Anketell Road West Drainage Strategy

Prepared for Main Roads WA

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Version C

OPPORTUNITIES THROUGH EXCELLENCE
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Contents

Appendices

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Abbreviations

Abbreviation	Description
1 EY	The number of times an event is likely to occur or be exceeded per year (EY)
AEP	Annual Exceedance Probability
AGRD	Austroads Guide to Road Design
ARI	Average Recurrence Interval
ARR	Australian Rainfall and Runoff
IFD	Intensity Frequency Duration
mAHD	Elevation in metres with respect to the Australian Height Datum

1. Introduction

1.1 Project Description

The Anketell Road Upgrade – Leath Road to Kwinana Freeway is the proposed upgrade of Anketell Road to an Expressway Standard between Leath Road, within the Kwinana Industrial Area, and Kwinana Freeway. The proposed Expressway links the Western Trade Coast, including the Kwinana Industrial Area, Rockingham Industry Zone, Australian Marine Complex and Latitude 32 to existing and future Industrial Areas via the upgraded section of Anketell Road and the existing Kwinana Freeway and Roe Highway.

The Anketell Road Upgrade – Leath Road to Kwinana Freeway includes:

- Upgrading Anketell Road to dual carriageway between Leath Road and Treeby Road
- Grade separation of Anketell Road / Treeby Road
- Grade separation of Anketell Road / Kwinana Freeway (3 level interchange)
- Grade separation of Anketell Road / Mandogalup Road
- Grade separation of Anketell Road / Abercrombie Road
- Grade separation of Anketell Road / Armstrong Road
- Grade separation of Anketell Road / Rockingham Road
- Upgrading of Rockingham Road from Macedonia Street to approx. 1.1km south of Anketell Road
- Significant other local road improvements

1.2 Scope of Report

This report presents the Drainage Strategy for the Anketell Road West ultimate design within the Development Envelope as shown in Figure 1.

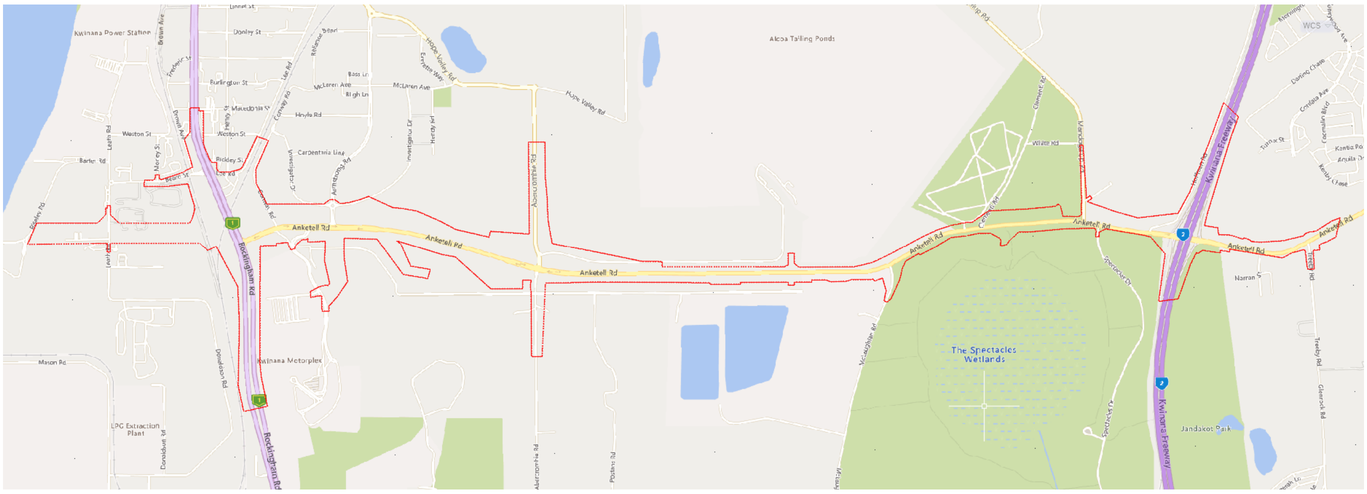

Figure 1: Project development envelope

2. Runoff Management Objectives

The runoff management objectives of the drainage strategy are:

- Minimise impact on wetlands, groundwater dependent ecosystems and adjacent environmental receptors.
- Maintain the hydrology of the project area.
- Minimise impact on surface water and groundwater.
- Provide for water sensitive urban design.
- Minimise clearing of vegetation.
- Minimise impact on existing utilities.

3. Infrastructure Sustainability Council

3.1 General

The Infrastructure Sustainability Council (ISC) is a member-based, purpose-led organisation working in Australia and Aotearoa New Zealand to enable sustainability outcomes in infrastructure

The Anketell Road Upgrade – Leath Road to Kwinana Freeway as part of the greater Westport project is being submitted to ISC to achieve a Planning Rating under ISv2.1. The Westport project has committed to achieving a Gold rating.

This section outlines how this Drainage Strategy was developed in accordance with ISC requirements.

3.2 Pla-2 Urban and Landscape Design

The intent of the Pla-2 credit is to create infrastructure that has been influenced by the local context, fits its setting, and meets the needs of the people that will use it, while preserving and enhancing scenic, aesthetic, cultural, community and environmental resources and values.

The drainage strategy has been developed through an options assessment process that considered the existing hydrology of the project area/local context, the runoff management objectives of the project and the maintenance/operational considerations of the asset owner.

The drainage strategy resulting from the options assessment process will maintain the hydrology of the project area through the infiltration of the small frequent rainfall events, which in turn will maintain the existing groundwater recharge benefitting adjacent wetlands and ecosystems. The strategy also provides for retention and infiltration of major storm events, managing flood risks to the new road and adjacent areas.

3.3 Lea-2 Risks and Opportunities

The intent of the Lea-2 credit is to identify, assess and manage key sustainability risks and opportunities relevant to the project context and meaningful to affected stakeholders.

The main drainage sustainability risks are related to climate change, with the potential impacts and how these are being addressed discussed in Section 4.

Two drainage opportunities have been identified and are discussed in Section 10.

3.4 Res-1 Climate, Natural Hazards and Resilience

The intent of the Res-1 credit is to identify, assess and treat risks to the asset associated with climate change and natural hazards.

Climate change and the potential impacts to the drainage of the project have been identified and discussed in Section 4. The most significant risk is the intensification of rainfall, and this has been considered in the selection and application of the drainage options to the project.

An overall project Climate Change and Natural Hazards risk register has been developed for the Anketell Road Upgrade project (Anketell Road CCNH Risk Register – 03072024). The register outlines key risks, such as the increasing intensity of rainfall, increase in extreme rainfall events and increase in bushfire weather

The risks associated with increased intensity of rainfall and increase in extreme rainfall events have been incorporated into the strategy by including the increased intensities in the sizing of basin elements as discussed in Section 4.4.2. The impacts on elements such as the capacity of conveyance networks like pit and pipe systems will be addressed in the detailed design stage.

The drainage risks associated with increasing bush fire weather, being increased risk of blockage from ash deposition, favour the use of more resilient open conveyance systems, which are also favoured from a WSUD perspective and were considered as part of the drainage strategy development. Where space constraints require the use of closed conveyance systems (e.g. pit and pipe networks) the risks from increased bushfire weather will be considered for those elements in the detailed design stage.

3.5 Res-2 Resilience Planning

The intent of the Res-2 credit is to develop resilient infrastructure that contributes to broader community resilience.

The drainage strategy has been developed to manage runoff from the project area in both minor and major events in a way that minimises flood risk to both the proposed road and the adjacent properties. The management of the runoff has also made allowance for rainfall intensification from climate change to provide a resilient solution.

Being a main road under the control of the department of Main Roads, the Anketell Road upgrade will provide a road with a high serviceability in rainfall events, providing a means of egress to the surrounding areas in major storm events.

3.6 Eco-1 Ecological Protection and Enhancement

The intent of the Eco-1 criteria is to identify, protect and enhance ecological value.

The drainage strategy was developed cognisant of the existing hydrology of the project area and how that supports the existing wetlands within/adjacent to the project area. The proposed drainage strategy provides for infiltration of the small frequent rainfall event through permeable base pits and infiltration basins to keep the infiltration of the frequent rainfall events, and hence the recharge of the groundwater, as close to source as possible and as close to the existing hydrology and recharge as possible.

In particular it was noted that the flow into the Spectacles wetland is a combination of surface flow from the Peel Main Drain upstream of the project area and groundwater inflow from around the project area. The infiltration of the project runoff therefore maintains the nature of flows into the Spectacles wetland by groundwater flow rather than surface flow for the area around the Spectacles. Maintaining the existing performance of the culverts under Anketell Road on the Peel Main Drain will also maintain the existing surface flows into the Spectacles wetland from the drain.

The siting of proposed infiltration basins has been undertaken to minimise impacts on vegetation by locating them in previously cleared areas where possible.

3.7 Her-1 Heritage

The intent of the Her-1 credit is to maintain or enhance local heritage values across all infrastructure phases and raise awareness of these values with project stakeholders and the community.

The project passes through a predominantly industrial area, which includes the Kwinana Industrial area around Rockingham Road, the Alcoa Kwinana Alumina Refinery and the Kwinana Wastewater Treatment Plant. The main area of heritage concern is the Spectacles wetland to the south of Anketell Road. The drainage strategy has been developed cognisant of the heritage value of the Spectacles wetland, with drainage options being selected to maintain the hydrology of the area and therefore of the wetland. The selected drainage options (infiltration basins) have been sighted to minimise impacts to the wetland and will be landscaped as ephemeral wetlands.

4. Climate Change

4.1 General

Main Roads Western Australia Guideline on Climate Change (MRWA, 2024, 3D)[5] requires the consideration of climate change aspects in the planning and delivery of infrastructure projects. Specifically, it requires consideration of sea level rise and rising temperatures including the impact rising temperature has on rainfall patterns. Australian Rainfall and Runoff A guide to flood estimation Book 1 – Scope and philosophy (ARR, 2024, Version 4.2)[1] – Climate Change Chapter has been updated in August 2024 and contains guidance on the impact of rising temperatures on rainfall. Each of these impacts and how they are being considered in this drainage strategy are discussed in the sections below.

4.2 Sea Level Rise

The Main Roads Guideline on Climate Change requires the implications of a 300mm sea level rise for roads to be considered as part of the planning, design and construction for all rehabilitation and expansion projects near coastal areas. (MRWA, 2011)[4]

With the western end of the project connecting to the Kwinana industrial area adjacent Cockburn Sound, the implications of sea level rise are being considered by the Drainage Strategy.

The area around Leath Road is around 5mAHD and therefore is unlikely to be directly impacted/flooded as a result of sea level rise. However, the Perth Groundwater Map (PGM) maximum water level contours show this area to have a maximum groundwater level between 0mAHD and 1mAHD, and sea level rise will likely impact the groundwater levels in the vicinity of Leath Road and possibly impact the drainage. In this area, drainage options will include consideration of the potential for groundwater levels to rise by up to 300mm, associated with a sea level rise of 300mm in accordance with the Main Roads Guideline. (MRWA, 2024)[5]

At the Rockingham Road / Anketell Road intersection, the ground level is around 17mAHD, with the maximum groundwater level in the PGM still just below 1mAHD. In this area, where there is significant separation between the groundwater levels and proposed infrastructure, sea level rise will not influence the drainage options (i.e. a slight change in clearance to the groundwater level will not materially affect the application of the deep water table model in infiltration calculations/performance).

Further east, in the vicinity of the Spectacles North wetland, the existing ground levels and proposed infrastructure levels are close to the maximum groundwater levels in the PGM. However, the wetlands are approximately 5.8km inland from the coast and the impacts of a 300mm sea level rise on groundwater levels are not expected to extend this far inland.

4.3 Rising Temperatures

The Main Roads Guideline noted that rising temperatures could potentially increase the hardening of the binder used in the road seal thereby reducing its lifespan.

Rising temperatures will also increase evaporation losses, and combined with changing rainfall (less total rainfall) increases the importance of managing runoff at source to maintain the existing site hydrology.

Rising temperatures also effect rainfall patterns, which are discussed in the following section.

4.4 Changing Rainfall

4.4.1 General

The Main Roads Guideline acknowledges that climate change projections released by the CSIRO and the Bureau of Meteorology, 2015 show that an increase in precipitation intensity is likely in the future. It notes that a warming climate can lead to a decrease in annual rainfall and increase in flood producing rainfall.

The Guideline recommends that Intensity Frequency Duration (IFD) rainfall data is adjusted for future climate change using the method outlined in A guide to flood estimation Book1, Chapter 6 of Australian Rainfall and Runoff (ARR, 2024, Version 4.2)[1] A Guide to Flood Estimation 2016.

As noted in Section 4.1, Book 1, Chapter 6 of ARR (2024, Version 4.2)[1] has recently been updated with regards to climate change and estimating the impacts on flood behaviour. It notes that when applying an event-based procedure to estimate flooding it generally takes into account the following climate related factors:

- Design storm of a given AEP (e.g. IFD data)
- Temporal patterns
- Spatial patterns
- Loss parameters that represent soil moisture conditions (in terms of an initial loss and continuing loss)

4.4.2 Intensity Frequency Duration

With regards to the IFD Curves, ARR notes that there has been warming since the 2016 IFD curves available from the Bureau of Meteorology were developed and recommends that these are adjusted to current day rainfall depths or intensities to account for the warming that has already happened.

