Joseph Road Precinct
Development Contributions Plan

Attachment 3

Joseph Road Precinct Preferred WSUD
Concepts by Alluvium Consulting
(May 2017)

Memo

Subject	Joseph Road Precinct Preferred WSUD Concepts
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1 Introduction

Maribyrnong City Council (council) engaged Alluvium to investigate the concept design of a stormwater treatment asset to treat flows from the redeveloped Joseph Road precinct in Footscray. The Joseph Road precinct will accommodate 3000 additional residents over the next 10 years. Redevelopment of the site must consider effects on stormwater quality and quantity with the aim of protecting the downstream environment in the Maribyrnong River.

This project investigated **three preliminary options** for stormwater quality treatment, followed by the development of **two preferred options** at a concept design level.

The three preliminary concept options investigated were:

1. Option 1: A bioretention system within Council owned land
2. Option 2: A wetland system (with sediment basin) requiring acquisition of privately owned land, and reconfiguration of the existing open drain into a vegetated swale
3. Option 3: A bioretention system with pre-treatment sediment basin requiring acquisition of privately owned land, and reconfiguration of the existing open drain into a vegetated swale

Based on Council feedback, Option 3 and a variant of Option 1 (Option 1b) were refined to a full concept design level providing Council with an option of a WSUD asset wholly located within Council owned land, and an option of a WSUD asset located within private land and partly within Council owned land.

2 Site context

The Joseph Road site encompasses approximately 15 hectares of previously industrial land bounded by the Maribyrnong River to the east, the Regional Rail Link corridor to the north and west, and Hopkins Road to the south (Figure 1).

The existing terrain around the Joseph Road site slopes towards the Maribyrnong River. The current drainage network splits runoff from the site to two outfalls on the Maribyrnong River. The northern outfall and network collects the majority of runoff and enters the river via a brick lined open drain (catchment area of 4.8 ha).

The open space in proximity of the outfall is the intended location for the stormwater quality treatment asset. Figure 2 shows the catchment area and drainage network upstream of the proposed treatment asset site.

This space is split between council owned land closer to the river and privately land northward (Figure 1). It has been assumed that Council acquisition of the private land portion is a possibility, and this has been considered into the stormwater quality treatment options developed (see section 4).

