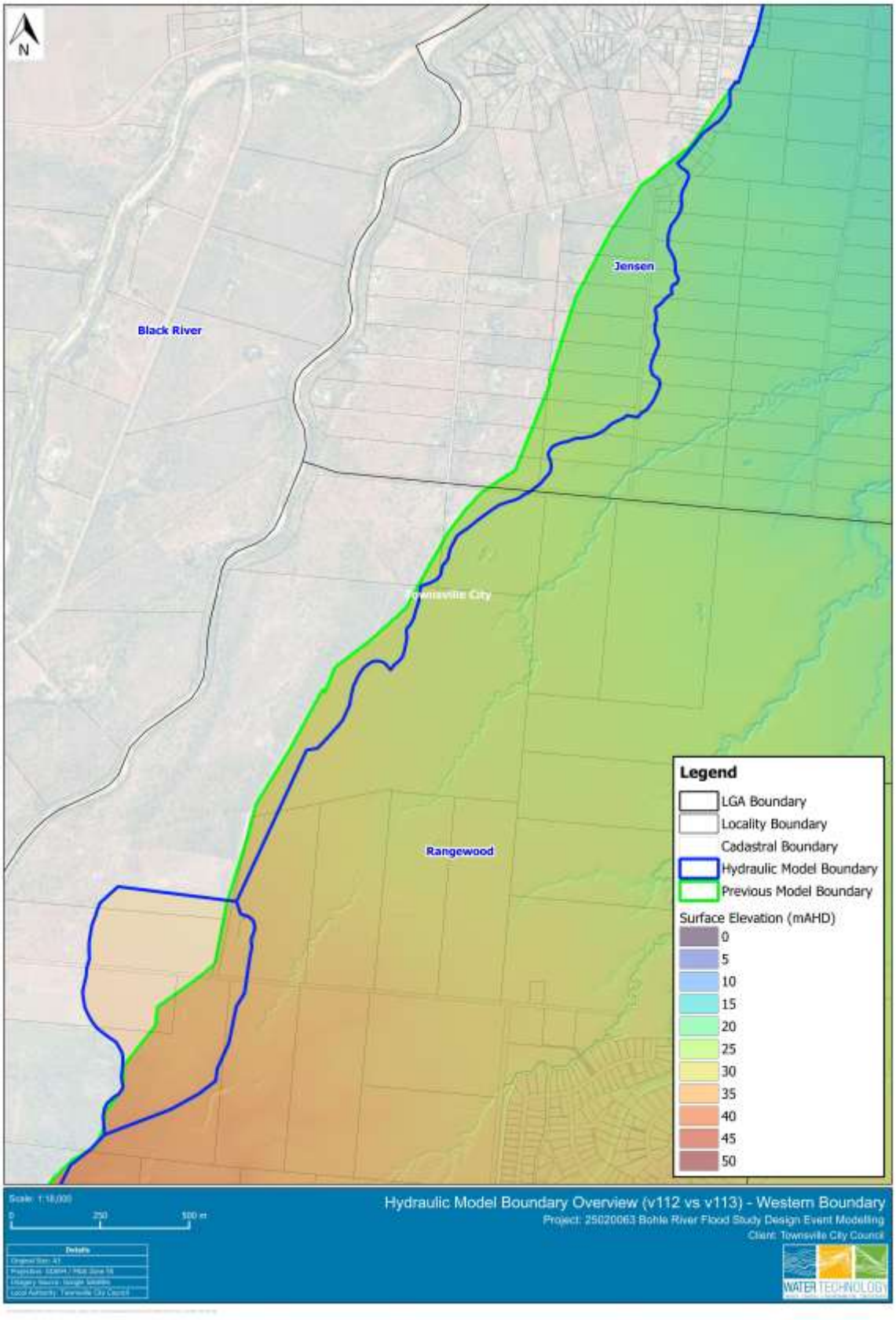


Figure 2.1 Hydraulic Model Boundary Overview (v112 vs v113) - West Boundary

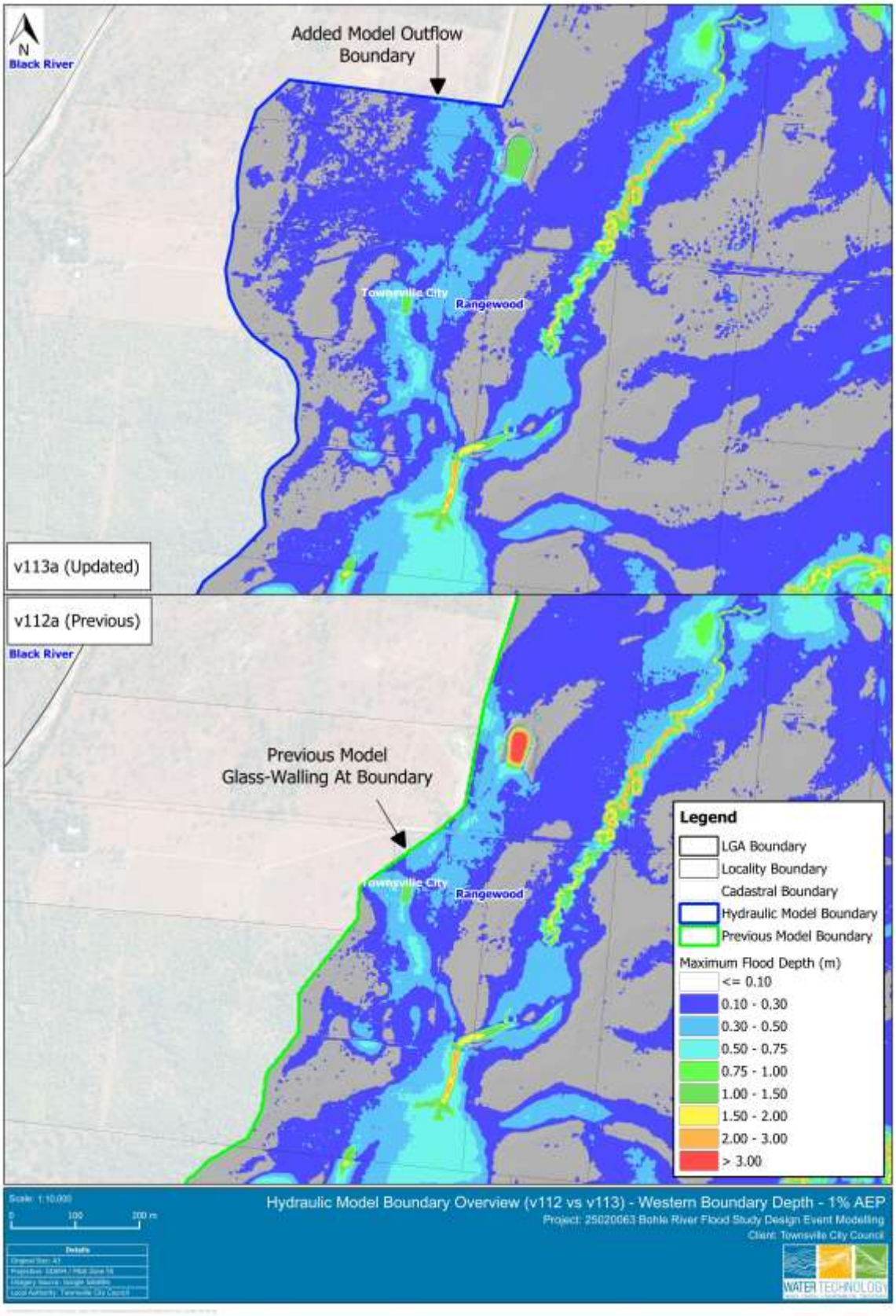


Figure 2.2 Hydraulic Model Boundary Overview (v112 vs v113) – West Boundary Depth – 1% AEP

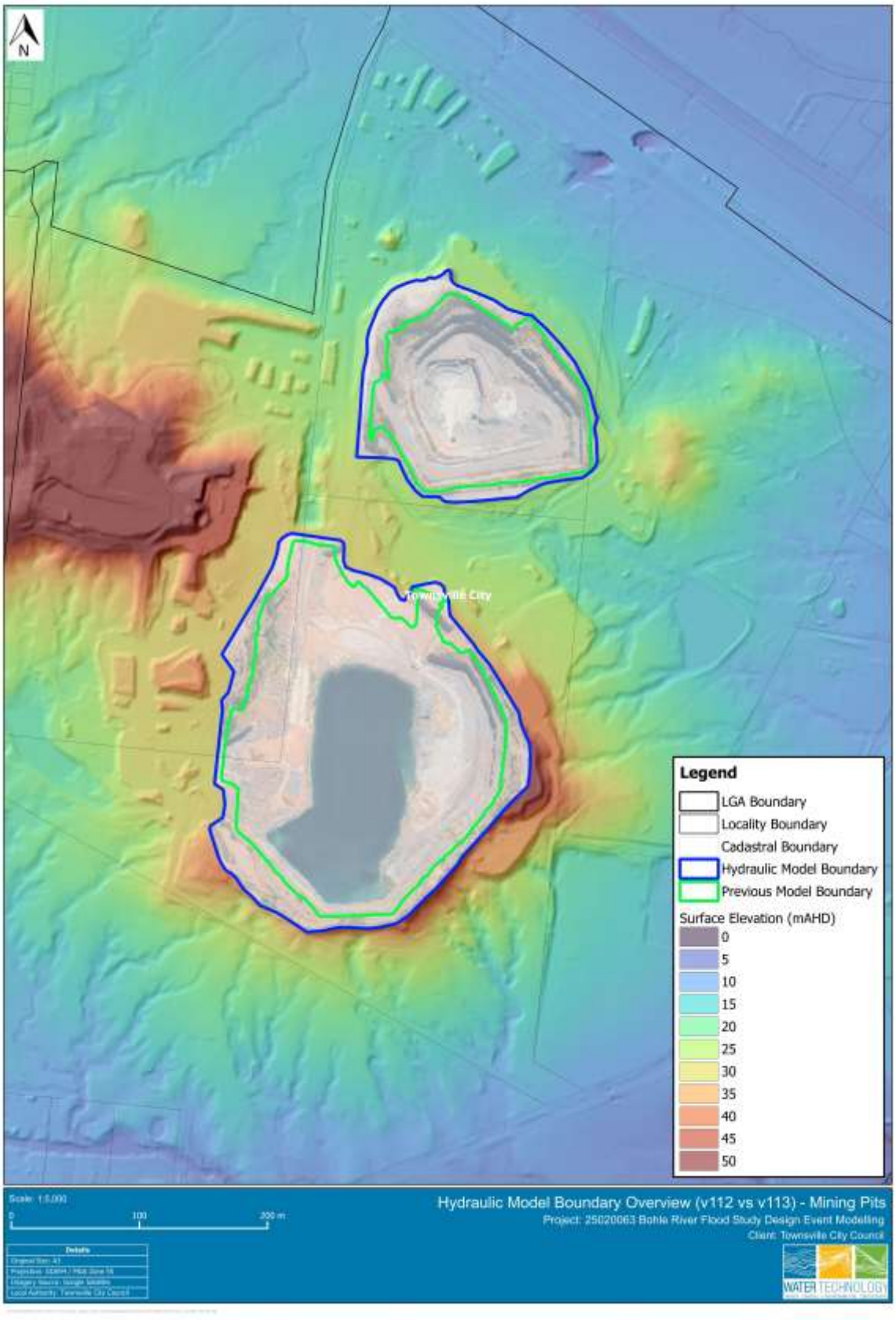


Figure 2.3 Hydraulic Model Boundary Overview (v112 vs v113) – Mining Pits

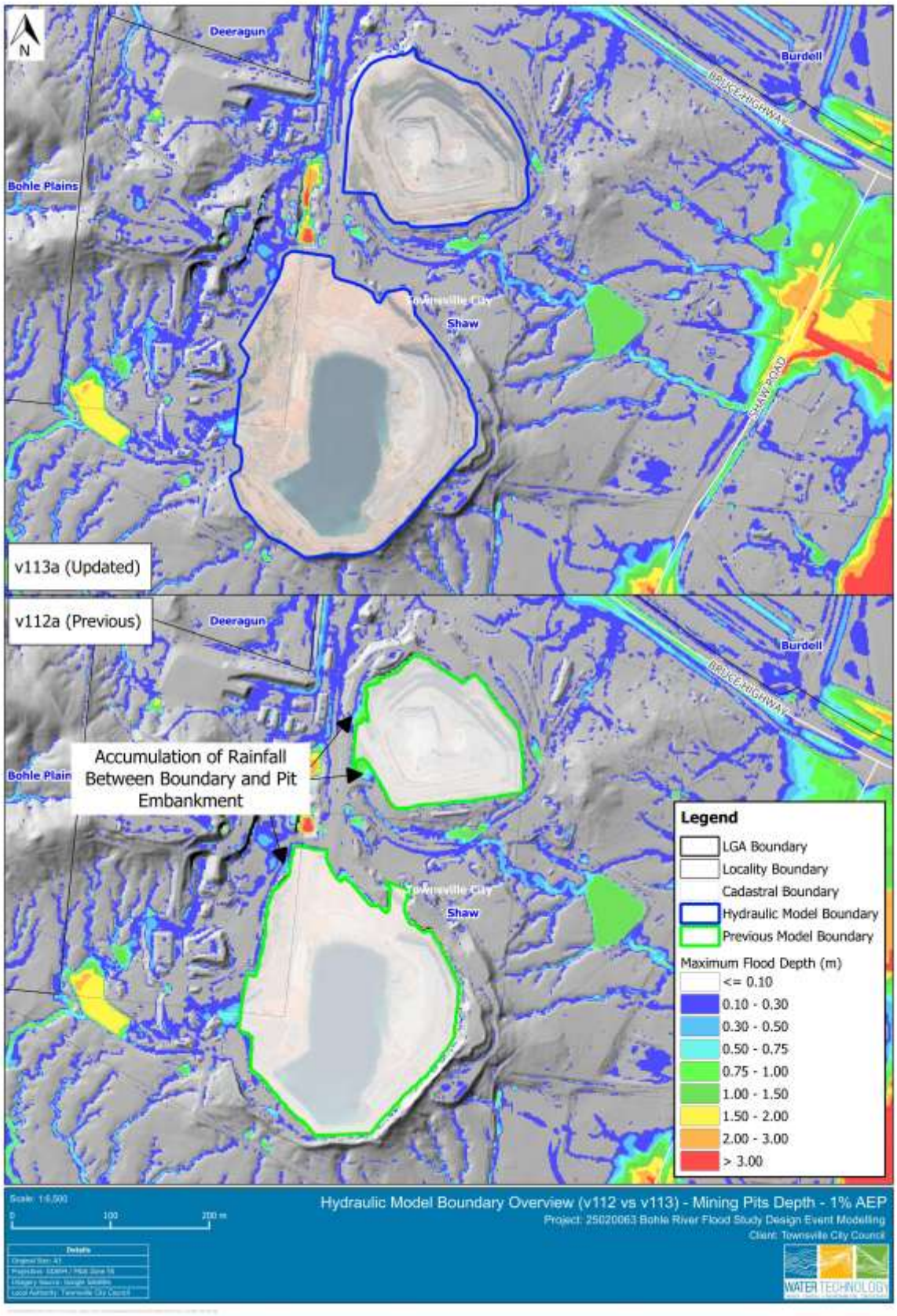


Figure 2.4 Hydraulic Model Boundary Overview (v112 vs v113) – Mining Pits Depth– 1% AEP

2.3 Sample Flow Comparison in Stony Creek

As previously discussed, the reduced overall catchment area and added outflow boundary to allow overflow from Stony Creek and Saunders Creek (part of the overall Bohle River catchment and as illustrated in Figure 2.1) to discharge into the adjacent catchment, there is less discharge downstream. As an example, flow hydrographs comparisons for the 1% AEP 360-minute TP04 design flood event at sample locations are shown below.

- Stony Creek at Old Georgetown Road - Figure 2.5
- Stony Creek at Ring Road Bridge - Figure 2.6

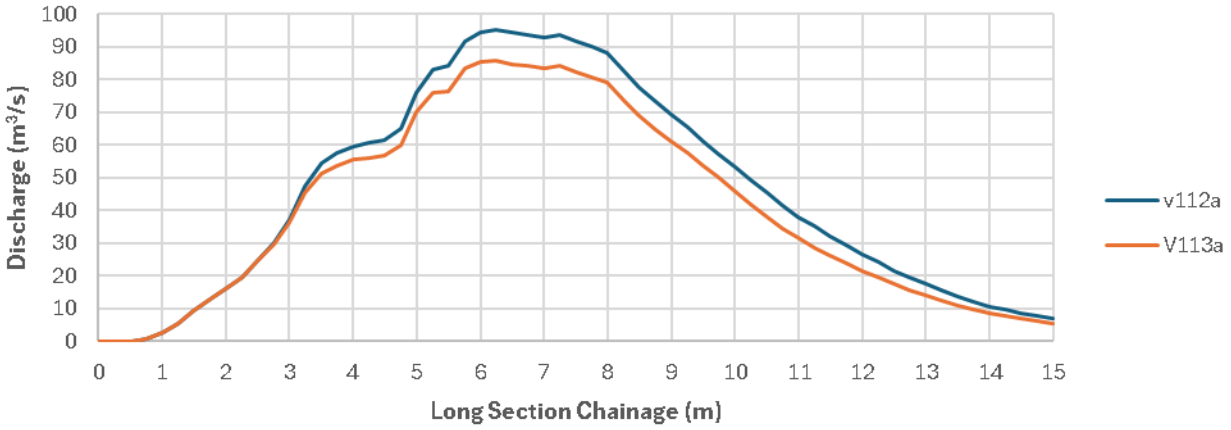


Figure 2.5 1% AEP 360-Minute TP04 Hydrograph Comparison – Stony Creek at Old Georgetown Road

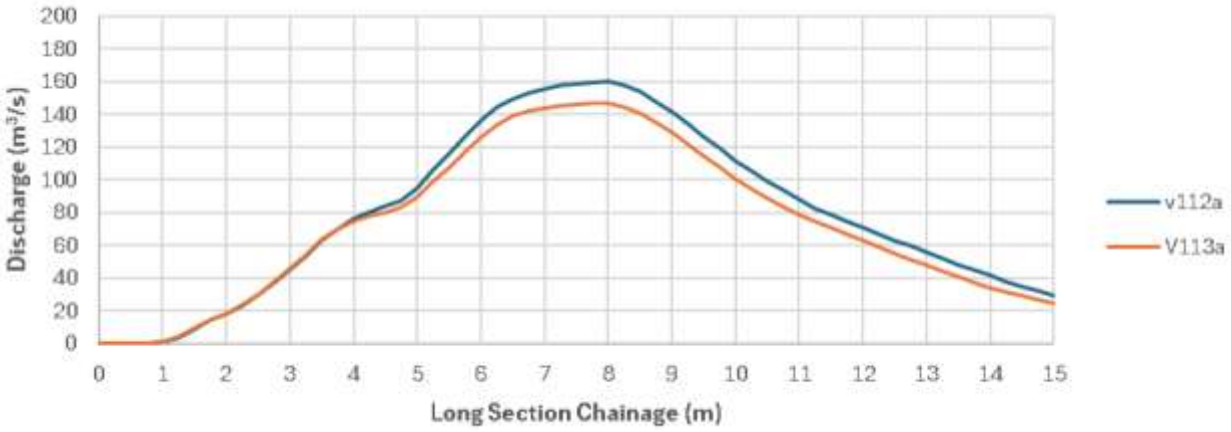


Figure 2.6 1% AEP 360-Minute TP04 Hydrograph Comparison – Stony Creek at Ring ROoad

2.4 Inclusion of Additional Development Designs

Townsville City Council has supplied Water Technology with numerous designs of the recent developments throughout the Bohle River catchment area. These designs are listed below. The coverage of these designs is illustrated in Figure 2.7.

- E1.dem
- X_B00393_tinAS_CON_SURFACE_super_faces_TIN_v2.dem
- Somers_Hervey_SuperTin.dem
- NORTH_SHORE_MGA2020_TIN_Plus_7p6m.asc
- 1059916-ACM-2000-SM-CSRF-TERRAIN.dem
- 1059916-ACM-1000-SM-CSRF-TERRAIN.dem
- TIN_DESIGN_SUBGRADE_1000_ALL.dem
- TIN_DESIGN_1000_ALL.dem
- TIN_DESIGN_430_EXCAVATION_1000_ALL.dem
- TIN_DESIGN_LAYER_1_1000_ALL.dem
- TIN_DESIGN_LAYER_2_1000_ALL.dem
- TABLE_DRAINS_AND_IO.dem
- Webb_Drive_Development\42716_020A_DTM_TRIANGLES_TIN.dem
- Webb_Drive_Development\AUSCO_NEW_LEVELS_JAN_20250_TIN.dem
- Webb_Drive_Development\Bunnings2_August_2023TIN_Existing_Bunnings_2_TIN.dem
- Webb_Drive_Development\Bunnings1_May_2023Bunnings_Existing_Tin_TIN.dem
- Webb_Drive_Development\CEVA_3D_Sep_20188053_CEVA_240918SURVEY_DTM_TIN.dem
- Webb_Drive_Development\SPLIT_SET_August_2023tin_UpdatedTin_030824_TIN.dem
- Webb_Drive_Development\Stage_4A_AsconstructedAdjustedStage_4A_As_ConstructedSURVEY_DTM_TIN.dem
- Webb_Drive_Development\Stage_4B_AsconstructedStage_4B_AsconSURVEY_DTM_TIN.dem
- Webb_Drive_Development\Triangle_blockTIN_Natural_Surface_TIN.dem
- Webb_Drive_Development\Vulcan1_August_2023TIN_Existing_Vulcan_TIN.dem
- Webb_Drive_Development\Webb_18_May_2024tin_Webb18_Existing_TIN_170624_TIN.dem
- Webb_Drive_Development\Webb_34_May_2023tin_Webb_34_Existing_TIN.dem
- Webb_Drive_Development\Webb_37_Nov_23tin_GDA94_Webb_37_Existing_Tin_TIN.dem
- Webb_Drive_Development\Webb_38_April_2024tin_Webb38_Existing_TIN_TIN.dem
- COSGROVE_STAGES_301-304_AND_COSGROVE_DRIVE_MGA94_TINa.dem
- GREATER_ASCOT_PRECINCT_8_MGA94_TIN.dem
- GREATER_ASCOT_STAGE_304_MGA94_TIN.dem
- HARRIS_CROSSING_MGA94_TIN.dem
- RIVERSTONE_STAGES_1_AND_2_MGA94_TIN.dem

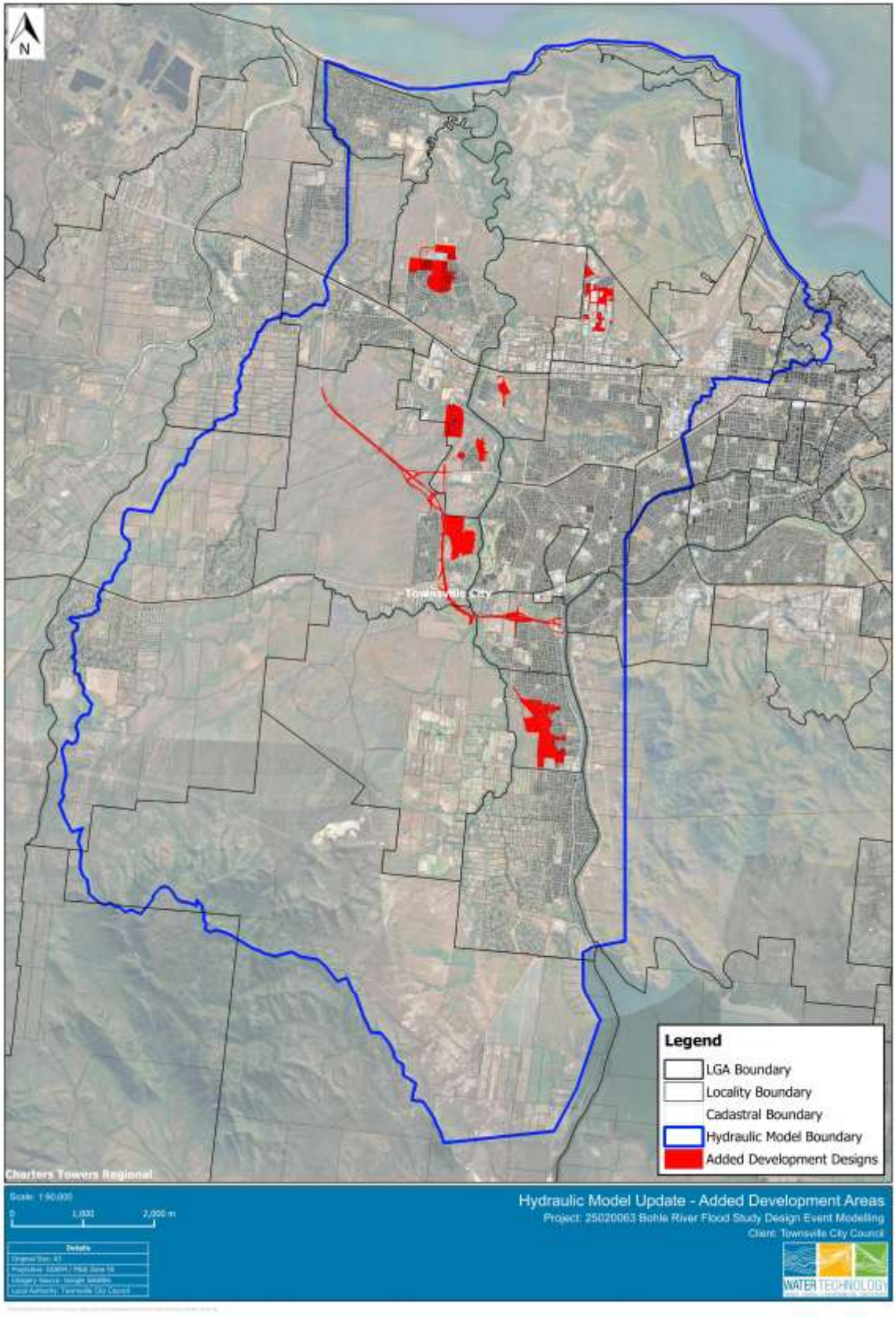


Figure 2.7 Hydraulic Model Update - Added Development Areas

2.5 Selected Examples of Model DEM and Output Comparison

A series of comparisons were undertaken between the updated hydraulic model digital elevation model and the resultant model outputs for key localities within the Bohle catchment. These comparisons are intended to demonstrate how the inclusion of recent landform and development changes within the DEM influence flood behaviour. The following figures present selected examples:

- DEM Comparison (Bohle Plains) Figure 2.8
- 1% AEP Depth Comparison (Bohle Plains) Figure 2.9
- DEM Comparison (Burdell) Figure 2.10
- 1% AEP Depth Comparison (Burdell) Figure 2.11
- DEM Comparison (Cosgrove) Figure 2.12
- 1% AEP Depth Comparison (Cosgrove) Figure 2.13
- DEM Comparison (Shaw) Figure 2.14
- 1% AEP Depth Comparison (Shaw) Figure 2.15

In several cases, these changes fundamentally shift flood behaviour, with observable differences in flood depths and flow distribution through and around developed areas.

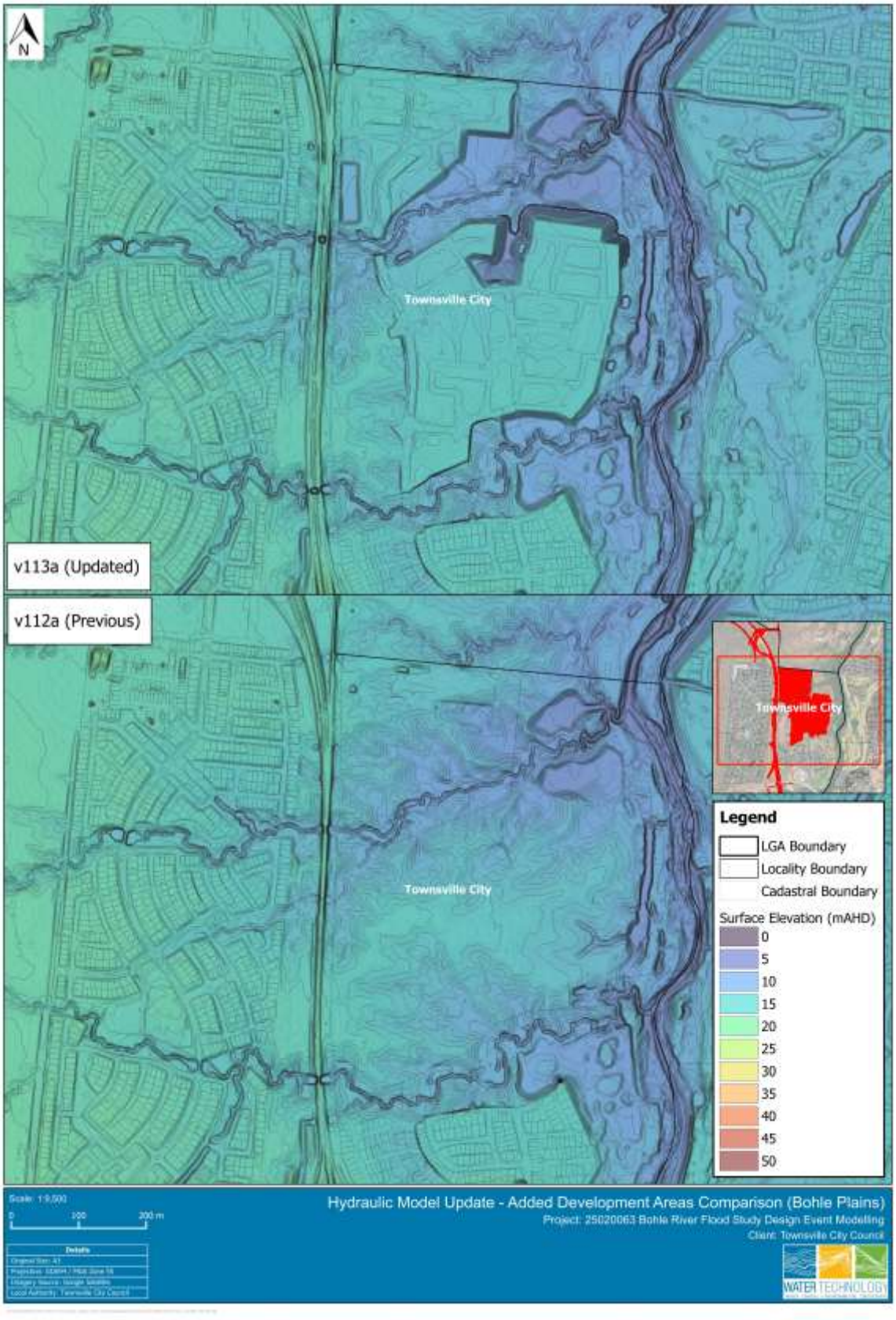


Figure 2.8 Added Development Areas Comparison (Bohle Plains)

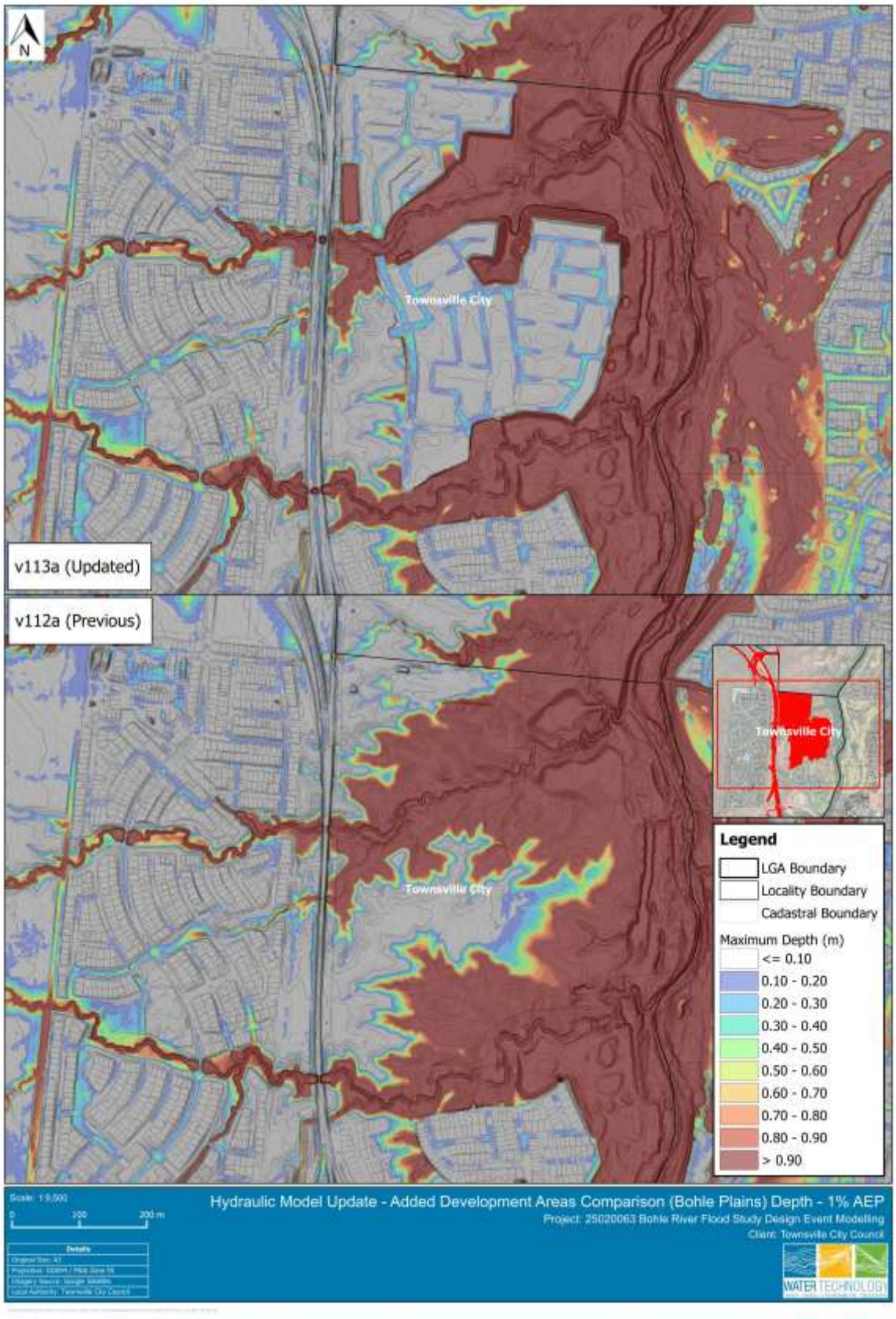


Figure 2.9 Added Development Areas Comparison (Bohle Plains) – Depth 1% AEP

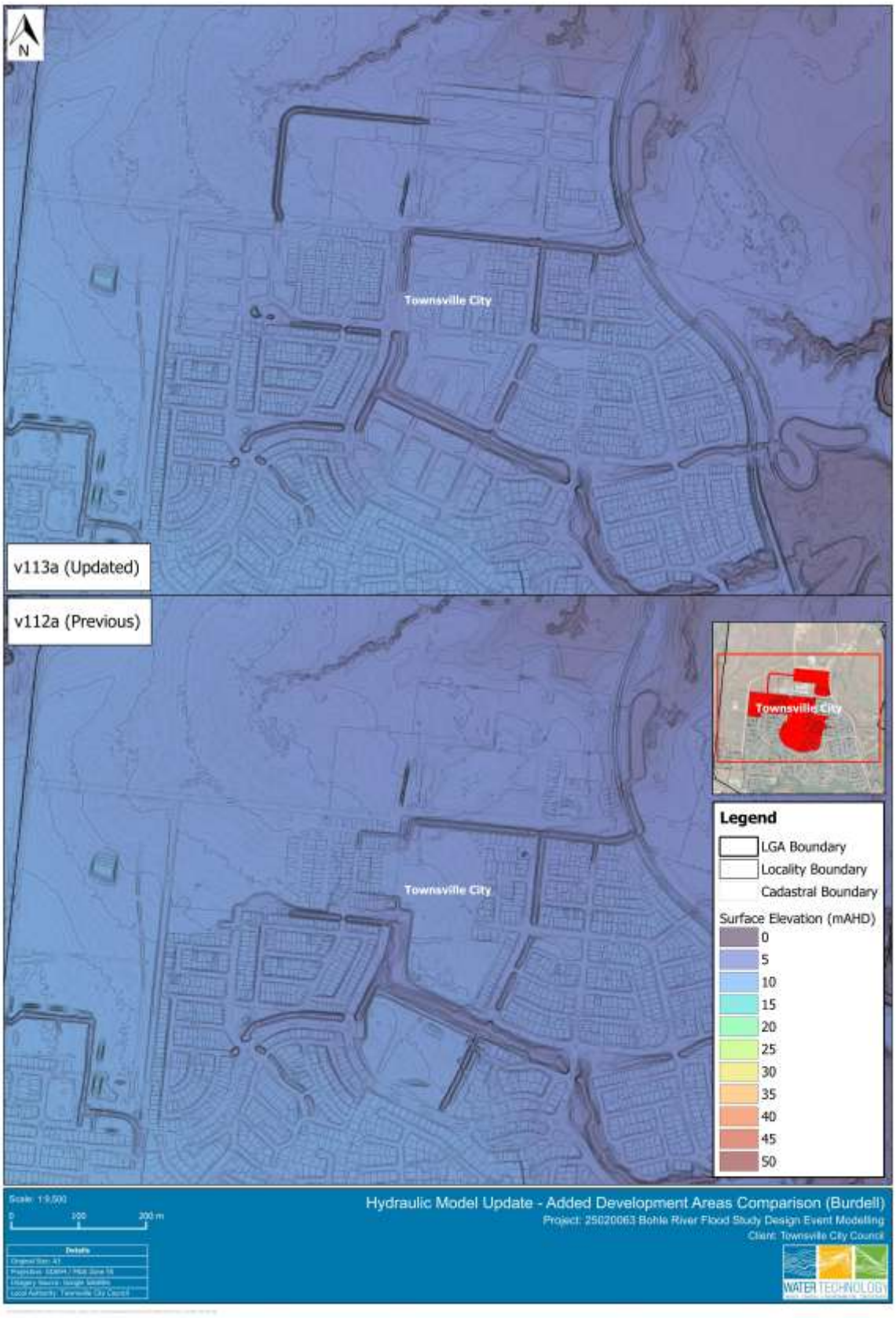


Figure 2.10 Added Development Areas Comparison (Burdell)

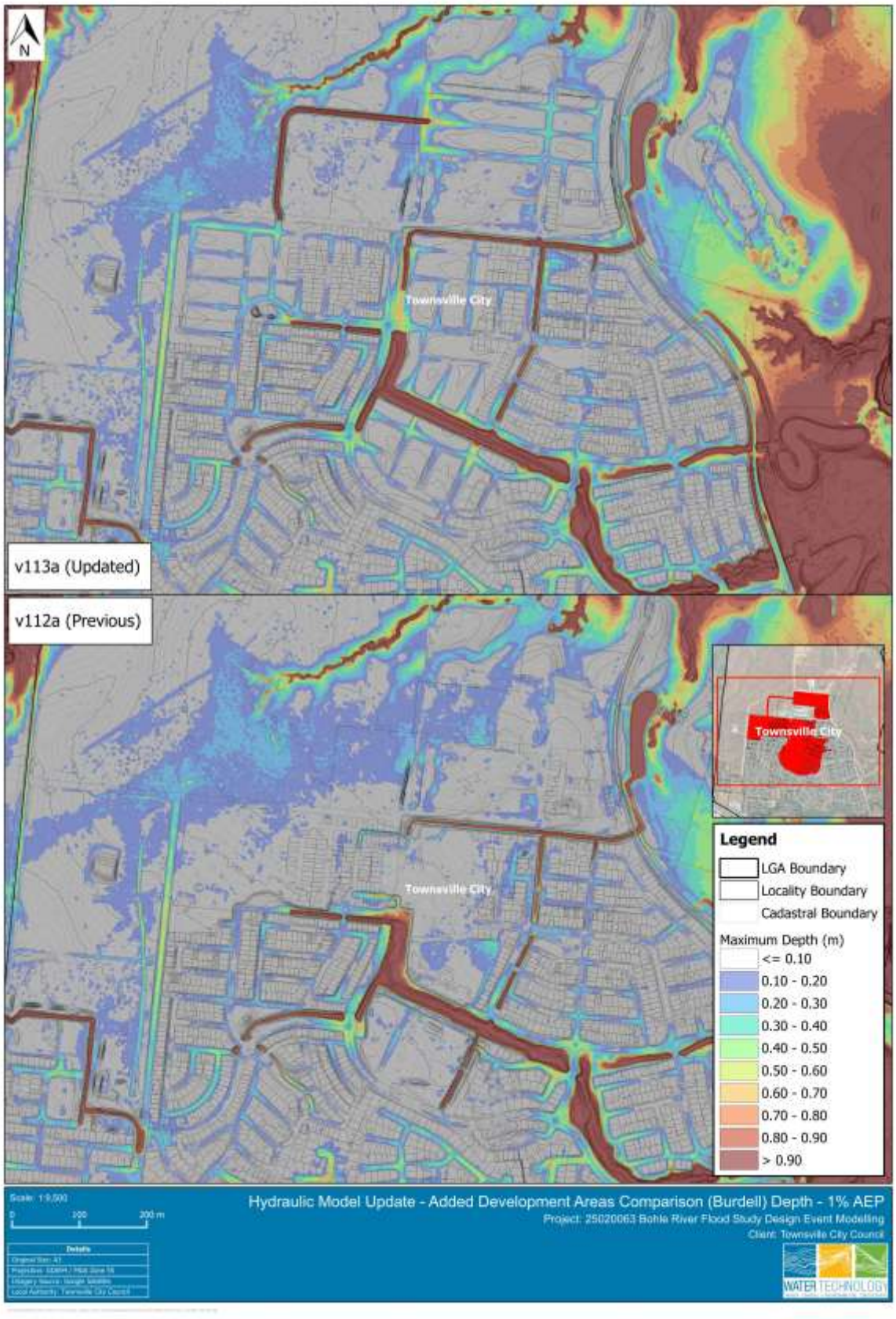


Figure 2.11 Added Development Areas Comparison (Burdell) – Depth 1% AEP

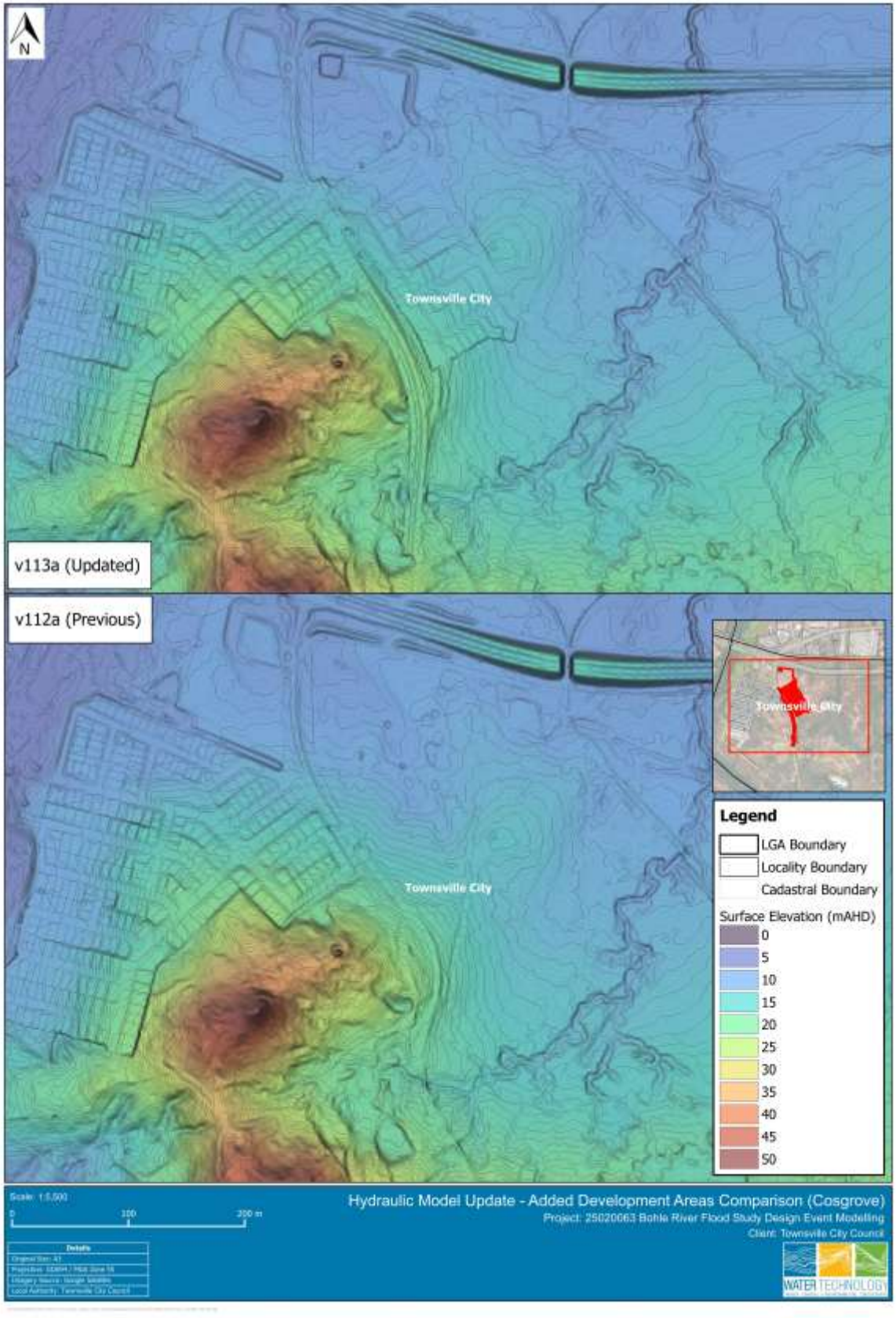


Figure 2.12 Added Development Areas Comparison (Cosgrove)

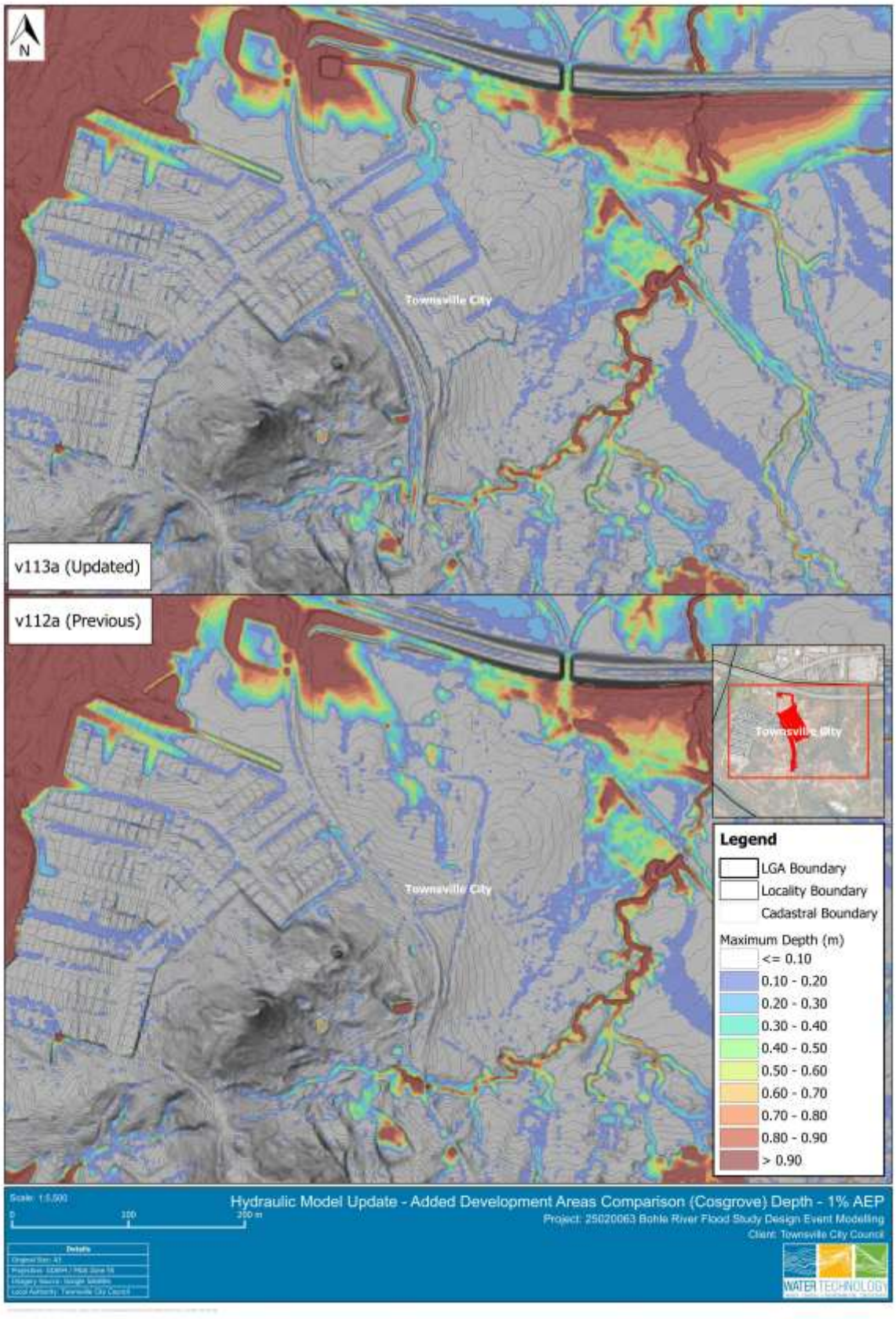


Figure 2.13 Added Development Areas Comparison (Cosgrove) – Depth 1% AEP

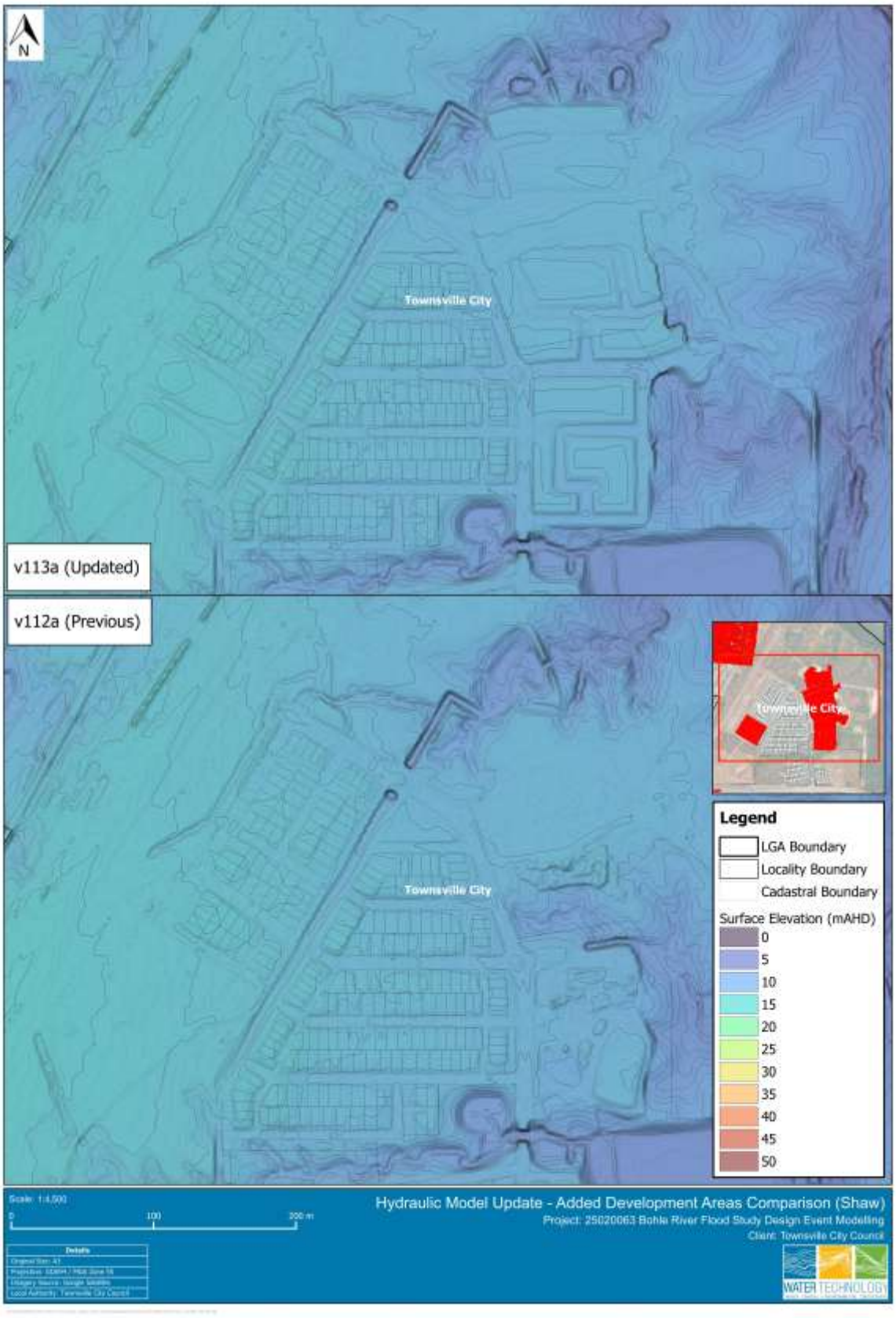


Figure 2.14 Added Development Areas Comparison (Shaw)

