DICKSON GROUP CENTRE AND PRECINCT FLOOD STUDY – FLOOD MITIGATION OPTIONS STUDY

REPORT

PREPARED FOR THE CHIEF MINISTER, TREASURY AND ECONOMIC DEVELOPMENT DIRECTORATE

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EXECUTIVE SUMMARY

Calibre Consulting has been engaged by The Chief Minister, Treasury and Economic Development Directorate (CMTEDD) to develop options to mitigate the flooding identified in the Sullivans Creek Flood Study undertaken by GHD. This includes, assessing the feasibility of naturalising the Dickson Channel to determine if this is a viable option for the area in the longer term, as well as identification of a suitable site for a new GPT, or upgrading of the existing Lyneham Wetland GPT.

The study area for this project is located within the red dashed line shown in Figure 4-1.

The objectives of this study are to:

- Develop options, and recommend a preferred option, for the future of the floodway along the Dickson channel, between Lyneham Wetland and Dickson Wetland.
- Liaise with CMA and report on the risks associated with the Dickson Channel crossing Northbourne Avenue.
- Liaise with Stakeholders to understand the proposed development plans for the site area.
- Develop options to address the flooding identified, within the Study Area, in the Sullivans Creek Flood Study.
- Identify urban design opportunities for the Dickson Channel corridor and explore opportunities for improved access and amenity along the Dickson Channel open space corridor without increasing the flood risk while maintaining public safety for users. A Master Planning Study for the Dickson Group Centre was completed in May 2011. The study outcomes were implemented through a new Precinct Code within the Territory Plan. Recommendations from the Dickson Centre Master Plan include introducing new pedestrian connections through the Centre and reinforcing existing pedestrian connections to and through the Centre, allowing for intensification of land use in the area including residential development.
- Assess the feasibility of naturalisation of the Dickson Channel to determine if this is a viable option for the area in the longer term.
- Identify a suitable site for a new GPT, or upgrading of the existing Lyneham Wetland GPT.
- Develop detailed cost and risk information for the preferred options.

GHD completed a flood study of Sullivans Creek in March 2015. The Sullivans Creek Flood Study identified a number of flooding issues in and around the Dickson Group Centre.

Under the National Partnership Agreement on Asset Recycling, the ACT Government intends to sell a number of sites in and around the Dickson Group Centre, including the Ambulance Station, the Motor Vehicle registry and the Lyneham and DeBurgh Flats. There are also a number of private sector redevelopments planned in this area. For this to happen, flood mitigation options need to be developed to minimise the flooding in and around the Dickson Group Centre, to allow development and selling of sites.

[redacted]

The recommended option to alleviate the flooding along Dickson Channel is a proposed retardation basin on the Dickson playing fields and levees at Cowper Street Bridge and De Burgh Street Bridge. We note that these options combined, alleviates the flooding along the Dickson Channel. Our opinion of the construction cost only for the flood mitigation treatments along the Dickson Channel is $1,706,954 including GST, with a 30% contingency.

The feasibility of naturalising the Dickson Channel has been investigated at a high level. It was found that naturalising the Dickson Channel would be a viable option for the longer term. Our opinion of the construction cost only for the proposed naturalisation of the Dickson Channel and associated flood mitigation treatments is $8,611,002 including GST, with a 30% contingency.

The recommended option to alleviate the flooding on Northbourne Avenue, just south of Antill Street, is to upsize and duplicate the existing 1350mm stormwater pipe between Northbourne Avenue and Sullivans Creek. Our opinion of the construction cost only for the flood mitigation treatments on Northbourne Avenue, just south of Antill Street is $1,910,056 including GST, with a 30% contingency.

An online pond adjacent to the Ambulance Station has been investigated. It was found that a pond in this location would have no retardation and very limited water quality functions. Therefore, offering no improvement to stormwater flows downstream. This pond would require considerable commitment to land area, thereby restricting development potential of adjacent sites.

Seven (7) Gross Pollutant Trap (GPT) options, between the Dickson Group Centre and Lyneham Wetland, have been investigated. A workshop with CMTEDD and TaMS was held on 14 January 2016. TaMS decided at the workshop to go with both, upgrading the existing Lyneham Wetland GPT (Option 5), and to have a new Baramy Vane Trap GPT immediately west of De Burgh Street. See the Concept Design Plan within Appendix N for the proposed new GPT layout and location.

Option 5 is to upgrade the existing Lyneham GPT to capture gross pollutants only, and to construct a proper forebay to capture the sediment within the Lyneham Wetland. The GPT upgrade would include: replacing the heavy concrete filled covers with grated covers (minor GPT covers), removing the two ECOSOL Net Litterbags, and constructing a vertical screen flush with the step in the GPT. The forebay is earth lined with a geofabric layer 300mm above the clay line to warn the maintenance contractor when to stop de-silting. The geofabric layer in the forebay would have to be reinstated after each cleaning. The total construction cost would be in the order of $160,000 excluding GST. The upgraded GPT will have a maintenance frequency of 6 months, and the forebay will have to be de-silted every 10 years. The remainder of the wetland does not have to be touched. The GPT would be maintained the same way as all minor GPTs within the ACT.

Subsequent to the workshop, the ACT Government confirmed that preparing the concept design and associated cost estimates (design cost and construction cost) for the new major GPT would form part of the scope of this study. TaMS's preferred GPT is a Baramy Vane Trap GPT.

The Baramy Vane Trap GPT is a proprietary product, and was selected by TaMS due to the GPT being easy to access and maintain. The Baramy Vane Trap GPT has a concrete ramp into the containment bay. This GPT also does not require a drying pad, as other GPTs do, due to the containment bay being able to drain dry. Currently, there is no similar product available in the market in Australia.

The Vane Trap GPT uses strategically placed vertical vanes, placed at varying heights and angles, to guide the pollutants into the containment bay. It uses the available energy in the water flow to transport the Gross Pollutants into the containment bays where is can drain dry.

Cost estimates for the exclusions listed in Section 16, can be provided upon agreement of the concept design by all parties involved with the new major GPT. Upon completion of the detailed design, Baramy can provide a firm quote for the construction of the GPT. This will exclude Superintendent's cost.

A list with all the client comments and responses is within Appendix O.

1 INTRODUCTION

Calibre Consulting has been engaged by The Chief Minister, Treasury and Economic Development Directorate (CMTEDD) to develop options to mitigate the flooding identified in the Sullivans Creek Flood Study undertaken by GHD. This includes assessing the feasibility of naturalising of the Dickson Channel to determine if this is a viable option for the area in the longer term, as well as identification of a suitable site for a new GPT, or upgrading of the existing Lyneham Wetland GPT.

2 PURPOSE OF THIS REPORT

The purpose of this report is to:

- Review the Sullivans Creek Flood Study undertaken by GHD,
- Develop options to address the flooding identified, within the Study Area, in the Sullivans Creek Flood Study,
- Assess the feasibility of naturalisation of the Dickson Channel,
- Identify a suitable site and design of a new GPT, or the upgrade and design of the existing Lyneham Wetland GPT,
- Identify landscaping and urban design opportunities for the Dickson Channel corridor, and
- Report on liaison with Capital Metro Agency (CMA).

3 OBJECTIVES

The objectives of this study are to:

- Develop options, and recommend a preferred option, for the future of the floodway along the Dickson channel, between Lyneham Wetland and Dickson Wetland.
- Liaise with CMA and report on the risks associated with the Dickson Channel crossing Northbourne Avenue.
- Liaise with Stakeholders to understand the proposed development plans for the site area.
- Develop options to address the flooding identified, within the Study Area, in the Sullivans Creek Flood Study.
- Identify urban design opportunities for the Dickson Channel corridor and explore opportunities for improved access and amenity along the Dickson Channel open space corridor without increasing the flood risk while maintaining public safety for users. A Master Planning Study for the Dickson Group Centre was completed in May 2011. The study outcomes were implemented through a new Precinct Code within the Territory Plan. Recommendations from the Dickson Centre Master Plan include introducing new pedestrian connections through the Centre and reinforcing existing pedestrian connections to and through the Centre, allowing for intensification of land use in the area including residential development.
- Assess the feasibility of naturalisation of the Dickson Channel to determine if this is a viable option for the area in the longer term.
- Identify a suitable site for a new GPT, or upgrading of the existing Lyneham Wetland GPT.
- Develop detailed cost and risk information for the preferred options.

4 STUDY AREA

The study area for this project is located within the red dashed line shown in Figure 4-1.

Figure 4-1: Study Area and existing 1% AEP flood extents

5 PROJECT BACKGROUND

GHD completed a flood study of Sullivans Creek in March 2015. The Sullivans Creek Flood Study identified a number of flooding issues in and around the Dickson Group Centre.

Under the National Partnership Agreement on Asset Recycling, the ACT Government intends to sell a number of sites in and around the Dickson Group Centre, including the Ambulance Station, the Motor Vehicle registry and the Lyneham and DeBurgh Flats. There are also a number of private sector redevelopments planned in this area. For this to happen, flood mitigation options need to be developed to minimise the flooding in and around the Dickson Group Centre, to allow development and selling of sites.

