APPENDIX 7B

AQ2 2019a - SURFACE WATER ASSESSMENT

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Memo

To	Craig Bovell	**Company**	Doral Mineral Sands
From	Wendy Green	**Job No.**	136B
Date	26/09/2019	**Doc No.**	004b
Subject	Surface Water Assessment for the proposed Yalyalup Heavy Mineral Sands Project		

Craig,

We are pleased to provide you with the following report outlining the Surface Water Assessment which has been completed for the Yalyalup Heavy Mineral Sands Operation.

1. INTRODUCTION

1.1 Background

The proposed Doral Yalyalup heavy mineral sands resource is located 10 to 14 km south-east of the Busselton CBD, in the south-west region of Western Australia (Figure 1). This assessment considers the proposed mining activities within the development disturbance area as shown on Figure 2.

The life of the mineral sands operation is expected to be 6 years, with the mining operation is characterised by the creation of small, shallow pit developments which are progressively backfilled and rehabilitated as the mine progresses. The project involves a processing plant area, workshops and administration buildings. Given the proposed mining method, the active disturbance area which is lost from contributing runoff to the environment is restricted to the active open pit, backfill, active rehabilitation and processing areas (rather than the whole site).

1.2 Purpose

This report has been prepared to support Doral's Environmental Review Document (ERD) submission to the Department of Water and Environmental Regulation (DWER, former Environmental Protection Agency (EPA)).

EPA's (2018) *Environmental Factor Guideline: Inland Waters* provides guidance for submissions. This report has been prepared to address DWERs guideline objectives for key environmental factors that relate to the surface water hydrological regime, as outlined in the Environmental Scoping Document by Doral (2018) and listed below.

- To maintain the hydrological regimes and quality of the groundwater and surface water so that environmental values are protected (hydrological processes).

Surface water quantity is the key hydrological component which has been assessed in this document as below (water quality is addressed in the ERD and not in this report):

- Assess how the proposed pit development will impact on local surface water flows, particularly within the Vasse-Wonnerup Ramsar wetland (e.g. the reduction in surface water to these water courses).

A site water balance study has been completed for the project (refer document 136_005) building on the work completed in this study.

1.3 Methodology

This surface water assessment has estimated how the proposed mine development will reduce the surface water runoff to the downstream water courses and minimise impacts by:

- Identification of the regional hydrology and local water courses/features nearby to the mine development to outline pathways to environmentally sensitive surface water receptor(s).
- Identification of the catchment area of the proposed mine infrastructure development (i.e. the 'Mine Envelope'). Identify any upslope catchments to the Mine Envelope.
- Review the location and elevation of the Mine Envelope relative to any local drainage lines to identify bunding and diversion requirements. Redirect any upstream catchments with 'clean flows' around the operations and back into existing flow lines where possible to minimise any impacts.
- Quantify the impact of the proposed development on the receptor(s) by assessing the reduction in catchment area (and thus inferred surface runoff yield) of the downstream receptor. This is done by comparing the size of the proposed mine development to the overall catchment area of the receptor.

2. HYDROLOGY

2.1 Regional Water Courses

The proposed mineral sands mine is located within the Lower Sabina River subcatchment (Figure 1). The Lower Sabina River flows from below the Sabina Diversion Weir to the RAMSAR listed Vasse-Wonnerup Wetlands. The Lower Sabina, Lower Vasse, Abba and Ludlow rivers drain into the Vasse-Wonnerup Wetlands, before discharging through the Wonnerup Inlet into Geographe Bay.

The Vasse-Wonnerup Wetlands is an environmentally sensitive surface water receptor. Most of the Lower Sabina catchment has either been cleared for agricultural uses or other mining operation (such as Cristal's Wonnerup Mineral Sands Mine in the northern portion, refer Figure 1). The Sabina River and Vasse River, both tributaries to the Vasse-Wonnerup Wetlands, have been historically modified with diversions to reduce flooding risk of Busselton.

