alluvium

DRAINAGE REVIEW:

Berwick Health and Education Precinct

for

Victorian Planning Authority

April 2017

Document history

Revision:

Revision no.	03
Author/s	Jonathon McLean
Approved	Jonathon McLean

Distribution:

Revision no.	03
Issue date	4 April 2017
Issued to	Belinda Smith (VPA)

Revision no.	02
Issue date	23 March 2017
Issued to	Belinda Smith (VPA)

Revision no.	01
Issue date	3 February 2017
Issued to	Belinda Smith (VPA)

Contact:

Name	Alluvium Consulting Pty Ltd
Contact person	Jonathon McLean
Ph.	0448 266 485
Email	Jonathon.mclean@alluvium.com.au
Address	105-115 Dover Street, Cremorne Victoria 3121

Ref: R:\Projects\2017\005_Berwick_HEP_drainage_review\1_Deliverables\P117005 drainage review v1.docx

1 Introduction

The Victorian Planning Authority (VPA) are in the process of preparing the “Future Urban Structure Plan” for the region known as the Berwick Health and Education Precinct. The focus area is west of Clyde Road, north of the Princess Freeway and south of the railway line (refer to Figure 1). Two open drainage lines, which service upstream external areas, traverse the site. The northern drainage line is known as the “Berwick Township Main Drain Catchment” and the southern drainage line is known as the “Berwick South Main Drain Catchment”.

The original drainage strategy for the site was prepared by Irwinconsult, which was based on a piped solution for the southern drainage line. The VPA did not consider this approach to be in accordance with its position for sustainable development. Following preliminary discussions with Melbourne Water, VPA agreed to pursue an open waterway solution for the Berwick South Main Drain, by relocating it to the southern boundary of the site to act as a green link and edge to the precinct. By designing the proposed wetland systems / retarding basins to connect to the southern waterway corridor a continuous linear open space network has been provided that will work for walking and cycling connections.

The purpose of the Alluvium engagement was to undertake a review of VPA’s preferred option and advise on how the outcome can be achieved with minimal land take. It is not the Surface Water Management Strategy (SWMS) for the site, which will need to be prepared at a later date to demonstrate (ie through functional design and calculations) the principles in this document.

Various information, documents and previous reports have been collated and relevant information extracted. This information included:

- VPA’s Draft Future Urban Structure Plan
- Irwinconsult Stormwater Drainage and Flood Assessment Report, November 2016
- Melbourne Water supplied RORB model
- Melbourne Water supplied MUSIC model
- VicRoads as-built plans of the Princess Freeway culverts
- VPA’s GIS layers of the Draft Future Urban Structure Plan
- Melbourne Water calculations and plans
- Nearmap aerial imagery

Alluvium’s review did not include the building of new models or major reconfiguration of the existing models. We did some modelling using the Melbourne Water supplied models, which involved making some minor changes / amendments to assess the preferred option, running the model and extracting the relevant information.

Figure 1: Area of focus for the review (shown by red dash line)

2 Key issues

Based upon a review of the background information and briefing from the VPA (Belinda Smith) the key issues are:

- The extent of the northern and southern catchments
- The proposed waterway corridor alignment and configuration
- The drainage line/culvert configuration at Clyde Road and the interface with the future urban layout
- The stormwater quality treatment needs and land budget to meet the best practice pollutant reduction targets
- The retardation basin storage requirements for the site to limit the peak 1 in 100 year ARI developed flows to the existing conditions peak 1 in 100 year ARI flows.

3 Catchments

There are two major external catchments that enter the subject site, as shown in Figure 2. A major flow path enters at the north boundary and another at the eastern boundary.