The following is a list of development proposals within the study area, which were considered as part of this project:

a) Block 3 Section 33 Dickson. The sale of the existing Ambulance Station under the National Partnership Agreement on Asset Recycling Initiative (ARI). The likely redevelopment outcome for this site would be a multi storey residential or mixed use development.

b) Block 8 Section 33 Dickson. The Territory and Municipal Services Directorate (TAMSD) has prepared a detailed design for an improved gross pollutant trap adjacent to the existing Ambulance Station. It is required to reduce the frequency of maintaining (cleaning) the existing underground GPT at the Lyneham Pond. The existing GPT is costly to clean as it is underground and access is difficult. A detailed design has already been developed for a new GPT adjacent to the ambulance station. However, its proposed location is in direct conflict with the redevelopment of the Ambulance Station.

c) Northbourne Housing Precinct. The Northbourne Avenue Corridor has been identified as an area for significant growth and will involve redevelopment of Government-owned residential and non-residential properties. As part of the ARI, the ACT Government will be redeveloping its ageing public housing stock – particularly the multi-unit properties along Northbourne Avenue – to invest in the Capital Metro project, to provide new public housing that meets the needs of contemporary public housing tenants, and to spearhead the urban renewal of the gateway to the National Capital. The area defined as the Northbourne Precinct is shown in **Attachment A**.

d) Part Block 8 Section 52, Lyneham. The ACT Government plans to retain a number of heritage buildings in the Lyneham and DeBurgh Flats (including the northernmost tower and a complete 'daisy chain' of units). The areas around these buildings will be redeveloped with the likely outcome being multiunit developments.

e) Capital Metro Agency (CMA) is planning a light rail line up the centre of Northbourne Avenue.

f) Proposals have been around for some time to "naturalise" the Dickson channel. Such work is aimed at improving the amenity of the area around the channel, but would have an impact on flood levels. The recently completed City and Gateway Urban Renewal Strategy highlights some specific suggestions for the proposed area, and a general overview of the urban design outcomes required.

g) Section 72, Dickson. The government is proposing to amend the Territory Plan to add residential use on the former Downer Club/Observatory (Block 25) and the former Salvation Army site (Block 22) of Section 72, Dickson. The proposal will allow residential development of up to 200 dwellings on the two vacant blocks with building heights no more than two to three storeys, and may also provide for social and affordable housing. The current zoning will remain, which will ensure the existing community facilities on Section 72 are not affected. It will also provide the opportunity for new community uses such as arts, cultural and seniors' facilities within the precinct. The Sullivans Creek Flood Study identified some flooding issues in this area.

h) Block 18 Section 33 Dickson. Plans are also being developed to extend Cape Street to Northbourne Avenue, and for that extension to include a new bus interchange aligned with the Capital Metro Dickson station. This area is subject to flooding in the 1%AEP storm event.

i) Block 17 Section 33 Dickson. The owners of the Transact Building have indicated their intent to redevelop this site. The likely redevelopment outcome is a commercial office or mixed use building.

j) Block 2 Section 33 Dickson. The existing Motor Vehicle Registry will be redeveloped under the ARI. The likely redevelopment outcome for this site is a commercial office building, but may include some other uses under a mixed use scenario.

k) The Cowper Street Bridge over the Dickson Channel also shows up as a flooding hot spot. A potential local solution for this problem was also examined as part of the Sullivans Creek Flood Study.

l) Part Block 23, Section 34, Dickson. Darramalan College has applied for a direct sale for part of this block with the intent to use the area for car parking. This block is currently open space and forms the floodway for the Dickson channel.

6 REVIEW OF SULLIVANS CREEK FLOOD STUDY (GHD)

6.1 RORB MODEL REVIEW

GHD created a RORB model for the hydrology component of the Sullivans Creek flood modelling. RORB is a runoff and stream flow routing program used to calculate flood hydrographs from rainfall and other channel inputs.

A review of the RORB model's input parameters have been undertaken to ensure that it is consistent with RORB parameters within the Territory and Municipal Services (TaMS) Design Standards for Urban Infrastructure – 1 Stormwater.

6.1.1 RAINFALL LOSS RATES

Rainfall loss parameters for pervious areas as specified in the TAMS Design Standards for Urban Infrastructure – 1 Stormwater within Table 1.8, is shown in Table 6-1 below. Table 6-2 shows the values used by GHD.

Table 6-1: RORB Pervious Area Rainfall Loss Parameters – TaMS Design Standards

Parameter	Value
Initial Loss	10 mm
Runoff Coefficient	45%

Table 6-2: RORB Pervious Area Rainfall Loss Parameters – Values used in GHD RORB model

Parameter	Value
Initial Loss	10mm
Runoff Coefficient	1% AEP – 26% 10% AEP – 20%

It can be seen that GHD has used different runoff coefficients, However, the runoff coefficient of 45% specified in the TaMS Design Standards is stated as a cautionary number, therefore adjusting these values as GHD has done to be more catchment specific is acceptable practice.

The kc value determined from the TaMS Design Standards for the 52km^2 Sullivans Creek catchment area, should be 15.86. GHD used a kc value of 14, which is more appropriate as the simulated peaks for the TaMS Design Standard were considerably higher than those observed, and significant lag time was also produced compared to the recorded hydrographs.

A typical "m" value of 0.8 was used by GHD, in accordance with the TaMS Design Guidelines.

GHD has comprehensively calibrated their RORB model based on flow data collected at various locations along Sullivans Creek. This is the reason in the variation from the TAMS Design Standard values, and is deemed to be appropriate.

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

6.1.3 CATCHMENT PLAN

A review of the average catchment sizes used in the RORB model has been carried out. The average area of each catchment was found to be approximately 16 ha. For a RORB model, this is determined to be an acceptable catchment size.

6.1.4 TEMPORAL PATTERN

The ARR Zone 2 temporal pattern has been adopted. This is appropriate.

6.2 TUFLOW MODEL REVIEW

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the

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[redacted]

7 EXISTING FLOODING

Flood Maps and Velocity Depth Product Maps of the existing scenario have been produced using GHD's TUFLOW model.

7.1 FLOOD MAPS

7.1.1 DICKSON CHANNEL

The existing riverine flooding along Dickson Channel can be seen on the Flood Maps within **Appendix B**. Figures F001.1_D to F001.3_D, shows there is extensive flooding at De Burgh Street Bridge, Challis Street Bridge, Cowper Street Bridge, and downstream of Dickson Wetland between the wetland and Cowper Street. The overtopping at Cowper Street Bridge and Challis Street Bridge causes flooding on Cowper Street, Wilshire Street, Dickson Place, Cape Street, Wolley Street., Challis Street and Morphett Street. This is significant flooding, with the flood extents extending into blocks. The overtopping at De Burgh Street causes significant flooding along De Burgh Street, with the flooding also extending into blocks.

7.1.2 NORTHBOURNE AVENUE

The existing flooding on Northbourne Avenue, just south of Antill Street, can be seen on the Flood Maps within **Appendix C.** Figure F013.1 shows the existing flooding on Northbourne Avenue just south of Antill Street, and associated flooding along the northern section of Challis Street.

7.2 VELOCITY DEPTH PRODUCT (V*D) MAPS

7.2.1 DICKSON CHANNEL

The Velocity Depth Product (V*D) Maps showing the existing V*D along the Dickson Channel are within **Appendix D**. Figures F003.1 to F003.3, show that the V*D along the middle of the concrete channel is less than 0.8m2/s, with the V*D reducing to less than $0.4m^2/s$ along the outer edge of the Dickson Channel.

7.2.2 NORTHBOURNE AVENUE

The V*D Maps showing the existing V*D on Northbourne Avenue and Challis Street are within **Appendix E**. Figure F013.3 shows that the V*D on Northbourne Avenue, just south of Antill Street, and on the northern section of Challis Street, is less than $0.4m^2/s$.

8 FLOOD MITIGATION ALONG DICKSON CHANNEL

Calibre has investigated the following options to alleviate the 1% AEP flooding along the Dickson Channel between Dickson Wetland and Lyneham Wetland.

- Levees only
- Retardation including levees

8.1 LEVEES ONLY

Levees only, at Cowper Street Bridge and De Burgh Street Bridge, have been investigated as options to alleviate the flooding along the Dickson Channel. However, it was found that for levees to alleviate the flooding the levees had to be considerably higher than the downstream road surface level. In the order of 1.5 metres higher than the adjacent road surface level.

This was not considered a good design outcome and not further considered.

8.2 RETARDATION INCLUDING LEVEES

The following options were found to alleviate the existing 1% AEP flooding along the existing Dickson Channel.

- Stormwater Retardation Basin at Dickson Playing Fields,
- Levees at Cowper Street Bridge, and
- Levees at De Burgh Street Bridge.

It must be noted that these options combined, alleviates the flooding along the Dickson Channel.

The Flood Maps showing the flooding extents for the flood mitigation treatments discussed in Sections 8.2.1 to 8.2.3 are within **Appendix F**.

Sketch Plans of the proposed retardation basin and levees option are within **Appendix G**.

8.2.1 RETARDATION BASIN AT DICKSON PLAYING FIELDS

Investigating retardation at the Dickson Playing fields was an option that was mentioned in the Project Brief. This option was listed as a possible option, which needed to be investigated to assist with alleviating flooding along the Dickson Channel.

This option takes advantage of the existing green space and partly constructed embankment, which is located northwest of the playing field.

Calibre considers this recommendation excellent, as it makes very good sense from a hydraulic point of view to choke the flow back in the Dickson Channel at this location. Figure 8-1 shows the proposed retardation basin at the Dickson playing fields.

The retardation basin is proposed to have a 1.4 metre high flood embankment between the partly constructed embankment, located northwest of the playing field, and the Dickson Wetland. The new embankment is aligned horizontally to avoid the irrigation tanks located northwest of the Dickson Wetland. The embankment ties in with the pedestrian footpath located along the western side of Dickson Wetland. This embankment height includes 300mm freeboard.

The retardation basin is proposed to have a minimum storage volume of 30,163m^3. Two new 525mm diameter concrete pipes are proposed through the embankment in-line with Dickson Channel. It is also proposed to reduce the existing five 1200mm diameter concrete pipes draining the Dickson Channel to five 525mm diameter orifices, via a stainless steel plate bolted to the inlet side of the five 1200mm diameter outlet structure.

