OXLEY PRIORITY DEVELOPMENT AREA STORMWATER MANAGEMENT PLAN

VERSION 3B

PLANS AND DOCUMENTS
referred to in the PDA
DEVELOPMENT APPROVAL

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Disclaimer

Potential implications of climate change

Unless expressly stated otherwise, historical climate data has been used in, or underpins, the analyses that are presented in this report. The historical climate is not necessarily a valid indicator of future climate, which may contain prolonged periods that are wetter or drier than the historical record used for this analysis. There is significant uncertainly surrounding how climate, and in particular, rainfall, will be impacted by various levels of greenhouse gas accumulation in the atmosphere. Rainfall has a much greater spatial variability than temperature and some areas are likely to become wetter whilst other areas become drier. Further to this there may be changes in the seasonality and intensity of rainfall. Such changes in climate could affect the conclusions and recommendations of this report.

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1 INTRODUCTION

Economic Development Queensland (EDQ) are seeking to redevelop the former Oxley Secondary College site located on 53 Seventeen Mile Rocks Road and 113 Cliveden Avenue, Oxley, described as Lot 600 SP236626 and Lot 551 SP142916 (Figure 1). The site covers an area of approximately 19.7 hectares and formerly housed the Oxley Secondary College (now demolished), sporting fields and a childcare centre. It is bounded by Cliveden Avenue to the north, existing residential properties fronting Blackheath Road to the east and large lot residential to the west extending up a forested slope towards Fort Road and the Canossa health precinct. The site forms a priority Development Area (PDA) under the Economic Development Act 2012.The proposed development includes detached low density residential dwellings, a retirement precinct, childcare centre and open space areas.

1.1 PURPOSE

This report outlines the stormwater quality, quantity and flood management strategies for the Oxley PDA site and demonstrates how the proposed development meets the operational water quality objectives defined in the *State Planning Policy* and Brisbane City Council City Plan. It also defines the required flood detention and conveyance infrastructure to mitigate impacts external to the site while providing flood free development.

This Version 3B report retains the stormwater quality and quality modelling data and results presented in *Oxley Priority Development Area Stormwater Management Plan – Version 3* (DesignFlow, June 2020) while acknowledging the current detailed design for the site is undergoing further flood modelling refinement and optimisation to manage the very localised and minor afflux issues occurring in Cliveden Avenue discussed in Section 5.4.1 (even though peak discharges have reduced) which are not considered to represent an increase in flood risk but will be resolved in any case. Design refinement of the site will also ensure that the 0.18 m^3/s (6%) increase in the 1 year ARI discharge from the site (section 5.4.2) is reduced to below pre-development discharge. The resolution of these minor issues does not require any significant change to the flood or stormwater management strategies for the site (only fine tuning) and can therefore be conditioned for compliance assessment by EDQ prior to works.

Figure 1. Site location

1.2 FURTHER ISSUES RESPONSE

This version of the report provides updated information to respond to the stormwater and flooding items within the EDQ Further Issues letter DEV2020/1099 (23 April 2020). The further issues letter includes both EDQ and third party (BMT) review issues. A summary of items and responses is provided in Table 1 (non-third party review items) and Table 2 (third party review items) below. Only those third party review comments that were included in 'recommendations' in each section of the BMT letter have been summarised in the table below.

A second further issues letter was issued by EDQ on 23 July 2020 for which a separate response letter has been provided for the stormwater and flooding related items (DesignFlow, 4 August 2020).

Table 1: Further Issues and Advice (non-third party items)

Further Issue / Advice	Response /SMP Section Reference
Stormwater Further Issues 11. Provide existing flood depth and flood hazard category data as the existing case flood mapping has not been provided. Note: Information currently provided is the "Developed Case vs Existing Site Scenario" and "Developed Site Scenario" plots. This existing case information is necessary	Refer to Appendix D. Pre-development flood depth and hazard now included for both ARR2019 and ARR1987 assessments.
Residential Flood Level (advice) BCC note that the Stormwater Management Plan report is quoting the Brisbane River defined flood level (DFL) for development levels, however, the residential flood level (RFL) should be used for residential development. BCC suggested to use the new Brisbane River Flood Study 1% level as it will be implemented as policy in due course.	The new Brisbane River Flood Study 1% AEP level of 11.6 mAHD has been used for the Residential Flood Level (RFL). Refer Section 5.4.6.
Referrable Dams (advice) Please note that the detention basin may trigger the requirement for a subsequent approval from SARA if it is considered a 'referrable dam'. The definition of referable dam in the Planning Regulation references the definition in the Water Supply (Safety and Reliability) Act 2008, section 341.	As agreed in meeting with EDQ and BMT (29/04/2020), the small size (height and volume) does not trigger referable dam status. Refer to 5.4.4. Furthermore, the failure of this basin would not result in an incremental increase in flood level of 300mm nor result in 2 or more persons at risk as all downstream dwellings are significantly above local flood levels.

Table 2: Further Issues (third party review items)

(Note: list numbering below provided for reference and was not provided in original letter)

Further Issue / Recommendation	Response /SMP Section Reference
1. Detailed design to consider raising level of bioretention filter media if practicable and for a backflow prevention device to be provided on the filter media drainage system.	Bioretention basin layout has been redesigned (including levels) to tie in with revised open space layout and flood management strategy. Refer Section 4.1 and Appendix A.
2. It is recommended that additional drainage be added to the basins as part of detailed design to direct flows up to at least the level of flood immunity desirable for the park (suggested minimum 50% AEP (2-year) event) to the watercourse and for the flood modelling to be updated to include the diversion and demonstrate	Bioretention basin has been redesigned (including levels) to tie in with revised open space layout. Refer Section 5.3.3.

Further Issue / Recommendation	Response /SMP Section Reference
that no unacceptable flood level impacts result from the diversion.	
3. It is recommended that development levels for residential lots be based on a Brisbane River flood level of 11.6 mAHD (noting that this will not affect the current design). It is recommended that EDQ provide direction in relation to whether the retirement living precinct will include any assisted care areas and, if so, whether the part of the site that is above 15.45 mAHD would be sufficient for this purpose.	The Brisbane River flood level of 11.6 mAHD has been adopted. All lots are above this level. Any floor levels of the retirement site used for supervised accommodation, medical or other support services will be constructed to be above the Brisbane River 0.2% AEP flood level of 15.45 mAHD. Road access to the retirement site remains at or above 15.45 mAHD. Refer Section 5.4.6 (and response item 4 below).
4. It is also recommended that a hazard assessment be completed (the methodology proposed in the Brisbane River Catchment Flood Management Study is suggested) to assess whether the site is lower or higher hazard given the reduced immunity requirements associated with lower hazard sites.	The site is partially within a high hazard area as assessed in Section 5.4.6. Site layout and design responses are provided.
5. Peak flows predicted by RAFTS model for existing and developed cases to be verified, preferably using the Rational Method according to the Queensland Urban Drainage Manual. The verification should be completed for a representative number of sub-catchments and include sub-catchments where development is occurring in order to confirm that the increase in runoff from the developed case is reflected.	Hydrological model verification is provided in Section 5.2.4.
6. Complete sensitivity analysis for the 10% AEP and 1% AEP events using 1987 ARR temporal patterns and rainfall data (hydrologic and hydraulic modelling) to determine whether the new version of ARR underestimates flows and flood levels to an unacceptable degree.	ARR1987 rainfall and temporal pattern data has been used to provide a comparative assessment to the ARR2019 data and methods. Data and results for both ARR2019 and ARR1987 assessments are provided in Sections 5.2, 5.3 and 5.4. ARR1987 generally results in greater flood extent and discharges than ARR2019. The mitigation strategy works for both cases.
7. Revise the hydrologic model (and therefore rerun the hydraulic model) to include a pre burst rainfall depth for storm durations less than 60 minutes equal to the 60 minute duration pre burst rainfall depth.	Short duration (<60 minutes) Hydrological and hydraulic models have now been updated using the 60 minute duration pre burst rainfall depth.
8. Detailed design to consider full range of events (including the 63% AEP (1-year) event to ensure that the waterway	1 year ARI events have been run. Refer to Section 5.4.2. The balance of the assessment has adopted the 50%, 10% & 1% AEP (ARR2019) and 2 year, 10 year & 100 year ARI

Further Issue / Recommendation	Response /SMP Section Reference
stability criterion is met by the development).	(ARR1987) to capture the range of event magnitudes.
9. It is recommended that the Manning's 'n' and initial water levels be modified as recommended above for detailed design or further justification provided for the adopted values.	Manning's 'n' and initial water levels have been updated. Refer to Sections 5.3.6 and 5.3.2 respectively.
10. Recommend that, for detailed design, the ensemble of temporal patterns be considered using the hydraulic model to determine the appropriate temporal pattern and critical storm duration for the watercourse.	As agreed in meeting with EDQ and BMT (29/04/2020), full hydraulic ensemble analysis is not required if ARR1987 comparative analysis achieves suitable flood mitigation/management outcomes. This report provides comparative assessment and results throughout.
11. The point of application of runoff from sub-catchment E is to be moved to upstream of the northern access road and the works required to ameliorate the increase in flood level on Cliveden Road identified.	Hydraulic model has been updated to reflect this.
12. Safety assessment to be completed as part of detailed with respect to the flood detention basin, bio-retention basin and sediment basin to confirm that flood risk can be mitigated	To be conditioned and assessment will be completed as part of the final detailed design of civil works and open space integration of stormwater treatment measures.
13. For detailed design, although it is desirable to limit the loss of floodplain storage in the Brisbane River, earthworks only need to achieve a balanced incremental solution with respect to local catchment flooding. With respect to Brisbane River flooding it is desirable but not essential to achieve an incremental solution with respect to floodplain storage. It will be necessary to include a statement including some level of quantification that the earthworks associated with the development will not affect flooding in the Brisbane River to any noticeable degree.	Noted. As agreed in meeting with EDQ and BMT (29/04/2020), the balanced incremental preservation of local flood storage within this site is not appropriate due to the steep terrain (and flood surface) and historical filling across the local watercourse. Brisbane River flood storage volume statement is provided in Section 5.4.7

2 OBJECTIVES

2.1 STORMWATER MANAGEMENT

2.1.1 Stormwater Quality

The objectives for stormwater quality management for The Oxley PDA are as per the Brisbane City Council Infrastructure Design Planning Scheme Policy (Chapter 7 Stormwater Drainage) and consistent with the State Planning Policy (SPP) 2017. These are summarised in Table 3.

Table 3: SPP stormwater quality objectives

Pollutant	Reductions in mean annual load from unmitigated development
Total suspended solids (TSS)	80%
Total phosphorus (TP)	60%
Total nitrogen (TN)	45%
Gross pollutants (GP) (>5mm)	90%

2.1.2 Stormwater Quantity and Flooding

Stormwater quantity and flood objectives for the site are consistent with the Brisbane City Council Stormwater Code, Flood overlay code and State Planning Policy 2017. These are broadly defined as:

- No adverse impact to flooding or drainage characteristics on properties external to the site (i.e. discharge and flood levels)
- Provide for development to achieve flood immunity levels commensurate with the proposed land use.

Consideration of flood hazard aspects of the development must therefore involve review of both local catchment discharge as well as backwater flooding from the Brisbane River.

The waterway stability objective is also applicable to this site. This requires that the post development 1 year ARI peak discharge it maintained at or below the pre-development case.

3 SITE DESCRIPTION

The following sub-sections provide a summary of site characteristics considered important in defining the stormwater and flood management strategy for the Oxley PDA site.

3.1 TOPOGRAPHY, CATCHMENT AND DRAINAGE

The site is defined by flat to very low gradient grassed areas (former sports fields) in the north east corner grading south, west and east into steeper and partially wooded slopes. The southern and eastern boundaries are defined by existing residential lots that front Seventeen Mile Rocks Road and Blackheath Road respectively. The western boundary lies on the lower slopes of a broader gully system whose local catchment is defined by Fort Road to the west and the Canossa Health Centre (on Seventeen Mile Rocks Road) to the south. This external catchment is predominantly mature trees of moderate density.

Figure 2: Site Layout and drainage

3.2 DOWNSTREAM DRAINAGE

The site discharges northward under Cliveden Avenue (via culverts) which subsequently drains along a table drain on the western side of Blackheath Road. Flows are then conveyed east under Blackheath Road in an unnamed ephemeral watercourse through rural land then northward into the Brisbane River approximately 500m downstream of the site.

3.3 REGIONAL FLOODING

The site is subject to Brisbane River flooding that extends up the unnamed water course over Blackheath Road and Cliveden Avenue. The FloodWise Property Report extract for the site is provided in Figure 3.

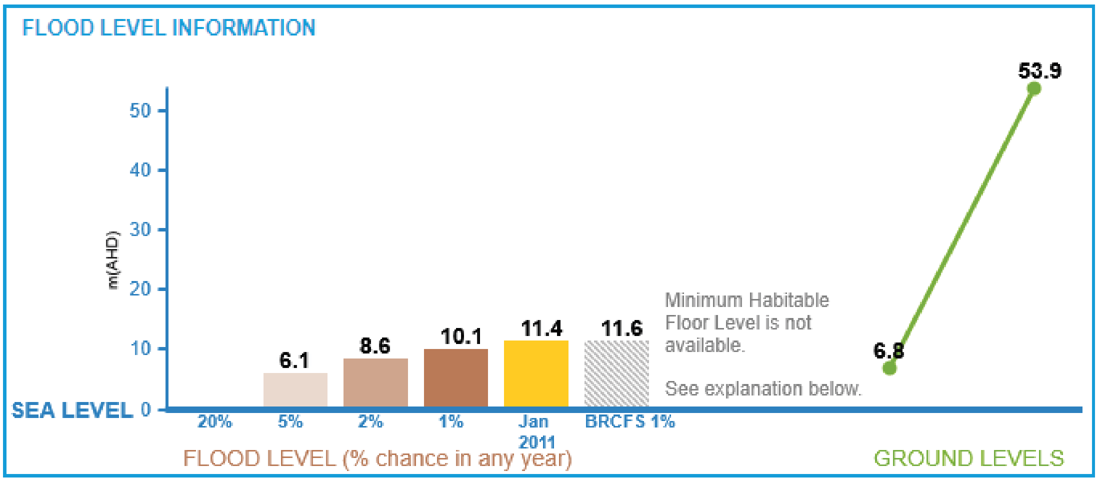


Figure 3: FloodWise property report extract (Lot 600 SP236626)

The 1% AEP flood extent from Council's currently available mapping data is shown in Figure 4 and defines the level (10.1 mAHD) to which compensatory earthworks must be achieved within the site. The flood level corresponding to the 2011 floods is 11.4m AHD and is illustrated by the pink line in Figure 4 which extends into the site. The more recent Brisbane River Catchment Flood Study (BRCFS) 1% AEP flood level is 11.6 mAHD (mapping not available) and has been therefore adopted as the Residential Flood Level (RFL) for the purpose of this assessment.

3.4 LAWFUL POINT OF DISCHARGE

The lawful point of discharge for the site is the existing drainage culverts under Cliveden Avenue in the north east corner of the site (location SD1 in Figure 2). These culverts drain into a downstream roadside table drain northward along Blackheath Road which in turn links to the unnamed drainage line/tributary through rural land linking to the Brisbane River. Much of this drain has permanent or prolonged ponding water extending up to Cliveden Avenue.

The existing culverts under Cliveden Avenue include 1 x 375 mm and 2 x 525 mm diameter pipes. Road flooding occurs in the 50% AEP event to approximately 100mm depth over the road crown.

Peak flow management of post development site discharge will ensure no adverse impacts to downstream drainage for minor to major storms. Increased seepage or very minor discharge from the site is unlikely to cause nuisance to downstream areas given the already ponded roadside drain within a rural/rural residential setting.

3.5 PROPOSED DEVELOPMENT LAND USE

The proposed development involves the creation of low density residential lots, retirement living precinct, childcare centre, public open space and associated roads. A significant area of public recreation park defines the northern extent (and is subjected to Brisbane River Flooding) while the western extent is defined by retained conservation open space. The proposed layout is shown in Figure 5.

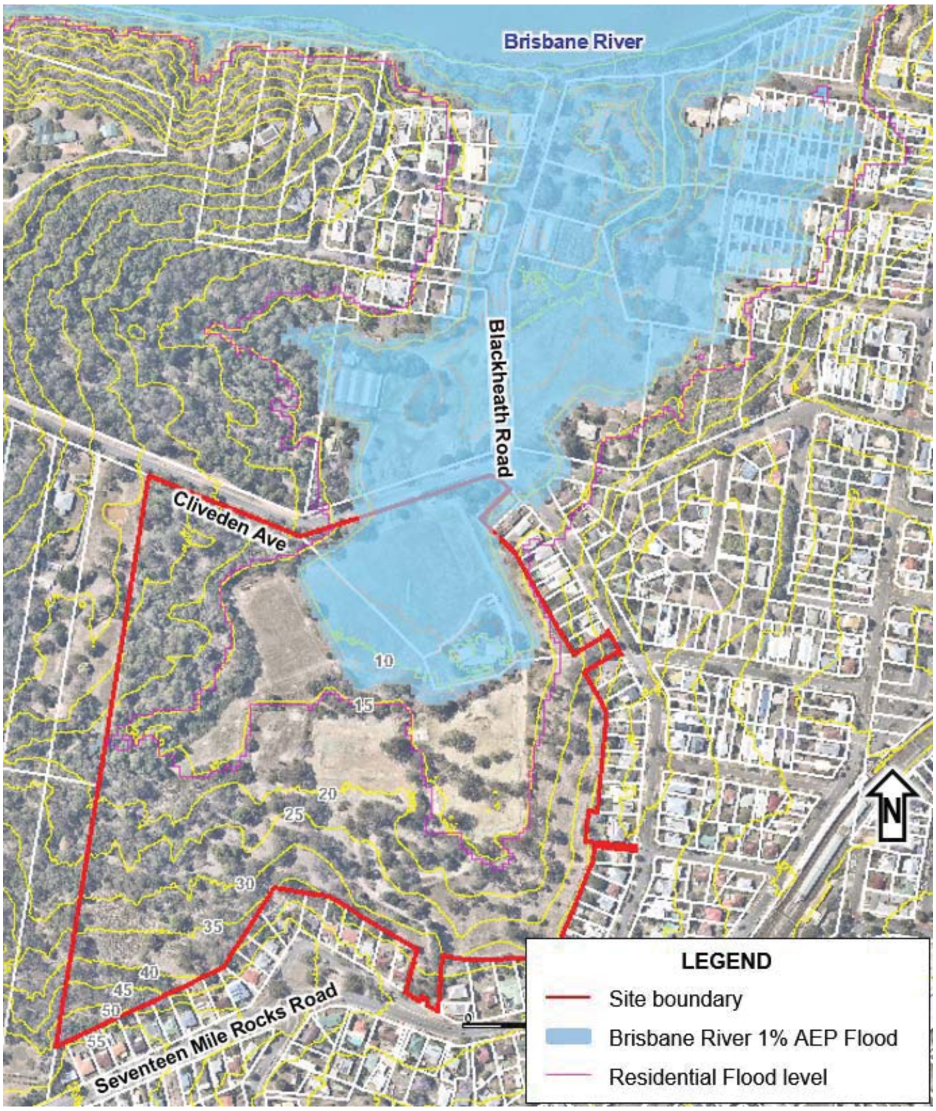


Figure 4: Brisbane River flooding (source: BCC Open Data)

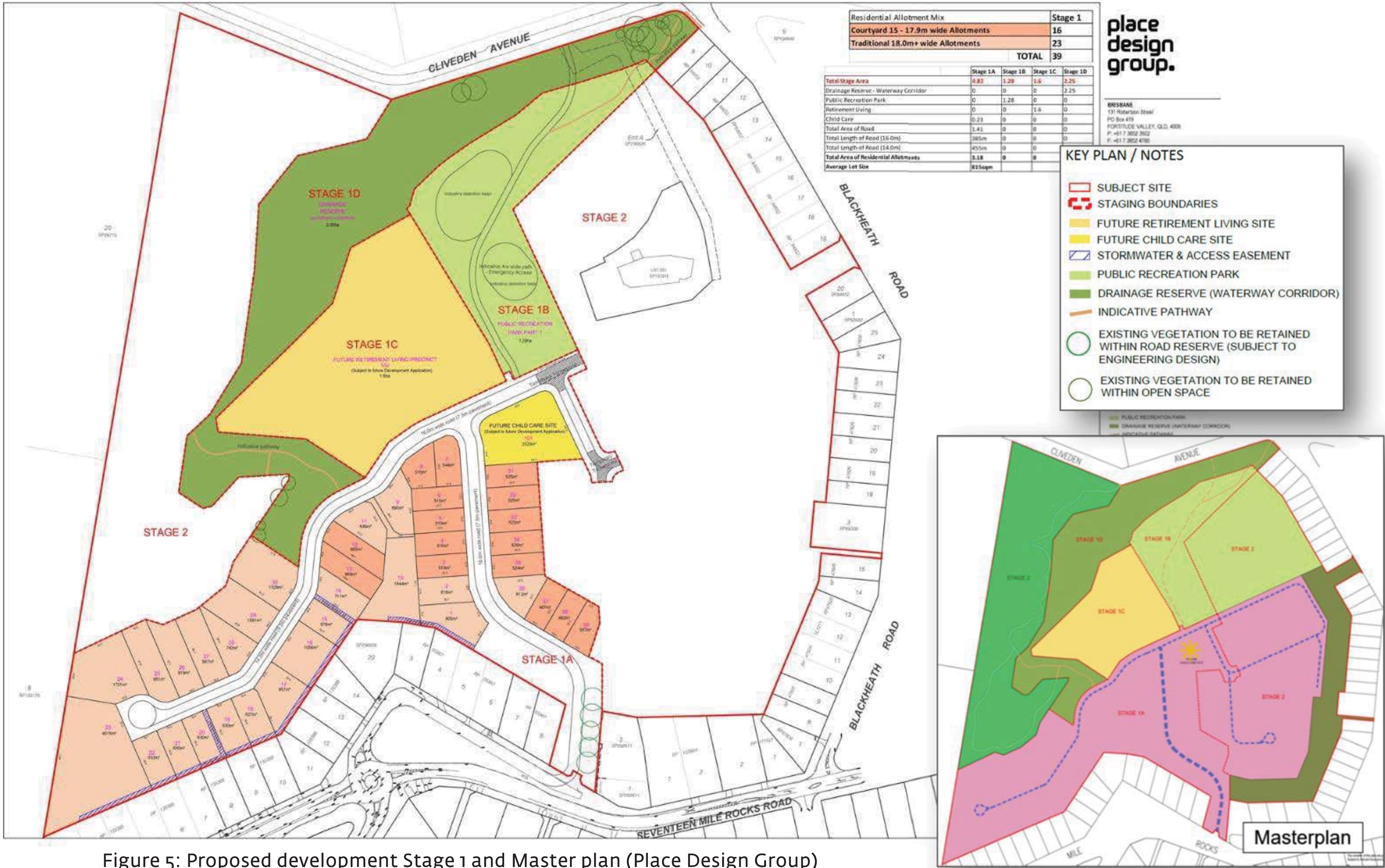


Figure 5: Proposed development Stage 1 and Master plan (Place Design Group)

4 STORMWATER QUALITY MANAGEMENT

4.1 STRATEGY OVERVIEW

The stormwater quality treatment strategy for the site includes a sediment basin (300 m²) and bioretention system (700 m²) located in the recreational park (Figure 7). The inclusion of the northern open drainage line as a grassed swale also contributes to the management of runoff lots that cannot be drained to the central treatment area.

Stormwater from Catchment A will be piped directly to the bioretention basin at the northern end. Stormwater from Catchments B and C will be piped to the sediment pond. The sediment pond will be designed to capture coarse sediment (>0.125mm) and will provide energy dissipation during larger storm flow events including overland flow from the adjacent road sag. Catchment D lots drain away from the street and cannot be directed towards the main treatment area. Allowance for partial treatment (predominantly suspended solids) has been made by inclusion of the northern open drainage line (downstream of detention basin) as mown grassed swale.

Conceptual details are provided in Figure 6. Earthworks design for the treatment systems have been completed to confirm sufficient space for batters and bunds is available, and that there is adequate level difference for the systems to freely drain. Refer to KN Group civil engineers Functional Design drawings in Appendix A.

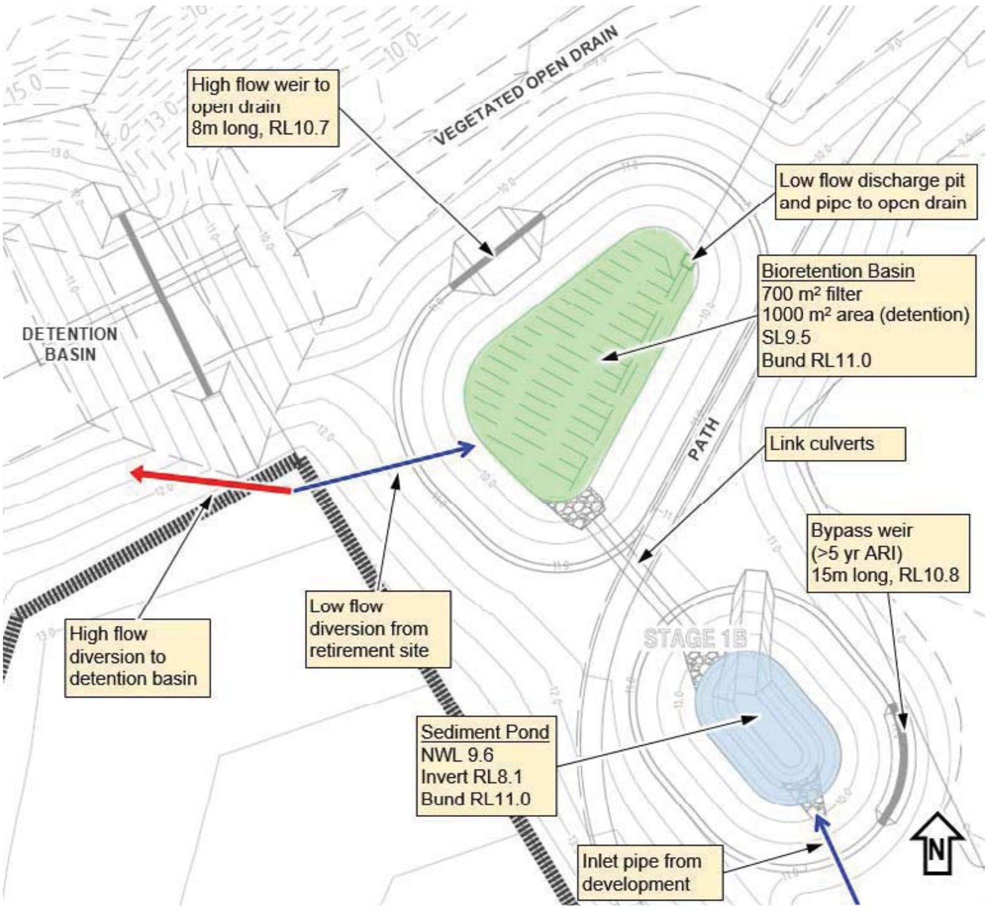


Figure 6: Conceptual sediment pond and bioretention basin design

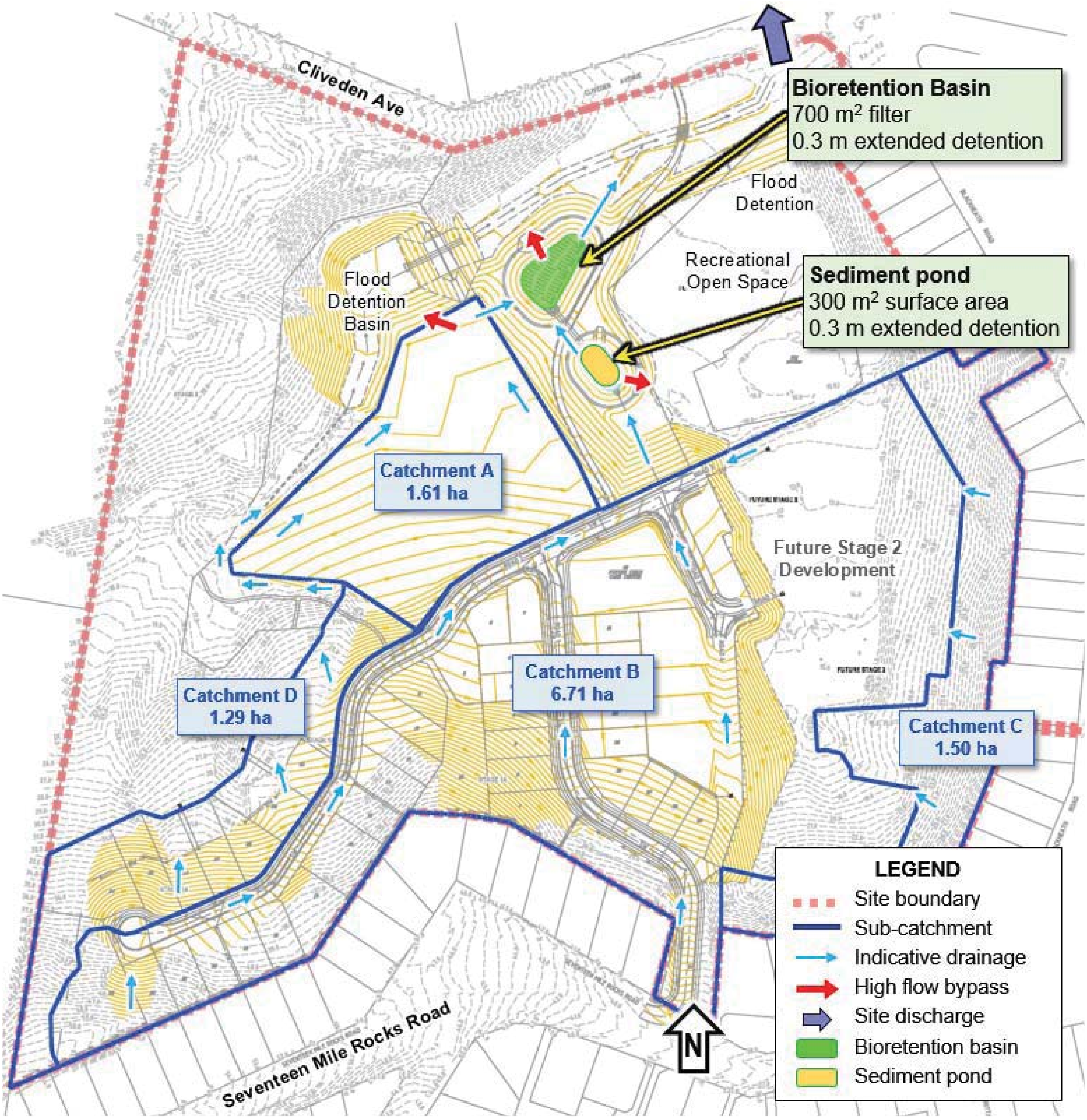


Figure 7: Stormwater quality treatment strategy

4.2 MODELLING

The proposed stormwater quality treatment strategy has been assessed in MUSIC in accordance with the MUSIC modelling Guidelines (Water by Design, 2010).

4.2.1 Catchments

Catchments for MUSIC modelling have been defined as developable land including open space drainage into urbanised areas. Other low use open spaces including conservation open space and stormwater treatment were not included as these were not considered to represent pollutant generating portions of catchment.

Catchment areas, land uses and impervious fractions adopted for this assessment are provided in Table 4. Impervious fractions have been derived from the *MUSIC Modelling Guidelines* (Water by Design, 2010) and adapted to land uses where specific guidance is not provided. It is acknowledged that there will be some differences between the impervious fractions adopted for MUSIC modelling versus those for the hydrological modelling based on the various guideline references associated with this two elements of modelling. The differences are however minimal and will not materially change the way the stormwater quality or flood mitigation strategies are delivered.

Table 4: Land use and impervious fraction

Catchment ID	Catchment Land Use	Catchment Area (ha)	Impervious %
A	Retirement living	1.61	80%
B	Low density residential	6.71	60%
C	Open space	1.50	10%
D	Low density residential	1.29	50% [1]

Notes: 1. Larger lot sizes and bushfire setback limits building envelope of lots within catchment D. Lower impervious fraction therefore adopted.

4.2.2 Treatment Measures

A sediment pond and bioretention basin have been adopted as the primary measures for achieving the water quality objectives for the site. The adopted sediment pond modelling parameters are provided in Table 5 with bioretention parameters in Table 6. The general layout of the proposed bioretention basins and their indicative catchments is shown in Figure 7.

Table 5: Sediment pond parameters

Parameter	Value
Surface area	300 m^2
Extended detention depth [1]	0.01 m
Permanent Pool Volume	210 m^3
Equivalent pipe diameter	1200 mm
Overflow weir length	10 m
Notional detention time	0.002 hrs

Notes:

1. Extended detention area (depth) added to bioretention basin with unrestricted flow from pond. Pond is not relied upon for anything other than inlet zone and coarse sediment management.

Table 6: Bioretention basin parameters

Parameter	Value
Extended detention depth	0.3 m
Surface area [1]	1000 m^2
Saturated hydraulic conductivity	200 mm/hr
Filter depth	0.7 m
Filter area	700 m^2
Surface area [2]	1000 m^2
Total nitrogen content	400 mg/kg
Ortho-phosphate content	30 mg/kg
Overflow weir length	10 m

Notes:

1. Extended detention area (depth) from sediment pond added to bioretention basin with unrestricted flow from pond. Pond is not relied upon for anything other than inlet zone and coarse sediment management.
2. Surface area is larger than filter for local minor storm flood attenuation.

Table 7: Swale parameters

Parameter	Value
Length	175 m
Slope	2 %
Base width	0.1 m
Top width	15
Depth	0.5m
Vegetation height	0.05 m

4.2.3 MUSIC Model layout

The MUSIC model structure is provided in Figure 8

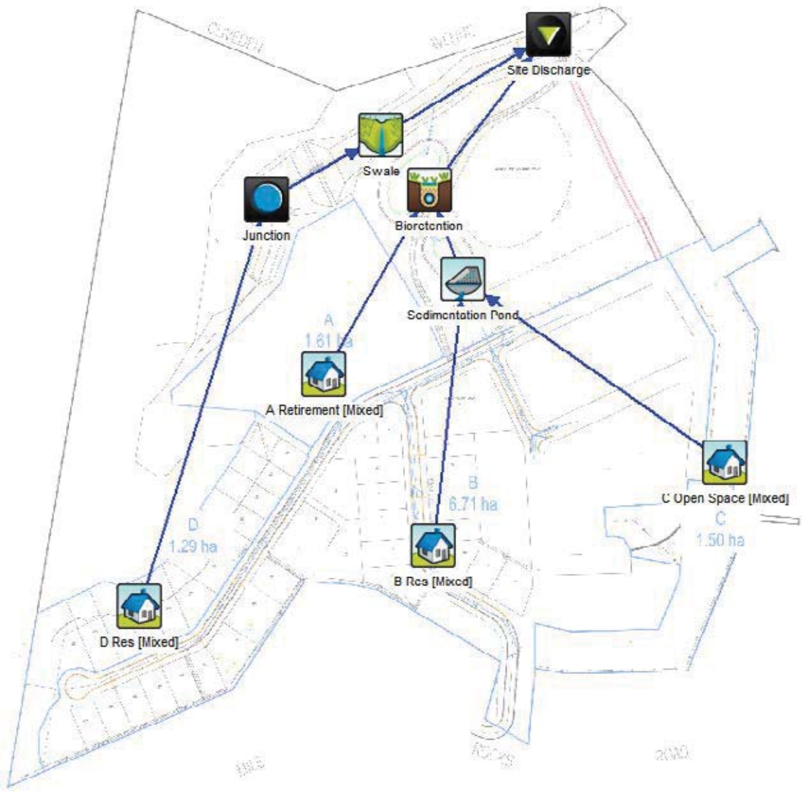


Figure 8: MUSIC model layout.

