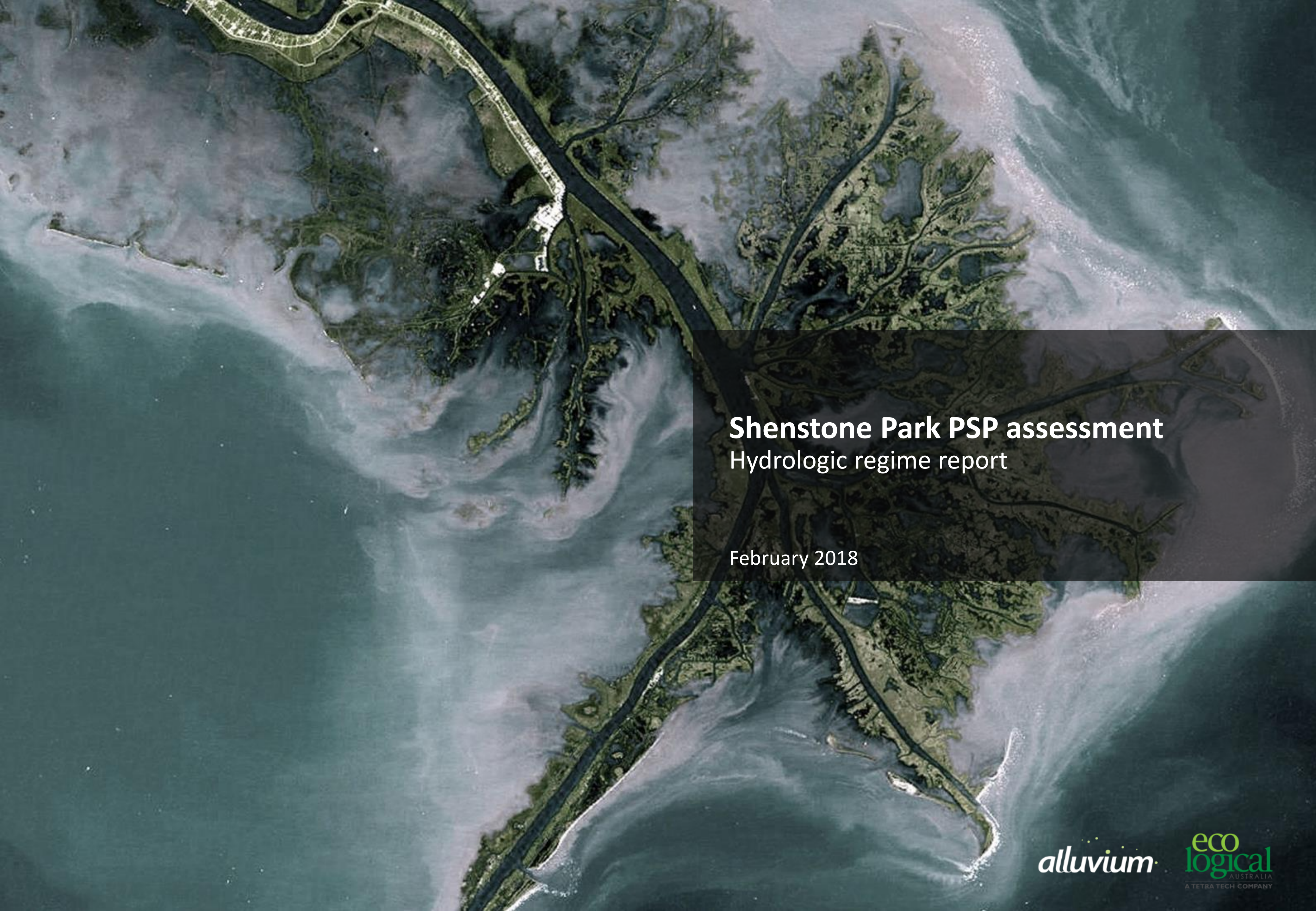

Shenstone Park PSP assessment

Hydrologic regime report

February 2018

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Introduction

The City of Whittlesea commissioned Alluvium and Eco Logical to assess the environmental values within the Shenstone Park PSP area and the adjoining Biodiversity Conservation Area 28 (CA28).

The study focus is the 100 year ARI flood extent around three nominated waterways. The assessment includes the current geomorphic values, and vegetation values, and the hydrological requirements of important vegetation values already identified within the conservation area. The assessment will be used to inform the Development Services Scheme (DSS) and the Precinct Structure Plan (PSP) for the site.

The overall objectives of the project are to:

• Determine the existing geomorphic condition, values and trajectory of the designated waterways

• Identify the native vegetation values of the designated waterways

• Provide recommendations on the magnitude and type of waterway management activities required to minimise the impacts of urban development and ensure that waterways are resilient to change

• Identify the significant native vegetation and ecological communities with the CA28 area

• Determine the relationship between the current hydrological regime of the conservation areas and the vegetation values

• Provide recommendations on the ideal future hydrological regime within the conservation area to maintain the important native vegetation values.

The outputs from the project are two reports:

- An assessment of the geomorphic and vegetation values of waterways in the study area (the values report).
- An assessment of the hydrologic regime of the waterways in the study area.

The objective of the hydrologic regime report is to provide recommendations for the optimal watering conditions to maintain the native vegetation communities in the study area.

This document is the hydrologic regime report, which builds on the values report (documented in the companion report).

The values report should be referred to for baseline values information, location maps and overall management recommendations. The recommendations from this hydrologic regime report have been incorporated into the overall recommendations.