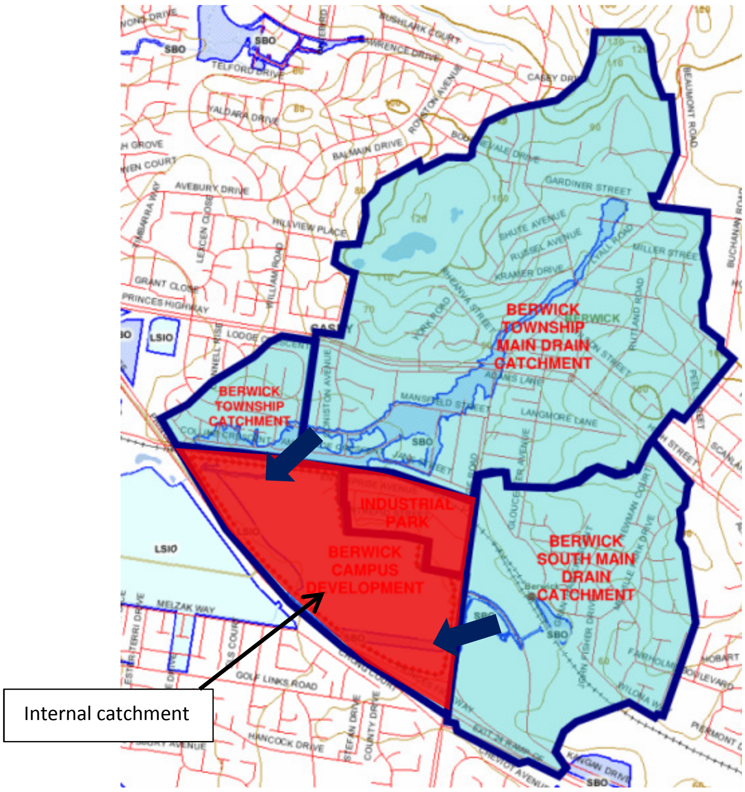


Figure 2: Overall catchments

During the review of the background information from Irwinconsult and Melbourne Water, there appeared to be some inconsistencies with respect to the division of the internal catchment into a northern and southern catchment. A gas transmission easement divides the internal catchment and from discussions with Melbourne Water and the VPA the view is that the gas easement should essentially form the internal catchment boundary to minimise the need for drainage crossings of the gas easement. However the existing Nossal High School provides a constraint on drainage from the east traversing through the school. As a result the northern/southern catchment boundary will be defined by the road on the western side of the Nossal High School (refer to Figure 3).

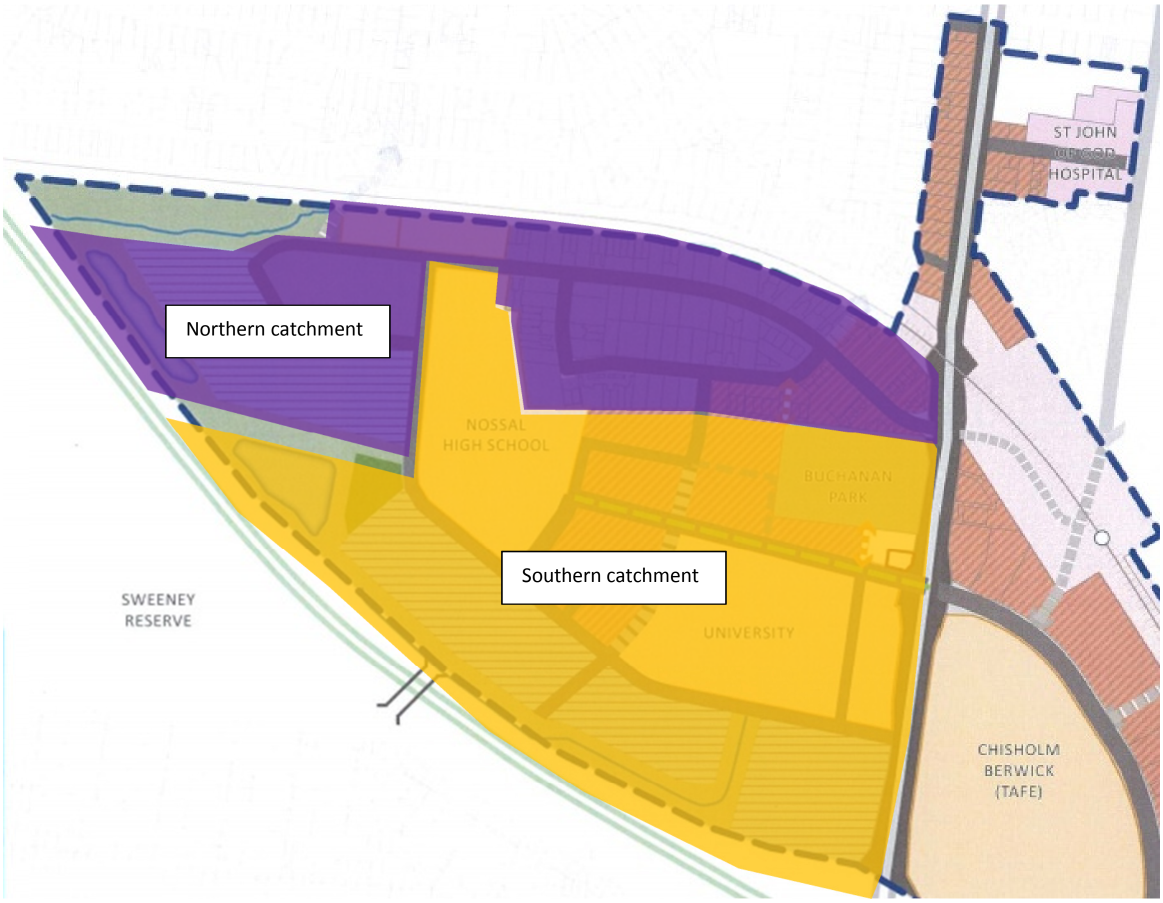


Figure 3: Internal northern catchment and southern catchment

4 Waterway Corridor

Under existing conditions, low flows from the Berwick South Main Drain catchment are conveyed by a 1500mm pipe under Clyde Road. During larger events (eg the 100 year ARI) overland flows in excess of the underground pipe are conveyed overland and are collected in a swale drain on the east side of Clyde Road. These overland flows are then conveyed under Clyde Road by the existing 1500mm diameter culverts. On the downstream side of Clyde Road, the underground drain and culverts discharge to an open channel system. This open channel system flows through the Berwick HEP site. Approximately 450 metres downstream the open channel alignment is located within the VicRoads reservation.

