Appendix I: Stormwater and Drainage Strategy

Byford Rail Extension (BRE)
Byford Station Precinct Drainage Strategy

Contents

Glossary

Site – the area shown in red boundary on Figure 2.1.

MUC - Multi-use Corridor (this is an overarching term used to describe the final aspiration of Oaklands North Drain / Oaklands South Drain / Oaklands Outfall Drain).

DEM – Digital Elevation Model

1. Introduction

The intent of this memorandum is to provide an overarching design strategy for the Byford Station drainage network and advise the civil design package [CI-300] for Byford Station Precinct.

The following planning documents have advised the development of this drainage strategy:

- **Abernethy Rd Local Water Management Strategy (LWMS) Addendum (HYD20, May 2021)**
  This document is an update of the 2020 version (undertaken by Hyd20), and the 2014 version which was issued by GHD in May 2021. This addendum seeks to align the stormwater management strategy with the Local Structure Plan and the District Water Management Strategy (Urbaqua, 2018), whilst ensuring that it reflects the most current stormwater management practices.
- **Byford Town Centre – structure plan (May 2021)**
  This document outlines the development plan for the Byford Town Centre. It provides guidance on land use, infrastructure, and transport planning.

2. Project Locality

The Byford Station Precinct is located along the proposed extension of the Armadale rail line, west of the existing Byford Town Centre in the Shire of Serpentine-Jarrahdale. This proposed precinct area will form the development of the western wing of the new planned precinct for Byford Town Centre and is subject to the current Town Centre structure plan. The new station precinct will form the end of the extension of the existing Armadale railway line, which will transform into the Byford railway line, post-development.

The proposed precinct site is located to the west of the Southwestern Hwy and south of Larsen Road and adjoins Abernethy Road between the existing rail line at George Street and the Byford Trotters horse-training complex at Thatcher Road.

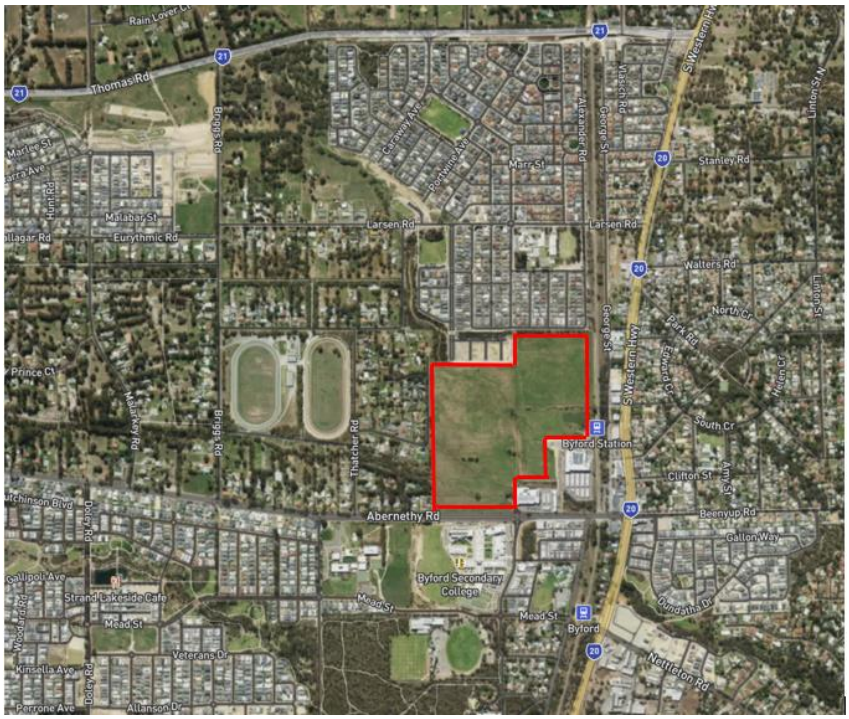

Figure 2.1. Project Locality

3. Site Description

The works associated with the Byford Station project will effectively be contained within the existing undeveloped greenfield site, which is proposed to form the Byford Station Precinct. The proposed precinct consists of a new station [Byford], plaza area [retail and event space], shared pedestrian/cyclist areas [PSP station connection], car parking facilities, and a bus interchange.

To facilitate the precinct, a new road network will be interspersed throughout the site which will include new access roads to the precinct and new road connections that link to the wider Byford Road network.

The primary roads that will be extended / introduced to the precinct are as follows:

- San Simeon Blvd
- Evans Way
- Clara Street

Refer to the Byford Station Precinct layout in Figure 3.1 and the Overall Site Layout in Figure 3.2, below.

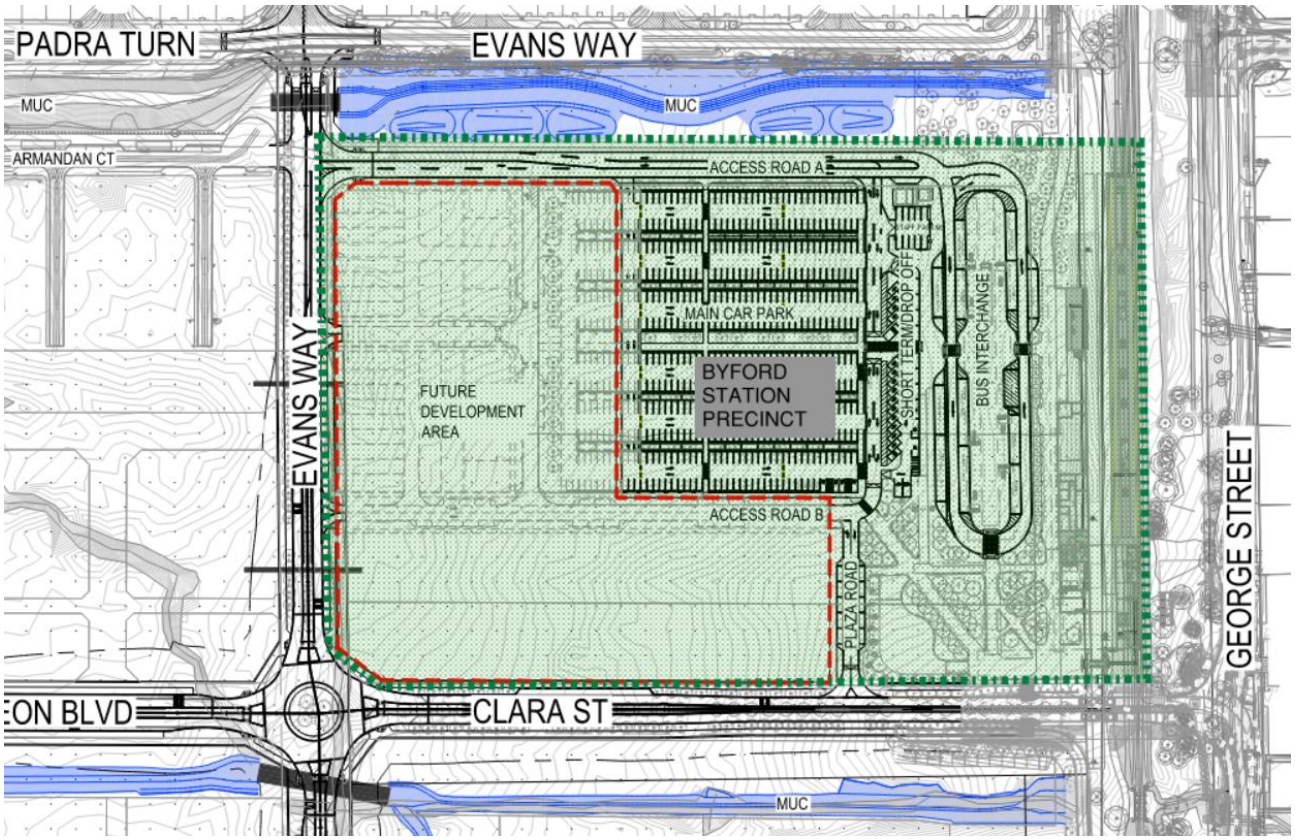

Figure 3.1. Byford Station Precinct Layout

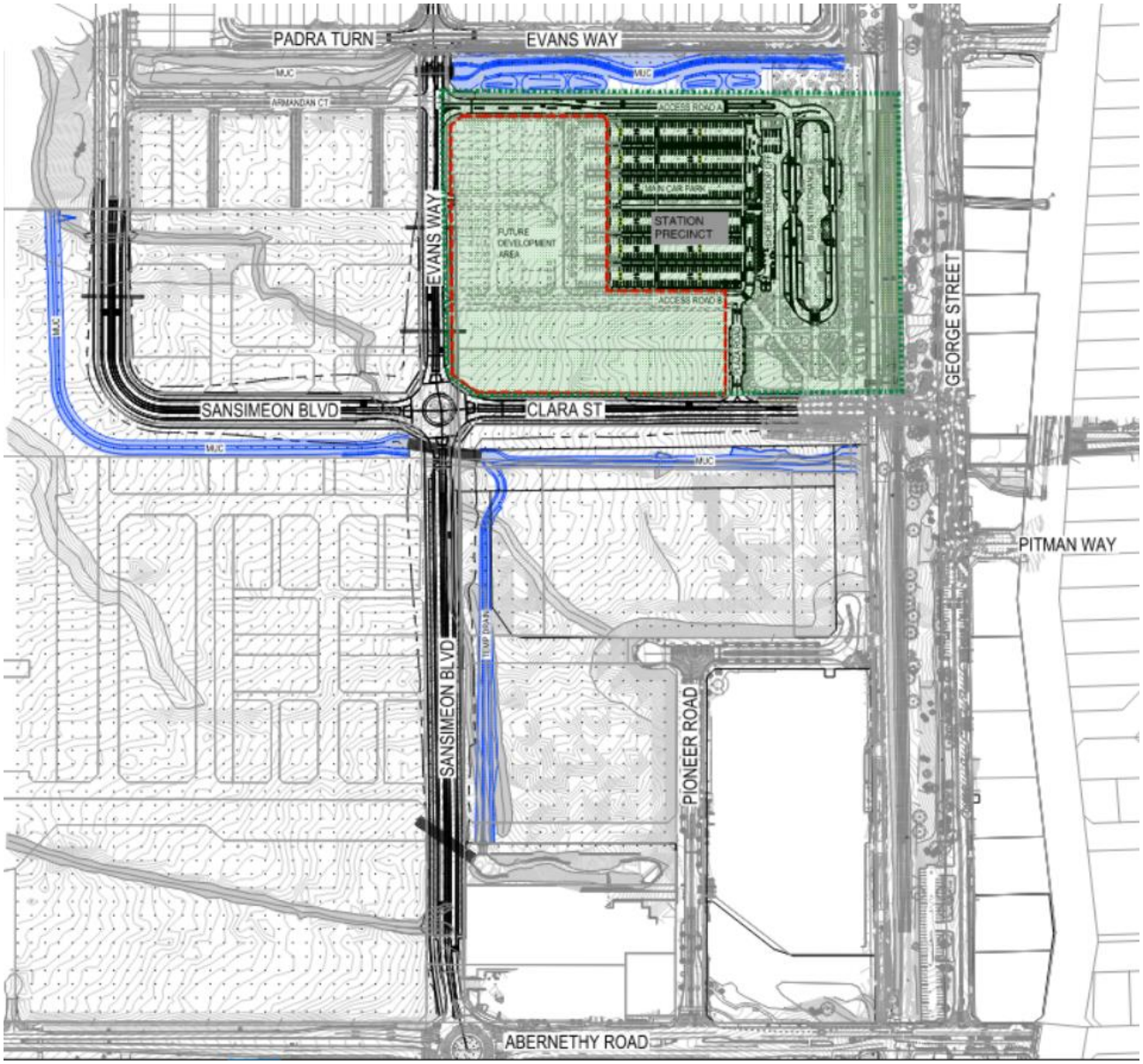

Figure 3.2. Overall Site Layout

Byford station precinct is surrounded by parcels of land which will be developed at a later date. Future development, according to the current local structure plan, will comprise a mix of residential development and commercial development. Please see figure 3.3 below.