4.2.4 MUSIC Model Assessment

The assessment outcomes for the proposed treatment strategy is summarised in Table 8. The sizing provides pollutant load reductions that exceed the water quality objectives. This has been done to provide flexibility in detailed design phases (e.g. reduce the filter size if space is constrained or to allow some small portions of the site to discharge untreated where drainage to the treatment systems is constrained.

Table 8: MUSIC model results

	Sources	Residual	% Reduction	Objective
Total Suspended Solids (kg/yr)	17300	2500	85.5%	80%
Total Phosphorus (kg/yr)	34.6	8.62	75.1%	60%
Total Nitrogen (kg/yr)	173	94.1	45.5%	45%
Gross Pollutants (kg/yr)	2050	0	100%	90%

4.3 STORMWATER QUALITY SUMMARY

The proposed stormwater treatment strategy for the Oxley PDA site achieves the pollutant load reductions defined in Section 2.1. This is done via the adoption of a sediment pond and bioretention basin capturing the majority of urban runoff from the proposed allotments, roads and some open spaces in combination with a vegetated swale for the northern drainage line.

5 STORMWATER QUANTITY AND FLOODING

5.1 STRATEGY

The Brisbane River Catchment Flood Study (BRCFS) 1% AEP flood level of 11.6 mAHD greatly restricts the amount of development potential in the lower (north east) part of the site which has been largely dedicated to public open space and drainage. The proposed stormwater quantity management strategy involves the implementation of a primary flood detention basin on the existing drainage line in the north west portion of the site which largely receives flow from the undeveloped portions of site and the external catchment due to the topographical limitations of draining the development area to this location. Shallow flooding also occurs across the stormwater treatment measures onsite (in minor events) and over the public open space zone in moderate to major flood events. The combined function of these flood management measures ensures peak discharge is controlled prior to discharge form the site at Cliveden Avenue. The proposed strategy is illustrated in Figure 9.

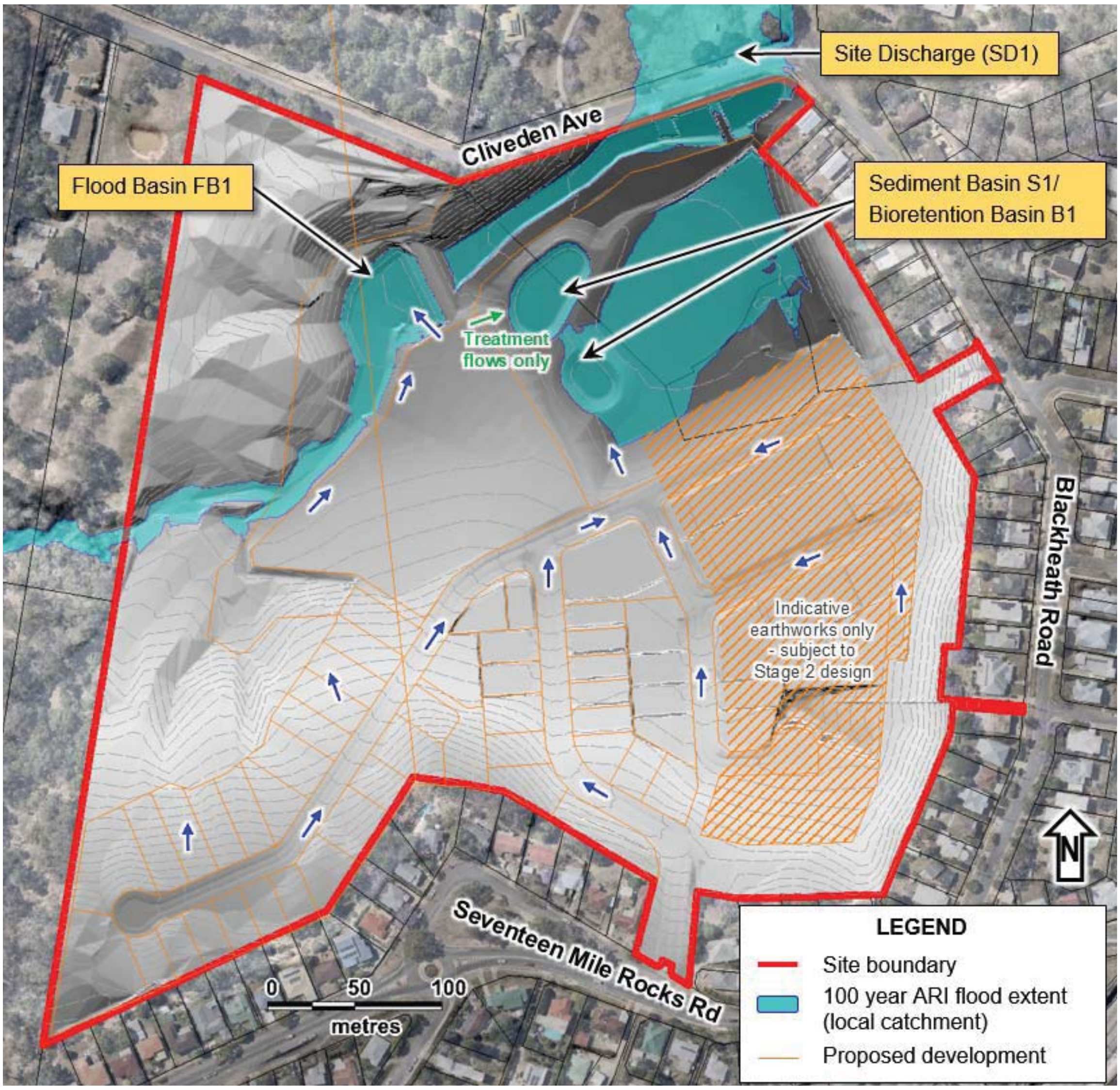


Figure 9: Flood management strategy layout

The site layout also considers the flood impacts from Brisbane River flooding which occurs as backwater inundation extending south into the site across Cliveden Avenue. While not forming part of the local hydrological or hydraulic modelling for the site, the regional flood data has been sourced from Brisbane City Council's available FloodWise property reports as well as BMT (for events greater than the 1% AEP). The results of this informs the flood hazard assessment for specific land uses provided in Section 5.4.

5.2 HYDROLOGICAL ANALYSIS

XPRAFTS version 2018.1 was used to define the hydrological model for the site and contributing catchments. The hydrological assessment has adopted the current Australian Rainfall and Runoff 2019 (ARR2019) approach to design storm definition and analysis which includes ensemble storms (10 temporal patterns per AEP duration), regionally derived losses and pre-burst rainfall depths from the ARR Data Hub. Following subsequent request for information discussions with EDQ and peer reviewer (BMT), a comparative assessment was also undertaken with the former ARR1987 rainfall data and corresponding loss assumptions to ensure concerns relating to reduced rainfall depths occurring under ARR2019 are adequately addressed. The presentation and discussion of data below therefore covers both the ARR2019 and ARR1987 methods.

5.2.1 Catchments

Sub-catchments were derived from the LIDAR merged with detailed survey. A total of 12 sub-catchments were adopted for the existing (pre-development) case as shown in Figure 10 and tabulated in Table 9. These were refined based on the developed case earthworks and proposed drainage (provided by KN Group) resulting in 14 post development sub-catchments as shown in Figure 11 and Table 10. Slopes for all sub-catchments were derived from the existing and developed DEMs (respectively).

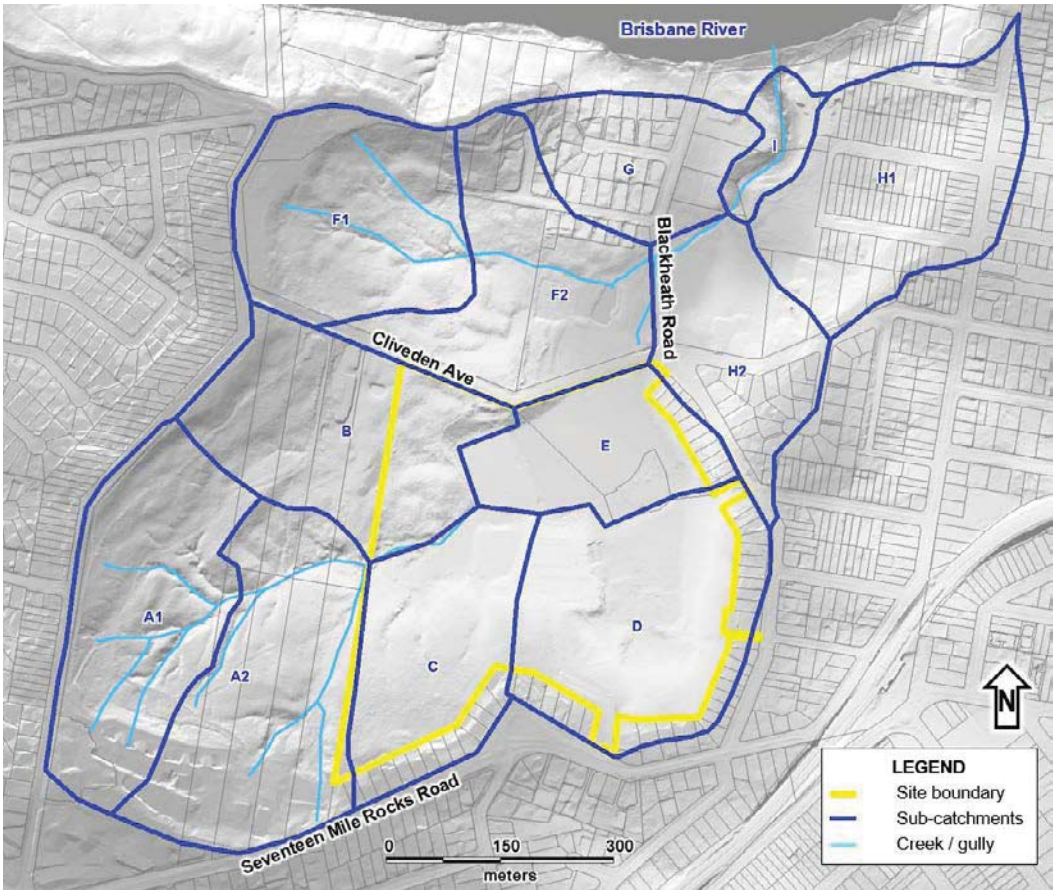


Figure 10: Pre-development XPRAFTS catchments

Table 9: Pre-development catchment data

ID	Area (ha)	Slope (%)	Fraction Impervious	Pervious Manning's n
A1	8.53	10.97	18%	0.06
A2	9.38	8.71	20%	0.06
B	8.28	11.83	6%	0.06
C	6.57	7.89	10%	0.05
D	9.37	8.19	41%	0.05
E	4.9	2.43	17%	0.035
F1	7.61	14.01	9%	0.06
F2	8.03	5.59	18%	0.05
G	4.44	6.58	50%	0.035
H1	8.78	4.64	53%	0.035
H2	5.42	7.46	41%	0.035
I	1.42	4.26	20%	0.06
Total	82.73			

* All catchments impervious n = 0.015

In the previous assessment, catchments A1, A2, B, F1 and I were assigned a manning's n of 0.07. Subsequent verification of the model as part of this updated assessment involving both ARR1987 and ARR2019 hydrological assessment resulted in these catchments being updated to n = 0.06.

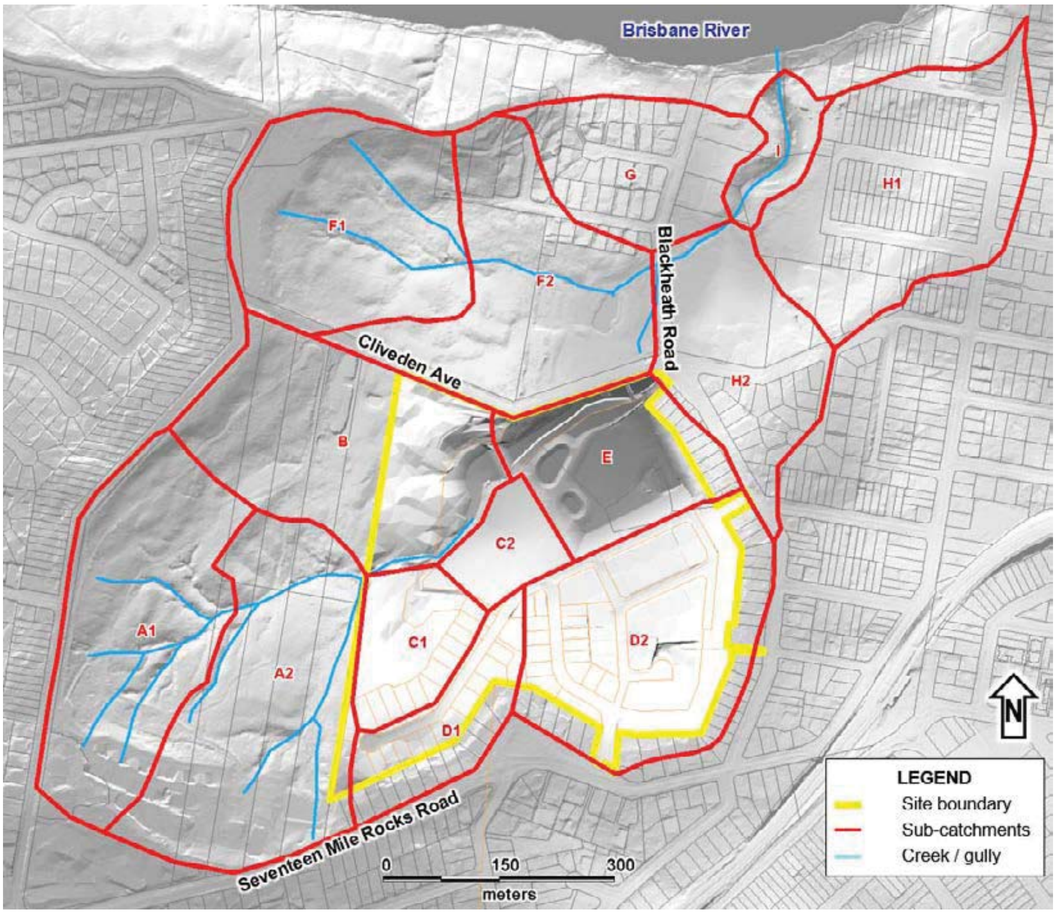


Figure 11: Post-development XPRAFTS catchments

Table 10: Post development catchment data

Catchment ID	Area (ha)	Slope (%)	Fraction Impervious	Pervious Manning' n
A1	8.53	10.97	20%	0.06
A2	9.49	8.71	22%	0.06
B	8.71	11.83	5%	0.06
C1	2.57	7.8	21%	0.05
C2	1.56	4.6	85%	0.035
D1	2.98	7.9	60%	0.035
D2	8.56	8.19	60%	0.035
E	4.55	2.43	25%	0.035
F1	7.61	14.01	9%	0.06
F2	8.03	5.59	22%	0.05
G	4.44	6.58	50%	0.035
H1	8.78	4.64	53%	0.035
H2	5.51	7.46	42%	0.035
I	1.42	4.26	20%	0.06
	82.74			

* All catchments impervious n = 0.015

5.2.2 Land Use and Imperviousness

Land use mapping (Figure 12) from Brisbane City Council was used to derive the fraction impervious and catchment roughness parameters for the existing urban, rural and open space zones surrounding the development site. Table 11 provides a summary of land uses within the catchment of interest with the fraction impervious (FI) and catchment roughness values (pervious) assumed for the hydrological modelling. Impervious areas in all land use categories were assigned a manning's value of 0.015. FI values were based on the Queensland Urban Drainage Manual (QUDM) ranges for land uses (where provided). However, where a specific land use had significant areas of existing forested areas (such as the Canossa health and aged care facility south west of the site), aerial photography was used to more accurately define fraction impervious (refer Figure 13).

The subject site is currently zoned as 'Educational Purposes' (former Oxley Secondary College) but exists as a priority development area (PDA). It has been represented in the existing (pre-development) case based on the fraction impervious measured from aerial photo (as of August 2018 and prior to the demolition of the site buildings).

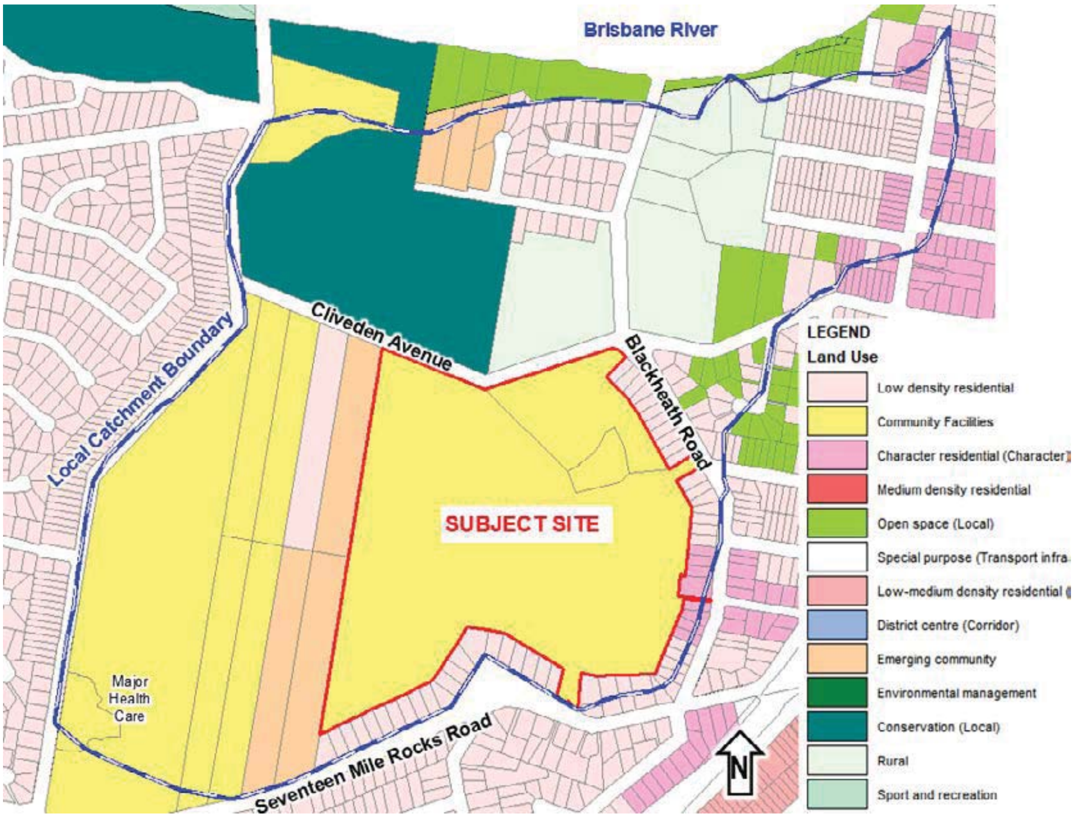


Figure 12: Existing land use (zoning)

Figure 13: Existing land cover (August 2018, prior to site demolition)

Table 11: Land use catchment parameters (hydrological)

Zone/Description	Fraction Impervious	Pervious Manning's n
Low density residential	0.6	0.035
Character residential	0.6	0.035
Emerging community	0	0.07
Rural	0.2	0.05
Open space - Trees	0	0.05
Open Space – grass	0	0.035
Conservation	0	0.07
Retirement	0.8	0.035

Notes:

1. Impervious area in all land uses were assigned a manning's n value of 0.015.

5.2.3 Rainfall and Losses

ARR2019

Data was sourced from the ARR Data Hub as well as the BOM Design Rainfall Data System. Due to the relatively small catchment being assessed (82.7 ha), point data was extracted without applying any aerial reduction factors. Location data relevant to this assessment is summarised in Table 12. The full data download summary from Data Hub is provided in Appendix B.

Table 12: ARR2019 Data Hub Summary

Parameter	Reference
Date accessed	28/2/2019
Longitude	-27.552
Latitude	152.968
River Region	Brisbane River
Temporal Patterns	East Coast North
Storm Loss ID	3380.0
Storm Initial Losses (mm) *	18.0
Storm Continuing Losses (mm/h) *	1.4

* losses are pervious losses for rural areas

Actual losses used in the representation of the urban catchment have been derived/modelled based on guidance from ARR2019 and summarised below:

- Impervious initial loss varies 1 – 2mm (adopted 1mm)
- Impervious continuing loss = 0
- Pervious initial loss – In absence of site specific data, adopt rural loss and make adjustments (reductions) based on pre-burst rainfall (see below)
- Pervious continuing loss – In absence of site specific data, use loss rural areas (applies only for the fully pervious portion of model sub catchments).

ARR2019 notes that this initial and continuing loss approach is not definitive but recommended in absence of better information. In order to adequately account for the influence of pre-burst rainfall influences on losses and runoff, modelling has used the median pre-bust rainfall from the ARR Data hub and included this at the front end of the design storm burst over 6 time steps. These pre-burst depths vary with AEP and duration (refer to Appendix B).

ARR1987

ARR1987 rainfall data was sourced directly from the BOM Design Rainfall Data System for the same co-ordinates used for the ARR2019 data and are generally consistent with Table 7.2.2.2.A of the Infrastructure Design Planning Scheme Policy. Pervious and impervious area loss assumptions used are summarised in Table 13.

Table 13: ARR1987 loss assumptions

Event	Surface Type	Initial Loss	Continuing Loss
1-10 year ARI	Pervious	10 mm	2.5 mm/hr
	Impervious	1 mm	0 mm/hr
20-100 year ARI	Pervious	0 mm	2.5 mm/hr
	Impervious	0 mm	0 mm/hr

5.2.4 Verification

No gauged flow data is available for this local catchment to enable calibration of the hydrological modelling against actual data. Review against the Regional Flood Frequent estimate (RFFE) is unsuitable as the catchment is significantly urbanised (RFFE suitable for rural catchments with <10% urban). Reliance therefore falls back to the Rational Method for verification of peak discharges as discussed below.

Rational Method

ARR2019 currently suggests limited reliance on the Rational Method for anything other than very small catchments. The verification was therefore undertaken only with the ARR1987 XPRAFTS model and the corresponding XPRAFTS catchment parameters were then applied to the ARR2019 model. No Rational Method results are provided for the ARR2019 data.

As a means of a rapid review of the potential limitations of the Rational Method application with ARR2019 for this site, a review of the rainfall depth differences is provided in Table 16 below which indicates that the ARR2019 rainfall depths are consistently less than that in ARR1987 by up to 9% for minor storms and up to 13% for major storms. When combined with the initial and continuing loss assumptions (an accounting for the pre-burst rainfall), the ARR2019 rainfall depths has the potential to be further reduced as a result of higher initial loss assumption (noting variability with AEP and duration). The subsequent distribution of the rainfall excess over the ARR2019 ensemble temporal patterns (and selection of only the mean peak discharge) has a further implication for peak discharge verification when attempting to compare to simplistic methods such as the Rational Method due to the potential variability from front or back end loaded temporal patterns for a particular catchment. It should also be noted that the 1 hour 10 year ARI (10% AEP) rainfall depth (and therefore intensity for 1 hour event) between ARR1987 and ARR2019 (shaded in table below) varies from 69.2 mm/hr to 62.4 mm/hr which has direct implications for the selection the C10 runoff coefficient from QUDM Table 4.5.3, which is more pronounced at low fractions impervious. Further review of ARR2019 with the Rational Method is therefore considered inappropriate (outside the scope of this project).

Table 14: Rainfall depth comparison between ARR1987 and ARR2019

Rainfall Depth (mm)									
Duration (min)	2 yr ARI	39.4% AEP	Change	10 yr ARI	10% AEP	Change	100 yr ARI	1% AEP	Change
	ARR1987	ARR2019		ARR1987	ARR2019		ARR1987	ARR2019	
5	12.4	11.4	-8%	17.9	16.7	-6%	27.2	25.1	-8%
10	19.0	18.7	-2%	27.6	27.2	-1%	42.3	40.2	-5%
15	24.0	23.7	-1%	35.2	34.5	-2%	54.5	51.1	-6%
30	34.4	32.9	-4%	51.3	48.2	-6%	80.4	72.1	-10%
45	41.1	38.3	-7%	61.7	56.4	-9%	97.4	85.5	-12%
60	45.9	42.2	-8%	69.2	62.4	-10%	109.6	95.4	-13%
90	52.7	47.8	-9%	79.6	71.0	-11%	126.5	110.0	-13%
120	57.4	52.0	-9%	86.8	77.5	-11%	137.9	121.1	-12%
180	63.9	58.5	-8%	96.7	87.6	-9%	153.6	138.3	-10%
360	76.1	72.4	-5%	114.9	108.9	-5%	182.2	174.4	-4%

The ARR1987 Rational Method review for this project has focussed on site and external catchments that did not represent 'complex catchments' as described in QUDM Section 4.2.2 (and associated QUDM Background Notes BN4.2.2). Catchments excluded due to complexity are summarised in Table 15.

Table 15: Sub-catchments excluded from Rational Method validation

Catchment	Limiting Characteristic for Rational Method Adoption	QUDM BN4.2.2 Catchment Condition Reference
E	Sports ovals	1
F2	Farm dam	7
H1, H2	Mixed urban (upper) and rural (lower) land uses and significant change in slope (upper to lower)	9, 12

Rational Method checks were done for local sub-catchments discharges only (as opposed to combined catchment/model discharge) as only basic lag routing was used in XPRAFTS (Tuflow relied on for routing in hydraulic model). Given the majority of the catchment remains unchanged post development and the pre-development catchment includes a range of land uses, no additional review was done for the developed case as parameters are appropriately represented.

A summary of the comparison of Rational Method peak discharge estimates to the XPRAFTS results for ARR1987 data is provided below with additional supporting data provided in Appendix C.

Table 16: ARR1987 sub-catchment discharge

ID	Area	Peak Discharge								
		2 year ARI			10 year ARI			100 year ARI		
		Rational Method	XPRAFTS	Diff	Rational Method	XPRAFTS	Diff	Rational Method	XPRAFTS	Diff
	ha	m^3/s	m^3/s		m^3/s	m^3/s		m^3/s	m^3/s	
A1	8.53	1.37	1.38	1%	2.37	2.38	0%	4.40	4.80	9%
A2	9.38	1.47	1.38	-6%	2.54	2.46	-3%	4.72	4.98	6%
B	8.28	1.32	1.32	0%	2.27	2.29	1%	4.20	4.43	5%
C	6.57	1.16	1.07	-8%	1.99	1.83	-8%	3.68	3.62	-2%
D	9.37	1.89	1.90	0%	3.23	3.27	1%	5.93	5.93	0%
F1	7.61	1.30	1.32	1%	2.23	2.21	-1%	4.12	4.37	6%
G	4.44	1.07	1.15	7%	1.82	1.9	4%	3.33	3.25	-2%
I	1.42	0.26	0.25	-4%	0.45	0.44	-1%	0.82	0.84	2%

The results from Table 16 indicate reasonably good agreement between the XPRAFTS sub-catchment discharge and the Rational Method estimates.

5.2.5 Design Events and Critical Duration Assessment

For the purpose of initial assessment, all links in XPRAFTS were assigned lag values (no routing) based on an assumed average velocity of 1 m/s over the total length. This was reviewed against expected travel times form manning's calculations for a number of these drainage lines and generally found 1 m/s to slightly underestimate velocity through the upper slopes and over-estimate in the mid to lower slopes. However, for the purpose of determining a critical storm duration for initial assessment, it was considered appropriate. The lag value selected does not have any bearing on the hydraulic modelling peak discharges as only local flows from the XPRAFTS hydrological model are input to the TUFLOW model and routing occurs within the actual channel cross sections in the DEM.

The critical storm for each AEP was determined from the hydrological model results as the storm that produced the maxim average discharge from the 10 ensemble patterns for each storm duration. This was reviewed both at the site boundary and at the downstream drainage line discharging to the Brisbane River. Table 17 summarises the critical durations for ARR2019 while Table 18 provides ARR1987 critical durations for the locations shown in Figure 14.

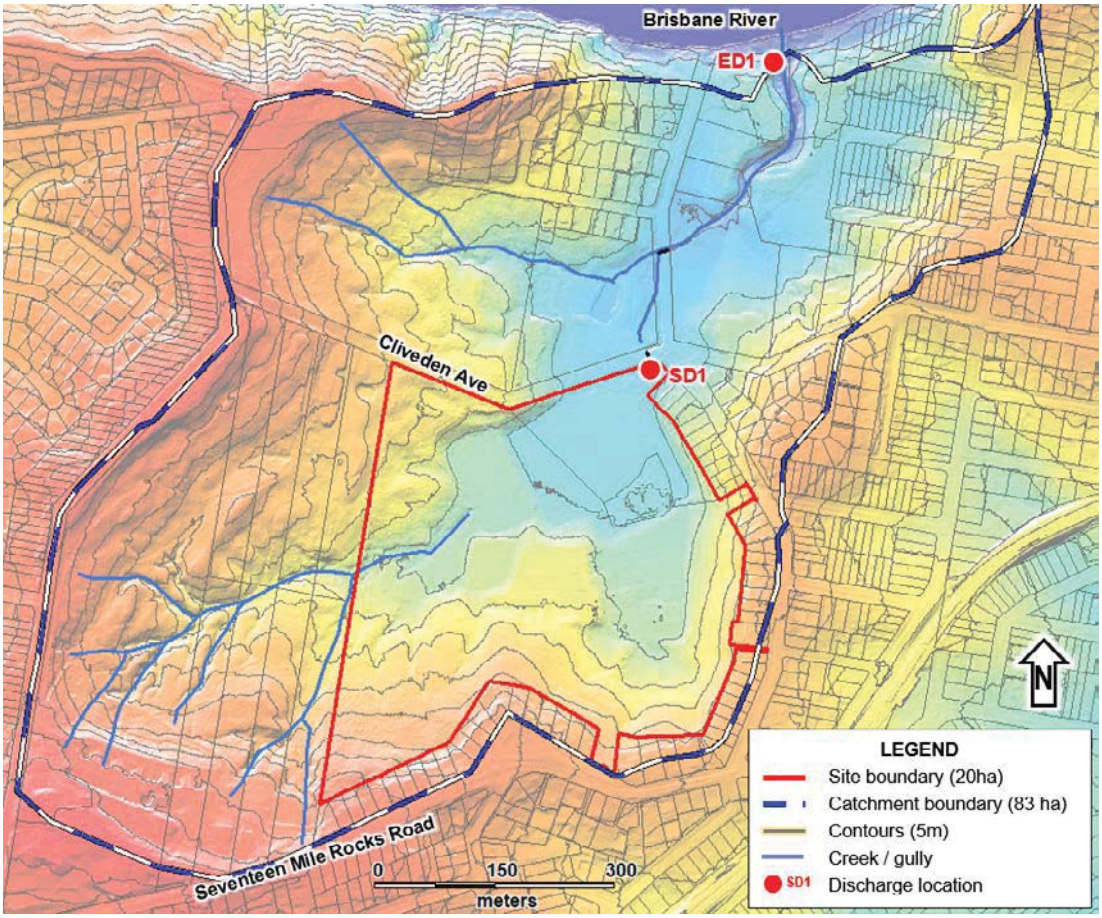


Figure 14: Discharge reporting locations

For the purpose of this initial assessment, only the 50%, 10% and 1% AEP events (and 2, 10 and 100 year ARI for ARR1987) were analysed to verify the range of local flood events could be adequately managed within the proposed flood mitigation infrastructure. The 1 year ARI (ARR1987) was also run in order to verify that the waterway stability objective could be met (hydraulic model).

Table 17: ARR2019 critical storm summary

Catchment/ Location	AEP	Critical Duration	Ensemble No.
E (SD1)	50%	1 hr	4
	10%	45 min	7
	1%	45 min	5
H2 (ED1)	50%	1 hr	4
	10%	45 min	6
	1%	45 min	5

Table 18: ARR1987critical storm summary

Catchment/ Location	ARI	Critical Duration
E (SD1)	2	1.5 hr
	10	1.5 hr
	100	1 hr
H2 (ED1)	2	1.5 hr
	10	1 hr
	100	1 hr

5.2.6 Discharge

Peak discharge results for the existing and unmitigated developed case models are provided in Table 19 for the site boundary and the downstream based on the estimated lag link routing only within XPRAFTS.

Table 19: XPRAFTS ARR2019 peak discharge estimates

Location	XPRAFTS Node	Scenario	Discharge (m^3/s)		
			50% AEP	10% AEP	1% AEP
Cliveden Avenue (SD1)	E	Pre	4.1	9.2	15.2
		Dev (unmit)	4.3	9.7	16.1
		Change	0.2 (7%)	0.5 (6%)	0.9 (6%)
Brisbane River (ED1)	H2	Pre	6.7	14.9	25.2
		Dev(unmit)	7.3	15.7	26.2
		Change	0.6 (9%)	0.8 (5%)	1.0 (4%)

Table 20: XPRAFTS ARR1987 peak discharge estimates

Location	XPRAFTS Node	Scenario	Discharge (m^3/s)		
			2 yr ARI	10 yr ARI	100 yr ARI
Cliveden Avenue (SD1)	E	Pre	6.8	12.2	23.0
		Dev (unmit)	7.3	12.6	24.0
		Change	0.5 (7%)	0.4 (3%)	1.0 (4%)
Brisbane River (ED1)	H2	Pre	11.2	19.5	37.0
		Dev(unmit)	11.9	21	38.9
		Change	0.7 (6%)	1.5 (8%)	1.9 (5%)

The increase in peak discharge from the site and extending to the Brisbane River requires mitigation infrastructure within the site to manage downstream impacts. This is assessed in detail within the hydraulic model.

5.3 HYDRAULIC ANALYSIS

The hydraulic model was developed in Tuflow in order to accurately define flood levels and extents from the runoff generated in XPRAFTS. Tuflow HPC Build 2018-03-AB_64_iSP was used. Key hydraulic model parameters are discussed below.

5.3.1 Topography

Topography is defined using LiDAR survey supplemented with detailed site survey provided by Land Partners. A model grid size of 1m was used. Developed case earthworks DEM was provided by KN Group, including the proposed detention basin bund north of the retirement site.

5.3.2 Roughness

Manning's 'n' values adopted for the Tuflow model are summarised in Table 21

Table 21: Tuflow manning's n

Surface	Manning's n
Road	0.02
Buildings	0.5
Bushland	0.08
Light bush/ unmaintained paddock	0.06
Cleared Open space	0.04

5.3.3 Hydraulic Structures

Existing road culverts have been incorporated into Tuflow using 1D network elements. Details are based on eBiMap data combined with detailed survey. All existing road culverts are to be retained. Proposed culverts within the site (as part of development) have been conceptually designed to achieve the required discharge capacity for the site basins and access road. Culverts details are provided in Table 22 and shown in Figure 15.