The Irwinconsult proposal was based on "piping" the open channel. However based on their sustainability and liveability objectives, VPA and Melbourne Water have pursued a constructed waterway solution for the Berwick South Main Drain, by relocating it to the southern boundary of the site to act as a green link and edge to the precinct. By connecting the proposed wetland / retarding basins in the north and south and extending the open waterway across the southern section a continuous open space network is created that will also work for walking and cycling connections.

Waterways, whether natural or constructed, need to have an appropriate waterway corridor or reserve provided adjacent to development in order to accommodate objectives for flood protection, river health, biodiversity and amenity.

A waterway corridor is defined as the waterway channel and its associated riparian zones. The riparian zones consist of two parts:

- the vegetated buffer

- the core riparian zone

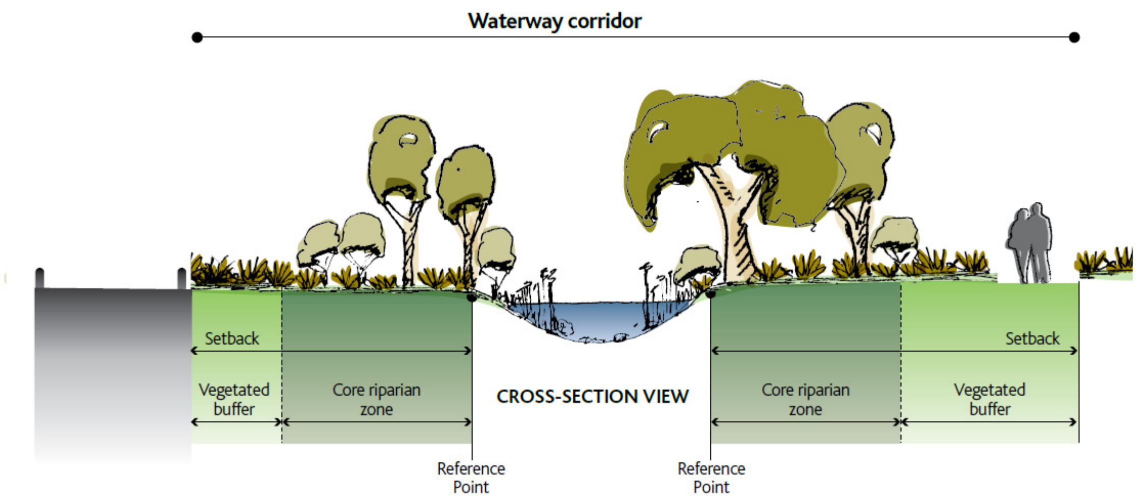


Figure 4. Waterway corridor (Melbourne Water's Waterway Corridor Guidelines)

A fundamental principle is to provide continuity along the core riparian zone, therefore the strong preference is to locate shared paths and other infrastructure outside of the core riparian zone.

Constructed waterway

The constructed waterway needs to be designed to carry the 100 year ARI peak flow (13.3 cumecs) through the waterway corridor, whilst also providing habitat, channel stability and visual amenity.

Based on the preliminary constructed waterway design (see below) by Alluvium, the hydraulic width is 20 metres and therefore the core riparian zone (CRZ) is 25 metres. Based on this design, and assuming active edges (eg roads or open space) on both sides, a minimum 40 metre corridor is required. This is based on the Melbourne Water *Waterway Corridor Guidelines*, which includes a vegetated buffer of 15 metres in total. If there are no active edges on either side, then the guidelines indicate that a corridor width of 50 metres is provided.

The proposed VPA Future Urban Structure Plan generally shows a 40 metre waterway corridor. The exception is in the lower reach where a proposed corridor of 20-25metres is shown, as this is where the existing waterway is located within the VicRoads reserve. Along this portion of the reach the effective waterway corridor width is a combination of the VicRoads and Berwick HEP site.

If the standard waterway corridor width cannot be provided within the Berwick HEP for whatever reason (eg commercial feasibility) it should be noted that Melbourne Water's *corridor guidelines* are just that – guidelines. Whilst it is strongly desirable to meet these requirements, the site specific constraints and issues should be considered and discussed with Melbourne Water. If the alternative is a piped solution, then the trade-off associated with a reduced buffer for a waterway corridor needs to be evaluated against losing all of the river health, ecology, liveability and amenity benefits that a 40 metre waterway corridor could still provide.

Table 3. Sliding scale for calculating constructed waterway corridor widths – assumes active edges (roads) that allow vehicle access along entire corridor length, on both sides of the corridor.