Figure 1. *Site context*

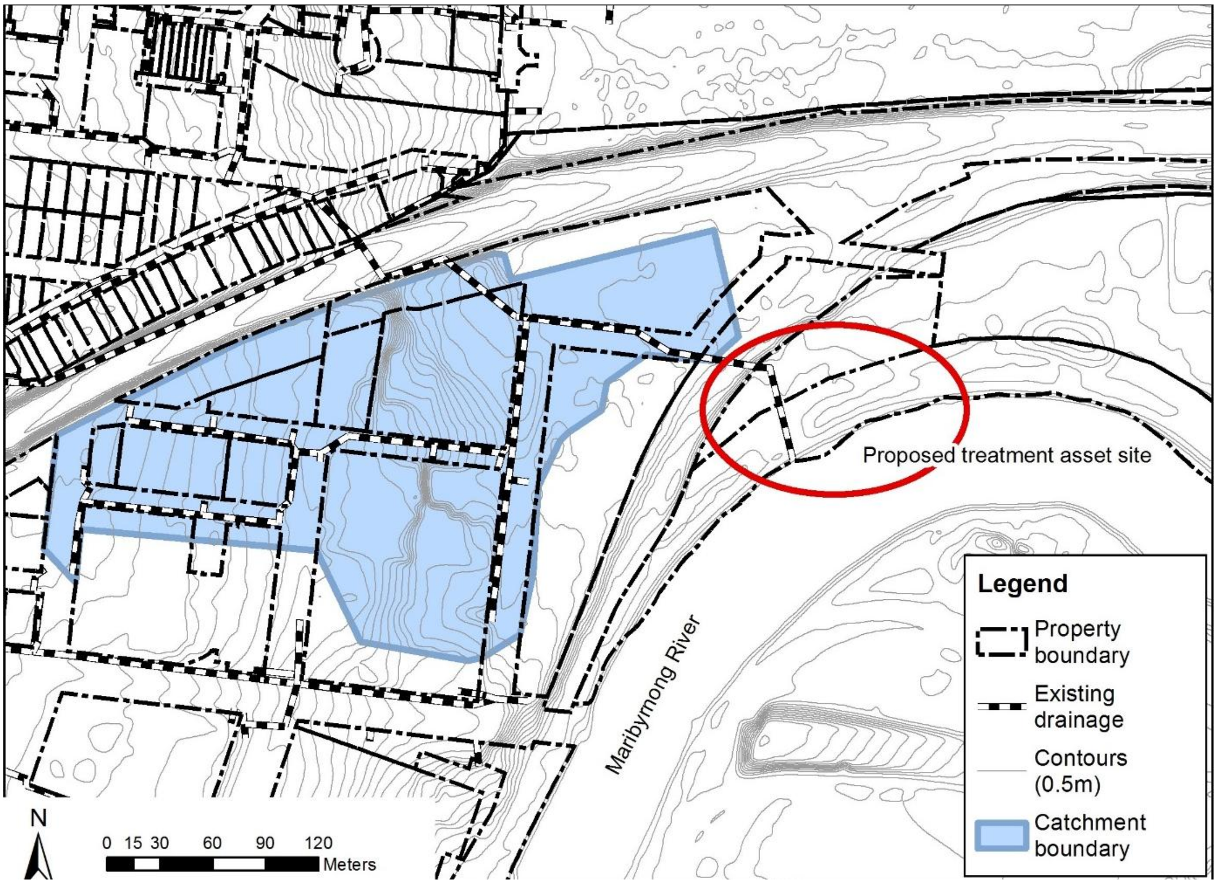


Figure 2 *Drainage catchment plan*

3 Asset type considered

The following asset types were considered in developing the preliminary concept options.

3.1 Wetland

Constructed wetland systems use enhanced sedimentation, fine filtration and biological uptake processes to remove pollutants from stormwater. They generally consist of:

- An inlet zone (such as a sediment basin)
- A macrophyte zone (a shallow heavily vegetated area to remove fine particulates and take up soluble pollutants), and
- A high-flow bypass pipe or channel (to protect the macrophyte zone).

Wetland systems can incorporate open water areas. In addition to playing an important role in stormwater treatment, wetlands can also have significant community benefits. They provide habitat for wildlife and a focus for recreation, including walking paths and resting areas. They can also improve the aesthetics of new developments and can be a central landscape feature. An example of an Alluvium designed constructed wetland is shown in Figure 3.

Figure 3 *Alluvium/Rakali designed wetland recently constructed in 2016*

3.2 Bioretention system

Bioretention systems treat stormwater by infiltrating it through a vegetated sand filter media (Figure 4). Bioretention systems are particularly efficient at removing nutrients and can achieve treatment performance over a small footprint compared to wetlands. The main components of the bioretention system include:

- A filter media layer
- Vegetation that uptakes nutrients in stormwater
- A transition layer (of sand or geotextile) that prevents the filtration media being washed away, and
- Perforated pipes to transfer treated stormwater downstream.

Figure 4. *Bioretention system examples*

3.3 Swale

A swale is a vegetated open channel, designed to convey flows and provide limited treatment of stormwater. Swales can be easily integrated into the surrounding landscape and provide additional amenity benefits over a traditional open drain. Swales typically occupy a larger footprint than a concrete drain to convey a given flow rate owing to higher surface roughness.

4 Preliminary concept designs

Three preliminary WSUD options were proposed to Council on 27th March 2017.

4.1 Option 1 – Bioretention system within council owned land

Option 1 consists of a bioretention system with a coarse sediment forebay (see Appendix B for concept plans). Table 1 outlines the key design parameters.

The 3-month ARI flows is diverted into the system for treatment from the proposed pit SEP21 with higher flows bypassing to the existing open drain. Treated flow re-joins the open drain before the outfall into the Maribyrnong River.

This option is constrained by the existing tree line to the south and the property boundary to the north. The existing site levels require a small section of mounding to maintain necessary pipe cover. Alternatively, a surcharge inlet could be used to avoid a fill mound. This arrangement will result in a submerged inlet pipe over approximately half its length.

Table 1 Option 1 key design parameters

Parameter	Figure
Treatment area/filter surface a (m^2)	150
NWL (m AHD)	RL 0.9
EDD (m)	0.35
TED (m AHD)	RL 1.25
Total footprint including batters (m^2)	490
Batter	1 in 5
Filter media depth	0.5 m
Transition layer and drainage layer	0.5 m

4.2 Option 2 – Wetland (with sediment basin) requiring acquisition of private land

Option 2 assumes Council acquisition of the privately owned land. This opens the opportunity for a constructed wetland system (refer to appendix B for concept plan). Table 2 outlines the key design parameters.