Table 22: Hydraulic structures

Location (Figure 15)	Tuflow Culvert ID	No./Size/Type [1]	Invert Level US/DS (mAHD)	Status
Cliveden Avenue	Ex_375	1/ 375 dia RCP	6.38 / 5.90	Existing/ retained
	Ex_2-525	2/ 525 dia RCP	6.95 / 6.51	Existing/ retained
Blackheath Road	Black_Ex	1/ 1200 x 600 RCBC	5.20 / 5.10	Existing/ retained
Northern access	accessrd	5/ 2400 x 600 RCBC	6.67 / 6.63	Proposed
Flood Basin 1	Bas_Low	3/ 650 dia orifices	9.80	proposed
	Basin_Pit	4m x 1.5m pit	SL11.5	proposed
	Bas_C1	3/ 900 dia RCP	9.80 / 9.67	Proposed
	Bas_W1	20m weir	11.8	Proposed
Sed pond 1	Sed_bas_out	3/ 2400 x 600 RCBC	9.60 / 9.50	Proposed
Bio Basin 1	Bio_Out_Pit	1.2m x 1.2m pit	SL9.8	Proposed
	Bio_Out	1/ 750 dia RCP	8.50 / 8.30	Proposed
	Bio_Weir	8m weir	10.70	Proposed
Open space bund	Oval_Out	1/ 450 dia RCP	8.5 / 6.9	proposed

Notes: RCP = reinforced concrete pipe, RCBC = reinforced concrete box culvert. All dimensions in mm unless stated otherwise.

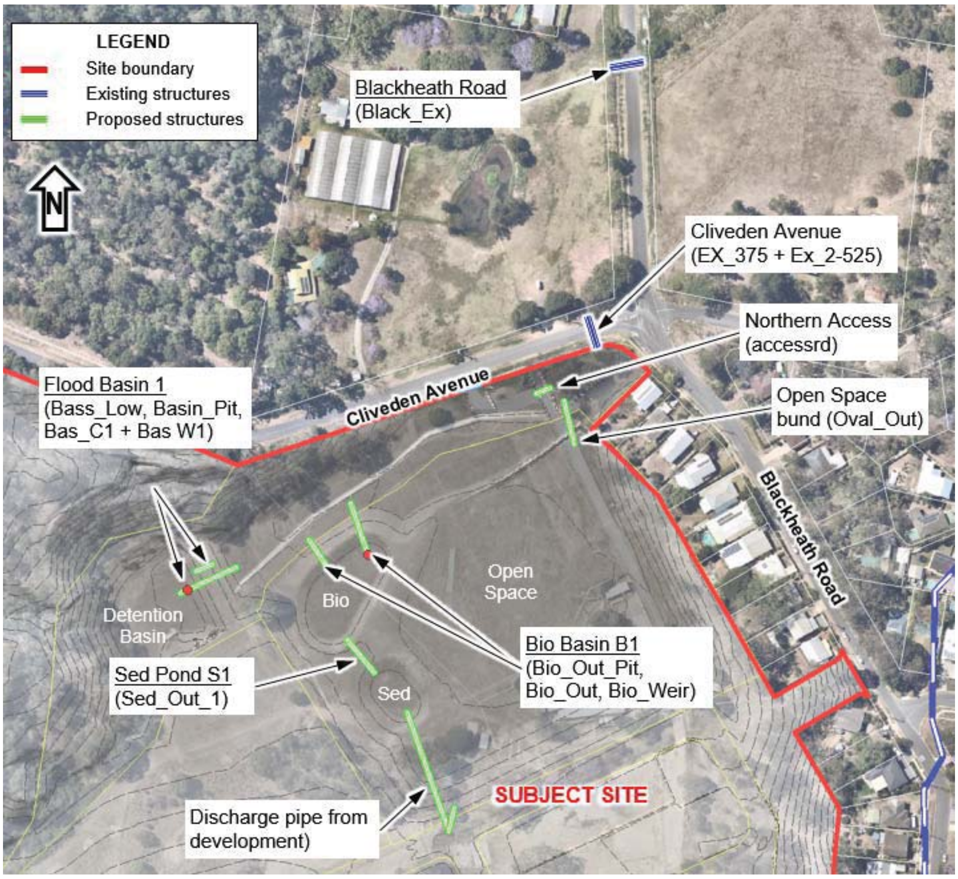


Figure 15: Hydraulic structures

5.3.4 Blockage Assessment

A sensitivity assessment was undertaken on potential structure blockage of the detention basin outlet structures and open space bund outlet pie to identify any potential areas of lot flooding or adverse flood diversion occur. Blockage assumptions are summarised in Table 23.

Table 23: Structure blockage

Location	Structure Element	Blockage Assumed
Flood Basin 1	Low level inlet (orifice)	100%
	High level pit	50%
	High flow weir	0%
Open Space bund	Outlet pipe	100%

The results of the blockage assessment are provide in Section 5.4.5 and Appendix D.

5.3.5 Proposed Detention Zones

Detention Basin

The proposed flood basin 1 north of the retirement living site comprises a 2.7m high bund across the drainage line that drains the external catchment and north west portion of the site. Proposed earthworks upstream of this bund maximises the flood storage within the gully within the constraints of existing retained vegetation and batter slopes. The flood bund is defined by 1:6 batter slopes with a 3m top width to facilitate maintenance access. The basin is drained by a two stage outlet structure involving a 4m x 1.5m pit at RL 11.5 with 3 x 650mm diameter orifices at the base (low flow inlet) and 3 x 900mm diameter pipes from the pit to downstream. A high flow weir is provided at RL11.8.

Open Space

Major storm overland flow that discharges from the upstream development through the open space area is partially attenuated via a low bund along the alignment of the perimeter access path. This bund is at a minimum of RL9.5 and provided with a 450mm diameter discharge pipe in the north east corner. Flood levels in this area reach a maximum of around 0.8m (locally in north east) in the major 100 year ARI event.

5.3.6 Flow inputs

RAFTS local catchment inflow hydrographs are input to TUFLOW using 2d_sa polygon (source area) approach.

An initial water level of 0.3m was applied to the sediment pond and bioretention basin to reflect the extended detention depth being full at the commencement of design storm events (i.e. does not contribute to flood detention volume).

5.3.7 Boundary Conditions

The model tailwater boundary condition is a water level fixed at highest astronomical tide (HAT) with a 0.8m allowance for climate change. This results in a water level boundary of 2.64 m AHD. Tide levels have been sourced from the QLD tide tables taken at Seventeen Mile Rocks.

5.3.8 Design Events

Pre and post development modelling has been run for the critical storm ensembles for the 50%, 10% and 1% AEP events for durations between 20 minutes and 2 hours for the ARR2019 cases and 2 year, 10 year and 100 year ARI for the ARR1987 cases. Critical storms for impact assessment are based on the mean peak discharge (ARR2019) at the site boundary.

The 1 year ARI (ARR1987) was also run in order to assess the waterway stability objective downstream of the site.

5.4 RESULTS

5.4.1 Site Discharge and Downstream Flood Impact

The hydraulic model results in Table 24 and Table 25 indicate that the site flood mitigation strategy achieves post development peak discharges at the site boundary and downstream at the Brisbane River typically at or below the pre-development scenario for the range of minor to Major flood events under both the current ARR2019 approach as well as ARR1987.

Table 24: ARR2019 Peak discharge results (Tuflow)

Location	PO Line	Scenario	Discharge (m^3/s)		
			50% AEP	10% AEP	1% AEP
Cliveden Avenue (SD1)	13	Pre	4.00	10.28	15.59
		Dev (mit)	3.20	9.30	14.90
		Change	-0.80	-0.98	-0.69
		%	-20%	-10%	-4%
Brisbane River (ED1)	1	Pre	6.32	16.41	26.09
		Dev (mit)	5.80	14.68	25.85
		Change	-0.52	-1.73	-0.24
		%	-8%	-11%	-1%

Notes:

1. Pre = pre-development, Dev (mit) = developed mitigated
2. Negative difference in flow refers to a reduction compared to pre-development conditions.

Table 25: ARR1987 Peak discharge results (Tuflow)

Location	PO Line	Scenario	Discharge (m^3/s)		
			2 yr ARI	10 yr ARI	100 yr ARI
Cliveden Avenue (SD1)	13	Pre	6.40	11.73	22.8
		Dev (mit)	5.23	10.71	21.01
		Change	-1.17	-1.02	-1.79
		%	-18%	-9%	-8%
Brisbane River (ED1)	1	Pre	10.13	18.7	36.26
		Dev (mit)	8.16	17.23	35.08
		Change	-1.97	-1.47	-1.18
		%	-19%	-8%	-3%

From the comparative assessment of both the ARR2019 and ARR1987 methods, the ARR1987 results in higher peak discharge and flood levels within and downstream of the site compared to ARR2019. The subsequent discussion therefore focuses on the ARR1987 results (as the worst case) but are generally applicable to the findings for ARR2019 also. Flood mapping of both scenarios is included in Appendix D.

The mitigated developed case results in the reduction in peak site discharge downstream of the site, with flood levels downstream of the site at or below pre-development conditions for all events with the exception of very minor and low hazard impact on the verge of Cliveden Avenue identified in Figure 16 and discussed below.

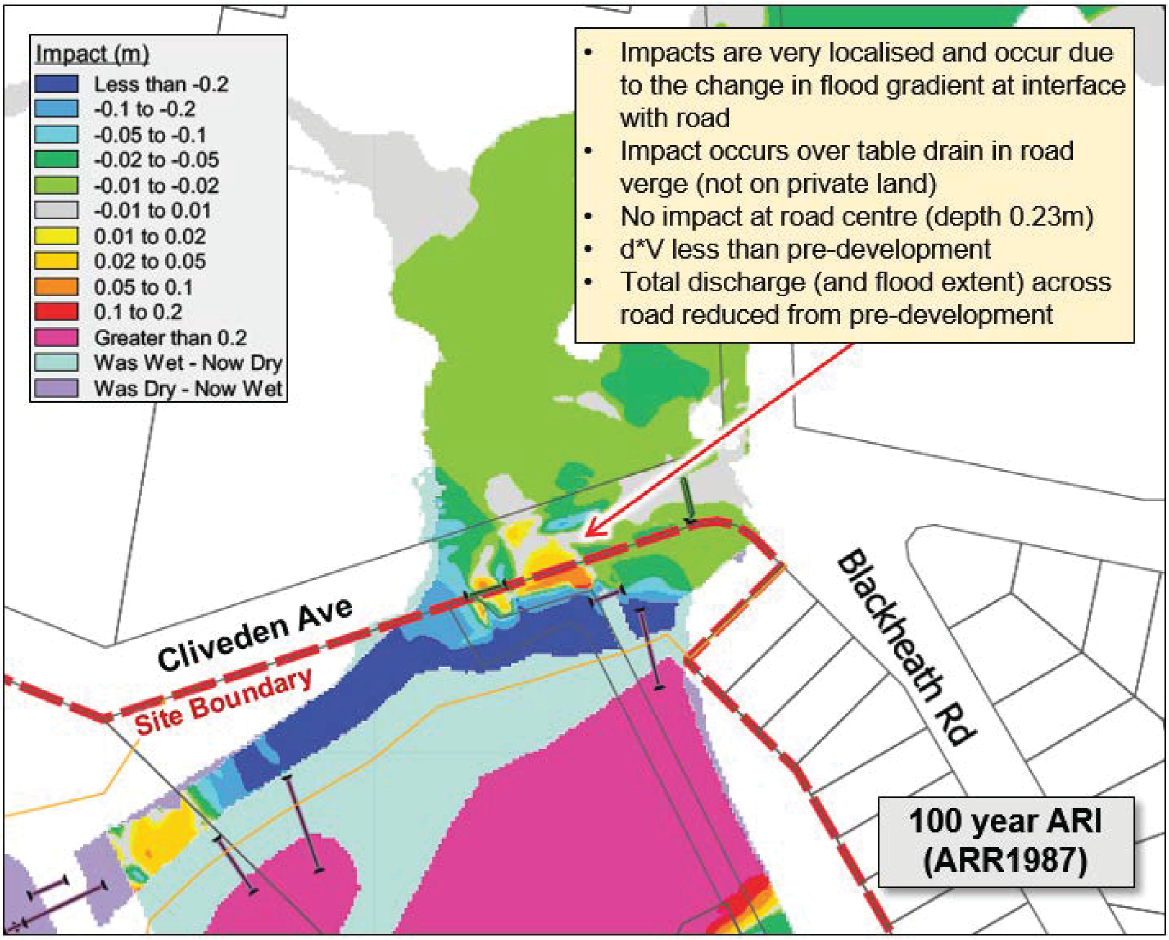


Figure 16: 100 year ARI (ARR1987) mitigated development flood level impacts

With reference to Figure 16, the peak 1% AEP (100 year ARI) flood levels at Cliveden Avenue indicate a localised impact within the road verges. This results from the site earthworks design changing the former broad shallow flood surface from the existing sports oval to being more efficiently conveyed along the proposed northern channel, thereby altering the flood gradient and road overtopping characteristics. Significant number of iterations to resolve this local impact were not able to completely remove the issues due to the very sensitive nature of the flood distribution (i.e. it moved the local impact slightly east or west along Cliveden Avenue). This is despite having reduced discharge in this location from the upstream detention basin. Therefore, the impact is considered to present no nuisance and acceptable within the existing flood hazard within Cliveden Avenue for the following reasons:

1. No impacts extent to private land
2. Impacts are 10-50mm above existing case flooding
3. Impacts occur only above the table drain beside Cliveden Avenue where flood depths are already 0.5-1m.
4. Does not result in increased hazard (depth*velocity) and in fact slightly reduces it due to lower velocity.

5. No impacts occur on the carriageway of Cliveden Avenue and therefore represents no worsening for emergency vehicle access (maximum depth over road centre is 0.23m).
6. Peak discharge leaving the development site is less than pre-development
7. Flooded extent of Cliveden Avenue is reduced under developed case
8. Flood depths are generally reduced downstream of site under developed case.

No adverse impacts occur in the minor events assessed. Flood mapping for the balance of events is provided in Appendix D for flood impact, depth and hazard for the range of events analysed for the site.

5.4.2 Waterway Stability

Table 26 summarises the pre and post development peak discharges for the 1 year ARI. There is a marginal 0.18 m^3/s (6%) increase in the minor discharge leaving the site, however this is not considered to represent an adverse impact on the downstream open drain stability given the low gradient and velocities associated with the drainage line.

Table 26: ARR1987 Peak 1 year ARI discharge results (Tuflow)

Location	PO Line	Scenario	Discharge (m^3/s)
			1 yr ARI
Cliveden Avenue (SD1)	13	Pre	3.08
		Dev (mit)	3.26

5.4.3 Site Flooding (Local Waterway)

Site flooding is confined to the open space and drainage reserve in the north east corner of the site fronting Cliveden Avenue and extending upstream around the northern edge of the development zone (retirement precinct) where the main flood detention basin attenuates upstream catchment flows. All development lot levels are above the 1% AEP/100 year ARI local flood level.

5.4.4 Flood Detention Basins

Flood detention occurs in the dedicated flood detention basin 1 as well as minor storage over the bioretention basin and open space area. The resultant 1% AEP and 100 year ARI flood condition within these basins is summarised in Table 27 amd Table 28. The depth in Bioretention basin 1 is taken from the filter surface although the first 300mm depth (extended detention depth) was assumed full at the commencement of the flood event.

Table 27: Flood detention basins (ARR2019)

Basin ID (Figure 9)	1% AEP flood elevation (mAHD)	1% AEP depth (m)
Flood Basin 1	12.04	2.17
Bioretention Basin 1	10.97	1.47
Open space	8.93	0.43

Table 28: Flood detention basins (ARR1987)

Basin ID (Figure 9)	100 year ARI flood elevation (mAHD)	100 year ARI depth (m)
Flood Basin 1	12.21	2.34
Bioretention Basin 1	10.98	1.48
Open space	9.27	0.78

As shown below in Figure 17 and Figure 18, the depth*velocity product of the Flood Basin 1 zone is significant and should therefore be reviewed further as part of design in terms of batter slopes for safe egress and/or fencing. Flooding across the open space zone is generally below 0.1m depth (sheet flow) in the 100 year ARI (ARR1987) increasing to 0.77m in the north east corner at the pipe outlet where local attention occurs upstream of the low bund. In all cases, the depth*velocity product remains below 0.3m²/s which is a low hazard for children and adults (QUDM Table 12.1.1). Flooding depth for ARR2019 assessment are considerably lower through this area.

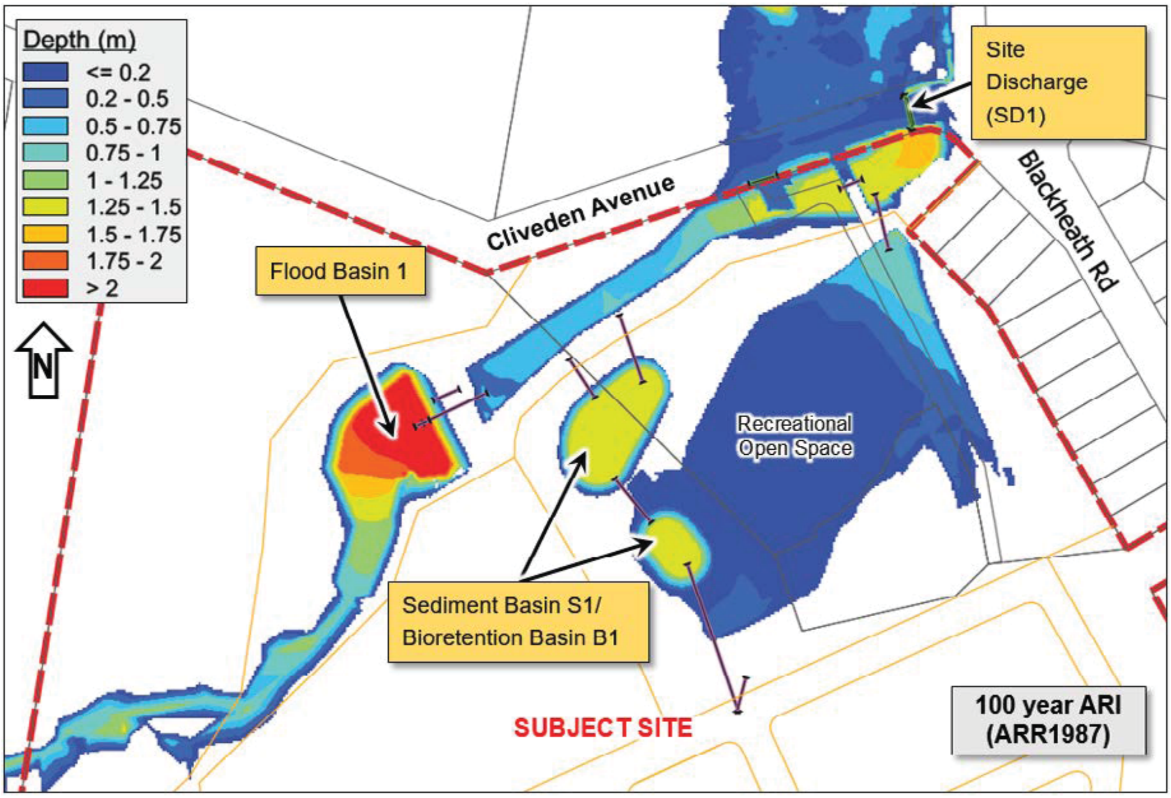


Figure 17: Site flood depth - 100 year ARI (ARR1987) mitigated flood

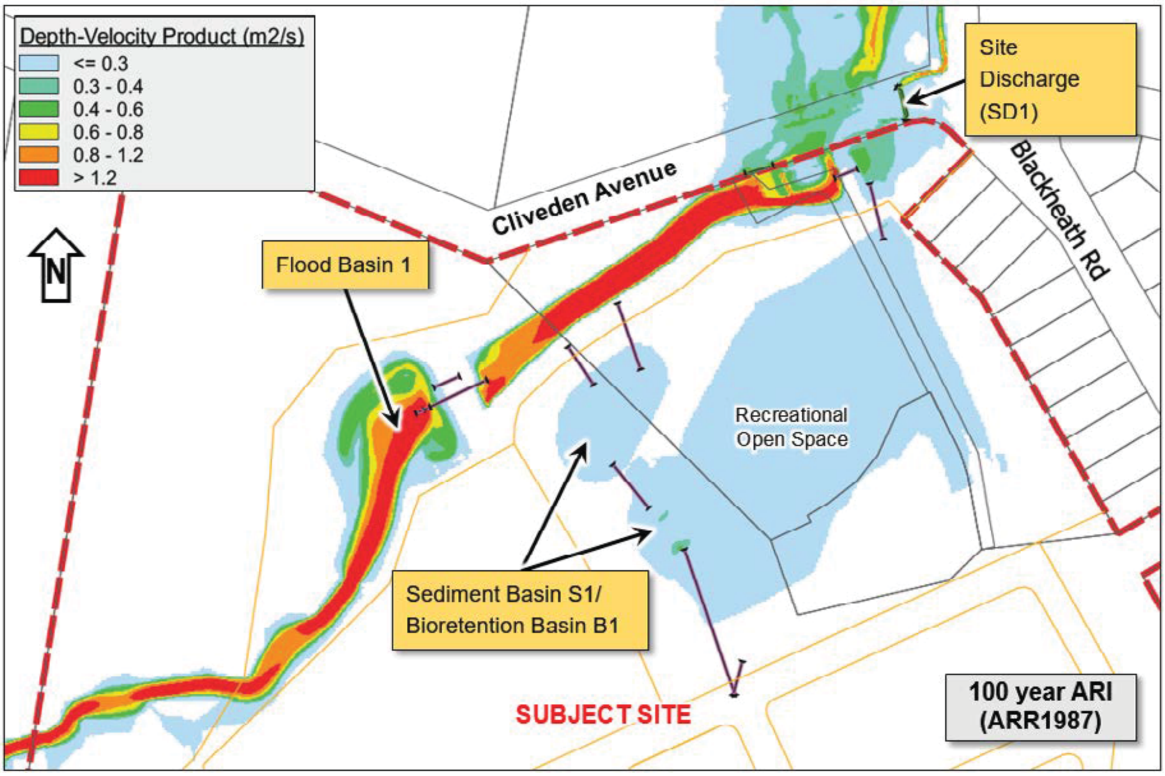


Figure 18: Site flood hazard (D*V) - 100 year ARI (ARR1987) mitigated flood

5.4.5 Blockage Assessment

The impact of potential blockage to either the detention basin outlets or the open space outlet pipe does not result in significant impacts or redirection of flows to development areas. Figure 19 shows the extent of impact for the ARR1987 case (ARR2019 is similar. See Appendix D mapping).

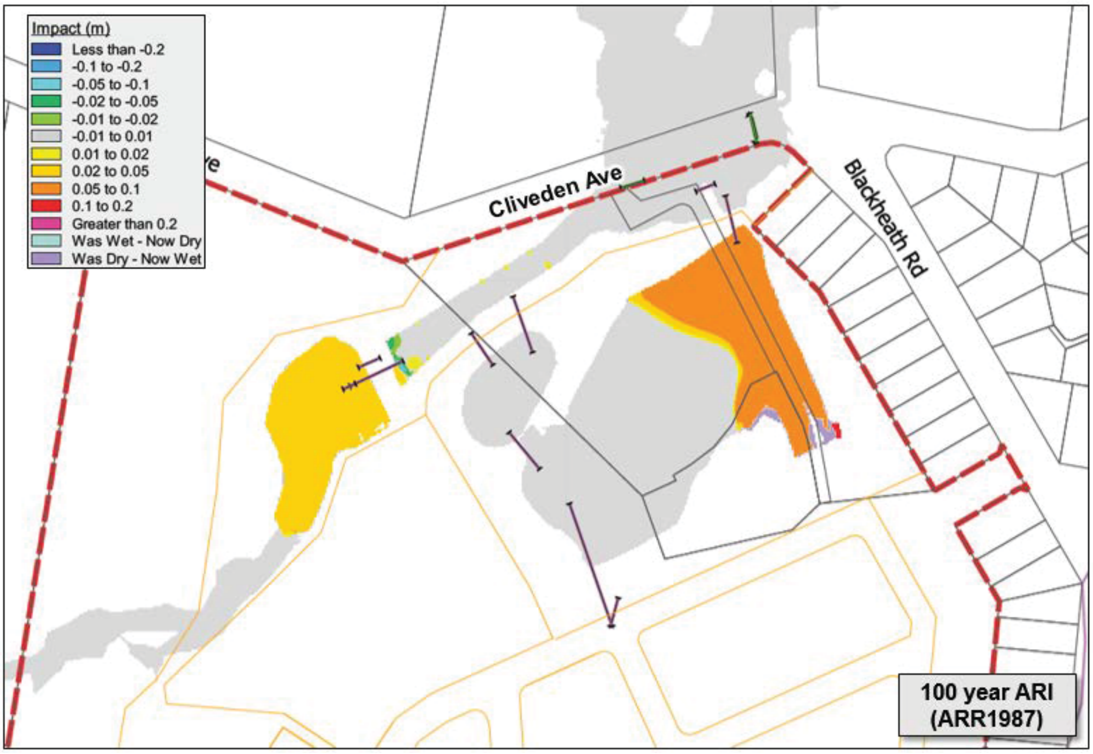


Figure 19: Blockage impact (compared to no blockage)

5.4.6 Site flooding (Brisbane River)

The River Flooding Level (RFL) adopted for this assessment has been taken as the Brisbane River Catchment Flood Study (BRCFS) 1% AEP level of 11.6 mAHD. All residential lot and road levels are above this level with a minimum of 500mm freeboard which satisfies all categories of flood planning levels in Table 8.2.11.3.L in the Flood Overlay Code.

An assessment of the flood hazard associated with Brisbane River flooding has also been undertaken for the vulnerable land uses associated with the proposed childcare and retirement sites within the development. In accordance with Council's flood overlay code, these uses require minimum floor levels above the 0.2% AEP (1 in 500 AEP) Brisbane River flood level of 15.45 mAHD (data supplied by BMT, 2020). As no details for floor levels are available for these sites, the current ground levels will be used for this assessment. Table 29 summarises the site details.

Table 29: Retirement and child care site details (for 0.2% AEP river flood)

	Site Elevation (mAHD)		Lot Area (ha)	Area below 0.2% AEP (ha)	Depth (m)	Velocity (m/s)	Hazard
	Min.	Max.			Max.		
Childcare site	15.1	18.3	0.23	0.002 [1]	n/a	n/a	nil
Retirement site	12.7	22.2	1.60	0.9	2.75	0.11	H1-H5

Notes:

1. Area of child care site is negligible and not assessed further

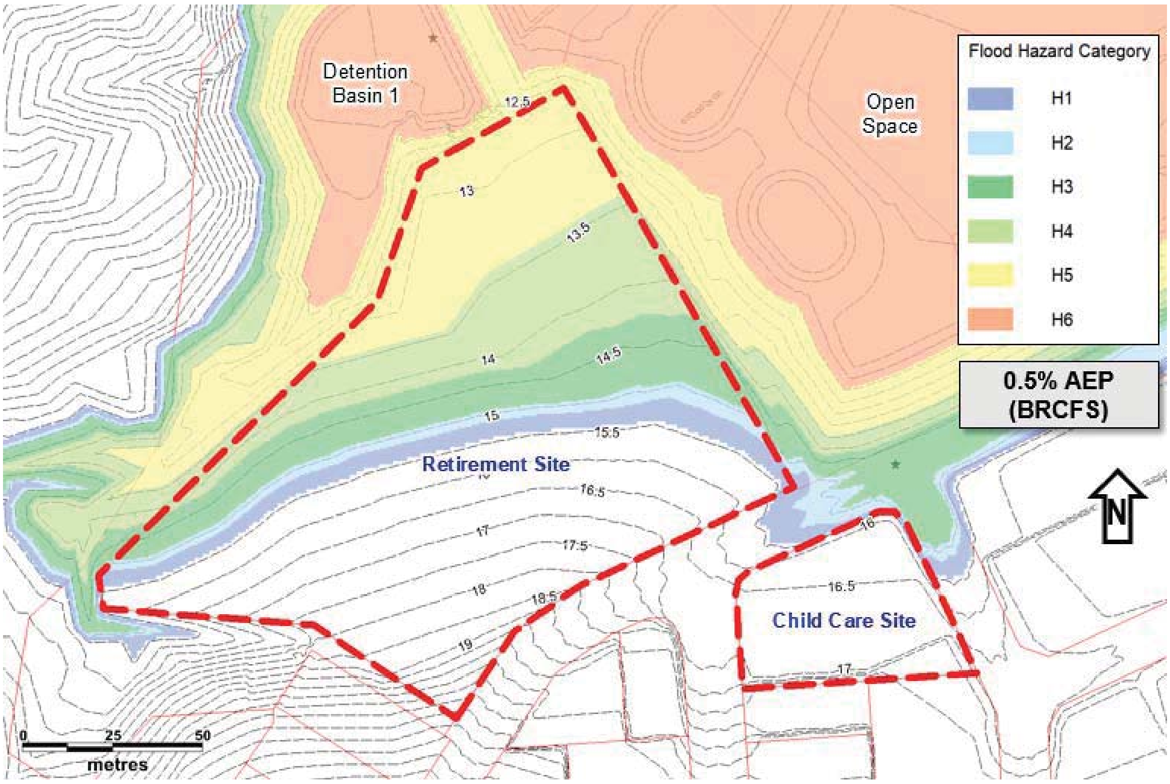


Figure 20: 0.2% AEP Brisbane River flood hazard vulnerability classification for retirement and child care sites

Based on the land use capability information provided in the *Brisbane River Strategic Floodplain Management Plan – Land Use Planning Guidance Material* (BMT and Ethos Urban 2018), both child care and retirement (community care/residence) are classed as vulnerable land use activities. Hydraulic Risk (HR) category HR4 is tolerable for these land uses in the Brisbane River floodplain. For the 1 in 500 (0.2%) AEP from figure 4 in the *Land Use Planning Guidance Material* (reproduced below), this relates to hazard vulnerability classification limit of H3 as defined in ARR2019 (H3 = depth*velocity ≤0.6 m^2/s, depth ≤1.2 m, velocity ≤2 m/s).

AEP	H1	H2	H3	H4	H5	H6
1 in 100k	HR5	HR5	HR5	HR5	HR5	HR5
1 in 2000	HR5	HR5	HR4	HR4	HR4	HR4
1 in 500	HR5	HR4	$\boxed{\text{HR4}}$	HR3	HR3	HR3
1 in 100	HR4	HR4	HR3	HR2	HR2	HR2
1 in 50	HR4	HR3	HR2	HR2	HR1	HR1
1 in 20	HR3	HR2	HR2	HR1	HR1	HR1
1 in 10	HR2	HR1	HR1	HR1	HR1	HR1

Figure 4 – Brisbane River SFMP Potential Hydraulic Risk Matrix

From Figure 20 above, it can be seen that the child care centre is not impacted by the 0.2% AEP flood (0.002 ha in northeast corner is negligible) while the retirement site has approximately 0.9ha below the 0.2% AEP regional flood level with around 0.5ha exceeding the H3 hazard classification. This is primarily related to the depth of flooding as the velocities are only 0.11 m/s (source: BMT, Martin Giles). Site layout and building design responses for this site should therefore consider the following:

- Supported/assisted retirement care (and any health services) to be preferably located in the southern half of the site outside the 0.2% AEP flood.
- Floor levels in the central and northern parts of site to be at or above 15.45 mAHD with provision of elevated access ways at or above 15.45 mAHD between buildings and from these areas to facilitate evacuation of elderly.

5.4.7 Floodplain Volume

While not triggered under the BCC Planning Scheme, a broad review of the development impact on the Brisbane River floodplain has been undertaken to assess the proposed earthworks in the context of the broader catchment. Using the proposed Brisbane River Flood Level (RFL) of 11.6 mAHD, a review of total volume within the site below this level was undertaken and reported in Table 30. This indicates that there is approximately 7500 m^3 reduction in the floodplain volume within the site boundary (just under 10%) compared to the existing case. Further review of the incremental volumes indicates that below 9.4 mAHD, the site has greater floodplain volume than the existing case with gradual reduction from 9.4 to 11.6 mAHD. In the context of the broader Brisbane River floodplain volumes, these marginal site gains at lower elevations (more frequent flood events) and losses at higher elevations are insignificant and would not have a measurable impact on regional flooding.

Table 30: Site floodplain volume review

Scenario	Site volume below 11.6 mAHD (m^3)	Change from Existing (m^3)
Existing	75800	-
Developed	68300	-7500 (-9.9%)

The planning scheme does require the preservation of local catchment/waterway incremental flood storage. However the incremental preservation of volume on this site is not practical nor warranted due to the following reasons:

- flood conveyance path is wholly contained within the site, and
- the site/flood gradient is steep (flood elevation range approximately 7 mAHD to 16 mAHD over less than 500m) and
- Significant historical modification to original waterway (i.e. filled over to create sports fields)
- findings of this flood assessment have shown that there are no adverse impacts upstream or downstream of the site which achieves the intention of the planning scheme.

5.5 FLOODING SUMMARY

The proposed adoption of a dedicated detention basin combined with localised flood storage over the bioretention basin and open space zone ensures that no adverse impacts from peak flow or flood level occur on downstream private property.

The propose strategy also provides for flood free development (with freeboard) up to the 1% AEP flood level from both the local flood conveyance as well as the Brisbane River flood (11.6 mAHD).

The layout and design of the retirement site will need to consider the safety and access for evacuation for floods up to 0.2% AEP from the Brisbane River. This will require parts of the site to have elevated floor levels and suitable access ways to these areas. The child care site lies above the 0.2% AEP flood.

6 CONCLUSION AND RECOMMENDATIONS

6.1 STORMWATER QUALITY

The proposed adoption of a 300m^2 sediment pond and 700m^2 bioretention basin to capture and treat the majority of the developed portions of the site in combination with open vegetated swale for the northern drainage line, meets the pollutant load reduction targets for the site. A refined MUSIC model and design of stormwater treatment elements will be undertaken as part of detailed design for operational works to verify the final design remains valid with this stormwater management plan.

6.2 STORMWATER QUANTITY AND FLOODING

The adoption of a detention basin integrated into the northern portion of the site achieves the required flood attenuation of upstream and portions of the internal catchment discharge (in conjunction with the bioretention basin and open space attenuation) to ensure peak discharge leaving the site under minor and major flood events does not result in adverse flood impacts downstream.

The site can be developed appropriately with all lots and internal roads servicing lots above the 1% AEP local and regional flood level with at least 500mm freeboard. The layout and design of the retirement site and buildings (vulnerable use) will need to consider the safety and access for evacuation for floods up to 0.2% AEP from the Brisbane River. This will require parts of the site to have elevated floor levels and suitable access ways to these areas. The proposed child care site lies above the 0.2% AEP Brisbane River flood level and therefore not at risk.

APPENDIX A FUNCTIONAL DESIGN DRAWINGS

DO NOT SCALE THIS DRAWING
IF IN DOUBT - ASK!