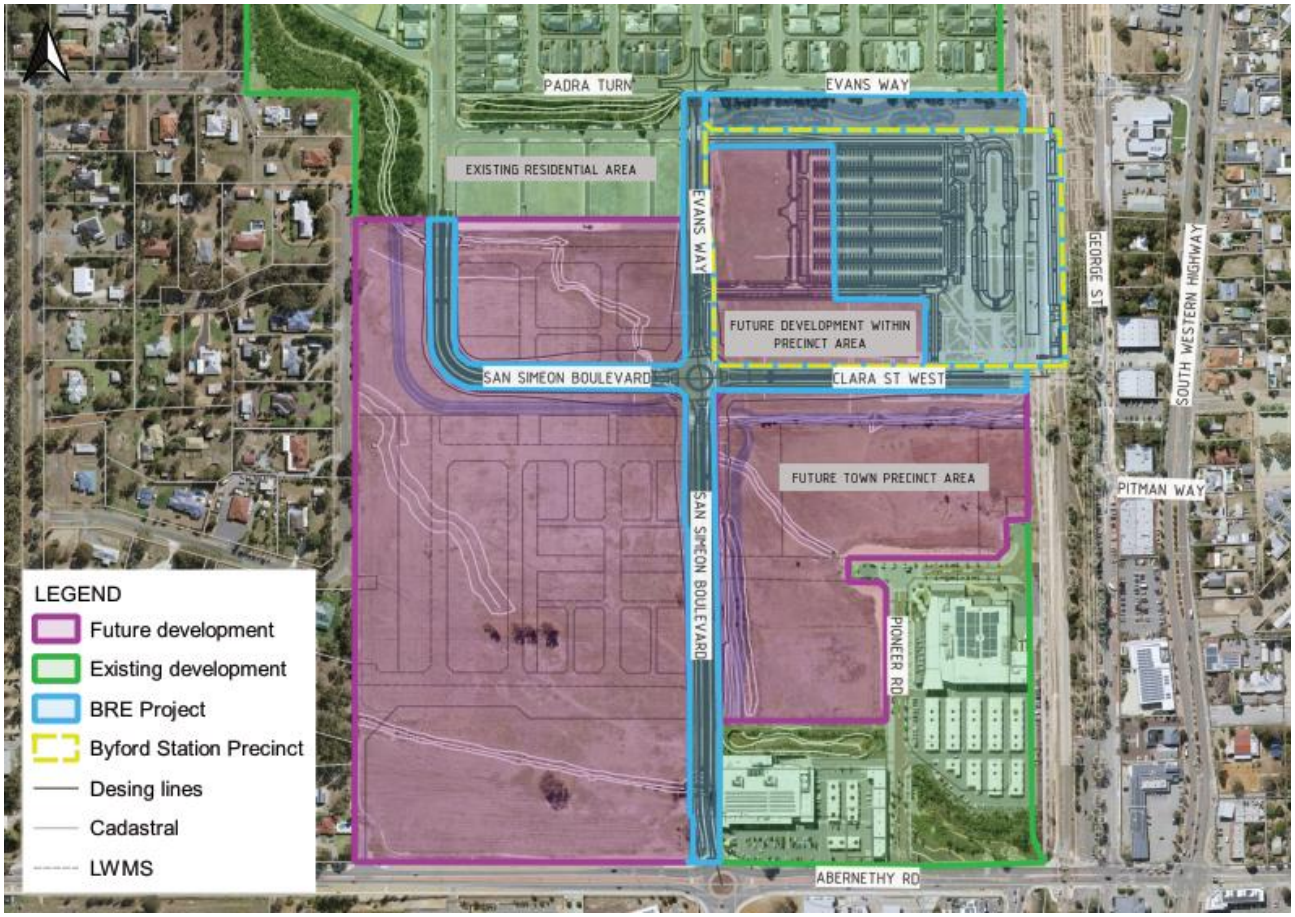

Figure 3.3. Future development areas

4. Existing Site Conditions

4.1 Topography

The existing site drains stormwater from southeast to northwest via overland flows into a series of open drains and grassy swales dispersed across the site plan. The site is a relative flat palusplain (seasonally waterlogged) with a gentle grade [approx. 1.25%].

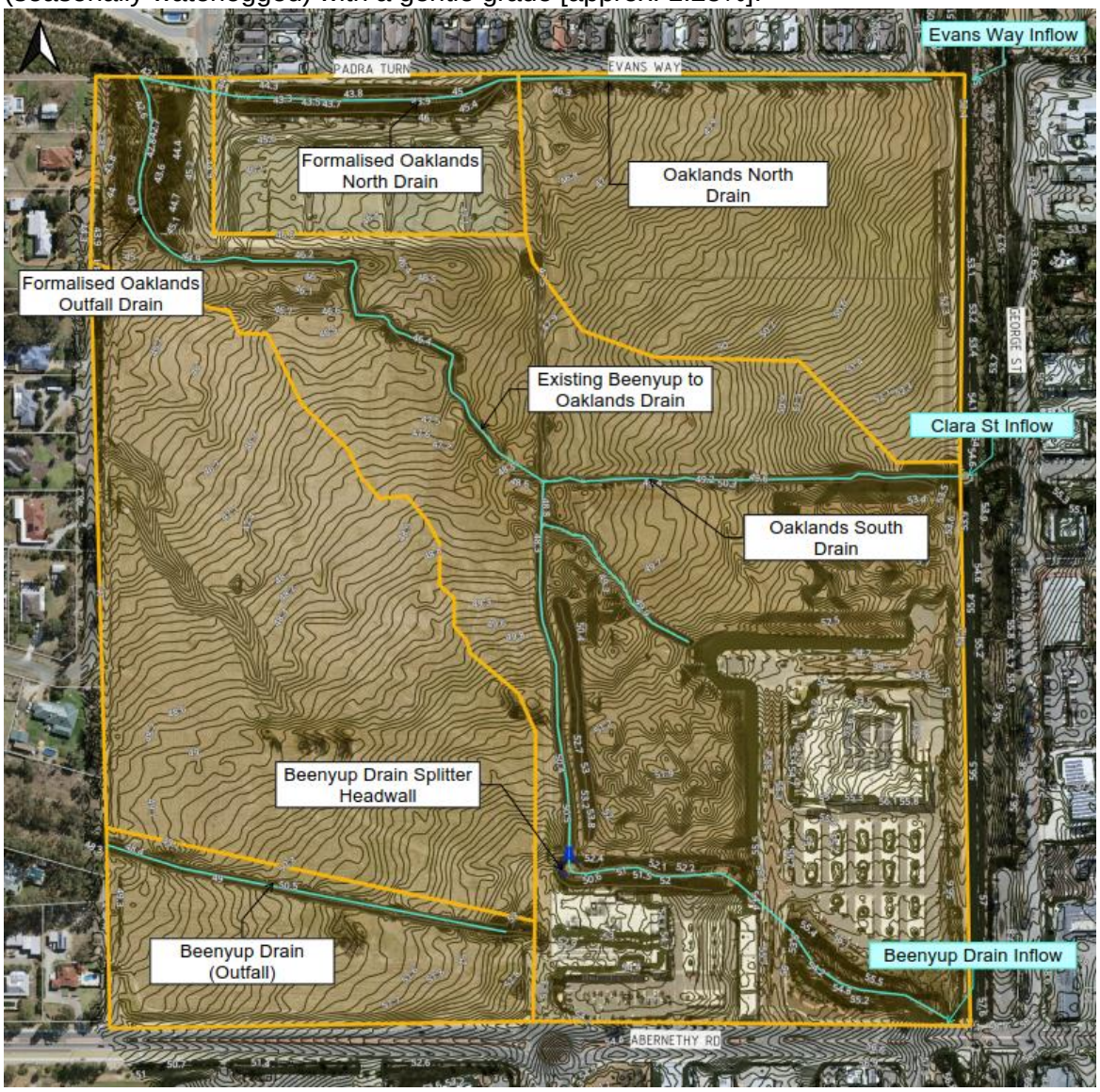

Figure 4.1. Existing catchments Byford Town Centre

4.2 Existing Catchments and contributing waterways

As per *Figure* 4.1*4.1*, there are numerous existing catchments that operate in a network to convey stormwater into and across the existing site; these have been catagorised below according to their primary function and will form part of the drainage strategy detailed in this memorandum.

There are three main inflow points to the Town Precinct area:

Inflow Points	Site Location	Description
Beenyup Drain Inflow	South-east corner	Crosses beneath Abernethy Rd

Inflow Points	Site Location	Description
Clara Street Inflow	Mid-East	Crosses beneath existing railway line
Evans Way Inflow	North-east corner	Crosses beneath existing railway line

There are two main outfall points from the Town Precinct area:

Outfall Points	Site Location	Description
Oakland Drain Outfall	North-west corner	Runs behind existing San Simeon Blvd and continues parallel to Thatcher Rd
Beenyup Drain Outfall	South-west corner	Runs west towards Thatcher Rd

There is also an existing headwall to the north of the existing Woolworths Shopping centre that directs all Beenyup Drain inflow to the Oakland South Drain. It is understood that this headwall was constructed with the intention to split flows between Beenyup Drain and Oakland South Drain, however the culvert formed in an easterly direction (intended as a continuation of the Beenyup Drain) was capped off and therefore all flows currently flow north towards Oaklands South Drain:

Inflow Points	Site Location	Description
Existing headwall	North of existing Woolworths	Diverts flows from Beenyup Drain to Oaklands South Drain

4.3 Geology & Groundwater

A geotechnical investigation of the existing site for the Byford Precinct was undertaken by Advisian [Nov 2021]. The analysis revealed the topsoil is comprised of a dark-brown silty sand, with a fine to medium sized grain with a depth of 100mm to 200mm.

The analysis also revealed that there are three primary soil types that underlay the site:

- Alluvium to Colluvium soils [up to 800m below ground level (BGL)] (sand and clayey sand)
- Guilford formation (silty sand/ clayey-silty sand / clayey sand)
- Yoganup Formation

The geotechnical investigation also identified the potential for perched groundwater to collect on the top of natural clayey soils on the site. Given that the natural soil permeability is low, this would undermine any infiltration design approach within natural soils.

