4.5 Model Adjustments

As noted above, it was necessary to make a number of modifications to the supplied model in order to improve the level of detail of the model in the region of interest and to ensure that the comparison of base case and developed case models was valid. The modifications were kept to the minimum possible to ensure that the base case model remained as similar as possible to the supplied calibrated model to avoid the potential for the modifications to affect the calibration previously completed by the consultants who constructed the model.

The changes effected to the base case model (and therefore the developed case models) are listed below (refer Figure 3).

- The existing 1200 mm diameter RCP culvert to the east of the Centenary Highway main crossing was added to the model.
- Additional channels were created at BC1.251 and BC1.239 to represent the proposed Barrams Bridge and the point of discharge from the southern basin to Bundamba Creek respectively. In each case, cross sections were interpolated between the upstream and downstream sections. The channels were added to the base case model to ensure that the impact of the bridge (added as part of the developed case scenarios) was correctly quantified.
- The inflow database setup and locations were changed to allow for the application of inflows from the local catchments BC26, BC29 and B30 at multiple locations proportionally to provide a more realistic application of inflows within the SUCE development area.
- The 2d_code_ULDA_049.mif was removed from the 4m grid domain.
- A Code of 1 was applied to 2d_bc_SUCE_2d2d_049.mif.
- The "invert" command was added to 2d_bc_SUCE_2d2d_049.mif for the 20m grid domain to deactivate the nested grid within the larger grid.

The changes detailed above were applied to the models used to assess the relative impact of development. As noted above, following the completion of the relative analysis the model was further revised to allow the conservative calculation of flood levels for the purpose of defining minimum lot and habitable floor levels.

To provide this more conservative estimation of flood levels in the creek for the specification of minimum development levels, the following modifications were made to the model.

- The initial water level in Daleys Lagoon at the head of the Bundamba Creek catchment was increased from 75 mAHD to 75.3 mAHD to reflect the road crest levels downstream of the lagoon (i.e. it was assumed that the lake was full at the commencement of rainfall).
- The negative bed slope around Barrams Road was corrected based on interpolated cross sections.
- Two existing culvert crossings of the Centenary Highway Extension (refer image below) on minor tributaries of Bundamba Creek to the west of the main channel (and discharging to Bundamba Creek downstream of the Centenary Highway extension) were added to the model.
- The existing culvert crossing of Ripley Road (refer image below) to the south of the Centenary Highway was added to the model.
- The 2D inflows that were applied in the main Creek were changed to 1D inflow points to maximise flow in the creek.
- The inflows from catchment BC28 (on the western side of Bundamba Creek- refer Figure 2) were split into two branches.

The other modification to the model made to allow the specification of minimum development levels is provided in Section 4.6.3.

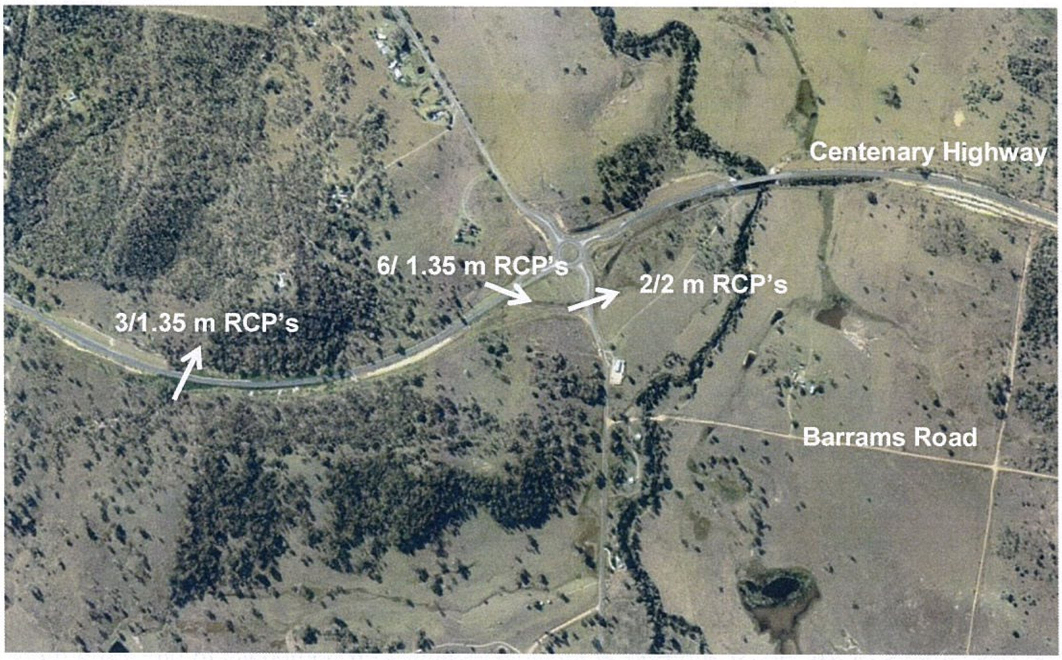


Image 2 **Location of additional structures modelled for calculation of development levels**

4.6 Developed Site Modelling

The specific elements added to the developed case TUFLOW model are detailed below for each development scenario.

4.6.1 Relative Analysis- Stages 1 to 3

The works considered for Stages 1 to 3 of the development include the construction of the Barrams Road Bridge and culverts. The works considered for Stages 1 to 3 are shown in Figure 3 and are described below.

- **Barrams Road Bridge**

  The proposed Barrams Road crossing includes a three 25 metre span bridge of 75 metres total span across Bundamba Creek. The assumed ultimate width of the bridge was 30 metres. The bridge, located at model cross section BC1.251, was modelled in 1D. To minimise afflux, the bridge soffit level was set at 44.38 mAHD. Allowing a 1.5 metre structure depth, the resultant minimum road level across the bridge is 45.9 mAHD. This road level will be sufficient to provide the road with a 100 year ARI flood immunity (Section 4.7.8 provides more discussion on the flood immunity of Barrams Road).

  The main bridge crossing was modelled using a localised HEC-RAS model to quantify the loss produced by the crossing. The afflux produced by the bridge was found to be 250 mm in the main channel. To match this afflux in TUFLOW a dynamic head loss coefficient (K) of 2.5 was adopted for the 1-D channel representing the proposed bridge.

  To ensure that the three-span bridge has adequate conveyance capacity, it is proposed to excavate beneath the span that crosses the eastern floodplain of Bundamba Creek. The extent of excavation is shown on Figure 3. With reference to Figure 3, it is proposed to excavate an area approximately 20 metres wide to a depth of less than two metres, removing the fill embankment associated with the existing alignment of Barrams Road. The resultant invert level of the excavation has been set relative to levels downstream of the bridge to allow for free drainage of flow at the downstream end of the excavated area.

The excavation will not affect the bed or banks of Bundamba Creek and will be wholly located in the eastern floodplain of the creek. Consequently, the excavated area will only convey flow when events of sufficient magnitude to cause the creek to overtop occur. The works will therefore not have any impact on the conveyance of low flows in Bundamba Creek.

- **Barrams Road Culverts**

  Flow from a local catchment to the west of Bundamba Creek currently crosses Barrams Road. It will be necessary to provide for the drainage of this flow as part of the upgrading of Barrams Road.

  Based on hydraulic modelling completed in support of the preparation of this report, it is proposed to construct culverts with the following configuration:

  - 2/ 3.0 x 1.5 m box culverts;
  - 40 metre culvert length (at an angle in the ultimate configuration);
  - Upstream invert level = 42.9 mAHD; and
  - Downstream invert level = 42.5 mAHD.

  The area just upstream of these culverts will have to be excavated by around 500 mm so that the slope of the culverts can be reduced and the fill embankment of the existing unmade Barrams Road removed. The headwall will also need to be rounded to reduce the entrance losses at this point. An entrance loss of 0.2 and exit loss of 1.0 were adopted for the culverts.