The TUFLOW modelling shows that retardation at this location causes backwater to overtop the Dickson Channel upstream of the Dickson Wetland, which then floods the properties located along the southern side of the channel. To avoid this flooding, a 0.5 metre high levee is proposed along the southern side of the channel between the Dickson Wetland and Majura Avenue. The height of this levee includes 300mm freeboard. See Figure 8-1 for the location of this levee. Overland flow connectivity from any local and upstream catchments, will need to be included during further design stages. The 1% AEP flood level behind the flood embankment is 584.45m AHD.

It should be noted that the design of this proposed retardation basin embankment to 'close' the Dickson Channel is not trivial. As part of the next design phase, it is vital that the consequence of failure of the retardation basin embankment be assessed against the Australian National Committee on Large Dams (ANCOLD) guidelines on dam safety, and NSW Dams Safety Committee (DSC) criteria.

The consequence of failure on an unlined channel also needs to be considered, in the subsequent assessment.

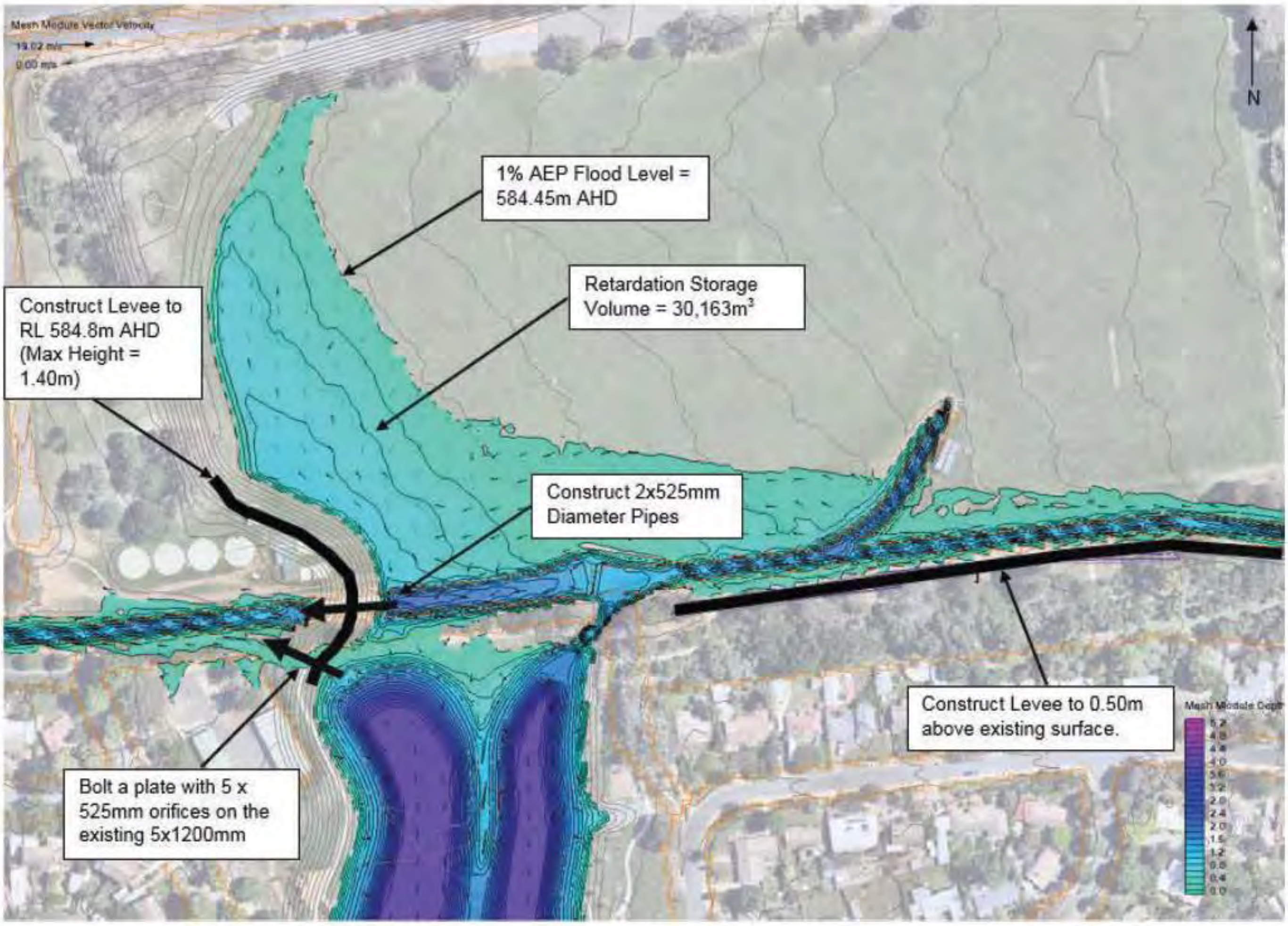

Figure 8-1: Retardation Basin at Dickson Playing Fields

A long section along the proposed earth embankment at Dickson Playing fields is shown in Figure 8-2. The long section shows that the existing pedestrian footpath along the western side of the Dickson Wetland will need to be reconstructed to provide a level embankment along the southwestern side of the wetland. This footpath will need to be constructed to RL584.8m AHD to avoid overtopping. RL584.8m AHD includes 300mm freeboard.

The length of new retardation embankment is approximately 135m, with an additional 100m of footpath along the western side of the Dickson Channel to be reconstructed to RL584.8m AHD.

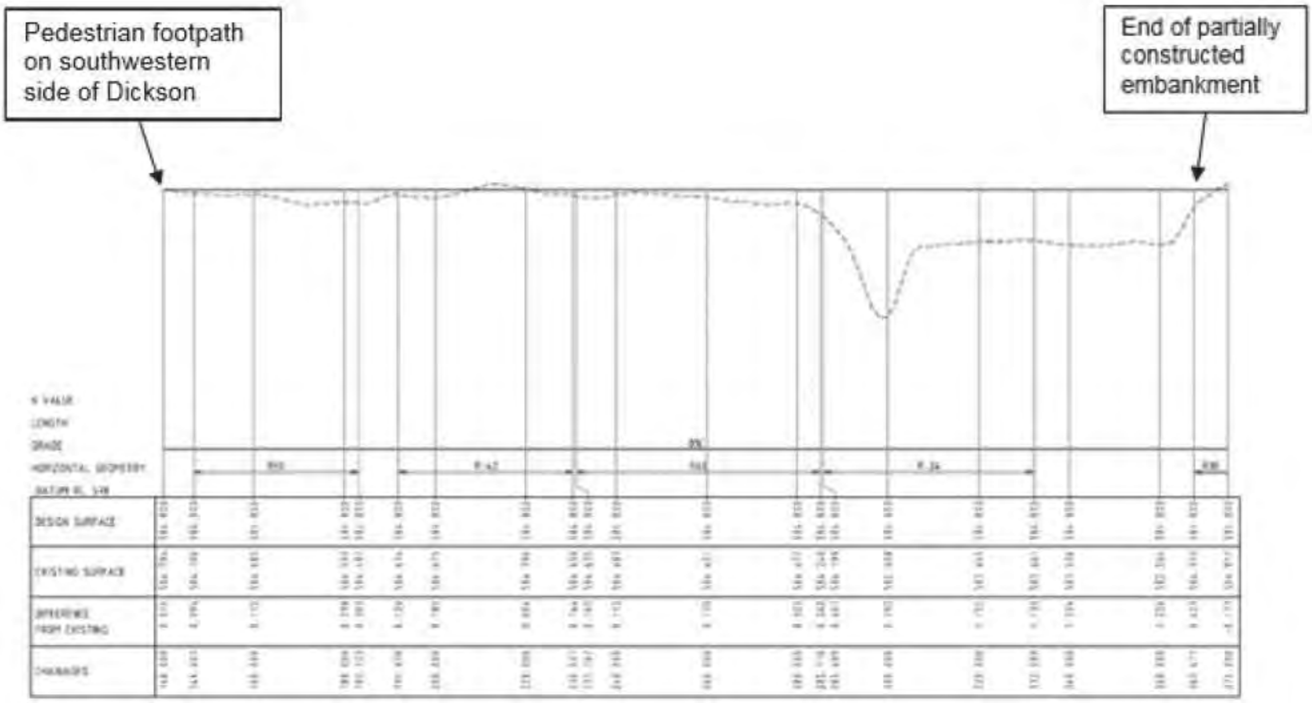

Figure 8-2: Retardation basin embankment long section

8.2.2 LEVEES AT COWPER STREET BRIDGE

Two levees located along the northern side and southern side of the Dickson Channel are required to alleviate the 1% AEP flooding at the Cowper Street Bridge. Figure 8-4 show the location of the levees and proposed heights in relation to the height of the road surface level on the Cowper Street Bridge. Both levees are modelled at RL576.8m AHD, which include 300mm freeboard. The maximum height of the northern levee is 0.5m and the maximum height of the southern levee is 0.8m. The levee alignments shown are indicative only, and can be refined at PSP stage to allow for site constraints.

The Cowper Street / Dickson Place intersection is currently undergoing redesign by Calibre Consulting on behalf of EDD. Refer to Figure 4-1 for the current redesign. At the time of writing this report, the construction of this intersection was about to commence, and the levee designs have not progress enough to include the levee construction as part of the intersection upgrade construction works.

The levees can be designed and constructed in the future to allow for site constraints present at the time of design.

