

Appendix C

Flood Assessment

Our Ref: L.M00630.001.00_Flood.docx

7 November 2025

Hansen Engineering Group
Suite 2, 354 Flinders Street
Townsville City, QLD 4810

Attention: Elin Shephard

Dear Elin

RE: DAINTREE FERRY INFRASTRUCTURE UPGRADE – FLOOD ASSESSMENT REPORT

Background

Venant Solutions Pty Ltd was engaged by Hansen Engineering Group to undertake a flood assessment of the proposed infrastructure upgrade for the Daintree Ferry located on Cape Tribulation Road at the Daintree River (the Site) (Figure 1). The upgrade includes ramp, road and parking works on both sides of the river.

The Site is located approximately 7.6 km north of the Kimberley Passage and 12.5 km south of Daintree Village. The catchment drains primarily south-eastwards to Daintree Ferry, and the total catchment is approximately 1329 km². The catchment is hilly at the upstream and relatively flat at the downstream closer to the mouth of Daintree River. The catchment area is heavily forested and surrounded by National Parks and native bushland making up most of the area, and a few rural residences scattered within.

The purpose of the assessment is to determine flood levels and velocity for the 20%, 10%, 5%, 1%, and 0.2% Annual Exceedance Probabilities (AEP) flood events for structural design and to assess afflux caused by the replacement ramp and road on either side of the river. This letter presents the methodology and findings of this assessment.

**Figure 1 Site Locality**

Hydrological Modelling

Hydrological assessments are used to determine flow rates for the range of design flood events of interest. For this assessment a calibrated RORB rainfall-runoff routing hydrologic model was developed with the design event flows reconciled to an at-site flood frequency analysis (FFA) at the Daintree River at Bairds stream gauge.

Daintree River at Bairds Flood Frequency Analysis

The Daintree River at Bairds stream gauge (108002A) is located approximately 24 km upstream of the site. The gauge is within the catchment that drains to the site and has an upstream area of about 1264 km². The gauge has water level and flow rate records from October 1968. Given the length of record and the reliability of the rating curve, the FFA will provide a reliable estimate of peak flow rates for events up to the 1% AEP.

TUFLOW FLIKE was used to perform the flood frequency analysis (FFA) on the gauged data.

The completeness of the annual maximum flow data for the gauge and gauging data (field measurements of flow) was checked, and the water year adjusted to start in October. During the summer of 2022/23 the gauge was not operational, and the gauge failed during the December 2023 flood event. As a result, the annual maximum series was ended in the water year starting in October 2021. This provided an annual maximum flow series record of 54 years. Figure 2 provides a graphical representation of annual flow series while flow values used are presented in Attachment 1.

The multiple Grubbs-Beck test was used to identify any potentially influential low flows which none were found.

Given that the December 2023 event is the largest know to have occurred since the gauge opened in 1968, it was included as censored event having one event greater than 4,148 m³/s (January 2019) in the three-year period since the 2021 water year.

Several probability distributions were trialled, with the Log-Normal distribution ultimately selected based on the best fit to the data. The results from the FFA can be seen in Table 1.

Table 1 FFA Results

AEP	Estimated Flow (m ³ /s)	Lower 90% Quantile Confidence Limits (m ³ /s)	Upper 90% Quantile Confidence Limits (m ³ /s)
20%	1,936	1,631	2,351
10%	2,637	2,167	3,316
2%	4537	3514	6183
5%	3,404	2,725	4,436
1%	5,496	4,160	7,706
0.2%	8,099	5,829	12,093

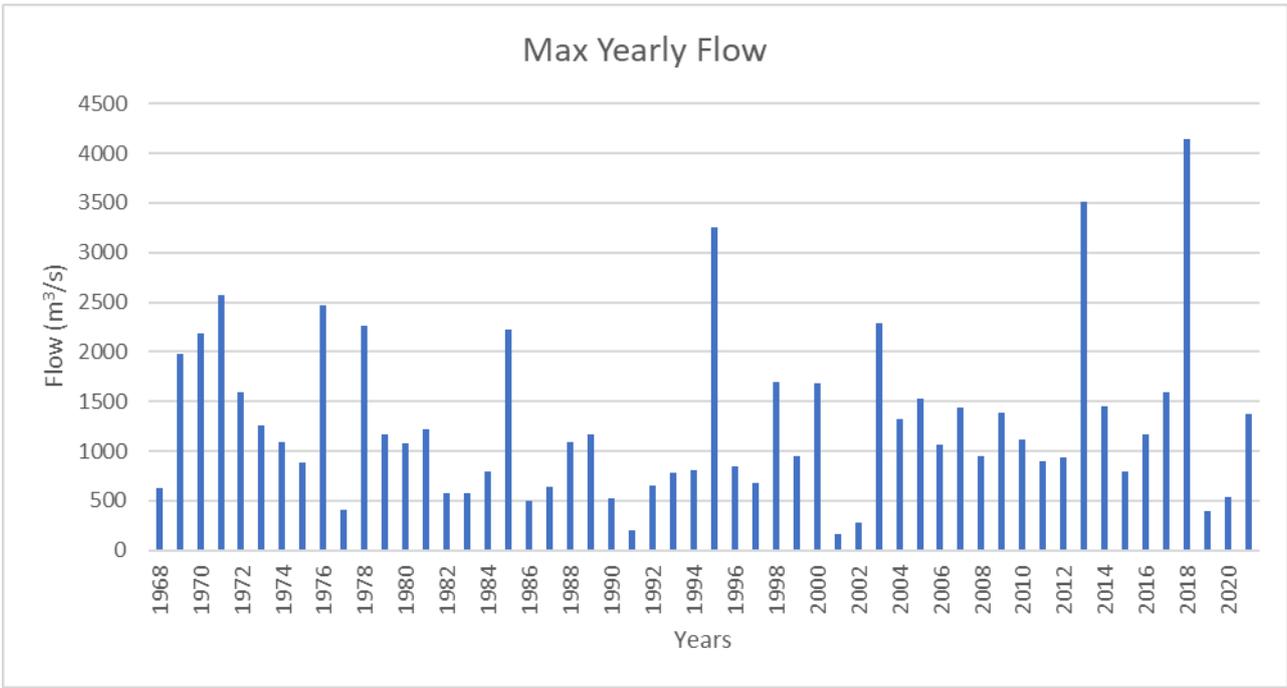


Figure 2 Annual Maximum Flow and field gauging data

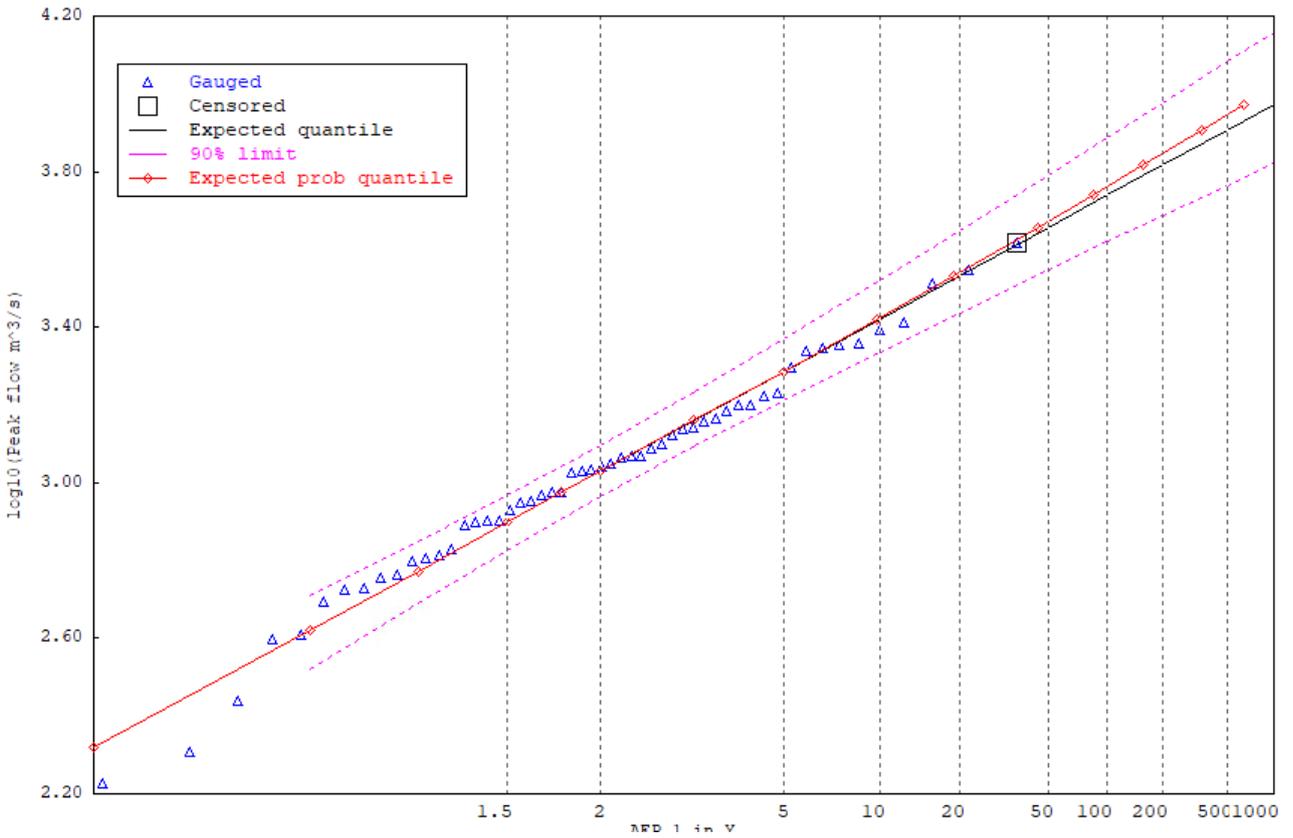


Figure 3 Flood Frequency Curve using Log Normal Distribution

RORB Model Development

RORB is a hydrologic software package that is regularly used throughout Australia and Version 6.52 was used. The model covered the whole catchment down to the Daintree River Mouth. Figure 4 shows the catchment, subareas, and reaches used in the RORB model. These features were defined using the hydrologically reinforced Shuttle Radar Topography Mission (SRTM) 1 second DEM data due to the lack of high-resolution LiDAR covering the area coupled with the large catchment size.

Given the undeveloped nature of the catchment 0 fraction impervious, “natural” Reach Type 1 was used throughout the model.

The model was developed with an interstation area at the Daintree River at Bairds gauge to assist in the validation of the RORB model to the FFA.

