To:	Ronaldo Retief	**Date:**	09-09-19
From:	Mashudu Rafundisani	**Proj #:**	LEA5522
RE:	**Musina SEZ Development - Storm Water Management Plan**		

1 Introduction

Surface water resources (rivers/streams, pans/wetlands and dams) are essential for the provision of basic human needs and the habitat for aquatic ecosystems. These water resources provide habitat for both fauna and flora as well as water supply for agricultural (irrigation and livestock watering), domestic (communities) and industrial purposes in nearby communities and urban areas.

While development activities are the key factors for improving our economic wellbeing and subsequently the quality of life in our communities and the country, the industrial and mining development activities have greater potential to negatively impact natural surface water resources causing deterioration of water quality and/or the decrease in water quantity or the natural catchment yield.

This memo serves to provide the recommended storm water management plan for the proposed Musina-Makhado Special Economic Zone (SEZ).

1.1 Project Background and Location

SEZ refers to an economic development tool to promote national economic growth and export by using dedicated support measures that are strategically placed to attract targeted foreign and domestic investment (Republic of South Africa, 2014:8). The SEZs are expected to contribute towards strengthening South Africa's terms of trade through the export of value-added commodities, the creation of stronger value chains and provision of much-needed jobs in previously disadvantaged regions.

The SEZ objectives include:

- To promote the acquisition and development of targeted industrial capabilities within the framework of the IPAP, New Growth Path and the National Development Plan

- To promote beneficiation and value-addition to the country's minerals and other natural resources

- To develop world-class infrastructure required to support the development of the targeted industrial activities
- To attract relevant foreign and domestic direct investment
- To develop certain regions
- To promote employment creation
- To support urban regeneration and rural development.

The proposed Musina-Makhado SEZ will be specifically designated to focus on energy and metallurgical processing, agro-processing, petrochemical and logistics. This SEZ will compromise of a connected pipeline of a minimum of eight catalytic projects.

This SEZ will be located across the Musina and Makhado local municipalities which fall under the Vhembe District Municipality in the Limpopo Province. The nearest towns are Makhado (located 31 km south) and Musina (located 36 km north) of the proposed SEZ site. This will be established across eight farms. The total farm sizes add up to approximately 8000 hectares of which 6000 hectares will be used for the SEZ. The locality of the project area can be seen on

The proposed project will comprise an offering of mixed land uses and infrastructure provision to ensure the optimal manufacturing operations in the energy and metallurgical complex. It is envisaged that the energy and metallurgical will initially consist of a power plant, steel plant, stainless steel plant, coking plant, ferrochrome plant, ferromanganese plant, ferrosilicon plant, pig iron metallurgy plant and a lime plant amongst other things. The full list of the project components is listed in Table 1-1 below

Table 1-1: Project Components

PROJECTS	AREA (ha)	Capacity (Mtpa)
Power Plant	300	3
Coke Plant	500	5
Ferrochromium Plant	500	3
Ferromanganese Plant	100	1
Pig Iron Plant	600	6
Carbon steel plant	200	2
Stainless steel plant	500	4
Lime plant	500	8
Silicon-manganese plant	100	0.5

PROJECTS	AREA (ha)	Capacity (Mtpa)
Metal silicon plant	50	0.3
Calcium carbide plant	50	0.3
Infrastructure	2600	
Total	**6000**	