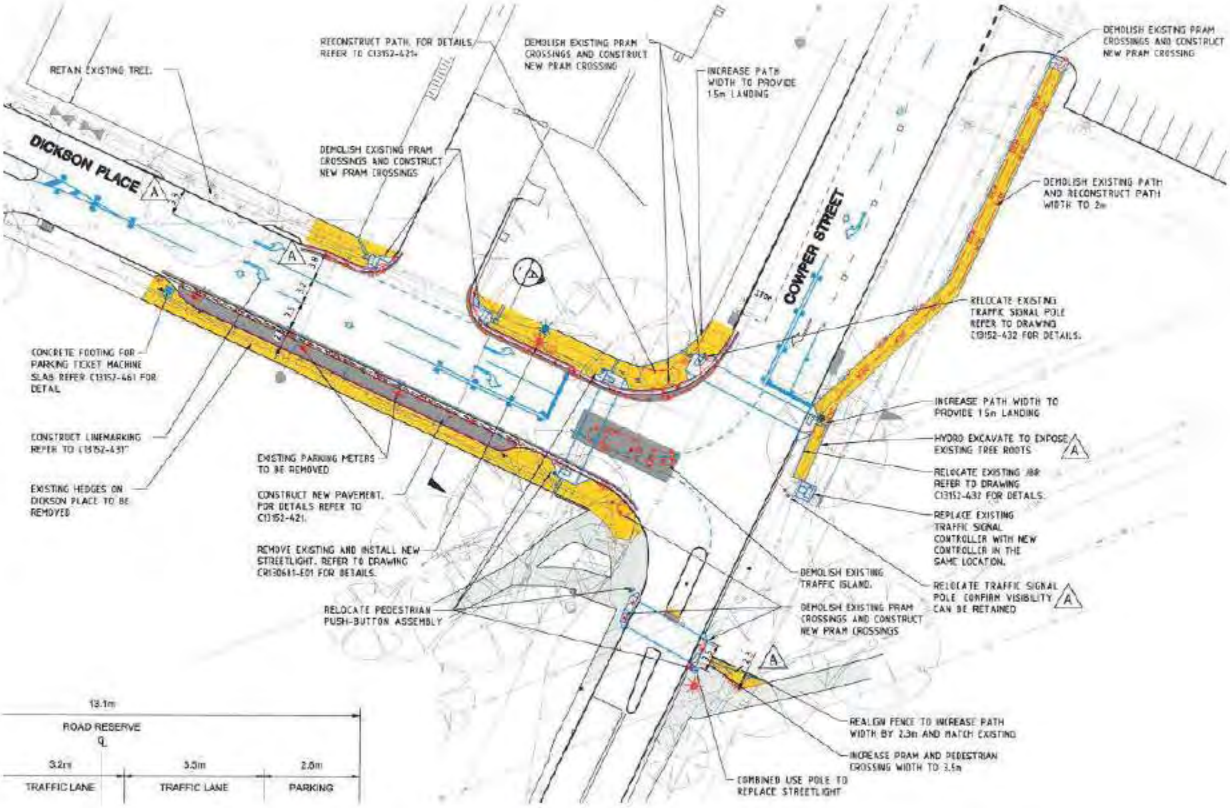

Figure 8-3 Cowper Street / Dickson Place intersection redesign

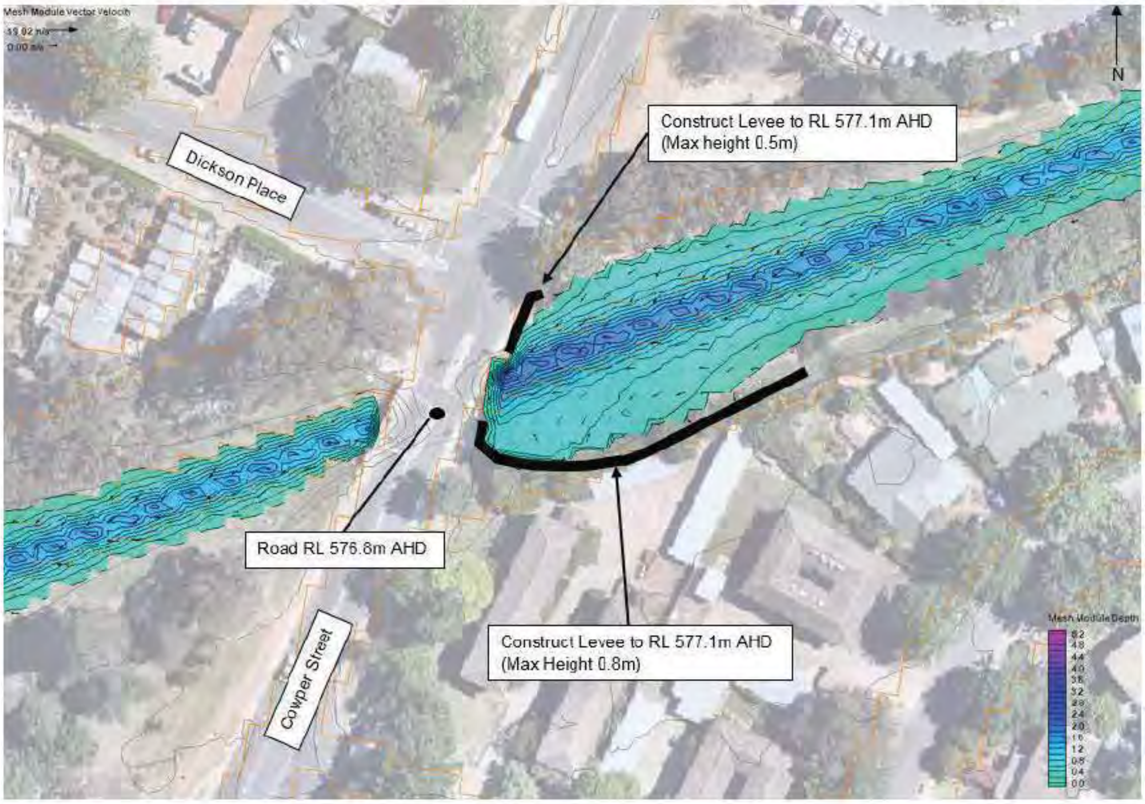

Figure 8-4: Levees at Cowper Street Bridge

8.2.3 LEVEES AT DE BURGH STREET BRIDGE

As per Cowper Street Bridge, two levees are also required at De Burgh Street Bridge to assist with alleviating the 1% AEP flooding at this location. The levees are modelled with a RL of 570.03m AHD, which include 300mm freeboard.

Figure 8-5 shows the location of the levees and the height of the levees in relation to the height of De Burgh Street Bridge. The levee alignments shown are indicative only, and can be refined at PSP stage to allow for site constraints.

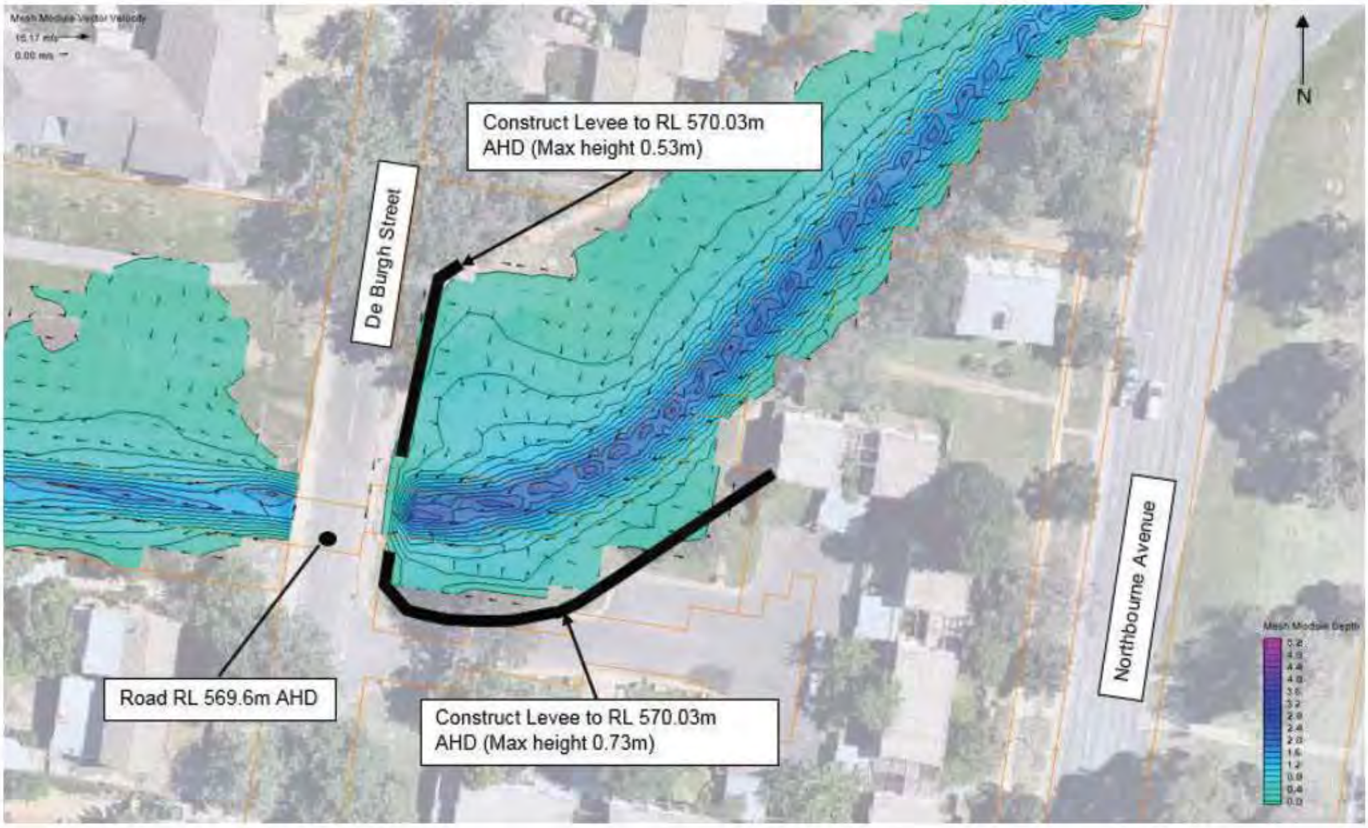

Figure 8-5: Levees at De Burgh Street Bridge

8.3 SAFETY

8.3.1 VELOCITY X DEPTH (V*D) LIMITS

Adequate provision for public safety should be allowed for during future design stages in accordance with TAMS design standards. Stormwater infrastructure should consider the safety of children and vehicles in design by limiting the V*D of flow in the major design storm event.

