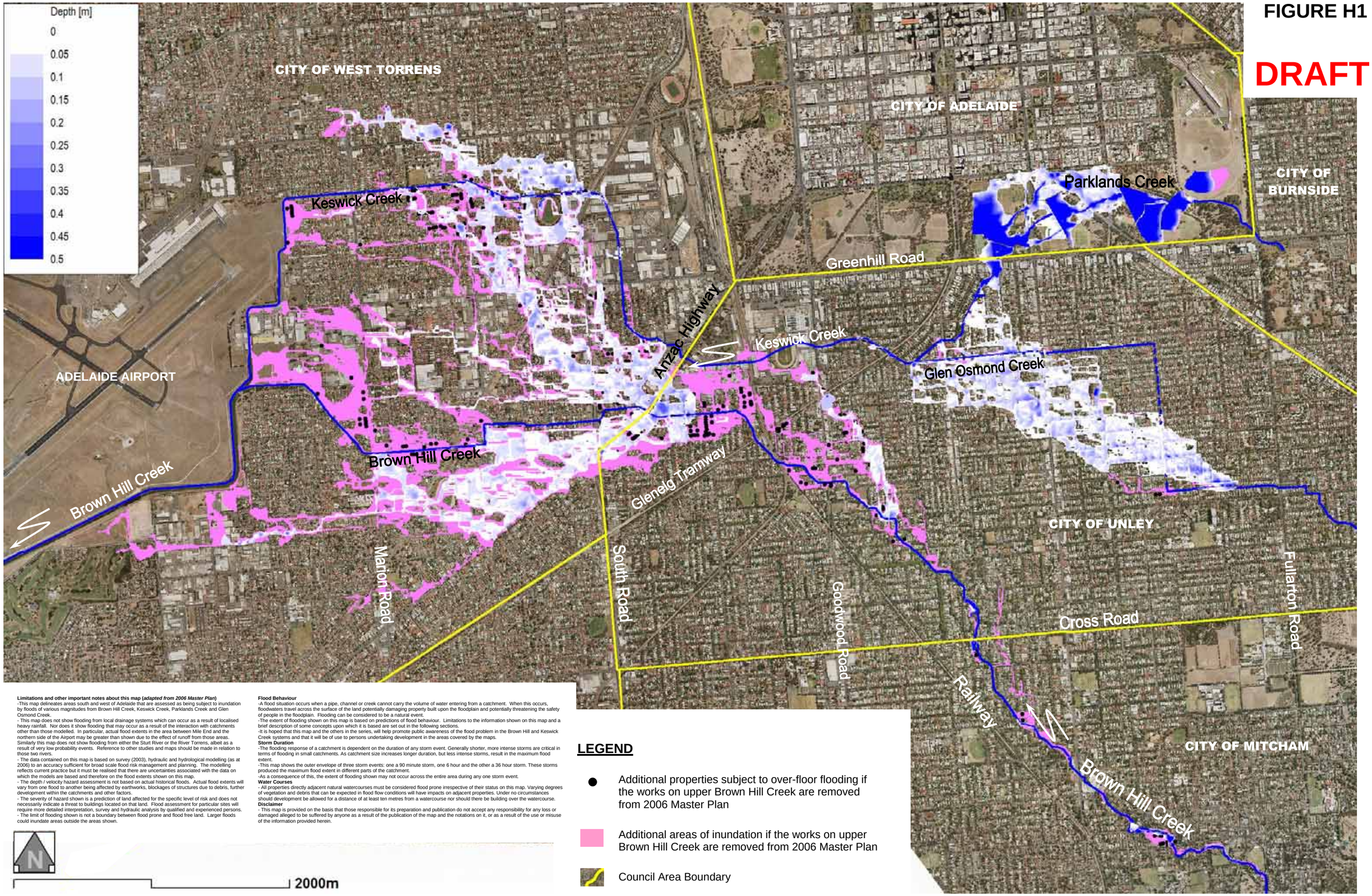
# Appendix H - Benefit-Cost Analysis for 2006 Master Plan Works on Upper Brown Hill Creek

FIGURE H1

DRAFT




**Limitations and other important notes about this map (*adapted from 2006 Master Plan*)**

-This map delineates areas south and west of Adelaide that are assessed as being subject to inundation by floods of various magnitudes from Brown Hill Creek, Keswick Creek, Parklands Creek and Glen Osmond Creek.

- This map does not show flooding from local drainage systems which can occur as a result of localised heavy rainfall. Nor does it show flooding that may occur as a result of the interaction with catchments other than those modelled. In particular, actual flood extents in the area between Mile End and the northern side of the Airport may be greater than shown due to the effect of runoff from those areas. Similarly this map does not show flooding from either the Sturt River or the River Torrens, albeit as a result of very low probability events. Reference to other studies and maps should be made in relation to those two rivers.

- The data contained on this map is based on survey (2003), hydraulic and hydrological modelling (as at 2006) to an accuracy sufficient for broad scale flood risk management and planning. The modelling reflects current practice but it must be realised that there are uncertainties associated with the data on which the models are based and therefore on the flood extents shown on this map.

- The depth / velocity hazard assessment is not based on actual historical floods. Actual flood extents will vary from one flood to another being affected by earthworks, blockages of structures due to debris, further development within the catchments and other factors.

- The severity of hazard shown is a prediction of land affected for the specific level of risk and does not necessarily indicate a threat to buildings located on that land. Flood assessment for particular sites will require more detailed interpretation, survey and hydraulic analysis by qualified and experienced persons.

- The limit of flooding shown is not a boundary between flood prone and flood free land. Larger floods could inundate areas outside the areas shown.

**Flood Behaviour**

-A flood situation occurs when a pipe, channel or creek cannot carry the volume of water entering from a catchment. When this occurs, floodwaters travel across the surface of the land potentially damaging property built upon the floodplain and potentially threatening the safety of people in the floodplain. Flooding can be considered to be a natural event.

-The extent of flooding shown on this map is based on predictions of flood behaviour. Limitations to the information shown on this map and a brief description of some concepts upon which it is based are set out in the following sections.

-It is hoped that this map and the others in the series, will help promote public awareness of the flood problem in the Brown Hill and Keswick Creek systems and that it will be of use to persons undertaking development in the areas covered by the maps.

**Storm Duration**

-The flooding response of a catchment is dependent on the duration of any storm event. Generally shorter, more intense storms are critical in terms of flooding in small catchments. As catchment size increases longer duration, but less intense storms, result in the maximum flood extent.

-This map shows the outer envelope of three storm events: one a 90 minute storm, one 6 hour and the other a 36 hour storm. These storms produced the maximum flood extent in different parts of the catchment.

-As a consequence of this, the extent of flooding shown may not occur across the entire area during any one storm event.

**Water Courses**

- All properties directly adjacent natural watercourses must be considered flood prone irrespective of their status on this map. Varying degrees of vegetation and debris that can be expected in flood flow conditions will have impacts on adjacent properties. Under no circumstances should development be allowed for a distance of at least ten metres from a watercourse nor should there be building over the watercourse.

**Disclaimer**

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## LEGEND

- Additional properties subject to over-floor flooding if the works on upper Brown Hill Creek are removed from 2006 Master Plan
- Additional areas of inundation if the works on upper Brown Hill Creek are removed from 2006 Master Plan
- Council Area Boundary

**Note:** 50 year ARI depth mapping shown is for 2006 Master Plan Works <u>with</u> the works on upper Brown Hill Creek.

Depths > 0.5 metres are shown in blue.

# 50 YEAR ARI MAPPING <u>WITH</u> VERSUS <u>WITHOUT</u> THE 2006 MASTER PLAN WORKS ON UPPER BROWN HILL CREEK

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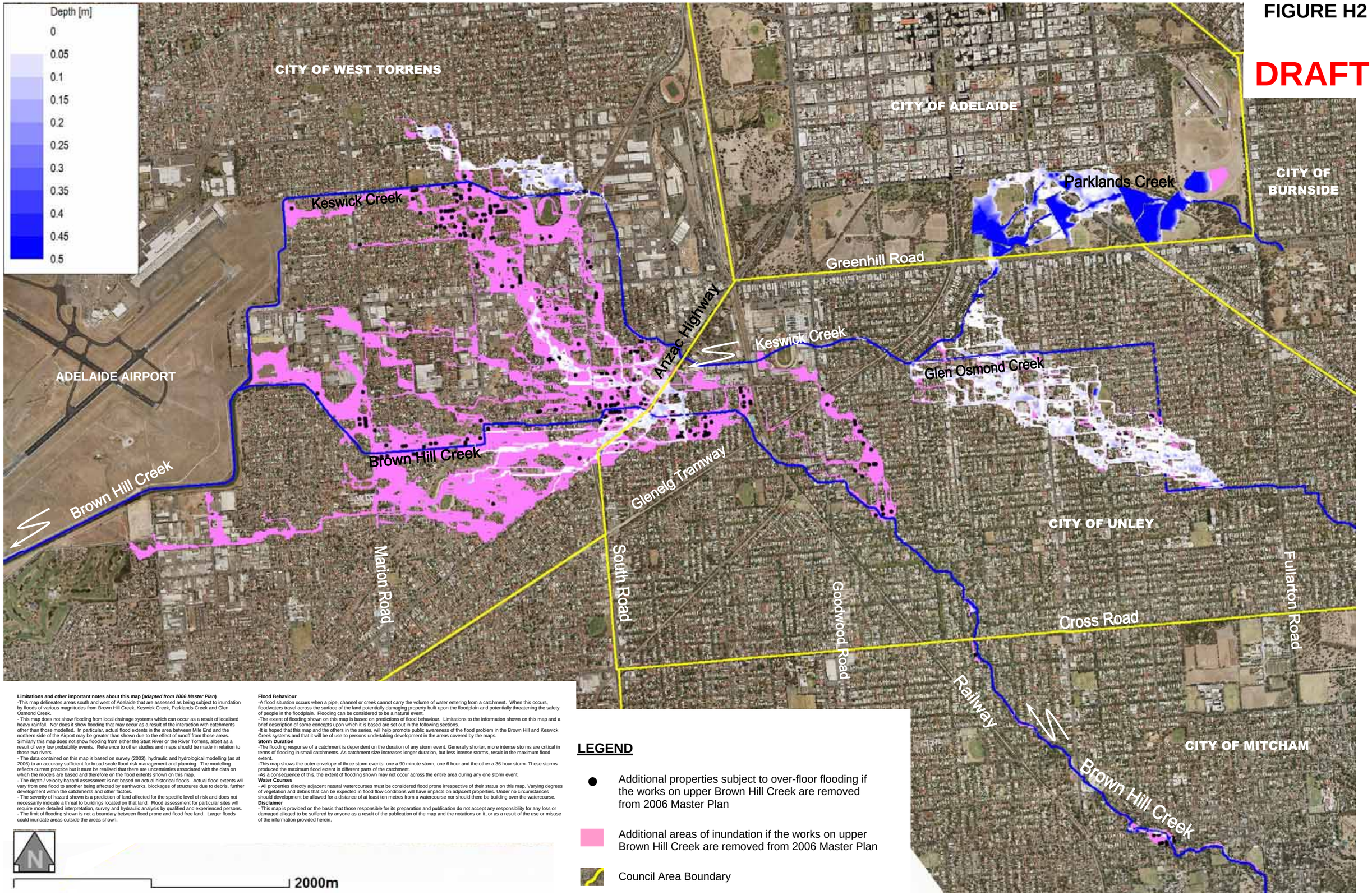
Rp301015-02356 – Brown Hill Keswick Creek SMP
fg301015-02356-110802-fig_50yrMPWvsnoMPW.doc

FIGURE H2

DRAFT

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- The data contained on this map is based on survey (2003), hydraulic and hydrological modelling (as at 2006) to an accuracy sufficient for broad scale flood risk management and planning. The modelling reflects current practice but it must be realised that there are uncertainties associated with the data on which the models are based and therefore on the flood extents shown on this map.

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**Water Courses**

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## LEGEND

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# 20 YEAR ARI MAPPING <u>WITH</u> VERSUS <u>WITHOUT</u> THE 2006 MASTER PLAN WORKS ON UPPER BROWN HILL CREEK

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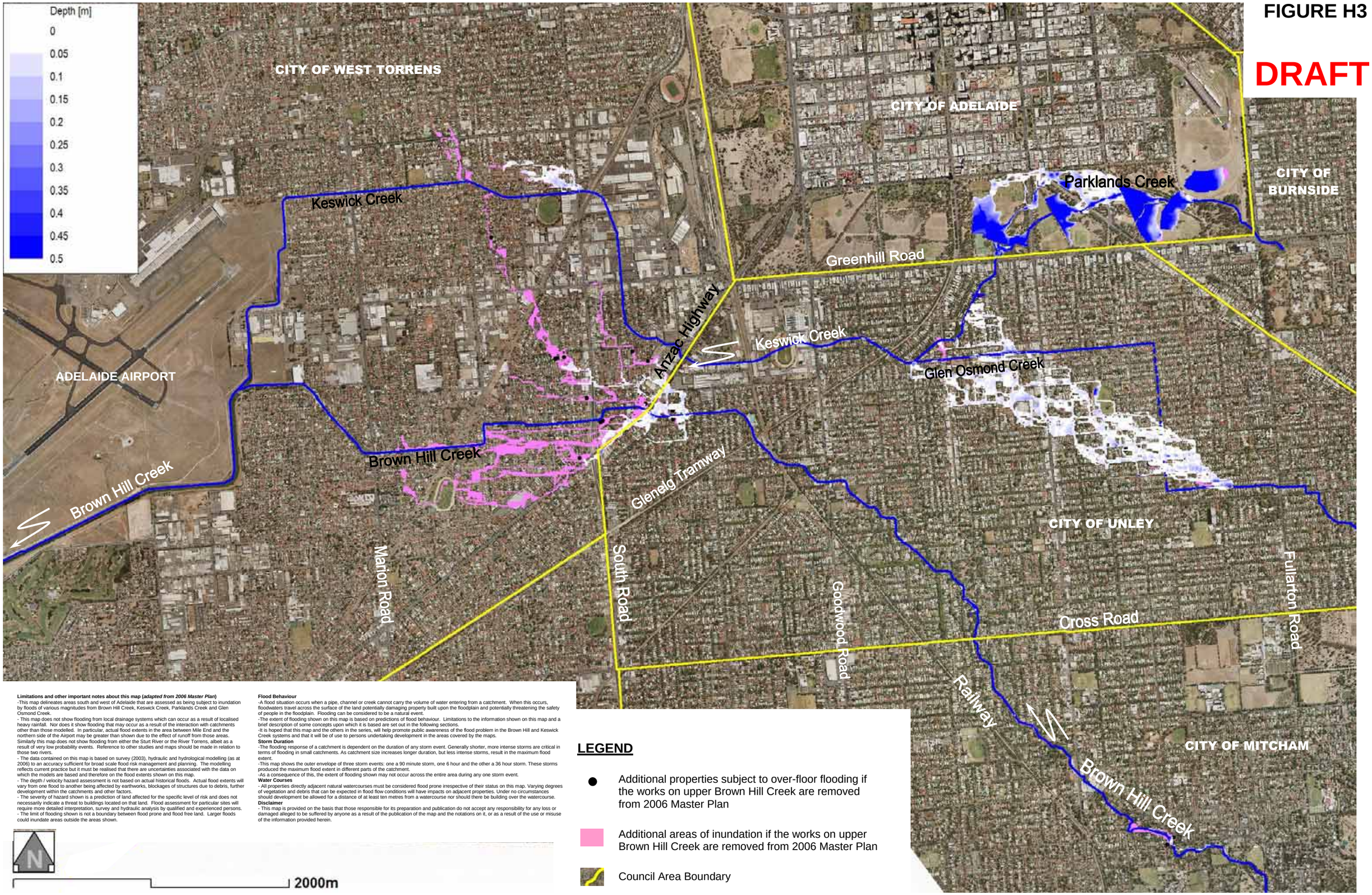
fg301015-02356-110802-fig_20yrMPWvsnoMPW.doc

FIGURE H3

DRAFT

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- The depth / velocity hazard assessment is not based on actual historical floods. Actual flood extents will vary from one flood to another being affected by earthworks, blockages of structures due to debris, further development within the catchments and other factors.

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# 10 YEAR ARI MAPPING <u>WITH</u> VERSUS <u>WITHOUT</u> THE 2006 MASTER PLAN WORKS ON UPPER BROWN HILL CREEK

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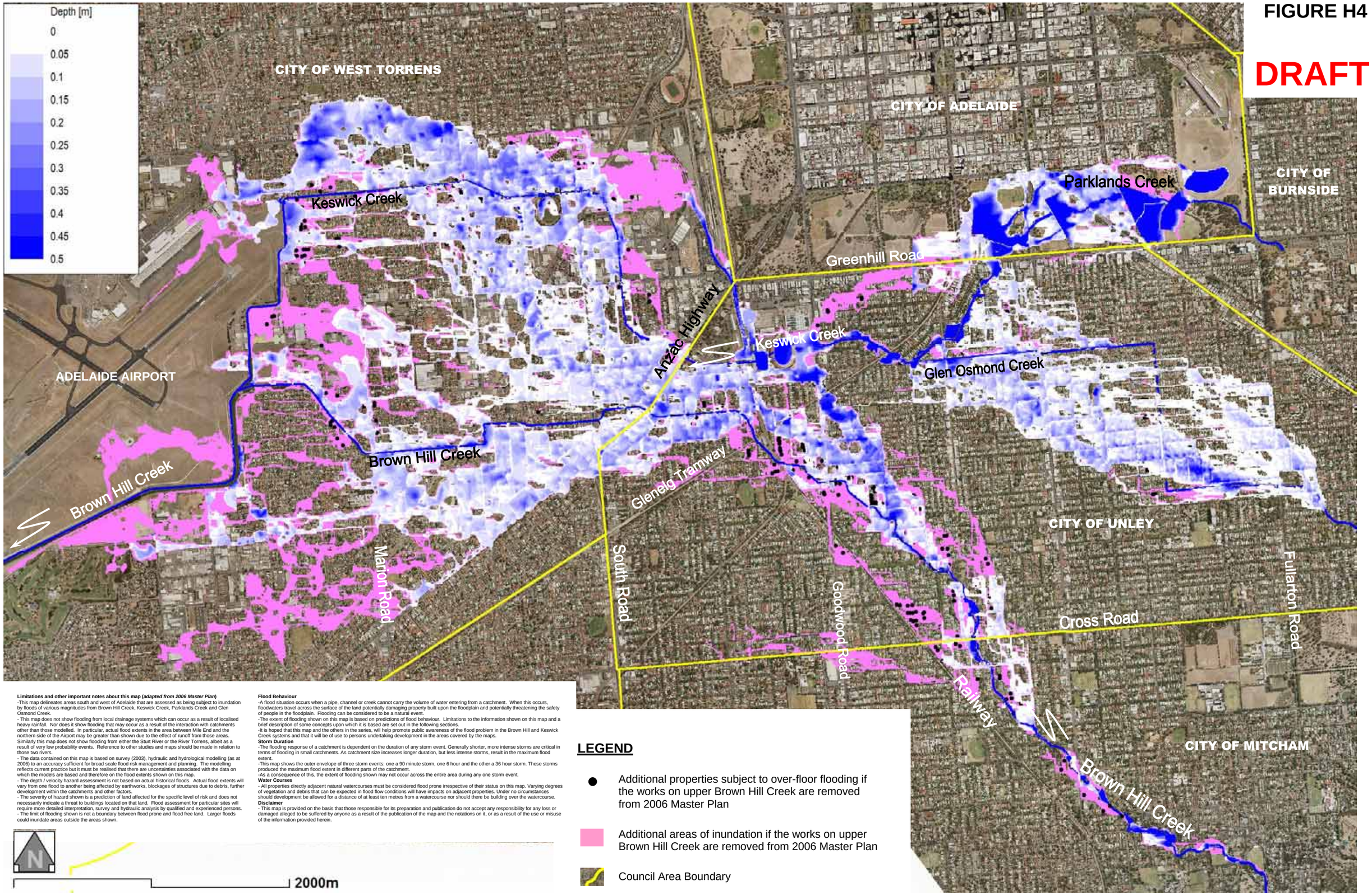
fg301015-02356-110802-fig_10yrMPWvsnoMPW.doc

FIGURE H4

DRAFT

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- Council Area Boundary

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Depths > 0.5 metres are shown in blue.

# 500 YEAR ARI MAPPING <u>WITH</u> VERSUS <u>WITHOUT</u> THE 2006 MASTER PLAN WORKS ON UPPER BROWN HILL CREEK

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# Appendix I - Multiple-Criteria Assessment for Alternative Flood Mitigation Options for Upper Brown Hill Creek