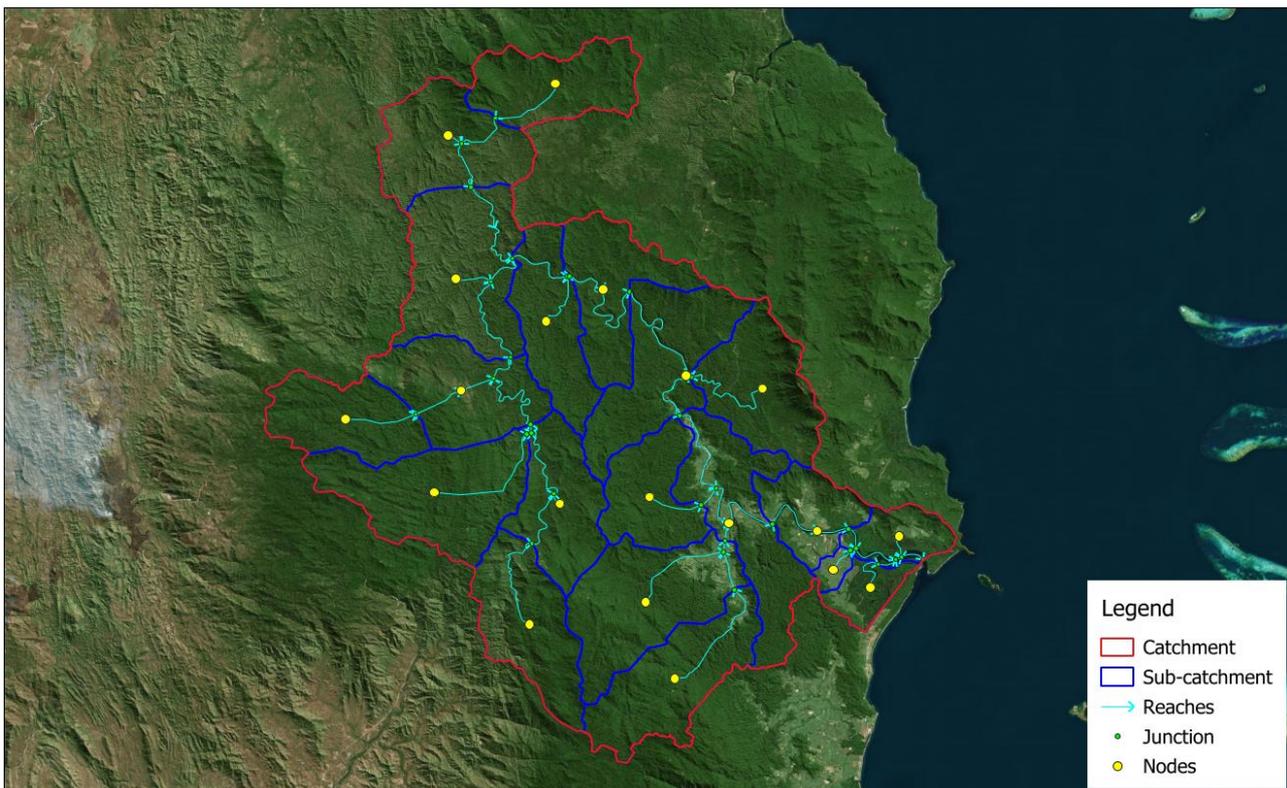


Figure 4 RORB model schematisation

RORB Model Calibration

The RORB model was calibrated to the January 2019 flood event to determine appropriate k_c and m hydrological routing parameters as routed flows will be applied to the upstream of hydraulic model. The January 2019 flood event rainfall, flow and spatial pattern data were sourced from the Bureau of Meteorology. The continues rainfall and flow data were sourced from Water Data Online. Then the timestep was converted to 15 minutes rainfall data to generate the hydrograph. The spatial pattern data was sourced from 25-29 January 2019 from the Recent and historical rainfall maps of the Bureau of Meteorology. A storm file was produced using these data to run the RORB model for this flood event. Then the RORB model was calibrated to the January 2019 flood event. Figure 5 shows the comparison of these RORB model results and the performance of the calibration is assessed in Table 2. The resulting routing parameters are as follows:

- $m = 0.8$ (default value)
- $k_c = 50.26$ and 25.95

A kc value of 50.26 was used up to Daintree River at Bairds gauge Site which matched the Aus wide Dyer (1994) data (Pearse et al, 2002) regional parameter equation. A kc value of 25.95 was adopted at the outlet base on the consistent kc/dav ratio.

Table 2 January 2019 Calibration Performance

Recorded Flow (m3/s)	RORB Result (m3/s)	Peak Flow Change (%)	Recorded Volume (m3/s)	RORB Volume (m3/s)	Volume Change (%)
4,148	4,318	4	4.24x10 ⁸	4.05x10 ⁸	-5

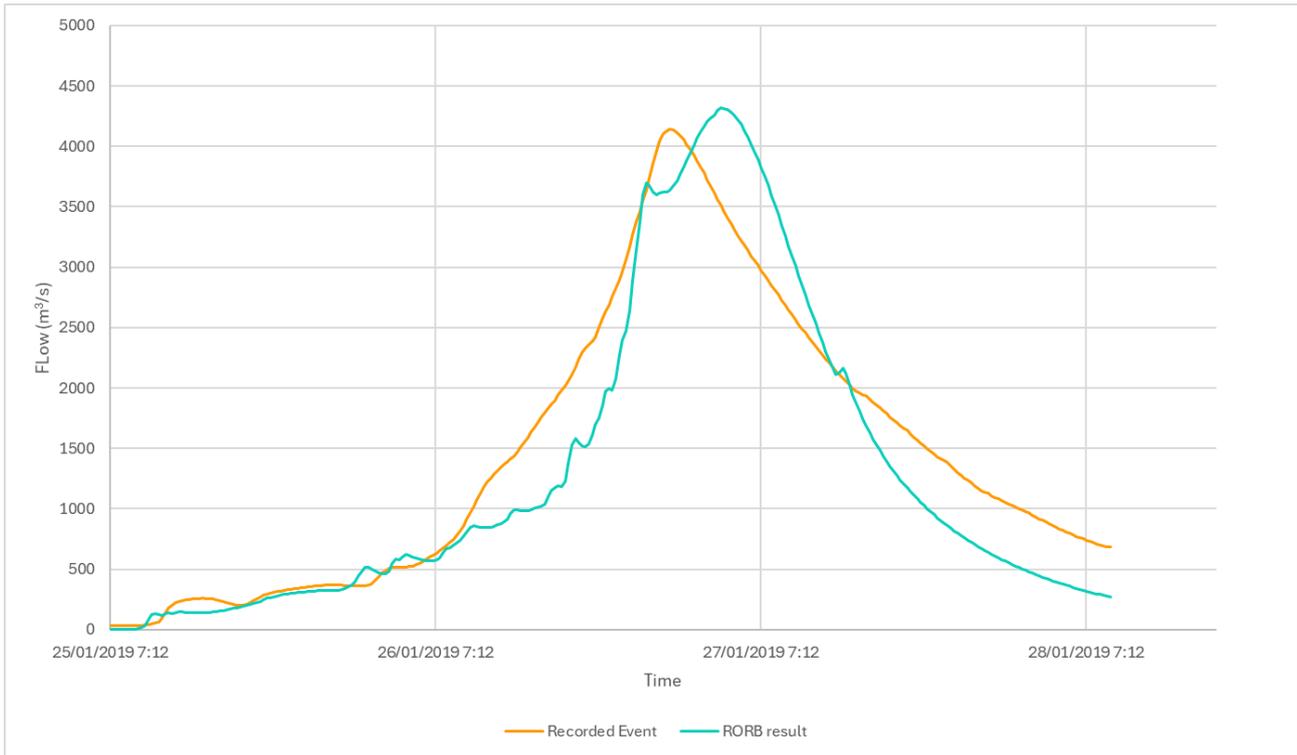


Figure 5 Flow comparison January 2019 for the Daintree River at Bairds gauge

RORB Design Event Modelling

Design event modelling has been undertaken for the 20%, 10%, 5%, 1% and 0.2% AEP in accordance with Version 4.2 of Australian Rainfall and Runoff (Ball, et al. 2019). The RORB model input parameters are as follows:

- Routing parameters – Calibrated routing parameters as described in the section above.
- Intensity-Frequency-Duration (IFDs) – Sourced from the Bureau of Meteorology’s Design Rainfall Data System (2016) (www.bom.gov.au/water/designRainfalls/revised-ifd/) for the coordinates; Latitude - 16.261, Longitude 145.351.

The BoM 2016 IFD curves are representative of a baseline period between 1961 – 1990. These rainfalls were factored to current and near-term climate conditions by factoring them up based on SSP5-8.5 climate change scenario.

As recommended in ARR for catchments with an area greater than 20 km² rainfall was spatially varied across the catchment using the gridded IFD data.

- Temporal Patterns - As per ARR for catchments greater than 75 km² aerial temporal have been used.
- Aerial Reduction Factors (ARF) - Intensity Frequency Duration design rainfall estimates from the Bureau of Meteorology (BoM) apply only to a point location. The estimates have to be adjusted when applied to

an entire catchment to allow for the fact that average rainfall over the whole catchment will be less than a given point location will experience. ARFs were applied using the in-built functionality in RORBwin.

- Storm losses – Storm losses parameters (initial and continuing losses) were derived reconciling the RORB model flows to those derived from the FFA. This was done using the ensemble modelling with the initial losses factored to account for median pre-burst rainfall depths from the ARR Data Hub were used and the unfactored BoM 2016 IFDs as they better represent the FFA annual maximum flow series period.

A comparison of the ensemble flows to the at-Site FFA results can be seen in Figure 6.

An initial loss of 20 mm and varies continue loss was found to provide a good match in peak flows to the FFA flows for the 20%-1% AEP range. The resulting losses are presented in Table 3. For the design event modelling they were factored to represent current and near-term climate conditions in accordance with ARR.

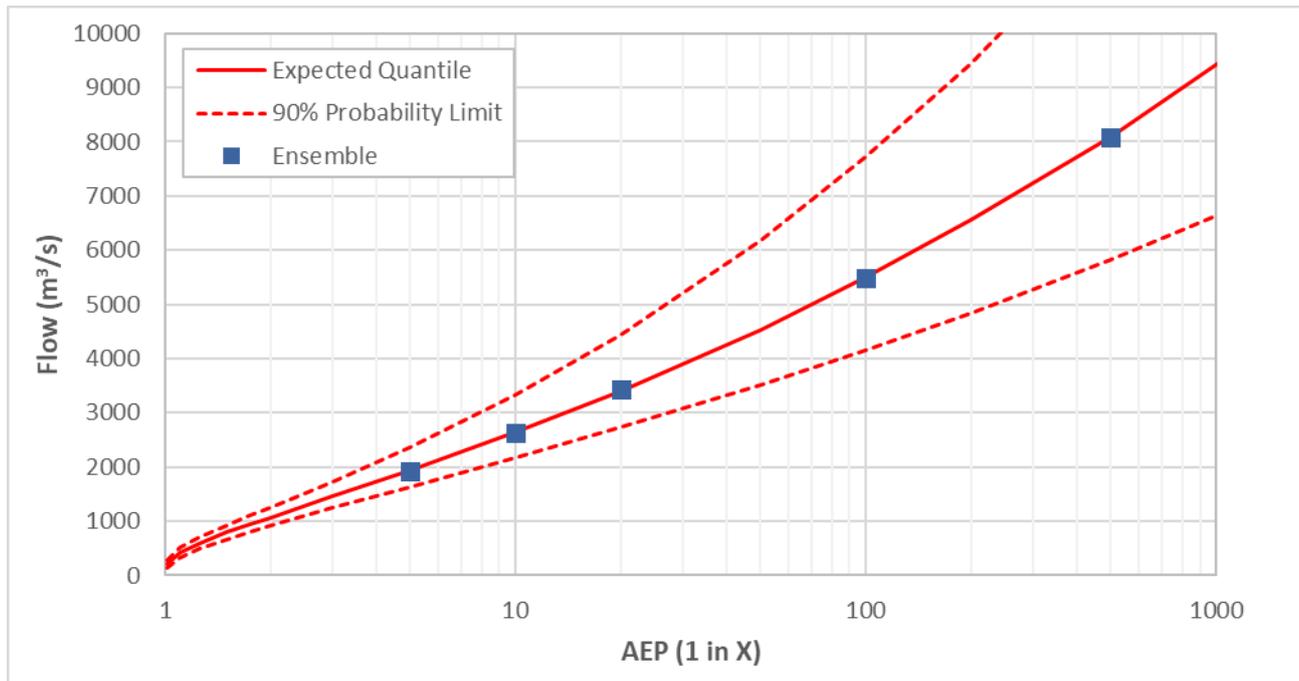


Figure 6 Calibration to FFA results (Ensemble method)

Table 3 Adopted initial losses

Parameter	Climate Period	20% AEP	10% AEP	5% AEP	1% AEP	0.2% AEP
IL (mm)	1961-1990	20	20	20	20	53
	Current and near term	20.2	20.2	20.2	20.2	53.53
CL (mm/h)	1961-1990	2.85	2.9	2.1	1.19	4
	Current and near term	3.91	2.96	2.14	1.21	4.08

The 20%, 10%, 5%, 1%, and 0.2% AEP design events and storm durations between 12 hours and 48 hours were considered in this assessment. The adopted temporal pattern for each AEP event is that which produces the peak flow closest to the median peak flow from all simulations in the ensemble analysis for a given duration and AEP. Table 4 shows the FFA results, critical durations and corresponding peak flows from the updated RORB model at the BAIRDS gauge. The RORB flows were used as inputs to the TUFLOW hydraulic model.