Table 8-1 shows the V*D limits for the 1% AEP storm event based on the likelihood of exposure of the public to the 1% AEP peak flow.

Table 8-1: Velocity x Depth (V*D) limits for 1% AEP storm event

Likelihood of exposure to pedestrians	Examples	Maximum Velocity x Depth (m^2/s)
Regular of likely exposure	Roads, footpaths, public open space	0.4
Irregular exposure	Minor waterways, major traffic routes	0.6
Rare or unlikely exposure or barriers to prevent access provided	Drop structures, dam spillways	No limit (signage required)

The V*D Maps within **Appendix H**, on Figures F006.1 to F006.3, show that the V*D along the middle of the concrete channel is less than $0.8m^2/s$, with the V*D reducing to less than $0.4m^2/s$ along the outer edge of the Dickson Channel and on Dickson Playing fields. This is similar to the existing V*D discussed in Section 7.2.1. This shows that the proposed mitigation works along the Dickson Channel do not increase the V*D along the Dickson Channel.

The V*D along the outer edge of the Dickson Channel and on the Dickson Playing fields deems to be acceptable. However, the V*D should be checked again at detailed design stage to ensure that it meets TAMS V*D requirements.

9 FLOOD MITIGATION ON NORTHBOURNE AVENUE

The following options have been investigated to alleviate the 1% AEP flooding on Northbourne Avenue, just south of Antill Street.

- Upsizing and duplicating the existing 1350mm diameter stormwater pipe
- Above ground retardation upstream of Northbourne Avenue

9.1 UPSIZING AND DUPLICATING 1350MM DIAMETER STORMWATER PIPE

Upsizing the 1350mm diameter stormwater pipe between Northbourne Avenue and Goodwin Street to a 1650mm diameter stormwater pipe, and duplicating the 1350mm diameter stormwater pipe between Goodwin Street and Sullivans Creek, was found to fully alleviate the flooding on Northbourne Avenue and within the Dickson group Centre. The Flood Maps showing the flooding extent on Northbourne Avenue within **Appendix I**.

Figure 9-1 shows the proposed alignment and sections of pipe to be upsized and duplicated. If this option is further developed, the design can be refined at Preliminary Sketch Plan (PSP) stage to optimise the pipe sizes required.

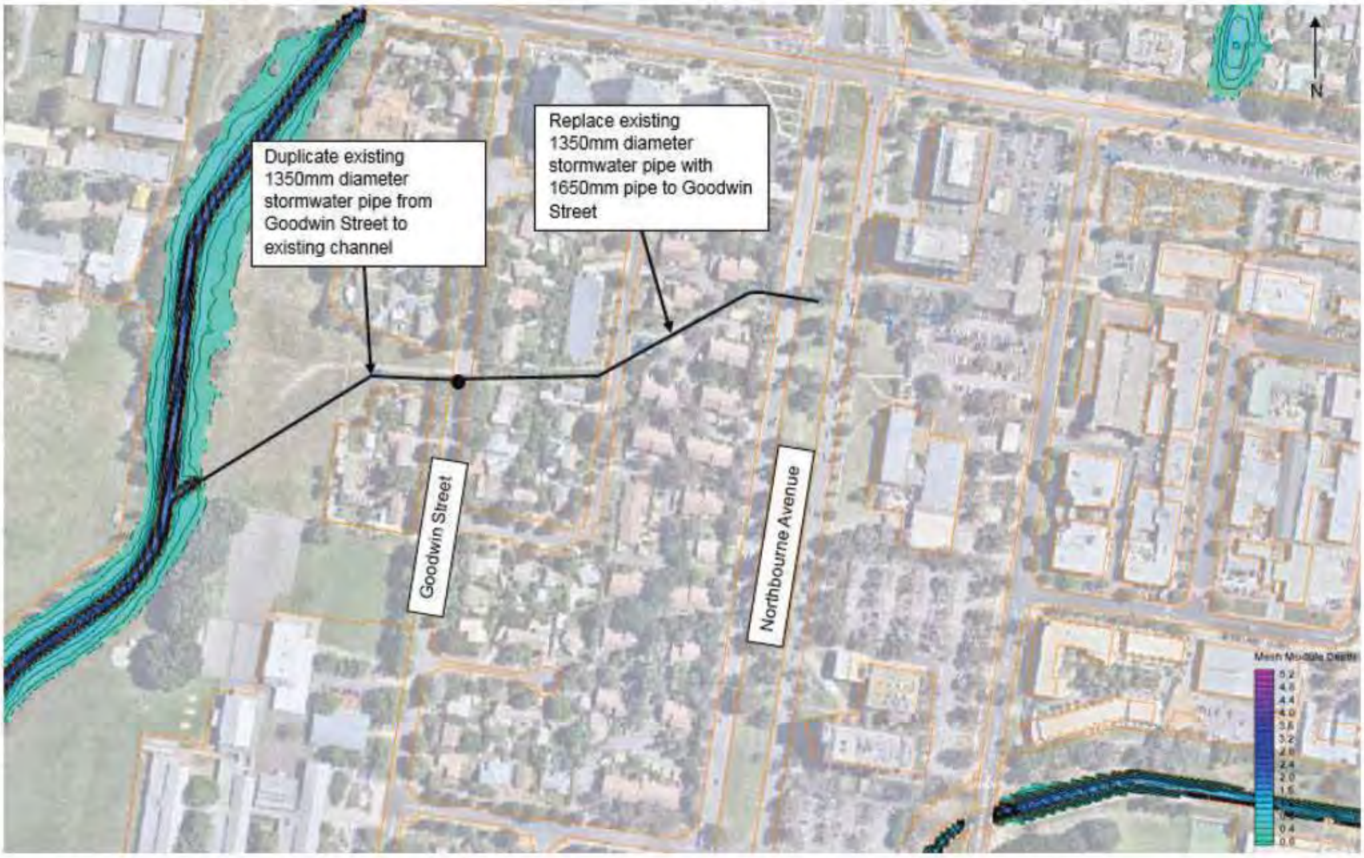

Figure 9-1: Upsizing and duplicating the 1350mm stormwater pipe

9.2 RETARDATION UPSTREAM OF NORTHBOURNE AVENUE

An above ground surcharge retardation basin at the location shown on Figure 9-2 was modelled in TUFLOW to determine if it would sufficiently lower the hydraulic grade line within the existing 1350mm diameter stormwater pipe to alleviate the flooding on Northbourne Avenue. The basin was graded to maximise its footprint area allowing for site constraints.

The retardation basin was modelled with a depth of 1.2m, side slopes of 1v:4h and a footprint area of 651m^2. The invert level of the surcharge structure was set to the obvert of the 1350mm diameter stormwater pipe.

The TUFLOW modelling showed that adding a surcharge point, at this location, along the 1350mm diameter stormwater pipe actually increases the flooding on Northbourne Avenue. As a result, this option was not further considered. This block is also identified for sale and redevelopment by ACT Government in the short term for intensive land uses.

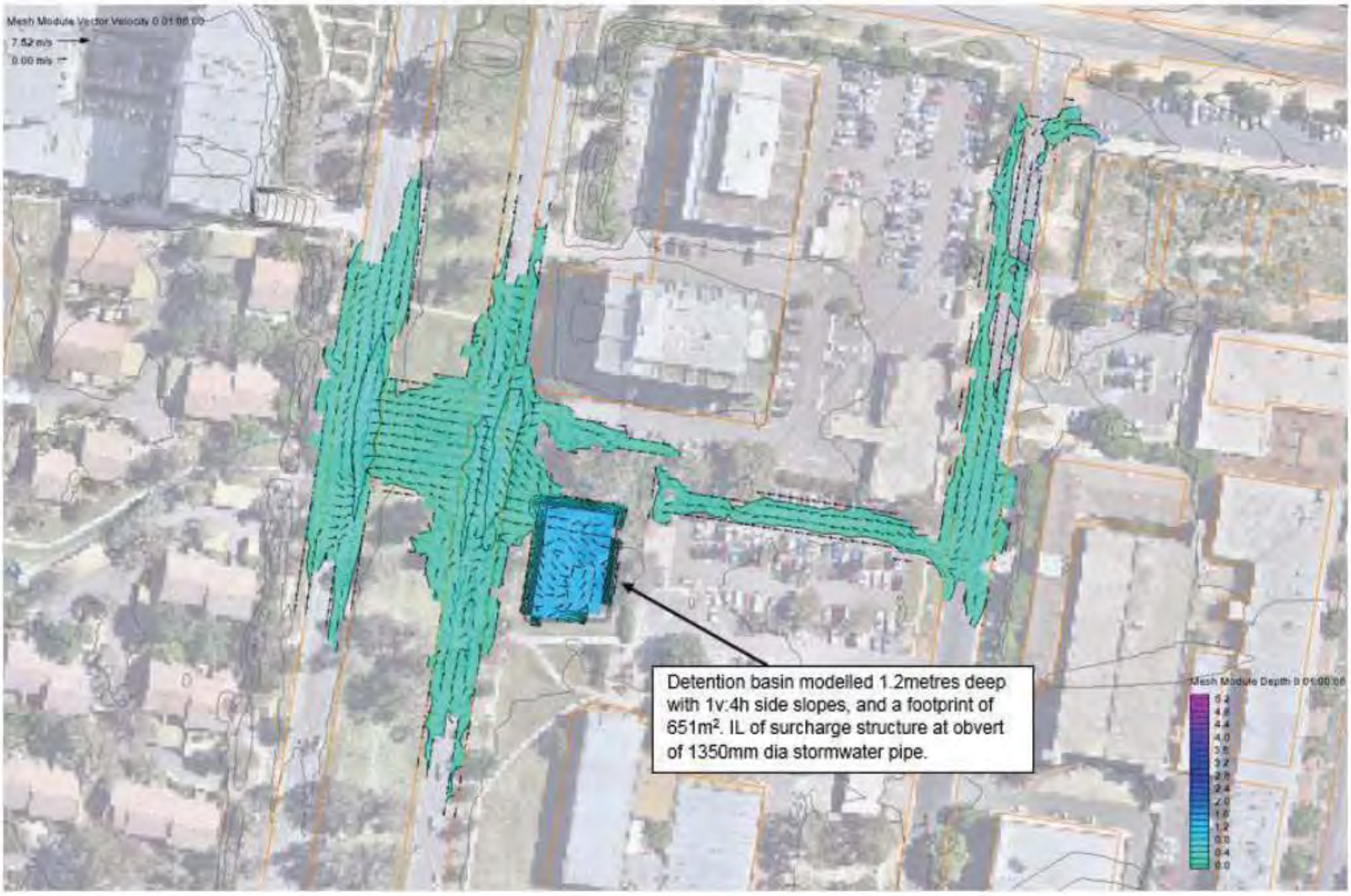

Figure 9-2: Above-ground retardation basin to alleviate flooding on Northbourne Avenue just south of Antill Street