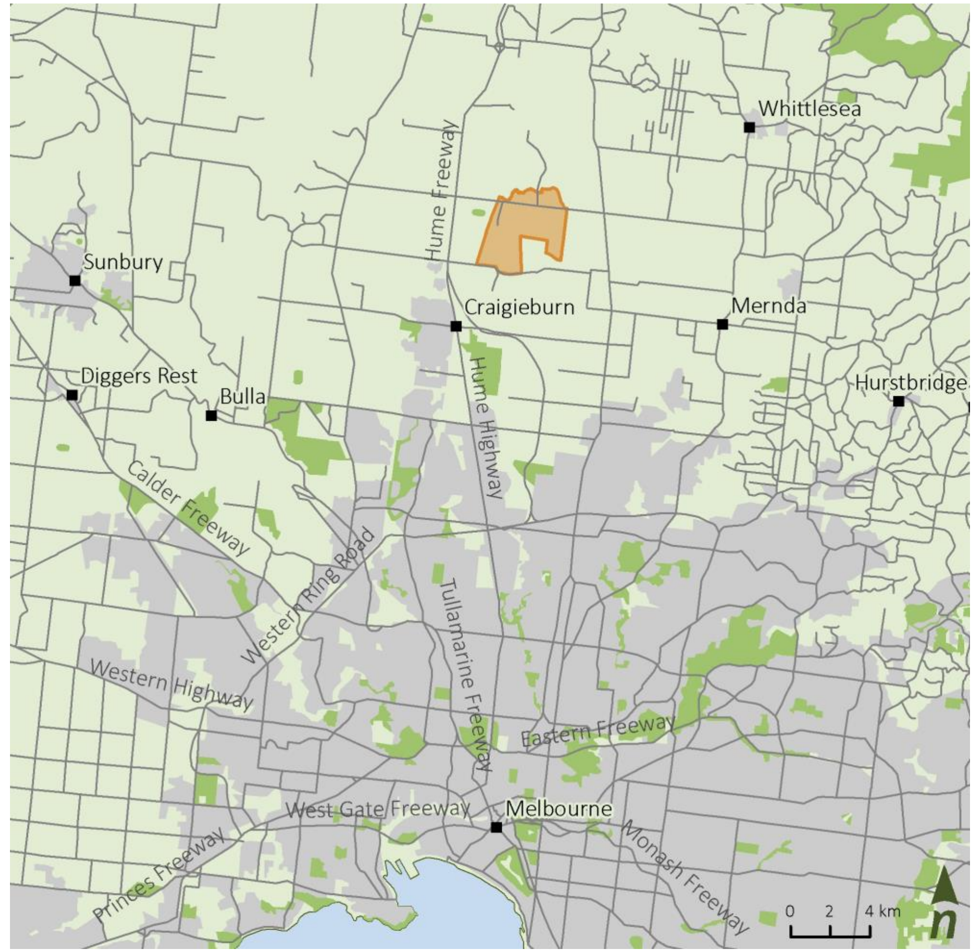

Figure 1. *Map showing location of study area in relation to Greater Melbourne*

Methods

The values report and hydrologic report are closely linked and have been developed in parallel.

An outline of the steps in the overall project method is provided on this page.

Our approach to the hydrological regime study is based around identification of key species, reviewing their water requirements, assessing likely changes to hydrology following urban development and understanding likely changes to communities under post-development conditions.

Full details of the hydrologic regime study method are provided in Appendix A.

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Phase	Activities			Outputs / Deliverables
1. Project inception	Inception meeting, project objectives, stakeholder mapping, communication protocols	Identification of key documents and other information sources		Clear understanding of project outcomes sought
2. Desktop assessments	Assessment of available data and information on geomorphic values	Assessment of available data and information on vegetation values		Baseline understanding of values
3. Consultation	Confirmation of scope of consultation	Consultation with stakeholders		Comprehensive understanding of issues
4. Site assessments	Organise access and inspect all sites	Collate field data		Detailed understanding of values
5. Values assessment report	Draft values assessment report			Draft report for comment
6. Hydrological regime report	Hydrological assessment a	Develop management actions	Draft hydrological regime report	Draft report for comment
7. Final report	Feedback on report	Final report		Final report Project debrief

Hydrologic regime assessment

A hydrologic regime assessment was undertaken to consider the potential impacts on significant vegetation and habitat along the existing waterways and within Conservation Area 28 and develop recommendations for the ideal watering conditions. The assessment was informed by desktop and field assessments—documented in the *values report*—which identified the following significant areas of vegetation within the 100 year flood extent in the study area:

- Plains Grassy Woodland (top right image) and modified indigenous wetland vegetation (bottom right) communities along the lower section of the Merri Creek tributary (Reach 3)
- Creekline Tussock Grassland vegetation community along Curly Sedge Creek (bottom left image)

These vegetation communities are described in detail on the following pages. Whilst additional areas of significant vegetation were identified outside the 100 year flood extent, these areas are unlikely to be influenced by changes in surface water hydrology associated with the named waterways. These communities are instead dependent on localised rainfall and the ability of the black, cracking basalt soils to soak up and retain high volumes of water. They should therefore be considered in the context of the relationship between soil moisture holding capacity, based on the parent material, and its influence on vegetation processes. Although these issues are outside the scope of this study, they should be considered in the broader design of the PSP.

A detailed methodology for the hydrologic regime assessment is provided in Appendix A.

