Watercourse EIA Report for the Proposed Aggeneis-Paulputs 400kV Power Line, Northern Cape Province

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Final Specialist Report

Report compiled for:

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IMPERATA CONSULTING

Wetlands • Ecology • Responsibility

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DECLARATION

I, Lourens Erasmus Retief Grobler, declare that I –

- act as an independent specialist consultant in the fields of botanical and ecological science;
- do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2006;
- have and will not have any vested interest in the proposed activity proceeding;
- have no, and will not engage in, conflicting interests in the undertaking of the activity;
- undertake to disclose, to the competent authority, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report; and
- will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not.

Lourens Erasmus Retief Grobler

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1. INTRODUCTION

1.1. Background, Location and Project Description

Imperata Consulting CC was subcontracted by Mokgope Consulting to undertake a watercourse assessment as part of the EIA phase for a proposed 400 kV power line between Aggeneis and Paulputs Substations in the Northern Cape Province. Paulputs Substation is located approximately 33 km north-northeast of Pofadder, near Konkoonsieskop, while Aggeneis Substation is located approximately 5 km southwest of Aggeneys town (Table1; Figure 1). Other towns in the nearby vicinity include Pella, located north of the study area, with the Orange River located further north (Figure 1).Three proposed route corridor alternatives with a width of 2 km wide, which widens to 4 km wide near Paulputs Substation to incorporate solar farms, were assessed as part of the EIA phase of the project. The corridors closer towards Paulputs substation will be 4km wide. This is to allow sufficient space within the corridors to locate the powerline and to avoid clashes with the IPPs in proximity to Paulputs substation. Deviation 3A was only included in 2017 after being suggested by landowners affected by Route 3, which they oppose. The corridor alternatives, including deviation 3A, and Solar Farms are indicated on the locality map (Figure 1).

The proposed 400 kV power line is required to address the following problems:

- Main Problem (Line Capacity): The Paulputs network is radial, and hence does not meet the minimum reliability standards of the South African Grid Code which require minimum N-1 reliability for the transmission network. This needs to be resolved as it is a mandatory requirement.
- Sub-Problem (Transmission Capacity): Planned transformation capacity will soon be exhausted at Paulputs if interest by IPPs continues at present levels. To address the line capacity issue, the construction of the 2nd Aggeneis-Paulputs 220kV line (97km) built at 400kV is the preferred solution. It ensures the network is firm for N-1 contingency, and also to ensure that there is sufficient line capacity to evacuate potential IPPs in the area.

Table 1: Received coordinates for the Aggeneis to Paulputs Substations that form the north-eastern and western extremities of the three investigated route corridor alternatives (also refer to Figure 1).

Substation Name	Coordinates	Source
Aggeneis Substation	29° 17′ 50.0″S 18° 48′ 15.0″E	Mokgope Consulting CC
Paulputs Substation	28° 52′ 38.3″S 19° 33′ 55.4″E	Mokgope Consulting CC

1.2. Details of the Author

Retief Grobler has undergrad majors in Botany (UP) and Soil Science (UP), an honours degree in Botany from the University of Pretoria (cum laude), and an MSc (cum laude) from the Department of Plant Sciences (UP) with a focus on peatland wetland systems. He is a registered Pr. Sci. Nat professional natural scientist in the fields of Botanical Science and Ecological Science (Reg. no. 400097/09), and has been working as a watercourse specialist consultant based in Gauteng over the last ten years. He has wetland and related watercourse specialist consulting work experience in Gauteng, Mpumalanga, North-West, Limpopo, Northern Cape, Free State, Eastern Cape and KwaZulu-Natal Provinces. International experience include wetland and watercourse assessments in Mozambique (Inhambane Province). Areas of specialisation include the delineation, description and assessment of watercourses, including wetlands, riparian habitats, and headwater drainage lines. A CV is provided in Appendix B.

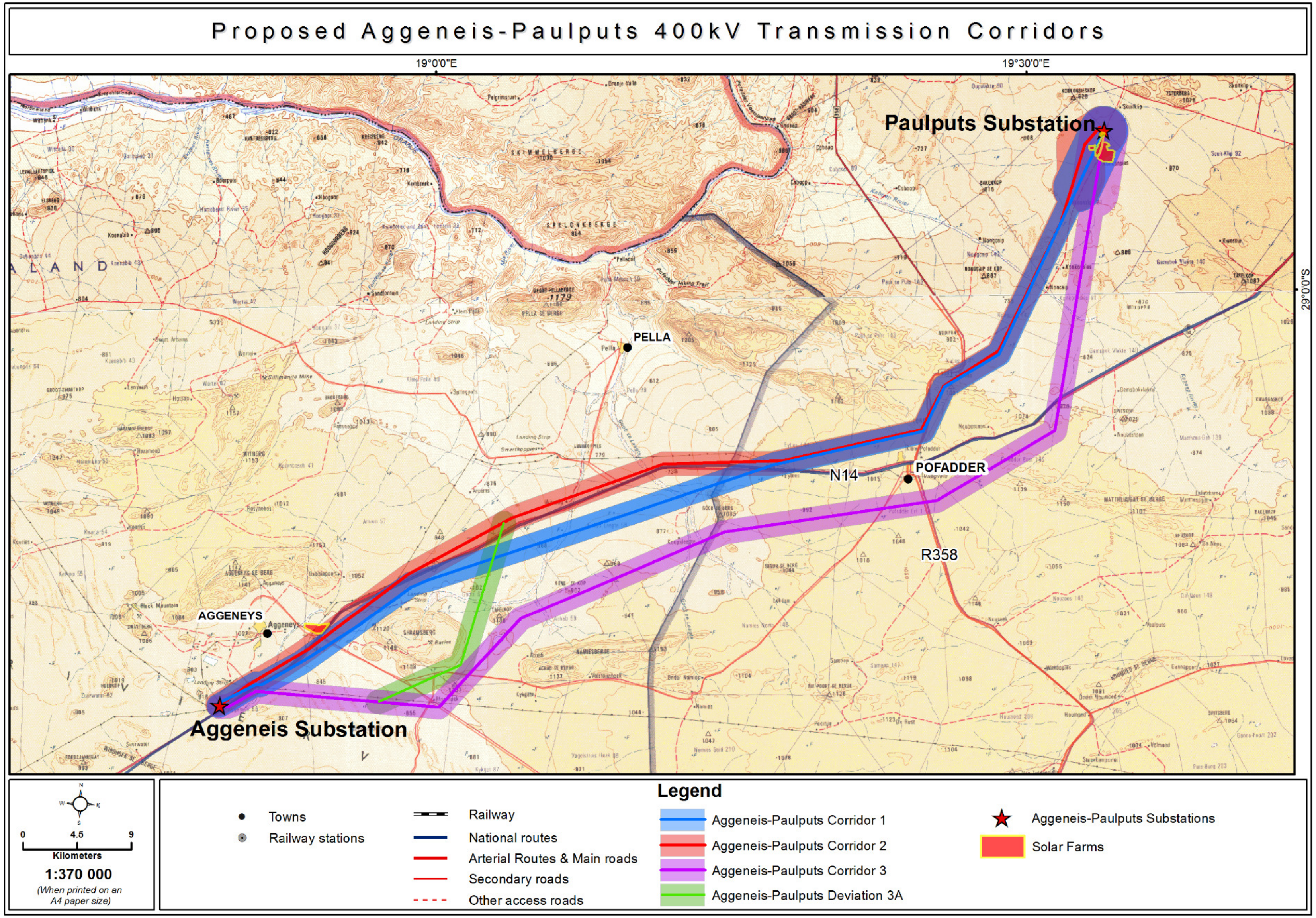

Figure 1: The study area consists of the three route corridor alternatives (number 1 to 3), as well as Deviation 3A, located between Aggeneis and Paulputs Substations in the Northern Cape.

2. TERMS OF REFERENCE

2.1. General

Terms of references associated with the specialist watercourse investigation include the following for the three proposed route corridor alternatives as illustrated in Figure 1:

- Desktop analyses and literature review of existing watercourse-related information for the study area and its associated quaternary catchments.
- The description of watercourses, particularly wetlands and rivers within the study area. Watercourses assessed during this study are based on the definitions stated in the National Water Act (Act No. 36 of 1998)(NWA):
  - A river or spring.
  - A natural channel in which water flows regularly or intermittently.
  - A wetland, lake or dam into which, or from which, water flows.
- Identify watercourse properties and components, which may be impacted by the proposed 400kV power line during different phases of the proposed development.
- General overview of watercourses within each of the three route corridor alternatives (henceforth referred to collectively as the study area) based on available watercourse information.
- Identification and delineation of watercourses within the three route corridor alternatives and deviation, as received from the client (Mokgope Consulting). The three corridor route alternatives and deviation that were received include the following (Figure 1):
  - Route corridor 1 (blue colour)
  - Route corridor 2 (red colour)
  - Route corridor 3 (pink colour)
  - Deviation 3A (green colour)
- Assess each corridor in terms of identified watercourse sensitivities and recommended the most suitable corridor alternative (where applicable), based on the results of the assessment. Provide a motivation to explain why the selected corridor is regarded as the preferred alternative.
- Undertake an impact assessment of expected project related activities on watercourses with and without recommended impact mitigation measures.
- The incorporation of the above into a single report.

2.2. Assumptions & Exclusions

- This study assumes that the project proponents will always strive to avoid, mitigate or offset potentially negative project related impacts on the environment, with impact avoidance being considered the most successful approach, followed by mitigation and offset. It further assumes that the project proponents will seek to enhance potential positive impacts on the environment.
- Spatial information received from the client regarding the three route corridor alternatives are accurate.
- The project proponents will commission an additional study to assess the impact(s) if there is a change in the size and/or extent of the study area or proposed infrastructure that is likely to have a potentially highly significant and/ or unavoidable impact on watercourses (e.g. wetlands).

3. RELEVANT LEGISLATION

3.1. National Water Act (Act No. 36 of 1998)

According to the National Water Act (Act No. 36 of 1998), a water resource is defined as:

"a watercourse, surface water, estuary, or aquifer. A watercourse in turn refers to

a) a river or spring;
b) a natural channel in which water flows regularly or intermittently;
c) a wetland, lake or dam into which, or from which, water flows; and
d) any collection of water which the Minister may, by notice in the *Gazette,* declare to be a watercourse. Reference to a watercourse includes, where relevant, its bed and banks."

A wetland is defined as: "land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances support or would support vegetation typically adapted to life in saturated soil.

Chapter 4 of the Act deals with the regulation of the use of water and the requirements for controlled activities, general authorisations, and licenses. In general, a water use must be licensed unless: it is listed in Schedule 1 of the Act as an existing lawful water use, or is permissible under a general authorisation, or if a responsible authority waives the need for a license.

According to the Department of Water and Sanitation (DWS), any activity that falls within the temporary zone of a wetland or the 1:100 year floodline (whichever is greater) qualifies as a Section 21 water use activity (depending on the use) and will thus require either a general authorization or Water Use License (WUL). According to the NWA, an application for a WUL should be submitted to the DWA if any of the above activities are to be undertaken.

Section 21 of the National Water Act (NWA Act No. 36 of 1998) covers the following activities, which might be applicable to the proposed project. According to Section 21 of the NWA and in relation to the river ecosystem, the following activity is considered a use, and therefore requires a water use license:

21 (c) impeding or diverting the flow of water in a watercourse;

21 (i) altering the bed, banks, course or characteristics of a watercourse;

In terms of Section 22 (1), a person may only undertake the abovementioned water uses if it is appropriately authorised:

22(1) A person may only use water

(a) without a licence

(i) if that water use is permissible under Schedule 1;

(ii) if that water use is permissible as a continuation of an existing lawful use; or

(iii) if that water use is permissible in terms of a general authorisation issued under section 39;

(b) if the water use is authorised by a licence under this Act; or

(c) if the responsible authority has dispensed with a licence requirement under subsection (3).

Section 13(1) (A) and (B) of the National Water Act (Act No.36 of 1998)

Resource Use (RU) Classes and Resource Quality Objectives (RQOs) of Water Resources for Catchments of the Middle Vaal in Terms of Section 13 (1) (A) and (B) of the National Water Act (Act No. 36 of 1998) were promulgated on the 22 April 2016. Classes of water resources and RQOs for catchments of the Middle Vaal, in the Schedule are issued under section 13(4) of the National Water Act (Act No. 36 of 1998). The RU and RQOs are determined for all or part of every significant water resource within the catchments of the Middle Vaal.

The Minister has, in terms of section 12 of the National Water Act, Act No 36 of 1998 (the Act), prescribed a system for classifying water resources by promulgating Regulation 810, Government Gazette 33541 dated 17 September 2010. In terms of section 13(1) of the Act the Minister must by notice in the *Gazette*, determine for all or part of every significant water resource, a class in accordance with the prescribed classification system.

Integrated Units of Analysis (IUA) are classified in terms of their extent of permissible utilisation and protection as either:

- Class I: indicating high environmental protection and minimal utilization; or
- Class II indicating moderate protection and moderate utilisation; and
- Class III indicating sustainable minimal protection and high utilisation.

Resource Quality Objectives are defined for each prioritised RU for every IUA in terms of water quantity, quality, habitat and biota.

Where specified, the ecological category or Recommended Ecological Category (REC) means the assigned ecological condition by the Minister to a water resource that reflects the ecological condition of that water resource in terms of the deviation of its biophysical components from a predevelopment condition.

3.2. Constitution of the Republic of South Africa

Section 24 of Chapter 2 of the Bill of Rights No. 108 of 1996 states that everyone has the right to:

(a) to an environment that is not harmful to their health or well-being; and

(b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that—

(i) prevent pollution and ecological degradation;

(ii) promote conservation; and

(iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

3.3. National Environmental Management Act (Act No. 107 of 1998)

Wetlands and other watercourses defined in the NWA are also protected in the National Environmental Management Act (Act 107 of 1998), (NEMA). The act lists several activities that require authorisation before they can be implemented. NEMA lists various activities that require authorisation when located within 32 m or less from the edge of a wetland or other watercourse type.

4. METHODS

4.1. Approach

The integrity and functioning of watercourses are directly dependant on their surrounding land area, which includes the local catchment and terrestrial habitat immediately bordering the watercourse (Dodds & Oaks, 2008; Environmental Law Institute, 2008). This study considers a wide range of watercourse types, including headwater drainage lines, which incorporates the entire drainage network. Headwater drainage lines, which include first and second order drainage lines and ephemeral channels, are also regarded as watercourses, even though they may have discontinuous or swale-like channels (Appendix A). Indistinct and very short first-order drainage lines have been largely excluded from the watercourse delineation process as these features are often very unclear and undistinguishable from the surrounding terrestrial environment. A higher degree of uncertainty is consequently associated with these systems compared to other linear watercourses. The exclusions of indistinct and short first order drainage lines and ephemeral channels help to prevent skewness in the interpretation of results when the three route corridors are compared with one another.