The Sabina Diversion Weir (6269283 mN, 355439 mE MGA 94, Figure 1) was constructed to allow overflow during extreme rainfall events from the Upper Sabina to the Lower Sabina (Figure 1), with regular flows through the Sabina Diversion Drain. The weir was over designed and the Upper Sabina catchment (78 km^2) no longer contributes any flow directly to the Lower Sabina river, although some minor sub-drains in the upper catchment may spill in large events (Marillier, 2018). The flow upgradient of the Sabina diversion weir is directed through the Sabina Diversion Drain to the Vasse Diversion Drain system and out to the Geographe Bay, rather than to Vasse-Wannerup Wetlands.

The Vasse-Wonnerup Wetlands catchment area is 473 km^2, excluding the diverted subcatchments (Figure 1). The Lower Sabina River catchment area of 45.5 km^2 is less than 10% of the Vasse-Wonnerup Wetland Catchment (Figure 1). The Abba River is one of the other major tributaries to the Vasse-Wonnerup Wetland and has a catchment area of 137 km^2 which is 29% of the Vasse-Wonnerup Wetlands catchment.

Other regional drainage features outside of the Vasse-Wonnerup Wetlands include the Vasse Diversion Drain, which has a catchment area of 303 km^2 and receives inflows from the diverted Upper Sabina (78 km^2) and Upper Vasse (catchment 180 km^2) rivers (Marillier, 2018).

There are no stream gauges in the Lower Sabina catchment. The closest stream gauges are on the Upper Sabina at the Sabina Diversion (site 610025), and on the Abba River (site 610062). Marillier (2018) analysed gauge information and estimated average annual flows (2001–14) in the major ungauged rivers flowing to the Vasse Estuary Wetland. Marillier (2018) estimated the Lower Sabina discharge as 5.7 GL/year, less than half the Abba River volumes (12.5 GL/yr). In contrast, 4 GL/year is diverted away from Vasse-Wonnerup Wetlands along the Sabina Diversion Drain, and 24 GL/yr is diverted via the Vasse Diversion Drain (Marillier, 2018). The Ludlow River discharges the second highest volumes to the Vasse-Wonnerup Wetlands an annual average of 11.4 GL/yr based on DWER gauging station summary statistics (DWER, 2019).

2.2 Local Water Courses

Several roads and man-made drains installed in the 20th century have modified the natural drainage patterns. The Mine Envelope is situated along Princefield road-side drain and other first order drainage lines which contributed to a tributary of the Lower Sabina River (downstream of the Sabina Diversion Weir). The local drains and waterways in the vicinity of the Project are shown on Figure 2. Culverts under roads were considered in the catchment mapping.

3. RAINFALL

Table 1 summarises rainfall for the closest rainfall gauges to the project area, which are Busselton Aero (Station 9603) and Vasse Hwy CB3 (Station 9984). Annual average rainfall for the site is estimated to be in the order of 680 mm.

Table 1: Rainfall Summary

	BoM 9603 Busselton Aero	**BoM 9984 Vasse Hwy CB3**
Location	115.4°E, 33.68°S, Within 5 km of site	115.4°E 33.7°S Within 5.5 km of site
Date Start, status	1997, Operating	2009, Operating
Years of data	22	10 (missing data in 2009-2010 and 2012-2013)
Average Annual Rainfall (mm)	683	670

4. CATCHMENT ANALYSIS

Figure 2 shows the Mine Envelope of proposed pits and infrastructure footprint areas. Not all areas will be disturbed at one time as the pits will be mined sequentially and rehabilitation will occur for completed areas. However, for the purposes of this report, conservatively the entire mine footprint area of 3.6 km^2 has been used as the basis for calculations (Table 2).

Several local subcatchments labelled A to D on Figure 2 drain toward the Mine Envelope, with areas of each of these subcatchments given in Table 2.

Table 2: Catchment Areas

	Total Area (km^2)	Subcatchment Area (km^2)			
		A	B	C	D
Upstream subcatchment Area (diverted around Mine Envelope)	4.7	1.08	2.59	1.05	0.017

4.1 Changes to Waterways During Mining

To minimise changes to downstream flows, diversion of the intercepted upslope catchments around the Mine Envelope to the downstream waterway(s) is proposed.

The diversion of Subcatchment B is located between site infrastructure. These diversions are proposed to convey only clean upgradient flows and not intercept site runoff from disturbed areas. Proposed diversions are shown on Figure 2.