Table 4 Peak flows for the various AEPs produced by RORB

AEP (%)	Critical Duration (h)	Temporal Pattern	RORB Flow at BAIRDS gauge (m ³ /s)	RORB Flow US of Ferry Site (m ³ /s)
20	36	TP1	2,321	2,821
10	36	TP9	2,864	3,987
5	36	TP9	3,712	5,346
1	36	TP6	5,968	8,658
0.2	36	TP9	8,757	10,666

Hydraulic Modelling

A new hydraulic model was developed for the purposes of this assessment. The model was developed using the industry standard TUFLOW hydraulic modelling software package (version 2025.2.0-iSP). The model setup is based on experience derived from the building of other models, published data, and aerial photography. Model schematisation is shown in Figure 7.

. The model was setup to assess both the existing conditions and developed conditions with the proposed ramp and roads to access afflux and advise flood levels and velocities for the structural design.

The developed case hydraulic model was set up with the following parameters:

- The model covers the Daintree River for approximately 7,700 m upstream of the Site, and approximately 9,300 m downstream of the Site.
- The model was developed at a base resolution of 10 m square grid elements to reduce model run time.
- Quadtree was used to reduce the grid size to 2.5 m to increase the model resolution in the area of interest.
- Break lines were added to the reinforce the road levels within the area of interest.
- Ground surface elevations were based on:
 - State sourced 1 m LiDAR (2010) from GeoScience Australia's Elvis website.
 - High-resolution depth model for the Great Barrier Reef - 30 m.
- Local survey of the bathymetry was captured for this project (372854-101-Pile Location merged GDA2020 LAT datum model.dwg).
- The TIN of the proposed ramp and roads was provided from the client (25019-COMPOSITE DESIGN TIN_Updated_20251028.dwg).
- Table 5 Manning's 'n' of various surfaces details the Manning's 'n' roughness of the surfaces covered by the model. These were based on aerial imagery of the waterway and surrounds and site photographs.

Table 5 Manning's 'n' of various surfaces

Area Characteristics	Manning's 'n'
Farmland	0.010
Minor vegetation	0.060
Moderate vegetation	0.080
Dense vegetation	0.100
Paved Road	0.020
Dirt roads	0.035
River	0.040
Urban	0.070

- The Design scenario material layer has been updated accordingly based on the proposed design.
- Upstream boundary inflows were hydrographs output from RORB with peak flows of the magnitudes shown in Table 4. These were represented as SA boundary using QT (flow – time series).
- The downstream boundaries were represented as
 - A HT (height – time series) boundary with a constant tide level of 0.91 m AHD and was in the ocean as the boundary levels can be applied.
 - Two HQ boundaries with a grade of 1 in 1000 (0.001) and were located sufficiently downstream so as not to affect flood levels at Site.

Flood levels and flow velocities at this location may vary due to fluctuations in downstream water levels influenced by tidal conditions. To assess the potential impact of these variations, a sensitivity analysis was conducted using five different tidal scenarios. This approach enabled a comprehensive understanding of how flood levels and velocities respond under varying tidal influences. The tide levels are obtained from previous 2019 study (RPS Flood study Daintree.pdf) and Queensland Tide Table 2025 for the Low Islets. Table 6 presents the peak flood levels and peak flow velocities on both sides of the ramp in 1% AEP under five distinct tidal scenarios. The location of the extracted flood levels and velocities are shown in Figure 7. Given the minimal variation in flood levels and velocities across these scenarios, the MHWS tidal scenario has been adopted for the remaining AEP events and the developed case, to maintain consistency with the previous 2019 study (RPS Flood study Daintree.pdf).

Table 6 Tidal Scenarios

Tidal Scenarios	Tide Levels (m AHD)	Peak Flood Levels of Southern Ramp (m AHD)	Peak Flood Levels of Northern Ramp (m AHD)	Flood Velocities of Southern Ramp (m/s)	Flood Velocities of Northern Ramp (m/s)
MHWS	0.91	5.87	5.87	0.89	0.73
MLWS	0.81	5.87	5.87	0.89	0.73
HAT	1.73	5.88	5.87	0.89	0.72
1996 TIDE	1.32	5.87	5.87	0.89	0.72
Calibrated Model (2019 Study)	0	5.87	5.87	0.89	0.73



Figure 7 TUFLOW Schematisation

Flood Mapping Outputs

The 20%, 10%, 5%, 1%, and 0.2% AEP events were simulated using the TUFLOW model. Flood level and velocity mapping is provided in Figure 9 to Figure 18 for each AEP.

Table 7 presents the peak flood levels and peak flow velocities on both sides of the ramp in 1% AEP under five distinct tidal scenarios. The location of the extracted flood levels and velocities are shown in.

Table 7 Peak Flood Levels and Velocities

AEP	Peak Levels Southern (m AHD)	Flood of Ramp	Peak Levels Northern (m AHD)	Flood of Ramp	Flood Velocities of Southern Ramp (m/s)	Flood Velocities of Northern Ramp (m/s)
20% AEP	3.88		3.89		0.65	0.63
10% AEP	4.35		4.36		0.72	0.66
5% AEP	4.87		4.88		0.79	0.7
1% AEP	5.87		5.87		0.89	0.73
0.2% AEP	6.29		6.29		1.03	0.77

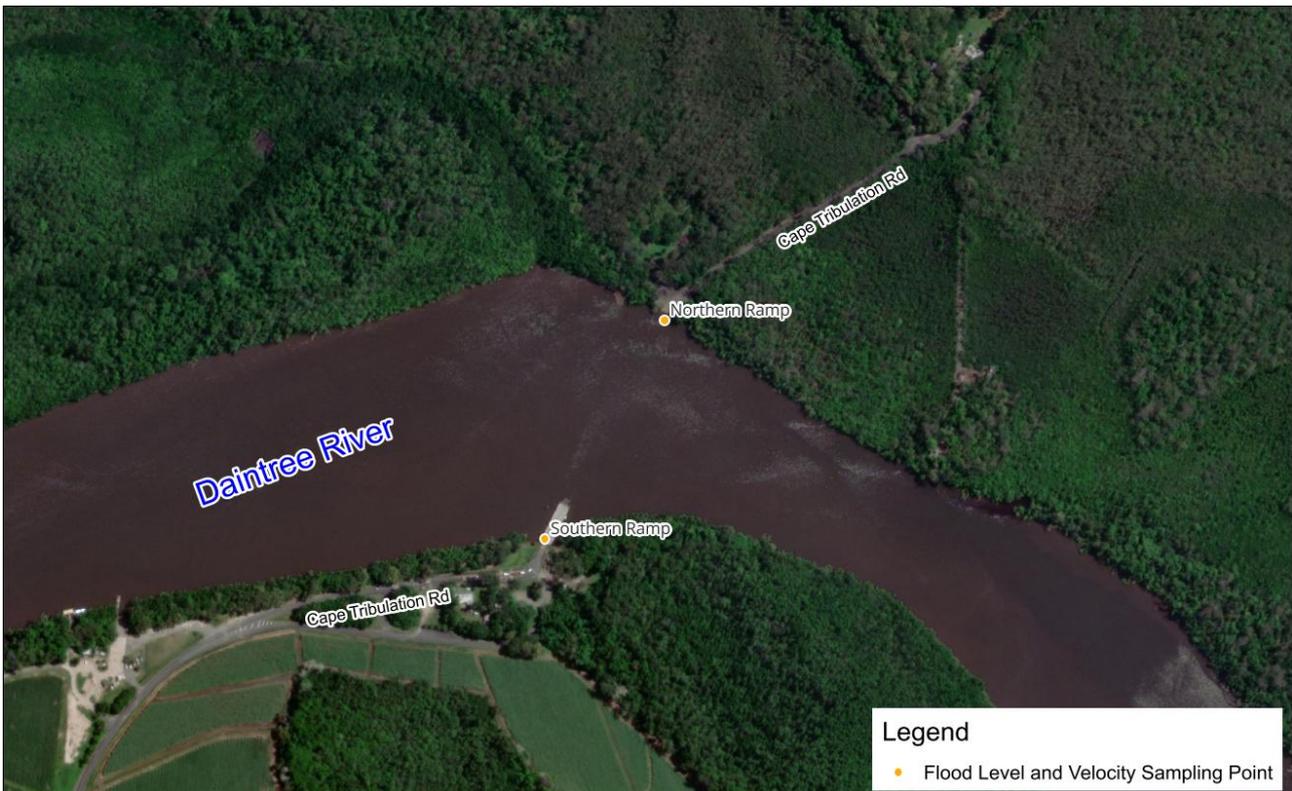


Figure 8 Peak Flood Levels and Velocities Location

Figure 19 to Figure 28 show the difference in peak flood levels and peak flood velocities between the existing case model and developed case model. No change in flood level within ± 10 mm or flood velocity within ± 10 cm is shown in pale yellow. The green shades represent areas where there would be reductions in flood level or flood velocity, and the orange/red shades represent areas where the flood level or flood velocity would be increased. The pink shade identifies areas that would currently be inundated but would be flood free with the development in place (was wet now dry) and the blue shade shows the reverse (was dry now wet). There has been no adverse impact in the vicinity of the proposed infrastructure upgrade area shown on the maps.

Summary & Conclusion

Hydrographs for a range of design flood events were determined at the Daintree Ferry using the calibrated RORB model which was reconciled to an FFA for Daintree River at Bairds (108002A) stream gauge. A 2D hydraulic model of the local area was developed in order to understand the flow behaviour, impact of the design, provide flood level and velocity for structural design purposes. Flood levels and velocities are provided over the ramp in a table for the purposes of the ramp design and an afflux assessment showed negligible difference in flood level in the vicinity of the Daintree Ferry works area.

Please do not hesitate to contact me should you require any further information.

