Longyuan Mulilo De Aar 2 North Wind Energy Facility: Stormwater and Erosion Management Plan

Final Report

April 2014

Submitted by:

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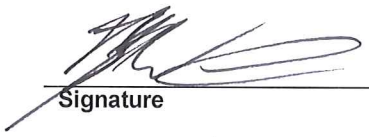
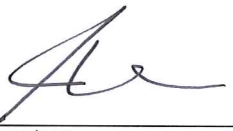
Compiled by	:	MB Wiese Initials & Surname	 Signature	05/05/2014 Date
Reviewed by	:	IF Malherbe Initials & Surname	 Signature	05/05/2014 Date
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List of Abbreviations

AECOM	AECOM SA (Pty) Ltd
DWA	Department of Water Affairs
ha	hectares
km	kilometres
km^2	square kilometres
Longyuan Mulilo	Longyuan Mulilo De Aar 2 North
m	metres
mamsl	metres above mean sea level
MAP	Mean Annual Precipitation
MW	Megawatt
N10	National Route 10
NEMA	National Environmental Management Act
NWA	National Water Act
R48	Regional Route 48
R389	Regional Route 389
SAWQG	South African Water Quality Guidelines
SWMP	Stormwater Management Plan
TSS	Total Suspended Solids
WEF	Wind Energy Facility
WRC	Water Research Commission

1. Introduction

1.1 Background

Longyuan Mulilo De Aar 2 North (Longyuan Mulilo) has identified a site ideal for the development of a Wind Energy Facilities (WEF), located south of the Regional Route 48 (R48) between De Aar and Philipstown, northeast of De Aar in the Northern Cape, South Africa, as indicated in **Figure 1.1**. The site extends across 12 farm portions located on a plateau.

The National Route 10 (N10) between Hanover and Britstown, passing south of De Aar, is located to the south of the site and Regional Route 389 (R389) cross the eastern parts of the site. Railway lines are located to the south and west of the site.

1.2 Scope of study

AECOM SA (Pty) Ltd (AECOM) has been appointed by Longyuan Mulilo to compile a Stormwater Management Plan (SWMP) for the proposed WEF site. The scope of work associated with the SWMP includes the identification of hydrological impacts, as a result of the development of a WEF at the proposed site, on the surrounding environment, and guidelines / objectives for the formulation of mitigation measures to prevent :

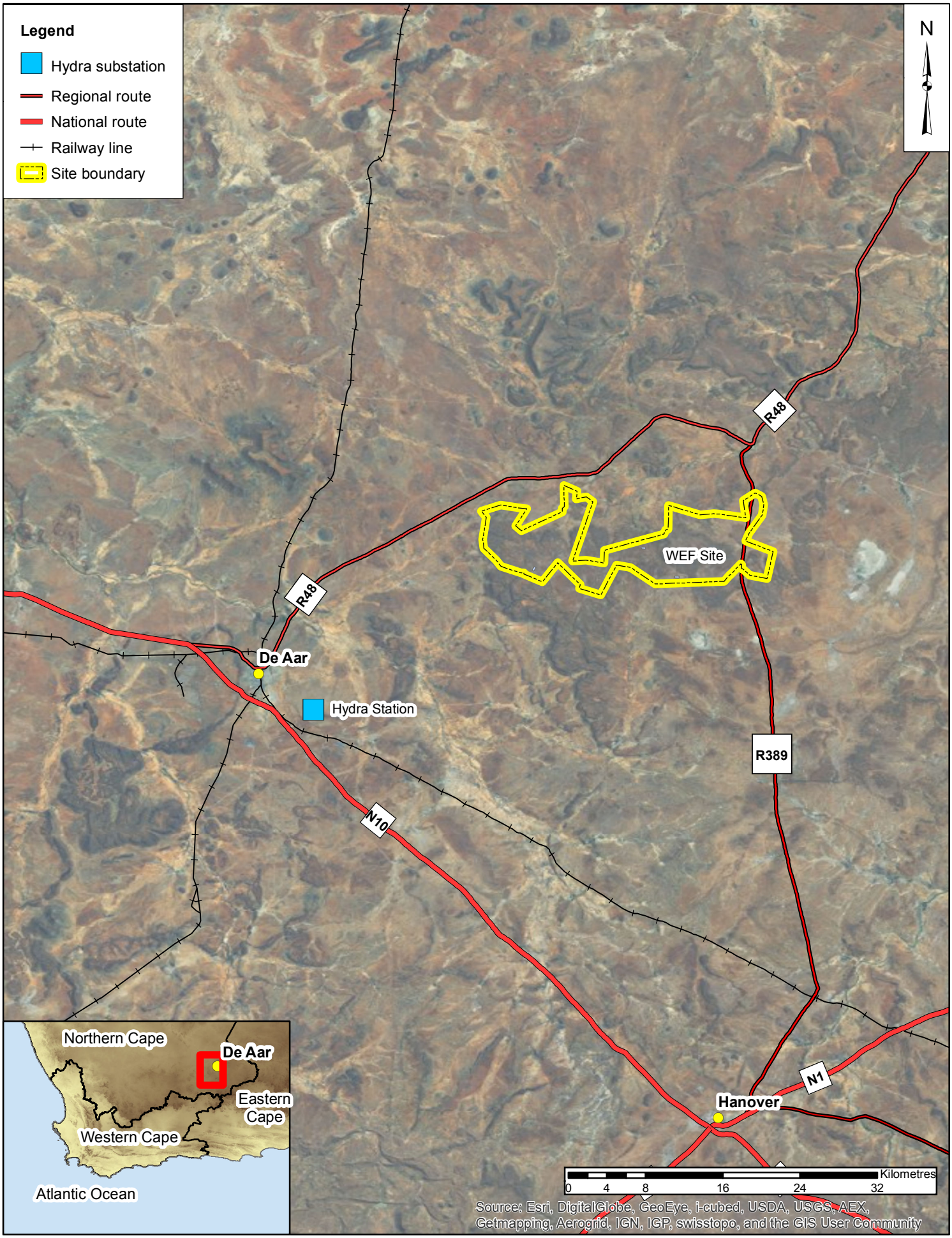
- The degradation of the natural environment.
- Impacts on the quality of water resources.
- Loss or damage to property.