HYDRAULIC WIDTH (M)	CRZ WIDTH (M)	VB WIDTH (M)	CORRIDOR WIDTH (M)
5	20	10	30
10	20	10	30
15	25	15	40
20	25	15	40
25	30	15	45
30	30	15	45
35	30	15	45
40	30	20	50
45	35	20	55
50	35	20	55
55	40	20	60
60	40	20	60
65	40	25	65
70	45	25	70

Table 4. Sliding scale for calculating constructed waterway corridor widths – addition of shared trail/maintenance track either side of channel (within vegetated buffer)

HYDRAULIC WIDTH (M)	CRZ WIDTH (M)	VB WIDTH (M)	CORRIDOR WIDTH (M)
5	20	20	40
10	20	20	40
15	20	25	45
20	25	25	50
25	30	25	55
30	30	25	55
35	30	25	55
40	35	25	60
45	35	25	60
50	35	25	60
55	40	25	65
60	40	25	65
65	40	25	65
70	45	25	70

Figure 5. *Constructed Waterway corridor requirements (Melbourne Water's Waterway Corridor Guidelines)*

Waterway design

VPA's proposal is to commence the waterway corridor about 200 metres downstream of Clyde Road. This is in response to the urban form and commercial need to have frontage along Clyde Road. Alluvium has assessed the hydraulic function of this arrangement. Based on the supplied RORB model, the peak 1 in 100 year ARI flow is 13 cumecs. To achieve the proposed VPA layout, an extension of the culverts/pipes under Clyde Road will be required. It is estimated that this can be achieved via twin 1650mm pipes. A transition structure is likely to be required immediately west of Clyde Road, at the junction of the existing culverts/pipes and the proposed new pipe extension.

The constructed waterway was assessed with respect to the Melbourne Water Draft Constructed Waterway Guidelines. Preliminary HEC-RAS modelling has been used to design the waterway and model the major flows through the waterways to determine flow depths.

The alignment of the constructed waterway generally follows the waterway corridor as shown on the Future Urban Structure Plan. The plan should be amended to show the constructed waterway corridor commencing at the boundary of the east-west collector road (see Figure 6).

Figure 6. *Waterway corridor alignment and culvert extension*

From the Clyde Road invert level to the open drain upstream of the existing Princess Freeway drop structure, there is an existing fall of 7 metres over 850 metres, creating an average grade of 1V: 120H. However in order to provide a stable waterway bed grade (based on shear stress thresholds), a longitudinal bed slope in the order of 1 in 150 is needed. As a result it is likely that a minimum of two small grade control structures/chutes, each with a drop of around 1 metre, will be required along the constructed waterway to manage the overall fall across the waterway length. These grade control structure could take the form of a "pool and riffle".

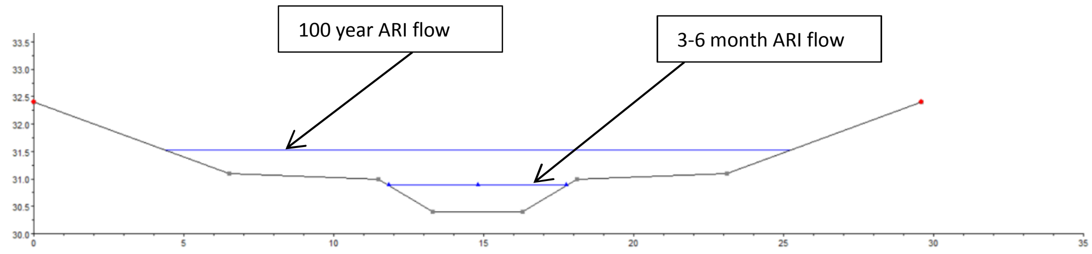


Figure 7 *Typical-section for the constructed waterway*

The low flow meandering channel is 0.6 m deep, with a base of 3 metres and slopes of 1 (V) : 3 (H). The low flow channel is to meander across the 13 metre base. It has a capacity of around 2 m^3/s, which is approximately a 3- 6 month ARI design flow. The high flow channel has the capacity of the 100 year ARI event (ie 13 cumecs).

In order to convey these flows and remain within the waterway corridor, a typical cross-section depicted in Figure 7 will be used.

The shear stress within the waterway corridor does not exceed 45 N/m^2 – the shear resistance of short native grass (Draft Constructed Waterway Manual Part B2). This is a conservative value, and with vegetation establishment, the channel could be designed to tolerate greater shear stresses.

The maximum depth of flow in the constructed waterway for the 100 year ARI event is 1.12 metres. The minimum proposed overall depth of the constructed waterway from natural surface is 2.0 metres, therefore 600mm of freeboard to development will be easily achieved.

The road network west of Clyde Rod will only need to accommodate the overland flows from the local catchment, until it can outfall into the waterway corridor or one of the drainage reserves. The maximum contributing catchment is likely to be less than 18 hectares and the resultant 1 in 100 year "gap" flows should easily be catered for in a 20 metre road reserve. The overland flows within the road reserves will be designed to meet Melbourne Water and Council's flood safety requirements. Refer to Appendix A for the indicative overland flow path layout plan.