4.2. General

The following methods were used as part of the watercourse investigation:

- A site visit was undertaken at the end of August 2016 during which time the physical environment of the proposed route corridor alternatives were inspected at selected points in each corridor. No detailed surveys along each corridor alternative were undertaken.
- The size of the study area, with related access constrains in areas made it impractical to visit each possible watercourse crossing within the different corridor alternatives. A strong desktop approach was therefore adopted to inform the watercourse delineation study.
- The recently completed National Freshwater Ecosystems Priority Areas (NFEPA) Wetland Types for South Africa shapefile (RSA Wetland Types) was used to identify potential wetland areas within the study area (route alternatives), (Van Deventer et al., 2010). The data was obtained from the BGIS website supported by the South African National Biodiversity Institute (SANBI).
- This Wetland Types for South Africa GIS layer has been formed by combing information from the National Land Cover 2000 data set (NLC 2000), 1:50 000 topographic maps and sub national data (Van Deventer et al., 2010).
- The 2011 NFEPA Rivers spatial dataset was used to identify perennial and non-perennial rivers that overlap with the study area. The data was obtained from the BGIS website supported by the South African National Biodiversity Institute (SANBI).
- The 1:50000 river lines vector shapefiles indicate the entire drainage network of the study area, from headwater streams (first and second order drainage lines), which may or may not be associated with wetland conditions, to larger Strahler stream order rivers. Drainage lines with higher Strahler stream orders are more likely to be associated with riparian habitat and/or wetland conditions.
- The 1:50 000 river line datasets, which illustrate the drainage networks within each of the route corridor alternativesand their surroundings,were obtained from the corresponding1:50000 topographical maps (2819DC Swartoup, 2919BA Mattheusgat, 2819CD Oupvlakte, 2919AAD Pella, 2918AC Namies, 2918BD Brabeees and 2918BB Aggenys).
- Inland waters, which indicate pans and dams, were also obtained from the relevant 1:50000 topographic datasets that overlap with the study area. The same grid references were used as for the drainage network spatial data.

- The recently released 2013-2014 South African National Land Cover dataset was also used to identify potential wetland areas, along with seasonal and permanent water bodies. This dataset covers the entire study area and indicates wetlands, permanent water and seasonal water based on the globally available Landsat 8 imagery (GTI, 2015). The dataset was downloaded from the Maps and Graphics section of the Department of Environmental Affairs (DEA), (GTI, 2015).
- Existing Eskom transmission and distribution lines were extracted from a 2014 dataset to illustrate existing powerlines within the study area.
- The 1:50000 road lines dataset was also obtained from the corresponding 1:50000 topographical maps to identify existing tracks/roads within each corridor route alternative. The rational being the more roads and tracks that are present in a route corridor will potentially allow the creation of fewer new tracks through wetlands and other watercourses.
- Shapefiles from the above mentioned spatial datasets were converted into .kml format and used in Google Earth Pro as part of background imagery to undertake an on-screen digitization of interpreted watercourse boundaries within each corridor alternative.
- A conservative approach was applied as part of the watercourse delineation process. Delineated watercourses that were captured through on-screen digitizing were grouped into a dataset that consists of three categories. These categories included hydro-geomorphic (HGM) wetland units as defined by Ollis *et al* (2013) and other types of watercourses as defined in the NWA.
- Old quarries that are associated with mining and road construction were not included as part of the watercourse delineation process.
- In order to assess the extent of road and track networks more accurately, a centre line was created for each corridor. The use of a centre line enables an approximation of the number of watercourse crossings, both from existing and created spatial datasets, which can be used as part of a comparison of corridor alternatives with one another.
- A spatial dataset from 2014 of existing Eskom power lines was overlaid with the study area to help identify existing Eskom linear infrastructure within the corridor alternatives associated with the proposed project. The reasoning behind this is that existing power lines that overlap with the study area indicate existing impacts within that are of a similar nature as the proposed 400 kV power line project. The existing infrastructure along existing lines do not only include towers, but important, also include existing access routes used for the maintenance of these power lines.
- The presence of drainage lines from the 50000 topographical map, rivers, NFEPA Wetlands, NFEPA Rivers, Land cover derived wetlands and waterbodies, road and tracks, and the newly delineated watercourse dataset are assessed and compared at different spatial scales. These include each individual route corridor alternative and centre lines for each corridor alternative and deviation.
- Information obtained from the existing and created spatial datasets were used to compare different corridor alternatives to one another, in order to identify the best suited option for the proposed 400 kV transmission line from a watercourse consideration.

References from the National Spatial Biodiversity Assessment (NSBA - Nel et al., 2004), the 2005 Water Resources of South Africa dataset (Middleton & Bailey, 2008), the National Freshwater Ecosystem Priority Areas (NFEPA - Nel *et al.,* 2011), and DWS (2015) were used to collect information on the aquatic ecosystems located in the study area. The Present Ecological State (PES), Ecological Importance (EI) & Ecological Sensitivity (ES) of the associated sub-quaternary catchments were obtained from DWS (2015), where sub-quaternary data was available.

The PES assessments compares the current condition of a watercourse or catchment to its perceived reference condition, in order to determine the extent to which the watercourse/catchment has been modified from its pristine (reference) condition. Results from PES assessments are rated into one of six categories ranging from unmodified/ pristine wetlands (Class A) to critically/ totally modified HGM wetland units (Class F), (Table 2).

Ecological Importance and Sensitivity (EIS) assessments of watercourses/catchment provide an indication of the conservation value and sensitivity of these areas within the site. EIS or EI and ES assessments consider the following criteria of catchments/watercourses (DWAF 1999c; Rountree & Malan 2013; Table 3):

- Habitat uniqueness
- Species of conservation concern
- Habitat fragmentation with regards to ecological corridors
- Prominent ecosystem services

Table 2: Description of A – F Present Ecological State (PES) categories for wetlands, rivers and other waterourses, ranging from "Natural" (Category A) to "Critically Modified" (Category F), (DWAF 1999a, DWAF 1999b, Rountree *et al.,* 2007).

Category		Description
A	Natural	Unmodified, Natural.
B	Largely Natural	Few modifications, small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.
C	Moderately Modified	A loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged.
D	Largely Modified	Large loss of natural habitat, biota and basic ecosystem functions has occurred.
E	Seriously Modified	The losses of natural habitat, biota and basic ecosystem functions are extensive.
F	Critically Modified	Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.

Table 3: Indicates Ecological Importance and Sensnsitivity (EIS) categrories for wetlands and other watercourses (DWAF, 1999c; also refer to Rountree *et al.,* 2013).

Ecological Importance and Sensitivity Category (EIS)
Very high Wetlands, rivers and other watercourses that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these watercourses is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.
High Wetlands, rivers and other watercourses that are considered to be ecologically important and sensitive. The biodiversity of these watercourses may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.
Moderate Wetlands, rivers and other watercourses that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these watercourses is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.
Low/marginal Wetlands, rivers and other watercourses that are not ecologically important and sensitive at any scale. The biodiversity of these watercourses is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.

4.3. Limitations

The large size of the study area and the presence of various corridor alternatives has restricted the use of detailed field surveys along each corridor. The identification and assessment of potential watercourses in this report have therefore mainly been undertaken as a desktop approach. It is foreseen that detailed watercourses surveys along proposed tower positions will be undertaken as part of the EMPR Walk Down survey for the selected/approved corridor alternative. This would enable the verification and a more accurate delineation of watercourse boundaries. Such a survey will form part of the EMPR 'Walk Down' watercourse assessment study once the final route has been selected.

Spatial databases available in the public domain are not comprehensive in terms of watercourse coverage, especially with regards to wetland and headwater drainage line coverage. The extent of wetlands and headwater drainage lines are almost always underrepresented in available spatial datasets present in the South African public domain, based on watercourse consulting experience.

Results from these datasets, as well as the newly created watercourse spatial layer for the study area, are therefore not expected to be complete. Indistinct drainage lines and small wetlands, specifically small pans/depressions, are expected to be under represented in the created watercourse layers. Other features may incorrectly be interpreted as pan/depression wetlands or other types of watercourses, examples include possible *heuweltjies,* which can appear as pan/depression wetlands on aerial imagery. These features may be present in the landscape, especially towards the west, around the Aggeneis substation, where the Succulent Karoo starts. This furthermore highlights the importance of an EMPR Walk Down watercourse assessment along the final route alignment to confirm the presence/absence of watercourses and refine their boundaries, including areas where *heuweltjies* are suspected to be present.

Lastly, Solar Farm areas illustrated on maps, such as Figure 1, are only intended for reference purposes, as they did not form part of this specialist study. Watercourses located in Solar Farms that do not overlap with the route corridors are therefore excluded from this study and are expected to have formed part of separate watercourse assessment studies.

5. STUDY AREA DESCRIPTION

The study area, which consists of the three corridor alternatives along with Deviation 3A (Figure 1; Table 4), is located in a portion of the Northern Cape Province that is commonly referred to as Bushmanland. It falls mainly within the Nama Karoo ecoregion, while a narrow portion near Pofadder town, overlaps with the Orange River Gorge ecoregion. The study area can be described as arid to semi-arid with a mean annual evapotranspiration that is 25 to 34 times larger than the mean annual rainfall, with the latter becoming drier towards the west (Table 5; Figure 2).

No listed Threatened Ecosystem area according to the 2011 Schedule (Government Gazette of December 2011) of the National Environmental Biodiversity Act (Act 10 of 2004) (NEMBA), overlaps with the study area. The nearest Threatened Ecosystem is the Lower Gariep Alluvial Vegetation (AZa3), which has an Endangered status and is restricted along the Orange River, located approximately 18 km north of route alternative 2.

The Boesmanland Vloere vegetation unit described by Mucina and Rutherford (2006) occurs in the surrounding area, outside of the study area, and represent both depression/pan wetlands and other ephemeral watercourses systems. This vegetation unit requires further future research as limited information is available on this watercourse associated vegetation unit (Mucina & Rutherford, 2006).

Rivers present within the study area are located in six quaternary catchments, all of which drain towards the Orange River and form part of the Lower Orange Water Management Area (WMA), (Table 4; Figure 2). The six quaternary catchment that overlap with the route corridor alternatives each have a Largely Natural (Class B) Present Ecological State (PES), while their Ecological Importance and Sensitivity (EIS) range from High to Low/Marginal (Table4; Figure 2)

Table 4: The surface area and centre line length of each of the three corridor alternatives, as well as Deviation 3A (Also refer to Figure 1).

Corridor alternative name	Surface area of corridor	Corridor centre line length
Aggeneis-Paulputs Corridor 1	21133.17 ha	93.96 km
Aggeneis-Paulputs Corridor 2	21469.04 ha	94.61 km
Aggeneis-Paulputs Corridor 3	22752.21 ha	102.10 km
Aggeneis-Paulputs Deviation 3A	4366.75 ha	20.02 km

Table 5: Indicates the mean annual precipitation (MAP), mean annual runoff (MAR) in million cubic meters (mcm), mean annual evapotranspiration (MAE), Ecological Importance and Sensitivity (EIS) class, and Present Ecological State (PES) class for each quaternary catchment in the study area (Middleton & Bailey, 2008). Available sub quaternary catchments that overlap with the study area are also included (DWS, 2015).

Quaternary Catchment (QC)	Sub Quaternary Catchment	QC Rainfall (MAP)	QC Runoff (MAR)	QC Evapotranspiration (MAE)	QC PES Class	QC EIS Class
Lower Orange River Water Management Area (WMA)						
D81E	D81E-03349	97 mm	0.88 mcm	3001 mm	B	High
D81F	Not Applicable	91 mm	1.00 mcm	3751 mm	B	High
D81G	Not Applicable	102 mm	0.62 mcm	2650 mm	B	High
D82A	Not Applicable	77 mm	0.19 mcm	2650 mm	B	High
D82B	Not Applicable	80 mm	1.95 mcm	2650 mm	B	Low/ marginal
D82C	Not Applicable	83 mm	1.95 mcm	2650 mm	B	Low/ marginal

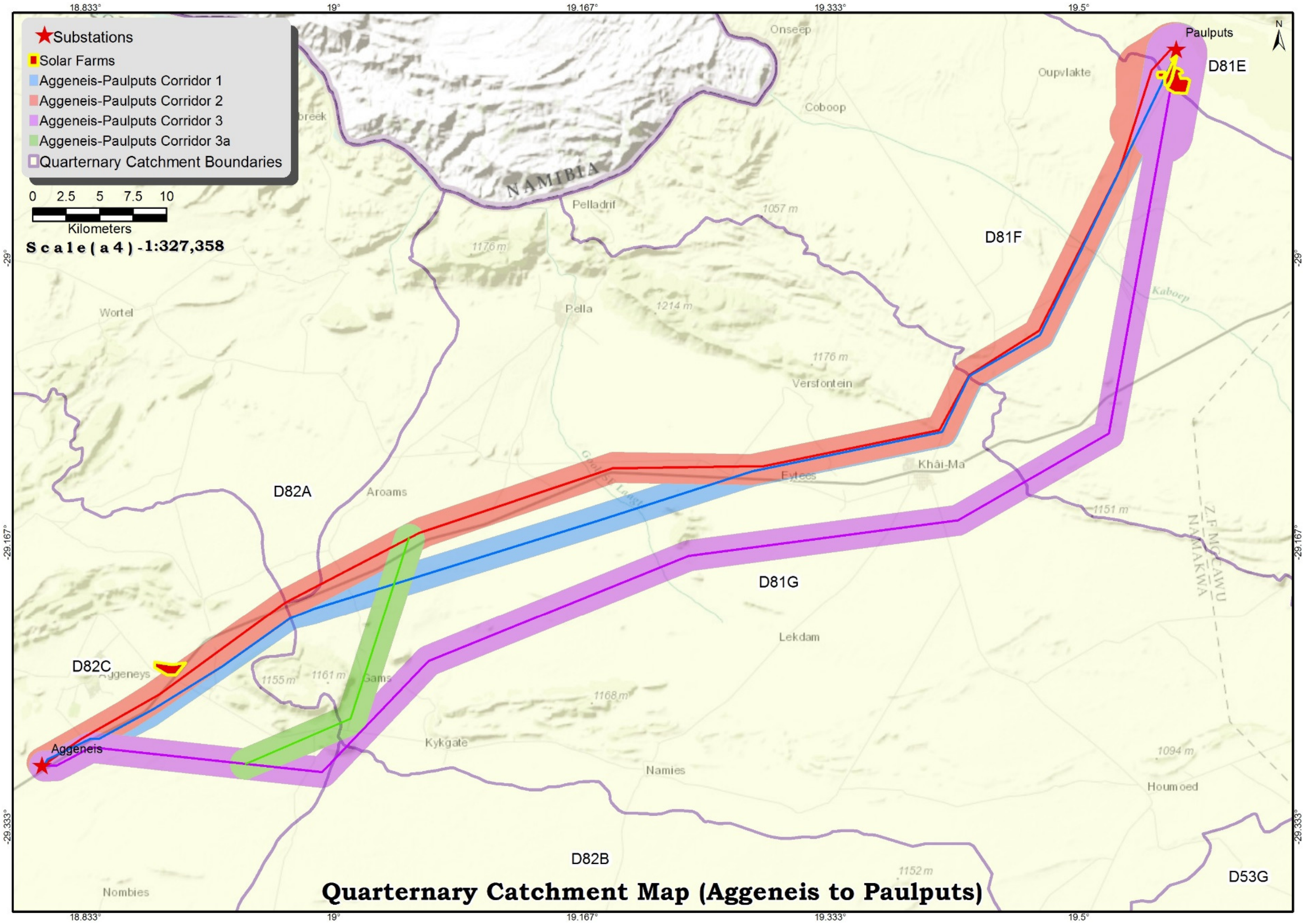

Figure 2 Route corridor alternatives associated with the 400kV Aggeneis-Paulputs power line and their quaternary catchments.