1.3 Study limitations

The SWMP is based on information received during the preliminary design stage of the proposed WEF, which is subject to change during further development stages.

1.4 Study approach

During this investigation, hydrological impacts, as a result of the proposed wind farm site and layout, during both construction and operational phases, were identified. Guidelines / objectives for the formulation of mitigation measures are proposed in this report, with the aim to prevent or minimise the abovementioned hydrological impacts as far as practicable possible, as required by legislation.



Project Title:	**Longyuan Mulilo De Aar 2 North Wind Energy Facility: Stormwater Management Plan**
Map Title:	**Locality plan**

Scale 1:500 000
(When page size is: A4 portrait)

FIGURE 1.1

Projection:	Geographic - Hartbeeshoek 1994
Drawn by:	MB Wiese
GIS QC by:	NG Letoao
Approved by:	I Malherbe
Date:	March 2014
Map Ref.:	Figure 1.1 - Locality plan.mxd
Revision:	00
Project Nr.:	14C00570

Sources:

Surveyor general. 2011.
Water Resources of South Africa 2005 Study. 2008.
Environmental Potential Atlas for South Africa. 2001.

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De Aar 2 - Figure 1.1 - Locality plan (A4).mxd

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1.5 Structure of report

The report is structured as follow :

Section 1 describes the background to, purpose of and structure of this report.

In **Section 2** a description of the site is provided.

The legislative requirements applicable to this investigation is summarised in **Section 3**.

Section 4 presents the hydrological setting of the site.

Section 5 describes the necessary stormwater management procedures.

In **Section 6** the conclusions from this investigation are provided and recommendations are presented.

References are listed in **Section 7**.

2. Site description

The proposed WEF site encompasses 12 farm portions located on an elevated plateau east of De Aar, which comprise a total area of approximately 141 km^2. The R389 is located along the eastern parts of the site and an existing secondary gravel road is located along the southern boundary of the side, which provides access for construction, maintenance and transportation vehicles, as indicated in **Figure 2.1**.

A network of approximately 4 m wide gravel roads is proposed, allowing access for the abovementioned vehicles to the wind turbines. Roadways are aligned to fit existing farm roads as closely as possible to prevent unnecessary cut and fill and the construction of new roads where no farm roads exist. The southern and central part of the WEF site, where construction is proposed, is undulating with gentle slopes. Two local elevated areas are located towards the eastern and western parts of the site, which could require steeply sloped roads in certain areas. The gravel roads cover a total distance of approximately 68 km.

The proposed site hosts 96 wind turbine structures located in elevated areas ranging approximately from 1 347 to 1 506 mamsl. Each of these wind turbines has a round foundation of 16 m diameter. An area of 0.35 ha, which includes the foundation, is required for the erection of each of the wind turbines, therefore covering a total area of approximately 33.6 ha.