This option will include a sediment basin and macrophyte zone area for stormwater treatment, with the existing open drain replaced by a vegetated swale. Flows up to the 3-month event are diverted into the system for treatment from the proposed pit SEP21 with higher flows bypassing the wetland. Treated flow re-joins the proposed swale before the outfall into the Maribyrnong River. Due to the downstream tailwater levels it must be noted that this outlet arrangement will require the sediment basin to be drained using pumps during maintenance clean outs (every 3-5 years).

Reconfiguration of the open drain into a swale provides a more integrated visual drainage. The wetland provides improved amenity over a larger footprint compared to the bioretention system options. However, the larger wetland footprint also takes up valuable open space for public use (assuming Council acquires the land in the first place).

Table 2 Option 2 key design parameters

Parameter	Figure
Sediment basin NWL area (m^2)	200
Treatment area at NWL (m^2)	870
NWL (m AHD)	RL 0.9
EDD (m)	0.35
TED (m AHD)	RL 1.25
Total footprint inc. batters (m^2)	2420
Batter	1 in 6
Swale length (m)	41
Swale top width (m)	6.5
Swale capacity (m^3/s)	2.0

4.3 Option 3 – Bioretention system and pre-treatment sediment basin requiring acquisition of private land

Option 3 assumes Council acquisition of the privately owned land to fit a larger asset and in turn improve treatment performance (compared to option 1). Acquisition of the private parcel also enables the opportunity to include a sediment basin to the bioretention system, which both serves to provide an interim stormwater quality asset during construction phase of the precinct and improve the overall treatment performance of the system enabling best practice targets to be achieved for TSS, TN and TP (Refer to appendix A for concept plan). Table 3 outlines the key design parameters.

Option 3 uses a bioretention system as the main treatment asset to the west side of the existing open drain and retains the swale design from option 2. Option 3 requires a smaller total footprint compared to Option 2, and achieves a higher level of water quality treatment (Total Nitrogen removal).

Table 3 Option 3 key design parameters

Parameter	Figure
Sediment basin NWL area (m^2)	200
Treatment area at filter surface (m^2)	100
NWL (m AHD)	0.9
EDD (m)	0.35
TED (m)	1.25
Total footprint inc. batters (m^2)	490
Batter	1 in 5
Filter media depth	0.5 m
Transition layer and drainage layer	0.5 m

4.4 Water quality modelling

The performance of the different options was modelled in MUSIC (v6.2) and results are outlined in Table 4.

Table 4 Treatment train performance for concept options

Pollutant	Sources	Percentage removed		
		Option 1	Option 2	Option 3
Flow (ML/yr)	19.3			
Total Suspended Solids (kg/yr)	3880	72 %	70.5 %	82.7 %
Total Phosphorus (kg/yr)	7.96	35.9 %	59.5 %	44.1 %
Total Nitrogen (kg/yr)	55.8	39.6 %	39.1 %	48 %
Gross Pollutants (kg/yr)	745	100 %	100 %	100 %

Table 5 BPEM requirements for treating urban pollutant loads

Pollutant	Target
Total suspended solids	80% retention (or removal) of the typical urban load
Total phosphorus	45% retention of the typical urban load
Total nitrogen	45% retention of the typical urban load
Litter	70% retention of the typical urban load
Flows	Maintain discharges for the 1-in-1.5 year ARI at pre-development

4.5 Preliminary high level cost estimate

A preliminary estimate of total construction and maintenance costs for the concept options has been prepared based on high level rates in the Melbourne Water WSUD Life cycle costing data guidelines (Table 6 and

Table 7). These are high-level cost estimates and are intended to be used as a reference guide when comparing options. More accurate cost estimate have been developed for the preferred options.

Table 6 Unit cost rates for construction and maintenance

	Wetland	Sediment basin	Swale	Bioretention system
Construction cost ($/m^2)	100	200	60	350
Maintenance cost ($/m^2/yr)	2	10	3	5

Table 7 Construction and maintenance cost estimate for concept options

Concept	Wetland area (m^2)	Sediment basin area (m^2)	Bioretention area (m^2)	Swale area (m^2)	Construction cost ($)	Maintenance cost ($/yr)
1	-	-	150	-	52,500	750
2	830	200	-	267	139,020	4460
3	-	200	100	267	91,020	3300

4.6 Summary – Option comparison

Table 8 provides a brief summary of the pros and cons of the proposed concept options, including their ranking in total footprint, treatment performance, cost, amenity, land acquisition and loss of open space.