9.3 SAFETY

9.3.1 VELOCITY X DEPTH (V*D) LIMITS

Upsizing the 1350mm diameter stormwater pipe between Northbourne Avenue and Goodwin Street, and duplicating the 1350mm diameter stormwater pipe between Goodwin Street and Sullivans Creek, was found to fully alleviate the flooding in this area. Therefore, there should be no exposure to the 1% AEP flow at this location on Northbourne Avenue to the public.

10 NATURALISATION OF DICKSON CHANNEL

Assessing the feasibility of naturalising the Dickson Channel, between Dickson Wetland and De Burgh Street, was modelled in TUFLOW to determine if this is a viable option for the area in the longer term.

The Flood Maps showing the extent of flooding associated with the proposed naturalised channel and associated flood mitigation treatments are shown within **Appendix J**.

10.1 CHANNEL CHARACTERISTICS

The naturalised channel was modelled as a trapezoidal channel with 1v:4h side slopes, a base width of 1m, depth similar to the existing concrete channel, top with of 15.4m and a bankfull manning's n = 0.035.

Figure 10-1 shows the naturalised channel cross sectional area compared to the cross sectional area of the existing concrete channel.

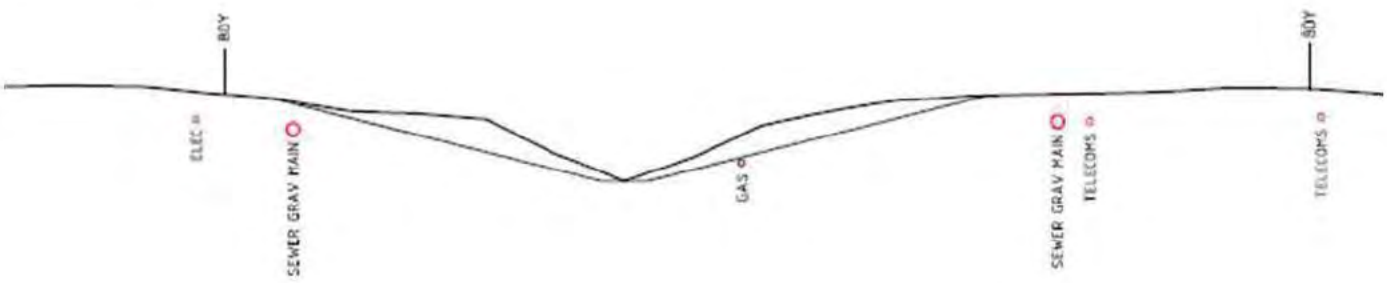

Figure 10-1: Naturalised channel with flatter side slopes compared existing concrete channel

The location of the existing services shown on the section have been obtained from WAE and DBYD information, with a minimum depth of 600mm. All underground services along the Dickson Channel will need to potholed and surveyed to ensure that minimum clearance requirements of the responsible authorities are satisfied.

The proposed modelled naturalised channel currently has mown grass banks, with unmaintained wetland plants on the channel bed, and a very slight meander, as shown on Figure 10-2.

Figure 10-2: Proposed Modelled Naturalised Channel

A bankfull manning's n value for the proposed channel in Figure 10-2 is 0.035 according to the Brisbane City Council Natural Channel Design Guidelines.

The ACT Government's Municipal Infrastructure Standards recommends a manning's n of 0.035 for tall grass.

10.2 FLOOD MITIGATION TREATMENTS

We note that this naturalised option requires the same flood mitigation treatments as discussed in Section 8.2 for the existing Dickson Channel.

10.3 WHY IS NATURALISING THE DICKSON CHANNEL FEASIBLE?

Naturalisation of the Dickson Channel works due to a combination of things, which are as follows:

The hydraulic capacity of the existing channel is limited by the Cowper Bridge and De Burgh Bridge.

The 1% AEP peak flow in the Dickson Channel is approximately 26.5m^3 /s. However, currently the Cowper Bridge and De Burgh Bridge can only convey 20.87m^3/s and 19.13m^3/s respectively, before overtopping.

Therefore, to avoid overtopping at these two bridges the 1% AEP peak flow in the channel needs to be reduced to at least 19m^3/s, without the need for excessively high levees upstream of the two bridges to avoid over topping.

In order to reduce the 1% AEP peak flow within the Dickson Channel from 26.5m^3/s to a flow that can be safely conveyed by the Cowper Bridge and De Burgh Bridge, retardation at the Dickson Playing Fields is required.

Through the proposed upstream retardation, and the increase in time of concentration within the naturalised Dickson Channel, the peak flow of 26.5m^3/s can be reduced to 20.08m^3/s.

This reduced flow of 20.08m^3/s can be conveyed by the proposed naturalised channel without excessively increasing the 1% AEP flood levels along the Dickson Channel.

10.4 SAFETY

10.4.1 VELOCITY X DEPTH (V*D) LIMITS

The V*D for the naturalised channel was found to be similar to the existing concrete channel, which is discussed in Section 7.2.1. Should this option be further developed, special care should be taken to keep the V*D as low as possible. The top edge of a naturalised channel will not be as clearly defined as with a concrete channel, it is recommended that appropriate signage be included as part of the detailed design to warn the public that they are approaching a flood way.

The V*D Maps showing the V*D for the proposed naturalised channel and associated flood mitigation treatments are within **Appendix K**.

10.4.2 CHANNEL SIDE SLOPES

More appropriate channel side slopes for the naturalised channel would be 1v:6h where there is no clear defined channel edge. Should this option be further developed, the channel side slopes should be designed to be 1v:6h where site constraints allow, and where there is no clearly defined channel edge.

10.5 SENSITIVITY ANALYSIS

A sensitivity analysis on the naturalised channel has been carried out to see how the 1% AEP flood levels will change if the bankfull manning's n value is increased from 0.035 to 0.045.

Figure F010.1 to F010.3 within the Flood Maps in **Appendix L**, show that by increasing the bankfull manning's n value from 0.035 to 0.045, the 1% AEP flood levels are still acceptable and is contained with the Dickson Channel corridor, except for at De Burgh Street Bridge.

We note that flooding does currently occur at De Burgh Street Bridge for the flood mitigation options proposed for the Dickson Channel. Refining of the retardation basin outlet structure and embankment designs, and re-running the TUFLOW model with detailed survey at De Burgh Street should fully alleviate the flooding in this area.

11 POND IN THE VICINITY OF THE AMBULANCE STATION

An online pond adjacent to the Ambulance Station was recommended to be investigated in the project brief. It was found that for a pond to function at this location, the pond's normal water level needs to be at the same level as the existing concrete channel invert. This means that the normal water level for the pond needs to be approximately 1.5m below the surrounding ground level.

A normal water level above the existing concrete channel invert, will result in backwater extending upstream along the channel, reducing the hydraulic capacity of the channel and raising the 1% AEP flood level upstream of the Northbourne Avenue Bridge.

Further discussions on this pond can be found in the Landscape Report within **Appendix M**.

12 LANDSCAPE AND URBAN DESIGN

Redbox Design Group as part of this study developed landscape and urban design options and recommendations for the future landscape and urban design character of the Dickson Channel. The Landscape Report prepared by Redbox Design Group is within **Appendix M**.

13 LIAISON WITH CAPITAL METRO AGENCY (CMA)

13.1 DICKSON CHANNEL

The proposed light rail line along Northbourne Avenue crosses over the Dickson Channel at the existing culvert under Northbourne Avenue. Calibre has been advised by Capital Metro Agency (CMA) that the proposed treatment for CMA is to retain and protect this existing culvert.

The TUFLOW model results show that there is currently 1.08m freeboard between the 1% AEP flood level and the Northbourne Avenue road surface level above the culvert. However, this will need to be confirmed by detailed survey of the Dickson Channel and Northbourne Avenue crossing. Therefore, based on information currently available to Calibre, there should be no flooding risk at this crossing.

13.2 NORTHBOURNE AVENUE

This study identifies that there is an existing flooding problem at Northbourne Avenue, which would potentially impact the light rail alignment and proposed infrastructure. The light rail project will need to respond to existing flood levels through infrastructure design and/or operational measures.

This study has developed an option to alleviate the flooding in this area, which CMA could adopt. See Section 9.1.

14 EXISTING SERVICES AND POSSIBLE UPGRADE / PROTECTION WORKS

14.1 EXISTING SERVICES

The location of the existing services for this project have been obtained from WAE drawings and DBYD information. All underground services will need to be potholed at PSP stage, to ensure that minimum clearance requirements of the responsible authorities are satisfied.