The ARR Guidelines also provide a calculation for adjusting rainfall depths/intensities based on a given time horizon and Shared Socioeconomic Pathways (SSPs) based on global temperature changes. Notably, when adjusting these depths/intensities, there is recognition that the increase is greater for shorter duration storms (≤ 1hr) than it is for longer duration storms (≥ 24hr).

Adopting the time horizon of 2080-2100 (2100) and SSP5-8.5 (which represents the trajectory climate change is on), the recommended adjustments to rainfall intensities are given in Table 1.

Table 1: Rainfall intensity increases for Climate Change

Duration	≤1hr	1.5hr	2hr	3hr	4.4hr	6hr	9hr	12hr	18hr	≥24hr
Increase	77%	69%	64%	58%	52%	49%	45%	42%	39%	37%

In accordance with Main Roads best practice recommendations, PC Sump, Version 6.1 was used to assess infiltration basins incorporating application of the Interim Climate Change Guideline from ARR (2019) for Design Rainfalls (which provides a maximum increase of 18% across all durations). The parameters provided in Table 2 were used when assessing infiltration options and a separate sensitivity check was made for the higher increases provided by the new guidance based on the critical storm durations.

The sensitivity check involves calculating the difference in increased total runoff (by increasing the total inflow reported for the critical storm in PC Sump by the additional increase required by the Climate Change guideline in ARR e.g. for a 3 hour critical duration the increased inflow would be 1.58/1.18 = 1.34 or a 34% increase) and then checking if the basin has storage available for the additional inflow. Where there is insufficient additional storage the basin size has been increased to provide the required storage.

Table 2: Parameters for Climate Change in PC Sump

Effective Service Life / Planning Horizon	2090
Consequence of Failure	High

4.4.3 Temporal Patterns

ARR notes that, whilst there is evidence that temporal patterns may become more front loaded and that the shift towards more front loaded storms based on the analysis of historical data is statistically significant, the magnitude of these changes is small and the impact of temporal pattern changes on design flood estimates may be of little practical significance.

ARR notes that there is no published methodology for quantifying the effect of changing temporal patterns on design flood estimates nor published literature on their impacts on design flood estimates. However, it does provide some guidance on how this might be approached if it was believed that the design flood estimate may be sensitive to small changes in temporal patterns.

For the assessment of options and application of those options at this planning level, it is considered that small changes to the temporal patterns (noting that design software already assess a range of temporal patterns for each duration) are not likely to impact the outcomes.

4.4.4 Spatial Patterns

ARR notes that whilst there is some evidence that climate change will influence spatial patterns of extreme rainfall, there are considerable uncertainties around such changes for localised regions and therefore does not recommend amending spatial patterns or areal reduction factors. It is also noted that the road drainage catchments are small compared to the waterway catchments and usually don't apply spatial effects/areal reduction factors because of their limited extent.

4.4.5 Loss Parameters

It is presented in ARR that historical changes in antecedent moisture conditions have impacted frequent flood peaks, with smaller proportional impacts for rarer events. A methodology for adjusting the Initial Loss (IL) and Continuing Loss (CL) based on climate change is presented, which utilises the formula for adjusting IFD rainfall depths/intensities. As the IL and CL changes are generally positive (higher losses), they will generally help to reduce the impacts of the increased rainfall intensities.

It is noted that the IL and CL changes in ARR are based on large catchments where a large percentage of the catchment will be pervious. The road drainage catchments in Western Australia are largely impervious, with relatively small areas of pervious catchment contributing unless the road is in a large cutting. It is also noted that the project is within an area of relatively high permeability soils (sands), and therefore, the major contributor of runoff to the road drainage system will be the impervious area. No adjustment will be made to the IL/CL losses when assessing drainage options/applying them to the strategy as it is not considered to be critical and will provide a slightly more conservative approach.

5. Site Conditions

5.1 Groundwater

Based on the maximum groundwater contours in the Perth Groundwater Map, the groundwater level generally falls from the Jandakot mound at the eastern end of the project towards the ocean at the western end of the project. To the west of Abercrombie Road, the groundwater contours are fairly flat, suggesting that this section may be influenced by the ocean tidal movements.

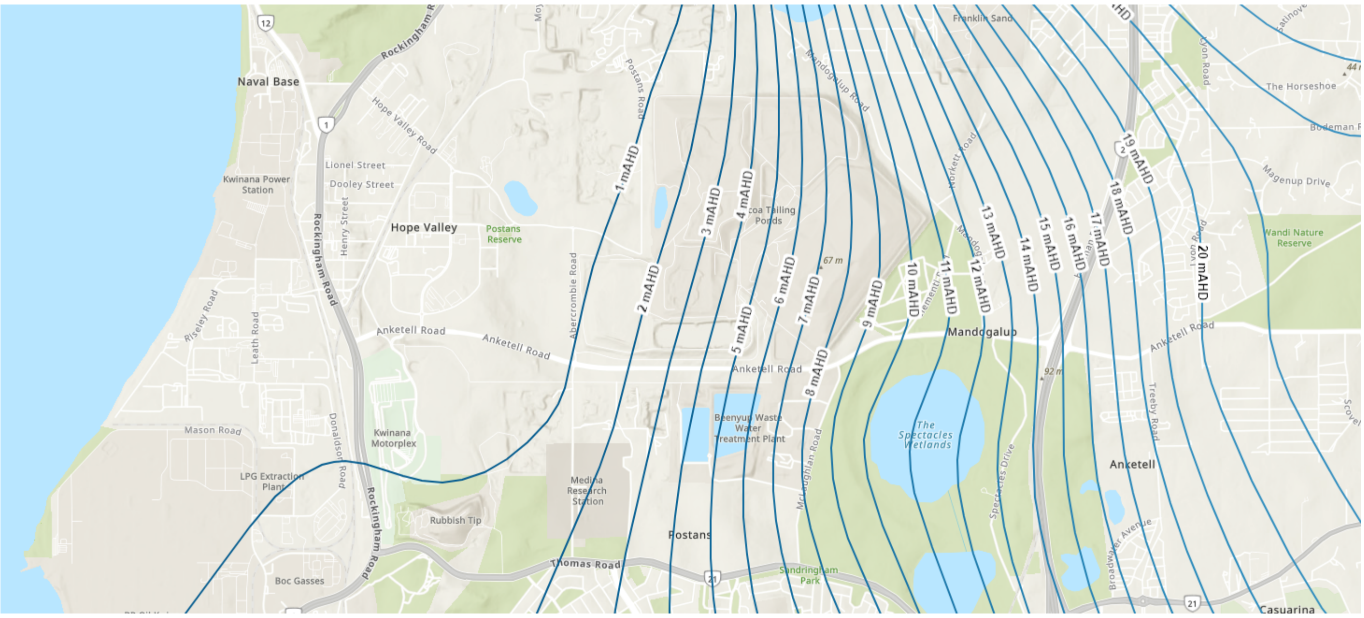

Figure 2: Excerpt of Perth Groundwater Map maximum contours (2019)

Main Roads is undertaking an investigation of the maximum and minimum groundwater levels across the project, based on groundwater monitoring they have conducted over the last year. The outcomes of this investigation will need to be considered at the subsequent stages of the project.

It is noted in *Inferring groundwater dynamics in a coastal aquifer near wastewater infiltration ponds and shallow wetlands (Kwinana, Western Australia) using combined hydrochemical, isotopic and statistical approaches* (Bekele et al, 2019) that the groundwater mound created by infiltration of secondary treated wastewater at Kwinana Waste Water Treatment Plant (KWWTP) influences groundwater flow west of the Spectacles Wetland and maintains water level at the wetland.

5.2 Geology

The project lies within the Swan Coastal Plain, in an area characterised by the Spearwood and Bassendean dune systems. The main hydrologic features within the project area are wetlands and swamps formed in the interdunal swales of the Bassendean dune system and intercarrier depressions between the Spearwood dune and the Bassendean dune systems, and within the Spearwood dune system.

The Pinjarra sheet of the Australia 1: 250 000 Geological Series of geological maps (excerpt in Figure 3 below) shows the site to be largely Tamala Limestone/limestone derived sand (at the western end near Rockingham Road) or quartz sand to the eastern end around the Spectacles wetland area. To the east of the Kwinana Freeway, it changes to Bassendean Sands. At the very western end, west of Rockingham Road, the site is composed of Safety Bay Sand.

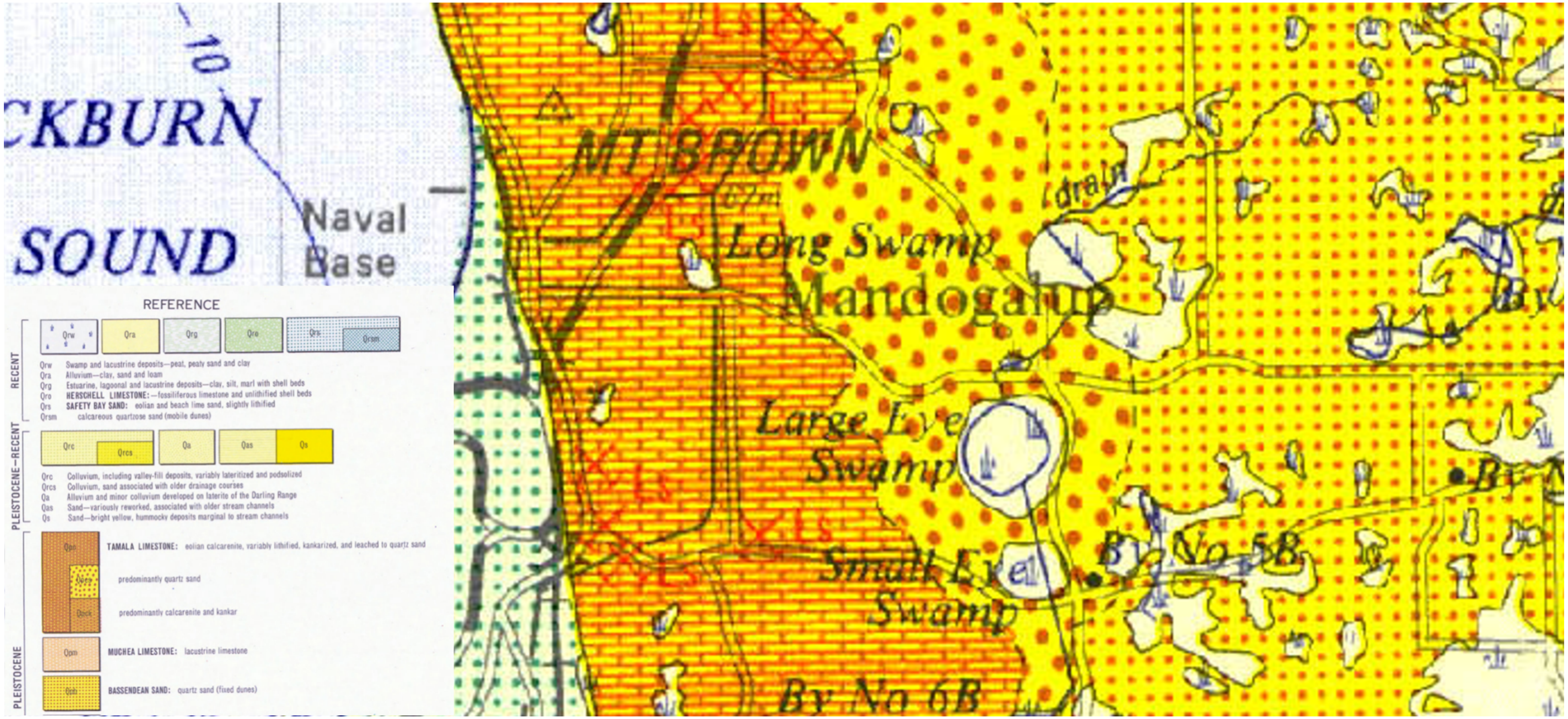

Figure 3: Excerpt of Pinjarra Sheet of Australia 1:250,000 Geological Series

5.3 Wetlands

The Department of Biodiversity, Conservation and Attractions Geomorphic Wetlands of the Swan Coastal Plain dataset (DBCA-019) shows multiple wetlands in the vicinity of the project. Notably, the Spectacles North Conservation Category wetland lies directly south of the existing Anketell Road and the Conway Swamp Resource Enhancement Category wetland lies to the northeast of the Anketell Road / Rockingham Road intersection.