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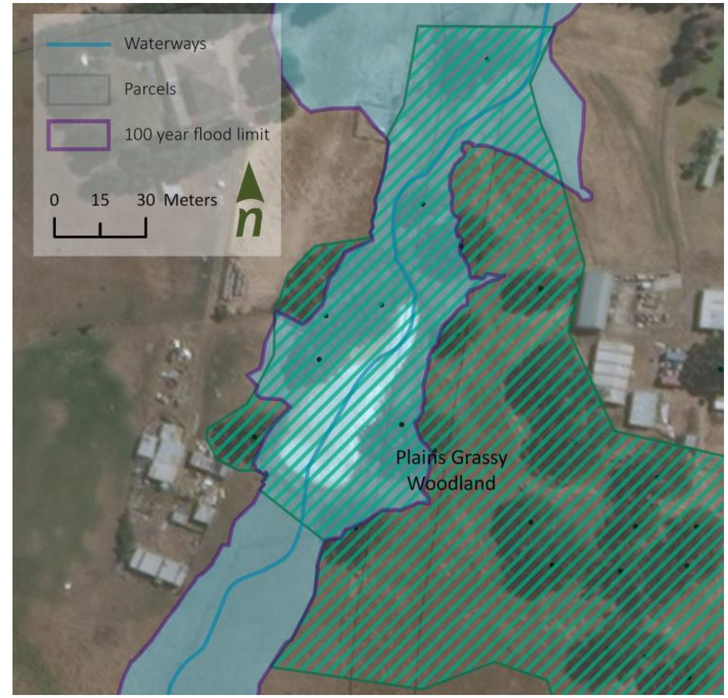
Plains Grassy Woodlands – Merri Creek tributary

Location and relationship to waterway	Comprised primarily of large, old River Red Gums (*Eucalyptus camaldulensis*) surrounding the existing dam and extending away from the stream to the south-east. The majority of this community is outside the 100 year flood extent.
Structure and cover	Large, old (100+ years) River Red Gums over a low, often sparse, understorey of indigenous and introduced grasses.
Area	0.75 hectares within the 100 year flood extent. Connected to a larger 150 hectare area containing a mixture of remnant Plains Grassy Woodland and Plains Grassland patches and scattered, old trees.
Key indigenous species and cover	Throughout: *Eucalyptus camaldulensis* (10%) Within 100 year flood extent: *Rytidosperma duttonianum* (5-25%), *Juncus* sp. (5-25%), *Amphibromus nervosus* (1-5%), *Eleocharis acuta* (1-5%), *Poa labillardierei* (<1%) Outside 100 year flood extent: *Rytidosperma caespitosum* (5 – 25%), *Rytidosperma racemosum* var. *racemosum* (5 – 25%), *Austrostipa scabra* (1-5%), *Austrostipa bigeniculata* (1-5%), *Rytidosperma geniculatum* (1-5%), *Anthosachne scabra* (1-5%)
Habitat features	Large old trees support a diversity of feeding, roosting and nesting habitats, including tree fissures and hollows. The shallow waters of the dam also supports semi-permanent aquatic habitat for a range of small fish and invertebrates.
Landscape context	Close proximity (<600m) from the vegetated Merri Creek corridor. Connected directly with much larger Plains Grassy Woodland remnants in corridor extending through CA28.
Conservation significance	The presence of large old trees, which provide critical habitat for a wide range of indigenous fauna, means this area is considered of moderate value for the conservation of biodiversity.
Threatened species	Whilst structurally the community is consistent with high quality remnants, floristic diversity is poor due to persistent grazing over long periods and subsequent introductions of exotic pasture and weed species. Threatened species are therefore considered to have a low likelihood of occurring within this community.
Recovery potential	High – the prevalence of large old trees provides an excellent basis for rehabilitation of this community and the associated biodiversity values.



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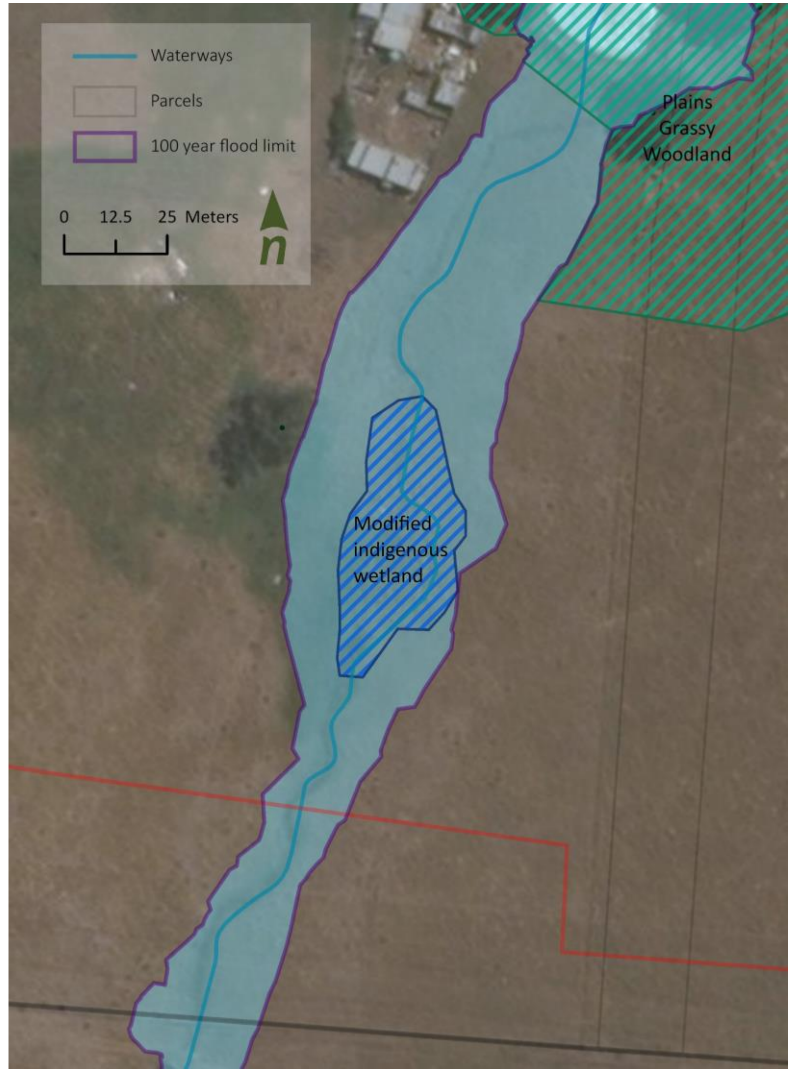
Modified indigenous wetlands – Merri Creek tributary