  A channel of approximately 20 metres width and 1 metre depth will be provided to link to the culverts at Ripley Road. The channel will be vegetated, except for a rock-lined low flow channel. The alignment of the channel was designed to minimise disturbance to existing vegetation.

  Barrams Road is also crossed by flow produced by runoff from local catchments to the east of Bundamba Creek. Similar to the western side of Bundamba Creek, it is proposed to provide for the drainage of this flow as part of the upgrading of Barrams Road. For the eastern floodplain crossing the following culvert configuration was found to be necessary:

  - 5/ 3.3 x 1.2 m box culverts;
  - 30 metre culvert length;
  - Upstream invert level = 43.7 mAHD; and
  - Downstream invert level = 43.5 mAHD.

  The eastern culverts will be located approximately 30 metres to the west of the existing low point in the floodplain. This is to allow for future development of this area for sportsgrounds. To ensure that flows can be directed towards these culverts some minimal excavation upstream will be required. Downstream of these culverts a rock-lined channel is proposed to convey flows to the main channel of Bundamba Creek. The channel will be approximately 25 metres wide and half a metre deep. The purpose of this channel is to divert low flows away from future parks and sportsground areas that will be located downstream of the bridge. During major flows the channel will overtop and flow will also be conveyed across the eastern floodplain. The headwall will also need to be rounded to reduce the entrance losses at this point. An entrance loss of 0.2 and exit loss of 1.0 were used.

  It can be noted that the final number and size of culverts will be confirmed as part of detailed design of the bridge crossing.

- **Filling for Stages 1 to 3**

  The area of the Stage 1-3 works will be filled above the 100 year ARI flood level. To allow for earthworks batters, a 10 metre buffer around the boundary of these works was also assumed to be filled.

- **Open Space Flood Immunity**

  In accordance with the requirements of the ULDA *Park Planning and Design Guidelines* (November 2011), sports fields will be provided with 20 year ARI flood immunity. The clubhouses, toilet and amenities blocks will be provided with 100 year ARI flood immunity. The recreation parks will be provided with 5 year ARI flood immunity. The formal playground area will be set at the 20 year ARI flood level.

- **Revegetation**

  The modelling included an allowance for revegetation of the creek as part of the SUCE development. For the analysis, only the revegetation of the buffer along the eastern side of the Creek was included as part of the impact assessment. A manning's 'n' of 0.1 was adopted for the proposed revegetation. Figure 6 shows the extent of the proposed revegetation for Stages 1 to 3 included in the relative impact assessment.

4.6.2 Relative Analysis- Ultimate SUCE Development Scenario

The earthworks considered for the ultimate SUCE development scenario (in addition to those proposed for Stages 1-3) are shown in Figure 4. Primarily, the works include the construction of a regional detention basin to the south of Barrams Road and a number of small detention basins to cater for the development of areas that drain to the north-east. Associated with the basins is the completion of earthworks to provide flood free lots and open space areas with an appropriate level of flood immunity.

The developed TUFLOW model incorporated the following:

- residential areas raised to provide 100 year ARI immunity (including the remainder of the area adjacent to Stages 1 to 3);
- sportsgrounds were modified (excavated or filled as necessary) to provide a minimum 20 year ARI immunity and provide flood storage;
- the car park area associated with the proposed regional sporting facility located to the south of Barrams Road was raised to provided 100 year ARI immunity;
- the proposed bio-retention basins in the southern detention basin were filled to above the 10 Year ARI flood level;
- the proposed track in the open space area was raised to above the 10 Year ARI flood level; and
- a detention basin with associated spillway and outlet pipes was included in the southern open space area.

The extent and excavation levels of the proposed southern detention basin are shown in Figure 4. The detention basin has an upstream invert level of 48.5 mAHD, grading down to 45.6 mAHD at its outlet.

The detention basin outlet structure consists of the following:

- 3/ 4.2 x 0.9 metre box culverts with upstream and downstream invert levels of 45.63 mAHD and 45.0 mAHD respectively; and
- 26 metre wide spillway with a crest level of 46.8 mAHD.

4.6.3 Minimum Development Level Modelling

In addition to the works detailed in Section 4.6.1 and 4.6.2, for the modelling completed to define minimum development levels for the SUCE site, it was assumed that the western side of Bundamba Creek would ultimately be revegetated. The extent of this revegetation, which was assumed to have a Mannings 'n' roughness value of 0.1, is shown on Figure 6.

4.7 TUFLOW Results

4.7.1 Flood Mapping Outputs

The results obtained from the TUFLOW model are presented graphically in Appendices B, C, and D.

Appendix B contains existing and developed case flood extent maps:

- Figure B1 Existing Case Q100 Flood Extent
- Figure B2 Existing Case Q20 Flood Extent
- Figure B3 Existing Case Q2 Flood Extent
- Figure B4 Existing Case Q1 Flood Extent
- Figure B5 Stages 1-3 Q100 Flood Extent
- Figure B6 Stages 1-3 Q20 Flood Extent
- Figure B7 Stages 1-3 Q2 Flood Extent
- Figure B8 Stages 1-3 Q1 Flood Extent
- Figure B9 Ultimate Case Q100 Flood Extent
- Figure B10 Ultimate Case Q20 Flood Extent
- Figure B11 Ultimate Case Q2 Flood Extent
- Figure B12 Ultimate Case Q1 Flood Extent

Appendix C presents the afflux (change in flood level) plots for the developed case:

- Figure C1 Stages 1-3 Q100 Afflux
- Figure C2 Stages 1-3 Q20 Afflux
- Figure C3 Stages 1-3 Q2 Afflux
- Figure C4 Stages 1-3 Q1 Afflux
- Figure C5 Ultimate Case Q100 Afflux
- Figure C6 Ultimate Case Q20 Afflux
- Figure C7 Ultimate Case Q2 Afflux
- Figure C8 Ultimate Case Q1 Afflux

Appendix D presents flood depth mapping for the existing and developed cases:

- Figure D1 Existing Case Q100 Flood Depth
- Figure D2 Existing Case Q20 Flood Depth
- Figure D3 Existing Case Q2 Flood Depth
- Figure D4 Existing Case Q1 Flood Depth
- Figure D5 Stages 1-3 Q100 Flood Depth
- Figure D6 Stages 1-3 Q20 Flood Depth
- Figure D7 Stages 1-3 Q2 Flood Depth
- Figure D8 Stages 1-3 Q1 Flood Depth
- Figure D9 Ultimate Case Q100 Flood Depth
- Figure D10 Ultimate Case Q20 Flood Depth
- Figure D11 Ultimate Case Q2 Flood Depth
- Figure D12 Ultimate Case Q1 Flood Depth

4.7.2 Afflux

Figure C1 to C4 in Appendix C show the impact of Stages 1 to 3 and Figure C5 to Figure C8 show the ultimate case impacts. The 100 year and 20 year ARI afflux plots show that the development will not cause any significant adverse impacts downstream and upstream of the subject site. While for the minor events, a slight increase in flood level was obtained, with any increase contained within the creek. Given the minimal impacts obtained overall, it is considered that the results are acceptable.

Following the reporting convention of KBR, flood levels were compared at 11 downstream catchment control points. The approximate locations of these points were provided by KBR and are shown in Figure 1. The results are summarised in Table 4-1 to 4-4.

As discussed above, it is considered that the results obtained from the analysis indicate that the development will have a minimal impact on flood levels external to the site. It can be noted that a slight increase in level (up to 48 mm) is reported for the 1 year event. It can be noted that the change in depth at the point (point 5) where the increase was determined represents less than 3 percent of the overall depth of flow. This, combined with the negligible change in velocity obtained for the 1 year event (refer Table 4-8) indicates that the change in level for the 1 year event is not of consequence.