Water from disturbed areas within the Mine Envelope will generally be captured and reused within the mining process. An emergency overflow spillway and licenced discharge point to a road-side drain along Princefield Road is part of the ERD as shown on Figure 2. The operation of the emergency discharge points is covered separately.

4.2 Estimated Catchment Area Change

The impact to the potential contributing surface water catchment during mining is a maximum 3% reduction for the Vasse-Wonnerup Wetlands (Table 3). This is a relatively small change for the large wetland system, which is the key environmental receptor downstream of the mining operation.

Table 3: Surface Water Contribution Area (%)

	Vasse-Wonnerup Wetlands	Lower Sabina River	Sabina prior to historical diversion
Catchment Area (km^2)	473	45	123
Mine/Infrastructure Envelope Area (km^2)	3.6	3.6	3.6
Catchment Area excluding Mine Envelope (km^2)	469.4	41.4	119.4
Contributing area remaining during mining (%)	99%	92%	97%

The Lower Sabina River is not considered a key receptor given its heavily modified catchment area (Upper Sabina Diversion, clearing and agricultural uses). A portion of flow in the Lower Sabina River will be groundwater baseflow, such that the impact on total discharge through the Lower Sabina River will be less than the catchment reduction shown.

During operations, the mine site will contain areas of operating pit, backfilling, and progressive rehabilitation. Thus, runoff from undisturbed and rehabilitated areas from within site will be allowed to drain offsite (and reduce Table 3 estimates). Therefore Table 3 is a conservative over-estimate of the impact on the catchment, as the entire mine and infrastructure area has been subtracted from the total catchment.

5. HAUL ROAD & UNALLOCATED POTENTIAL USE AREA

A strip of Land was obtained by Doral to the east of the Mine Envelope for the primary purpose of constructing a haul road (refer to north east part of Figure 2). The land use either side of the proposed haul road alignment is currently unallocated use and may be sought to be utilised in the future. As the landuse is unknown, surface water management planning for activities in this area has not been completed, but can be included in the future when a use is proposed.

The haul road is proposed to connect Ludlow-Hithergreen Road to the mine, and the proposed road runs east-west across existing farmland and the Abba River as shown on Figure 2. Doral will maintain surface water flows across the haul road alignment by installing culverts (or other structures) to maintain flow paths.

We trust that this surface water assessment memo meets your requirements. Please contact us if you require additional information regarding this assessment.