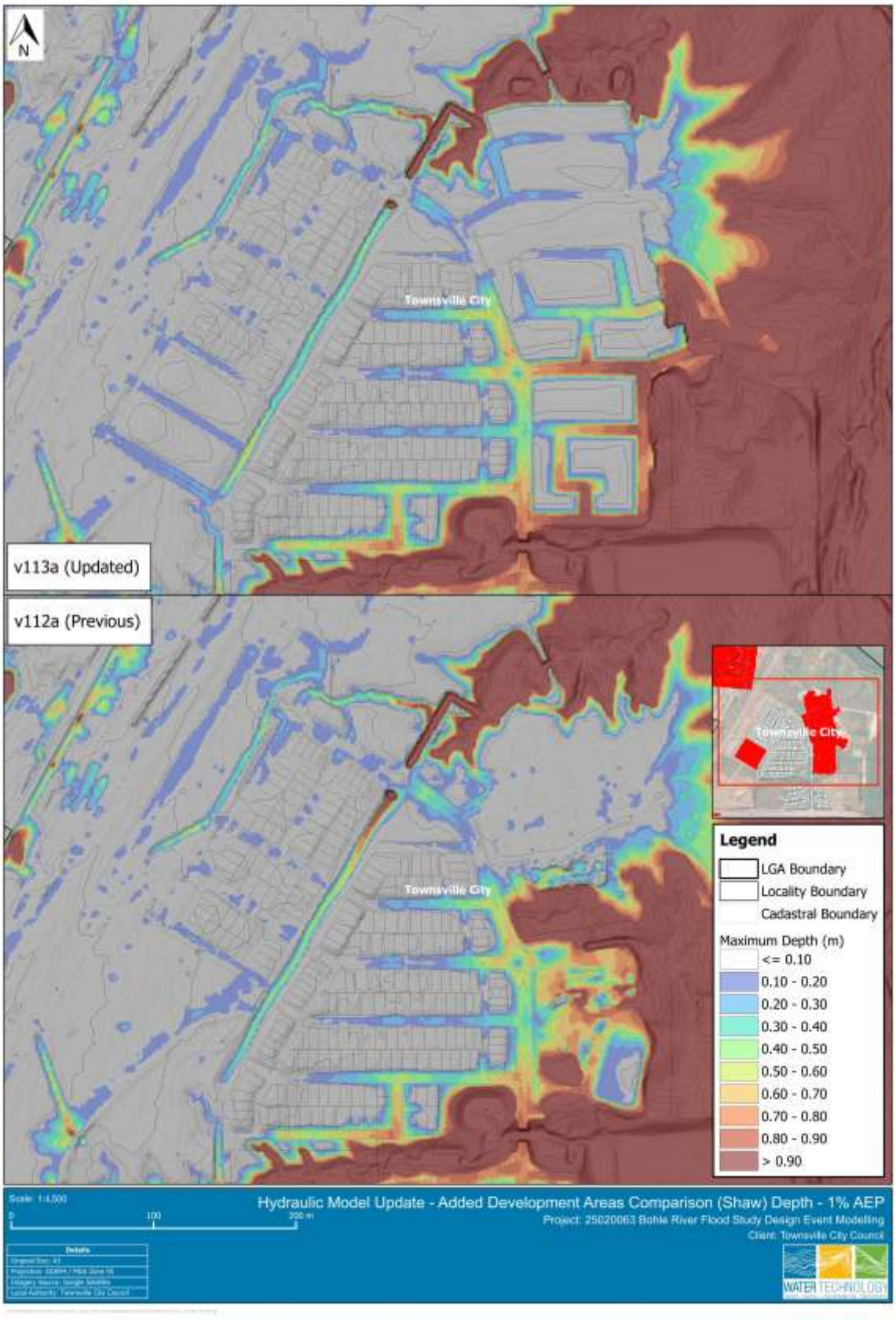


Figure 2.15 Added Development Areas Comparison (Shaw) – Depth 1% AEP

3 UPDATED MODEL RESULTS

A summary of the updated model results including a comparison to the previous flood study results is provided below.

3.1 Peak Water Surface Level Differences

Figure 3.1 shows the difference between the previous model (112) and the updated model (113) 1% AEP maximum flood level. The results show the updated model is generally consistent with the previous model with minimal differences across the modelled area.

Figure 3.2 shows the location of four longitudinal sections which have been plotted to show more detailed differences in the flood model results for the 1% AEP maximum flood level through the main linear infrastructure bisecting the various main waterways through the model. The water levels showing on top of embankments from the direct rainfall have been removed for the purpose of the long section plot.

Figure 3.3 shows the water surface profile for Section A which follows the centreline of Saunders Creek, a tributary of the Bohle River, through the Townsville Ring Road crossing. The results show a negligible changes in flood level (no more than 0.025m difference).

Figure 3.4 shows the water surface profile for Section B which follows the centreline of an unnamed tributary of the Bohle River, through the Townsville Ring Road crossing. The results similarly show negligible changes upstream of the Ring Road.

Figure 3.5 shows the water surface profile for Section C which follows the centreline of an unnamed tributary of the Bohle River, through the Kalynda Parade and Townsville Ring Road crossings as well as Shaw road at the downstream end. Similarly, the results show negligible change in flood level upstream of the Kalynda Parade and the Ring Road.

Figure 3.6 shows the water surface profile for Section D which follows the centreline of an unnamed tributary of the Bohle River, through the Townsville Ring Road crossing. The results show negligible changes in flood upstream of the Ring Road. Immediately downstream of the crossing there are minor increases occurring where the floodplain is constricted by the proposed development, which neutralises once the flow converges with the main river further downstream.

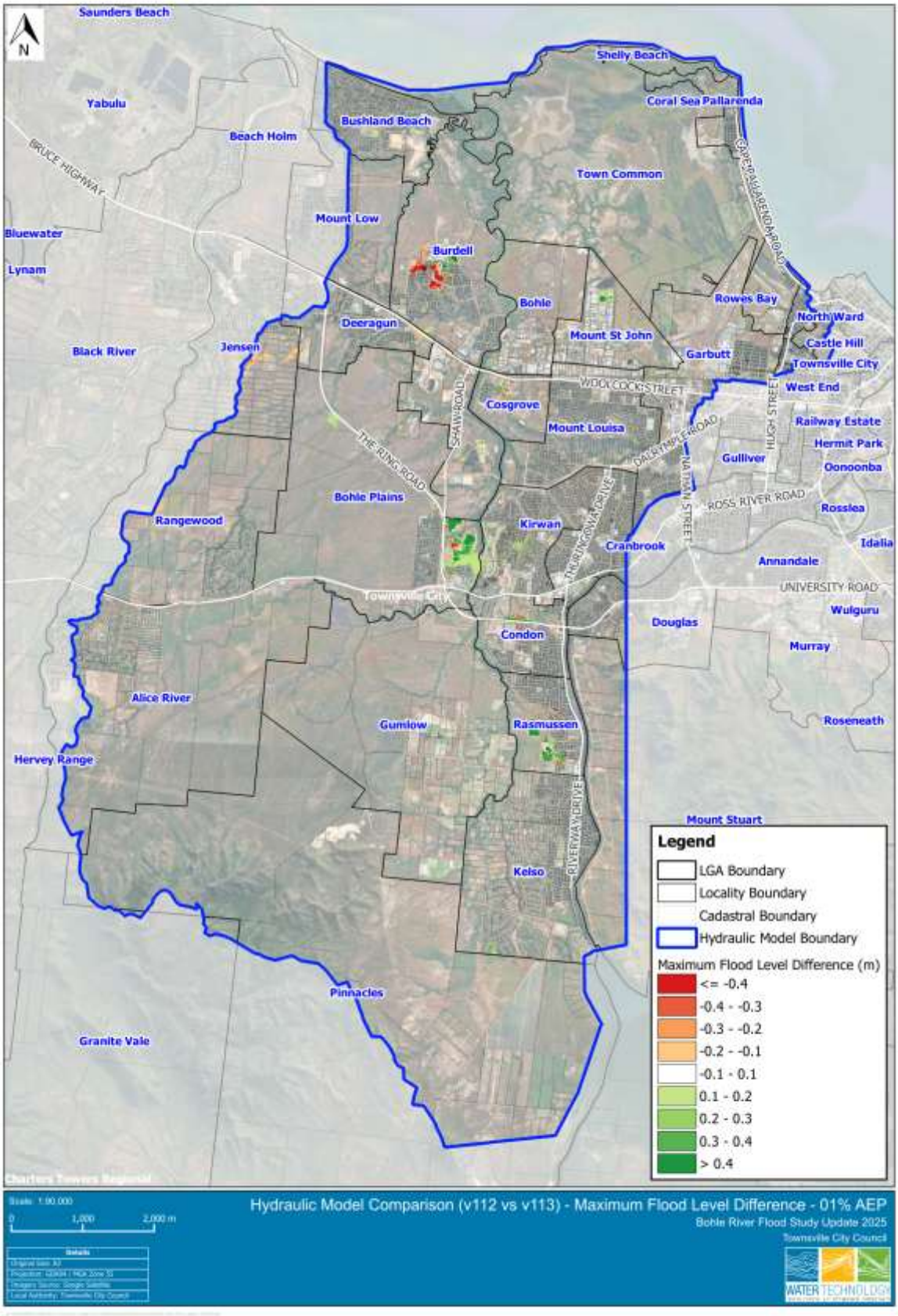


Figure 3.1 Model Comparison (v112a vs v113a) – Maximum Flood Level Difference – 1% AEP

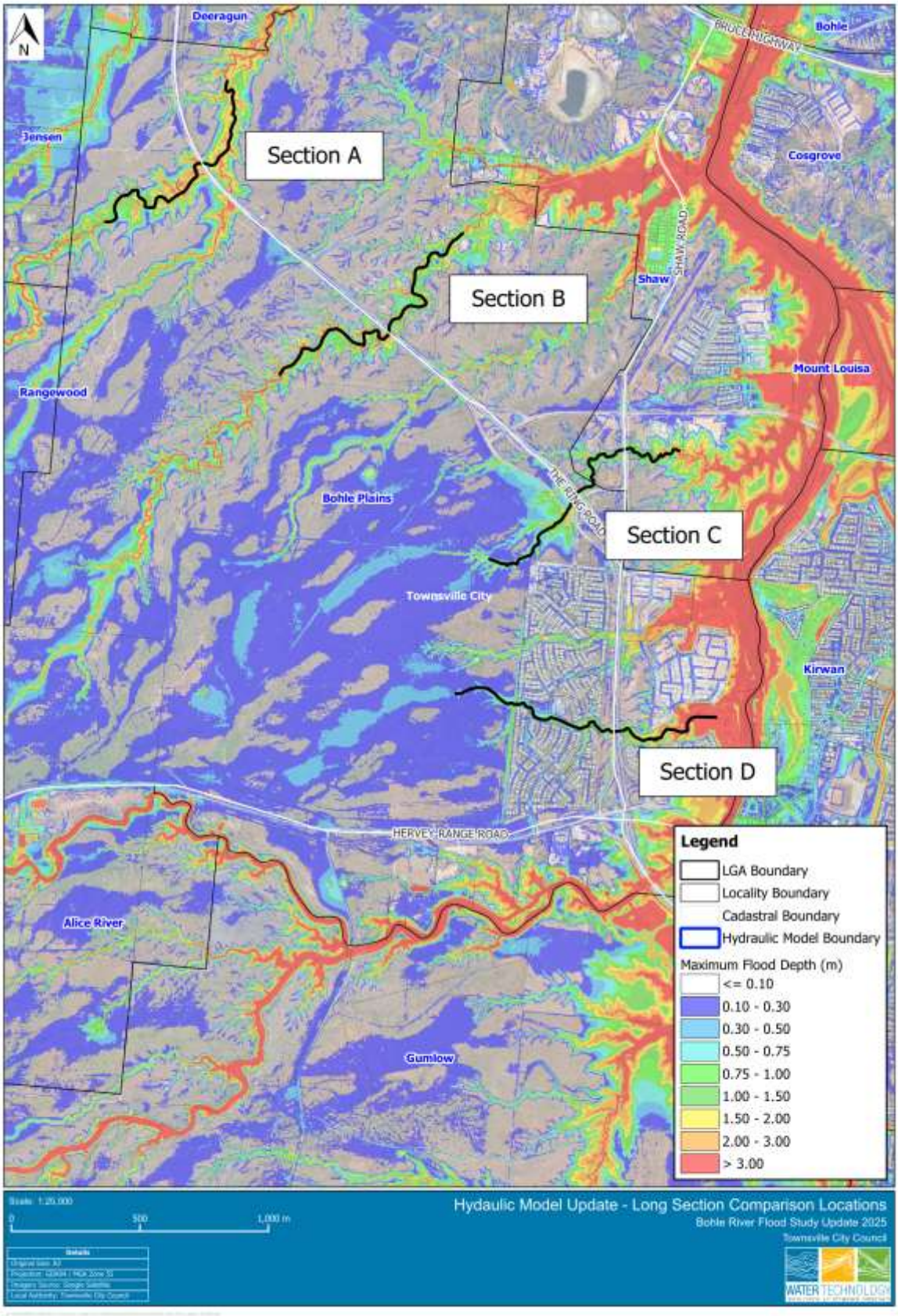


Figure 3.2 Model Comparison (v112a vs v113a) – Long Section Comparison Locations

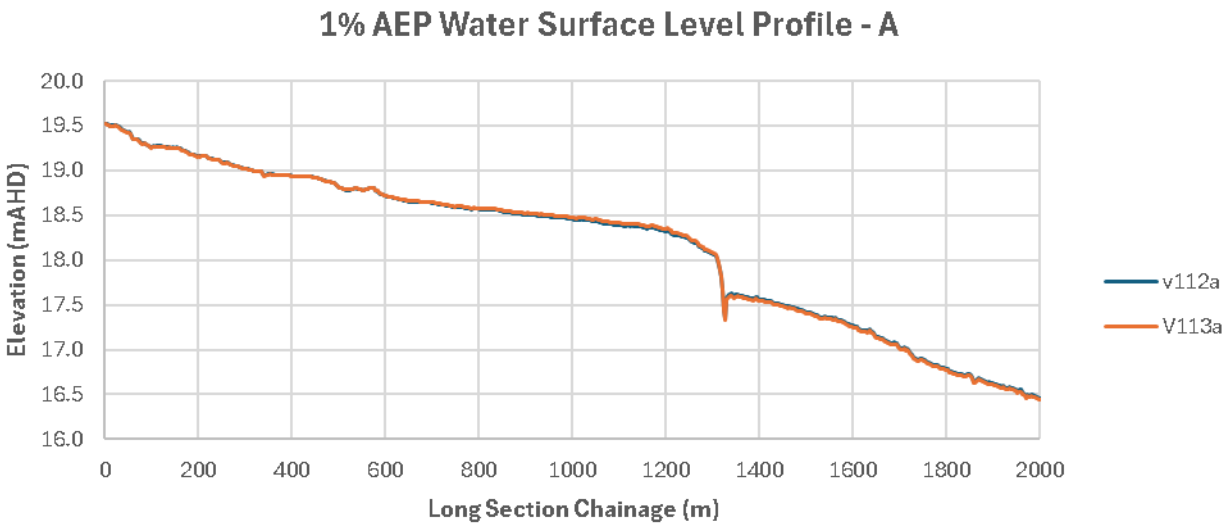


Figure 3.3 Selected 1% AEP Water Surface Level Profile Comparison – Section A

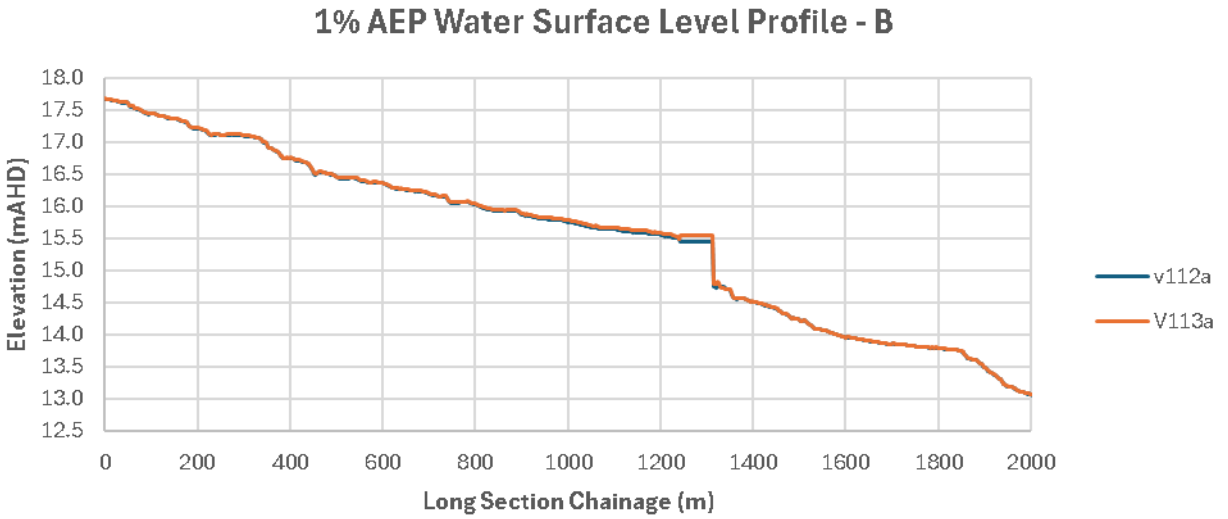


Figure 3.4 Selected 1% AEP Water Surface Level Profile Comparison – Section B

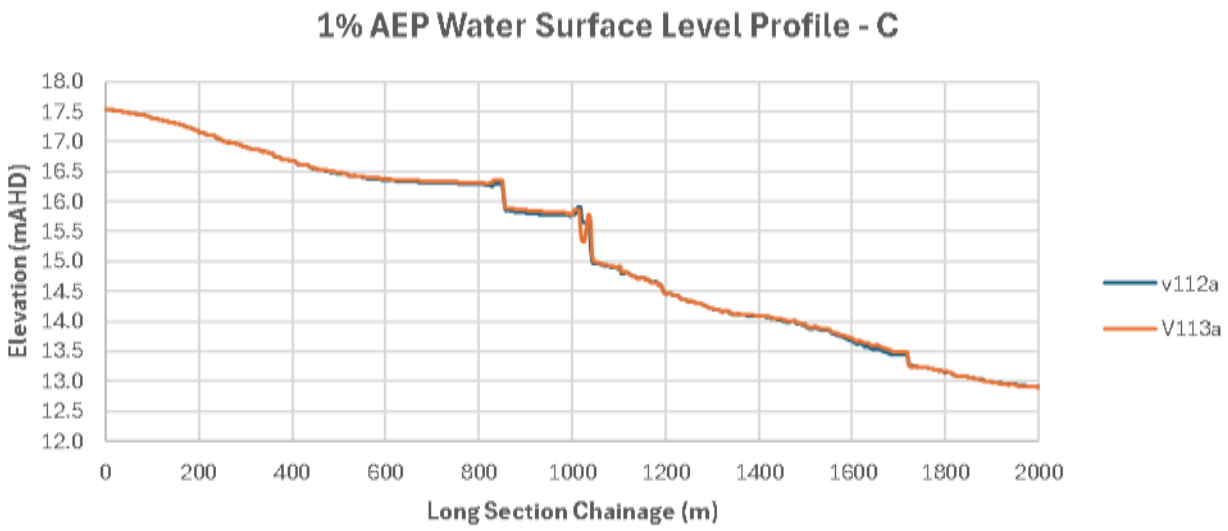


Figure 3.5 Selected 1% AEP Water Surface Level Profile Comparison – Section C

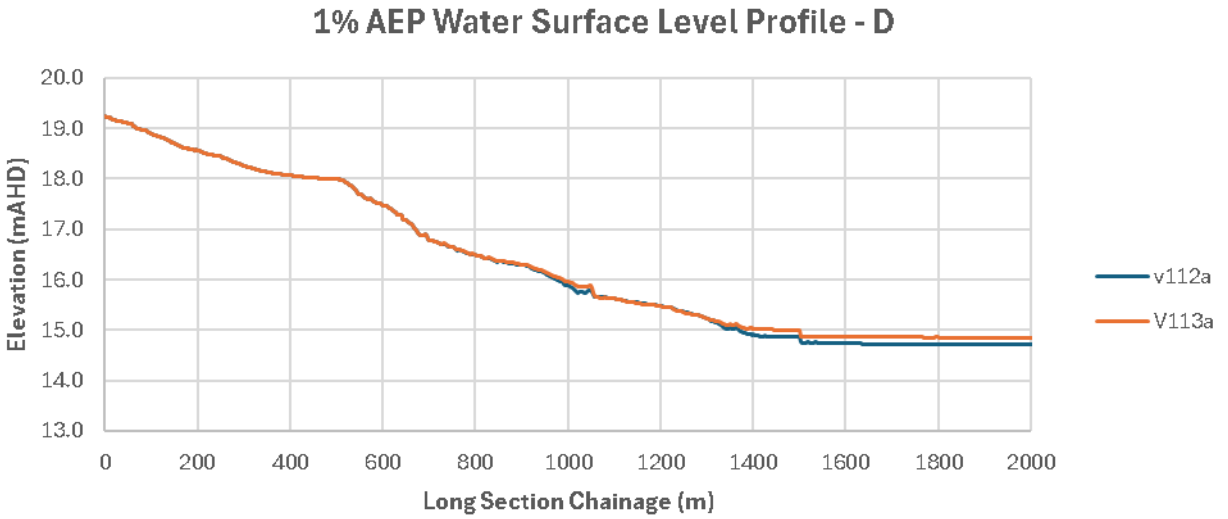


Figure 3.6 Selected 1% AEP Water Surface Level Profile Comparison – Section D

3.2 Updated Model Results

Updated model results for the 1% AEP event are shown in the following figures:

- Figure 3.7 Maximum Flood Depth
  - Maps for other events are provided in Appendix A.
- Figure 3.8 Maximum Flood Hazard (Z0)
  - Maps for other events are provided in Appendix B.
- Figure 3.9 Maximum Flood Hazard (ZAEM1)
  - Maps for other events are provided in Appendix C.
- Figure 3.10 Maximum Flood Level
  - Maps for other events are provided in Appendix D.
- Figure 3.11 Maximum Flood Velocity
  - Maps for other events are provided in Appendix E.
- Maps showing 1% and 2% AEP climate change results are provided in Appendix F.

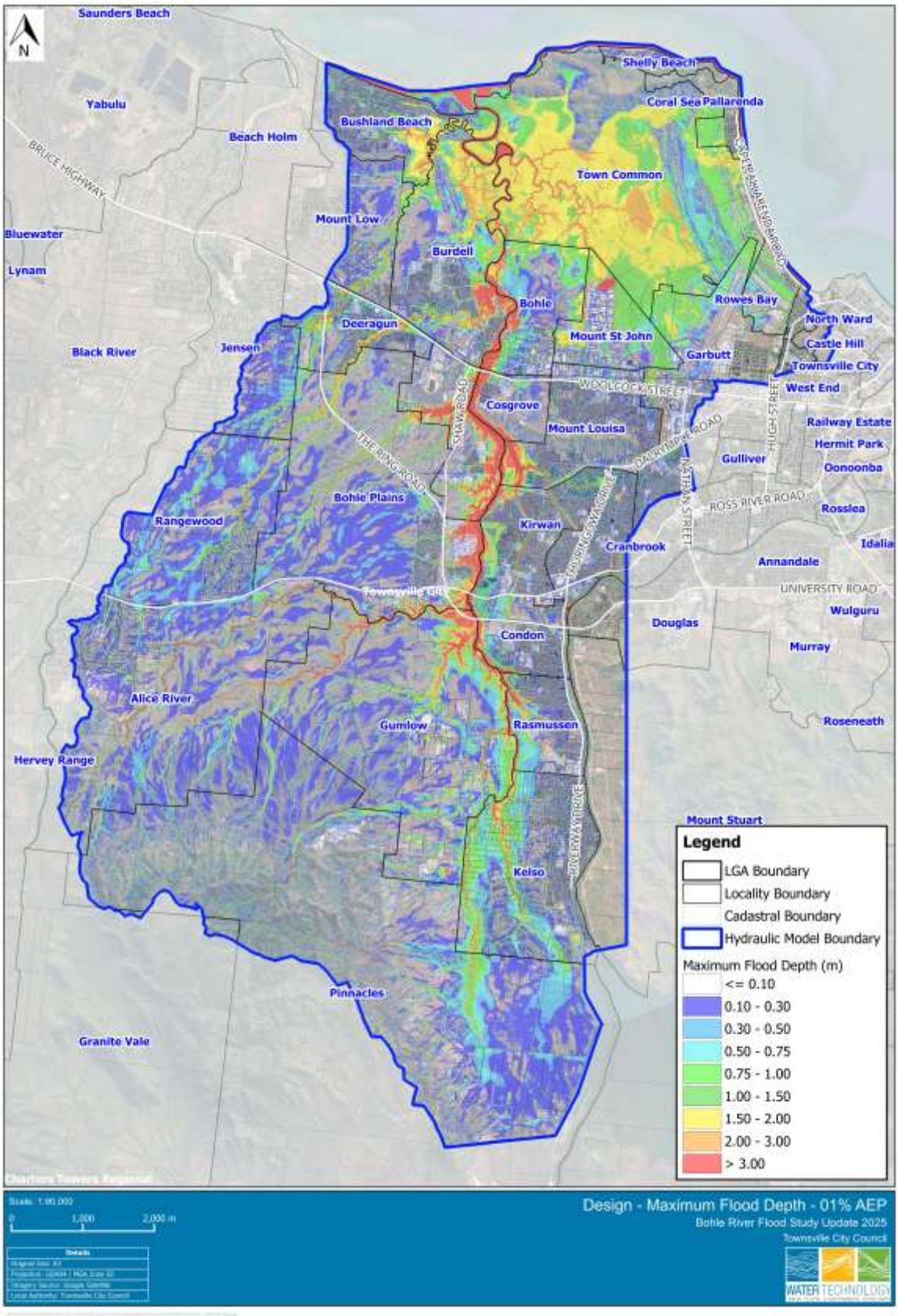


Figure 3.7 Maximum Flood Depth – 1% AEP

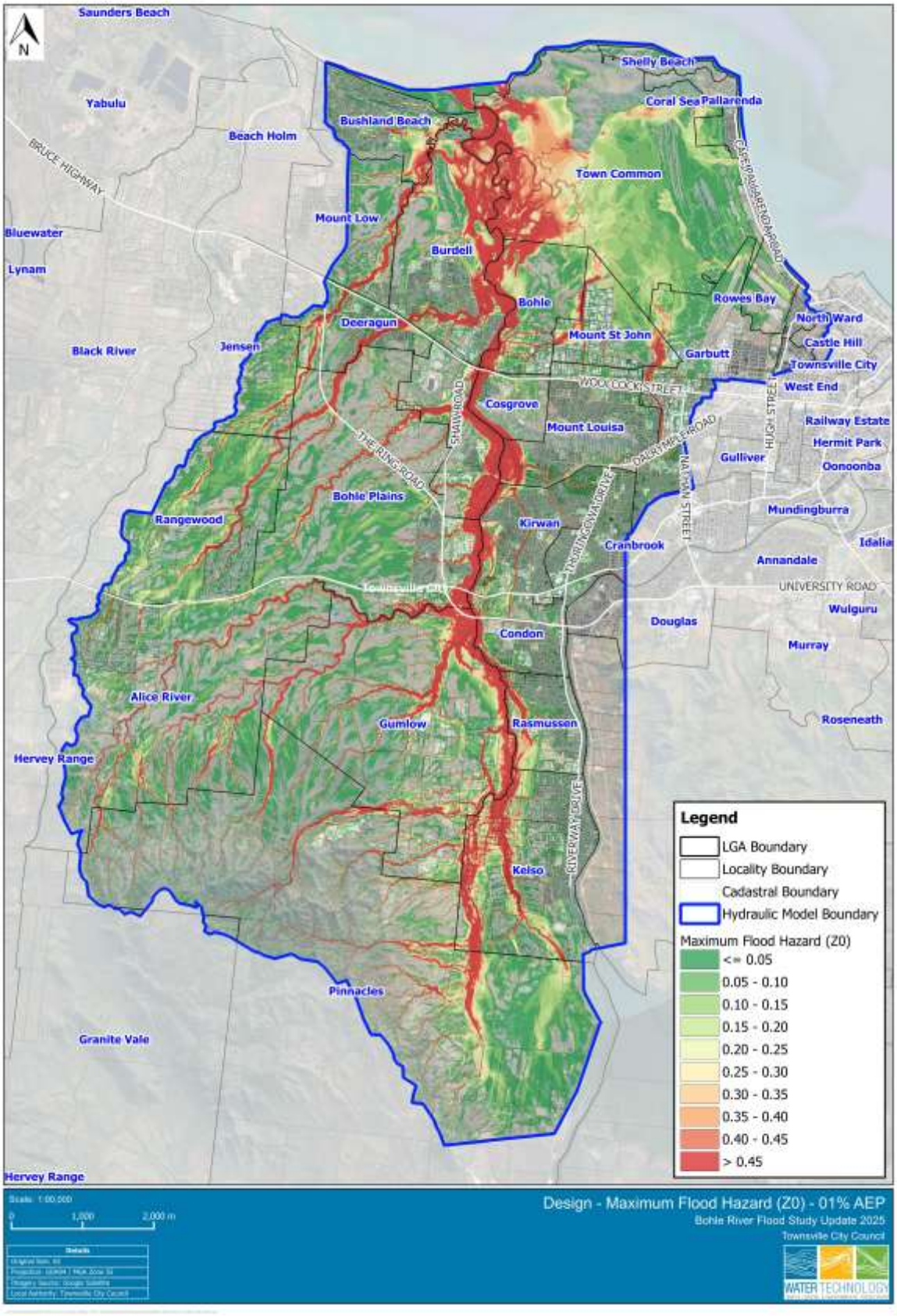


Figure 3.8 Maximum Flood Hazard (Z0) – 1% AEP

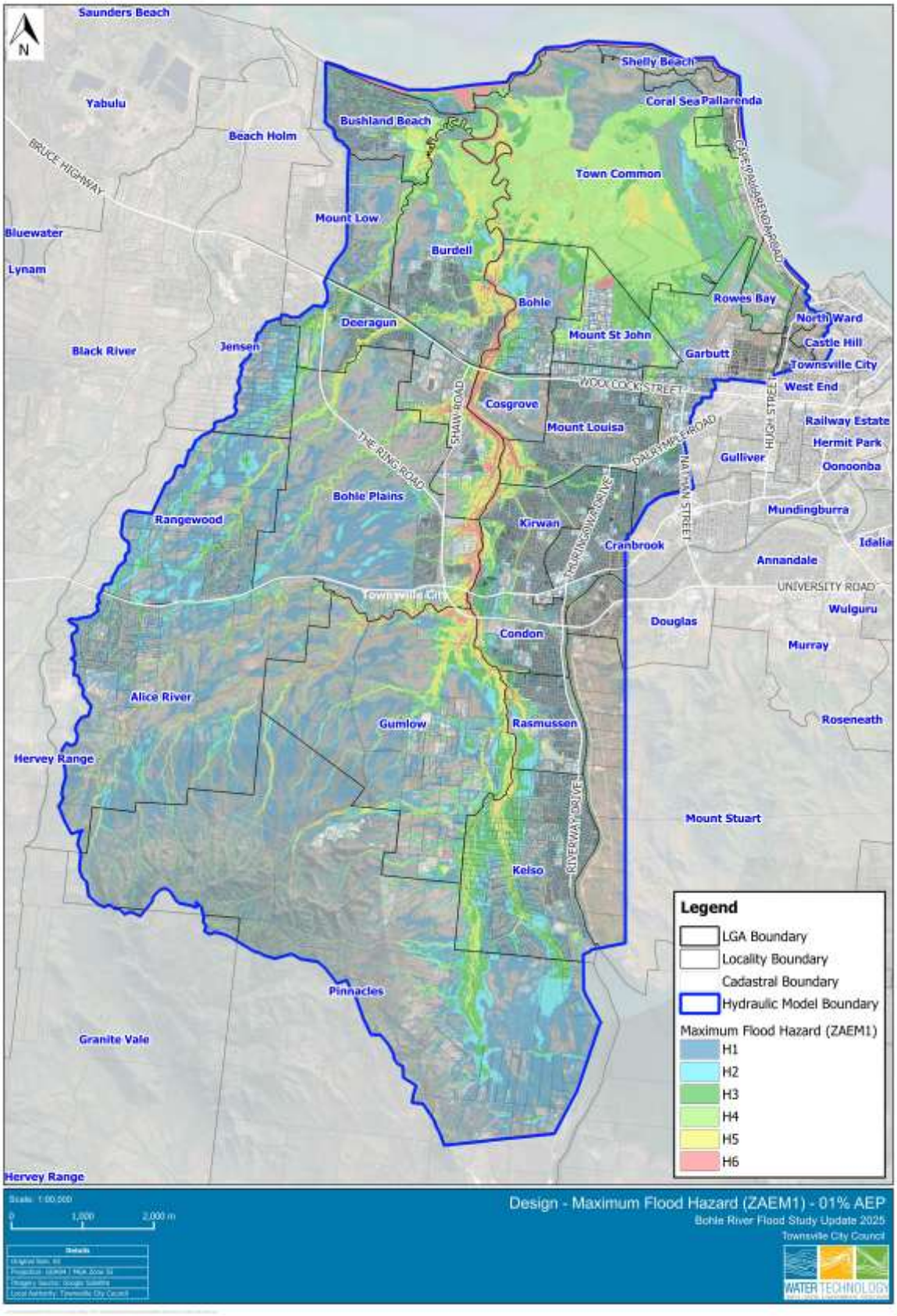


Figure 3.9 Maximum Flood Hazard (ZAEM1) – 1% AEP

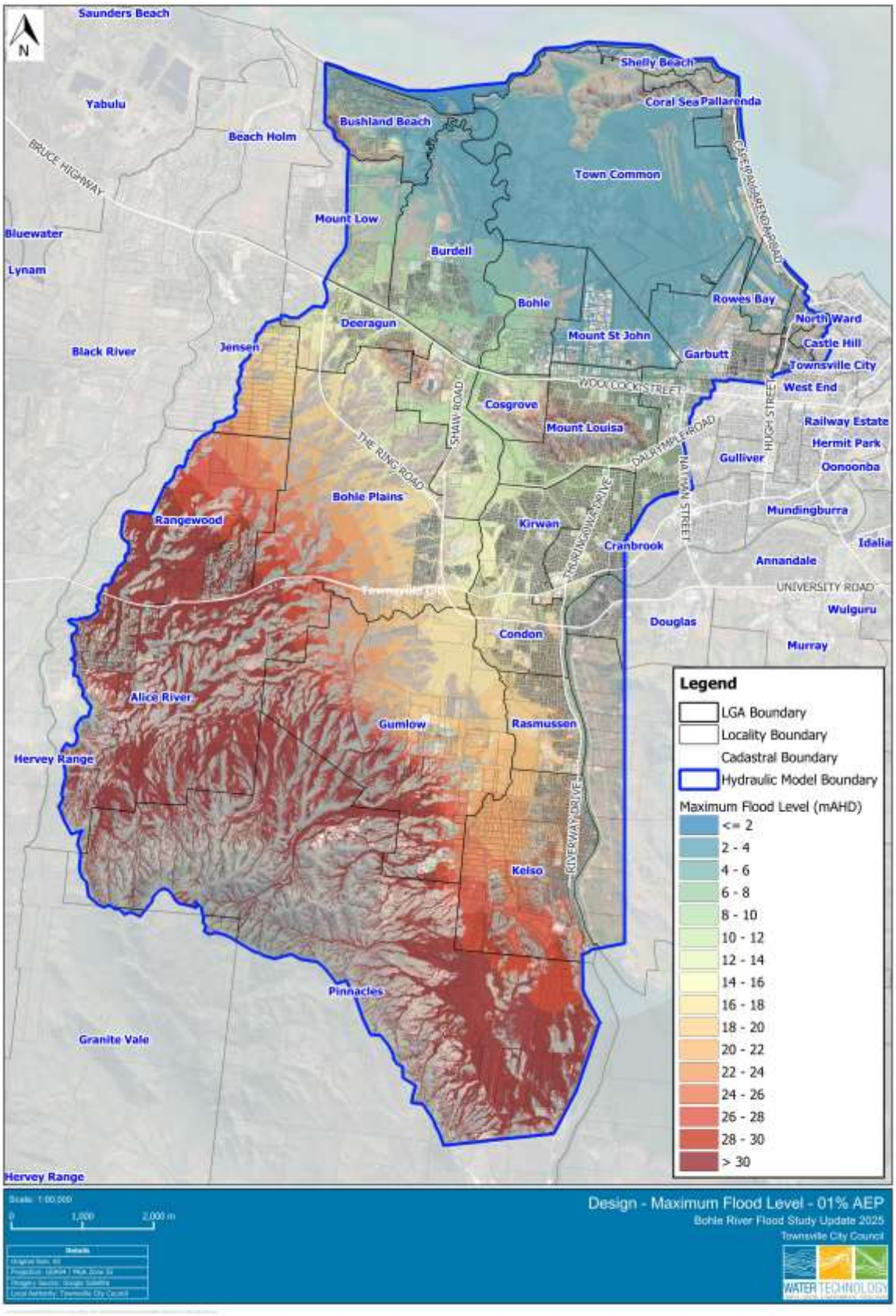


Figure 3.10 Maximum Flood Level – 1% AEP

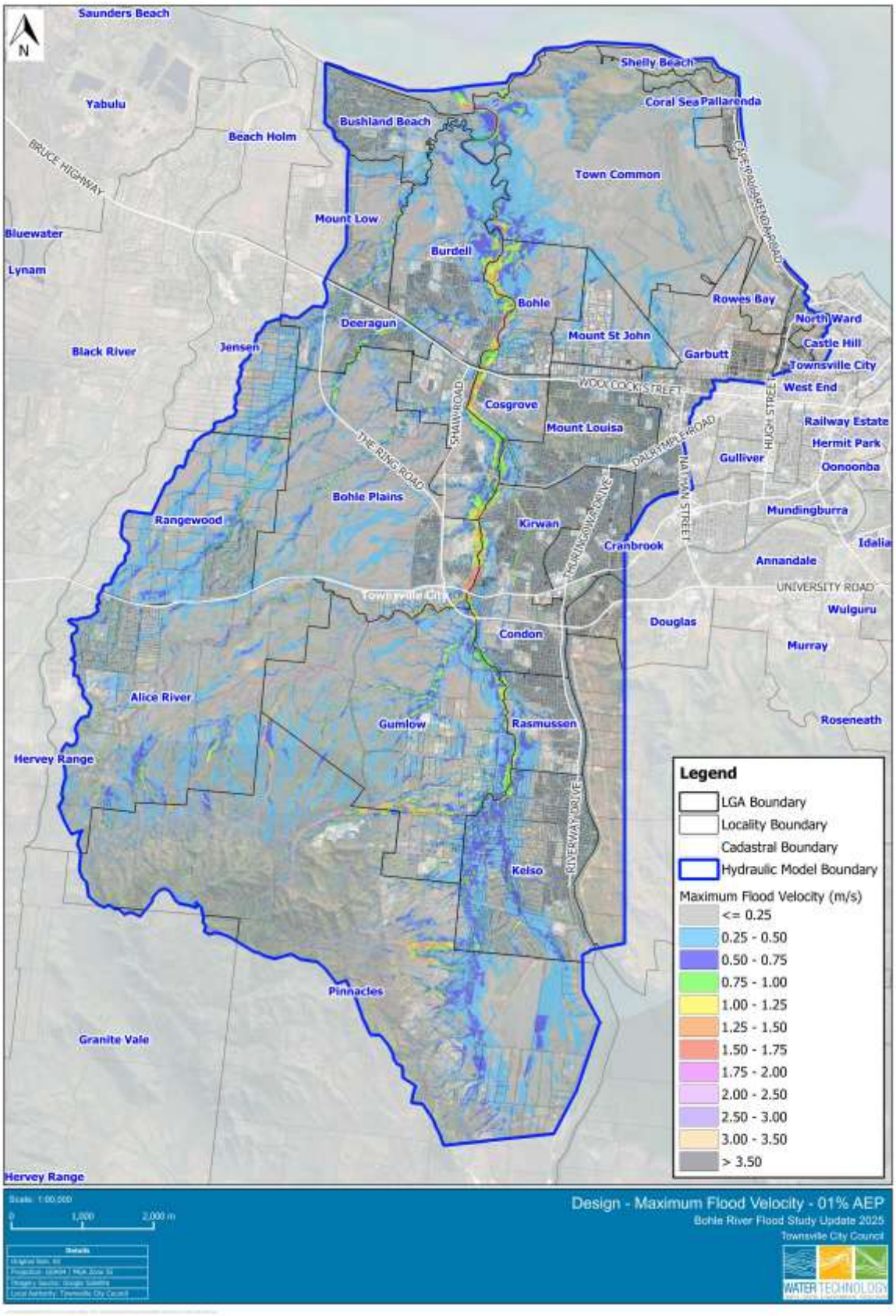


Figure 3.11 Maximum Flood Velocity – 1% AEP

3.3 Climate Change Provisions

The Bohle River Flood Study Update (2025) incorporated the assessment of projected climate change impacts on design flood behaviour, consistent with the latest Australian Rainfall and Runoff (2019) guidance. In particular, simulations were undertaken for the 1% AEP and 2% AEP design flood events

The analysis identified changes in both peak flood levels and hazard classification (ZAEM1) across the floodplain. The magnitude and spatial distribution of these changes provide an indication of the sensitivity of the Bohle River catchment to projected climate change. Increases in flood levels were observed in areas of hydraulic control, with corresponding increases in hazard classifications where flow velocities and depths combine to elevate flood risk to people, property, and infrastructure.

The updated change in peak flood level and hazard (ZAEM1) caused by the consideration of climate change provisions are also mapped in Figure 3.12 and Figure 3.13.

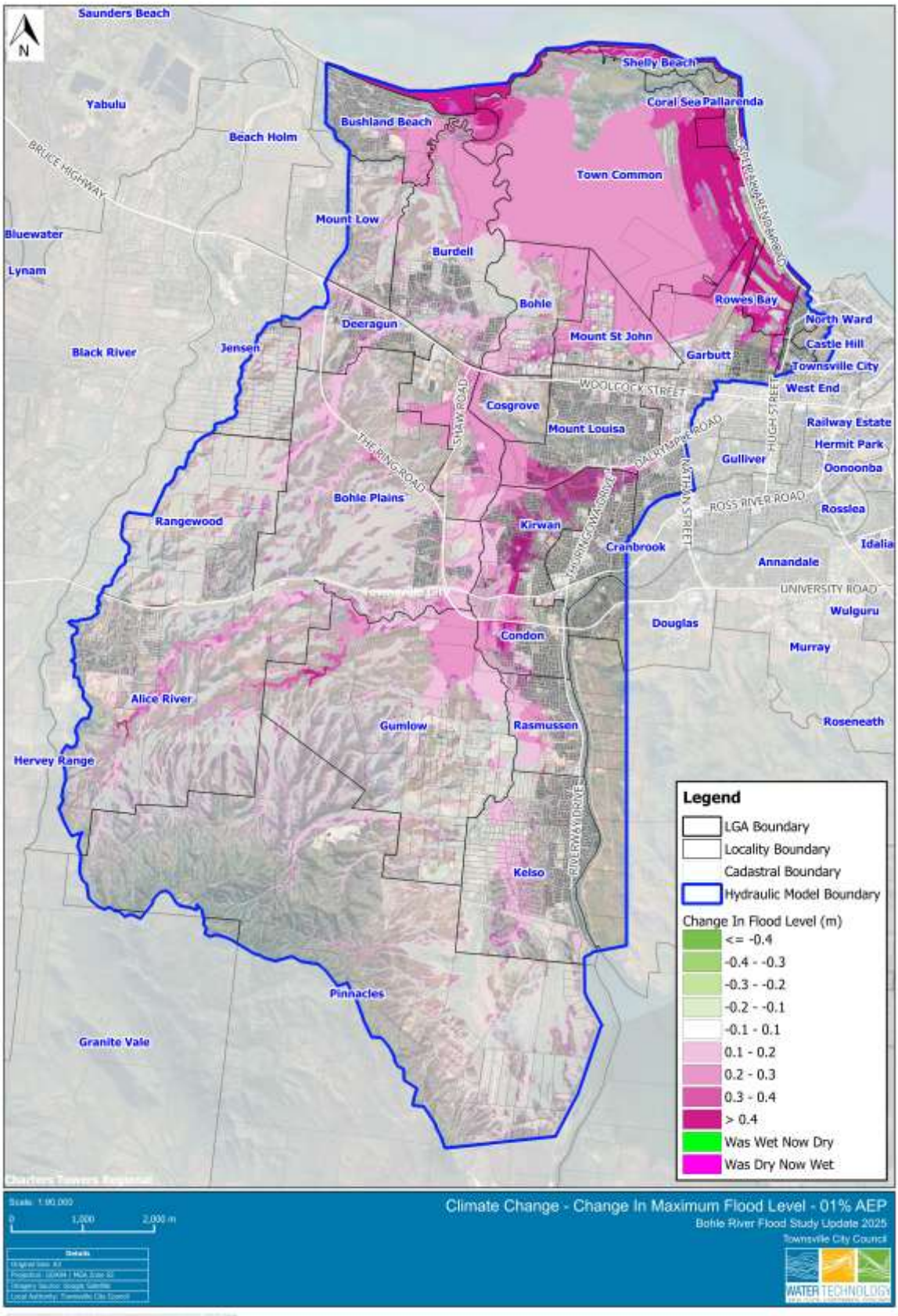


Figure 3.12 Change in Maximum Flood Level – 1% AEP (Climate Change)

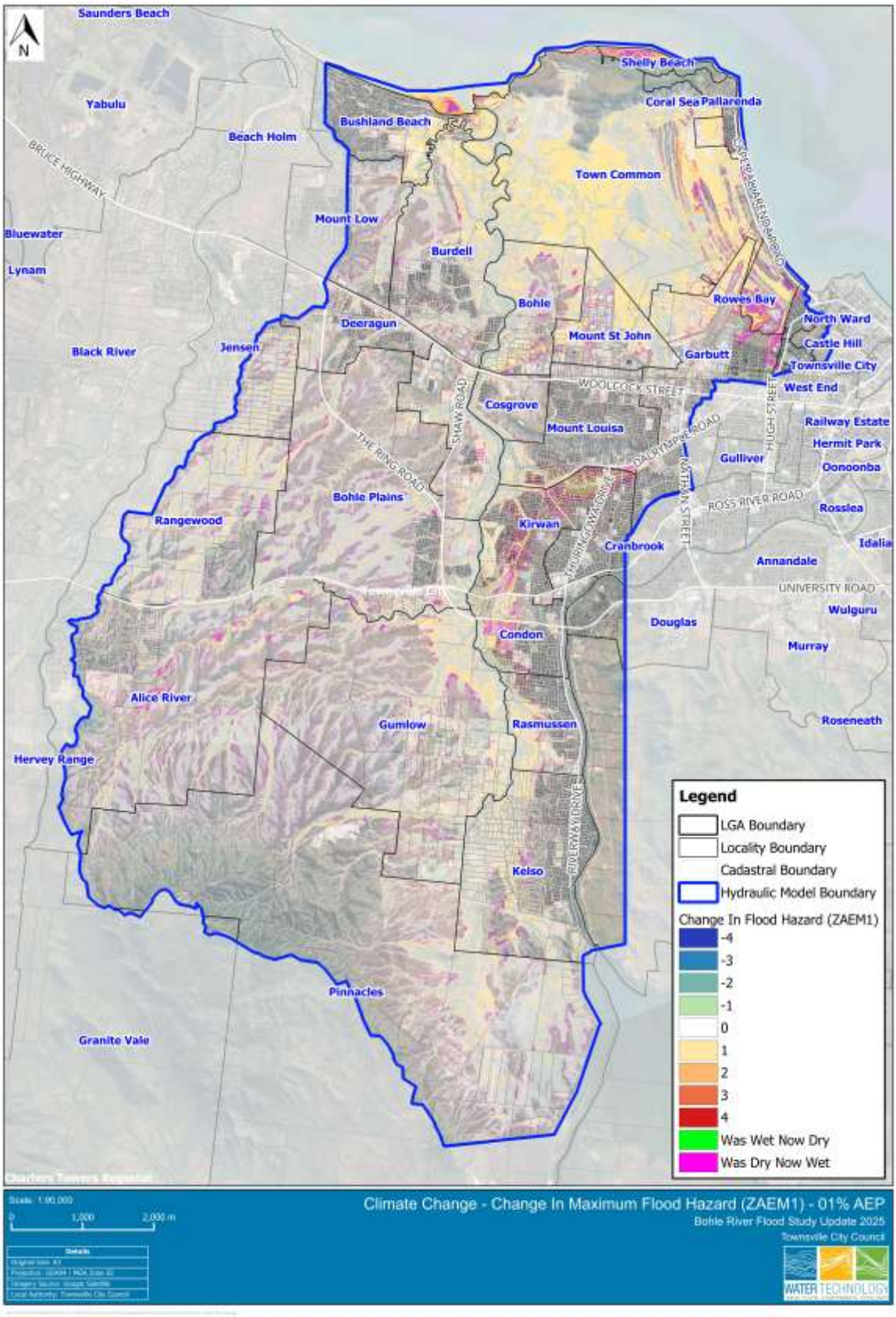


Figure 3.13 Change in Maximum Flood Hazard (ZAEM1) – 1% AEP (Climate Change)

3.4 Joint Probability Zone – Interaction of Coastal and Fluvial Flooding

A key consideration in the assessment of design events and adoption of design planning levels for the Bohle River catchment is understanding the driving processers and the associated sensitivity between fluvial and coastal flooding, including quantification of the joint probability zone.