Table 8 Concept option comparison

Concept	**Ranking**							
	Construction cost	**Maintenance cost**	**Total footprint**	**Treatment performance**	**Interim treatment option**	**Improved amenity**	**Land acquisition**	**Loss of open space**
Option 1	1	1	1	3	2	2	1	1
Option 2	3	3	3	2	1	1	3	3
Option 3	2	2	2	1	1	2	2	2

*Note: ranking is such that 1 = more desirable (i.e. lowest cost, lowest footprint, best performance).

5 Final concept designs – Preferred options

Based on feedback from Council, a bioretention system was preferred for the site and two options were developed to a full concept design level – Option 3 and a variant of Option 1.

1. Variant of Option 1 (Option 1b): A bioretention system within Council owned land (see Appendix A)

   The preference was to relocate the WSUD asset to the west side of the open drain. This reduces the length of pipe required, and the ground is also lower on the West side reducing the extent of batters. This location impacts on an existing treed area, however only one tree needs to be removed.

   A surcharge inlet pit is preferred to avoid mounding above the diversion pipe. This inlet arrangement will require more frequent maintenance as it is more prone to blockages. However, the inclusion of an upstream GPT will provide pre-treatment of litter and coarse sediment, and thus reduce the risk of the surcharge pit becoming blocked.

2. Option 3: A bioretention system with pre-treatment sediment basin requiring acquisition of privately owned land, and reconfiguration of the existing open drain into a vegetated swale (see Appendix A)

   This concept was largely based on the preliminary option. The asset footprint has been refined with improved earthwork modelling.

The options have also been optimised to meet best practice pollutant removal targets (Table 5 and Table 9).

Table 9 Treatment train performance for final concept options

Pollutant	Sources	Percentage removed	
		Option 1b	Option 2
Total Suspended Solids (kg/yr)	3920	79 %	83 %
Total Phosphorus (kg/yr)	8	45 %	50 %
Total Nitrogen (kg/yr)	55	47 %	47 %
Gross Pollutants (kg/yr)	745	100 %	100 %

5.1 Costing

The costing for option 1b and 3 are presented in Table 10 and Table 11 below.

The construction cost of Option 1b is estimated at $ 397,000.

The construction cost of Option 3 is estimated at $ 464,000. However, this does not include land acquisition.

5.2 Risks

A key risk with the WSUD options presented is tidal influences from the Maribyrnong River. Given that the invert level of the asset outlet pipe is low (0.35 m AHD), there is possibility of inflows from the Maribyrnong River into the WSUD asset during high tides. This will impact on the ability of the asset to drain effectively. Salt water intrusion can also impact on plant health. To manage this risk, further investigation of the water level in the Maribyrnong River is required in future design stages, as well as monitoring of flows from the Maribyrnong River at the existing open drain to confirm the extent of tidal influences. In terms of design, this risk can also be managed by elevating the invert of the outlet pipe by another 150 mm, and/or lifting the bioretention filter media by another 150 mm (i.e. NWL of 1.0 m AHD with higher embankment required), and/or locating the bioretention system closer to the existing escarpment (i.e. where the sediment pond of Option 3 is located) on slightly higher ground (approximately 350 mm higher).

6 Conclusion and recommendations

This projects has provided Council with two potential WSUD concept options for the Joseph Road Precinct with sufficient detail to progress further to detailed design and construction.

The selection of a preferred option by Council will depend on the potential to acquire the private parcel, available budget, Council's interest in an interim treatment asset during the precinct development (i.e. sediment pond in Option 3), and Council's view on the loss of available open space and impact on existing trees.

Future design stages will require further investigation of the Maribyrnong River water level and monitoring of flows at the existing open drain.

Table 10 Costing (Option 1b)