Construction yards are proposed at three locations along the abovementioned access roads, as indicated in **Figure 2.1**. One of the construction yards are proposed along the secondary road located along the southern boundary of the site and the other two are proposed to the east and west of the site. Each of these construction yards are 400 x 200 m, covering an area of 8 ha.

A substation / control building is proposed along the south-western edge of the proposed site, located on the higher elevated, gently sloped central parts of the plateau.

Legend

- Proposed wind turbines
- Proposed access road
- Proposed construction yard
- Proposed substation / control building
- Site boundary
- Watercourse
- Secondary roads
- Regional routes
- D31B Quaternary catchment
- 20m contours

N

R48

R389

D62F

D62D

D31B

D32F

D32J

ROOIBLOMSLOOT

HONDEBLAF

Endoreic areas

Tributary of the Brak River

Kilometres
0 1 2 4 6 8

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Project Title:	**Longyuan Mulilo De Aar 2 North Wind Energy Facility : Stormwater Management Plan**
Map Title:	**Site layout and regional drainage**

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FIGURE 2.1

Projection:	Geographic - Hartbeeshoek 1994
Drawn by:	MB Wiese
GIS QC by:	NG Letoao
Approved by:	I Malherbe
Date:	April 2014
Map Ref.:	Figure 2.1.mxd
Revision:	00
Project Nr.:	14C00570

Sources:

Surveyor general. 2011.
Water Resources of South Africa 2005 Study. 2008.
Environmental Potential Atlas for South Africa. 2001.

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3. Legislative requirements

3.1 National Water Act

The National Water Act (NWA), 1998 (Act No 36 of 1998) provides the Department of Water Affairs (DWA) with the mandate to protect, use, develop, conserve, manage and control the country's water resources in an integrated manner. It provides the legal basis on which to develop tools and the means to affect this mandate. Chapters 3 and 4 of the NWA deals with pollution prevention and water use. The person who owns, controls, occupies, or uses the land in question is responsible for taking measures to prevent pollution of water resources. Any structures which may be located where they may have an impact on current water resources are governed by sections of the NWA and / or regulations published in terms of this Act.

The means necessary to prevent pollution of water resources can be broadly outlined as follow :

- Water contaminated by activities / infrastructure may not be discharged to water resources.
- Prevention of erosion.
- The separation of clean and "dirty" stormwater runoff.
- Monitoring programmes.

3.2 South African Water Quality Guidelines

The NWA, Section 21 (f) and (g), states that the discharging of water containing waste into a water resource and disposing of waste which may detrimentally impact on a water resource should be prevented. The South African Water Quality Guidelines (SAWQG) are a series of documents published by DWA, which forms an integral part of the water quality management strategy to safe keep and maintain the water quality in South Africa. These guidelines are used by the DWA as a primary source of information and decision-support to judge the fitness for use of water and for other water quality management purposes. The content of the SAWQG provides information on the ideal water quality and acceptable concentrations for various constituents of concern.

Construction sites are generally considered as an industrial activity, however, due to the nature of the WEF, the water quality guidelines for industrial use are considered onerous. It is therefore recommended that the water quality of stormwater runoff should adhere to the guidelines provided in Volume 7 : Aquatic Ecosystems of the SAWQG, to ensure acceptable conditions in the aquatic ecosystems downstream of the WEF, primarily focussing on the concentrations of Total Suspended Solids (TSS), which can be considered as one of the main constituents of concern due to the removal of vegetation and concentration of flow associated which result in accelerated erosion.

According to the abovementioned guideline, "any increase in TSS concentrations must be limited to < 10 % of the background TSS concentrations at a specific site and time".

3.3 National Environmental Management Act

The National Environmental Management Act (NEMA), 1998 (Act No 107 of 1998) covers the control and management of environmental impacts and, *inter alia*, provides a framework for measures that "prevent pollution and ecological degradation; promotes conservation; and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development".

4. Hydrological setting

The WEF site is located on the catchment divide between quaternary catchments D62D and D31B, draining towards the Brak and Hondeblaf Rivers, respectively. Due to the elevated nature of the site, the impact of stormwater runoff on the infrastructure is expected to be generally localised in nature.

The north-western part of the site drains in a general north-easterly direction towards the Hondeblaf River, which discharges into the Van Der Kloof Dam. The Brak River drains the southern and south-western parts of the site in a north-westerly direction towards the Oranje River. The eastern part of the site is drained via watercourses in a south-easterly direction, which discharge stormwater runoff to localised lows, or endoreic areas, as indicated in **Figure 2.1**.