Joint probability is a statistical consideration of the likelihood of two events occurring at the same time. In the case of the Bohle River the 'joint probability zone' is defined as the region in which the dependence between fluvial and coastal processes has the potential to influence the design flood level. Figure 3.14 illustrates this region by indicating the range of possible flood levels corresponding to a given AEP bounded by cases where fluvial flood events and ocean levels are completely dependent (upper curve) and completely independent (lower curves).

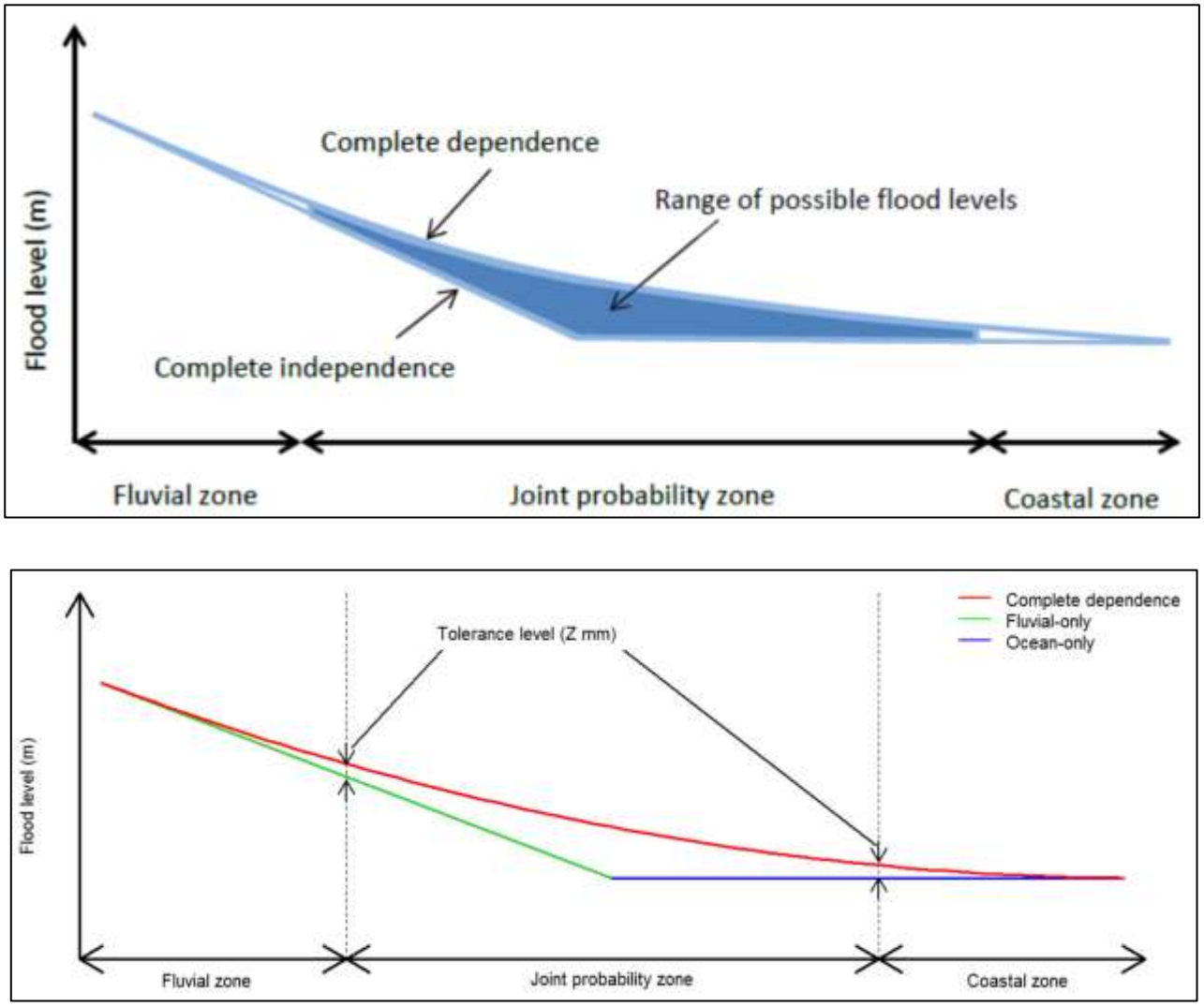


Figure 3.14 Joint Probability Zone (Source – ARR19)

Book 6, Chapter 5 of ARR19 provides guidance relating to joint probability as well as outlines two key stages for assessing joint probability. Understanding the difference in flood magnitude between independence and full dependence of coastal and fluvial flooding can be determined by undertaking the Pre-Screening Analysis stage set out in the Design Variable Method outlined in ARR19. This stage is used to inform whether a more complex joint probability approach (Stage 2) is warranted.

WT have considered and reviewed a set of varying tailwater conditions for both the 1% AEP baseline and climate change design events. To complete the analysis, WT utilised the supplied coastal flooding results from the previous 2017 Townsville Strom Tide Mapping Update undertaken by GHD (GHD 2017).

A total of five (5) model scenarios were investigated as part of the Pre-Screening Analysis, comprising the three (3) cases described below with regard to both the 1% AEP baseline and climate change design events:

- **Case 1 – Independent Coastal Flood**. This case quantifies the flood extent and level based solely on the instance of a coastal flood occurring in the absence of a rainfall event. For this study, the base coastal water level conditions were taken as Mean Sea Level (MSL) with the occurrence of an ocean event of 0.8m Sea Level Rise (SLR).
- **Case 2 – Independent Fluvial Flood**. This case quantifies the flood extent and level based solely on the instance of a fluvial flood occurring in the absence of an ocean event. For this study, two (2) fluvial flood events were assessed, 1% AEP baseline and 1% AEP climate change. The base coastal tail water level conditions were taken as Mean Sea Level (MSL) without the occurrence of an ocean event.
- **Case 3 – Complete Dependence Coastal and Fluvial Flooding.** This case quantifies the flood extent and level based on the combined instances of a fluvial and coastal flood occurring simultaneously. Again, for this study, two (2) fluvial flood events were assessed, 1% AEP baseline and 1% AEP climate change. However, in this case, the base coastal tail water level conditions were taken as Mean Sea Level (MSL) with the occurrence of an ocean event of 0.8m Sea Level Rise (SLR) and 1.1 SLR for the 1% AEP and 1% AEP climate change respectively.

To determine the dominant flood condition, Coastal, Fluvial or Combined, a threshold value of 'Z' is defined to represent the acceptable tolerance between the benefit of the Pre-Screening Analysis and the additional effort required to undertake a complete joint probability assessment. In the case of the Bohle River Flood Study, a threshold value 'Z' was adopted to be 300mm which was selected to match the required freeboard typically applied to building flood planning levels as defined in the TCC City Plan - Sections SC6.4.4.4.3 and SC6.7.4.

Flood level difference maps showing the corresponding impacts of the joint probability assessment throughout the Lower Bohle region are illustrated in Figure 3.15 and Figure 3.16 for the 1% and 1% plus climate change respectively.

The analysis completed demonstrates that the dominant flood condition was taken as the fluvial flooding case that resulted in the greatest flood level occurrence of the independent coastal flood, independent fluvial flood, and the dependant combined coastal and fluvial flood; only if the difference in the dependant case flood level to the independent case flood levels was greater than the defined tolerance, 'Z' mm.

The results of the Pre-Screening Analysis of the joint probability zone, undertaken as part of this Study, indicate that the zone of influence within the lower region of the Bohle River is primarily dominated by Coastal Flooding which changes to Fluvial Flooding dominance in areas of higher elevation. It should be noted that our scope of works for this study did not include a full joint probability assessment which was outside of the technical scope.

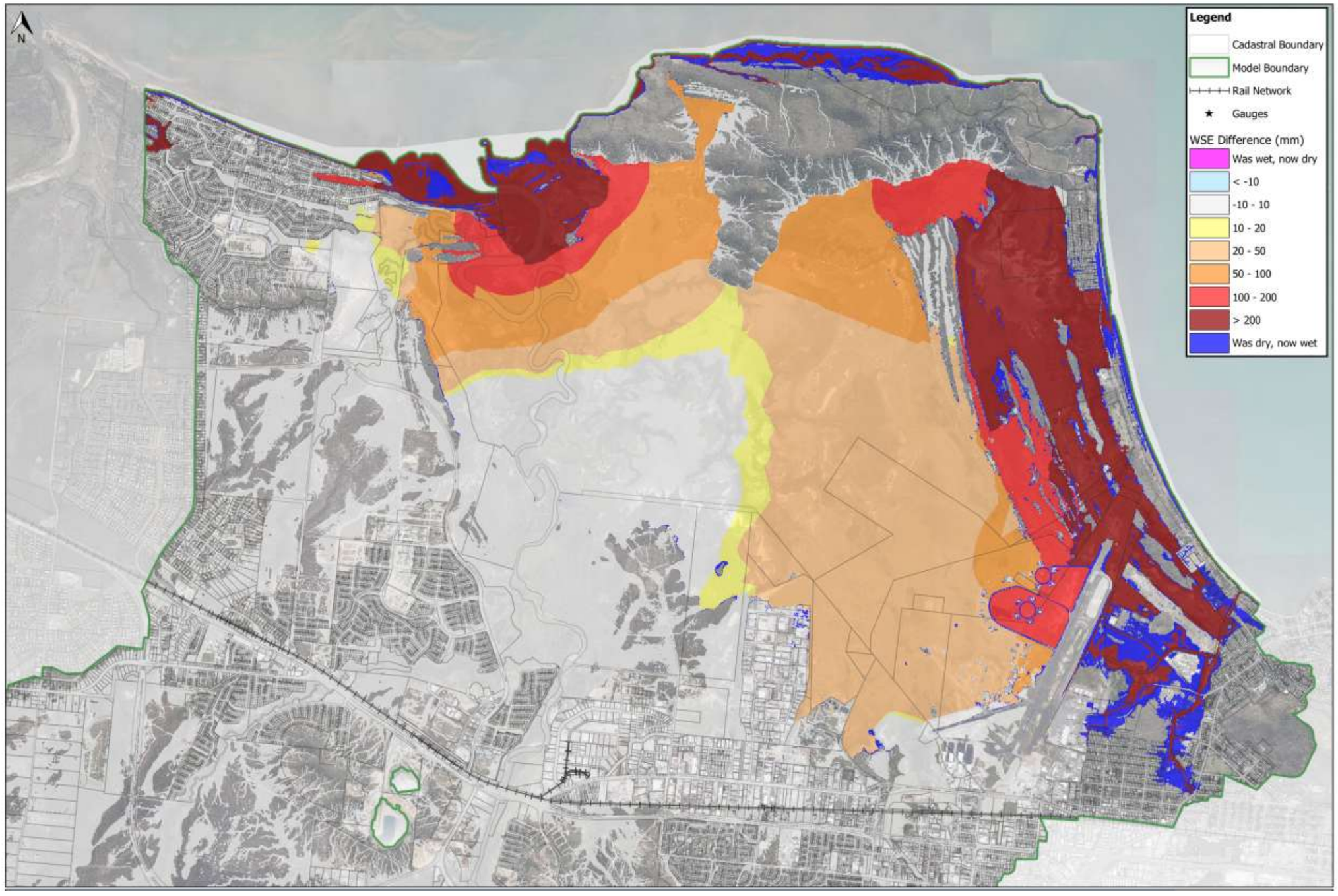


Figure 3.15 Complete Dependence Coastal and Fluvial Flooding – 1% AEP with MSL and 0.8m Tailwater Conditions

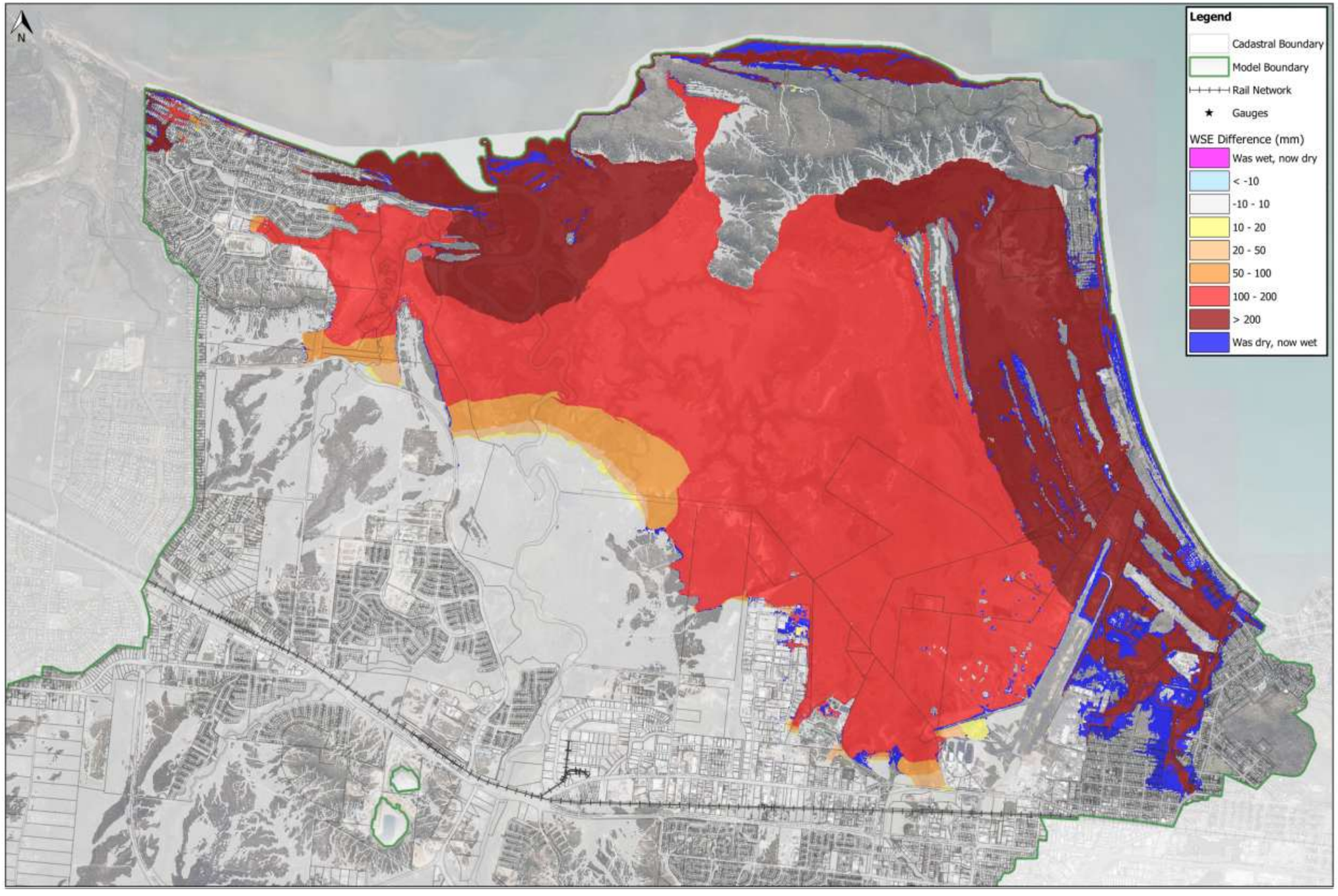


Figure 3.16 Complete Dependence Coastal and Fluvial Flooding – 1% AEP CC with MSL and 1.1m Tailwater Conditions

3.5 Flood Hazard Categorisation

IN addition to the ZAEM1 hazard categorisation, an additional categorisation into low, medium, and high flood hazard areas has been produced, to be used as part of the flood hazard overlay mapping. This hazard categorisation has been produced based on the depth x velocity criteria as shown in Figure 3.17. This has been prepared based on the 1% AEP design event, without and with climate change provisions.

The TCC flood hazard mapping without and with climate change provisions are illustrated in Figure 3.18 and Figure 3.19, respectively.

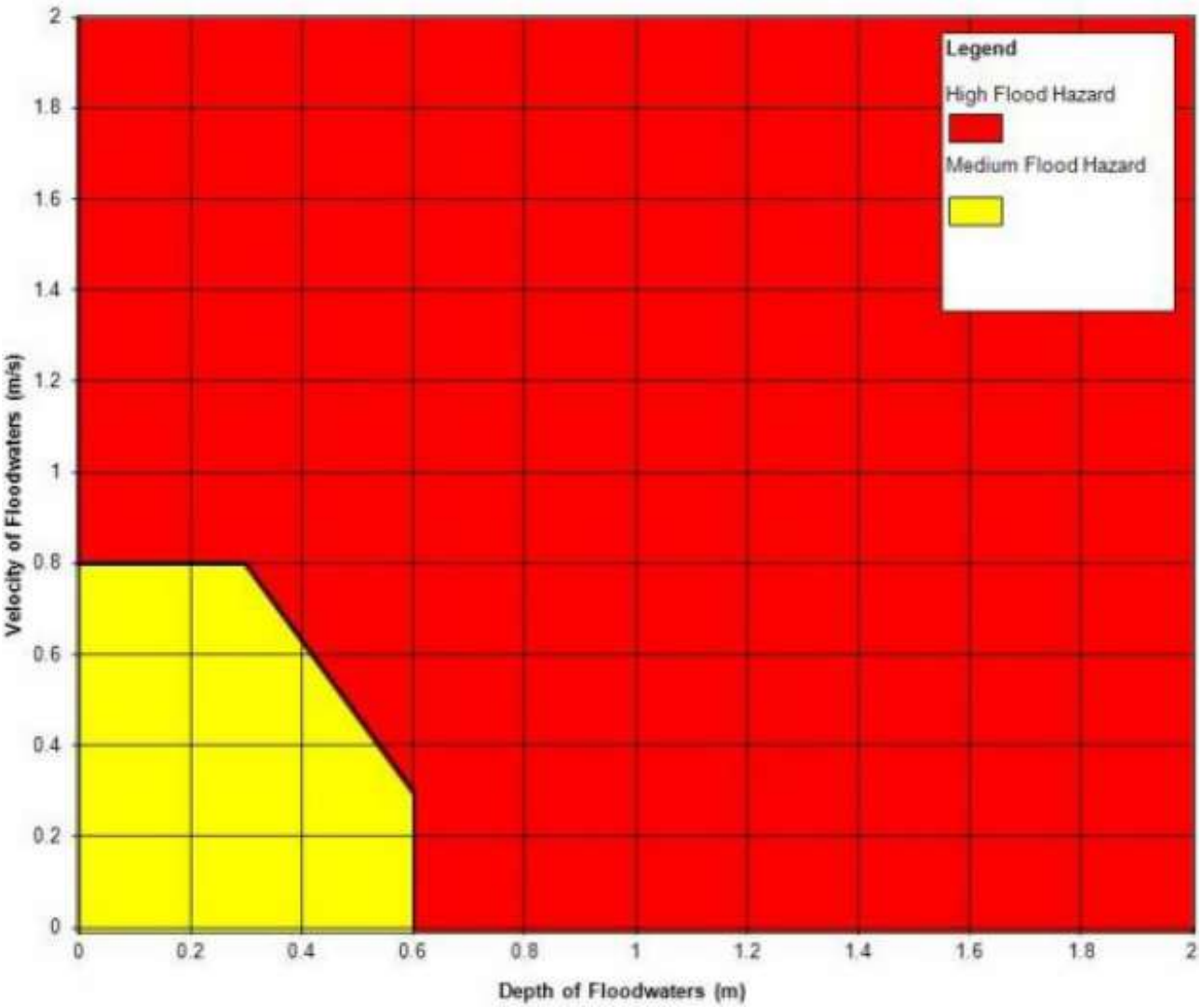


Figure 3.17 TCC Flood Hazard Categorisation On 1% AEP Flood

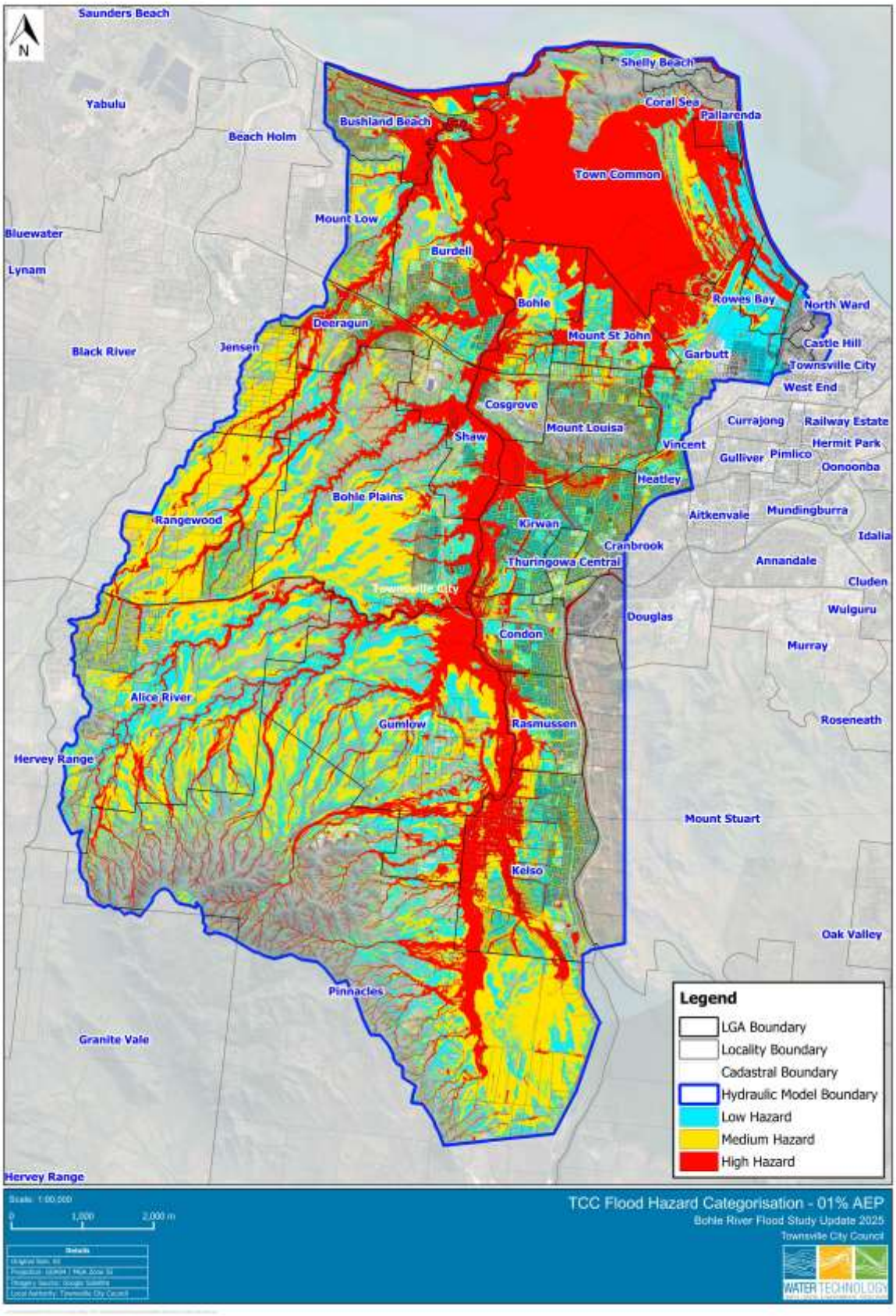


Figure 3.18 TCC Flood Hazard Categorisation – 1% AEP

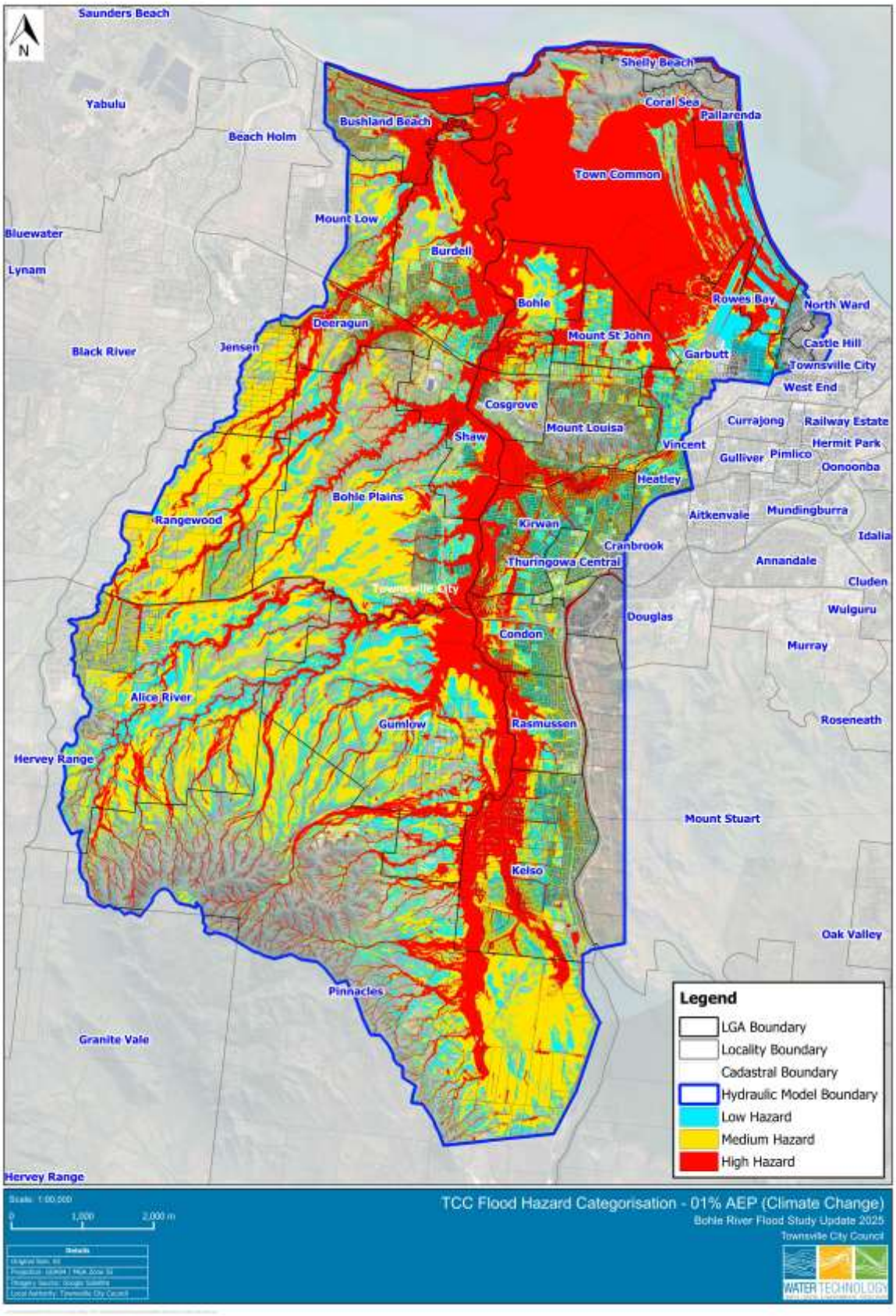


Figure 3.19 TCC Flood Hazard Categorisation – 1% AEP (Climate Change)

4 MODEL UPDATE SUMMARY

Water Technology have updated the Bohle River Flood Study to include the following changes:

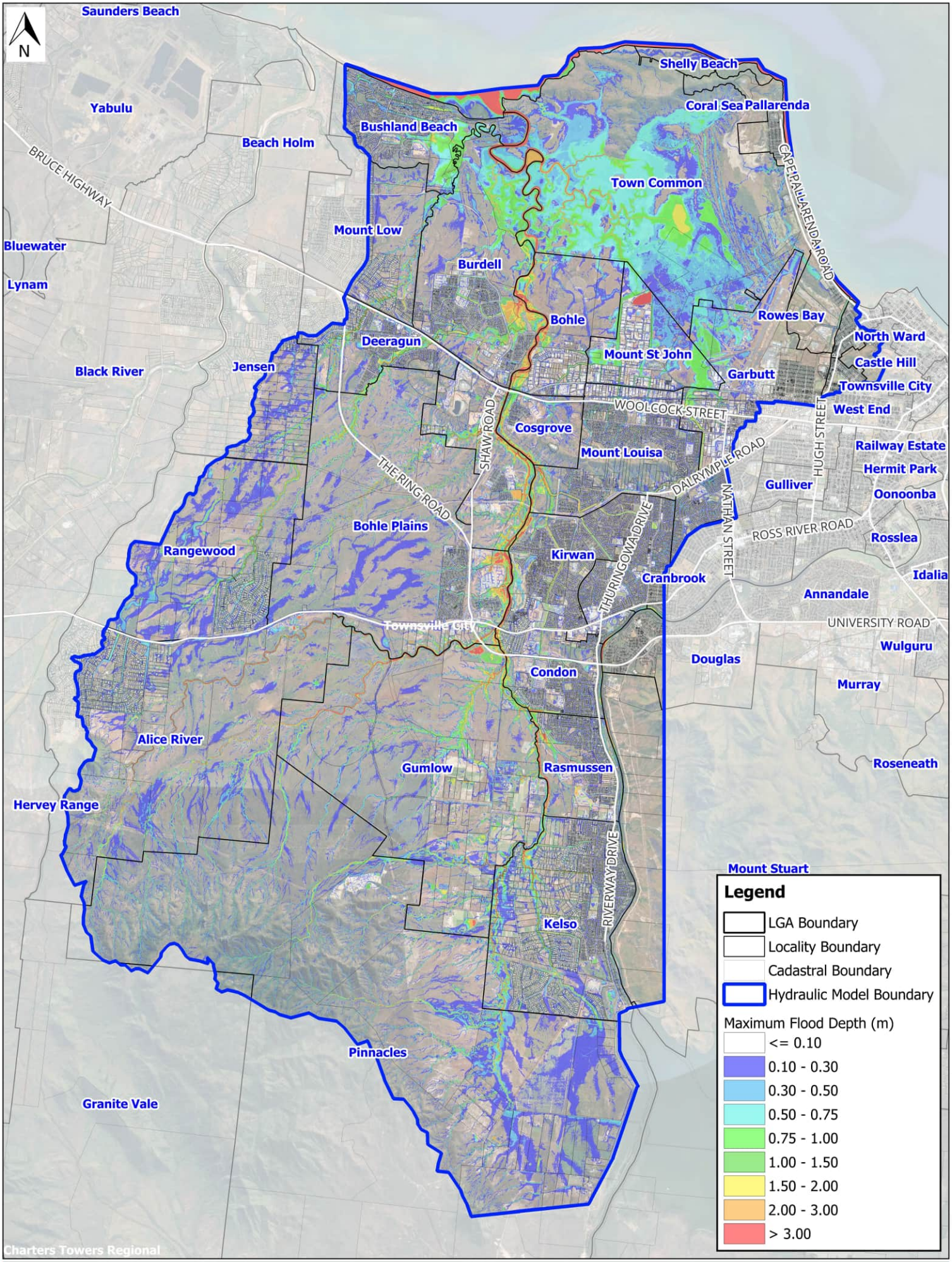
1. Application of revised IFDs.
2. Revision of TUFLOW model boundary.
3. Inclusion of recent development and Stage 5 of the Townsville Ring Road.

The updated version of the Bohle River flood model was simulated for a comparable selection of design events and temporal patterns as per the Bohle River Flood Study (2023) report.

The updated model results have been compared to the previous model for the 1% AEP maximum flood level to ascertain the impact of the model updates on the flood behaviour of the Bohle River catchment. The results show the updated model is generally consistent with the previous model with minimal differences across the modelled area, with isolated patches of change in the immediate vicinity of the newly added developments.

APPENDIX A
DESIGN EVENT MAPPING – FLOOD DEPTH





Scale: 1:90,000

0 1,000 2,000 m

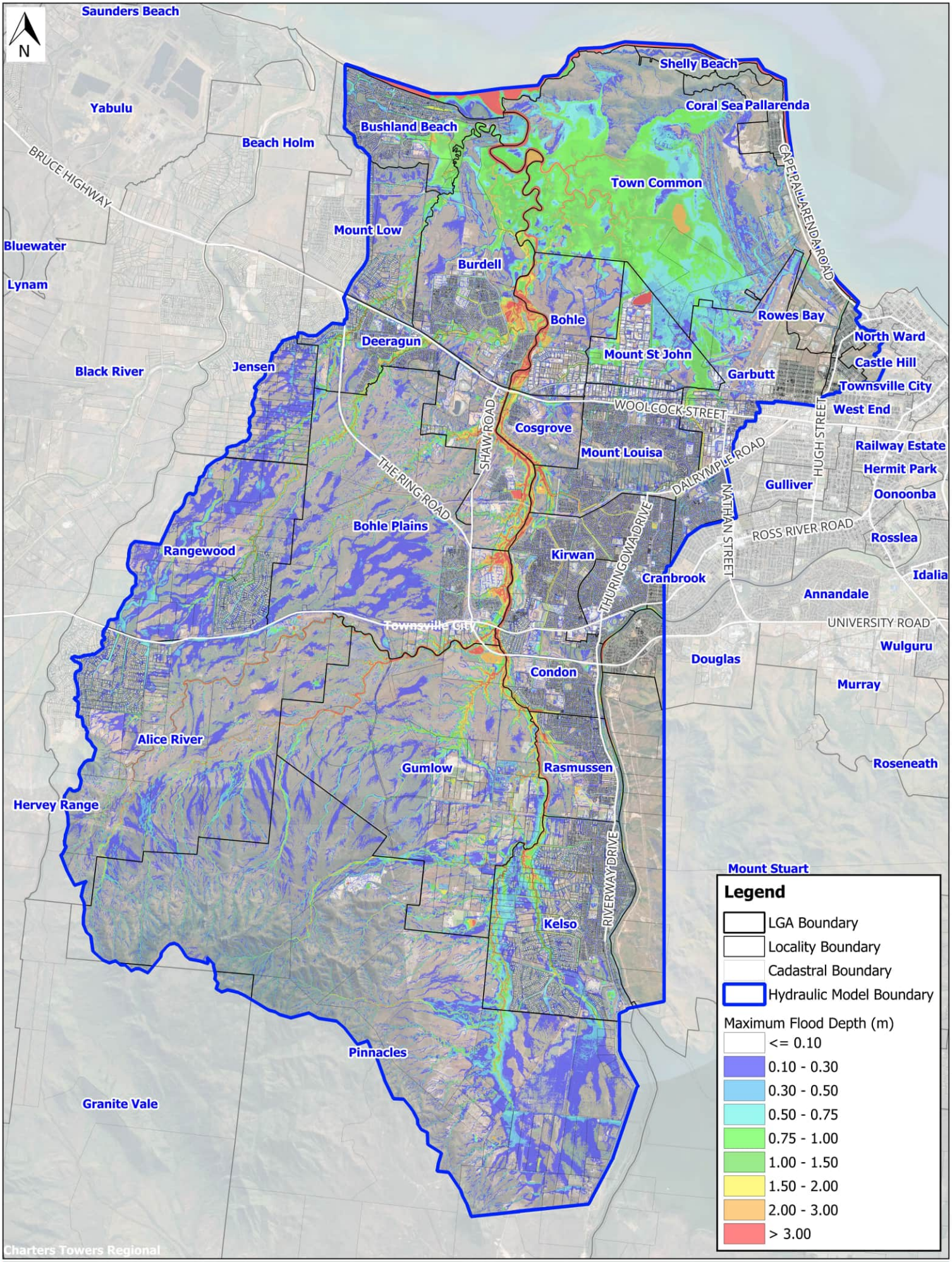
Details
Original Size: A3
Projection: GDA94 / MGA Zone 55
Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Depth - 50% AEP

Bohle River Flood Study Update 2025

Townsville City Council

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Scale: 1:90,000

0 1,000 2,000 m

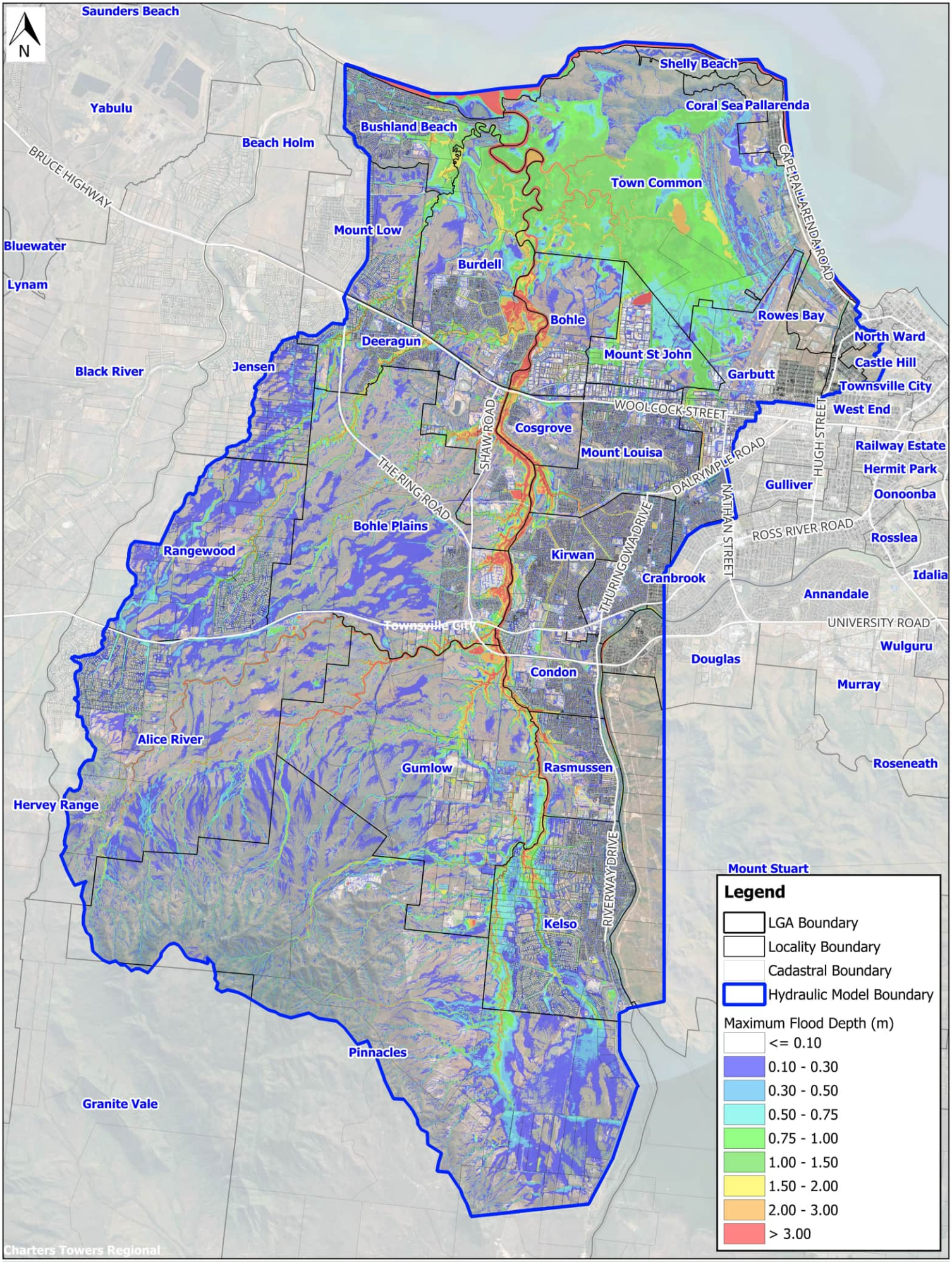
Details
Original Size: A3
Projection: GDA94 / MGA Zone 55
Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Depth - 20% AEP

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Scale: 1:90,000

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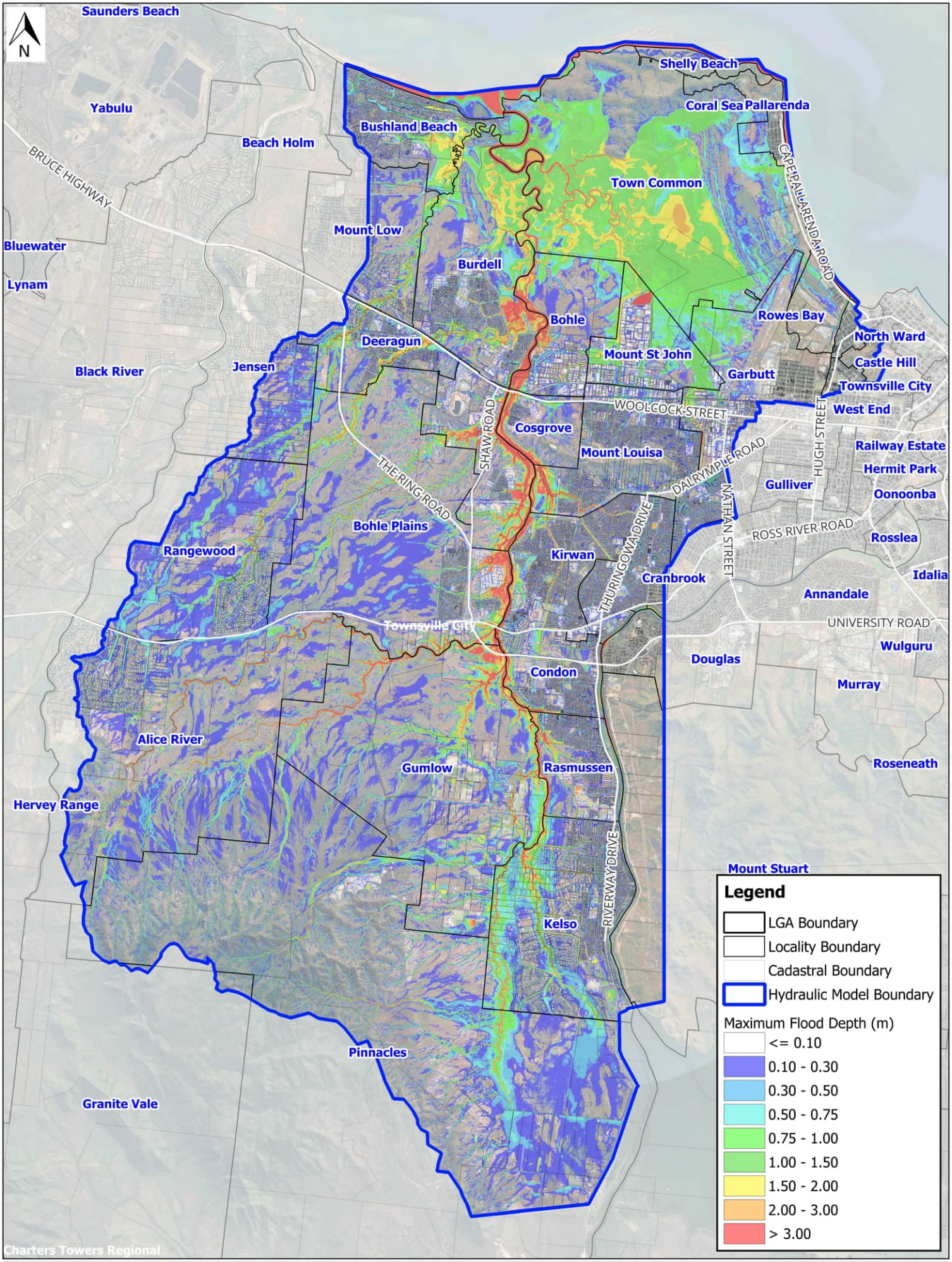
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Projection: GDA94 / MGA Zone 55
Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Depth - 10% AEP

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Scale: 1:90,000

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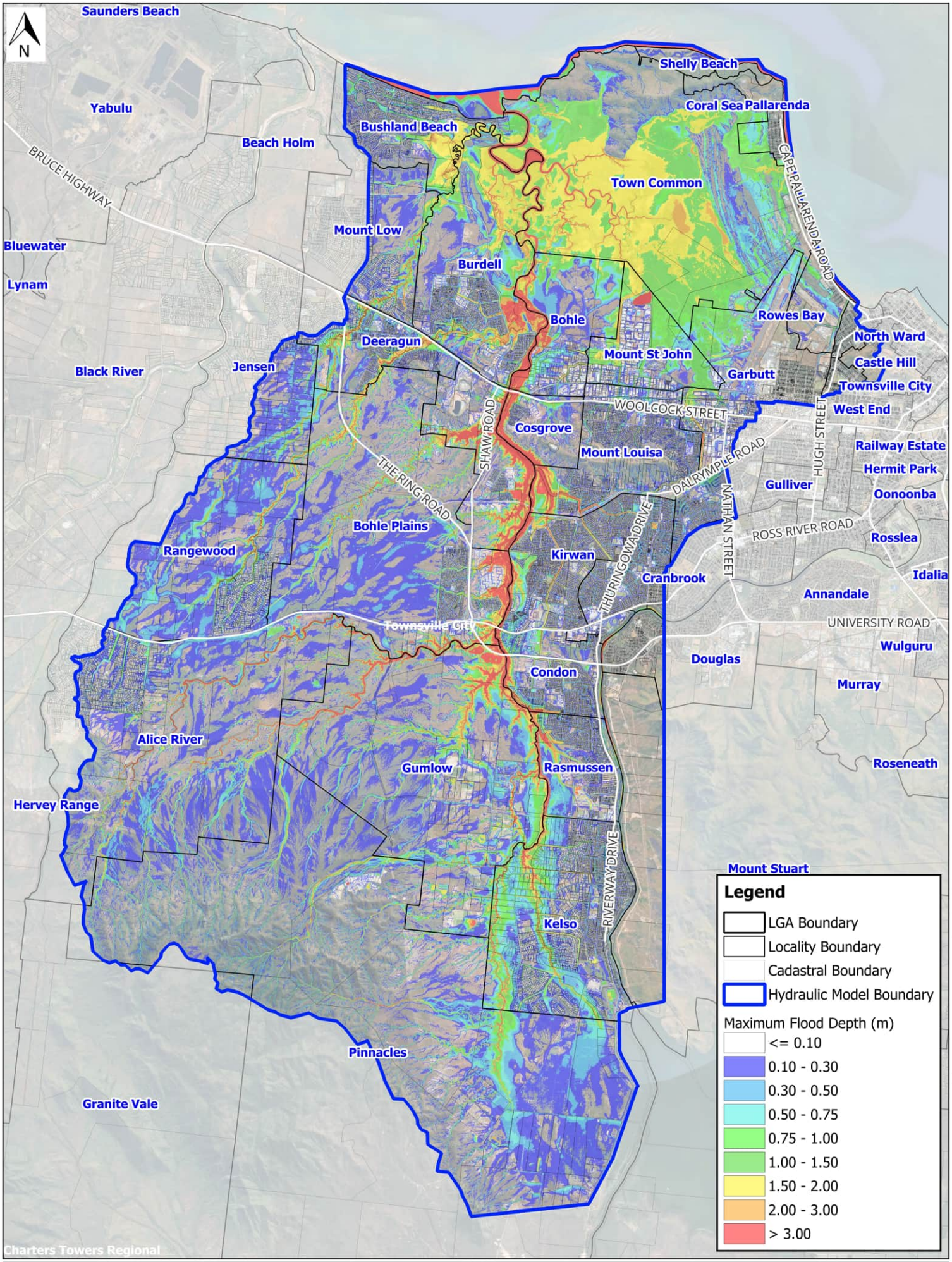
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Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Depth - 05% AEP