**Rating of Assessment Criteria**

**H = High**
**M = Moderate**
**L = Low**
**N = Nil**

| | Flood Mitigation Option | Key Information and Data | Significant Impacts / Comments | Reduction in Flooding Impacts | Technical Feasibility | Likely Community Acceptance | Water Quality and Reuse | Protection of Environmental Features | Improve Recreational Amenity | Opportunity to Improve Biodiversity | Approx. Cost of Works |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Upper Brown Hill Creek Detention** | | | | | | | | | | | |
| A1 | Flood control dams at Sites 2 & 4 (2006 Master Plan) | As for 2006 Master Plan. Dam 2 on north tributary is 20 metres height to spillway and 335 ML storage capacity and dam 4 on south tributary is 19 metres height with 60 ML storage capacity. Reduction in 100 year ARI peak flow from 26 to 13 $m^3/s$ at Scotch College. | Site 4 requires road access to be constructed. See notes for Site 2 in A2. Both sites are on private property and were subject to preliminary environmental and heritage investigations by GHD in 2008, which identified potential impacts that could be remedied. Visual impact may be an issue. Effective at mitigating peak rural flow over the catchment. Does not mitigate peak urban flow - with consequent flooding in Unley, spilling into West Torrens. | H | H | L | L | L | L | N | $22 M |
| A2 | Single flood control dam at Site 2 | Height to spillway 20 metres. Reduction in 100 year ARI peak flow from 26 to 16 $m^3/s$. Otherwise, as for A1. | Site 2 is located across two private properties, but with minimal impact in terms of land use. However, alternative access may need to be provided to substitute for loss of access route along the base of the valley. Preliminary investigations have been carried out (as for A1). Tillys Hill Road nearby is unaffected. Visual impact may be an issue. Mitigation impacts similar to that for A1, indicating that the dam at Site 2 provides a majority of the flow reduction afforded by the 2006 Master Plan dams. | H | H | M | L | L | L | N | $14 M |
| A3 | Single larger flood control dam at Site 2 | Height to spillway 22.5 metres and 475 ML storage volume (42% increase). Reduction in 100 year ARI peak flow from 26 to 14.9 m3/s. | The height of a dam at Site 2 can be raised by several metres without dretracting from original dam 2 characteristics. This may be a more cost effective option than a second dam. However, additional mitigation benefits are minimal compared with the significant additional storage volume provided. | H | H | L | L | L | L | N | $16 M |
| A4 | Single flood control dam at Site 1 | Height to spillway of 15 metres (smaller than original dam at Site 1 from 2005 Stage 1 Technical Report). Reduction in 100 year ARI peak flow from 26 to 11.4 m3/s. At increased spillway height of about 20 metres outflow can be reduced to about 5 m3/s. | The optimum site in terms of capturing runoff from a majority of the rural catchment - which provides better performance in reducing flows than for the Site 2 location. Situated in Brown Hill Recreation Reserve - but Park Management Plan refers to potential flood control dam. Visual impact may be an issue. Site 1 is generally more wooded than Site 2. Road relocation is likely to be required. Up to 3 or 4 private properties and dwellings may be affected by the spread of water stored temporarily behind the dam. Mitigation impacts similar and marginally better than for A1. | H | H | L | L | L | L | N | $14 M |
| A5 | Single (smaller) flood control dam at Site 1 | Height to spillway of about 12 metres, with a storage capacity of about 90ML. Reduction in 100 year ARI peak flow from 26 to 19.5 m3/s. | As for A4, the optimum site also enables the dam to have a lower height than for the Site 2 location. The height of 12 metres is about the limit at which nearby houses would not be affected by the spread of water stored temporarily behind the dam. At peak outflow of 19.5 m3/s there may still be some localised flooding adjacent to creek upstream from Belair Road. Otherwise, the dam would reduce peak rural flows to a similar level as the peak urban flow at downstream locations. | H | H | M | L | M | L | N | $10 M |
| A6 | Multiple flood control dams (10 No.) | Same as Scenario 3 of 2008 AWE report - 10 basins with storage volumes from 15 to 150 ML and dam heights from 9 to 15 metres - to reduce 100 year ARI flow at Scotch College to 13 m3/s. | The cost and environmental impact of constructing multiple structures are higher than for other dam options for no greater benefits. Refer to AWE report for further details (AWE, 2008). | H | H | L | L | L | L | N | $40 M |
| A7 | Multiple flood control dams (4 No.) | Same as Scenario 4 of 2008 AWE report - 4 basins with storage volumes from 60 to 170 ML and dam heights from 14 to 19 metres - to reduce flow at Scotch College to 13 m3/s. | As for A6. | H | H | L | L | L | L | N | $27 M |
| A8 | Proposal for flood control dams at Springwood Park Estate | 3 potential sites as identified by property manager in 2011 with dam heights of 25, 20 and 15 metres, with a combined storage of up to 400ML. Peak 100 year ARI flow of about 19 $m^3/s$ at Scotch College. | As for A6; however, benefit in reducing downstream is not as great. Significant costs for property acquistion included. | L | H | H | L | L | L | N | $50 M |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| **Minor Detention Basins** | | | | | | | | | | | |
| B1 | System of weirs at Brown Hill Creek Recreation Reserve | Up to 9 weirs ranging from 3 to 7 metres in height, with total storage capacity of 80 ML. When used in combination with flood control dam at Site 2, the peak 100 year ARI flow at Scotch College would be about 14 m3/s | Would be effective only if used in combination with a flood control dam (Site 1 or 2), hence the potential High rating for flood reduction. Weirs would be configured to minimise encroachment into public space in the recreation reserve . Their overall advantage is that they could be relatively unobtrusive in the landscape. | M/H | H | M | L | L | M | N | $9 M |
| B2 | Caravan park flood control dam (adjacent McElligots Reserve) | Would have a maximum capacity of about 120 ML. | Offers reduced benefit compared with larger dams at Sites 1 or 2 and likely to require closure of the Caravan Park and will have associated social impacts. | M | H | L | L | L | N | N | $10 M |
| B3 | Basin at Mitcham Reserve | Maximum potential capacity of about 6.5ML. | Compared to volume of flow in 100 year ARI event ~ 450ML, this basin would have minimal benefit in reducing peak flows. | L | L | L | N | L | N | N | $1 M |
| B4 | Basin at Scotch College ovals | Maximum potential capacity of about 10ML. | As for B3. | L | L | L | N | L | N | N | $1 M |
| B5 | Five basins at Soldiers Memorial Gardens / Morris / Delwood Reserves | Maximum combined capacity of about 18ML. | Would require a levee bank system around each park which may be regarded as unsightly and would restrict ease of access. Available area and potential volume are too small to have any significant benefit in mitigating the peak rural storm. VDM Consulting (2010) reported on the detention potential for these areas, from which it can be concluded that any benefits would be minimal on a whole of catchment scale. A similar conclusion can be drawn for most options involving relatively small detention basins along the urban sections of the channel. | L | M | L | N | L | N | N | $2 M |
| B6 | Basin at Orphanage Park | Maximum potential capacity of about 14ML. | Would require a levee bank system around the park which may be regarded as unsightly and would restrict ease of access. Any benefit would be to mitigate the peak urban storm only and would have minimal benefit in mitigating the peak rural storm. | L | M | L | N | L | N | N | $1 M |
| B7 | Lower and bund Heywood Park | Maximum potential capacity of about 24ML. | As for B6. | L | M | L | N | L | N | N | $1 M |
| **Channel Upgrades to Increase Capacity** | | | | | | | | | | | |
| C1 | Muggs Hill Road to George Street | Culverts under Mitcham shopping centre (35 m3/s) and Belair Road (20-25 m3/s) have adequate capacity. Otherwise unlined / private property. Existing channel capacity is rated at ~18 m3/s. | Channel may be marginally under-capacity, subject to final configuration of any upper catchment detention. This needs further detailed analysis to confirm cost. Base case peak 100 year ARI flow is 26 m3/s. Choke point near Paisley Street with house built over the channel is a source of local break-out and flooding (refer D5). Otherwise, minor works may involve vegetation management and landscaping. | L | M | L | N | M | L | N | $6 M |
| C2 | George Street to Devonshire Street | Unlined / Private property. Existing channel capacity is rated at ~22 m3/s. | Likely to accommodate peak urban flow (subject to more detailed investigation), but not peak rural flow. Floodplain mapping (100 yr ARI) shows break-out in vicinity of George Street. George Street bridge is planned to be upgraded which may alleviate the situation. With George Street bridge upgraded, there is potential that breakout could occur at downstream bridges (refer D2 for additional bridge upgrade works that may be required). | L | H | L | N | M | L | N | $3 M |
| C3 | Devonshire Street to Hampton Street | Unlined / Public reserve. Existing channel capacity is rated at ~22 m3/s. | The channel could be widened marginally, if necessary, by landscaping the banks. | L | H | M | N | M | L | N | $0.5 M |
| C4 | Hampton Street to Cross Road | Unlined / Private property. Existing channel capacity is rated at ~22 m3/s - but this is inconsistent with evidence of breakouts in this section. | A recognised problem section. VDM Consulting (2010) confirmed the potential problem along this section and discussed acquisition of adjacent properties and use of the land as a retardation basin. Upgrade works would involve concrete linig to create rectangular section 4 m wide, or wider if upper catchment detention is not used. | M | H | M | N | M | L | N | $2.8 M |
| C5 | Cross Road to Orphanage Park | Unlined / Private property. Existing channel capacity is rated at ~22 m3/s to Malcolm St, then down to 17 - 20 m3/s. Upgrade works would involve widening channel by 1 to 2 metres. | Floodplain mapping evidence of breakout between Malcolm St and Regent St. Impracticable to increase channel width to accommodate maximum design flow. Feasible in places for excess flow to bypass creek channel. Costs excluded for bridge upgrades (refer D3). | M | M | L | N | M | L | N | $8 M |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| C6 | Orphanage Park | Unlined / Public reserve.<br>Works would widen channel by 1 metre for length ~200m . | Local residents group is opposed to remedial work on the creek in the park. | M | H | L | N | M | M | N | $1 M |
| C7 | Mitchell Street to Forestville Reserve | Partially lined / Private property.<br>Works would widen channel by 1 metre and concrete lining for length > 400m . | Upgrades required between Cranbrook Avenue and the Glenelg Tramway. Impracticable to increase channel width to accommodate maximum design flow. Feasible in places for excess flow to bypass creek channel. Costs excluded for bridge upgrades at Railway, factories over the channel and the Tramway (refer D4). | M | M | L | N | M | L | N | $6 M |
| C8 | Forestville Reserve | Mainly unlined and landscaped / Public reserve. | Would be effective only if used in conjunction with other downstream upgrades. Creek in this area would lend itself to expansion in keeping with existing creek landscaping in southern half. Only minor works would be required. | M | H | M | N | M | L | N | < $0.5 M |
| C9 | Ethel Street to Leah Street | Concrete-lined / mainly public property (Unley Council). | Likely to have sufficient capacity (subject to more detailed investigation) and therefore no works required. But note requirements for bridge upgrades (refer D5). | | | | | | | | - |
| C10 | Adjacent Wilberforce Walk, between Leah St and Anzac Highway. | Channel has insufficient capacity to carry peak rural or urban flow in 100 year ARI event, leading to breakouts and overland flow across Anzac Hwy. Works would widen channel by 3 metres for ~500m length. | Creek in this area would lend itself to widening due to contiguity with Council land. Costs excluded for bridge upgrades at Anzac Highway, First and Second Avenues and works at Leah Street (refer D5). | H | H | M | N | M | M | N | $8 M |
| C11 | Full length channel upgrade | Required to accommodate: 30 m3/s at Belair Rd / 36 m3/s at Cross Rd / 37 m3/s at Goodwood Rd / 39 m3/s at Anzac Hwy | Comments for individual sections (C1 to C10) are applicable. Generally, upgrading the channel in all private properties is likely to be impracticable due to significant social impacts. Cost includes all required bridge upgrades | H | H | L | L | M | L | N | $45 M+ |
| | **Bridge / Culvert Upgrades and Choke Point Removal** | | | | | | | | | | |
| D1 | Upgrade bridges at Fife Ave and Ayr Ave to increase capacity | Fife Ave and Ayr Ave bridges are at natural low-lying areas and there is potential to raise bridge decks to increase capacity | George Street bridge to be upgraded by City of Mitcham. | M | H | H | N | M | N | N | $0.5 M |
| D2 | Upgrade bridges at between Kent St and Jervois St | Includes upgrades at 3 x pedestrian access bridges, Devonshire St and Jervois St | Existing bridges determined to be under-capacity in 100 year ARI event, which may lead to breakouts. | M | H | H | N | H | N | N | $0.8 M |
| D3 | Upgrade bridges in Unley between Cross Rd and Mitchell St | Includes upgrades at Cross Rd, Heywood Ave, Victoria Ave, Northgate, Malcolm, Avenue and Regent Streets | Sections of the channel in between bridges is privately owned and therefore upgrade of channel to match upgraded bridge capacities would be difficult (refer C5). | M | H | M | N | H | N | N | $3 M |
| D4 | Upgrade bridges in Unley between Mitchell St and Forestville Reserve | Requires upgrades at Goodwood Rd, Cranbrook Ave, Railway crossing, factory, & Tramway | Sections of the channel in between bridges is privately owned and therefore upgrade of channel to match upgraded bridge capacities would be difficult (refer C7). | M | H | M | N | H | N | N | $2.5 M |
| D5 | Upgrade bridges between Forestville Reserve and Anzac Highway to increase capacity | Requires upgrades at First and Second Avenues, Charles St and Anzac Highway | It should be noted that bridges/culverts at Third Ave and Leah Streets have been upgraded, and Ethel Street is planned to be upgraded in 2011/12. Includes some minor works at Leah Street to ensure 100 year ARI capacity. Refer C10. | H | H | H | N | H | N | N | $2 M |
| D6 | Constriction presented by house near Paisley Avenue Torrens Park, built over channel | The house restricts the capacity of the watercourse, leading to localised overtopping and inundation. | High-flow bypass is an option. This is probably more cost effective than increasing upstream dam capacity to further reduce peak flow. Base case mapping for events greater than 20 year ARI suggests that there is a problem from about this point down to Fife Avenue bridge. | M | M | M | N | M | N | N | $2 M |

**Rating of Assessment Criteria**

**H = High**
**M = Moderate**
**L = Low**
**N = Nil**

| | Flood Mitigation Option | Key Information and Data | Significant Impacts / Comments | Reduction in Flooding Impacts | Technical Feasibility | Likely Community Acceptance | Water Quality and Reuse | Protection of Environmental Features | Improve Recreational Amenity | Opportunity to Improve Biodiversity | Approx. Cost of Works |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Overland Flow Interceptors** | | | | | | | | | | |
| E1 | Glenelg Tramway interceptor | 610 metre box culvert with dimensions 2.1 x 1.8m. Flow capacity = 9 m3/s.<br>Up to 20 x 5m side entry pits along the Tramway to intercept overland flow. | Would intercept overland flow arriving at the Glenelg Tramway and feed back into the creek channel upstream from Forestville Reserve thereby minimising flooding in areas north and west of tramline. However, there would be no reduction in flooding upstream from the tramline. Option also incorporates upgrade of channel required from Leah St to Anzac Highway to 100 year ARI peak flow (costs included, refer C9 and D5). Some trees may have to be removed along Tramway. | H | M | M | N | L | N | N | $17 M |
| E2 | Leader Street interceptor (combined with Keswick Creek diversion culverts) | 400 metre section of box culvert (1.8 x 1.5m), as extention to diversion culvert along Leader St.<br>Flow capacity ~ 5 m3/s, and designed to match height of diversion culvert. | For interception system to be effective, would also require separate interceptor culvert on Third Avenue south of the creek (capacit = 4 m3/s) and a small section of channel upgrade (included in cost). Further analysis of catchment hydrology would be required to confirm that peak flow being diverted from Keswick Creek catchment would not coincide with flow to be intercepted from the Brown Hill Creek catchment. Would offer no reduction in flooding upstream from Leader Street. | H | M | M | N | M | N | N | $8 M |
| E3 | Leader Street interceptor | 1300 metre section of box culvert (1.8 x 1.8m), independent to diversion culvert along Leader St.<br>Peak flow capacity = 15 m3/s. | For interception system to be effective, would also require separate interceptor culvert on Third Avenue south of the creek (capacit = 4 m3/s) and a small section of channel upgrade (included in cost). Feasibility of this option is low due to additional relocation of services that might be required. | H | M | M | N | M | N | N | $15 M |
| E4 | Mitchell Street overland flow collector drain | 530 metre section of 700mm RCP.<br>Flow capacity = 4 m3/s. | Would serve to intercept any residual overtopping and flow down Regent St. It would feed flow back into channel at Mitchell St. | M | M | M | N | M | N | N | $1 M |
| | **Flow Diversions and High-Flow Bypass Culverts** | | | | | | | | | | |
| F1 | Divert partial flow to Sturt River catchment | Length of over 6 km and large diameter conduit along Cross Road and Anzac Highway. Assume flow diversion of up to 20 m3/s. | Lack of capacity in Sturt River system and high estimated cost precludes this option from further consideration. | H | L | M | N | M | N | N | $40 M |
| F2 | High-flow Bypass Culvert between Malcolm Street and Glenelg Tramway | 1700 metre section of box culvert (1.8 x 1.5m) to be installed along roadways to avoid private property. Peak flow capacity = 10 m3/s. | Culvert would operate during large storms to carry a portion of the total peak urban flow, thereby reducing load on section of creek between Malcolm St and Forestville Reserve. Would need to be implemented with downstream channel upgrades to ensure that breakout location is not simply transferred downstream (refer C9 and D5, costs not included). | H | H | H | N | M | N | N | $11 M |
| F3 | High-flow Bypass Culvert between Mitchell Street and the Railway | 600 metre section of box culvert (1.8 x 1.5m) to be installed along roadways to avoid private property. Peak flow capacity = 10 m3/s. | Culvert would operate during large storms to carry a portion of the total peak urban flow, thereby reducing load on section of creek between Mitchell St and the Railway. Would need to be implemented with downstream channel upgrades between the Railway and Anzac Hwy to ensure that breakout location is not simply transferred downstream (refer C9 and D5, costs not included). | H | H | H | N | M | N | N | $4 M |

**Rating of Assessment Criteria**

**H = High**
**M = Moderate**
**L = Low**
**N = Nil**

| | Flood Mitigation Option | Key Information and Data | Significant Impacts / Comments | Reduction in Flooding Impacts | Technical Feasibility | Likely Community Acceptance | Water Quality and Reuse | Protection of Environmental Features | Improve Recreational Amenity | Opportunity to Improve Biodiversity | Approx. Cost of Works |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Miscellaneous Options** | | | | | | | | | | | |
| G1 | Revegetation of cleared rural areas | Applicable for rural areas in the Upper Brown Hill Creek catchment. | Maximum 14% reduction in peak runoff would not have as much impact as dams.<br>100 year ARI - reduction in peak flow from 27 to 23 m3/s at Scotch College. Unreliable & impracticable as a sustainable measure. | L | M | H | M | H | M | H | High |
| G2 | Increased use of rainwater tanks | 10 kL tank on 1,000 properties provides 10 ML of storage maximum, assuming that tanks are empty at start of rainfall. | Work to prepare 2006 Master Plan considered the findings of Pezzanati (2003), which showed little benefit of rainwater tank storage during large storm events. Up to 10ML possible storage would not have significant benefit in reduing runoff volumes during a major storm. | L | M | M | M | H | N | N | High |
| G3 | Water sensitive urban design | Reported by VDM Consulting (2010). | Very limited areas for further application. Not expected to be significant benefit in reducing flooding during larger events. | L | H | H | H | H | N | N | High |
| G4 | Creation of creek meanders in reserves | For reserves in Mitcham: Mitcham, Soldiers Memorial, Morris and Delwood. Reserves in Unley: Heywood, Orphanage and Forestville. | Would provide little flood mitigation impact on peak flows due to relatively short length of creek in reserves and associated small areas in which to temporarily store the volume of flow | L | H | H | L | M | M | L | $0.5 M |
| G5 | Clear channel of trees and vegetation | Reports by IDA (2000) and Tonkin (2008) confirm ingress of trees and vegetation. Current state of channels being investigated by AMLR NRM Board | Would have medium mitigation impact if completed in conjunction with other measures. Would require significant consultation with private property owners / Property owners may value vegetation overgrowth and exotic trees (refer H2) | L/M | H | L | L | M | L | N | TBA |
| G6 | Raise floors for properties at high risk | Required raising of floor levels would be > 1m in some areas of West Torrens. Impractical and costly to implement. | Floodplain flow patterns not improved. Would minimise damage to buildings that are raised, but it would take a very long time to fully implement. Good practice is to have habitable floor levels 300 mm above 100 year ARI level. Better to adopt for new houses and developments (refer H4). | L | L | L | L | L | L | N | High |
| **Non-structural Options** | | | | | | | | | | | |
| H1 | Purchase properties at high risk | Would require purchase of several properties along the creek channels and in other high hazard areas. Impractical and costly to implement. | In terms of the concept planning level of detail for the SMP, the purchase of high risk properties as a flood mitigation measure would not be economical compared with other measures. A small number of full or partial acquisitions may be necessary to accommodate infrastructure works. VDM Consulting (2010) identified high risk properties between Hampton Street and Cross Road in which the channel has been identified for upgrading (refer C4). | L | H | L | L | L | M | L | High |
| H2 | Clarifying responsibilities for ensuring appropriate channel maintenance. Potential measures:<br>- regular surveys of creek condition<br>- offer maintenance services to landowners<br>- offer to aquire easement over the watercourse | Reports by IDA (2000) and Tonkin (2008) confirm poor state of maintenance. Legislation:<br>NRM Act - sections 31 and 131<br>Local Govt Act - Schedule 1A - section 21<br>It is noted that statutory power already exists for the State to maintain lower Brown Hill Creek and Keswick Creek | Issues include:<br>- Agreement as to meaning of satisfactory maintenance (i.e., maintaining a watercourse in 'good condition')<br>- Public control over a watercourse in private property - through land acquisition or creation of an easement<br>- Responsibility for on-going maintenance, as between private owner or public authority<br>- Poor condition of watercourse downstream can adversey impact upstream areas<br>- Political difficulties in implementation but potential long term social and environmental benefits for upper Brown Hill Creek<br>- extensive consultation required with landowners for each instance of easement acquisition | M | H | M/L | H | H | M | M | TBA |
| H3 | Flood awareness and warning | Increasing flood awareness and preparedness through continuation and improvement of the FloodSafe Program | Interviews with residents affected by flooding in 2005 showed that most could not recall being visited by SES as part of the FloodSafe program (Tonkin, 2011), which implies that they did not act in contacting SES on receiving the FloodSafe information pack from Council. Improvements could be made to FloodSafe to make it more effective in terms of consultation and communication. | M | H | H | N | N | N | N | $100 K / year |
| H4 | Implementation of the new Emergency Response Plan being prepared by SES | The SES is consulting the five catchment councils, the BOM and the Adelaide and Mount Lofty Ranges NRM Board as part of development of the plan. It is expected to be completed later this year and will be tested through desktop simulations and field exercises (Tonkin, 2011). | It is envisaged that this Emergency Response Plan would complement any existing internal flood and storm response plans that are currently in use by the catchment councils. | M | H | H | N | N | N | N | TBA |
| H5 | Building regulations (flood proofing or flood protection measures) and appropriate Planning Policy to incorporate WSUD as part of new developments | Planning policy and development assessment is discussed in Stage 1 Technical Report (2005). Councils' Development Plans have general policies relating to flood protection based on the 100 year ARI criteria, although the design standard can vary from council to council. | It is beyond the scope of this analysis to recommend any specific changes to councils' DPs. Councils are to consider a review of development assessment method as per recent City of Unley report (Tonkin, 2010). Effort/cost for any changes to Development Plans would be borne by individual councils. | H | H | M | N | M | N | N | NA |

# Appendix J - Alternative Flood Mitigation Scenarios for Upper Brown Hill Creek

# J. MITIGATION SCENARIOS 1 – 7 AND 9

## J.1 SCENARIO 1 – FLOOD CONTROL DAM AT SITE 1 (15 M SPILLWAY HEIGHT)

This mitigation scenario involves the construction of a single flood control dam at Site 1, within the Brown Hill Creek Recreation Reserve. The approximate location of the dam is shown in **Figure 19**.

As shown in **Figure 13**, a dam at Site 1 would capture the largest proportion of the catchment area relative to other upper catchment detention options, thereby providing the most effective detention method for reducing peak flow from the upper catchment (*during a 36 hour storm*).

A dam at Site 1 with a spillway height of about 19 metres was originally investigated as part of the *Stage 1 Technical Report* (*2005*). This mitigation scenario was re-visited, while also considering the potential to reduce the size of such a dam, thereby reducing the cost and construction impacts.

Key features include the following:

- Height of dam to spillway level is 15 metres, which represents the peak level of storage during the 100 year ARI 36 hour storm. The approximate crest length is 125 metres.
- Storage volume at the spillway level is approximately 400 ML.
- Storage of runoff would be temporary and the dam would otherwise be empty under normal seasonal weather conditions.
- The dam orifice diameter is 1050 mm to control the rate of discharge during events up to and including the 100 year ARI storm.
- The form of the dam and spillway (*including construction method, materials and geometry*) is subject to further detailed investigations.
- The spillway would be designed considering the Probable Maximum Flood (*PMF*).
- While the objective should be to make the dam as unobtrusive as possible, spillway arrangements are a major consideration in the final form and layout of the works.
- The existing Brown Hill Creek Road would have to be relocated further south up the side of the hill to above the maximum storage level.
- Acquisition is required of three private properties (*including houses*) that are within the temporary storage area of the dam for the 100 year ARI flood.
- Department of Environment, Water and Natural Resources (*DEWNR*) is custodian of the recreation reserve. The Brown Hill Creek Recreation Park Management Plan contemplates that a flood control dam may have to be located within the reserve.
- Relevant Commonwealth and State Government approvals would be required for any action that may have significant ecological or heritage impacts. Preliminary advice from DEWNR indicates

that there are no threatened vegetation communities or high value habitat at risk in the immediate area.

- The capital cost is estimated to be approximately **$14.1M** (*refer to* **Appendix J1** *for a cost break-down*), based on an earth embankment design.
- The Hampton Street to Cross Road channel upgrade (*refer Section 9.1.2*) would be retained as a component of this mitigation scenario. The estimated cost is approximately **$2.4M** (*refer to* **Appendix J2**).

### J.1.1 Impact on Peak Flows

A summary of the impact that the dam would have in reducing flows for the 100 year ARI storm is provided in **Table J1**.

The flows contained in **Table J1** (*and similar subsequent tables*) are based on the assumption that flow down through the floodplain is contained within the channel and flow is not lost from the system; i.e. it indicates the required flow conveyance of the channel to avoid spillage onto the floodplain.

As shown in the table, the proposed dam would offer significant benefit in reducing downstream flows during the 36 hour storm and also in reducing the potential volume that would overtop the channel.



**TABLE J1 FLOW REDUCTION AFFORDED BY FLOOD CONTROL DAM AT SITE 1**

| LOCATION | PEAK FLOW DURING 36 HOUR STORM *($m^3/s$)* | | |
|---|---|---|---|
| | BASE CASE *(no dams)* | DAM AT SITE 1 *(15 m spillway height)* | REDUCTION |
| Scotch College | 26.1 | 11.4 | 14.7 |
| Belair Road | 30.2 | 14.1 | 16.1 |
| Cross Road | 36.4 | 20.2 | 16.2 |
| Goodwood Road | 37.1 | 20.7 | 16.4 |
| Hydrograph volume above 18 $m^3/s$ at Goodwood Road | 250 ML | 14 ML | 236 ML |
| Anzac Highway | 38.9 | 22.9 | 16.0 |

### J.1.2 Reduction in 100 Year ARI Flood Damages

A 15 metre high flood control dam at Site 1 significantly reduces the 100 year ARI flood extent and provides increased flood mitigation compared with the combination of dams at Sites 2 and 4, as included in the 2006 Master Plan.

Despite this improvement, overtopping of the Brown Hill Creek channel would still occur at locations between Forestville Reserve and the Anzac Highway, leading to overland flow across the Highway and into West Torrens. Breakout would also occur in the vicinity of Regent Street, Millswood.

It is estimated that the dam would reduce the 100 year ARI damage bill to **$28.9M**, which is a saving of approximately **$149M** compared with the Base Case damages estimate of **$178M**.

### J.1.3 Summary

A dam at Site 1 (*15 metre spillway height*) is a viable engineering option, and is the optimal site in terms of detention effectiveness in reducing downstream flows due to peak runoff from the rural part of the catchment. However, by itself it does not address all flooding that emanates from Brown Hill Creek upstream of Anzac Highway.



## J.2 SCENARIO 2 – FLOOD CONTROL DAM AT SITE 2 (20 M SPILLWAY HEIGHT)

This mitigation scenario would involve the construction of a single flood control dam at Site 2, as included in the 2006 Master Plan but excluding the dam at Site 4. Based on hydrologic modelling, the dam at Site 2 provides a majority of the detention benefit afforded by the 2006 Master Plan dams.

The location of the dam at Site 2 is shown in **Figure 19**. A summary of the proposed works is as follows:

- Height of dam to spillway level is 20 metres, which represents the peak level of storage during the 100 year ARI 36 hour storm. The approximate crest length is 160 metres.
- Storage volume at the spillway level is approximately 335 ML.
- Storage of runoff would be temporary and the dam would otherwise be empty under normal seasonal weather conditions.
- The dam orifice diameter is 600 mm to control the rate of discharge during events up to and including the 100 year ARI storm.
- The form of the dam and spillway is subject to further detailed investigations.
- The spillway would be designed considering the PMF.
- While the objective should be to make the dam as unobtrusive as possible, spillway arrangements are a major consideration in the final form and layout of the works.

- An access route (*undeveloped road reserve*) along the alignment of the creek would have to be relocated, which may require a cutting to be made in the side of the hill and associated land acquisition (*refer* **Figure 19**).
- A portion of each of two private properties located on either side of the watercourse would have to be acquired to accommodate the footprint of the dam, as well as closure the road reserve (*refer* **Figure 19**).
- The capital cost of the dam at Site 2 is estimated to be approximately **$14.4M** (*refer to* **Appendix J3** *for a cost break-down*), based on an earth embankment design.
- The Hampton Street to Cross Road channel upgrade (*refer Section 9.1.2*) would be retained as a component of this scenario. The estimated cost is approximately **$2.4M** (*refer to* **Appendix J2**).

### J.2.1 Impact on Peak Flows

As shown in **Figure 13**, a dam at Site 2 would capture flow from a significant portion of the upper catchment. A summary of the impact that the dam would have in reducing flows for the 100 year ARI is provided in **Table J2**.

**TABLE J2 FLOW REDUCTION AFFORDED BY FLOOD CONTROL DAM AT SITE 2**

| LOCATION | PEAK FLOW DURING 36 HOUR STORM *($m^3/s$)* | | | |
|---|---|---|---|---|
| | BASE CASE *(no dams)* | DAMS AT SITES 2 AND 4 *(2006 Master Plan)* | DAM AT SITE 2 *(20 m spillway height)* | REDUCTION |
| Scotch College | 26.1 | 13.1 | 16.0 | 10.1 |
| Belair Road | 30.2 | 16.9 | 20.1 | 10.1 |
| Cross Road | 36.4 | 23.1 | 26.3 | 10.1 |
| Goodwood Road | 37.1 | 23.6 | 26.9 | 10.2 |
| Hydrograph volume above 18 $m^3/s$ at Goodwood Road | 250 ML | 42 ML | 76 ML | 174 ML |
| Anzac Highway | 38.9 | 25.7 | 28.7 | 10.2 |



For comparison purposes, **Table J2** also contains hydrologic modelling results for the 2006 Master Plan configuration (*i.e. dams at Sites 2 and 4*). Although not as effective as the combined dams, the single dam at Site 2 provides significant reduction in peak flow; typically about 10 $m^3/s$ less than the Base Case at all locations along Brown Hill Creek upstream from Anzac Highway.

Flow values in the table indicate that the inclusion of the dam at Site 4 provides additional flow reduction of only about 3 $m^3/s$.

### J.2.2 Reduction in 100 Year ARI Flood Damages

A 20 metre high flood control dam at Site 2 significantly reduces the 100 year ARI flood extent for the 36 hour storm, and provides only marginally less flood mitigation than the 2006 Master Plan works.

Despite this improvement, overtopping of the Brown Hill Creek channel would still occur at locations between Forestville Reserve and the Anzac Highway, leading to overland flow across the Highway and into West Torrens. Breakout would also occur in the vicinity of Regent Street, Millswood.

It is estimated that the single dam at Site 2 would reduce 100 ARI damages to **$41.6M**, which is similar to the reduction in damages afforded by the 2006 Master Plan (*approximately* **$136M** *relative to the Base Case damages estimate of* **$178M**).

### J.2.3 Summary

A dam at Site 2 is a viable option, particularly considering it provides similar flood mitigation as the 2006 Master Plan works at significantly reduced cost. However, by itself it does not address all flooding that emanates from Brown Hill Creek upstream of Anzac Highway.



## J.3 SCENARIO 3 – DAM AT SITE 2 + WEIR SYSTEM IN BROWN HILL CREEK RECREATION RESERVE

This mitigation scenario comprises a flood control dam at Site 2, as outlined in Section J.2.