6. FINDINGS

6.1. Watercourse Delineation

- All known NFEPA Wetlands and Rivers within the study area are illustrated in Figure 3, while drainage lines obtained from the 1:50000 topographical datasets are illustrated in Figure 4
- Existing watercourse information, such as the NFEPA River and Wetland datasets, drainage lines from the 1:50000 topographical map dataset and wetlands indicated in the more recent 2013-2014 National Landcover spatial dataset, are however, expected to under represent watercourses present within the study area based on EIA and EMPR watercourse assessment experience on similar powerline projects.
- In order to increase the accuracy regarding the number of watercourses present within the corridor alternatives an on-screen watercourse delineation process was applied to create a new watercourse dataset that is expected to be more representative of actual watercourses within the study area.
- Watercourses identified and delineated within each corridor alternative were classified into three groups and illustrated in Figures 5-11.
- The three classified watercourse classes that were mapped include the following:
    - Ephemeral channels and drainage lines - Represent linear and narrow watercourses in the form of headwater drainage lines (second order drainage lines and channels). These features were captured as lines during the delineation process and are expected to be consistent with the NWA watercourse definition of ‘natural channels that flow regularly or intermittently’. They can be marginal in nature with discontinuous or poorly developed channels that represent swales due to poor channel development in arid areas with low rainfall, high evapotranspiration and high infiltration in areas with sandy soils. No hydromorphic (wetland soil) or hydrophyte (wetland plant) indicators are expected in these watercourses. Aerial imagery interpretations identified linear features with textural changes that were regarded to be associated with areas of preferential flows during cyclic surface flow events that can occur at frequencies that are several years apart. These features were considered as drainage lines and ephemeral channels based on a conservative approach due to the lack of current information on these drainage systems and what exactly constitutes a ‘natural channel” in a South African context in terms of the NWA.
    - Washes and ephemeral rivers - These captured polygon features represent larger and wider watercourses that include NFEPA rivers and broad watercourses that can lack distinct channel development, such as washes (*laagtes* in Afrikaans). Washes that lack distinct channel features do often display braided channel configuration referred to as *bar and swale* topography. Discontinuous streams can also display a stream pattern characterized by alternating erosional and depositional reaches (Appendix A).
    - Pan/Depression wetlands - Represent pan or depression wetlands. Pan is a synonym for depression wetlands, as described by Ollis *et al.* (2013). Depression wetlands, or pan wetlands as they are also common referred to, represent depressions in a landscape that are inwardly draining (endorheic). In arid to semi-arid environment, such as the study area, these watercourses are not necessarily associated with signs of hydromorphic features or hydrophytes, due to infrequent inundation cycles and shorter periods of saturation. This watercourse type is expected to be under represented within the study area as numerous small pan wetlands the size of a small house and smaller can easily be missed as part of the described approach. In addition, features that were regarded as possible *heuweltjies* (circular terrestrial landscape features formed by termite activity), were not incorporated as watercourses during the delineation process.

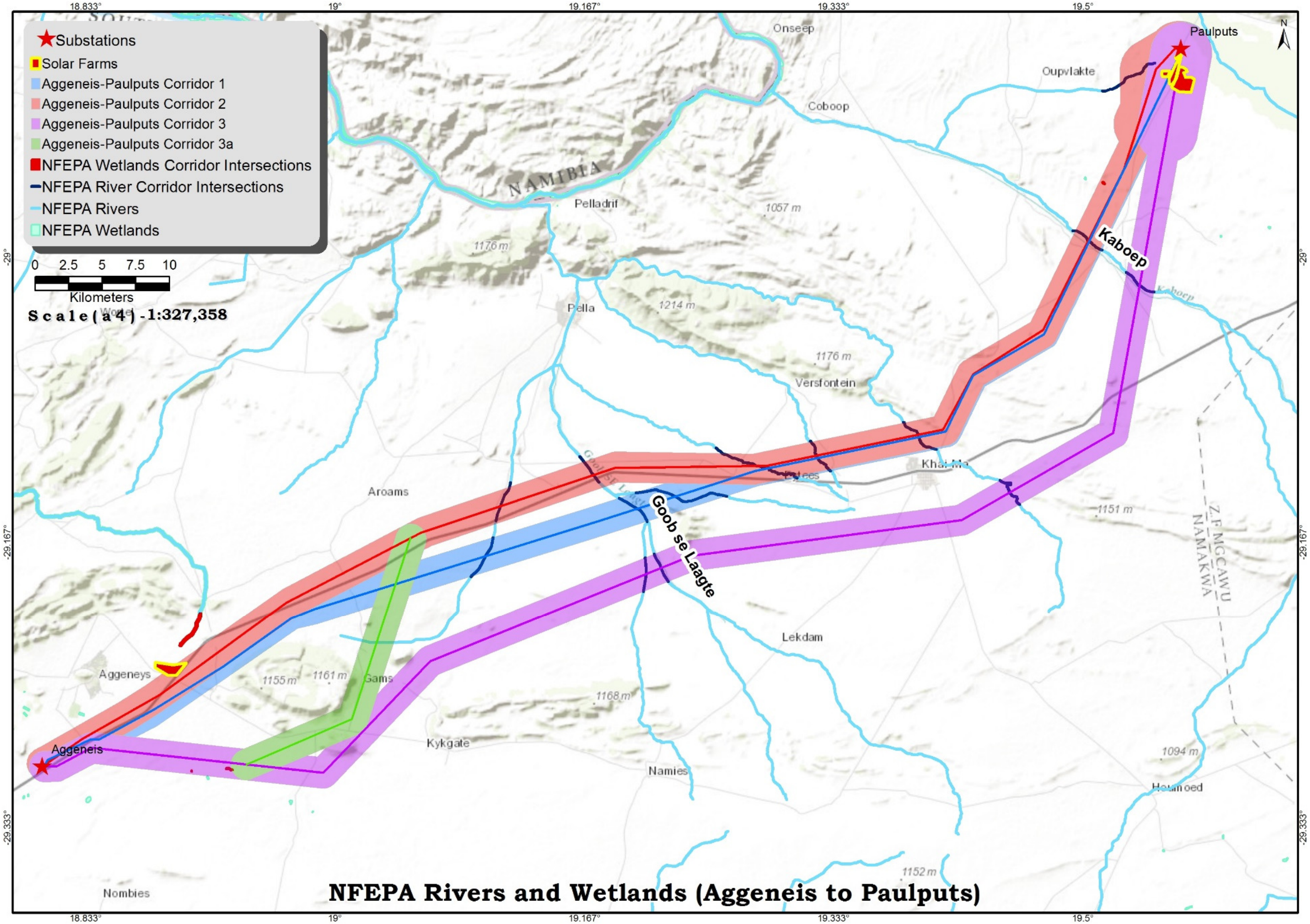

Figure 3: Illustrates rivers and wetlands from the National Freshwater Ecosystem Priority Areas spatial datasets (Nel *et al*., 2011) present within the study area and its surroundings.

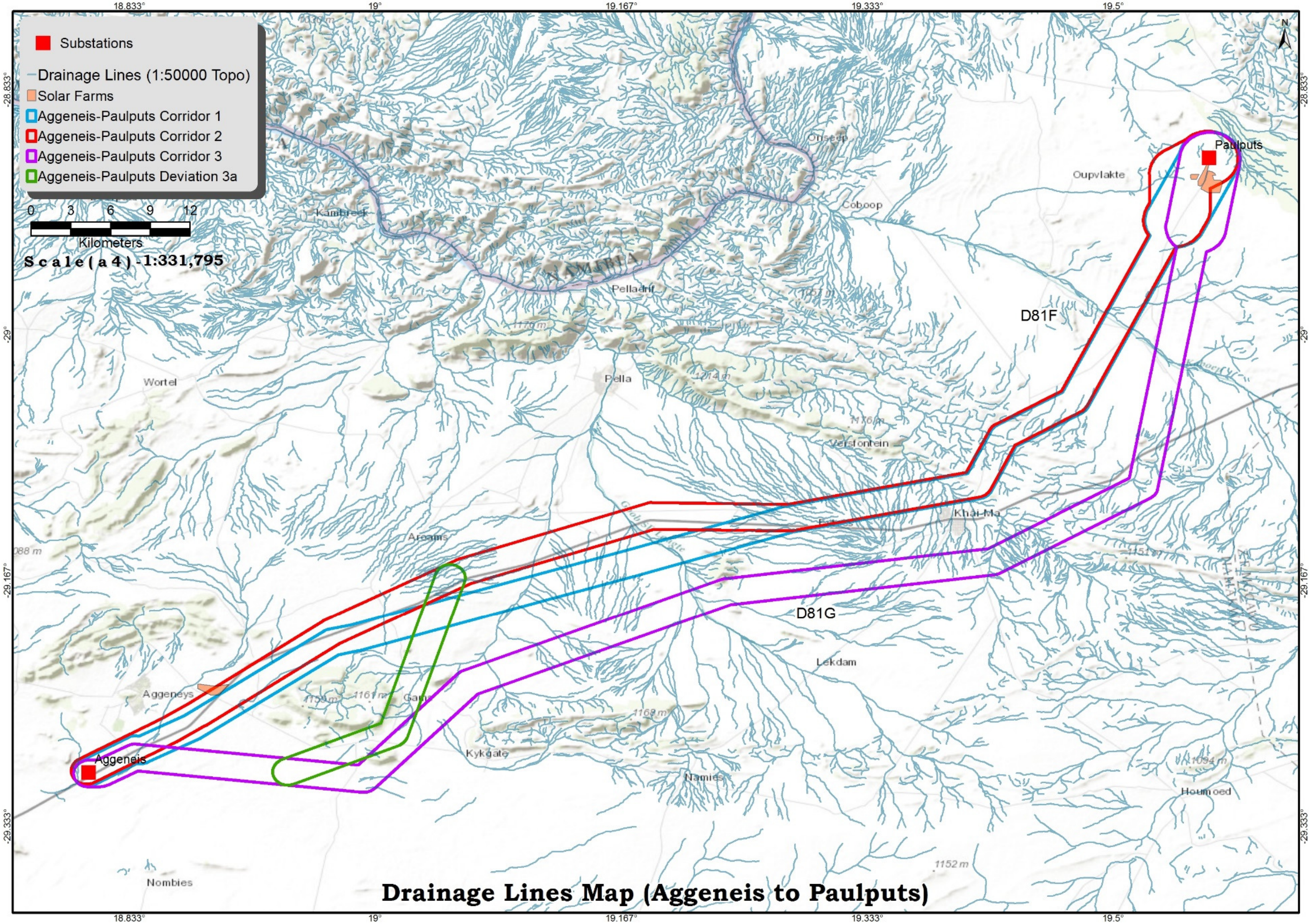

Figure 4: Illustrate the drainage network for the study area and its surroundings based on the 1:50000 river lines datasets from the corresponding topographical maps.

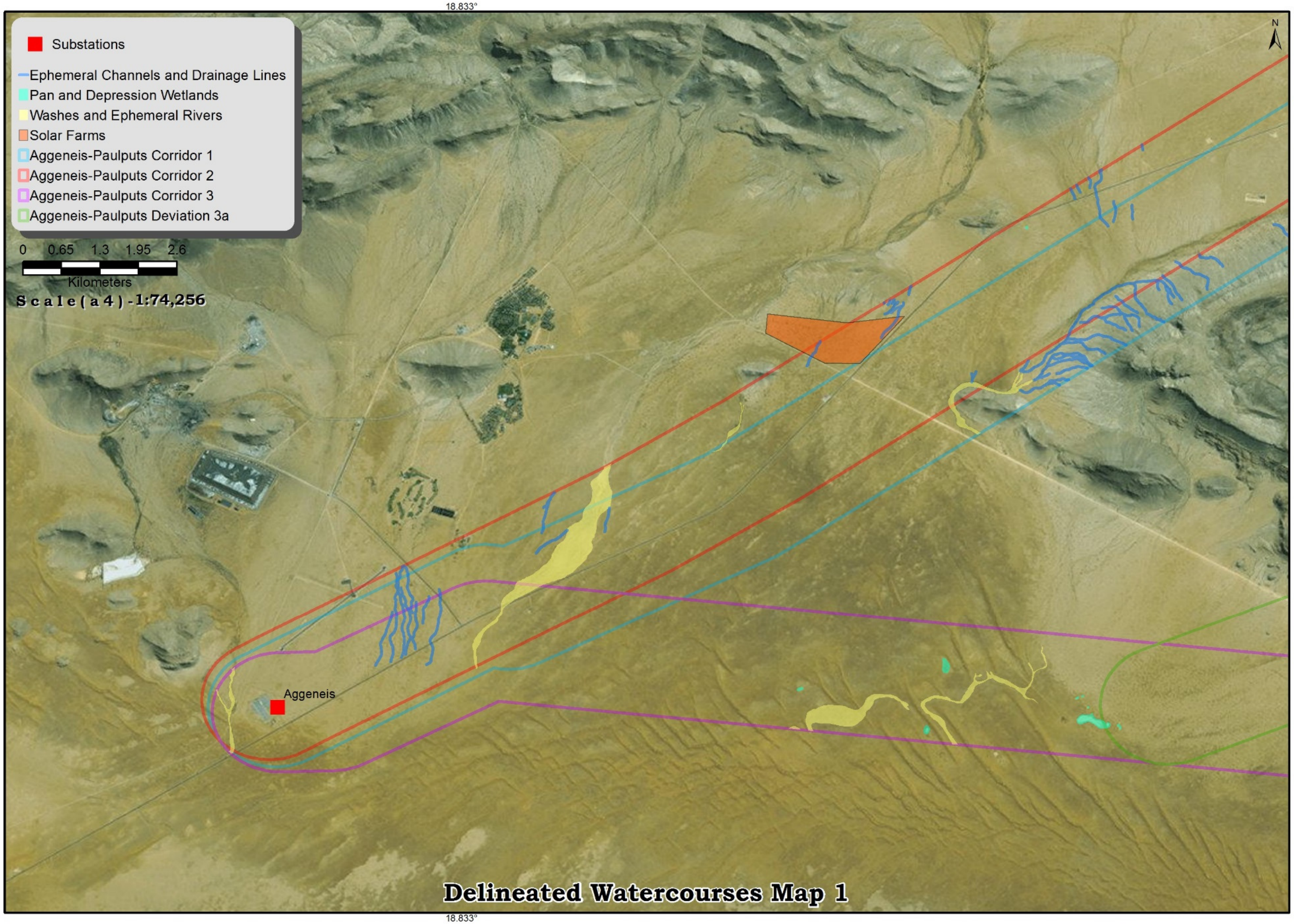

Figure 5: Delineated watercourses in the western-most section of the study area around Aggeneis Substation.