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Scale: 1:90,000

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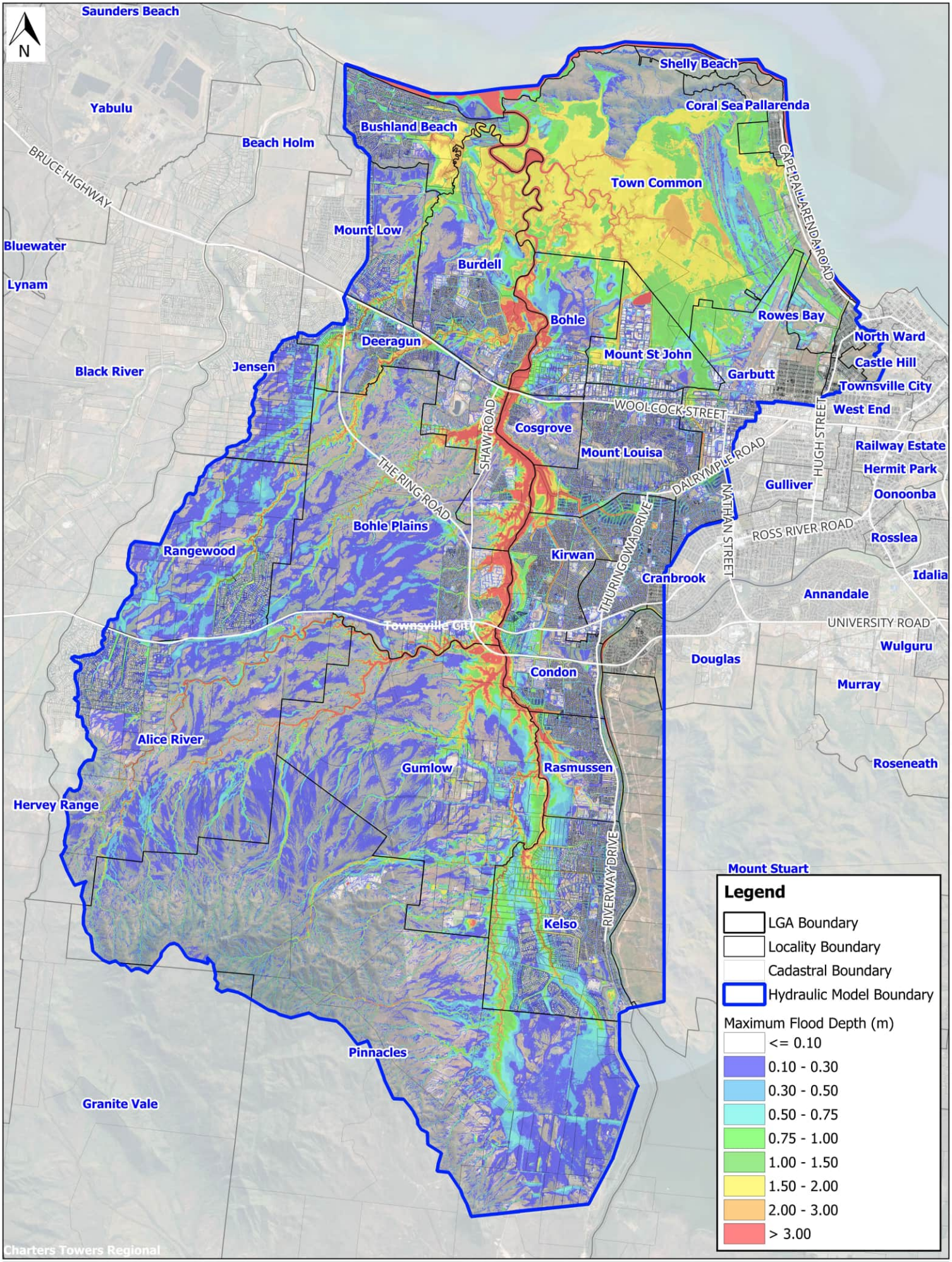
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Local Authority: Townsville City Council

Design - Maximum Flood Depth - 02% AEP

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Scale: 1:90,000

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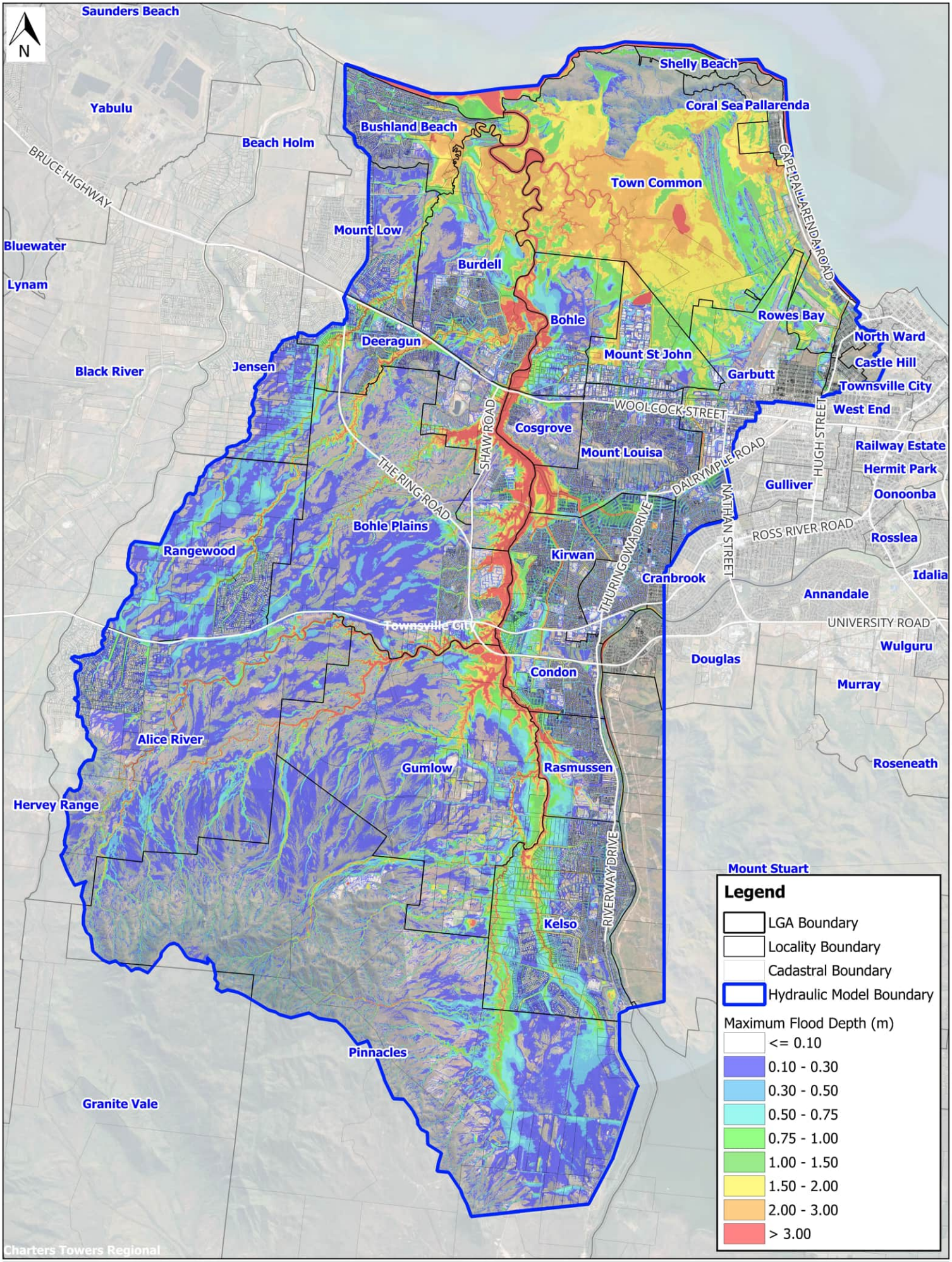
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Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Depth - 01% AEP

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Scale: 1:90,000

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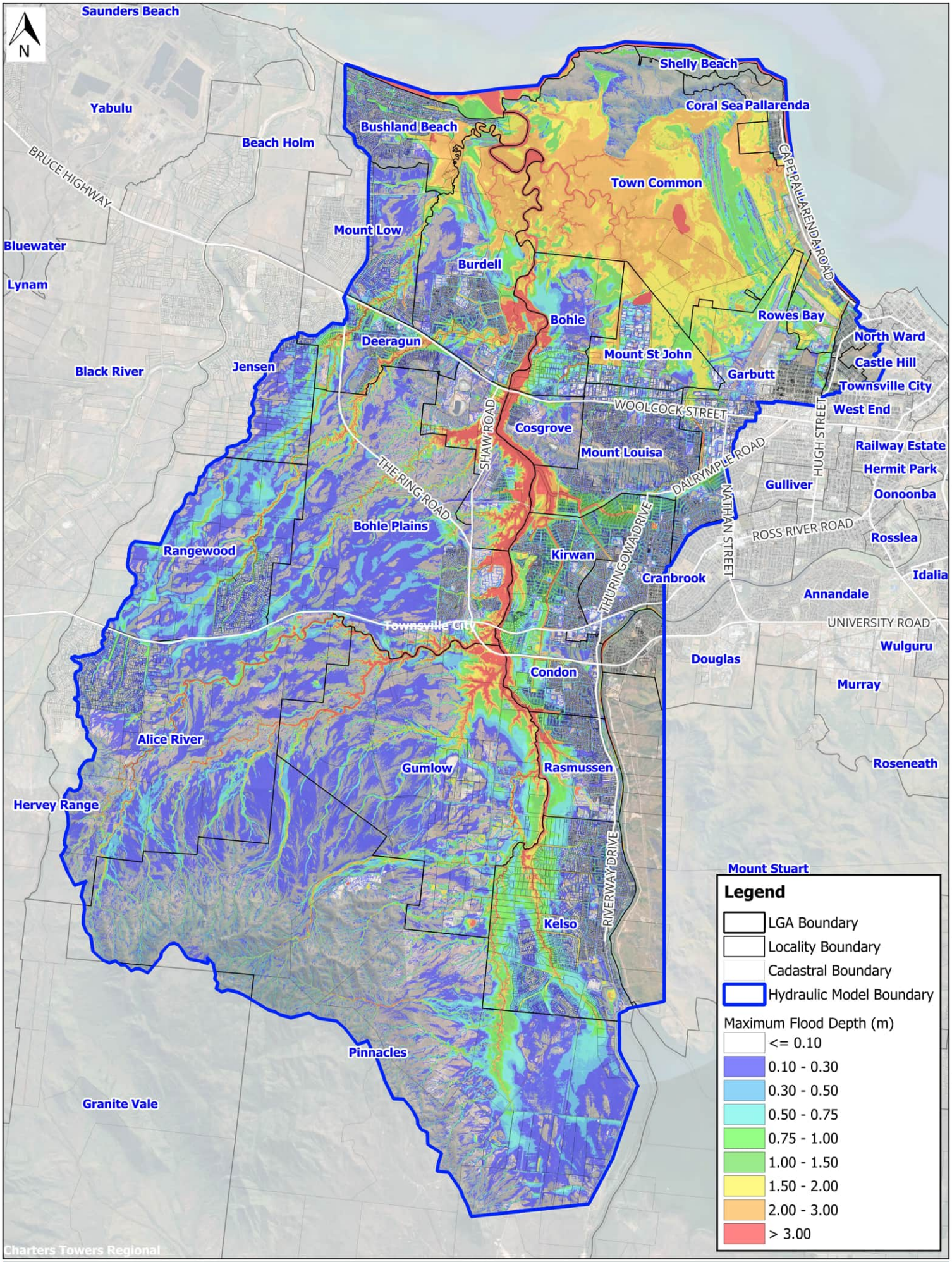
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Local Authority: Townsville City Council

Design - Maximum Flood Depth - 0.5% AEP

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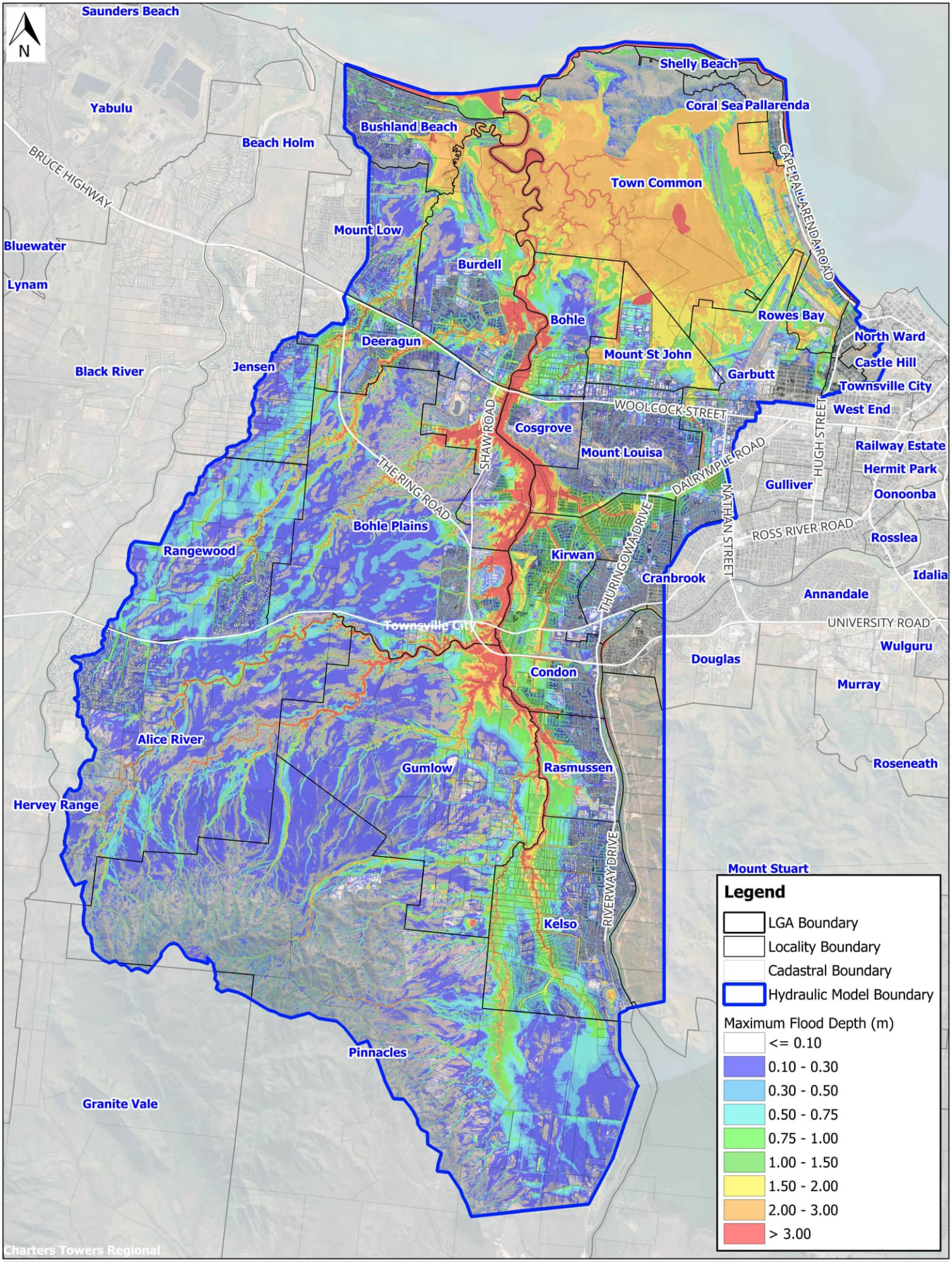
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Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Depth - 0.2% AEP

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Scale: 1:90,000

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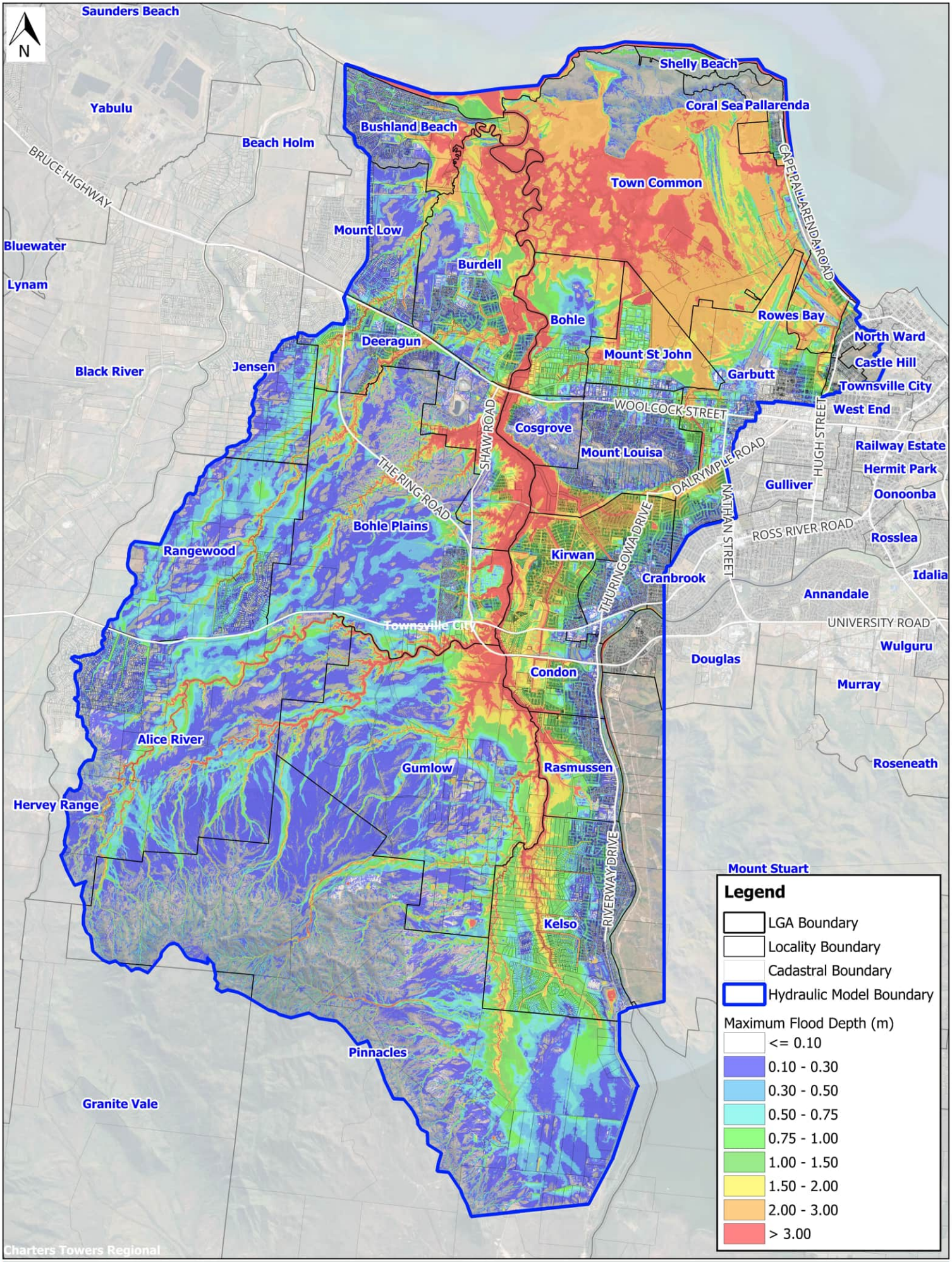
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Design - Maximum Flood Depth - 0.05% AEP

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Scale: 1:90,000

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Projection: GDA94 / MGA Zone 55
Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Depth - _PMF

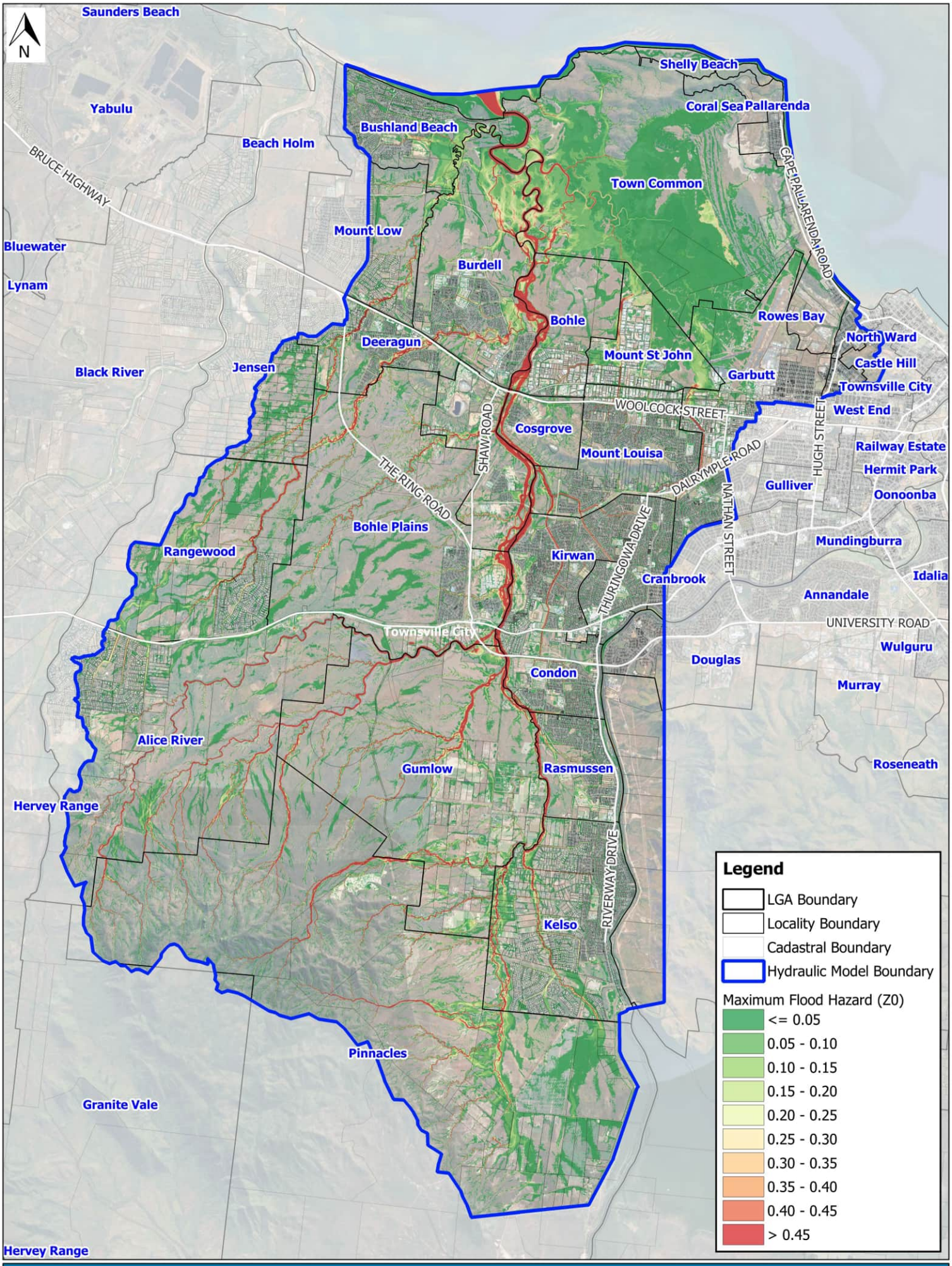
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APPENDIX B
DESIGN EVENT MAPPING – FLOOD HAZARD (Z0)





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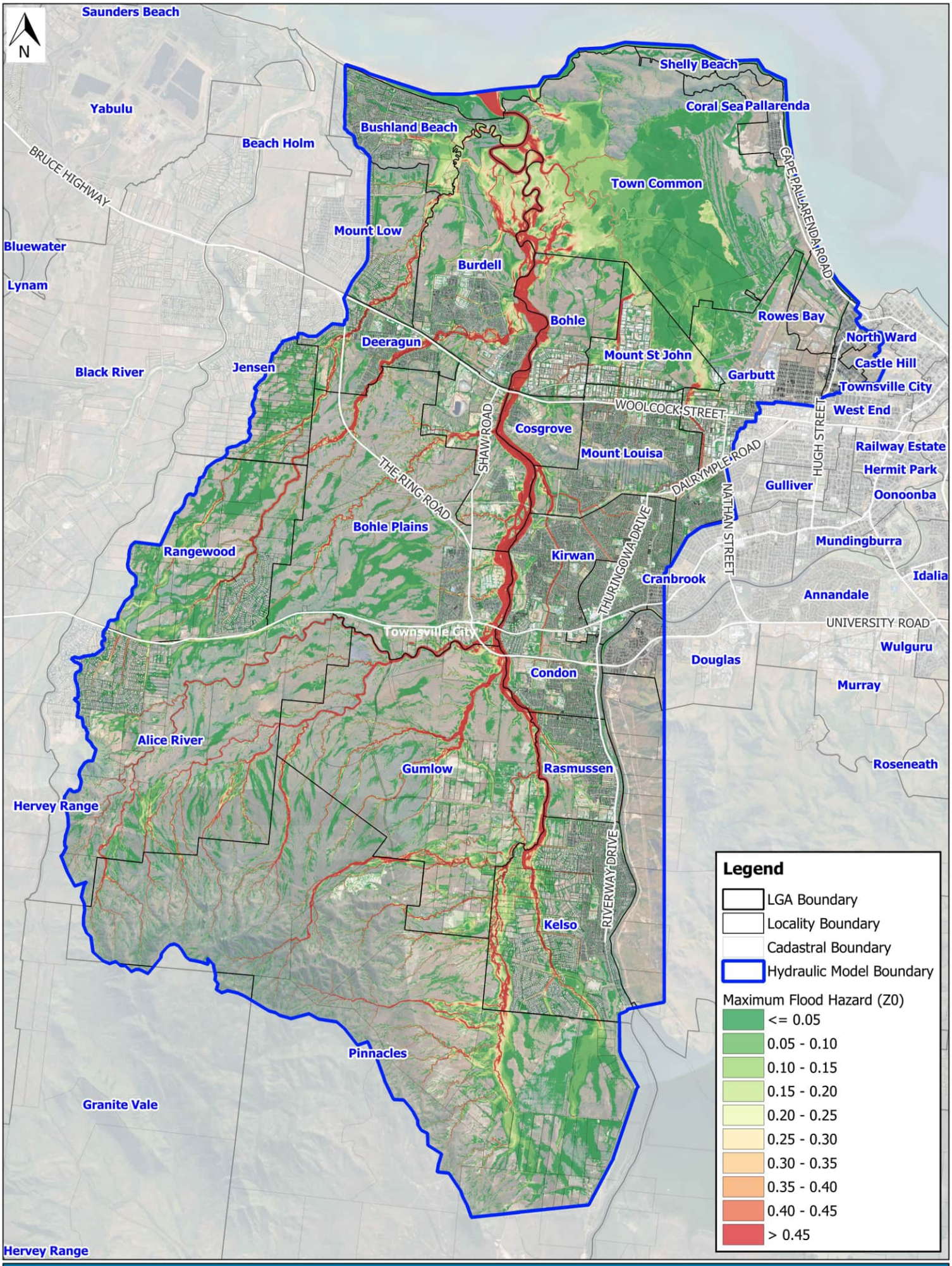
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Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Hazard (Z0) - 50% AEP

Bohle River Flood Study Update 2025

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Scale: 1:90,000

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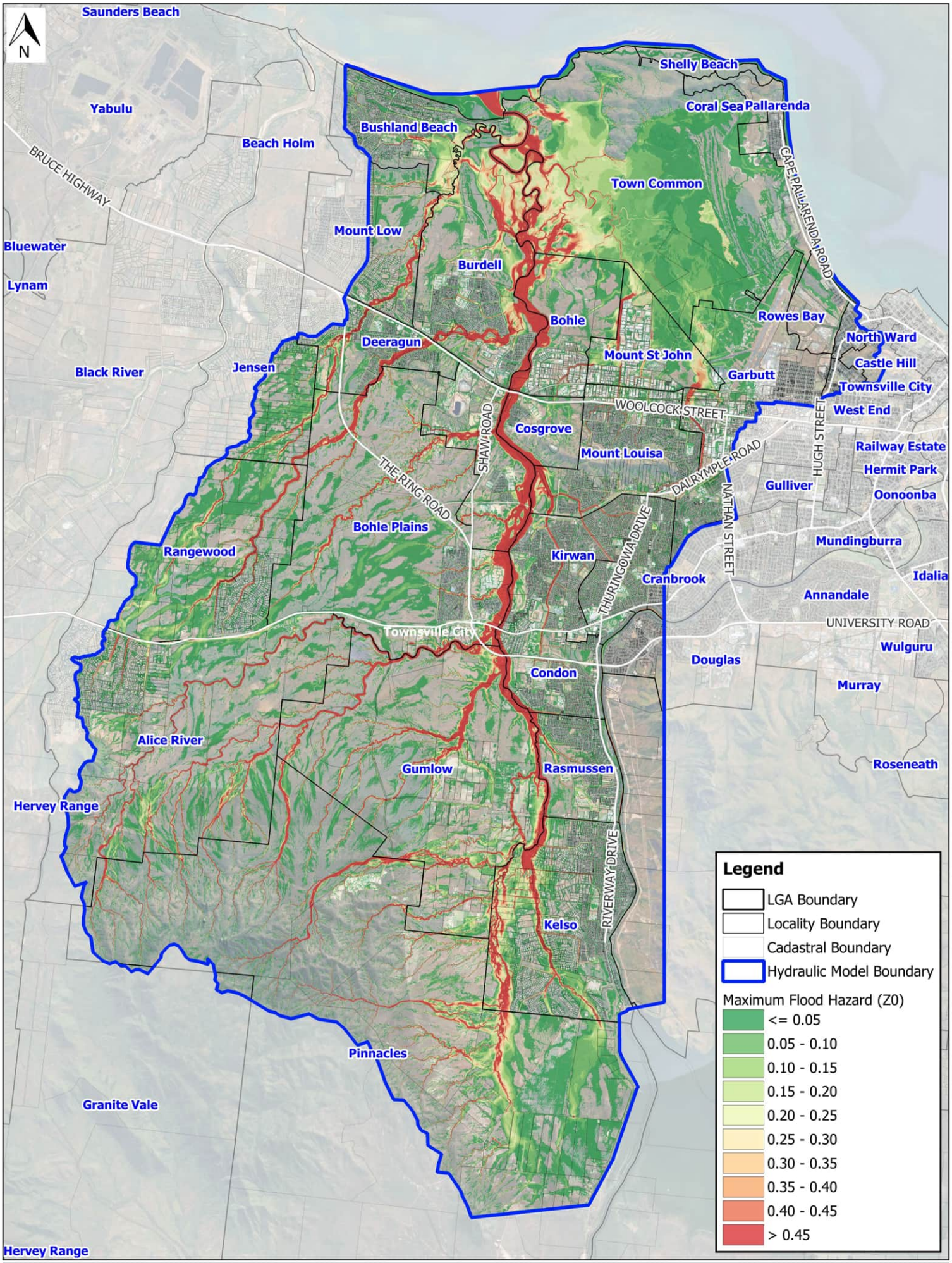
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Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Hazard (Z0) - 20% AEP

Bohle River Flood Study Update 2025

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Scale: 1:90,000

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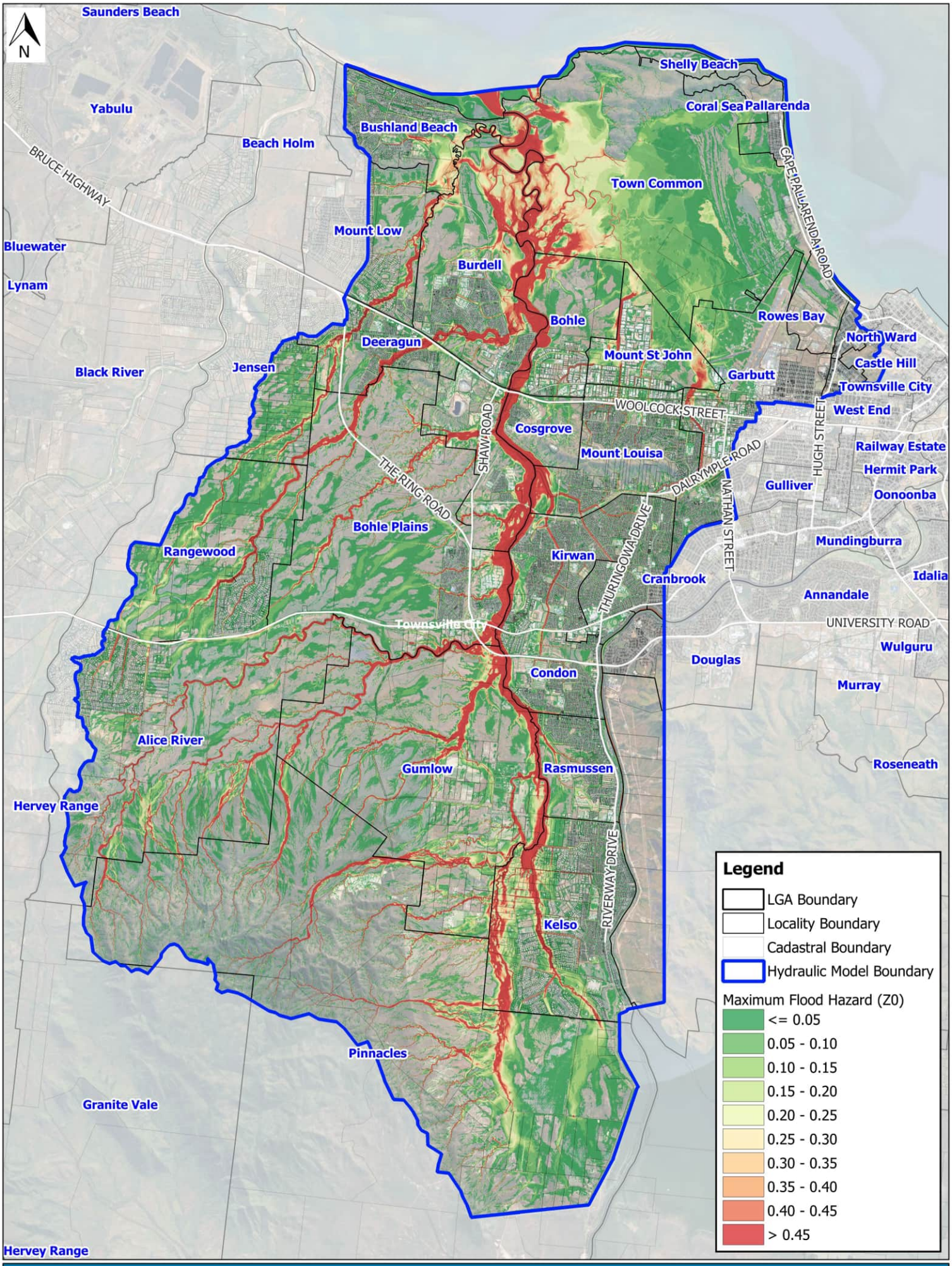
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Imagery Source: Google Satellite
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Design - Maximum Flood Hazard (Z0) - 10% AEP

Bohle River Flood Study Update 2025

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WATER TECHNOLOGY



Scale: 1:90,000

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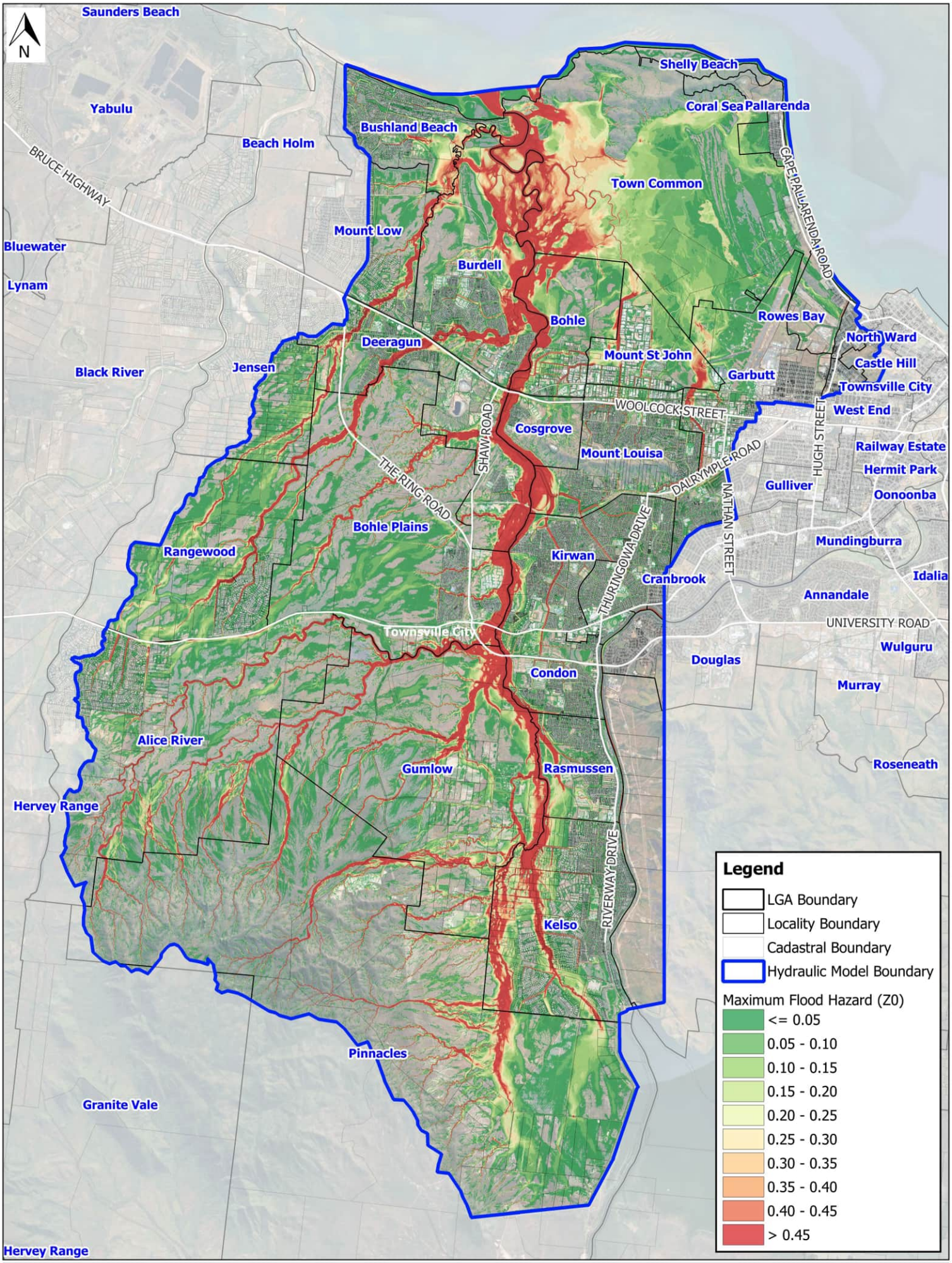
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Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Hazard (Z0) - 05% AEP

Bohle River Flood Study Update 2025

Townsville City Council

WATER TECHNOLOGY



Scale: 1:90,000

0 1,000 2,000 m

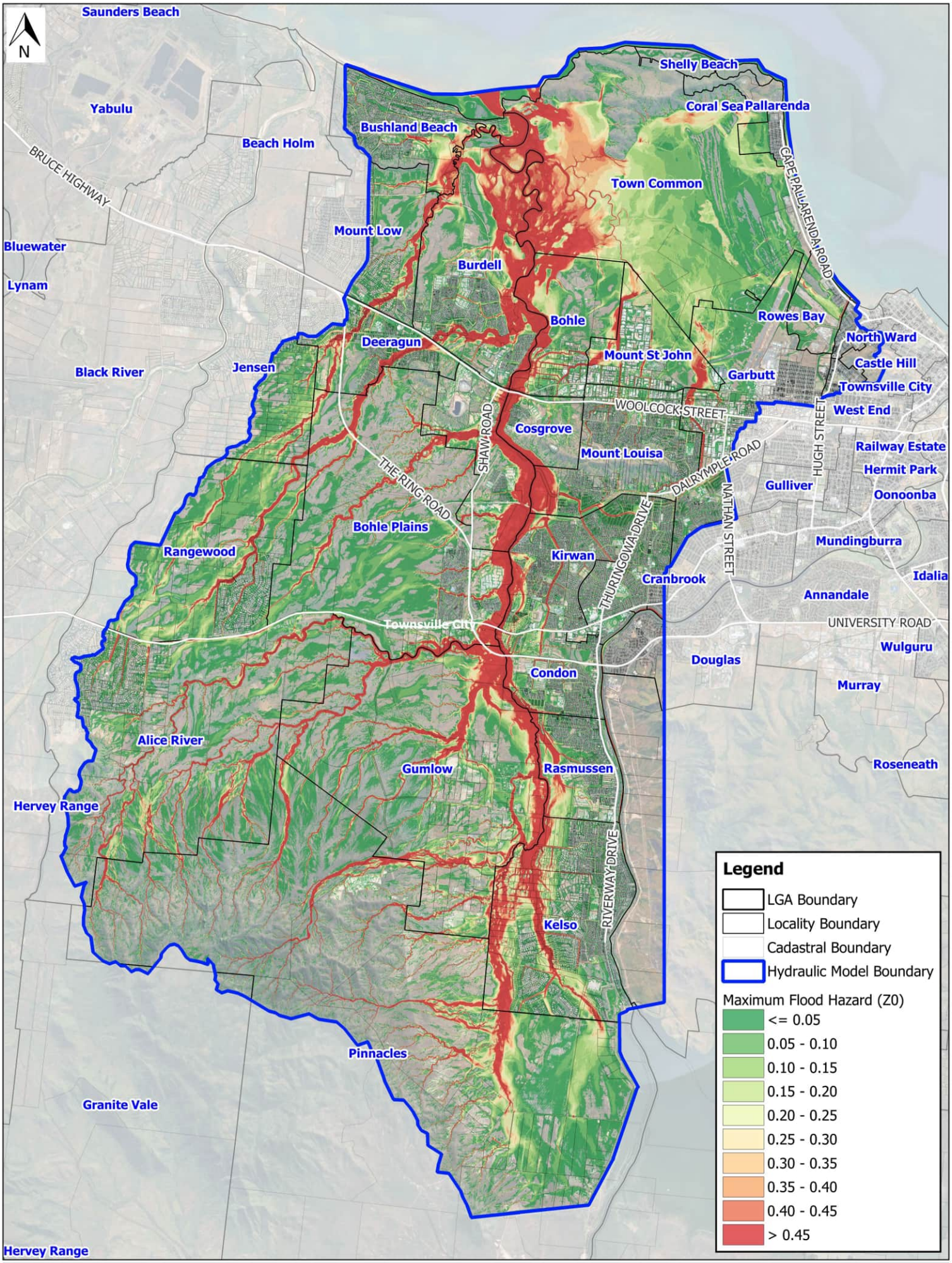
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Original Size: A3
Projection: GDA94 / MGA Zone 55
Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Hazard (Z0) - 02% AEP

Bohle River Flood Study Update 2025

Townsville City Council

WATER TECHNOLOGY



Scale: 1:90,000

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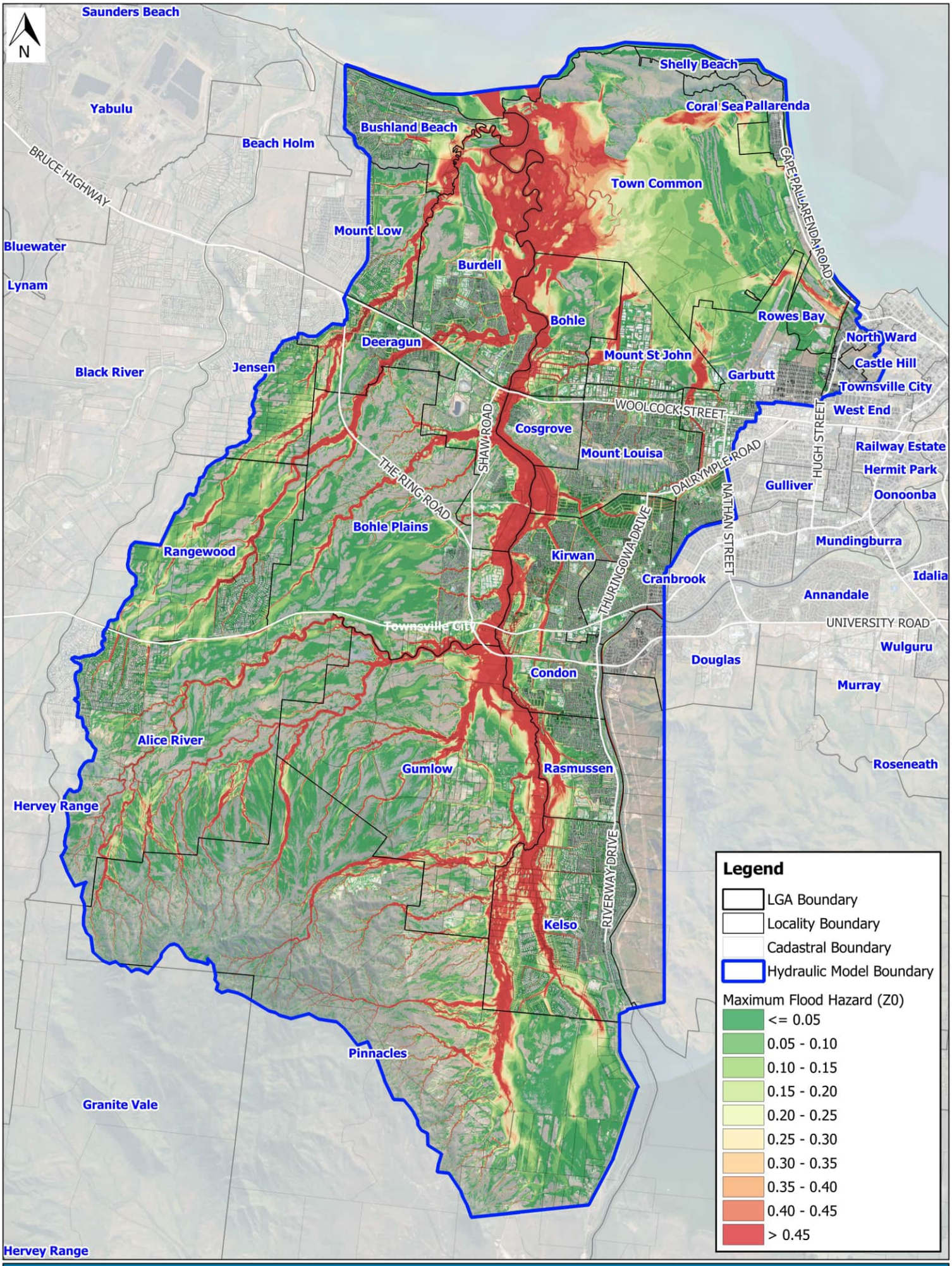
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Original Size: A3
Projection: GDA94 / MGA Zone 55
Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Hazard (Z0) - 01% AEP