Table 4-1 100 Year Event Peak Flood Level Comparison

Catchment Control point	Corresponding 1D Node Name	Flood Level (mAHD)			Impact (m)	
		Existing	Stages 1-3	Ultimate Case	Stage 1-3	Ultimate
1	BC1.262.2	42.546	42.528	42.513	-0.018	-0.033
2	BC1.305.2	37.369	37.352	37.335	-0.017	-0.035
3	BC1.336.2	30.907	30.893	30.881	-0.015	-0.027
4	BC1.367.2	26.837	26.824	26.816	-0.014	-0.021
5	BC1.418.2	23.566	23.552	23.543	-0.014	-0.023
6	BC1.443.2	21.014	20.999	20.990	-0.015	-0.024
7	BC1.481.2	17.287	17.273	17.267	-0.014	-0.020
8	BC1.519.2	10.954	10.934	10.928	-0.020	-0.026
9	BC1.561.2	6.167	6.153	6.153	-0.014	-0.014
10	N/A	47.395	47.395	47.401	0.00	0.006
11	N/A	38.869	38.845	38.825	-0.024	-0.044

Note: Refer to Figure 1 for location of reporting points

Table 4-2 20 Year Event Peak Flood Level Comparison

Catchment Control point	Corresponding 1D Node Name	Flood Level (mAHD)			Impact (m)	
		Existing	Stages 1-3	Ultimate Case	Stage 1-3	Ultimate
1	BC1.262.2	42.153	42.143	42.130	-0.011	-0.023
2	BC1.305.2	36.880	36.870	36.862	-0.009	-0.018
3	BC1.336.2	30.502	30.496	30.492	-0.005	-0.009
4	BC1.367.2	26.318	26.312	26.306	-0.006	-0.012
5	BC1.418.2	23.051	23.046	23.044	-0.003	-0.006
6	BC1.443.2	20.404	20.402	20.400	-0.002	-0.004
7	BC1.481.2	16.606	16.604	16.602	-0.001	-0.003
8	BC1.519.2	9.940	9.941	9.941	0.001	0.001

Catchment Control point	Corresponding 1D Node Name	Flood Level (mAHD)			Impact (m)	
		Existing	Stages 1-3	Ultimate Case	Stage 1-3	Ultimate
9	BC1.561.2	5.200	5.207	5.204	0.007	0.004
10	N/A	47.118	47.117	47.144	-0.001	0.026
11	N/A	38.288	38.275	38.263	-0.013	-0.024

Note: Refer to Figure 1 for location of reporting points

Table 4-3 2 Year Event Peak Flood Level Comparison

Catchment Control point	Corresponding 1D Node Name	Flood Level (mAHD)			Impact (m)	
		Existing	Stages 1-3	Ultimate Case	Stage 1-3	Ultimate
1	BC1.262.2	40.270	40.320	40.298	0.049	0.028
2	BC1.305.2	35.682	35.691	35.702	0.010	0.020
3	BC1.336.2	29.820	29.823	29.826	0.003	0.006
4	BC1.367.2	25.281	25.287	25.290	0.006	0.009
5	BC1.418.2	21.949	21.964	21.979	0.020	0.030
6	BC1.443.2	19.052	19.074	19.086	0.022	0.034
7	BC1.481.2	14.883	14.907	14.922	0.024	0.039
8	BC1.519.2	7.935	7.958	7.973	0.023	0.038
9	BC1.561.2	3.182	3.205	3.216	0.023	0.035
10	N/A	46.502	46.502	46.508	0.000	0.006
11	N/A	37.657	37.629	37.654	-0.028	-0.003

Note: Refer to Figure 1 for location of reporting points

Table 4-4 1 Year Event Peak Flood Level Comparison

Catchment Control point	Corresponding 1D Node Name	Flood Level (mAHD)			Impact (m)	
		Existing	Stages 1-3	Ultimate Case	Stage 1-3	Ultimate
1	BC1.262.2	39.453	39.482	39.472	0.029	0.019
2	BC1.305.2	34.844	34.875	34.885	0.031	0.041
3	BC1.336.2	29.475	29.489	29.493	0.014	0.018
4	BC1.367.2	24.760	24.775	24.785	0.015	0.025
5	BC1.418.2	20.956	20.982	21.004	0.026	0.048
6	BC1.443.2	18.087	18.115	18.134	0.028	0.047
7	BC1.481.2	13.861	13.885	13.903	0.024	0.042
8	BC1.519.2	6.953	6.976	6.995	0.023	0.042
9	BC1.561.2	2.386	2.402	2.415	0.016	0.029
10	N/A	46.294	46.294	46.298	0.000	0.004
11	N/A	37.259	37.272	37.307	0.013	0.048

Note: Refer to Figure 1 for location of reporting points

With reference to the results presented in the above tables, it is considered that the impact of the development is acceptable.

4.7.3 Peak Velocities

The velocity impacts at the 11 downstream catchment control points are summarised in Table 4-5 to 4-8. The results show that change in velocity due to the proposed development is not considered to be significant. Although relatively small, the largest increase is noted at point 1 which is located at the Centenary Highway Extension bridge.

The increase noted in the table was derived based on a review of flow velocities and flow rates. It is noted that the review indicated that the results at point 1 were not representative of conditions in the creek given the relatively small change in level and peak flow caused by development.

Table 4-5 100 Year Event Peak Flood Velocity Comparison

Catchment Control point	Corresponding 1D Node Name	Peak Velocity (m/s)			Change (positive for increase) (m/s)	
		Existing	Stages 1-3	Ultimate Case	Stage 1-3	Ultimate
1	BC1.567	3.64	3.76	3.84	-0.12	0.20
2	BC1.306	1.61	1.60	1.59	-0.01	-0.02
3	BC1.337	0.88	0.88	0.88	0	0
4	BC1.570	2.80	2.80	2.79	0	-0.01
5	BC1.418	1.30	1.29	1.29	-0.01	-0.01
6	BC1.571	1.67	1.67	1.67	0	0
7	BC1.482	1.95	1.95	1.95	0	0
8	BC1.519	1.11	1.11	1.11	0	0
9	BC1.563	3.87	3.87	3.87	0	0
10	N/A	3.05	3.05	3.05	0	0
11	N/A	1.08	1.06	1.06	-0.02	-0.02

Note: Refer to Figure 1 for location of reporting points

Table 4-6 20 Year Event Peak Flood Velocity Comparison

Catchment Control point	Corresponding 1D Node Name	Peak Velocity (m/s)			Change (positive for increase) (m/s)	
		Existing	Stages 1-3	Ultimate Case	Stage 1-3	Ultimate
1	BC1.262.2	3.29	3.23	3.17	-0.06	-0.12
2	BC1.305.2	1.27	1.27	1.25	0	-0.02
3	BC1.336.2	0.75	0.75	0.75	0	0
4	BC1.367.2	2.35	2.35	2.35	0	0
5	BC1.418.2	1.25	1.24	1.24	-0.01	-0.01
6	BC1.443.2	1.58	1.58	1.58	0	0
7	BC1.481.2	1.38	1.38	1.38	0	0
8	BC1.519.2	0.97	0.97	0.97	0	0
9	BC1.561.2	3.31	3.32	3.32	0.01	0.01
10	N/A	2.90	2.90	2.90	0	0
11	N/A	0.98	0.97	0.97	-0.01	-0.01