Regards,

Wendy

Consulting Hydrologist

Mark

Consulting Water Resources Engineer

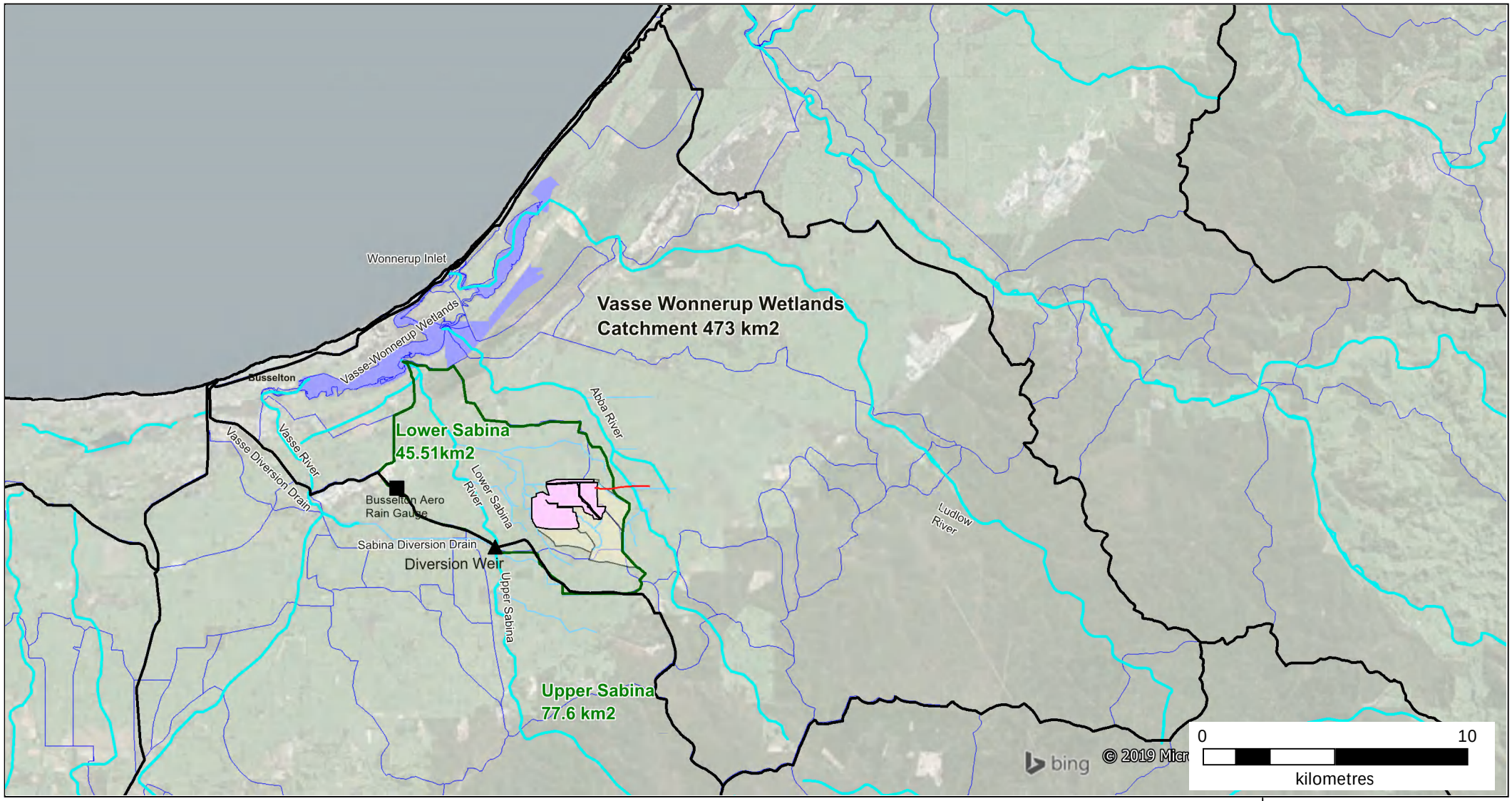
Author: WG (26/09/19)
Checked: MN (26/09/19)
Reviewed: MN (26/09/19)

Figures

Figure 1: Location Plan and Regional Catchment
Figure 2: Catchment Plan and Local Surface Drainage (including mining pit extent)

References

Marillier, B 2018, Reconnecting rivers flowing to the Vasse Estuary, Water Science Technical Series, report no. 81, Water Science Branch, Department of Water and Environmental Regulation (DWER), Perth, Western Australia



LOCATION MAP

Location: F:\136\4.GIS\Figures_Hydrology

LEGEND

- Regional Catchment (DWER)
- Regional Subcatchments (DWER)
- Lower Sabina Subcatchment
- WA Drainage Lines
- Site
- Upslope Catchment Extent
- Haul Access Road
- local drainage
- Busselton Aero Rain Gauge
- Sabina Diversion Weir
- Ramsar Wetlands - Vasse Wonnerup