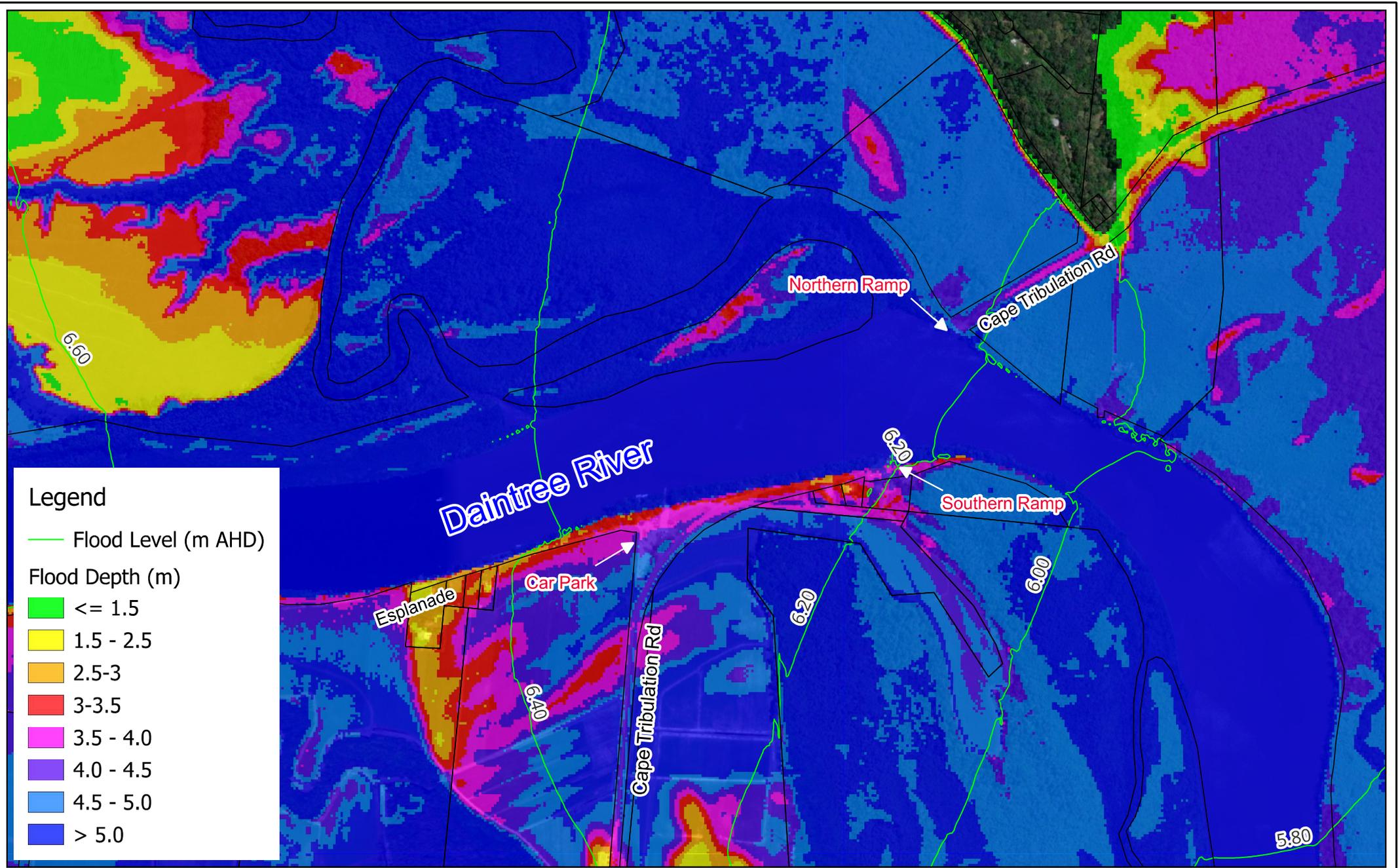
Yours sincerely,

Atoosa Towzihian
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Michael South
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RPEQ 29221

References

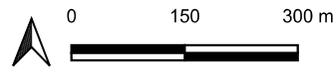
Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I (Ed) (2019), *Australian Rainfall and Runoff: A Guide to Flood Estimation*, Version 4.2, Commonwealth of Australia (Geoscience Australia).



Title: **Daintree Ferry infrastructure upgrade**
0.2% AEP Peak Flood Depth - Developed Case

Figure: **9**

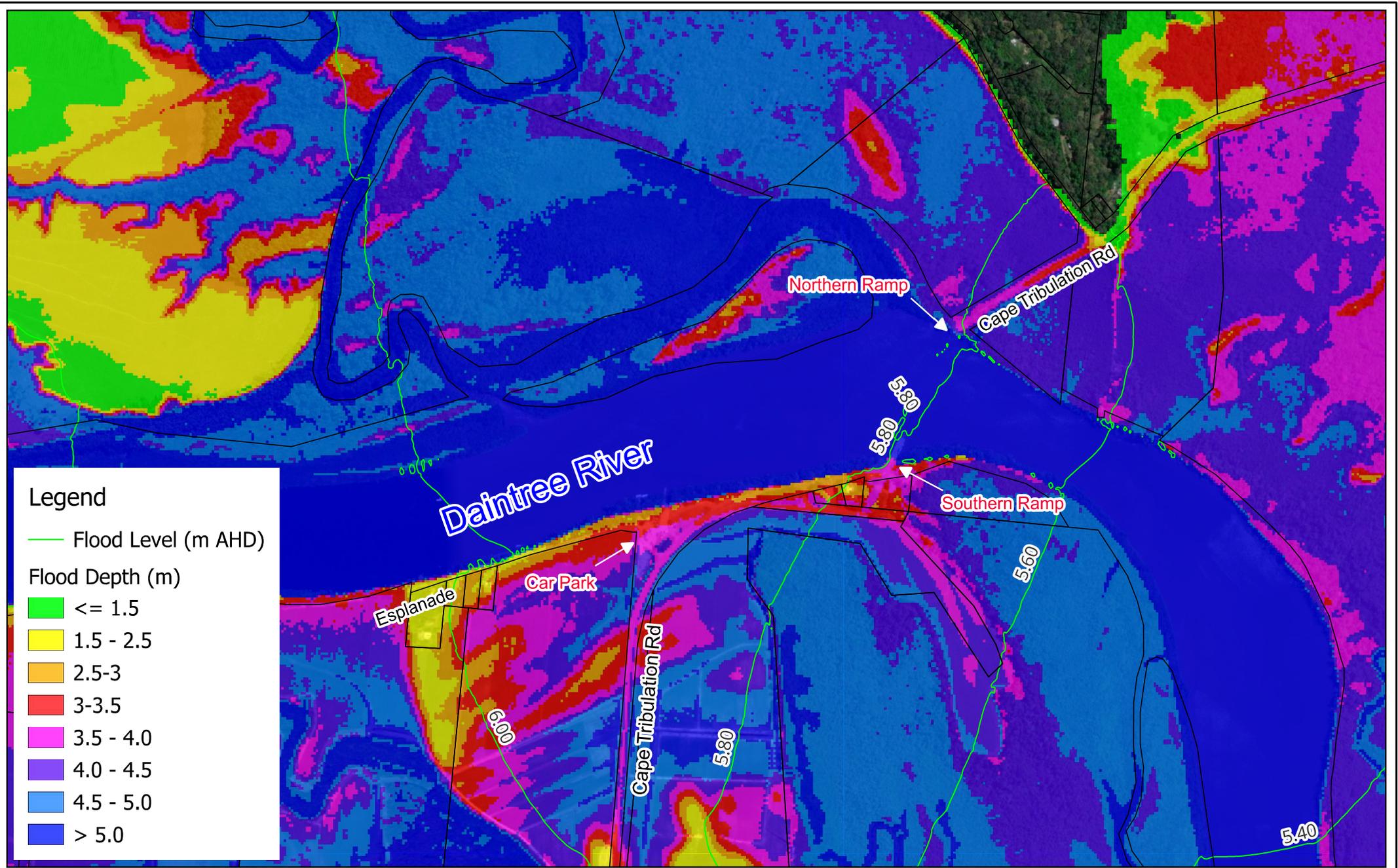
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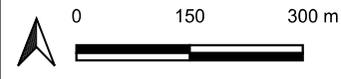
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Title: **Daintree Ferry infrastructure upgrade**
1% AEP Peak Flood Depth - Developed Case

Figure: **10**

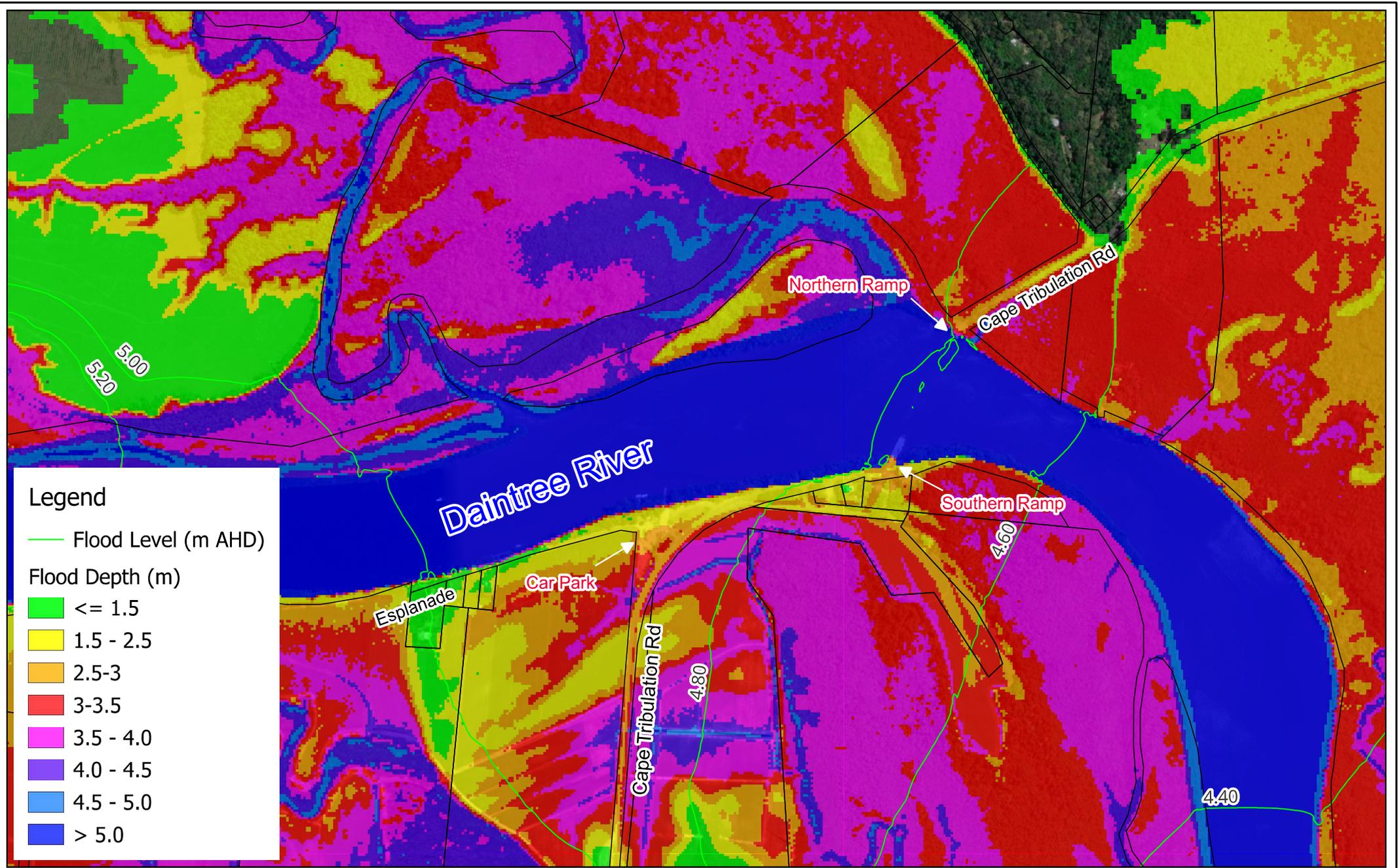
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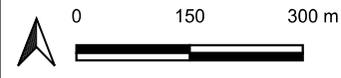
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Title: **Daintree Ferry infrastructure upgrade**
5% AEP Peak Flood Depth - Developed Case