Waterway corridor:

- ✓ Twin 1650mm culvert extensions downstream of Clyde Road for 200 metres
- ✓ Flow/flooding
  - ✓ Q100 flows contained within waterway corridor
  - ✓ All subdivisional pipe drainage (apart from a 3.3ha in the south east corner) west of Clyde Road will be contained within road reserves and easements and discharge to the stormwater treatment assets. That is low flows do not discharge directly to the waterway corridor.
  - ✓ Development parcels can be graded to allow the major drainage system (high flow events) to convey overland flows to the waterway corridor.
  - ✓ Road reserves only need to accommodate overland flows from the local catchment and therefore have sufficient capacity
  - ✓ 600 mm freeboard to lots

Waterway corridor (cont...):

- ✓ Design a constructed waterway to convey flows through the study area
  - ✓ Compound channel (waterway corridor 40 metres)
    - ▪ High-flow channel capacity: Q100 year (20m width)
    - ▪ Low flow meander channel: 3-6month
  - ✓ Shear stress less than 45 N/ms
  - ✓ Batter slopes no steeper than 1:5
  - ✓ Access Paths provided

5 Clyde Road Culvert Crossing

Based on the supplied RORB model, the peak 1 in 100 year ARI flow is 13 cumecs along the Berwick South Main Drain catchment. Under existing conditions, low flows from the Berwick South Main Drain catchment are conveyed by a 1500mm pipe under Clyde Road. During larger events (eg the 100 year ARI) overland flows in excess of the underground pipe are conveyed overland and are collected in a swale drain on the east side of Clyde Road. These overland flows are then conveyed under Clyde Road by 1500mm diameter culverts. On the downstream side of Clyde Road, the underground drain and culverts discharge to an open channel system (see Figure 8).

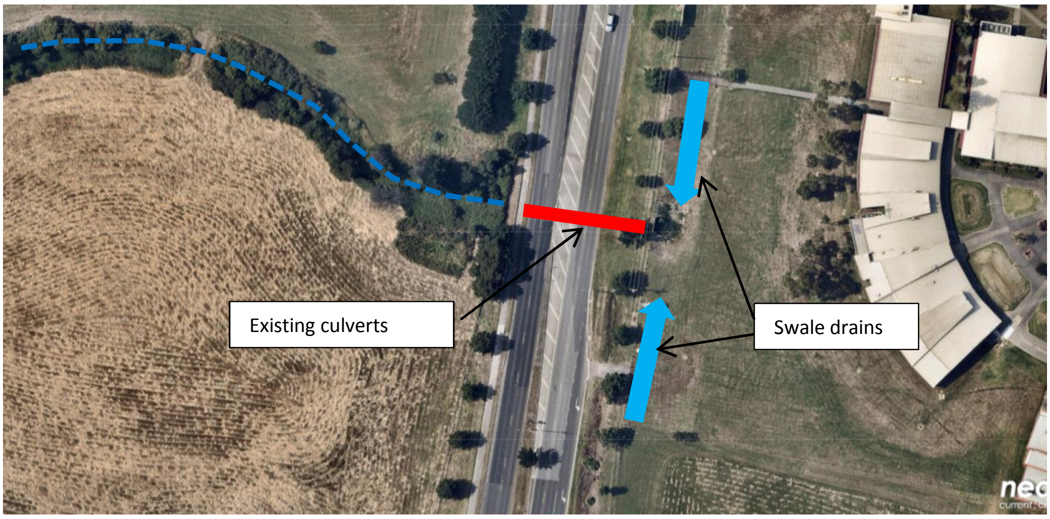


Figure 8 *Existing conditions*

VPA's proposal is to commence the waterway corridor about 200 metres downstream of Clyde Road. This is in response to the urban form and commercial need to have frontage along Clyde Road. Alluvium has assessed the hydraulic function of this arrangement.

To achieve the proposed VPA layout, an extension of the culverts/pipes under Clyde Road will be required. It is estimated that this can be achieved via twin 1650mm pipes. A transition structure (ie a concrete "makeup" section to connect the existing culverts to the proposed pipes) is likely to be required immediately west of Clyde Road, at the junction of the existing culverts/pipes and the proposed new pipe extension. The key issue is that the existing Clyde Road culvert crossing does not align with the future east-west road link. The VPA proposal is to have commercial development situated at the existing open drain alignment. There are two potential options to overcome this issue:

Option 1:

Due to the size and hydraulic operation of the 100 year ARI culverts/pipes, it is not appropriate to have two right angle bends in the pipe in order to follow the proposed alignments. The east-west road will need to have an extended splay on the south side of the road reserve to accommodate the curve and bend in the pipe system. The minimum radius for the curve in the pipe would be about 14 metres. The future SWMS to be prepared for the site will provide the functional details of the road reserve and splay layout to accommodate the necessary curved pipe radius for the 1 in 100 year ARI pipes. This will include the functional hydraulic design of the pipe, which incorporates an allowance for losses (eg bends).

Whilst the culvert/pipe would be designed to carry the 100 year ARI design flows, it is good floodplain management practice to provide an auxillary overland flow path. This auxillary flow path could be provide by the proposed east-west road. The current crown of Clyde Road at the low point appears to be relatively broad (approx RL 39.5m – this needs to be confirmed by survey). Therefore the proposed commercial development should be filled a minimum of 600mm above the Clyde Road crown at the east-west intersection to enable any auxillary overland flows to “funnel” down the east-west road.