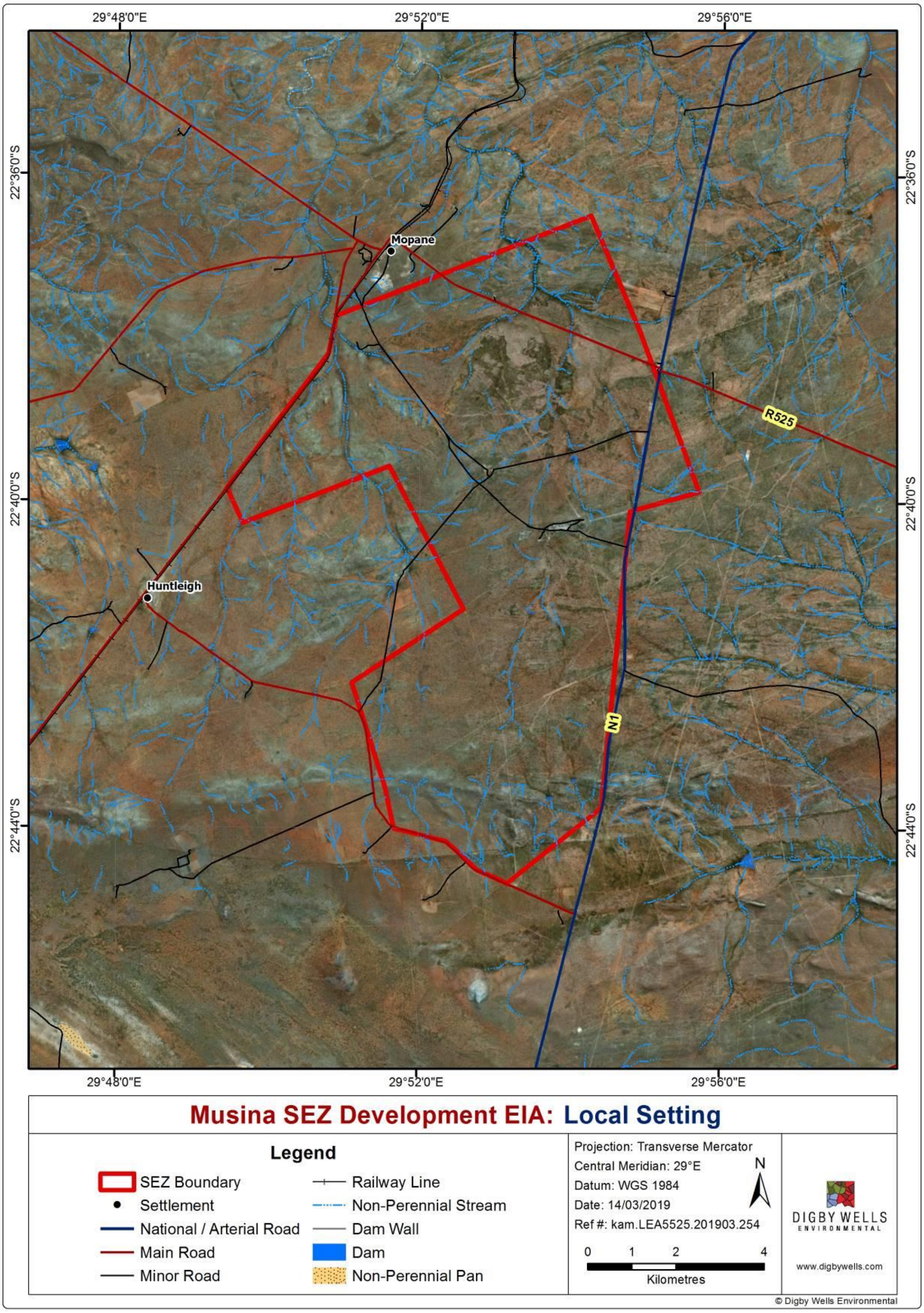


Figure 1-1: Locality of the Proposed SEZ

2 Scope of Work

To achieve the study objectives the following scope of work was undertaken:

- Baseline hydrological assessment;
- Delineation of clean and dirty catchment areas;
- Calculation of the 1:50 year peak flows originating from clean and dirty water catchments; and
- Conceptual placement of clean and dirty water structures will be indicated on a plan.

3 Methodology

3.1 Baseline hydrology

Climate data obtained from the Water Resources of South Africa study (WR2012) (WRC, 2015) was analysed to determine the mean annual precipitation (MAP), mean annual runoff (MAR) and mean annual evaporation (MAE) of the project site.

3.2 Catchment Delineation and Peak Flows

Based on the Digital Elevation Model (DEM) generated from 1m contour data set, three dirty water catchments were delineated using Global Mapper and the runoff peak-flows were calculated for these three catchments. The peak-flows were calculated for the 1:50 year storm event as prescribed GN 704 regulation and this will inform the appropriate sizing of the storm water management infrastructures.

Design rainfall depths were calculated using the Design Rainfall Programme for South Africa and the modified Hershfield equation for use in determining flood peaks. Widely used and recommended methods including the Rational Method Alternative 3 (RM3), Standard Design Flood (SDF) and the Midgley & Pitman (MIPI) were used to calculate the 1:50-year peak flows for the delineated catchment at the project site. The peak flow methods are summarised in Box 3-1.

Box 3-1: Summary of peak flow methods used

Rational Method: The Rational Method is described by the formula Q = CIA, where I is rainfall intensity, A the runoff contributing area, C the runoff coefficient and Q, the peak flow. To calculate point precipitation depths, the RM3 uses the Design Rainfall software for South Africa which adapts the method to rainfall trends typical of South African conditions (SANRAL, 2013).

Standard Design Flood Method: The Standard Design Flood (SDF) method is an empirical regionally calibrated version of the Rational Method (SANRAL, 2013). The runoff coefficient (C) is replaced by a calibrated value based on the subdivision of the country into 26 regions. The design methodology is slightly different and looks at the probability of a peak flood event occurring at any one of a series of similarly sized catchments in a wider region, while other methods focus on point probabilities (SANRAL, 2013). The information required in this method is the area of the catchment, the length and slope of the main stream and the drainage basin in which it is located.

Midgley & Pitman: The Midgley and Pitman (MIPI), which is an empirical method, is based on correlation between peak flows and some catchment characteristics which include, the effective catchment area, length to catchment centroid, MAP and a derived constant (K_T) for a T-year return period. Regional parameters are then mapped out for South Africa. These methods are mostly suitable for medium to large catchments (SANRAL, 2013). MIPI is particularly for obtaining an advance indication of the order of magnitude of peak discharges, serving as a rough check on the results of non-statistical methods (SANRAL, 2013).

4 Baseline Environment

4.1 Hydrological Setting

The project area is predominantly located in the A71K quaternary catchment with a smaller portion on the south which falls within A80F quaternary catchment, both the two catchments are within the Limpopo WMA (1) as revised in the 2012 water management area boundary descriptions (government gazette No. 35517), this is shown in Figure 4-1. The surface water attributes of the affected quaternary catchment; namely Mean Annual Precipitation (MAP), Mean Annual Runoff (MAR), and Mean Annual Evaporation (MAE) were obtained from the Water Resources of South Africa 2012 Study (WR2012) and are summarised in Table 4-1.

Table 4-1: Summary of the surface water attributes of the A71K quaternary catchment

Catchment	Area (km^2)	MAP (mm)	MAR $m^3 * 10^6$	MAE (mm)
A71K	1668	305	7.28	2000

The A71K quaternary catchments has a net area of 1 668 km^2 which receives an average of 305 mm of rainfall per annum with an average potential S-pan evaporation rate of 2 000 mm per annum.