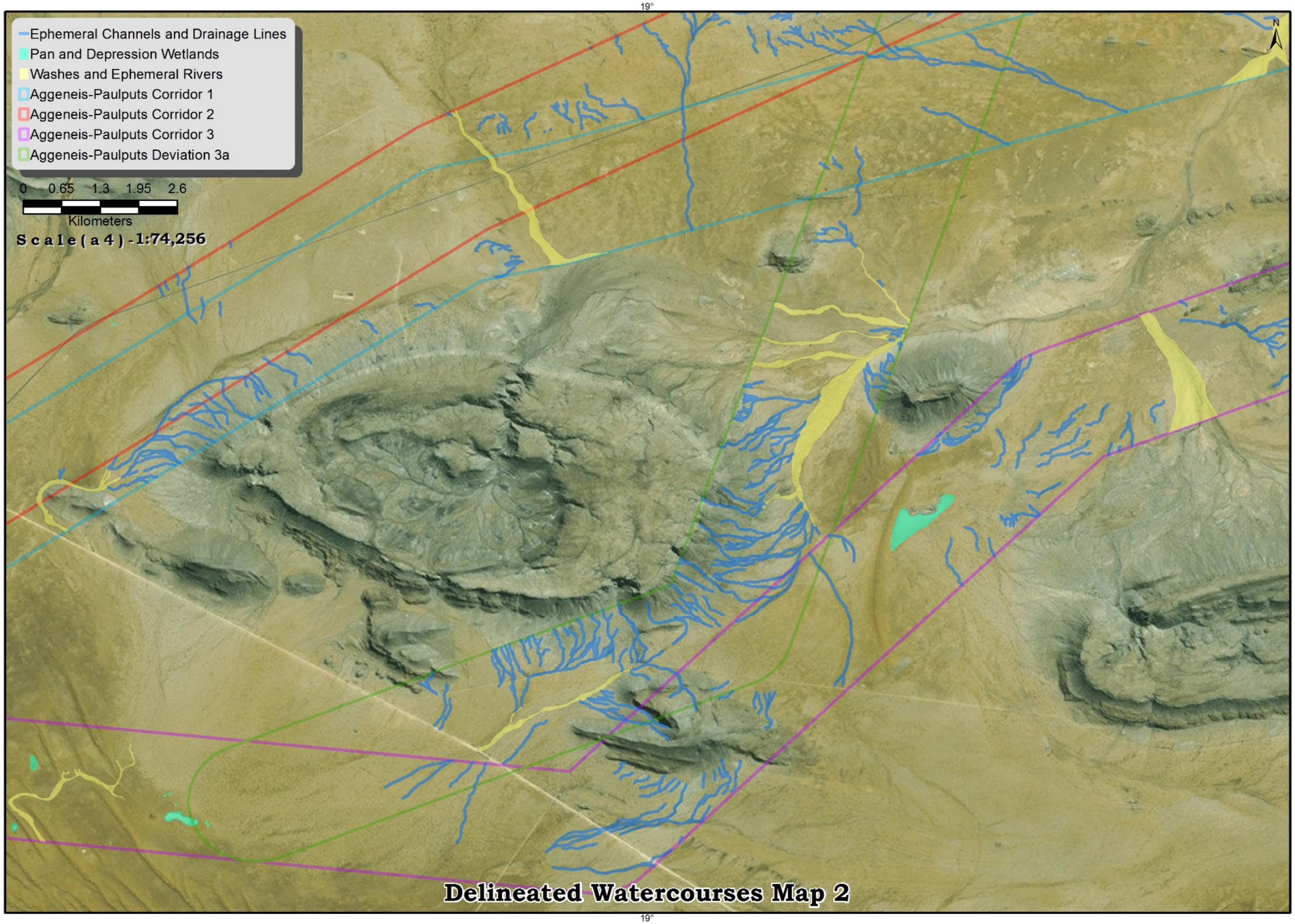

Figure 6: Delineated watercourses in the western portion of the study area around Aggeneys se Berge (far northwest), Ghaamsberg (centre) and Tafelkop (east).

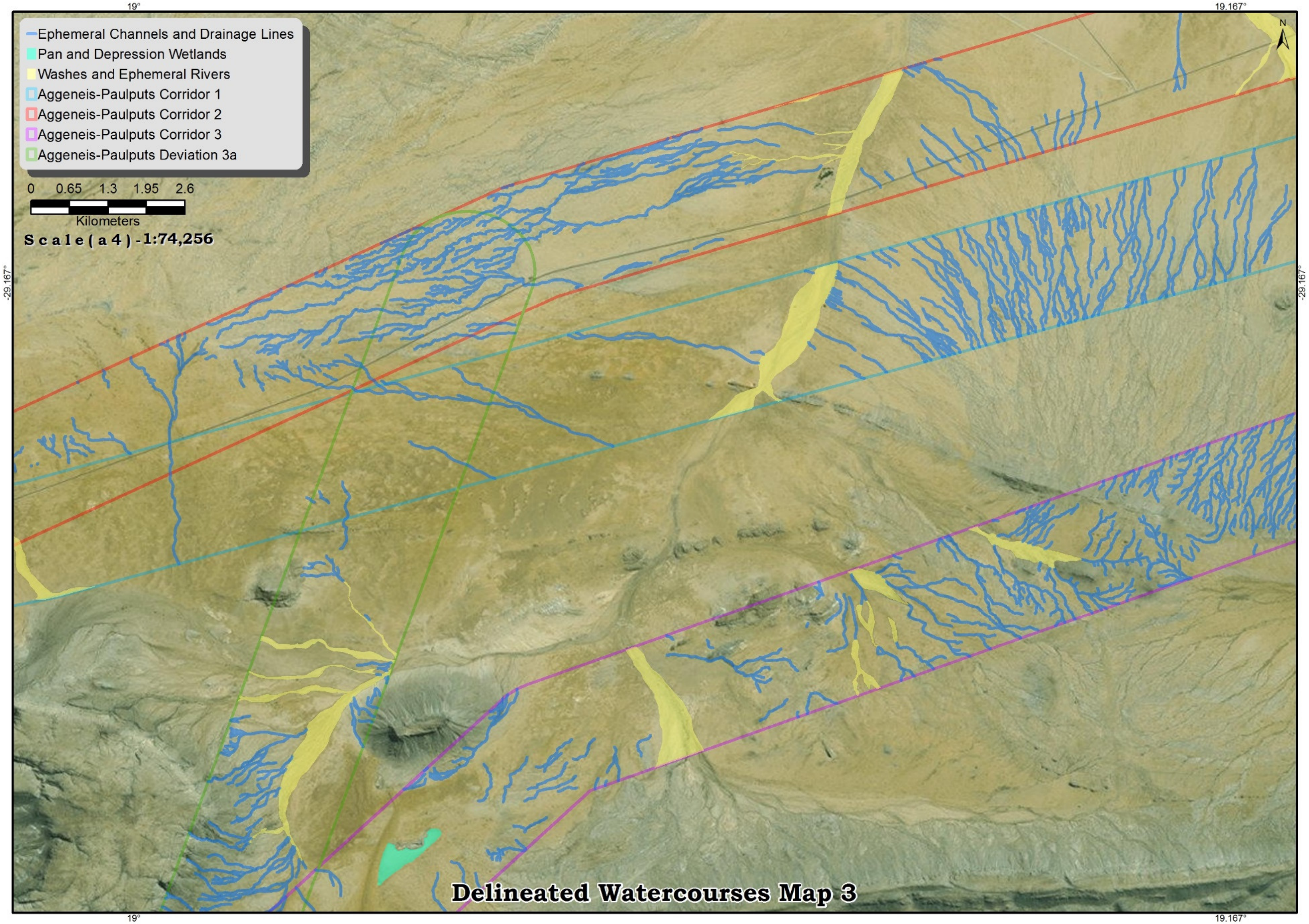

Figure 7: Delineated watercourses in the western-central portion of the study area south of Pella, between Ghaamsberg in the west and T'Goob se Berg in the east (located just outside of the map frame).

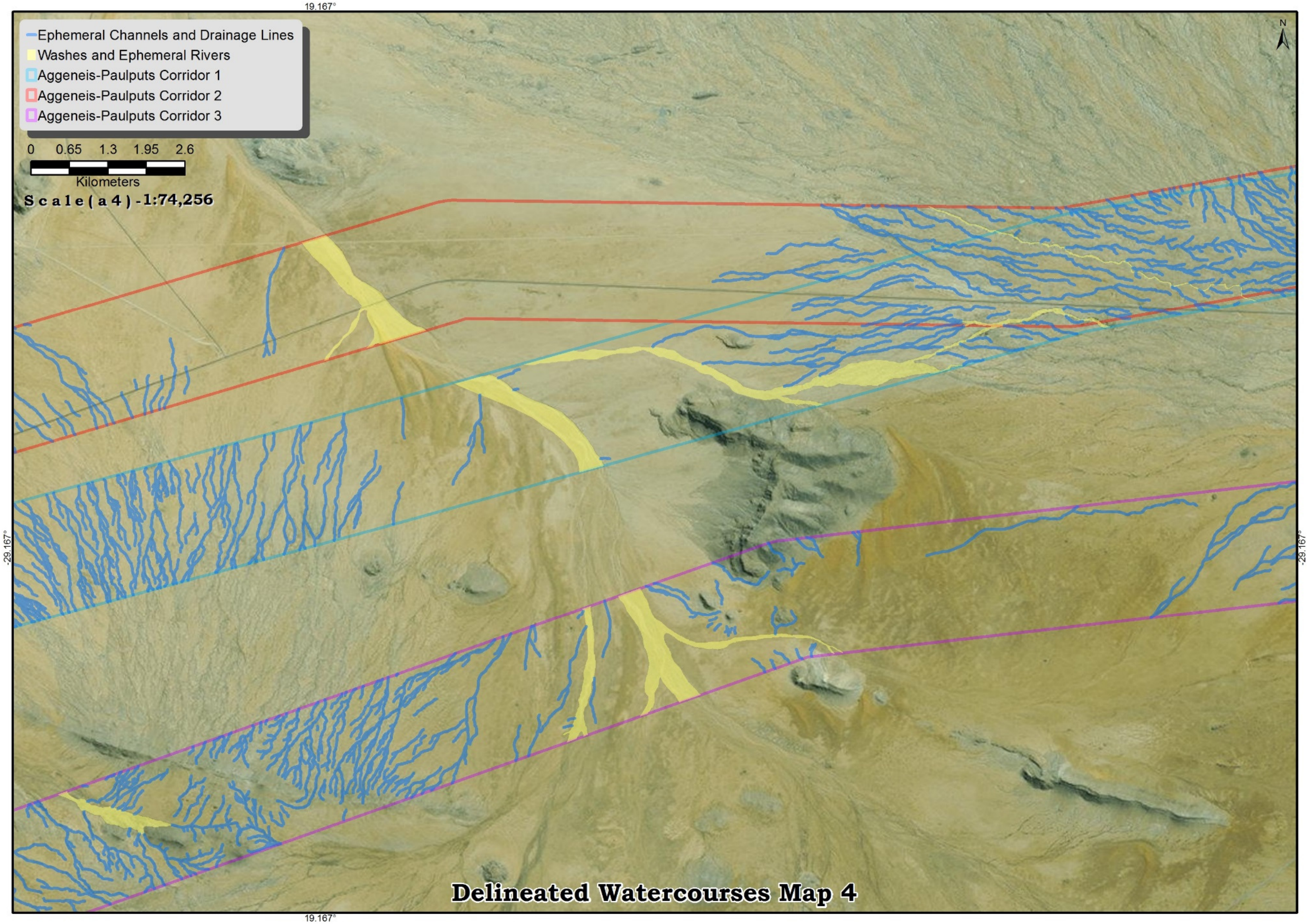

Figure 8: Delineated watercourses in the central portion of the study area, around T'Goob se Berg.

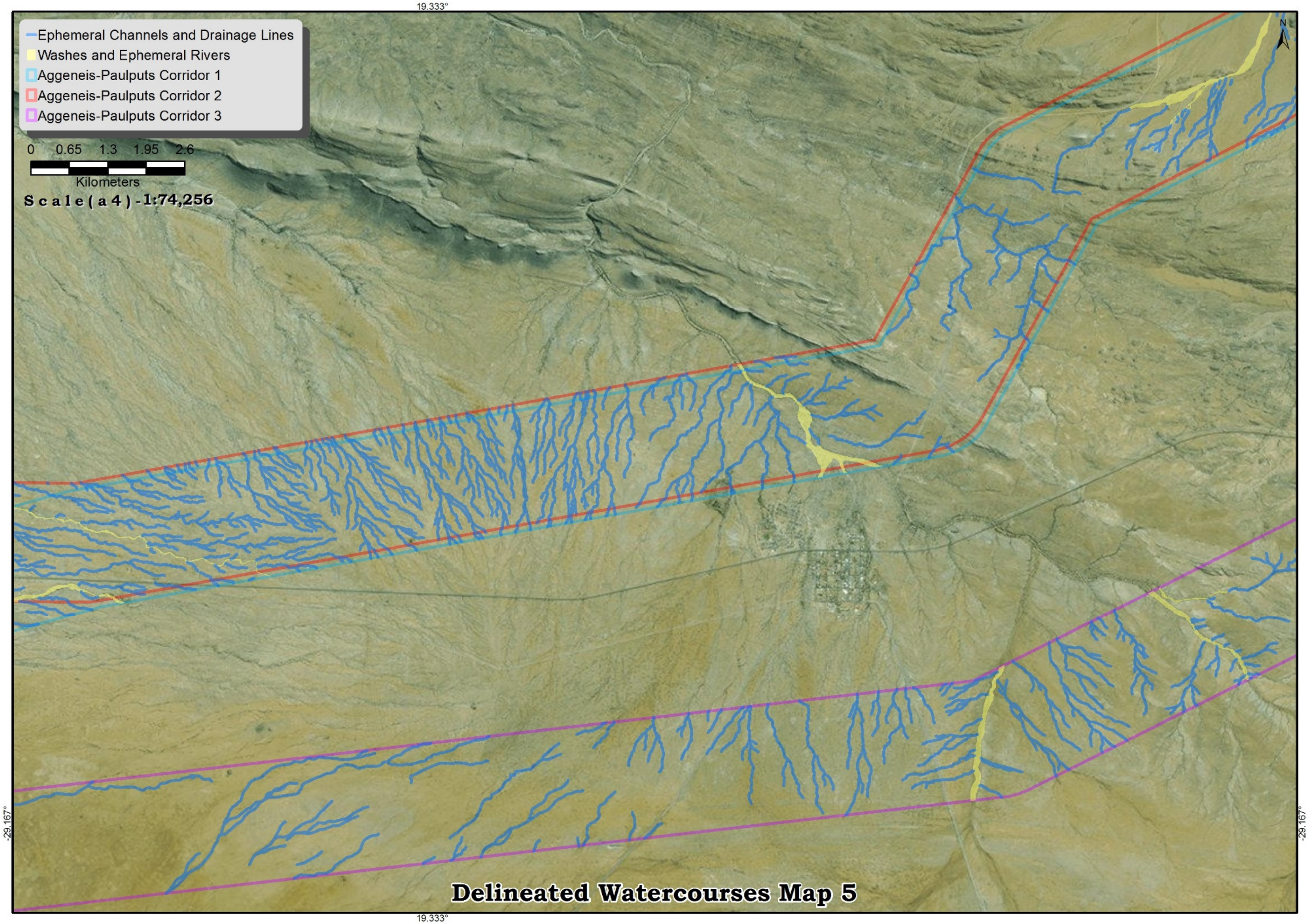

Figure 9: Delineated watercourses in the eastern-central portion of the study area, around Pofadder town.