From a safety perspective, it is likely that the inlet on the existing culverts may need to prevent public access through the use of a grill or cage type structure.

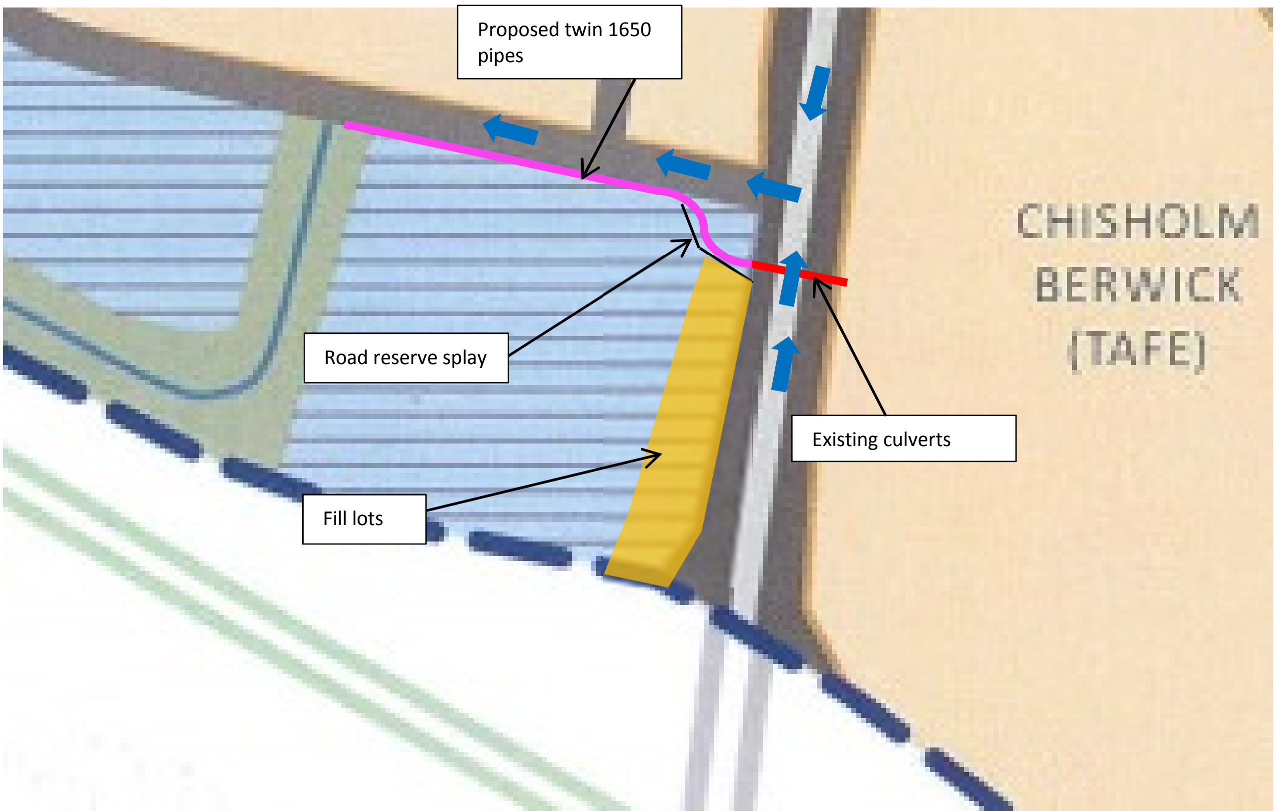


Figure 9 *Option 1 – culvert extension*

Option 2:

Abandon the existing culvert crossing of Clyde Road and re-construct the 100 year culvert crossing further north (at the proposed east-west road location) as part of the future intersection works.