Note: Refer to Figure 1 for location of reporting points

Table 4-7 2 Year Event Peak Flood Velocity Comparison

Catchment Control point	Corresponding 1D Node Name	Peak Velocity (m/s)			Change (positive for increase) (m/s)	
		Existing	Stages 1-3	Ultimate Case	Stage 1-3	Ultimate
1	BC1.262.2	3.09	3.21	3.14	-0.12	0.05
2	BC1.305.2	0.80	0.80	0.80	0	0
3	BC1.336.2	0.64	0.64	0.64	0	0
4	BC1.367.2	2.32	2.32	2.32	0	0
5	BC1.418.2	0.97	0.97	0.97	0	0
6	BC1.443.2	1.41	1.41	1.41	0	0
7	BC1.481.2	0.70	0.70	0.70	0	0
8	BC1.519.2	0.73	0.73	0.73	0	0
9	BC1.561.2	1.44	1.45	1.46	0.01	0.02
10	N/A	1.42	1.42	1.42	0	0
11	N/A	0.65	0.63	0.63	-0.02	-0.02

Note: Refer to Figure 1 for location of reporting points

Table 4-8 1 Year Event Peak Flood Velocity Comparison

Catchment Control point	Corresponding 1D Node Name	Peak Velocity (m/s)			Impact (m/s)	
		Existing	Stages 1-3	Ultimate Case	Stage 1-3	Ultimate
1	BC1.262.2	2.98	2.97	2.87	-0.01	-0.11
2	BC1.305.2	0.65	0.66	0.66	0.01	0.01
3	BC1.336.2	0.55	0.56	0.56	0.01	0.01
4	BC1.367.2	2.31	2.31	2.31	0	0
5	BC1.418.2	0.87	0.87	0.88	0	0.01
6	BC1.443.2	1.10	1.14	1.14	0.04	0.04
7	BC1.481.2	0.70	0.73	0.73	0.03	0.03
8	BC1.519.2	0.63	0.68	0.68	0.05	0.05
9	BC1.561.2	0.82	0.83	0.85	0.01	0.03
10	N/A	0.53	0.53	0.53	0	0
11	N/A	0.21	0.22	0.22	0.01	0.01

Note: Refer to Figure 1 for location of reporting points

4.7.4 Impact on Timing of Peak Flows

Flow hydrographs were derived at each of the 9 reporting points located in the 1-D area identified by KBR (refer Figure 1).

In each case, hydrographs were derived for the existing case, Stage 1-3 developed case, and the ultimate case. The hydrographs are provided in Appendix A.

The graphs show that the proposed development does not have a significant impact on the timing of the peak flows at all locations of interest and therefore no significant impact on current warning times with respect to flooding of downstream areas.

4.7.5 Flood Levels at Nearby Residences

For consistency with previous reports, flood levels have also been calculated at each of the nearby residences to the SUCE area. The location of these residences/buildings is shown on Figure 1.

Table 4-9 lists the floor/ground level applicable to each location, together with the peak flood levels calculated for the 100 and 20 year recurrence interval events.

With reference to Table 4-9, the location of buildings in most cases is such that the building is not affected by flooding (hence the N/A value). In those cases where a building is potentially affected by flooding, the development does not increase flood levels.

Further, agreement has been reached with the owner of BLD1 and BLD2 (immediately upstream of Barrams Road on the western side of Bundamba Creek) in relation to the acceptance of the increase in level noted for BLD1 due to the fact that the developed case flood level is approximately a metre below the floor level of BLD1 and the flood immunity of the building is adequate given the freeboard typically adopted to the 100 year flood level.

It is therefore considered that the development is acceptable with respect to existing residences.

Table 4-9 Flood Level Comparison at Nearby Building Locations

Building	Floor /Ground Level (mAHD)	100 Year Peak Flood Level (mAHD)			20 Year Peak Flood Level (mAHD)		
		Existing	Stages 1-3	Ultimate Case	Existing	Stages 1-3	Ultimate Case
BLD1	46.22 (floor)	45.13	45.26	45.26	45.02	N/A	N/A
BLD2	45.95 (floor)	N/A	N/A	N/A	N/A	N/A	N/A
BLD3	46.59	46.73	46.73	46.73	N/A	N/A	N/A
BLD4	47.60	N/A	N/A	N/A	N/A	N/A	N/A
BLD5	48.21	48.14	48.14	48.14	N/A	N/A	N/A
BLD6	50.54	N/A	N/A	N/A	N/A	N/A	N/A
BLD7	55.16	N/A	N/A	N/A	N/A	N/A	N/A

Note: Refer to Figure 1 for location of reporting points.
N/A indicates no flooding at site for event being considered.

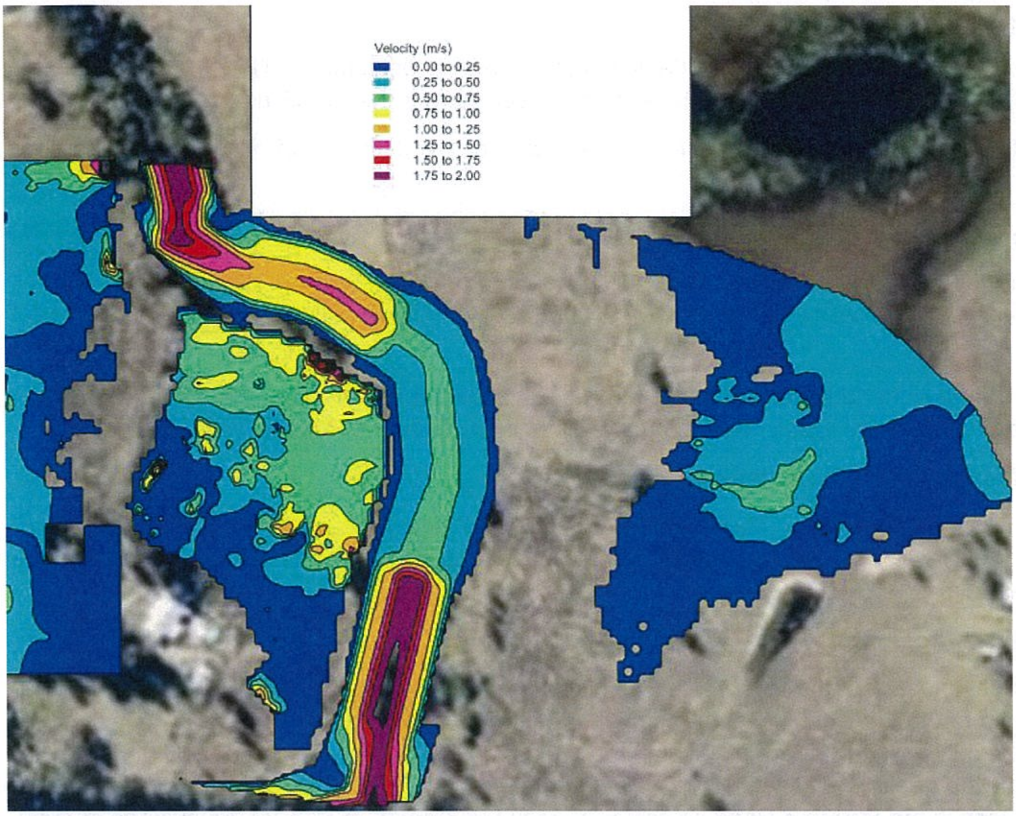
4.7.6 Velocity at Outlet of Southern Basin

Flow will be discharged from the regional basin to the south of Barrams Road via a number of culverts. The calculated peak velocity in the culverts for the 100 year event is 2.7 m/s. This value is well below the velocity nominated in the information request (refer Section 2.1.7) which was based on modelling that is now superseded.