NORTH

LOCALITY PLAN

REVISIONS

No	Description	Date	By
A	FOR APPROVAL	18/02/2020	DJS
B	REISSUE FOR APPROVAL	21/02/2020	DES
C	REISSUE FOR APPROVAL	04/06/2020	SLK
D	REISSUE FOR APPROVAL	19/08/2020	DES

Associated Consultants

Client
ECONOMIC DEVELOPMENT QUEENSLAND (EDQ)

Project
OXLEY SECONDARY COLLEGE REDEVELOPMENT STAGE 1

KN GROUP PTY LTD
CONSULTING ENGINEERS
LEVEL 1 - 62 ASTOR TCE
SPRING HILL, QLD 4000
PHONE 07 3017 1900
EMAIL kng@knpl.com.au
ABN 35 112 053 611

Approved

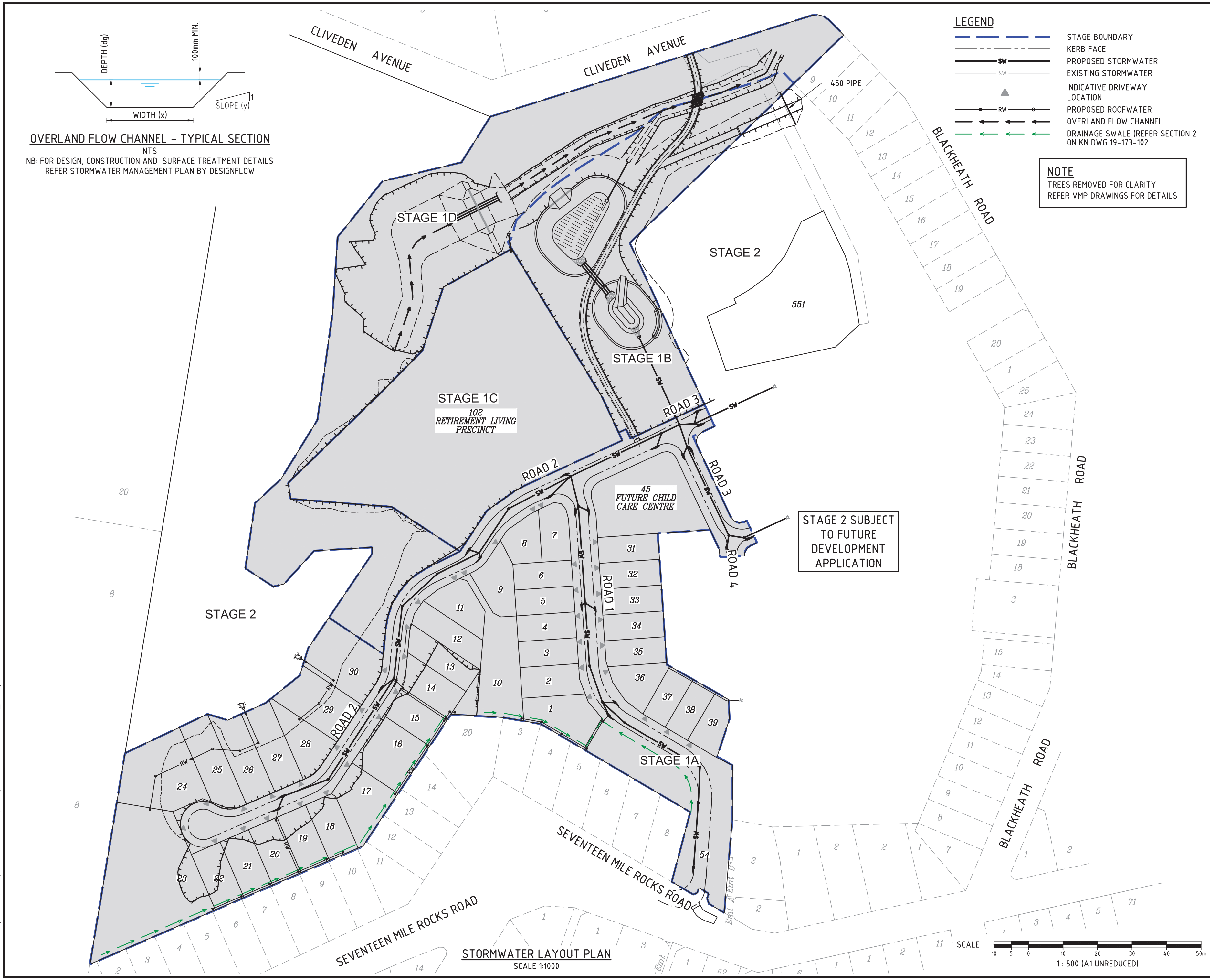
Drawing Title
FUNCTIONAL LAYOUT
EARTHWORKS PLAN

Drawn	Designed	Checked	Date
RW	DJS	GBG	FEB 20

Scale: AS SHOWN | Sheet: 1 of 11

A1 | Drawing No: 19-173-101 | Revision: D

M:\2019\19173 Oxley Secondary College Redevelopment DA\Engineering\Acad\FUNCTIONAL\19-173-101-102-EW.dwg Plotted by: DS on 19/08/2020 5:40:53 PM



DO NOT SCALE THIS DRAWING
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NORTH

LOCALITY PLAN

REVISIONS

No	Description	Date	By
A	FOR APPROVAL	18/02/2020	DJS
B	REISSUE FOR APPROVAL	21/02/2020	DES
C	REISSUE FOR APPROVAL	04/06/2020	SLK
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Client

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KN GROUP PTY LTD
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LEVEL 1 - 62 ASTOR TCE
SPRING HILL, QLD 4000
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ABN 35 112 053 611

Approved

Drawing Title

FUNCTIONAL LAYOUT STORMWATER

Drawn	Designed	Checked	Date
RW	DJS	GBG	FEB 20

Scale: AS SHOWN
Sheet: 5 of 11

A1 | Drawing No: 19-173-105 | Revision: D

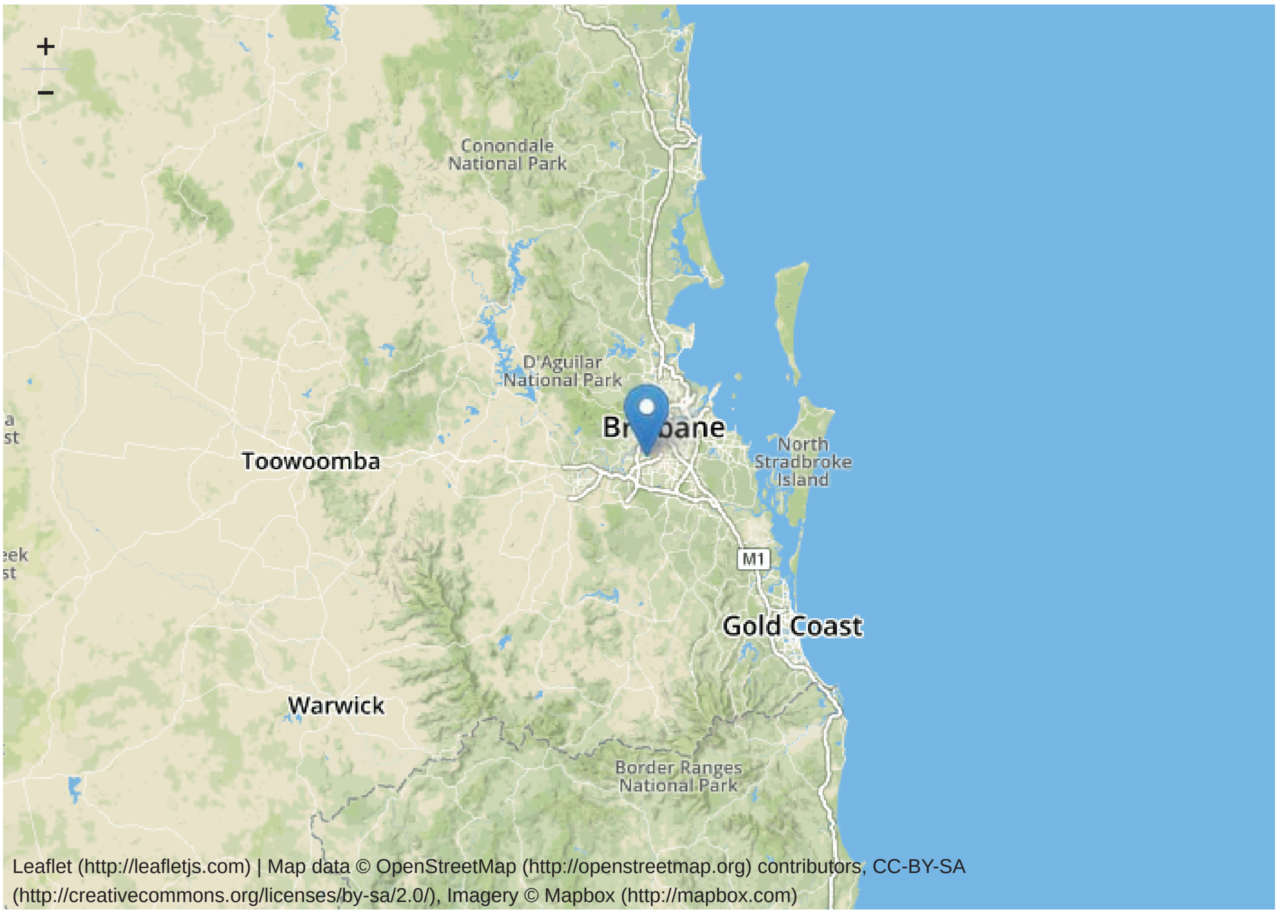
M:\2019\19173 Oxley Secondary College Redevelopment DA\Engineering\Acad\FUNCTIONAL\19-173-105_SW.dwg Plotted by: DS on 19/08/2020 5:41:02 PM

APPENDIX B ARR DATA HUB SUMMARY

Australian Rainfall & Runoff Data Hub - Results

Input Data

Longitude	152.968
Latitude	-27.552
Selected Regions (clear)	
River Region	show
ARF Parameters	show
Storm Losses	show
Temporal Patterns	show
Areal Temporal Patterns	show
Interim Climate Change Factors	show



Region Information

Data Category	Region
River Region	Brisbane River
ARF Parameters	East Coast North

Data Category	Region
Temporal Patterns	East Coast North

Data

River Region

division	North East Coast
rivregnum	43
River Region	Brisbane River

Layer Info

Time Accessed	28 February 2019 11:47AM
Version	2016_v1

ARF Parameters

Long Duration ARF

$$ARF = Min\left\{1, \left[1 - a\left(Area^{b} - c\log_{10}Duration\right)Duration^{-d} + eArea^{f}Duration^{g}\left(0.3 + \log_{10}AEP\right) + h10^{iArea\frac{Duration}{1440}}\left(0.3 + \log_{10}AEP\right)\right]\right\}$$

Zone	a	b	c	d	e	f	g	h	i
East Coast North	0.327	0.241	0.448	0.36	0.00096	0.48	-0.21	0.012	-0.0013

Short Duration ARF

$$ARF = Min\left[1, 1 - 0.287\left(Area^{0.265} - 0.439\log_{10}(Duration)\right).Duration^{-0.36} + 2.26 \text{ x } 10^{-3} \text{ x } Area^{0.226}.Duration^{0.125}\left(0.3 + \log_{10}(AEP)\right) + 0.0141 \text{ x } Area^{0.213} \text{ x } 10^{-0.021\frac{(Duration-180)^{2}}{1440}}\left(0.3 + \log_{10}(AEP)\right)\right]$$

Layer Info

Time Accessed	28 February 2019 11:47AM
Version	2016_v1

Storm Losses

Note: Burst Loss = Storm Loss - Preburst

Note: These losses are only for rural use and are **NOT FOR USE** in urban areas

id	3380.0
Storm Initial Losses (mm)	18.0
Storm Continuing Losses (mm/h)	1.4

Layer Info

Time Accessed	28 February 2019 11:47AM
Version	2016_v1

Temporal Patterns | Download (.zip) (./temporal_patterns/tp/ECnorth.zip)

code	ECnorth
Label	East Coast North

Layer Info

Time Accessed	28 February 2019 11:47AM
Version	2016_v2

Areal Temporal Patterns | Download (.zip) (./temporal_patterns/areal/Areal_ECnorth.zip)

code	ECnorth
arealabel	East Coast North

Layer Info

Time Accessed	28 February 2019 11:47AM
Version	2016_v2

BOM IFD Depths

Click here (http://www.bom.gov.au/water/designRainfalls/revised-ifd/?year=2016&coordinate_type=dd&latitude=-27.552&longitude=152.968&sdmin=true&sdhr=true&sdday=true&user_label=) to obtain the IFD depths for catchment centroid from the BoM website

No data	No data found at this location!

Layer Info

Time Accessed	28 February 2019 11:47AM

Median Preburst Depths and Ratios

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	3.0 (0.080)	6.1 (0.116)	8.1 (0.129)	10.0 (0.138)	10.5 (0.124)	11.0 (0.115)
90 (1.5)	2.3 (0.053)	10.0 (0.168)	15.1 (0.213)	20.0 (0.242)	14.9 (0.153)	11.2 (0.101)
120 (2.0)	1.0 (0.021)	8.9 (0.137)	14.1 (0.182)	19.1 (0.212)	18.3 (0.170)	17.7 (0.146)
180 (3.0)	3.4 (0.065)	9.2 (0.126)	13.0 (0.149)	16.7 (0.163)	22.3 (0.183)	26.6 (0.192)
360 (6.0)	8.7 (0.133)	15.4 (0.170)	19.9 (0.183)	24.2 (0.190)	42.9 (0.280)	56.9 (0.326)
720 (12.0)	4.1 (0.050)	10.8 (0.094)	15.3 (0.111)	19.6 (0.121)	33.9 (0.172)	44.6 (0.198)
1080 (18.0)	1.6 (0.017)	8.4 (0.063)	12.8 (0.080)	17.1 (0.090)	29.4 (0.127)	38.7 (0.146)
1440 (24.0)	0.9 (0.008)	6.6 (0.044)	10.3 (0.057)	13.9 (0.065)	25.4 (0.098)	34.0 (0.114)
2160 (36.0)	0.0 (0.000)	2.8 (0.017)	4.7 (0.023)	6.5 (0.026)	14.5 (0.048)	20.6 (0.058)
2880 (48.0)	0.0 (0.000)	1.3 (0.007)	2.1 (0.009)	2.9 (0.011)	9.9 (0.029)	15.0 (0.038)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	2.2 (0.006)	3.8 (0.008)

Layer Info

Time Accessed	28 February 2019 11:47AM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

10% Preburst Depths

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
90 (1.5)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
120 (2.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
180 (3.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
360 (6.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
720 (12.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
1080 (18.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
1440 (24.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2160 (36.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2880 (48.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)

Layer Info

Time Accessed	28 February 2019 11:47AM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

25% Preburst Depths

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	0.0 (0.000)	0.1 (0.003)	0.2 (0.004)	0.3 (0.005)	0.7 (0.008)	1.0 (0.010)
90 (1.5)	0.0 (0.000)	0.6 (0.010)	1.0 (0.015)	1.4 (0.017)	0.8 (0.008)	0.4 (0.003)
120 (2.0)	0.0 (0.000)	1.1 (0.016)	1.8 (0.023)	2.4 (0.027)	1.5 (0.014)	0.9 (0.007)
180 (3.0)	0.0 (0.000)	0.2 (0.003)	0.4 (0.005)	0.5 (0.005)	0.9 (0.007)	1.2 (0.009)
360 (6.0)	0.0 (0.000)	0.6 (0.007)	1.0 (0.009)	1.4 (0.011)	4.3 (0.028)	6.4 (0.037)
720 (12.0)	0.0 (0.000)	1.9 (0.017)	3.2 (0.023)	4.4 (0.027)	6.7 (0.034)	8.4 (0.037)
1080 (18.0)	0.0 (0.000)	0.4 (0.003)	0.7 (0.004)	1.0 (0.005)	4.8 (0.021)	7.6 (0.029)
1440 (24.0)	0.0 (0.000)	0.1 (0.000)	0.1 (0.001)	0.1 (0.001)	3.0 (0.012)	5.1 (0.017)
2160 (36.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.1 (0.000)	0.2 (0.000)
2880 (48.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)

Layer Info

Time Accessed	28 February 2019 11:47AM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

75% Preburst Depths

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	34.1 (0.899)	44.1 (0.842)	50.8 (0.814)	57.1 (0.791)	49.2 (0.577)	43.2 (0.453)
90 (1.5)	28.0 (0.651)	41.7 (0.700)	50.8 (0.715)	59.5 (0.721)	78.5 (0.801)	92.7 (0.843)
120 (2.0)	26.4 (0.563)	50.0 (0.771)	65.7 (0.847)	80.7 (0.894)	115.2 (1.071)	141.0 (1.164)
180 (3.0)	35.5 (0.673)	53.5 (0.731)	65.4 (0.747)	76.8 (0.751)	116.3 (0.950)	145.8 (1.054)
360 (6.0)	46.5 (0.714)	59.0 (0.650)	67.2 (0.617)	75.1 (0.589)	115.5 (0.753)	145.8 (0.836)
720 (12.0)	40.2 (0.490)	54.6 (0.475)	64.1 (0.462)	73.2 (0.450)	96.7 (0.490)	114.3 (0.508)
1080 (18.0)	21.4 (0.227)	40.8 (0.307)	53.7 (0.333)	66.0 (0.347)	93.6 (0.405)	114.3 (0.432)
1440 (24.0)	19.5 (0.187)	40.8 (0.276)	54.9 (0.305)	68.4 (0.322)	80.4 (0.310)	89.4 (0.300)
2160 (36.0)	6.2 (0.052)	18.2 (0.106)	26.2 (0.125)	33.8 (0.136)	49.0 (0.160)	60.4 (0.172)
2880 (48.0)	4.0 (0.030)	13.4 (0.071)	19.7 (0.085)	25.7 (0.093)	47.7 (0.140)	64.2 (0.163)
4320 (72.0)	0.2 (0.001)	5.6 (0.026)	9.2 (0.035)	12.6 (0.040)	31.4 (0.080)	45.6 (0.100)

Layer Info

Time Accessed	28 February 2019 11:47AM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

90% Preburst Depths

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	119.2 (3.138)	137.2 (2.617)	149.2 (2.392)	160.7 (2.226)	191.8 (2.249)	215.1 (2.255)
90 (1.5)	112.8 (2.622)	141.1 (2.370)	159.9 (2.251)	177.9 (2.156)	215.1 (2.195)	243.0 (2.209)
120 (2.0)	84.1 (1.795)	115.9 (1.787)	137.0 (1.767)	157.2 (1.742)	216.4 (2.012)	260.7 (2.152)
180 (3.0)	102.7 (1.948)	128.7 (1.760)	145.9 (1.665)	162.4 (1.588)	251.4 (2.055)	318.1 (2.300)
360 (6.0)	85.0 (1.304)	111.5 (1.230)	129.0 (1.185)	145.8 (1.143)	236.3 (1.539)	304.0 (1.743)
720 (12.0)	89.6 (1.092)	129.9 (1.130)	156.5 (1.130)	182.1 (1.118)	208.1 (1.055)	227.5 (1.011)
1080 (18.0)	61.7 (0.654)	87.7 (0.659)	104.9 (0.651)	121.4 (0.639)	173.0 (0.749)	211.6 (0.800)
1440 (24.0)	58.6 (0.562)	87.0 (0.587)	105.8 (0.588)	123.8 (0.583)	157.5 (0.607)	182.7 (0.613)
2160 (36.0)	32.0 (0.269)	60.2 (0.351)	78.8 (0.377)	96.7 (0.389)	133.5 (0.437)	161.1 (0.458)
2880 (48.0)	36.5 (0.281)	62.3 (0.330)	79.3 (0.343)	95.7 (0.347)	124.8 (0.365)	146.5 (0.371)
4320 (72.0)	19.9 (0.137)	41.2 (0.193)	55.2 (0.210)	68.7 (0.218)	83.2 (0.212)	94.1 (0.207)

Layer Info

Time Accessed	28 February 2019 11:47AM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

Interim Climate Change Factors

Values are of the format temperature increase in degrees Celcius (% increase in rainfall)

	RCP 4.5	RCP6	**RCP 8.5**
2030	**0.892 (4.5%)**	0.775 (3.9%)	**0.979 (4.9%)**
2040	**1.121 (5.6%)**	1.002 (5.0%)	**1.351 (6.8%)**
2050	**1.334 (6.7%)**	1.28 (6.4%)	**1.765 (8.8%)**
2060	**1.522 (7.6%)**	1.527 (7.6%)	**2.23 (11.2%)**
2070	**1.659 (8.3%)**	1.745 (8.7%)	**2.741 (13.7%)**
2080	**1.78 (8.9%)**	1.999 (10.0%)	**3.249 (16.2%)**
2090	**1.825 (9.1%)**	2.271 (11.4%)	**3.727 (18.6%)**

Layer Info

Time Accessed	28 February 2019 11:47AM
Version	2016_v1
Note	ARR recommends the use of RCP4.5 and RCP 8.5 values

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APPENDIX C RATIONAL METHOD ASSESSMENT

RATIONAL METHOD DISCHARGE ESTIMATES

Rational Method calculations have adopted the following assumptions:

- Friends equation – sheet flow (QUDM 4.6.6)
- Standard inlet times (for urbanised areas in upper catchment only) (QUDM 4.6.4)
- Average velocity for concentrated surface flow = 1.5m/s
- Average velocity for pipe flow = 2m/s (QUDM 4.6.9)
- Frequency factors – QUDM Table 4.5.2
- Review based on pre-development case which includes a range of land use types and imperviousness.
- Catchments E, F2, H1 and H2 excluded based on catchment complexity described in QUDM (refer Table 15 in main report)

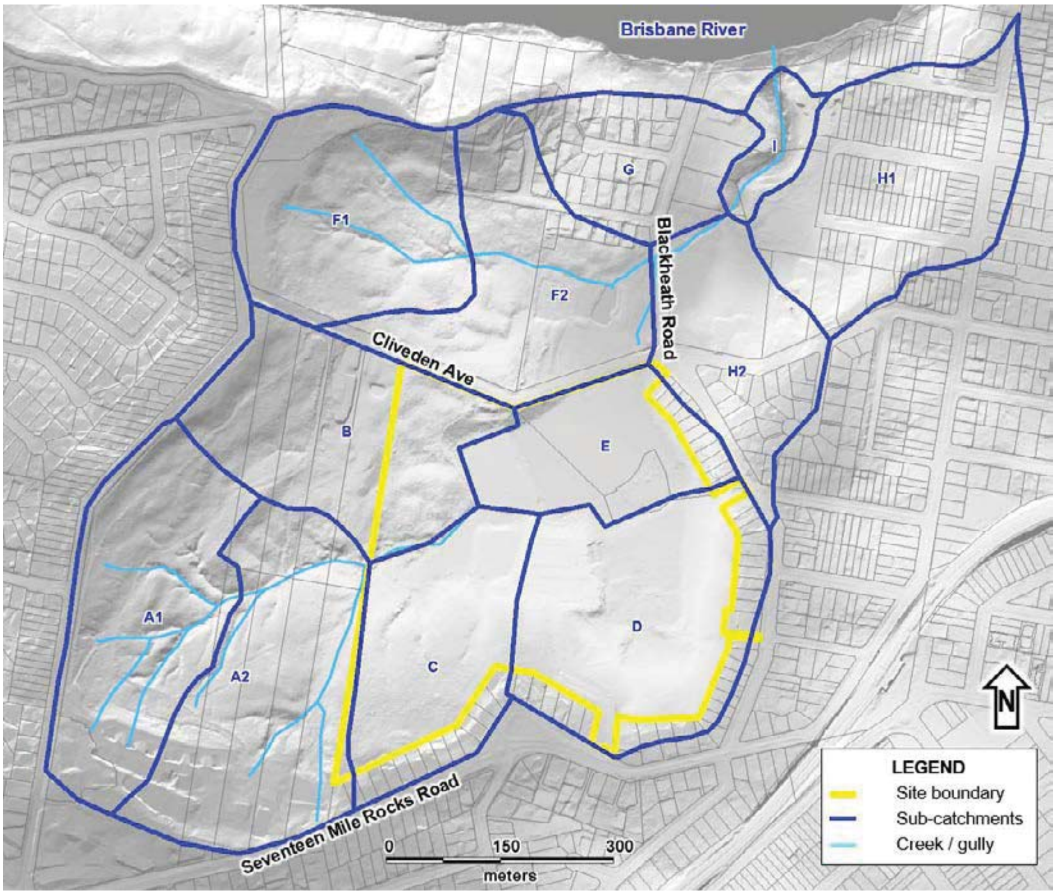


Figure C1: catchment plan

Table C1: Rational Method catchment data and Tc

Catchment				Sheet flow / Standard Inlet Time				Concentrated Flow				
ID	Area	% Imperv	Total flow length	Sheet Flow length	Hortons 'n'	Surface Slope	Sheet Tc/ Std inlet time	Conc. flow length	Slope	Vel. (av)	Conc. Tc	Total Tc
	ha	%	m	m		%	min	m	%	m/s	min	min
A1	8.53	20%	365	20	0.06	9.1	11.2	345	12.6	1.5	3.8	15.0
A2	9.38	20%	493	20	0.06	10.7	10.8	473	10.6	1.5	5.3	16.1
B	8.28	6%	462	20	0.06	23.9	9.2	442	10.7	1.5	4.9	14.1
C	6.57	10%	431	std [1]	-	17.5	5.0 [1]	381	10.5	1.0	6.4	11.4
D	9.37	41%	335	std [1]	-	20.4	5.0 [1]	285	8.3	1.0	4.8	9.8
F1	7.61	9%	330	20	0.045	7.8	8.7	310	13.6	1.5	3.4	12.1
G	4.44	50%	333	std [1]	-	18.3	5.0 [1]	283	12.4	2.0 [2]	2.4	7.4
I	1.42	20%	211	50	0.045	12.9	7.8	191	1.6	1.0	3.2	11.0

Notes:

1. 'Std' indicated standard inlet time used for upper catchment flow time (i.e. where upper catchment is urbanised)
2. Pipe drainage velocity at 2 m/s

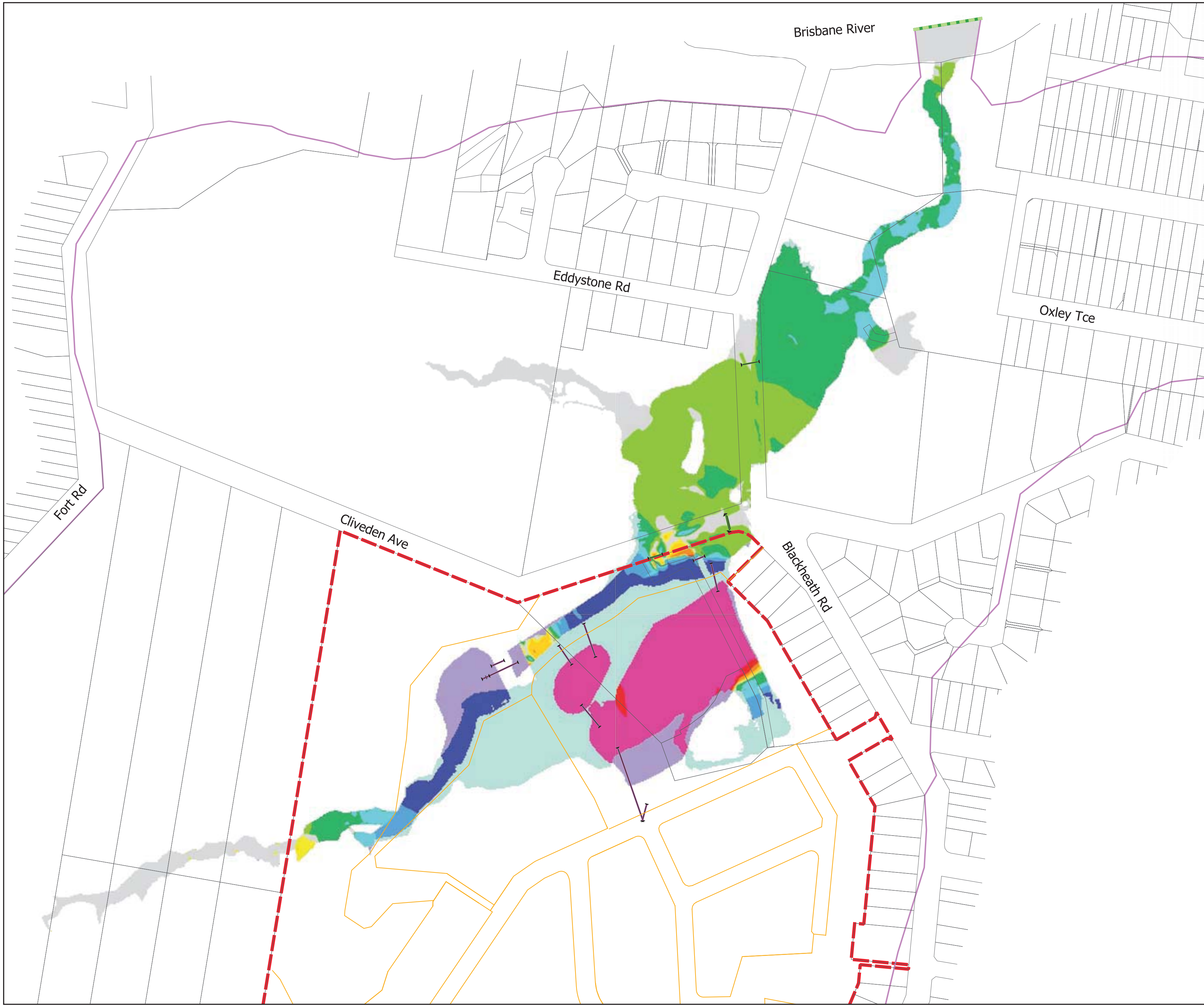
Table C2: ARR1987 Rational Method discharge

Catchment				2 year ARI			10 Year ARI			100 year ARI		
ID	Area	C10	Total tc	Rainfall Intensity	C	Peak Discharge	Rainfall Intensity	C	Peak Discharge	Rainfall Intensity	C	Peak Discharge
	ha		min	mm/hr		m^3/s	mm/hr		m^3/s	mm/hr		m^3/s
A1	8.53	0.71	15.0	96	0.604	1.37	141	0.710	2.37	218	0.852	4.40
A2	9.38	0.71	16.1	93	0.604	1.47	137	0.710	2.54	212	0.852	4.72
B	8.28	0.68	14.1	99	0.578	1.32	145	0.680	2.27	224	0.816	4.20
C	6.57	0.69	11.4	110	0.582	1.16	159	0.685	1.99	245	0.822	3.68
D	9.37	0.72	9.8	119	0.612	1.89	172	0.720	3.23	263	0.864	5.93
F1	7.61	0.69	12.1	106	0.582	1.30	154	0.685	2.23	237	0.822	4.12
G	4.44	0.78	7.4	131	0.663	1.07	189	0.780	1.82	288	0.936	3.33
I	1.42	0.71	11.0	110	0.604	0.26	159	0.710	0.45	245	0.852	0.82

Flood Impact Map Reference Index (in order of following pages)

Pre = pre-development, Dev = Post development (mitigated)

Map Type		Event	Method	Map Reference
Flood Impact	Pre vs Dev	100 yr ARI	ARR1987	J00311_Diff_H_M03c-B02a_100Yr
		1% AEP	ARR2019	J00311_Diff_H_M03c-B02a_1pc
		10 yr ARI	ARR1987	J00311_Diff_H_M03c-B02a_10Yr
		10% AEP	ARR2019	J00311_Diff_H_M03c-B02a_10pc
		2 yr ARI	ARR1987	J00311_Diff_H_M03c-B02a_2Yr
		50% AEP	ARR2019	J00311_Diff_H_M03c-B02a_50pc
Flood Depth	Pre	100 yr ARI	ARR1987	J00311_Dep_B02a_100Yr
		1% AEP	ARR2019	J00311_Dep_B02a_1pc
		10 yr ARI	ARR1987	J00311_Dep_B02a_10Yr
		10% AEP	ARR2019	J00311_Dep_B02a_10pc
		2 yr ARI	ARR1987	J00311_Dep_B02a_2Yr
		50% AEP	ARR2019	J00311_Dep_B02a_50pc
	Dev	100 yr ARI	ARR1987	J00311_Dep_M03c_100Yr
		1% AEP	ARR2019	J00311_Dep_ M03c _1pc
		10 yr ARI	ARR1987	J00311_Dep_ M03c _10Yr
		10% AEP	ARR2019	J00311_Dep_ M03c _10pc
		2 yr ARI	ARR1987	J00311_Dep_ M03c _2Yr
		50% AEP	ARR2019	J00311_Dep_ M03c _50pc
Flood Hazard (D*V)	Pre	100 yr ARI	ARR1987	J00311_DV_B02a_100Yr
		1% AEP	ARR2019	J00311_ DV _B02a_1pc
		10 yr ARI	ARR1987	J00311_ DV _B02a_10Yr
		10% AEP	ARR2019	J00311_ DV _B02a_10pc
		2 yr ARI	ARR1987	J00311_ DV _B02a_2Yr
		50% AEP	ARR2019	J00311_ DV _B02a_50pc
	Dev	100 yr ARI	ARR1987	J00311_DV_M03c_100Yr
		1% AEP	ARR2019	J00311_ DV _ M03c _1pc
		10 yr ARI	ARR1987	J00311_ DV _ M03c _10Yr
		10% AEP	ARR2019	J00311_ DV _ M03c _10pc
		2 yr ARI	ARR1987	J00311_ DV _ M03c _2Yr
		50% AEP	ARR2019	J00311_ DV _ M03c _50pc
Flood Level	Dev	100 yr ARI	ARR1987	J00311_WSL_M03c_100Yr
		1% AEP	ARR2019	J00311_ WSL _ M03c _1pc
		10 yr ARI	ARR1987	J00311_ WSL _ M03c _10Yr
		10% AEP	ARR2019	J00311_ WSL _ M03c _10pc
		2 yr ARI	ARR1987	J00311_ WSL _ M03c _2Yr
		50% AEP	ARR2019	J00311_ WSL _ M03c _50pc
Blockage Impact	Dev	100 yr ARI	ARR1987	J00311_Diff_H_M03c_B1-M03c_100Yr
		1% AEP	ARR2019	J00311_Diff_H_M03c_B1-M03c_1pc
Blockage Hazard (D*V)	Dev	100 yr ARI	ARR1987	J00311_M03c_B1_DV_100Yr
		1% AEP	ARR2019	J00311_M03c_B1_DV_1pc



Hydrology & Water Management Consulting

DesignFlow

Oxley Priority Development Area

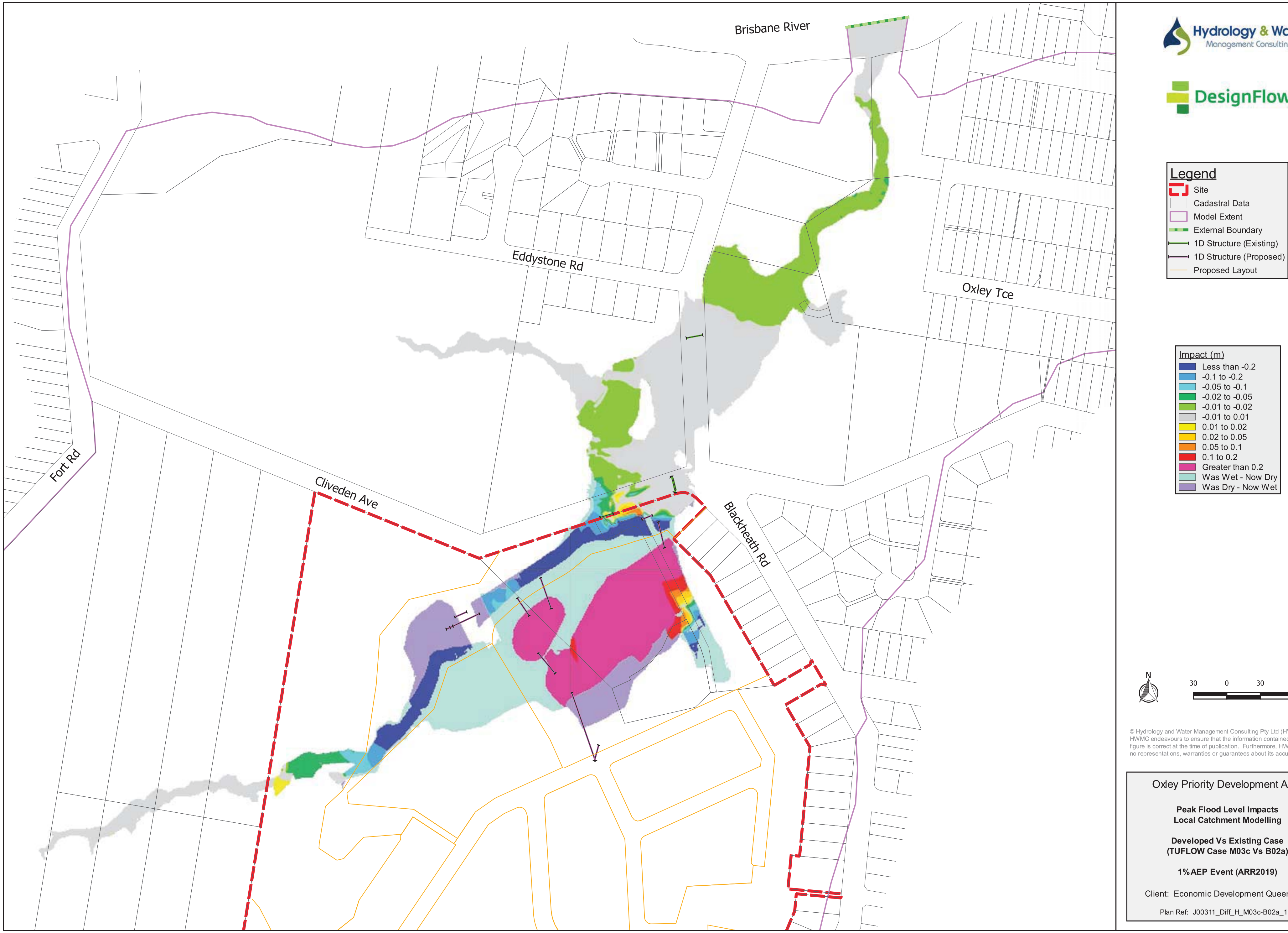
Peak Flood Level Impacts
Local Catchment Modelling