4.3.1 Acid Sulphate Soils

Acid Sulfate Soils (ASS) typically occur in low-lying areas under waterlogged or anaerobic conditions. The Western Australian Planning Commission's Planning Bulletin[1] indicates that the soils within the site extents have a low to moderate risk of ASS at depths greater than 3 m BGL.

[1] Bulletin No. 64 [2009] – Developed based upon a review of existing geomorphological, geological, and hydrological information.

4.3.2 Groundwater

Maximum groundwater is typically below 2.5m BGL, but this is observed to move deeper on the eastern extent of the site.

5. Background

The Local Water Management Strategy (LMWS)[2] for the existing Byford greenfield site identifies the establishment of a link to divert a portion of the Beenyup Drain flows towards Oakland Outfall Drain in order to alleviate downstream flooding, as set out in the Byford District Water Management Strategy (DWMS).[3]

The LWMS had intended to integrate the split of flows at the Beenyup Drain mid-block between the western site boundary and the new San Simeon Boulevard. However, a headwall was established during the development of Woolworths Shopping Centre, which is located to the east of the new San Simeon Boulevard.

Consequently, the split of flows is not strictly in accordance with the LWMS (due to the headwall formed as part of the Woolworths development). It is also noted that the current structure plan layout does not allow for the provision of an open drain east of San Simeon-Boulevard.

[2] GHD LMWS [2014] – Superseded by Hyd2o LWMS [2021]
[3] Urbaqua DWMS [2018]

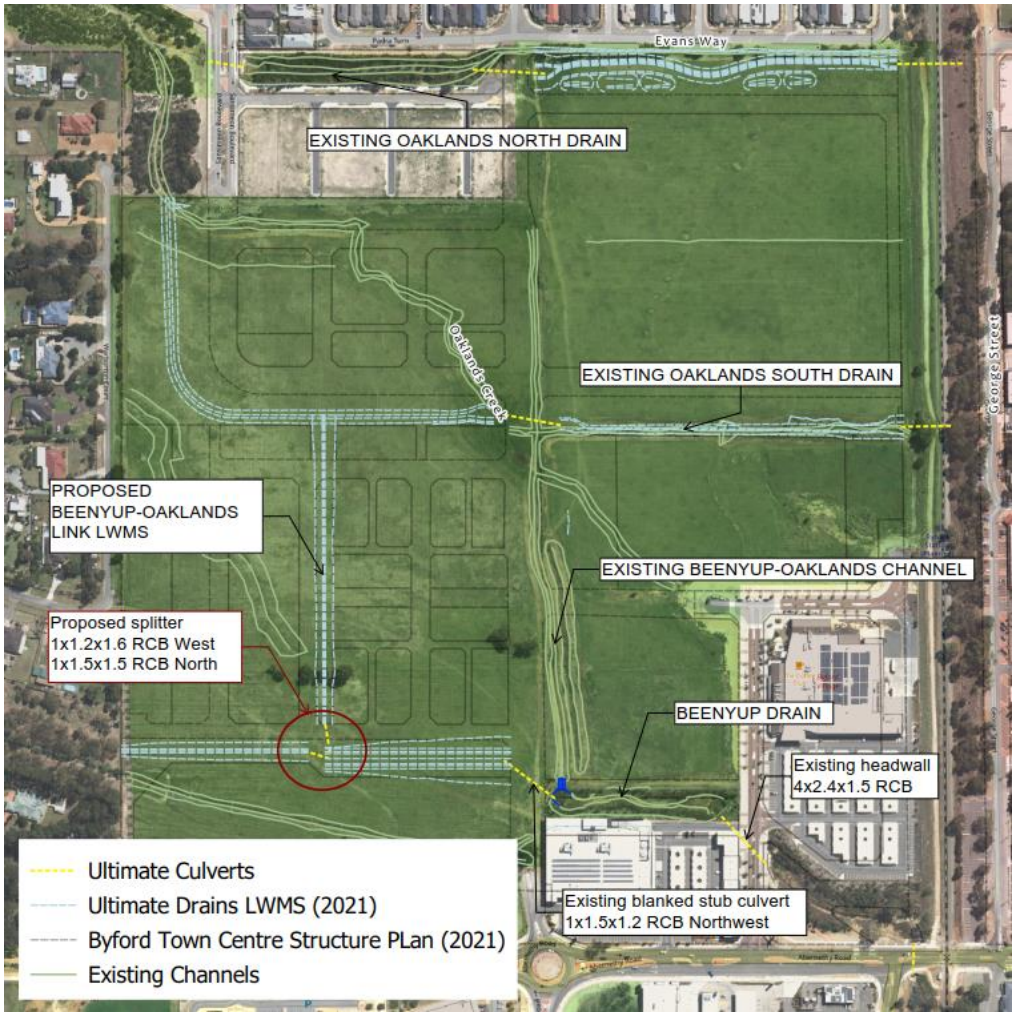

Figure 5.1. Existing Conditions and LWMS for Byford Town Centre

6. Proposed Development

6.1 Key Project Interfaces

The Byford Station Precinct preliminary layout is shown below in Figure *6.1*.

The following key areas have been identified:

- Station Precinct Carpark
- Bus Interchange
- Clara Street
- Evans Way
- San Simeon Blvd
- MUC – Oaklands Outfall
- MUC – Oaklands North
- MUC – Oaklands South

Figure 6.1. Byford Station Precinct Concept Layout

6.2 Key Drainage Interfaces

In addition to the key interfaces identified above (*Section 6.1*), the following key interfaces that the project drainage network will tie into are identified as follows:

- Track - Oaklands South Drain Culvert Crossing
- Track - Oaklands North Drain Culvert Crossing
- Beenyup Drain headwall (NW corner of Woolworths)
- Existing Oakland Outfall formalised MUC drain
- Existing Oakland North formalised MUC drain

7. Drainage Strategy

7.1 Current Planning Documents

7.1.1 Abernethy Rd Local Water Management Strategy (LWMS) – Addendum [HYD20, May 2021]

The purpose of this Addendum is to update the overarching Local Storm Water Management Strategy (LMWS) [2014] by aligning the Local Structure Plan (LSP) and the District Water Management Strategy (DWMS) [Urbaqua, 2018] together to ensure that it reflects the most current stormwater management practices.

Refer to *Figure 7.1* for an excerpt of the LMWS Stormwater Plan Overview.

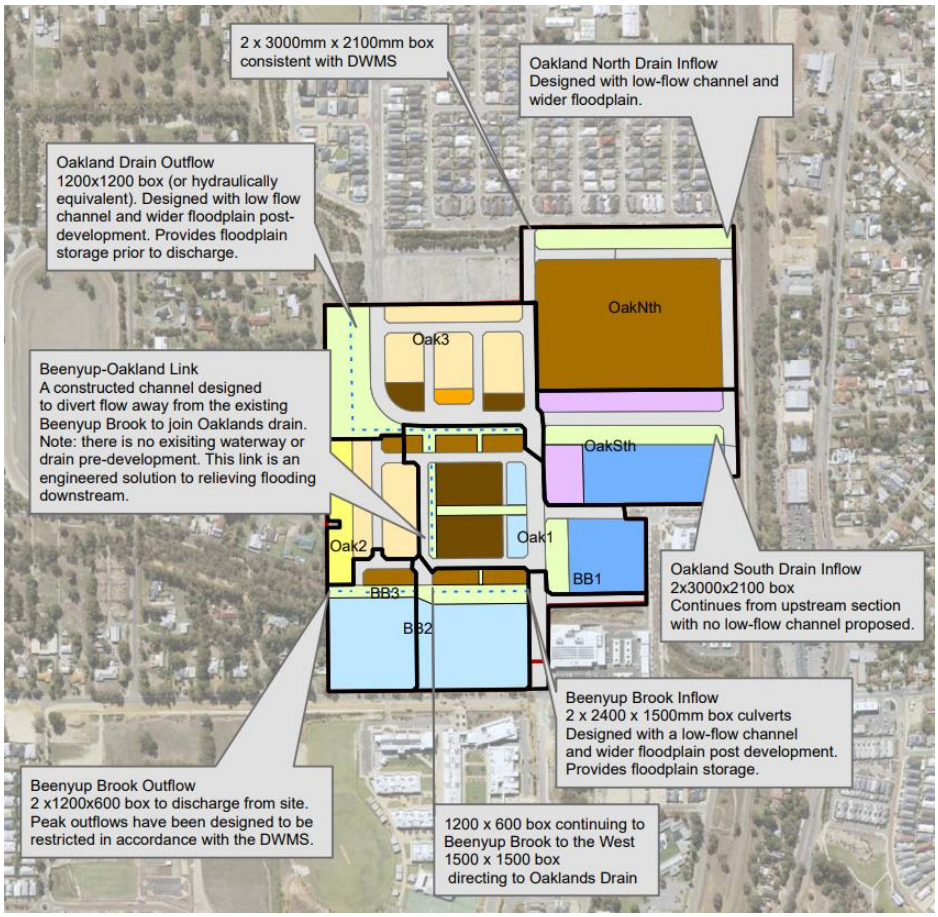

Figure 7.1. Abernethy Rd: LWMS Amendment Stormwater Overview (2021)

7.1.2 Byford Town Centre Structure Plan [May 2021]

The Byford Town Centre Structure Plan outlines the development plan for the Byford Town Centre by providing guidance on land use, infrastructure, and transport planning.

Refer to *Figure 7.2* (below) for an excerpt of the current structure plan for the Byford Town Centre [WAPC REF: SPN 0098M-3, May 2021].

Figure 7.2. Byford Town Centre structure plan (2021)

7.2 Design Guidelines

The design guidelines for PTA assets (ie. carpark, interchange, and Plaza area) are listed sequentially below.

Refer to *Section 7.1* for the guidelines for LGA assets such as the MUC and LGA roads; these are covered by the Shire of Serpentine-Jarrahdale documents i.e. current LWMS and LSP documents.

Document Title	Document No.	Publication Date
Scope of Work and Technical Criteria (SWTC)	SWTC-BRE-PTAWA-PM_RPT-00007	8 April 2022
Design of Drainage for PTA Infrastructure	8880-450-090 – Specification	4 October 2022
A Guide to Water Sensitive Urban Design for Public Transport Infrastructure in Western Australia	-	11 July 2022
Stormwater Management Manual of Western Australia	-	May 2022
Australian Runoff Quality: A Guide to WSUD	-	31 December 2007
Adoption Guidelines for Stormwater Biofiltration Systems produced by the CRC for Water Sensitive Cities	-	2015

7.3 Design Objectives

The design criteria adopted is based on the following key LWMS (HYD20, May 2021) requirements:

1. First flush – 15mm runoff of impervious areas to be managed on site as close to source as possible.
2. No offline subdivisional detention – All additional flows above the 15mm are to be directed and handled within the MUC areas, see below excerpt from LWMS:

> There are no offline stormwater detention areas proposed for the site. Subdivisional drainage will utilise the online storage of the district drainage network as the critical duration from the subdivision is1hr whereas the critical duration for the regional flows provided by Urbaqua is 3hrs.