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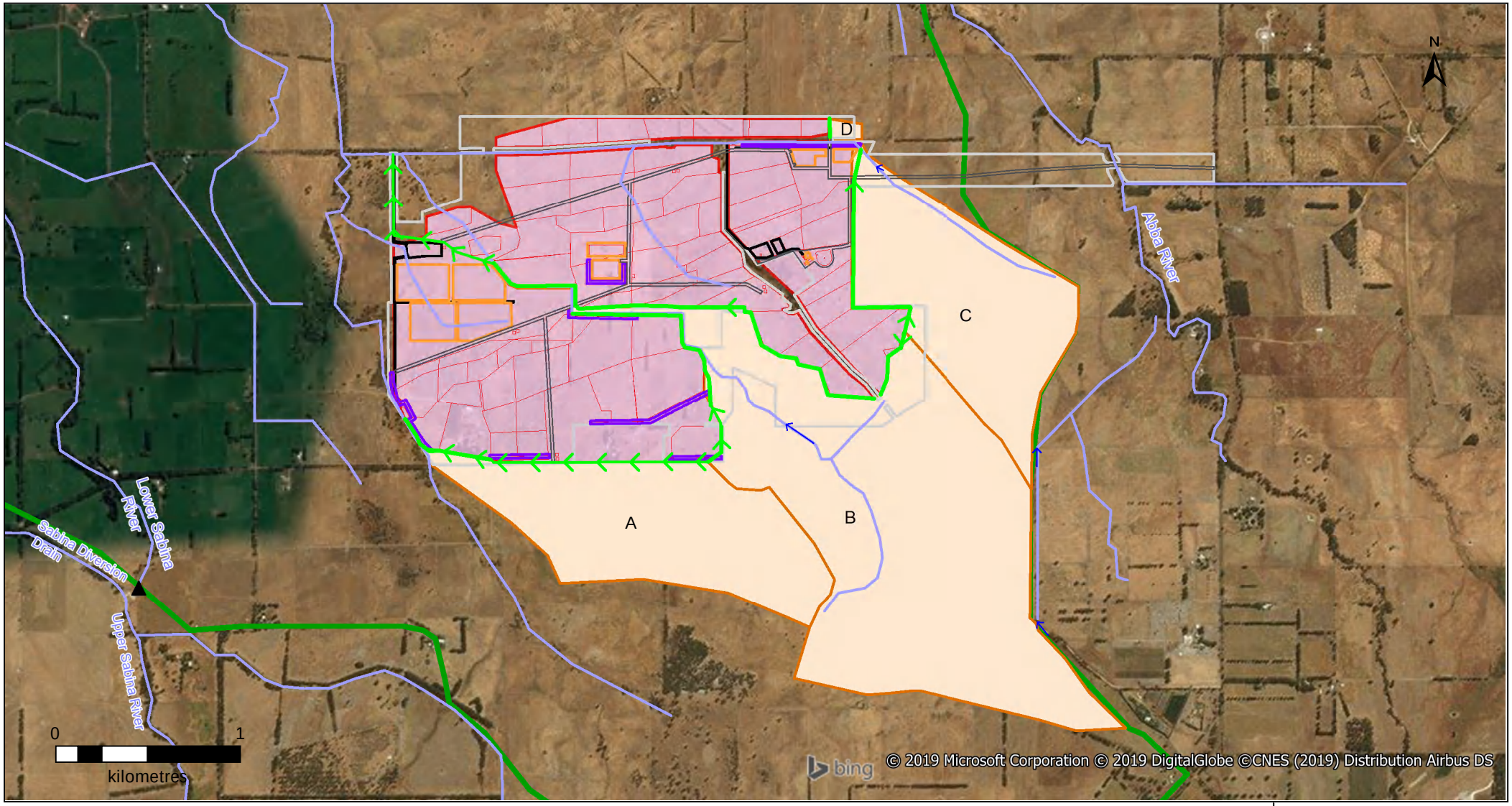
NOTES & DATA SOURCES:

Lower Sabina catchment based on local drains, DWER subcatchments and Topographic 2m contours from DPIRD - Department of Primary Industries and Regional Development (1999)

FIGURE 1

CATCHMENT PLAN & SURFACE DRAINAGE



LOCATION MAP

LEGEND

- Project Mine Envelope
- A — Upslope Catchment
- Lower Sabina Catchment
- Drainage Line
- Bund/Diversion
- Clean Water Diversion
- Pit Outline Locations
- Stockpiles (topsoil and overburden)
- Other Infrastructure (workshop/admin/slime tailings)
- Potential Disturbance Envelope
- Haul Road
- Doral Pipes/Drains

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NOTES & DATA SOURCES:

Pit Upslope catchment based on Topographic 2m contours from DPIRD - Department of Primary Industries and Regional Development (1999); and local culvert under Yalyalup Road
Pit Locations and Infrastructure from Doral (2019)

FIGURE 2

CATCHMENT PLAN & LOCAL SURFACE DRAINAGE

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