Sand River is the only major river within this quaternary catchment (approximately 8 km North-west of the project area). The Sand River flows from the South-west side of the project area towards the north-east side where it eventually joins the Limpopo River approximately 50 km away from the project area.

Few drainage lines exist towards the northern boundary of the demarcated project area and runoff from this area flows towards the northern direction via these drainage line and finally reports to the Sand River approximately 8 km west of the project site.

The flows in the lower Sand River (adjacent to the project area), its tributaries and minor streams are highly intermittent. Run-off occurs after rainfall events, with flow in the main stem of longer duration after major, wide-spread rainfall in its catchment area.

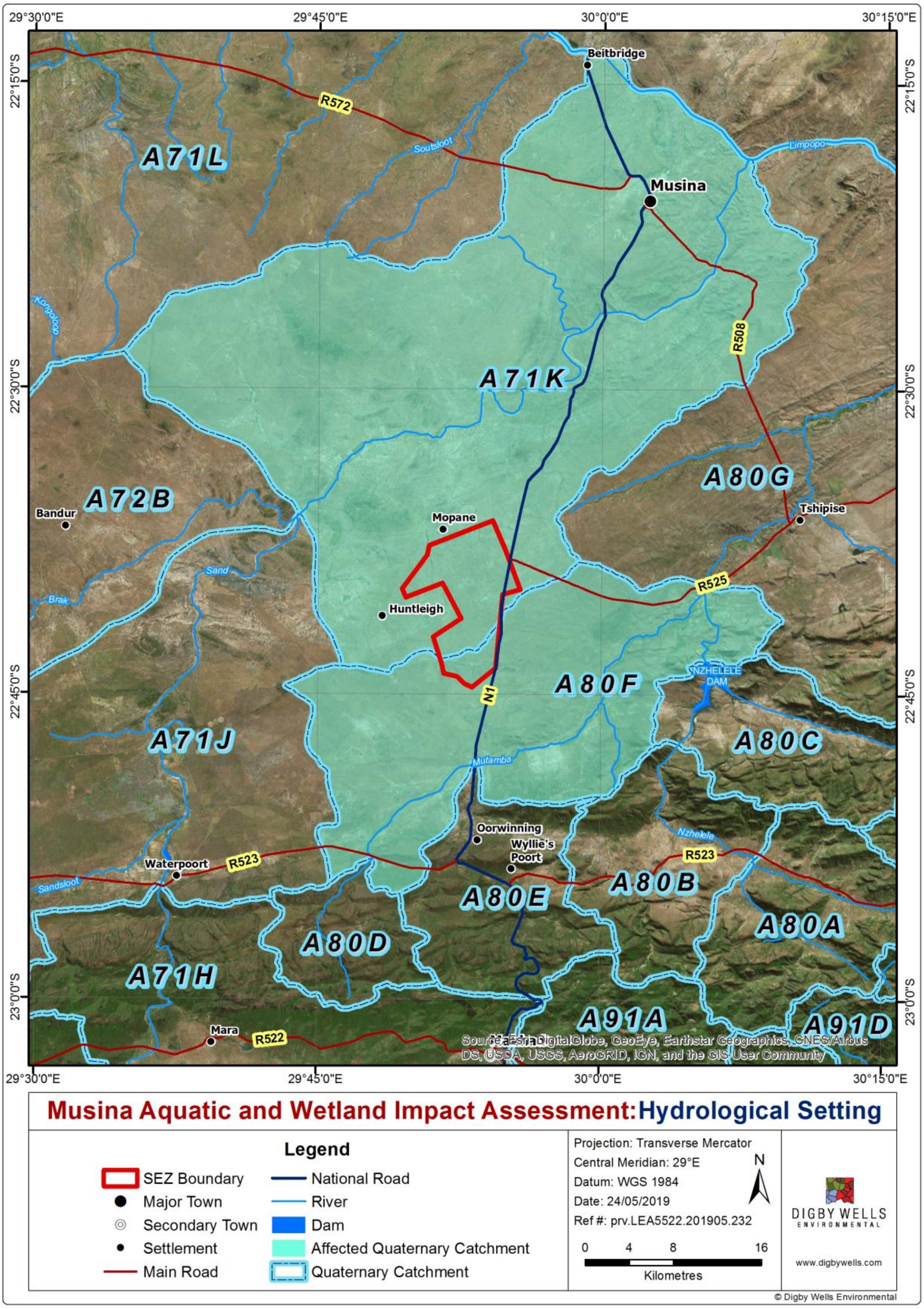


Figure 4-1: Hydrological Setting

4.2 Climate

The project area is situated in a semi-arid zone to the north of the Soutpansberg. The regional climate is strongly influenced by the east-west orientated mountain range which represents an effective barrier between the south-easterly maritime climate that originates from the Indian Ocean and the continental climate that is influenced predominantly by the Inter-Tropical Convergence Zone and the Congo Air Mass coming from the north.

The mountains give rise to wind patterns that play an important role in determining local climates. These wind effects include wind erosion, aridification and air warming (WSM LESHIKA, 2013).

4.2.1 Rainfall and Evaporation

Table 4-2 presents the average monthly rainfall and evaporation for the A71K quaternary catchment. This data is based on the average monthly rainfall and evaporation data for the period 1920 to 2009.