In order to further reduce residual overflows from the channel, additional detention is provided using a series of weirs within the Brown Hill Creek Recreation Reserve, as follows:

- Construction of nine weirs of various sizes at spacing of 100 to 150 metres between the Brown Hill Creek Caravan Park and the intersection of Brown Hill Creek Road and Tilleys Hill Road (*refer* **Figure 19**).

- As a preliminary concept design, the weirs have the following dimensions (*ordered from 1 to 9, downstream to upstream*):

  Weir 1. 2.5 m high x 32 m wide (*length across the channel*)

  Weir 2. 4 m high x 30 m wide

  Weir 3. 4 m high x 28 m wide

  Weir 4. 4.5 m high x 25 m wide

  Weir 5. 7 m high x 38 m wide

  Weir 6. 4.5 m high x 53 m wide

  Weir 7. 6 m high x 70 m wide

Weir 8. 4 m high x 32 m wide

Weir 9. 4 m high x 49 m wide

- The weirs would have a combined storage volume of 80.8ML.
- It is unlikely that Brown Hill Creek Road would need to be relocated.
- As discussed above, the capital cost of the dam at Site 2 is estimated to be approximately **$14.4M** (*refer to* **Appendix J3**).
- It is estimated the weirs would cost approximately **$9.2M** (*refer to* **Appendix J4** *for cost breakdown*), based on a concrete wall design.
- The Hampton Street to Cross Road channel upgrade would be retained as part of this scenario. The estimated cost is approximately **$2.4M**.

### J.3.1 Impact on Peak Flows

This scenario offers a similar reduction in peak flows as the flood control dam at Site 1 (*15 metre spillway height*) (*refer* **Table J1**).

The dam at Site 2 would capture runoff from the tributaries within the northern portion of the upper catchment (*refer* **Figure 13**) and the weir system would act to provide detention of flows from the very upper-most reaches of Brown Hill Creek in the southern portion of the catchment, thereby capturing a similar upstream area as a dam at Site 1.



### J.3.2 Reduction in 100 Year ARI Flood Damages

The 100 year ARI floodplain mapping for this scenario would be similar to the mapping associated with the single dam option at Site 1. Accordingly, it is estimated that the scenario would reduce the 100 year ARI damages to **$28.9M**.

### J.3.3 Summary

The weirs are a viable option for providing additional flood mitigation benefit to a dam at Site 2. However, this scenario by itself does not address all flooding that emanates from Brown Hill Creek upstream from Anzac Highway.

## J.4 SCENARIO 4 – DAM AT SITE 2 + GLENELG TRAMWAY INTERCEPTOR

In order to minimise residual flooding in areas of Unley and West Torrens for the Site 2 dam scenario (*refer* **Figure 12**), it is proposed overland flow could be intercepted at the Glenelg Tramway and then returned to the channel.

Further works would also be required to ensure that overtopping of the channel does not occur downstream from the tramway so that the 100 year ARI flow is retained within Brown Hill Creek and is fed into the upgraded channel that is proposed downstream from the highway as part of the 2006 Master Plan.

The proposed works are:

Flood control dam at Site 2

- As described above (*refer* **Figure 19**). The estimated cost is **$14.4M** (*refer* **Appendix J3**).

Glenelg Tramway Interceptor

- Installation of a 610 metre long 1.8m (W) x 1.2m (H) box culvert along the southern side of the Glenelg Tramway from the Brown Hill Creek channel to approximately 50 metres beyond Goodwood Road (*refer* **Figure J1**).
- Five sets of large side-entry pits (*lintels*) up to 150mm high and additional sag inlet pits would be installed at key locations to intercept overland flow arriving at the tramway in the vicinity of Goodwood Road and the railway.
- The tramway creates an existing ridge of higher terrain, but additional minor earthworks may be required to ensure that overland flows are directed into the culvert.
- Estimated cost is **$3.4M** (*refer* **Appendix J5**).

Channel upgrade works – Leah Street to Anzac Highway

- Upgrade of the channel capacity involves widening the channel by 3 metres and removal of the existing low-flow channel tier (*refer* **Figure J1**).
- A majority of this work would be undertaken within the creek section adjacent to Wilberforce Walk, with potential for minor impact on privately owned land immediately upstream from Anzac Highway.
- The creek adjacent to Wilberforce Walk is in private ownership and acquisition of this section of the creek, together with the section immediately upstream from Anzac Highway would be required.
- The upgrade works would be configured such that widening of the channel would encroach into council land, rather than increase the current footprint of the channel over private land.
- The channel upgrade would also involve works to increase the capacity of bridge culverts at Leah Street (*subject to verification*), First and Second Avenues, Anzac Highway and Charles Street. The bridge at Ethel/Nichols Street is planned to be upgraded by Unley Council in the near future and presumably it will be designed to accommodate the peak 100 year ARI flow.
- Estimated cost is **$10.1M** (*refer* **Appendix J6**).

Hampton Street to Cross Road channel upgrade

- The upgrade would be retained as part of this scenario at an estimated cost of **$2.4M**.

### J.4.1 Reduction in 100 Year ARI Flood Damages

The effectiveness of a flood control dam at Site 2 in reducing peak 100 year ARI flows for the critical 36 hour storm is documented above in **Table J2**.

Hydraulic modelling was undertaken for the scenario to produce the 100 year ARI mapping in **Figure J1**. As shown, the interceptor culvert at the tramway would be configured to ensure that overland flow along Goodwood Road and the railway is successfully transferred back to the channel immediately upstream of Forestville Reserve.

Implementing the channel upgrades downstream from the reserve will minimise any potential overtopping from the channel immediately upstream from the Anzac Highway so that flow is successfully directed into the proposed channel upgrades downstream from the highway.

It is estimated that this mitigation scenario would reduce the 100 year ARI flood damages to **$18.9M**, which is a saving in damages over the Base Case of approximately **$159M**.

### J.4.2 Summary

The tramway interceptor, as modelled, provides additional flood mitigation benefit to a flood control dam at Site 2. However, there is uncertainty in the operational effectiveness of such a system compared with other options, and it may be regarded as inequitable because areas upstream of the interceptor are still exposed to flooding.



## J.5 SCENARIO 5 – DAM AT SITE 2 + SUPPLEMENTARY WORKS

An alternative to the Glenelg Tramway interceptor culvert that was also investigated involved a separate set of supplementary works, also for use in conjunction with the dam at Site 2. The design rationale again is to limit breakouts and capture any residual overflows upstream from the Anzac Highway, thereby minimising the flood extent and damages downstream from the Highway.

The proposed works are:

Flood control dam at Site 2

- As described above (*refer* **Figure 19**). The estimated cost is **$14.4M** (*refer* **Appendix J3**).

Mitchell Street Collector

- Installation of a 530 metre long, 1350 mm diameter pipe culvert along Mitchell Street to the east of the Brown Hill Creek channel to capture any residual flow that has broken out from the channel upstream near Regent Street (*refer* **Figure J2**).
- Up to 8 metres length of large side-entry pits (*lintels*) up to 150mm high would be installed at key locations along the kerb and gutter of Mitchell Street to intercept overland flow and then feed it back to the channel.
- Estimated cost is **$1.8M** (*refer* **Appendix J7**).

High-Flow Bypass – Mitchell Street to Railway

- Installation of a 560 metre long high-flow bypass box culvert with dimensions 1.8m (W) x 1.5m (H) between Mitchell Street and the railway to carry up to 12 $m^3/s$ of flow during major storm events, thereby reducing the load on the existing open channel between these locations (*refer* **Figure J2**).

- Estimated cost is **$3.7M** (*refer* **Appendix J8**).

High-Flow Bypass – Victoria Street to Tramway

- Installation of an additional 260 metre long high-flow bypass box culvert with dimensions 1.8m (W) x 1.5m (H) between Victoria Street and the Glenelg Tramway to carry up to 12 $m^3/s$ of flow (*refer* **Figure J2**). Upgrade of the bridge at the railway is also required.

- Estimated cost is **$2.5M** (*refer* **Appendix J9**).

Channel upgrade – Leah Street to Anzac Highway

- As outlined in Section J.4. Estimated cost is **$10.1M** (*refer* **Appendix J6**).

Hampton Street to Cross Road channel upgrade

- The upgrade would be retained as part of this scenario at an estimated cost of **$2.4M**.



### J.5.1 Reduction in 100 Year ARI Flood Damages

The effectiveness of a flood control dam at Site 2 in reducing peak 100 year ARI flows for the critical 36 hour storm is documented above in **Table J2**.

Hydraulic modelling was undertaken for the scenario to produce the 100 year ARI mapping in **Figure J2**. The "supplementary works" (*i.e. all ancillary works between Mitchell Street and Anzac Highway*) would mainly act to retain flows within the creek channel and also collect any residual flow that might spill from the channel upstream from Mitchell Street.

Including the channel upgrades downstream from Forestville Reserve will minimise any potential overtopping from the channel immediately upstream from the Anzac Highway so that flow is successfully directed into the proposed channel upgrades downstream from the highway.

It is estimated that this mitigation scenario would reduce the 100 year ARI flood damages to **$16.7M**, which is a saving in damages over the Base Case of more than **$161M**.

### J.5.2 Summary

This is an effective scenario for flooding reduction. However, it still leaves the area in the vicinity of Regent and Avenue Streets at risk. Also, it may be impracticable to install a high-flow bypass culvert along the railway north of Cranbrook Avenue as this may encroach into privately owned land and affect existing dwellings.

## J.6 SCENARIO 6 – GLENELG TRAMWAY INTERCEPTOR + CHANNEL UPGRADE WORKS

The option for installing a flow interceptor culvert at the Glenelg Tramway was also considered in isolation of any upper catchment detention options. In this case, the interceptor would need to have increased capacity in order to capture additional overland flows that are expected to come off the upper catchment.

Similar to the mitigation scenario in Section J.4, additional channel upgrade works would be required to ensure that overtopping of the channel does not occur downstream from the tramway.

The proposed works are:

Glenelg Tramway Interceptor

- Installation of a 610 metre long 2.1m (W) x 1.8m (H) box culvert along the southern side of the Glenelg Tramway from the Brown Hill Creek channel to approximately 50 metres beyond Goodwood Road (*refer* **Figure J3**).
- The length of culvert is similar to that for the interceptor described above in Section J.4 because the overall extent of the overland flow paths between Goodwood Road and the railway is not significantly increased despite the omission of the dam at Site 2 from this scenario (*compare* **Figures J1** *and* **J3**).
- Up to 20 large side-entry pits (*lintels*) up to 150mm high and additional sag inlet pits would be installed at locations to intercept overland flow arriving at the tramway in between Goodwood Road and the railway.
- The tramway creates an existing ridge of higher terrain, but additional minor earthworks may be required to ensure that overland flows are directed into the culvert.
- There is increased scope of work compared with works of the Section J.4 option due to increased flow conveyance required in lieu of upper catchment detention.
- Estimated cost is **$6.2M** (*refer* **Appendix J10**).

Channel upgrade – Leah Street to Anzac Highway

- Upgrade of the Brown Hill Creek channel between Leah Street and the Anzac Highway involving widening of the channel by 3 metres, removal of the existing low-flow channel tier and additional bunding to a height of 0.2 to 0.5 metres (*refer* **Figure J3**).
- There is increased scope of work compared with works of the Section J.4 option due to increased flow conveyance required in lieu of upper catchment detention.
- Estimated cost is **$10.4M** (*refer* **Appendix J11**).

Hampton Street to Cross Road channel upgrade

- This would be retained. However, additional channel width will be required compared to the upgrade retained for detention scenarios. The estimated cost is approximately **$2.8M** (*refer* **Appendix J12**).

### J.6.1 Reduction in 100 Year ARI Flood Damages

As shown in **Figure J3**, the interceptor culvert at the tramway would be configured to ensure that overland flow between Goodwood Road and the railway is captured and transferred back to the channel immediately upstream of Forestville Reserve.

Implementing the downstream channel upgrades will minimise any potential overtopping from the channel immediately upstream from the Anzac Highway so that flow is directed into the proposed channel upgrades downstream from the Highway.

It is estimated that this mitigation scenario would reduce the 100 year ARI flood damages to **$29.5M**, which is a saving in damages over the Base Case of approximately **$148M**.

### J.6.2 Summary

There is significant reduction in flood damages for areas downstream from the tramway, including West Torrens. However, the interceptor does not provide any flood mitigation benefit for areas upstream from the tramway, with significant breakouts still occurring in the vicinity of Cross Road, Regent Street and Goodwood Road.



## J.7 SCENARIO 7 – KESWICK CREEK DIVERSION INTERCEPTOR

An interceptor system to feed into the previously proposed diversion culverts from Keswick Creek (*2006 Master Plan*) was considered as an alternative to upper catchment detention and to take advantage of the diversion works already proposed for construction at minimal extra cost.

The proposed works are:

Diversion Interceptor at Leader Street

- Installation of a 370 metre long 1.8m (W) x 1.5m (H) box culvert along Leader Street between Devon Street North and Goodwood Road to feed into the Le Hunte Street diversion culvert, south of the Showgrounds at Devon Street North (*refer* **Figure J4**). This would effectively represent an extension to the diversion culvert along Leader Street to capture overland flows east of Devon Street North.

- Up to 35 large side-entry pits up to 150mm high would be installed at various intervals along Leader Street and Anzac Highway to intercept overland flow, including at the additional culvert section described above, while some would also feed directly into the diversion culvert further to the west.

- Estimated cost is **$2.3M** (*refer* **Appendix J13**).

Interceptor at Third Avenue

- Installation of an additional 200 metre section of 1.8m (W) x 1.2m (H) box culvert along Third Avenue between Everard Terrace and the Brown Hill Creek channel to capture overland flows on the southern side of the channel (*refer* **Figure J4**). This interceptor would require up to 10 large side-entry pits.

- Estimated cost is **$1.2M** (*refer* **Appendix J14**).

Channel upgrade – Third Avenue to Anzac Highway

- This involves widening the channel by 3 metres and removal of the existing low-flow channel tier (*refer* **Figure J4**).

- There may be potential for minor impact on privately owned land immediately upstream from Anzac Highway, as outlined in Section J.4.

- The culvert beneath Anzac Highway also needs to be upgraded to increase its capacity.

- Estimated cost is **$4.2M** (*refer* **Appendix J15**).

Hampton Street to Cross Road channel upgrade

- The channel upgrade would be retained as part of this scenario at an estimated cost of **$2.8M** (*refer* **Appendix J12**).



### J.7.1 Hydrologic Analysis

The latest concept design for the Keswick Creek diversion (*Tonkin 2010*) comprises two separate culverts; the Le Hunte Street diversion and the Anzac Highway diversion (*refer* **Figure J4**). The culverts are designed to carry a combined flow of 24 $m^3/s$ (*reduced from 25 $m^3/s$, as reported in Tonkin Consulting, 2009 & 2010a*), comprising off-takes of 14 $m^3/s$ at Le Hunte Street and 10 $m^3/s$ at Anzac Highway.

The primary function of the diversion culverts will be to divert flow from Keswick Creek during the 90 minute storm as this is the critical duration storm for the urbanised Keswick Creek catchment.

The Leader Street diversion was investigated also for its potential to intercept overland flows that are primarily the result of overflows from Brown Hill Creek during the 36 hour storm (*i.e. flows originating principally from the upper rural portion of the catchment*).

Hydrologic modelling by DPTI for the catchment based on the latest concept designs for the diversion culverts and for the proposed detention system in South Park Lands shows that the peak diverted flow through the culverts during the 36 hour storm (*100 year ARI*) would be approximately 18 $m^3/s$, resulting in spare capacity in the culverts of about 6 $m^3/s$.

However, hydraulic modelling results for Brown Hill Creek indicate that the total overland flow arriving at Leader Street and Anzac Highway during the 36 hour storm would be about

15 $m^3/s$. It is therefore unlikely that the diversion culverts would have sufficient spare capacity to carry this additional flow.

Enlarging the diversion culvert along Leader Street was considered as a method for accommodating the overland flow. However, according to the concept design drawings for the diversions prepared by Tonkin Consulting (*2011a*), increasing the width or height of the box culvert is likely to interfere with the existing services in the roadways, particularly along Leader Street and in the vicinity of the intersection with Anzac Highway. Subject to further investigation, it may be feasible to relocate the services, but at significant additional cost and disruption.

Another issue is the potential for surcharge to occur from the large side-entry pits when the diversion culverts are flowing full and under pressure with flow from Keswick Creek. Further detailed analysis would be required to determine the hydraulic behaviour of the culverts under a variety of headwater and tailwater conditions.

### J.7.2 Reduction in 100 Year ARI Flood Damages

Assuming that the feasibility issues can be overcome, it is expected that the interceptor culverts at Leader Street and Third Avenue would minimise the overland flow across the Anzac Highway and into West Torrens during the 36 hour storm (*refer* **Figure J4**).

It is estimated that the associated reduction in 100 year ARI flood damages would be approximately **$33.4M**, which is a saving in damages over the Base Case of approximately **$145M**.



### J.7.3 Summary

There is significant reduction in flood damages for areas downstream from Leader Street / Third Avenue, but there is limited benefit for upstream areas.

The option is unlikely to be feasible because there is minimal capacity for the culverts to accept overland flows for either the 90 minute or 36 hour storm and there is potential for surcharge to occur when flowing full.

Increasing the capacity of the diversion culvert to accept the increased flow is unlikely to be feasible due to the proximity of existing underground services along Leader Street, and the large costs involved with any potential relocation. The cost for culvert enlargement or services relocation has not been considered at this stage.

## J.8 SCENARIO 9 – COMPLETE CHANNEL UPGRADE (MUGGS HILL ROAD TO ANZAC HIGHWAY)

The option has been included in this assessment of alternative mitigation scenarios primarily to put into perspective the extent of channel upgrading works required to eliminate any overtopping along upper Brown Hill Creek, in the absence of other mitigation measures, including detention of the peak rural flow.

A summary of the proposed works is as follows (*from downstream to upstream*):

- Upgrade of the Brown Hill Creek channel between Leah Street and the Anzac Highway involving widening of the channel by 3 metres, removal of the existing low-flow channel tier and some additional bunding to a height of 0.2 to 0.5 metres (*refer* **Figure J5**). It would also involve works to increase the capacity of bridges/culverts at Leah Street, First and Second Avenues, Anzac Highway and Charles Street. The estimated cost is **$10.4M** (*refer* **Appendix J11**).

- Upgrade of the channel between Victoria Street and the Glenelg Tramway involving widening of the channel by 1 to 3 metres and some additional bunding to a height of 0.2 metres (*refer* **Figure J5**). It would also involve works to increase the capacity of bridges/culverts at the railway near Victoria Street, factories over the channel and the Glenelg Tramway crossing. The estimated cost is **$5.1M** (*refer* **Appendix J19**).

- Upgrade of the channel between Cranbrook Avenue and the railway line involving widening of the channel by 1 metre (*refer* **Figure J5**). It would also involve works to increase the capacity of the bridge/culvert at Cranbrook Avenue. The estimated cost is **$3.7M** (*refer* **Appendix JG20**).

- Upgrade of the channel between Victoria Avenue and Mitchell Street involving widening of the channel by between 1 and 3 metres and additional bunding to a height of 0.2 to 0.5 metres (*refer* **Figure J5**). It would also involve works to increase the capacity of the bridges/culverts at Victoria Avenue, Northgate Street, Malcolm Street, Avenue Street, Regent Street, and the pedestrian bridge at Percy and Douglas Streets. The estimated cost is **$7.9M** (*refer* **Appendix J21**).

- Upgrade of the channel between Hampton Street and Heywood Avenue involving widening of the channel by between 1 and 4 metres and additional bunding to a height of 0.5 metres (*refer* **Figure J5**). It would also involve works to increase the capacity of the bridges/culverts at Hampton Street, Cross Road, the factory over the channel downstream from Cross Road and at Heywood Avenue. The estimated cost is **$7.4M** (*refer* **Appendix J22** *and* **J12**).

- Channel upgrades between Muggs Hill Road and Devonshire Street involving widening of the channel of 1 to 2 metres at three separate sections of the creek (*refer* **Figure J5**). It would also involve removal or bypass of the constriction at Paisley Avenue. The estimated cost is **$9.0M** (*refer* **Appendix J23**).

- Additional bridge/culvert capacity upgrades:

  ⇒ Goodwood Road

  ⇒ Whistler Avenue pedestrian access bridge

  ⇒ George Street (*although this is proposed to be completed in the near future*)

  ⇒ Devonshire Street

  ⇒ Ayr Avenue

  ⇒ Fife Avenue

  ⇒ Estimated cost is **$3.6M** (*refer* **Appendix J24**).

### J.8.1 Reduction in 100 Year ARI Flood Damages

In assessing the potential reduction in flood damages for this mitigation scenario, it was assumed that the full channel upgrade would eliminate all overtopping of the channel upstream from Anzac Highway and thereby direct all flow into the downstream channel upgrades previously proposed as part of the 2006 Master Plan.

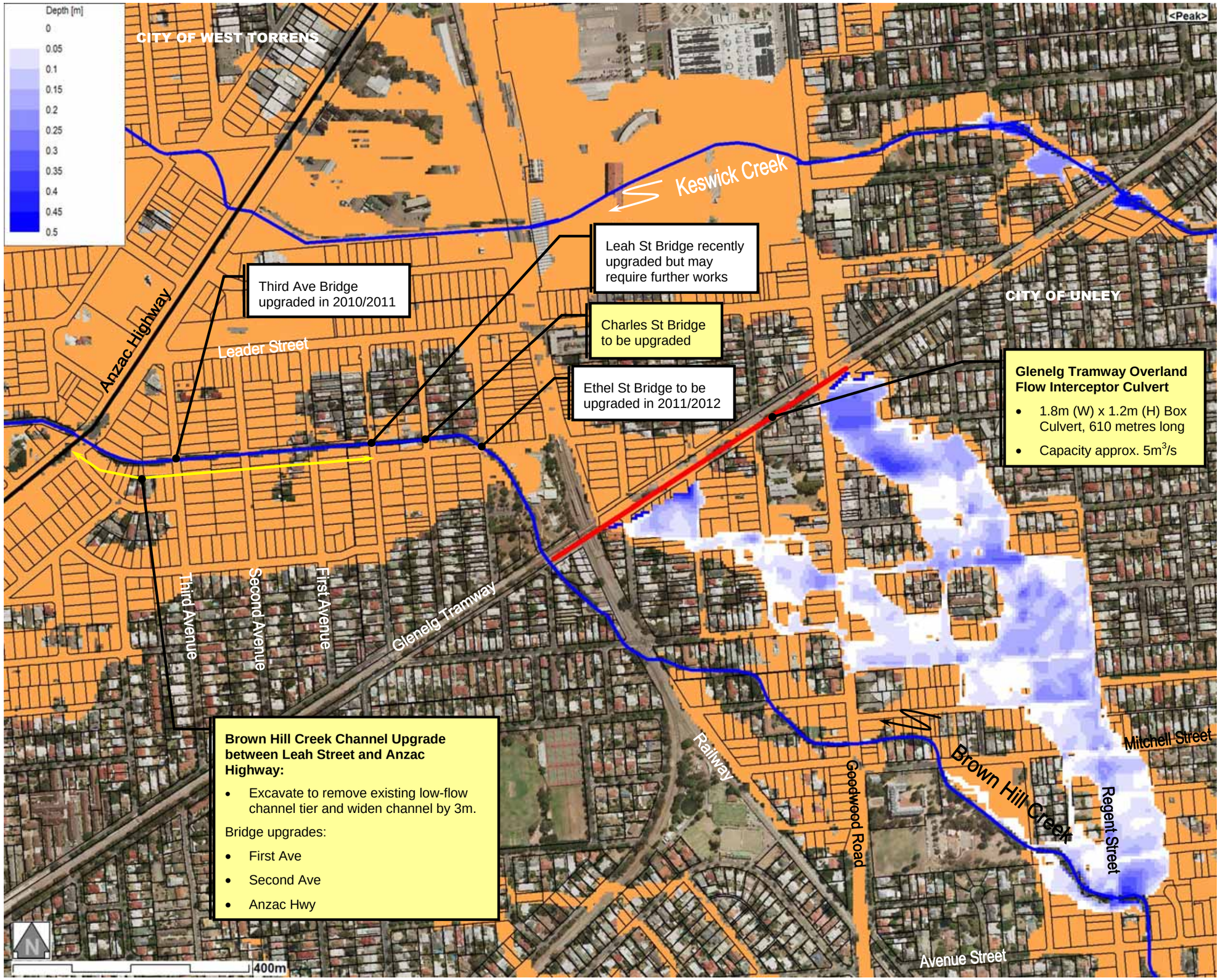
In this regard, it is estimated that this mitigation scenario would reduce 100 ARI damages to **$15.7M**, which corresponds to a damages saving over the Base Case of approximately **$162M**.

### J.8.2 Summary

Undertaking a complete upgrade of the channel would cause significant private property impacts and it would be very difficult to gain community acceptance or support for this scenario. It is also significantly more expensive than other scenarios that offer similar flood mitigation outcomes.