Developed Vs Existing Case
(TUFLOW Case M03c Vs B02a)

100Yr ARI Event (ARR1987)

Client: Economic Development Queensland

Plan Ref: J00311_Diff_H_M03c-B02a_100Yr



Oxley Priority Development Area

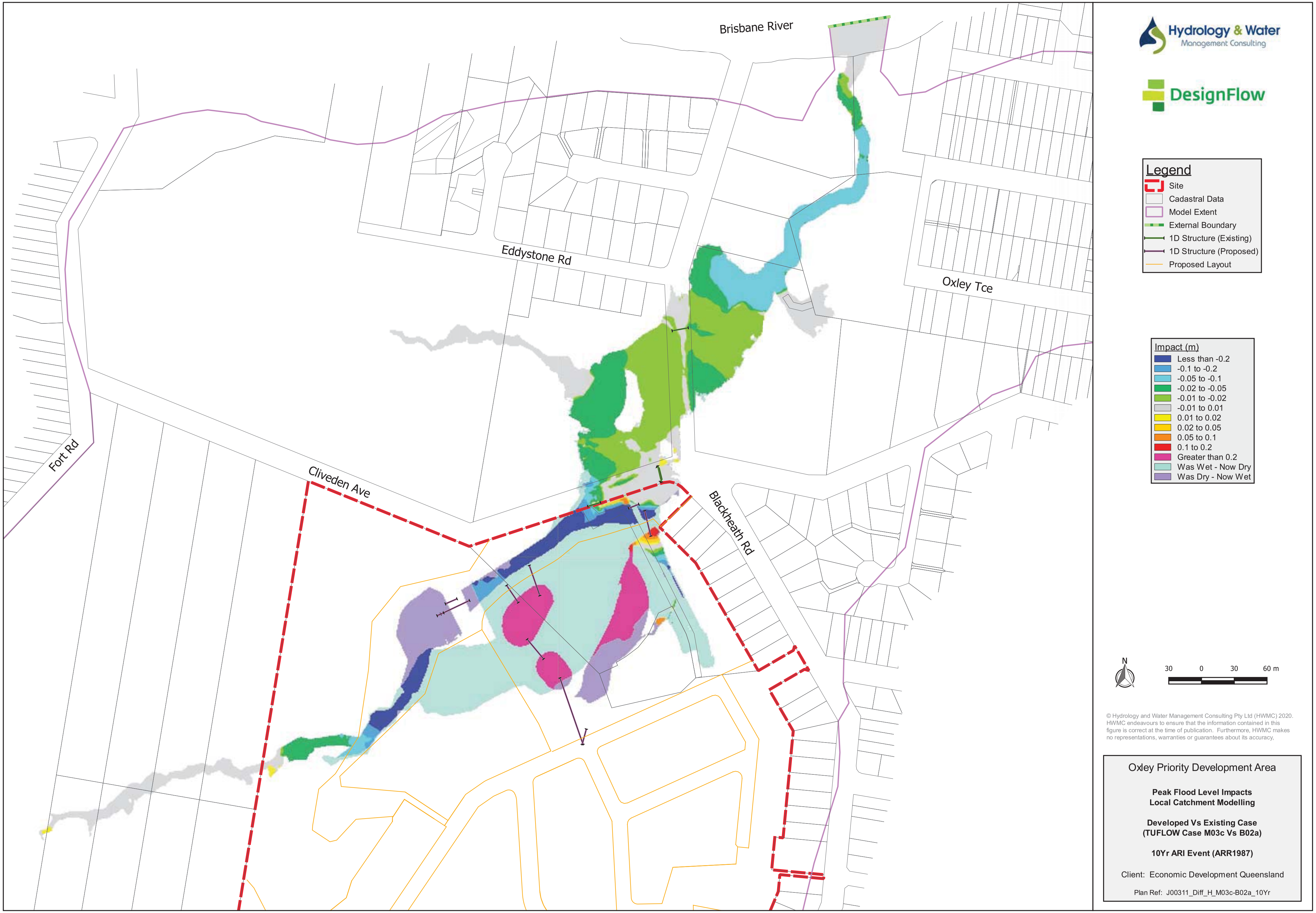
Peak Flood Level Impacts
Local Catchment Modelling

Developed Vs Existing Case
(TUFLOW Case M03c Vs B02a)

1%AEP Event (ARR2019)

Client: Economic Development Queensland

Plan Ref: J00311_Diff_H_M03c-B02a_1pc



Oxley Priority Development Area

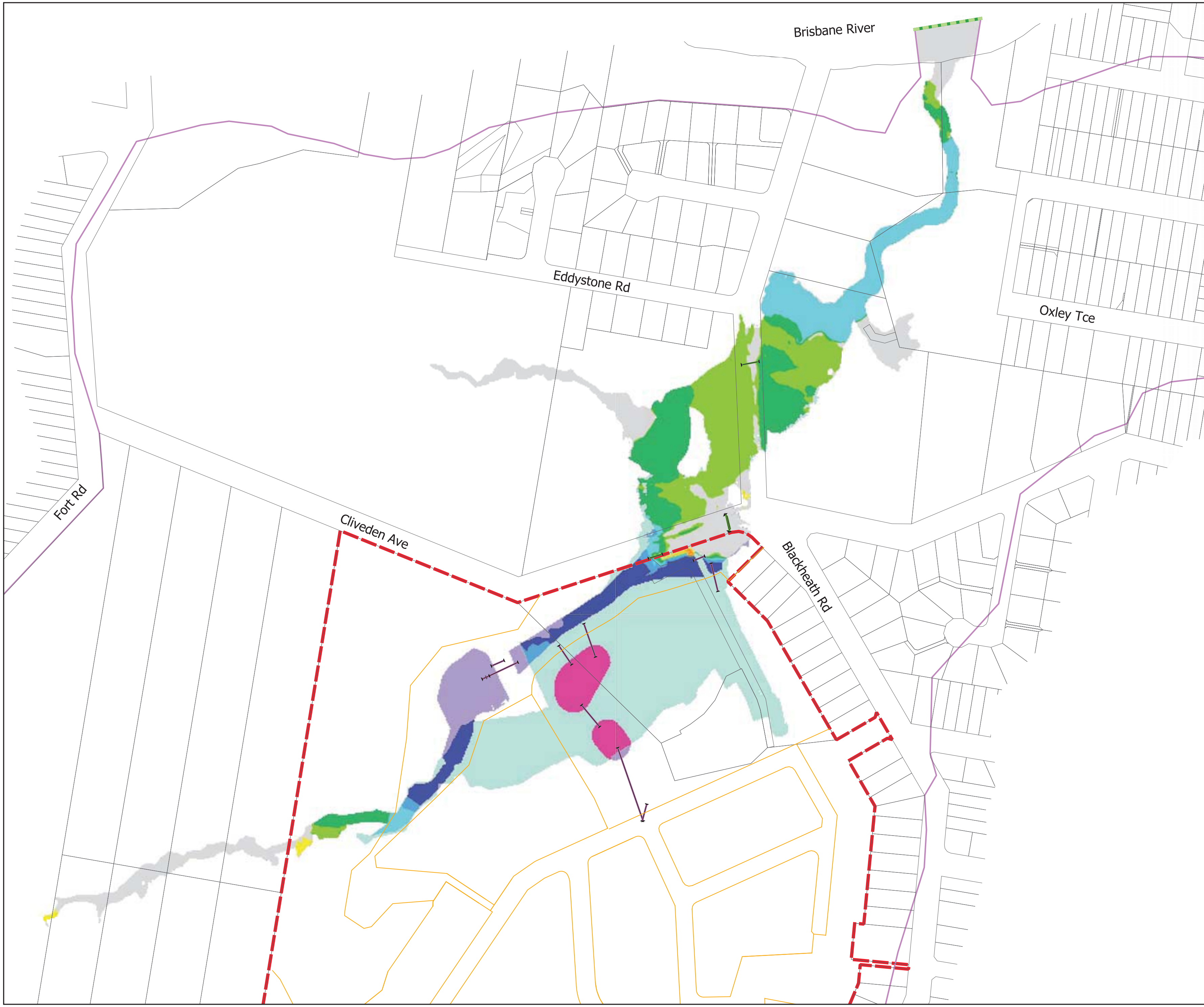
Peak Flood Level Impacts
Local Catchment Modelling

Developed Vs Existing Case
(TUFLOW Case M03c Vs B02a)

10Yr ARI Event (ARR1987)

Client: Economic Development Queensland

Plan Ref: J00311_Diff_H_M03c-B02a_10Yr



Hydrology & Water Management Consulting

DesignFlow

Oxley Priority Development Area

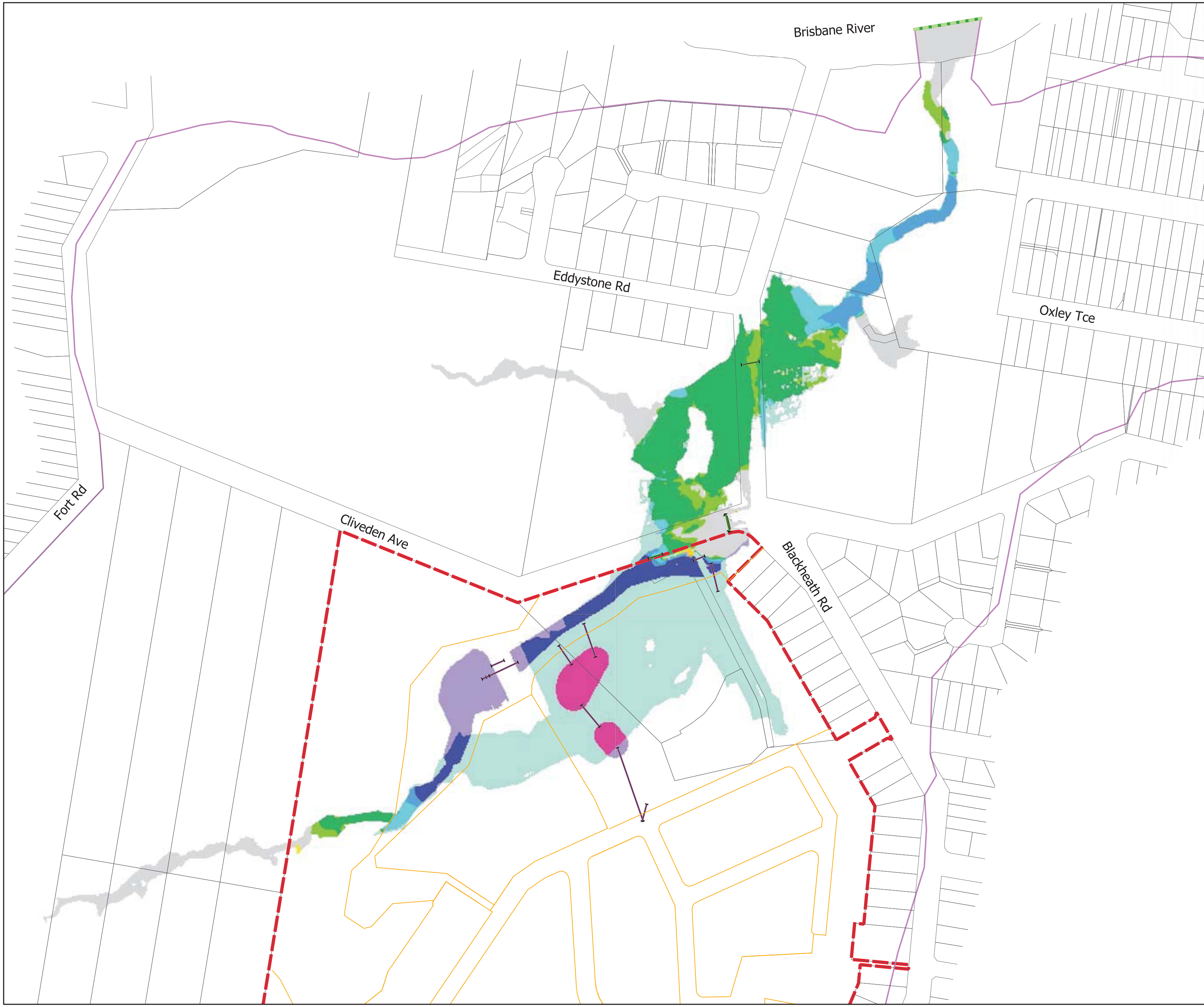
Peak Flood Level Impacts
Local Catchment Modelling

Developed Vs Existing Case
(TUFLOW Case M03c Vs B02a)

10%AEP Event (ARR2019)

Client: Economic Development Queensland

Plan Ref: J00311_Diff_H_M03c-B02a_10pc



Hydrology & Water Management Consulting

DesignFlow

Legend

- Site
- Cadastral Data
- Model Extent
- External Boundary
- 1D Structure (Existing)
- 1D Structure (Proposed)
- Proposed Layout

Impact (m)

- Less than -0.2
- -0.1 to -0.2
- -0.05 to -0.1
- -0.02 to -0.05
- -0.01 to -0.02
- -0.01 to 0.01
- 0.01 to 0.02
- 0.02 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- Greater than 0.2
- Was Wet - Now Dry
- Was Dry - Now Wet

N

30 0 30 60 m

Oxley Priority Development Area

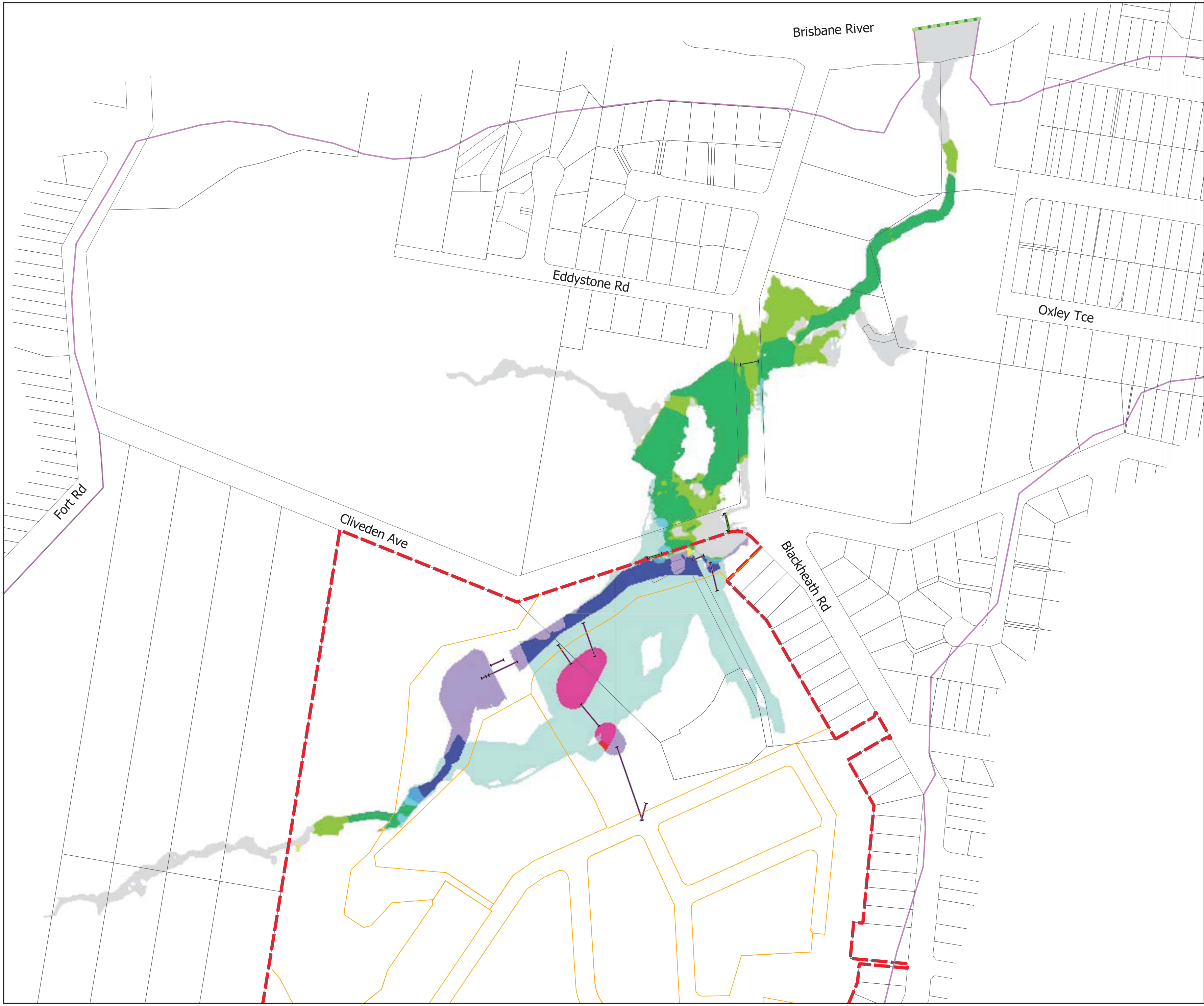
Peak Flood Level Impacts
Local Catchment Modelling

Developed Vs Existing Case
(TUFLOW Case M03c Vs B02a)

21Yr AI Event (r AAR987)

Client: Economic Development Queensland

Plan Ref: J00311_Diff_H_M03c-B02a_2Yr



Hydrology & Water Management Consulting

DesignFlow

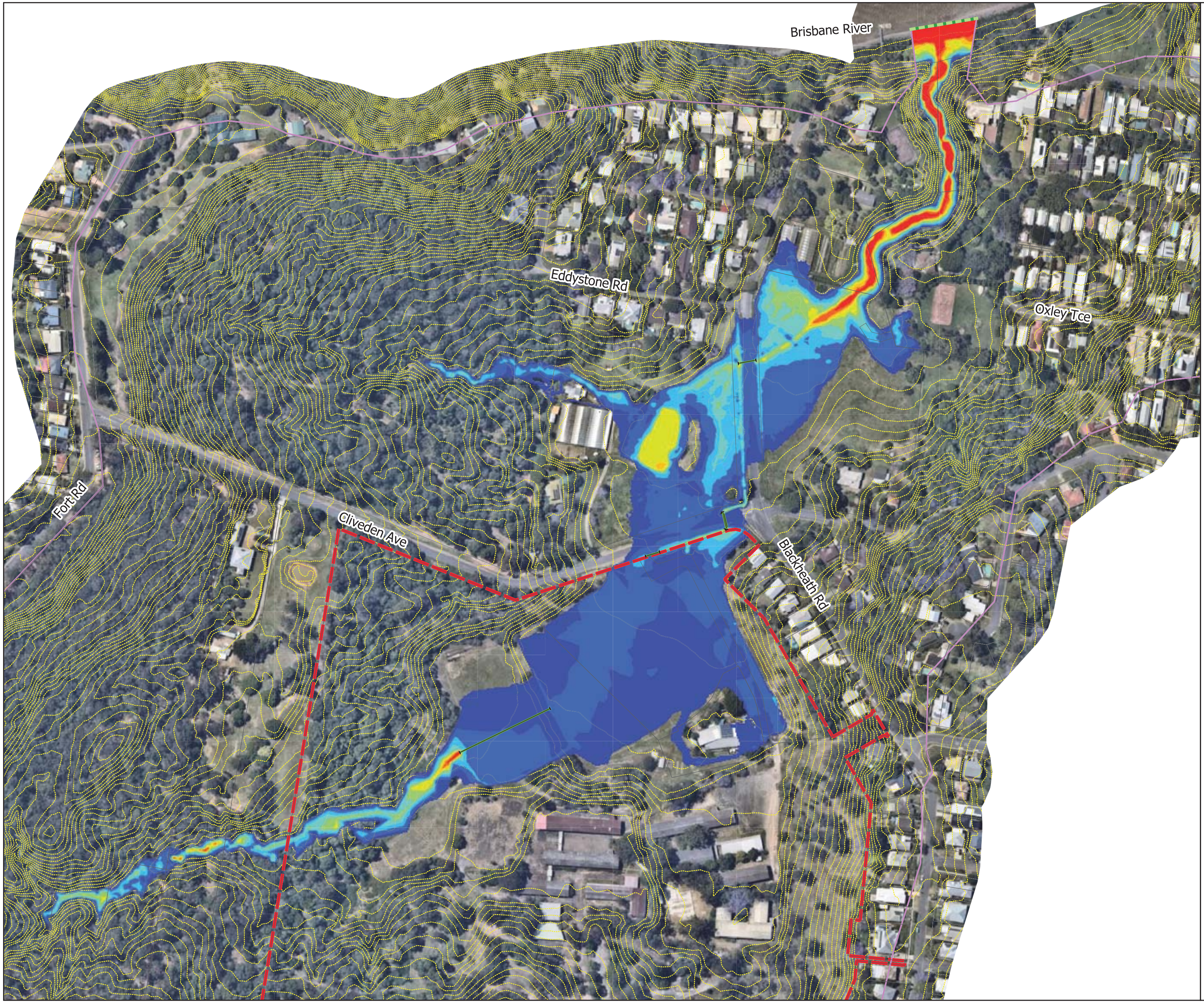
30 0 30 60 m

Peak Flood Level Impacts
Local Catchment Modelling

Developed Vs Existing Case
(TUFLOW Case M03c Vs B02a)

50% AEP Event (ARR2019)

Plan Ref: J00311_Diff_H_M03c-B02a_p0Oc



Oxley Priority Development Area

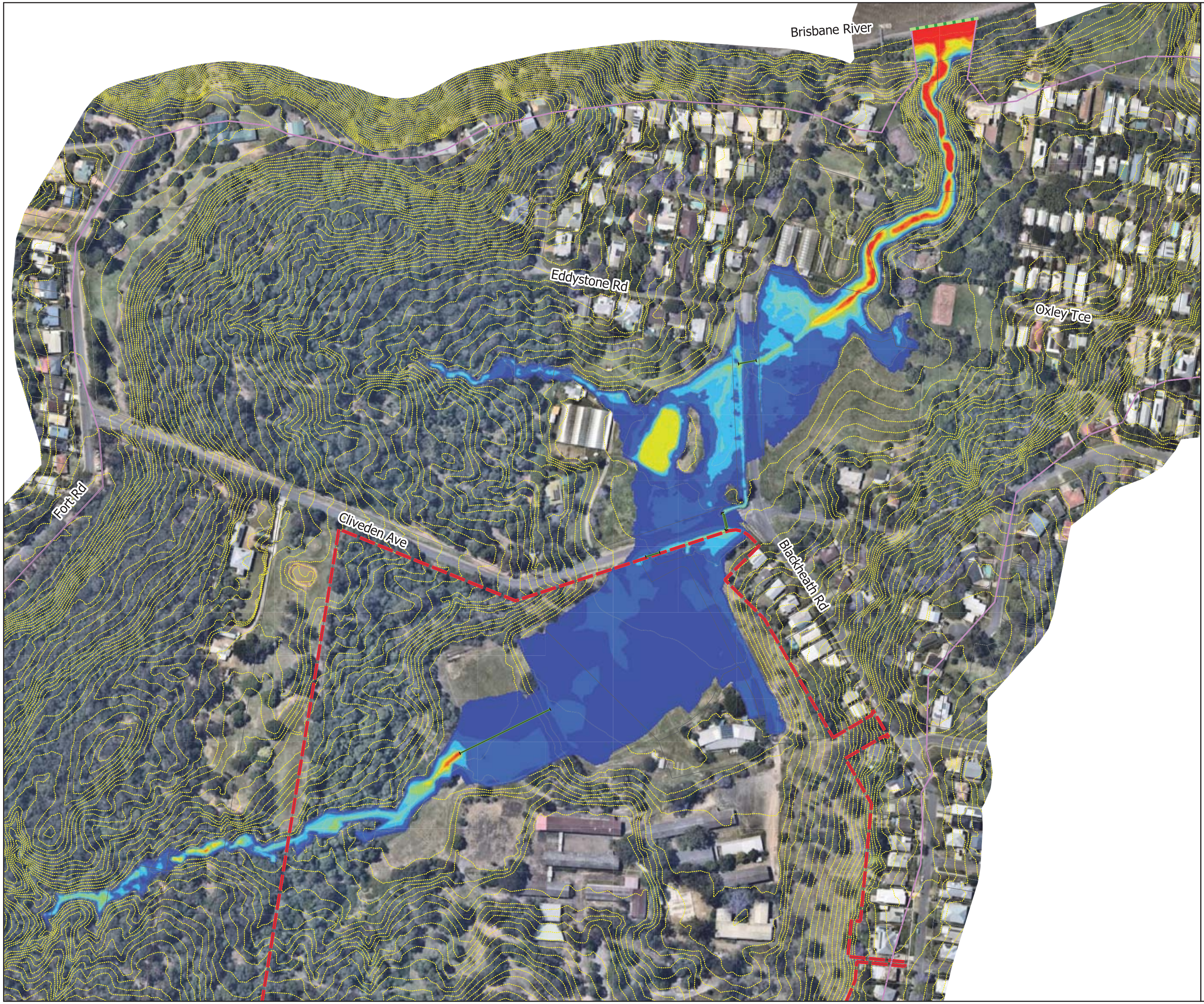
Peak Flood Depths
Local Catchment Modelling

Existing Case
(TUFLOW Case B02a)

100Yr ARI Event (ARR1987)

Client: Economic Development Queensland

Plan Ref: J00311_B02a_Dep_100Yr



Hydrology & Water Management Consulting

DesignFlow

Oxley Priority Development Area

Peak Flood Depths
Local Catchment Modelling

Existing Case
(TUFLOW Case B02a)

1% AEP Event (ARR2019)

Client: Economic Development Queensland

Plan Ref: J00311_B02a_Dep_1pc

LEGEND

- Site
- Cadastral Data
- Model Extent
- External Boundary
- 1D Structure (Existing)
- 1m Contours

Depth (m)

- <= 0.2
- 0.2 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- > 2

Oxley Priority Development Area

Peak Flood Depths
Local Catchment Modelling

Existing Case
(TUFLOW Case B02a)

10Yr ARI Event (ARR1987)

Client: Economic Development Queensland

Plan Ref: J00311_B02a_Dep_10Yr

Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site
- Cadastral Data
- Model Extent
- External Boundary
- 1D Structure (Existing)
- 1m Contours

Depth (m)

- <= 0.2
- 0.2 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- > 2

N

30 0 30 60 m

Oxley Priority Development Area

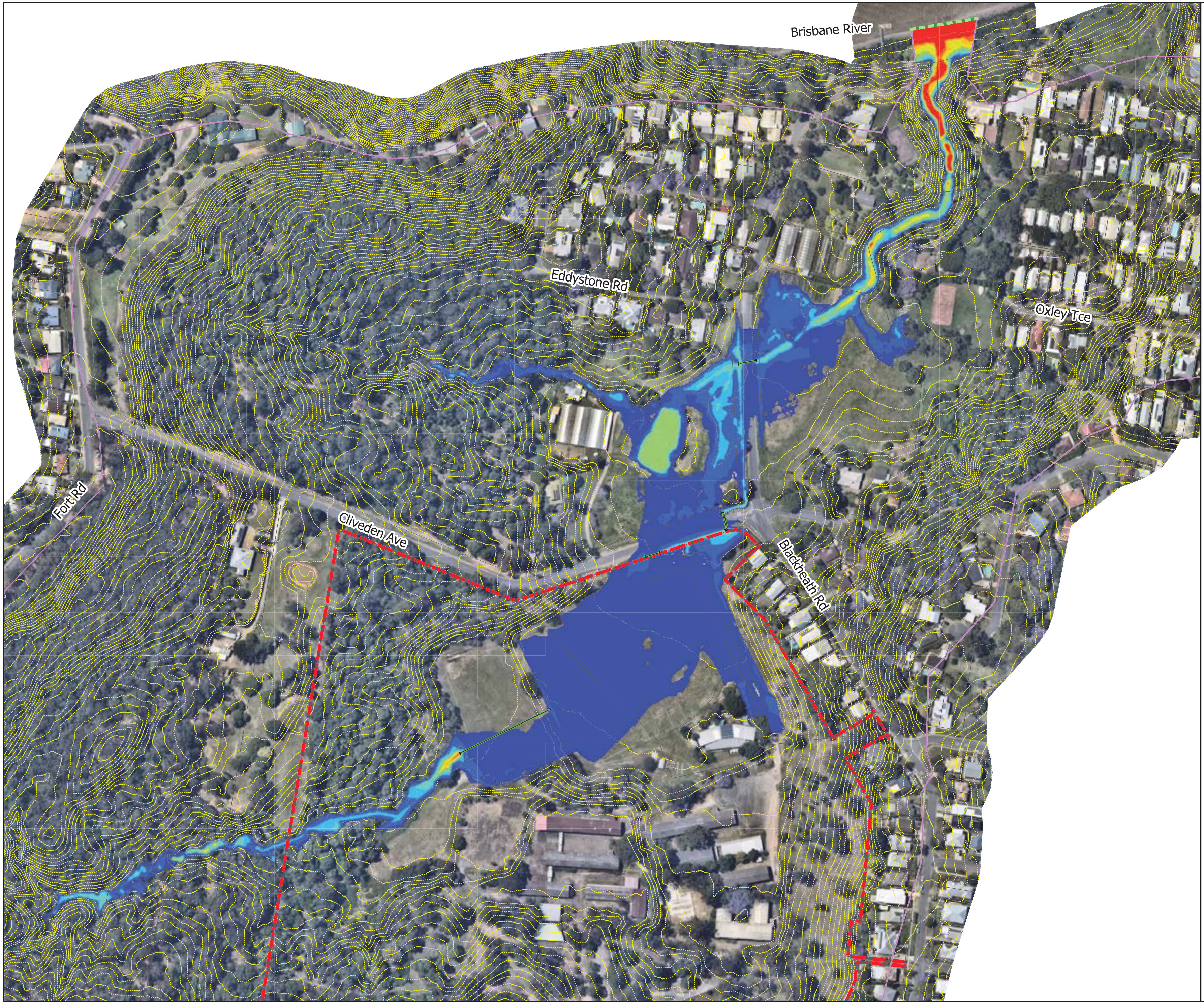
Peak Flood Depths
Local Catchment Modelling

Existing Case
(TUFLOW Case B02a)

10%AEP Event (ARR2019)

Client: Economic Development Queensland

Plan Ref: J00311_B02a_Dep_10pc



Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site
- Cadastral Data
- Model Extent
- External Boundary
- 1D Structure (Existing)
- 1m Contours

Depth (m)

- <= 0.2
- 0.2 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- > 2

N

30 0 30 60 m

Oxley Priority Development Area

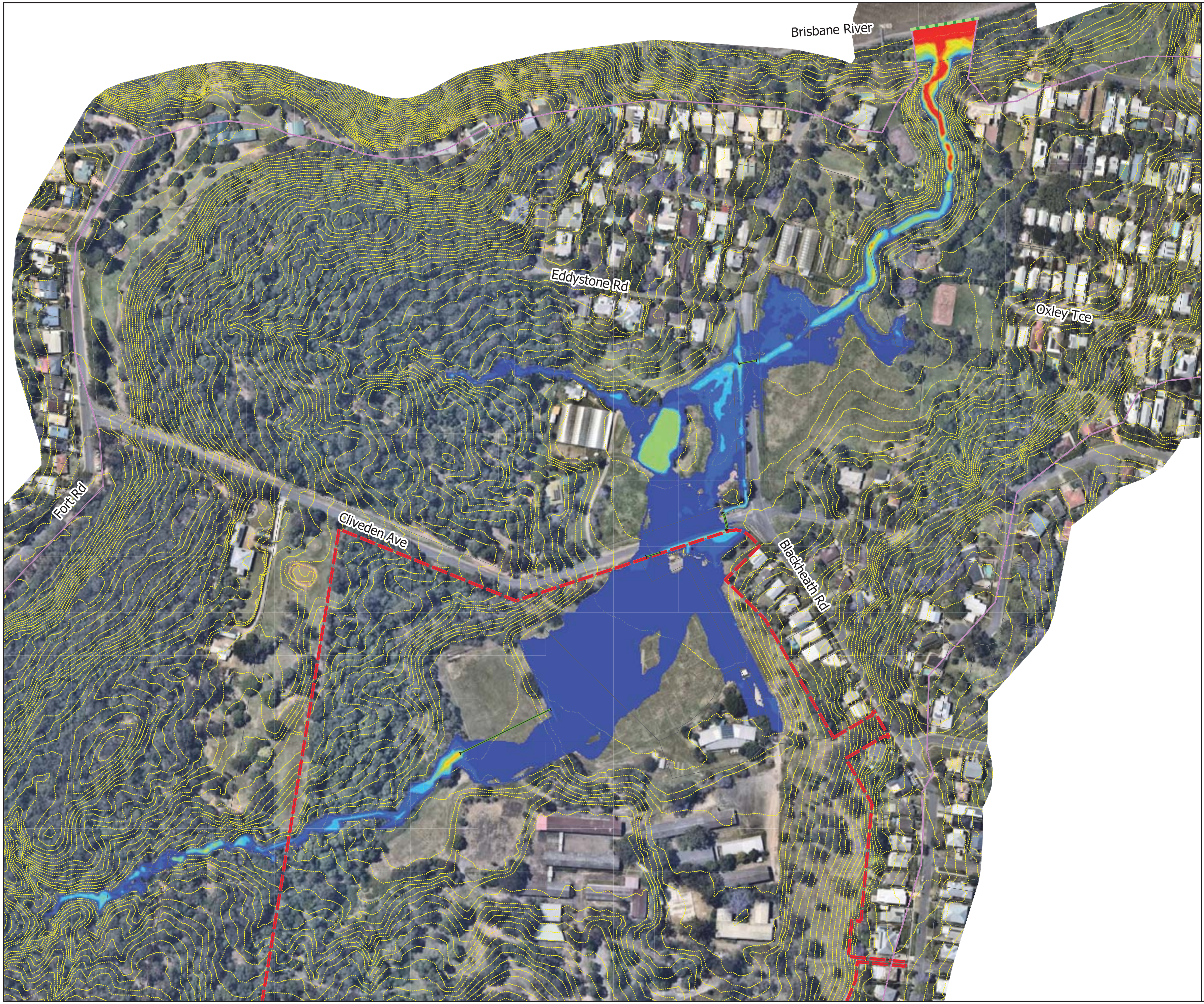
Peak Flood Depths
Local Catchment Modelling