Bohle River Flood Study Update 2025

Townsville City Council

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Scale: 1:90,000

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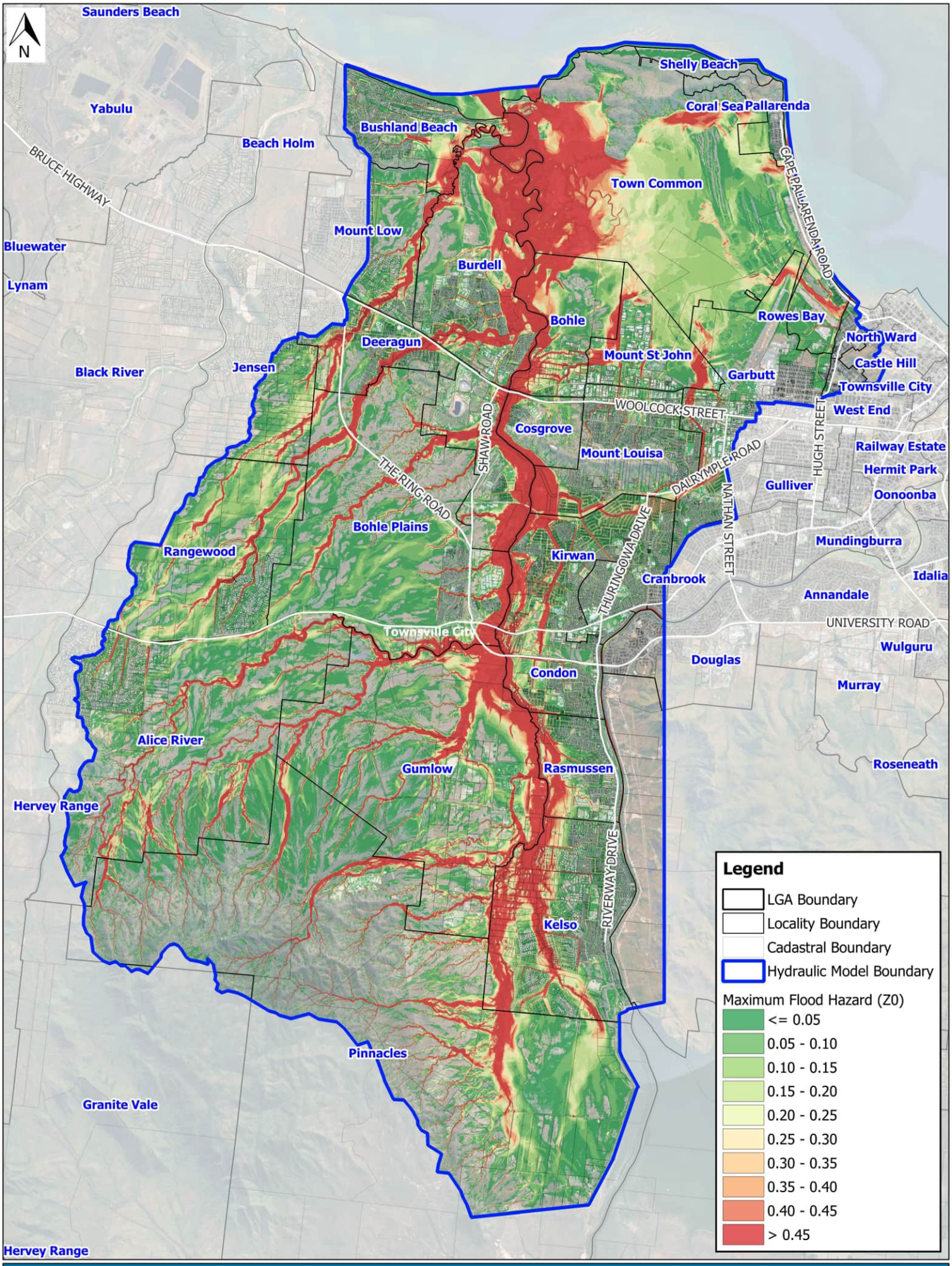
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Local Authority: Townsville City Council

Design - Maximum Flood Hazard (Z0) - 0.5% AEP

Bohle River Flood Study Update 2025

Townsville City Council

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Scale: 1:90,000

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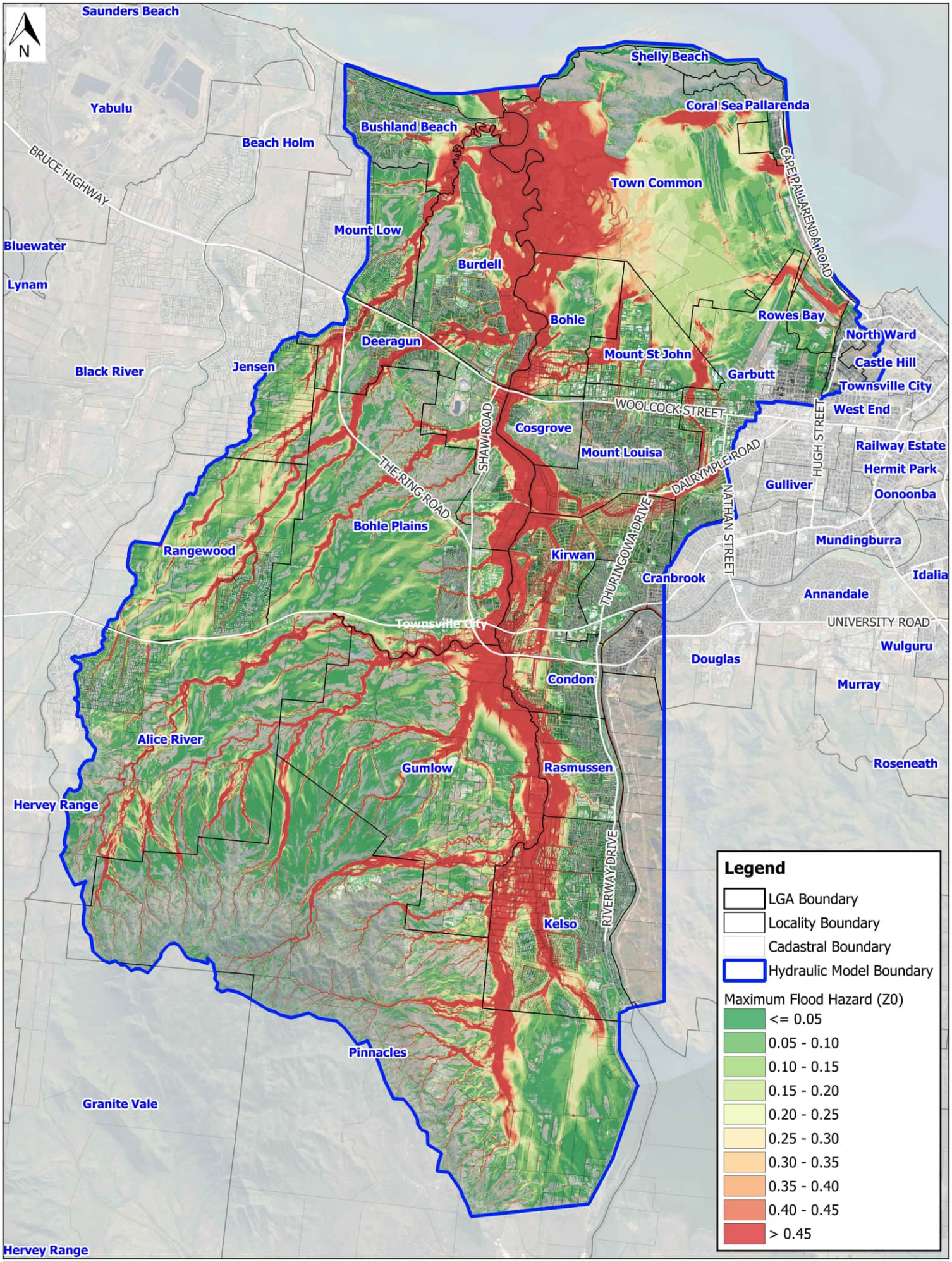
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Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Hazard (Z0) - 0.2% AEP

Bohle River Flood Study Update 2025

Townsville City Council

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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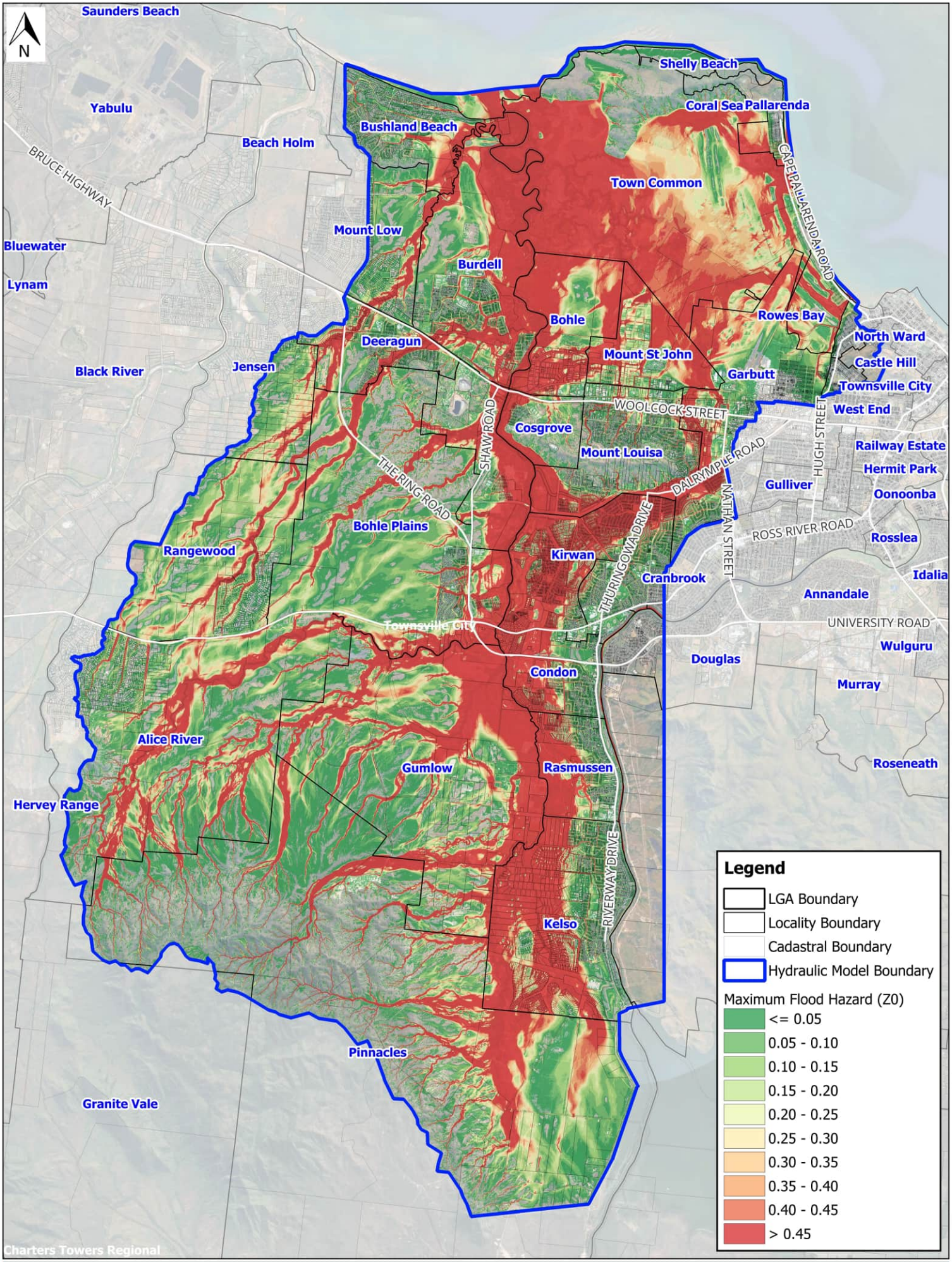
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Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Hazard (Z0) - 0.05% AEP

Bohle River Flood Study Update 2025

Townsville City Council

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Scale: 1:90,000

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Details
Original Size: A3
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Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Hazard (Z0) - _PMF

Bohle River Flood Study Update 2025

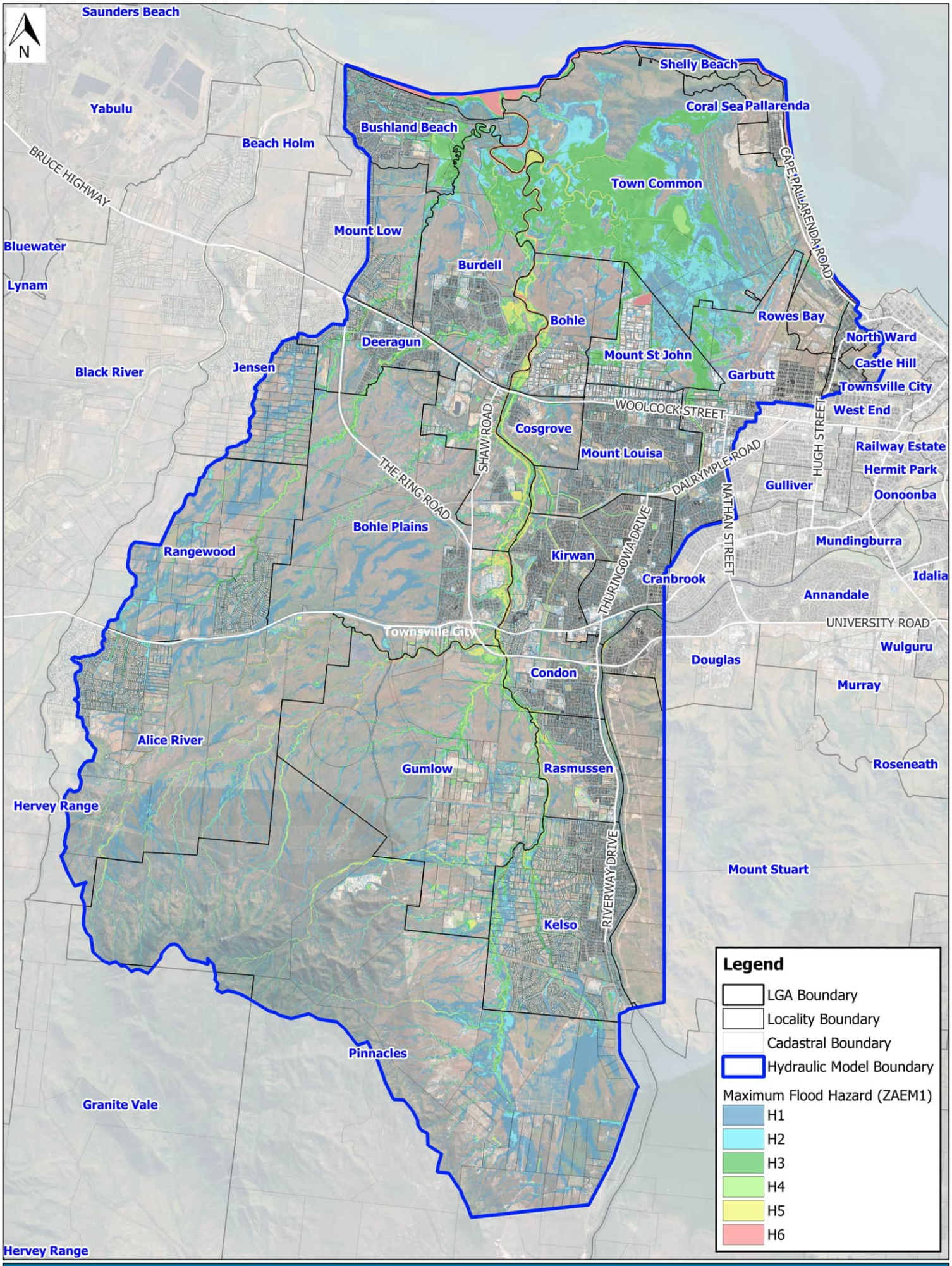
Townsville City Council

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

APPENDIX C
DESIGN EVENT MAPPING – FLOOD HAZARD (ZAEM1)





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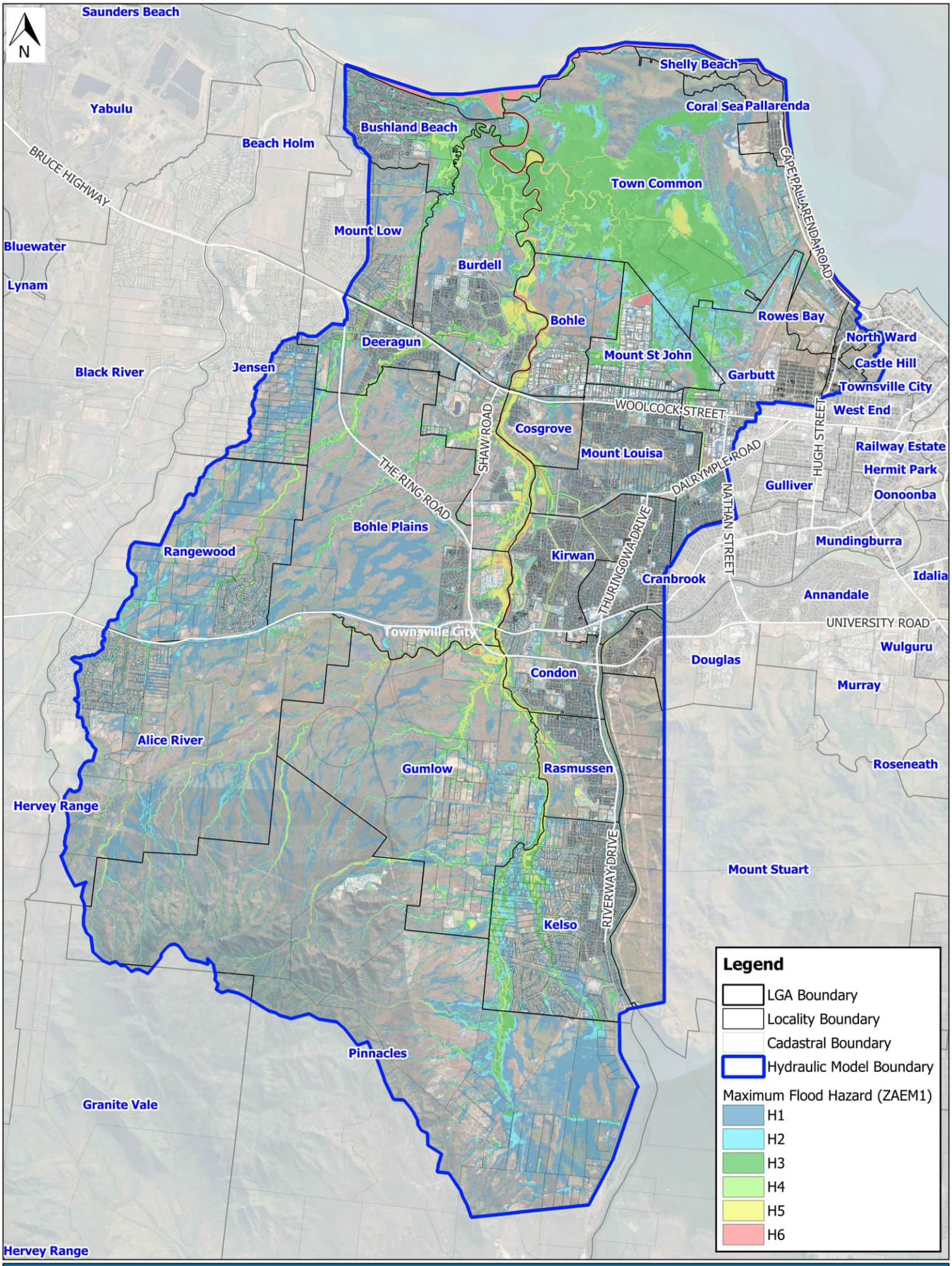
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Projection: GDA94 / MGA Zone 55
Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Hazard (ZAEM1) - 50% AEP

Bohle River Flood Study Update 2025

Townsville City Council

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Scale: 1:90,000

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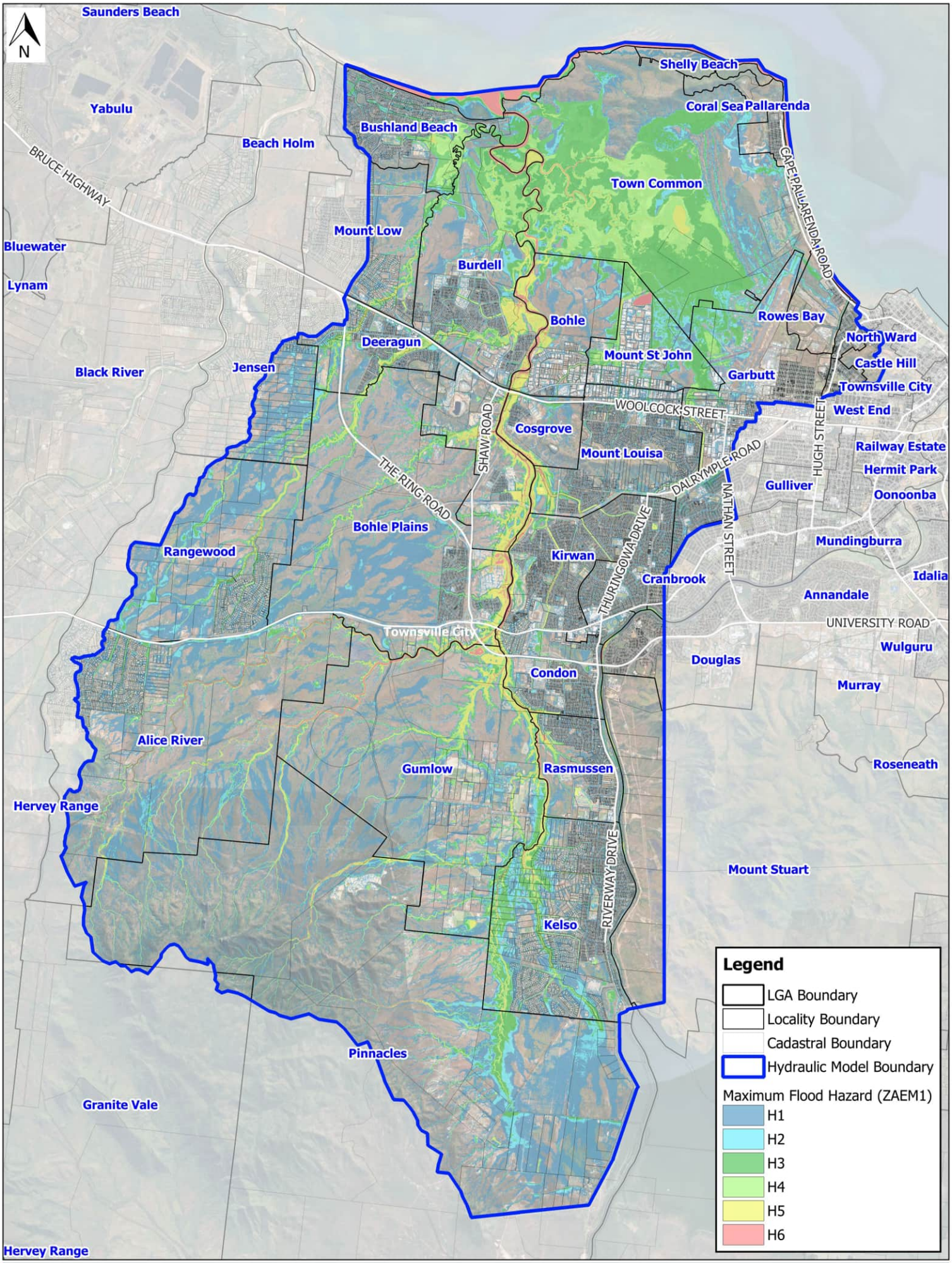
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Projection: GDA94 / MGA Zone 55
Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Hazard (ZAEM1) - 20% AEP

Bohle River Flood Study Update 2025

Townsville City Council

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Scale: 1:90,000

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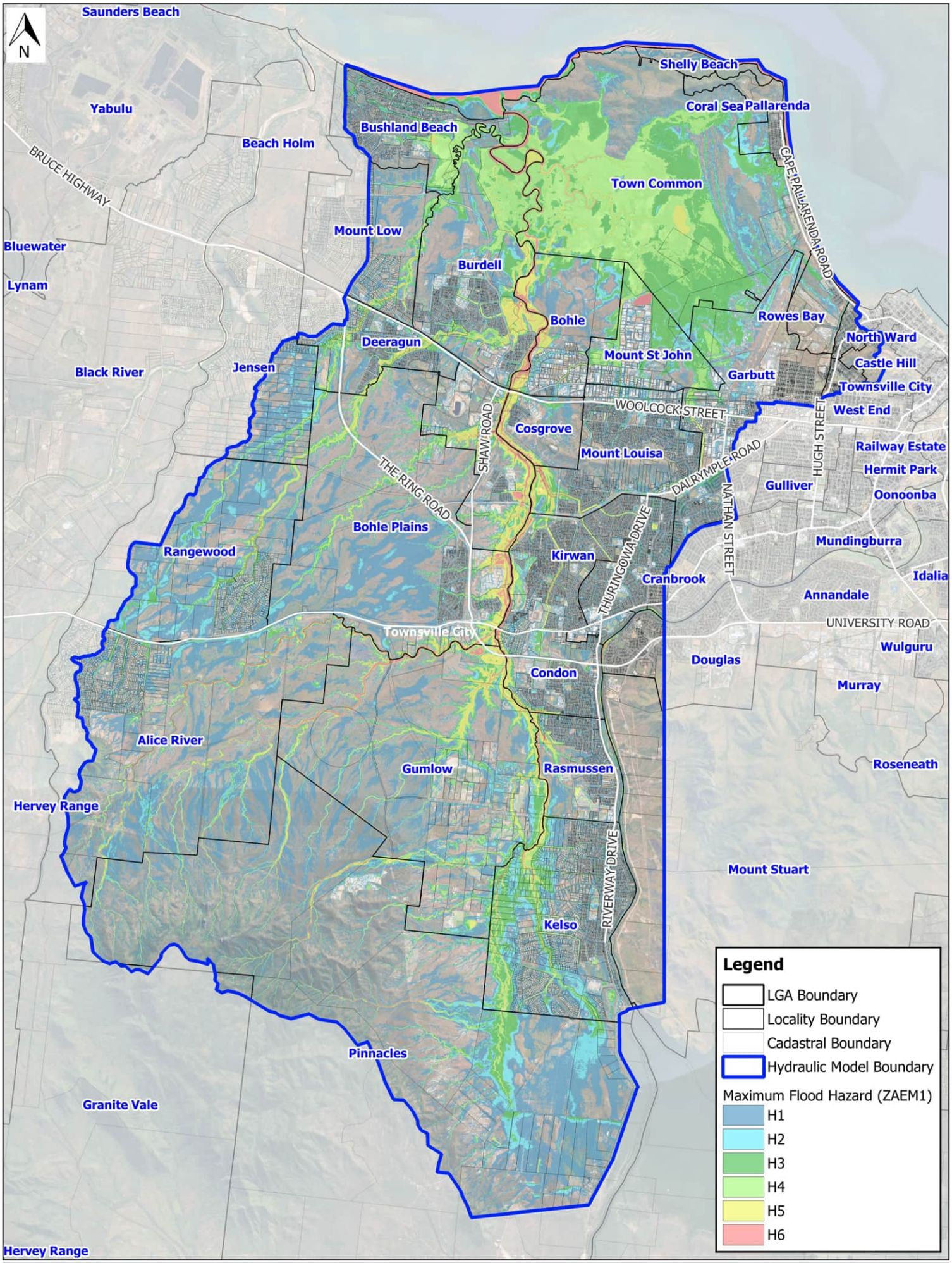
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Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Hazard (ZAEM1) - 10% AEP

Bohle River Flood Study Update 2025

Townsville City Council

WATER TECHNOLOGY



Scale: 1:90,000

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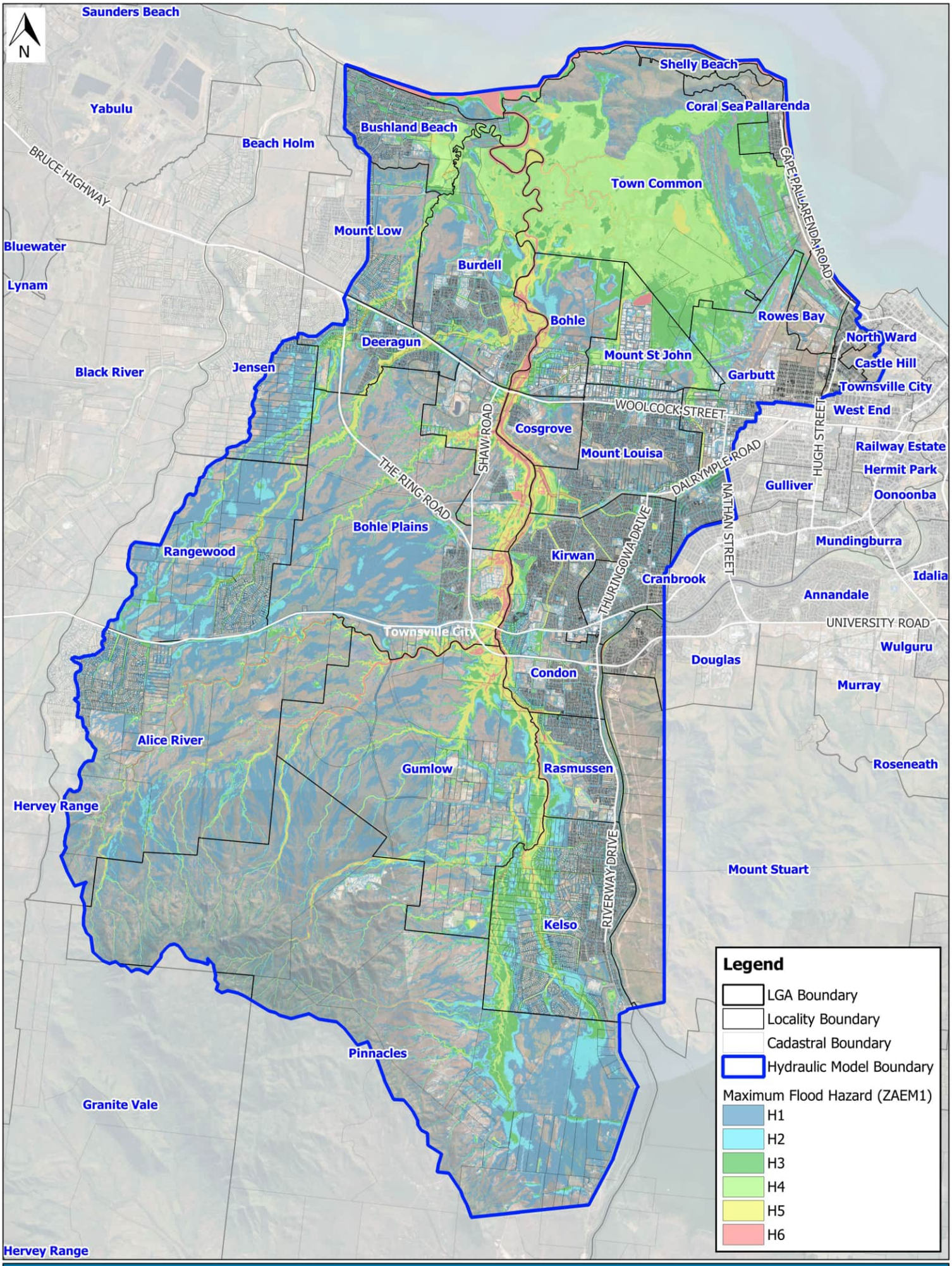
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Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Hazard (ZAEM1) - 05% AEP

Bohle River Flood Study Update 2025

Townsville City Council

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Scale: 1:90,000

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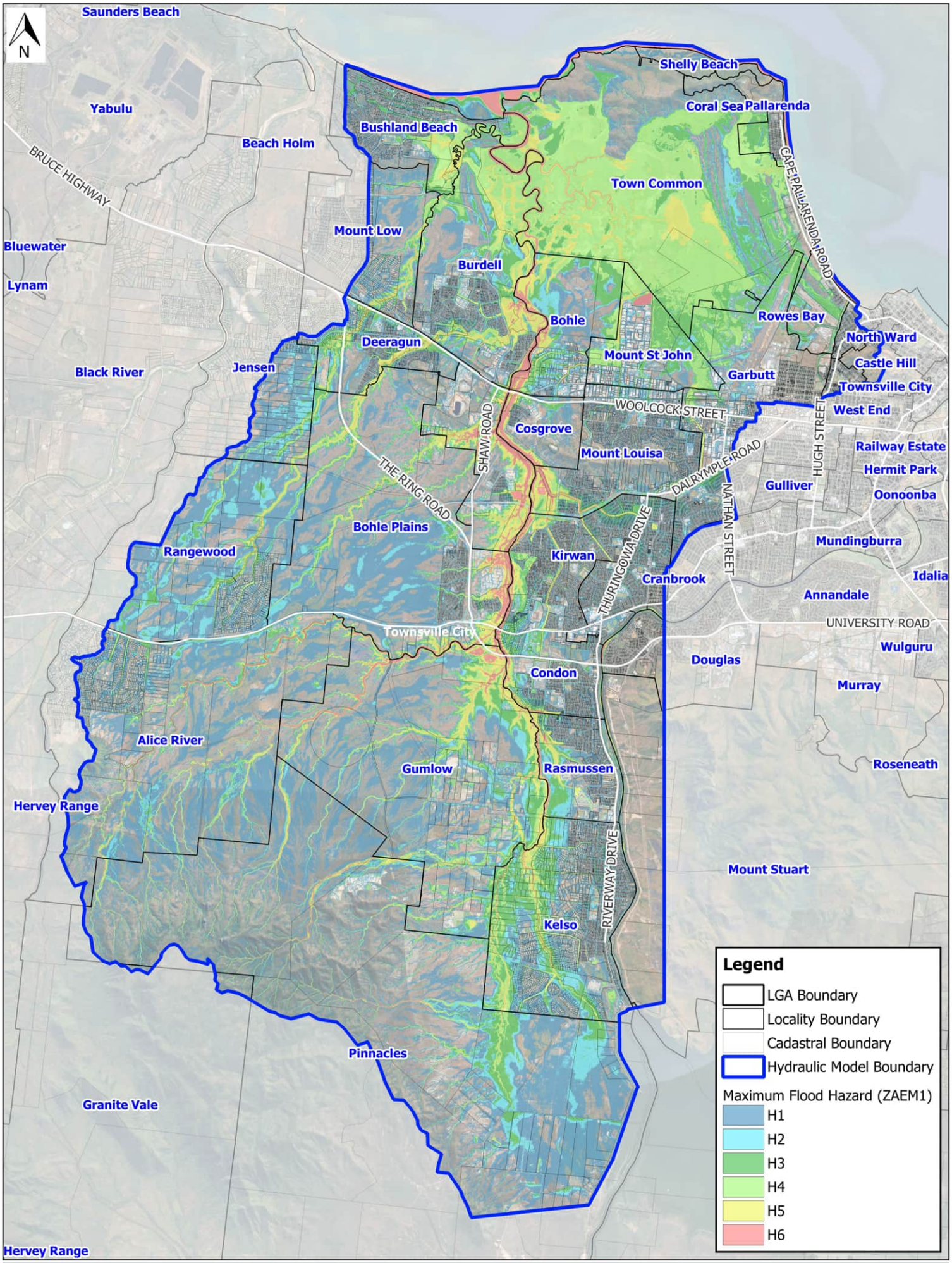
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Projection: GDA94 / MGA Zone 55
Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Hazard (ZAEM1) - 02% AEP

Bohle River Flood Study Update 2025

Townsville City Council

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Scale: 1:90,000

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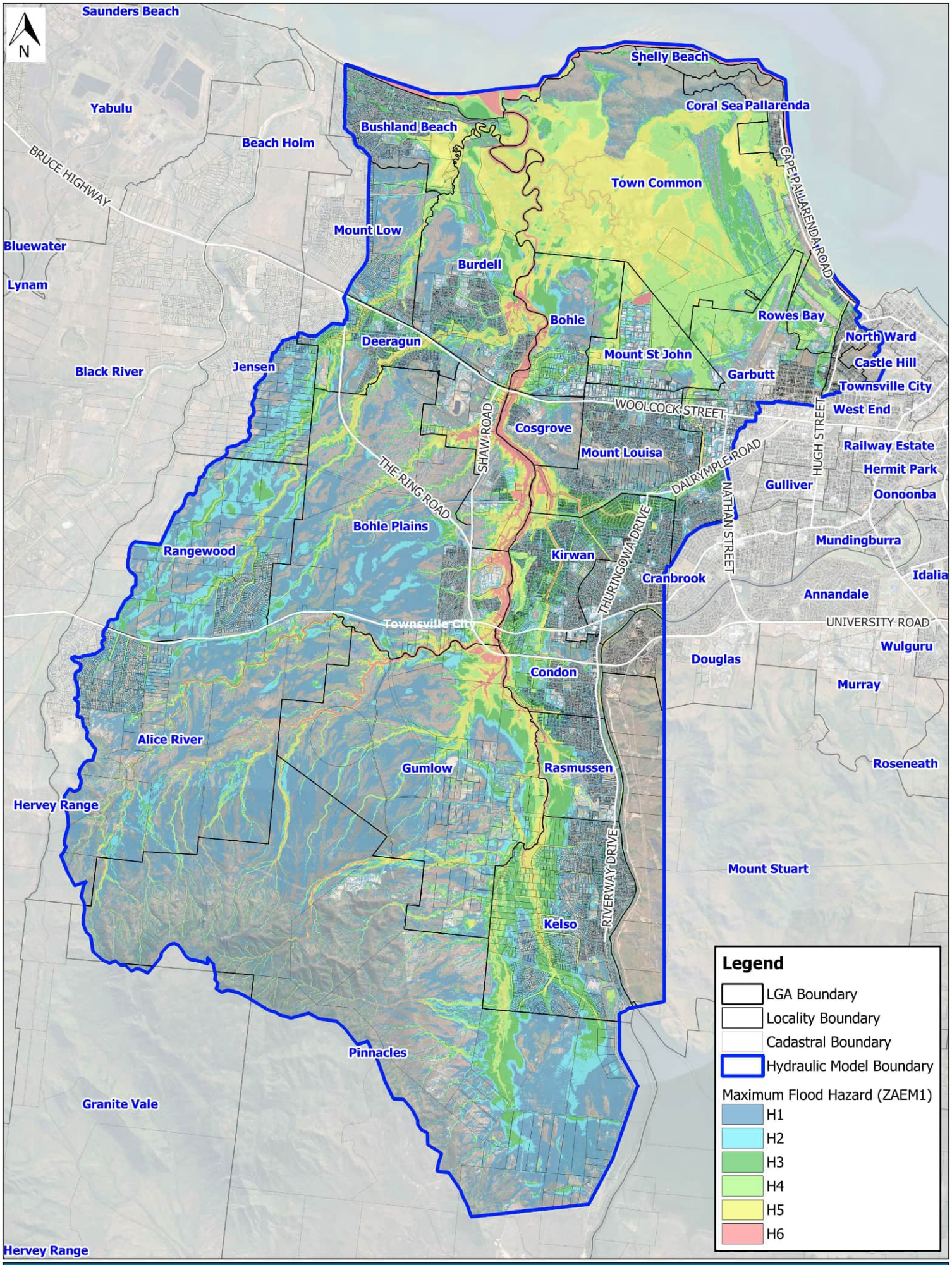
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Design - Maximum Flood Hazard (ZAEM1) - 01% AEP

Bohle River Flood Study Update 2025

Townsville City Council

WATER TECHNOLOGY
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Scale: 1:90,000

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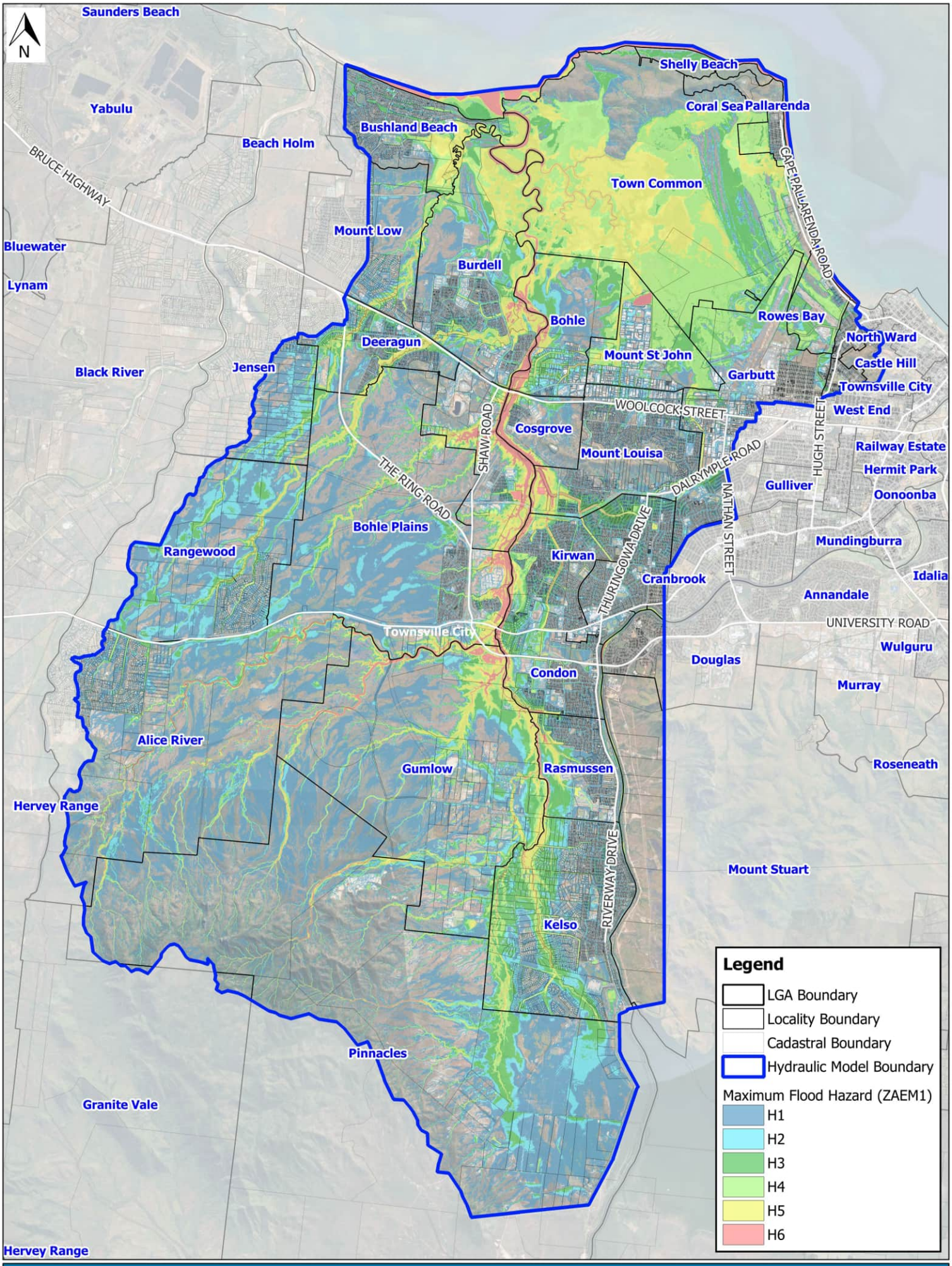
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Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Hazard (ZAEM1) - 0.2% AEP

Bohle River Flood Study Update 2025

Townsville City Council

WATER TECHNOLOGY



Scale: 1:90,000

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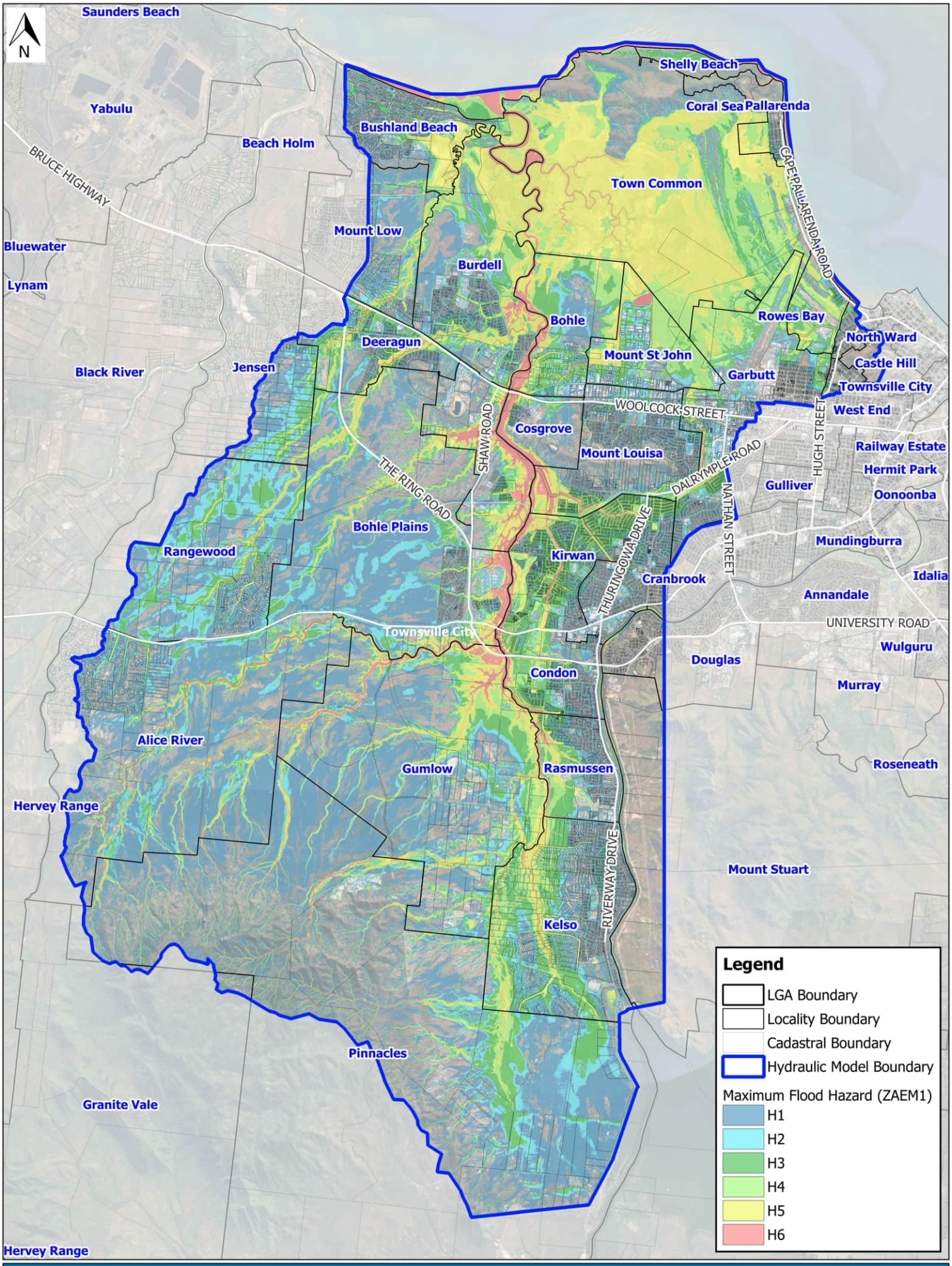
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Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Hazard (ZAEM1) - 0.5% AEP

Bohle River Flood Study Update 2025

Townsville City Council

WATER TECHNOLOGY



Scale: 1:90,000

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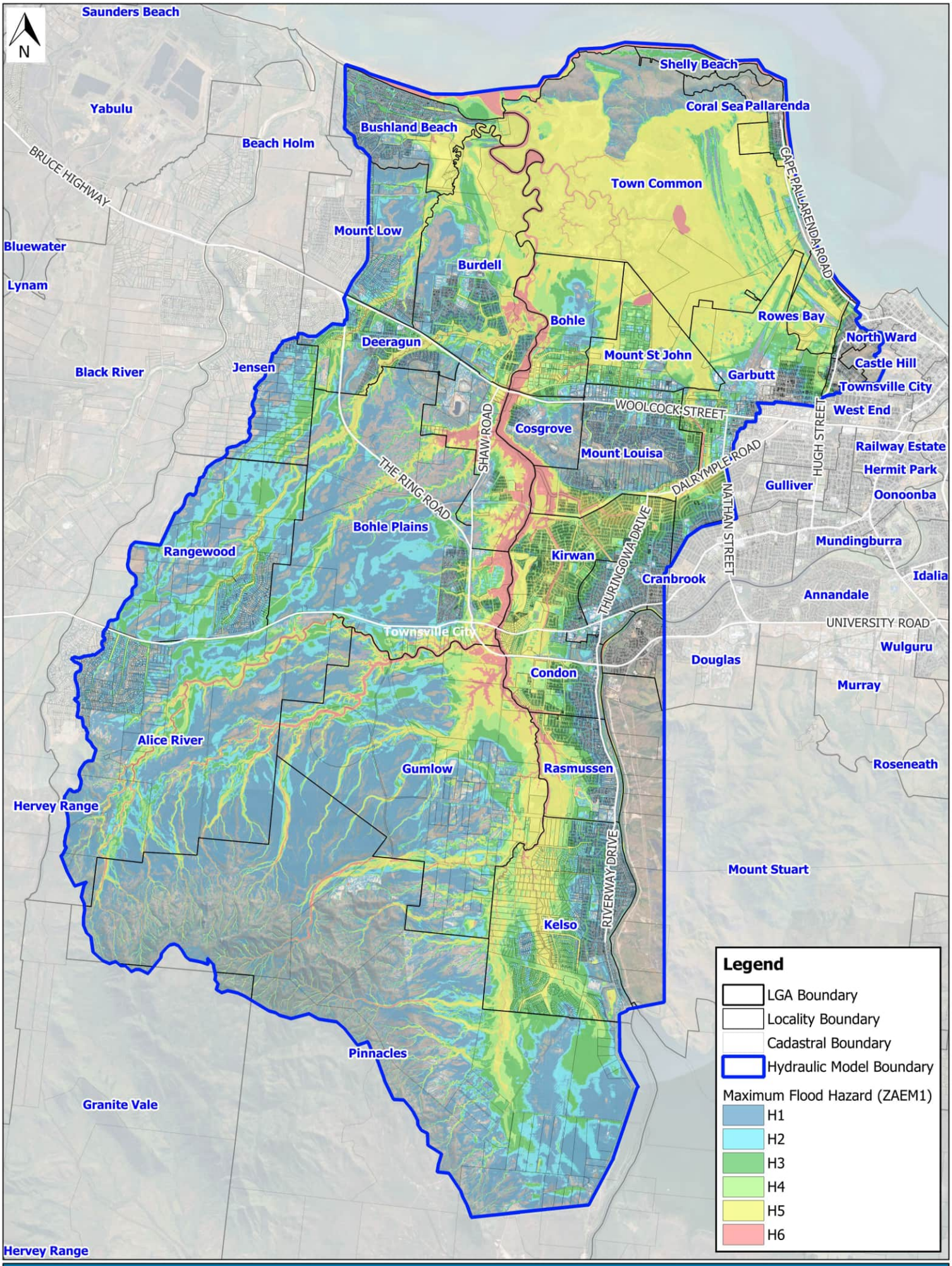
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Local Authority: Townsville City Council

Design - Maximum Flood Hazard (ZAEM1) - 0.05% AEP

Bohle River Flood Study Update 2025

Townsville City Council

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WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Scale: 1:90,000