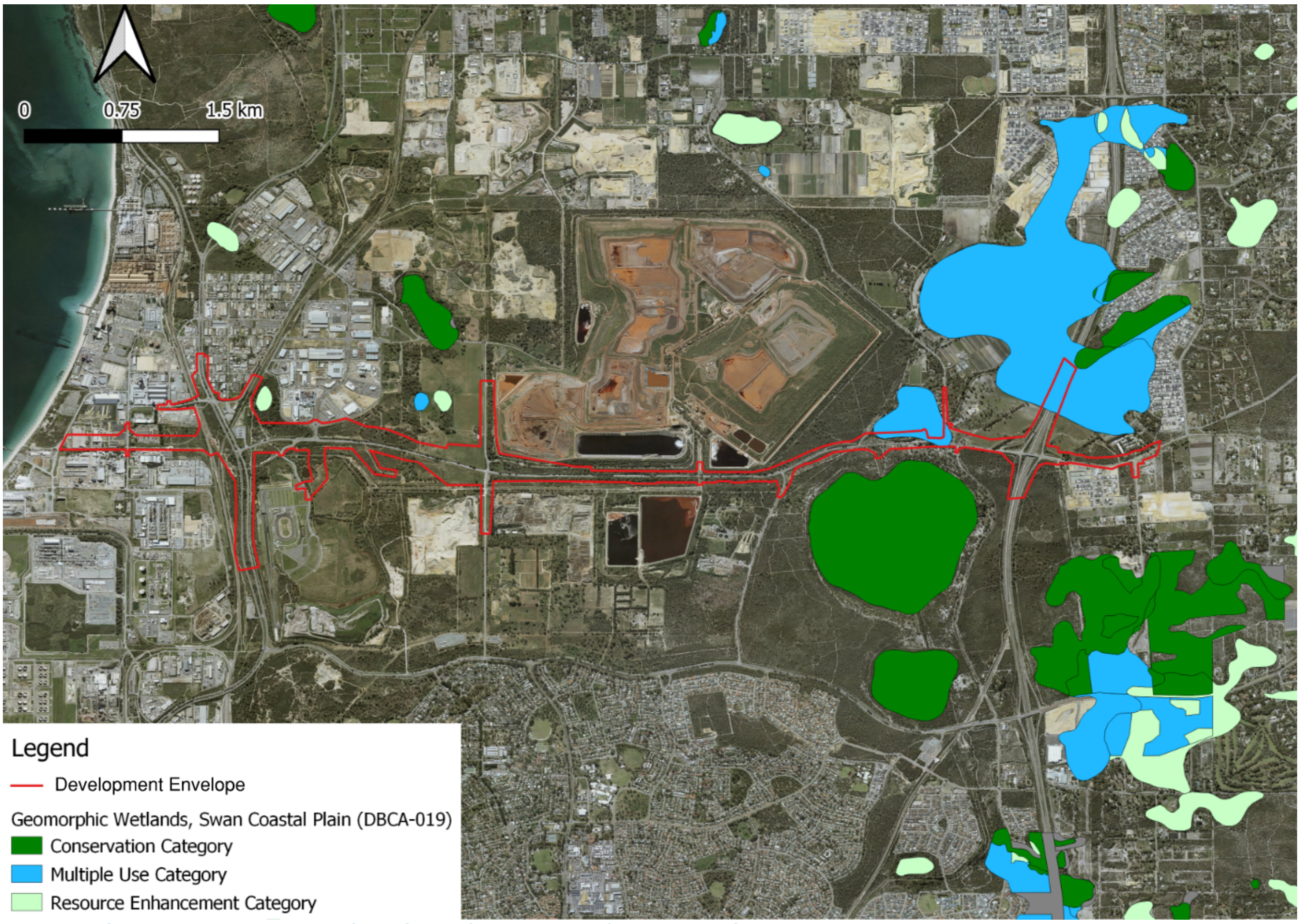

Figure 4: Geomorphic Wetlands of the Swan Coastal Plain from the DBCA-019 dataset

The Department of Water and Environmental Regulations (formerly Department of Water) *Jandakot drainage and water management plan – Peel main drain catchment* provides the below discussion of the importance of the Spectacles wetland:

"To the south of Mandogalup Bushland, in the mid-west of the study area lies the most important Bush forever and Environmental protection policy lake in the Jandakot area. The Spectacles wetlands, consisting of Spectacles north and Spectacles south, are Environmental protection policy lakes, are part of the Beeliar Regional Park, are listed on the Directory of important wetlands in Australia (Environment Australia, 2001) and lie within Bush forever site 269. The 349ha area contains significant flora Dodonaea hackettiana, a number of significant mammal and reptile species and provides an important waterfowl breeding site."

The management plan also notes that a comprehensive hydrological and nutrient balance investigation was undertaken by the Waters and Rivers Commission in 1997 with one of the key findings being that the Peel Main

Drain contributes approximately 48% of the water entering the Spectacles, with the remaining water being groundwater. It also notes that the northern extent of the Peel Main Drain is often not hydraulically connected to groundwater.

5.4 Threatened Ecological Communities and Bush Forever Sites

There are several types of threatened ecological communities (TECs) within the project area, including patches of the Commonwealth listed ‘Banksia woodlands of the Swan Coastal Plain’, ‘Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain’ and ‘Honeymyrtle shrubland’. The State listed ‘*Melaleuca huegelii – Melaleuca systena* shrublands on limestone ridges’ is also found in the project area.

The vegetation around the Spectacles wetlands (to the south of Anketell Road), to the east of the Alcoa Refinery site and north of Anketell Road and to the east of Kwinana Freeway (south of Anketell Road), as shown in Figure 5, is listed as Bush Forever. Within the Bush Forever area around the Spectacles wetland and to the east of Kwinana Freeway, there are areas classified as Class A reserve.

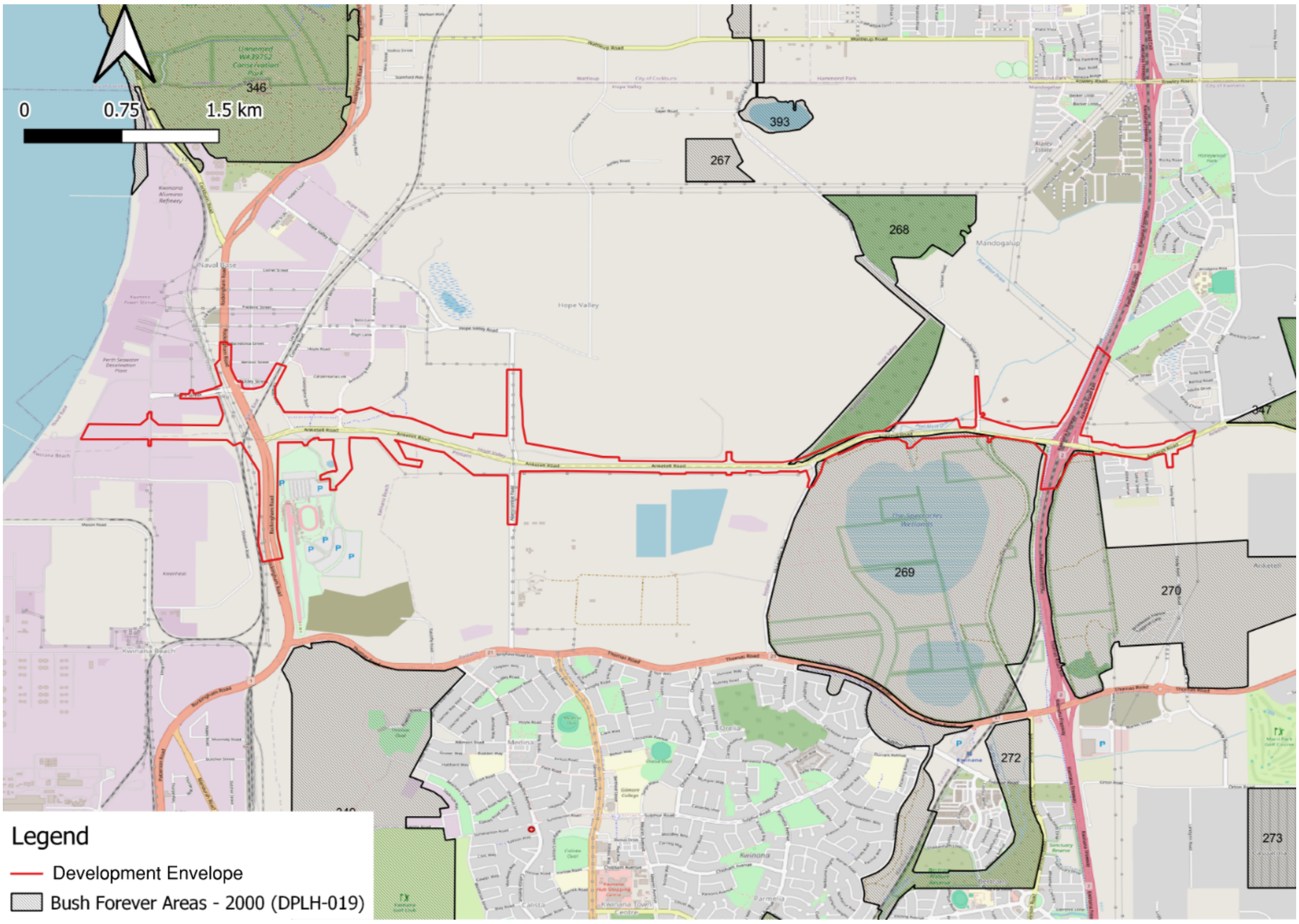

Figure 5: Bush Forever Areas from the DPLH-019 dataset

For more information about the TECs and other flora and flora present within the development envelope please refer to the *Anketell Road Upgrade Project Consolidated Biological Report* (Biota Environmental Services February 2024).

5.5 Contamination

There are contaminated sites within the development envelope as shown in Figure 6 below. Of note are the sites listed as 'Contaminated - remediation required' to the north and south of Anketell Road, associated with the refining of alumina.

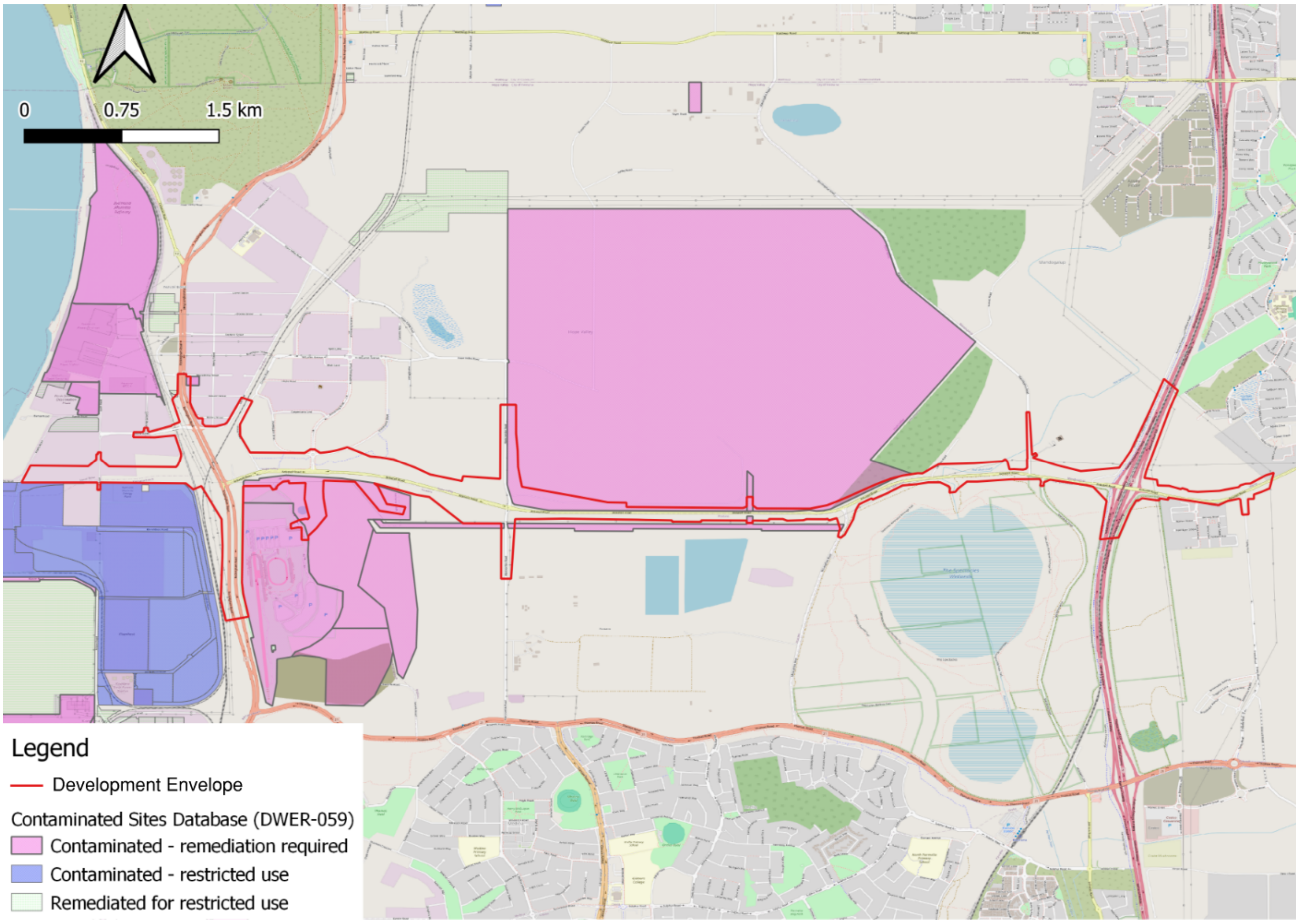

Figure 6: Contaminated Sites (DWER-059 Dataset)

5.6 Land Use

5.6.1 Existing

The existing land use around Anketell Road is predominantly industrial to the west of Kwinana Freeway. This includes the Kwinana Industrial Area to the west of Rockingham Road, the Alcoa Alumina Refinery to the north of Anketell Road between Abercrombie Road and Clementi Road and a WA Limestone quarry, Eclipse Resource Recovery Centre, and Kwinana Wastewater Treatment Plant to the south. Non-industrial land use to the west of Kwinana Freeway includes the Perth Motorplex motor racing facility to the south of Anketell Road on the east side of Rockingham Road, the Bush Forever sites as noted in Section 5.4 and rural residential to the north of Anketell Road between Clementi Road and Kwinana Freeway.