FIGURE J1

DRAFT




**LEGEND**

Council Area Boundary

Base case extent shown for comparison purposes, areas north of tramway are otherwise protected by interceptor and other works on Keswick/Parklands/Glen Osmond Creeks

**Note:** 100 year ARI depth mapping shown for Site 2 Flood Control Dam scenario. Depths > 0.5 metres are shown in blue.

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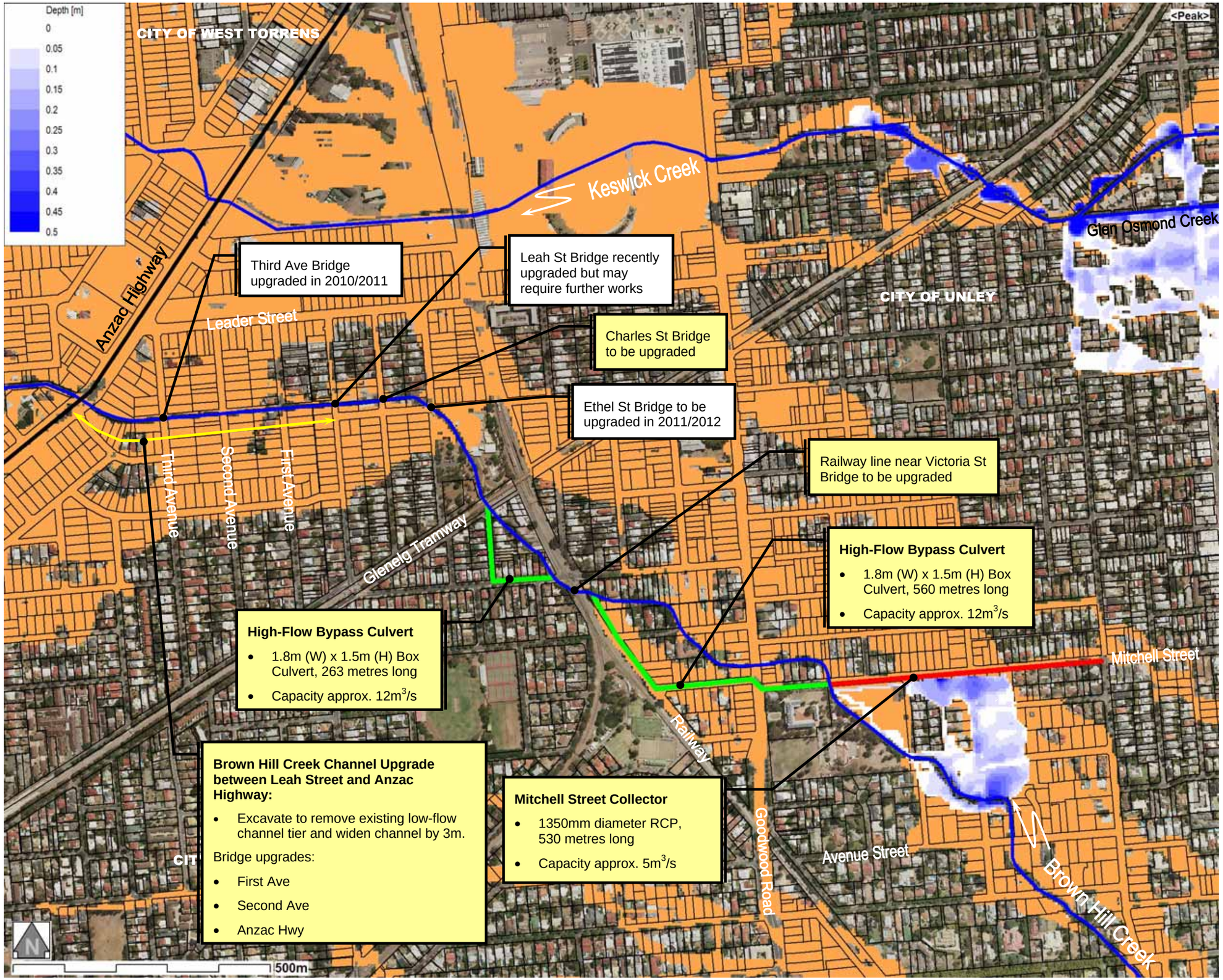
resources & energy

Rp301015-02356 – Brown Hill Keswick Creek SMP
fg301015-02356-110802-fig_Tramway+Dam2.doc

# GLENELG TRAMWAY OVERLAND FLOW INTERCEPTOR CULVERT TO BE USED WITH FLOOD CONTROL DAM AT SITE 2

FIGURE J2

DRAFT




**LEGEND**

Council Area Boundary

Base case extent shown for comparison purposes, areas north of Mitchell Street are otherwise protected by interceptor and other works on Keswick/Parklands/Glen Osmond Creeks

**Note:** 100 year ARI depth mapping shown for Site 2 Flood Control Dam scenario.
Depths > 0.5 metres are shown in blue.

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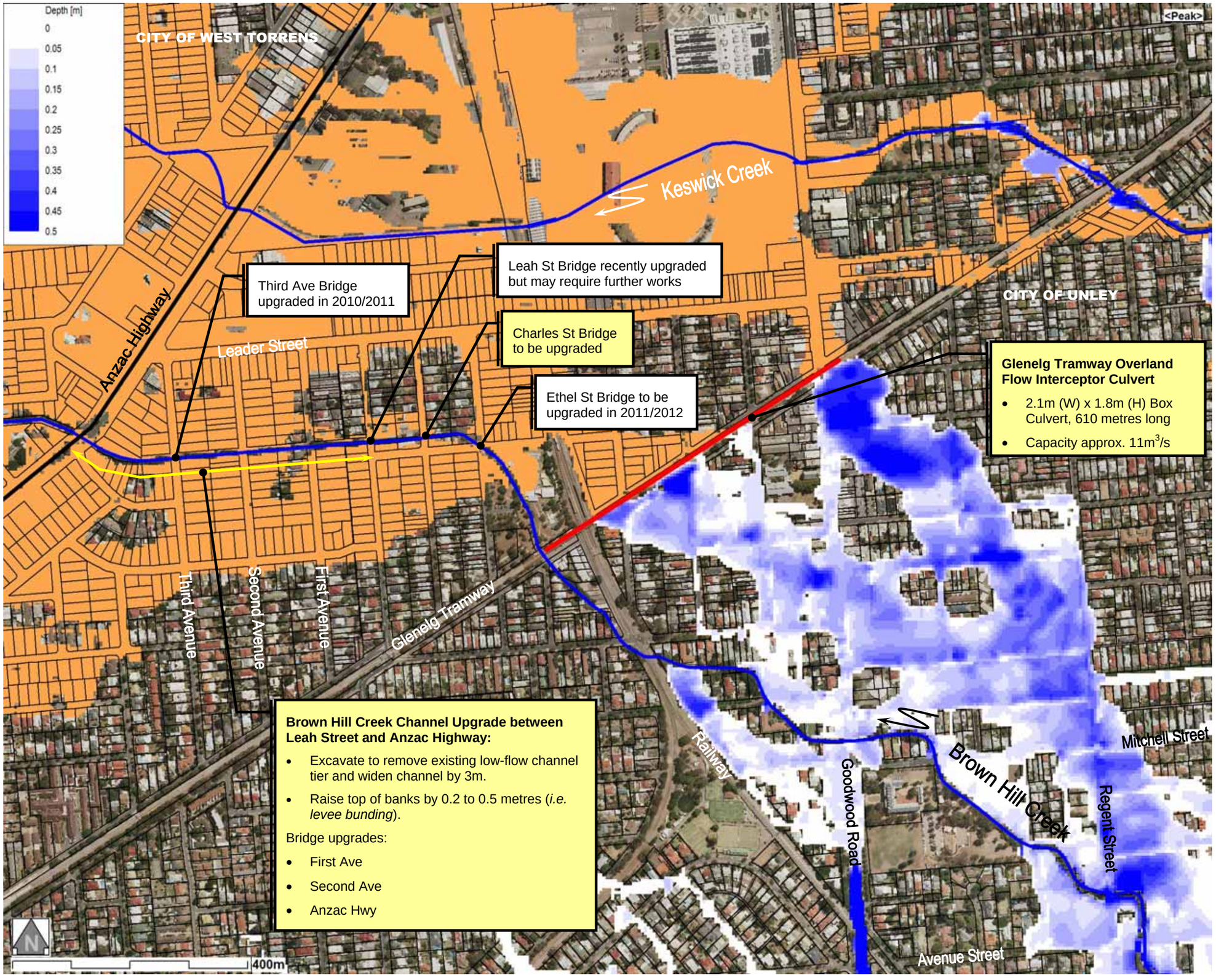
fg301015-02356-110802-fig_SuppWorks+Dam2.doc

## SUPPLEMENTARY WORKS TO BE USED WITH FLOOD CONTROL DAM AT SITE 2

FIGURE J3

DRAFT




**LEGEND**

Council Area Boundary

Base case extent otherwise protected by interceptor and other works on Keswick/Parklands/Glen Osmond Creeks

**Note:** Base case 100 year ARI depth mapping shown (*no upper catchment detention*). Depths > 0.5 metres are shown in blue.

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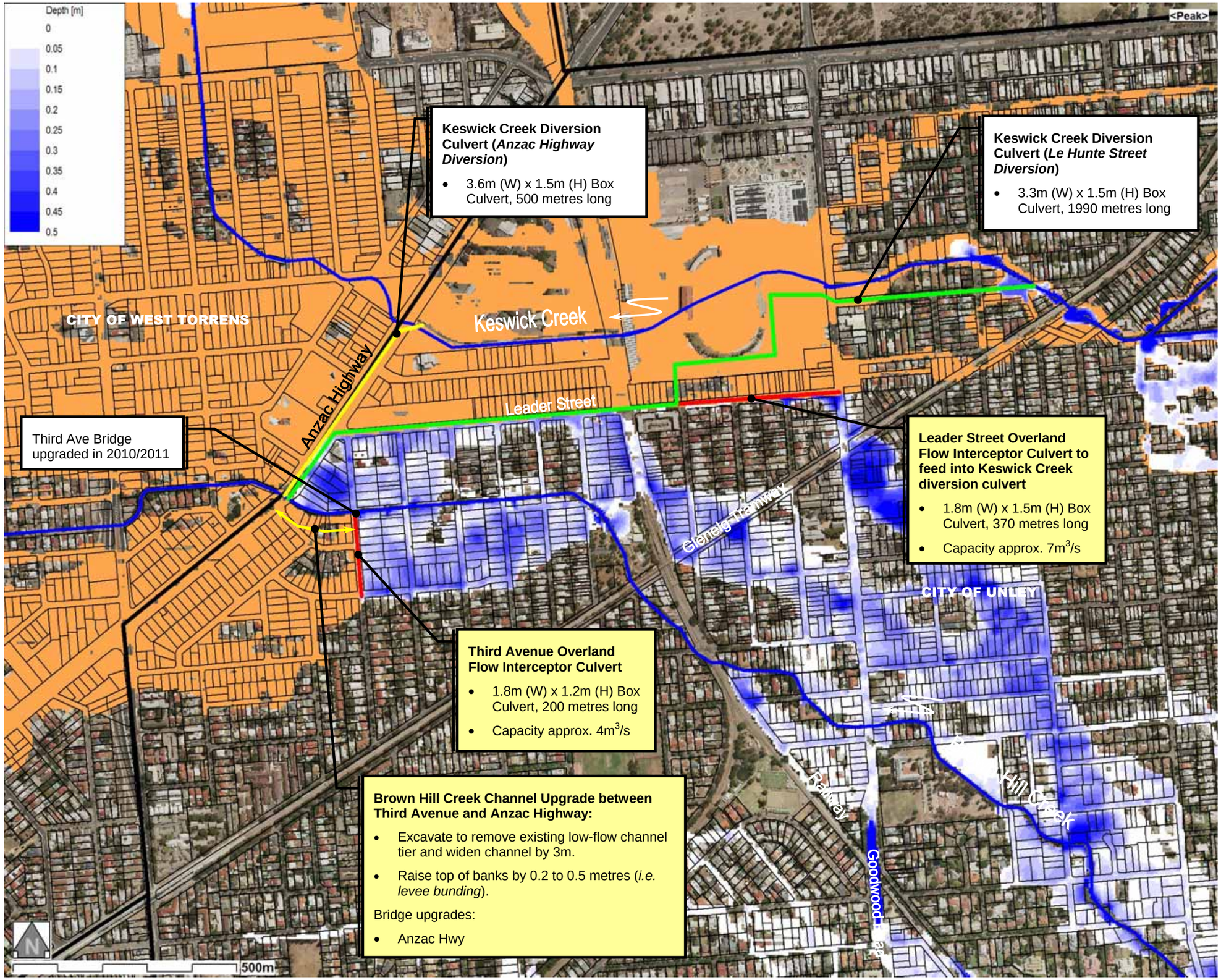
fg301015-02356-110802-fig_Tramway.doc

# GLENELG TRAMWAY OVERLAND FLOW INTERCEPTOR CULVERT

FIGURE J4

DRAFT




**LEGEND**

Council Area Boundary

Base case extent otherwise protected by interceptor culverts and other works on Keswick/Parklands/Glen Osmond Creeks

**Note:** Base Case 100 year ARI depth mapping shown (*no upper catchment detention*). Depths > 0.5 metres are shown in blue.

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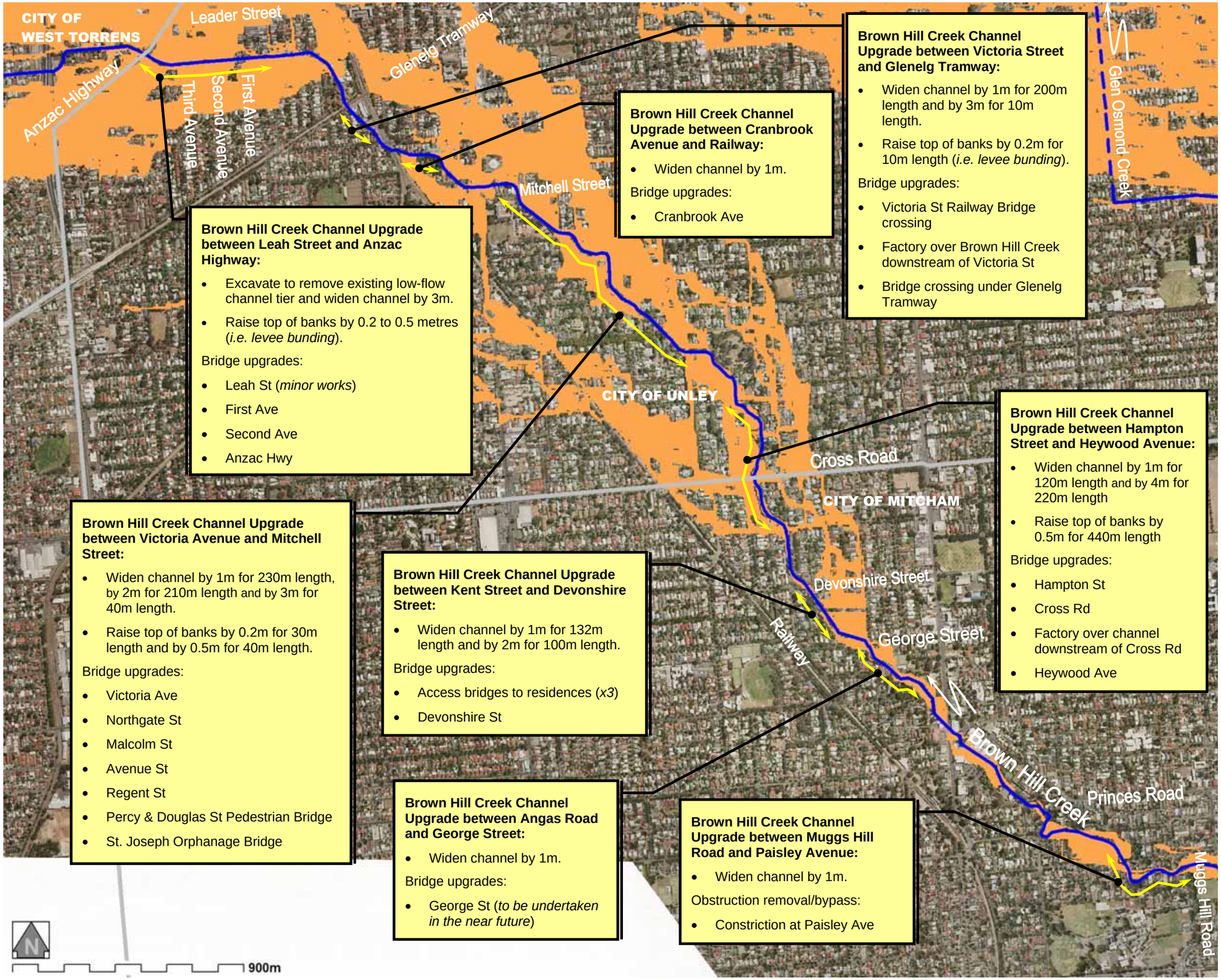
Rp301015-02356 – Brown Hill Keswick Creek SMP
fg301015-02356-110802-fig_KCkDivInterceptor.doc

# INTERCEPTOR CULVERT AT KESWICK CREEK DIVERSION

FIGURE J5

DRAFT




**Additional bridge upgrades**

- Fife/Lochwinndoch Ave
- Ayr Ave
- Whistler Ave Pedestrian Access Bridge
- Goodwood Rd
- Ethel/Nichols St
- Charles St

**LEGEND**

- Council Area Boundary
- Base case extent shown for comparison purposes

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Rp301015-02356 – Brown Hill Keswick Creek SMP
fg301015-02356-110802-fig_Channel Upgrades.doc

# BROWN HILL CREEK CHANNEL UPGRADES FROM MUGGS HILL ROAD TO ANZAC HIGHWAY

Appendix J1: Cost Estimate for Brown Hill Creek Flood Control Dam at Site 1 (Spillway Height = 15 metres)

NOTE:
This cost estimate has been adapted from the 2006 Master Plan, with materials and quantities altered to suit. Rates have been inflated to represent 2011 dollars.
Detailed survey and geotechnical information is required to prepare a detailed cost estimate.
Estimate based on earth embankment design with separate spillway.

| ITEM | DESCRIPTION | UNIT | QUANTITY | RATE $ | DIRECT COST $ | CONTINGENCY % | TOTAL | Sub-total |
|---|---|---|---|---|---|---|---|---|
| 1 | PRELIMINARIES | | | 20% | | | | $1,803,546 |
| 1.01 | Contractor's supervision | Item | | | | | | |
| 1.02 | Site Establishment | Item | | | | | | |
| 1.03 | Site Running Costs | Item | | | | | | |
| 1.04 | Plant and Equipment | Item | | | | | | |
| 1.05 | Fees & Charges (Including insurances) | Item | | | | | | |
| 1.06 | Other - Construct Haul Roads | Item | | | | | | |
| | | | | | | | | |
| 2 | DIVERSION CONTROL AND WATER SUPPLY DURING CONSTRUCTION | | | | | | | $275,024 |
| 2.01 | Cofferdam | | | | | | | |
| 2.02 | Strip embankment crest - 1.0m depth | $m^3$ | 2,070 | 12 | 25,854 | 25 | 32,318 | |
| 2.03 | Raise Embankment 4m with selected fill | $m^3$ | 1,600 | 55 | 88,000 | 25 | 110,000 | |
| 2.04 | Spillway Construction | LS | 1 | 6,245 | 6,245 | 25 | 7,806 | |
| 2.05 | DN200 PVC Water Supply Pipeline | m | 400 | 187 | 74940 | 25 | 93,675 | |
| 2.06 | Pump Set + Power | LS | 1 | 24980 | 24980 | 25 | 31,225 | |
| | | | | | | | | |
| 3 | EXCAVATION AND EARTHWORKS | | | | | | | $1,675,762 |
| | Embankment, Abutment and Borrow | | | | | | | |
| 3.01 | Clearing | $m^2$ | 12,350 | 3.75 | 46,275 | 25 | 57,844 | |
| 3.02 | Topsoil stripping - 150 mm depth | $m^3$ | 1,853 | 9.37 | 17,353 | 25 | 21,692 | |
| 3.03 | Excavate Borrow Material | $m^3$ | 10,498 | 6.25 | 65,609 | 25 | 82,012 | |
| 3.04 | Special cleanoff of foundation (10% of stripping) | $m^2$ | 2,470 | 25 | 61,701 | 25 | 77,126 | |
| | | | | | | | | |
| | Outlet Works | | | | | | | |
| 3.05 | Excavation for pipe - soil | $m^3$ | 1,172 | 17.50 | 20,508 | 25 | 25,635 | |
| 3.06 | Excavation for pipe - rock | $m^3$ | 3,828 | 34.20 | 130,922 | 25 | 163,652 | |
| | | | | | | | | |

| ITEM | DESCRIPTION | UNIT | QUANTITY | RATE $ | DIRECT COST $ | CONTINGENCY % | TOTAL | Sub-total |
|---|---|---|---|---|---|---|---|---|
| | Spillway | | | | | | | |
| 3.07 | Excavation of Top Soil for Spillway Approach and Chute | $m^3$ | 1,763 | 9.37 | 16,510 | 25 | 20,638 | |
| 3.08 | Excavation for Spillway in Soil | $m^3$ | 9,988 | 17.50 | 174,781 | 25 | 218,477 | |
| 3.09 | Excavation for Spillway in Rock | $m^3$ | 23,500 | 34.20 | 803,700 | 25 | 1,004,625 | |
| 3.10 | Excavation for Invert Drains and Joints | $m^3$ | 130 | 25.00 | 3,250 | 25 | 4,063 | |
| | | | | | | | | |
| 4 | DRAINAGE | | | | | | | $34,566 |
| 4.01 | Construct stone pitched drains along rock toe | $m^2$ | 246 | 112.41 | 27,653 | 25 | 34,566 | |
| | | | | | | | | |
| 5 | EMBANKMENT CONSTRUCTION | | | | | | | $4,721,049 |
| 5.01 | Conduct roller trial. | $m^3$ | 200 | 55.00 | 11,000 | 25 | 13,750 | |
| 5.02 | Embankment core (selected fill material) | $m^3$ | 14,630 | 90.00 | 1,316,700 | 25 | 1,645,875 | |
| 5.03 | Embankment - upstream & downstream fill material | $m^3$ | 41,420 | 55.00 | 2,278,100 | 25 | 2,847,625 | |
| 5.04 | Construct rock toe | $m^3$ | 1,107 | 62.45 | 69,132 | 25 | 86,415 | |
| 5.05 | Topsoil spreading | $m^2$ | 3,464 | 6.87 | 23,795 | 25 | 29,744 | |
| 5.06 | Rip Rap on upstream face (500mm thick) | $m^3$ | 615 | 124.90 | 76,814 | 25 | 96,017 | |
| 5.07 | Hydromulching and pulping | ha | 0.35 | 3,747.00 | 1,298 | 25 | 1,622 | |
| | | | | | | | | |
| 6 | INSTRUMENTATION | | | | | | | $10,929 |
| | Dam instrumentation, supply and install (GIS) | | | | | | | |
| 6.01 | Supply & Install Rain gauge (pluviograph) | No. | 1 | 3,123 | 3,123 | 25 | 3,903 | |
| 6.02 | Supply & Install Water level monitor | No. | 1 | 5,621 | 5,621 | 25 | 7,026 | |
| | | | | | | | | |
| 7 | CONCRETE IN STRUCTURES | | | | | | | $260,487 |
| | Outlet Works | | | | | | | |
| 7.01 | Concrete in d/s outlet & dissipator | $m^3$ | 22 | 1,374 | 30,226 | 25 | 37,782 | |
| 7.02 | Outlet pipe - 1050 mm RCP | m | 120 | 1,365 | 163,800 | 25 | 204,750 | |
| 7.03 | Upstream headwall | No. | 1 | 6,245 | 6,245 | 25 | 7,806 | |
| 7.04 | Construct scour outlet rock protection | $m^3$ | 100 | 81 | 8,119 | 25 | 10,148 | |
| | | | | | | | | |

| ITEM | DESCRIPTION | UNIT | QUANTITY | RATE $ | DIRECT COST $ | CONTINGENCY % | TOTAL | Sub-total |
|---|---|---|---|---|---|---|---|---|
| 8 | GEOTEXTILES and PLASTICS | | | | | | | $14,051 |
| 8.01 | Supply and install filter fabric "Bidim A44" for Rock Toe. | $m^2$ | 2,000 | 5.62 | 11,241 | 25 | 14,051 | |
| | | | | | | | | |
| 9 | ROADWORKS | | | | | | | $864,694 |
| | Crest access road | | | | | | | |
| 9.01 | Trim, level, grade surface | $m^2$ | 615 | 7.00 | 4,305 | 25 | 5,381 | |
| 9.02 | Basecourse material | $m^2$ | 615 | 50 | 30,725 | 25 | 38,407 | |
| 9.03 | Bitumen sealing | $m^2$ | 615 | 15 | 9,225 | 25 | 11,531 | |
| | Relocation of Brown Hill Creek Road | | | | | | | |
| 9.04 | Excavation for road | $m^3$ | 15,000 | 17.50 | 262,500 | 25 | 328,125 | |
| 9.05 | Country highway - two lanes | m | 1,000 | 385 | 385,000 | 25 | 481,250 | |
| | | | | | | | | |
| 10 | FENCING and SIGNAGE | | | | | | | $31,225 |
| 10.01 | Supply and install fencing and signage around the spillway | Item | 1 | 18,735 | 18,735 | 25 | 23,419 | |
| 10.02 | Supply and install fencing and signage around the site | Item | 1 | 6,245 | 6,245 | 25 | 7,806 | |
| | | | | | | | | |
| 11 | PROPERTY ACQUISITION | | | | | | | $3,384,375 |
| 11.01 | Property acquisition | $m^2$ | 67,000 | 23 | 1,507,500 | 25 | 1,884,375 | |
| 11.02 | House acquisition | Item | 3 | 400,000 | 1,200,000 | 25 | 1,500,000 | |
| | | | | | | | | |
| | CAPITAL COST ESTIMATE TOTAL | | | | $ 9,017,730 | | | $13,075,708 |
| | INVESTIGATION, DESIGN & PROJECT MANAGEMENT | Item | 8,113,775 | 10% | 811,378 | 25 | 1,014,222 | $1,014,222 |
| | | | | | | | TOTAL | $14,089,930 |

# Appendix J2: Cost Estimate for Brown Hill Creek Channel Upgrade between Hampton St and Cross Rd (Flood Control Dam Scenario)

NOTE: This cost estimate has been adapted from the 2006 Master Plan, with materials and quantities altered to suit. Rates have been inflated to represent 2011 dollars. Detailed survey and geotechnical information is required to prepare a detailed cost estimate.



| Item | Description | Quantity | Unit | Rate | Costs |
|---|---|---|---|---|---|
| **1** | Overheads & Preliminaries | 1 | Item | 5% | $74,226 |
| **2** | Construct Coffer Dam to existing Channel to allow water to be | 1 | No | $24,980 | $24,980 |
| | diverted around live construction site | | | | |
| **3** | Construct vehicle & equipment access ramp to channel floor | 1 | No | $18,735 | $18,735 |
| **4** | Pump & generator hire | 90 | Day | $500 | $44,964 |
| **5** | Purchase 500m of 200mm dia hose | 300 | m | $144 | $43,091 |
| **6** | Clamps & connectors to suit 200mm dia.hose | 30 | No | $175 | $5,246 |
| **7** | Set up pumps & hoses | 2 | day | $749 | $1,499 |
| **8** | Trim existing unlined walls x 255m | 205 | $m^3$ | $187 | $38,407 |
| **9** | Earthworks to Base Level & sides (incld support) | 1530 | $m^3$ | $94 | $143,323 |
| **10** | Disposal of soil | 1735 | $m^3$ | $37 | $65,010 |
| **11** | Install trench support (Closed Boarding) - avg2.4m high | 1224 | $m^2$ | $37 | $45,863 |
| **12** | Allow 200mm FCR compacted to Culvert floor | 205 | $m^3$ | $75 | $15,363 |
| **13** | Lay 200mm Blinding Concrete under panels | 205 | $m^3$ | $350 | $71,693 |
| **14** | Construct Base Slab | 210 | $m^3$ | $525 | $110,162 |
| **15** | Pour Concrete Walls, incl labour | 350 | $m^3$ | $1,374 | $480,865 |
| **16** | Property Acquisition | 8 | Item | $31,225 | $249,800 |
| **17** | Traffic Control | 1 | Item | $84,308 | $84,308 |
| **18** | Service Location | 1 | Item | $31,225 | $31,225 |
| **19** | Domestic Service Connection Relocations | 8 | no | $1,249 | $9,992 |
| | | | | | |
| | Sub-Total | | | | $1,558,750 |
| | Design Costs | | | 30% | $467,625 |
| | Contingency | | | 25% | $389,688 |
| | | | | **TOTAL** | **$2,416,063** |

Appendix J3: Cost Estimate for Brown Hill Creek Flood Control Dam at Site 2 (Spillway Height = 20 metres)

NOTE:
This cost estimate has been adapted from the 2006 Master Plan, with materials and quantities altered to suit. Rates have been inflated to represent 2011 dollars.
Detailed survey and geotechnical information is required to prepare a detailed cost estimate.
Estimate based on earth embankment design with separate spillway.