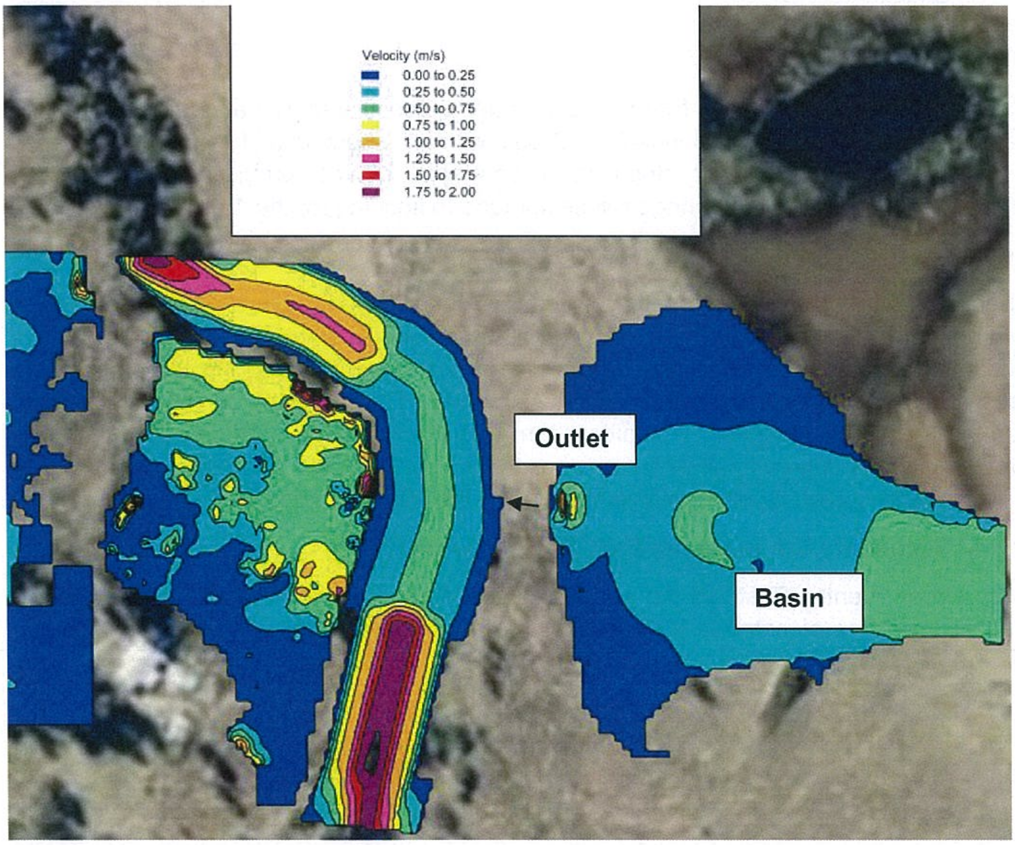
The plots below show the peak velocity map for the 100 year event for existing and developed cases. It can be noted that the velocity in the main channel of the creek is reduced due to a significant outbreak flow that occurs from a point upstream of the point of discharge from the basin. The velocity of discharge from the basin (allowing for the rapid reduction in velocity that will occur downstream of the basin outlet) is comparable with that obtained within the creek.

The outlet from the basin will need to be appropriately protected. It is considered that the provision of protection for the outlet can be readily achieved, even given the soil types present in the area. For example, a 150 mm thick Reno mattress with a rock size less than 100 mm would be able to withstand the predicted velocity.

Ultimately, the extent and type of protection provided at the outlet will be the subject of detailed design. It is expected that the design will involve setting up a local model of the area with a reduced grid size and considering both discharge from the basin in isolation (i.e. without significant flow in the creek) and with flow in Bundamba Creek. Based on this work, the extent of protection can be accurately determined.



Peak Velocities- Existing Case 100 Year Event



Peak Velocities- Developed Case 100 Year Event

4.7.7 Final Development Levels

As noted in Section 4.4, the developed case model was conservatively adjusted to allow the calculation of flood levels suitable for the definition of minimum lot and floor levels across the SUCE development.

The peak flood levels calculated for the 100 year event suitable for the definition of minimum lot and floor levels are presented in Figure 6.

4.7.8 Emergency Access to Site Via Barrams Road

In the early stages of development, access to the Secondary Urban Centre East will be achieved from the Centenary Highway via Ripley Road and Barrams Road. Emergency access will also need to be achieved by this route.

Based on the detailed modelling described in this report, both the Centenary Highway and Ripley Road are immune to flooding for the 100 year event. The immunity achieved by Barrams Road is discussed below.

- **Ripley Road and Barrams Road Intersection**

  The existing ground level at the intersection of Ripley Road and Barrams Road is of the order of 46.3 mAHD. This level is well above the 100 year flood level and the intersection will have immunity to the 100 year event.

- **Western Culvert Crossing**

  As noted in Section 4.6.1 of the report, a set of culverts will be provided to allow for the drainage of the local catchment to the west of Bundamba Creek that drains across Barrams Road. The level of the soffit of the culvert (allowing for a link slab in the final design) will be approximately 44.8 mAHD. In comparison, the peak flood level for the 100 year event at this point is 45.4 mAHD. The need to allow for services in the Barrams Road crossing will result in a depth of fill over the culverts of more than 600 mm. Consequently, the minimum road level at the western culvert crossing will be higher than the 100 year flood level.

- **Main Creek Crossing**

  With reference to Section 4.6.1, allowing for the structure depth associated with a 25 metre span, the road level at the main crossing of Bundamba Creek will be approximately 45.9 mAHD. In comparison, the calculated 100 year flood level upstream of the bridge is 44.8 mAHD. Consequently, the road crossing of the bridge will be immune to flooding for the 100 year event.

- **Eastern Culvert Crossing**

  As noted in Section 4.6.1 of the report, a set of culverts will be provided to allow for the drainage of the local catchment to the east of Bundamba Creek that drains across Barrams Road. The level of the soffit of the culvert (allowing for link slabs) will be approximately 45.3 mAHD. In comparison, the peak flood level for the 100 year event at this point is 45 mAHD. The top of the culvert will therefore be higher than the 100 year flood level. In addition, similar to the western culvert crossing, there will be a need for fill above the culvert to allow for services in the road corridor. Therefore, the minimum road level at the western culvert crossing will be higher than the 100 year flood level.

- **Point of Entry to Secondary Urban Centre East (Edge of floodplain)**

  The Secondary Urban Centre East will be set above the 100 year flood level. Consequently, Barrams Road at the point of entry to the Secondary Urban Centre East will have immunity to flooding for the 100 year event.

In summary, based on the flood modelling detailed in this report, the Barrams Road connection to the Secondary Urban Centre East from Ripley Road will be immune to flooding for the 100 year flood event. Consequently, it can be concluded that appropriate emergency access to the Secondary Urban Centre East can be achieved.

4.7.9 Immunity of Park Areas

Open Space areas will achieve the flood immunity levels required by the ULDA *Park Planning and Design Guidelines* of November 2011. In particular, the following will be achieved:

- Recreation parks will have a maximum of 30 percent of any park below the 5 year ARI flood level;
- Sports parks will have 20 year ARI flood immunity (including the sports fields to the north of Barrams Road); and
- Clubhouses, courts, toilets and amenities blocks and other buildings have 100 year ARI flood immunity.

It can be noted that these immunity levels were conservatively based on dense revegetation of the waterway corridor which resulted in higher flood levels than those derived using the model as supplied by Council.

For the district recreational parks to the north of Barrams Road bridge, a maximum depth of 0.7 metres was obtained for the 100 year event together with a depth velocity product significantly less than the recommended limit of 0.6 m^2/s.

The peak depth of flooding for the district sports park was found to be 0.25 m for the 100 year event. The depth velocity product for the 100 year event is significantly less than 0.6 m^2/s.

The district playground area has a maximum depth of 0.2 metres for the 100 year event and a depth velocity product significantly less than 0.6 m^2/s. The playground area has immunity to the 50 year event.

The major sports park will achieve relevant flood risk performance criteria required by the guidelines, with a peak depth during the 100 year event of 0.65 metres and a depth velocity product less than 0.6 m^2/s.

Given these results, it is considered that there will be ample opportunity for evacuation and that the flood depths associated with the 100 year event will not pose a significant flood risk. Further, rainfall sufficient to cause flooding of Bundamba Creek would also be expected to cause people (and particularly young children) to leave the open space areas prior to the peak flow occurring in the creek.