Figure 7.3: LWMS Excerpt - No Offline Detention

In addition to the above the following specific criteria shall be applied:

7.3.1 SWTC -BRE-PTAWA-PM-RPT-00007

Relevant extracts from the SWTC are reproduced below:

Clause	Excerpt
2.1.3-8	Provision of bio-retention filter media shall comply with the Stormwater Management Manual for Western Australia. Typically, filter media consists of a sandy loam with a saturated hydraulic conductivity between 50 and 300 mm/hr
2.1.3-9	The maximum emptying time for infiltration drainage system within the station precinct and outside the rail reserve shall comply with the Stormwater Management Manual for Western Australia. **Table 1. Extract from Stormwater management manual chapter 9 Table 5** **AEP** / **1 EY** **Maximum Emptying Time in days**
2.1.3-10	The maximum storage depth of bio-retention areas in the station precinct where accessible to public shall be limited to 300mm with 1 in 4 batter slopes.
9.2.3-1	All rainwater run-off from roofed and platform paved areas shall be collected and be disposed of onsite via soak wells or via the local area stormwater drainage system where the NOP actions make this possible. Rainwater run-off from bus interchange shelters shall connect to the civil engineers' car park drainage system. Where soil conditions beneath platforms is not considered suitable for onsite disposal, consideration shall be given to drainage lines connecting to the civil engineers 'PERWAY' drainage system.

7.3.2 8880-450-090 - Specification: Design of Drainage for PTA Infrastructure

This PTA specification document relates to the design requirements for the PTA owned assets which sit within the Byford Station Precinct. Relevant extracts from the specification are reproduced in *Table 2*Table 2. Extract from 880-450-090 (Table 7: Drainage Annual Exceedance Probabilities for Outside the Rail Reserve) below:

Table 2. Extract from 880-450-090 (Table 7: Drainage Annual Exceedance Probabilities for Outside the Rail Reserve)

Item	Situation	AEP %
1	Major system check: TWL to property and railway building floor levels with 300mm freeboard	1
2	Stormwater drainage contained in principal shared path (PSP) corridor: PSP crossfall shall be away from the rail reserve. For larger storms and major storm overland flow paths, and where discharge into PTA rail reserve is unavoidable, this shall be communicated with and accepted by the PTA prior to construction.	20
3	Water Corporation main / branch drains.	
4	Kerb overtopping.	20
5	Drainage basins and sumps (where not covered by LGA & LWMS)	10
6	Swales and open drains.	20
7	Gutter flow spread limits.	20
8	Piped system with 150 mm of freeboard from HGL to FSL.	20
9	Groundwater level (dry subgrade).	2
10	Drainage system overflows that might cause erosion or scour.	10
11	Drainage basin backwater onto pavement.	5
12	Swales and open drains backwater onto pavement.	10

Other relevant excerpts are recorded below:

Clause	Excerpt
2.3.5.5	Stormwater runoff from constructed impervious surfaces generated by the first 15 mm of rainfall from a frequently occurring event shall be retained and/or detained, and treated (if required) at the source as much as practical to meet WSUD requirements
2.3.5.13	No part of the carparks shall be flooded, or inundated, during any storm event smaller than the 10% AEP storm event. The depth of stormwater during the 1% AEP event shall not be more than 200 millimetres in any part of the carpark, at any time, and there shall not be any ponding of stormwater for longer than six hours in any part of the carpark during a 1% AEP storm event
2.3.15.1	Any discharge into existing drains shall be compensated to reduce peak flows to pre-development flows or limits acceptable to the controlling authorities
2.3.15.2 a.	Infiltration into natural surface: If the soil permeability is adequate and no adverse environmental or community effects will result from standing water up to 96 hours, the run-off shall be managed in open drains and swales to infiltrate. Drain blocks at regular intervals and based on hydraulic calculations can be used to maximise infiltration. Excess run-off shall be treated by passing through a vegetated detention basin or approved treatment system. In the sites with potential high-risk pollution (e.g. fuel filling or storage areas, station open carparks, open train and other vehicle depot), first flush runoff should have appropriate treatment before infiltrating to groundwater or discharging to downstream environment when infiltration is not feasible.

2.3.17.5	Infiltration / detention basins shall be designed to include a stormwater biofilter (where treatment of runoff is required) unless otherwise approved by the PTA. Biofilters shall be designed and installed in accordance with the Adoption Guidelines for Stormwater Biofiltration Systems produced by the CRC for Water Sensitive Cities. Where treatment of runoff is not required, basins/flood storage areas shall be designed with vegetative retention/detention systems noting that the root systems of vegetation help to minimise potential soil clogging and maintain infiltration of runoff.

7.3.3 Current LWMS gaps and current proposed amendment.

7.3.3.1 Discrepancy of Beenyup Drain

A key discrepancy has been noted between the current DWMS, the LWMS, and As-Built infrastructure constructed onsite. This discrepancy relates to the split of the Beenyup Drain flows, which has resulted in majority of this flow being directed north to the Oakland Outfall Drain in the northwest of the site.

The DWMS documents the intention for the Beenyup Drain flow to be split at the west end of the site, whereas the LWMS documents the intention for the split to occur at the mid-block between the proposed San Simeon Blvd and the sites west boundary (refer to *Figure 7.1*).

The Woolworths Shopping Centre Development has since constructed a headwall ('existing splitter headwall' on Figure 7.4) located to the east side of San Simeon Blvd prompting the new Beenyup-Oakland link to be located on the east side of San Simeon Blvd (refer to *Figure 7.4*). However, the current structure plan layout does not allow for this open drain provision.

In addition, Beenyup Drain flows are being directed northwards towards the Oakland Outfall Drain at the existing splitter headwall. This is attributed to the existing headwall constructed with only a stub provision for flows which are intended to head west in the LWMS, therefore directing all flows north.

The resolution that has been agreed with the Shire of Serpentine-Jarrahdale (SoSJ) is documented in GCOR-00467 and ensures compliance with the current structure plan and associated LWMS.

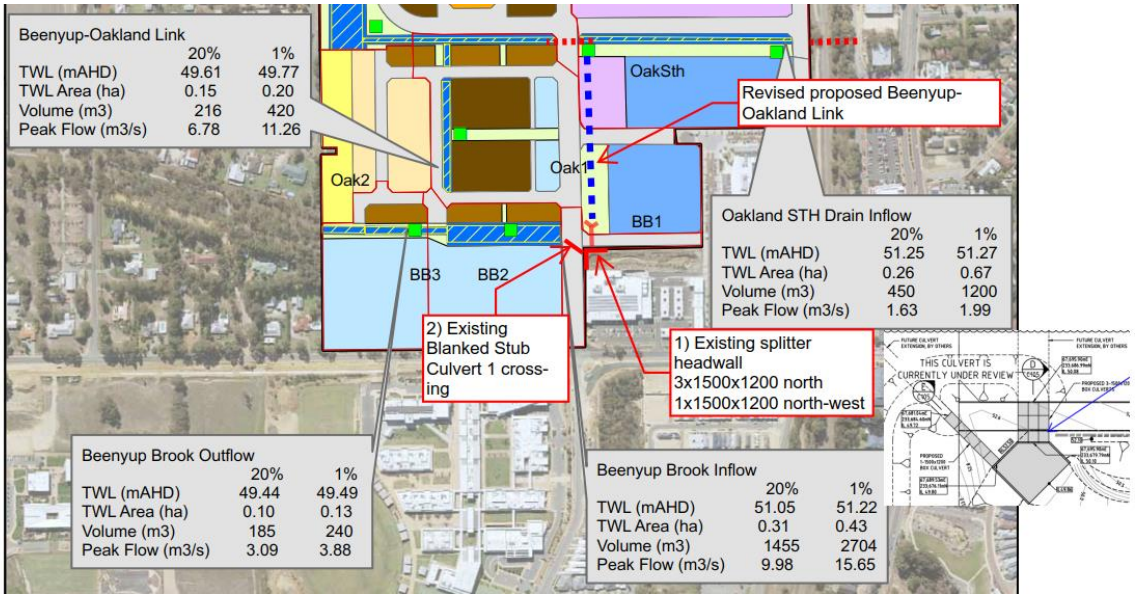

Figure 7.4. Beenyup Drain Split on-site discrepancy

7.3.4 Onsite Compensation

PTA specification, 2.3.15.1 states:

> *'Any discharge into existing drains shall be compensated to reduce peak flows to pre-development flows or limits acceptable to the controlling authorities.'*

For the Byford Station Precinct development and the associated external roads, the proposed design has adopted the LWMS requirements as the governing requirement for the development. The LWMS states that flows generated from the subdivisions are small in comparison to the design of the MUC corridors, which convey larger flows from the area to the East of the new Byford Station Precinct. As such there are no stormwater basins proposed as part of the development and all subdivisional flows can be managed in the MUC area. The LWMS explains that this strategy is feasible due to the critical storm event durations occurring at different timings i.e. critical duration from sites subdivisions being 1 hours, whereas the critical durations from the regional flows being 3 hours.

7.3.5 BRE Flood and Hydrology Study: Peak flow comparisons for main drains

A flood and hydrology study has been carried out for the extent of the BRE project and detailed in the R30-MET-RPT-CI-160-00001 report.

A comparison of peak 1% AEP flows are detailed in *Table 3*. BRE peak flows have temporarily been adopted to estimate major culvert sizes.

Table 3. LWMS vs BRE main drain flows

MAIN DRAIN	LWMS (2020) – 1% AEP	BRE (2023) – 1% AEP	% DIFF.
Oakland Drain Outflow	12.0 m^3/s	14.8 m^3/s	+23%
Oakland NORTH Drain	8.9 m^3/s	1.6 m^3/s	-82%
Oakland SOUTH Drain	2.0 m^3/s	3.0 m^3/s	+50%
Beenyup-Oakland Link	11.3 m^3/s	13.8 m^3/s	+29%

7.3.6 Overview of SW drainage strategy

Refer to the below excerpt from Hyd20 October 2021 LWMS addendum, that references the aforementioned LWMS requirement: Onsite development attenuation is for the first flush only (15mm) with attenuation for greater events handled within the MUC.

> *'The flows generated from the subdivision post development are small in comparison to the design of the MUC corridors which convey flows of approximately 18m^3/s. As such there are no stormwater basins proposed as part of the development and all subdivisional flows will be managed in the MUC area*.'

Based on this statement, it can be determined that the site has been designed to utilise Water Sensitive Urban Design (WSUD) features such as bio retention swales, central median swales, and bio retention basins, with a maximum storage depth of 300mm (as per the PTA requirements). Additionally, the design levels nominated throughout the site have been arranged to ensure surface water flows are directed to these WSUD features to achieve treatment at source.

The drainage strategy for the Byford Station Precinct and external roads, utilises WSUD features to retain and treat the first flush (15mm). Storms greater than the first flush volumes overtop into an overflow pit and are conveyed to the MUCs via a piped system that is designed to cater for the 20% AEP rainfall event. The surface water system is then designed to allow major storm events

(eg. 1% AEP) to overtop these WSUD features, with site levels manipulated in such a way to convey overland flows to the MUCs, which run from east to west through the site.

A description of the WSUD features used throughout the site, along with the drainage strategy for each individual area, are detailed below:

7.3.6.1 Connector Roads External to Precinct (San Simeon Blvd / Evans Way / Clara Street)

The recommended strategy to be implemented along the external connector roads, is for the initial treatment [first flush] to pass through the bio swales within the median strip, as per existing strategy in the development to the north of the site.