Existing Case
(TUFLOW Case B02a)

21 Yr AREI ent (r AAv987)

Client: Economic Development Queensland

Plan Ref: J00311_B02a_Dep_2Yr



Hydrology & Water Management Consulting

DesignFlow

N

30 0 30 60 m

Peak Flood Depths
Local Catchment Modelling

Existing Case
(TUFLOW Case B02a)

50% AEP Event (ARR2019)

Plan Ref: J00311_B02a_Dep_c0pO

Hydrology & Water Management Consulting

DesignFlow

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1D wtrs2tsre LPropoQed(
PropoQed uayost

Depth Lm(
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0.5 - 0.75
0.75 - 1
1 - 1.)5
1.)5 - 1.5
1.5 - 1.75
1.75 -)
>)

N

30 0 30 60 m

Oxley Priority Development Area

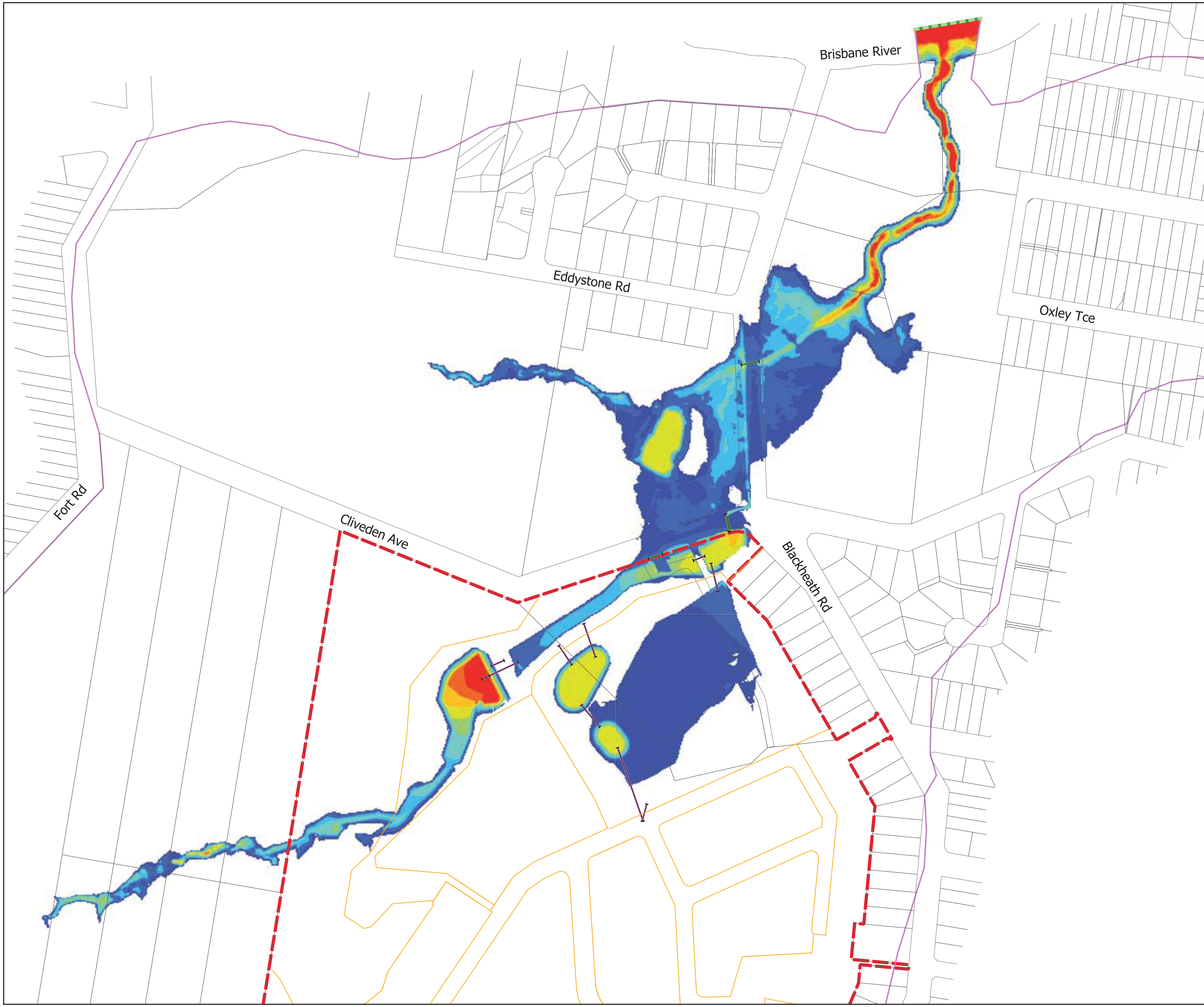
Peak Flood Depths
Local Catchment Modelling

Developed Case
(TUFLOW Case M03c)

100Yr ARI Event (ARR1987)

Mient: S2onomi2 Development QseenQand

Plan Ref: J00311_B032_Dep_100Yr



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DesignFlow

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30 0 30 60 m

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c Qex Pyi yox Det eli pv enomyea

Peak Flood Depths
Local Catchment Modelling

Developed Case
(TUFLOW Case M03c)

1% AEP Event (ARR2019)

Wreno S2i ni v r2 Det eli pv enoQQeenMenH

Plan Ref: J00311_B032_Dep_1p2

Hydrology & Water Management Consulting

DesignFlow

uSGSND
Site
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Sxternal Eosndary
1D wtrs2tsre LSxiQing(
1D wtrs2tsre LPropoQed(
PropoQed uayost

Depth Lm(
<= 0.)
0.) - 0.5
0.5 - 0.75
0.75 - 1
1 - 1.)5
1.)5 - 1.5
1.5 - 1.75
1.75 -)
>)

N

30 0 30 60 m

Oxley Priority Development Area

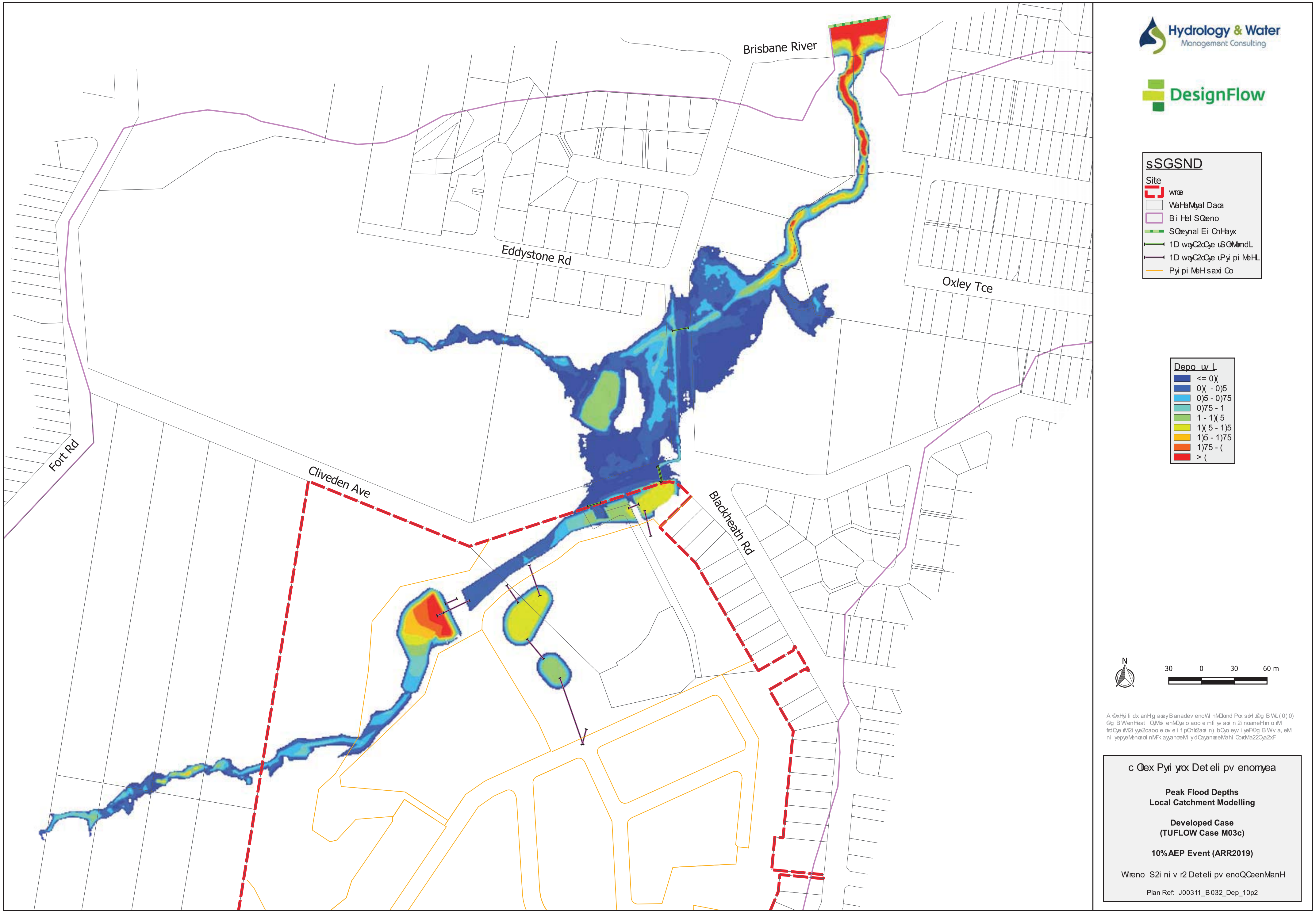
Peak Flood Depths
Local Catchment Modelling

Developed Case
(TUFLOW Case M03c)

10Yr ARI Event (ARR1987)

Mlient: S2onomi2 Development QseenQland

Plan Ref: J00311_B032_Dep_10Yr



Peak Flood Depths
Local Catchment Modelling

Developed Case
(TUFLOW Case M03c)

10% AEP Event (ARR2019)

Plan Ref: J00311_B032_Dep_10p2

Hydrology & Water Management Consulting

DesignFlow

LSGSND

Site

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⊢	1D wᏫ2uᏫ (PᏫpt seg)
—	PᏫpt seg Lait uv

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■	0.Y - 0.5
■	0.5 - 0.75
■	0.75 - 1
■	1 - 1.Y5
■	1.Y5 - 1.5
■	1.5 - 1.75
■	1.75 - Y
■	> Y

N

30 0 30 60 m

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Peak Flood Depths
Local Catchment Modelling

Developed Case
(TUFLOW Case M03c)

2Yr ARI Event (ARR1987)

Cloenv. S2t nt AᏫ Denelt pA envQueenslang

Plan Ref: J00311_B032_Dep_Yr O

Hydrology & Water Management Consulting

DesignFlow

uENE<D

Site

- Site
- MadaQral Data
- Bodel Extent
- External Gosndary
- 1D Strs2tsre LExiQing(
- 1D Strs2tsre LPropoQed(
- PropoQed uayost

Depth Lm(

- =- 0.)
- 0.) 50.c
- 0.c 50.7c
- 0.7c 51
- 1 51.) c
- 1.) c 51.c
- 1.c 51.7c
- 1.7c 5)
- >)

N

30 0 30 60 m

Oxley Priority Development Area

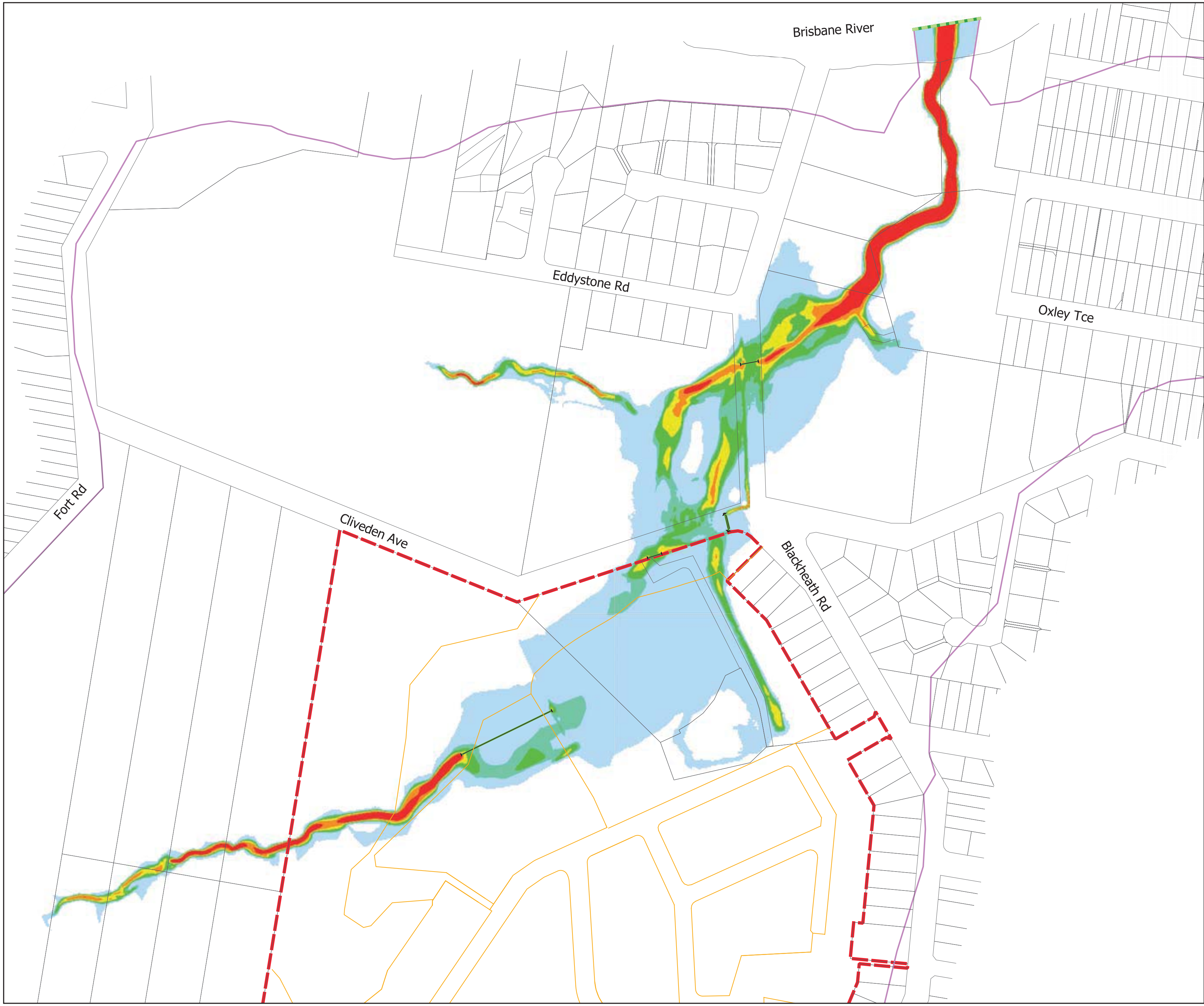
Peak Flood Depths
Local Catchment Modelling

Developed Case
(TUFLOW Case M03c)

50%AEP Event (ARR2019)

Mient: E2onomi2 Development QseenQand

Plan Ref: J00311_B032_Dep_c0p2



Hydrology & Water Management Consulting

DesignFlow

Oxley Priority Development Area

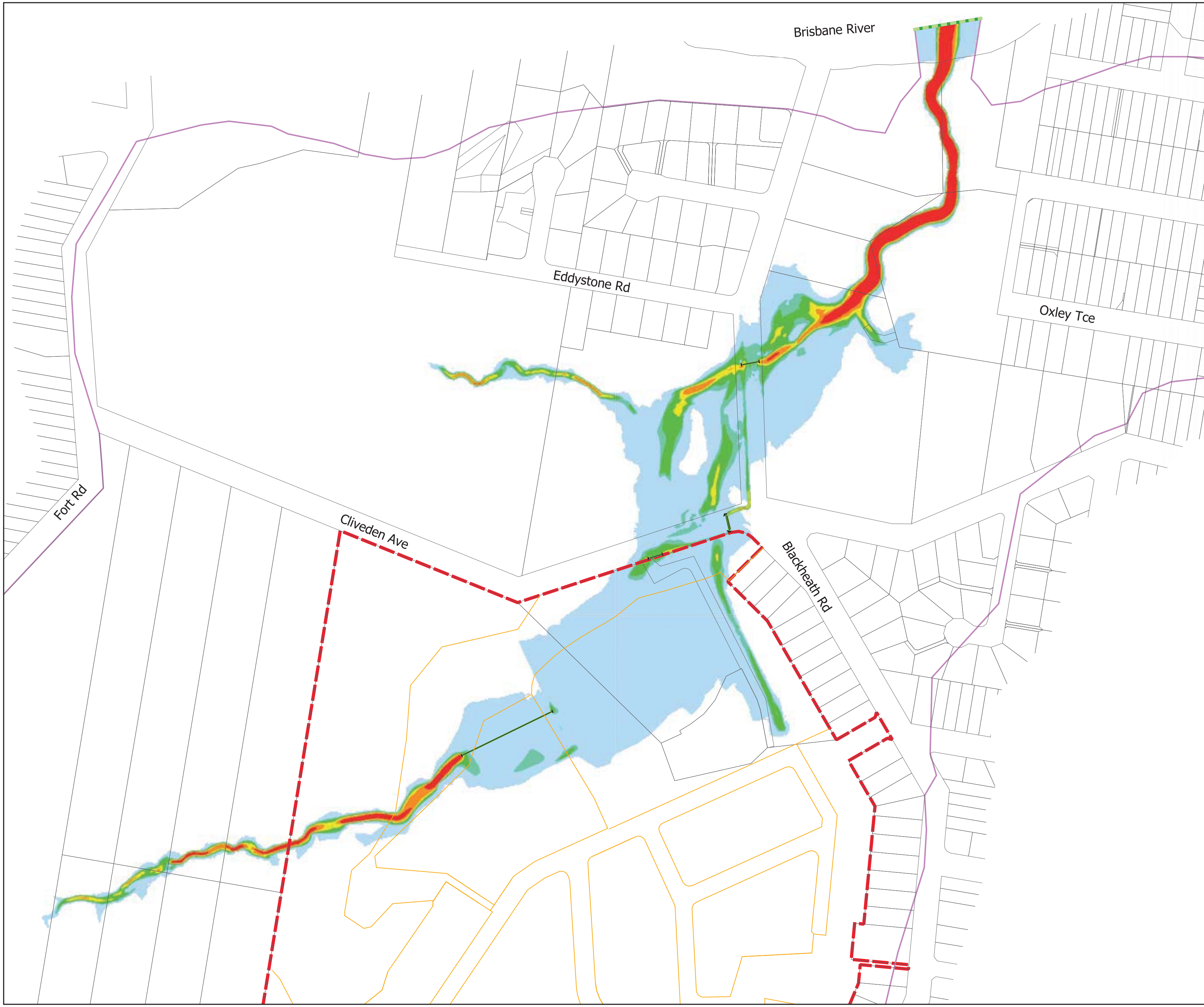
Peak Depth-Velocity Product
Local Catchment Modelling

Existing Case
(TUFLOW Case B02a)

100Yr ARI Event

Client: Economic Development Queensland

Plan Ref: J00311_B02a_DV_100Yr



Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site Boundary
- Cadastral Data
- Model Extent
- External Boundary
- 1D Structure (Existing)

Depth-Velocity Product (m2/s)

- <= 0.3
- 0.3 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.2
- > 1.2

N

30 0 30 60 m

Oxley Priority Development Area

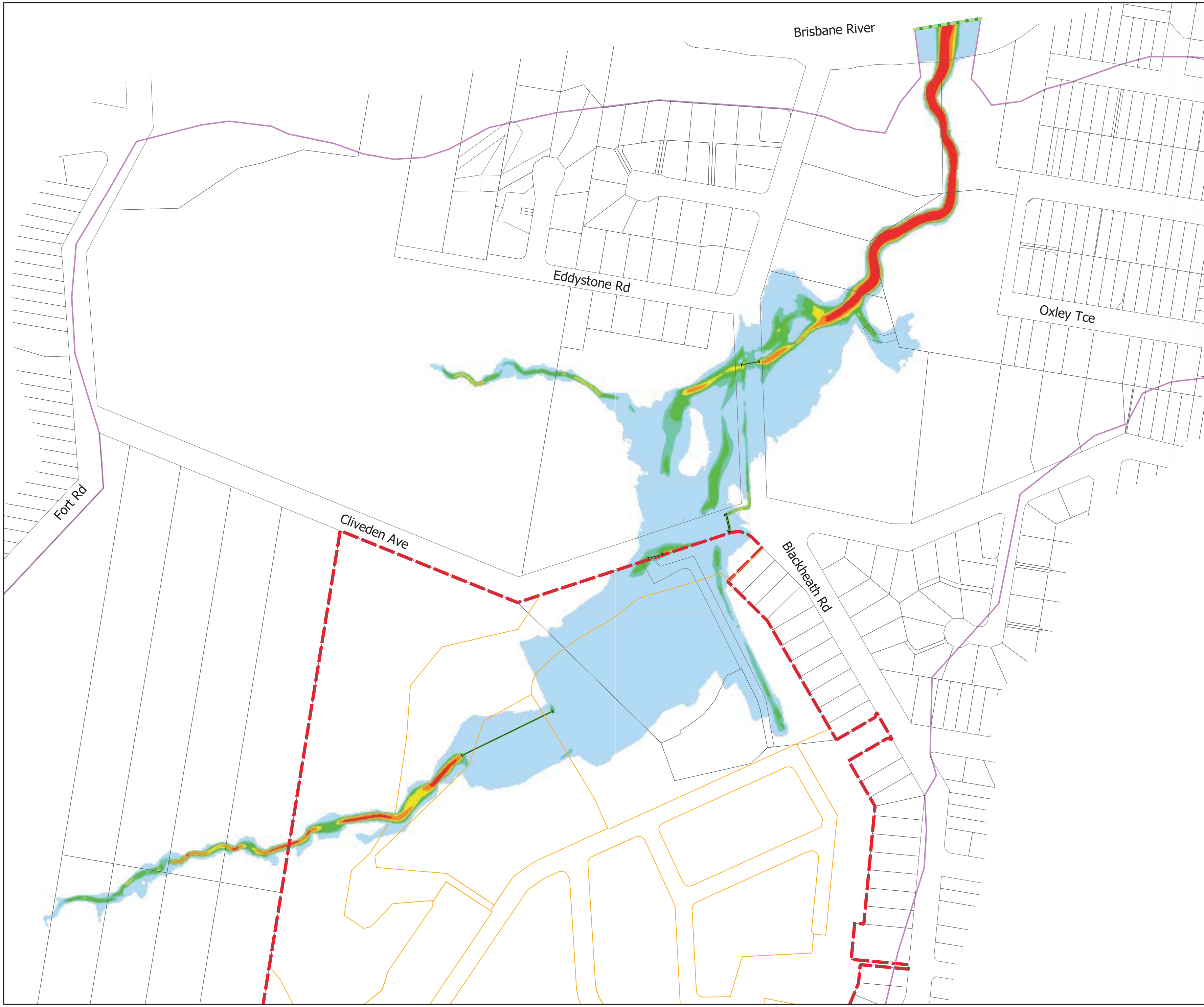
Peak Depth-Velocity Product
Local Catchment Modelling

Existing Case
(TUFLOW Case B02a)

1%AEP Event

Client: Economic Development Queensland

Plan Ref: J00311_B02a_DV_1pc



LEGEND
- Site Boundary
- Cadastral Data
- Model Extent
- External Boundary
- 1D Structure (Existing)

Depth-Velocity Product (m2/s)
- <= 0.3
- 0.3 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.2
- > 1.2

Oxley Priority Development Area

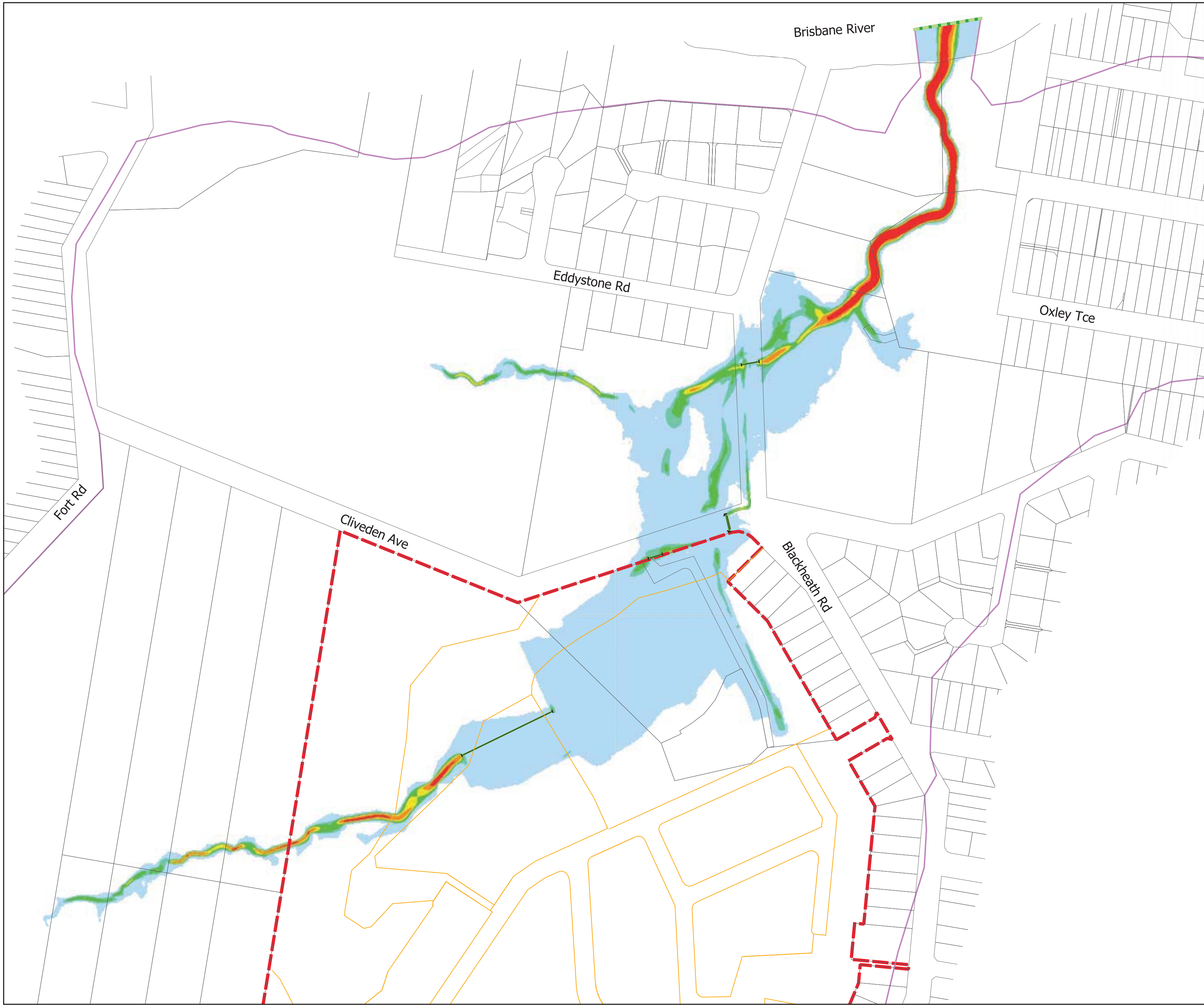
Peak Depth-Velocity Product
Local Catchment Modelling

Existing Case
(TUFLOW Case B02a)

10Yr ARI Event

Client: Economic Development Queensland

Plan Ref: J00311_B02a_DV_10Yr



Hydrology & Water Management Consulting

DesignFlow

Oxley Priority Development Area

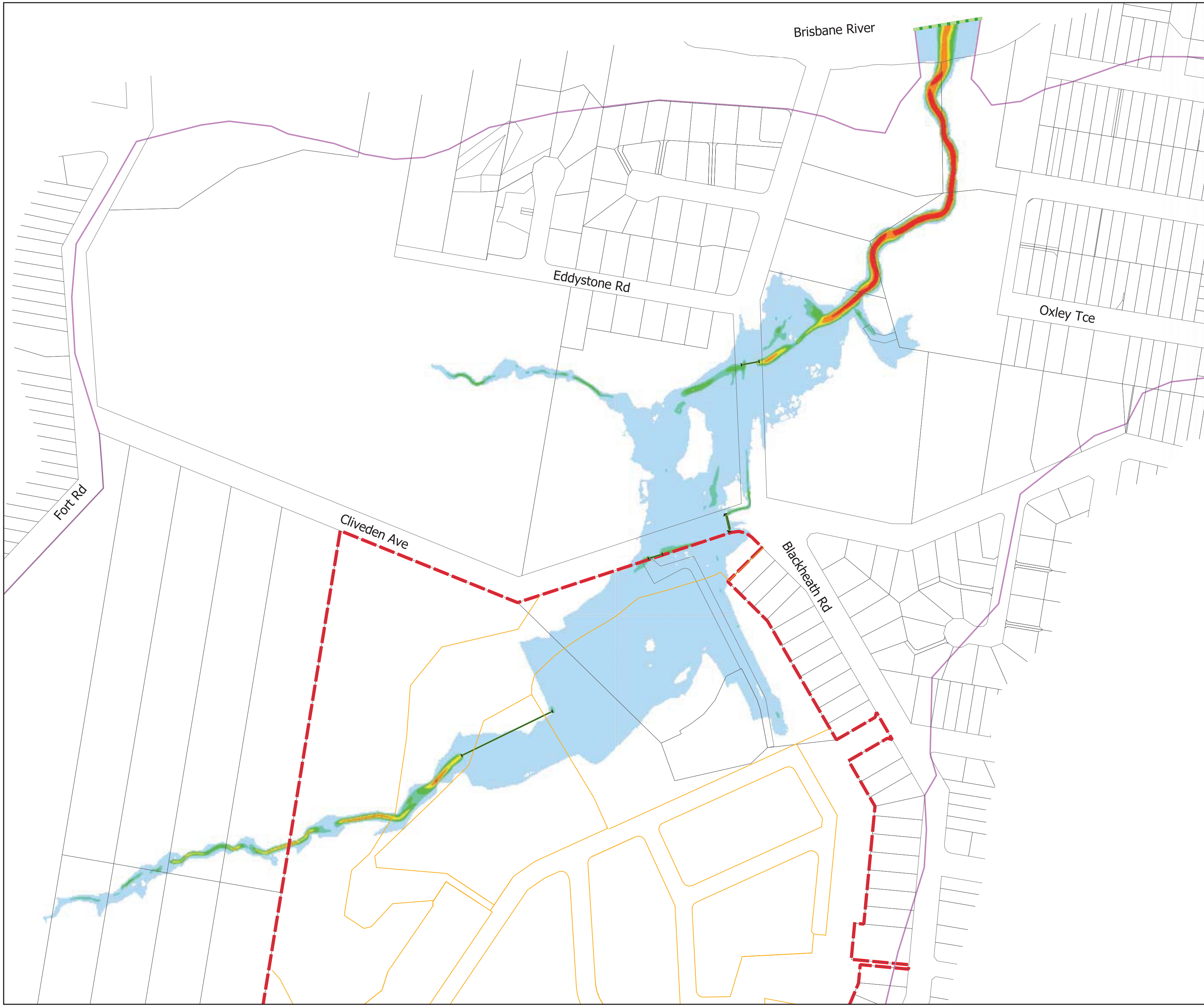
Peak Depth-Velocity Product
Local Catchment Modelling

Existing Case
(TUFLOW Case B02a)

10%AEP Event

Client: Economic Development Queensland

Plan Ref: J00311_B02a_DV_10pc



LEGEND
- Site Boundary
- Cadastral Data
- Model Extent
- External Boundary
- 1D Structure (Existing)

Depth-Velocity Product (m2/s)
- <= 0.3
- 0.3 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.2
- > 1.2

Oxley Priority Development Area

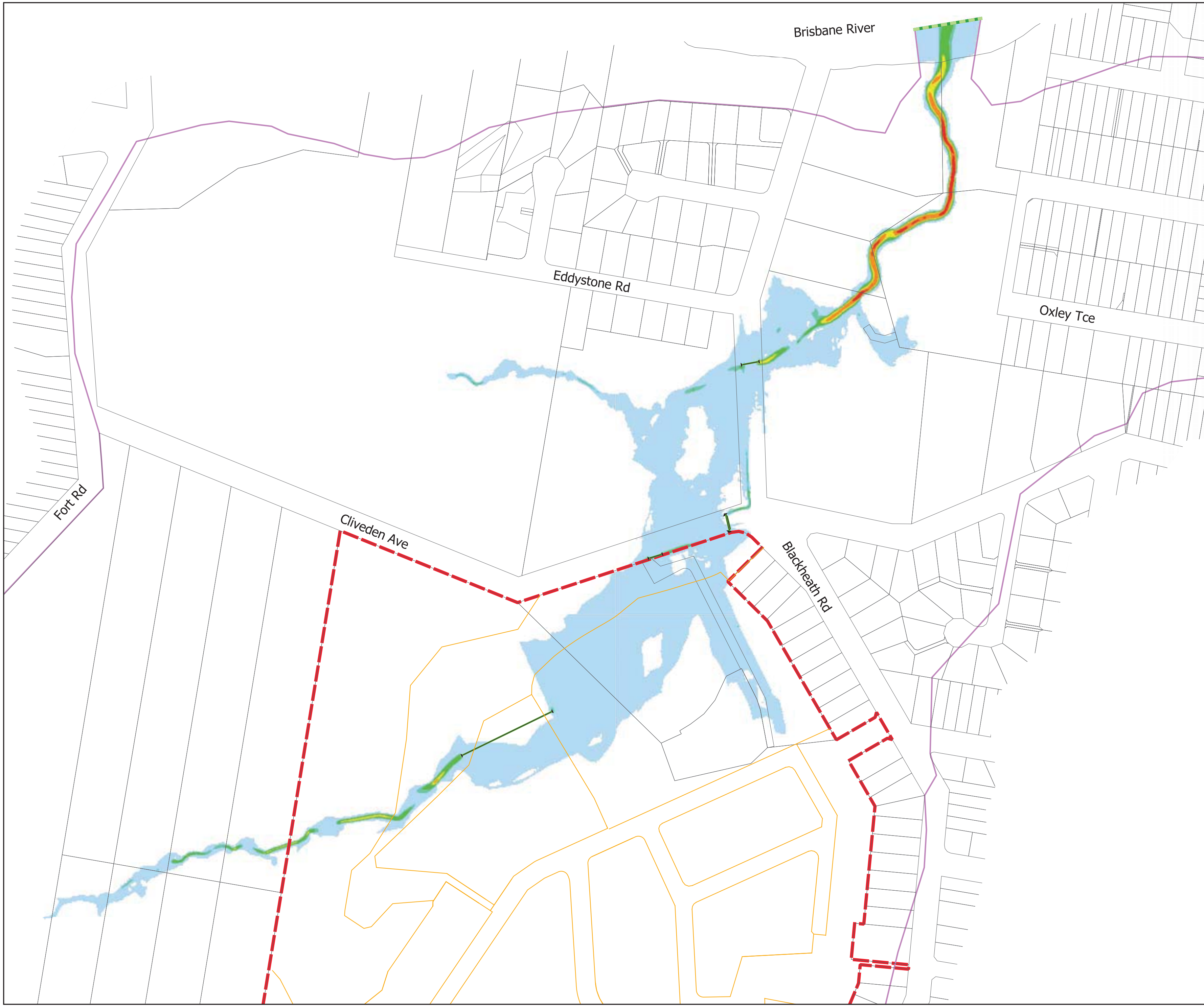
Peak Depth-Velocity Product
Local Catchment Modelling

Existing Case
(TUFLOW Case B02a)

2Yr ARI Event

Client: Economic Development Queensland

Plan Ref: J00311_B02a_DV_2Yr



Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site Boundary
- Cadastral Data
- Model Extent
- External Boundary
- 1D Structure (Existing)

Depth-Velocity Product (m2/s)
<= 0.3
0.3 - 0.4
0.4 - 0.6
0.6 - 0.8
0.8 - 1.2
> 1.2

Oxley Priority Development Area

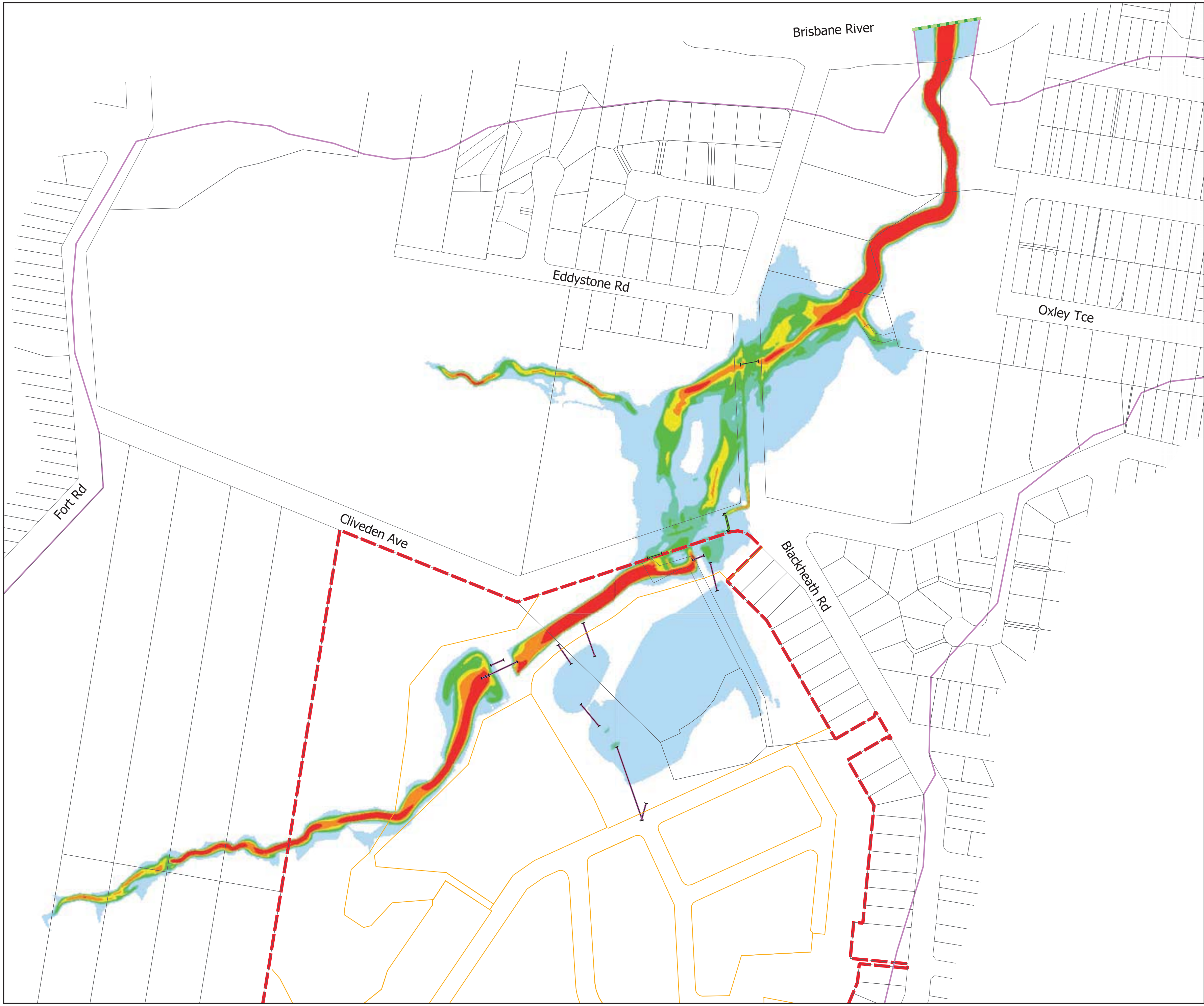
Peak Depth-Velocity Product
Local Catchment Modelling

Existing Case
(TUFLOW Case B02a)

50%AEP Event

Client: Economic Development Queensland

Plan Ref: J00311_B02a_DV_50pc



Hydrology & Water Management Consulting

DesignFlow

uEGEND
- wite Sosndary
- MadaQral Data
- Bodel Extent
- External Sosndary
- 1D wtrs2tsre LExiQing(
- 1D wtrs2tsre LPropoQed(
- PropoQed uayost

Depth-Velo2ity Prods2t Lm) /Q(
- <= 0.3
- 0.3 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.)
- > 1.)