Table 4-2: Summary of Rainfall and Evaporation data extracted from the WR2012

Months	Rainfall (mm)	Lake Evaporation (mm)
January	62.6	175.2
February	50.8	149.4
March	37.4	149.4
April	15.1	122.1
May	5.7	114.0
June	3.9	91.8
July	1.8	100.9
August	0.9	120.2
September	7.8	146.3
October	21.4	169.5
November	45.8	164.5
December	52.0	177.3

Months	Rainfall (mm)	Lake Evaporation (mm)
Mean Annuals	**305**	**1681**

From the data above, higher rainfall values (52 mm, 62.6 mm and 50.8 mm) were recorded for the months of December, January and February respectively whilst the minimum or lowest rainfall was recorded in August. In general, this area receives a MAP of 305 mm per annum.

The MAE of 2000 mm presented in Table 4-1 is based on Symons Pan evaporation measurements and needs to be converted to lake evaporation. This is due to the Symons Pan being located below the ground surface and painted black which results in the temperature in the water being higher than that of a natural open water body. The Symons Pan figure is then multiplied by a lake evaporation factor to obtain the adopted lake evaporation figure which presents the monthly evaporation rates of a natural open water body. The MAE was calculated to be 1 681 mm per annum.

Higher potential evaporation rates are experienced throughout the whole year with the highest being 177 mm in December. The combined or summary of the climatic data for this quaternary has been presented in Figure 4-2.

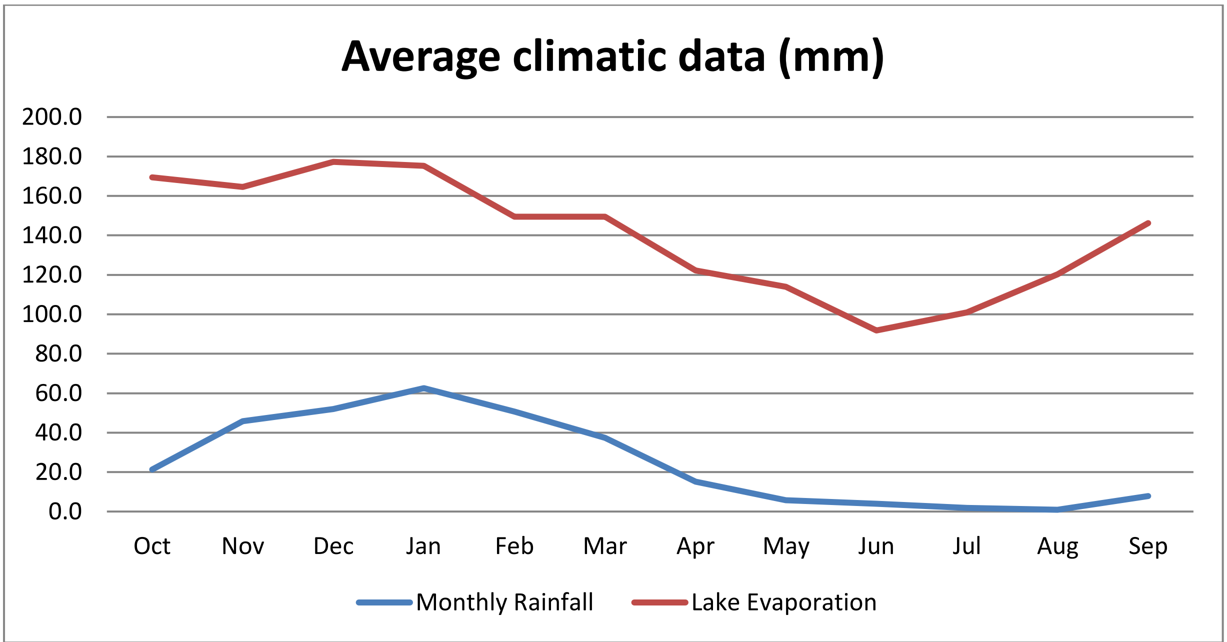


Figure 4-2: Summary of the average monthly climatic data for A71K quaternary catchment

4.3 Land and Water Uses

The predominant current land use in the wider area is agriculture with potential for mining, whilst the main use of surface water in the area is agricultural (irrigation). The water requirements within the Sand River catchment are large compared to the rest of the WMA, with irrigation comprising the largest water use. The majority of the irrigation sector's water requirements are met by the extraction of groundwater reserves via boreholes in the Sand / Limpopo Rivers which have been over-exploited. Although the urban requirements are high, a large portion of water is supplied through transfers from other WMAs (Savannah Environmental, March 2017).

5 Storm Water Management Plan

Storm Water Management Plan (SWMP) provides guidelines for ensuring that flood and rainfall events in general do not result in adverse impacts on neighbouring water resources, affect surrounding land.

Good storm water management is based on clean and dirty water separation and therefore incorporates the fundamental principle of pollution prevention. The following primary principles should be applied in developing the SWMP at the site:

- To keep clean water clean, and to keep clean and dirty water systems separated (ensure that clean water is diverted around the site into the natural environment);
- To contain any dirty water within the system and minimize the risk of spillages into any clean water system; and
- Minimisation of dirty water catchment and promote recycling or re-use of dirty within the system to minimise raw water intake.