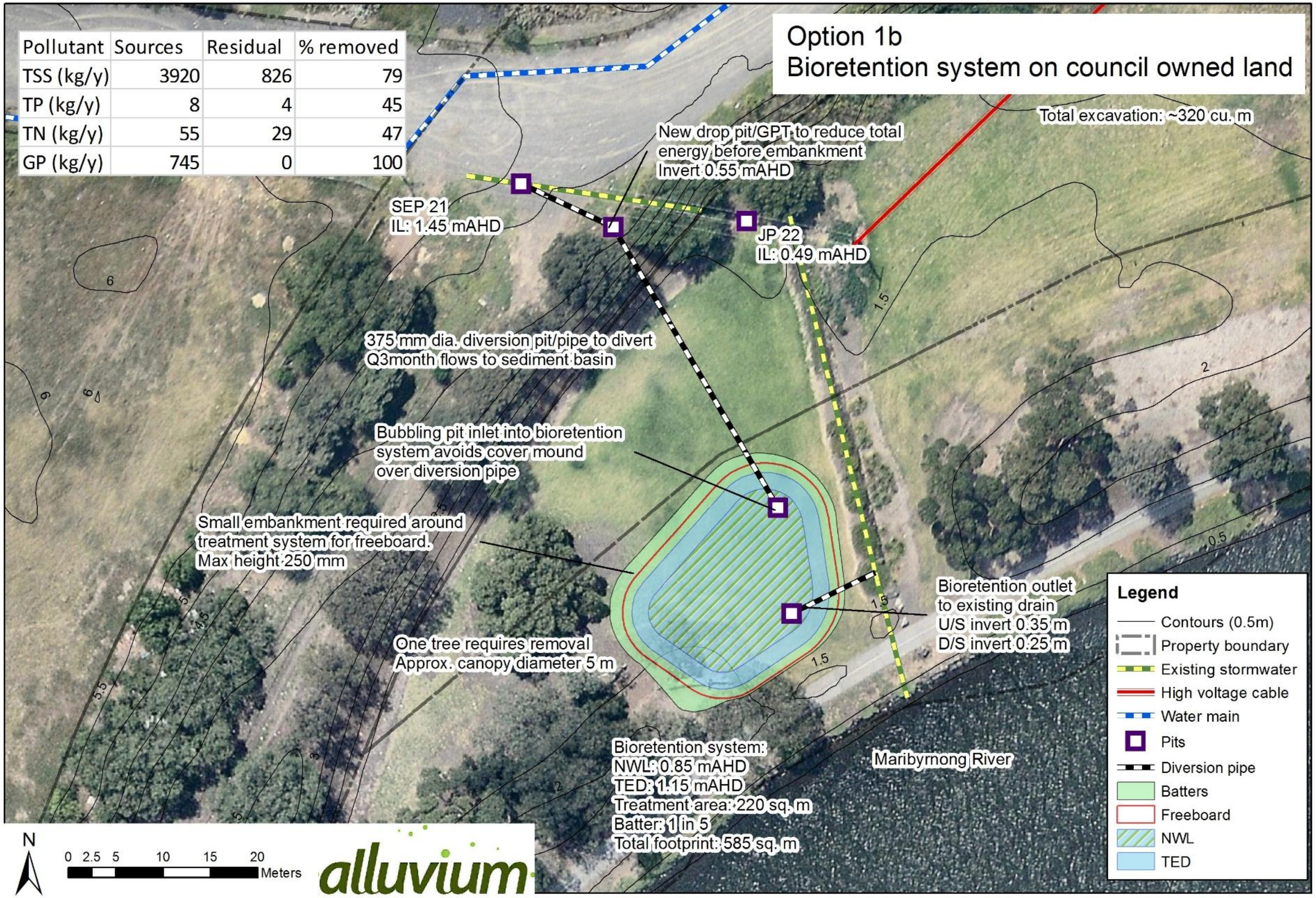
	Quantity	*Unit*	*Unit Rate*	*Cost*
General items				
Site establishment, sediment and erosion control	1	No	5%	$ 12,106
Subtotal				***$ 12,106***
GPT				
Supply and install < 300 L/s	1	No	$ 60,000	$ 60,000
Subtotal				***$ 60,000***
Bioretention system				
Strip and stockpile site topsoil prior to bulk excavation (avg. depth 100mm)	58.5	m^3	$ 50	$ 2,925
Excavation	262	m^3	$ 20	$ 5,230
Dispose of excess spoil offsite (Category C)	233	m^3	$ 420	$ 97,650
Supply and place liner	372	m^2	$ 30	$ 11,153
Supply and place subsoil drain	146	m	$ 26	$ 3,792
Supply and lay gravel and filter media (bioretention)	220	m^3	$ 80	$ 17,600
Supply and place rock mulch in bioretention system (50mm)	11	m^3	$ 150	$ 1,650
Supply and place bark mulch on batter (50mm thick)	18	m^3	$ 60	$ 1,095
Re spread 200 mm depth site top soil to batters surrounding bioretention areas	29	m^3	$ 50	$ 1,450
Planting (6 plants/sqm)	220	m^2	$ 30	$ 6,600
Inlet zone				
Supply and construct 375 dia pipe outlet endwall	1	No.	$ 2,000	$ 2,000
Install rock apron at inlet	4	m^2	$ 150	$ 600
Embankment				
Compaction of soil to 85% using site soil	20	m^3	$ 50	$ 1,000
Subtotal				***$ 152,745***
Stormwater drainage works				
Modify pit with concrete weir (diversion point)	1	No	$ 5,000	$ 5,000
Supply and install new drop pit and bubbling pit	1	No	$ 8,000	$ 8,000
Supply and install stormwater diversion pipe / inlet pipe	44	m	$ 45	$ 1,980
Supply and install overflow/outlet pipe	10	m	$ 45	$ 450
Supply and install new pit (overflow pit)	1	No	$ 3,000	$ 3,000
Subtotal				***$ 18,430***
Landscaping				
Planting (4 plants/sqm)	365	m^2	$ 30	$ 10,950
Subtotal				***$ 10,950***
Subtotal for all items				**$ 254,231**
Other				
Allowance for approvals (heritage, ecology etc.)	0	No	$ 5,000	$ -
Allowance for service alterations	0	No	$ 5,000	$ -
Design	1	No	10%	$ 25,423
Site investigations (geotech, survey, service detection, potholing, contam, etc)	1	No	5%	$ 12,712
Maintenance and establishment period	1	No	15%	$ 38,135
Subtotal				***$ 76,269***
Subtotal for all items				**$ 330,501**
Contingency			20%	$ 66,100
Total				**$ 397,000**