To accommodate this, the median swale will consist of a series of drain blocks [check dams] to hold back the initial 15mm [first flush] and a high flow catchpit to capture greater flows (i.e. 20%AEP). Treatment of the first flush will be via swale planting and filtration through an underlying medium [loamy sands] and subsoil drains, which connect into the pit and pipe network.

Minor flows will be conveyed via swales and pit/pipe network. Major flows will be safely conveyed within the carriageway, ensuring serviceability is maintained i.e. dry half lane widths, and a safe velocity depth.

Figure 7.5. San Simeon Blvd – Median Swale Treatment

7.3.6.2 LGA Minor Roads

LGA minor roads, such Access Road A and Access Road B [future road], will adopt bio-pockets due to spatial constraints within the precinct area. Details for the bio-pockets located in the verge are to comply with SoSJ's typical details.

Figure 7.6. San Simeon Blvd – Median Swale Treatment

7.3.6.3 Station Precinct Carpark

The Byford Station Precinct carpark runoff is directed towards swale median areas, similar to the San Simeon Blvd design. This strategy will incorporate a series of key drainage approaches, that will create a comprehensive network, as listed below:

1. Planted swales with a filtration medium and with subsoil pipe collection.
2. Series of check dams within swales to promote first flush retention and treatment.
3. Pit & pipe network to meet serviceability and safe major event conveyance requirements to outfall to adjacent MUC [Oakland North Drain].
4. Design levels in the carpark ensure that stormwater flows from high-category storm events are directed to the MUCs via overland flow routes.

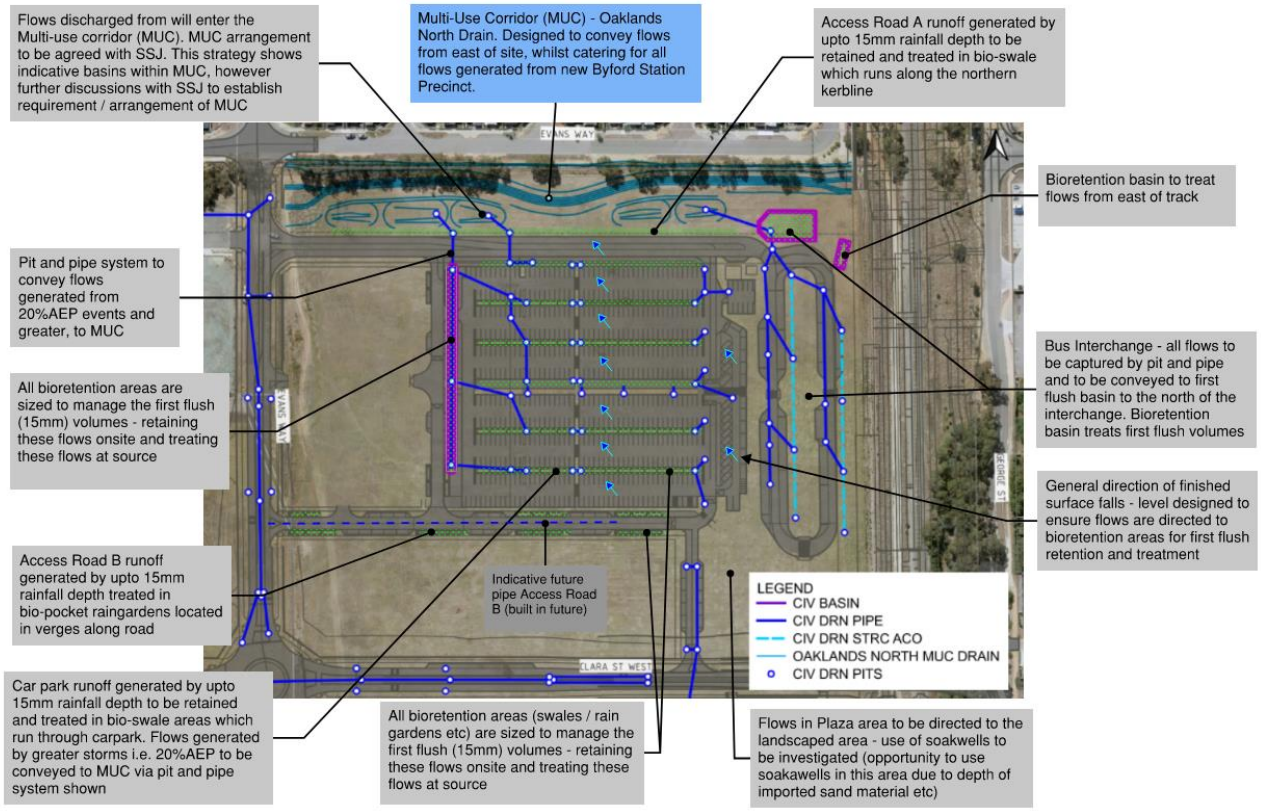

Figure 7.7. Precinct Drainage Strategy – Minor events

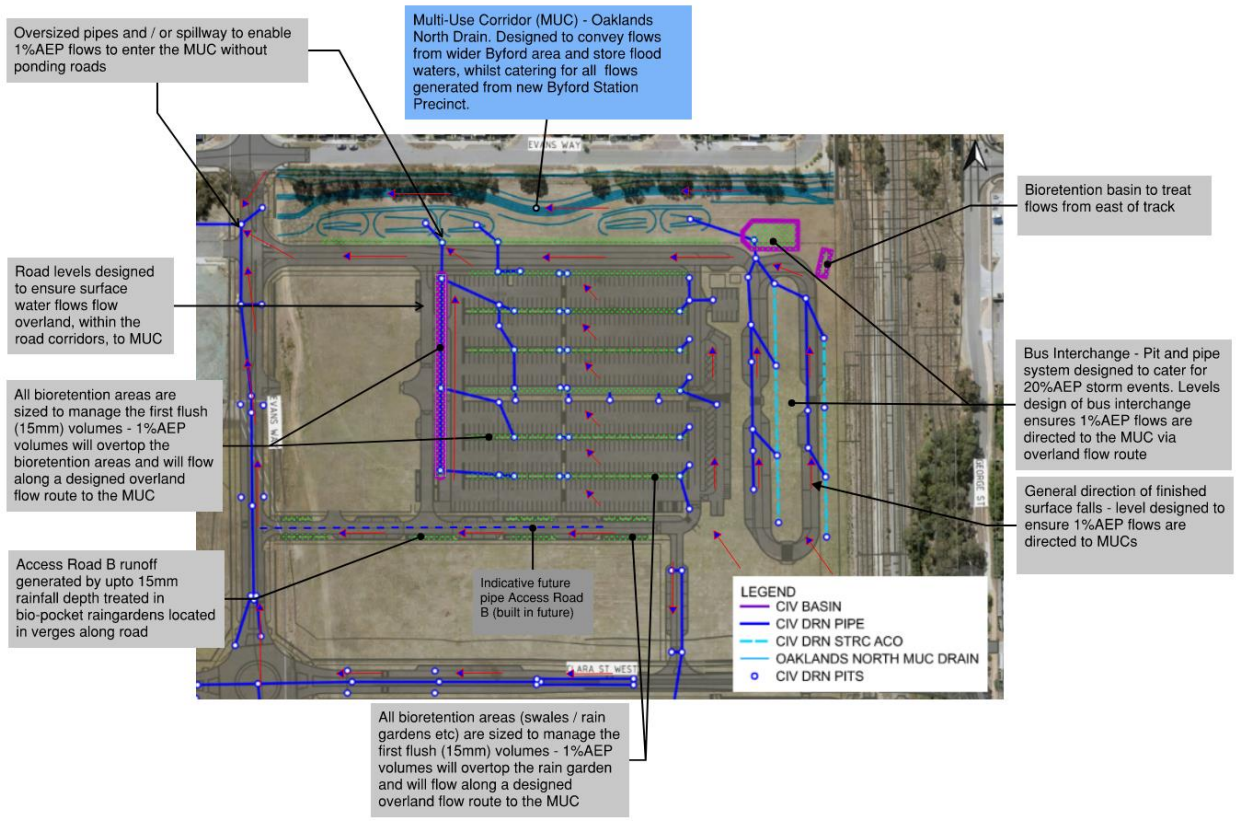

Figure 7.8. Precinct Drainage Strategy – Major events

Figure 7.9. Typical Carpark Bio Swale Treatment Area

7.3.6.4 Bus Interchange Area

The bus interchange area is primarily a hardstand area that falls northwards towards the Oaklands North MUC. The initial first flush volume will be directed towards a designated treatment area to the north as there is little opportunity to provide at source treatment areas within the interchange area.

The volume of sand fill to the station and bus interchange area is relatively high [2.0 – 2.5m] due to culvert and track levels. Soak wells for these areas present an opportunity and should be investigated further. Final subsoil placement is required and must ensure that localised groundwater mounding is controlled to acceptable limits.

Figure 7.10. Bus Interchange/Forecourt & Station (North Facing)

7.3.6.5 Station and Plaza Area

Station and Plaza area runoff can be captured via soakwells for non-trafficable areas (i.e. building and pedestrian traffic hardstand areas). The proposed fill [sand] for this area is relatively high [2.0m – 2.5m] due to culvert and track levels. Final subsoil placement will be required to ensure localised groundwater mounding is controlled to acceptable limits.

7.3.6.6 Subsoil Drainage

Subsoil drainage considerations for future lot areas between formalised LGA roads need to be considered and installed as part of the precinct works to ensure that effective mounding control can be provided when lots are created.

7.3.6.7 Multi-use Corridors (MUC)

Essential works are to maintain the continuity of northward Beenyup Drain flow towards the Oakland Outfall drain while ensuring the associated works undertaken do not preclude the development of the site in accordance with the local water management strategy.

As part of the Beenyup Drain Project Relocation Strategy, the following actions have been proposed:

1. The Woolworths existing splitter headwall will remain unchanged (3 x 1.5 x 1.2 RBC north, Single 1500 x 1200 NW stub), refer to *Figure 7.12*.
2. An ultimate culvert crossing arrangement (4 x 1.5 x 1.2 RBC) will be installed under San Simeon Blvd, which will be built to within the extents of the road reserve and capped off for future extension by others, refer to *Figure 7.12*.
3. The existing south-to-north open drain will be temporarily reconstructed to convey flow along the eastern side of the San Simeon Blvd embankment in the interim until development to the west occurs.

4. A secondary permanent San Simeon Blvd crossing will be installed (4 x 1.5 x 1.2 RBC) at the intersection of San Simeon Blvd and Clara St West, with an oversized capacity to manage Beenyup Drain's interim flows until the future west development is completed and the permanent main south crossing is connected (4 x 1.5 x 1.2 RBC).
5. A new culvert crossing will be installed for Evans Way roundabout (3 x 1.2 x 0.45 RCB).
6. The Oaklands North Drain section extending from the current rail corridor to the proposed Evans Way roundabout crossing will be formalised. Final treatment and requirements for this area is still to be agreed with the SoSJ.
7. The Oaklands South Drain Inflow will remain informal from its existing formalised tie-in point to the NW of the site, typical example in *Figure 7.11* below.
8. The future Oakland South Outflow will remain informal, and a temporary channel will be used until it is graded to its ultimate design. Formalisation of this MUC will occur once the remaining boundary edge is developed, refer to *Figure 7.12* below.