14.2 POSSIBLE UPGRADE / PROTECTION WORKS

We note that the Opinion of Costs prepared for each option include the possible upgrade and protection works discussed in the sections below.

14.2.1 FLOOD MITIGATION ALONG DICKSON CHANNEL

14.2.1.1 STORMWATER RETARDATION BASIN AT DICKSON PLAYING FIELDS

Protection of existing sewer during civil construction. A communication cable for the irrigation main and two long jump pits will need to be relocated during civil construction

14.2.1.2 LEVEES AT COWPER STREET BRIDGE

Protection of existing sewer, stormwater, irrigation main, electricity, and telecommunication during civil construction.

14.2.1.3 LEVEES AT DE BURGH STREET BRIDGE.

Protection of existing sewer, telecommunication and electricity during civil construction. A sewer manhole needs to be raised to match the levee design level.

14.2.2 FLOOD MITIGATION ON NORTHBOURNE AVENUE SOUTH OF ANTILL STREET

14.2.2.1 STORMWATER PIPE UPGRADE BETWEEN NORTHBOURNE AVENUE AND GOODWIN STREET

Protection of the existing sewer and electrical services crossing underneath or above the existing 1350mm stormwater pipe, between Northbourne Avenue and Goodwin Street, during civil works.

Protection of existing sewer running parallel with the existing 1350mm stormwater pipe, between Northbourne Avenue and Goodwin Street, during civil works.

14.2.2.2 STORMWATER PIPE DUPLICATION BETWEEN GOODWIN STREET AND SULLIVANS CREEK

Protection of the existing sewer running parallel to Sullivans Creek during civil construction.

The existing 1350mm stormwater pipe currently crosses this existing sewer pipe. The assumption has been made that the second pipe would also be able to cross the exiting sewer pipe.

14.2.3 PROPOSED NATURALISED CHANNEL

The invert of the natural channel is proposed at the same level as the existing concrete channel. Therefore, the assumption has been made that all services crossing underneath the existing concrete channel will have to be protected during civil works, but will not require to be relocated.

There is currently 22 stormwater pipes discharging into the side of the existing concrete channel. These outlets will need upgrade works if the channel is to be naturalised.

Based on our investigation to date, it looks like the natural channel can be constructed to accommodate the existing sewer within the Dickson Channel corridor. This is based on a channel side slope of 1v:4h.

There are telecommunication and electrical services that may have to be realigned for the naturalised channel. These services are currently shown just outside the extent of the proposed naturalised channel. The opinion of cost do allow for this.

There is a 250m long gas pipe, between Cowper Street and the Dickson Playing Fields, which runs adjacent to the northern edge of the existing concrete channel. Depending on its depth, this gas pipe may require realignment. The opinion of cost do allow for this. Gas pipe size and alignment to be confirm by potholing. The gas pipe is described as "DistributionMain, Nylon, InService" on the ActewAGL Gas Networks Legend.

15 SEWER UPGRADES CURRENTLY PROPOSED

A new 300mm diameter sewer pipe is proposed along the Dickson Channel between Northbourne Avenue and Cowper Street as shown on Figure 15-1. At the time of writing this report, the design was at concept design stage. The horizontal alignment of this sewer pipe will need to be re-aligned to accommodate for naturalisation of the Dickson Channel, should naturalising the Dickson Channel be further developed.

Upgrading of an existing sewer pipe is also proposed between Oliver Street and Sullivans Creek as shown on Figure 15-2.

These designs are undertaken by TaMS on behalf of Icon Water.

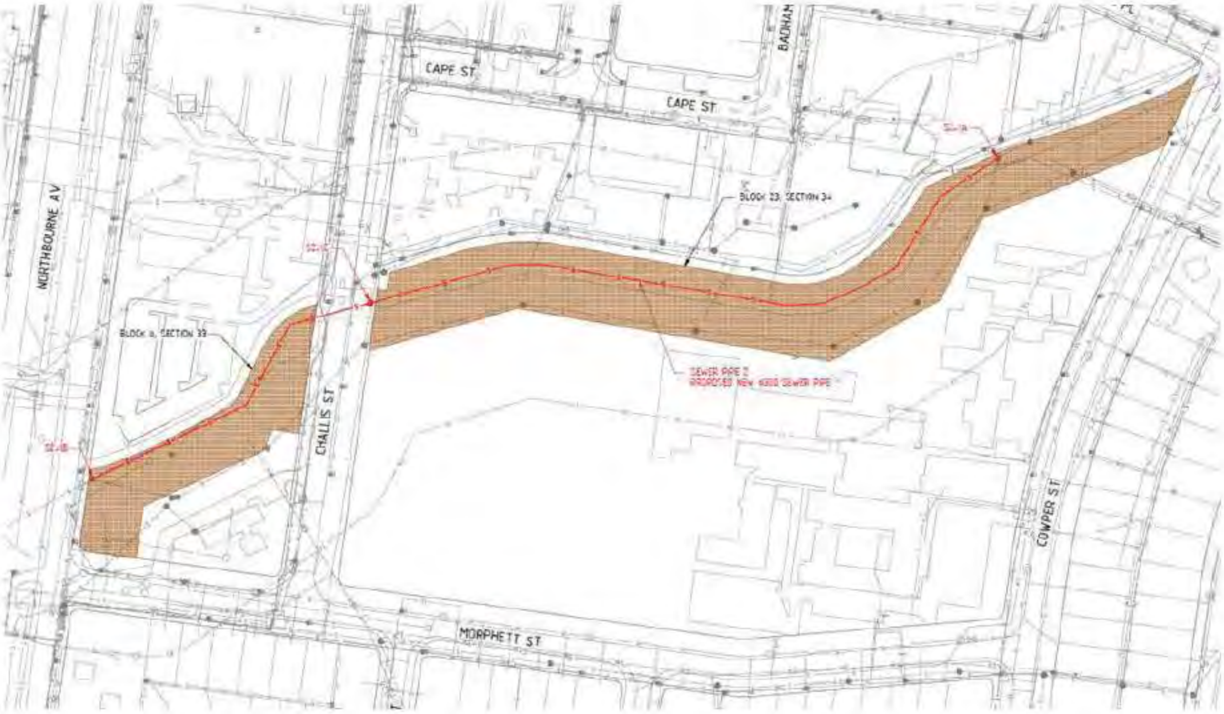

Figure 15-1: Proposed sewer works within the Dickson Channel corridor

Figure 15-2: Proposed sewer works between Northbourne Avenue and Sullivans Creek

16 GROSS POLLUTANT TRAP (GPT) OPTIONS

As part of this study, Calibre was asked to identify a suitable site for a new Gross Pollutant Trap (GPT) located between the Dickson Group Centre and the Lyneham Wetland, or upgrade the existing Lyneham Wetland GPT as an alternative to an additional site.

Calibre developed seven (7) GPT options and held a workshop with CMTEDD and TaMS on 14 January 2016, to discuss in detail each GPT option, including estimated construction costs.

Below is a summary of the GPT options, in no particular order.

Option 1:

Option 1 is to have two twin minor GPTs at the same location as the existing Lyneham GPT. The total construction cost would be in the order of $345,000 excluding GST, with a maintenance frequency of 6 months. This option would be maintained the same way as all minor GPTs within the ACT.

Option 2:

Option 2 is to have a SPEL Bafflebox SBB-8-14-600x2 at the same location of the existing Lyneham GPT. The total construction cost would be in the order of $155,500 excluding GST, with a maintenance frequency of 2 months. A sucker truck will be required to maintain this GPT.

Option 3:

Option 3 is to have a Rocla CDS 2028 Unit at the same location of the Existing Lyneham GPT. The total construction cost would be in the order of $135,000 excluding GST, with a maintenance frequency of 4 months. A sucker truck will be required to maintain this GPT.

Option 4:

Option 4 is to upgrade the existing Lyneham GPT to capture gross pollutants only, and to leave the wetland to capture the sediment as per URS's design. The GPT upgrade would include: replacing the heavy concrete filled covers with grated covers (minor GPT covers), removing the two ECOSOL Net Litterbags, and constructing a vertical screen flush with the step in the GPT. The total construction cost would be in the order of $25,000 excluding GST. The upgraded GPT will have a maintenance frequency of 6 months, and the entire wetland will have to be de-silted every 50 years. In this option, the GPT would be maintained the same way as all minor GPTs within the ACT.

Option 5:

Option 5 is to upgrade the existing Lyneham GPT as per Option 4, and to construct a proper forebay to capture the sediment within the Lyneham Wetland. In this option, the forebay is earth lined with a geofabric layer 300mm above the clay line to warn the maintenance contractor when to stop de-silting. The geofabric layer in the forebay would have to be reinstated after each cleaning. The total construction cost would be in the order of $160,000 excluding GST. The upgraded GPT will have a maintenance frequency of 6 months, and the forebay will have to be de-silted every 10 years. The rest of the wetland do not have to be touched. In this option, the GPT would be maintained the same way as all minor GPTs within the ACT.

Option 6:

Option 6 is to upgrade the existing Lyneham GPT as per Option 4, and to construct a proper forebay to capture the sediment within the Lyneham Wetland. In this option, the forebay is concrete lined to be more robust. The total construction cost would be in the order of $179,000 excluding GST. The upgraded GPT will have a maintenance frequency of 6 months, and the forebay will have to be de-silted every 10 years. The rest of the wetland do not have to be touched. In this option, the GPT would be maintained the same way as all minor GPTs within the ACT.

Option 7:

Option 7 is to construct a Baramy Vane Trap GPT adjacent to and east of De Burgh Street. The total construction cost would be in the order of $300,000 excluding GST, with a maintenance frequency of 6 months. This option is, however, not preferred, due to LDA planning to develop the block adjacent to the proposed GPT between De Burgh Street and Northbourne Avenue. This options also clashes with an existing wastewater line.