To the east of Kwinana Freeway, the existing land use is predominantly residential to the south of Anketell Road, with the exception of the Bush Forever site adjacent the freeway. To the north of Anketell Road, the land is generally undeveloped with the exception of a poultry farm directly north of Treeby Road.

The project area from Riseley Road to Rockingham Road passes through the existing Kwinana Industrial Area. From Rockingham Road to Abercrombie Road, there is an industrial area to the north and the Perth Motorplex and WA Limestone quarry to the south.

5.6.2 Proposed

There are proposed changes/developments within the land around the project area, particularly to the north of Anketell Road as discussed below.

Mandogalup Improvement Scheme No. 1

The Department of Lands, Planning and Heritage have an improvement scheme for the Mandogalup area to the north of Anketell Road, extending up to Rowley Road. The scheme is centred around a proposed extension of Hammond Road that would connect to Anketell Road at the current Mandogalup Road intersection. The scheme proposes a mixture of light industrial, general industrial, composite and service commercial development.

Hope Valley Redevelopment Masterplan

The Hope Valley Redevelopment Masterplan covers the Hope Valley area east of Rockingham Road, extending north of Anketell Road to Russel Road. The development plan is for an industrial precinct and includes the Latitude 32 light industrial and general industrial developments. The masterplan includes a new north-south road reserve between Armstrong Road and Abercrombie Road.

Kwinana Town Planning Scheme

The Kwinana Town Planning Scheme generally reflects the schemes above, although it shows the area between Mandogalup Road and the Kwinana Freeway as a mix of development (residential) and Rural A as opposed to the industrial development proposed by the Mandogalup Improvement Scheme No. 1, however, noting the improvement scheme is the more recent document.

6. Existing Drainage

6.1 General

The existing drainage along Anketell Road and within the development envelope is a mixture of unkerbed roads that sheet to the verge/roadside drains to infiltrate, and kerbed roads with localised pit and pipe networks that discharge to nearby infiltration basins. The existing drainage through each section is discussed in more detail below.

6.2 Riseley Road to Rockingham Road

The section of the project between Riseley Road and Rockingham Road is currently a combination of an unused road reserve with no formal drainage and industrial properties that typically would be required to retain runoff on their lot.

Leath Road to the south of the project is kerbed with a pit and pipe system. The pit and pipe system discharges into a basin on the east side of Leath Road at the southern side of the project boundary. To the north, Leath Road is unkerbed, with runoff sheeting to the verge to infiltrate.

6.3 Rockingham Road / Anketell Road Intersection

Rockingham Road at the intersection with Anketell Road is locally kerbed and drained by small pit and pipe networks. The northbound carriageway is kerbed from just north of the signals to approximately 120m south of the signals and is drained by a pit and pipe network to an infiltration basin located between Rockingham Road and the Alcoa pipeline to the south of the intersection.

The southbound carriageway is only kerbed at the intersection and is drained by a pit and pipe network into a small infiltration basin in the southeast quadrant of the intersection.

Outside of the kerbed extents, Rockingham Road is unkerbed with runoff sheeting to the verge/median to infiltrate in table drains. Excess runoff from the southbound carriageway north of the intersection is collected in a catchpit/gully grate and piped to the infiltration basin in the southeast quadrant. The southbound carriageway south of the intersection is in superelevation and runoff sheets into the median to infiltrate. The northbound carriageway to the south of the intersection sheets to the verge, with excess runoff flowing along the verge in a table drain to the north side of the Alco pipeline, where it runs across the verge towards the basin. The northbound carriageway north of the intersection and south of the railway bridge sheets to the verge with excess runoff flowing across the verge towards a topographic low point adjacent to the railway to the west.

The pavement area in the median at the intersection is drained by two pits that discharge to a small infiltration basin in the median immediately south of the intersection.

Anketell Road grades downhill to the east from the intersection and is kerbed. The drainage of Anketell Road is discussed in the section below.

6.4 Anketell Road – Rockingham Road to Armstrong Road

Anketell Road eastbound is in superelevation from the intersection with Rockingham Road through to the access to the Perth Motorplex. The median is kerbed and drained by pits that discharge to the southern verge. The outside edge is unkerbed from just east of the intersection through to the Motorplex entrance, where it is kerbed again through to Armstrong Road. To the west of Armstrong Road, the low point on the eastbound carriageway is drained by two side entry pits that discharge to the northern verge into the bushland around Conway Swamp,

The westbound carriageway is kerbed from the intersection with Rockingham Road through to the Perth Motorplex westbound exit. A small pit and pipe network (that also picks up the westbound median) discharges to the verge to the east of the access. To the east of the Motorplex westbound exit, Anketell Road westbound is unkerbed with runoff sheeting to infiltrate and/or flow east towards the Perth Motorplex access. The Perth Motorplex access at the intersection with Anketell Road, Anketell Road westbound east of the intersection and the Armstrong Road intersection (including Armstrong Road near the intersection) is drained by a pit and pipe network to infiltration basins located to the south of Anketell Road and east of the Motorplex access.

6.5 Anketell Road – Armstrong Road to Abercrombie Road

There is a crest on Anketell Road approximately 500m east of the intersection with Armstrong Road, with runoff to the west of the crest flowing back towards Armstrong Road and runoff to the east flowing towards Abercrombie Road to a sag approximately 80m west of the roundabout.

To the west of the crest, Anketell Road eastbound is unkerbed with runoff sheeting into a roadside table drain to infiltrate, with excess runoff flowing towards Armstrong Road and flowing back onto the road at the intersection to enter the pit and pipe system that discharges to the basins on the south side of Anketell Road as described in the previous section. The westbound carriageway to the west of the crest is also unkerbed, however it appears to be in adverse crossfall, with runoff sheeting to the northern verge/eastbound carriageway table drain. Approaching the intersection, a kerbed median is formed with pit and pipe drainage that discharges to the basins at the Anketell Road / Perth Motorplex intersection, as described in the previous section.

To the east of the crest, Anketell Road is unkerbed and sheets into roadside table drains. It appears that the westbound lane is mostly in slight adverse crossfall and flows into the eastbound side table drain. The eastbound lane becomes kerbed approximately 77m from the Abercrombie Road roundabout, and the roadside table drain is collected by a catchpit and piped to an infiltration basin on the south side of Anketell Road. A kerbed median is formed approximately 200m west of the roundabout, with the westbound lane concentrating on the median kerb and being collected in two gully grates at the sag and discharged into the basin on the south side of Anketell Road.

6.6 Anketell Road / Abercrombie Road

The Anketell Road / Abercrombie Road roundabout is kerbed and generally grades from the southeast to the northwest.

The western leg of the roundabout grades towards the sag on Anketell Road, as described in the previous section.

The northern leg grades towards the north to a side entry pit between the roundabout and the Alcoa entry. This pit appears to discharge to the adjacent verge area (either via headwall or bubble up pit), where runoff can infiltrate or flow north to a topographic low point in the adjacent property. Opposite the Alcoa entry, there is a kerb opening to discharge runoff to the verge/topographic low point.

The eastern leg of the roundabout has a gully grate in the median island to capture the runoff from the westbound lane and discharge it to basins in the southeast quadrant to infiltrate. The eastbound lane is kerbed at the roundabout, with runoff flowing along the kerb and across to the side entry pit on the northern leg of the roundabout.

The southern leg of the roundabout is kerbed approaching the roundabout. It appears that most runoff concentrates on the western kerb and is collected by a side entry pit on the northbound side at the roundabout. This pit appears connected to the basin on the south side of Anketell Road adjacent to the sag, as discussed in the previous section. Data from the City of Kwinana shows it connected to a bubble up structure, however, Street View imagery from November 2023 shows a manhole at this location.

6.7 Anketell Road – Abercrombie Road to McLaughlan Road

Between Abercrombie Road and McLaughlan Road, there are two crests on Anketell Road, one approximately 600m east of Abercrombie Road (crest 1) and the other approximately 340m west of McLaughlan Road (crest 2), with a sag between them.

To the west of crest 1, Anketell Road is unkerbed with the eastbound lane sheeting into a roadside table drain to infiltrate. Excess runoff flows along the drain to a low area in the northeast quadrant of the Abercrombie roundabout, adjacent the Alcoa access. The westbound lane appears to be mostly in adverse crossfall, with runoff concentrating on a median island, which is captured by the gully grate discussed in the previous section. There is also a roadside table drain along the westbound lane that directs any runoff flowing into it towards the basin in the southeast quadrant of the Abercrombie roundabout.

Between crest 1 and crest 2, both lanes are generally unkerbed. The eastbound lane sheets into table drains to infiltrate, with excess runoff flowing to the sag where it is discharged to an infiltration basin located on the north side of Anketell Road. There is a short section of kerning on the eastbound lane at the sag, which is collected by a side entry pit that presumably discharges to the basin to the north. The westbound carriageway again appears to fall across to the north side of road and into the eastbound table drains, however, there are table drains alongside the westbound lane to capture any runoff that does flow off to the south. These table drains direct runoff that doesn't infiltrate to topographic low points either side of the main pond of the Kwinana Wastewater Treatment Plant, on the south side of Anketell Road.

To the east of crest 2, the road is in superelevation, with runoff sheeting off into a roadside table drain on the north side (eastbound side) to infiltrate, with excess runoff flowing to the east to Clementi Road.

6.8 Anketell Road – McLaughlan Road to Peel Main Drain

Anketell Road to the east of McLaughlan Road is generally unkerbed with runoff sheeting to roadside drains/swales.

The Anketell Road westbound turn pocket onto McLaughlan Road is kerbed for approximately 90m east of McLaughlan Road. Anketell Road is grading to the east and runoff that collects on the kerb is discharged to the adjacent verge via a kerb opening at the eastern end of the turn pocket.

The eastbound table drain flows along Anketell Road to Clementi Road, where excess runoff that does not infiltrate in the table drain will flow under Anketell Road to the southern verge via a culvert and toward the topographic low point discussed below.

The westbound table drain grades eastward along Anketell Road to a topographic low point adjacent the Peel Main Drain, opposite Clementi Road. Runoff infiltrates into the table drain or into the topographic low point. In large events it possibly flows into the Peel Main Drain adjacent Anketell Road.

6.9 Anketell Road – Peel Main Drain to Mandogalup Road

From the Peel Main Drain to Mandogalup Road, Anketell Road is relatively flat, and the drainage is not well defined. The road is unkerbed with the exception of an approximately 40m long section at the Peel Main Drain to prevent direct runoff to the drain. Runoff from Anketell Road sheets to the adjacent verge to infiltrate. On the north side, the verge and adjacent land continue to grade north towards the Peel Main Drain, and runoff that doesn't infiltrate will enter the drain via a break in the levy along the drain approximately halfway between the Anketell Road crossing and Mandogalup Road.

Anketell Road appears to be predominantly in crossfall to the north, with minimal runoff to the south side. Runoff that does sheet off to the south, however, will flow along the road in informal table drains to a sag approximately 230m east of the Peel Main Drain. Runoff that doesn't infiltrate will pond alongside the road at the sag.

6.10 Anketell Road - Mandogalup Road to Hoffman Road

Apart from some localised kerbing at Spectacles Drive and Mandogalup Road, Anketell Road is unkerbed and crowned to the west of Hoffman Road. Runoff sheets into roadside drains to infiltrate with excess runoff flowing west/into adjacent land to infiltrate.

6.11 Anketell Road / Kwinana Freeway

Anketell Road at the Kwinana Freeway (from Hoffman Road through to approximately 270m east of the freeway) is kerbed. It is drained by pit and pipe systems to infiltration basins located in the northwest (between Hoffman Road, Anketell Road and the northbound entry ramp) and northeast quadrants.

Kwinana Freeway grades from south of Anketell Road to a low point approximately 690m north of Anketell Road. The freeway is unkerbed (apart from short sections at the ramp noses) with runoff sheeting to roadside table drains to infiltrate/flow to the north. The ramps are kerbed and drained by a pit and pipe network, which extends from the south facing ramps north to a detention basin on the east side of the freeway, south of the Peel Main Drain crossing. The pipe system also provides a high-level overflow from the infiltration basins in the northwest and northeast quadrants. Excess runoff in the table drains to the south of Anketell Road and from the southbound carriageway to the north of Anketell Road is captured in the pit and pipe system and directed to the detention basin on the east side of the freeway. There is a second smaller pipe network that collects runoff from the northbound entry ramp and excess runoff from the northbound carriageway north of Anketell Road and conveys it to a smaller detention basin on the west side of the freeway, south of the Peel Main Drain. There are subsoil drains along the west side of the freeway between the northbound entry ramp and the Peel Main Drain that discharge to this smaller pipe network.