Figure 7.81. Splitter Culvert Temporary Outlet Drain

Figure 7.12. Beenyup Drain Relocation Strategy

7.3.6.8 Byford Station Precinct Catchments

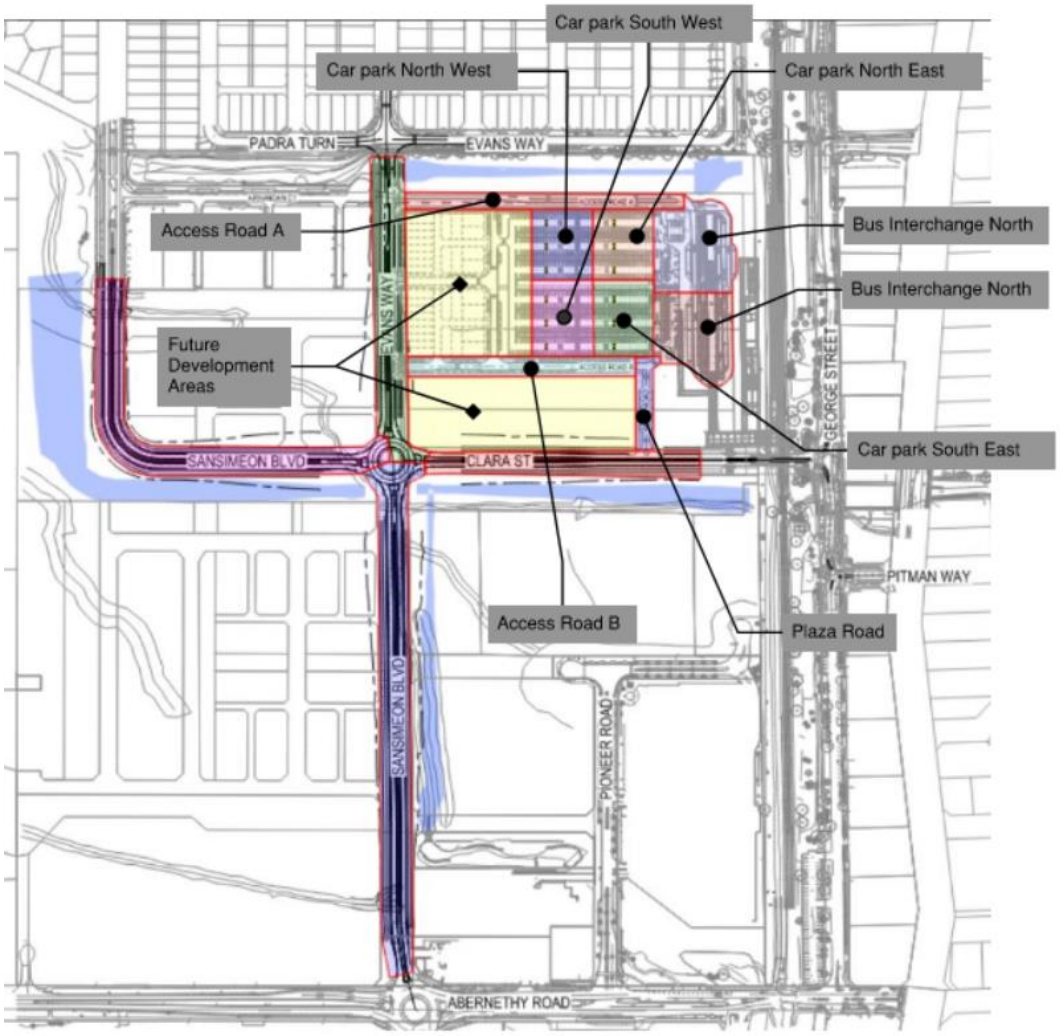

Figure 7.13. Byford Station Precinct Catchments

Figure 7.13, shows the different catchments throughout the proposed precinct. These have been segmented based on the proposed sites levels design, which is influenced by the track and station levels, and the sites existing topography.

Table 4 below summarises the data for each of these catchments. The table includes the catchment volumes for 15mm rainfall as well as the indicative treatment surface areas based on the 2% of impervious catchment guideline.

Table 4. Catchment Information

CATCHMENT	TOAL AREA (m^2)	IMPERVIOUS AREA (m^2)	15mm VOLUME (m^3)	2% IMP Area (m^2)
San Simeon Blvd West (Incl. section of roundabout)	9,678	5,898	89	118
San Simeon Blvd South (Incl. section of roundabout)	11,282	7,502	113	150
Evans Way	6,133	4,445	66	89

CATCHMENT	TOAL AREA (m^2)	IMPERVIOUS AREA (m^2)	15mm VOLUME (m^3)	2% IMP Area (m^2)
(Incl. section of roundabout)				
Clara Street (No roundabout area included)	4,852	3,037	46	61
Access Road A (to interchange)	4,114	3,604	54	72
Access Road B (Future Road)	3,347	2,772	42	55
Plaza Road	1,037	1,022	16	21
Car park North East	2,891	2,731	41	55
Car Park South East	3,312	3,072	46	61
Car Park North West	2,652	2,497	38	49
Car Park South West	3,000	2,770	41	55
Bus Interchange North (Inclu. Section of KnR)	4,654	4,654	70	93
Bus Interchange South (Incl. Section of KnR)	4,638	4,638	70	93

7.3.6.9 Climate Change

Sensitivity analysis of peak major event flows for the MUC corridors and culvert crossings will be provided in the next phase of works based on results from the project flood and hydrology studies.

8. Hydrologic Input Data

8.1 Rainfall

The rainfall data for the Byford Station Precinct area has been extracted from the Bureau of Meteorology and is provided as Intensity-Frequency- Durations (IFD). This data provides more context into the average rainfall for the region and is used to estimate the approximate stormwater volume that the drainage network will need to convey, manage, and store.

8.1.1 Intensity Frequency Duration Data

Table 5. IFD Extraction Data and Location

IFD Design Rainfall Depth (mm)				
Issued:	27-Jun-23			
Location Label:				
Requested coordinate:	Latitude	-32.2190	Longitude	116.0056
Nearest grid cell:	Latitude	32.2125 (S)	Longitude	116.0125 (E)

Table 6. IFD Data

Duration in min	63.20%	50%	20%	10%	5%	2%	1%
1	1.84	2.03	2.66	3.12	3.59	4.23	4.76
2	3.24	3.54	4.55	5.28	6.03	7.07	7.92
3	4.33	4.75	6.13	7.13	8.16	9.59	10.8
4	5.22	5.74	7.46	8.7	9.98	11.7	13.2
5	5.98	6.59	8.59	10	11.5	13.6	15.3

Duration in min	63.20%	50%	20%	10%	5%	2%	1%
10	8.63	9.56	12.6	14.8	17	20.1	22.6
15	10.4	11.5	15.2	17.8	20.5	24.2	27.2
20	11.7	13	17.1	20.1	23.1	27.3	30.6
25	12.9	14.2	18.7	21.9	25.2	29.8	33.4
30	13.8	15.3	20	23.5	27	31.8	35.8
45	16.2	17.8	23.2	27.1	31.2	36.9	41.5
60	18.1	19.8	25.7	30	34.5	40.9	46.1
90	21.1	23	29.7	34.6	39.9	47.4	53.6
120	23.5	25.6	32.9	38.4	44.2	52.7	59.9
180	27.3	29.7	38	44.5	51.4	61.6	70.3
270	31.8	34.5	44.1	51.6	59.8	72.1	82.8
360	35.3	38.3	49.1	57.5	66.7	80.6	92.8
540	40.8	44.4	56.8	66.6	77.4	93.9	108

8.1.2 Pre-burst

Median Pre-burst Rainfall depths were applied to rainfall data to account for ARR Data Hub storm losses. The median pre-burst rainfall data is published in *Table 7*.

The conversion from storm Initial losses to burst initial losses is shown in *Equation 1*:

Burst Loss = Storm Loss - Preburst

Equation 1

Table 7. Median Pre-burst rainfall depths

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	6.4	6.3	6.3	6.3	5.6	5.1
90 (1.5)	7.3	7.5	7.6	7.7	7.9	8
120 (2.0)	3.4	4.7	5.6	6.5	6.5	6.5
180 (3.0)	3.2	3.8	4.3	4.7	5.1	5.4
360 (6.0)	1.9	2.1	2.2	2.3	3.1	3.7
720 (12.0)	0.6	0.7	0.7	0.7	1.9	2.8
1080 (18.0)	0.2	0.2	0.2	0.2	1	1.5
1440 (24.0)	0	0	0	0	0.4	0.7
2160 (36.0)	0	0	0	0	0	0
2880 (48.0)	0	0	0	0	0	0
4320 (72.0)	0	0	0	0	0	0

8.2 Losses

Initial and continuing losses have been extracted from the ARR Data Hub for use in hydrologic modelling and are shown in *Table 8* below.

Table 8. Storm Losses

ID	Value
Storm Initial Losses (mm) - Pervious	26
Storm Continuing Losses (mm/h) - Pervious	6

Storm Initial Losses (mm) - Impervious	1
Storm Continuing Losses (mm/h) - Impervious	0
Antecedent Moisture Condition (AMC)	3 – Rather Wet
Soil Type/Classification	C – Slow Infiltration rates

9. Flood and Hydrology Study

The Byford Rail Extension (BRE) Byford Station Precinct has been modelled with an interim development condition to reflect the initial development, prior to full development of the site; which will ultimately be developed inline Byford Station precinct LWMS dated May 2021. As part of this process, the flood and hydrology study has been carried out considering two scenarios:

The Interim Town Precinct Development or BRE Project scenario, which aims to demonstrate the effectiveness of the proposed works in a 10% AEP event, and to determine the flood extent in a 1% AEP event. This scenario includes:

- The existing Woolworths headwall and culvert arrangement remain unchanged.
- The proposed culvert crossings: Evans Way roundabout and San Simeon roundabout.
- The formalised drains: Oaklands North Inflow
- The temporary drains: Beenyup-Oaklands link and Oaklands South Drain Oakland Outflow Drain.

The Ultimate Town Precinct Development scenario, which aims to ensure that the alliance strategy aligns with the future MUC drains to be installed by the developer and meets the requirements of the LWMS. This scenario includes:

- The blocking of the existing culverts (at the existing Woolworths headwall) which enable flows north to Oaklands South Drain.
- The proposed culvert crossings: Evans Way roundabout, San Simeon roundabout and the new San Simeon culvert which connecting existing Beenyup Brook with LWMS proposed Beenyup Drains (i.e. flows enabled from east to west over San Simeon Blvd).
- The formalised drains: Oaklands North Inflow
- The temporary drains: Oaklands South Inflow and Oaklands South Outflow
- LWMS proposed splitter 1x1.5x1.5 directing to Oaklands drain and 1x1.2x1.6 continuing to Beenyup Brook.
- LWMS proposed drains: Beenyup Inflow drain, Beenyup Outflow drain, and Beenyup-Oaklands link.