A conceptual storm water management plan indicating the placement of storm water infrastructures has been developed in accordance with the Government Notice 704 (GN 704) of the National Water Act 1998 (Act 36 of 1998). This was developed based on the infrastructure layout provided by the client. The recommended storm water infrastructure plan can be seen in Figure 5-3 and Figure 5-4

5.1 Delineated Sub-Catchments

The conceptual SWMP indicates the separation of clean and contaminated water through storm water channels/drains, Berms, contaminated storm water dams or return water dams and silt traps, also referred to as sediment control structures. The schematic of stormwater drains is presented in Figure 5-1 which shows an adjoining drain and berm structure required to channel stormflow as well as separate clean water from entering contaminated catchments. Three contaminated sub-catchments were delineated for the project site (

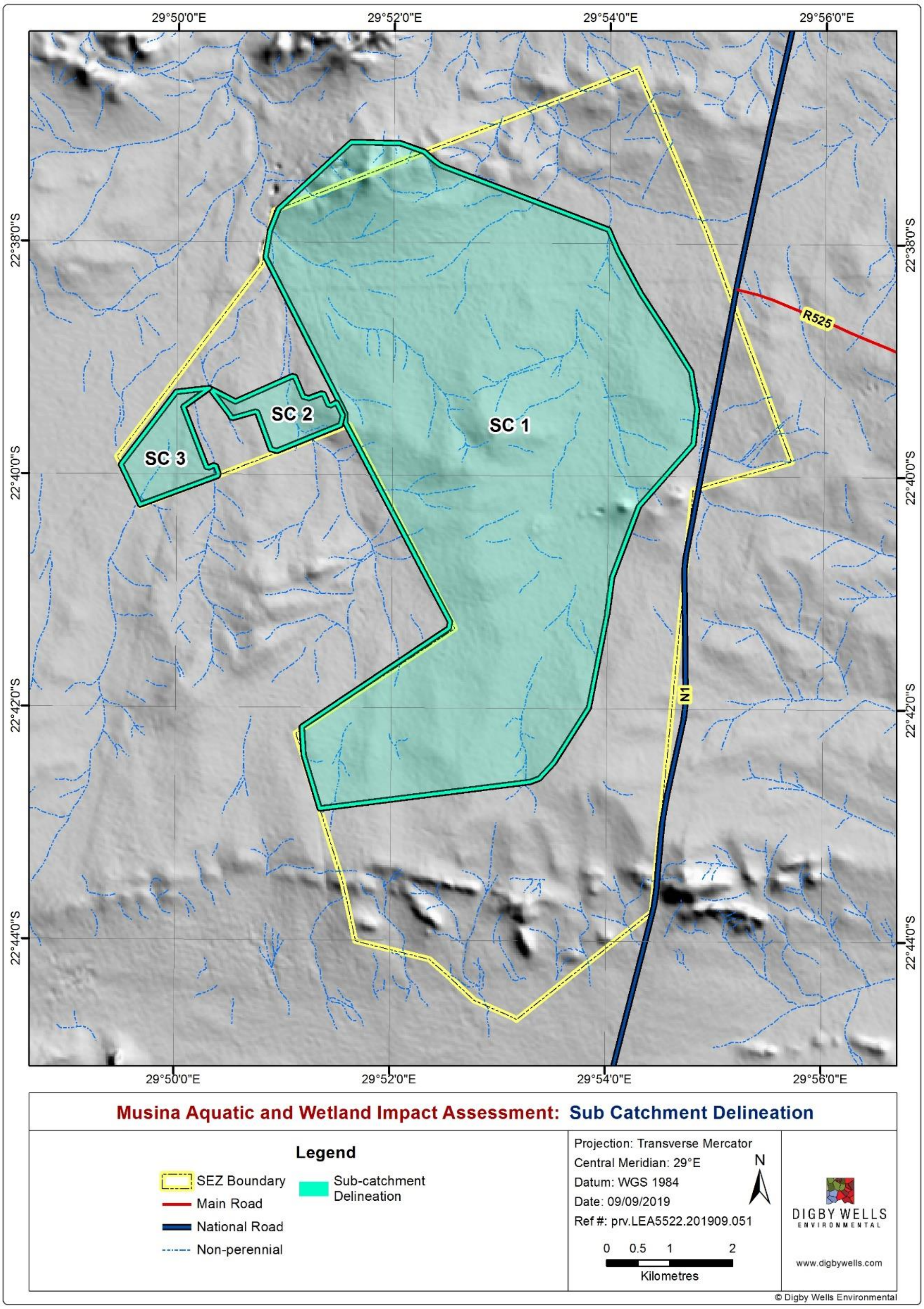


Figure 5-2) which include the plant areas, power plant area and the Ash dam area.