Figure: **11**

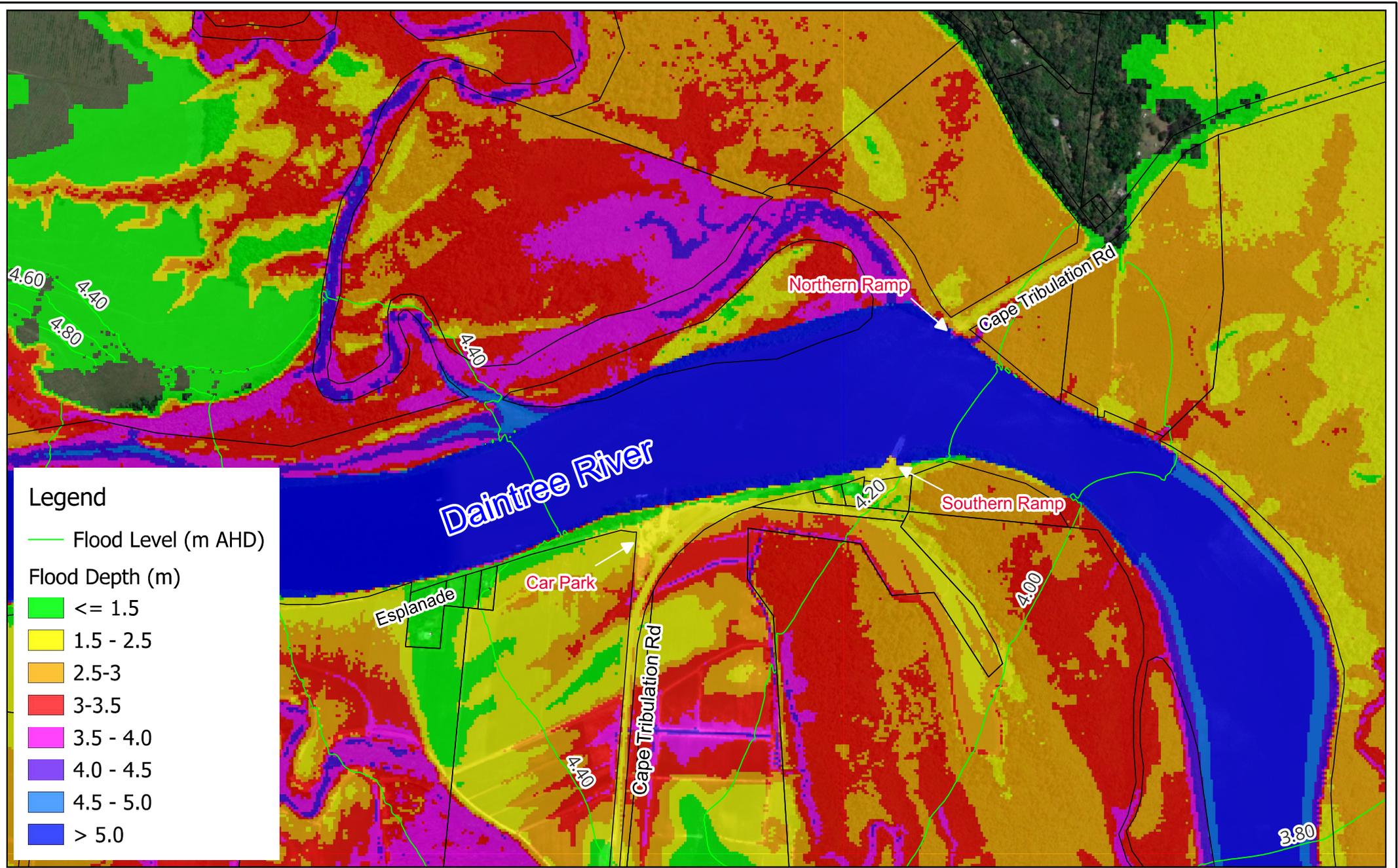
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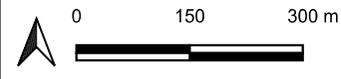
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Title: **Daintree Ferry infrastructure upgrade**
10% AEP Peak Flood Depth - Developed Case

Figure: **12**

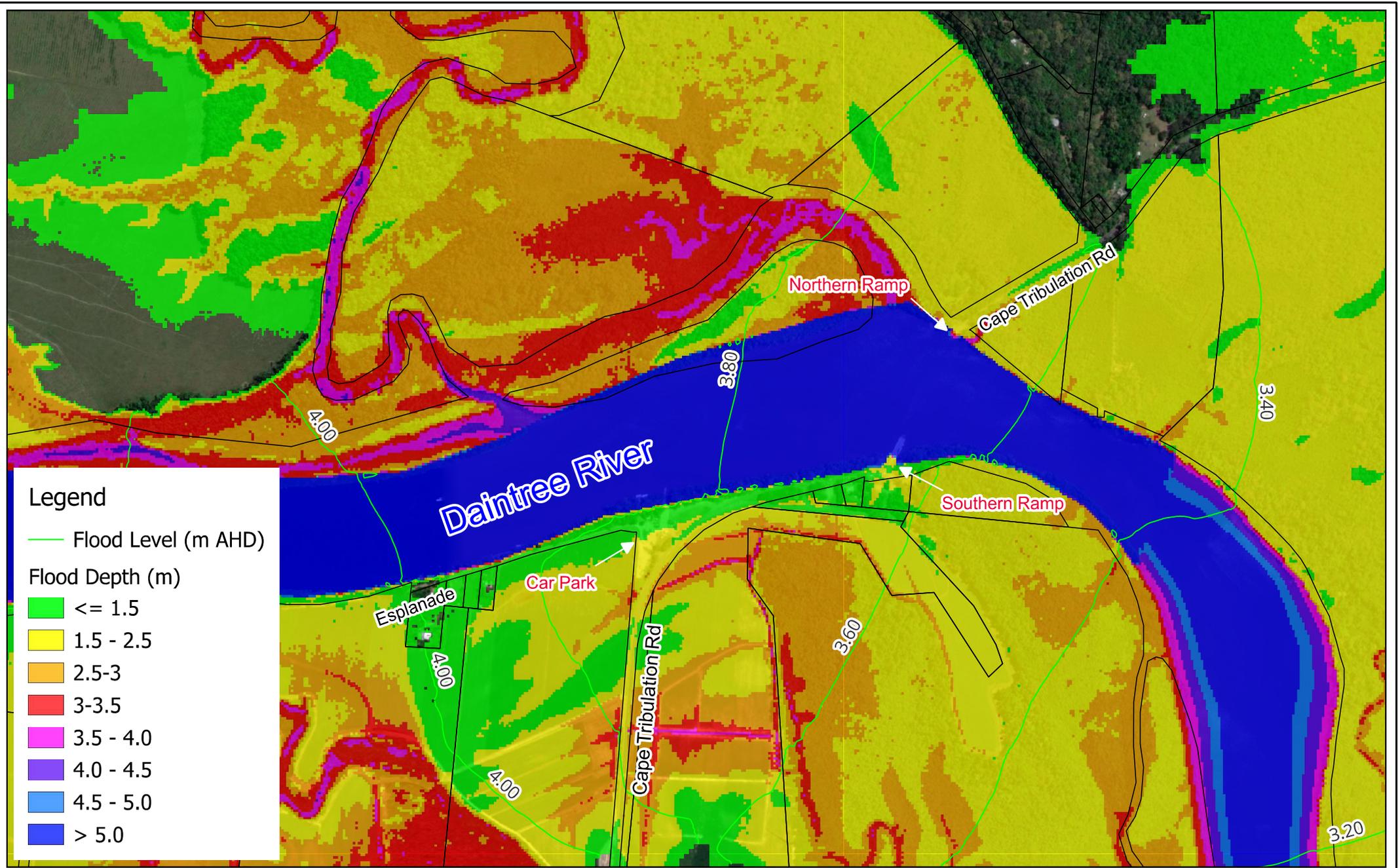
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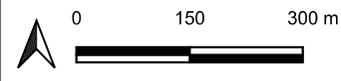
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Title: **Daintree Ferry infrastructure upgrade**
20% AEP Peak Flood Depth - Developed Case

Figure: **13**

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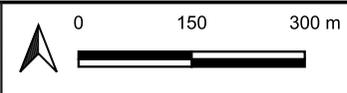
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Title: **Daintree Ferry infrastructure upgrade**
0.2% AEP Peak Flood Velocity - Developed Case

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By: TL Nov 2025



Title: **Daintree Ferry infrastructure upgrade**
1% AEP Peak Flood Velocity - Developed Case

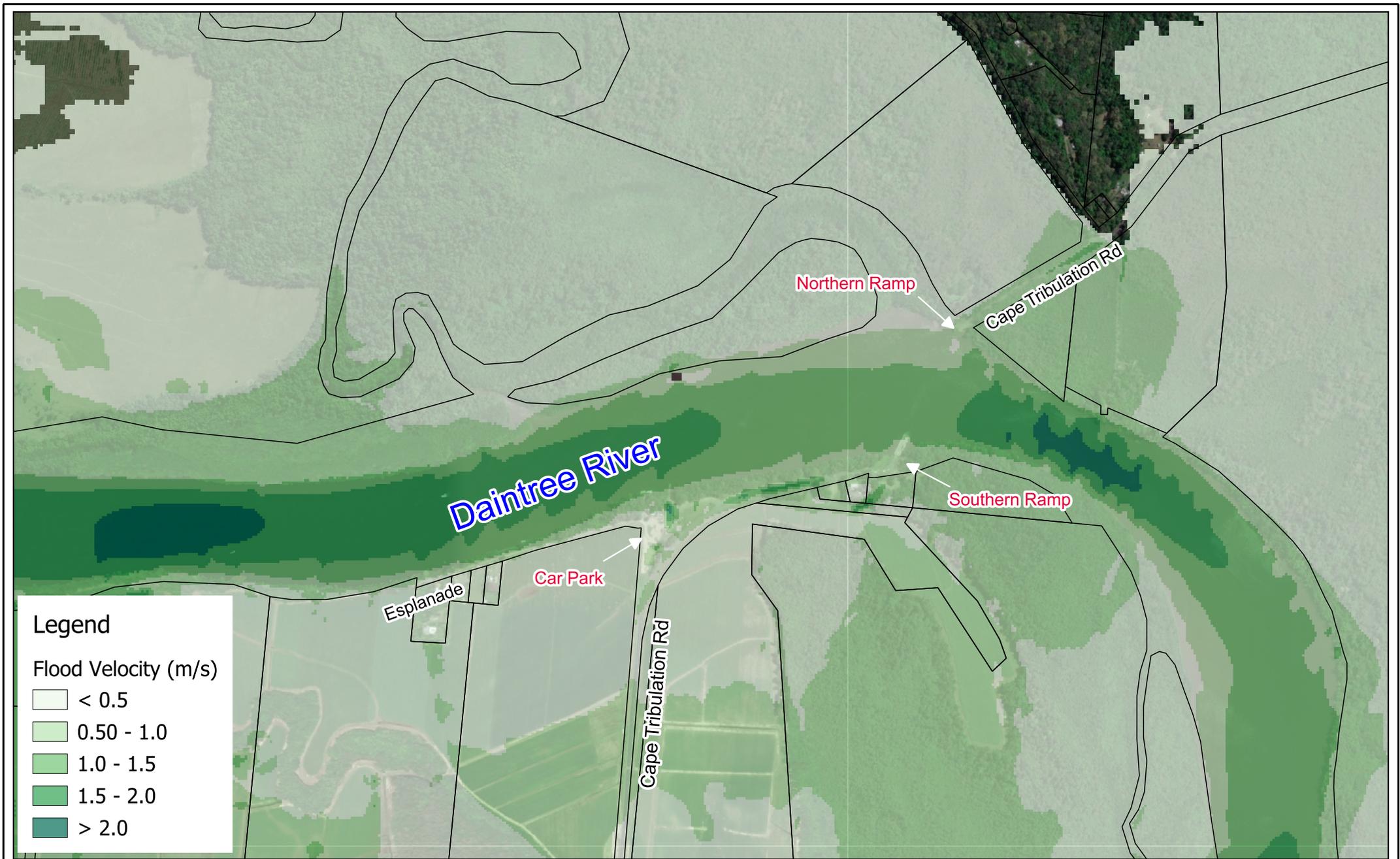
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Title: **Daintree Ferry infrastructure upgrade**
5% AEP Peak Flood Velocity - Developed Case