9.1 Contributing waterways

The Byford Precinct area receives inflow from three main points, as reflected in Table 9 and summarised below:

- Culvert 14 - Evans Way (3 x 1.2 x 0.45 RCB). Culvert crossing located at the NE corner of Byford Station Precinct, underneath the design rail line at chainage 36025. Detail design is provided in the interfacing package - CI-155, Linewide Earthworks and Drainage design package.
- Culvert 15 - Clara Street (4 x 1.5 x 1.2 RCB). Culvert replacing the Bridge at chainage 36322 that spans the Macora Brook in Byford town centre. It is located at the mid-east section, crossing underneath the design rail line. Design details provided in CI-155, Linewide Earthworks and Drainage design package.

- Crossing underneath Pioneer Road (4 x 2.4 x 1.5 RCB). It is located in the existing Beenyup Drain at the SE corner.

Table 9. Peak Flow Inflows Byford Precinct

Location	LWMS 1% AEP Peak Flow (m^3/s)	BRE Flood Study 1% AEP Peak Flow (m^3/s)
CUL 14 – Evans Way	8.9	1.55
CUL 15 – Clara Street	1.99	2.93
Beenyup Brook	15.65	13.83

In the Interim BRE Project scenario, the only outfall point is the Oakland Drain Outfall at the NW corner. In the ultimate Town Precinct Development scenario, there are two outfall points from the Town Precinct area: the Oakland Drain Outfall at the NW corner and the Beenyup Drain Outfall near the SW corner.

9.2 Results Interim (BRE Project Scenario)

9.2.1 MUC Oaklands North and Byford Station Precinct

In the critical 1% AEP event, the proposed Oaklands North is designed to transport water efficiently from CUL 14 to Evans Way CUL.

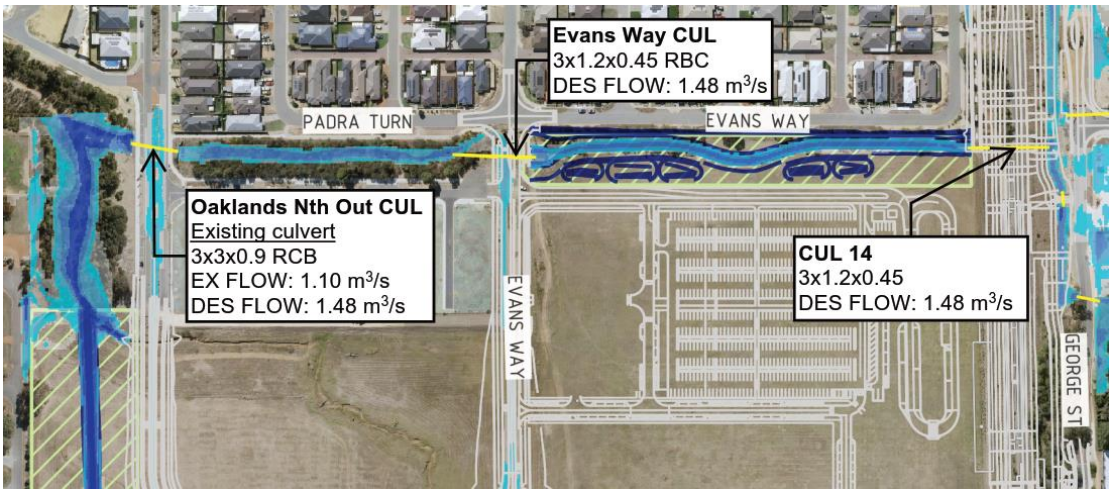

Figure 9.1. 1% AEP Interim Design Flood Map – Oaklands North Drain

The Byford Station Precinct Digital Elevation Model has been included in the TUFLOW model. The flood levels have been assessed for the 1% AEP flood with an allowance for 300mm freeboard to railway station finished floor levels. As can be seen, all flows are managed within Oaklands North Drain and Oaklands North Outlet. A small area of flood is shown in the model and this can be associated with flows from Abernethy – which is explained later in this document.

The Byford station is located between chainage 36000 and 36500. Figure below shows the 1% AEP flood elevation adjacent to Byford station.

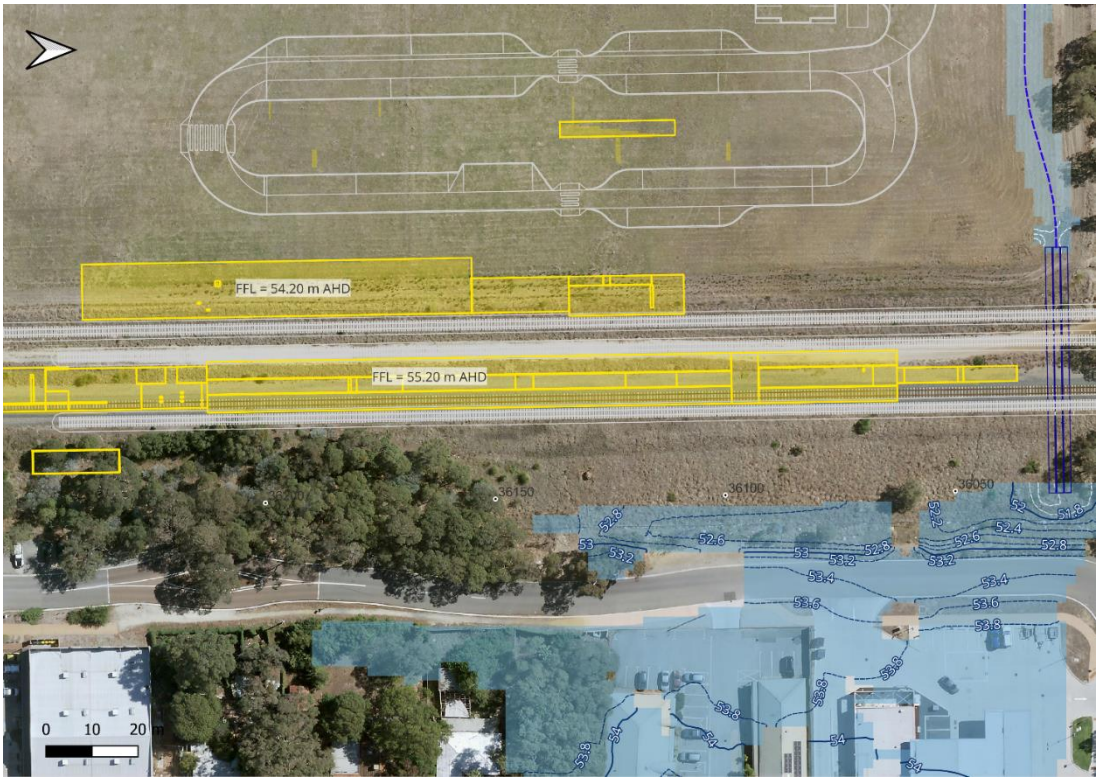

Figure 9.2: Byford Station Flood Immunity

9.2.2 MUC Oaklands South and Beenyup Brook

The permanent San Simeon Boulevard roundabout crossing (4x1.5x1.2 RBC) has the capacity to handle 90% of the combined flows from the Oaklands South Inflow and interim Beenyup Drains. However, the lot located to the south of the Oaklands Drain Inflow MUC is vulnerable to flooding in the event of a 1% AEP occurrence. In such a scenario, floodwaters could reach a maximum depth of 1m and inundate an area of 1 hectare however, this considered unlikely to occur as development of this lot is likely to occur within 10-15 years at which time the ultimate scenario would be in effect.

On the downstream end of the culvert, approximately 0.2 hectares of land would be affected by flooding, with maximum depths reaching 0.25m. As per above this would be unlikely.

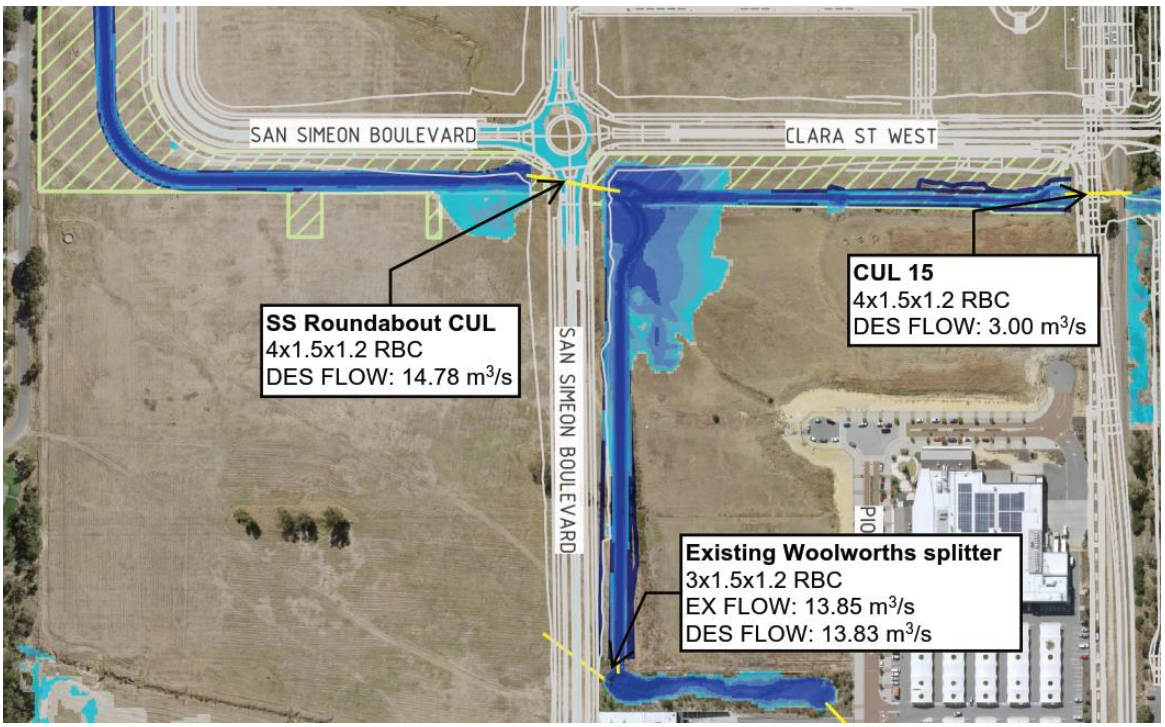

Figure 9.3. 1% AEP Interim TP or BRE Project Scenario Flood Map – Oaklands South Drains and Interim Beenyup-Oaklands Link

9.2.3 Abernethy Road

In both the existing and design scenarios, during the 1% AEP flood event, Beenyup Brook exceeds its banks before the crossing culvert at Abernethy Road. The flow rate overflowing during this event is measured at 0.5m^3/s. The water flow continues draining to the roundabout, where it bifurcates, with one branch draining towards San Simeon Boulevard and Evans Way, and the other following Abernethy Road.

Figure 9.4. 1% AEP Flood Map - Abernethy Road

9.3 Results Ultimate Town Precinct Scenario

In the 1% AEP event, the proposed drainage systems in Oaklands North and Oaklands South have been designed to efficiently convey water from culverts 14 and 15 to the existing Oakland North drain tie-in located at the northwest corner of the town centre site.