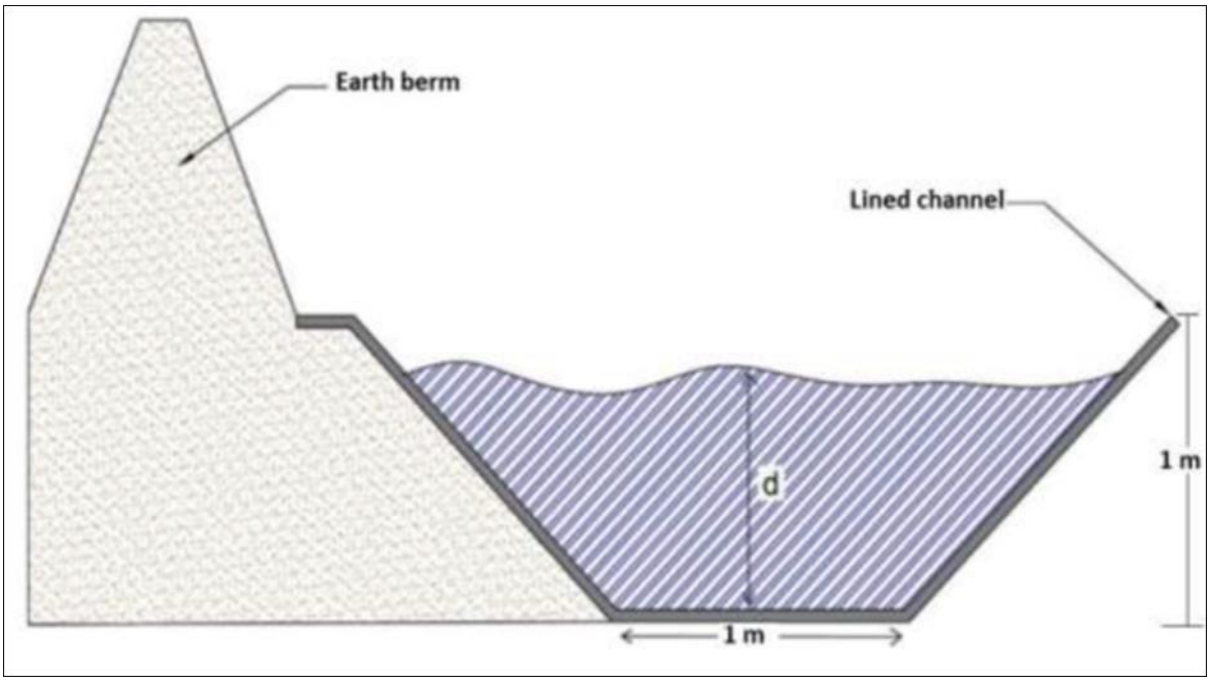


Figure 5-1: Typical drain adjoined to a berm for stormwater channelization

5.2 Peak Flows

The design rainfall depths were used as input in the RM3 method for peak flows calculation. Peak flows calculated using the MIPI method were much lower while the RM3 and SDF flood peaks were considered realistic as they were much closer to each other and these can be considered to be the most conservative peak flows for the three catchments and these are presented in Table 5-1.

Table 5-1: Calculated peak flows for the three sub-catchments (Applicable at the catchment outlet)

Catchment	Method		
	Rational Alt 3	SDF	MIPI
	1:50yr	1:50yr	1:50yr
	(m^3/s)		
SC1	185.299	180.54	50.29
SC2	16.903	15.35	6.15
SC3	33.568	31.62	8.13