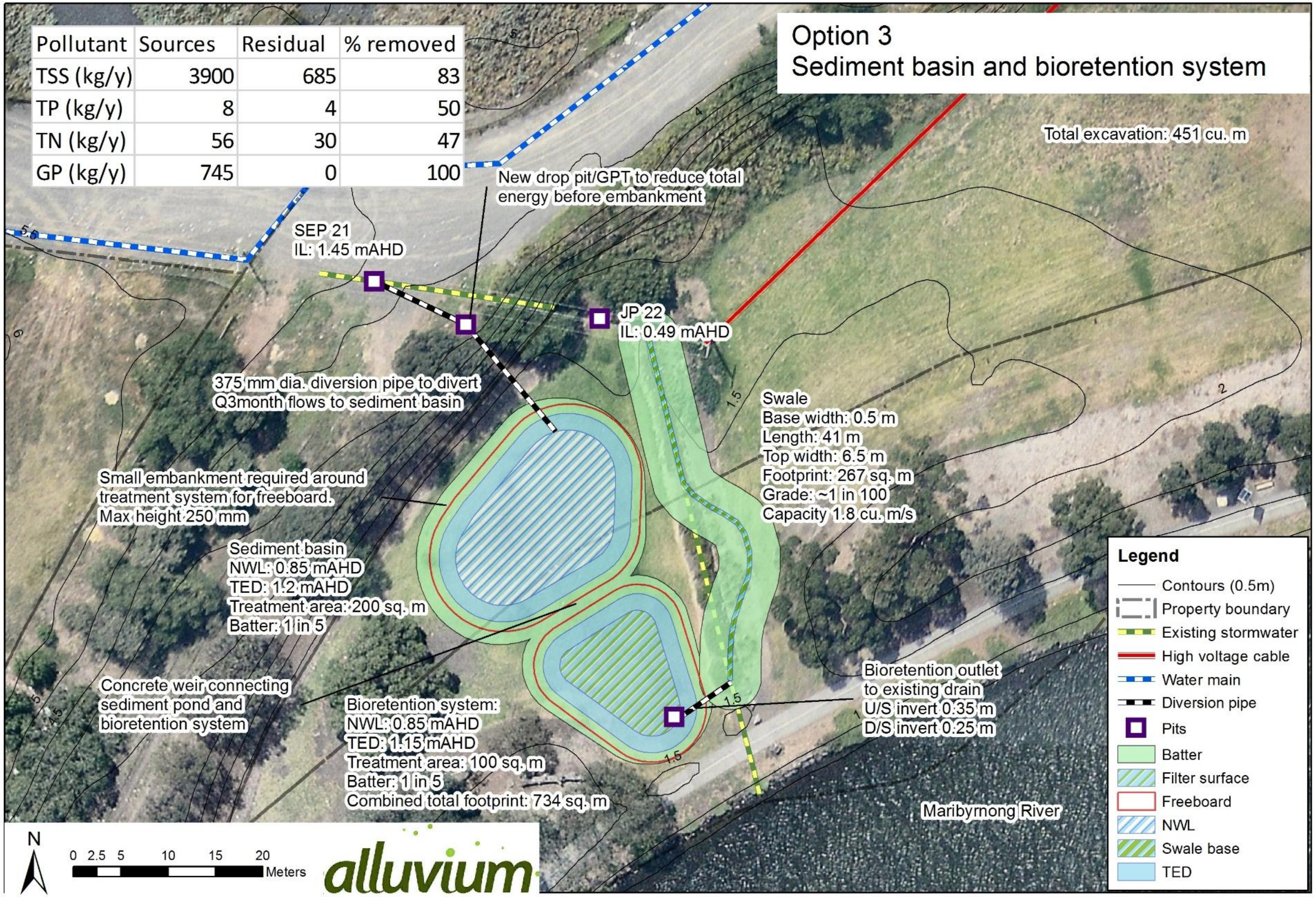
Table 11 Costing (Option 3)