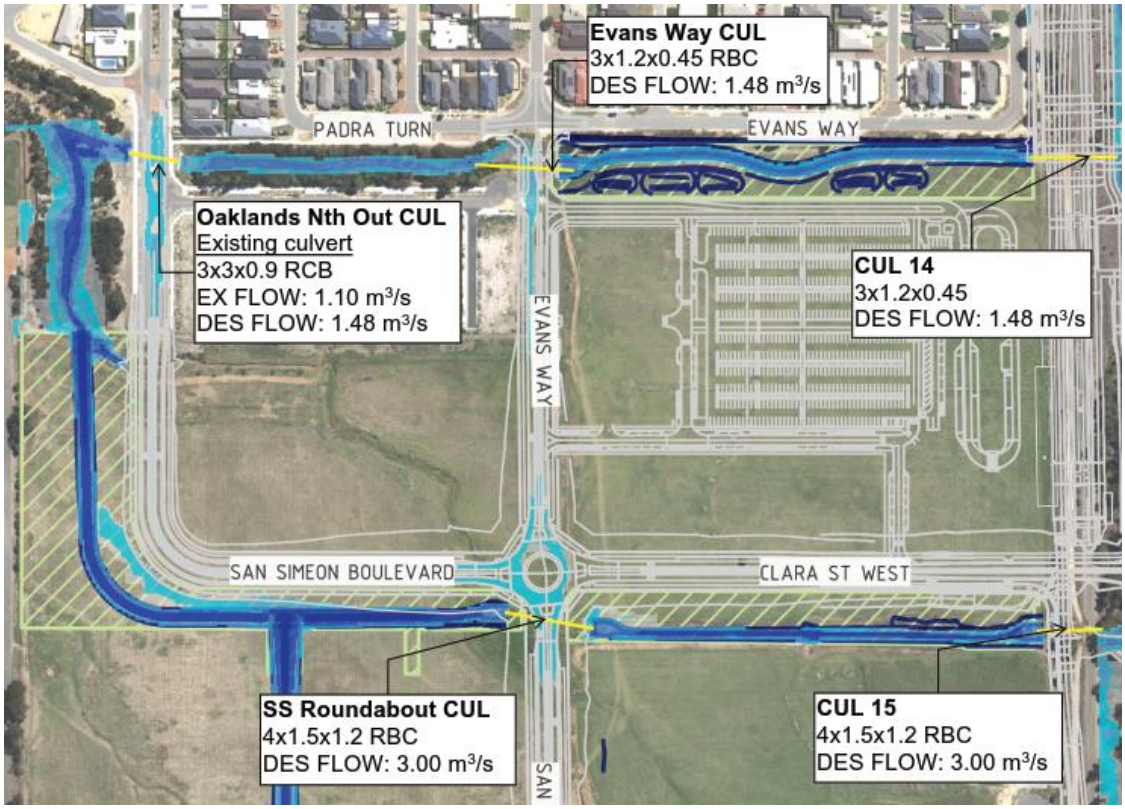

Figure 9.5. 1% AEP Flood Map Ultimate Design – Oaklands North and Oaklands South drains

According to our model results, the split system proposed in the LWMS, consisting of a 1.5x1.5 metre box culvert directing flow to Oaklands and a 1.2x0.6-meter box culvert continuing to Beenyup Brook, is inadequate to handle the 13.8 m^3/s of water flowing from the upstream culvert.

It is worth noting that the existing culvert beneath Pioneer Road has a much larger 4x2.1x1.2-meter arrangement capable of accommodating 100% of the existing Beenyup Drain flows. Given the significant disparity in size between the existing culvert beneath Pioneer Road and the two smaller culverts in the proposed split system, it seems impractical to expect the latter to handle the same peak flow of water as the former.

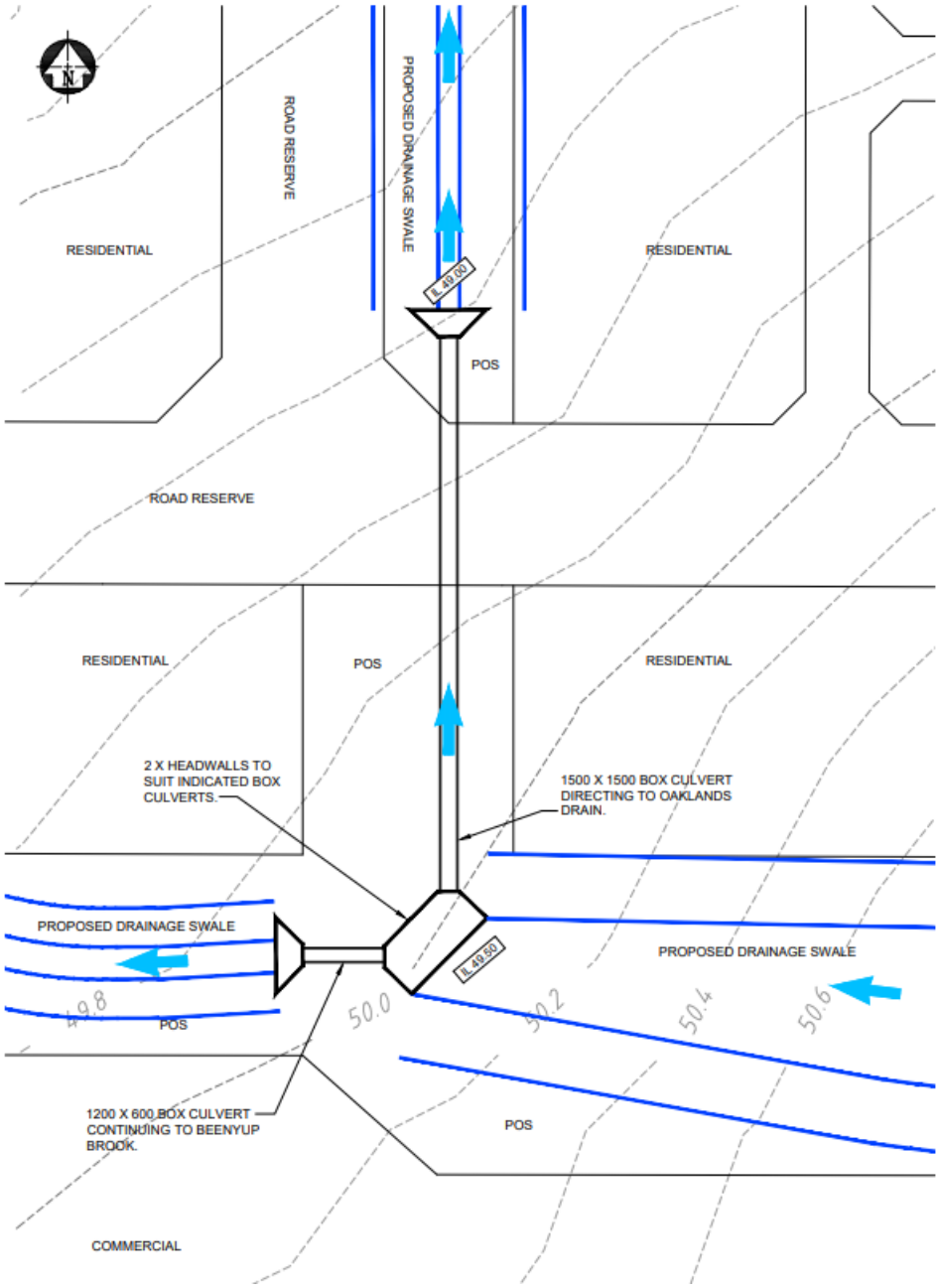

Figure 9.6. Proposed Beenyup Brook Splitter LWMS (2021)

Considering these findings, MetCONNX proposes that a larger arrangement be installed in the future to ensure adequate conveyance of water. In our modelling, the alliance has taken into account a doubling of the capacity, assuming an arrangement of 2x1.5x1.5 meters directing flow to Oaklands and 2x1.5x0.6 meters continuing to the Beenyup outflow. This will provide a more robust system capable of handling the flow rates from the upstream culvert and ensure that flooding risks are minimized. It is recommended the future development further investigates and consults with relevant stakeholders to determine the optimal design and implementation strategy.

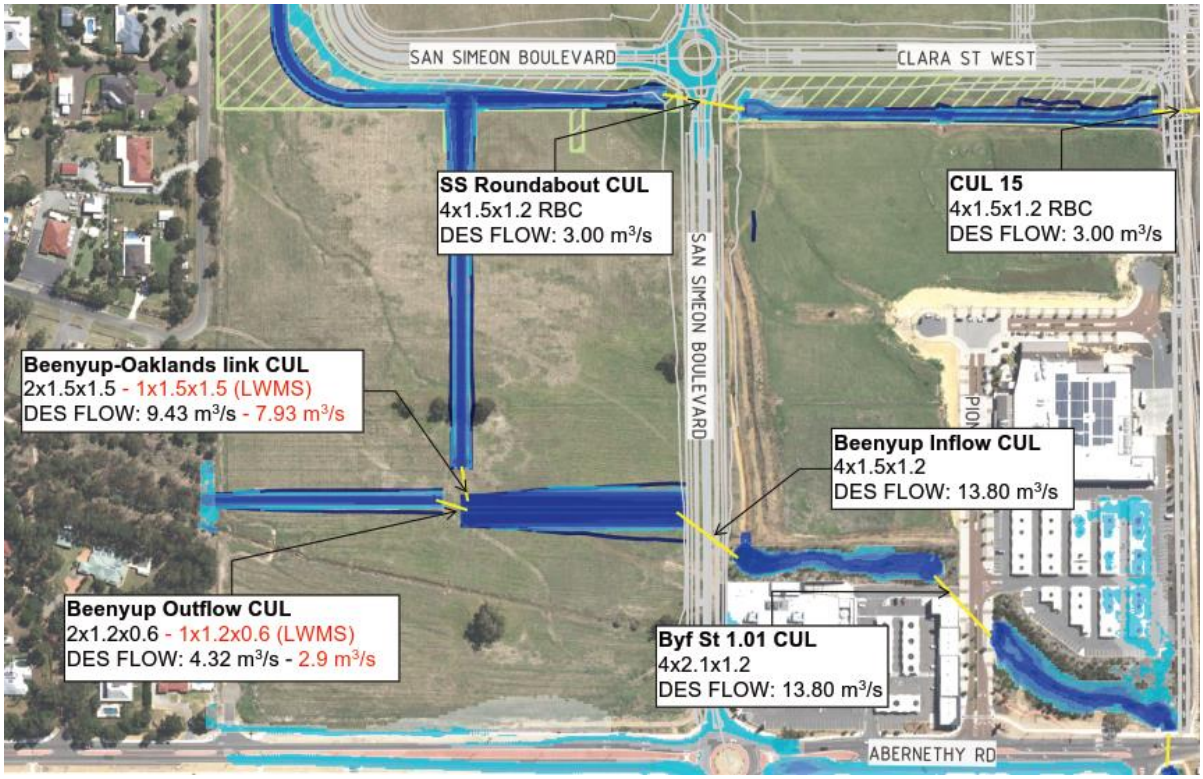

Figure 9.7. 1% AEP Ultimate Town Precinct Design Flood Map – Beenyup Brook and Beenyup-Oaklands Link

Appendix A – Local Water Management Strategy Addendum (LWMS)

Appendix B – Local Structure Plan (LSP)

LWMS 2021