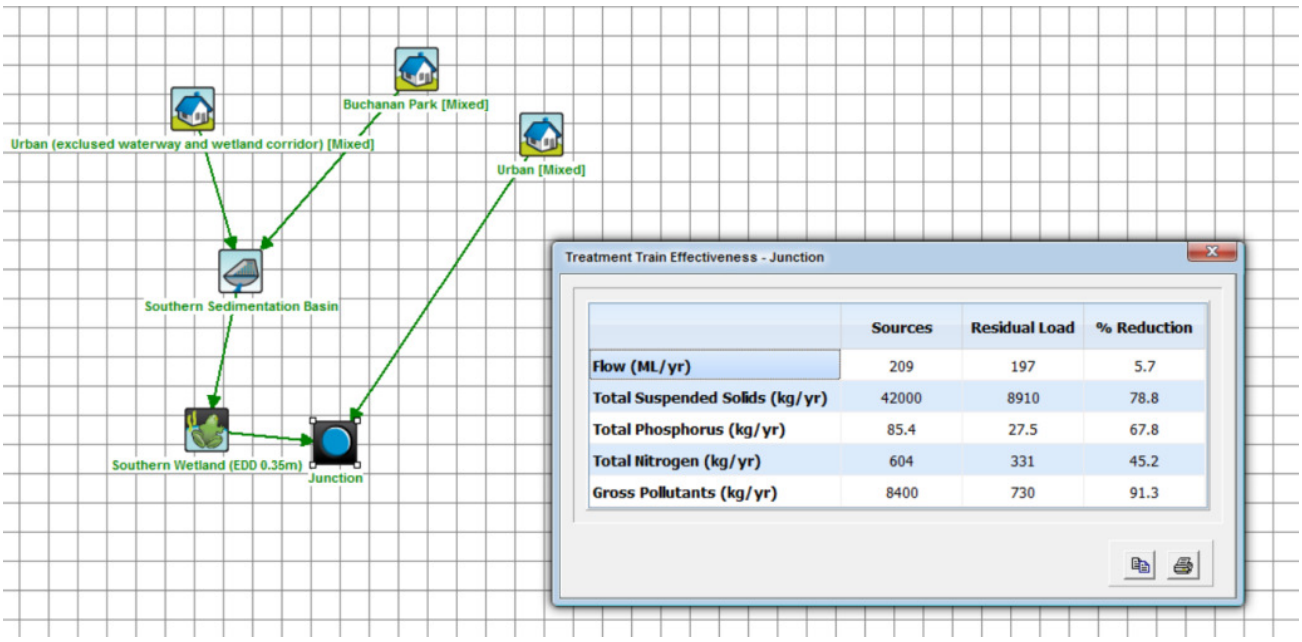
This option would need to consider any existing services in Clyde Road that may need to be avoided. The existing swale drains on the east of Clyde Road would need to be re-graded to fall to a new low point at the proposed culvert relocation.

6 Stormwater quality treatment

The criteria is to provide stormwater treatment to meet the best practice pollutant reduction targets for all of the catchment area west of Clyde Road. Alluvium has established MUSIC models to determine the stomwater treatment requirements.

<u>Southern Catchment</u>

- Catchment area to be treated is 37.7ha
- There is 3.1 ha of catchment in the south east corner that is isolated by the waterway corridor. This area will discharge directly to the waterway corridor. As a result this equivalent pollutant load will need to be offset as part of the wetland sizing. The balance of the urban area should discharge stormwater to the wetland/retarding basin
- The required wetland treatment area is as follows:
  - Sediment pond of 600m2
  - Wetland of 9200m2
  - Therefore total treatment area of 9800m2.
  - Normal water level 27.5m



	Sources	Residual Load	% Reduction
Flow (ML/yr)	209	197	5.7
Total Suspended Solids (kg/yr)	42000	8910	78.8
Total Phosphorus (kg/yr)	85.4	27.5	67.8
Total Nitrogen (kg/yr)	604	331	45.2
Gross Pollutants (kg/yr)	8400	730	91.3

Figure 10 *MUSIC model – southern catchment*

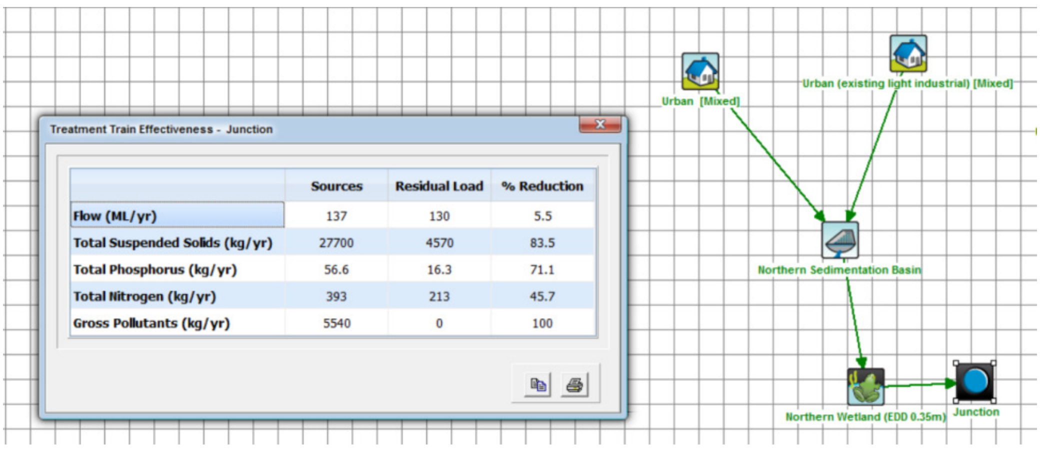
A concept layout (refer to Figure 11) has been prepared which shows that the wetland can fit within the nominated drainage reserve as shown on the Future Urban Structure Plan. The footprint required is 2.35ha.

The batter slopes have been designed at 1 in 6 around the asset. Also a 4m wide access track was designed around the asset to provide required accessibility for maintenance works. For the wetland, the length is more than four times the average width. Provision for sediment dewatering has also been made.