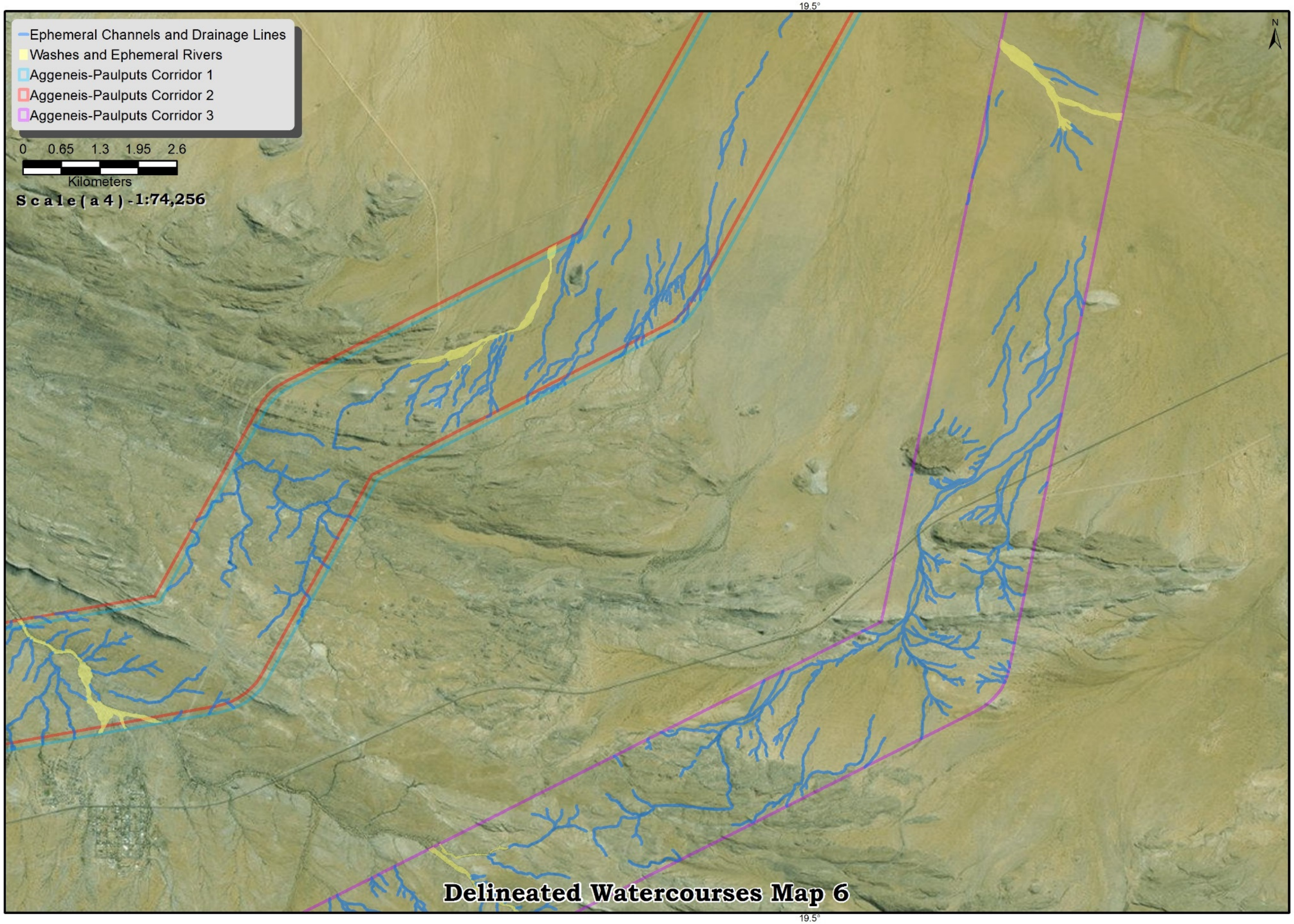

Figure 10: Delineated watercourses located between Pofadder town in the west and Paulputs Substation to the northeast (not visible on map).

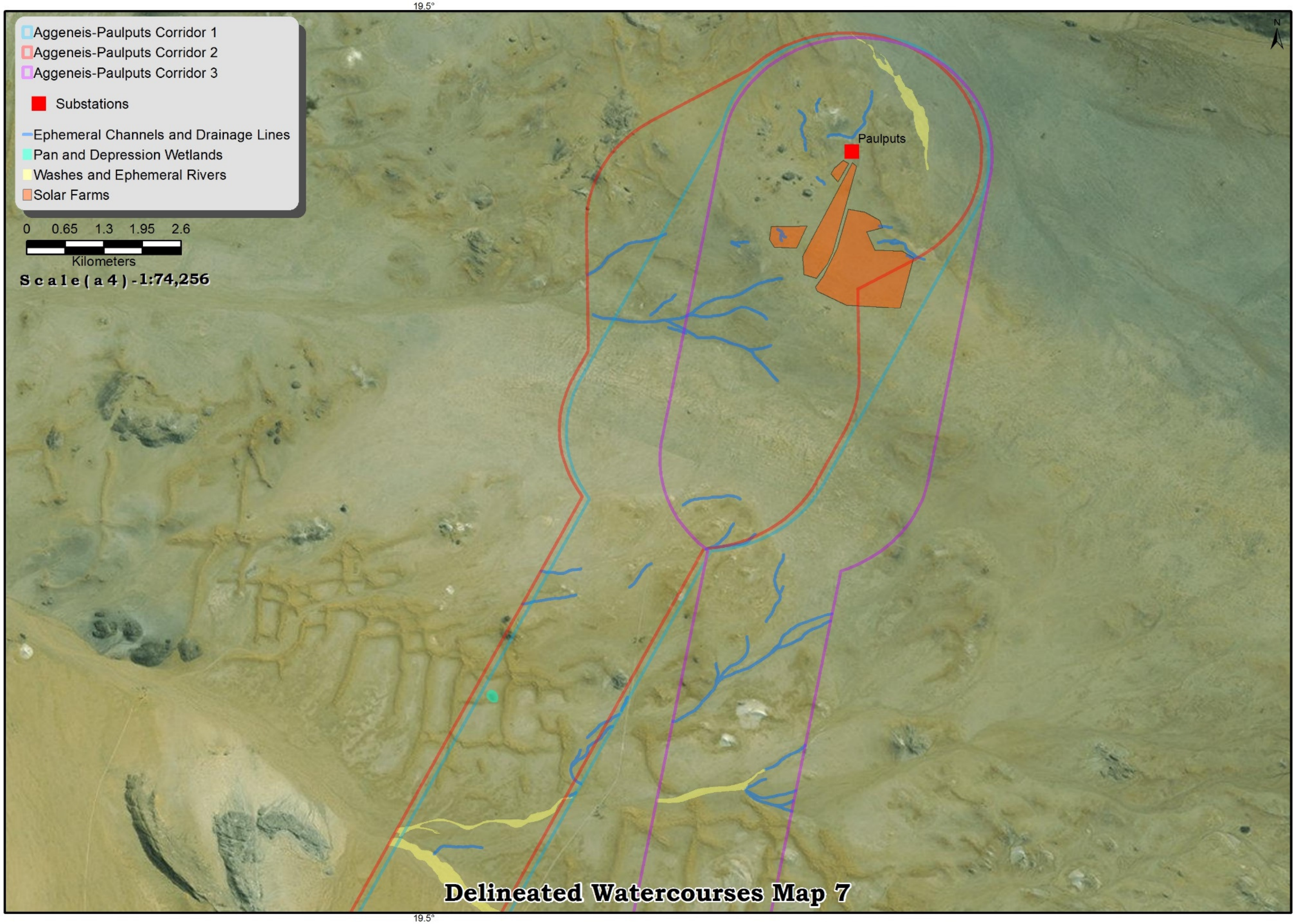

Figure 11: Delineated watercourses in the north-eastern-most portion of the study area, with the end point at Paulputs Substation.

6.2. Watercourse Assessment

Watercourse properties obtained from spatial datasets available in the public domain as well as the delineated watercourse spatial dataset created specifically for this project are discussed in this section. A series of tables are used to provide information regarding the size, number and crossing distances of different watercourses in each corridor alternative and along corridor centre lines (Tables 6–11). Deviation 3A does not directly form part of the comparisons, as it is not a viable alternative on its own, but forms part of an alternative for route corridor 3 (Figure 1). Findings from comparisons of exiting spatial datasets include the following:

- Several 1:500000 river crossings are present within the study area (Figure3; Table 6). Centre line crossings for route corridor 1 is 8, corridor 2 has 7, corridor 3 has 4 and Deviation 3A has only 1. Route corridor 3 has a significantly shorter length of combined river segments compared to route corridors 1 and 2. All of the rivers are ephemeral in nature, have an intact condition, a largely natural Present Ecological State and a mostly Endangered conservation status (Table 6).
- Results from the 1:50000 river line assessment, which included headwater channels, larger stream and rivers (collectively referred to as drainage lines), indicate that route corridor 1 has the highest number of drainage line crossings along its centre line (Figure 4; Table 6). Route corridor 2 is closely second with only 5 fewer centre line crossings, while route corridor 3 has 22 fewer crossings compared to route corridor 2.
- The combined length of drainage lines is for all practical purposes comparable for each corridor, with route corridor 3 containing the longest by a small margin (Figure 4; Table 7).
- Not a single NFEPA wetland is intersected by one of the centre lines.
- Route corridor 3 has the longest combined surface area of NFEPA wetlands, while the values for route corridors 1 and 2 are the same (Figure 3: Table 8).
- Findings from an analyses of the 2013-2014 Land Cover dataset indicate that no wetland area, nor areas with seasonal or permanent wetness, overlap with any of the route corridors (GTI, 2015).
- Road lines obtained from the 1:50000 topographical map dataset indicates that route corridor 2 has the largest combine length of existing roads and also has the highest number of centre line road crossings, followed by route corridor 1 (Table 9).
- Existing Eskom power line alignments within the study area overlap primarily with route corridor 1, which has an existing line along its entire length (Figure 12). Existing powerlines, specifically transmission lines, will be associated with existing access roads/tracks for maintenance, which makes new alignments along these existing lines more favourable, as fewer new access road and track crossings through watercourses are expected to be required.

Comparisons of watercourse classes that were delineated and grouped as part of this study, are summarised below (Figures 5-11; Tables 10-11):

- Route corridor 2 has the highest number of delineated ‘ephemeral channels and drainage lines’, as well as ‘washes and ephemeral rivers’, followed closely by route corridor 1 (Table 10). Route corridor 3 has 51 % fewer ‘ephemeral channels and drainage lines’ and 42 % fewer ‘washes and ephemeral rivers’, compared to route corridor 1 (Table 10).
- Route corridor 1 has the largest combined surface area of ‘ephemeral channels and drainage lines’, as well as ‘washes and ephemeral rivers’, with route corridor 3 again having the lowest value for both watercourse classes (Table 10).
- Route corridor 3 does, however, have the largest number and combined surface area for ‘pan/depression wetlands’, but both these values are regarded as low compared to the other watercourse classes present in the study area (Table 10).
- The number of centre line crossings and the combined length of crossings through ‘washes and ephemeral rivers’, as well as ‘pans/depressions’ differ only slightly between the three route corridors. The number of centre line crossings is however distinctly higher in route corridors 1 and 2, compared to route corridor 3 (Table 11).

Table 6: Summary of properties for different river datasets (Driver *et* al., 2004; DWS, 2015;Nel*et* al., 2011) in each route corridor and along each route corridor centre line. Calculated maximum and minimum values for each of the three corridor route alternatives are indicated in red and green respectively. Deviation 3A does not directly form part of the comparision as it is not a viable alternative on its own.

	Route Corridor 1	**Route Corridor 2**	**Route Corridor 3**	**Deviation 3A**
Ecoregions present	Nama Karoo (majority of rivers) and Orange River Gorge (one river)	Nama Karoo (majority of rivers) and Orange River Gorge (one river)	Nama Karoo (majority of rivers) and Orange River Gorge (one river)	Nama Karoo (majority of rivers) and Orange River Gorge (one river)
Number of river centre line crossings in each corridor (calculated) (also refer to Figure 3)	8	7	4	1
Sub-quaternary reaches (DWS, 2015)	Not applicable	Not applicable	Not applicable	Not applicable
River stream orders (Nel *et al.*, 2011) (also refer to Figure 4)	1 and 2	1 and 2	1 and 2	1
Flow conditions (Nel *et al.*, 2011) (also refer to Figure 4)	Ephemeral	Ephemeral	Ephemeral	Ephemeral
River types (Nel *et al.*, 2011) (also refer to Figure 4)	Not permanent/flashy upper foothills (majority of rivers) to Not permanent/flashy lowland river (one river)	Not permanent/flashy upper foothills (majority of rivers) to Not permanent/flashy lowland river (one river)	Not permanent/flashy upper foothills	Not permanent/flashy upper foothills
Present Ecological State (Nel *et al.*, 2011) (also refer to Figure 4)	B (Largely natural)	B (Largely natural)	B (Largely natural)	B (Largely natural)
River condition (Nel *et al.*, 2011) (also refer to Figure 4)	AB (Intact)	AB (Intact)	AB (Intact)	AB (Intact)
Conservation status (Driver *et al.*, 2004) (also refer to Figure 4)	Endangered (majority of rivers) and Non threatened (one reach)	Endangered (majority of rivers) and Non threatened (one reach)	Endangered	Endangered
FEPA river classes (Nel *et al.*, 2011) (also refer to Figure 4)	2 x FEPA (Kaboeb River and an unnamed tributary of Goob se Laagte); 6 x upstream management area rivers	2 x FEPA reaches (Kaboeb River and an unnamed tributary of Goob se Laagte); 4 x upstream management area rivers	1 x FEPA (Kaboeb River); 3 x upstream management area rivers	Upstream management area river
Combined river length in each route corridor (calculated) (also refer to Figure 4)	25.46 km	20.58 km	9.96 km	2.10 km

Table 7: Summary of properties for drainage line properties obtained from the 1:50000 topographical maps river line datasets in each route corridor and along each route corridor centre line. Calculated maximum and minimum values for each of the three corridor route alternatives are indicated in red and green respectively. Deviation 3A does not directly form part of the comparision as it is not a viable alternative on its own.