Further, it is not expected that the sportsground would be in use should a rainfall event sufficient to cause flooding occur. Those sports that are played in the rain (e.g. rugby) are typically winter sports and major flooding would not be expected in the winter months. The summer sports (e.g. cricket) tend to be cancelled in the event of rainfall. It is therefore reasonable to assume that the sports fields would not be in use if a flood were to occur.

5 Conclusion

Detailed modelling has been completed in support of the development of the AMEX Secondary Urban Centre East site.

This modelling, which has been completed using the calibrated model of Bundamba Creek provided by Ipswich City Council, has indicated that development can proceed without producing a significant change in flood level external to the site and certainly no change in level sufficient to cause an actionable nuisance.

Further, the development will not produce any significant change in the rate of rise or peak flood level in downstream areas, thereby protecting existing flood immunity and flood warning times.

Finally, the development and its associated open space areas achieve the levels of flood immunity required under ULDA guidelines. This includes the Barrams Road crossing of Bundamba Creek, which will be immune to flooding for the 100 year event.

Given this, it is considered that the development can proceed as proposed and will not produce unacceptable impacts with respect to flooding.

Ripley Valley Secondary Urban Centre East

FIGURES

Figure 1 Location of Site and Catchment Control Points

Figure 2 Catchment Plan

Figure 3 Stages 1 to 3 Developed Site

Figure 4 Ultimate Case Developed Site

Figure 5 North-Eastern Detention Basins

Figure 6 Development Levels

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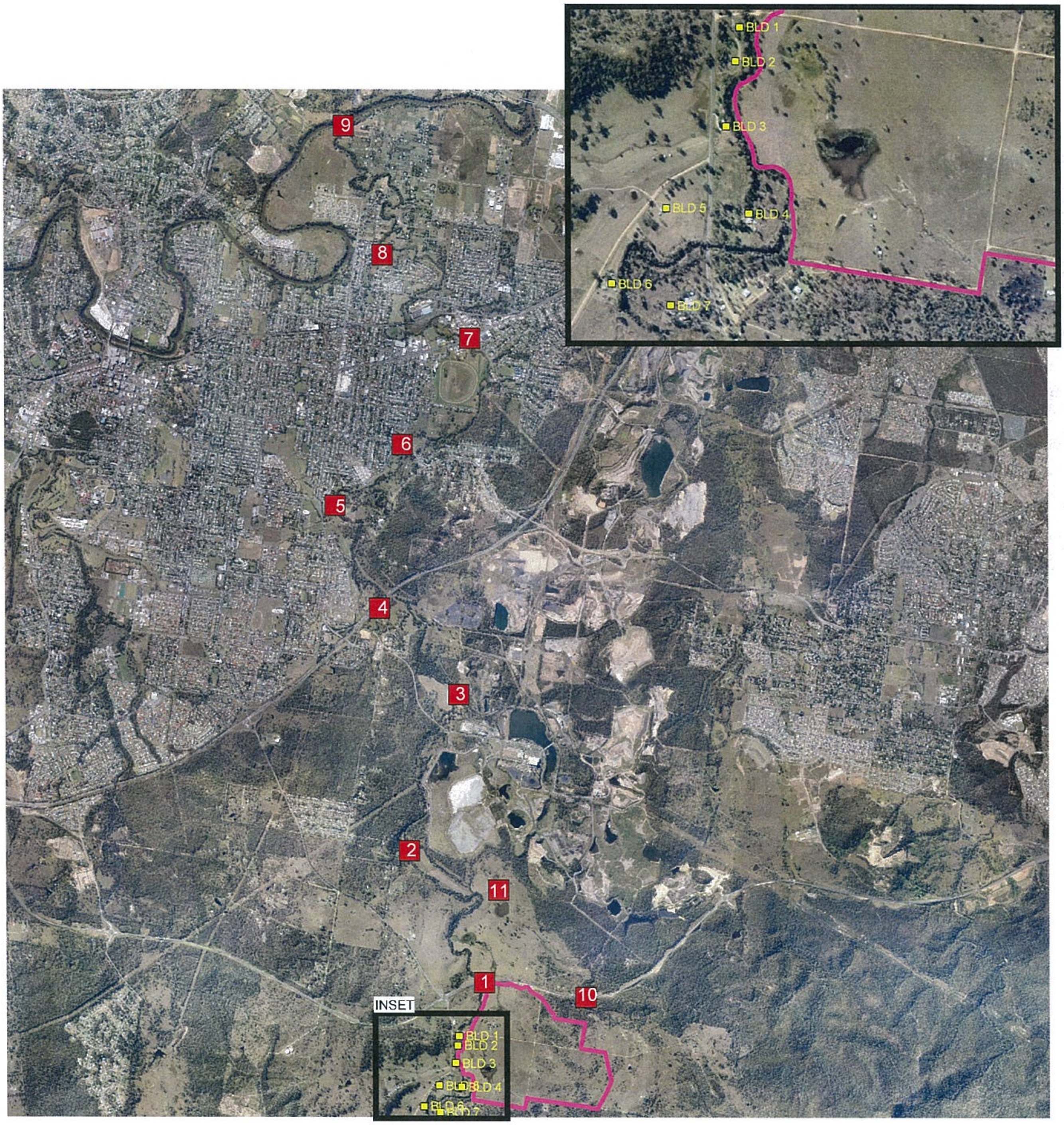

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Project No:	7901-47-027
Date:	12 December 2012
Revision Number:	1
Designed by:	NE
Client Name:	Amex Corporation Pty Ltd

LEGEND

- Existing Building
- Catchment Control Point
- Secondary Urban Centre East

N W E S

Figure 1

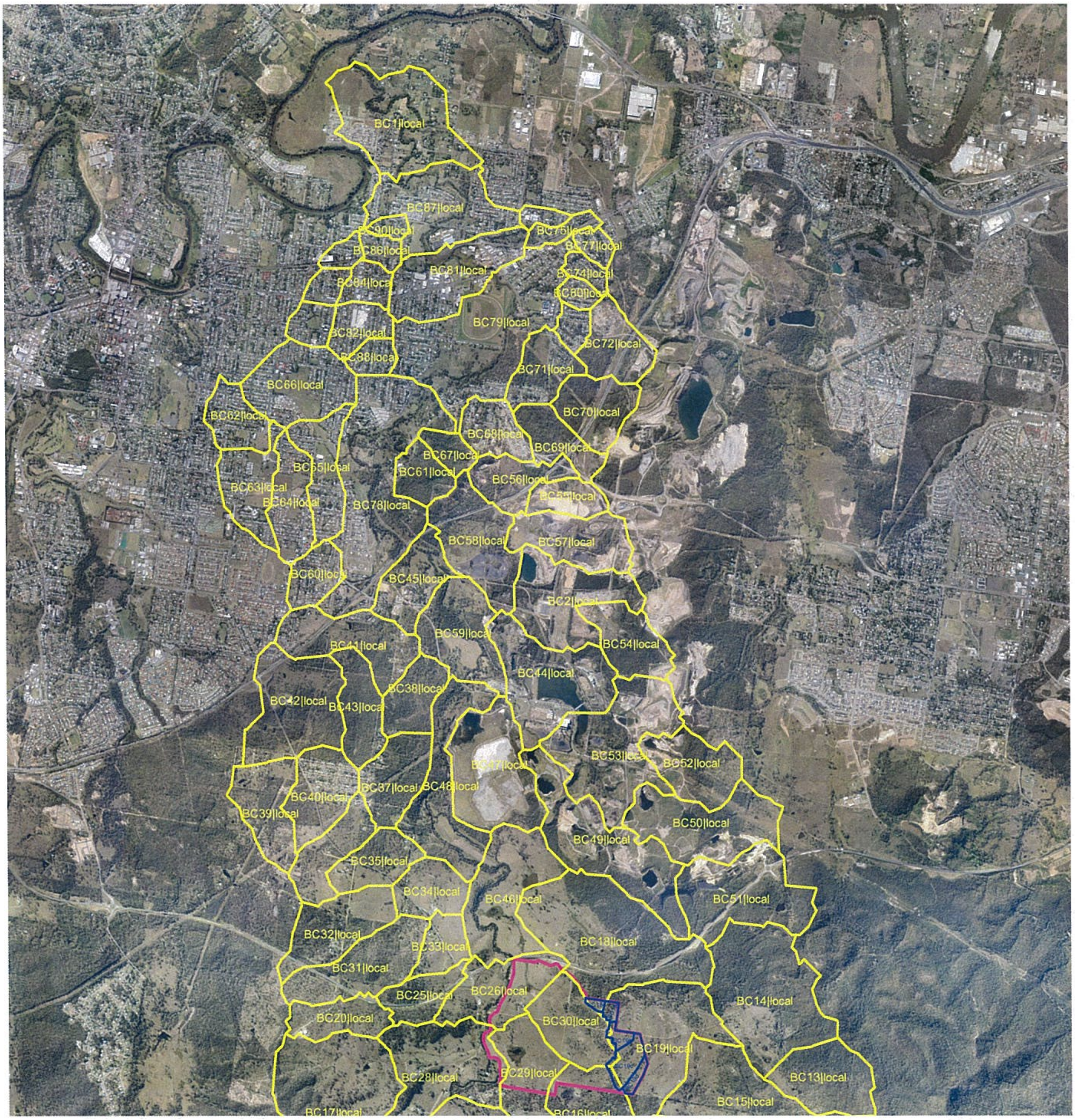
Location of Site and Catchment Control Points