0 1,000 2,000 m

Details
Original Size: A3
Projection: GDA94 / MGA Zone 55
Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Hazard (ZAEM1) - _PMF

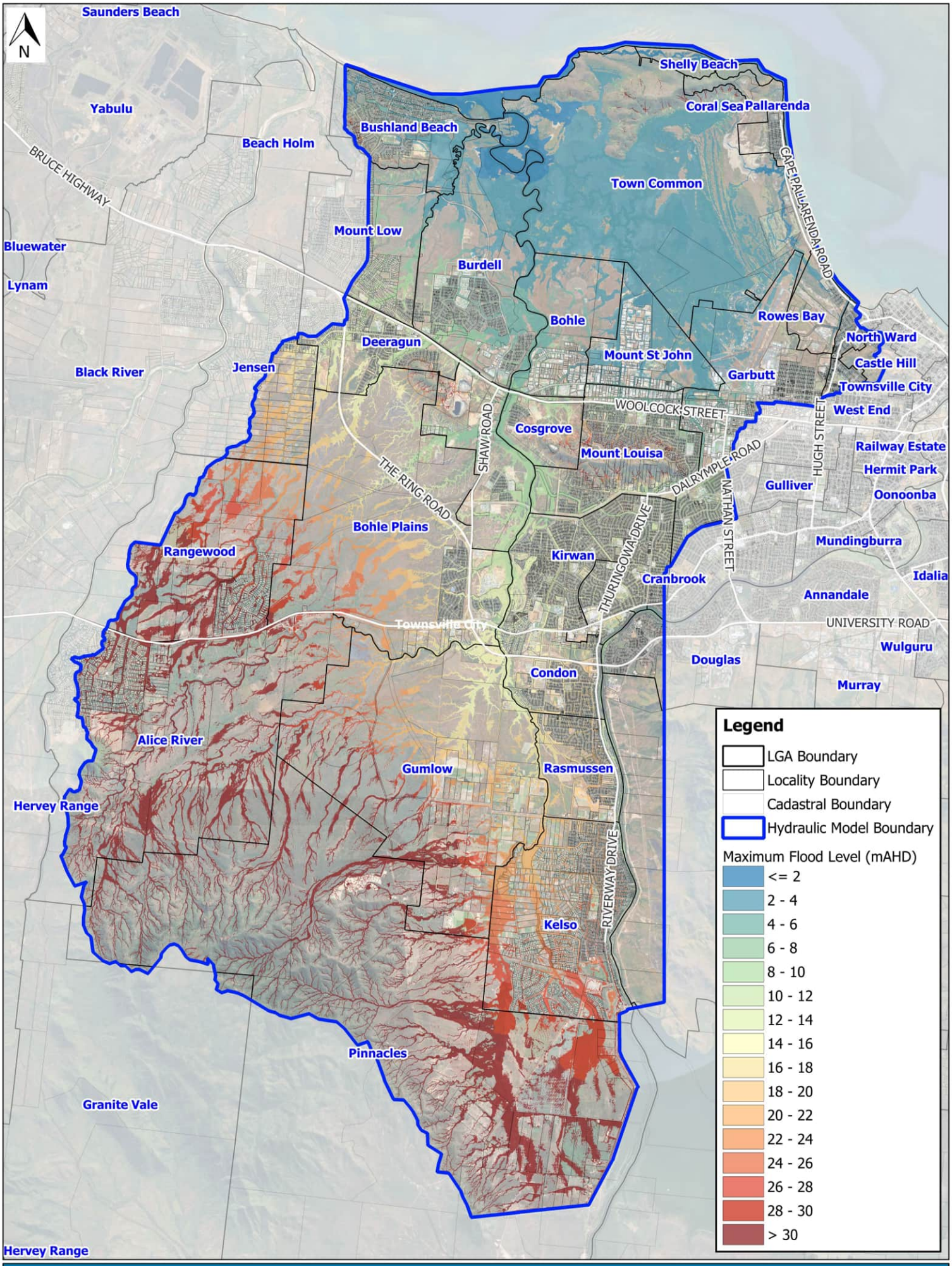
Bohle River Flood Study Update 2025

Townsville City Council

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

APPENDIX D
DESIGN EVENT MAPPING – FLOOD LEVEL





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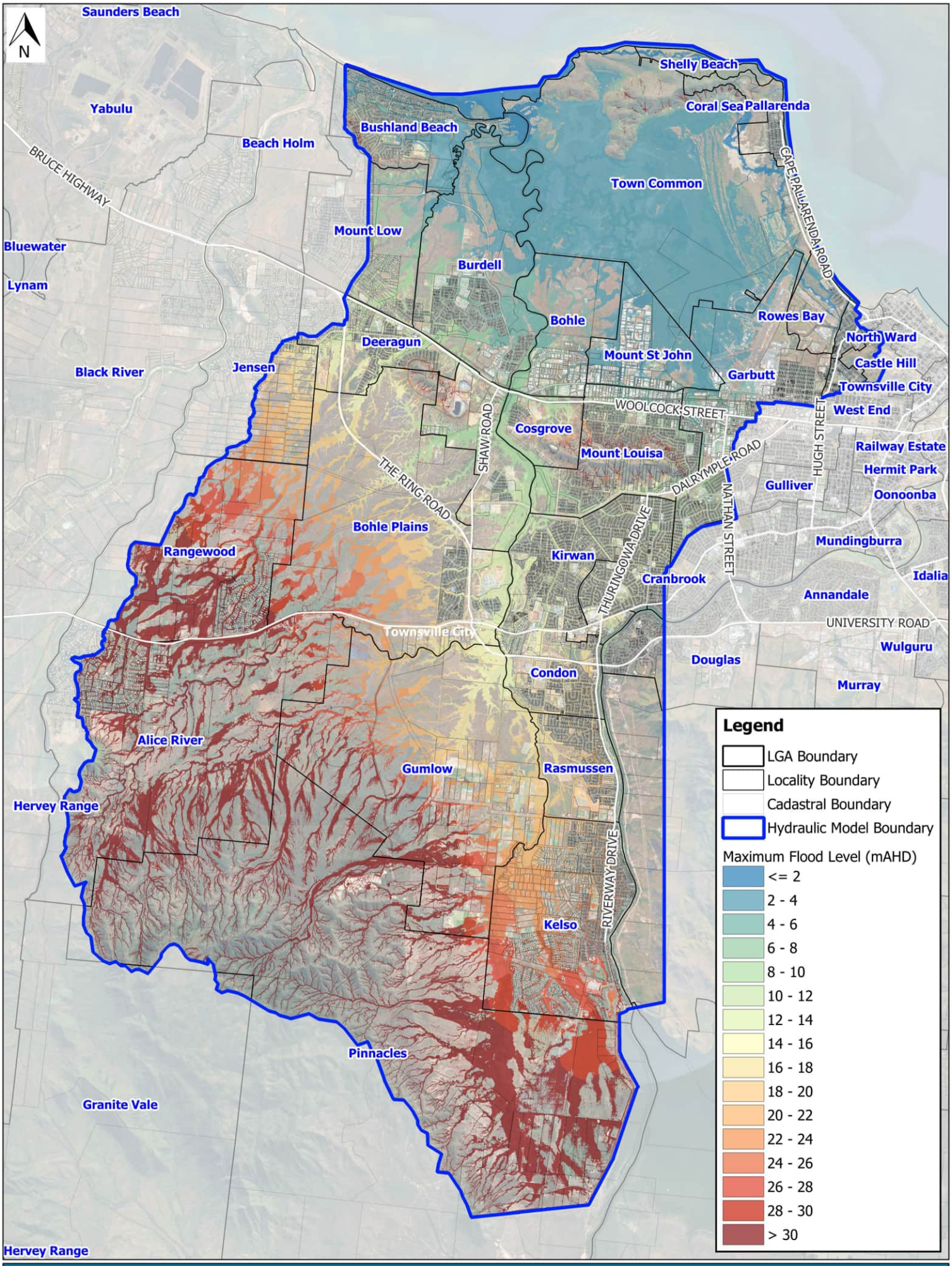
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Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Level - 50% AEP

Bohle River Flood Study Update 2025

Townsville City Council

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Scale: 1:90,000

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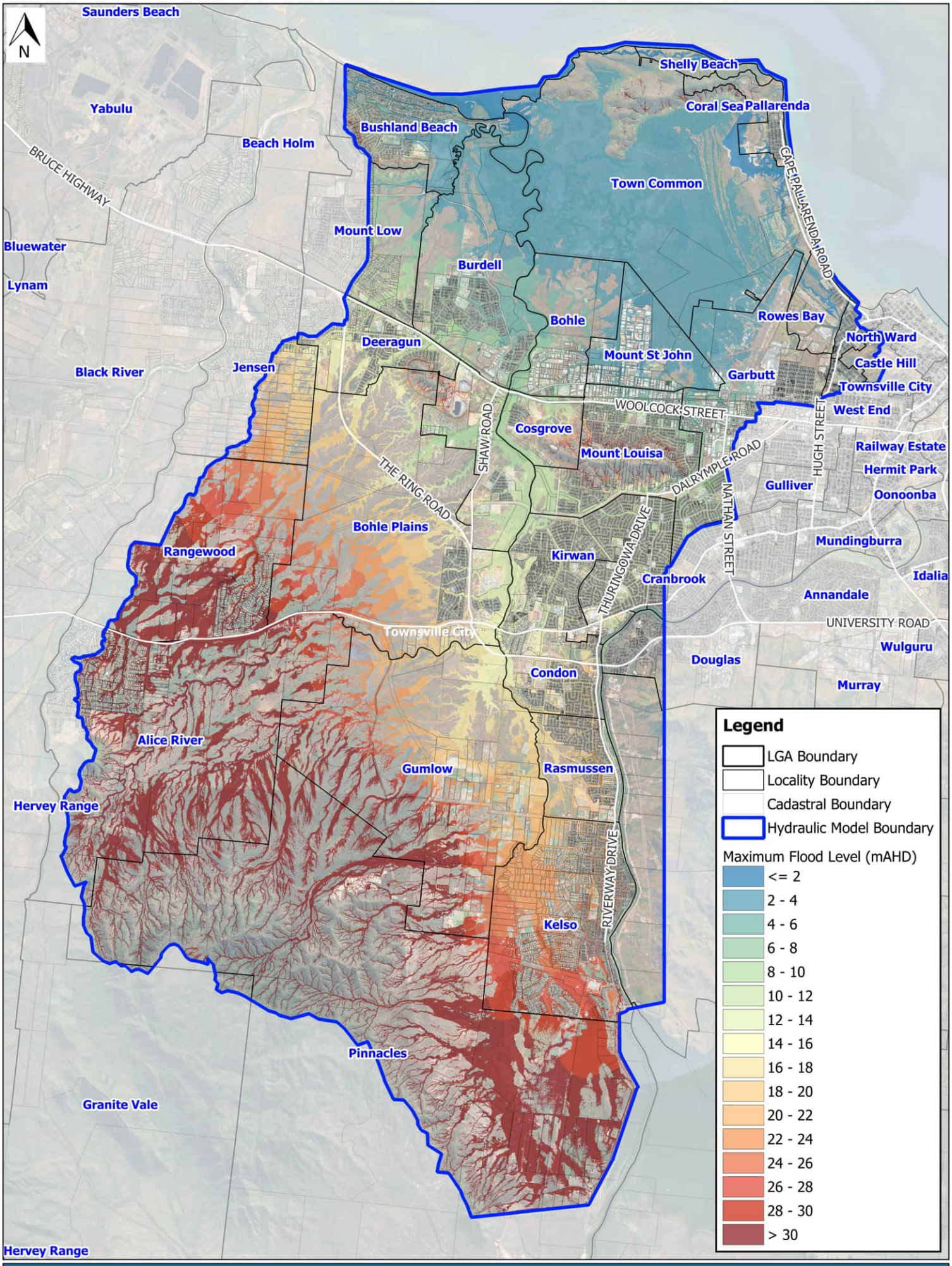
Details
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Local Authority: Townsville City Council

Design - Maximum Flood Level - 20% AEP

Bohle River Flood Study Update 2025

Townsville City Council

WATER TECHNOLOGY



Scale: 1:90,000

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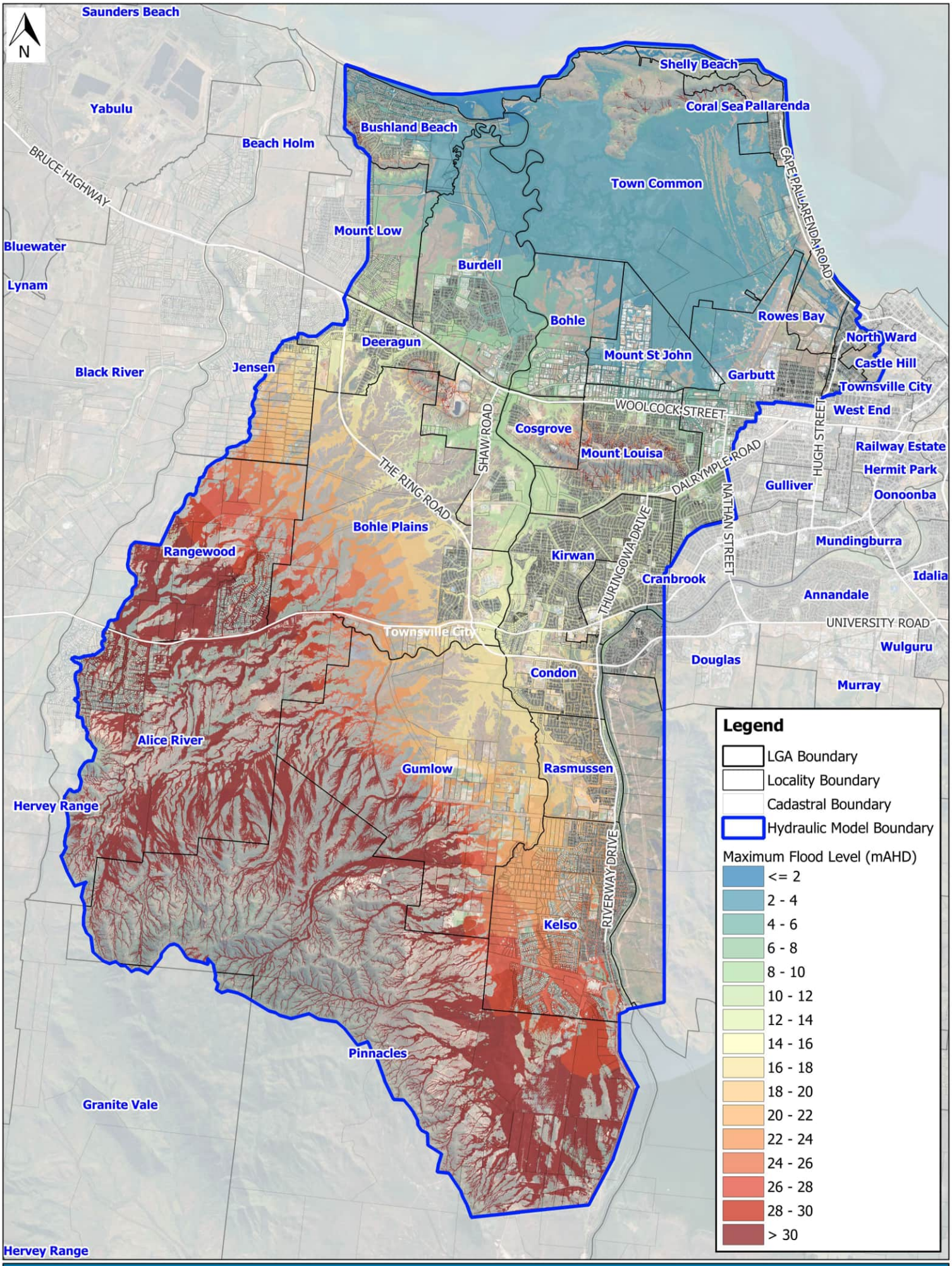
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Projection: GDA94 / MGA Zone 55
Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Level - 10% AEP

Bohle River Flood Study Update 2025

Townsville City Council

WATER TECHNOLOGY



Scale: 1:90,000

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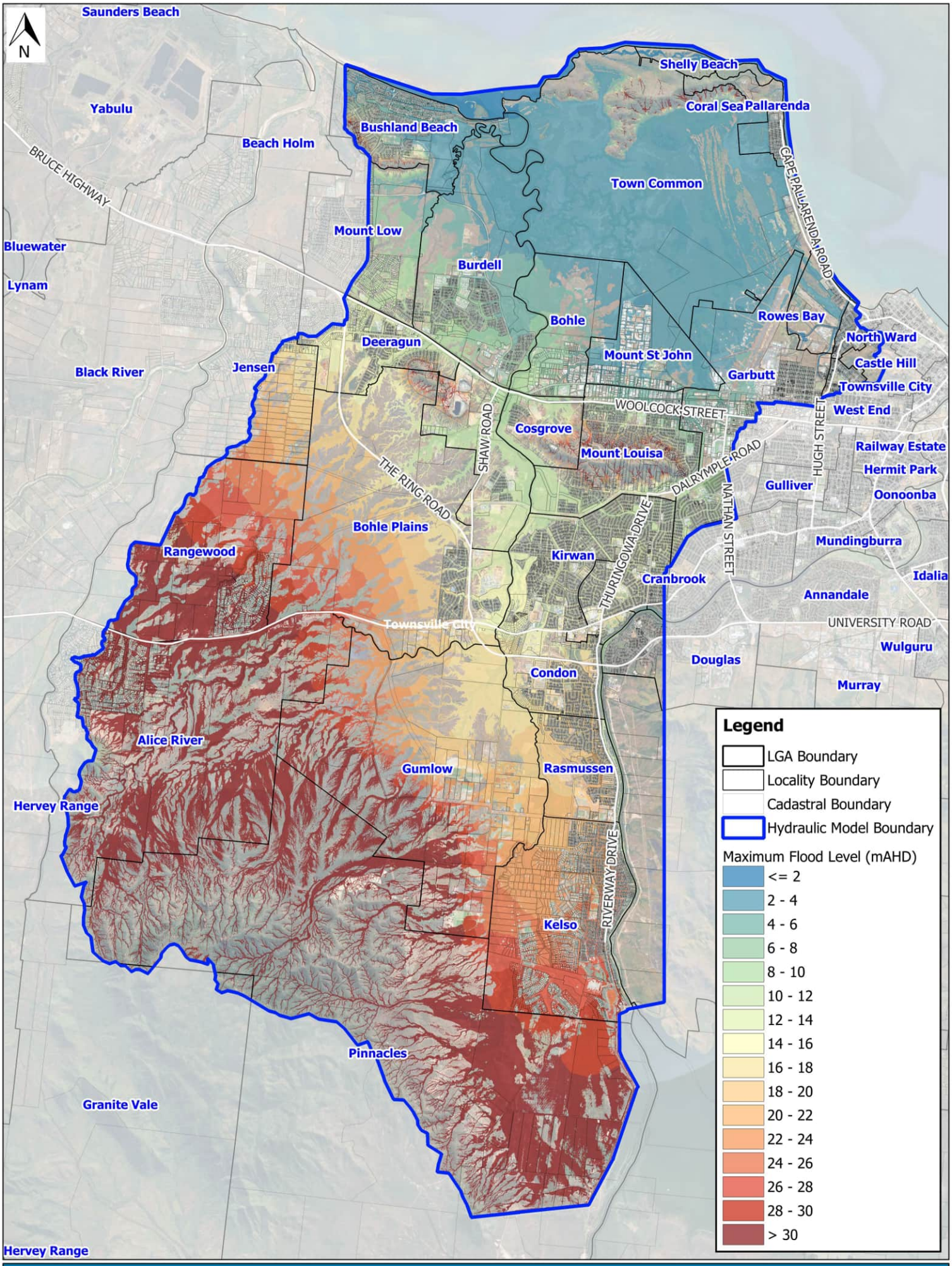
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Original Size: A3
Projection: GDA94 / MGA Zone 55
Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Level - 05% AEP

Bohle River Flood Study Update 2025

Townsville City Council

WATER TECHNOLOGY



Scale: 1:90,000

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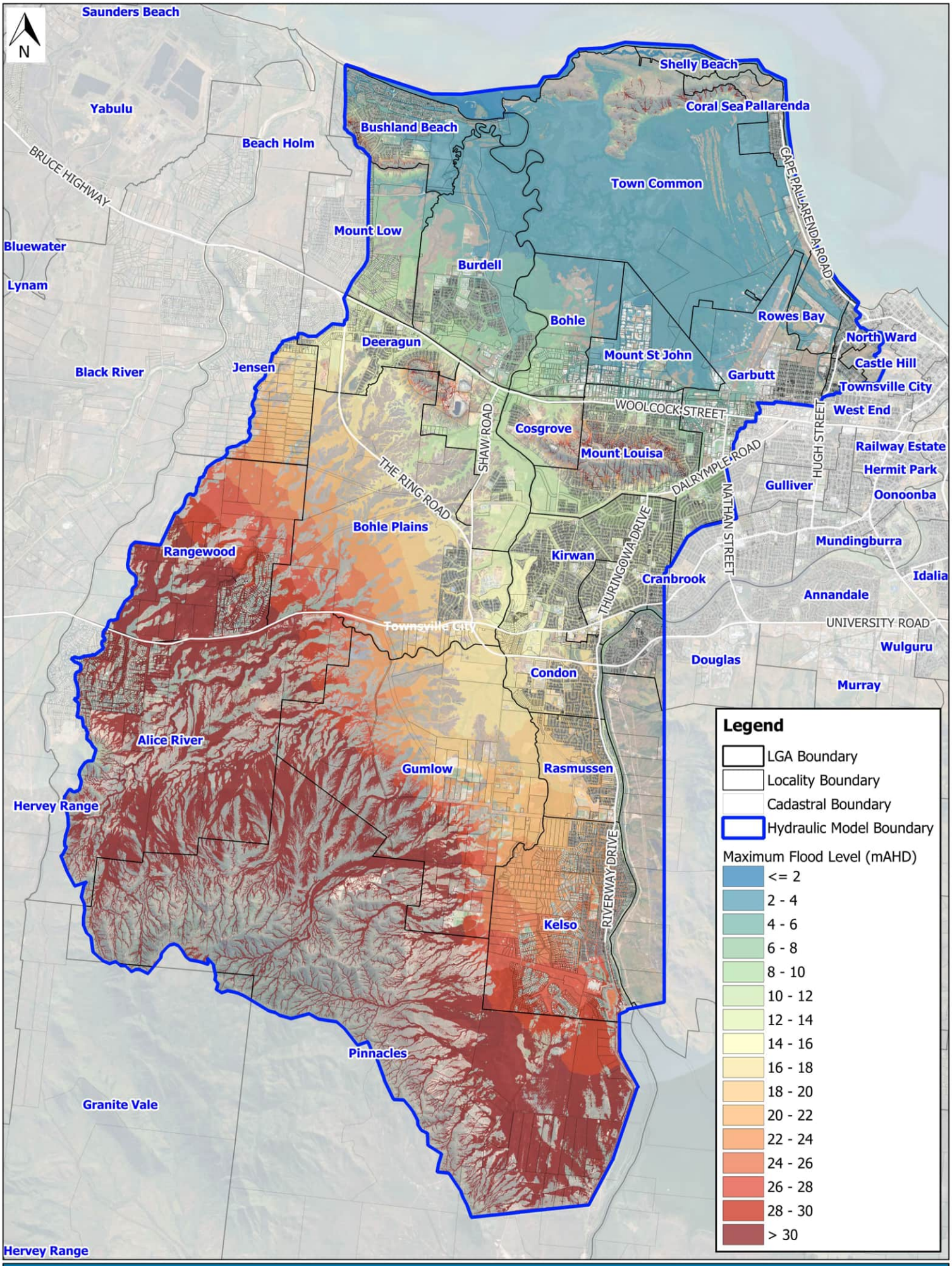
Details
Original Size: A3
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Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Level - 02% AEP

Bohle River Flood Study Update 2025

Townsville City Council

WATER TECHNOLOGY



Scale: 1:90,000

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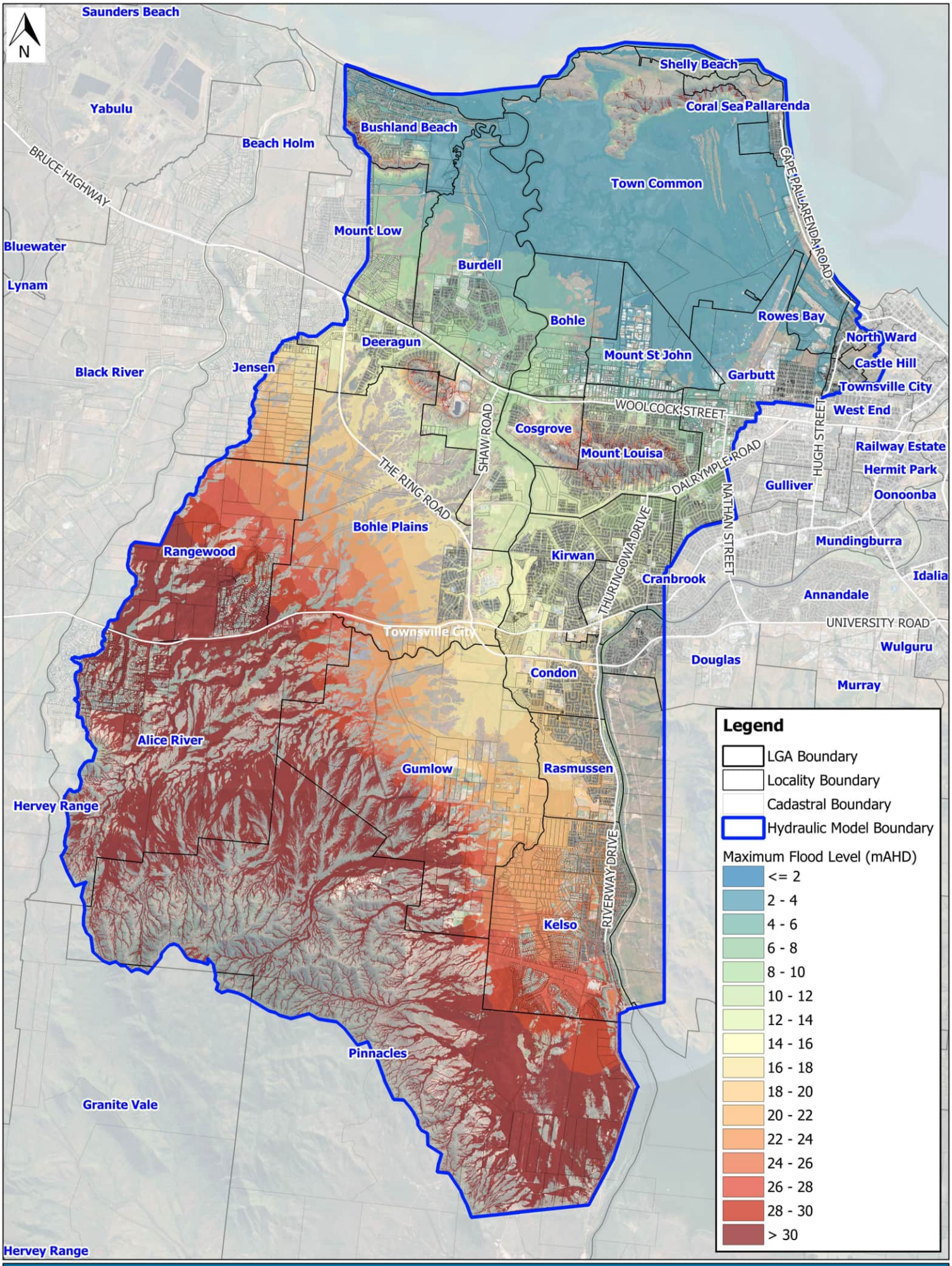
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Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Level - 01% AEP

Bohle River Flood Study Update 2025

Townsville City Council

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Scale: 1:90,000

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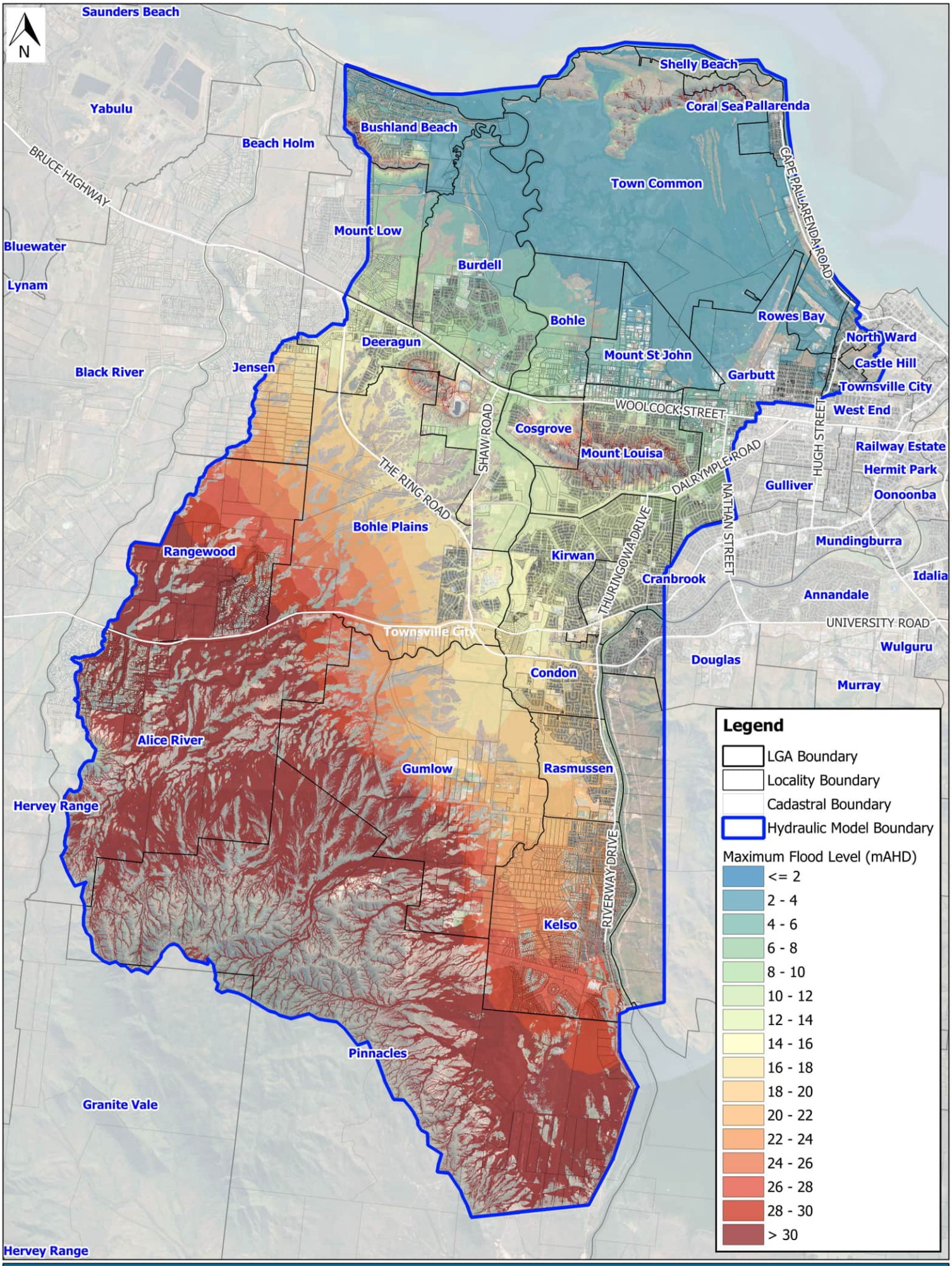
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Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Level - 0.5% AEP

Bohle River Flood Study Update 2025

Townsville City Council

WATER TECHNOLOGY



Scale: 1:90,000

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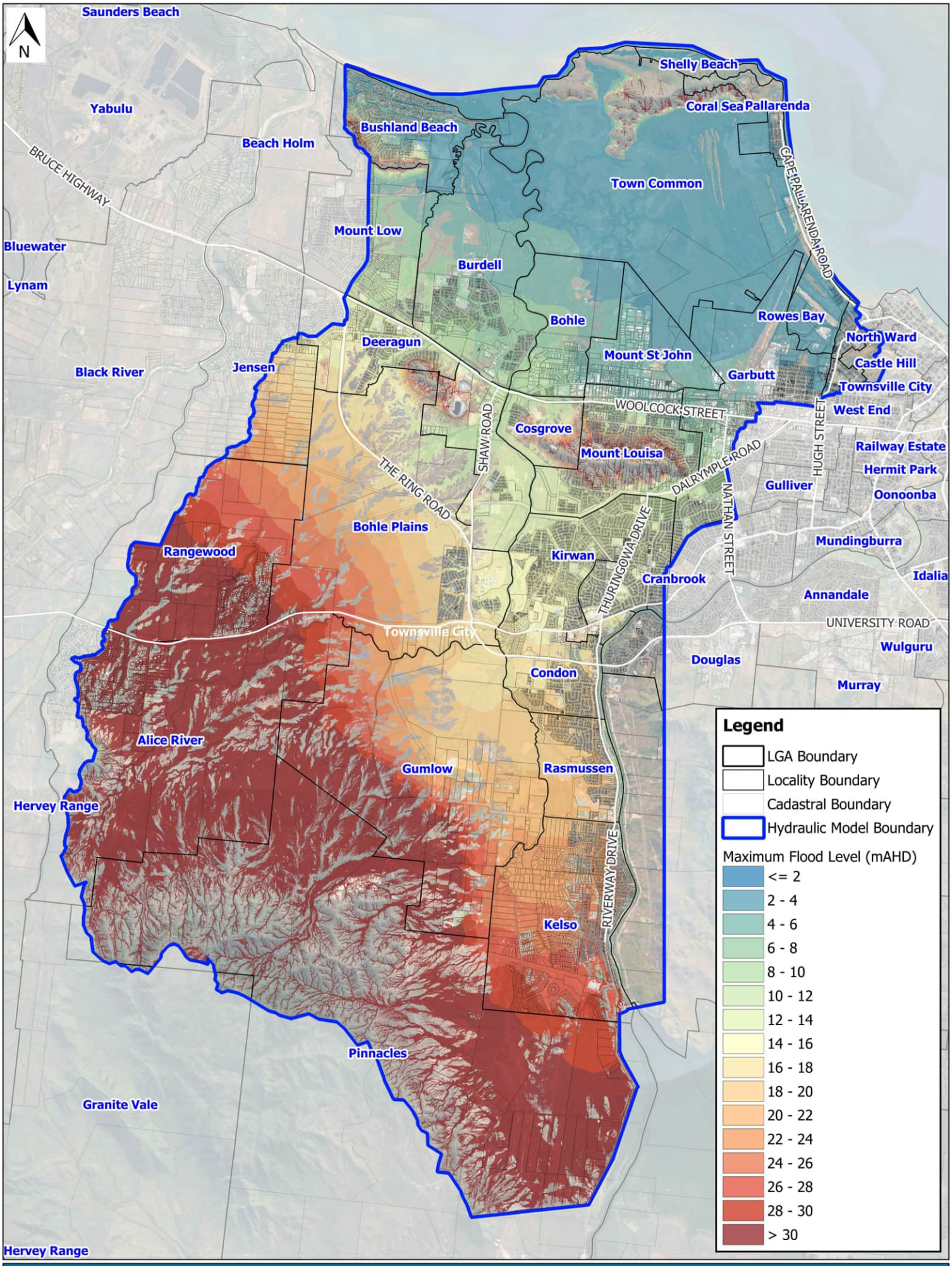
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Original Size: A3
Projection: GDA94 / MGA Zone 55
Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Level - 0.2% AEP

Bohle River Flood Study Update 2025

Townsville City Council

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



Scale: 1:90,000

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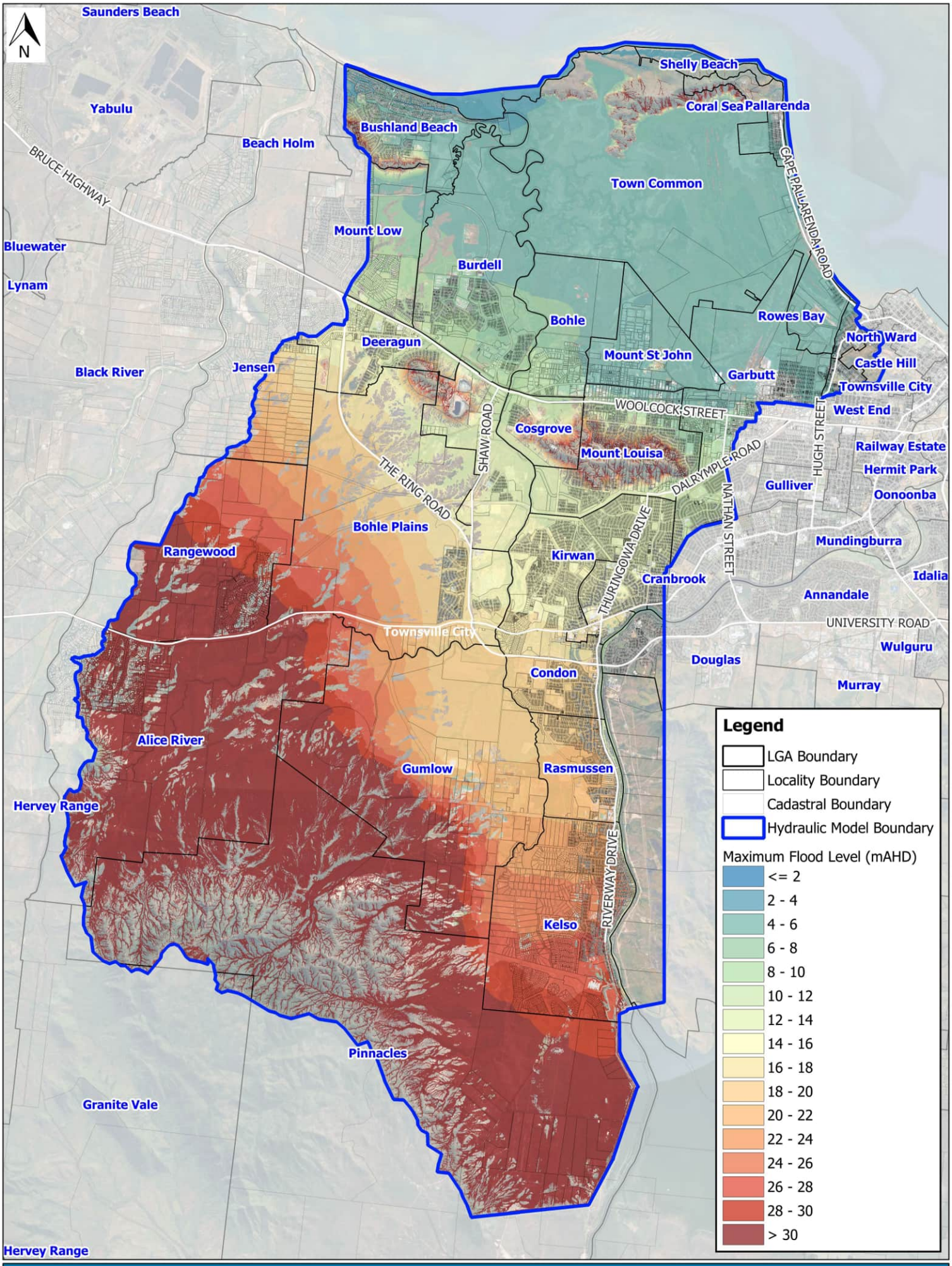
Details
Original Size: A3
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Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Level - 0.05% AEP

Bohle River Flood Study Update 2025

Townsville City Council

WATER TECHNOLOGY



Scale: 1:90,000

0 1,000 2,000 m

Details
Original Size: A3
Projection: GDA94 / MGA Zone 55
Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Level - _PMF

Bohle River Flood Study Update 2025

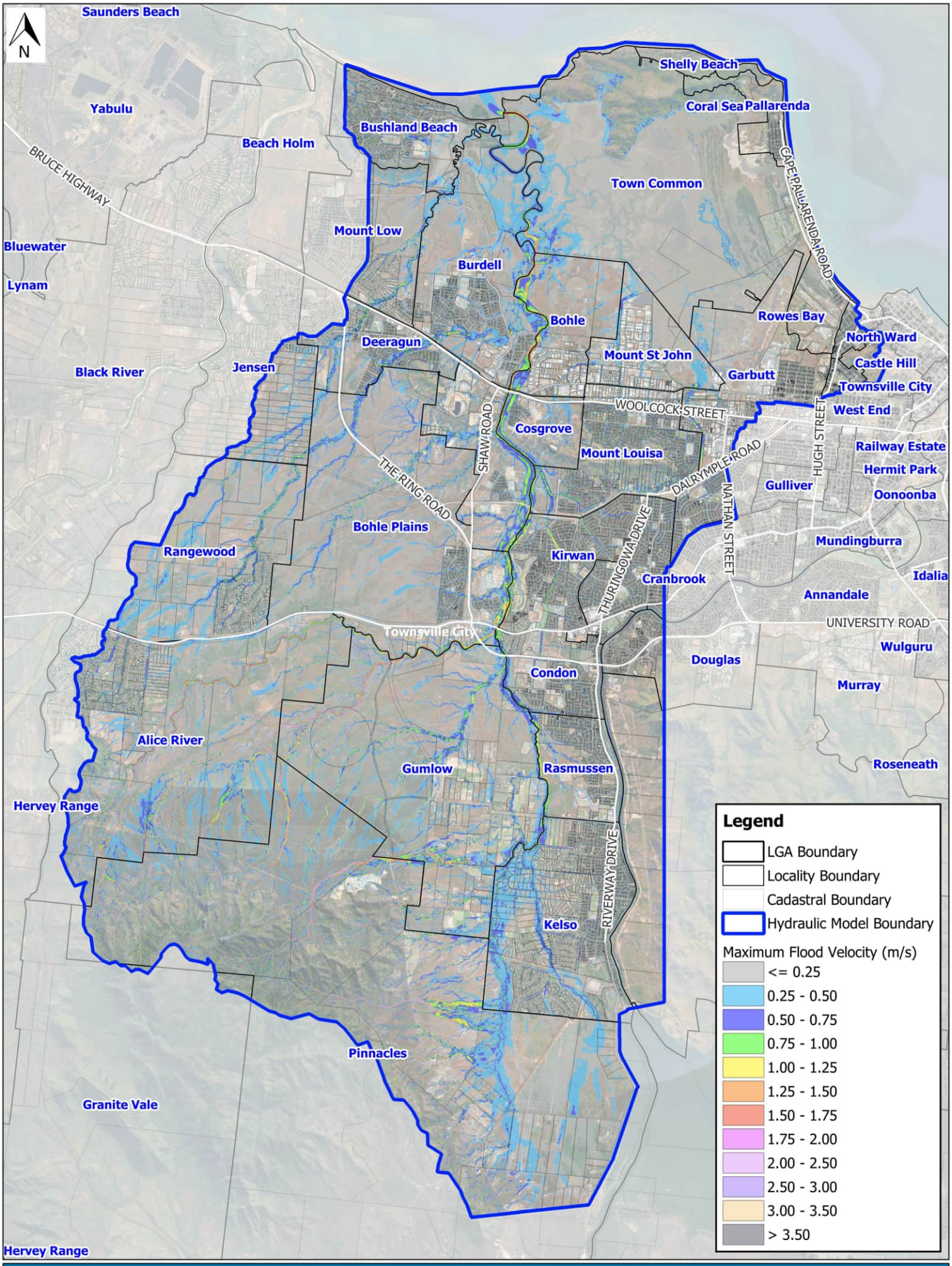
Townsville City Council

WATER TECHNOLOGY

WATER TECHNOLOGY
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APPENDIX E
DESIGN EVENT MAPPING – FLOOD VELOCITY





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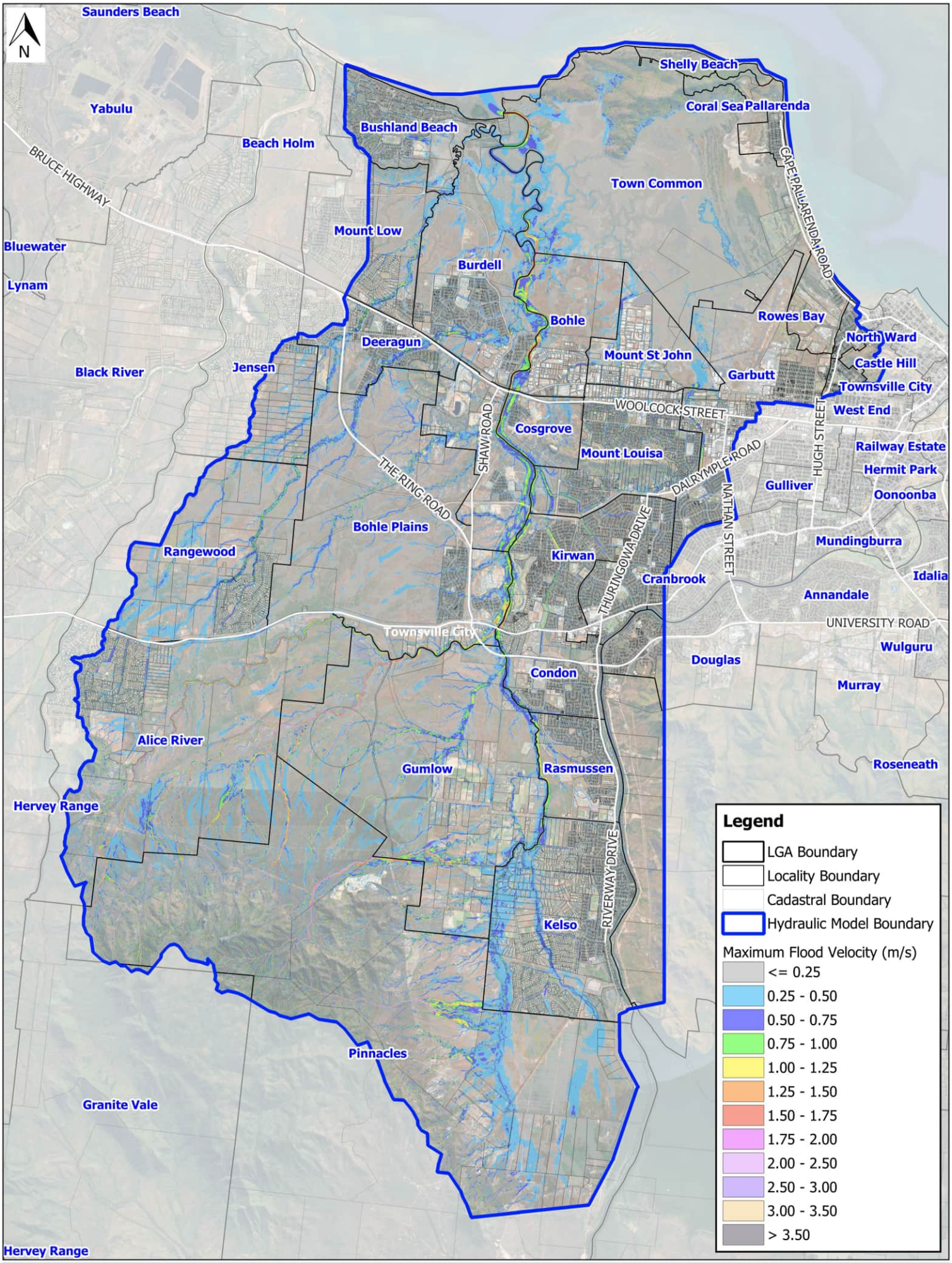
Details
Original Size: A3
Projection: GDA94 / MGA Zone 55
Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Velocity - 50% AEP

Bohle River Flood Study Update 2025

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WATER TECHNOLOGY



Scale: 1:90,000

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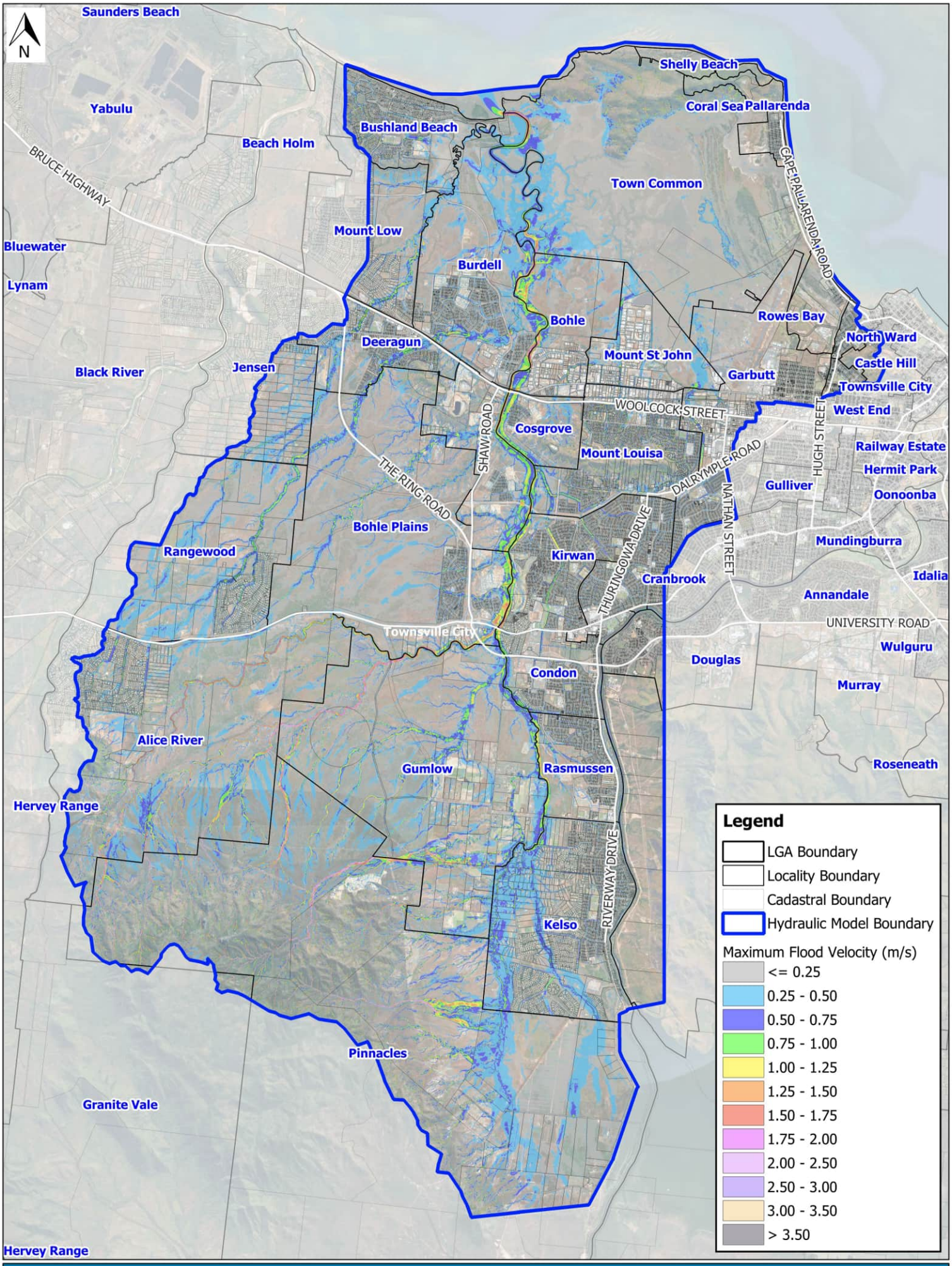
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Projection: GDA94 / MGA Zone 55
Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Velocity - 20% AEP