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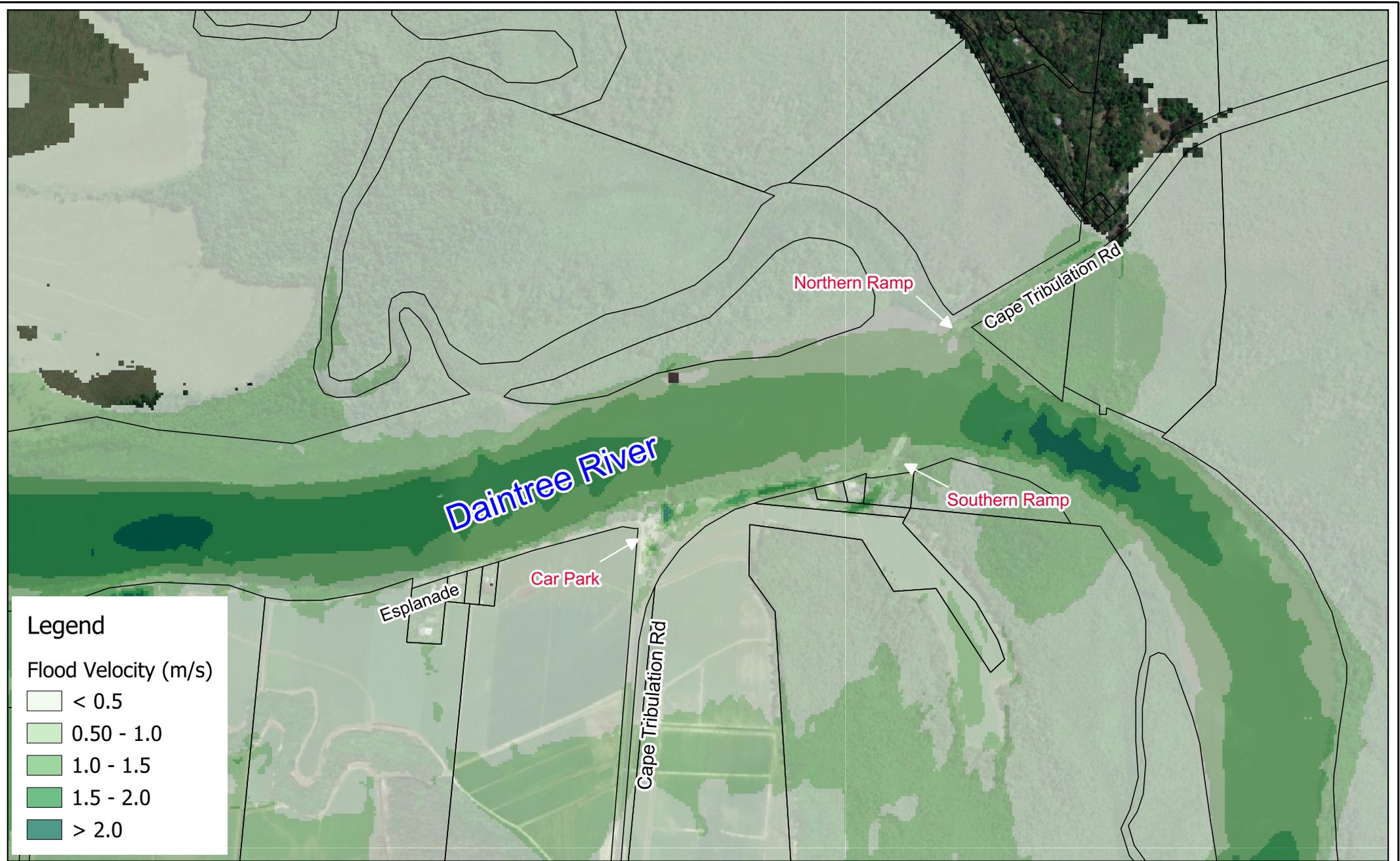
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Title: **Daintree Ferry infrastructure upgrade**
10% AEP Peak Flood Velocity - Developed Case

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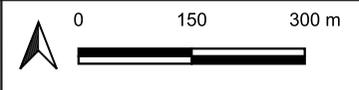


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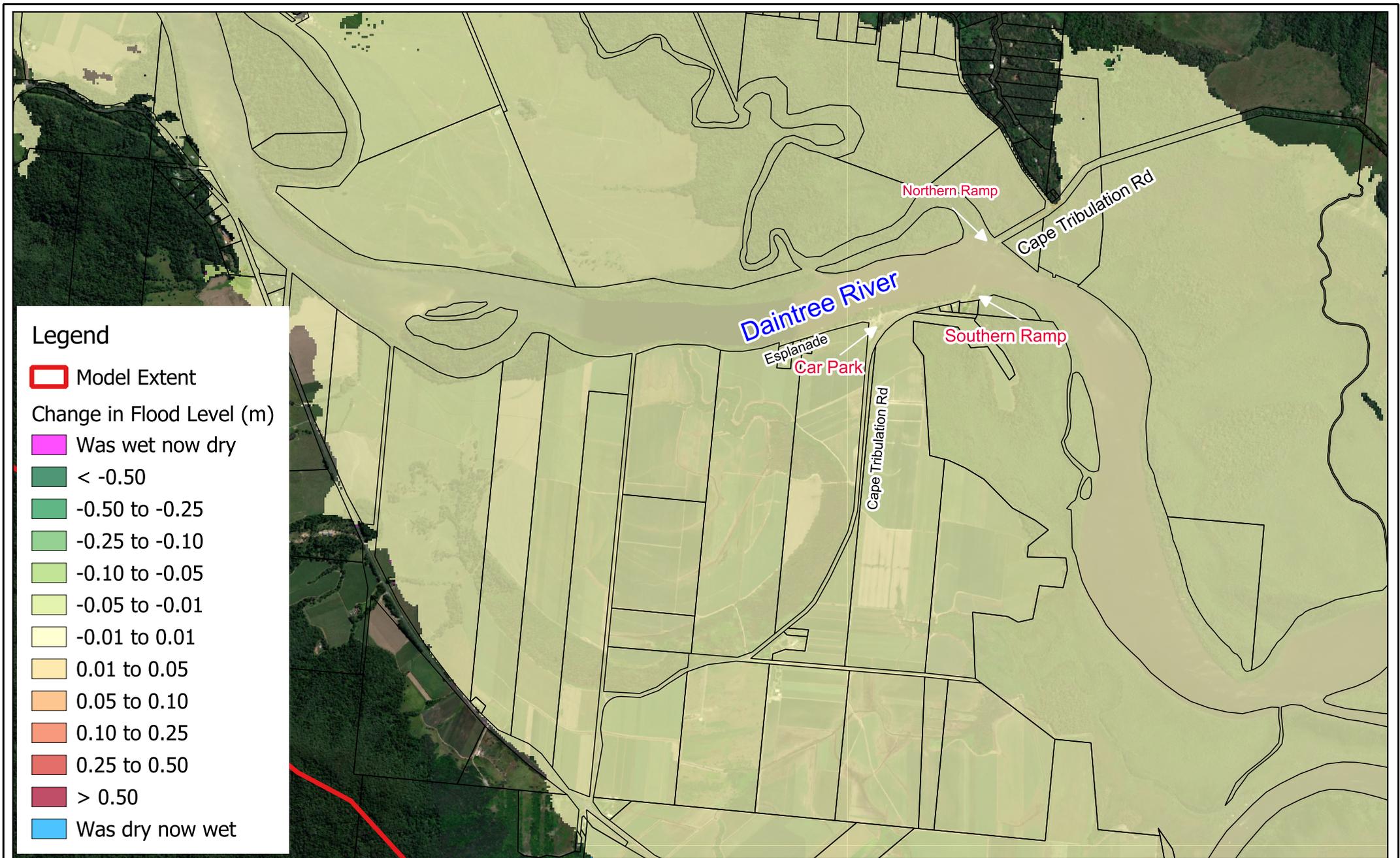
Title: Daintree Ferry infrastructure upgrade
20% AEP Peak Flood Velocity - Developed Case

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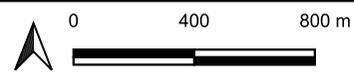
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Title: Daintree Ferry infrastructure upgrade
0.2% AEP Change in Peak Flood Level

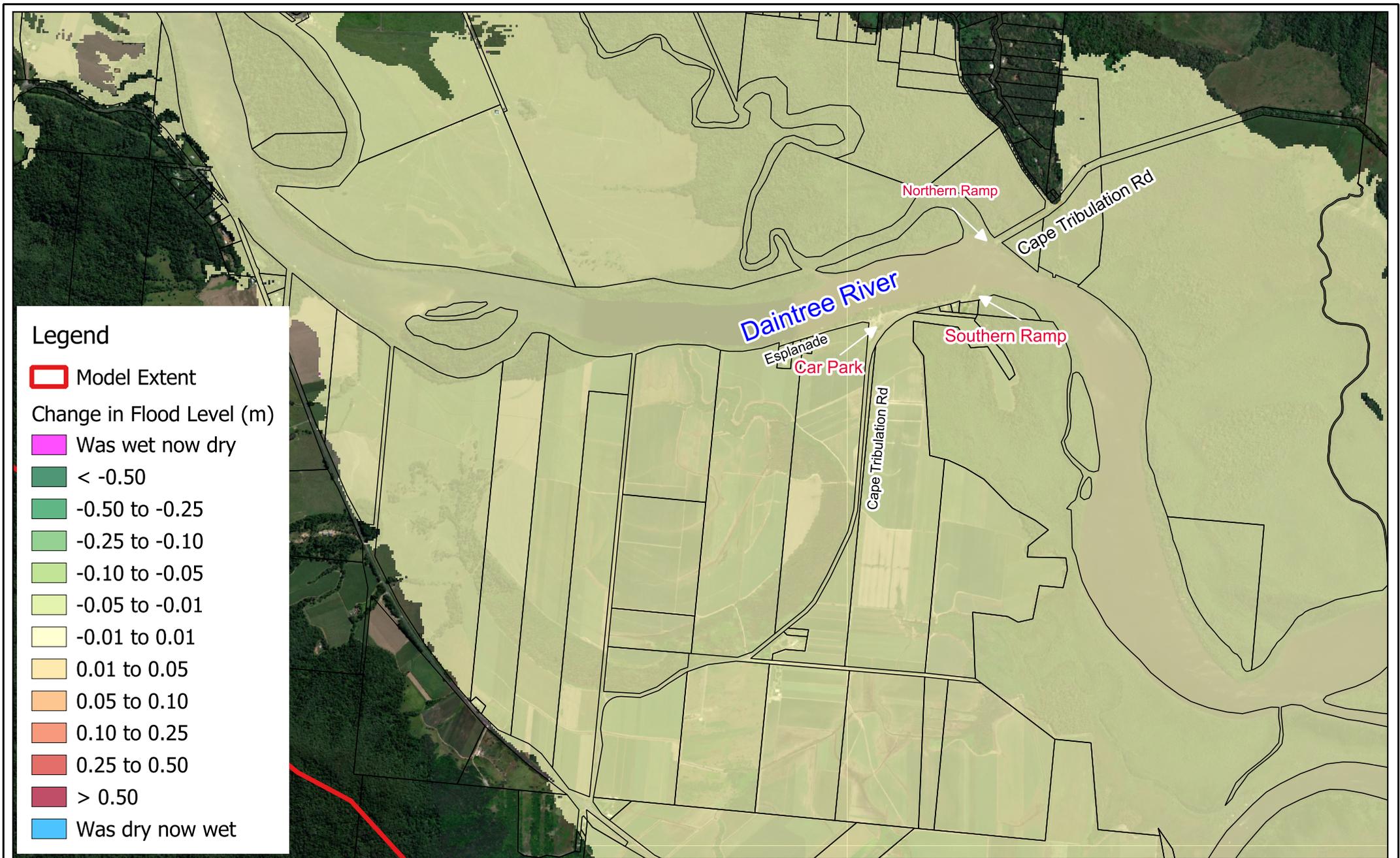
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Title: Daintree Ferry infrastructure upgrade
1% AEP Change in Peak Flood Level