Location and relationship to waterway	A small in-stream marsh and associated ponds formed upstream of an exposed rock outcrop which has caused localised ponding of flow.
Structure and cover	Dense sward of rushes (40%) above grassy understorey with occasional herbaceous species.
Area	0.14 hectares
Key indigenous species and cover	*Juncus flavidus (25-50%),* ***Juncus filicaulis (5-25%),*** *Rytidosperma duttonianum (1-5%), Amphibromus nervosus (<1%), Carex inversa (<1%), Eleocharis acuta (<1%), Poa labillardierei (<1%)*
Habitat features	Sitting water, dense rushes and tussocks, surface rocks (basalt)
Landscape context	Close proximity (<500 m) from the vegetated Merri Creek corridor
Conservation significance	Poor indigenous species diversity and the small extent means this community is of limited value for the conservation of biodiversity.
Threatened species	Whilst this community has a relatively high cover of indigenous species compared to other sections of the tributary, it still contains a high cover of introduced species which are monopolising the inter-tussock habitats and associated resources. Threatened species are therefore considered to have a low likelihood of occurring within this community.
Recovery potential	Moderate – whilst floristically simple, the existing community has a high cover of large rushes, sedges and semi-aquatic grasses providing the foundation for further rehabilitation to improve diversity.



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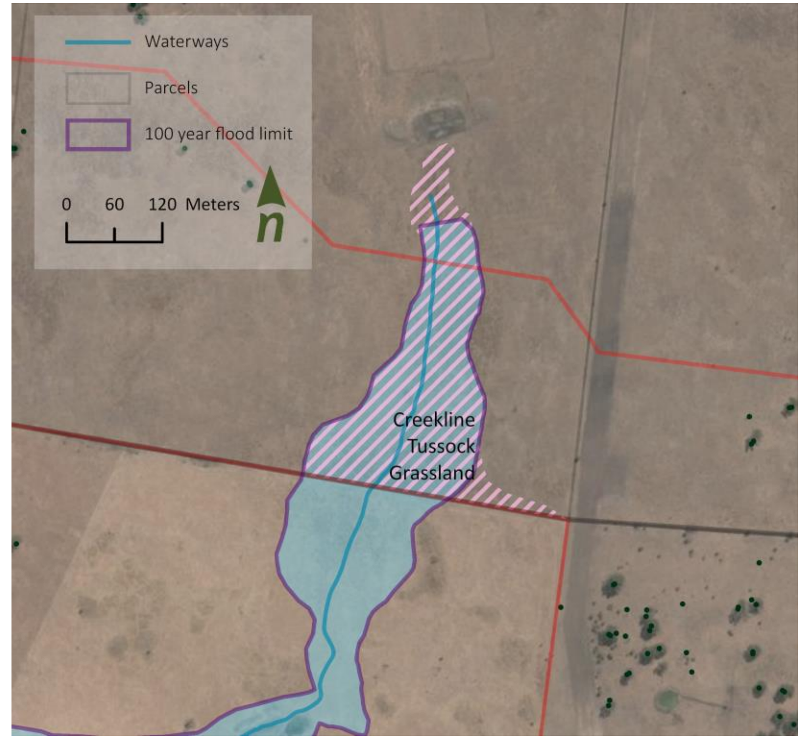
Creekline Tussock Grassland – Curly Sedge Creek

Location and relationship to waterway	Situated within the head of Curly Sedge Creek, this community covers the majority of the open valley floor. The stream channel is poorly defined through this section and shallow flows will disperse across large areas of the tussock grassland during heavy rains.
Structure and cover	Moderate to dense grassland comprised of 0.5 – 1 m tall Common Tussock-grass (*Poa laballedrei*) over a primarily exotic understorey of grasses and occasional herbaceous species. In wetter areas immediately below the farm dam and near the precinct boundary, the cover of rushes and sedges has increased. The cover of Common Tussock-grass varies across the area, ranging from dense swards (>50% cover) to individual, scattered plants (<5% cover).
Area	5 hectares
Key indigenous species and cover	*Poa labillardierei (5-50%), Juncus flavidus (5-25%), Juncus filicaulis (1-5%),* ***Juncus gregiflorus (1-5%)****, Carex tereticaulis (<1%), Calocephalus lacteus (<1%), Rytidosperma duttonianum (<1%)*
Habitat features	Open grasslands, dense rushes and tussocks, surface rocks (basalt) and small pools
Landscape context	Located within Conservation Area 28, the grassland is bordered by two knolls supporting Stony Knoll Shrubland which is in turn closely associated with large areas of Plains Grassy Woodland, Plains Grassland and scattered, old River Red Gums.
Conservation significance	Whilst floristic diversity is poor, the community qualifies as the nationally significant Natural Temperate Grassland of the Victorian Volcanic Plain due to the dominance of *Common Tussock-grass* and low non-grass weed cover. This remnant is therefore important for the conservation of threatened biodiversity on the volcanic plains and requires careful consideration of impacts and associated management.
Threatened species	Floristic diversity within this community is low due to a history of grazing. As a result, much of the inter-tussock space has been colonised by introduced species, reducing the availability of habitat for threatened species. Threatened species are therefore considered to have a low likelihood of occurring within this community.
Recovery potential	High – the existing cover of large tussocks provides an important structural foundation for improving the abundance and diversity of complementary native species and the overall value of this nationally significant community.