N

30 0 30 60 m

Oxley Priority Development Area

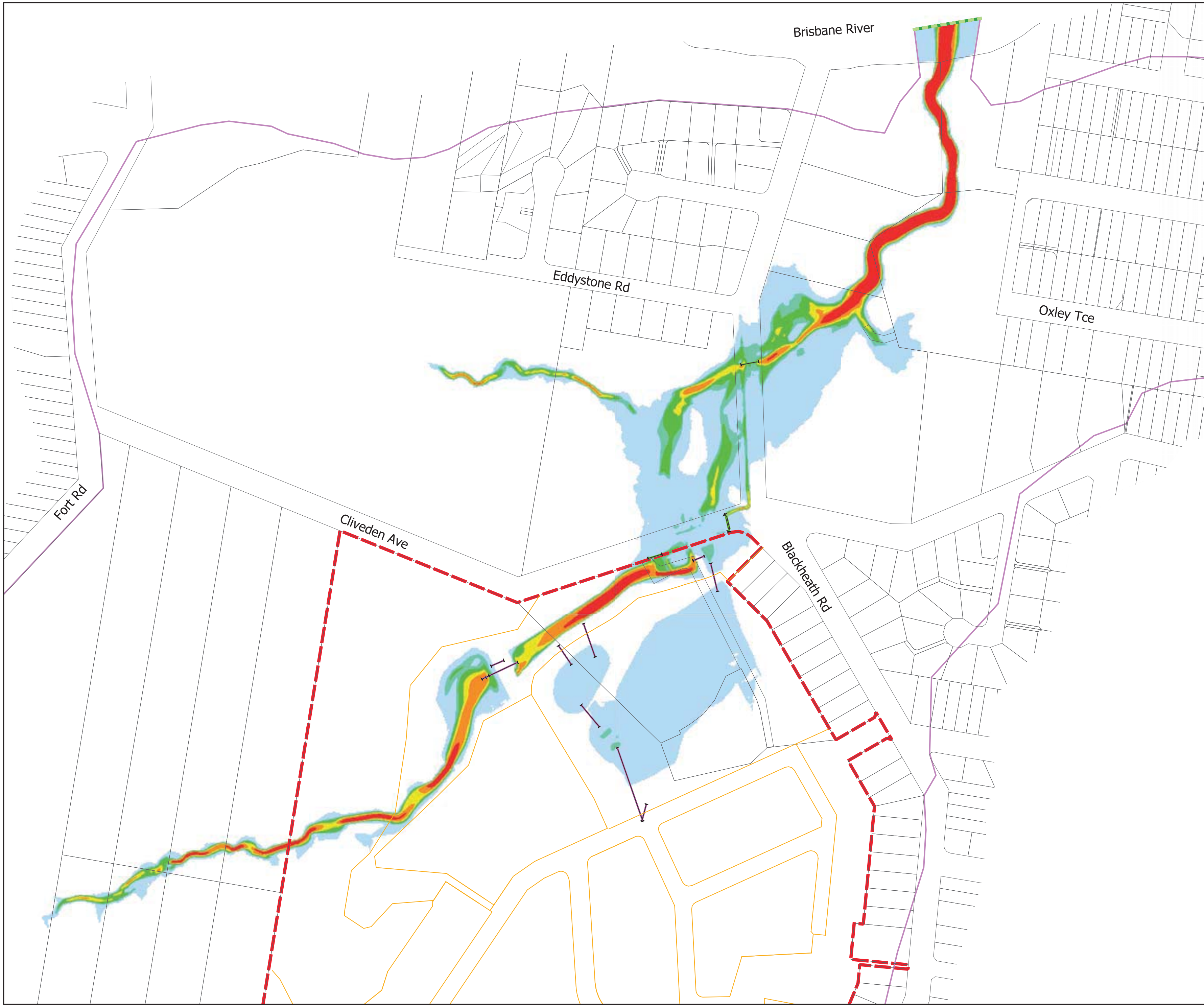
Peak Depth-Velocity Product
Local Catchment Modelling

Developed Case
(TUFLOW Case M03c)

100Yr ARI Event

Mient: E2onomi2 Development QseenQand

Plan Ref: J00311_B032_DV_100Yr



Hydrology & Water Management Consulting

DesignFlow

sEGEND
wme Si OnHayx
WaHaMyal Daca
Bi Hel EOeno
EOeynal Si OnHayx
1D wqC2oOye uEGMmdL
1D wqC2oOye uPyi pi MeHL
Pyi pi MeHsaxi Co

Depo -Veli 2mx Pyi HC2ouv (/ML
<= 0)3
0)3 - 0)4
0)4 - 0)6
0)6 - 0)8
0)8 - 1)(
> 1)(

N

30 0 30 60 m

c Oex Pyi yox Det eli pv enomyea

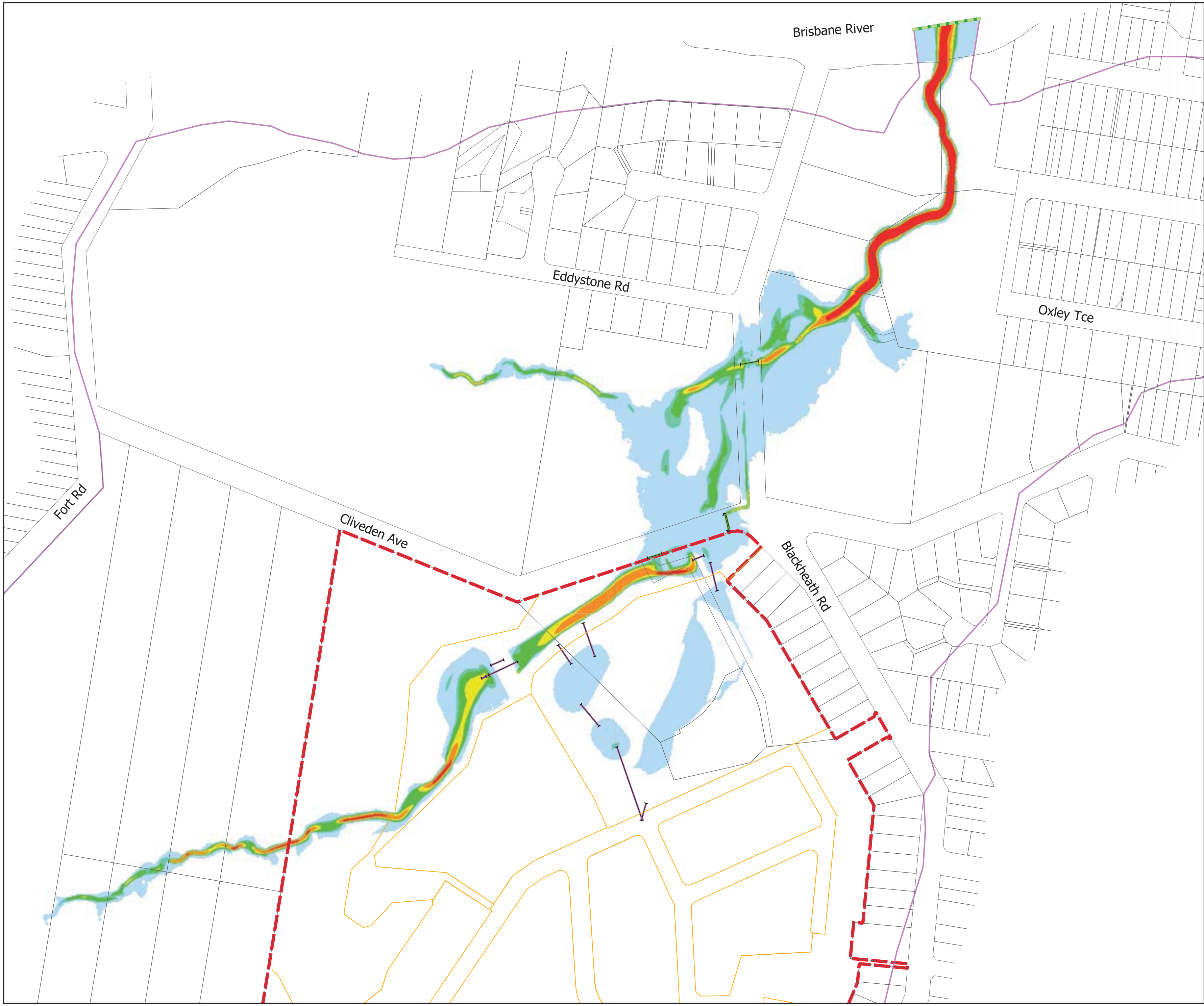
Peak Depth-Velocity Product
Local Catchment Modelling

Developed Case
(TUFLOW Case M03c)

1%AEP Event

Wreno E2i ni v r2 Det eli pv enoQOeenManH

Plan Ref: J00311_B032_DV_1p2



Hydrology & Water Management Consulting

DesignFlow

uEGEND

- wite Sosndary
- MadaCral Data
- Bodel Extent
- External Sosndary
- 1D wtrs2tsre LExiCing(
- 1D wtrs2tsre LPropoCed(
- PropoCed uayost

Depth-Velo2ity Prods2t Lm) /C(

- <= 0.3
- 0.3 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.)
- > 1.)

N

30 0 30 60 m

Oxley Priority Development Area

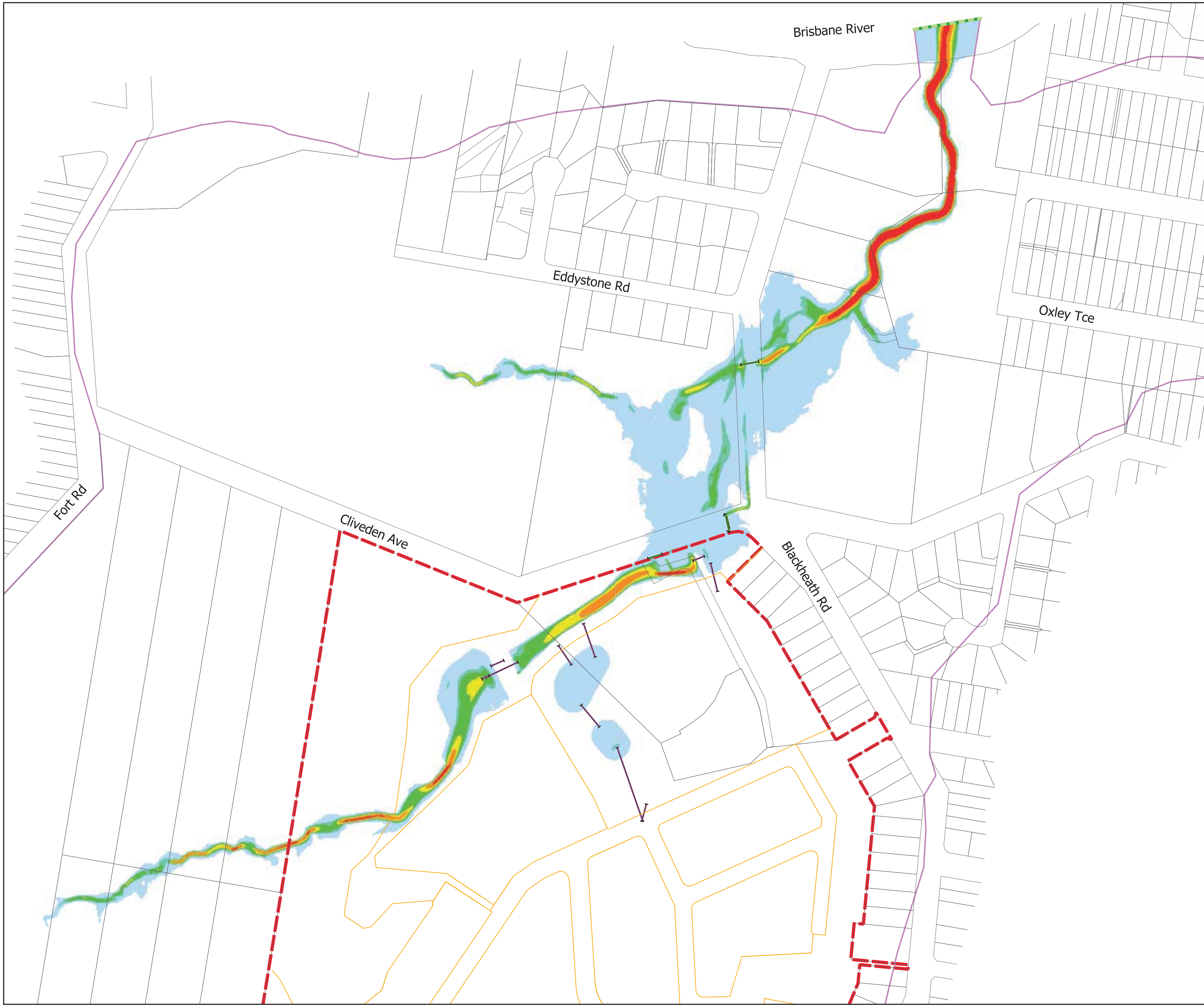
Peak Depth-Velocity Product
Local Catchment Modelling

Developed Case
(TUFLOW Case M03c)

10Yr ARI Event

Mient: E2onomi2 Development QseenCland

Plan Ref: J00311_B032_DV_10Yr



Hydrology & Water Management Consulting

DesignFlow

sEGEND

1D
1D

<= 0)3
0)3 - 0)4
0)4 - 0)6
0)6 - 0)8
0)8 - 1)(
> 1)(

N

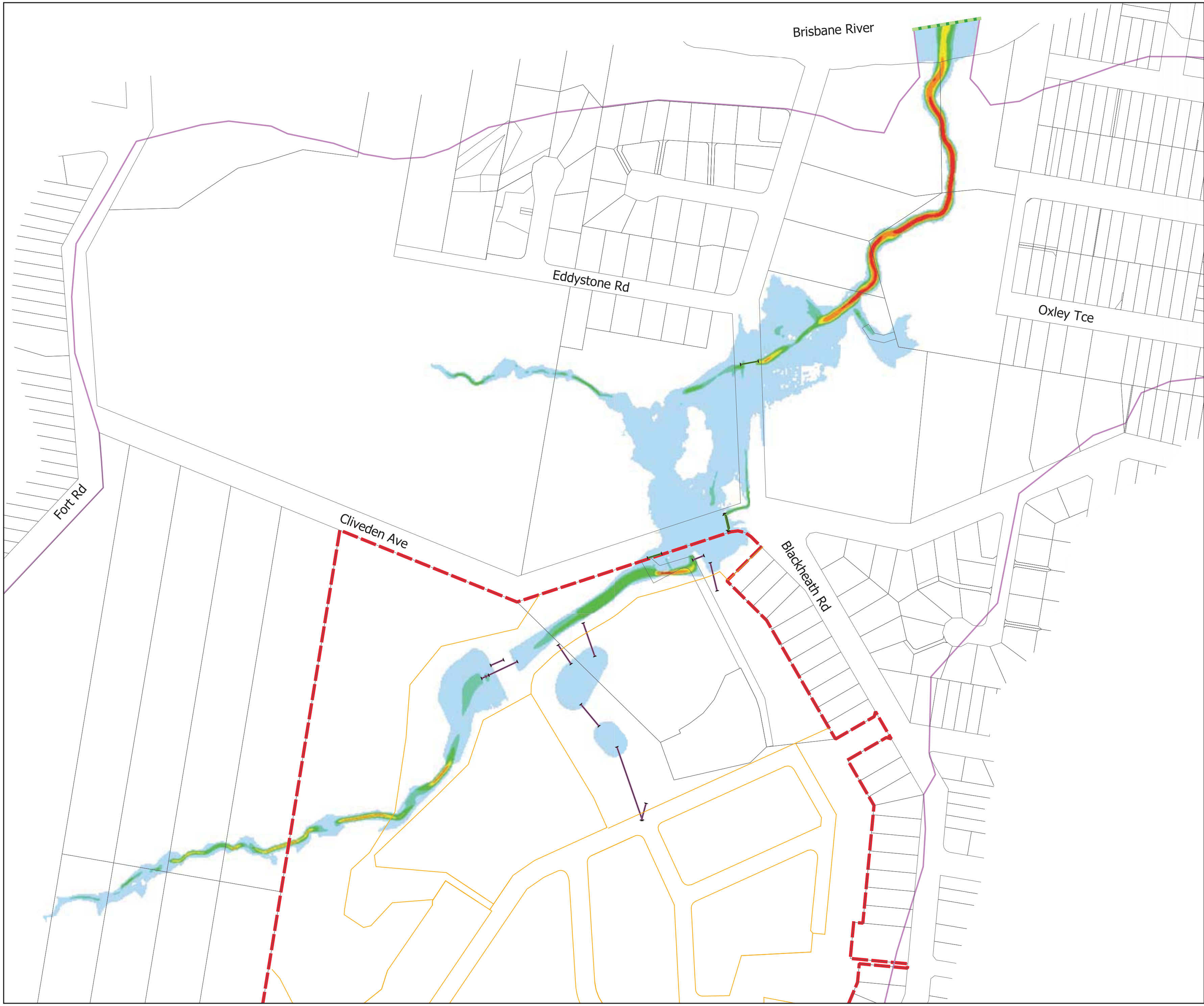
30 0 30 60 m

Peak Depth-Velocity Product
Local Catchment Modelling

Developed Case
(TUFLOW Case M03c)

10% AEP Event

Plan Ref: J00311_B032_DV_10p2



Hydrology & Water Management Consulting

DesignFlow

LEGEND

Depth-Velocity Product
<= 0.3
0.3 - 0.4
0.4 - 0.6
0.6 - 0.8
0.8 - 1.Y
> 1.Y

N

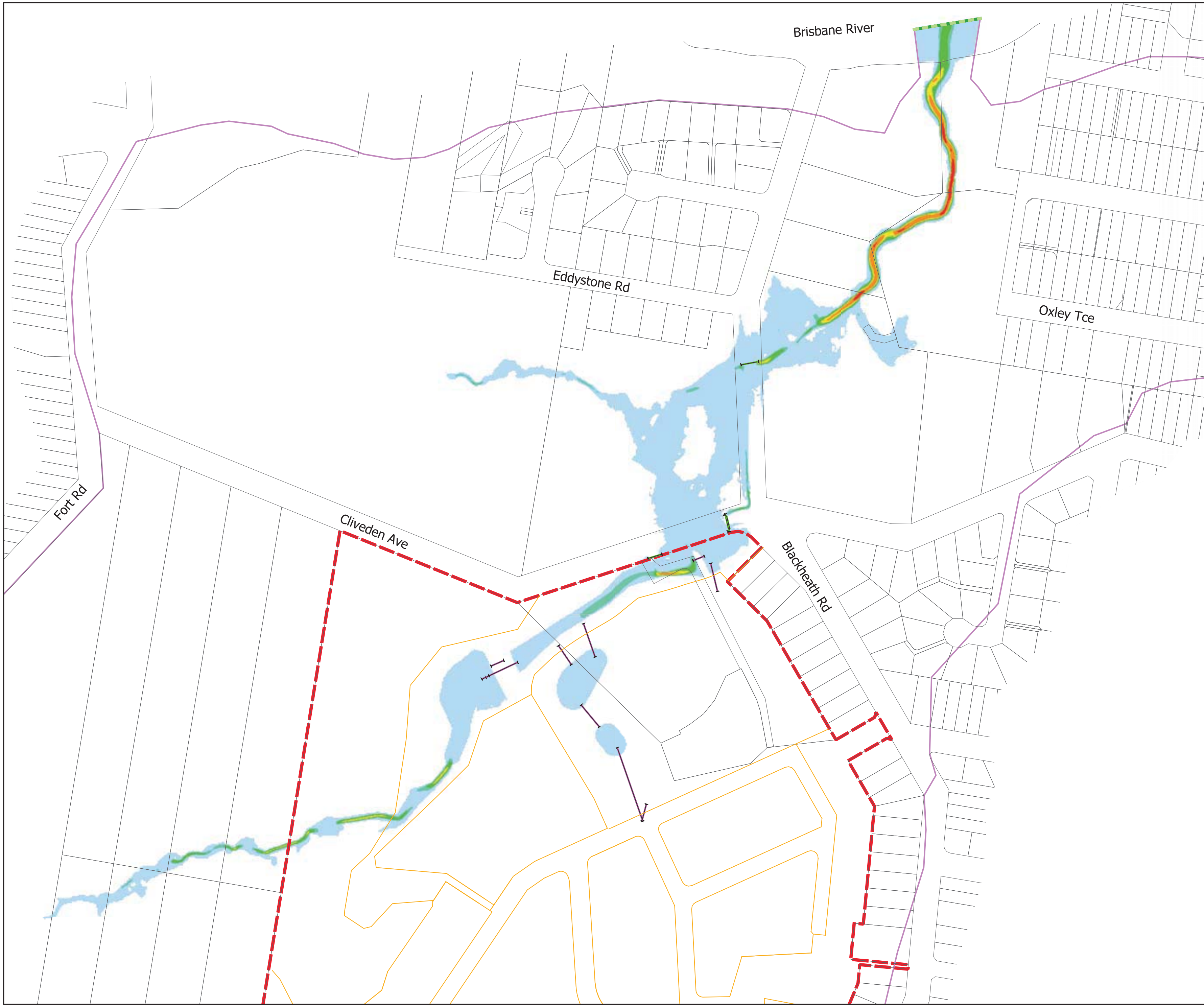
30 0 30 60 m

Peak Depth-Velocity Product
Local Catchment Modelling

Developed Case
(TUFLOW Case M03c)

2Yr ARI Event

Plan Ref: J00311_B032_DV_Yr O



Hydrology & Water Management Consulting

DesignFlow

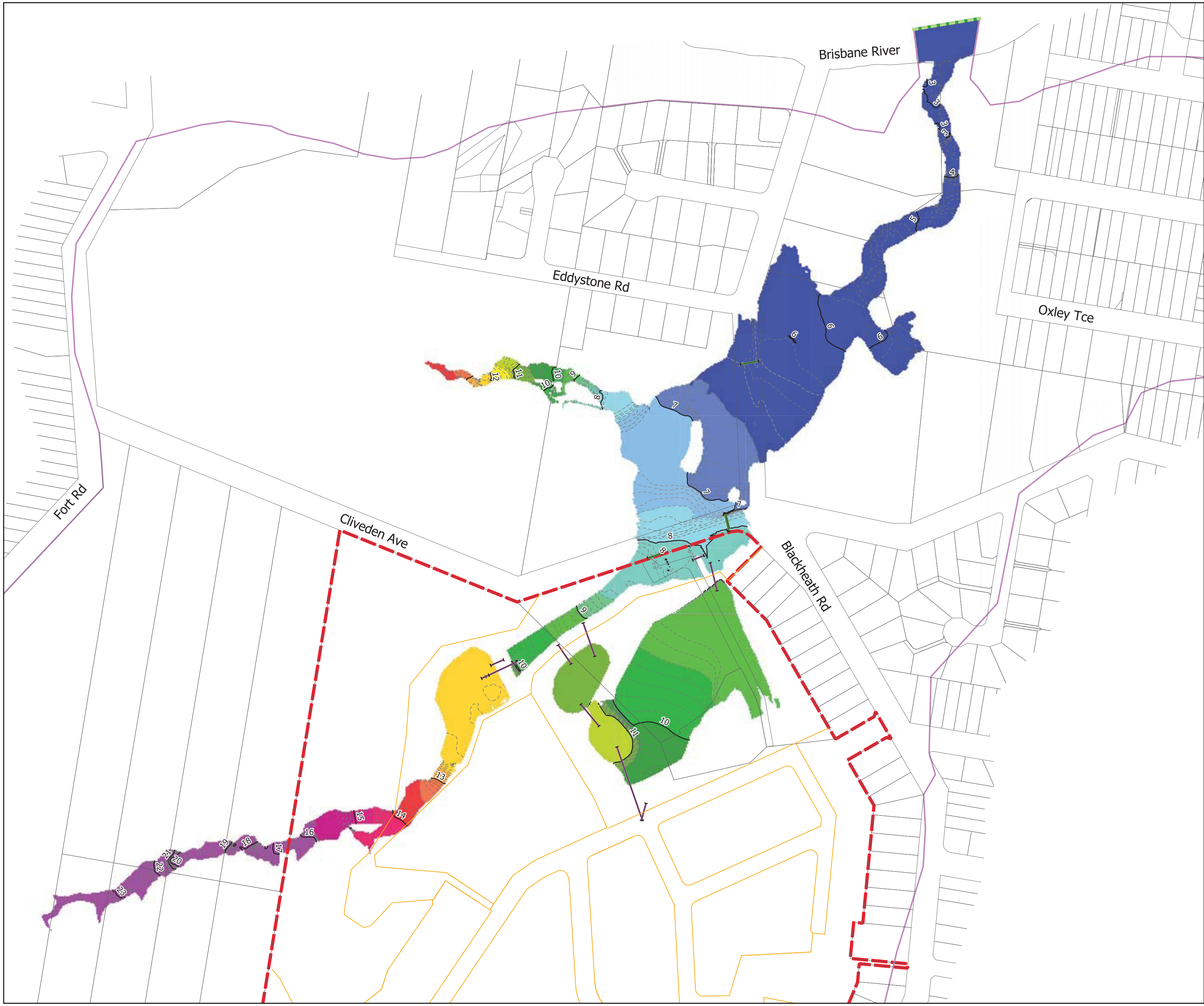
30 0 30 60 m

Peak Depth-Velocity Product
Local Catchment Modelling

Developed Case
(TUFLOW Case M03c)

50% AEP Event

Plan Ref: J00311_B032_DV_50p2



Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site
- Cadastral Data
- Model Extent
- External Boundary
- 1D Structure (Existing)
- 1D Structure (Proposed)
- Proposed Layout
- Flood Level Contour (1m Increment)
- Flood Level Contour (0.1m Increment)

Level (mAHD)
<= 6.5
6.5 - 7
7 - 7.5
7.5 - 8
8 - 8.5
8.5 - 9
9 - 9.5
9.5 - 10
10 - 10.5
10.5 - 11
11 - 11.5
11.5 - 12
12 - 12.5
12.5 - 13
13 - 13.5
13.5 - 14
14 - 14.5
14.5 - 15
15 - 15.5
> 15.5

N

30 0 30 60 m

Oxley Priority Development Area

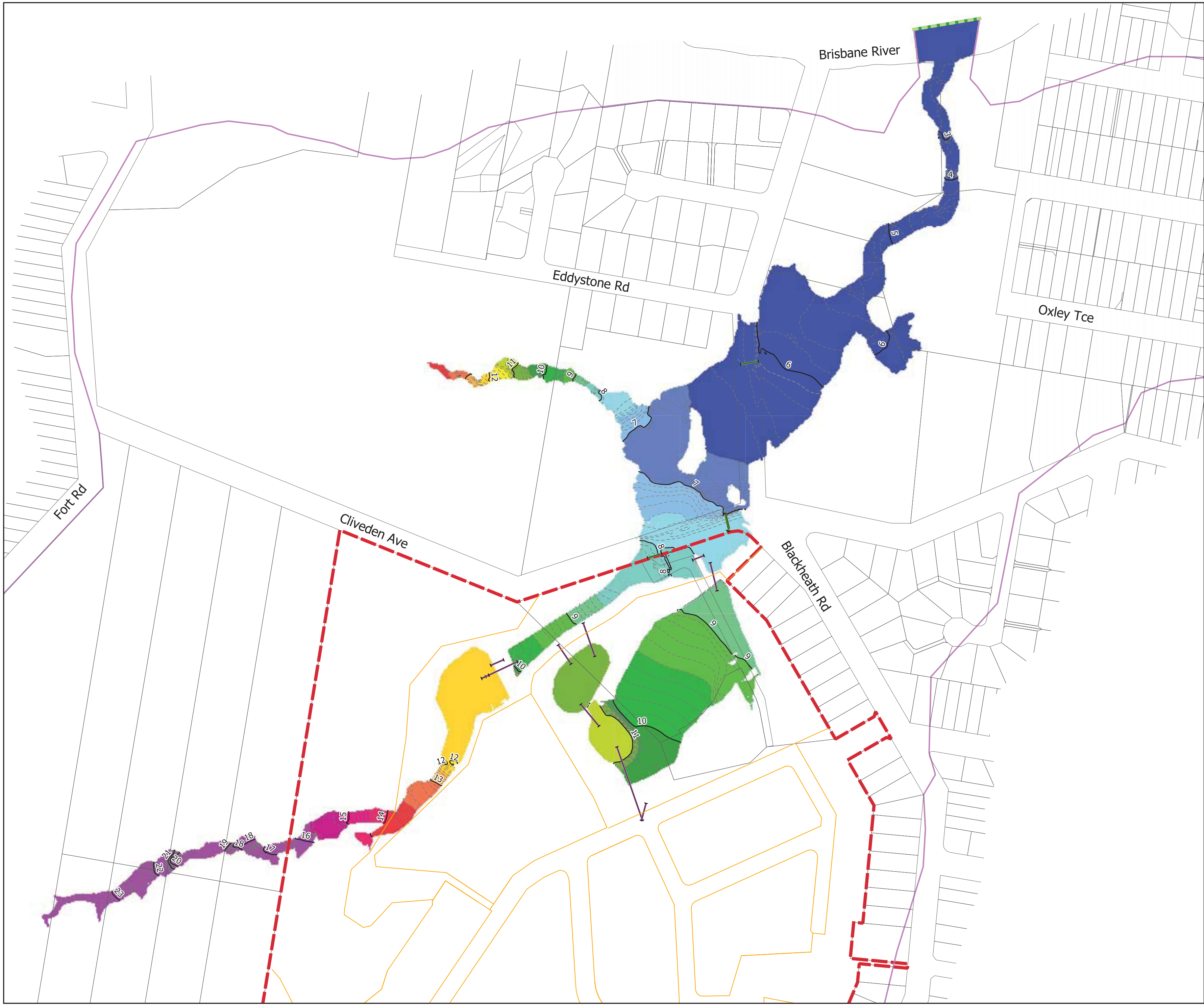
Peak Flood Depelt
Dohal s alhcC enLn odellMi

gepeloved s at e
(TUFDOW s at e n 03h)

100Yr ARI EpenL(ARR1987)

Client: Economic Development Queensland

Plan Ref: J00311_WSL_M03a_100Yr



Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site
- Cadastral Data
- Model Extent
- External Boundary
- 1D Structure (Existing)
- 1D Structure (Proposed)
- Proposed Layout
- Flood Level Contour (1m Increment)
- Flood Level Contour (0.1m Increment)