The Mandurah Rail line runs in the middle of the Kwinana freeway through the project area and is drained by open drains that infiltrate runoff with excess runoff being discharged to the Main Roads pipe systems described above.

6.12 Anketell Road - Kwinana Freeway to Treeby Road

Anketell Road east of Kwinana Freeway is generally unkerbed. From Kwinana Freeway to Albina Avenue, the road is unkerbed and runoff sheets into roadside drains to infiltrate, with excess runoff flowing west alongside the road towards the pit and pipe network adjacent to the freeway. To the east of Albina Avenue up to Treeby Road, Anketell Road is in superelevation with runoff sheeting to the northern verge to infiltrate. Excess runoff appears to flow north into the adjacent properties to infiltrate. There is some kerbing on the north side of Anketell Road adjacent to Treeby Road, however there is no associated pit and pipe network, with runoff instead flowing to the verge at the end of the kerbed section.

7. Order of Design & Design Standards

The order of design for the design of drainage elements should follow the Decision process for stormwater management in Western Australia, (DWER, 2017)[2].

In general, this requires the consideration of groundwater, followed by the management of the small frequent rainfall events (up to 15mm rainfall depth), and then consideration of flood management for major storm events.

The “Decision process for stormwater management in WA” targets management of the small frequent rainfall events separate to flood management issues, as the majority of the annual average rainfall in the Perth Region and in parts of the state is contained within these small frequent events, and therefore these are the target for treating water quality and need to be considered separately to the flood management issues of the larger and rarer events.

The “Decision process for stormwater management in WA” was followed in the development of the drainage strategy.

The drainage strategy has also been developed with reference to the Stormwater Management Manual for Western Australia (DWER, 2023)[3] and Main Roads WA Supplements to Austroads Guide to Road Design, standard drawings and Main Roads Standards.

8. Drainage Options

The identification and assessment of drainage options for the development of the Drainage Strategy is documented in Appendix B. A summary of the process and outcomes is provided below.

The assessment considered the following structural controls from the Stormwater Management Manual for WA:

- Stormwater storage and use
  - Rainwater storage systems
  - Managed aquifer recharge
- Infiltration systems
  - Infiltration basins and trenches
  - Soakwells (leaky pits/permeable base pits)
  - Permeable/porous pavement
- Conveyance systems
  - Swales and buffer strips
  - Bioretention systems
  - Living streams
- Detention Systems
  - Dry/ephemeral detention areas
  - Constructed wetlands
- Pollutant control
  - Litter and sediment management
  - Hydrocarbon management

These options were assessed for the applicability given the site conditions (soil types, separation to groundwater) and their ability to address the target pollutants for the small frequent rainfall event. The infiltration and detention systems were also assessed as options for flood management. In general, the preferred options resulting from the assessment were:

- Infiltration (via permeable base pits and basins) for water quality in the small frequent rainfall event.
- Swales and buffer strips (via an unkerbed road) where possible, noting opportunity at early design stage.
- Infiltration (via basins) for flood management.

These options were preferred as they are effective at removing the target pollutants whilst maintaining the existing hydrologic regime through infiltration at/near source.

There were some special considerations for specific areas of the project which are discussed in the drainage strategy section.

9. Transverse Drainage

As discussed in section 5.2 the project lies within the Swan Coastal Plain, in an area characterised by the Spearwood and Bassendean dune systems. The only transverse feature is the Water Corporations Peel Main Drain, being a constructed drain, which crosses Anketell Road from north to south approximately 70m east of Clementi Road.

Construction of the Peel Main Drain and local sub drains began in late 1920 and were originally constructed to control regional winter groundwater levels within its catchment to enable agricultural use of the land. The drain runs generally north-south and discharges into the Serpentine River to the south, which in turn discharges to the Peel inlet. Within the context of the project area, the Peel Main Drain flows into the Spectacles wetland system on the south side of Anketell Road and contributes approximately 48% of the water entering the wetland. Therefore, it is important to maintain the existing hydraulic and hydrologic regime of the drain.

The Water Corporation modelled performance of the Peel Main Drain at Anketell Road, as presented in the *Jandakot drainage and water management plan – Peel main drain catchment* (Department of Water 2009) provides flow rates of 1.15m^3/s and 1.59m^3/s for the 10 year ARI (10% AEP) and 100 year ARI (1% AEP) respectively. It is noted that results are not provided for the 1 EY event, which would be more relevant to maintaining the total volume of runoff entering the wetland as the bulk of the annual average rainfall occurs in small frequent rainfall events (events of up to 15mm rainfall) that are better represented by the 1 EY storm.

The project impacts the Peel Main Drain locally around Anketell Road and will require the existing culvert to be extended or replaced and a section of the existing drain to be realigned. The drainage strategy for the impacts to the drain is:

- To replicate the existing culvert size and invert levels to maintain the existing performance
- The drain realignment will not add any additional length to the drain
- The size of the realigned channel will replicate the existing channel size and characteristics

The drain and culvert are Water Corporation assets, and proposed changes to their infrastructure require their approval, which typically involves any changes being incorporated into their hydrologic/hydraulic model to satisfy them that it does not negatively impact the drainage system.

10. Opportunities

The following opportunities were identified as part of the drainage strategy development.

10.1 Peel Main Drain Realignment

The Peel Main Drain between Mandogalup Road and Anketell Road is impacted by the proposed road upgrade and requires realignment. The drain through this section is a well-defined trapezoidal drain, providing efficient conveyance of water to meet the land drainage and flood mitigation requirements it was originally constructed for. There is an opportunity, over the potentially 470m long realignment section, to change the drain profile to more of a living stream type treatment, with the aim to potentially provide water quality benefits for flows through this section as well as to provide community benefits though passive recreation.

Designing living streams typically involves trying to design the drain to match natural streams/creeks present in the same area, however, as there are no natural streams in the area around the drain it will need to be based on 'typical' living stream treatment. This would usually entail a low flow (typically a 1EY or less) channel that meanders within a vegetated flood fringe (designed to convey the major event flow) and incorporates riffle zones and pools.

10.2 Permeable Paving Trial on PSP

As discussed in the Drainage Options assessment in Appendix B, the use of permeable paving for impervious surfaces is an effective way to achieve the goal of infiltration at source/treatment at source of rainfall. However, there are some barriers to its adoption/use by the road authority including concerns about durability and maintenance requirements, particularly on heavily trafficked pavements such as those on main roads and freight routes.

There is an opportunity on the Anketell Road Upgrade project though, to install a trial section (1km) of permeable paving on the PSP to enable the performance of the pavement to be monitored and actual maintenance requirements in the context of the Perth region to be established. The PSP does not have the same durability concerns as the road pavement as it is utilised only by bicycle/foot traffic and occasional maintenance vehicles.

The sandy nature of the site with generally good separation to groundwater also makes the Anketell Road project a good candidate for a trial of permeable pavement as the subsurface conditions are well suited to permeable pavement without needing additional subsurface drainage.

11. Drainage Strategy

11.1 General

The drainage strategy for the Anketell Road upgrade, based on the options assessment process documented in Appendix B, is to provide infiltration at the source using permeable base pits or as close to the source as possible via infiltration basins for the small frequent rainfall event to address the runoff management objectives for the project. The infiltration basins will also be used for flood mitigation and protection of the road infrastructure and surrounding properties in major storm events. The use of swales to disconnect the drainage system for conveyance of runoff to the infiltration basins/flood mitigation measures should be included where possible.

The use of permeable base pits (leaky pits) and infiltration basins for the small frequent rainfall events will maintain the existing hydrology of the project area, where currently impervious surfaces flow onto pervious surfaces to infiltrate. This will minimise the impact on wetlands and groundwater dependant ecosystems through maintaining the existing recharge of groundwater and disbursing the recharge via the permeable base pits.

During major events, the infiltration basins will create some localised mounding of groundwater at the basin locations, however, these are expected to be temporary with the mounding dissipating as the runoff infiltrates.

11.2 Special Considerations

11.2.1 Peel Main Drain

The Peel Main Drain is present at the eastern end of the project area (to the west of the Kwinana Freeway) and across the northern end of the project area at the Kwinana Freeway. It is a significant drain in the region, providing a connection between the wetlands of the region and eventually flowing down into the Peel-Harvey estuary via the Serpentine River. The drainage strategy is cognisant of the importance of the drain and has been developed to maintain the existing hydrology of the drain where the project interacts with it through infiltration of runoff generated from the project area and design of the impacted transverse drainage crossing to ensure that the existing hydraulic capacity of the drain is maintained (as discussed in Section 9).

11.2.2 Kwinana Freeway

The Kwinana Freeway including the interchange ramps are currently drained by a combination of open and piped drains to detention basins located on the south side of the Peel Main Drain. The proposed Anketell Road Upgrade includes changes to the ramps at the Kwinana Freeway / Anketell Road interchange and the drainage strategy for these catchments is to maintain the existing drainage where possible and augment it with new drainage where necessary. Where new drainage is required, infiltration/detention at source shall be included where possible to minimise the impact to the existing detention basins from the increased impervious area. If sufficient infiltration at source cannot be provided, the existing detention basins will need to be expanded to maintain the outflow to the Peel Main Drain at existing rates. This could include expansion longitudinally or by increasing storage through the provision of walls within the basins.

11.2.3 Treeby Dive Structure

To the east of the Kwinana Freeway, the dedicated freight lanes are in a dive structure providing an uninterrupted freight movement to the east, whilst enabling connectivity of the CD roads with the local road network, notably Treeby Road. This puts the freight lanes within approximately 1.5m of peak groundwater levels and approximately 4m below existing ground levels locally at Treeby Road.

Whilst it is technically possible to provide infiltration under the dive structure via an infiltration tank, there are several challenges to this approach, including:

- the proximity to the peak groundwater levels limits the effectiveness of the infiltration tank, increasing the tank size
- providing treatment of runoff prior to it entering the tank, particularly for floating pollutants such as hydrocarbons, as these can't be easily removed from the pervious base of the tank, is complicated in the space constrained dive structure
- maintenance access to the treatment device/system discussed above as well as to the tank would need to be from the dive structure, which would require closing of the freight route to conduct maintenance or exposing maintenance personnel to live traffic which can become a safety in design risk.

To mitigate the challenges mentioned above, it is proposed to connect the dive structure drainage to a pump station, located adjacent the road, to lift the runoff up to surface level basins/tanks.

11.2.4 Infiltration Tanks

Where there are space constraints limiting the use of infiltration basins and infiltration tanks are therefore required (such as at the eastern end near Treeby Road), the connected drainage system will require treatment upstream of the tanks to capture floating pollutants. As is discussed in Appendix B, floating pollutants such as hydrocarbons within a tank cannot be easily remediated via excavation as is possible in a basin situation and therefore a treatment such as a hydrodynamic separator should be installed upstream of the tank to intercept floating pollutants.

12. References

1. Australian Rainfall and Runoff. (2024). *A guide to flood estimation Book 1 – Scope and philosophy (Version 4.2).* https://www.arr-software.org/pdfs/ARR_190514_Book1_V4.2.pdf
2. Department of Water and Environmental Regulation. (2017). *Decision process for stormwater management in Western Australia*. (A component of Chapter 4: Integrating stormwater management approaches, Stormwater management manual for Western Australia (the former Department of Water 2004–07)). https://www.wa.gov.au/system/files/2022-05/Decision-process-for-stormwater-management-in-Western-Australia.pdf
3. Department of Water and Environmental Regulation. (2023). *Stormwater Management Manual for Western Australia*. https://www.wa.gov.au/government/document-collections/stormwater-management-manual-of-western-australia
4. Main Roads Western Australia. (2011). *Identification of highways and main roads that may be at risk due to a rise in sea level.* https://www.mainroads.wa.gov.au/4aaf0b/globalassets/technical-commercial/technical-library/road-and-traffic-engineering/climate-change/major-roads-at-potential-risk-due-to-climate-change.pdf
5. Main Roads Western Australia. (2024). *Guideline on Climate Change (3D).* https://www.mainroads.wa.gov.au/technical-commercial/technical-library/road-traffic-engineering/climate-change/

Appendices

Appendix A - Drainage Strategy Sketch

BG&E

PLAN
1:5000

NOTES
1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
2. LEAKY PITS/MRWA PERMEABLE BASE PITS ARE TO BE USED FOR PIT AND PIPE NETWORKS WHERE THE BASE OF THE PIT IS ABOVE GROUNDWATER.

LEGEND

- CADASTRAL
- ENVIRONMENTAL REFERRAL BOUNDARY
- INFILTRATION BASIN (TYPICAL)
- INFILTRATION BASIN CATCHMENT (TYPICAL)
- DETENTION BASIN (TYPICAL)
- DETENTION BASIN CATCHMENT (TYPICAL)

SKETCH ONLY

BG&E

DATE	07/10/2024	PROJECT	ANKETELL ROAD DRAINAGE STRATEGY
SCALE	1:5000	TITLE	DRAINAGE STRAGETY PLAN
GRID	MGA94		
PREPARED	IH		
SHEET	1 OF 1	PROJECT No. BGE-0248	SKETCH No. SK-C-0001 — REV C

Appendix B - Drainage Options

B DRAINAGE OPTIONS

B.1 General

Initial development of the drainage strategy involved researching and collating typical options for mitigating flood risks and managing water quality.