	Quantity	*Unit*	*Unit Rate*	*Cost*
General items				
Site establishment, sediment and erosion control	1	No	5%	$ 14,164
Subtotal				***$ 14,164***
GPT				
Supply and install < 300 L/s	1	No	$ 60,000	$ 60,000
Subtotal				***$ 60,000***
Bioretention system				
Strip and stockpile site topsoil prior to bulk excavation (avg. depth 100mm)	73.4	m^3	$ 50	$ 3,670
Excavation (bioretention system + sediment pond)	378	m^3	$ 20	$ 7,552
Dispose of excess spoil offsite (Category C)	311	m^3	$ 420	$ 130,536
Supply and place liner	206	m^2	$ 30	$ 6,187
Supply and place subsoil drain	72	m	$ 26	$ 1,872
Supply and lay gravel and filter media (bioretention)	100	m^3	$ 80	$ 8,000
Supply and place rock mulch in bioretention system (50mm)	5	m^3	$ 150	$ 750
Supply and place bark mulch on batter (50mm thick)	9	m^3	$ 60	$ 510
Re spread 200 mm depth site top soil to batters surrounding bioretention areas and sed pond	67	m^3	$ 50	$ 3,340
Planting (6 plants/sqm)	100	m^2	$ 25	$ 2,500
Sediment pond				
Supply and construct 375 dia pipe endwall	3	No.	$ 500	$ 1,500
Install rock beaching at inlet zone	4	m^3	$ 150	$ 600
Access ramp bulk excavation (200 mm deep) and compaction of ground	8	m^3	$ 50	$ 400
Ramp construction (bottom100 mm layer of FCR and top 100 mm layer of 0-40 mm NDCR)	10	m	$ 150	$ 1,500
Supply and build rock base	2	m^3	$ 600	$ 1,260
Embankment				
Compaction of soil to 85% using site soil	22	m^3	$ 50	$ 1,100
Subtotal				***$ 171,277***
Stormwater drainage works				
Modify pit with concrete weir (diversion point)	1	No	$ 5,000	$ 5,000
Supply and install new drop pit	1	No	$ 5,000	$ 5,000
Supply and install stormwater diversion pipe / inlet pipe	26	m	$ 45	$ 1,170
Supply and install overflow/outlet pipe	7	m	$ 45	$ 315
Concrete weir separating sediment pond and bioretention system	2.45	m^3	$ 550	$ 1,348
Supply and install new pit (overflow pit)	1	No	$ 3,000	$ 3,000
Subtotal				***$ 15,833***
Landscaping				
Planting (2 plants/sqm)	434	m^2	$ 20	$ 8,680
Subtotal				***$ 8,680***
Swale				
Demolition of brick drain	1	No	$ 7,500	$ 7,500
Earthworks and drainage (approximate)	1	No	$ 12,500	$ 12,500
Preparation, supply and planting for revegetation works (approximate)	300	m^2	$ 25	$ 7,500
Subtotal				***$ 27,500***
Subtotal for all items				**$ 297,454**
Other				
Allowance for approvals (heritage, ecology etc.)	0	No	$ 5,000	$ -
Allowance for service alterations	0	No	$ 5,000	$ -
Land acquisition	910	m^2	TBC	
Design	1	No	10%	$ 29,745
Site investigations (geotech, survey, service detection, potholing, contam, etc)	1	No	5%	$ 14,873
Maintenance and establishment period	1	No	15%	$ 44,618
Subtotal				***$ 89,236***
Subtotal for all items				**$ 386,691**
Contingency			20%	$ 77,338
Total				**$ 464,000**