| ITEM | DESCRIPTION | UNIT | QUANTITY | RATE $ | DIRECT COST $ | CONTINGENCY % | TOTAL | Sub-total |
|---|---|---|---|---|---|---|---|---|
| 1 | PRELIMINARIES | | | 20% | | | | $1,838,297 |
| 1.01 | Contractor's supervision | Item | Included | | | | | |
| 1.02 | Site Establishment | Item | Included | | | | | |
| 1.03 | Site Running Costs | Item | Included | | | | | |
| 1.04 | Plant and Equipment | Item | Included | | | | | |
| 1.05 | Fees & Charges (Including insurances) | Item | Included | | | | | |
| 1.06 | Other - Construct Haul Roads | Item | Included | | | | | |
| | | | | | | | | |
| 2 | DIVERSION CONTROL AND WATER SUPPLY DURING CONSTRUCTION | | | | | | | $275,024 |
| 2.01 | Cofferdam (x 1) | | | | | | | |
| 2.02 | Strip embankment crest - 1.0m depth | $m^3$ | 2,070 | 12 | 25,854 | 25 | 32,318 | |
| 2.03 | Raise Embankment 4m with selected fill | $m^3$ | 1,600 | 55 | 88,000 | 25 | 110,000 | |
| 2.04 | Spillway Construction | LS | 1 | 6,245 | 6,245 | 25 | 7,806 | |
| 2.05 | DN200 PVC Water Supply Pipeline | m | 400 | 187 | 74,940 | 25 | 93,675 | |
| 2.06 | Pump Set + Power | LS | 1 | 24,980 | 24,980 | 25 | 31,225 | |
| | | | | | | | | |
| 3 | EXCAVATION AND EARTHWORKS | | | | | | | $1,550,802 |
| | Embankment, Abutment and Borrow | | | | | | | |
| 3.01 | Clearing | $m^2$ | 12,000 | 3.75 | 44,964 | 25 | 56,205 | |
| 3.02 | Topsoil stripping - 150 mm depth | $m^3$ | 1,800 | 9.37 | 16,862 | 25 | 21,077 | |
| 3.03 | Excavate Borrow Material | $m^3$ | 11,000 | 6.25 | 68,695 | 25 | 85,869 | |
| 3.04 | Special cleanoff of foundation (10% of stripping) | $m^2$ | 2,400 | 25 | 59,952 | 25 | 74,940 | |
| | | | | | | | | |
| | Outlet Works | | | | | | | |
| 3.05 | Excavation for pipe - soil | $m^3$ | 1,172 | 17.50 | 20,508 | 25 | 25,635 | |
| 3.06 | Excavation for pipe - rock | $m^3$ | 3,828 | 34.20 | 130,922 | 25 | 163,652 | |
| | | | | | | | | |

| ITEM | DESCRIPTION | UNIT | QUANTITY | RATE $ | DIRECT COST $ | CONTINGENCY % | TOTAL | Sub-total |
|---|---|---|---|---|---|---|---|---|
| | Spillway | | | | | | | |
| 3.07 | Excavation of Top Soil for Spillway Approach and Chute | $m^3$ | 1,586 | 9 | 14,859 | 25 | 18,574 | |
| 3.08 | Excavation for Spillway in Soil | $m^3$ | 8,989 | 17.50 | 157,303 | 25 | 196,629 | |
| 3.09 | Excavation for Spillway in Rock | $m^3$ | 21,150 | 34.20 | 723,330 | 25 | 904,163 | |
| 3.10 | Excavation for Invert Drains and Joints | $m^3$ | 130 | 25 | 3,247 | 25 | 4,059 | |
| | | | | | | | | |
| 4 | DRAINAGE | | | | | | | $44,964 |
| 4.01 | Construct stone pitched drains along rock toe | $m^2$ | 320 | 112 | 35,971 | 25 | 44,964 | |
| | | | | | | | | |
| 5 | EMBANKMENT CONSTRUCTION | | | | | | | $6,049,191 |
| 5.01 | Conduct roller trial. | $m^3$ | 200 | 55 | 11,000 | 25 | 13,750 | |
| 5.02 | Embankment (selected fill material) | $m^3$ | 19,245 | 90 | 1,732,038 | 25 | 2,165,048 | |
| 5.03 | Embankment - upstream & downstream fill material | $m^3$ | 54,485 | 55 | 2,996,701 | 25 | 3,745,876 | |
| 5.04 | Construct downstream rock toe | $m^3$ | 317 | 62 | 19,804 | 25 | 24,755 | |
| 5.05 | Topsoil spreading | $m^2$ | 5,550 | 7 | 38,122 | 25 | 47,653 | |
| 5.06 | Rip Rap on upstream face (500mm thick) | $m^3$ | 317 | 125 | 39,608 | 25 | 49,510 | |
| 5.07 | Hydromulching and pulping | ha | 0.55 | 3,747 | 2,079 | 25 | 2,599 | |
| | | | | | | | | |
| 6 | INSTRUMENTATION | | | | | | | $10,929 |
| | Dam instrumentation, supply and install (GIS) | | | | | | | |
| 6.01 | Supply & Install Rain gauge (pluviograph) | No. | 1 | 3,123 | 3,123 | 25 | 3,903 | |
| 6.02 | Supply & Install Water level monitor | No. | 1 | 5,621 | 5,621 | 25 | 7,026 | |
| | | | | | | | | |
| 7 | CONCRETE IN STRUCTURES | | | | | | | $158,787 |
| | Outlet Works | | | | | | | |
| 7.01 | Concrete in d/s outlet & dissipator | $m^3$ | 22 | 1,374 | 30,226 | 25 | 37,782 | |
| 7.02 | Outlet pipe - 600 mm RCP | m | 120 | 687 | 82,440 | 25 | 103,050 | |
| 7.03 | Upstream headwall | No. | 1 | 6,245 | 6,245 | 25 | 7,806 | |
| 7.04 | Construct scour outlet rock protection | $m^3$ | 100 | 81 | 8,119 | 25 | 10,148 | |
| | | | | | | | | |

| ITEM | DESCRIPTION | UNIT | QUANTITY | RATE $ | DIRECT COST $ | CONTINGENCY % | TOTAL | Sub-total |
|---|---|---|---|---|---|---|---|---|
| 8 | GEOTEXTILES and PLASTICS | | | | | | | $15,269 |
| 8.01 | Supply and install filter fabric "Bidim A44" for Rock Toe. | $m^2$ | 2,173 | 6 | 12,215 | 25 | 15,269 | |
| | | | | | | | | |
| 9 | ROADWORKS | | | | | | | $81,608 |
| | Crest access road | | | | | | | |
| 9.01 | Trim, level, grade surface | $m^2$ | 815 | 7 | 5,344 | 25 | 6,680 | |
| 9.02 | Basecourse material | $m^2$ | 815 | 50 | 40,717 | 25 | 50,897 | |
| 9.03 | Bitumen sealing | $m^2$ | 815 | 15 | 12,225 | 25 | 15,281 | |
| | Access Road to Dam 2 | | | | | | | |
| 9.04 | Trim, level, regrade surface as required | $m^2$ | 1,000 | 7 | 7,000 | 25 | 8,750 | |
| | | | | | | | | |
| 10 | FENCING and SIGNAGE | | | | | | | $31,225 |
| 10.01 | Supply and install fencing and signage around the spillway | Item | 1 | 18,735 | 18,735 | 25 | 23,419 | |
| 10.02 | Supply and install fencing and signage around the site | Item | 1 | 6,245 | 6,245 | 25 | 7,806 | |
| | | | | | | | | |
| 11 | PROPERTY ACQUISITION | | | | | | | $3,271,559 |
| 11.01 | Property acquisition - Dam 2 | $m^2$ | 94,118 | 23 | 2,617,247 | 25 | 3,271,559 | |
| | CAPITAL COST ESTIMATE TOTAL | | | | $ 9,191,486 | | | $13,327,655 |
| | INVESTIGATION, DESIGN & PROJECT MANAGEMENT | Item | 8,412,537 | 10% | 841,254 | 25 | 1,051,567 | $1,051,567 |
| | | | | | | | TOTAL | $14,379,222 |

Appendix J4: Cost Estimate for Weir System in Brown Hill Creek Recreation Reserve

NOTE: This cost estimate has been adapted from the 2006 Master Plan, with materials and quantities altered to suit. Rates have been inflated to represent 2011 dollars.
Detailed survey and geotechnical information is required to prepare a detailed cost estimate.

| ITEM | DESCRIPTION | UNIT | QUANTITY | RATE $ | DIRECT COST $ | CONTINGENCY % | TOTAL | Sub-total |
|---|---|---|---|---|---|---|---|---|
| 1 | PRELIMINARIES | | | 20% | | | | $1,175,404 |
| 1.01 | Contractor's supervision | Item | Included | | | | | |
| 1.02 | Site Establishment | Item | Included | | | | | |
| 1.03 | Site Running Costs | Item | Included | | | | | |
| 1.04 | Plant and Equipment | Item | Included | | | | | |
| 1.05 | Fees & Charges (Including insurances) | Item | Included | | | | | |
| 1.06 | Other - Construct Haul Roads | Item | Included | | | | | |
| | | | | | | | | |
| 2 | DIVERSION CONTROL AND WATER SUPPLY DURING CONSTRUCTION | | | | | | | $370,400 |
| 2.01 | Cofferdam (x3) | | | | | | | |
| 2.02 | Strip embankment crest - 1.0m depth | $m^3$ | 2,600 | 12 | 32,474 | 25 | 40,593 | |
| 2.03 | Raise Embankments 2m with selected fill | $m^3$ | 1,300 | 55 | 71,500 | 25 | 89,375 | |
| 2.04 | Spillway Construction | LS | 3 | 6,245 | 18,735 | 25 | 23,419 | |
| 2.05 | DN200 PVC Water Supply Pipeline | m | 750 | 187 | 140,513 | 25 | 175,641 | |
| 2.06 | Pump Set + Power | LS | 1 | 24,980 | 24,980 | 25 | 31,225 | |
| 2.07 | Remove cofferdams from channel | $m^3$ | 1,300 | 6 | 8,119 | 25 | 10,148 | |
| | | | | | | | | |

| ITEM | DESCRIPTION | UNIT | QUANTITY | RATE $ | DIRECT COST $ | CONTINGENCY % | TOTAL | Sub-total |
|---|---|---|---|---|---|---|---|---|
| 3 | EXCAVATION AND EARTHWORKS | | | | | | | $151,882 |
| | Embankment, Abutment and Borrow | | | | | | | |
| 3.01 | Clearing | $m^2$ | 7,140 | 4 | 26,754 | 25 | 33,442 | |
| 3.02 | Topsoil stripping - 150 mm depth | $m^3$ | 1,071 | 9 | 10,033 | 25 | 12,541 | |
| 3.03 | Excavate Borrow Material | $m^3$ | 7,854 | 6 | 49,048 | 25 | 61,310 | |
| 3.04 | Special cleanoff of foundation (10% of stripping) | $m^2$ | 1,428 | 25 | 35,671 | 25 | 44,589 | |
| | | | | | | | | |
| 4 | WEIR CONSTRUCTION | | | | | | | $4,281,990 |
| 4.01 | Weir core - roller compacted concrete | $m^3$ | 8,400 | 226 | 1,896,905 | 25 | 2,371,131 | |
| 4.02 | Spillway, abutments and precast concrete wall finishes - reinforced | $m^3$ | 1,831 | 835 | 1,528,688 | 25 | 1,910,859 | |
| | | | | | | | | |
| 5 | CONCRETE IN STRUCTURES | | | | | | | $616,674 |
| | Outlet Works | | | | | | | |
| 5.01 | Concrete in d/s outlet & dissipator | $m^3$ | 198 | 1,374 | 272,032 | 25 | 340,040 | |
| 5.02 | Outlet pipes - 1600/1700 mm RCP | m | 90 | 1,632 | 146,836 | 25 | 183,544 | |
| 5.03 | Upstream headwall | No. | 9 | 6,245 | 56,205 | 25 | 70,256 | |
| 5.04 | Construct scour outlet rock protection | $m^3$ | 225 | 81 | 18,267 | 25 | 22,833 | |
| | | | | | | | | |
| 6 | FENCING and SIGNAGE | | | | | | | $18,579 |
| 6.01 | Supply and install fencing and signage around the site | Item | 1 | 14,863 | 14,863 | 25 | 18,579 | |
| | | | | | | | | |
| 7 | PROPERTY ACQUISITION | | | | | | | $1,906,750 |
| 7.01 | Property acquisition | $m^2$ | 44,600 | 23 | 1,525,400 | 25 | 1,906,750 | |
| | CAPITAL COST ESTIMATE TOTAL | | | | $ 5,877,021 | | | $8,521,680 |
| | INVESTIGATION, DESIGN & PROJECT MANAGEMENT | Item | 5,527,025 | 10% | 552,702 | 25 | 690,878 | $690,878 |
| | | | | | | | TOTAL | $9,212,558 |

# Appendix J5: Cost Estimate for Overland Flow Interceptor Culvert at Glenelg Tramway, for use with Flood Control Dam at Site 2

NOTE: This cost estimate has been adapted from the 2006 Master Plan, with materials and quantities altered to suit. Rates have been inflated to represent 2011 dollars. Detailed survey and geotechnical information is required to prepare a detailed cost estimate.



| Item | Description | Quantity | Unit | Rate ($) | Costs ($) |
|---|---|---|---|---|---|
| **1** | Overheads & Preliminaries | 1 | Item | 5% | $127,347 |
| **2** | Trenching, laying, backfill and reinstate | | | | |
| | 1800mm x 1200mm RCBC | 612 | m | $2,762 | $1,690,389 |
| **3** | Headwall - inlet & outlet works | 2 | Item | $24,980 | $49,960 |
| **4** | Lintels - kerb and gutter works | 50 | m | $1,200 | $60,000 |
| **5** | Bunding for lintel drainage basin | 84 | $m^3$ | $50 | $4,197 |
| **6** | Sag pits for lintel drainage basin | 4 | item | $2,483 | $9,932 |
| **7** | Upgrade of culvert under Tramway and culvert under railway | 1 | Item | $300,000 | $300,000 |
| **8** | Service Relocation | 1 | Item | 15% | $253,558 |
| **9** | Traffic Control | 1 | Item | $176,397 | $176,397 |
| **10** | Domestic Service Connection Relocations | 2 | no | $1,249 | $2,498 |
| | | | | | |
| | Sub-Total | | | | $2,674,278 |
| | Design Costs<br>Contingency | | | 20%<br>25% | $534,856<br>$668,570 |
| | | | | **TOTAL** | **$3,877,704** |

# Appendix J6: Cost Estimate for Channel Upgrade between Leah St and Anzac Hwy (Flood Control Dam Scenario)

NOTE: This cost estimate has been adapted from the 2006 Master Plan, with materials and quantities altered to suit. Rates have been inflated to represent 2011 dollars. Detailed survey and geotechnical information is required to prepare a detailed cost estimate.

| Item | Description | Quantity | Unit | Rate ($) | Costs ($) |
|---|---|---|---|---|---|
| **1** | Overheads & Preliminaries | 1 | Item | 5% | $333,441 |
| **2** | Tree removal | 0.5 | km | $25,000 | $12,325 |
| **3** | Construct Coffer Dam to existing channel to allow water to be | 3 | No | $25,000 | $75,000 |
| | diverted around live construction site - | | | | |
| **4** | Construct vehicle & equipment access ramp to channel floor | 4 | No | $20,000 | $80,000 |
| **5** | Pump & generator hire | 78 | Day | $500 | $38,727 |
| **6** | Purchase 500m of 200mm dia hose | 500 | m | $144 | $71,818 |
| **7** | Clamps & connectors to suit 200mm dia.hose | 50 | No | $175 | $8,743 |
| **8** | Set up pumps & hoses | 2 | day | $749 | $1,499 |
| **9** | Demolish existing Concrete walls | 749 | $m^3$ | $187 | $140,393 |
| **10** | Remove concrete to tip | 749 | $m^3$ | $37 | $28,079 |
| **11** | Excavate sides of channel x 493m length | 4930 | $m^3$ | $44 | $215,515 |
| **12** | Disposal of soil | 5670 | $m^3$ | $37 | $212,436 |
| **13** | Lay 200mm Blinding Concrete under panels | 1055 | $m^3$ | $350 | $368,962 |
| **14** | Prefabricated Concrete Walls & Floor Panels x 593 panels | 5275 | $m^2$ | $387 | $2,042,466 |
| | including labour | | | | |
| **15** | Cranage to assist with Concrete Panel installation | 593 | Hrs | $225 | $133,253 |
| **16** | **Road Crossings (incl. material supply)** | | | | |
| a | Charles Street | 1 | Item | $200,000 | $200,000 |
| b | Leah Street | 1 | Item | $50,000 | $50,000 |
| c | First Avenue | 1 | Item | $200,000 | $200,000 |
| d | Second Avenue | 1 | Item | $200,000 | $200,000 |
| e | ANZAC Highway | 1 | Item | $1,000,000 | $1,000,000 |
| **17** | Service Relocation for bridge crossings | 1 | Item | 5% | $82,500 |
| **18** | Traffic Control | 1 | Item | $142,098 | $142,098 |
| **19** | Property acquisition/easements | 2730 | $m^2$ | $500 | $1,365,000 |
| | | | | | |
| | Sub-Total | | | | $7,002,252 |
| | Design Costs | | | 20% | $1,400,450 |
| | Contingency | | | 25% | $1,750,563 |
| | | | | **TOTAL** | **$10,153,265** |

# Appendix J7: Cost Estimate for Overland Flow Collector Drain at Mitchell St

NOTE: This cost estimate has been adapted from the 2006 Master Plan, with materials and quantities altered to suit. Rates have been inflated to represent 2011 dollars. Detailed survey and geotechnical information is required to prepare a detailed cost estimate.



| Item | Description | Quantity | Unit | Rate ($) | Costs ($) |
|---|---|---|---|---|---|
| **1** | Overheads & Preliminaries | 1 | Item | 5% | $60,679 |
| **2** | Trenching, laying, backfill and reinstate | | | | |
| | 1350mm RCP | 534 | m | $1,518 | $810,364 |
| **3** | Headwall - inlet & outlet works | 2 | Item | $24,980 | $49,960 |
| **4** | Lintels - kerb and gutter works | 44 | m | $1,200 | $52,800 |
| **5** | Service Relocation | 1 | Item | 15% | $121,555 |
| **6** | Traffic Control | 1 | Item | $153,915 | $153,915 |
| **7** | Domestic Service Connection Relocations | 20 | no | $1,249 | $24,980 |
| | | | | | |
| | Sub-Total | | | | $1,274,252 |
| | Design Costs<br>Contingency | | | 20%<br>25% | $254,850<br>$318,563 |
| | | | | **TOTAL** | **$1,847,666** |

# Appendix J8: Cost Estimate for High-Flow Bypass Culvert between Mitchell St and Railway

NOTE: This cost estimate has been adapted from the 2006 Master Plan, with materials and quantities altered to suit. Rates have been inflated to represent 2011 dollars. Detailed survey and geotechnical information is required to prepare a detailed cost estimate.



| Item | Description | Quantity | Unit | Rate ($) | Costs ($) |
|---|---|---|---|---|---|
| **1** | Overheads & Preliminaries | 1 | Item | 5% | $122,102 |
| **2** | Trenching, laying, backfill and reinstate | | | | |
| | 1800mm x 1500mm RCBC | 557 | m | $3,453 | $1,923,094 |
| **3** | Headwall - inlet & outlet works | 2 | Item | $24,980 | $49,960 |
| **4** | Service Relocation | 1 | Item | $288,464 | $288,464 |
| **5** | Traffic Control | 1 | Item | $160,545 | $160,545 |
| **6** | Domestic Service Connection Relocations | 16 | no | $1,249 | $19,984 |
| | | | | | |
| | Sub-Total | | | | $2,564,149 |
| | Design Costs<br>Contingency | | | 20%<br>25% | $512,830<br>$641,037 |
| | | | | **TOTAL** | **$3,718,016** |

# Appendix J9: Cost Estimate for High-Flow Bypass Culvert between Victoria St and Glenelg Tramway

NOTE: This cost estimate has been adapted from the 2006 Master Plan, with materials and quantities altered to suit. Rates have been inflated to represent 2011 dollars. Detailed survey and geotechnical information is required to prepare a detailed cost estimate.

| Item | Description | Quantity | Unit | Rate ($) | Costs ($) |
|---|---|---|---|---|---|
| **1** | Overheads & Preliminaries | 1 | Item | 5% | $81,937 |
| **2** | Trenching, laying, backfill and reinstate | | | | |
| | 1800mm x 1500mm RCBC | 263 | m | $3,453 | $908,032 |
| **3** | Headwall - inlet & outlet works | 2 | Item | $24,980 | $49,960 |
| **4** | Upgrade of culvert under Tramway | 1 | Item | $150,000 | $150,000 |
| **5** | Railway Line near Victoria St Bridge | 1 | Item | $300,000 | $300,000 |
| **6** | Service Relocation | 1 | Item | $136,205 | $136,205 |
| **7** | Traffic Control | 1 | Item | $75,805 | $75,805 |
| **8** | Domestic Service Connection Relocations | 15 | no | $1,249 | $18,735 |
| | | | | | |
| | Sub-Total | | | | $1,720,673 |
| | Design Costs<br>Contingency | | | 20%<br>25% | $344,135<br>$430,168 |
| | | | | **TOTAL** | **$2,494,976** |

# Appendix J10: Cost Estimate for Overland Flow Interceptor Culvert at Glenelg Tramway (no upper catchment detention)

NOTE: This cost estimate has been adapted from the 2006 Master Plan, with materials and quantities altered to suit. Rates have been inflated to represent 2011 dollars. Detailed survey and geotechnical information is required to prepare a detailed cost estimate.

| Item | Description | Quantity | Unit | Rate ($) | Costs ($) |
|---|---|---|---|---|---|
| **1** | Overheads & Preliminaries | 1 | Item | 5% | $204,045 |
| **2** | Trenching, laying, backfill and reinstate | | | | |
| | 2100mm x 1800mm RCBC | 612 | m | $4,834 | $2,958,182 |
| **3** | Headwall - inlet & outlet works | 2 | Item | $24,980 | $49,960 |
| **4** | Lintels - kerb and gutter works | 103 | m | $1,200 | $123,600 |
| **5** | Bunding for lintel drainage basin | 84 | $m^3$ | $50 | $4,197 |
| **6** | Sag pits for lintel drainage basin | 9 | item | $2,483 | $22,347 |
| **7** | Upgrade of culvert under Tramway and culvert under railway | 1 | Item | $300,000 | $300,000 |
| **8** | Service Relocation | 1 | Item | 15% | $443,727 |
| **9** | Traffic Control | 1 | Item | $176,397 | $176,397 |
| **10** | Domestic Service Connection Relocations | 2 | no | $1,249 | $2,498 |
| | | | | | |
| | Sub-Total | | | | $4,284,953 |
| | Design Costs<br>Contingency | | | 20%<br>25% | $856,991<br>$1,071,238 |
| | | | | **TOTAL** | **$6,213,182** |

# Appendix J11: Cost Estimate for Brown Hill Creek Channel Upgrade between Leah St and Anzac Hwy (no upper catchment detention)

NOTE: This cost estimate has been adapted from the 2006 Master Plan, with materials and quantities altered to suit. Rates have been inflated to represent 2011 dollars. Detailed survey and geotechnical information is required to prepare a detailed cost estimate.

| Item | Description | Quantity | Unit | Rate | Costs ($) |
|---|---|---|---|---|---|
| **1** | Overheads & Preliminaries | 1 | Item | 5% | $342,103 |
| **2** | Tree removal | 0.5 | km | $25,000 | $12,325 |
| **3** | Construct Coffer Dam for existing channel to allow water to be | 3 | No | $25,000 | $75,000 |
| | diverted around live construction site - | | | | |
| **4** | Construct vehicle & equipment access ramp to channel floor | 4 | No | $20,000 | $80,000 |
| **5** | Pump & generator hire | 76 | Day | $500 | $37,893 |
| **6** | Purchase 500m of 200mm dia hose | 500 | m | $144 | $71,818 |
| **7** | Clamps & connectors to suit 200mm dia.hose | 50 | No | $175 | $8,743 |
| **8** | Set up pumps & hoses | 2 | day | $750 | $1,500 |
| **9** | Demolish existing Concrete walls | 749 | $m^3$ | $187 | $140,393 |
| **10** | Remove concrete to tip | 749 | $m^3$ | $37 | $28,079 |
| **11** | Excavate sides of channel x 493m length | 3944 | $m^3$ | $44 | $172,412 |
| **12** | Raise top of channel banks | 789 | $m^3$ | $50 | $39,408 |
| **13** | Disposal of soil | 3659 | $m^3$ | $37 | $137,109 |
| **14** | Lay 200mm Blinding Concrete under panels | 1134 | $m^3$ | $350 | $396,548 |
| **15** | Prefabricated Concrete Walls & Floor Panels x 638 panels | 5670 | $m^2$ | $400 | $2,267,800 |
| | including labour | | | | |
| **16** | Cranage to assist with Concrete Panel installation | 638 | Hrs | $225 | $143,435 |
| **17** | **Road Crossings (incl. material supply)** | | | | |
| a | Charles Street | 1 | Item | $200,000 | $200,000 |
| b | Leah Street | 1 | Item | $50,000 | $50,000 |
| c | First Avenue | 1 | Item | $200,000 | $200,000 |
| d | Second Avenue | 1 | Item | $200,000 | $200,000 |
| e | ANZAC Highway | 1 | Item | $1,000,000 | $1,000,000 |
| **18** | Service Relocation for bridge crossings | 1 | Item | 5% | $72,500 |
| **19** | Traffic Control | 1 | Item | $142,098 | $142,098 |
| **20** | Property acquisition/easements | 2730 | $m^2$ | $500 | $1,365,000 |
| | | | | | |
| | Sub-Total | | | | $7,184,162 |
| | Design, Project Management, Consultation | | | 20% | $1,436,832 |
| | Contingency | | | 25% | $1,796,040 |
| | | | | **TOTAL** | **$10,417,000** |

# Appendix J12: Cost Estimate for Brown Hill Creek Channel Upgrade between Hampton St and Cross Rd (no upper catchment detention)

NOTE: This cost estimate has been adapted from the 2006 Master Plan, with materials and quantities altered to suit. Rates have been inflated to represent 2011 dollars. Detailed survey and geotechnical information is required to prepare a detailed cost estimate.