Each option was assessed based on performance against the strategy objectives, effectiveness considering the site conditions, cost and maintenance requirements. The assessment determined preferred options which were then adopted to form the drainage strategy.

B.2 Road Runoff Water Quality

To inform the selection of appropriate treatments for the runoff off Anketell Road, the main constituents in road runoff (for main/arterial roads) were identified and are presented below:

- Sediment
- Heavy metals
- Oil and Grease/hydrocarbons
- Inorganic
- Nutrients

Sediment is a major component of road runoff, originating from the wear and tear of road surfaces, the erosion of nearby land, and particles released by vehicles. Effective sediment removal is essential for maintaining the functionality of stormwater infrastructure and minimizing environmental impacts.

Heavy metals present in road runoff primarily originate from vehicle wear, fuel combustion, and atmospheric deposition, and are largely insoluble and adhere to sediments. Therefore, the removal of sediment from road runoff is also effective at removing heavy metals.

Oil and grease, including hydrocarbons, enter road runoff from vehicle leaks, spills, and atmospheric deposition. They are typically present at low levels in urban runoff and have a high soil affinity and can be biodegraded.

Inorganic constituents, including minerals and metals, contribute to road runoff as a result of road material weathering. A significant amount of inorganic contaminants is sediment bound. Therefore, the removal of sediment from the runoff, significantly reduce inorganic contaminants.

Nutrients (TN and TP) in arterial road runoff are largely from atmospheric deposition. There is also some loading resulting from spillage from stock haulage, spillage of fertiliser from trucks and fertiliser application along the highway, however, the contribution of nutrients to the catchment from Anketell Road is minor compared to the land uses within the broader catchment upstream of the road, which are predominantly rural as shown in Figure B1 below.

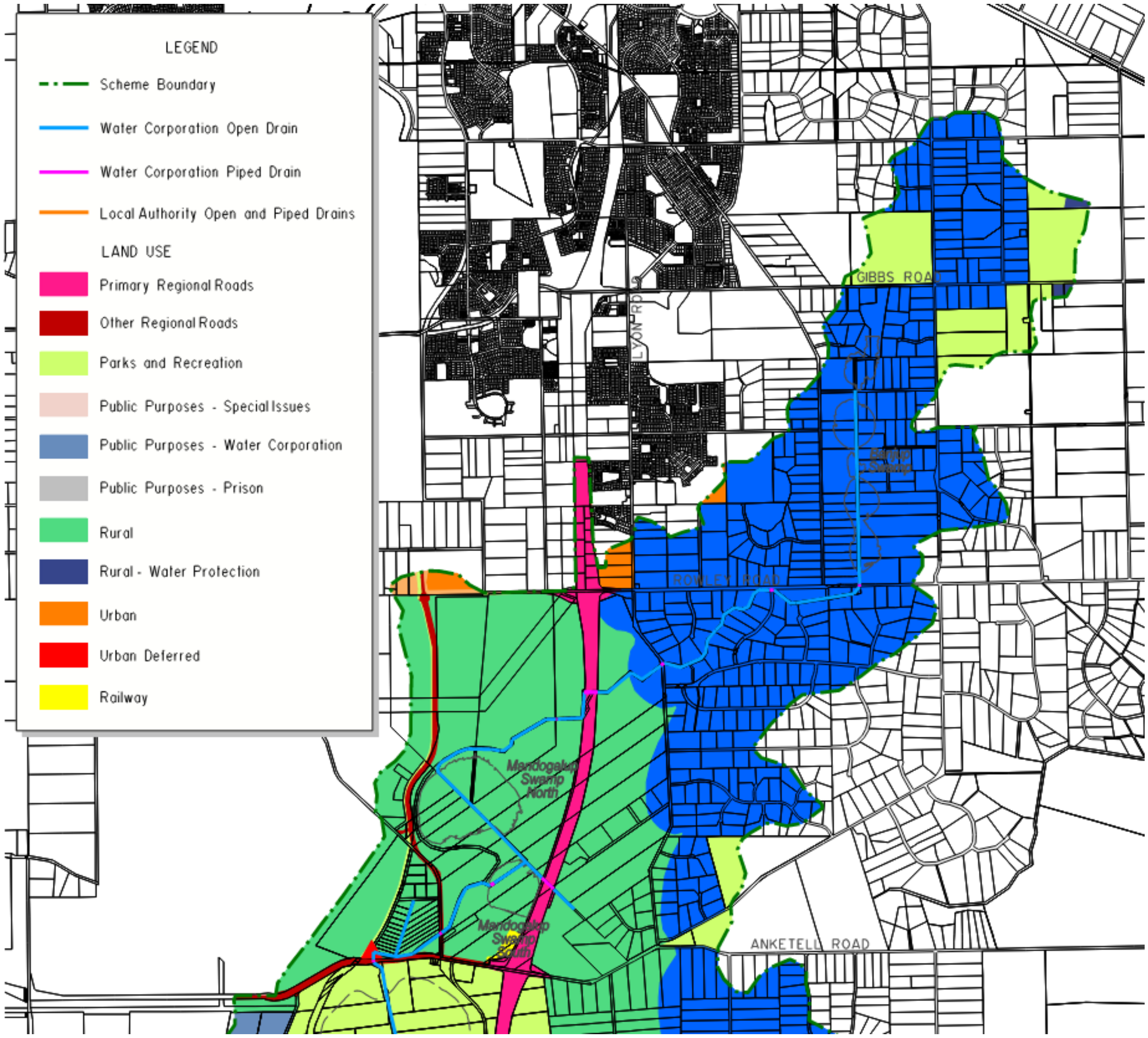

Figure B1: Excerpt of Figure 2.4 of Jandakot drainage and water management plan – Peel Main Drain

B.3 Peel Main Drain / Peel Harvey Estuary Water Quality Improvement Plan (WQIP)

The Peel Harvey Estuary Catchment Nutrient Report 2018 (DWER, 2021)[3] summarizes data collected from the Peel Main Drain sampling site in 2018, along with historical data from 2004 to 2018. It emphasizes the impact of nitrogen and phosphorus on waterway health. The report discusses the risks associated with excessive nutrients entering waterways, such as algal blooms, decreased oxygen levels, and harm to aquatic life. Additionally, the report includes data on total suspended solids, pH, and salinity, providing further insight into environmental processes within the catchment area.

The Peel Main Drain has a catchment area of about 125 km^2, with just over half of it cleared for various uses. The catchment includes residential areas, beef and sheep grazing, as well as properties with horses. The upper part of the catchment still has some native vegetation. Peel Main Drain is a highly modified system, with several other drains constructed to quickly remove water from agricultural and residential land.

Most of the catchment has soils with a low capacity to bind phosphorus. This is often so poor that any phosphorus applied to them can be quickly washed into drains and other waterways. The high-intensity agricultural and urban land use, as well as the highly modified drainage system present, contributed to the high nutrient concentrations recorded.

The Water Quality Improvement Plan (WQIP) for the Rivers and Estuary of the Peel-Harvey System - Phosphorus Management (the Plan) (EPA, 2008)[9] aims to improve water quality by reducing phosphorus discharges from the catchment through changes to agricultural and urban practices and land use planning.

The Water Quality Objective of the Plan is:

Median loadings of total phosphorus to estuarine waters should be less than 75 tonnes per annum in an average year with –

- the median load of total phosphorus flowing in the estuary from the Serpentine River being less than 21 tonnes.
- the median load of total phosphorus flowing in the estuary from the Murray River being
- less than 16 tonnes; and
- the median load of total phosphorus flowing in the estuary from the Harvey River being less than 38 tonnes.

Water qualities in streams in winter are to meet mean concentrations of 0.1 mg/L at current mean flows.

The report recommends the following Best Management Practices (BMPs) to assist in meeting these targets:

- Agricultural land practices: Implement better fertilizers, soil amendments, perennial pastures, and improved irrigation management.
- Urban land practices: Implement better fertilizer and soil amendment techniques; employ water-sensitive design with a whole-of-water-cycle approach in planning and approvals.
- Urban and rural effluent: Retrofit septic tanks with nutrient-reducing alternatives, ensure full sewerage connections, and improve livestock management.
- Licensed discharges: Regulate agricultural nutrient discharges entering the estuary.
- Wetland protection and revegetation: Maintain buffers and riparian vegetation; implement stock exclusion for wetlands and waterways.
- Drainage management: Modify practices to reduce sediment movement in channels as opportunities arise.
- Research and investigation: Continuously explore best management practices for nutrient reduction in both rural and urban settings to enhance understanding and refine actions.
- Monitoring and reporting: Establish a program for monitoring and reporting suitable indicators and targets to evaluate the plan's effectiveness.
- Barriers identification: Recognize and address obstacles to the adoption of best management practices within the catchment.
- Community partnerships: Foster awareness and collaborative management of water quality issues among community stakeholders.

Of the proposed BMPs, modify practices to reduce in-channel sediment movement as opportunities arise is most applicable to the Anketell Road Upgrade project.

B.4 Jandakot Drainage and Water Management Plan – Peel Main Drain Catchment

The Department of Water (now the Department of Water and Environmental Regulation) published the *Jandakot Drainage and Water Management Plan – Peel Main Drain Catchment* (DoW, 2009)[1] to guide development within the Peel Main Drain catchment whilst protecting the hydrological regime of the catchment and ensuring that water quantity and quality outcomes are met.

The plan notes that the Spectacles wetlands, consisting of the Spectacles north and Spectacles south, are the most important Bush forever site within the Jandakot area and is an Environmental Protection Policy Lake. The management plan also notes that a comprehensive hydrological and nutrient balance investigation was undertaken by the Waters and Rivers Commission in 1997 with one of the key findings being that the Peel Main Drain contributes approximately 48% of the water entering the Spectacles, with the remaining water being groundwater.

The plan provides the key objectives for surface water management in the Peel Main Drain catchment are:

- Protection of wetlands and waterways from impacts of urban runoff
- Protection of infrastructure and assets from flooding and inundation

It provides a catchment wide stormwater management strategy that is broken down into:

- Floodplain management strategy
- Surface water quantity management
- Surface water quality management
- Key design criteria (which summarises the main elements identified in the previous 3 sections)

The Jandakot Drainage and Water Management Plan – Peel Main Drain focuses on the maintenance of the existing hydrologic/hydraulic regime of the catchment, i.e. maintaining pre-development flows in the post development scenario. This principle is also important in achieving the project runoff management objectives and has therefore been considered in the options assessed.

The first three elements are summarised below.

Floodplain Management Strategy

The floodplain management strategy considers flood modification, property modification and response modification.

The suggested flood modification measures in the Jandakot structure plan area are:

- Retention and/or detention of the one-year-one-hour average recurrence interval event at source.
- Maximisation of infiltration at source
- Detention near source
- Channel modification (with appropriate investigation of impacts and engagement with stakeholders such as Department of Water and Environmental Regulation).
- Revegetation – e.g. strategic channel stabilisation
- Maintenance
- Upgrade of undersized infrastructure as part of a maintenance/upgrade program

The first 3 measures are directly applicable to the Anketell Road drainage strategy. The channel modification and revegetation of channels can be considered as part of the detailed design stage for the section of the Peel Main Drain that requires realignment adjacent to Anketell Road. No upsizing of infrastructure is proposed as the existing Peel Main Drain culvert under Anketell Road controls the flow of surface water from the upstream catchment into the Spectacles wetlands and therefore needs to be maintained to maintain the existing flow regime.

The property modification criteria are not directly applicable to the Anketell Road drainage strategy, other than that major arterial roads with immunity to the 100-year average recurrence interval flood that access new residential areas and provide egress to emergency services should be identified. Anketell Road would classify as a major arterial road and the Main Roads standard design criteria (as will be applied to the upgraded Anketell Road) would provide the level of immunity required.

The Response modification measures are beyond the scope of the Anketell Road drainage strategy and focus on community education and relevant stakeholders having response and recovery plans in place.

Surface Water Quantity Management

The surface water quantity management section targets minimising changes in hydrology to prevent impacts on receiving environments with the following design objectives:

- For the critical one-year-one-hour average recurrence interval event, the post-development discharge volume and peak flows rates should be maintained relative to pre-development conditions.
- Manage catchment runoff within the development area to pre-development peak flow rates (for events greater than the one-year average recurrence interval).

- Water sensitive urban design and best management practices form the basis of the surface water quantity management strategy for minor events.

These objectives align with the objectives and approach of the Anketell Road drainage strategy.

Surface Water Quality Management

The surface water quality management section notes that provided the pre-development discharge rates and volumes from developed catchments are maintained (as per the surface water quantity management section) it is expected that it will prevent the majority of contaminants from reaching the waterways.

B.5 Small Event and Water Quality Management

Based on the main constituents identified in road runoff, the drainage system should target the removal of sediments/TSS, heavy metals and hydrocarbons/oils/grease. Removal of nutrients should also be considered; however, it is noted that the road runoff is a minor contributor of nutrients, and the removal of the target pollutants should be a priority.