Ripley Valley Secondary Urban Centre East

Scale: 1:50,000

500 0 500 1000 1500
Metres

File Path: O:\7901-47-027 Amex West\Map\Info\Flood Study\SUCE\Figure 1



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LEGEND

N W E S

- North East Catchments
- Catchment Boundary
- Subject Site

Figure 2

Catchments Plan for Dowstream of Site

Ripley Valley Secondary Urban Centre East

Scale: 1:50,000

500 0 500 1000 1500

Metres

O:\7901-47-027 Amex West\Mapinfo\Flood Study\SUCE\Figure 3

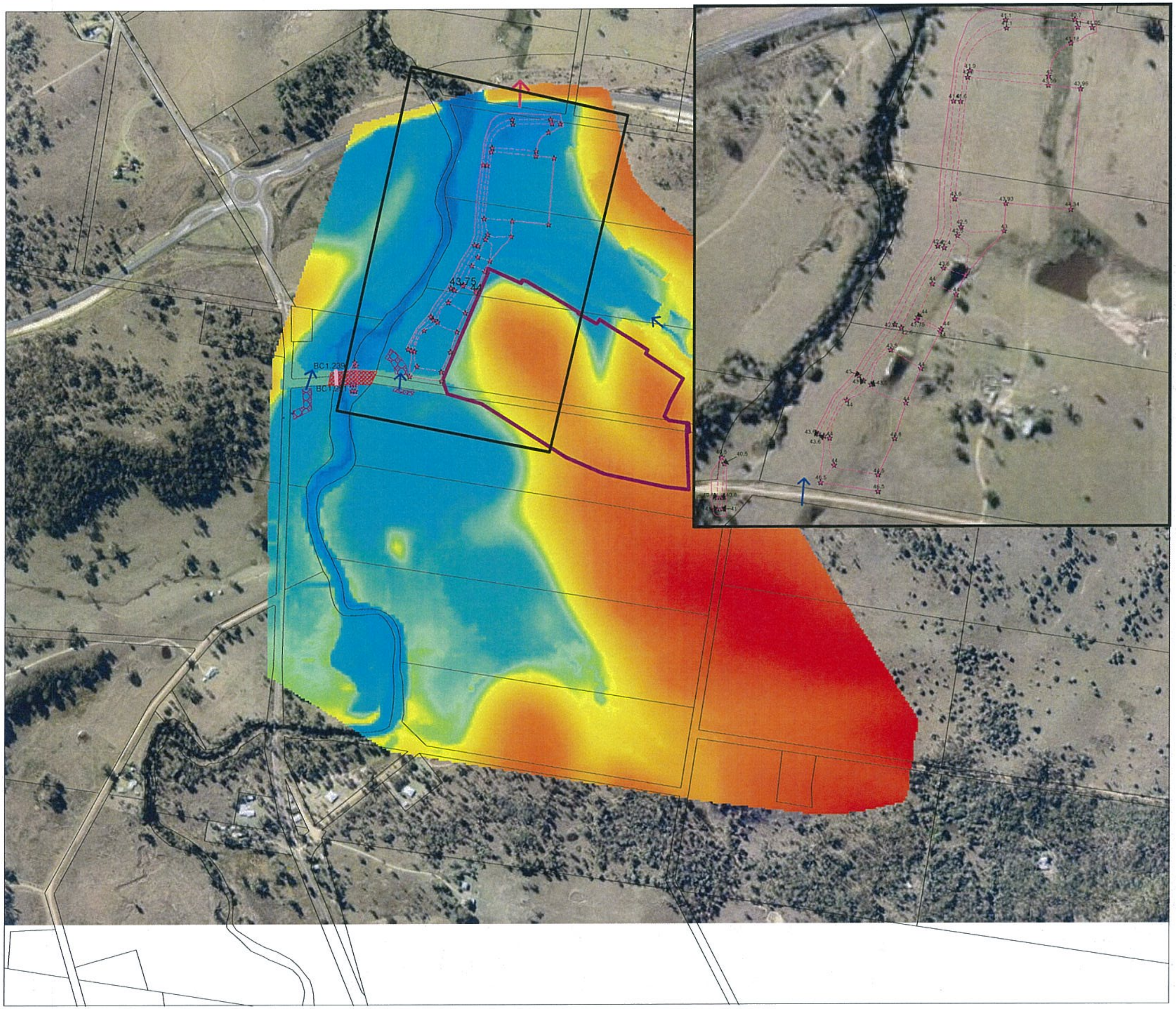

Figure 3 Stages 1 to 3 Developed Site

Ripley Valley Secondary Urban Centre East

LEGEND

Landscape

- Proposed Level
- Level Line
- Boundary
- Proposed Bridge
- Culvert
- Drainage Channel
- Stage 1-3
- Existing 1200mm Culvert
- BC1.251 BC1.239 Barrams Bridge Channel

Ground Elevation(mAHD)

- 30 to 35
- 35 to 40
- 40 to 45
- 45 to 50
- 50 to 55
- 55 to 60
- 60 to 65
- 65 to 70
- 70 to 75
- 75 to 80
- 80 to 85