Figure 11 *Southern wetland layout*

<u>Northern Catchment</u>

- The existing Enterprise Avenue area does not have existing stormwater treatment to remove suspended solids and nutrients. As a result the treatment area required for the northern catchment area has been upsized to accommodate this treatment.
- Catchment area to be treated is 23.5ha
- The required wetland treatment area is as follows:
    - Sediment pond of 450m2
    - Wetland of 5700m2
    - Therefore total treatment area of 6150m2.
    - Normal water level 27.8m



	Sources	Residual Load	% Reduction
Flow (ML/yr)	137	130	5.5
Total Suspended Solids (kg/yr)	27700	4570	83.5
Total Phosphorus (kg/yr)	56.6	16.3	71.1
Total Nitrogen (kg/yr)	393	213	45.7
Gross Pollutants (kg/yr)	5540	0	100

Figure 12 *MUSIC model – northern catchment*

The batter slopes have been designed at 1 in 6 around the asset. Also a 4m wide access track was designed around the asset to provide required accessibility for maintenance works. For the wetland, the length is more than four times the average width. Provision for sediment dewatering has also been made.

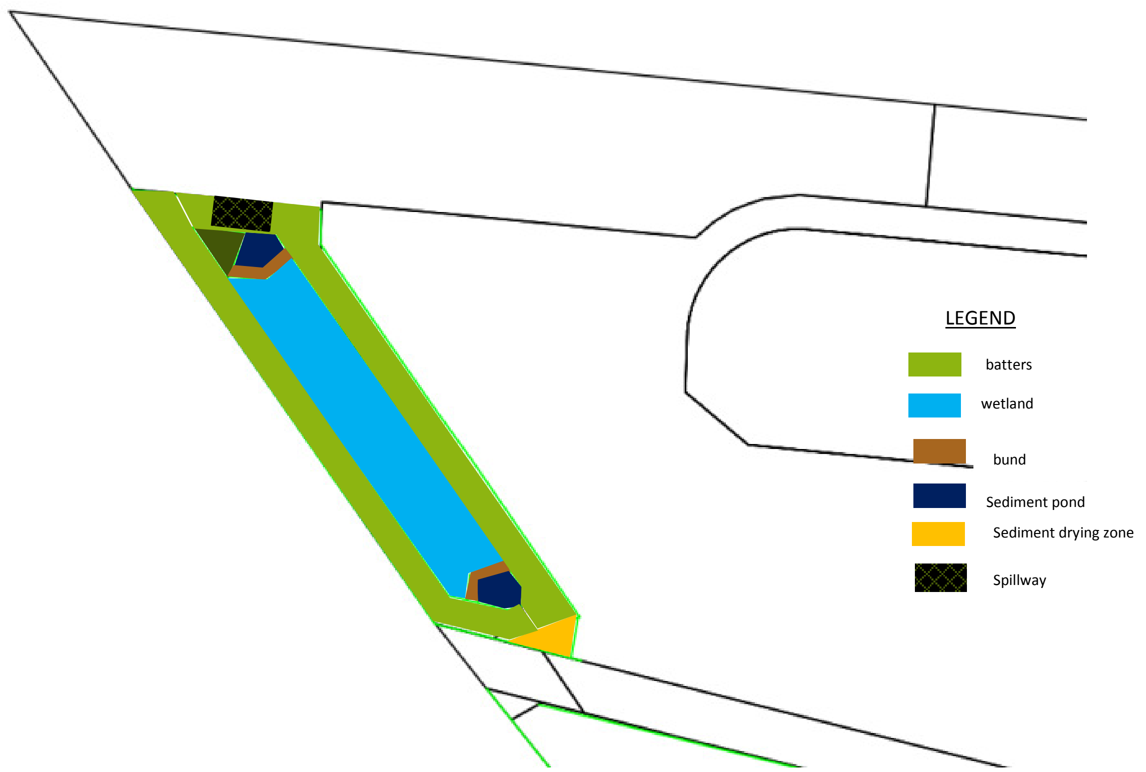


Figure 13 *Northern wetland layout*

7 Retardation requirements

The northern and southern wetlands also need to play a role as part of the retardation requirements for the site. Based on the RORB modelling undertaken by Melbourne Water, the drainage reserves identified for the northern and southern wetlands can accommodate the required storage volumes.

8 Interim works

The ability exists to implement the drainage strategy in a staged approach if required. For example the initial phase of development could be undertaken with interim stormwater quantity and quality works.

Depending upon the staging of development, outfall drains from the stage should be directed to either the northern or southern drainage reserves. An interim sediment pond could be constructed within the envelope of the ultimate wetland system. With this approach earthworks are not wasted on temporary arrangements as the initial volume of excavation is simply “brought forward” from a timing perspective. The interim sediment pond should be sized to provide temporary water quality control (ie capture 95% of coarse particles ≥ 125 µm diameter for the peak three month ARI).

For a stormwater quantity perspective the same principle applies (ie undertake interim works within the ultimate envelope). A hydrologic/modelling analysis should be undertaken to determine the required interim storage requirements based upon the staged area of development.

Appendix A

Indicative overland flow path layout


BERWICK VILLAGE
ST JOHN OF GOD HOSPITAL
BERWICK STATION
CASEY HOSPITAL
ST JOHN OF GOD HOSPITAL
CHISHOLM BERWICK (TAFE)
BUCHANAN PARK
UNIVERSITY
NOSSAL HIGH SCHOOL
SWEENEY RESERVE
LEGEND
Overland Flow path