Bohle River Flood Study Update 2025

Townsville City Council

WATER TECHNOLOGY



Scale: 1:90,000

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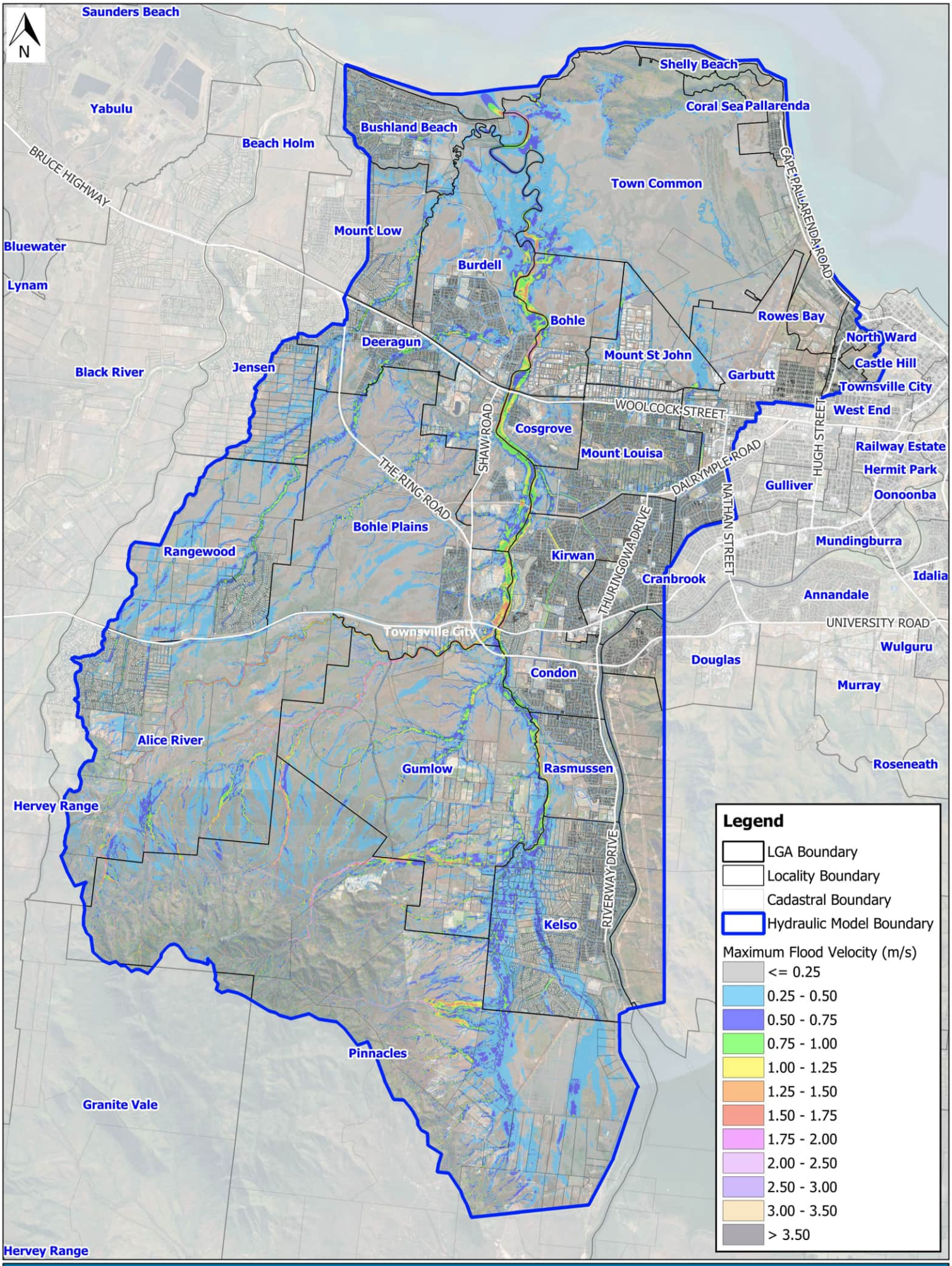
Details
Original Size: A3
Projection: GDA94 / MGA Zone 55
Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Velocity - 10% AEP

Bohle River Flood Study Update 2025

Townsville City Council

WATER TECHNOLOGY



Scale: 1:90,000

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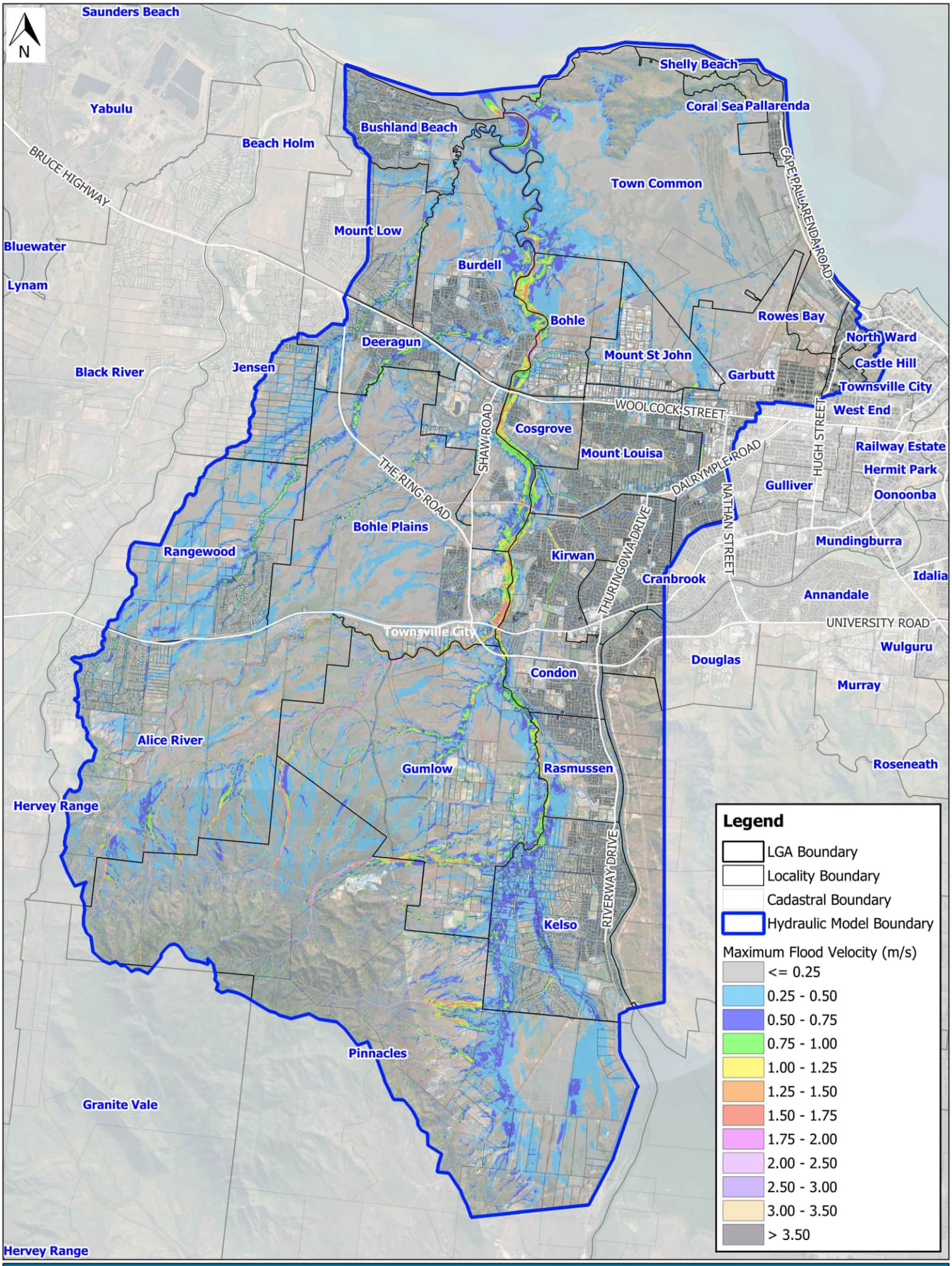
Details
Original Size: A3
Projection: GDA94 / MGA Zone 55
Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Velocity - 05% AEP

Bohle River Flood Study Update 2025

Townsville City Council

WATER TECHNOLOGY



Scale: 1:90,000

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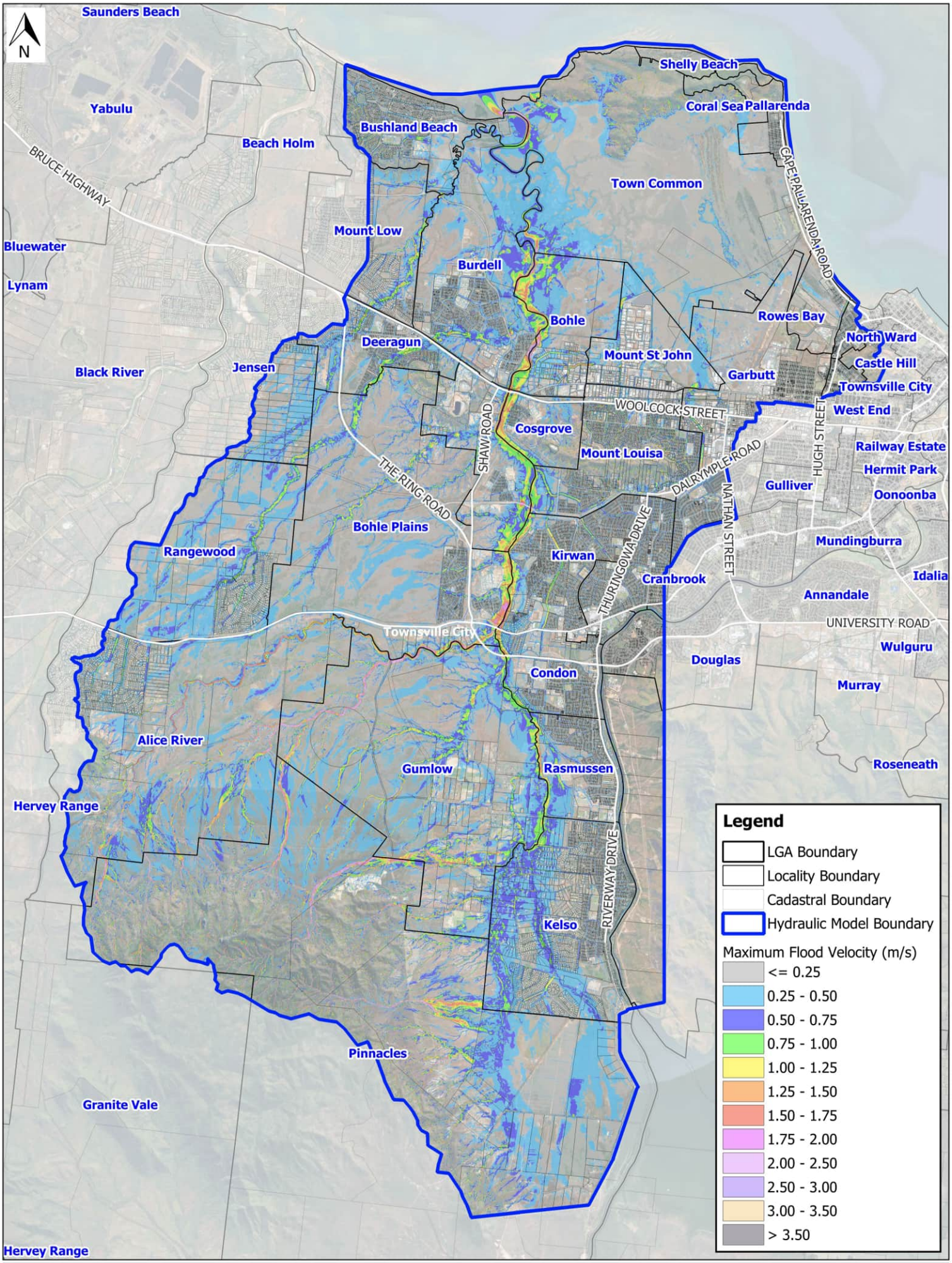
Details
Original Size: A3
Projection: GDA94 / MGA Zone 55
Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Velocity - 02% AEP

Bohle River Flood Study Update 2025

Townsville City Council

WATER TECHNOLOGY



Scale: 1:90,000

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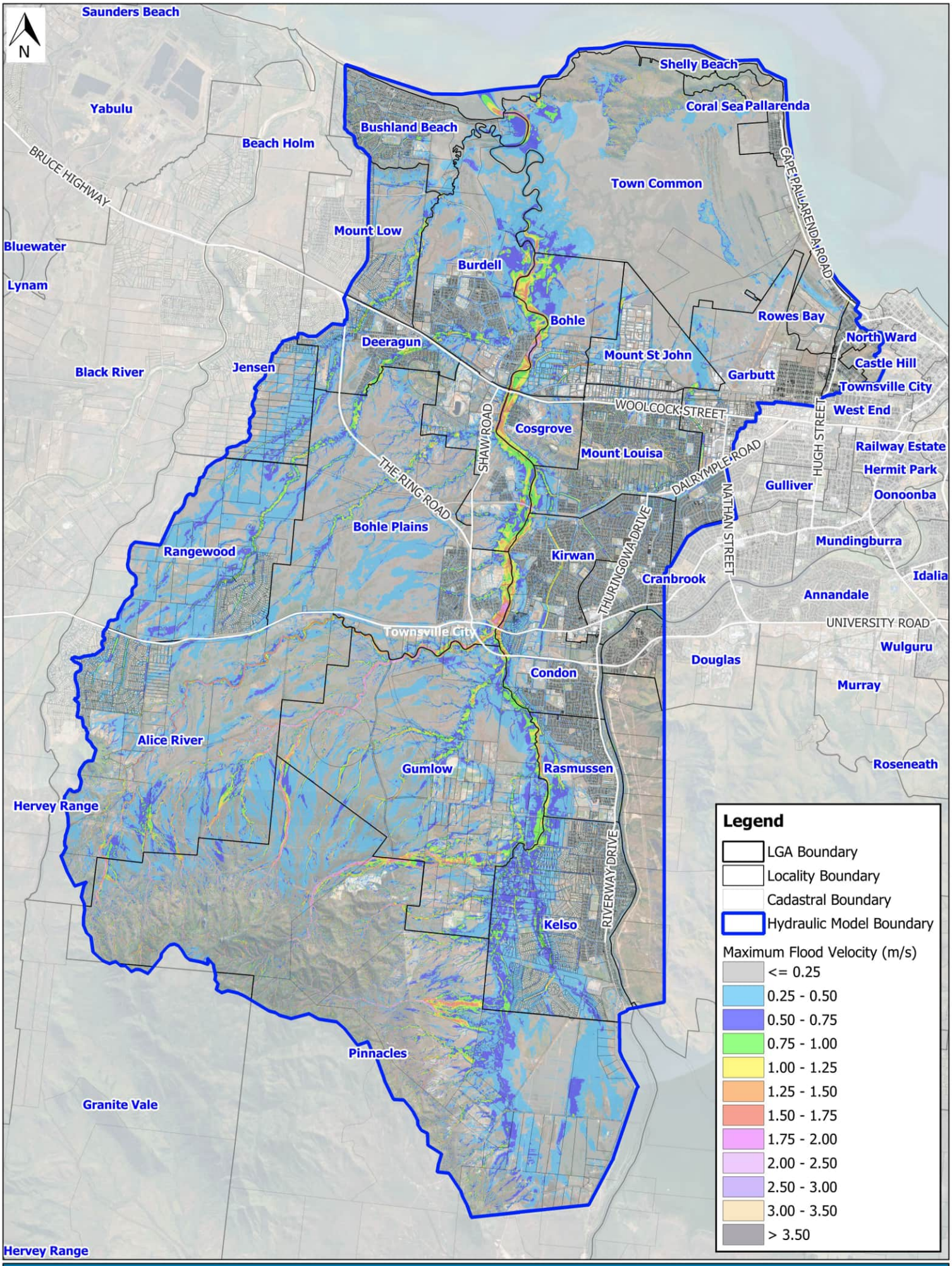
Details
Original Size: A3
Projection: GDA94 / MGA Zone 55
Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Velocity - 01% AEP

Bohle River Flood Study Update 2025

Townsville City Council

WATER TECHNOLOGY



Scale: 1:90,000

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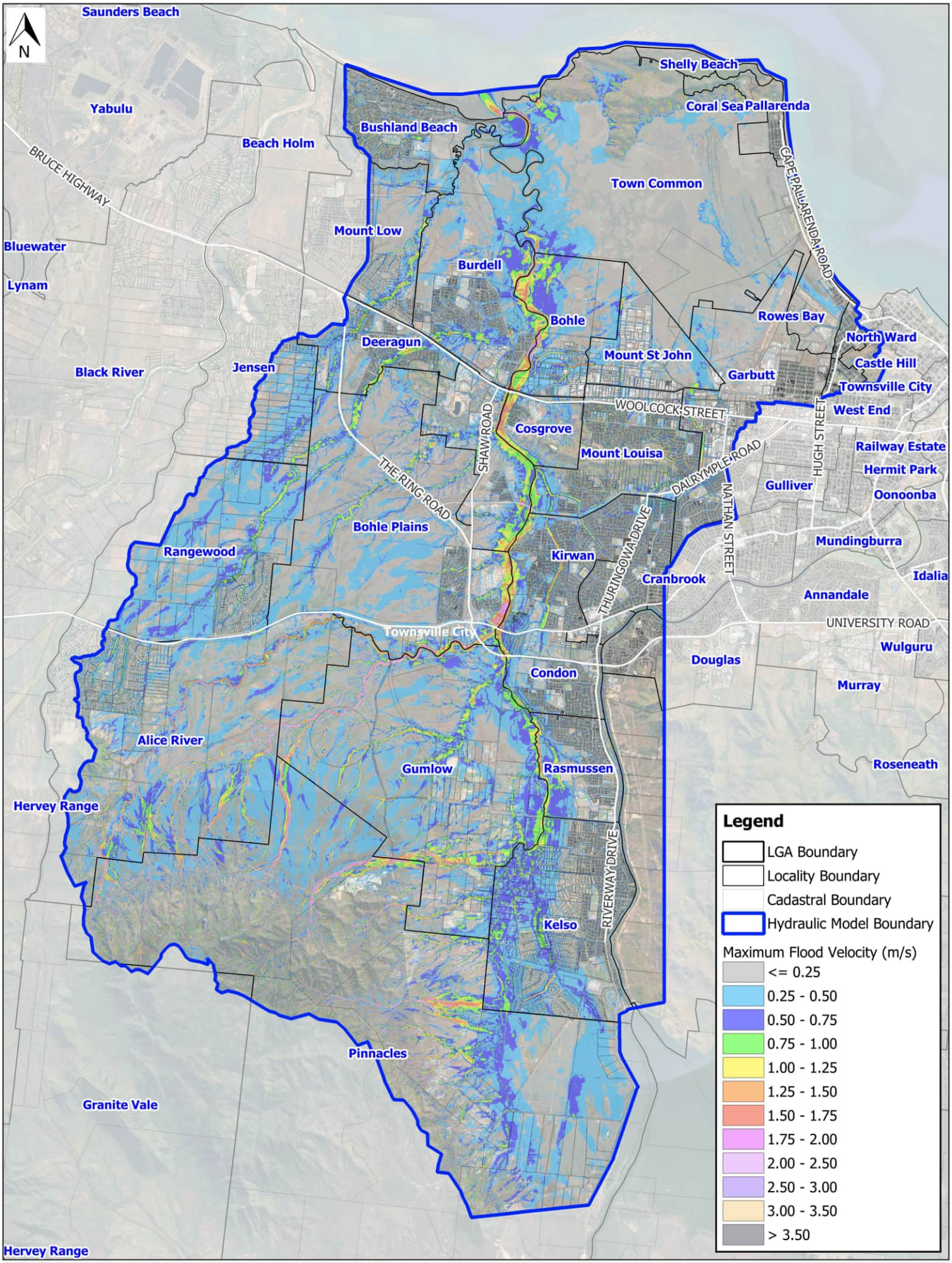
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Projection: GDA94 / MGA Zone 55
Imagery Source: Google Satellite
Local Authority: Townsville City Council

Design - Maximum Flood Velocity - 0.5% AEP

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WATER TECHNOLOGY
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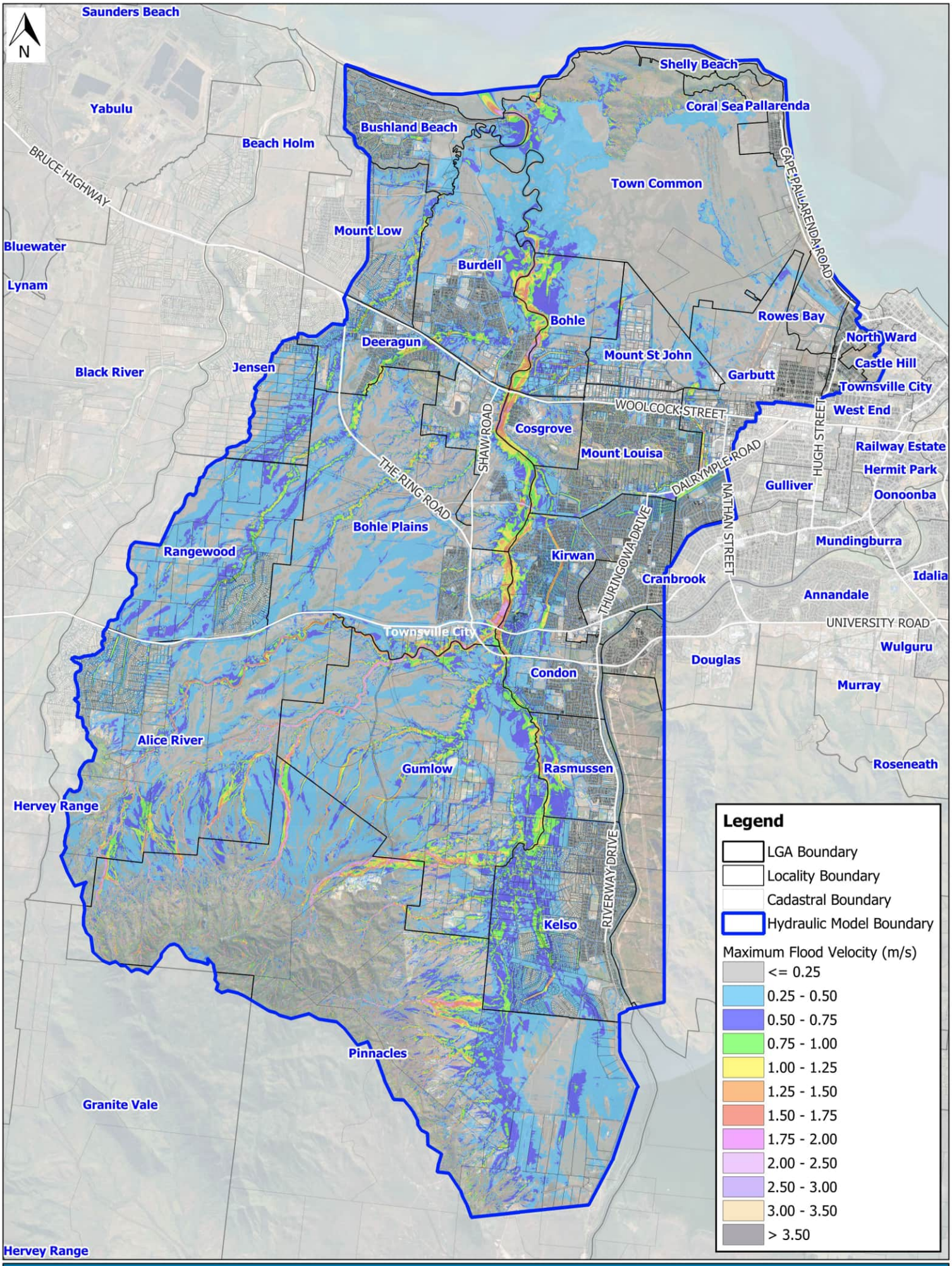
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Imagery Source: Google Satellite
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Design - Maximum Flood Velocity - 0.2% AEP

Bohle River Flood Study Update 2025

Townsville City Council

WATER TECHNOLOGY



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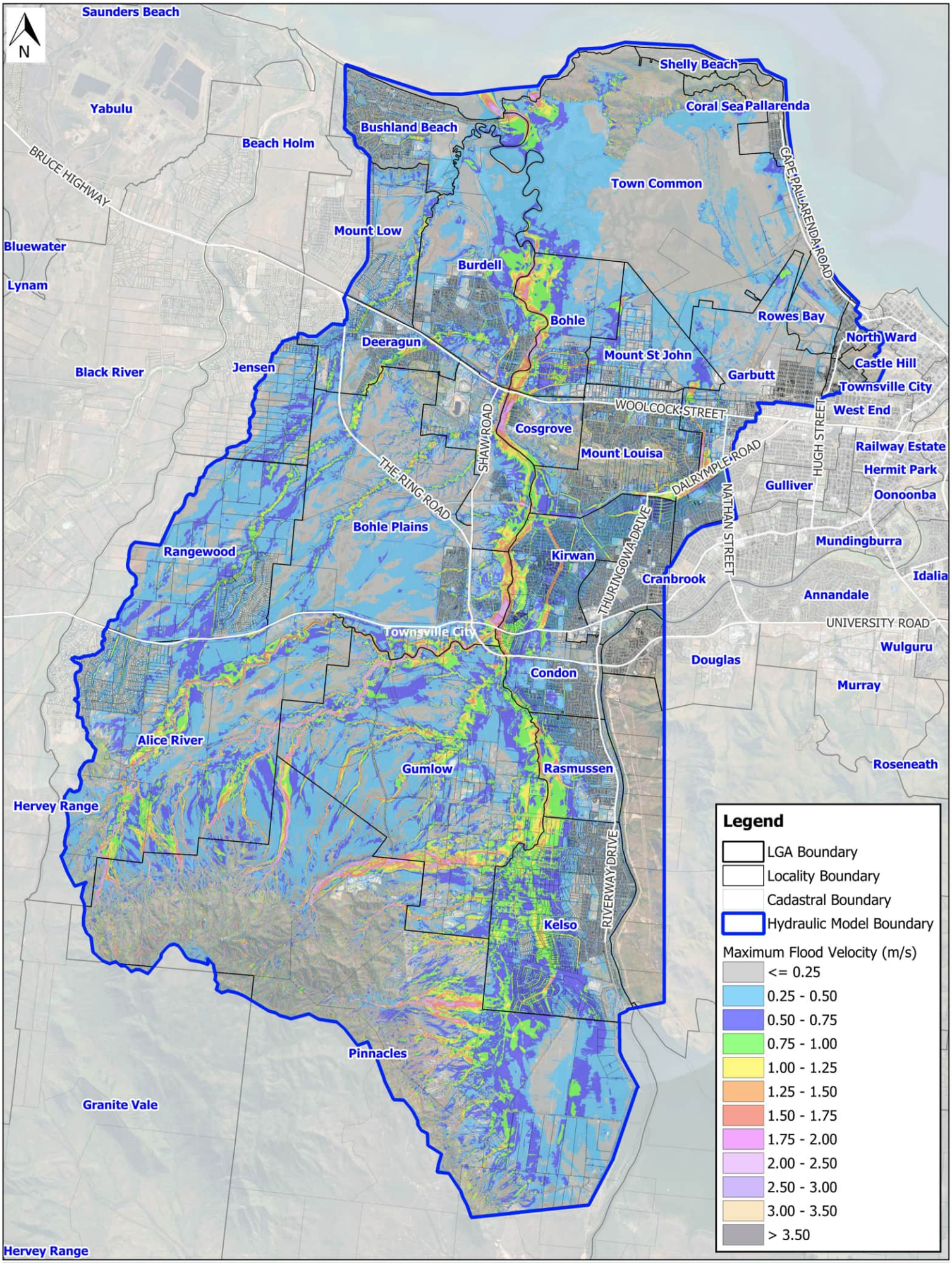
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Scale: 1:90,000

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Details
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Local Authority: Townsville City Council

Design - Maximum Flood Velocity - _PMF

Bohle River Flood Study Update 2025

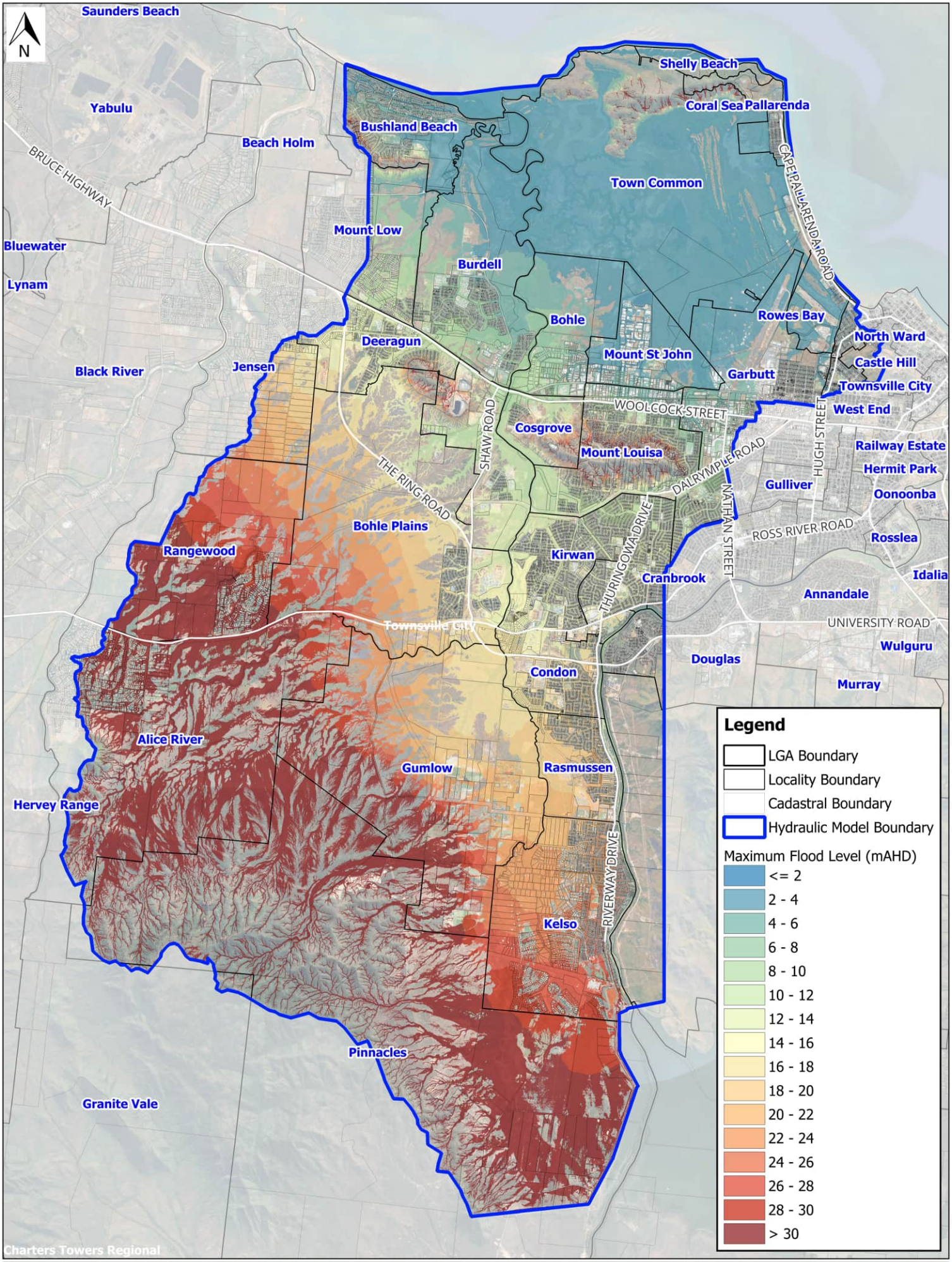
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APPENDIX F
1% AEP CLIMATE CHANGE EVENT MAPPING





Scale: 1:90,000

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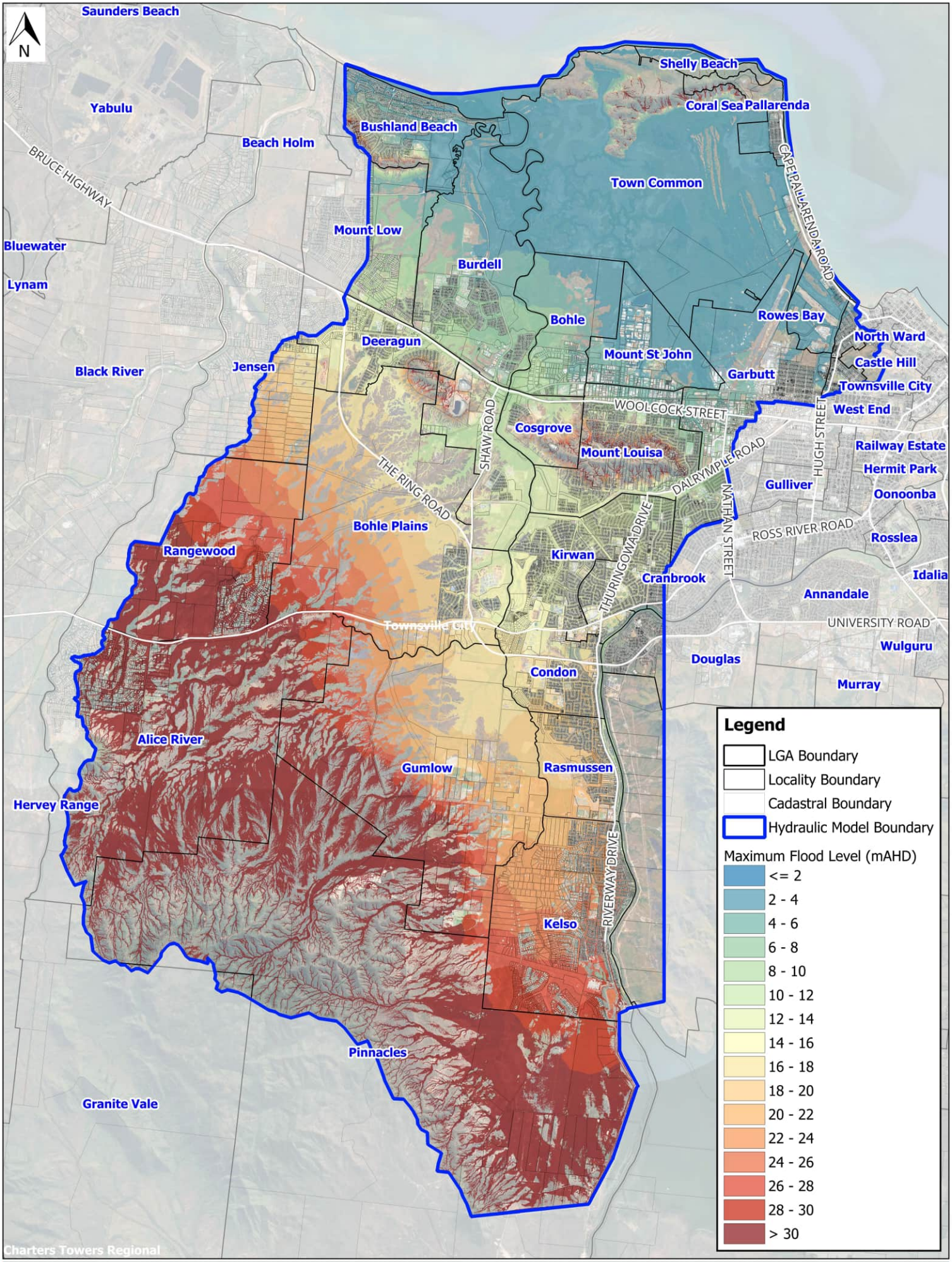
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Climate Change - Maximum Flood Level - 02% AEP

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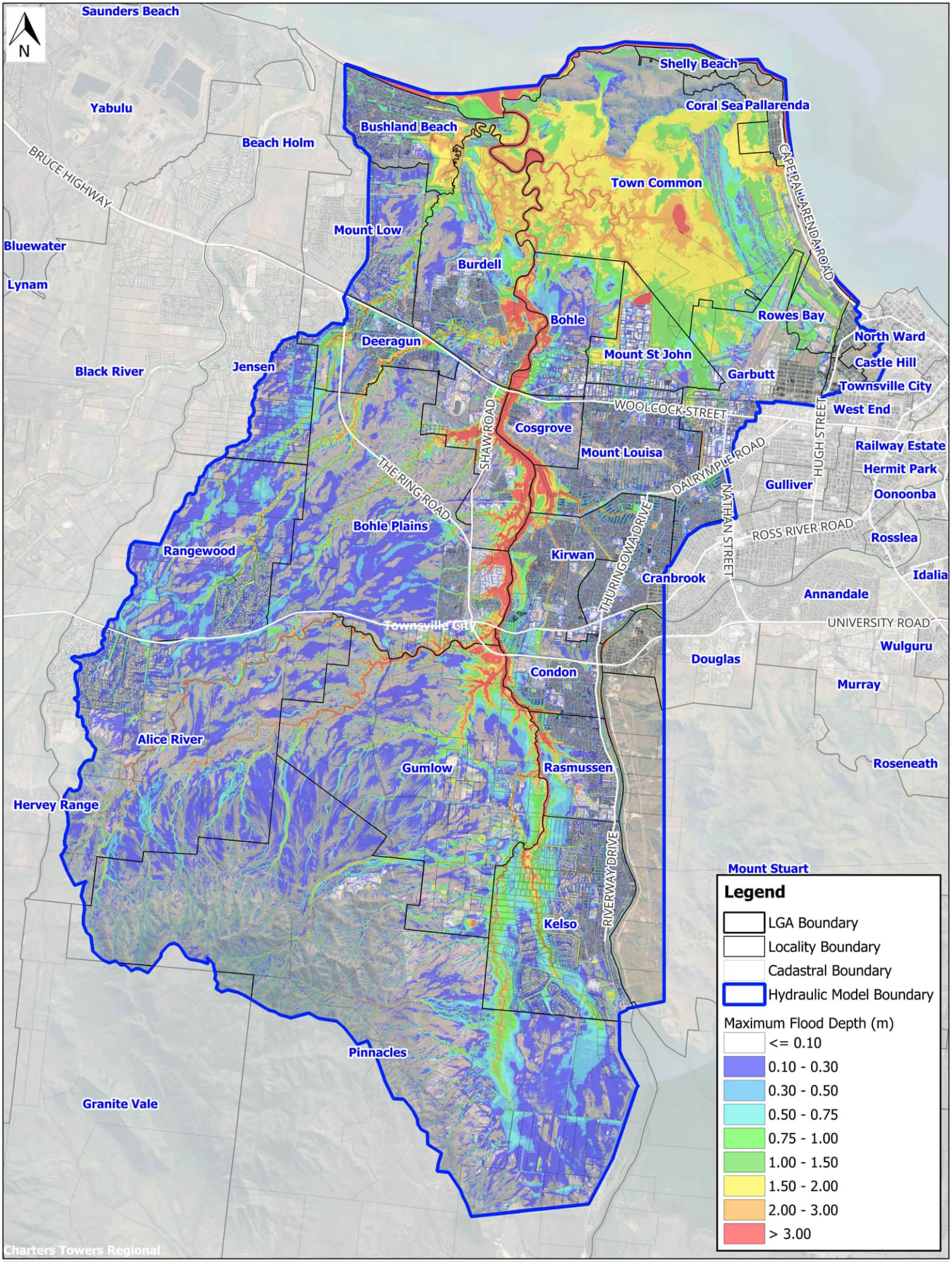
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Climate Change - Maximum Flood Level - 01% AEP

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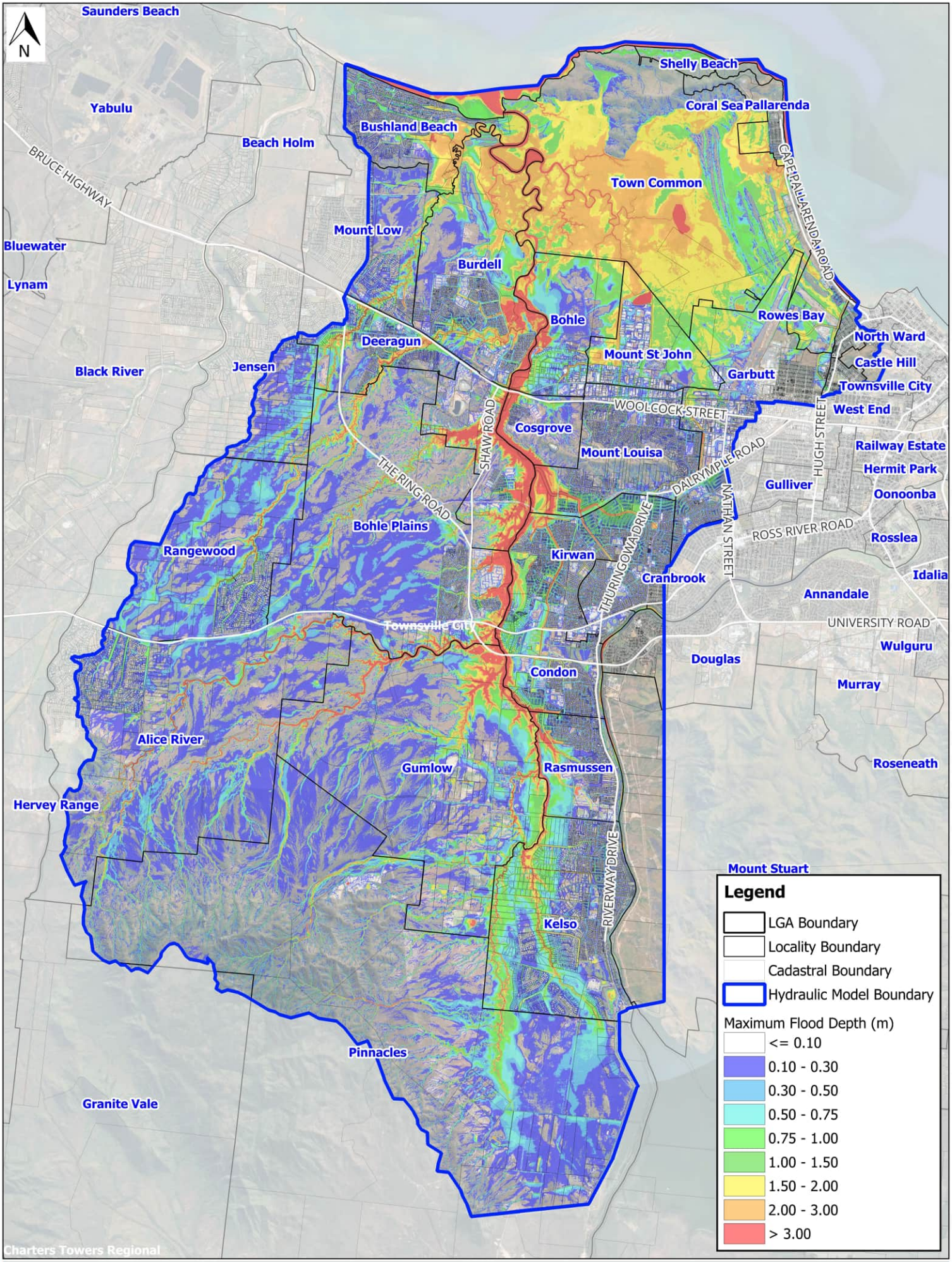
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Climate Change - Maximum Flood Depth - 02% AEP

Bohle River Flood Study Update 2025

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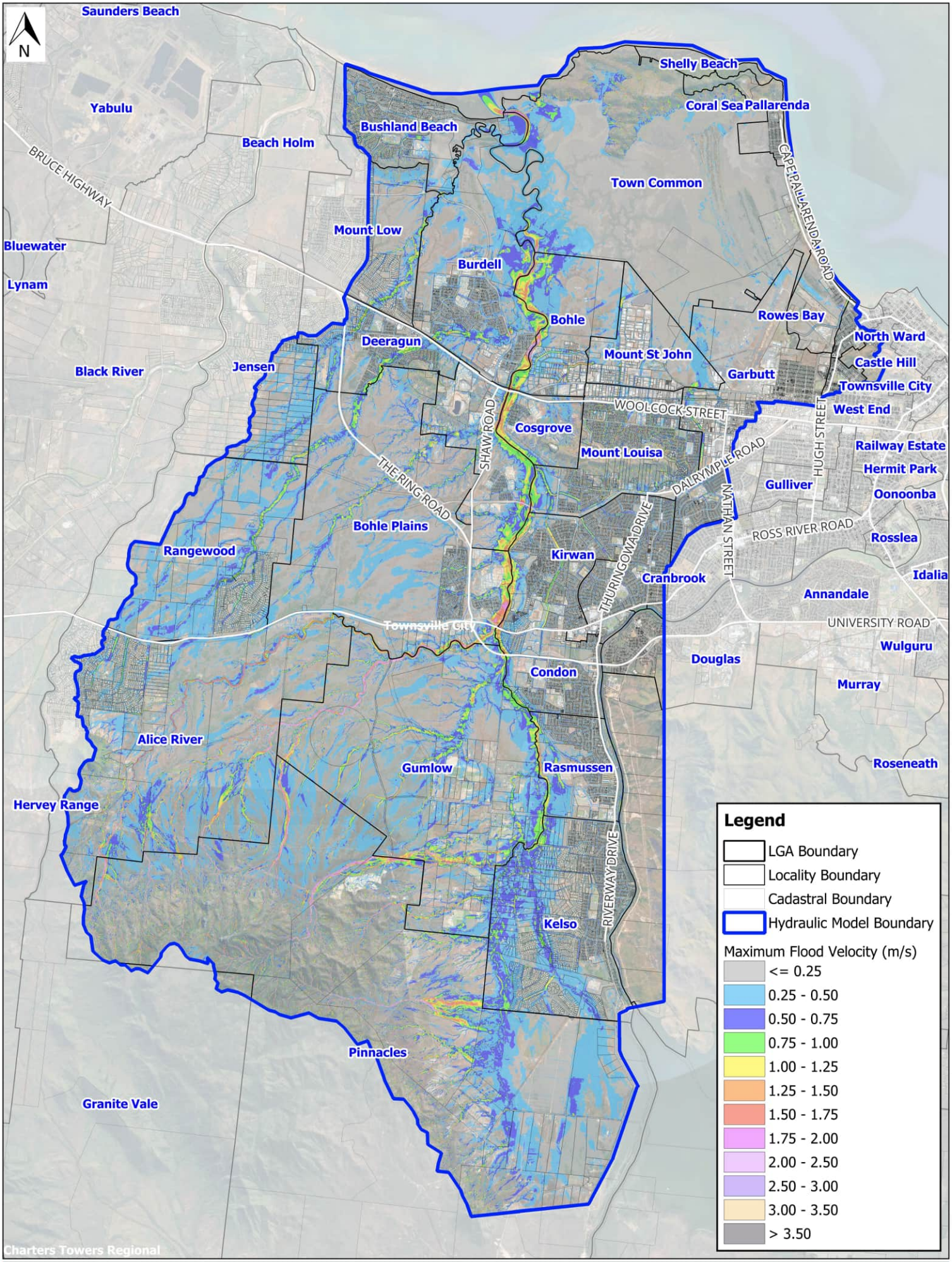
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Climate Change - Maximum Flood Depth - 01% AEP