	Route Corridor 1	Route Corridor 2	Route Corridor 3	Deviation 3A
Number of drainage line crossings along each route centre line	98	93	71	12
Combined length of drainage lines in each route corridor	222.35 km	223.82 km	225.91 km	40.90 km

Table 8: Summary of properties for the NFEPA wetland dataset (Nel *et al.*, 2011) for each route corridor. Calculated maximum and minimum values for each of the three corridor route alternatives are indicated in red and green respectively. Deviation 3A does not directly form part of the comparision as it is not a viable alternative on its own.

	Route Corridor 1	Route Corridor 2	Route Corridor 3	Deviation 3A
Combined area of NFEPA wetlands (all wetland types) within route corridor	2.54 ha	2.54 ha	6.80 ha	0.44 ha

Table 9: Summary of road properties obtained from the different 1:50000 topographical map road lines datasets in each route corridor and along each route corridor centre line. Calculated maximum and minimum values for each of the three corridor route alternatives are indicated in red and green respectively. Deviation 3A does not directly form part of the comparision as it is not a viable alternative on its own.

	Route Corridor 1	Route Corridor 2	Route Corridor 3	Deviation 3A
Number of road crossings along each route centre line	88	91	50	12
Combined length of roads within each route corridor	218.47 km	266.56 km	146.70 km	37.49 km

Table 10: Indicates properties of different types of watercourses, delineated as part of this study, which overlap with each of the route corridor alternatives. Calculated maximum and minimum values for each of the three corridor route alternatives are indicated in red and green respectively. Deviation 3A does not directly form part of the comparision as it is not a viable alternative on its own.

	Route Corridor 1	Route Corridor 2	Route Corridor 3	Deviation 3A
Number of Washes and ephemeral rivers in corridor	57	61	30	3
Total surface area of Washes and ephemeral rivers in corridor	733.43 ha	594.19 ha	479.80 ha	135.28 ha
Number of Ephemeral channels and drainage lines in corridor	1709	1874	995	272
Total length of Ephemeral channels and drainage lines in corridor	638.55 km	627.66 km	398.96 km	108.50 km
Number of Pan/depression wetlands in corridor	1	2	10	2
Total surface area of Pan/depression wetlands in corridor	2.49 ha	2.64 ha	35.12 ha	0.84 ha

Table 11: Indicates properties of different types of watercourses, delineated as part of this study, which overlap with each of the route corridor alternative centre lines Calculated maximum and minimum values for each of the three corridor route alternatives are indicated in red and green respectively. Deviation 3A does not directly form part of the comparision as it is not a viable alternative on its own.

	Route Corridor 1	Route Corridor 2	Route Corridor 3	Deviation 3A
Number of centre line crossings with Washes and ephemeral rivers	17	14	12	2
Combined length of Washes and ephemeral rivers centre line crossings	2.76 km	4.04 km	2.37 km	0.43 km
Number of centre line crossings with Ephemeral channels and drainage lines	213	179	110	21
Number of centre line crossings with Pan/depression wetlands	0	0	1	0
Combined length of Pan/depression wetlands centre line crossings	0	0	0.03 km	

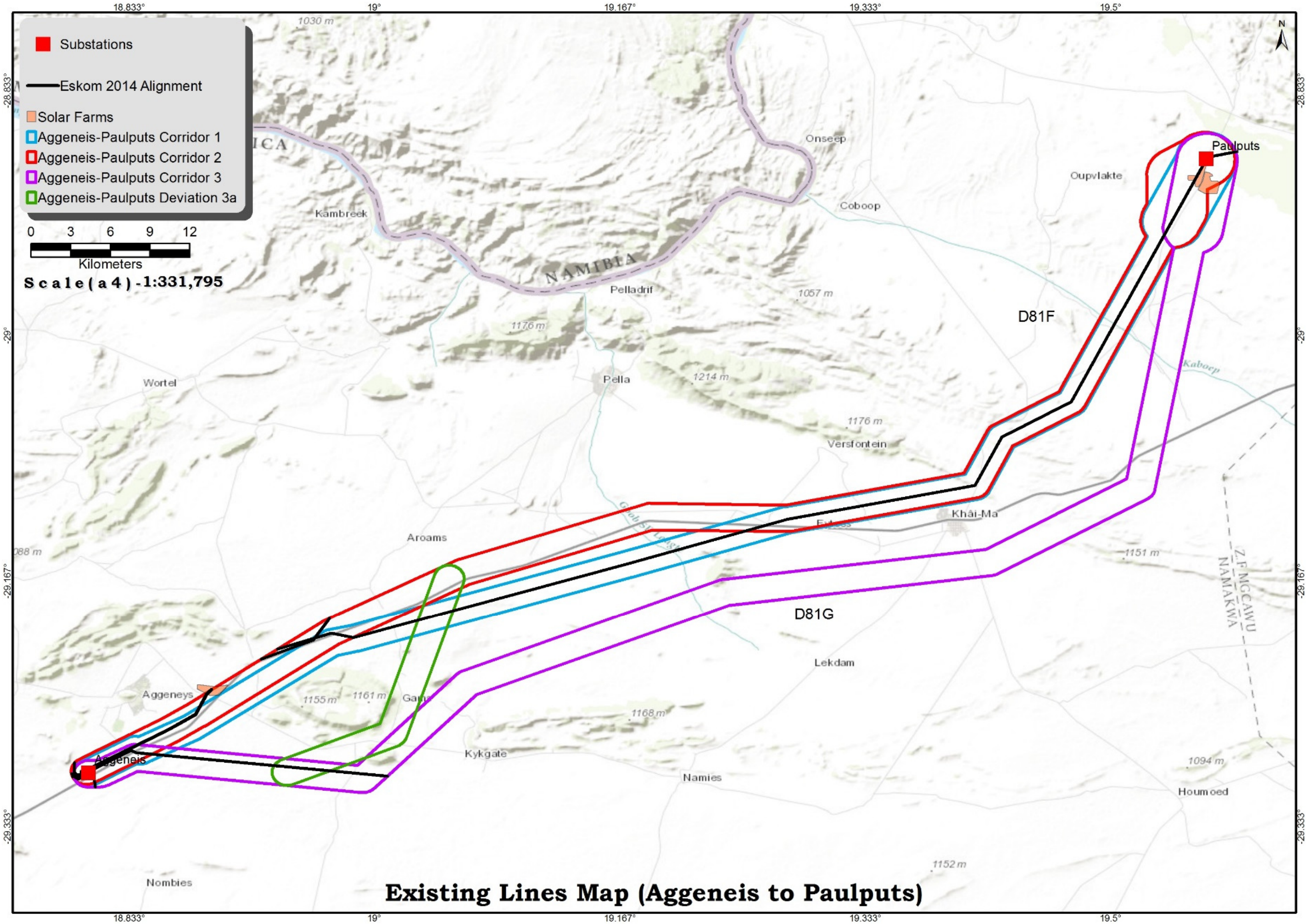

Figure 12: Illustrates existing power lines within the study area, based on existing powerlines that were obtained from a 2014 Eskom spatial dataset.

7. IMPACT ASSESSMENT AND MITIGATION

7.1. Impact Assessment Method

The impact assessment methodology is guided by the requirements of the NEMA EIA Regulations (2014), and is based on the method received from Mokgope Consulting.

7.1.1. Nature of impact

The environmental impacts of a project are those resultant changes in environmental parameters, in space and time, compared with what would have happened had the project not been undertaken. It is an appraisal of the type of effect the proposed activity would have on the affected environmental parameter. Its description should include what is being affected, and how.

7.1.2. Spatial extent

This addresses the physical and spatial scale of the impact. A series of standard terms relating to the spatial extent of an impact / effect are outlined in Table 12.

Table 12: Rating scale for the assessment of the spatial extent of predicted effect / impact

Rating	Spatial descriptor
7	International - The impacted area extends beyond national boundaries
6	National - The impacted area extends beyond provincial boundaries
5	Ecosystem - The impact could affect areas essentially linked to the property in terms of significantly impacting ecosystem functioning
4	Regional - The impact could affect the area including the neighbouring farms, the transport routes and the adjoining towns
3	Landscape - The impact could affect all areas generally visible to the naked eye, as well as those areas essentially linked to the property in terms of ecosystem functioning
2	Site related - The impacted area extends further than the actual physical disturbance footprint; the impact could affect the whole, or a measurable portion of a number of properties
1	Local - The impacted area extends only as far as the activity e.g. a footprint; the loss is considered inconsequential in terms of the spatial context of the relevant environmental aspect

7.1.3. Severity / Intensity / Magnitude

A qualitative assessment of the severity of a predicted impact / effect was undertaken. Quantitative measures were undertaken wherever possible. A series of standard terms relating to the magnitude of an impact / effect are outlined in Table 13.

Table 13: Rating scale for the assessment of the severity of a predicted effect / impact[1]

Rating	Magnitude descriptor
7	Total / consuming / eliminating - Function or process of the affected environment is altered to the extent that it is permanently changed
6	Profound / considerable / substantial - Function or process of the affected environment is altered to the extent where it is permanently modified to a sub-optimal state. In the case of positive impacts it is permanently modified to an improved state
5	Material / important - Function or process of the affected environment is altered to the extent where it is temporarily altered, be it in a positive or negative manner.
4	Discernible / noticeable - The affected environment is altered, but function and process continue, albeit in a modified way.
3	Marginal / slight / minor - The affected environment is altered, but natural function and process continue.
2	Unimportant / inconsequential / indiscernible - The impact alters the affected environment in such a way that the natural processes or functions are negligibly affected.
1	No effect / not applicable

7.1.4. Duration

This describes the predicted lifetime of the impact (Table 14).

Table 14: Rating scale for the assessment of the temporal scale of a predicted effect / impact

Rating	Temporal descriptor
7	Long-term – Permanent. Beyond decommissioning and cannot be negated on decommissioning. More than 15 years.
3	Medium term – Lifespan of the project. Reversible over time. 5 to 15 years.
1	Short-term – Quickly reversible. Less than the project lifespan. The impact will either disappear with mitigation or will be mitigated through natural process in a span shorter than any of the phases. 0 to 5 years.

7.1.5. Irreplaceable loss of resources

Environmental resources cannot always be replaced; once destroyed, some may be lost forever. It may be possible to replace, compensate for or reconstruct a lost resource in some cases, but substitutions are rarely ideal. The loss of a resource may become more serious later, and assessment must take this into account. The rating scale for irreplaceable loss of resources is provided in Table 15.

[1] **Source:** adapted from Glasson J, Therivel R & Chadwick A. Introduction to Environmental Impact Assessment, 2nd Edition. 1999. pp 258. Spon Press, United Kingdom.

Table 15: Rating scale for the assessment of the loss of resources due to a predicted effect / impact.

Rating	Resource loss descriptor
7	Long-term – The loss of a non-renewable / threatened resource which cannot be renewed / recovered with or through natural process, in a time span of over 15 years, or by artificial means.
5	Long-term – The loss of a non-renewable / threatened resource which cannot be renewed / recovered with or through natural process, in a time span of over 15 years, but can be mitigated by other means.
4	Loss of an 'at risk' resource - one that is not deemed critical for biodiversity targets, planning goals, community welfare, agricultural production, or other criteria, but cumulative effects may render such loss as significant.
3	Medium term – The resource can be recovered within the lifespan of the project. The resource can be renewed / recovered with mitigation or will be mitigated through natural process in a span between 5 and 15 years.
2	Loss of an 'expendable' resource - one that is not deemed critical for biodiversity targets, planning goals, community welfare, agricultural production, or other criteria.
1	Short-term – Quickly recoverable. Less than the project lifespan. The resource can be renewed / recovered with mitigation or will be mitigated through natural process in a span shorter than any of the phases, or in a time span of 0 to 5 years.

7.1.6. Reversibility / potential for rehabilitation

The distinction between reversible and irreversible impacts is a very important one, and the irreversible impacts, not susceptible to mitigation, can constitute significant impacts in an EIA (Glasson *et al*, 1999). The potential for rehabilitation is the major determinant factor when considering the temporal scale of most predicted impacts (Table 16).

Table 16: Rating scale for the assessment of reversibility of a predicted effect / impact

Rating	Reversibility descriptor
7	Long-term – The impact / effect will never be returned to its benchmark state.
3	Medium term – The impact / effect will be returned to its benchmark state through mitigation or natural processes in a span shorter than the lifetime of the project, or in a time span between 5 and 15 years.
1	Short-term – The impact / effect will be returned to its benchmark state through mitigation or natural processes in a span shorter than any of the phases of the project, or in a time span of 0 to 5 years.

7.1.7. Probability

An assessment of the probability of an impact / effect was undertaken in accordance with Table 17.

Table 17: Rating scale for the assessment of the probability of a predicted effect / impact 2

Rating	Probability descriptor
1.0	Absolute certainty
0.9	Near certainty / very high probability
0.7 – 0.8	High probability – to be expected
0.4 - 0.6	Likelihood / normal anticipation – to be anticipated
0.3	Seriously anticipated possibility
0.2	Possibility
0.0 - 0.1	Remote possibility

7.1.8. Mitigation

The potential to mitigate the negative impacts and enhance the positive impacts should be determined for each identified impact, mitigation objectives that would result in a measurable reduction in impact should be provided (Tables 18 and 19). For each impact, practical mitigation measures that can affect the significance rating should be recommended. Management actions that could enhance the condition of the environment (i.e. potential positive impacts of the proposed project) should be identified. Where no mitigation is considered feasible, this must be stated and the reasons provided (DEAT, 2002).

The significance of environmental impacts will be assessed taking into account any proposed mitigations. The significance of the impact "without mitigation" is the prime determinant of the nature and degree of mitigation required.