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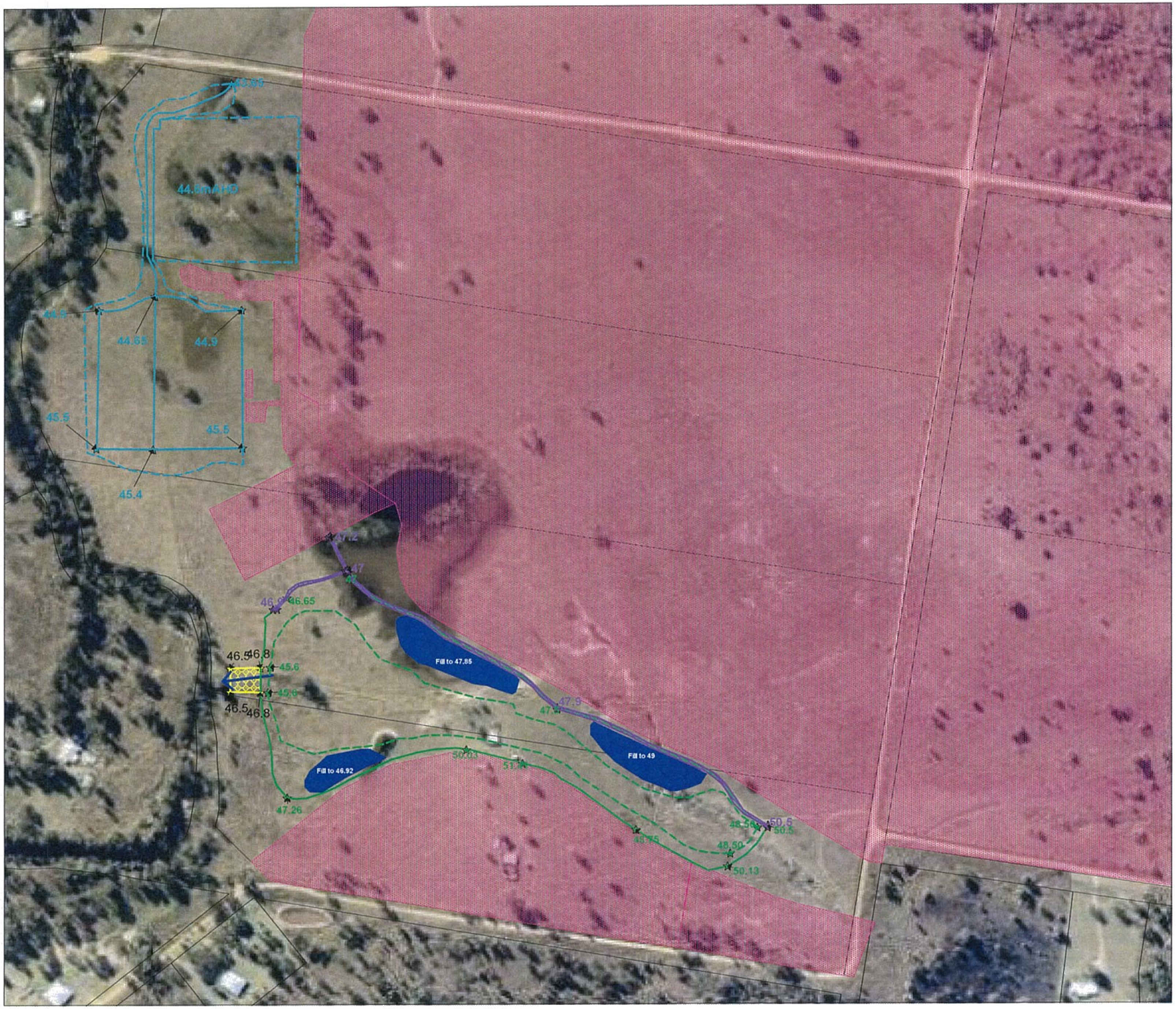

Figure 4 Ultimate Case Developed Site

Ripley Valley Secondary Urban Centre East

N W E S

LEGEND

Detention Basin
- Base and Top Levels
- Base Line
- Detention Boundary

Sport Field Excavation
- Levels
- Boundary

Spillway
- Level
- Width

Outlet Pipe

Bioretention Fill Area

Area above Creek Q100 Level

Track
- Level
- Boundary

0 100 200
meters
Scale: 1:4,000

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Date:	22 January 2013
Revision Number:	2
Designed by:	NE
Client Name:	Amex Corporation Pty Ltd

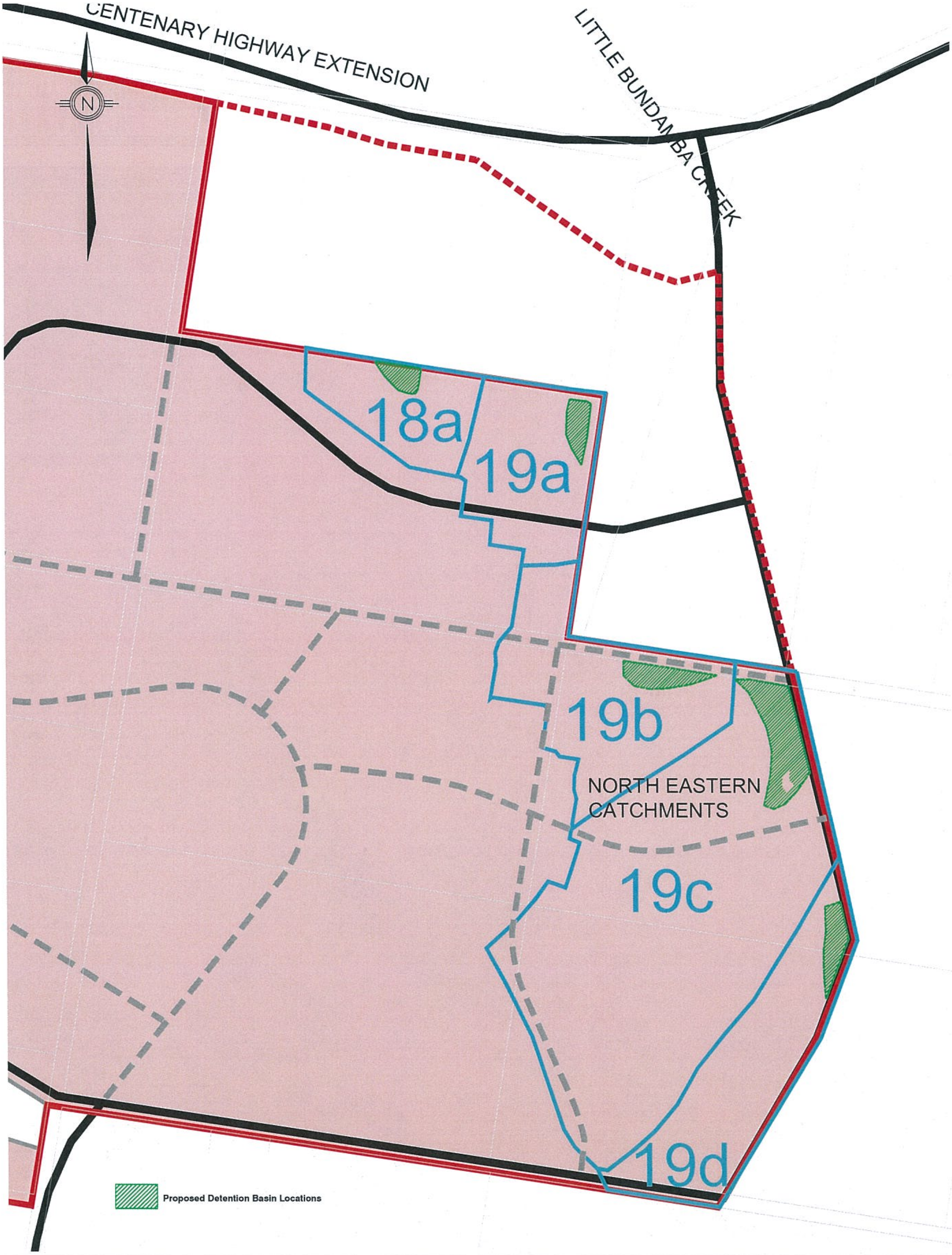

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FIGURE 5
North Eastern Detention Basins

Rev: 2 | Drawn: H.D | Checked: M.G | Date: 22/01/2013

Project No.: 7901-47

AMEX Corporation PTY LTD

PRINT DATE: 22 January, 2013 - 4:30pm

CAD FILE: O:\7901-47-027 Amex West\ACAD\SUCE\Flood Study Figures\V4\Figure 5 - North Eastern Detention Basins V4.dwg
XREF's: 6837-158F SUCE Master Concept etrans; 6837-157 SUCE Overall Base; 6837-SUCE Contours; DCDB