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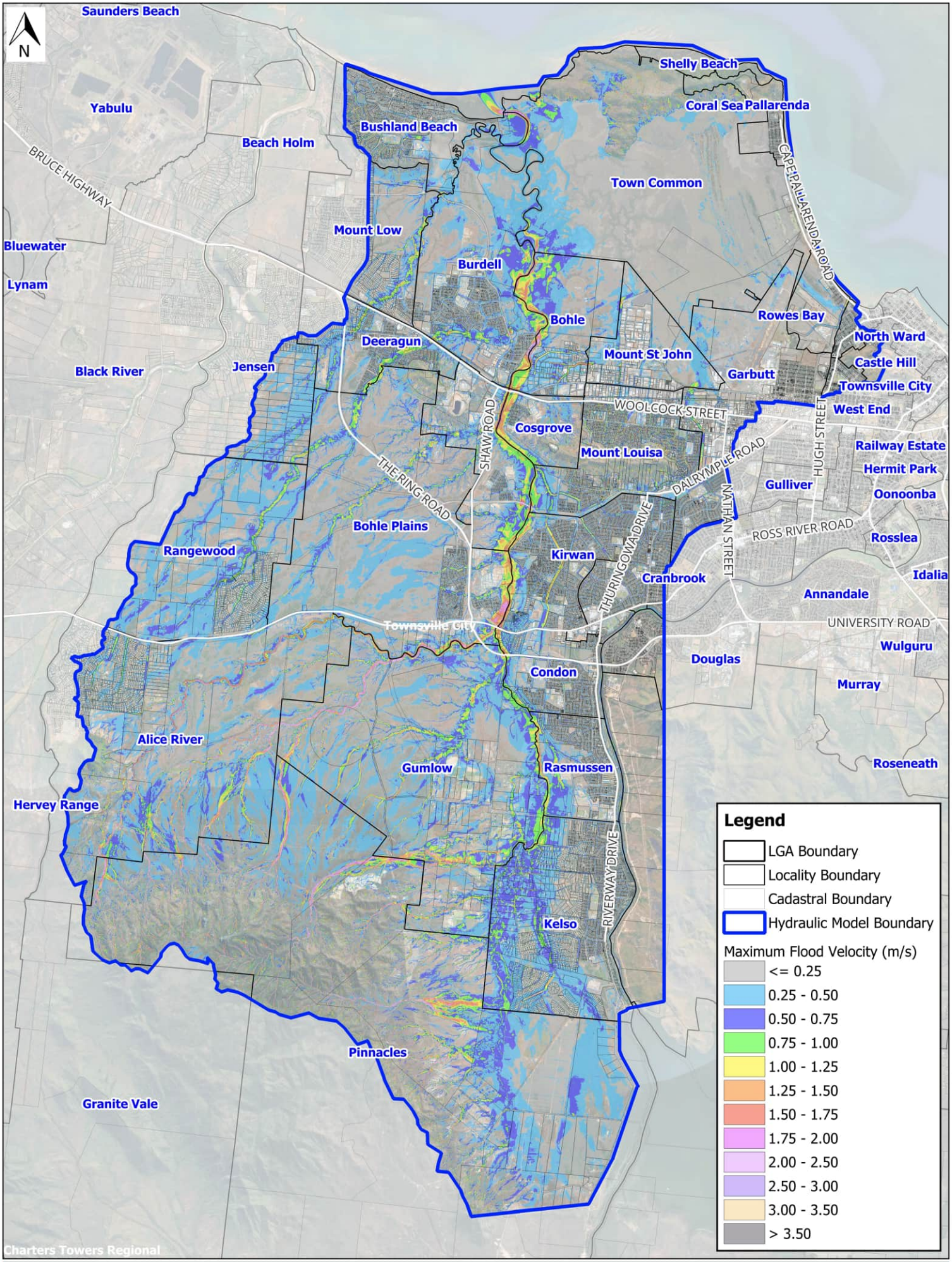
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Climate Change - Maximum Flood Velocity - 02% AEP

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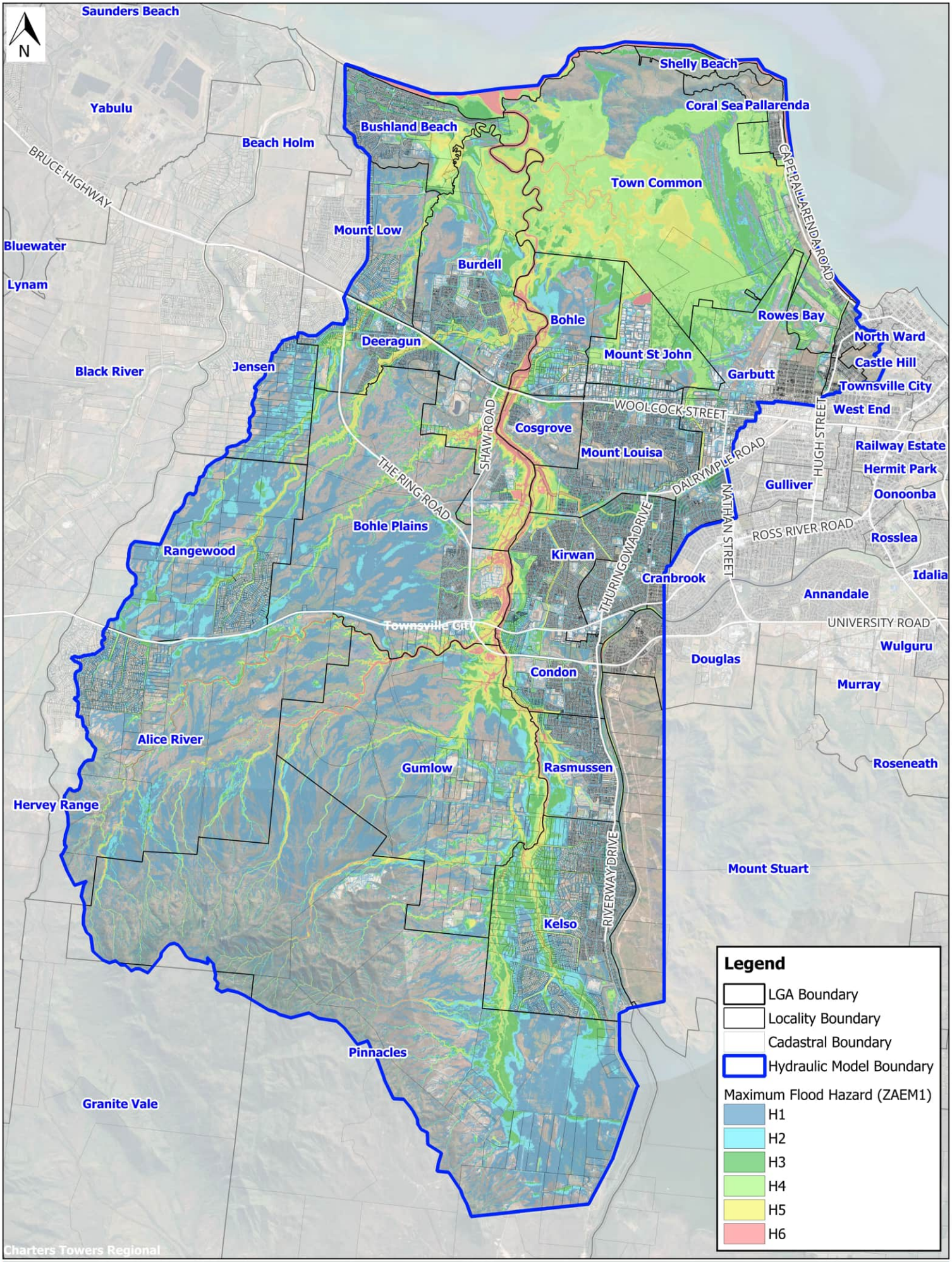
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Climate Change - Maximum Flood Velocity - 01% AEP

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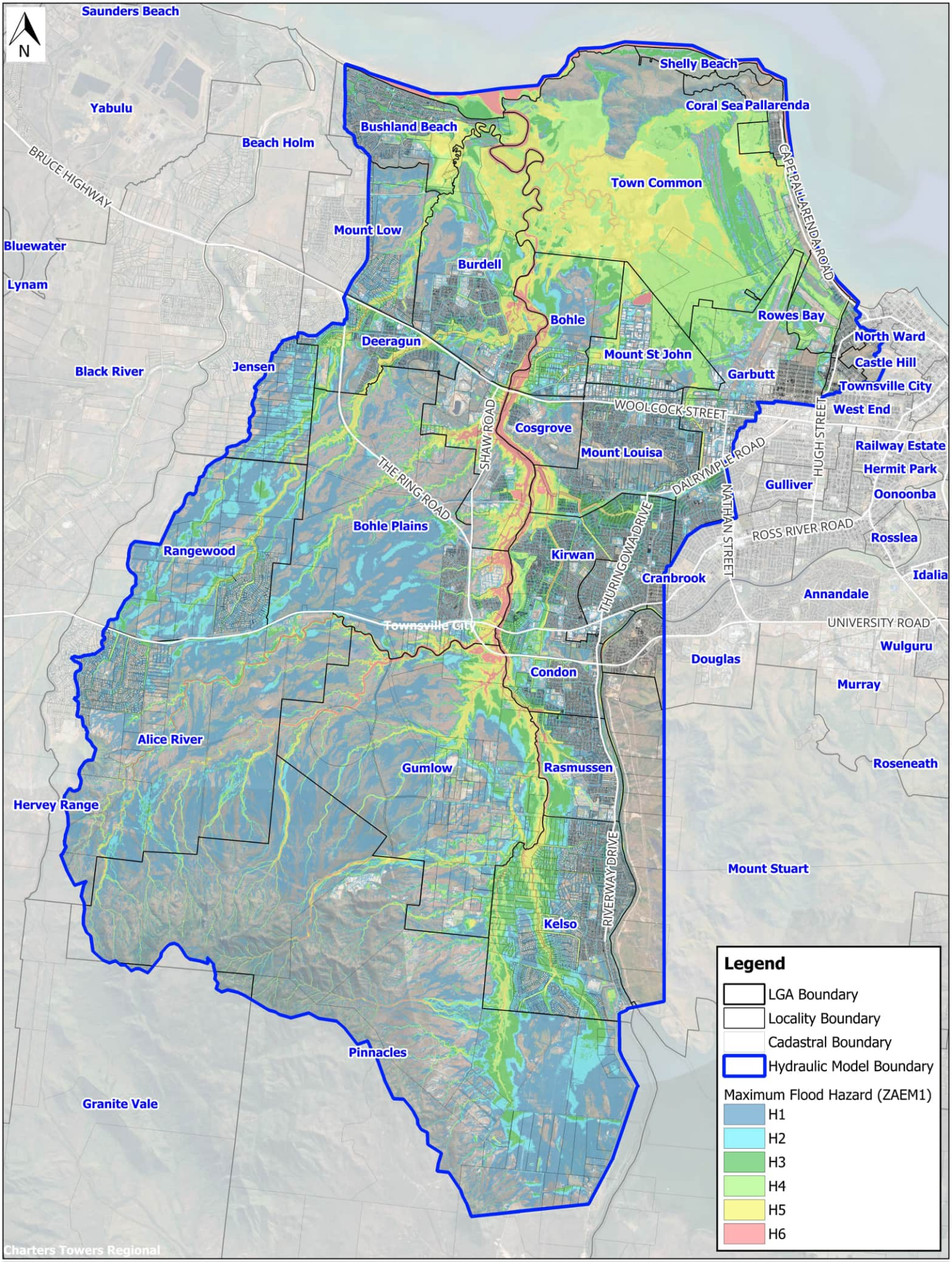
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Climate Change - Maximum Flood Hazard (ZAEM1) - 02% AEP

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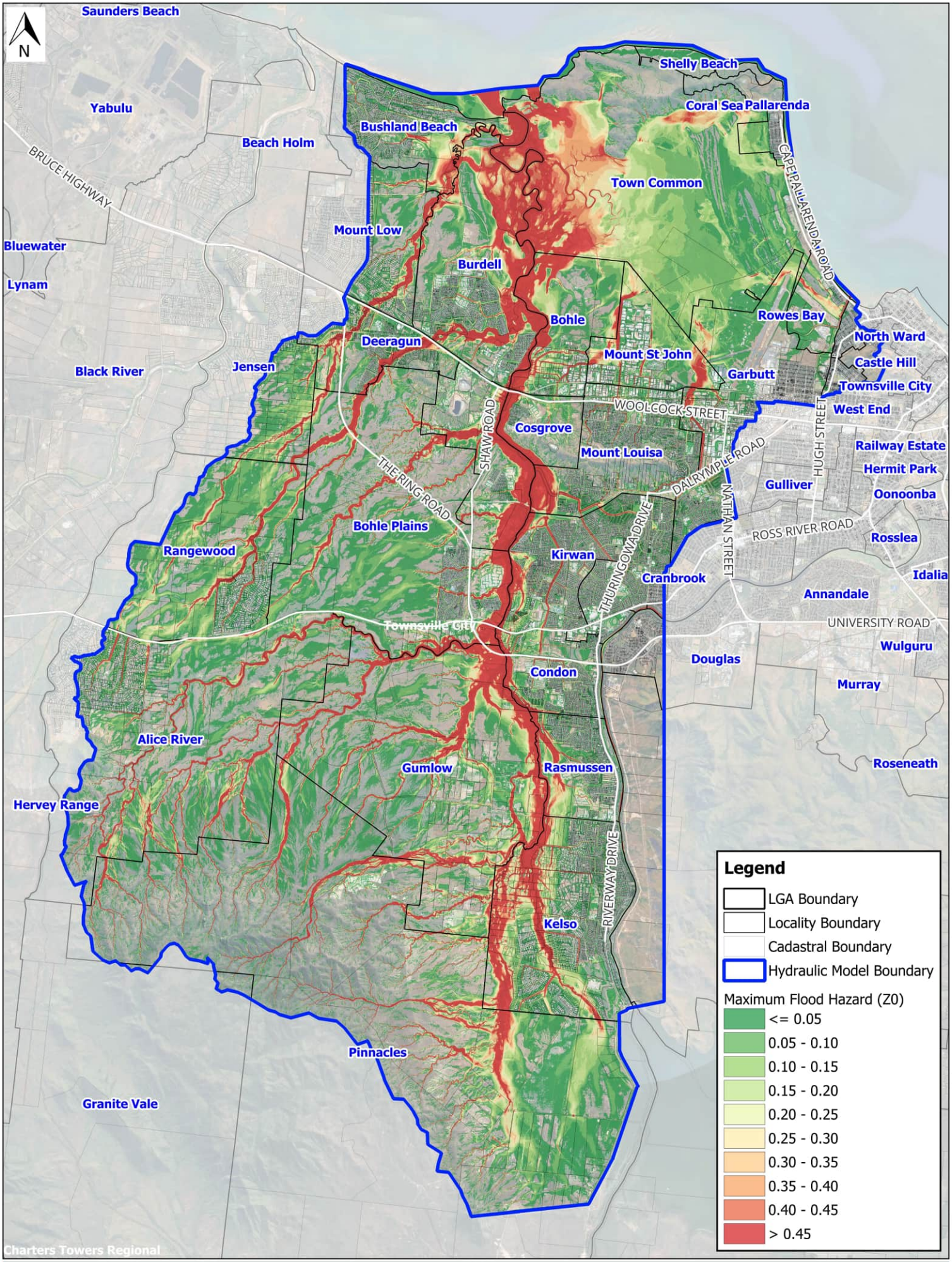
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Climate Change - Maximum Flood Hazard (ZAEM1) - 01% AEP

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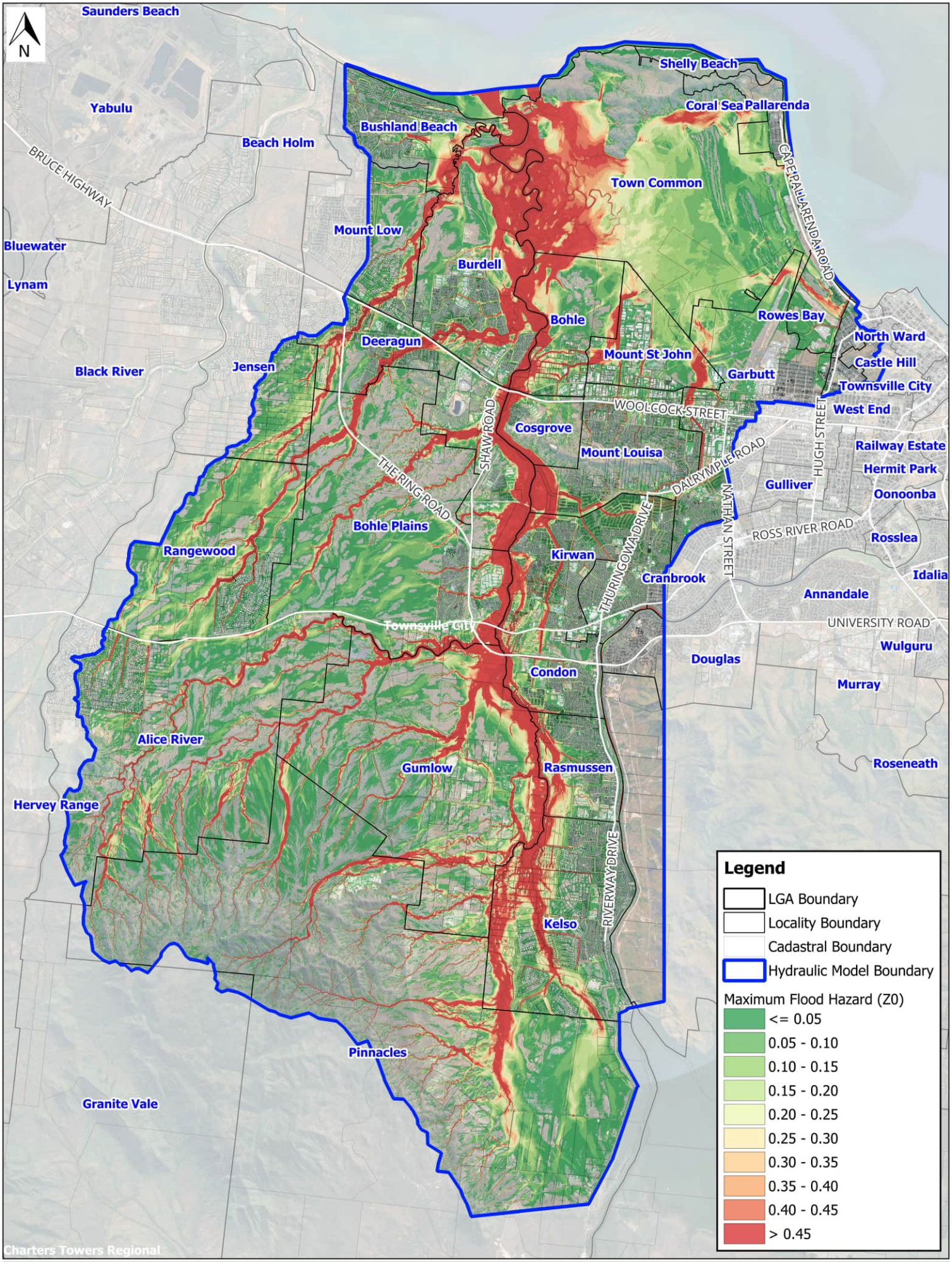
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Climate Change - Maximum Flood Hazard (Z0) - 02% AEP

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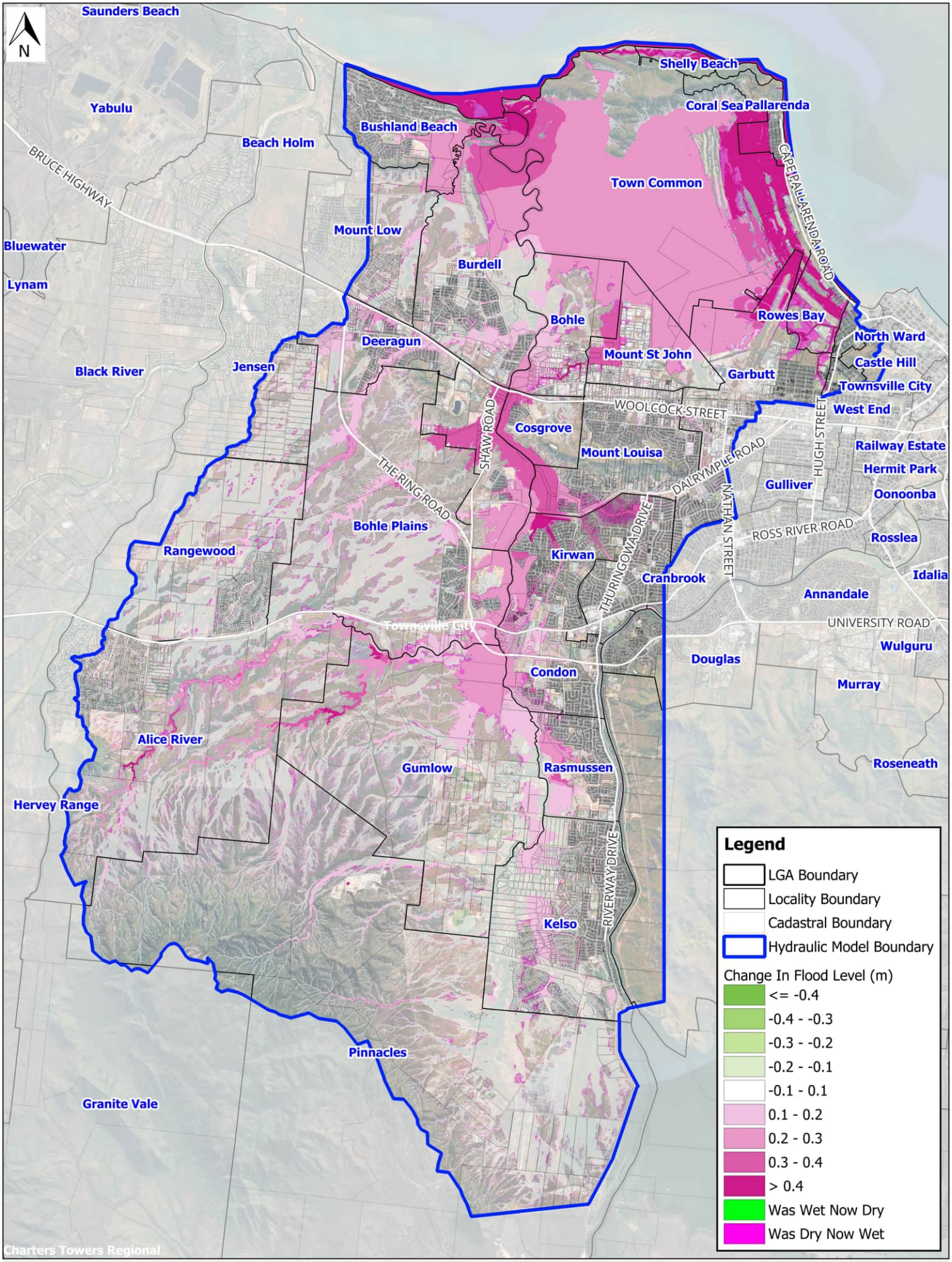
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Climate Change - Maximum Flood Hazard (Z0) - 01% AEP

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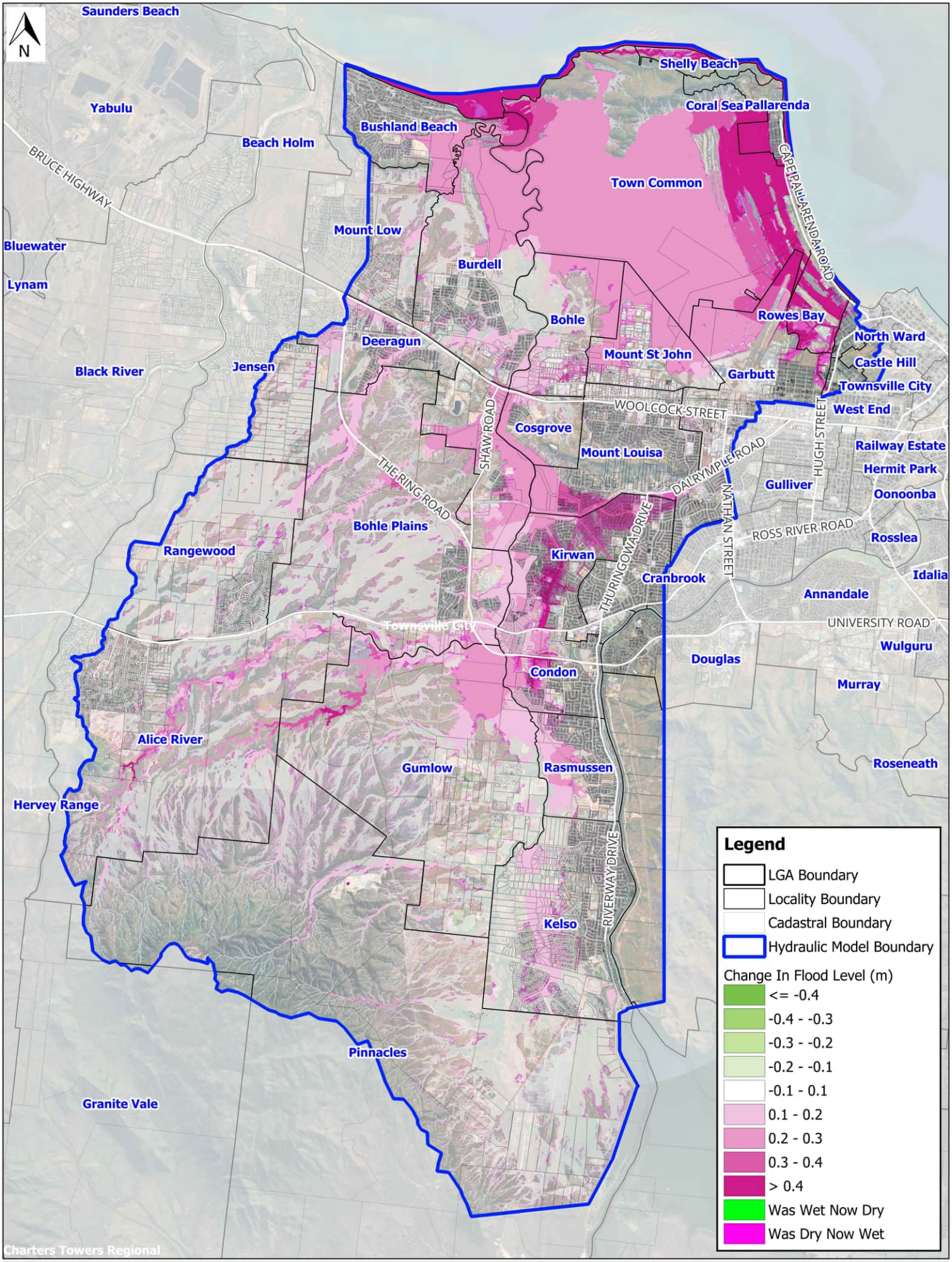
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Climate Change - Change In Maximum Flood Level - 02% AEP

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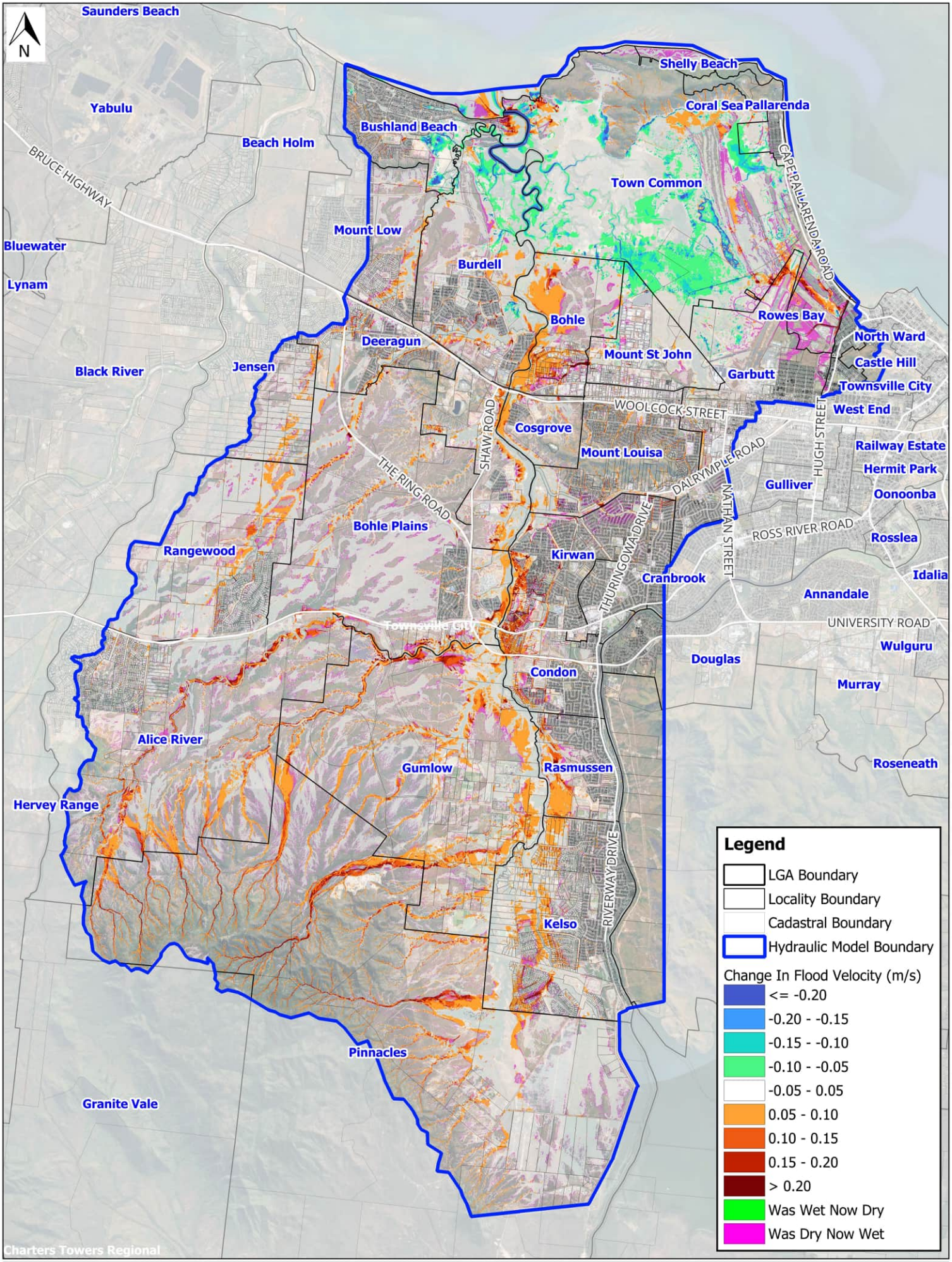
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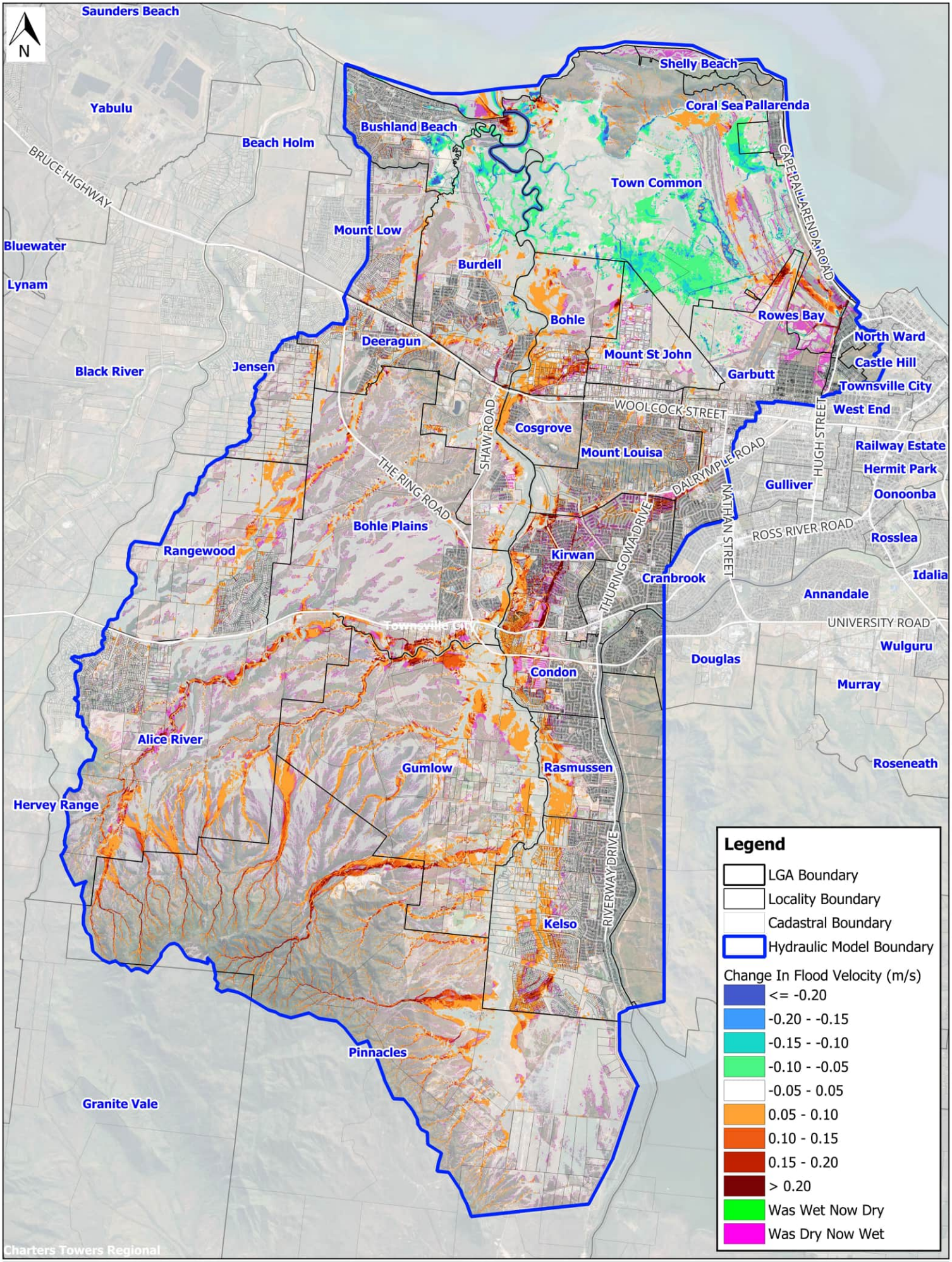
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Climate Change - Change In Maximum Flood Velocity - 02% AEP

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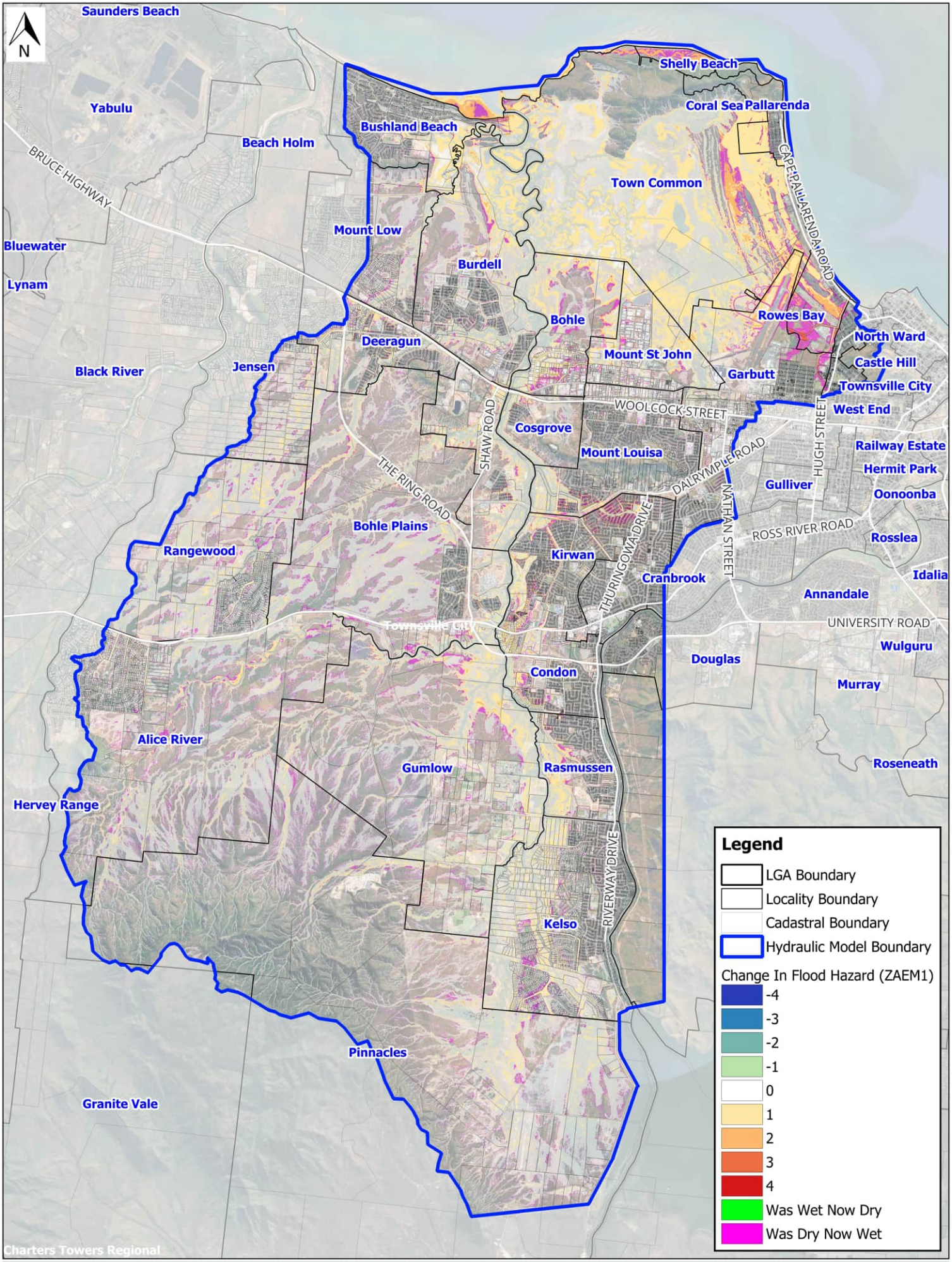
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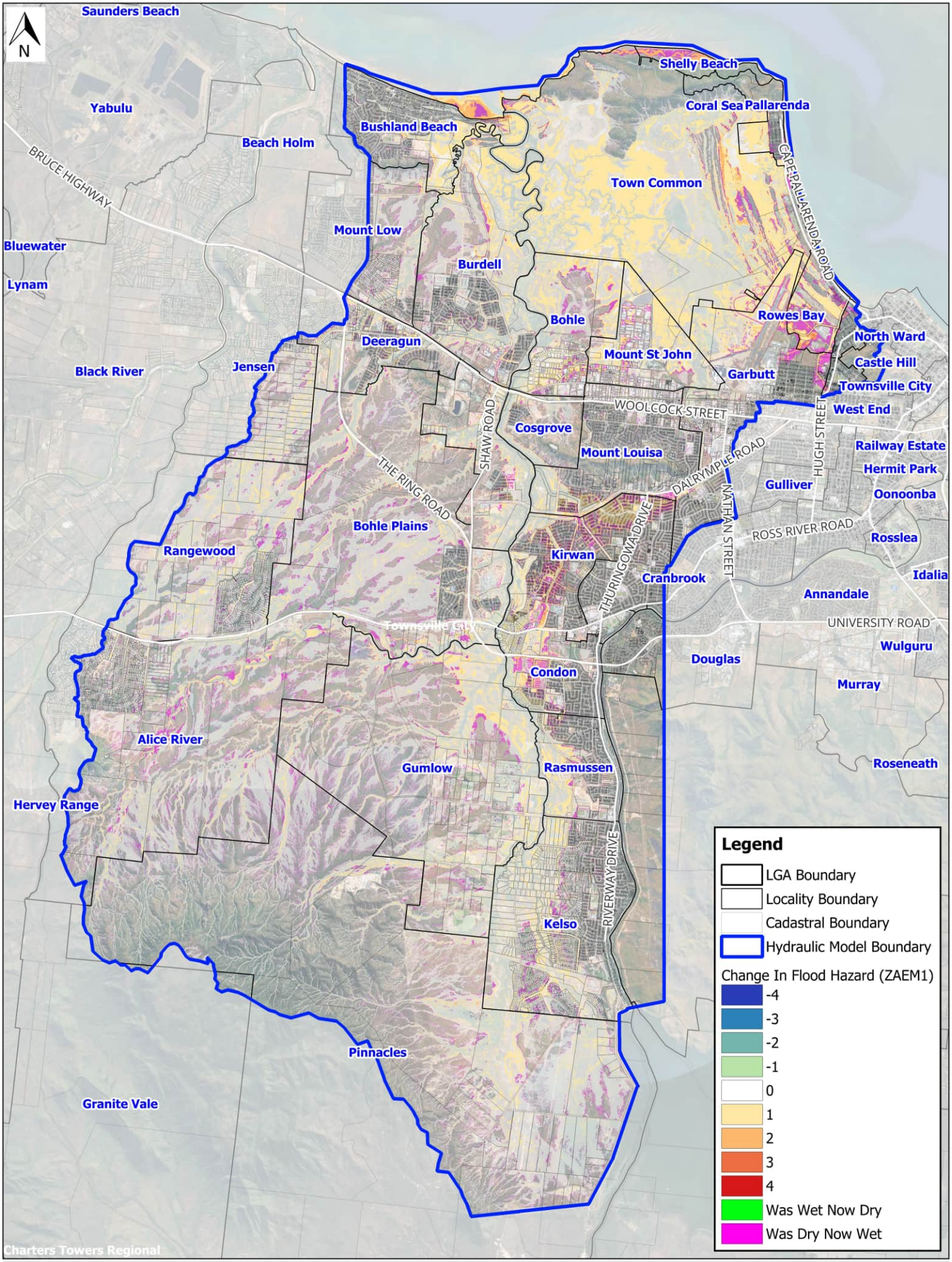
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Climate Change - Change In Maximum Flood Hazard (ZAEM1) - 02% AEP

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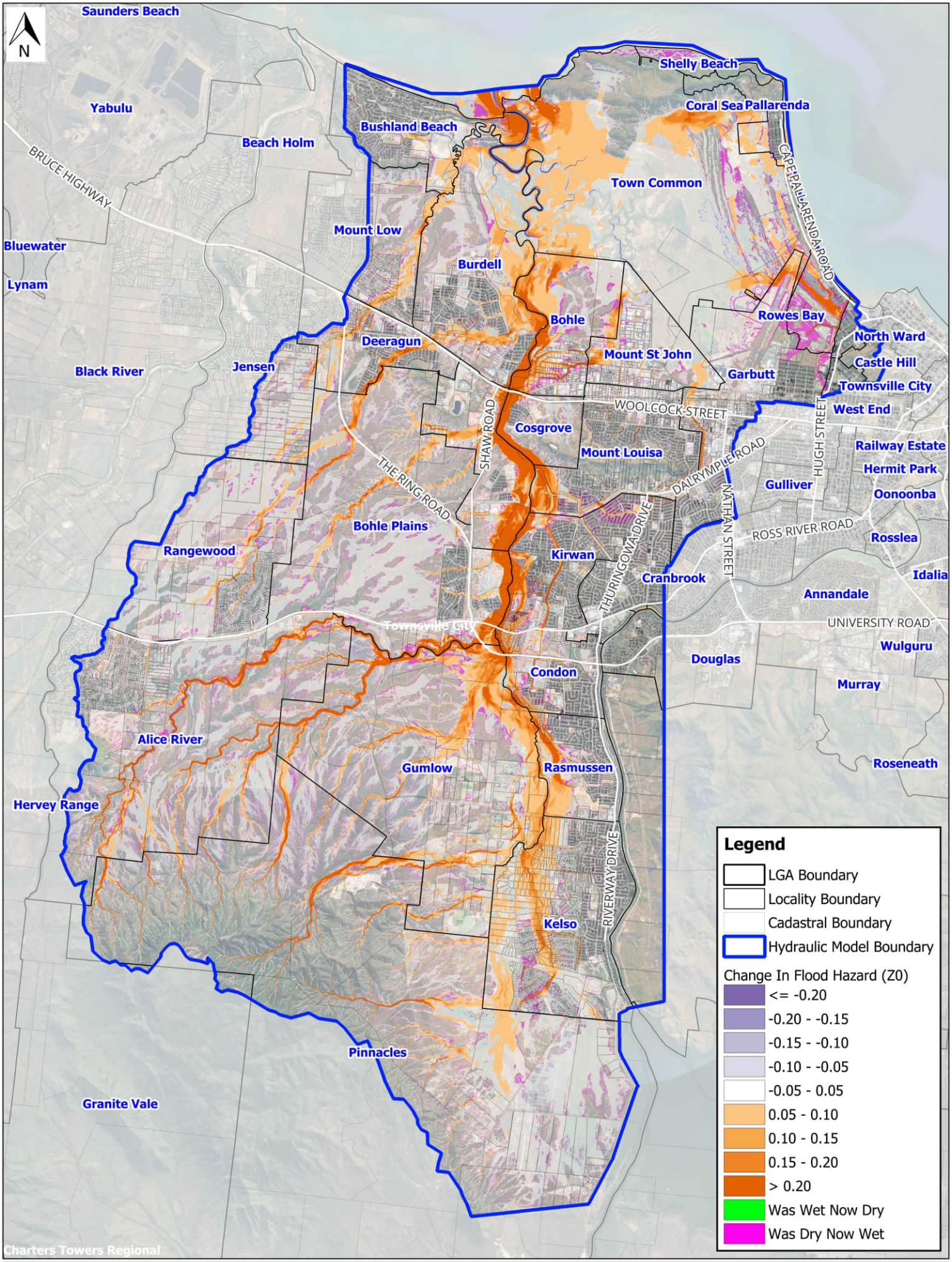
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Climate Change - Change In Maximum Flood Hazard (ZAEM1) - 01% AEP

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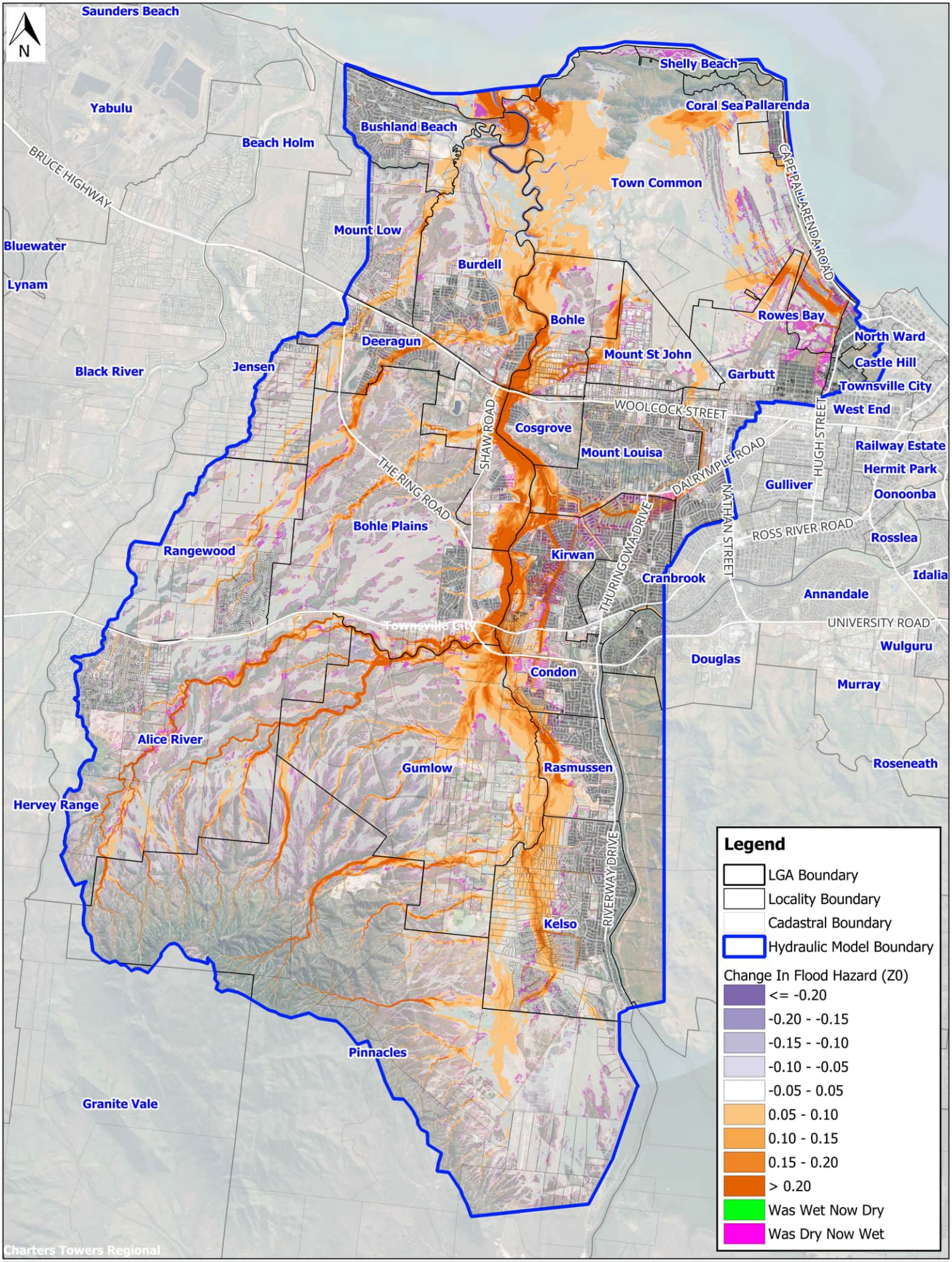
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Climate Change - Change In Maximum Flood Hazard (Z0) - 02% AEP

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Climate Change - Change In Maximum Flood Hazard (Z0) - 01% AEP

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Notting Hill VIC 3168

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South Brisbane QLD 4101

Perth
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Fremantle WA 6160

Wangaratta
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Wangaratta VIC 3677

Wimmera
597 Joel South Road
Stawell VIC 3380

Darwin
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Darwin City NT 0800

Sydney
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Parramatta NSW 2150

Adelaide
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Eastwood SA 5063

New Zealand
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Cambridge New Zealand 3434

Geelong
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Geelong VIC 3220

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Varsity Lakes QLD 4227

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Birtinya QLD 4575

1300 198 413

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