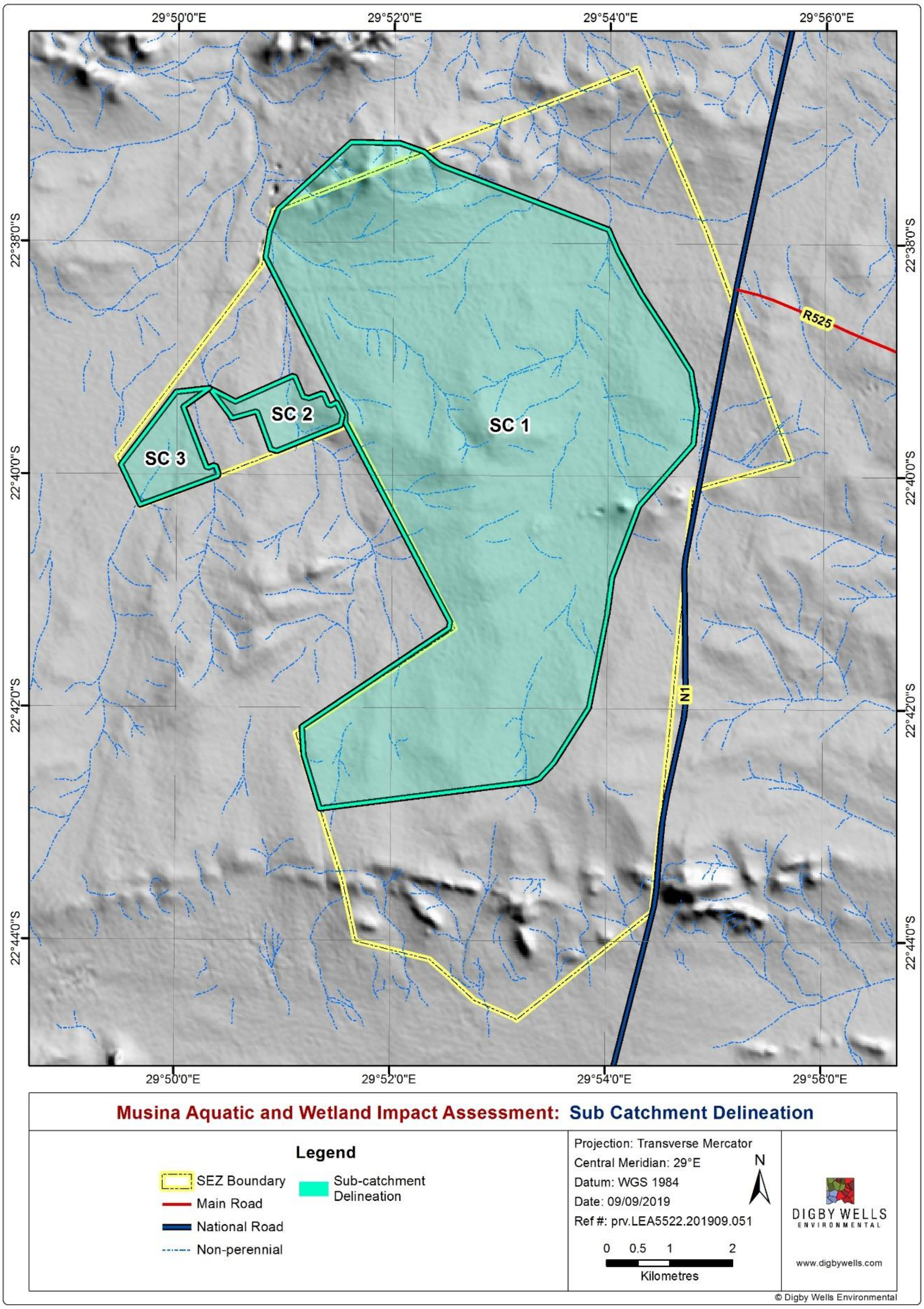
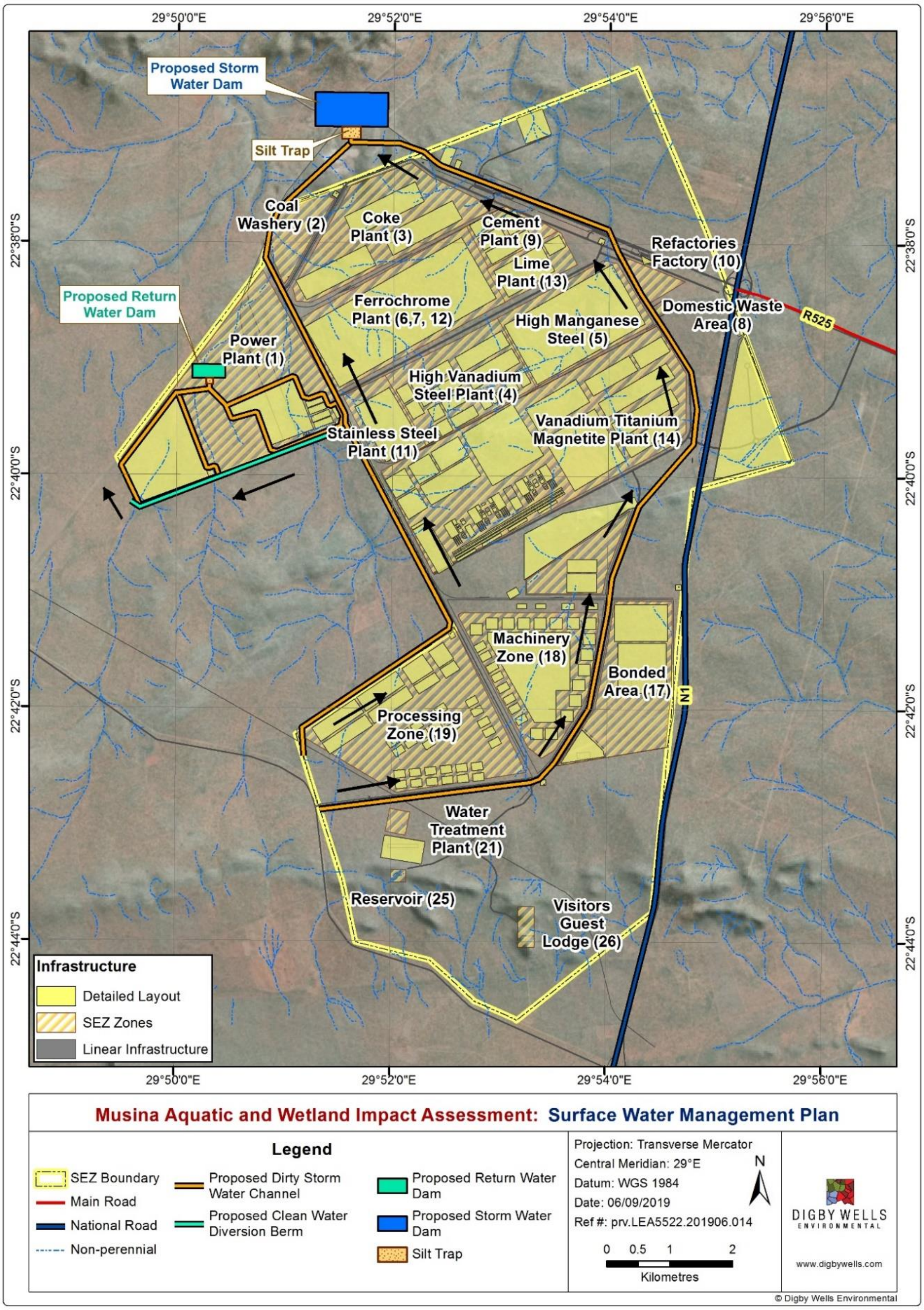