Figure: 20

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Title: Daintree Ferry infrastructure upgrade
5% AEP Change in Peak Flood Level

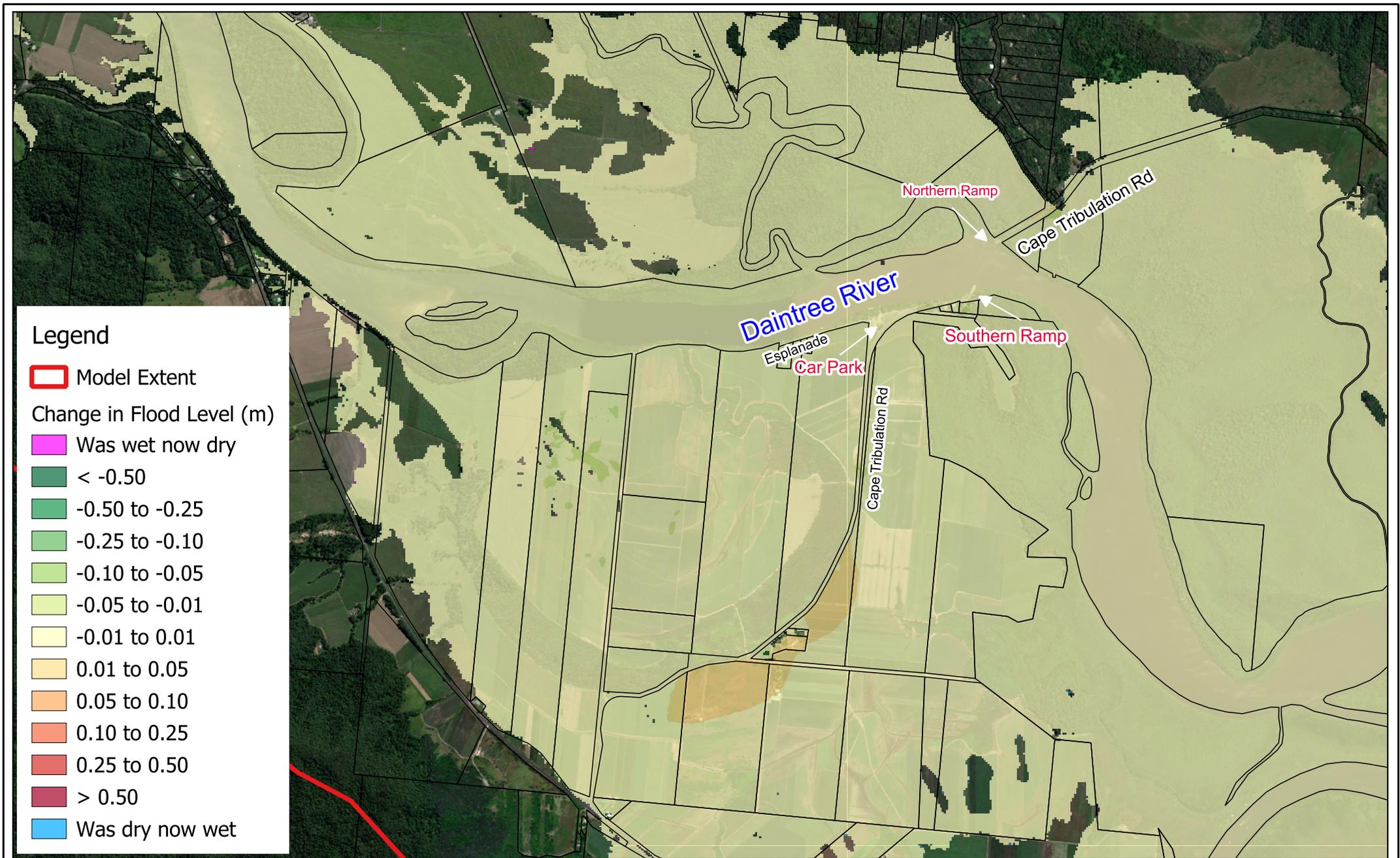
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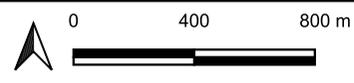




Title: Daintree Ferry infrastructure upgrade
10% AEP Change in Peak Flood Level

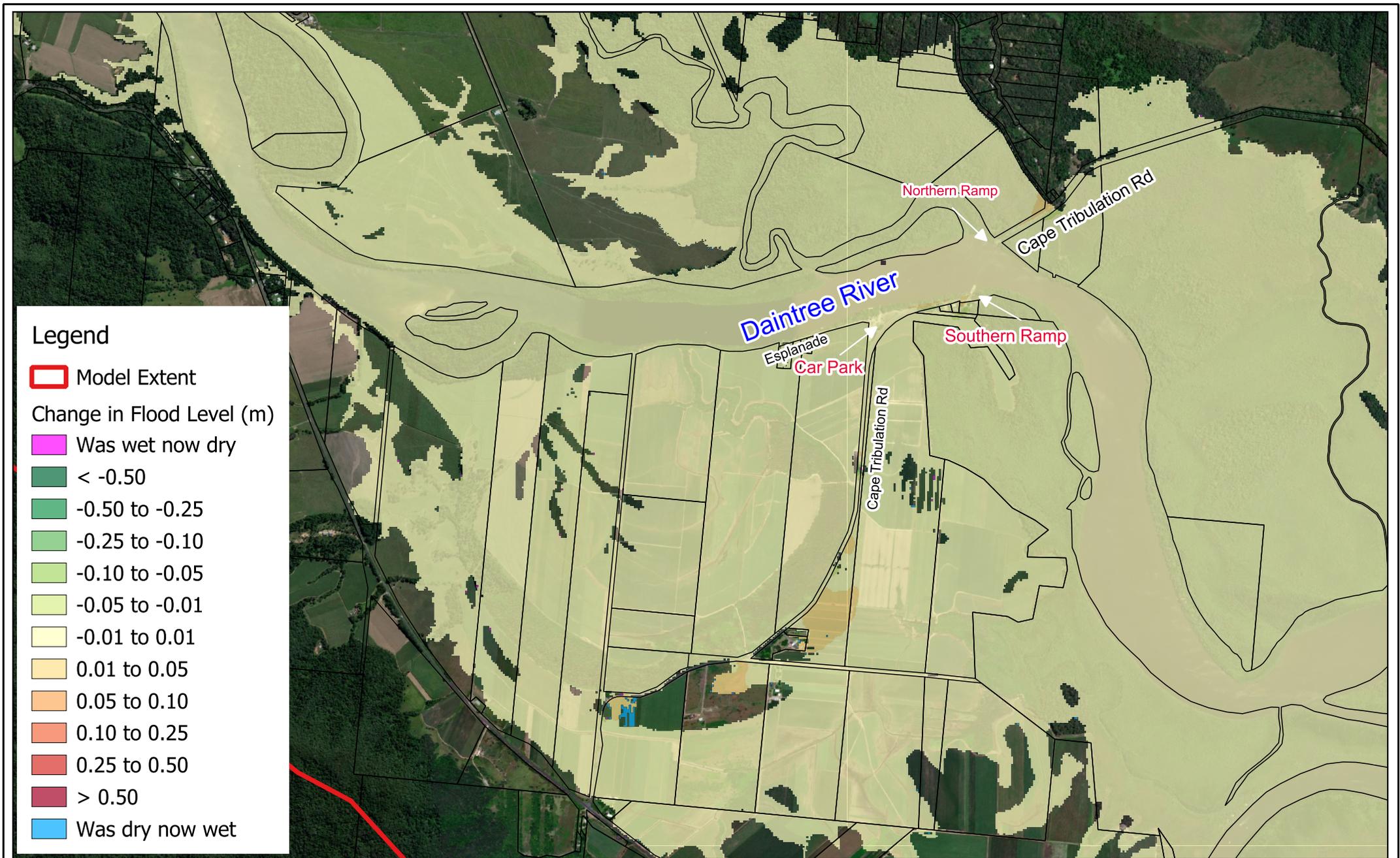
Figure: 22

Rev: A



This mapping product is based on techniques and data in accordance with the study scope. Users should consider the mapping in the context of the report. No two floods are the same and care should be taken in the use and interpretation of the results presented.





Title: Daintree Ferry infrastructure upgrade
20% AEP Change in Peak Flood Level

Figure: 23
Rev: A



This mapping product is based on techniques and data in accordance with the study scope. Users should consider the mapping in the context of the report. No two floods are the same and care should be taken in the use and interpretation of the results presented.

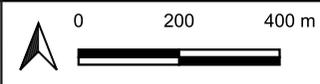




Title: Daintree Ferry infrastructure upgrade
0.2% AEP Peak Flood Velocity

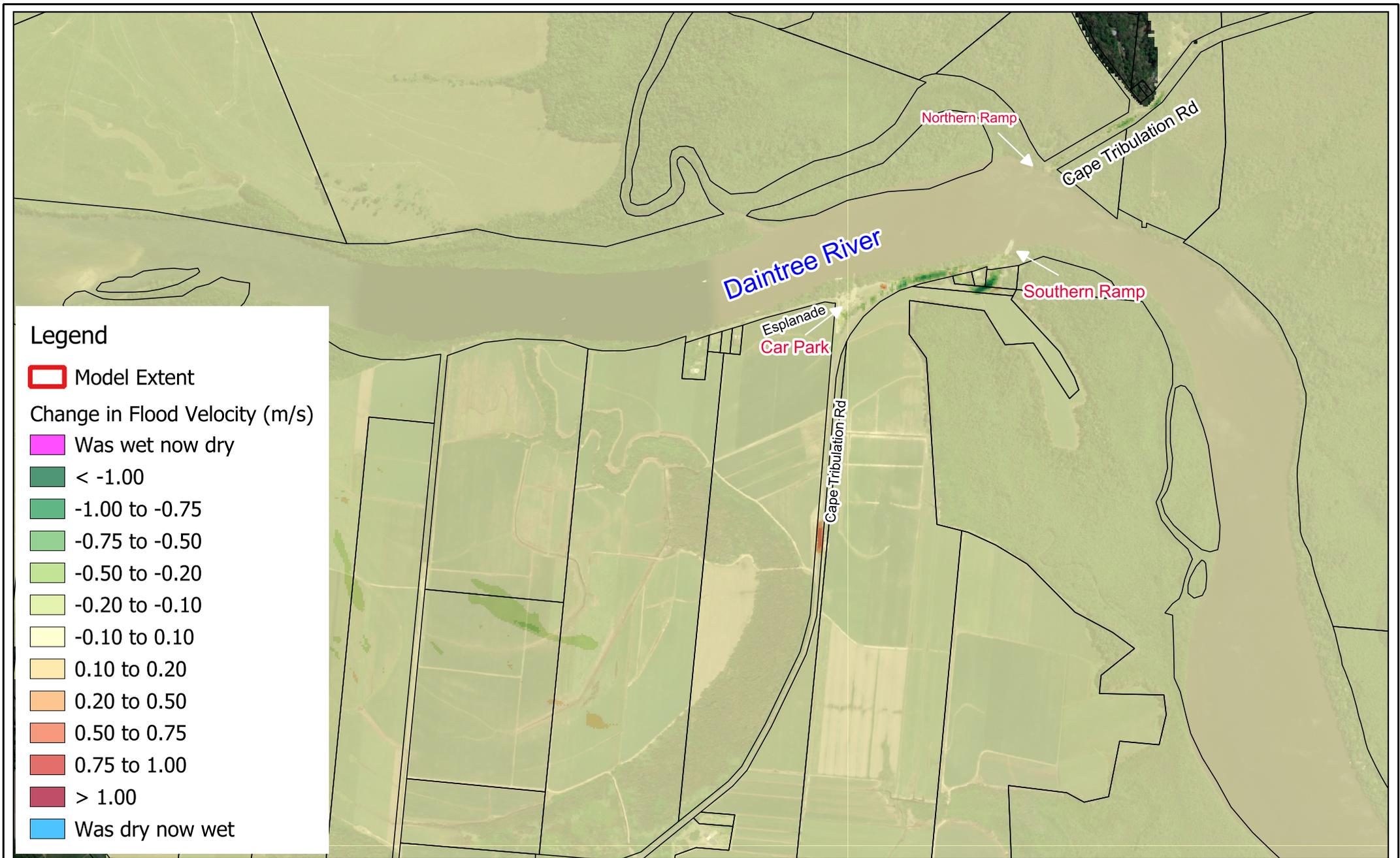
Figure: 24

Rev: A



This mapping product is based on techniques and data in accordance with the study scope. Users should consider the mapping in the context of the report. No two floods are the same and care should be taken in the use and interpretation of the results presented.