| Item | Description | Quantity | Unit | Rate | Costs ($) |
|---|---|---|---|---|---|
| **1** | Overheads & Preliminaries | | Item | 5% | $85,419 |
| **2** | Tree removal | 0.2 | km | $25,000 | $5,500 |
| **3** | Construct Coffer Dam to existing channel to allow water to be | 1 | No | $25,000 | $25,000 |
| | diverted around live construction site - | | | | |
| **4** | Construct vehicle & equipment access ramp to channel floor | 1 | No | $20,000 | $20,000 |
| **5** | Pump & generator hire | 34 | Day | $500 | $16,910 |
| **6** | Purchase 500m of 200mm dia hose | 500 | m | $144 | $71,818 |
| **7** | Clamps & connectors to suit 200mm dia.hose | 50 | No | $175 | $8,743 |
| **8** | Set up pumps & hoses | 2 | day | $749 | $1,499 |
| **9** | Excavate sides of channel | 1128 | $m^3$ | $44 | $49,313 |
| **10** | Raise top of channel banks | 660 | $m^3$ | $50 | $32,974 |
| **11** | Surface treatement of excavated sections (compaction etc) | 3190 | $m^2$ | $5.00 | $15,950 |
| **12** | Disposal of soil | 564 | $m^3$ | $37 | $21,130 |
| **13** | Revegate banks | 3190 | $m^2$ | $12 | $39,843 |
| **14** | **Road Crossings (incl. material supply)** | | | | |
| a | Hampton St | 1 | Item | $400,000 | $400,000 |
| **15** | Service Relocation for bridge crossings | | Item | 5% | $20,000 |
| **16** | Traffic Control | 1 | Item | $63,411 | $63,411 |
| **17** | Property acquisition/easements | 1833 | $m^2$ | $500 | $916,300 |
| | | | | | |
| | Sub-Total | | | | $1,793,809 |
| | Design, Project Management, Consultation | | | 30% | $538,143 |
| | Contingency | | | 25% | $448,452 |
| | | | | **TOTAL** | **$2,780,000** |

# Appendix J13: Cost Estimate for Overland Flow Interceptor Culvert at Leader St

NOTE: This cost estimate has been adapted from the 2006 Master Plan, with materials and quantities altered to suit. Rates have been inflated to represent 2011 dollars. Detailed survey and geotechnical information is required to prepare a detailed cost estimate.

| Item | Description | Quantity | Unit | Rate ($) | Costs ($) |
|---|---|---|---|---|---|
| **1** | Overheads & Preliminaries | 1 | Item | 5% | $74,099 |
| **2** | Trenching, laying, backfill and reinstate | | | | |
| | 1800mm x 1500mm RCBC | 365 | m | $3,453 | $1,260,196 |
| **3** | Headwall - inlet & outlet works | 1 | Item | $24,980 | $24,980 |
| **4** | Lintels - kerb and gutter works | 164 | m | $1,200 | $196,800 |
| | | | | | |
| | Sub-Total | | | | $1,556,075 |
| | Design Costs | | | 20% | $311,215 |
| | Contingency | | | 25% | $389,019 |
| | | | | **TOTAL** | **$2,256,309** |

# Appendix J14: Cost Estimate for Overland Flow Interceptor Culvert at Third Avenue

NOTE: This cost estimate has been adapted from the 2006 Master Plan, with materials and quantities altered to suit. Rates have been inflated to represent 2011 dollars. Detailed survey and geotechnical information is required to prepare a detailed cost estimate.



| Item | Description | Quantity | Unit | Rate ($) | Costs ($) |
|---|---|---|---|---|---|
| **1** | Overheads & Preliminaries | 1 | Item | 5% | $39,035 |
| **2** | Trenching, laying, backfill and reinstate | | | | |
| | 1800mm x 1200mm RCBC | 200 | m | $2,762 | $552,415 |
| **3** | Headwall - inlet & outlet works | 1 | Item | $24,980 | $24,980 |
| **4** | Lintels - kerb & gutter works | 44 | m | $1,200 | $52,800 |
| **5** | Service Relocation | 1 | Item | $82,862 | $82,862 |
| **6** | Traffic Control | 1 | Item | $57,646 | $57,646 |
| **7** | Domestic Service Connection Relocations | 8 | no | $1,249 | $9,993 |
| | | | | | |
| | Sub-Total | | | | $819,731 |
| | Design Costs<br>Contingency | | | 20%<br>25% | $163,946<br>$204,933 |
| | | | | **TOTAL** | **$1,188,610** |

# Appendix J15: Cost Estimate for Brown Hill Creek Channel Upgrade between Third Ave and Anzac Hwy (for use with Leader St and Third Ave Interceptors)

NOTE: This cost estimate has been adapted from the 2006 Master Plan, with materials and quantities altered to suit. Rates have been inflated to represent 2011 dollars. Detailed survey and geotechnical information is required to prepare a detailed cost estimate.

| Item | Description | Quantity | Unit | Rate ($) | Costs ($) |
|---|---|---|---|---|---|
| **1** | Overheads & Preliminaries | 1 | Item | 5% | $137,404 |
| **2** | Tree removal | 0.2 | km | $24,980 | $3,997 |
| **3** | Construct Coffer Dam to existing channel to allow water to be | 1 | No | $24,980 | $24,980 |
| | diverted around live construction site - | | | | |
| **4** | Construct vehicle & equipment access ramp to channel floor | 1 | No | $18,735 | $18,735 |
| **5** | Pump & generator hire | 25 | Day | $500 | $12,569 |
| **6** | Purchase 500m of 200mm dia hose | 250 | m | $144 | $35,909 |
| **7** | Clamps & connectors to suit 200mm dia.hose | 50 | No | $175 | $8,743 |
| **8** | Set up pumps & hoses | 2 | day | $749 | $1,499 |
| **9** | Demolish existing Concrete walls | 243 | $m^3$ | $187 | $45,564 |
| **10** | Remove concrete to tip | 243 | $m^3$ | $37 | $9,113 |
| **11** | Excavate sides of channel x 493m length | 1280 | $m^3$ | $44 | $55,955 |
| **12** | Raise top of channel banks | 256 | $m^3$ | $50 | $12,790 |
| **13** | Disposal of soil | 1188 | $m^3$ | $37 | $44,498 |
| **14** | Lay 200mm Blinding Concrete under panels | 368 | $m^3$ | $350 | $128,697 |
| **15** | Prefabricated Concrete Walls & Floor Panels x 207 panels | 1840 | $m^2$ | $387 | $712,430 |
| | including labour | | | | |
| **16** | Cranage to assist with Concrete Panel installation | 207 | Hrs | $225 | $46,480 |
| **17** | **Road Crossings (incl. material supply)** | | | | |
| a | ANZAC Highway | 1 | Item | $1,000,000 | $1,000,000 |
| **18** | Service Relocation | 1 | Item | 5% | $50,000 |
| **19** | Traffic Control | 1 | Item | $46,117 | $46,117 |
| **20** | Property acquisition | 980 | $m^2$ | $500 | $490,000 |
| | | | | | |
| | Sub-Total | | | | $2,885,477 |
| | Design Costs | | | 20% | $577,095 |
| | Contingency | | | 25% | $721,369 |
| | | | | **TOTAL** | **$4,183,941** |

Appendix J16: Cost Estimate for Brown Hill Creek Flood Control Dam at Site 1 (Spillway Height = 12 metres)

NOTE:
This cost estimate has been adapted from the 2006 Master Plan, with materials and quantities altered to suit. Rates have been inflated to represent 2011 dollars.
Detailed survey and geotechnical information is required to prepare a detailed cost estimate.
Estimate based on earth embankment design with separate spillway.



| ITEM | DESCRIPTION | UNIT | QUANTITY | RATE $ | DIRECT COST $ | CONTINGENCY % | TOTAL | Sub-total |
|---|---|---|---|---|---|---|---|---|
| 1 | PRELIMINARIES | | | 20% | | | | $1,299,926 |
| 1.01 | Contractor's supervision | Item | | | | | | |
| 1.02 | Site Establishment | Item | | | | | | |
| 1.03 | Site Running Costs | Item | | | | | | |
| 1.04 | Plant and Equipment | Item | | | | | | |
| 1.05 | Fees & Charges (Including insurances) | Item | | | | | | |
| 1.06 | Other - Construct Haul Roads | Item | | | | | | |
| | | | | | | | | |
| 2 | DIVERSION CONTROL AND WATER SUPPLY DURING CONSTRUCTION | | | | | | | $275,024 |
| 2.01 | Cofferdam | | | | | | | |
| 2.02 | Strip embankment crest - 1.0m depth | $m^3$ | 2,070 | 12 | 25,854 | 25 | 32,318 | |
| 2.03 | Raise Embankment 4m with selected fill | $m^3$ | 1,600 | 55 | 88,000 | 25 | 110,000 | |
| 2.04 | Spillway Construction | LS | 1 | 6,245 | 6,245 | 25 | 7,806 | |
| 2.05 | DN200 PVC Water Supply Pipeline | m | 400 | 187 | 74940 | 25 | 93,675 | |
| 2.06 | Pump Set + Power | LS | 1 | 24980 | 24980 | 25 | 31,225 | |
| | | | | | | | | |
| 3 | EXCAVATION AND EARTHWORKS | | | | | | | $1,623,643 |
| | Embankment, Abutment and Borrow | | | | | | | |
| 3.01 | Clearing | $m^2$ | 9,750 | 3.75 | 36,533 | 25 | 45,667 | |
| 3.02 | Topsoil stripping - 150 mm depth | $m^3$ | 1,463 | 9.37 | 13,700 | 25 | 17,125 | |
| 3.03 | Excavate Borrow Material | $m^3$ | 8,288 | 6.25 | 51,797 | 25 | 64,746 | |
| 3.04 | Special cleanoff of foundation | $m^2$ | 1,950 | 25 | 48,711 | 25 | 60,889 | |
| | | | | | | | | |
| | Outlet Works | | | | | | | |
| 3.05 | Excavation for pipe - soil | $m^3$ | 1,172 | 17.50 | 20,508 | 25 | 25,635 | |
| 3.06 | Excavation for pipe - rock | $m^3$ | 3,828 | 34.20 | 130,922 | 25 | 163,652 | |
| | | | | | | | | |

| ITEM | DESCRIPTION | UNIT | QUANTITY | RATE $ | DIRECT COST $ | CONTINGENCY % | TOTAL | Sub-total |
|---|---|---|---|---|---|---|---|---|
| | Spillway | | | | | | | |
| 3.07 | Excavation of Top Soil for Spillway Approach and Chute | $m^3$ | 1,763 | 9.37 | 16,510 | 25 | 20,638 | |
| 3.08 | Excavation for Spillway in Soil | $m^3$ | 9,988 | 17.35 | 173,283 | 25 | 216,604 | |
| 3.09 | Excavation for Spillway in Rock | $m^3$ | 23,500 | 34.20 | 803,700 | 25 | 1,004,625 | |
| 3.10 | Excavation for Invert Drains and Joints | $m^3$ | 130 | 25.00 | 3,250 | 25 | 4,063 | |
| | | | | | | | | |
| 4 | DRAINAGE | | | | | | | $29,227 |
| 4.01 | Construct stone pitched drains along rock toe | $m^2$ | 208 | 112.41 | 23,381 | 25 | 29,227 | |
| | | | | | | | | |
| 5 | EMBANKMENT CONSTRUCTION | | | | | | | $3,736,429 |
| 5.01 | Conduct roller trial. | $m^3$ | 200 | 55.00 | 11,000 | 25 | 13,750 | |
| 5.02 | Embankment core (selected fill material) | $m^3$ | 11,550 | 90.00 | 1,039,500 | 25 | 1,299,375 | |
| 5.03 | Embankment - upstream & downstream fill material | $m^3$ | 32,700 | 55.00 | 1,798,500 | 25 | 2,248,125 | |
| 5.04 | Construct rock toe | $m^3$ | 936 | 62.45 | 58,453 | 25 | 73,067 | |
| 5.05 | Topsoil spreading | $m^2$ | 2,311 | 6.87 | 15,876 | 25 | 19,845 | |
| 5.06 | Rip Rap on upstream face (500mm thick) | $m^3$ | 520 | 124.90 | 64,948 | 25 | 81,185 | |
| 5.07 | Hydromulching and pulping | ha | 0.23 | 3,747.00 | 866 | 25 | 1,082 | |
| | | | | | | | | |
| 6 | INSTRUMENTATION | | | | | | | $10,929 |
| | Dam instrumentation, supply and install (GIS) | | | | | | | |
| 6.01 | Supply & Install Rain gauge (pluviograph) | No. | 1 | 3,123 | 3,123 | 25 | 3,903 | |
| 6.02 | Supply & Install Water level monitor | No. | 1 | 5,621 | 5,621 | 25 | 7,026 | |
| | | | | | | | | |
| 7 | CONCRETE IN STRUCTURES | | | | | | | $338,487 |
| | Outlet Works | | | | | | | |
| 7.01 | Concrete in d/s outlet & dissipator | $m^3$ | 22 | 1,374 | 30,226 | 25 | 37,782 | |
| 7.02 | Outlet pipe - 1450 mm RCP | m | 120 | 1,885 | 226,200 | 25 | 282,750 | |
| 7.03 | Upstream headwall | No. | 1 | 6,245 | 6,245 | 25 | 7,806 | |
| 7.04 | Construct scour outlet rock protection | $m^3$ | 100 | 81 | 8,119 | 25 | 10,148 | |
| | | | | | | | | |

| ITEM | DESCRIPTION | UNIT | QUANTITY | RATE $ | DIRECT COST $ | CONTINGENCY % | TOTAL | Sub-total |
|---|---|---|---|---|---|---|---|---|
| 8 | GEOTEXTILES and PLASTICS | | | | | | | $14,051 |
| 8.01 | Supply and install filter fabric "Bidim A44" for Rock Toe. | $m^2$ | 2,000 | 5.62 | 11,241 | 25 | 14,051 | |
| | | | | | | | | |
| 9 | ROADWORKS | | | | | | | $856,149 |
| | Crest access road | | | | | | | |
| 9.01 | Trim, level, grade surface | $m^2$ | 520 | 7.00 | 3,640 | 25 | 4,550 | |
| 9.02 | Basecourse material | $m^2$ | 520 | 50 | 25,979 | 25 | 32,474 | |
| 9.03 | Bitumen sealing | $m^2$ | 520 | 15 | 7,800 | 25 | 9,750 | |
| | Relocation of Brown Hill Creek Road | | | | | | | |
| 9.04 | Excavation for road | $m^3$ | 15,000 | 17.50 | 262,500 | 25 | 328,125 | |
| 9.05 | Country highway - two lanes | m | 1,000 | 385 | 385,000 | 25 | 481,250 | |
| | | | | | | | | |
| 10 | FENCING and SIGNAGE | | | | | | | $31,225 |
| 10.01 | Supply and install fencing and signage around the spillway | Item | 1 | 18,735 | 18,735 | 25 | 23,419 | |
| 10.02 | Supply and install fencing and signage around the site | Item | 1 | 6,245 | 6,245 | 25 | 7,806 | |
| | | | | | | | | |
| 11 | PROPERTY ACQUISITION | | | | | | | $1,209,375 |
| 11.01 | Property acquisition | $m^2$ | 43,000 | 23 | 967,500 | 25 | 1,209,375 | |
| | | | | | | | | |
| | CAPITAL COST ESTIMATE TOTAL | | | | $ 6,499,630 | | | $9,424,464 |
| | INVESTIGATION, DESIGN & PROJECT MANAGEMENT | Item | 6,832,057 | 10% | 683,206 | 25 | 854,007 | $854,007 |
| | | | | | | | TOTAL | $10,278,471 |

# Appendix J17: Cost Estimate for High-Flow Bypass Culvert from Malcolm Street to Glenelg Tramway

NOTE: This cost estimate has been adapted from the 2006 Master Plan, with materials and quantities altered to suit. Rates have been inflated to represent 2011 dollars. Detailed survey and geotechnical information is required to prepare a detailed cost estimate.



| Item | Description | Quantity | Unit | Rate ($) | Costs ($) |
|---|---|---|---|---|---|
| **1** | Overheads & Preliminaries | 1 | Item | 5% | $368,734 |
| **2** | Trenching, laying, backfill and reinstate | | | | |
| | 1800mm x 1500mm RCBC | 1668 | m | $3,453 | $5,758,925 |
| **3** | Headwall - inlet & outlet works | 2 | Item | $24,980 | $49,960 |
| **4** | Culvert upgrade at tramway | 1 | Item | $150,000 | $150,000 |
| **5** | Service Relocation | 1 | Item | $863,839 | $863,839 |
| **6** | Traffic Control | 1 | Item | $480,769 | $480,769 |
| **7** | Domestic Service Connection Relocations | 57 | no | $1,249 | $71,193 |
| | | | | | |
| | Sub-Total | | | | $7,743,420 |
| | Design Costs | | | 20% | $1,548,684 |
| | Contingency | | | 25% | $1,935,855 |
| | | | | **TOTAL** | **$11,227,959** |

# Appendix J18: Cost Estimate for Brown Hill Creek Channel Upgrade between Hampton St and Cross Rd (reduced upper catchment detention)

NOTE: This cost estimate has been adapted from the 2006 Master Plan, with materials and quantities altered to suit. Rates have been inflated to represent 2011 dollars. Detailed survey and geotechnical information is required to prepare a detailed cost estimate.

| Item | Description | Quantity | Unit | Rate | Costs |
|---|---|---|---|---|---|
| **1** | Overheads & Preliminaries | 1 | Item | 5% | $82,310 |
| **2** | Construct Coffer Dam to existing Channel to allow water to be | 1 | No | $24,980 | $24,980 |
| | diverted around live construction site | | | | |
| **3** | Construct vehicle & equipment access ramp to channel floor | 1 | No | $18,735 | $18,735 |
| **4** | Pump & generator hire | 90 | Day | $500 | $44,964 |
| **5** | Purchase 500m of 200mm dia hose | 300 | m | $144 | $43,091 |
| **6** | Clamps & connectors to suit 200mm dia.hose | 30 | No | $175 | $5,246 |
| **7** | Set up pumps & hoses | 2 | day | $749 | $1,499 |
| **8** | Trim existing unlined walls x 255m | 205 | $m^3$ | $187 | $38,407 |
| **9** | Earthworks to Base Level & sides (incld support) | 2040 | $m^3$ | $94 | $191,097 |
| **10** | Disposal of soil | 2245 | $m^3$ | $37 | $84,120 |
| **11** | Install trench support (Closed Boarding) - avg2.4m high | 1224 | $m^2$ | $37 | $45,863 |
| **12** | Allow 200mm FCR compacted to Culvert floor | 255 | $m^3$ | $75 | $19,110 |
| **13** | Lay 200mm Blinding Concrete under panels | 255 | $m^3$ | $350 | $89,179 |
| **14** | Construct Base Slab | 255 | $m^3$ | $525 | $133,768 |
| **15** | Pour Concrete Walls, incl labour | 350 | $m^3$ | $1,374 | $480,865 |
| **16** | Property Acquisition | 8 | Item | $37,470 | $299,760 |
| **17** | Traffic Control | 1 | Item | $84,308 | $84,308 |
| **18** | Service Location | 1 | Item | $31,225 | $31,225 |
| **19** | Domestic Service Connection Relocations | 8 | no | $1,249 | $9,992 |
| | | | | | |
| | Sub-Total | | | | $1,728,517 |
| | Design Costs | | | 30% | $518,555 |
| | Contingency | | | 25% | $432,129 |
| | | | | **TOTAL** | **$2,679,202** |

# Appendix J19: Cost Estimate for Brown Hill Creek Channel Upgrade between Victoria St and Glenelg Tramway (as part of complete channel upgrade)

NOTE: This cost estimate has been adapted from the 2006 Master Plan, with materials and quantities altered to suit. Rates have been inflated to represent 2011 dollars. Detailed survey and geotechnical information is required to prepare a detailed cost estimate.

| Item | Description | Quantity | Unit | Rate | Costs ($) |
|---|---|---|---|---|---|
| **1** | Overheads & Preliminaries | | Item | 5% | $156,860 |
| **2** | Tree removal | 0.2 | km | $25,000 | $5,625 |
| **3** | Construct Coffer Dam for existing channel to allow water to be | 1 | No | $25,000 | $25,000 |
| | diverted around live construction site - | | | | |
| **4** | Construct vehicle & equipment access ramp to channel floor | 2 | No | $20,000 | $40,000 |
| **5** | Pump & generator hire | 35 | Day | $500 | $17,294 |
| **6** | Purchase 500m of 200mm dia hose | 500 | m | $144 | $71,818 |
| **7** | Clamps & connectors to suit 200mm dia.hose | 50 | No | $175 | $8,743 |
| **8** | Set up pumps & hoses | 2 | day | $750 | $1,500 |
| **9** | Demolish existing Concrete walls | 322 | $m^3$ | $187 | $60,256 |
| **10** | Remove concrete to tip | 322 | $m^3$ | $37 | $12,051 |
| **11** | Excavate sides of channel | 1010 | $m^3$ | $44 | $44,168 |
| **12** | Raise top of channel banks | 8 | $m^3$ | $50 | $420 |
| **13** | Disposal of soil | 1153 | $m^3$ | $37 | $43,187 |
| **14** | Lay 200mm Blinding Concrete under panels | 411 | $m^3$ | $350 | $143,700 |
| **15** | Prefabricated Concrete Walls & Floor Panels x 231 panels | 2055 | $m^2$ | $400 | $821,800 |
| | including labour | | | | |
| **16** | Cranage to assist with Concrete Panel installation | 231 | Hrs | $225 | $51,933 |

| Item | Description | Quantity | Unit | Rate | Costs ($) |
|---|---|---|---|---|---|
| **17** | **Road Crossings (incl. material supply)** | | | | |
| a | Railway Line near Victoria St Bridge | 1 | Item | $300,000 | $300,000 |
| b | Factory over channel downstream of Victoria St | 1 | Item | $300,000 | $300,000 |
| c | Bridge under Glenelg tramway | 1 | Item | $300,000 | $300,000 |
| **18** | Service Relocation for bridge crossings | | Item | 5% | $45,000 |
| **19** | Traffic Control | 1 | Item | $64,852 | $64,852 |
| **20** | Property acquisition/easements | 1560 | $m^2$ | $500 | $779,850 |
| | | | | | |
| | Sub-Total | | | | $3,294,056 |
| | Design, Project Management, Consultation<br>Contingency | | | 30%<br>25% | $988,217<br>$823,514 |
| | | | | **TOTAL** | **$5,106,000** |

# Appendix J20: Cost Estimate for Brown Hill Creek Channel Upgrade between Cranbrook Ave and Railway (as part of complete channel upgrade)

NOTE: This cost estimate has been adapted from the 2006 Master Plan, with materials and quantities altered to suit. Rates have been inflated to represent 2011 dollars. Detailed survey and geotechnical information is required to prepare a detailed cost estimate.



| Item | Description | Quantity | Unit | Rate | Costs ($) |
|---|---|---|---|---|---|
| **1** | Overheads & Preliminaries | | Item | 5% | $112,803 |
| **2** | Tree removal | 0.2 | km | $25,000 | $5,225 |
| **3** | Construct Coffer Dam for existing channel to allow water to be | 1 | No | $25,000 | $25,000 |
| | diverted around live construction site - | | | | |
| **4** | Construct vehicle & equipment access ramp to channel floor | 1 | No | $20,000 | $20,000 |
| **5** | Pump & generator hire | 32 | Day | $500 | $16,064 |
| **6** | Purchase 500m of 200mm dia hose | 500 | m | $144 | $71,818 |
| **7** | Clamps & connectors to suit 200mm dia.hose | 50 | No | $175 | $8,743 |
| **8** | Set up pumps & hoses | 2 | day | $750 | $1,500 |
| **9** | Demolish existing Concrete walls | 301 | $m^3$ | $187 | $56,385 |
| **10** | Remove concrete to tip | 301 | $m^3$ | $37 | $11,277 |
| **11** | Excavate sides of channel | 927 | $m^3$ | $44 | $40,542 |
| **12** | Disposal of soil | 1067 | $m^3$ | $37 | $39,963 |
| **13** | Lay 200mm Blinding Concrete under panels | 372 | $m^3$ | $350 | $130,103 |
| **14** | Prefabricated Concrete Walls & Floor Panels x 209 panels | 1860 | $m^2$ | $400 | $744,040 |
| | including labour | | | | |
| **15** | Cranage to assist with Concrete Panel installation | 209 | Hrs | $225 | $46,987 |
| **16** | **Road Crossings (incl. material supply)** | | | | |
| a | Cranbrook Ave | 1 | Item | $200,000 | $200,000 |
| **17** | Service Relocation for bridge crossings | 1 | Item | 5% | $8,000 |
| **18** | Traffic Control | 1 | Item | $60,240 | $60,240 |
| **19** | Property acquisition/easements | 1540 | $m^2$ | $500 | $770,165 |
| | | | | | |
| | Sub-Total | | | | $2,368,855 |
| | Design, Project Management, Consultation | | | 30% | $710,657 |
| | Contingency | | | 25% | $592,214 |
| | | | | **TOTAL** | **$3,672,000** |

# Appendix J21: Cost Estimate for Brown Hill Creek Channel Upgrade between Victoria Ave and Mitchell St (as part of complete channel upgrade)

NOTE: This cost estimate has been adapted from the 2006 Master Plan, with materials and quantities altered to suit. Rates have been inflated to represent 2011 dollars. Detailed survey and geotechnical information is required to prepare a detailed cost estimate.

| Item | Description | Quantity | Unit | Rate | Costs ($) |
|---|---|---|---|---|---|
| **1** | Overheads & Preliminaries | | Item | 5% | $329,397 |
| **2** | Tree removal | 1.0 | km | $25,000 | $25,900 |
| **3** | Construct Coffer Dam for existing channel to allow water to be | 5 | No | $25,000 | $125,000 |
| | diverted around live construction site - | | | | |
| **4** | Construct vehicle & equipment access ramp to channel floor | 5 | No | $20,000 | $100,000 |
| **5** | Pump & generator hire | 159 | Day | $500 | $79,629 |
| **6** | Purchase 500m of 200mm dia hose | 500 | m | $144 | $71,818 |
| **7** | Clamps & connectors to suit 200mm dia.hose | 50 | No | $175 | $8,743 |
| **8** | Set up pumps & hoses | 2 | day | $750 | $1,500 |
| **9** | Demolish existing Concrete walls | 21 | $m^3$ | $187 | $3,991 |
| **10** | Remove concrete to tip | 21 | $m^3$ | $37 | $798 |
| **11** | Excavate sides of channel | 4123 | $m^3$ | $44 | $180,227 |
| **12** | Raise top of channel banks | 166 | $m^3$ | $50 | $8,293 |
| **13** | Surface treatement of excavated sections (compaction etc) | 5975 | $m^2$ | $5.00 | $29,873 |
| **14** | Disposal of soil | 4557 | $m^3$ | $37 | $170,741 |
| **15** | Lay 200mm Blinding Concrete under panels | 33 | $m^3$ | $350 | $11,646 |
| **16** | Prefabricated Concrete  Walls & Floor Panels x 19 panels | 167 | $m^2$ | $400 | $66,600 |
| | including labour | | | | |
| **17** | Cranage to assist with Concrete Panel installation | 19 | Hrs | $225 | $4,272 |
| **18** | Revegate banks | 5975 | $m^2$ | $12 | $74,622 |

| Item | Description | Quantity | Unit | Rate | Costs ($) |
|---|---|---|---|---|---|
| **19** | **Road Crossings (incl. material supply)** | | | | |
| a | Victoria Ave | 1 | Item | $650,000 | $650,000 |
| b | Northgate St | 1 | Item | $200,000 | $200,000 |
| c | Malcolm St | 1 | Item | $200,000 | $200,000 |
| d | Avenue St | 1 | Item | $200,000 | $200,000 |
| e | Regent St | 1 | Item | $200,000 | $200,000 |
| f | Percy & Douglas St Pedestrian Bridge | 1 | Item | $100,000 | $100,000 |
| g | St Joseph Orphanage Bridge | 1 | Item | $200,000 | $200,000 |
| **20** | Service Relocation for bridge crossings | | Item | 5% | $87,500 |
| **21** | Traffic Control | 1 | Item | $298,607 | $298,607 |
| **22** | Property acquisition/easements | 3488 | $m^2$ | $1,000 | $3,488,190 |
| | | | | | |
| | Sub-Total | | | | $6,917,344 |
| | Design, Project Management, Consultation | | | 30% | $2,075,203 |
| | Contingency | | | 25% | $1,729,336 |
| | | | | **TOTAL** | **$10,722,000** |