The central parts of the plateau are undulating with gentle slopes, covered by scarce grasslands and scrub, as indicated in **Figure 4.2**. Along the edges of the plateau are rock outcrops and larger scrub, as indicated in **Figure 4.3**. General infiltration rates on the site are expected to be moderate to high; however, lower infiltration rates are expected along the rocky perimeter of the plateau.

The proposed roads and turbines are located at an elevated level. Watercourses draining these catchments on the mountains have steep slopes, resulting in high velocities and associated erosion potential should the groundcover be removed or disturbed.

The Mean Annual Precipitation (MAP) of the proposed WEF site is approximately 320 mm, with the highest monthly precipitation experienced between November and April (WRC, 2004), as indicated in **Figure 4.1**. Rainfall events in this area are of high intensity, resulting in flash floods. Shortly after rain events, surface water speedily seeps away or is evaporated.

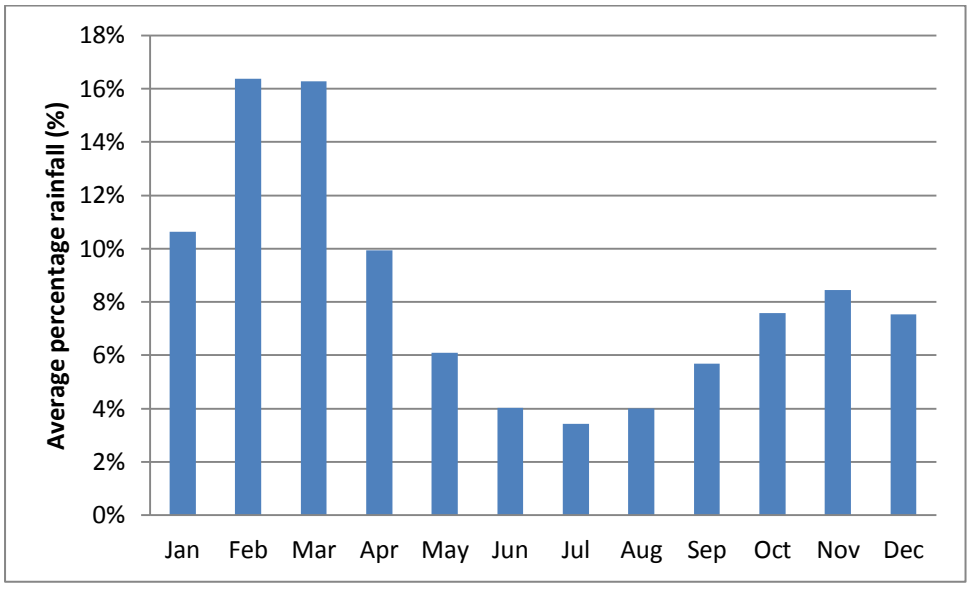

Figure 4.1 : Average percentage MAP experienced each month

Figure 4.2 : Sparse grasslands covering the central and southern parts of the site

Figure 4.3 : Scattered scrub and rocks along the steeper sloped western parts of the site

5. Stormwater management

5.1 General

Stormwater management is required both during and after the construction of the WEF to prevent damage to property, degradation of the water quality in water resources and negative impacts to the surrounding environment. The impacts during construction phase are temporary, while impacts during operational phase are permanent and could result in a greater cumulative impact. Impacts during both these phases should be controlled at the source, to minimise or prevent the long-term and short-term impacts.

5.2 Construction phase

5.2.1 Possible impacts

Stormwater runoff could, in the case of the three temporary construction yards, potentially come in contact with areas dedicated for the handling of contaminants such as fuel storage areas or in the case of wind turbine sites or the substation / control building, with areas where potential contaminants such as concrete is being handled. This could result in contaminated stormwater runoff being discharged downstream.

During the construction of roads the removal or disturbance of vegetation could result in the concentration of flow and consequently in accelerated erosion along roads where steep slopes dominate, which will result in an increase of suspended solids and sedimentation of the downstream environment. Erosion of the proposed roads is further possible at watercourse crossings due to the concentration of flow. Removal or disturbance of vegetation from areas such as new roads, the construction yards and the substation / control building could also result in erosion due to the soil stability being affected.

5.2.2 Proposed mitigation measures

Typical mitigation measures for the impacts mentioned in **Section 5.2.1**, *inter alia* include :

Table 5.1 : Typical mitigation measures during construction phase

Impact	Typical mitigation measures
Contamination of stormwater runoff	• Construction areas such construction yards, wind turbine sites and the substation / control building site should be protected from external stormwater runoff approaching these sites, by implementing cut-off drains or berms along the upstream boundary of the area to divert stormwater runoff away from the site and discharge diverted stormwater as per predevelopment conditions.