Table 18: (a) Significance scoring of a Negative impact / effect

Scoring value	Significance
35	Total / consuming / eliminating - In the case of adverse impacts, there is no possible mitigation that could offset the impact, or mitigation is difficult, expensive, time-consuming or some combination of these. Social, cultural and economic activities of communities are disrupted to such an extent that these come to a halt. Mitigation may not be possible / practical. Consider fatal flaw.
26 - 34	Profound - In the case of adverse impacts, there are few opportunities for mitigation that could offset the impact, or mitigation has a limited effect on the impact. Social, cultural and economic activities of communities are disrupted to such an extent that their operation is severely impeded. Mitigation may not be possible / practical. Consider fatal flaw.
21 – 25	Considerable / substantial - The impact is of great importance. Failure to mitigate with the objective of reducing the impact to acceptable levels could render the entire

[2] **Source:** adapted from Glasson J, Therivel R & Chadwick A. Introduction to Environmental Impact Assessment, 2nd Edition. 1999. pp 258. Spon Press, United Kingdom.

Scoring value	Significance
	project option or entire project proposal unacceptable. Mitigation is therefore essential.
8 – 20	Material / important to investigate - The impact is of importance and is therefore considered to have a substantial impact. Mitigation is required to reduce the negative impacts and such impacts need to be evaluated carefully.
5 – 7	Marginal / slight / minor - The impact is of little importance, but may require limited mitigation; or it may be rendered acceptable in light of proposed mitigation.
0 – 4	Unimportant / inconsequential / indiscernible; or it may be rendered acceptable in light of proposed mitigation.

Table 19: (b) Significance scoring of a Positive impact / effect

Scoring value	Significance
16 - 21	Very highly beneficial
12 – 15	Highly beneficial
5 - 11	Moderately beneficial
3 – 4	Slightly beneficial
0 – 2	Beneficial

7.2. Non-assessed Impacts: Planning and Design Phase

No formal impact assessment was undertaken for the planning and design phase of the project, but important principles are discussed. Avoidance is regarded as the best form of mitigation. The creation of the delineated watercourse shapefiles submitted with this report and illustrated in Figures 5 to 10 can be used during the planning and design phase to help create a route within the selected corridor that avoids as many watercourses as practically possible. This can be achieved through the following:

- Careful tower (pylon) positioning that prevent overlap with delineated watercourses. This will reduce the length of power line sections and number of towers in watercourse crossings. Many watercourse crossings can be spanned through this process as part of initial planning, prior to the start of the EMPR phase of the project.
- Impacts associated with the construction of permanent access tracks for maintenance of pylons and the servitude line more difficult to mitigate. Planning in the alignment route of the power line can help to make use of existing access tracks as far as possible in order to help prevent the creation of new access roads in watercourses.

7.3. Assessment of Identified Watercourse Impacts

Project-related impacts on identified watercourses, as well as recommended mitigation measures are discussed below for different project phases based on the above. The significance of each impact is rated without mitigation measures and with impact mitigation measures for each route corridor alternative (Tables 20-22). Relevant corridor alternatives and project phases are indicated for each assessed impact.

Table 20: Significance analysis of potential watercourse-related impacts for route corridor alternative 1: Proposed Aggeneis-Paulputs 400kV transmission powerline and substations upgrade, DEA ref: 14/12/16/3/3/2/1012. 'Without' refers to no mitigation; 'With' refers to with mitigation.

	NEGATIVE IMPACTS / EFFECTS														
	Activity	**Nature of impact**	**Spatial extent**		**Severity/ intensity/ magnitude**		**Duration**		**Resource loss**	**Reversibility**		**Probability**		**Significance scoring without mitigation**	**Significance scoring with mitigation**
			Without	**With**	**Without**	**With**	**Without**	**With**		**Without**	**With**	**Without**	**With**		
Planning Phase	**No significant impacts anticipated**														
Construction Phase	Driving through watercourses	Compaction of watercourse soils	2	1	2	2	3	3	3	3	2	0.5	0.2	**6.8**	**2.2**
	Infrastructure construction	Flow changes, increased sedimentation and erosion in watercourses	1	1	4	3	4	2	4	4	2	0.5	0.2	**8.8**	**2.4**
	Infrastructure construction	Loss of watercourse habitat	1	1	4	3	4	2	5	4	3	0.5	0.2	**9.3**	**2.8**
	Refuelling and storage of materials	Contamination of water resources	2	1	5	2	3	2	3	3	1	0.8	0.2	**11.8**	**1.8**
	Soil disturbances and vegetation clearing	Encroachment of alien species into watercourses	2	1	4	2	6	1	4	3	1	0.7	0.2	**13.8**	**1.8**

	NEGATIVE IMPACTS / EFFECTS														
	Activity	**Nature of impact**	**Spatial extent**		**Severity/ intensity/ magnitude**		**Duration**		**Resource loss**	**Reversibility**		**Probability**		**Significance scoring without mitigation**	**Significance scoring with mitigation**
			Without	**With**	**Without**	**With**	**Without**	**With**		**Without**	**With**	**Without**	**With**		
Operational Phase	Driving through watercourses	Compaction of watercourse soils	2	1	2	2	3	3	3	3	2	0.5	0.2	**6.8**	**2.2**
	Soil disturbances and vegetation clearing	Encroachment of alien species into watercourses	2	1	4	2	6	1	3	3	1	0.5	0.2	**9.3**	**1.6**

Table 21: Significance analysis of potential watercourse-related impacts for route corridor alternative 2: Proposed Aggeneis-Paulputs 400kV transmission powerline and substations upgrade, DEA ref: 14/12/16/3/3/2/1012. 'Without' refers to no mitigation; 'With' refers to with mitigation.

	NEGATIVE IMPACTS / EFFECTS															
	Activity	**Nature of impact**	**Spatial extent**		**Severity/ intensity/ magnitude**		**Duration**		**Resource loss**	**Reversibility**		**Probability**		**Significance scoring without mitigation**	**Significance scoring with mitigation**
			Without	**With**	**Without**	**With**	**Without**	**With**		**Without**	**With**	**Without**	**With**		
Planning Phase	**No significant impacts anticipated**															
Construction Phase	Driving through watercourses	Compaction of watercourse soils	2	1	4	3	4	2	3	4	2	0.9	0.3	**16.1**	**3.4**
	Infrastructure construction	Flow changes, increased sedimentation and erosion in watercourses	1	1	6	3	5	2	4	5	2	0.9	0.3	**19.7**	**3.7**
	Infrastructure construction	Loss of watercourse habitat	1	1	5	4	5	3	5	5	3	0.9	0.4	**19.7**	**6.6**
	Refuelling and storage of materials	Contamination of water resources	2	1	5	2	3	2	3	3	1	0.8	0.2	**13.4**	**1.8**
	Soil disturbances and vegetation clearing	Encroachment of alien species into watercourses	2	1	5	2	6	1	4	3	1	1	0.2	**21.0**	**1.8**

	NEGATIVE IMPACTS / EFFECTS														
	Activity	**Nature of impact**	**Spatial extent**		**Severity/ intensity/ magnitude**		**Duration**		**Resource loss**	**Reversibility**		**Probability**		**Significance scoring without mitigation**	**Significance scoring with mitigation**
			Without	**With**	**Without**	**With**	**Without**	**With**		**Without**	**With**	**Without**	**With**		
Operational Phase	Driving through watercourses	Compaction of watercourse soils	2	1	4	3	4	2	3	4	2	1	0.3	**18.0**	**3.4**
	Soil disturbances and vegetation clearing	Encroachment of alien species into watercourses	2	1	4	2	6	1	3	3	1	0.7	0.2	**13.1**	**1.6**

Table 22: Significance analysis of potential watercourse-related impacts for route corridor alternative 3 (Deviation 3A is also included as part of this analysis as the expected project-related impacts score similarly): Proposed Aggeneis-Paulputs 400kV transmission powerline and substations upgrade, DEA ref: 14/12/16/3/3/2/1012. 'Without' refers to no mitigation; 'With' refers to with mitigation.

	NEGATIVE IMPACTS / EFFECTS													
	Activity	**Nature of impact**	**Spatial extent**		**Severity/ intensity/ magnitude**		**Duration**		**Resource loss**	**Reversibility**		**Probability**		**Significance scoring without mitigation**	**Significance scoring with mitigation**
			Without	**With**	**Without**	**With**	**Without**	**With**		**Without**	**With**	**Without**	**With**		
Planning Phase	**No significant impacts anticipated**														
Construction Phase	Driving through watercourses	Compaction of watercourse soils	2	1	4	2	4	2	3	4	3	1	0.5	**18.0**	**5.8**
	Infrastructure construction	Flow changes, increased sedimentation and erosion in watercourses	1	1	6	3	5	2	4	5	2	1	0.5	**22.0**	**6.3**
	Infrastructure construction	Loss of watercourse habitat	1	1	6	3	5	3	5	5	3	1	0.5	**23.0**	**7.8**
	Refuelling and storage of materials	Contamination of water resources	2	1	5	2	3	2	3	3	1	0.8	0.2	**13.4**	**1.8**

	NEGATIVE IMPACTS / EFFECTS														
	Activity	**Nature of impact**	**Spatial extent**		**Severity/ intensity/ magnitude**		**Duration**		**Resource loss**	**Reversibility**		**Probability**		**Significance scoring without mitigation**	**Significance scoring with mitigation**
			Without	**With**	**Without**	**With**	**Without**	**With**		**Without**	**With**	**Without**	**With**		
	Soil disturbances and vegetation clearing	Encroachment of alien species into watercourses	2	1	5	2	6	1	4	3	1	1	0.2	**21.0**	**1.8**
Operational Phase	Driving through watercourses	Compaction of watercourse soils	2	1	4	2	4	2	3	4	3	1	0.5	**18.0**	**5.8**
Operational Phase	Soil disturbances and vegetation clearing	Encroachment of alien species into watercourses	2	1	4	2	6	1	3	3	1	0.7	0.2	**13.1**	**1.6**

7.3.1. Compaction of watercourse soils

Driving through watercourses during the construction and operational phases of the project will result in soil compaction within watercourse, which may affect watercourse vegetation and result in erosion (also refer to Section 7.3.2). Driving should be done on existing roads and tracks as far as possible, in order to prevent vehicle track entrenchment and avoid the potential for new channel initiation and erosion. Where this is unavoidable crossing structures can be put in place across channelled watercourses along with a relevant Water Use License requirements. No new crossings should, however, be made in pan/depression watercourses, as these areas can be avoided during the planning phase, access tracks should drive around pan/depression watercourses. Linear watercourses that are unchannelled, or contain weakly developed channel features (e.g. swales), and are dry/ephemeral, may not require a road crossing, but could potentially be driven as is based on findings from the Walk Down EMP assessment. Recommended crossings structures or the absence of crossing structures can include the following, but should ideally be based on evaluated site conditions for individual watercourse crossings along with engineering input:

- A wearing course (wear surface) should be added as a surface layer on top of geotextile fabrics, which forms base for surface capping.
- A wearing course (surface cap) of good quality clastic or gravel material also has the potential to reduce surface scour by creating a mix that will easily bind together and minimise detachment of particles.
- Geotextiles provide four important functions in temporary road and trail surface construction that includes separation, drainage, reinforcement, and stabilisation.
- Geotextiles work as separation fabrics when they are placed between gravel caps and underlying soils to prevent the materials from mixing.
- Additional benefits of such as crossing structure include:
    - It defines a single route alignment for vehicle travel.
    - Provides a 'wear and carry' surface over unsuitable and easily compactable watercourse, especially wetland, soils.
    - This results in a stable, durable crossing surface for vehicle access, including heavy motor vehicle traffic.
    - Halts the widening and the development of braided crossing sections, while formerly used track alignments are allowed to naturally stabilise and revegetate

7.3.2. Flow, sedimentation and erosion changes in watercourses due to infrastructure construction

This refer to changes in the pattern of surface and subsurface flow in watercourses, as well as resultant sediment depositional impacts and erosion impacts, which are associated with new access road crossings through, and pylon positioning within watercourses. The following mitigation measures are recommended:

- Restrict the construction of infrastructure in watercourses as far as possible.
- Tower construction in watercourses should only be allowed in exceptional circumstances where these areas cannot be spanned.
- All unavoidable overlap between individual towers and watercourses, and new or upgraded watercourse road crossings will require a Water Use License (WUL) in order to be allowable. Efforts should therefore be undertaken during the planning phase and proposed walk down phase to avoid infrastructure overlap as far as possible. This includes the use of existing access roads.
- New access roads and tracks should also be located outside of watercourses as far as possible (see mitigation measures provided for the compaction of watercourse soils impact).
- Road crossings should make provision for dispersed flow and energy dissipation. Refer to the abovementioned recommendation regarding pylon (tower) construction in watercourses.
- Management of roadside drainage is the most effective way of controlling sediment runoff from unsealed roads that have to be constructed. To minimise sediment load, an unsealed road

network should have an emphasis on slowing drainage flows and dispersing them more frequently.

- Stormwater should be diverted away from the road early and often, so as to reduce the catchment area of the road.
- The use of drains, such as table drains and cut-off drains, should not be used in any of the watercourse crossings. These types of drains typically have concentrated high-velocity flows and can frequently form channels within the watercourse. These channels provide an easy pathway for sediment to reach streams and adversely impact on water quality.
- Alternative options for stormwater control should therefore be considered. These include the use of:
  - Vegetated swales.
  - Entrenched rock (rip rap) aprons.
  - Sediment traps, such as hay bales or silt traps. These structures do, however, require maintenance.
  - Vegetated buffer/ filter strips. The use of vegetation in the watercourse, especially downstream of unsealed road surfaces, will help to provide soil stability and reduce sediment input. It is important to use local and indigenous plant species.
- Permanent crossing structures across channelled watercourses can include unvented fords that are constructed of riprap, gabions, or concrete to provide a stream crossing without the use of pipes. Water will periodically flow over the crossing structure. Measures therefore need to be incorporated into the design to protect downstream watercourse habitat from scour erosion during flow events. This is more important in large watercourses, such as ephemeral rivers.
- If the construction of a crossing is unavoidable make sure that substrate continuity in the watercourse is maintained within upstream and downstream portions of the channel bed.
- Unvented fords are best suited for ephemeral or intermittent streams (streams that are dry most of the year). Unvented fords may also be used across some shallow, low velocity perennial streams.
- Other important best management practices associated with ford design, construction, operation and maintenance that should be adhered to as far as possible, include (Anon 2006):
  - Where possible locate crossings on straight channel segments (avoid meanders).
  - To the extent possible align crossings perpendicular to the stream channel.
  - Minimize the extent and duration of the hydrological disruption.
  - Use appropriate energy dissipaters and erosion control at the outlet drop.
  - Minimize impact to riparian vegetation during construction
  - Prevent excavated material from running into water bodies and other sensitive areas.
  - Use appropriate sediment barriers (silt fence and hay bales).
  - Dewater prior to excavation.
  - Check construction surveys to ensure slopes and elevations meet design specifications.
  - Use appropriately graded material (according to design specifications) that has been properly mixed before placement inside the structure.
  - Compact bed material.
  - Tie constructed banks into upstream and downstream banks.
  - Evaluate structure stability

7.3.3. Loss of watercourse habitat due to infrastructure construction.

This impact refers to the direct loss of watercourse habitat due to infrastructure (e.g. pylons and access road) construction within watercourses. The following mitigation measures are recommended:

- No towers (pylons), construction camps or quarries should not be constructed within watercourses.