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Water requirements for key species

The hydrologic requirements and tolerances for key species in each native vegetation community were identified from the scientific literature.
The key hydrologic metrics for the species are presented below, with the source information (a full list of the literature review is provided in Appendix A).

Species	Common name	Flow frequency	Inundation Duration	Water depth	Seasonality	Comment
Eucalyptus camaldulensis	River Red-gum	1-3 years forests 5-7 years for woodlands	5-7 months forest 2-4 months woodlands	Not critical	Flooding in winter-spring-summer	Does not form seed bank so important to keep trees in good condition. [2]
Juncus spp. (flavidus, filicaulis and gregiflorus)	Rush	Annual or near annual	1-6 months	5-50cm	At least spring to early summer	Establishment is increased by shallow flooding (to 20cm). [2]
Poa labillardierei	Common Tussock-grass	Annual or near annual	1-3 months (though prolonged inundation may reduce condition. [3])	<30cm	Unknown	No specific requirements available. Requirements for wetland communities associated with this species. [1] However, its prevalence in woodlands suggests that it also handles drier conditions than stated here. [4]
Eleocharis acuta	Common Spike-sedge	Annual or near annual	4-6 months	30-40cm	Dry phase should be in Summer to Autumn	Avoid repeated short floods, as these may deplete rhizome reserves. [2]
Carex inversa	Knob Sedge	Annual or near annual	<1 month	<30cm	Unknown	No specific requirements available. Requirements for communities associated with this species. [1]
Calocephalus lacteus	Milky Beauty-heads	Annual or near annual	1-3 months	<30cm	Unknown	No specific requirements available. Requirements for communities associated with this species. [1]
Amphibromus nervosus	Common Swamp Wallaby-grass	Annual or near annual	1-6 months	<30cm	Unknown	No specific requirements available. Requirements for communities associated with this species.[1]
Rytidosperma duttonianum	Brown-back Wallaby-grass	Annual or near annual	1-6 months	<30cm	Unknown	No specific requirements available. Requirements for communities associated with this species. [1]

1. Frood. D. & Papas. P. (2016) A guide to water regime, salinity ranges and bioregional conservation status of Victorian wetland Ecological Vegetation Classes. Technical Report Series No. 266. Arthur Rylah Institute for Environmental Research. Heidelberg, Victoria.
2. Roberts. J. & Marston. F (2011) Water regime for wetland and floodplain plants: a source book for the Murray-Darling Basin, National Water Commission, Canberra.
3. Dr Lachlan Copeland, ELA senior Botanist
4. A/Prof. Wal Whalley, University of New England

Hydrological change

The current and post-development hydrologic regime was modelled for the Merri Creek tributary and Curly Sedge Creek using the MUSIC software (details of the modelling approach are provided in Appendix B). The modelling clearly indicated that there will be an overall increase in flow in both the Merri Creek tributary and Curly Sedge Creek. For each system three flow thresholds were analysed: a low flow, bankfull flow and a higher overbank flow. The increase in flow rates (between 1 and 14%) tended to be greatest in small to mid flows that remain in the creek channels. The critical flow metrics for the vegetation communities (known as *ecohydrologic metrics*) are the frequency of flows, their duration and the duration of dry spells between flows. This information is presented below with comparisons between current and 'post' development modelling scenarios for flows that are likely to influence the riparian vegetation communities within the 1 in 100 year ARI flood extent.

Curly Sedge Creek - Reach 1 (estimated flow to overtop banks is 3 cumecs)

	Current			Post-development		
Metric	1.6 cumecs	3 cumecs	5 cumecs	1.6 cumecs	3 cumecs	5 cumecs
No of events per year	4	2	1	96	34	12
Average duration	1	1	1	1.1	1.1	1.16
Average days between events	721	1211	2422	37	106	272
Longest days between events	1057	1364	2422	214	335	335

Merri Creek Tributary – Reach 3 (estimated flow to overtop banks is 3.4 cumecs)

	Current			Post-development		
Metric	2 cumecs	3.4 cumecs	6.6 cumecs	2 cumecs	3.4 cumecs	6.6 cumecs
No of events per year	62	22	4	355	236	101
Average duration	1.06	1.1	1.25	1.36	1.22	1.1
Average days between events	57	164	720	9	14	35
Longest days between events	272	366	1057	154	35	272

The ecohydrologic analysis presented above clearly shows that the urban development will increase the frequency of events and the decrease the duration of time between events. Changes to the duration of the flows are less pronounced. The implications of these changes for significant vegetation communities are discussed on the following pages.