TaMS decided at the workshop to go with both, upgrading the existing Lyneham Wetland GPT (Option 5), and to have a new Baramy Vane Trap GPT immediately west of De Burgh Street. See the Concept Design Plan within **Appendix N** for the proposed new GPT layout and location.

Subsequent to the workshop, the ACT Government confirmed that preparing the concept design and associated cost estimates (design cost and construction cost) for the new Baramy Vane Trap GPT would form part of the scope of this study.

The Baramy Vane Trap GPT is a proprietary product, and was selected by TaMS due to the GPT being easy to access and maintain. The Baramy Vane Trap GPT has a concrete ramp into the containment bay. This GPT also does not require a drying pad, as other GPTs do, due to the containment bay being able to drain dry. Currently, there is no similar product available in the market in Australia.

The Vane Trap GPT uses strategically placed vertical vanes, placed at varying heights and angles, to guide the pollutants into the containment bay. It uses the available energy in the water flow to transport the Gross Pollutants into the containment bays where is can drain dry.

Baramy's estimated detailed design and civil construction cost for this GPT is $300,000.00 excluding GST. Detailed design and construction to be carried out by Baramy. Baramy's quote to undertake the detailed design is within **Appendix N.** This fee is included in the $300,000.00 excluding GST estimate provided above.

The quote to undertake the detailed design exclude:

- Public Consultation,
- Obtaining Approvals,
- Detailed survey,
- Potholing of services,
- Design of any service relocations, and
- Landscape design

Cost estimates for the exclusions listed above, can be provided upon agreement of the concept design by all parties involved with the new Baramy Vane Trap GPT.

Upon completion of the detailed design, Baramy can provide a firm quote for the construction of the GPT. This will exclude Superintendent's cost.

17 INITIAL OPINION OF COSTS

A summary of the opinion of costs for each of the flood mitigation options within the study area are presented in Section 17.1 to 17.3.

The costs in this section exclude the additional project costs associated with:

- Shared Services Procurement (SSP),
- Insurance,
- Obtaining Approvals,
- Environmental Assessments,
- Consultation,
- Preparation of the Capital Works Documentation, etc.

17.1 FLOOD MITIGATION ALONG DICKSON CHANNEL (CONCRETE CHANNEL)

The construction cost in Table 17-1 includes the following:

- The construction cost associated with constructing the proposed levees at the Cowper Street Bridge and De Burgh Street Bridge,
- The construction cost associated with constructing the proposed retardation basin at Dickson Playing Fields, and
- The landscape works for the proposed levees and retardation basin.

Table 17-1: Cost estimate for construction works required for the levees and retardation basin along Dickson Channel to alleviate flooding.

Construction (including GST)		
No	Description	Amount (GST Inclusive)
0	Preliminaries	[redacted]
1	Provision For Traffic	[redacted]
2	Earthworks	[redacted]
3	Underground Services	[redacted]
8	Incidental Works	[redacted]
9	Landscape	[redacted]
	SUB-TOTAL	[redacted]
	CONTINGENCY [redacted]	[redacted]
	Total	**$1,706,954**

Table 17-2: Cost estimate for consultancy services required for the levees and retardation basin along Dickson Channel to alleviate flooding.

Consultancy (including GST)		
No	Description	Amount (GST Inclusive)
0	Detailed design / documentation	[redacted]
1	Superintendent	[redacted]
2	Clerk of Works [redacted])	[redacted]
	Total	**$270,000**

17.2 FLOOD MITIGATION ON NORTHBOURNE AVENUE SOUTH OF ANTILL STREET

The construction cost in Table 17-3 include:

- The construction cost associated with upsizing the 1350mm stormwater pipe between Northbourne Avenue and Goodwin Street to a 1650mm stormwater pipe, and duplicating the 1350mm stormwater pipe between Goodwin Street and Cravens Creek, and
- Dryland grassing.

Table 17-3: Cost estimate for construction works required for upgrading the 1350mm diameter stormwater pipe between Northbourne Avenue and Sullivans Creek

Construction (including GST)		
No	Description	Amount (GST Inclusive)
0	Preliminaries	[redacted]
1	Provision For Traffic	[redacted]
2	Earthworks	[redacted]
3	Underground Services	[redacted]
4	Flexible Pavement Construction	[redacted]
6	Concrete Kerbs, Footpaths & Minor Works	[redacted]
9	Landscape	[redacted]
	SUB-TOTAL	[redacted]
	CONTINGENCY [redacted]	[redacted]
	Total	**$1,910,056**

Table 17-4: Cost estimate for consultancy services required for upgrading the 1350mm diameter stormwater pipe between Northbourne Avenue and Sullivans Creek

Consultancy (including GST)		
No	Description	Amount (GST Inclusive)
0	Detailed design / documentation	[redacted]
1	Superintendent	[redacted]
2	Clerk of Works [redacted]	[redacted]
	Total	[redacted]

17.3 PROPOSED NATURALISATION OF DICKSON CHANNEL BETWEEN DICKSON WETLAND AND DE BURGH STREET

The construction cost in Table 17-5 includes the following:

- The construction cost associated with converting the concrete channel to a naturalised channel,
- The construction cost associated with constructing the proposed levees at the Cowper Street Bridge and De Burgh Street Bridge,
- The construction cost associated with constructing the proposed retardation basin at Dickson Playing Fields, and
- The restorative landscape works as per Redbox Landscape Restorative Works Sketch Plan 02.

Table 17-5: Cost estimate for construction works required for naturalising the Dickson Channel, levees and retardation basin required to alleviate flooding.

Construction (including GST)		
No	Description	Amount (GST Inclusive)
0	Preliminaries	[redacted]
1	Provision For Traffic	[redacted]
2	Earthworks	[redacted]
3	Underground Services	[redacted]
4	Flexible Pavement Construction	[redacted]
8	Incidental Works	[redacted]
9	Landscape	[redacted]
11	Pavement Marking	[redacted]
	SUB-TOTAL	$6,623,848

Construction (including GST)		
	CONTINGENCY [redacted]	[redacted]
	Total	**$8,611,003**

Table 17-6: Cost estimate for consultancy services required for naturalising the Dickson Channel, levees and retardation basin required to alleviate flooding.

Construction (including GST)		
No	Description	Amount (GST Inclusive)
0	Detailed design / documentation	[redacted]
1	Superintendent	[redacted]
2	Clerk of Works [redacted]	[redacted]
	Total	**$950,000**

18 RISKS

The following have been identified as possible risks during the project lifetime, which need to be considered and managed in order to avoid possible project delays and cost blow outs.

18.1 DURING DETAILED DESIGN

- Integration with CMA design on Northbourne Avenue.
- Integration with the sewer augmentation works adjacent to the Dickson Channel.
- Agreement on design aspects by all stakeholders may drag out timeframes and not allow completion before the 2019 deadline for LDA land sales to receive the federal government bonus.
- Coordination between stakeholders.
- Limited locations for Gross Pollutant Traps for pipe networks that discharge directly to the proposed naturalised channel.
- Vertical accuracy of the LiDAR survey not adequate for detail design.

18.2 DURING CONSTRUCTION

- Relocation of existing services and disruptions to existing customers.
- Services are of an age that could contain asbestos.
- Management of erosion control and plant establishment during construction in a “live” watercourse.
- Possible unknown existing services within the brownfield environment that may clash with design elements, which may cause time delays and unforeseen increase in construction costs.
- Existing decommissioned services may have remained in the ground and may need to be removed as part of naturalising the Dickson Channel.
- Lost time and costs due to above average rainfall.
- Public interruption as this is a main cycle route.

18.3 MAINTENANCE AND PUBLIC ACCESS

- Increased maintenance along the Dickson Channel corridor due to the proposed naturalised channel. Naturalised channel will have to be regularly maintained to ensure an acceptable 1% AEP flood level.
- The top edge of a naturalised channel will not be as clearly defined as with a concrete channel, it is recommended that appropriate signage be included as part of the detailed design to warn the public that they are approaching a flood way.

19 MATTERS TO BE FURTHER CONSIDERED

The following need to be considered at the next stage of design:

- Detailed surveying and potholing of existing services and site constraints.
- Increasing the hydraulic efficiency of the bridge inlets and outlets on De Burgh Street and Cowper Street.
- Refining the proposed retardation basin design.
- Levee designs to include overland flow connectivity from any local and upstream catchments.

20 RECOMMENDATIONS

The recommended option to alleviate the flooding along Dickson Channel is the proposed retardation basin on the Dickson playing fields and the levees at Cowper Street Bridge and De Burgh Street Bridge, as discussed in Section 8.2. We do note again that these options combined, alleviates the flooding along the Dickson Channel. Levees alone will not alleviate the flooding.

The feasibility of naturalising the Dickson Channel has been investigated at a high level. It was found that for the proposed naturalised channel characteristics as discussed in Section 10, naturalising the Dickson Channel would be a viable option for the longer term.

The recommended option to alleviate the flooding on Northbourne Avenue, just south of Antill Street, is to upsize and duplicate the existing 1350mm stormwater pipe between Northbourne Avenue and Sullivans Creek. This option is discussed in Section 9.1.

An online pond adjacent to the Ambulance Station has been investigated. It was found that a pond in this location would have no retardation and very limited water quality functions. Therefore, offering no improvement to stormwater flows downstream. This pond would require considerable commitment to land area, thereby restricting development potential of adjacent sites.

Seven (7) Gross Pollutant Trap (GPT) options, between the Dickson Group Centre and Lyneham Wetland, have been investigated. A workshop with CMTEDD and TaMS was held on 14 January 2016. TaMS decided at the workshop to go with both, upgrading the existing Lyneham Wetland GPT (Option 5), and to have a new Baramy Vane Trap GPT immediately west of De Burgh Street. See the Concept Design Plan within Appendix N for the proposed new GPT layout and location.