Appendix A: Preferred Options

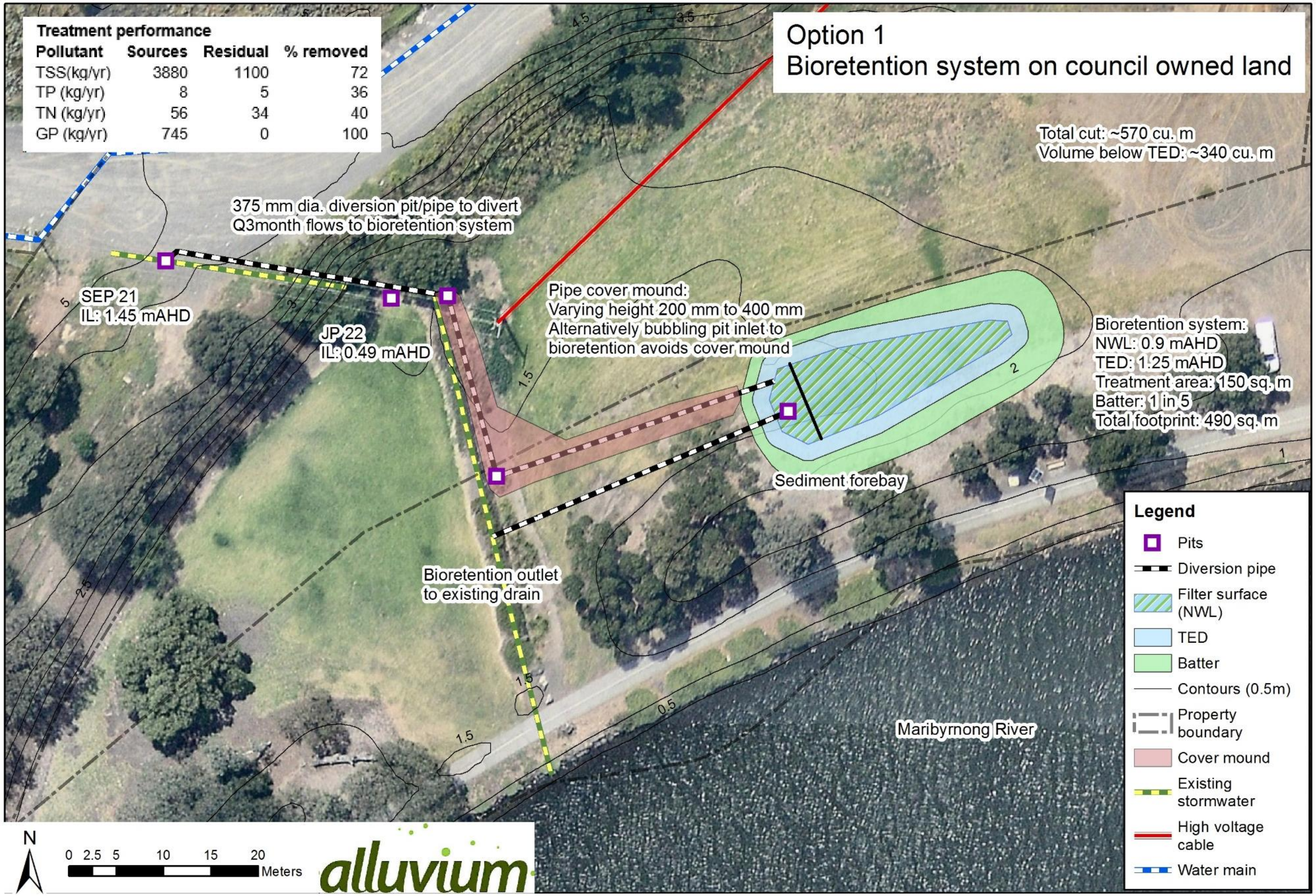
Pollutant	Sources	Residual	% removed
TSS (kg/y)	3920	826	79
TP (kg/y)	8	4	45
TN (kg/y)	55	29	47
GP (kg/y)	745	0	100





Pollutant	Sources	Residual	% removed
TSS (kg/y)	3900	685	83
TP (kg/y)	8	4	50
TN (kg/y)	56	30	47
GP (kg/y)	745	0	100

Appendix B: Other options investigated



Treatment performance

Pollutant	Sources	Residual	% removed
TSS(kg/yr)	3880	1100	72
TP (kg/yr)	8	5	36
TN (kg/yr)	56	34	40
GP (kg/yr)	745	0	100

Option 2
Wetland, sediment basin and swale on expanded parcel

Treatment performance

Pollutant	Sources	Residual	% removed
TSS(kg/yr)	3880	1140	71
TP (kg/yr)	8	3	60
TN (kg/yr)	56	34	39
GP (kg/yr)	745	0	100