Relationship between current hydrology and vegetation

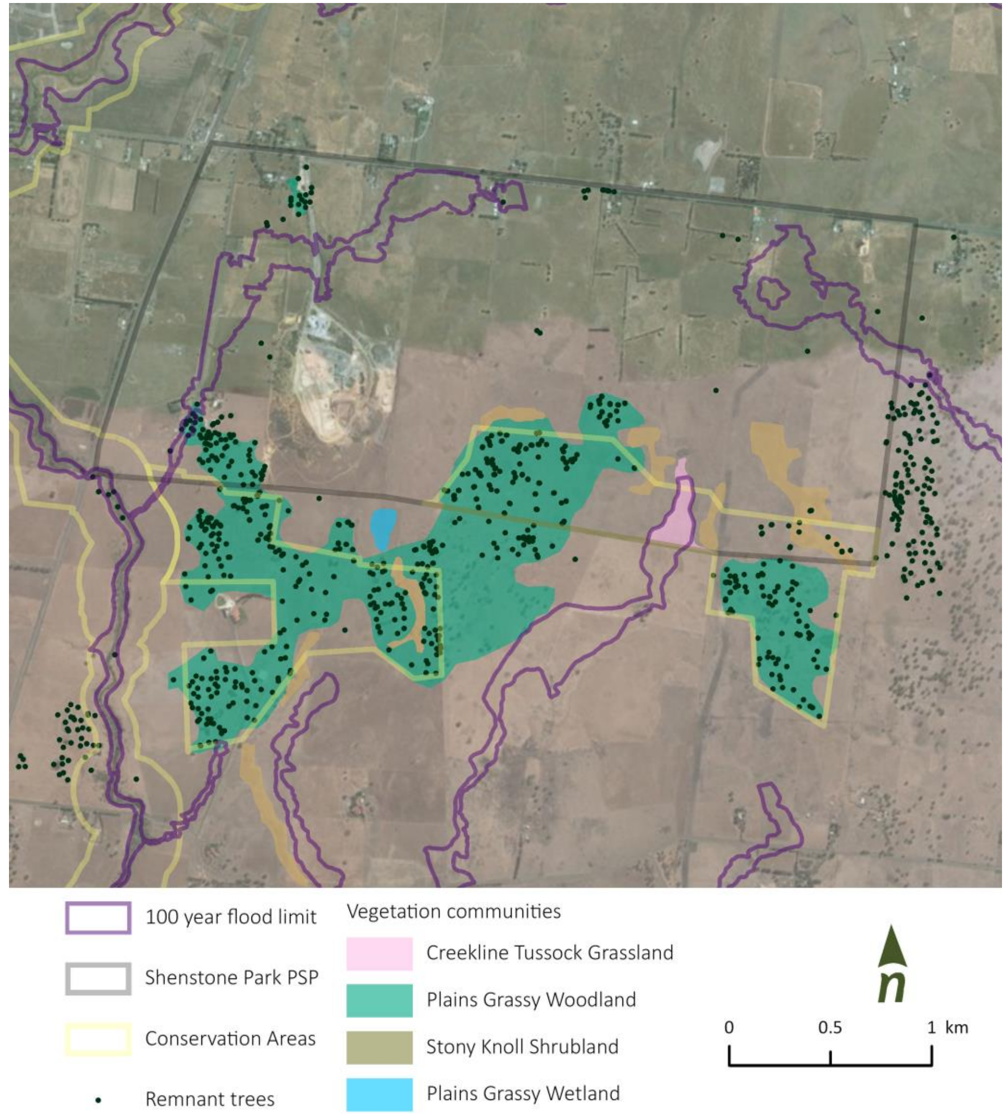
The distribution and composition of the key vegetation species at each location appear to be well correlated to both the geomorphology and current hydrology of the site. The primarily grass dominated communities at each site suggest that much of the 1 in 100 year flood extent only experiences periodic inundation (4 years in 10 and less) with significant periods between events (maximum period of 2.8 years and longer). A map is provided on the next page, and more site specific relationships are described below.

Merri Creek tributary

- Much of the Plains Grassy Woodland community that contain scattered River Red Gum trees in the vicinity of the Merri Creek tributary lie outside of the 1 in 100 year flood extent, hence their composition is reflective of broader rainfall patterns and potentially localised groundwater sources.
- Within the flood extent, scattered river red gums lie away from the creek line, in an area that would get inundated about 4 years in 10. This is slightly more frequent than their stated ideal inundation range (5-7 years for woodlands), but given the short duration of these flows (1.25 days on average), it is likely that water would not pond on the surface for long periods of time.
- The prevalence of the Wallaby Grasses (*Rytidosperma* spp.) and Spear Grass (*Austrostipa* spp.) further away from the creek line is evidence of the less frequent and shorter duration flow regime in these areas.
- The thicker stand of River Red Gums adjacent to the dam at this site is reflective of the more prolonged access to water due to localised flooding from the farm dam situated on the creekline.
- Similarly, the prevalence of Rush and Spike Sedge species within the small wetland community down stream is reflective of the marshy conditions generated by a widening and ponding of water in this section of the creek line. These species prefer more frequent inundation of longer duration and are unlikely to be impacted by an increase in flood events.

Curly Sedge Creek

- The increased dominance of *Common Tussock-grass (Poa laballedrei)* at this site is consistent with the drier conditions (inundation 1 in 10) experienced across most of the site.
- Rushes were more prevalent in locations experiencing wetter conditions (inundation 2-6 in 10 years) below the farm dam (potentially a result of seepage) and along the southern boundary of the precinct where exposed basalt had created ponding of the water in places.



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Impacts and recommendations

The hydrological modelling clearly indicates that under post-development conditions waterways within the study area will carry more water than under current conditions. This will primarily be expressed as an increase in the frequency of inundation events, rather than a significant increase in the duration of events. Most of the key riparian species observed within the significant vegetation communities are adapted to wetter conditions, being able to withstand frequent inundation for extended durations (months). The anticipated changes in significant vegetation communities are outlined for ground cover and tree species below.

Ground cover

Of all the species present, the Common Tussock-grass (*Poa labillardierei)* is likely to be the most sensitive to the increases in inundation frequency, with a likely reduction in its condition, especially along Curly Sedge Creek . However, given the short duration of inundation events and reasonably long periods between events (106-272 days on average) expected under post-development conditions, it would be unlikely that this species would be lost from the site due to overwatering. Rather, it will likely be maintained in areas of the site that are slightly higher in elevation, being replaced in lower, more wet areas with Rush and Sedge species. It is therefore reasonable to assume that while some change in the proportional make-up of the species may occur (i.e. less *Poa* sp., more Rush and Sedge), this will be unlikely to cause a complete change in vegetation community class altogether.