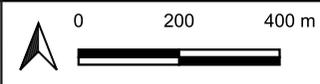




Title: Daintree Ferry infrastructure upgrade
1% AEP Peak Flood Velocity

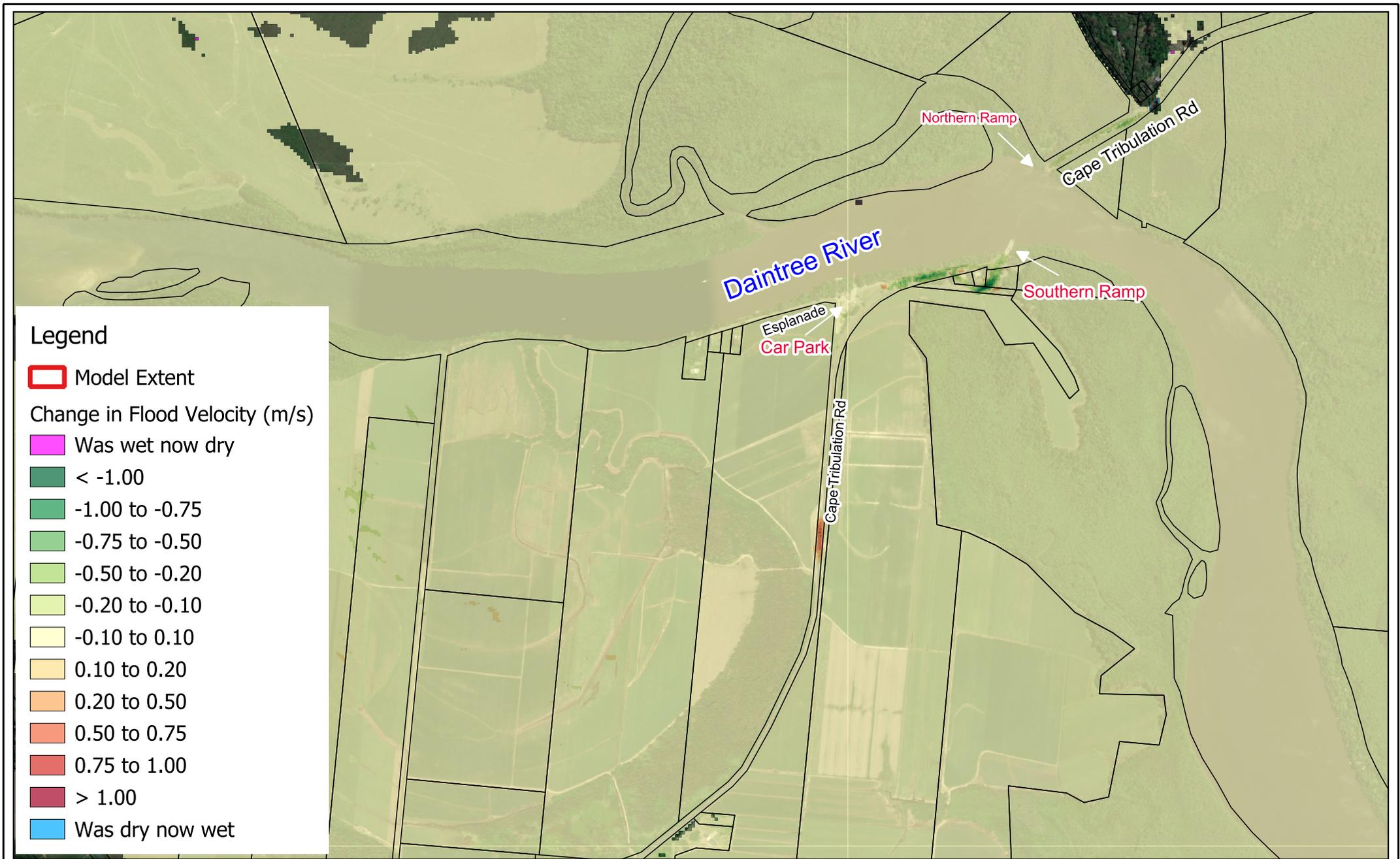
Figure: 25

Rev: A



This mapping product is based on techniques and data in accordance with the study scope. Users should consider the mapping in the context of the report. No two floods are the same and care should be taken in the use and interpretation of the results presented.

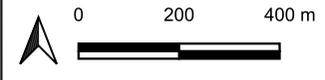




Title: Daintree Ferry infrastructure upgrade
5% AEP Peak Flood Velocity

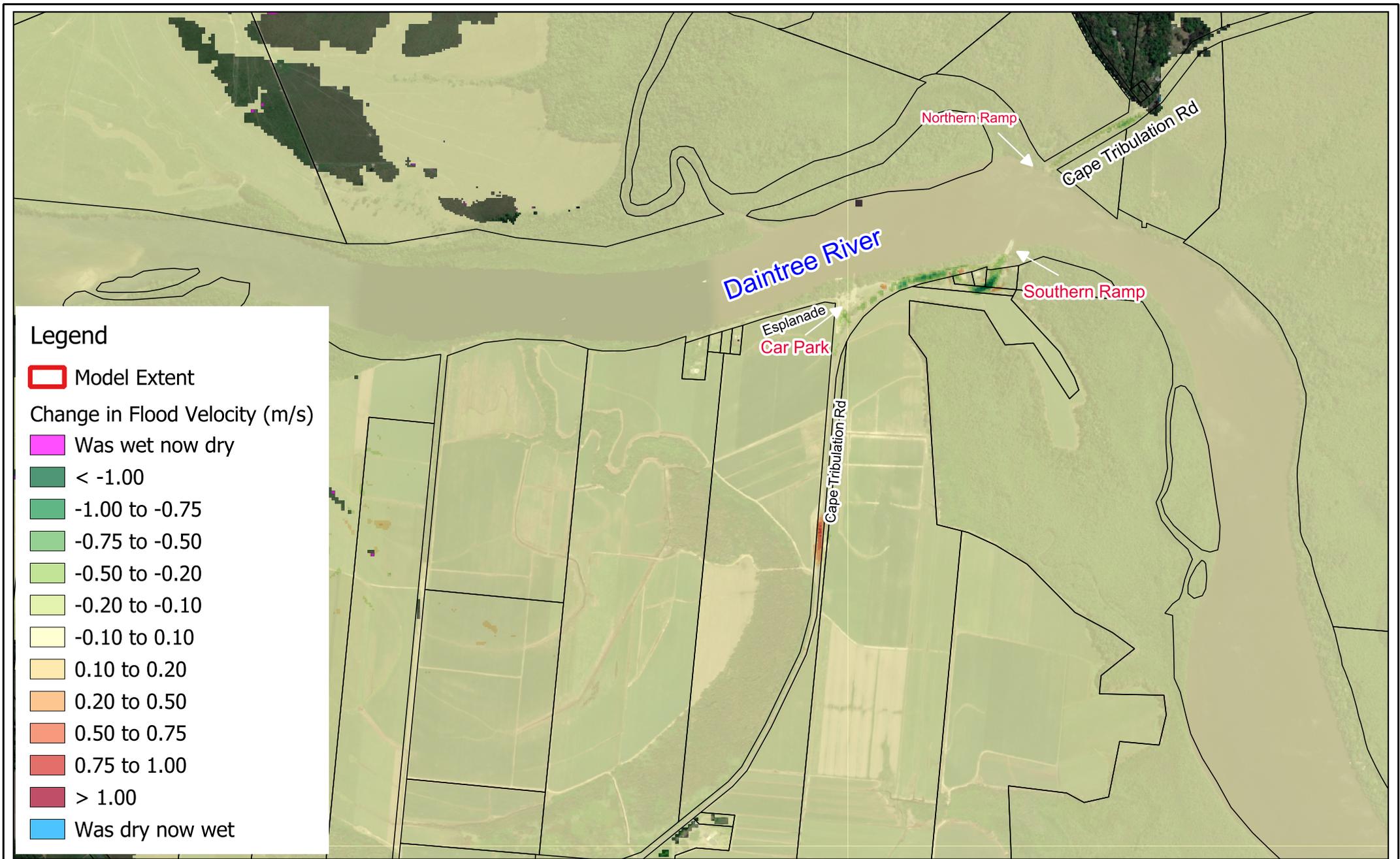
Figure: 26

Rev: A



This mapping product is based on techniques and data in accordance with the study scope. Users should consider the mapping in the context of the report. No two floods are the same and care should be taken in the use and interpretation of the results presented.





Title: Daintree Ferry infrastructure upgrade
10% AEP Peak Flood Velocity

Figure: 27

Rev: A



This mapping product is based on techniques and data in accordance with the study scope. Users should consider the mapping in the context of the report. No two floods are the same and care should be taken in the use and interpretation of the results presented.





Title: Daintree Ferry infrastructure upgrade
20% AEP Peak Flood Velocity

Figure: 28

Rev: A



This mapping product is based on techniques and data in accordance with the study scope. Users should consider the mapping in the context of the report. No two floods are the same and care should be taken in the use and interpretation of the results presented.



Attachment 1 – Daintree River at Bairds Annual Maximum Series

Water Year	Maximum Flow (m ³ /s)	Water Year	Maximum Flow (m ³ /s)
1968	630	1995	3,251
1969	1,977	1996	848
1970	2,184	1997	674
1971	2,577	1998	1,700
1972	1,591	1999	949
1973	1,258	2000	1,678
1974	1,096	2001	168
1975	887	2002	275
1976	2,467	2003	2,292
1977	407	2004	1,326
1978	2,260	2005	1,525
1979	1,166	2006	1,065
1980	1,075	2007	1,443
1981	1,224	2008	947
1982	571	2009	1,386
1983	579	2010	1,119
1984	798	2011	893
1985	2,223	2012	931
1986	494	2013	3,517
1987	639	2014	1,458
1988	1,086	2015	789
1989	1,166	2016	1,175
1990	529	2017	1,589
1991	203	2018	4,148
1992	651	2019	397
1993	778	2020	536
1994	802	2021	1,373