Figure 5-2: Delineated Catchments



Proposed Storm Water Dam
Silt Trap
Coal Washery (2)
Coke Plant (3)
Cement Plant (9)
Refactories Factory (10)
Lime Plant (13)
Proposed Return Water Dam
Ferrochrome Plant (6,7, 12)
High Manganese Steel (5)
Domestic Waste Area (8)
R525
Power Plant (1)
High Vanadium Steel Plant (4)
Stainless Steel Plant (11)
Vanadium Titanium Magnetite Plant (14)
Machinery Zone (18)
Bonded Area (17)
N1
Processing Zone (19)
Water Treatment Plant (21)
Reservoir (25)
Visitors Guest Lodge (26)
29°50'0"E
29°52'0"E
29°54'0"E
29°56'0"E
22°38'0"S
22°40'0"S
22°42'0"S
22°44'0"S
Infrastructure
Detailed Layout
SEZ Zones
Linear Infrastructure
Musina Aquatic and Wetland Impact Assessment: Surface Water Management Plan
Legend
SEZ Boundary
Main Road
National Road
Non-perennial
Proposed Dirty Storm Water Channel
Proposed Clean Water Diversion Berm
Proposed Return Water Dam
Proposed Storm Water Dam
Silt Trap
Projection: Transverse Mercator
Central Meridian: 29°E
Datum: WGS 1984
Date: 06/09/2019
Ref #: prv.LEA5522.201906.014
N
0 0.5 1 2
Kilometres
DIGBY WELLS ENVIRONMENTAL
www.digbywells.com
© Digby Wells Environmental

Figure 5-3: Proposed Storm Water Management Plan

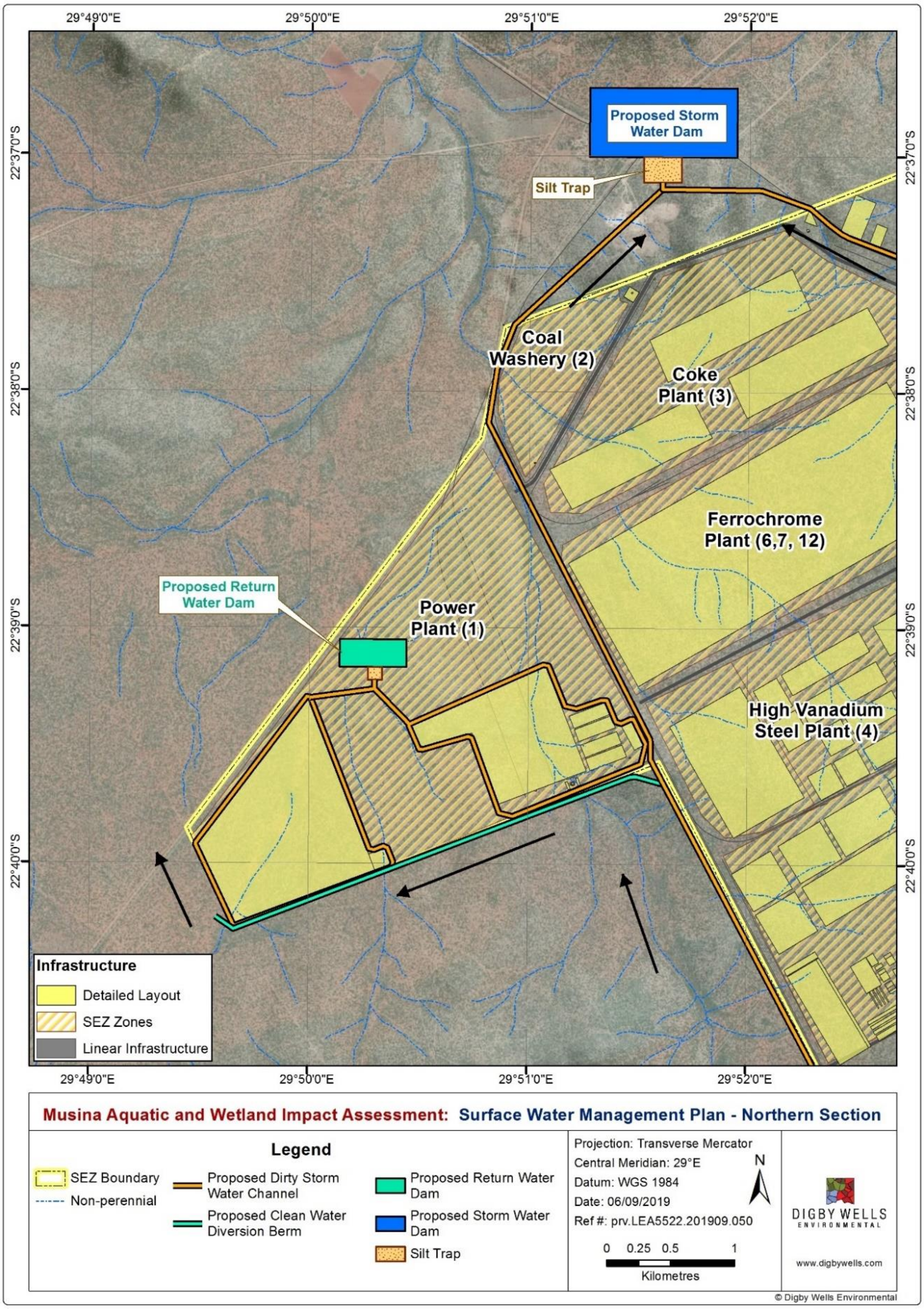


Figure 5-4: Proposed Storm Water Management Plan

6 References

Alexander, J. (2002). The Standard Design Flood. *South African Institution of Engineers*, 26-30.

SANRAL. (2013). *South African Drainage Manual.* Pretoria: SANRAL.

WRC. (2015). *Water resources of South Africa 2012 study.* Pretoria: Water Research Commission.

Daniel Fundisi

Hydrologist

Mashudu Rafundisani

Manager: Surface Water