The options for water quality management focus on the control of runoff from the *small frequent rainfall event*, defined in Decision process for stormwater management in Western Australia (DWER, 2017)[2] as up to the first 15mm of rainfall.

The options investigated to address water quality are in line with the best management practices presented in the Department of Water and Environmental Regulation's *Stormwater Management Manual for WA* (DWER, 2023)[6] and are discussed below.

B.5.1 Stormwater Storage and Use

B.5.1.1 Rainwater Storage Systems

Rainwater storage systems involve the collection, storage and later reuse of runoff from typically impervious surfaces. Previous investigations into the storage and reuse of highway (or major arterial road) runoff identified that a committed demand for the runoff is required for the systems to be feasible. The previous investigation also found that collection and storage of road runoff for landscaping reticulation is generally not feasible due to the majority of rainfall occurring in winter and the reticulation demand being in summer leading to very large storages being required.

The majority of the project is located between the Kwinana Industrial Area and a wetland reserve, The Spectacles Wetlands, surrounded by degraded native bushland, with no feasible demands for stored runoff being identified. Less than half (45%) of the water used in the Perth-Peel region is from scheme supply. The remainder (55%) is self-supplied for non-potable water uses such as green spaces watering, irrigated agriculture, industry and domestic garden bores.

The Kwinana Water Reclamation Plant (KWRP) is situated near the Anketell Road Upgrade project and has reduced the industrial sector's dependence on bore and scheme water. The facility processes about 24 megalitres of wastewater per day from the Woodman Point Wastewater Treatment Plant. The reclaimed water is then supplied to various industries in the Kwinana industrial area at a lower cost than traditional scheme water. As a more reliable supply that is not seasonal like harvested rainwater, the KWRP would already be meeting most of the possible demands in a sustainable way that may have been considered within the Kwinana Industrial precinct at the western end of the project.

The Alcoa Kwinana Alumina Refinery is adjacent the project and may have provided a possible demand for non-potable water, however, Alcoa has announced it plans to curtail operations at its Kwinana Alumina Refinery in Western Australia by 2024, with the process starting in the second quarter. As a result, the future demand for a non-potable water source will decrease, making it difficult to justify the construction of a runoff storage system.

The groundwater level is relatively shallow at the western end of the project, specifically west of Rockingham Road, and at the east end of the project around the Spectacles wetland, which would limit the depth of storage basins, thereby increasing their area and evaporation losses. Due to the limited available space on the site, providing an economical runoff storage system, such as excavated basins, presents significant challenges. An alternative option, such as tanked storage, is available; however, it is often prohibitively expensive.

Rainwater storage systems are not considered appropriate for the Anketell Road Upgrade project.

B.5.1.2 Managed Aquifer Recharge

Managed aquifer recharge (MAR) is the infiltration or injection of water into an aquifer. In the context of the Anketell Road Upgrade project and drainage strategy, it would be the infiltration or injection of runoff from the road into either the Superficial, Leederville or Yarragadee aquifers.

The geology of the project consists of Tamala Limestone/limestone derived sand (at the western end near Rockingham Road) or quartz sand to the eastern end around the Spectacles wetland area. To the east of the Kwinana Freeway, it changes to Bassendean Sands. At the very western end, west of Rockingham Road, the site is composed of Safety Bay Sand. MAR into the Superficial Aquifer appears most suited to western coastal-plain areas underlain by Tamala Limestone. This area has high transmissivity aquifers, which also can neutralise acidity and remove phosphorus and heavy metals.

To justify the collection of runoff from the road, providing sufficient treatment to ensure the water is of acceptable quality for injection into the aquifer and then operating the injection bores, a demand for the injected water is needed. As mentioned in Section B.5.1.1, there are no known uses for the harvested/recharged water outside of Anketell Road and there is already an established water re-use system supplying non-potable water to the area. The use of the recharged water for summer irrigation of the Anketell Road landscaping is an option, however, the revegetation of road corridors by Main Roads typically looks to establish native vegetation which would not require long term irrigation. Another justification for implementing a MAR system would be to improve environmental outcomes for the aquifer, such as preventing/minimising salt water intrusion into the aquifer, however, this is not believed to be an issue for the aquifers under the Anketell Road project.

Using MAR for the treatment of small frequent rainfall events on the Anketell Road Upgrade project is not considered appropriate.

B.5.2 Infiltration Systems

B.5.2.1 Infiltration Basins and Trenches

Infiltration basins and trenches treat runoff by retaining and infiltrating the runoff within a constructed depression or aggregate filled trench. As discussed in Section B.5.1.2 above, the geology of the project area consists of Tamala Limestone/limestone derived sand, quartz sand, Bassendean Sand and Safety Bay Sand. The relatively high permeability of the sandy soils allows water to infiltrate quickly, enabling efficiently sized basins or trenches. There is also generally good separation from groundwater in the project area (with the exception of the western coastal end and adjacent the Spectacles wetland), which also helps to provide efficient infiltration systems.

Infiltration basins and trenches are effective at removing litter, total suspended solids (sediment) and heavy metals from stormwater flows through retention and filtration of the runoff through the soil. Their performance in removing nutrients is dependent on the vegetation and soils within the basin or trench but is typically low due to the low phosphorus retention index of most Western Australian native soils on the Swan Coastal Plain. The stormwater management manual lists infiltration basins as being applicable to some extent in the treatment of hydrocarbons. As discussed in Section B.2, hydrocarbons such as oils and greases tend to have a high soil affinity so will bond to the upper layer of soil in the basin and can be biodegraded, so will break down over time.

The use of infiltration basins or trenches for small, frequent rainfall events effectively removes the target pollutants. This method is recommended for treatment if the basins can empty in an acceptable timeframe and have adequate effective permeability.

B.5.2.2 Soakwells

Soakwells are typically used in urban residential areas in the Perth metropolitan area and other areas in Western Australia situated on the sandy soils of the Swan Coastal Plain for infiltration of small catchments. They may also be used by local government authorities on minor roads. Soakwells are typically not suitable for arterial road drainage systems.

A variation on soakwells, known as leaky pits or permeable base pits, can be used in main road/arterial road environments. Leaky pits/permeable base pits consist of a standard road drainage pit with a hole in the base slab that allows for some infiltration of the runoff entering the pit. The Main Roads WA (MRWA) permeable base pits are a type of leaky pit. MRWA standard drawing for a 'Drainage Structure with a Permeable Base' (MRWA, drawing number 201531-0045-1) features a 600 mm diameter (or 500mm x 500mm square) hole in the base slab with a 300mm deep layer of 19mm aggregate below the base slab to provide some additional storage and to increase the infiltration area available.

Where the road drainage system is kerbed, the use of leaky pits/permeable base pits can assist in achieving treatment at source by providing some infiltration of runoff across the network rather than just at the outlet. The use of leaky pits/permeable base pits in areas of high or perched water tables needs to be considered as the base of the pit should be above groundwater or saturated conditions to enable it to perform.

Leaky pits help maintain the existing hydrological flow regime by infiltrating runoff as close to source as possible. As an infiltration system they are effective at trapping suspended solids (sediment) and the associated heavy metals and organic compounds that are bound to the sediment. They have low nutrient treatment due to the low phosphorus retention index of the sands in the Anketell Road area and lack of vegetation within the pit. They will have some retention of hydrocarbons within the soil under the pit however may be less effective at biodegrading these as they are not exposed to sunlight.

The use of leaky pits/permeable base pits on the Anketell Road Upgrade project is recommended where pit and pipe systems are required, and pits are above the groundwater level.

B.5.2.3 Permeable/Pervious Pavement

The use of permeable or porous paving on major roads has historically not been supported by Main Roads due to concerns over pavement structural performance, long term drainage performance (clogging of the pavement) and associated maintenance.

There are different types of porous pavement including porous asphalt pavement, porous concrete pavement and interlocking concrete or clay pavers with internal or external drainage cells. The porous pavement is typically laid on top of a high-void aggregate or gravel base layer, separated by a geotextile layer, to provide temporary storage while the runoff infiltrates into the soil below.

Use of a porous paving for other impervious areas on the project, such as the Principal Shared Path (PSP), which is not subject to large motor vehicle traffic and only at low speed, was considered, however the provision of a porous pavement would be more expensive than the traditional PSP pavement (typical PSP pavement costs are around \$35/m^2 and the Stormwater Management Manual of WA (DWER, 2022)[4] lists typical porous paving with asphalt as \$67/m^2).

To maintain the permeability of porous pavement, it is recommended (DEP, Montgomery County, Maryland)[8] that the surface is vacuum swept twice per year, which is a significant increase in maintenance requirements over a traditional PSP pavement.

With the increased construction and maintenance costs, porous paving for the PSP is generally not considered appropriate for the Anketell Road Upgrade project.

The use of porous/permeable interlocking concrete or clay pavers could be considered for paved areas within islands and medians. The potential benefits of the use of porous pavers within these areas would need to be balanced against the increased potential for weed growth and the resulting increase in maintenance required. This maintenance may involve the use of herbicides to control weed growth, which in turn introduces pollutants into the runoff.

B.5.3 Conveyance Systems

B.5.3.1 Swales and Buffer Strips

The use of swales is important to disconnect the impervious areas of the road from downstream surface water bodies and receiving environments. Swales convey runoff but also promote infiltration thereby reducing peak runoff volumes and due to reduced hydraulic efficiency (particularly for vegetated swales) compared to piped systems and lined drains they also reduce peak runoff flow rates and velocities.

A vegetated swale is a broad, shallow channel with vegetation covering the sides and the base. The vegetation used within a swale can range from grasses to native sedges and shrubs.

The performance of vegetated swales to remove pollutants and reduce runoff is dependent on the site conditions (soil type, water table), length and slope of swale as well as the vegetation within the swale. Previous studies in the USA have found vegetated swales were capable of removing sediments, hydrocarbons and heavy metals from runoff, with removal efficiencies of up to 83% for sediment, 75% for hydrocarbons and >60% for heavy metals.

Table 1 in Stormwater Management Manual for WA – Chapter 9 Structural Controls, (DWER, 2022, Section 4.1)[5] based on *Australian Rainfall Quality,* presents the removal effectiveness for vegetated swales (based on research of eastern states catchments) as high (>80%) for litter and coarse sediment; medium to high for total suspended solids; low to medium for heavy metals and total phosphorus; and low for total nitrogen.

Buffer strips are areas of vegetation, aligned perpendicular to the direction of flow, through which runoff passes (typically as sheet flow). Buffer strips can reduce sediment loads by slowing the flow of runoff and trapping coarse sediments. The vegetated batters of an unkerbed section of road act as a buffer strip, trapping coarse sediment from the sheet flow off the road whilst also providing protection against scour of the batters. Previous studies in the USA (Effects of Highway Runoff on Streamflow and Water Quality in the Sevenmile Creek Basin, a Rural Area in the Piedmont Province of North Carolina, July 1981 to July 1982. Douglas, Harned)[7] have found that vegetated strips adjacent to major roads, although not intended for treatment of stormwater runoff, played an important role in reducing the concentrations of pollutants into receiving waters.

Maintenance of vegetated swales is relatively simple (pruning/mowing of vegetation and removal of debris/blockages) and conducted at a relatively low frequency.

As revegetation of the road batters is a requirement of Main Roads projects, buffer strips are included by default (where the road is unkerbed and runoff sheets over the verge) as part of the landscaping of the project.

The sandy soils and good separation to groundwater in the project area support the use of excavated swales to improve water quality and reduce peak flow rates. The relatively low maintenance requirements for swales and buffer strips are well suited to the freight corridor environment and these treatments are effective at removing target pollutants. Swales and buffer strips should therefore be utilised on the project; however, it is noted that the project geometric constraints may limit the use of buffer strips (the road is predominantly kerbed and/or in high fill or cut) and swales.

B.5.3.2 Bioretention Systems

A bioretention system consists of an excavated basin or trench that is filled with porous filter media and planted with vegetation. Bioretention systems operate by filtering runoff through the surface vegetation, followed by the stormwater percolating into the porous filter media, where filtration, extended detention treatment, denitrification and some biological uptake occurs. The porous filter media in the bioretention system can be drained either by direct infiltration into the surrounding soil (where highly permeable soils are present) or by a subsoil or base drain. A bioretention system can also incorporate a submerged zone beneath the outlet drain to improve nutrient removal.

The *Stormwater Management Manual for WA* (DWER, 2022)[4] lists the removal effectiveness of bioretention systems as high (>80%) for coarse sediment, total suspended solids and heavy metals; and medium (>50%) for total nitrogen and total phosphorus.

The sandy soils present over the project area combined with generally good separation to groundwater would enable excavated bioretention systems that drain by direct infiltration into the surrounding soil.

Bioretention systems require more maintenance than other conveyance systems, such as swales and buffer strips, to ensure they perform as designed. A well designed bioretention system will feature a sediment trap upstream of the system to protect the filter media from clogging from coarse sediments. These require maintenance/cleaning to offer continued protection. The bioretention system also needs to be kept weed free, which is very difficult in the project environment with industrial and bushland adjacent. Providing adequate root barriers and maintaining bioretention systems as weed free is more readily achieved in urbanised areas where the systems are often surrounded by impervious areas or areas of high landscape value.