# Appendix J22: Cost Estimate for Brown Hill Creek Channel Upgrade between Cross Rd and Heywood Ave (as part of complete channel upgrade)

NOTE: This cost estimate has been adapted from the 2006 Master Plan, with materials and quantities altered to suit. Rates have been inflated to represent 2011 dollars. Detailed survey and geotechnical information is required to prepare a detailed cost estimate.

| Item | Description | Quantity | Unit | Rate | Costs ($) |
|---|---|---|---|---|---|
| **1** | Overheads & Preliminaries | | Item | 5% | $140,945 |
| **2** | Tree removal | 0.4 | km | $25,000 | $9,325 |
| **3** | Construct Coffer Dam for existing channel to allow water to be | 2 | No | $25,000 | $50,000 |
| | diverted around live construction site - | | | | |
| **4** | Construct vehicle & equipment access ramp to channel floor | 1 | No | $20,000 | $20,000 |
| **5** | Pump & generator hire | 57 | Day | $500 | $28,669 |
| **6** | Purchase 500m of 200mm dia hose | 500 | m | $144 | $71,818 |
| **7** | Clamps & connectors to suit 200mm dia.hose | 50 | No | $175 | $8,743 |
| **8** | Set up pumps & hoses | 2 | day | $750 | $1,500 |
| **9** | Excavate sides of channel | 549 | $m^3$ | $44 | $23,980 |
| **10** | Raise top of channel banks | 493 | $m^3$ | $50 | $24,618 |
| **11** | Surface treatement of excavated sections (compaction etc) | 2814 | $m^2$ | $5.00 | $14,068 |
| **12** | Disposal of soil | 83 | $m^3$ | $37 | $3,123 |
| **13** | Revegate banks | 2814 | $m^2$ | $12 | $35,142 |
| **14** | **Road Crossings (incl. material supply)** | | | | |
| a | Cross Rd | 1 | Item | $1,400,000 | $1,400,000 |
| b | Factory over channel downstream of Cross Rd | 1 | Item | $300,000 | $300,000 |
| c | Heywood Ave | 1 | Item | $200,000 | $200,000 |
| **15** | Service Relocation for bridge crossings | | Item | 5% | $95,000 |
| **16** | Traffic Control | 1 | Item | $107,510 | $107,510 |
| **17** | Property acquisition/easements | 851 | $m^2$ | $500 | $425,400 |
| | | | | | |
| | Sub-Total | | | | $2,959,840 |
| | Design, Project Management, Consultation | | | 30% | $887,952 |
| | Contingency | | | 25% | $739,960 |
| | | | | **TOTAL** | **$4,588,000** |

# Appendix J23: Cost Estimate for Brown Hill Creek Channel Upgrades between Muggs Hill Rd and Devonshire St (as part of complete channel upgrade)

NOTE: This cost estimate has been adapted from the 2006 Master Plan, with materials and quantities altered to suit. Rates have been inflated to represent 2011 dollars. Detailed survey and geotechnical information is required to prepare a detailed cost estimate.

| Item | Description | Quantity | Unit | Rate | Costs ($) |
|---|---|---|---|---|---|
| **1** | Overheads & Preliminaries | | Item | 5% | $83,874 |
| **2** | Tree removal | 1.0 | km | $25,000 | $25,950 |
| **3** | Construct Coffer Dam to existing channel to allow water to be | 5 | No | $25,000 | $125,000 |
| | diverted around live construction site - | | | | |
| **4** | Construct vehicle & equipment access ramp to channel floor | 4 | No | $20,000 | $80,000 |
| **5** | Pump & generator hire | 160 | Day | $500 | $79,782 |
| **6** | Purchase 500m of 200mm dia hose | 500 | m | $144 | $71,818 |
| **7** | Clamps & connectors to suit 200mm dia.hose | 50 | No | $175 | $8,743 |
| **8** | Set up pumps & hoses | 2 | day | $749 | $1,499 |
| **9** | Excavate sides of channel | 1163 | $m^3$ | $44 | $50,828 |
| **10** | Surface treatement of excavated sections (compaction etc) | 7051 | $m^2$ | $5.00 | $35,253 |
| **11** | Disposal of soil | 1337 | $m^3$ | $37 | $50,102 |
| **12** | Revegate banks | 7051 | $m^2$ | $12 | $88,062 |
| **13** | **Road Crossings (incl. material supply)** | | | | |
| a | Constriction at Paisley Ave | 1 | Item | $250,000 | $250,000 |
| b | Access bridges to residences | 3 | Item | $25,000 | $75,000 |
| c | Devonshire St | 1 | Item | $400,000 | $400,000 |
| **14** | Service Relocation for bridge crossings | | Item | 5% | $36,250 |
| **15** | Traffic Control | 1 | Item | $299,184 | $299,184 |
| **16** | Property acquisition/easements | 8050 | $m^2$ | $500 | $4,024,945 |
| | | | | | |
| | Sub-Total | | | | $5,786,289 |
| | Design, Project Management, Consultation | | | 30% | $1,735,887 |
| | Contingency | | | 25% | $1,446,572 |
| | | | | **TOTAL** | **$8,969,000** |

# Appendix J24: Cost Estimate for Additional Bridge Upgrades along Brown Hill Creek (as part of complete channel upgrade)

NOTE: This cost estimate has been adapted from the 2006 Master Plan, with materials and quantities altered to suit. Rates have been inflated to represent 2011 dollars. Detailed survey and geotechnical information is required to prepare a detailed cost estimate.

| Item | Description | Quantity | Unit | Rate | Costs ($) |
|---|---|---|---|---|---|
| **1** | Overheads & Preliminaries | | Item | 5% | $103,750 |
| **2** | Road Crossings (incl. material supply) | | | | |
| a | Fife/Lochwinndoch Ave | 1 | Item | $400,000 | $400,000 |
| b | Ayr Ave | 1 | Item | $250,000 | $250,000 |
| c | Whistler Ave pedestrian access bridge | 1 | Item | $25,000 | $25,000 |
| d | Goodwood Rd | 1 | Item | $1,400,000 | $1,400,000 |
| **3** | Service Relocation | | Item | 5% | $103,750 |
| **4** | Traffic Control | | Item | 10% | $207,500 |
| | | | | | |
| | Sub-Total | | | | $2,490,000 |
| | Design, Project Management, Consultation | | | 20% | $498,000 |
| | Contingency | | | 25% | $622,500 |
| | | | | **TOTAL** | **$3,611,000** |

# Appendix K - 2011 Draft SMP – Part B Works

# K1. PART B WORKS – 2011 DRAFT SMP

The following flood mitigation works for upper Brown Hill Creek were identified and presented in the 2011 Draft SMP. Estimated costs are in 2011 dollars.

As discussed in Section 3.3, the catchment councils have agreed to a strategy and process for determining a final mitigation scenario for upper Brown Hill Creek. This includes investigations of alternatives to the components described below, specifically involving options that exclude the dam.

The proposed channel upgrade between Leah Street and Anzac Highway is proposed to be undertaken as part of the Part A mitigation works and is therefore documented in Section 12 of the SMP.

## K1.1 FLOOD CONTROL DAM

Features of the proposed flood control dam in Brownhill Creek Recreation Park are as follows:

- Located at Site 1 (*refer* **Figure 20**).
- Height to spillway level is approximately 12 metres, which represents the peak level of storage during the 100 year ARI 36 hour critical duration storm. During an event of this magnitude it is expected that the water level would temporarily inundate an area of up to 24,000 $m^2$ for up to 12 hours.
- The storage volume at the spillway level is approximately 110 ML.
- The peak 100 year ARI flow of 26.1 $m^3/s$ at Scotch College would be reduced to 19.5 $m^3/s$ for the 36 hour critical duration storm.
- It is assumed that during normal flow events (*i.e. less than a 5 year ARI flood*) water may be stored behind the flood control dam to a depth of one metre for two to three hours. Such an event is likely to be contained largely within the existing creek channel, thereby having minimal effect on flora and fauna on the upstream side of the dam.
- Storage volume and inundation footprints are based on a preliminary assessment only. Further survey will be required to confirm levels during detailed design.
- The dam orifice diameter is 1450 mm to control the rate of discharge during events up to and including the 100 year ARI storm.
- For the purpose of cost estimating, geotechnical conditions are assumed to be one metre depth of soil overlying rock. Further survey and geotechnical investigations are required to properly assess the foundation conditions.
- The form of dam, as part of a feasibility design and estimated construction cost, would be based on detailed survey and further investigation of foundation conditions and spillway arrangements.
- Construction of the dam would require the relocation of the existing Brown Hill Creek Road to move the road further up the hill on the side of the valley to above the 100 year ARI storage level.

- The configuration of the dam is such that the acquisition of any private property will be avoided and the nearby residences would not be affected during any flooding up to and beyond the 100 year ARI event, subject to further design.

- Estimated cost was approximately **$10.3 Million**.

The 2006 Master Plan identified that flood control dams on upper Brown Hill Creek would be potentially classified as "High C" under the ANCOLD *Guidelines on Assessment of the Consequences of Dam Failure* (*2000*). Subject to determination of the downstream population at risk, the classification could increase to "High A". Accordingly, implementation of this option would have to satisfy a certain level of technical design, with minimum spillway capacities and ongoing surveillance requirements. A comprehensive assessment will be required during the feasibility design phase to confirm the correct classification and associated design parameters.

Passage of the Probable Maximum Flood (*PMF*), which is several times larger than in the 100 year ARI flood, will be a critical design consideration for the dam and development of a suitable spillway design will be a challenging aspect.

A hybrid form of construction may be possible, using a concrete core but with more aesthetic protection works on both sides (*e.g. grass covered earth, large rock or mattresses of wire mesh filled with rock*). A concrete core would allow spillway discharge over a portion of the dam itself onto part of the downstream face of the dam covered with appropriately designed aesthetic protection works. Such an arrangement would have capacity to convey significant flow up to say the 2,000 year ARI event. In the event of a larger flood up to the PMF, the remainder of the "aesthetic" protection works would be sacrificed, but the concrete core would remain intact.



Consultation is required with the Department for Environment, Water and Natural Resources as custodian of the Recreation Park, and also with a range of community and local interest groups.

Relevant Commonwealth and State approvals are required concerning any action that may have a significant impact on the ecology and natural resources of the area, and appropriate studies will need to be undertaken in conjunction with feasibility designs.

Project works may provide opportunity to clear undesirable exotic plant species and enhance the remnant native vegetation.

The location of the dam in the Recreation Park is a sensitive issue for the local community due to perceived threat to the natural value of the area, particularly in terms of recreational, heritage, environmental, visual and aesthetic aspects.

It is proposed that the dam is positioned as shown in **Figure 20** at a "pinch-point" in a steeper section of the valley so that the width of the dam can be minimised. A view of the proposed location is shown overleaf, looking upstream. Suitable vegetation on or about the structure, subject to its form, should help to minimise any visual and aesthetic concerns

View looking upstream to site of proposed flood control dam at Site 1



## K1.2 MINOR CHANNEL WORKS AND BRIDGE UPGRADES IN MITCHAM

The proposed dam at Site 1 would help to reduce the peak 100 year ARI flows through areas of Mitcham by up to 8.5 $m^3/s$ (*refer* **Table 9**), with peak flows being limited to about 20 $m^3/s$. This is expected to largely confine flow to the channel or immediate overbank areas.

Notwithstanding, cursory inspections of the channel at areas upstream from Mitcham shopping centre have identified that relatively minor works could be undertaken at some noticeable "choke points" to help increase the channel capacity and thereby further reduce local flood risk.

The scope of works would need to be confirmed through more detailed assessment of hydraulic capacity of the channel, but it is proposed that they could include the following:

- Removal of trees and overgrowth within the channel likely to restrict the passage of flow.
- Minor regrading works in the approaches to bridges/culverts at Fife and Ayr Avenue.
- High-flow bypass at a localised constriction in the channel near Paisley Avenue.

A nominal estimated cost for these works is about **$0.8 Million**.

It is understood that the City of Mitcham currently plans to upgrade the bridge at George Street for the purpose of structural integrity. It is recommended that the hydraulic design capacity of the bridge be increased from 18 to 25 $m^3/s$ to convey the 100 year ARI flow for the case that the flood control dam at Site 1 is implemented.

## K1.3 BROWN HILL CREEK CHANNEL UPGRADE BETWEEN HAMPTON STREET AND CROSS ROAD

Hampton Street to Cross Road is a known breakout point for storm flows down Brown Hill Creek. The channel upstream of Cross Road has insufficient capacity and spillage into the immediate overbank area occurs during events larger than the 10 year ARI flood, causing localised flooding of dwellings along Denning Street. During events larger than the 20 year ARI flood the breakout flow is expected to travel further afield through downstream suburbs.

Upgrading this section of channel would ideally contain flow within the channel up to the equivalent capacity of the Hampton Street and Cross Road bridges (*both about 30 $m^3/s$*).

In the 2006 Master Plan a channel upgrade between these bridges was designed to have capacity of about 25 $m^3/s$, due to the reduction in peak flows during the 36 hour storm provided by the two flood control dams that were originally proposed.

A concept design drawing for the 2006 Master Plan upgrade is provided in **Appendix L**. It involves the replacement and upgrade of about 250 metres of concrete-lined channel with dimensions of 4 metres base width and 2 metres height. The concept design also allowed for transitioning of the height to 3 metres over a distance of 50 metres upstream from the bridge at Cross Road.

In light of the revised configuration for upper catchment detention with only a single flood control dam at Site 1, the peak 100 year ARI 36 hour flow at Cross Road is expected to be about 28 $m^3/s$ (*refer* **Table 9**), which is an increase of 3 $m^3/s$ above the flow with two dams.

A basic hydraulic review of the original concept design indicates that it should be able to accommodate the increased flow of 28 $m^3/s$ and hence, no alteration to the design would be required.

It is recommended that detailed survey be undertaken as part of detail design to confirm existing levels and finalise the configuration of the upgrade. An easement over or channel acquisition from the affected properties will also be required.

The cost of construction of the channel upgrade was estimated to be approximately **$2.7 Million**.

## K1.4 HIGH-FLOW BYPASS CULVERT BETWEEN MALCOLM STREET AND THE GLENELG TRAMWAY

The 100 year ARI flow at Malcolm Street is expected to be about 28 $m^3/s$ in the case of both the critical 90 minute storm and the 36 hour storm, as “throttled” back by the proposed dam at Site 1.

Removal of 12 $m^3/s$ from the peak flow and diversion to a downstream location using a high-flow bypass culvert would reduce the residual load on the downstream channel to less than 18 $m^3/s$, which is typically within the flow capacity of the channel. Accordingly, the diversion of flow through the culvert would ideally eliminate potential breakouts between the culvert off-take and inflow points.

However, the following design and estimated cost are subject to review as a result of findings of the Channel Capacity Assessment (*AWE, 2012*) and the proposed Goodwood Junction Railway Project.

The concept for the proposed high-flow bypass is as follows (*refer* **Figure 21**):

- Installation of a 1670 metre long 1.8m (W) x 1.5m (H) box culvert between Malcolm Street and the Glenelg Tramway. The overall grade between these points is 0.67%, which will provide a culvert capacity of more than 10 $m^3/s$.
- The off-take point from the channel would take advantage of the angle of the creek alignment to Malcolm Street in that flows will not be forced to make a 90 degree or more acute bend as they are fed into the bypass culvert, thereby offering better hydraulic efficiency than at other locations.
- The point of return to the channel would be on the upstream side of the Glenelg Tramway, near the northern end of Foster Street. Works will be required to increase the capacity of the culvert beneath the tramway.
- The proposed route for the culvert would follow Malcolm Street onto Vardon Terrace, then cross Goodwood Road and track west and then north along Arundel Avenue. After crossing the railway line at Cranbrook into Chelmsford Avenue, the culvert would turn north into Oakley Avenue, then west into Victoria Street and then north again along Foster Street.
- This alignment follows existing roadways or other public land so as to avoid private property incursion. Existing sewer and water supply services have been reviewed to determine that for most of the route the installation of the 1.8 m wide culvert will be feasible. Further modification and revision of the route may be required to avoid some services in the vicinity of the Goodwood Road underpass. It is envisaged that an appropriate alternative alignment would be readily available.



It was estimated that the cost of these works would be approximately **$11.3 Million**.

# Appendix L - Concept Design Plans for Structural Flood Mitigation Works

# BROWN HILL KESWICK CREEK STORMWATER PROJECT

## PROJECT UPDATE

March 2011

### STORMWATER MANAGEMENT IN THE SOUTH PARK LANDS

This update outlines the status of stormwater management in the South Park Lands which is a part of the Brown Hill Keswick Creek Stormwater Project.

Technical investigations and preliminary consultation with stakeholders resulted in the completion of a feasibility study during 2010. This study confirmed that the flood risk from large storms (such as the 1 in 100 year storm) could be reduced downstream of the Park Lands by using three areas for temporary flood storage. The three areas are:

- North-west corner of Glenside Campus
- Southern part of Victoria Park in the area identified in the Victoria Park Master Plan as a site for stormwater wetlands
- Southern part of Park 20 (between Peacock and Unley Roads)

In addition to flood reduction, the feasibility study identified opportunities for water quality improvement, stormwater harvesting and environmental and recreational enhancement.

### Concept Design

The following pages outline the primary design features proposed for the three areas in response to outcomes from the previous feasibility study.

## Key Concept Design Features

The most desired elements for the project identified from the stakeholder interviews and workshop include:

- **Reduce** flood risk downstream of Greenhill Road
- **Utilise** the existing gross pollutant trap in Glenside site and construct an enlarged sedimentation basin to improve the quality of water entering the South Park Lands
- **Divert** stormwater flow out of Parklands Creek and through a series of ephemeral wetlands in the southern portion of Victoria Park. The wetlands will slow down water flow and provide further treatment prior to returning water back into Parklands Creek
- **Improve** the biodiversity of each site through the inclusion of native vegetation and habitat opportunities
- **Provide** an alternative water flow path in Park 20 to reduce the erosion of Parklands Creek and control the release of water under Greenhill Road
- **Provide** temporary flood storage in the Glenside site, at the wetlands in Victoria Park and in Park 20
- **Enhance** amenity and recreational opportunities for the southern part of Victoria Park

Glenside


# Victoria Park

**LEGEND**

- Existing trees
- New trees
- Footpath
- Shelter
- Water flow path
- 1 in 100 year flood extent

North

**NOTES**

1. Perimeter footpath
2. Open water
3. Shallow marsh
4. Deep marsh
5. Sports fields
6. Carpark
7. Shelter + viewing deck
8. Running track
9. Diversion weir
10. Spillway
11. Outlet
12. Environmental flow

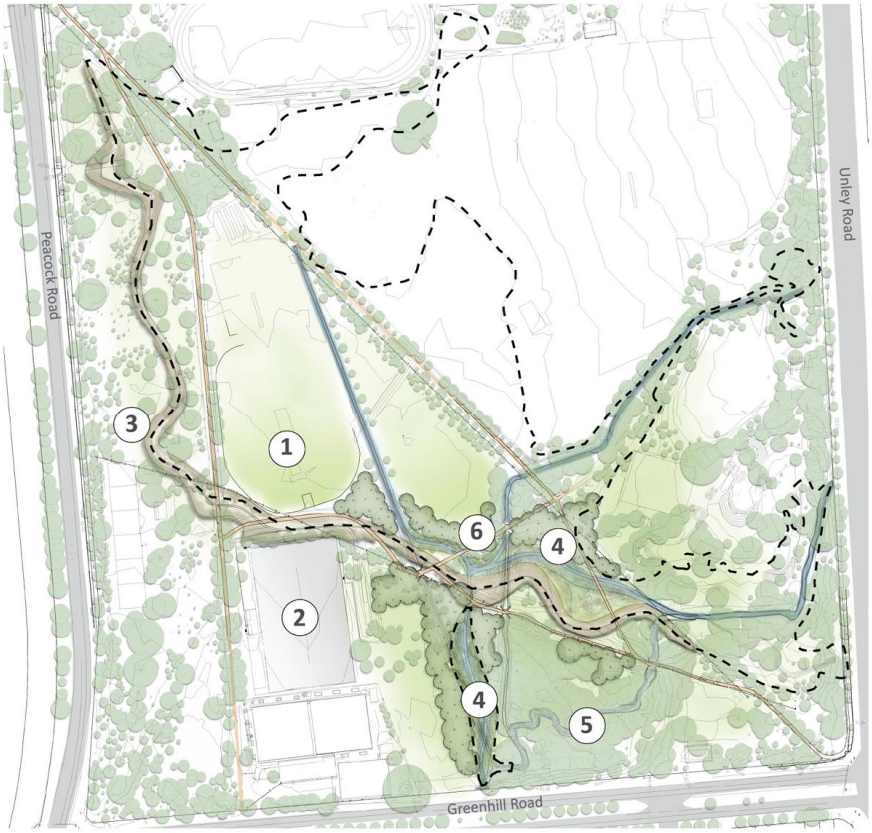

# Park 20

**LEGEND**

- Existing trees
- New trees
- Footpath
- 1 in 100 year flood extent
- North

**NOTES**

1. Existing oval
2. Existing tennis courts
3. Flood control mound
4. New creek alignment
5. Rock filled existing creek
6. New creek convergence




## Next Steps of the Project

- **Consultation** will soon be underway to inform and review the conceptual layouts and water movement models with stakeholders, agencies and the wider community to gain feedback on the primary design features proposed for the parks.
- **Finalisation** of the concept. The project team will review the feedback gained through consultation and finalise the concept plan during mid 2011.
- **Implementation** of the proposal is subject to approvals and funding commitment from project proponents.

A3

N

DISTRIBUTION MAIN TO DOWNSTREAM RESERVES

SUBJECT DAM

121.0 AHD (TOP OF CONCRETE WALL)

SIGNIFICANT TREE TREE PROTECTION ZONE

PUMP: 20L/s

POOL WL 115.0

CENTRAL OVERFLOW WEIR

ROCK SPILLWAY

WEIR LEVEL 118.0

RETAINING WALL 1.5m HIGH, 10m LONG

RETAINING WALL 1.0m HIGH, 15m LONG

ROCK RIFFLE

WEIR CREST 116.4m AHD

POOL WL 116.4

WL 116.7

WL 117.1

TO RIDGE PARK IRRIGATION

BALANCE TANK

MECHANICAL TREATMENT PLANT AND BACKWASH EFFLUENT TANK

ASR 'INJECTION' LINE TO SECOND BORE ADJACENT GLEN OSMOND ROAD

PUMPED TO TREATMENT PLANT 20L/s

BOARDWALK OVER BIORETENTION AREA

0.75m HIGH WALL

ASR 'INJECTION' LINE

IL 119.30 AHD
TOB 119.60 AHD

RISING MAIN TO BIORETENTION

WEIR CREST 117.4m AHD

BORE

BIORETENTION AREA
FLAT BASE 350m², 300mm DEEP
BATTERS TO NS 1 in 6 TO 1 in 8
YIELD = 60ML/a

RETAINING WALL 0.75m HIGH 27m LONG

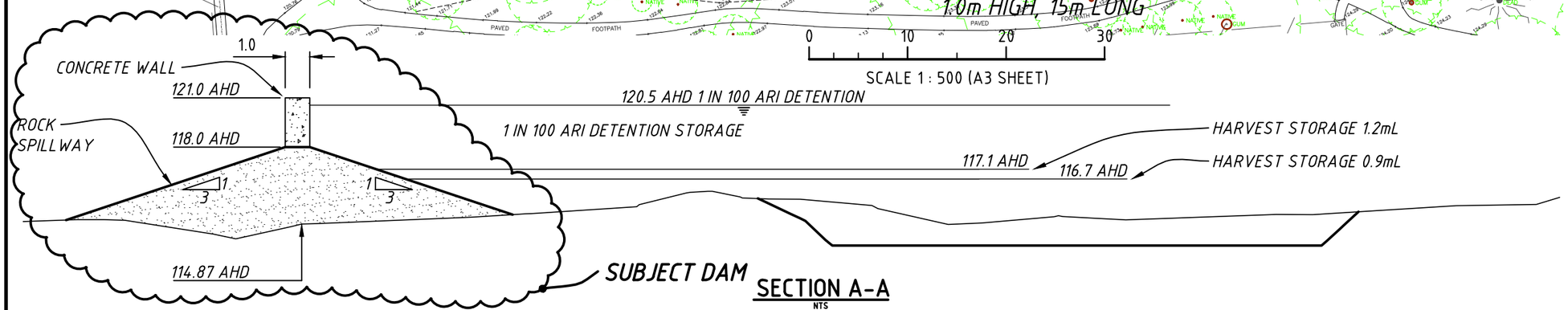
ROCK RIFFLE

POOL WL 117.4

RETAINING WALL 1.0m HIGH, 15m LONG

0 10 20 30

SCALE 1 : 500 (A3 SHEET)




SECTION A-A
NTS

| | | |
|---|---|---|
| D | 13.01.12 | LAYOUT AMENDED |
| C | 25.08.11 | LAYOUT AMENDED |
| B | 25.08.11 | LAYOUT AMENDED |
| A | . | . |

Amendments


Australian WATER Environments
1/198 Greenhill Road, EASTWOOD SA 5063
Tel: (08) 8378 8000 Fax: (08) 8357 8988
www.austwaterenv.com.au