Level (mAHD)

- <= 6.5
- 6.5 - 7
- 7 - 7.5
- 7.5 - 8
- 8 - 8.5
- 8.5 - 9
- 9 - 9.5
- 9.5 - 10
- 10 - 10.5
- 10.5 - 11
- 11 - 11.5
- 11.5 - 12
- 12 - 12.5
- 12.5 - 13
- 13 - 13.5
- 13.5 - 14
- 14 - 14.5
- 14.5 - 15
- 15 - 15.5
- > 15.5

N

30 0 30 60 m

Oxley Priority Development Area

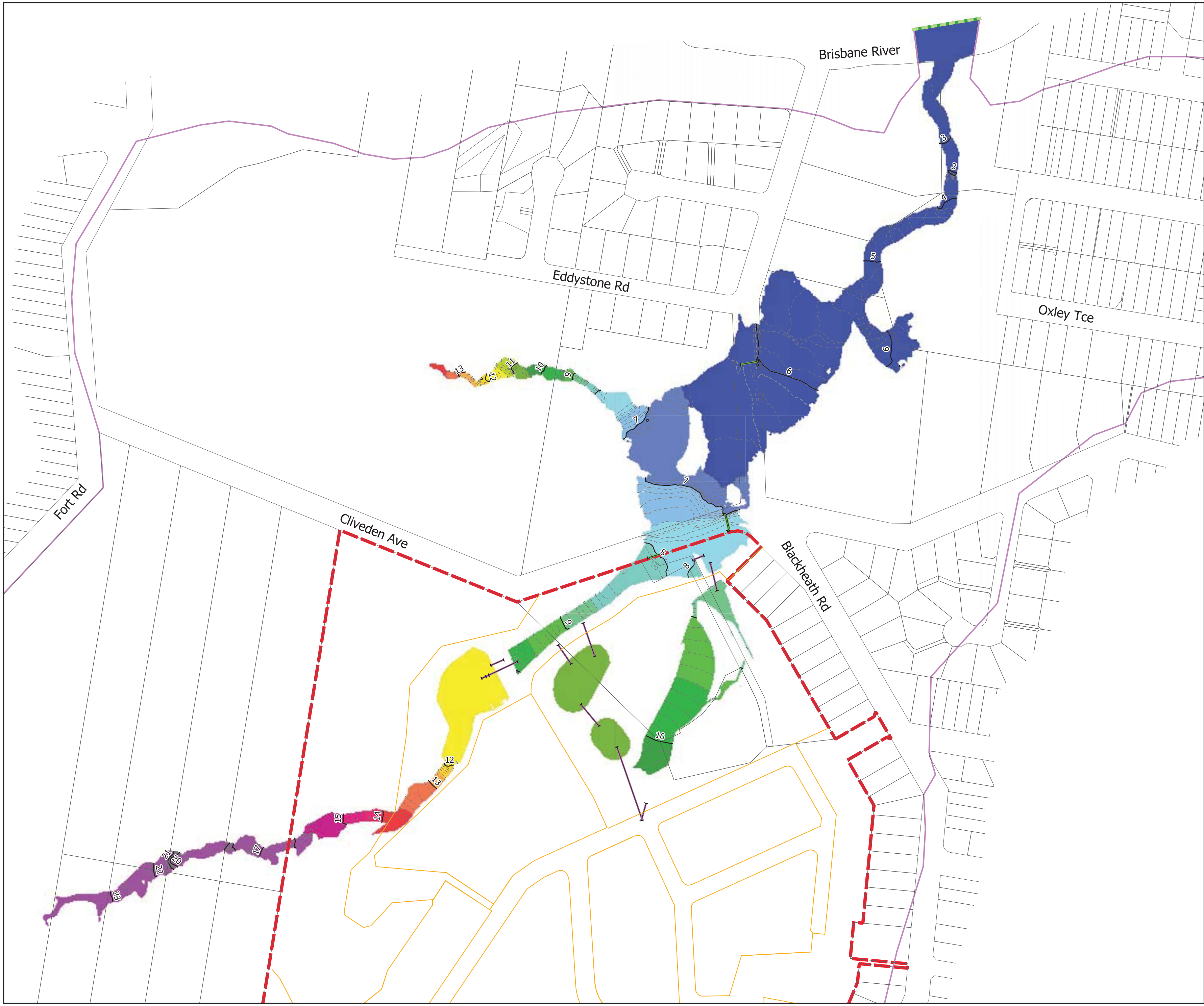
Peak Flood Depelt
Dohal s alhcC erLn odellMi

gepeloved s at e
(TUFDOW s at e n 03h)

1% AEP EpenL(ARR2019)

Client: Economic Development Queensland

Plan Ref: J00311_WSL_M03a_1pc



Hydrology & Water
Management Consulting

DesignFlow

LEGEND

- Site
- Cadastral Data
- Model Extent
- External Boundary
- 1D Structure (Existing)
- 1D Structure (Proposed)
- Proposed Layout
- Flood Level Contour (1m Increment)
- Flood Level Contour (0.1m Increment)

Level (mAHD)
<= 6.5
6.5 - 7
7 - 7.5
7.5 - 8
8 - 8.5
8.5 - 9
9 - 9.5
9.5 - 10
10 - 10.5
10.5 - 11
11 - 11.5
11.5 - 12
12 - 12.5
12.5 - 13
13 - 13.5
13.5 - 14
14 - 14.5
14.5 - 15
15 - 15.5
> 15.5

N

30 0 30 60 m

Oxley Priority Development Area

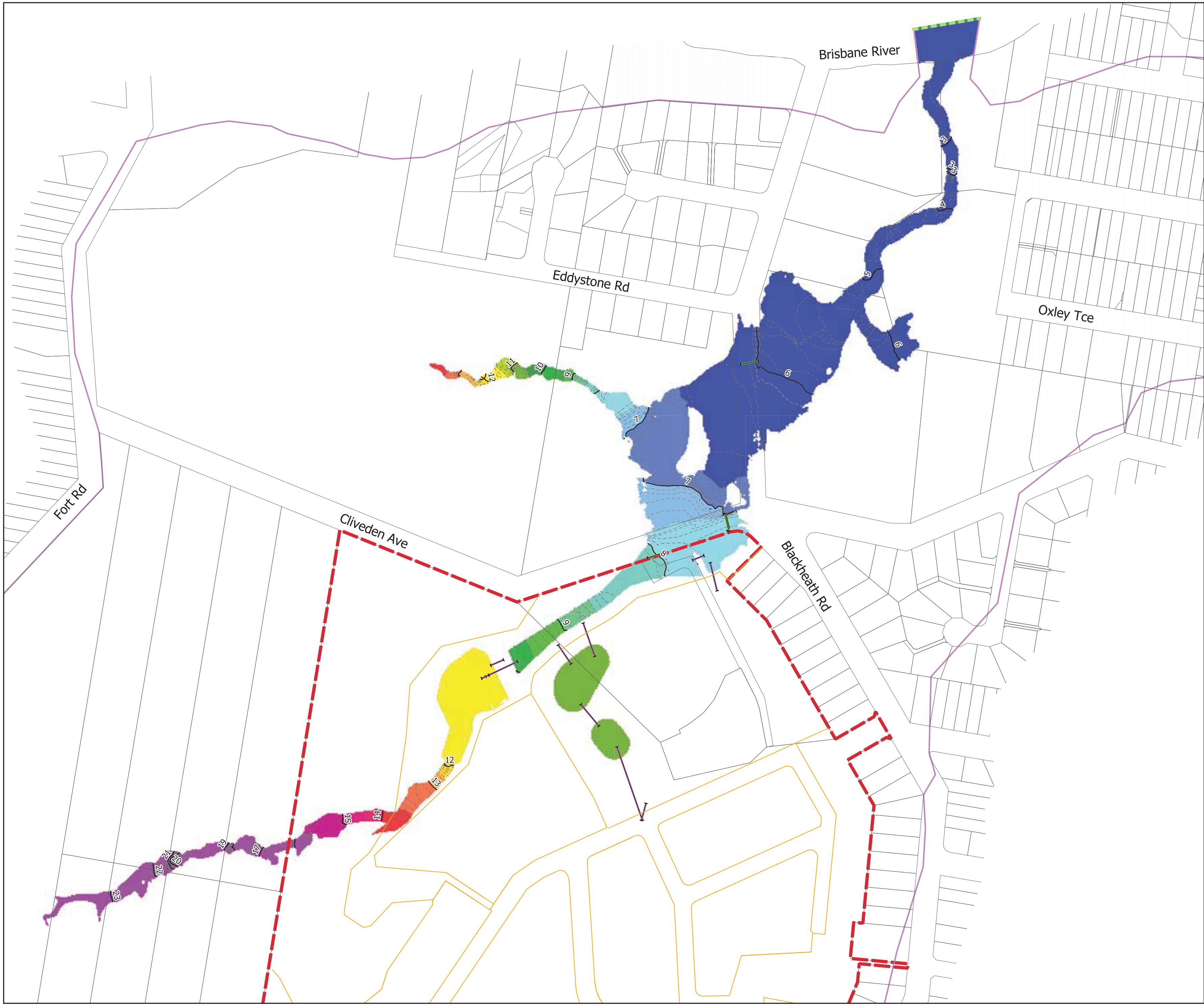
Peak Flood Depelt
Dohal s alhcC enLn odellMi

gepeloved s at e
(TUFDOW s at e n 03h)

10Yr ARI EpenL(ARR1987)

Client: Economic Development Queensland

Plan Ref: J00311_WSL_M03a_10Yr



Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site
- Cadastral Data
- Model Extent
- External Boundary
- 1D Structure (Existing)
- 1D Structure (Proposed)
- Proposed Layout
- Flood Level Contour (1m Increment)
- Flood Level Contour (0.1m Increment)

Level (mAHD)

- <= 6.5
- 6.5 - 7
- 7 - 7.5
- 7.5 - 8
- 8 - 8.5
- 8.5 - 9
- 9 - 9.5
- 9.5 - 10
- 10 - 10.5
- 10.5 - 11
- 11 - 11.5
- 11.5 - 12
- 12 - 12.5
- 12.5 - 13
- 13 - 13.5
- 13.5 - 14
- 14 - 14.5
- 14.5 - 15
- 15 - 15.5
- > 15.5

N

30 0 30 60 m

Oxley Priority Development Area

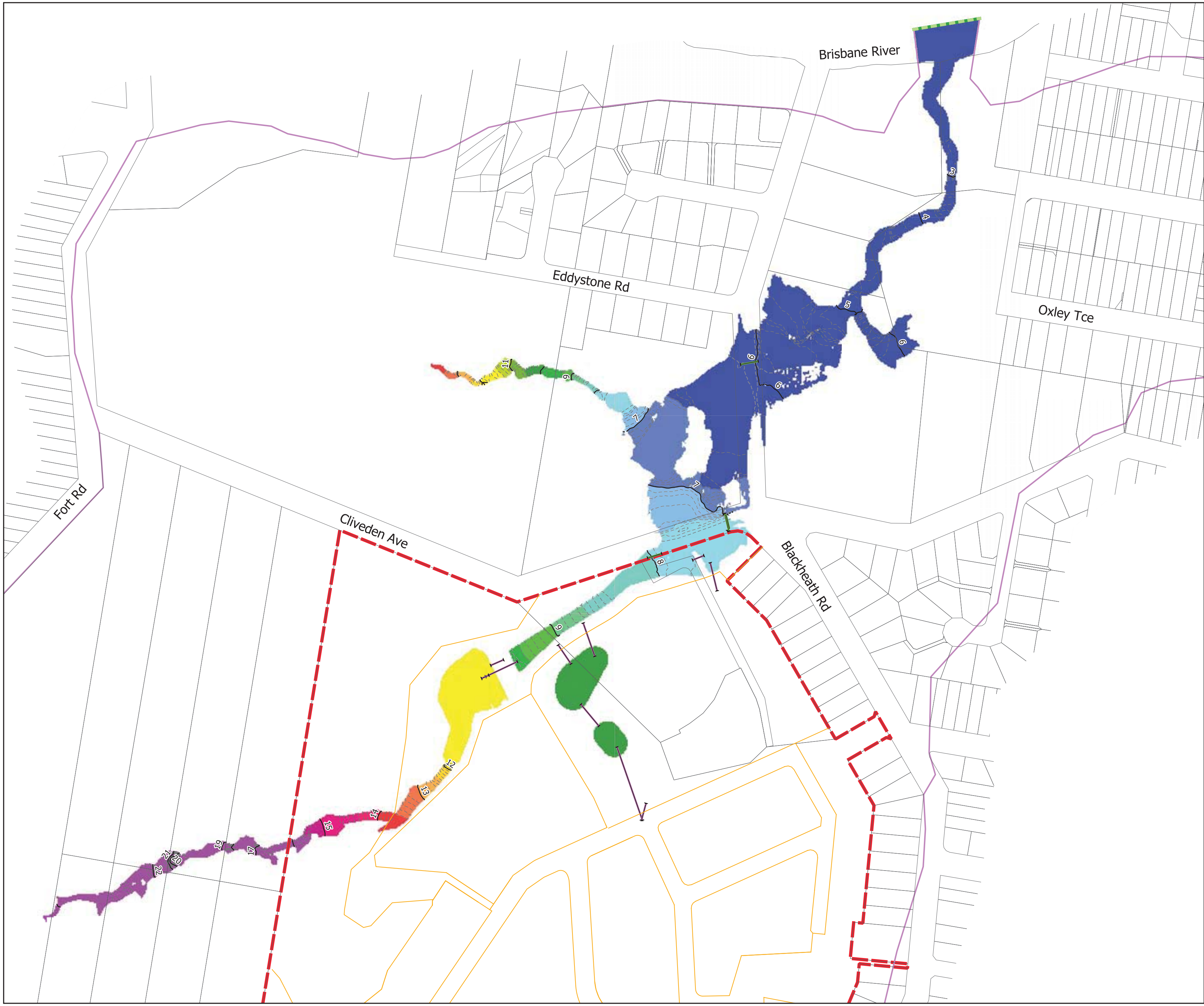
Peak Flood Depelt
Dohal s alhcC enLn odellMi

gepeloved s at e
(TUFDOW s at e n 03h)

10%AEP EpenL(ARR2019)

Client: Economic Development Queensland

Plan Ref: J00311_WSL_M03a_10pc



Hydrology & Water Management Consulting

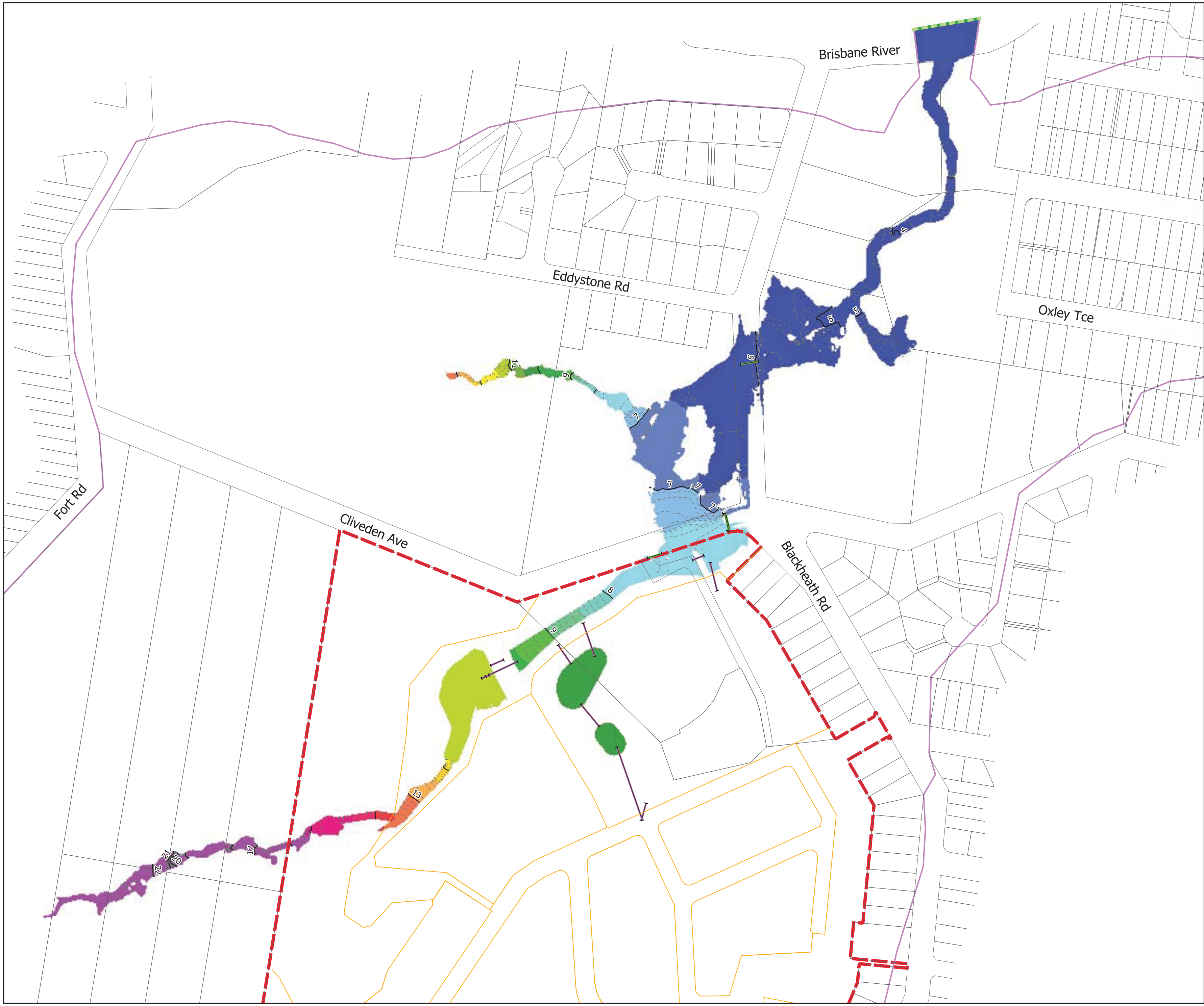
DesignFlow

Lepel)A ©d v 2
<= 6.5
6.5 - 7
7 - 7.5
7.5 - 8
8 - 8.5
8.5 - 9
9 - 9.5
9.5 - 10
10 - 10.5
10.5 - 11
11 - 11.5
11.5 - 1Y
1Y - 1Y.5
1Y.5 - 13
13 - 13.5
13.5 - 14
14 - 14.5
14.5 - 15
15 - 15.5
> 15.5

Peak Flood Depelt

2Yr ARI EpenL(ARR1987)

Plan Ref: J00311_WSL_M03a_Yr O



Hydrology & Water Management Consulting

DesignFlow

N

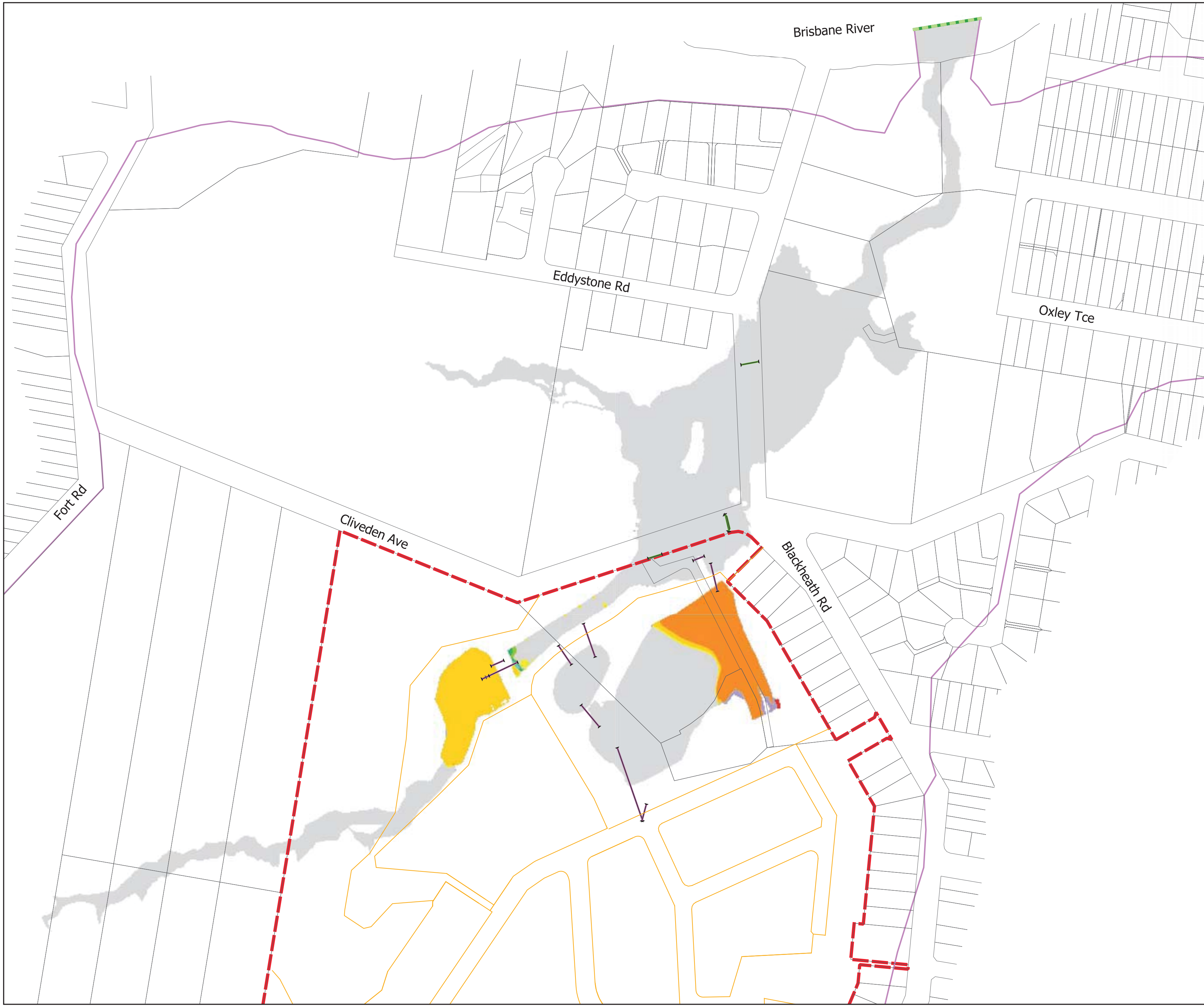
30 0 30 60 m

Peak Flood Levels
Local Catchment Modelling

Developed Case
(TUFLOW Case M03c)

50pc AEP Event (ARR2019)

Plan Ref: J00311_WSL_M03a_p0cO



N

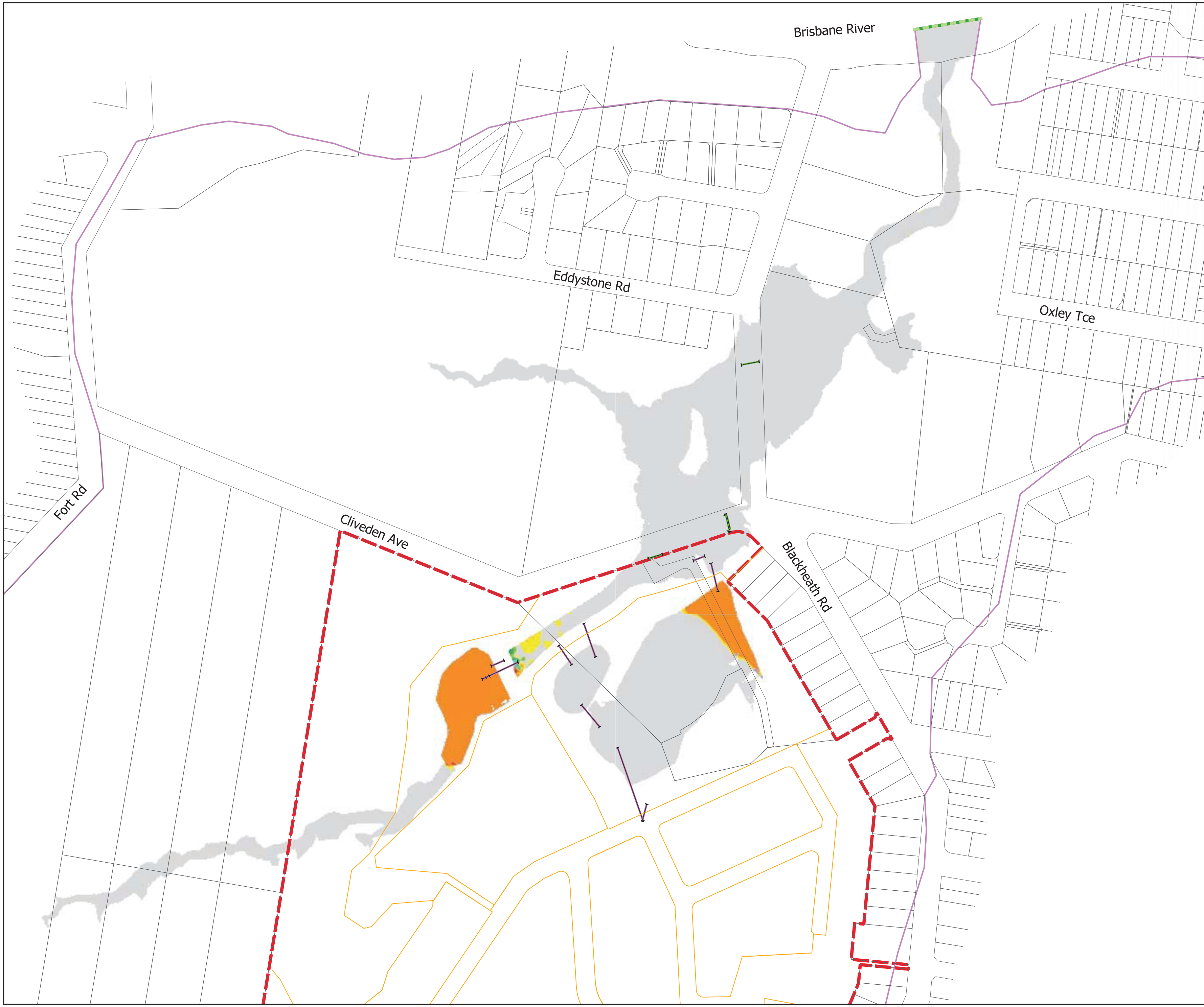
30 0 30 60 m

Peak Flood Level Impacts
Associated with Structure Blockage

Developed Case with Blockage Vs
Developed Case
(TUFLOW Case M03c_B1 Vs M03c)

100Yr ARI Event (ARR1987)

Plan Ref: J00311_Diff_H_M03c_-1BM03c_1002Y



Hydrology & Water Management Consulting

DesignFlow

N

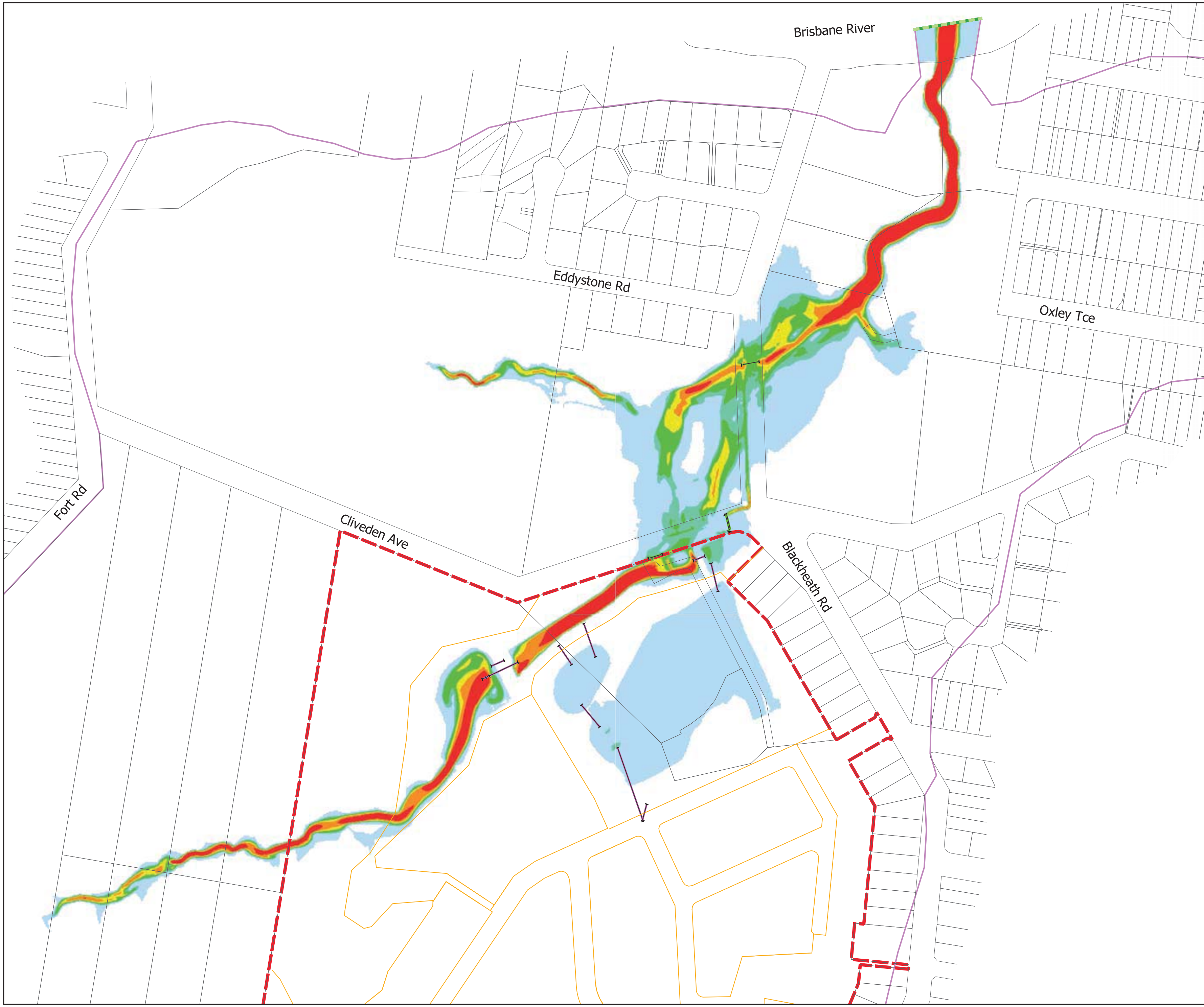
30 0 30 60 m

Peak Flood Level Impacts Associated with Structure Blockage

Developed Case with Blockage Vs Developed Case (TUFLOW Case M03c_B1 Vs M03c)

1% AEP Event (ARR2019)

Plan Ref: J00311_Diff_H_M03c_- 1BM03c_12c



Hydrology & Water Management Consulting

DesignFlow

LEGENV

N

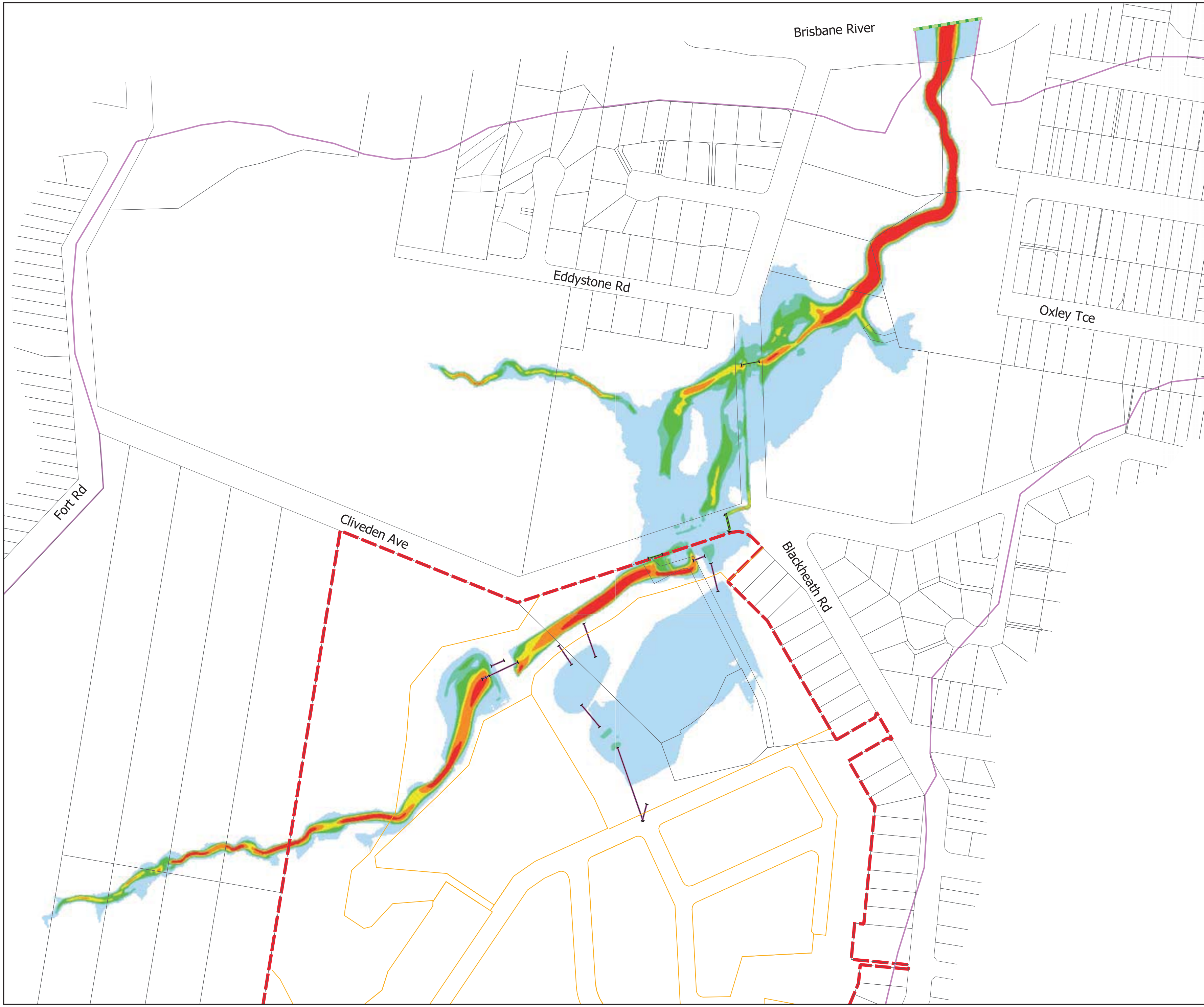
30 0 30 60 m

Peak Depth-Velocity Product
Local Catchment Modelling

Developed Case With Structure Blockage
(TUFLOW Case M03c_B1)

100Yr ARI Event

Plan Ref: J00311_B032_D1_VY_100r O



Hydrology & Water Management Consulting

DesignFlow

uEGENV

- Site Dosndary
- MadaQral Vata
- B odel Extent
- External Dosndary
- 1V Strs2tsre LExiQing(
- 1V Strs2tsre LProcoQed(
- ProcoQed uayost

Vecth-pelo2ity Prods2t Lm) /Q

- <= 0.3
- 0.3 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.)
- > 1.)

N

30 0 30 60 m

Oxley Priority Vevelocment Area

Peak Depth-Velocity Product
Local Catchment Modelling

Developed Case With Structure Blockage
(TUFLOW Case M03c_B1)

1%AEP Event

Mient: E2onomi2 Vevelocment QseenQand

Plan Ref: J00311_B032_D1_Vp_1c2