Whilst bioretention systems do offer some improved performance for removal of the target pollutants and for the removal of nutrients, they would have a higher maintenance requirement and keeping them weed free would be impracticable in the project environment. The use of bioretention is not recommended as the other treatment options offer lower maintenance solutions that will still be effective in removing the target pollutants.

B.5.3.3 Living Streams

Living streams are linear elements designed to mimic the natural stream processes found in the area. A living stream achieves multiple outcomes, including creating a healthy ecosystem, improving water quality, conveying floodwaters and creating an attractive landscape feature for the community.

The main hydrologic features within the project area are wetlands and swamps formed in the interdunal swales of the Bassendean dune system and intercarrier depressions between the Spearwood dune and the Bassendean dune systems, and within the Spearwood dune system. There are no natural streams within the project area. Given the project space constraints and absence of natural streams in the area, the concept of a living stream is not applicable to the broader project area.

The existing Peel Main Drain in the vicinity of the project is a well-defined trapezoidal drain. The project impacts the Peel Main Drain locally around Anketell Road and will require the existing Water Corporation culvert to be extended or replaced and a section of the existing drain to be realigned. There may be an opportunity, in consultation with Water Corporation, to convert a replaced section of drain into a living stream, however, this would likely require additional land.

B.5.4 Detention Systems

B.5.4.1 Dry/Ephemeral Detention Areas

Dry/ephemeral detention areas are areas used for the temporary storage of runoff. They can be either excavated, bunded or can utilise/enhance natural swales or depressions. The areas are typically landscaped as ephemeral wetlands. The temporary storage of runoff prevents excessive runoff peaks and subsequent scour in downstream receiving environments and also serves to remove particulate based pollutants and sediment.

The performance of dry/ephemeral detention areas in Western Australia is not well researched, however, they operate on a similar principle to sedimentation basins that have been assessed. Based on the operation of sedimentation basins, dry/ephemeral detention areas have high (>80%) removal of litter and coarse sediment; medium to high (50-80%) removal of total suspended solids, heavy metals and total phosphorus; and low to medium removal of total nitrogen. It should be noted that sedimentation basins are typically not vegetated and therefore the dry/ephemeral detention areas may have improved performance due to biological uptake of nutrients and soluble pollutants from the detained runoff.

Maintenance requirements for dry/ephemeral detention areas is relatively low and consists of clearing out accumulated litter and debris and control of vegetation where required. Removal of accumulated sediments is also required; however, this is typically at a frequency only every 5-7 years.

The project area is characterised by dunal systems with wetlands/damplands in the interdunal zones, there are no natural conveyance systems, with rainfall generally infiltrating into the sandy soils and recharging the groundwater, as such the use of dry/ephemeral detention areas is generally not appropriate for treatment of road runoff within the project, as they do not align with the existing hydrological regime, however, they are applicable to the sections of the Kwinana Freeway that currently discharge to the Peel Main Drain.

B.5.4.2 Constructed Wetlands

Constructed wetlands are vegetated detention areas designed and built specifically to remove pollutants from stormwater runoff. In particular, constructed wetlands are more effective at treating runoff with high concentrations of soluble pollutants than other treatment methods. The size of constructed wetlands typically needs to be 1-2% of the total contributing catchment area. Constructed wetlands are complex systems that typically contain a sediment forebay (to protect the main wetland area) and areas of varying depth including dry areas. To provide a system containing all these elements, the wetland typically needs to be fairly large and therefore is suited to larger urban catchments.

The linear nature of major roads tends to result in regular discharge from smaller catchments, that would either require a wetland that was greater than 1-2% of the catchment area (to contain all of the different treatment zones) which might therefore not receive enough runoff to be sustainable or the wetland would be too small to contain the necessary treatment zones.

Similar to dry/ephemeral detention basins, constructed wetlands are used to treat runoff before it enters downstream systems. As previously discussed, apart from the constructed Peel Main Drain, there are no conveyance systems in the project area and therefore constructed wetlands would not have a suitable discharge point. At the Peel Main Drain, there is an existing wetland to the south and the existing hydrology of the project area is that rainfall is infiltrated and generally does not enter the Peel Main Drain or wetland directly.

Constructed wetlands are not recommended due to them not matching the existing hydrologic regime, the land take required and other treatment measures being available to deliver the required treatment outcomes.

It is recommended that other drainage treatments such as swales and infiltration areas are landscaped as ephemeral wetlands.

B.5.5 Pollutant Control

B.5.5.1 Litter and Sediment Management

The management of litter and sediment is the management of gross pollutants. Gross pollutants include debris items larger than 5mm and coarse sediments (grain sizes >0.5mm). Litter and sediment management systems include trash racks, Gross Pollutant Traps (GPTs) and sediment basins.

Trash racks are typically installed across a flow path (either a drain/watercourse or pipe system) to screen litter and debris from the flow. The accumulation of litter and debris on the rack requires frequent maintenance to clear the screen/remove the litter to prevent blockages and if not performed the racks can become a constriction to flow. Trash racks are typically better suited to pipe systems or defined engineered channels where the screen can be easily installed across the flow path and opportunities for the flow to bypass the screen can be minimised.

Similar to trash racks, GPTs are typically installed on pipe systems at the discharge point to collect litter, debris and sediment. Most modern GPT designs include bypasses that prevent the system from blocking and trapped pollutants from re-entering the flow once the storage volume is filled. Frequent maintenance is still required, however, to empty the GPT to enable new pollutants to be trapped.

Sediment basins are similar to detention basins and are designed to slow the flow of runoff through the basin such that sediment settles out of the water to the floor of the basin and the ‘clear’ water is then discharged from the other end of the basin. Dedicated sedimentation basins are not considered necessary as their function is being provided by other structural controls, the exception would be at the inlet to bioretention areas/wetlands where some form of sediment basin/trap should be included as part of the bioretention area/wetland design, however, these are not recommended options for the Anketell Road project.

Litter and sediment management is being provided through other treatment measures (such as buffer strips, swales and retention areas) and therefore separate litter and sediment management devices are not considered to be required unless space constraints require compact forms of management of these issues.

B.5.5.2 Hydrocarbon Management

Hydrocarbon management in the context of the Stormwater Management Manual for WA (DWER, 2022)[4] relates to specific devices such as oil and water separators (e.g. as used for service station forecourts) where there is a high risk of spills.

These types of devices are generally not used on arterial road environments. Where the arterial road is highly spaced constrained and near a sensitive receiving environment, hydrodynamic separators (specifically designed to remove hydrocarbons and suspended solids from stormwater runoff) are sometimes used to provide trapping of hydrocarbons in both small rainfall events and in spill situations. These devices also have the benefit of providing sediment removal (and correspondingly heavy metal removal) as well. These types of devices should also be used upstream of covered retention areas (eg infiltration tanks) to minimise the risk of spills of floating pollutants, such as hydrocarbons, from entering the covered storage as these areas are much more difficult to remediate than open storages that can have affected material in the base excavated and replaced.

Management of hydrocarbons and other floating pollutant spills does need to be considered as part of the Anketell Road drainage system, particularly near sensitive receiving environments such as: the Peel Main Drain and the Spectacles wetland and Conway Road Swamp.

The preferred method for controlling spills of floating pollutants is through the provision of retention basins at the outlet of drainage systems. As discussed in section B.6, the retention areas provide both small frequent event storage and flood event management storage and will therefore retain spills. Following a spill, remediation of the basin will be required.

Another option for controlling spills of floating pollutants is by the provision of a baffled outlet structure on a basin or swale. The baffled outlet has the benefit that it is capable of trapping floating pollutants during wet weather/when the upstream basin/swale is already inundated. The drawback to providing a baffled outlet is that they require routine maintenance to ensure the baffle does not silt up. The use of baffled outlets may however be required where retention basins/areas are not likely to empty in a reasonable timeframe between rainfall events. When they are required the design of the upstream basin/swale should try to minimise the potential for sediments entering the baffle structure.

As noted above, hydrocarbon management in the form of hydrodynamic separators shall be considered where the preferred options cannot be used due to space/other constraints or upstream of covered storages where remediation is more difficult than for open storages.

B.6 Flood Event Management

The management of runoff for the small frequent rainfall event is discussed in Section B.5, however, when the runoff (from major storm events) exceeds the capacity of the small event system, the excess runoff needs to be managed to ensure that there is no damage to property/infrastructure and no adverse effects downstream.

The options identified and investigated for flood event management, being events greater than the small frequent rainfall event and up to 1% AEP (100 year ARI), are discussed below.

B.6.1 Retention/Infiltration

In Section C.5.1.2, it was discussed that the geology of the project area consists of relatively high permeability sandy soils that allow water to infiltrate quickly. With the exception of the western coastal end and adjacent the Spectacles wetland, there is generally good separation from groundwater in the project area, which helps to provide efficient infiltration systems.

As the site geology and separation to groundwater enable efficient infiltration basins, the use of retention and infiltration for flood event management is considered appropriate in the project area.

B.6.2 Detention

Detention for flood event management involves the restriction of post-development peak flow rates to pre-development levels into receiving conveyance systems. With the exception of the Peel Main Drain that crosses Kwinana Freeway at the north end of the project area and Anketell Road to the west of the Kwinana Freeway, there are no conveyance systems within the project area and therefore, outside of these two locations the use of detention for flood management is not appropriate.

At the Peel Main Drain crossing of Kwinana Freeway, the existing freeway drainage within the project area utilises detention basins for flood event management prior to discharging to the drain. The changes proposed by the project within the catchment of these basins is small and therefore the continued use of detention for flood event management is considered appropriate.

Where the Peel Main Drain crosses Anketell Road, the existing road drainage does not appear to contribute directly to the Peel Main Drain or the Spectacles wetland with runoff infiltrating into the adjacent verge. The use of detention is considered to be less appropriate than retention/infiltration at the Peel Main Drain, however, it could be considered if the retention/infiltration leads to excessively large or slow to empty storages. The detention option in that case would need to be developed to maintain the hydrology of the Peel Main Drain and the Spectacles wetland.

B.6.3 Conveyance

Conveyance refers to the use of existing water courses and/or district/regional drainage systems to manage the excess runoff resulting from major events to receiving waters safely.

With the exception of the Peel Main Drain crossing Anketell Road to the west of the Kwinana Freeway, there are no conveyance systems within the project area and therefore conveyance, in general, is not an option for flood event management.

At the Peel Main Drain, the *Jandakot Drainage and Water Management Plan – Peel Main Drain Catchment* (DoW, 2009)[1], discusses the importance of maintaining the existing peak flow rates entering the Spectacles wetland and as such conveyance is not an option for flood event management at the Peel Main Drain.

B.7 References

1. Department of Water. (2009). *Jandakot Drainage and Water Management Plan – Peel Main Drain Catchment*. https://www.wa.gov.au/system/files/2022-12/Jandakot-drainage-and-water-management-plan.pdf
2. Department of Water and Environmental Regulation. (2017). *Decision process for stormwater management in Western Australia*. (A component of Chapter 4: Integrating stormwater management approaches, Stormwater management manual for Western Australia (the former Department of Water 2004–07)). https://www.wa.gov.au/system/files/2022-05/Decision-process-for-stormwater-management-in-Western-Australia.pdf
3. Department of Water and Environmental Regulation. (2021). *The Peel Harvey Estuary Catchment Nutrient Report 2018. (*Harvey River Issue 1) https://www.wa.gov.au/system/files/2022-06/Harvey_River_2018.pdf
4. Department of Water and Environmental Regulation. (2022). *Stormwater Management Manual for Western Australia*. *Chapter 9 Structural controls.* https://www.wa.gov.au/system/files/2022-05/Stormwater-management-manual-Chapter-9-Structural-controls.pdf
5. Department of Water and Environmental Regulation. (2022). *Stormwater Management Manual for Western Australia*. *Chapter 9 Structural controls.* (Table 1, page 69) https://www.wa.gov.au/system/files/2022-05/Stormwater-management-manual-Chapter-9-Structural-controls.pdf
6. Department of Water and Environmental Regulation. (2023). *Stormwater Management Manual for Western Australia*. https://www.wa.gov.au/government/document-collections/stormwater-management-manual-of-western-australia
7. Douglas, Harned. (1988). *Effects of Highway Runoff on Streamflow and Water Quality in the Sevenmile Creek Basin, a Rural Area in the Piedmont Province of North Carolina, July 1981 to July 1982.* https://pubs.usgs.gov/wsp/2329/report.pdf
8. Department of Environmental Protection, Montgomery County, Maryland. *How to Maintain your Porous Pavement Stormwater facility maintenance program* (https://www.montgomerycountymd.gov/DEP/Resources/Files/clean-water/stormwater-management/PorousPavement.pdf) and National Asphalt Pavement Association (https://www.asphaltpavement.org/)
9. Environmental Protection Authority Government of Western Australia. (2008). *Water Quality Improvement Plan for the Rivers and Estuary of the Peel-Harvey System – Phosphorus Management.* https://www.epa.wa.gov.au/sites/default/files/Policies_and_Guidance/Peel_Harvey_WQIP151208.pdf

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