Impact	Typical mitigation measures
	• Inside the construction yard, stormwater runoff must be kept separate from areas dedicated to containing hazardous substances such as bunded areas for wash bays, fuel storage areas and refuelling areas.
Erosion	• Minimize the WEF footprint, disturbance of drainage paths and ground cover by, *inter alia*,fencing off construction areas and "no-go" areas. • Minimise the extent of earthworks. • Plan to reintroduce the existing topsoil and groundcover of disturbed areas after construction. • Encourage the use of natural flow paths downstream of construction sites. • Attenuate stormwater runoff and reduce flow velocities as much as possible with the use of small gabion weirs, stilling basins and vegetated swales. • Apply erosion control, e.g. by using straw bales, and good "house-keeping" practices. • The discharge of stormwater should be spread over a wide area to reduce the energy as a result of concentrated flow, and return to sheet flow downstream of the construction site. • Protect stockpiles from erosion. • Water quality must be monitored to ensure that the TSS concentration does not exceed the concentration limits stated in **Section 3.2**. • Trench breakers, such as earth or sand filled sacks, should be used to prevent or slow the unrestricted flow of water along an excavated trench. • Sediment traps need to be placed where sediment laden water is expected.

5.3 Operational phase

5.3.1 Possible impacts

During the operation of the wind farm site, an increase in stormwater runoff is expected due to an increase in impervious surfaces, i.e. proposed roads and turbine foundations. However, this increase in hardened surfaces can be considered as negligible. Therefore, very little to no increase in peak flow in the watercourses are expected.

Other potential impacts due to the additional hardened surfaces include erosion of the surrounding environment. Eroded material carried to downstream water resources can also result in the decrease in quality of downstream water resources, due to sedimentation.

Stormwater runoff in the vicinity of the substation / control building and wind turbines could come into contact with dedicated areas where hazardous substances are handled such as fuels and oils which could result in contaminated stormwater runoff being discharged downstream.

Structures such as the substation / control building could be impacted by localised flooding.

5.3.2 Proposed mitigation measures

Typical mitigation measures for the impacts mentioned in **Section 5.3.1**, *inter alia,* include the following measures, the majority which needs to be incorporated during the design phase of the project :

Table 5.2 : Typical mitigation measures during operational phase

Impact	Typical mitigation measures
Contamination of stormwater runoff	• Prevent stormwater runoff to come in contact with dedicated areas where hazardous substances are handled, by diverting flow with berms and cut-off drains to divert stormwater runoff away from the site and discharge diverted stormwater as per predevelopment conditions, and good house-keeping.
Erosion	• Where culverts are proposed, the number of culvert barrels should be maximised, resulting in a wider discharge area and less concentration of flow. • Downstream invert levels of culverts should tie into the natural ground level to prevent erosion downstream of the culvert. • Erosion protection measures, such as rip-rap, are required at the downstream end of culverts. • Where drifts are proposed, the drift should be designed so that the road surface follows the natural ground level, minimising the reduction of the cross-sectional area. • Apply erosion protection measures such as reno mattresses and stone pitching downstream of steep roadside channels. • Any sudden change in level at the downstream end of a drift should include a stilling basin to prevent erosion. • Protection of the wind turbine base by means of a cut-off drain or berm along the uphill side of the base. • Stormwater infrastructure installed to mitigate possible hydrological impacts must be regularly maintained throughout the lifespan of the infrastructure to ensure its optimum functionality.
Flooding	• Protect structures such as the wind turbine bases and substation / control building from localised flooding by constructing cut-off berms / diverting flow on the uphill side in flood prone areas.

6. Conclusions and recommendations

6.1 Conclusions

From the SWMP of the proposed WEF site, located south of the R48 and northeast of De Aar, it can be concluded that the majority of the hydrological impacts would be of a water quality nature, due to the steep slopes on certain parts of the site and the nature of the construction activities. The potential impacts primarily include erosion and stormwater runoff coming in contact with areas dedicated to collect, contain and treat hazardous substances such as fuel storage areas as well as localised flooding. Mitigation measures must be put into place to prevent or reduce the impact on the downstream environment, as described in **Section 5**.

6.2 Recommendations

The SWMP for the proposed WEF is based on information received during the preliminary design stage. It would be recommended that the SWMP be updated when detail design information is available.

It is further recommended that the mitigation measures, included in **Section 5**, be implemented during the design, construction and operational phases of the project to achieve the stormwater management objectives outlines in this report.

7. References

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