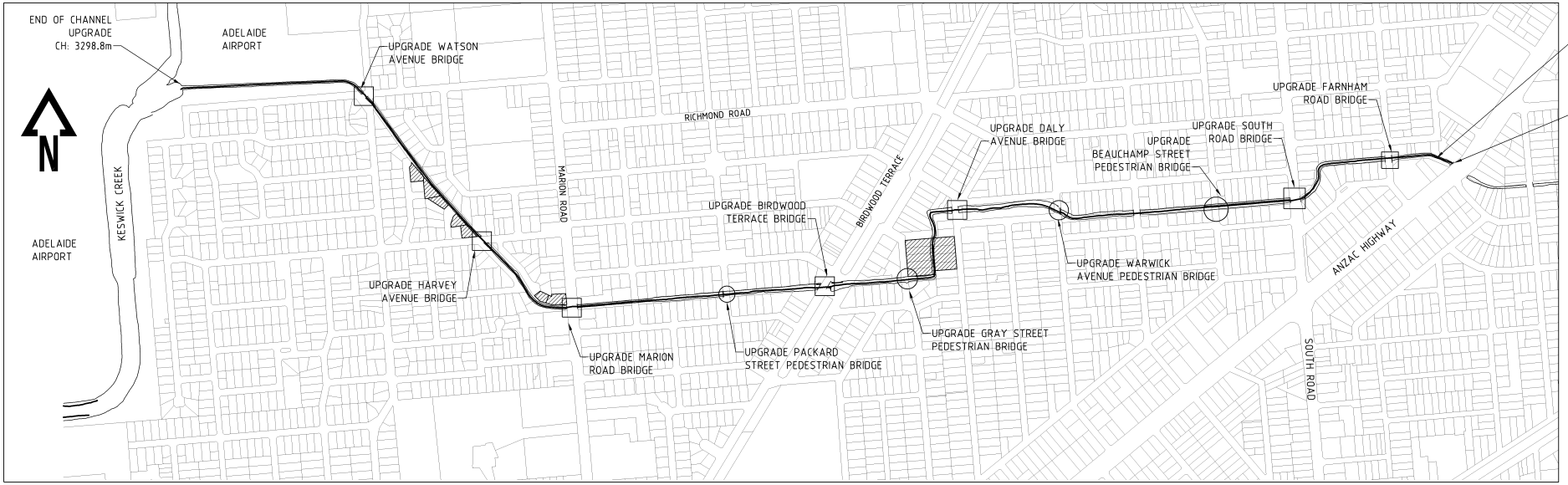

CLIENT: THE CITY of Unley

PROJECT:
RIDGE PARK MANAGED AQUIFER RECHARGE PROJECT
GLEN OSMOND

| | |
|---|---|
| DESIGNED BY: . | DRAWN BY: MJB |
| DRAWING DATE: 23.08.11 | CHECKED: . |
| CP ENG. DATE | SCALE: AS SHOWN |
| FILE: XX | |

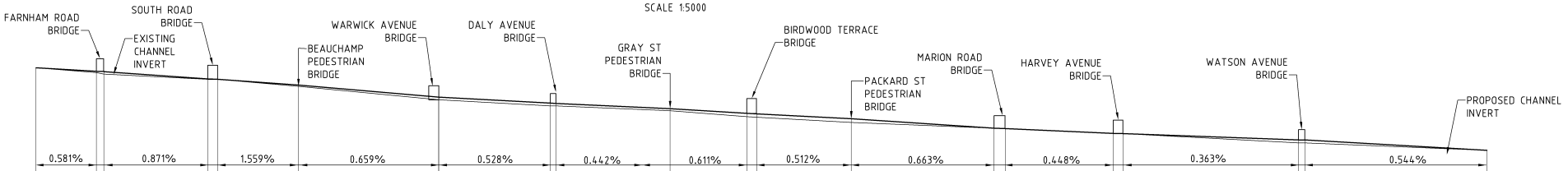
STORMWATER HARVESTING & TREATMENT CONCEPT DESIGN

| PROJECT No. | DRAWING No. | REV. |
|---|---|---|
| 11143 | Figure 6 | D |




## BROWNHILL CHANNEL UPGRADE ($Q=60m^3/s$)

SCALE 1:5000




| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PROPOSED INVERT R.L. (m) | 24.05 | 23.25 | 23.15 | 21.50 | 21.40 | 20.10 | 17.34 | 16.00 | 15.90 | 14.75 | 13.69 | 13.55 | 12.45 | 10.30 | 10.20 | 9.10 | 9.05 | 7.60 | 7.50 | 5.25 |
| EXISTING INVERT R.L. (m) | 24.05 | 22.95 | 22.60 | 21.50 | 21.40 | 19.80 | 16.75 | 15.50 | 15.35 | 14.25 | 12.90 | 12.80 | 11.60 | 10.30 | 10.20 | 9.10 | 9.05 | 7.05 | 6.95 | 5.25 |
| CHAINAGE (m) | 0.00 | 137.8 | 201.3 | 390.7 | 413.6 | 597.0 | 916.0 | 1169.9 | 1182.8 | 1443.0 | 1616.4 | 1639.1 | 1856.0 | 2178.5 | 2204.0 | 2449.3 | 2471.5 | 2870.6 | 2884.9 | 3298.8 |

## LONGITUDINAL SECTION

HORIZONTAL SCALE 1:5000
VERTICAL SCALE 1:500

## LEGEND

- BRIDGE UPGRADE
- PEDESTRIAN BRIDGE UPGRADE
- PROPOSED PARTIAL PROPERTY ACQUISITION

ISSUED FOR COMMENT

100 50 0 100 200 300m
SCALE 1:5000

10 5 0 10 20 30m
SCALE 1:500

## NOTES:

1. CANAL INVERTS BASED ON EXISTING AVAILBLE SURVEY WHICH IS PRELIMINARY ONLY.
2. DETAILED SURVEY OF THE EXISTING CHANNEL WILL BE REQUIRED DURING DETAILED DESIGN AND HYDRAULIC ANALYSIS TO CONFIRM CHANNEL INVERT LEVELS.
3. CONCRETE:
   F'c = 32MPa
   NOMINAL MAX AGGREGATE SIZE = 20mm
   MINIMUM REINFORCEMENT COVER = 50mm
4. EXACT LOCATIONS OF SERVICES TO BE DETERMINED ON SITE DURING CONSTRUCTION.
5. PROPERTY ACQUISITION IS PROPOSED AT THIS STAGE UNTIL CONFIRMED DURING DETAILED DESIGN.
6. CHANNEL TO BE LOCATED CENTRALLY, WHERE APPROPRIATE TO FIT WITHIN EXISTING DRAINAGE CORRIDOR.

ALTERATIONS

SIGNATURES INDICATED ARE ON ORIGINAL OR REVISIONS) STORED IN PLAN ROOM.

REFERENCE
CROSS SECTIONS SA-201587-0009-02

REPR'D FROM REV

DRAWN C.J.L.
CHECKED
DESIGNED
CHECKED
APPROVED
DATE
CLIENT AG'D
PAE APP'D

Hydro Tasmania
the renewable energy business

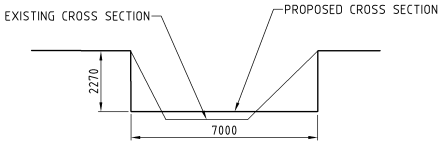


CLIENT ADELAIDE & MT. LOFTY RANGES NAT. RESOURCES BOARD

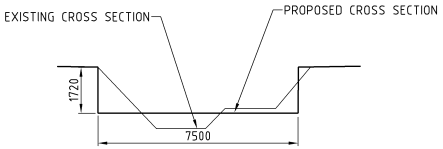
TITLE BROWNHILL & KESWICK CREEK FLOOD MITIGATION STUDY BROWNHILL CHANNEL PLAN AND DETAILS

DRAWING SA-201587-0009 SHT. 01 REV.

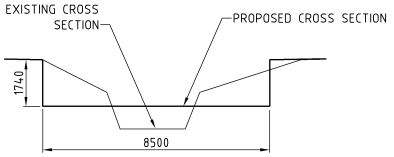
SCALE NOTED NOTED
REF No.
INDEX
A1



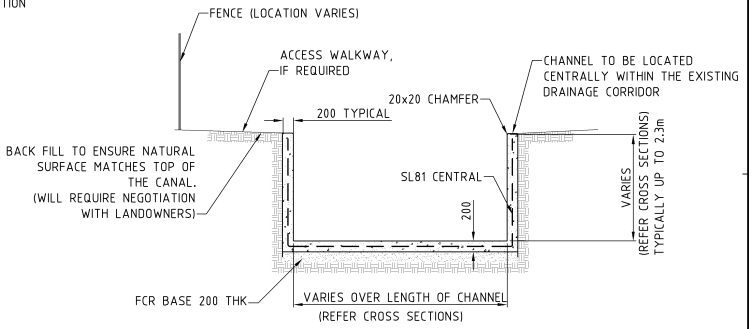

CHAINAGE 0.0m - 429.0m




CHAINAGE 853.0m - 1355.0m

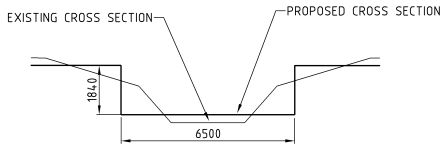



CHAINAGE 1769.0m - 2390.0m

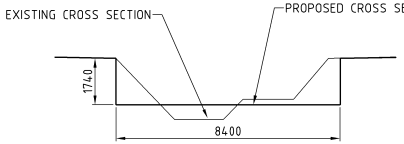



TYPICAL CHANNEL CROSS SECTION

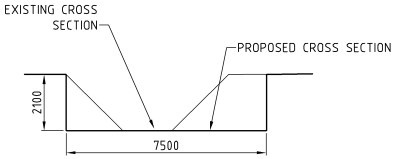
SCALE 1:50



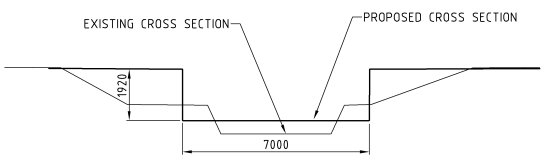

CHAINAGE 429.0m - 686.0m



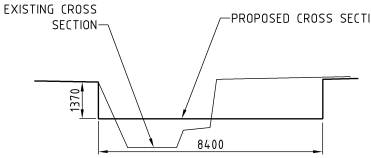

CHAINAGE 1355.0m - 1485.0m




CHAINAGE 2390.0m - 3298.1m


CHAINAGE 686.0m - 853.0m




CHAINAGE 1485.0m - 1769.0m

ISSUED FOR COMMENT

NOTES:

1. CANAL INVERTS BASED ON EXISTING AVAILBLE SURVEY WHICH IS PRELIMINARY ONLY.
2. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS STATED OTHERWISE.
3. DETAILED SURVEY OF THE EXISTING CHANNEL WILL BE REQUIRED DURING DETAILED DESIGN AND HYDRAULIC ANALYSIS TO CONFIRM CHANNEL INVERT LEVELS.
4. CONCRETE:
   F'c = 32MPa
   NOMINAL MAX AGGREGATE SIZE = 20mm
   MINIMUM REINFORCEMENT COVER = 50mm
5. EXACT LOCATIONS OF SERVICES TO BE DETERMINED ON SITE DURING CONSTRUCTION.

ALTERATIONS

SIGNATURES INDICATED ARE ON ORGINAL OR REVISIONS) STORED IN PLAN ROOM.

REFERENCE

PLAN AND DETAILS SA-201587-0009-01

REPR'D FROM REV

| | |
|---|---|
| DRAWN | C.J.L. |
| CHECKED | |
| DESIGNED | |
| CHECKED | |
| APPROVED | |
| DATE | |
| CLIENT AG'D | |
| PAE APP'D | |

Hydro Tasmania
the renewable energy business



CLIENT ADELAIDE & MT. LOFTY RANGES NAT. RESOURCES BOARD

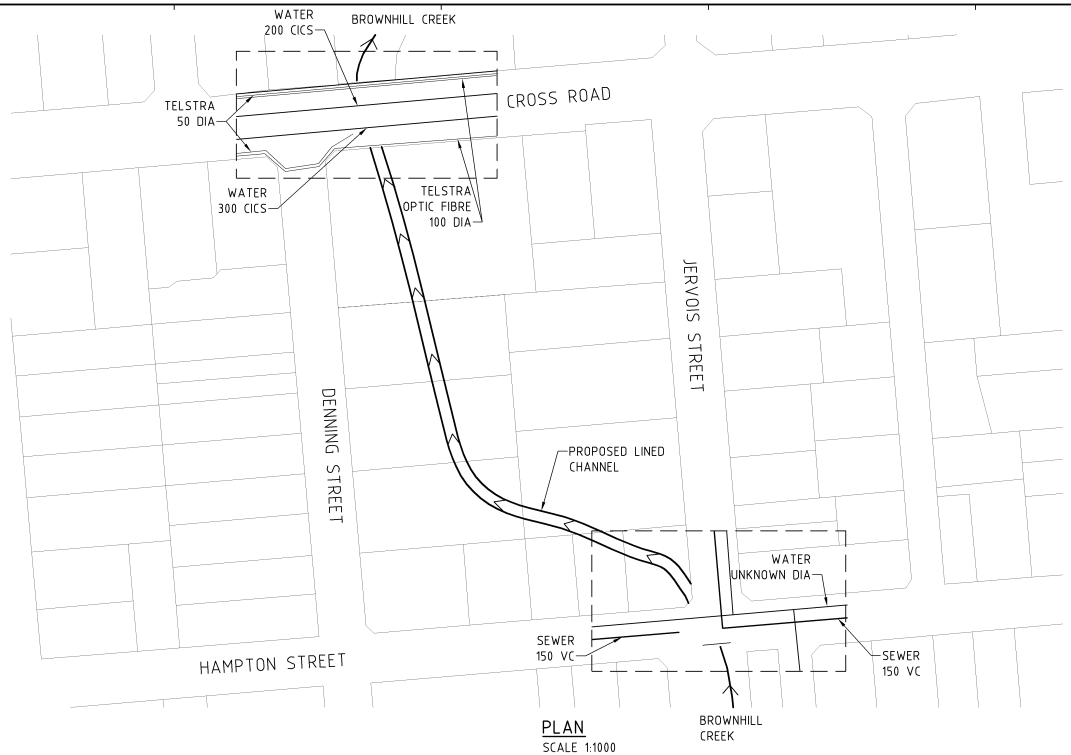
TITLE BROWNHILL & KESWICK CREEK FLOOD MITIGATION STUDY BROWNHILL CHANNEL CROSS SECTIONS

DRAWING SA-201587-0009 SHT. 02 REV. A1

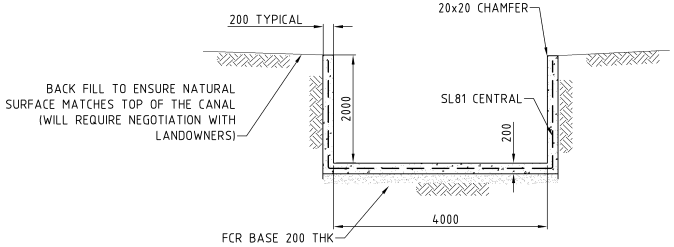
SCALE NOTED NOTED

REF No.

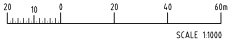
INDEX




PLAN
SCALE 1:1000




CHANNEL CROSS SECTION
CHAINAGE 0.0m - 205.52m
SCALE 1:50



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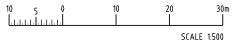
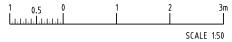
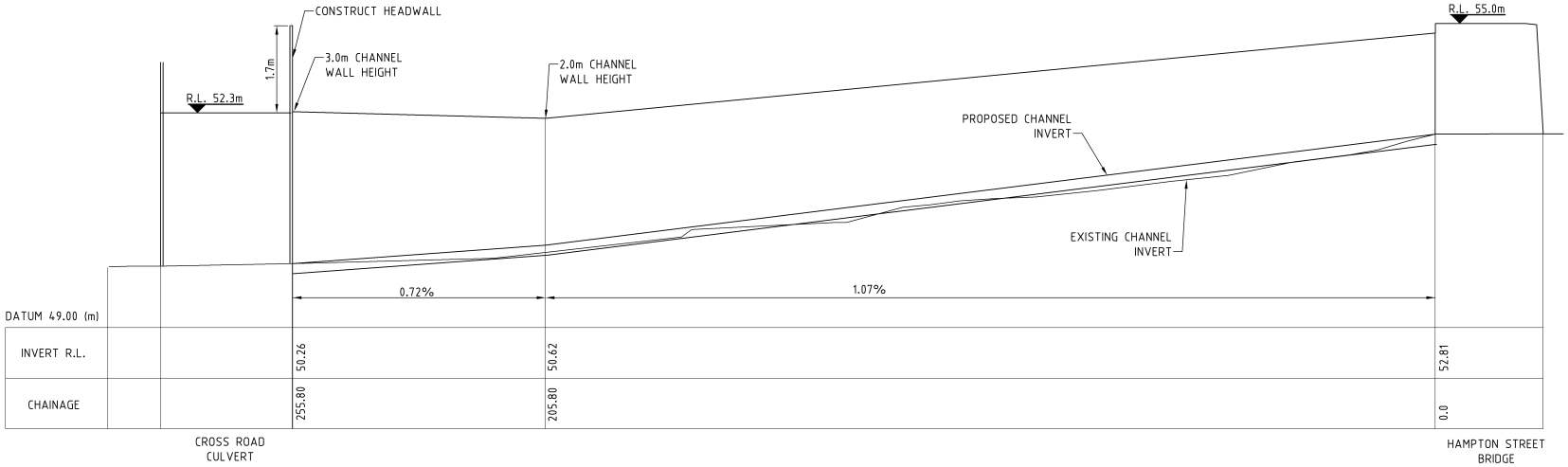


SCALE 1:500



SCALE 1:50




LONGITUDINAL SECTION
HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:50

ISSUED FOR COMMENT

NOTES:

1. HAMPTON ST BRIDGE AND CROSS RD CULVERT HAVE SUFFICIENT CAPACITY TO PASS THE 1:100 AEP MITIGATION INFILL FLOW OF APPROX 18m3/s.
2. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS STATED OTHERWISE.
3. DETAILED SURVEY OF THE EXISTING CHANNEL WILL BE REQUIRED DURING DETAILED DESIGN AND HYDRAULIC ANALYSIS TO CONFIRM CHANNEL INVERT LEVELS.
4. CONCRETE:
   F'c = 32MPa
   NOMINAL MAX AGGREGATE SIZE = 20mm
   MINIMUM REINFORCEMENT COVER = 50mm
5. EXACT LOCATIONS OF SERVICES TO BE DETERMINED ON SITE DURING CONSTRUCTION.
6. ALL PIPE DIAMETERS ARE IN MILLIMETRES UNLESS STATED OTHERWISE.
7. LOCATION OF SERIVCES ARE BASED ON DIAL BEFORE YOU DIG INFORMATION AND SERVICE PROVIDERS. NOT ALL DEPTH AND LOCATION INFORMATION COULD BE RETRIEVED AND LOCATIONS MUST BE CHECKED DURING DETAILED DESIGN PHASE.
8. WATER PIPE LOCATIONS ARE SCALED BY SA WATER IN VERBAL DISCUSSIONS. EXACT DEPTH TO PIPES UNKNOWN, TYPICAL MINIMUM DEPTH ADOPTED. WILL NEED ON SITE MEASUREMENT TO CONFIRM.
9. CANAL INVERTS BASED ON EXISTING AVAILBLE SURVEY WHICH IS PRELIMINARY ONLY.

ALTERATIONS

SIGNATURES INDICATED ARE ON ORIGINAL OR REVISION(S) STORED IN PLAN ROOM.

REFERENCE

REPRO'D FROM REV

DRAWN C.J.L.
CHECKED
DESIGNED
CHECKED
APPROVED
DATE
CLIENT AG'D
PAC APP'D

Hydro Tasmania
the renewable energy business



CLIENT ADELAIDE & MT. LOFTY RANGES NAT. RESOURCES BOARD

TITLE BROWN HILL & KESWICK CREEK
MITIGATION STUDY
CROSS RD TO HAMPTON ST
CANAL UPGRADE

DRAWING SA-201587-0008 SHT. REV.

SCALE NOTED NOTED
REF No.
INDEX
A1

# Appendix M - Benefit-Cost Analysis for Stormwater Management Strategy (Part A + Part B)

WorleyParsons
resources & energy

## 2012 STORMWATER MANAGEMENT PLAN (PART A + PART B WORKS)

| **Values in $ '000 (Real Terms)** | Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *2012/13* | *2013/14* | *2014/15* | *2015/16* | *2016/17* | *2017/18* | *2018/19* | *2019/20* | *2020/21* | *2021/22* | *2022/23* | *2023/24* | *2024/25* | *2025/26* | *2035/36* | *2036/37* | *2037/38* | *2038/39* | *2039/40* | *2040/41* | *2041/42* |
| **Benefits (Damage Reduction)** | | - | - | 1,000 | 1,000 | 4,000 | 4,000 | 5,000 | 5,000 | 7,000 | 7,000 | 8,968 | 8,968 | 8,968 | 8,968 | 8,968 | 8,968 | 8,968 | 8,968 | 8,968 | 8,968 | 8,968 |
| | | | | | | | | | | | | | | | | | | | | | | |
| **Costs** | **Previous** | **Future** | | | | | | | | | | | | | | | | | | | | |
| Ridge Park Detention System | 30 | 972 | 57 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| South Park Lands Detention System | 373 | 175 | 7,600 | 7,600 | 1,889 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Lower Brown Hill Creek Channel Upgrade | | 435 | 500 | 12,500 | 17,500 | 15,000 | 3,197 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Keswick Creek Diversion Culverts | 131 | - | - | 100 | 650 | 5,500 | 12,000 | 10,000 | 3,470 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Anzac Hwy to Forestville Reserve Channel Upgrade (No Dam Scenario) | | - | - | - | 50 | 300 | 5,500 | 7,500 | 1,530 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Bypass Culvert at Fisher St | | - | - | - | - | - | - | 200 | 3,000 | 1,345 | - | - | - | - | - | - | - | - | - | - | - | - |
| Dam at Site 1 (12 m Spillway Height) | 160 | - | - | - | - | - | 300 | 1,000 | 5,000 | 3,000 | 1,304 | - | - | - | - | - | - | - | - | - | - | - |
| High-Flow Bypass Culvert (Malcolm St to Tramway) | | - | - | - | - | - | 200 | 1,500 | 5,500 | 5,500 | 1,410 | - | - | - | - | - | - | - | - | - | - | - |
| Hampton St to Cross Rd Channel Upgrade | | - | - | - | - | - | - | - | - | 100 | 2,689 | - | - | - | - | - | - | - | - | - | - | - |
| Minor Channel Works in Mitcham | | - | - | - | - | - | - | - | - | 100 | 706 | - | - | - | - | - | - | - | - | - | - | - |
| Maintenance (0.2% of CAPEX to previous 2 yrs) | | - | - | 5 | 21 | 61 | 102 | 143 | 186 | 226 | 263 | 283 | 295 | 295 | 295 | 295 | 295 | 295 | 295 | 295 | 295 | 295 |
| SMP Administration Costs | 915 | 230 | 230 | 230 | 230 | 230 | 230 | 230 | 230 | 200 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| SMP Study and Consultation | 730 | 125 | 50 | | | | | | | | | | | | | | | | | | | |
| **Total Costs** | **2,339** | **1,937** | **8,437** | **20,435** | **20,340** | **21,091** | **21,529** | **20,573** | **18,916** | **10,471** | **6,522** | **433** | **445** | **445** | **445** | **445** | **445** | **445** | **445** | **445** | **445** | **445** |
| | | | | | | | | | | | | | | | | | | | | | | |
| **Net Balance** | | **- 1,937** | **- 8,437** | **- 19,435** | **- 19,340** | **- 17,091** | **- 17,529** | **- 15,573** | **- 13,916** | **- 3,471** | **478** | **8,535** | **8,523** | **8,523** | **8,523** | **8,523** | **8,523** | **8,523** | **8,523** | **8,523** | **8,523** | **8,523** |

| | |
|---|---|
| Present value of Benefits | 68,783 |
| Present value of Costs | 105,985 |
| Net Present Value | - 37,202 |
| Internal rate return (%) | 2.6% |
| **Benefit Cost Ratio** | **0.65** |
| Real Discount Rate (%) | 7% |



Method reviewed and
Template provided by

EVANS & PECK

Note:
Previous expenditure includes allowance for previous design work, particularly for South Park Lands and Keswick Creek Diversion

Dollar values as at December 2011 (indicative of start of 2012)

# Appendix N - Benefit-Cost Analysis for Part A Works

WorleyParsons
resources & energy

## PART A WORKS

| Values in $ '000 (Real Terms) | Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2012/13 | 2013/14 | 2014/15 | 2015/16 | 2016/17 | 2017/18 | 2018/19 | 2019/20 | 2020/21 | 2021/22 | 2022/23 | 2023/24 | 2024/25 | 2025/26 | 2035/36 | 2036/37 | 2037/38 | 2038/39 | 2039/40 | 2040/41 | 2041/42 |
| **Benefits (Damage Reduction)** | | - | - | 1,000 | 1,000 | 2,000 | 2,000 | 4,000 | 4,000 | 7,000 | 7,727 | 7,727 | 7,727 | 7,727 | 7,727 | 7,727 | 7,727 | 7,727 | 7,727 | 7,727 | 7,727 | 7,727 |
| | | | | | | | | | | | | | | | | | | | | | | |
| **Costs** | **Previous** | **Future** | | | | | | | | | | | | | | | | | | | | |
| Ridge Park Detention System | 30 | 972 | 57 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| South Park Lands Detention System | 373 | 175 | 7,600 | 7,600 | 1,889 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Lower Brown Hill Creek Channel Upgrade | | 435 | 500 | 12,500 | 17,500 | 15,000 | 3,197 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Keswick Creek Diversion Culverts | 131 | - | - | 100 | 650 | 5,500 | 12,000 | 10,000 | 3,470 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Anzac Hwy to Forestville Reserve Channel Upgrade (No Dam Scenario) | | - | - | - | 50 | 300 | 5,500 | 7,500 | 1,530 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Bypass Culvert at Fisher St | | - | - | - | - | - | - | 200 | 3,000 | 1,345 | - | - | - | - | - | - | - | - | - | - | - | - |
| Maintenance (0.2% of CAPEX to previous 2 yrs) | | - | - | 4 | 21 | 61 | 101 | 143 | 184 | 220 | 236 | 238 | 238 | 238 | 238 | 238 | 238 | 238 | 238 | 238 | 238 | 238 |
| SMP Administration Costs | 915 | 230 | 230 | 230 | 230 | 230 | 230 | 230 | 230 | 200 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| SMP Study and Consultation | 730 | 125 | 50 | | | | | | | | | | | | | | | | | | | |
| **Total Costs** | **2,179** | **1,937** | **8,437** | **20,434** | **20,340** | **21,091** | **21,028** | **18,073** | **8,414** | **1,765** | **386** | **388** | **388** | **388** | **388** | **388** | **388** | **388** | **388** | **388** | **388** | **388** |
| | | | | | | | | | | | | | | | | | | | | | | |
| **Net Balance** | | **- 1,937** | **- 8,437** | **- 19,434** | **- 19,340** | **- 19,091** | **- 19,028** | **- 14,073** | **- 4,414** | **5,235** | **7,341** | **7,339** | **7,339** | **7,339** | **7,339** | **7,339** | **7,339** | **7,339** | **7,339** | **7,339** | **7,339** | **7,339** |

| | |
|---|---|
| Present value of Benefits | 58,506 |
| Present value of Costs | 89,826 |
| Net Present Value | - 31,320 |
| Internal rate return (%) | 2.9% |
| **Benefit Cost Ratio** | **0.65** |
| Real Discount Rate (%) | 7% |



Method reviewed and
Template provided by

EVANS & PECK

Note:
Previous expenditure includes allowance for previous design work, particularly for South Park Lands and Keswick Creek Diversion

Dollar values as at December 2011 (indicative of start of 2012)