It should be recognised that the above conclusion is based on the limited information available describing physiological tolerances of the key understorey species. Actual tolerances and thresholds at the site may vary due to the influence of local factors including soil structure, community dynamics and land form. Should these thresholds be exceeded, it is likely to result in the rapid degradation and loss of the community, potentially due to invasion by *Phalaris aquatica* or *Juncus acutus*, rather than a gradual transition to an alternative 'native' community. Given its protection under the Melbourne Strategic Assessment approval (EPBC Act), a precautionary approach should therefore be considered to avoid impacts on the area of Creekline Tussock Grassland.

Trees

The dominant tree species present throughout the precinct and Conservation Area is River Red Gum (*Eucalyptus camaldulensis*). At the Merri Creek tributary site (reach 3 – see values report for details) it is found as both woodlands and a small, regenerating stand near the dam.

As with the groundcover analysis, the modelled flow heights likely to inundate the woodlands adjacent to the creek are short in duration (1.1 days) and spaced around a month apart. This will likely only affect River Red Gums in this area if water ponds at the site for significant periods of time (i.e. over 3-4 years). Given the location of the site in an upland area, inundation durations for this extent would be highly unlikely. Therefore, no significant change in condition or distribution of River Red Gums would be anticipated post-development.

Summary and recommendations

Vegetation communities associated with the Shenstone Park PSP and Conservation Area 28 waterways are considered to be relatively water tolerant and unlikely to be significantly impacted by an increase in the frequency of inundation. Although minor alterations to community structure are anticipated under the post-development hydrological regime, they are unlikely to lead to the degradation or wholesale change of the vegetation community.

However, should localised ponding occur due to an increase in the duration of inundation, significant impacts to native vegetation associated with Curly Sedge Creek and the lower reach of Merri Creek tributary are considered likely. It is therefore important that during the development phase no physical modifications are made in these reaches that will increase the duration of inundation (e.g. creation of stormwater treatment systems).

To better understand the likelihood of localised ponding occurring and the associated impacts on vegetation communities, the following options are available:

- Pre-development hydraulic modelling of the sites in question
- Post-development monitoring of ponding and changes in vegetation health and structure

Given that prolonged ponding is not anticipated to be an issue, we would recommend the second option be implemented within the area of Creekline Tussock Grassland at Curly Sedge Creek, and appropriate controls implemented if impacts are observed (e.g. flow management systems). Additional management recommendations pertaining to the rehabilitation and management of values associated with the waterways are provided in the values report.

Appendix A. Ecohydrological assessment methodology

The Ecohydrological Assessment builds upon the findings of the Geomorphic and Vegetation Values Assessment and investigates the potential impacts on ecological values in the PSP and Conservation Area 28 due to changes in the hydrological regime of the waterways.

The relationship between the current hydrology of the site and the identified vegetation values was determined by combining the inundation frequency modelling and vegetation community distribution information gained from the desktop, field and hydrologic assessments. This process involved:

1. Identify key vegetation communities and value - Information collected through the vegetation survey was used to identify the key vegetation communities and the species within them that would be most susceptible to hydrological change. Only the areas within the 1:100 year flood extent were considered in this analysis.
2. Review water requirements for key species - A literature review and expert knowledge was used to determine water requirements of the key species identified in step 1. A list of all information sources reviewed is provided opposite.
3. Assess change to hydrological regime using modelled flow data (current and 'post' development) - Key flow metrics (number and average duration of events, duration between events) relevant to vegetation were calculated for several flow thresholds at each site. This was undertaken for the modelled current scenario and 'post' development model scenario for the period 1970-1980.
4. Link key species to current flow regime - There are many facets of the flow regime that vegetation responds too. This step combined information from steps 2 and 3 to provide comment on the likely metrics within the pre development flow regime which are structuring the vegetation communities.
5. Assess likely changes to communities post-development and provide recommendations on ideal watering conditions - Based on the hydrological modelling the likely changes to key vegetation communities resulting from the development were assessed. In light of these predicted changes, recommendations on the ideal watering conditions post-development were presented.

The findings of the Ecohydrological assessment have been used to develop high level management recommendations to inform development of the Shenstone Park PSP. These recommendations are presented in the Geomorphic and Vegetation Values Assessment report).

The following information sources were reviewed as par of the Ecohydrological assessment:

- Bacon, P. E., Stone, C., Binns, D. L., Leslie, D. J., & Edwards, D. W. (1993). Relationships between water availability and Eucalyptus camaldulensis growth in a riparian forest. Journal of Hydrology, 150(2-4), 541-561.
- Batson M-G 1998, 'Agrostis castellana (Poaceae), dominant Agrostis species, found in bent grass pastures in south-eastern Australia', Australian Journal of Botany, vol. 46, pp. 697- 705.
- Carr, G.W., Yugovic, J.V. and Robinson, K.E. 1992, Environmental weed invasions in Victoria: Conservation and management implications, Department of Conservation and Natural Resources and Ecological Horticulture, Victoria.
- Frood. D. & Papas. P. (2016) A guide to water regime, salinity ranges and bioregional conservation status of Victorian wetland Ecological Vegetation Classes. Technical Report Series No. 266. Arthur Rylah Institute for Environmental Research. Heidelberg, Victoria.
- Marcum, KB 2004, Use of Saline and Non-potable Water in the Turfgrass Industry: Constraints and Developments, 4th International Crop Science Conference proceedings: New Directions for a Diverse Planet, http://www.cropscience.org.au/icsc2004/pdf/709_marcum.pdf
- Mensforth, L. J., Thorburn, P. J., Tyerman, S. D., & Walker, G. R. (1994). Sources of water used by riparian Eucalyptus camaldulensis overlying highly saline groundwater. Oecologia, 100(1), 21-28.
- Roberts, J. and Marston, F. (2011) Water regime for wetland and floodplain plants: A source book for the Murray-Darling Basin. National Water Commission, Canberra.
- Sanchez AM & Peco B 2004, 'Interference between perennial grassland and Lavandula stoechas subsp. Pedunculata seedlings: a case of spatial segregation cause by competition', Acta Oecologica, vol. 26, pp. 39-44.
- Thorburn, P. J., & Walker, G. R. (1994). Variations in stream water uptake by Eucalyptus camaldulensis with differing access to stream water. Oecologia, 100(3), 293-301.
- Ward K (1996) 'Flood requirements of vegetation for the rehabilitation of Lake Mokoan'. Draft report. Vic. Dept of Natural Resources and Environment: Melbourne. Watt S, García-Berthou E and Vilar L (2007)
- Personal communication with Dr Lachlan Copeland, ELA senior Botanist
- Personal communication with A/Prof. Wal Whalley, University of New England
- Personal communication with Rob Dabal, University of Melbourne

Appendix B. Hydrologic modelling methodology

Hydrologic modelling was undertaken to assess changes in the hydrological regime of the waterways due to proposed development in the catchments of the three nominated waterways.

This process involved:

1. Catchment delineation – Catchments for each of the four study rivers was computed based on a digital elevation model (DEM) and the stream network to determine flow directions and contributing area. A total of 16 sub-catchments were identified.
2. Land use characterisation – each sub-catchment was divided into land use zones for both current and post-development conditions. Land use for the current condition was determined from the VPA planning zone data, and the post-development condition land use was based on Council's proposed Future Urban Structure for Shenstone Park.
3. Fraction effective imperviousness – Zone codes were adopted for the proposed future land zones that reflected their description and a fraction effective imperviousness adopted from Melbourne Water's MUSIC Guidelines. This is shown in the table on this page.
4. MUSIC model setup – Adopted fraction impervious areas were applied to each sub-catchment to determine an effective impervious area which were used as input parameters into the a MUSIC (Model for Urban Stormwater Improvement Conceptualisation) model along with rainfall data from Melbourne Airport (1971-1980) at 6 min time-step.
5. Pre- and post-development flow analysis – regimes for each study river were produced from the MUSIC model and analysed to produce the hydrologic metrics presented in the hydrologic regime report.

Post-development adopted zone descriptions and fraction effective imperviousness

Future Urban Structure for Shenstone Park land use description	Adopted zone description	Adopted zone code	Adopted fraction effective imperviousness
Employment	COMMERCIAL 1 ZONE	C1Z	0.9
Residential	RESIDENTIAL GROWTH ZONE - SCHEDULE 1	RGZ1	0.6
Utilities area (yarra valley water)	PUBLIC USE ZONE - SERVICE AND UTILITY	PUZ6	0.7
Local parks (unencumbered)	PUBLIC PARK AND RECREATION ZONE	PPRZ	0.1
Gas transmission easement	PUBLIC USE ZONE - SERVICE AND UTILITY	PUZ6	0.7
Community facility	PUBLIC USE ZONE - HEALTH AND COMMUNITY	PUZ3	0.85
Sports reserve (unenumbered)	PUBLIC PARK AND RECREATION ZONE	PPRZ	0.1
Potential government school	PUBLIC USE ZONE - EDUCATION	PUZ2	0.7
Local town centre	COMMERCIAL 1 ZONE	C1Z	0.9
Arterial road	ROAD ZONE - CATEGORY 1	RDZ1	0.7
Woody Hill Quarry	SPECIAL USE ZONE - SCHEDULE 4	SUZ4	0.6
Post contact heritage place	PUBLIC USE ZONE - HEALTH AND COMMUNITY	PUZ3	0.85
Potential water storage	URBAN FLOODWAY ZONE	UFZ	0
Local Park	PUBLIC PARK AND RECREATION ZONE	PPRZ	0.1
Nature Conservation	RURAL CONSERVATION ZONE	RCZ	0.05
Residential/Mixed Use	GENERAL RESIDENTIAL ZONE - SCHEDULE 1	GRZ1	0.75
Retarding Basin/WQT Wetland	URBAN FLOODWAY ZONE	UFZ	0
Water/Sewer	PUBLIC USE ZONE - SERVICE AND UTILITY	PUZ6	0.7
Local Town Centre	COMMERCIAL 1 ZONE	C1Z	0.9
Government School	PUBLIC USE ZONE - EDUCATION	PUZ2	0.7
Non-Government School	PUBLIC USE ZONE - EDUCATION	PUZ2	0.7
Municipal Park	PUBLIC PARK AND RECREATION ZONE	PPRZ	0.1
Local Sports Reserve	PUBLIC PARK AND RECREATION ZONE	PPRZ	0.1
Local Convenience Centre	COMMERCIAL 1 ZONE	C1Z	0.9
Widening/Intersection Flaring	ROAD ZONE - CATEGORY 1	RDZ1	0.7
Gas/Oil	PUBLIC USE ZONE - SERVICE AND UTILITY	PUZ6	0.7
Residential	GENERAL RESIDENTIAL ZONE - SCHEDULE 1	GRZ1	0.75
Conventional Density Residential	GENERAL RESIDENTIAL ZONE - SCHEDULE 1	GRZ1	0.75