- The smallest possible footprint should be utilized and positioned as close to the boundary of the affected watercourse in cases where tower construction in a watercourse is unavoidable.
- Tower construction activities in these areas should be completed in the shortest possible time and preferably during the dry season.
- Excavated watercourses should be re-sloped to a stable gradient (e.g. a slope of 1:3), revegetated with naturally occurring indigenous species or annual grass species, such as *Eragrostis tef*, and covered with biojute to help facilitate revegetation soon after construction.
- Towers in watercourses should not be located on steep slopes, channels or other surfaces with visible erosion features.
- New roads and access tracks should not be constructed in watercourses as far as possible. Existing access tracks and roads should rather be used where available.
- Please note that these tower construction recommendations are the last mitigation option and all other attempts should first be attempted to prevent towers in watercourses. Infrastructure construction in watercourses would also require a Water Use License from the DWS.

7.3.4. Low water quality inflows into watercourses

This impact refers to a decrease in watercourse water quality due to pollution through construction related activities. The following mitigation measures are recommended:

- No refuelling of construction vehicles should occur within 50 m of demarcated watercourses.
- Hydrocarbons should not be stored within 50 m of watercourses.
- Stockpiles should not be located within 50 m of watercourses.
- Temporary toilets should not be located within 50 m of watercourses.
- Drip trays should be used when working with generators within watercourses or within a 50 m buffer around them.

7.3.5. Encroachment of alien species into watercourses

This impact refers to the encroachment and establishment of alien plant species within the servitude due to construction-phase related soil and vegetation disturbances, as well as due to ongoing access (e.g. vehicle driving and vegetation clearing) during the operational phase of the project. The following mitigation measures are recommended:

- Powerline towers and access roads/tracks should be located outside of demarcated watercourses to restrict disturbances and opportunities for alien and invasive species (AIS) to encroach and become established within watercourses.
- Restrict the clearing of watercourse vegetation as far as possible. Areas that have been cleared should be revegetated with indigenous species after construction.
- Compile and implement an alien plant control program near the end of the construction phase.
- Continue with alien control along access roads and underneath the powerline during the operational phase of the project.

8. DISCUSSION

8.1. Watercourse Sensitivity and the Preferred Alternative

In summary, route corridor 3 has the fewest watercourse crossings and smallest combined surface area for most linear watercourses, apart from washes and ephemeral rivers, in which case the value is only marginally larger than the two other route corridors. Pan/depression wetlands are most prominent within route corridor 3, but still occurs at relatively low values compared to the two other route corridors. Route corridors 1 and 2 collectively have the highest number and combined surface area for delineated 'ephemeral streams and drainage lines' and 'washes and ephemeral rivers'. These two corridors also have the highest collective number of centre line crossings for delineated 'ephemeral channels and drainage lines' and washes and ephemeral rivers'.

Route corridor 1 is regarded as the most sensitive and the least favourable alternative for the proposed powerline based on the significance analyses in the impact assessment (Tables 20 to 22). It is the only route corridor that has an existing power line along its entire length (Figure 12). The presence of an existing Eskom line is of special significance, as existing access roads should already be in place for maintenance purposes along the existing power line within route corridor 1. Road impacts are regarded to be of greater significance compared to tower (pylon) positions and other impacts (Section 7.3), which increases the favourability of route corridor 1. Route corridor 3, including Deviation 3a, has no known existing power lines along the majority of its length and the fewest of all three corridor alternatives (Figure 12). It has the lowest number of existing roads based on available data from the 1:50000 topographical map datasets. Route corridor 2 has existing Eskom power lines along more than 50 % of its length and also has the second highest number of roads indicated on the 1:50000 topographical map datasets.

Considering all of the above route corridor 1 is considered as the most favourable for the proposed 400 kV power line development from a watercourse consideration. It may also be possible to combine route corridors 1 and 2 to create another functional corridor alternative due to their close proximity. Corridor route 2 is regarded as the second preferred corridor alternative. The rating is in large part due to the presence of an existing Eskom line and associated existing access road along the entire length of the corridor alternative 1, which provided an effective means of impact mitigation as determined in Section 7.3.

Delineated watercourse shapefiles presented with this report can be used to help with the planning phase in order to locate as many pylon towers as possible outside of expected watercourse features.

Route corridor 3, including Deviation 3A, are regarded as the least preferred alternative, mainly due to the lack of existing access roads along the majority of its length, which resulted in the highest impact scores of all three corridor alternatives (Section 7.3).

8.2. Legislative Aspects

Wetlands and other watercourses are protected water resources in the National Water Act (Act 36 of 1998) (NWA). Development within watercourses, which can include the construction of towers and access roads, is regarded as a water use activity. Water use activities can only be allowed through an approved Water Use License, irrespective of the condition of the affected watercourse.

Section 21 of the NWA defines different types of water use activities in a watercourse. Water uses activities associated with wetlands, riparian streams, and other watercourses typically include the following:

(c) impeding or diverting the flow of water in a watercourse

(i) altering the bed, banks, course or characteristics of a watercourse.

The implication is that authorization will have to be obtained from the Department of Water and Sanitation (DWS) before water use activities can be initiated in demarcated wetlands, and riparian areas. This will have to be done through a Water Use License Application (WULA). Various Listed Activities, as provided in the National Environmental Management Act (Act 107 of 1998) (NEMA) and amended in December 2014, also pertain to wetlands and other watercourses for which permission will have to be obtained from the Department of Environmental Affairs (DEA).

In order to obtain environmental authorisation the proposed power line infrastructure will have to be assessed in terms of their expected impacts on sensitive environmental features, such as watercourses, along with recommended impact mitigation measures. This study is only primarily focussed on the selection of a suitable corridor from the available alternatives, but also provides an impact assessment with recommended mitigation measures (Section 6). Pylon specific mitigation and access road mitigation will only be possible once a final corridor alternative has been approved. Engineering design and route planning that is influenced by the delineated watercourse spatial dataset will already assist with the first part of the impact mitigation process by aiding the determination of a proposed construction servitude that has already incorporated the presence of potential watercourses. A Walk Down EMP survey thereafter that will confirm the number and extent of watercourse features within the proposed construction servitude, which will result in a refinement of mitigation recommendations, such as the movement of individual towers (pylons) out of watercourses.

8.3. Recommendations

Avoidance is regarded as the best form of mitigation. The creation of the delineated watercourse shapefiles submitted with this report can be used during the planning phase to help create a route within the selected corridor that avoids as many watercourses as practically possible. This can be achieved through the following:

- Careful tower (pylon) positioning that prevent overlap with delineated watercourses. This will reduce the length of power line sections and number of towers in watercourse crossings. Many watercourse crossings can be spanned through this process as part of initial planning, prior to the start of the EMPR phase of the project.
- Impacts associated with the construction of permanent access tracks for maintenance of pylons and the servitude line more difficult to mitigate. Planning in the alignment route of the power line can help to make use of existing access tracks as far as possible in order to help prevent the creation of new access roads in watercourses.

Five project-related watercourse impacts have been identified and assessed (Section 7):

- Compaction of watercourse soils
- Flow, sedimentation and erosion in watercourses due to infrastructure construction
- Loss of watercourse habitat due to infrastructure construction
- Low water quality inflows into watercourses
- Encroachment of alien species into watercourses

None of the assessed impacts have a High significance after mitigation for any of the assessed project phases (Section 7).

The proposed power line development is not considered to contain any fatal flaws in terms of watercourses that were assessed in this report, provided that recommendations and impact mitigation measures provided in this report are implemented (also refer to Section 7 in this regard). There is therefore no objection to the project from a watercourse perspective given the above conditions.

The following additional recommendations have been made with regards to expected project-related watercourse impacts (also refer to Figures 5 to 10):

- All delineated watercourses are regarded as sensitive features.
- These areas should therefore be avoided by all practical means and no construction may be undertaken in these areas without the necessary environmental authorization and adherence to mitigation measures.
- It follows, that construction impacts should be avoided or reduced as far as possible in watercourses and headwater drainage lines due to their vulnerability to erosion and potential to support rare and protected biodiversity.
- Watercourse lines and polygons that were delineated as part of this study and submitted with this report as GIS shapefiles should be used by the Eskom engineers and technical personnel to help find a best fit route alignment in the selected corridor alternative prior to the start of the EMP phase of the proposed development.
- Such a best fit would require planning input to reduce the number of watercourse crossings and the number of crossing lengths that cannot be spanned. The extent and positioning of watercourse boundaries can then be refined through a field verification process along the final alignment (EMPR Walk Down assessment).
- A summer survey is recommended for the EMP Walk Down survey in order to allow the use of the widest array of watercourse indicators, as the study area primarily overlaps with a summer rainfall area. This will enable a more accurate identification and demarcation of watercourses as defined by the NWA as more indicators will be available. It will also enable the provision of tower specific recommendations regarding watercourse impacts.
- A summer survey will also enable a more reliable assessment of 'species of conservation concern' (sensu Raimondo *et al.,* 2009), which will inform the Ecological Importance and Sensitivity (EIS) assessment of associated watercourses.
- Watercourse boundaries should be marked for the construction teams to ensure easy identification and trigger appropriate mitigation measures/actions.
- It is important to determine whether new project-related infrastructure structures in watercourses will be permanent or temporary. Water Use License requirements for permanent structures, such as road crossings, are expected to require more thorough mitigation compared to temporary watercourse road crossing structures.
- The creation of new watercourse road crossings should be kept to the absolute minimum by giving preference to the use of existing access roads and vehicle tracks.
- Monitoring is recommended along sediment control structures and road crossings in and through watercourse crossings during the construction phase. Vehicle tracks / roads that have been created for access and maintenance in watercourses should be monitored for erosion and blockages during the operational phase of the project.
- More detailed watercourse impact mitigation measures are provided for impacts assessed in Section 7.

9. REFERENCES

Brinson M. 1993. A hydro-geomorphic classification for wetlands. Wetland Research Programme Technical Report WRP-DE-4. US Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

City of Johannesburg (COJ). 2008. Wetland Audit for the City of Johannesburg, Draft Report. Wetland Consulting Services, Pretoria.

Department of Water Affairs and Forestry (DWAF). 1999a. Habitat Integrity Assessment Method for River Ecosystems.

Department of Water Affairs and Forestry (DWAF). 1999b. Resource Directed Measures for Protection of Water Resources. Wetland Ecosystems. Version 1.0, September 1999.

Department of Water Affairs and Forestry (DWAF). 1999c. R7: Assessment of Ecological Importance and Sensitivity. Resource Directed Measures for Protection of Water Resources: River Ecosystems Version 1.0. Institute for Water Quality Studies, Department of Water Affairs and Forestry, Pretoria, South Africa

Department of Water Affairs and Forestry (DWAF). 2005. A practical field procedure for identification and delineation of wetland and riparian areas. DWAF, Pretoria.

Department of Water Affairs and Forestry (DWAF). 2007. Manual for the assessment of a Wetland Index of Habitat Integrity for South African floodplain and channelled valley bottom wetland types by M. Rountree (ed); C.P. Todd, C. J. Kleynhans, A. L. Batchelor, M. D. Louw, D. Kotze, D. Walters, S. Schroeder, P. Illgner, M. Uys. and G.C. Marneweck. Report no. N/0000/00/WEI/0407. Resource Quality Services, Department of Water Affairs and Forestry, Pretoria, South Africa.

Department of Water Affairs and Forestry (DWAF). 2008. Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas, prepared by M. Rountree, A. L. Batchelor, J. MacKenzie and D. Hoare. Report no. XXXXXXXXX. Stream Flow Reduction Activities, Department of Water Affairs and Forestry, Pretoria, South Africa.

Department of Water Affairs and Forestry (DWAF). 2009. Government Gazette No. 32805. Impeding or Diverting the Flow of Water in a Watercourse [Section 21(c)] and Altering the Bed, Banks, Course or Characteristics of a Watercourse [Section 21(i)]. Pp66-71, Pretoria.

Department of Water and Sanitation (DWS). 2015. PES, EI and ES Scores for sub-quaternary catchments in Secondary Catchment A2. Pretoria, South Africa.

Dodds W.K. & Oaks R.M. 2008. Headwater influences on downstream water quality. Environmental Management 41:367–377.

GeoTerraImage (GTI), 2015. 2013 - 2014 South African National Land Cover Dataset version 05. DEA Open Access. Obtained from: https://www.environment.gov.za/mapsgraphics.

Gomi, T., Sidl, R.C., Richardson, J.S. 2002. Understanding processes and downstream linkages of headwater systems. BioScience, 52, 10, 905-916.

Graf, W.L. 1988. Definition of flood plains along arid-region rivers. In Flood geomorphology, ed. V. Baker, R.C. Kockel, and P.C. Patton. New York: John Wiley and Sons.

Kleynhans, CJ, Thirion, C and Moolman, J. 2005. A Level I River Ecoregion classification System for South Africa, Lesotho and Swaziland. Report No. N/0000/00/REQ0104. Resource Quality Services, Department of Water Affairs and Forestry, Pretoria, South Africa.

Lichvar, R., Finnegan, D.C. & Ericsson, M.P. 2004. Using hydrogeomorphic surfaces for delineating floodplains: Black Water Creek test reach within the upper Puerco watershed, Navajo nation. Hanover, NH: U.S. Army Engineer Research and Development Center.

Lichvar, R.W. &Wakeley, J.S. 2004. Review of ordinary high water mark indicators for delineating arid streams in the southwestern United States. ERDC TR-04-1. Hanover, NH: U.S. Army Engineer Research and Development Center.

Levick, L., Fonseca, J, Goodrich, D., Hernandez, M., Semmens, D., Stromberg, J., Leidy, R., Scianni, M., Guertin, D.P., Tluczek, M. &Kepner, W. 2008.The Ecological and Hydrological Significance of Ephemeral and Intermittent Streams in the Arid and Semi-arid American Southwest.U.S. Environmental Protection Agency and USDA/ARS Southwest Watershed Research Center, EPA/600/R-08/134, ARS/233046.

Macfarlane D.M, Kotze D, Walters D, Ellery W, KoopmanV, Goodman P, and Goge C. 2007. WET-Health: A Technique for Rapidly Assessing Wetland Health. Unpublished draft report submitted to the Water Research Commission, Pretoria.

Meyer, J.L. & Wallace, J.B. 2001.Lost linkages and lotic ecology: Rediscovering small streams. Pages 295–317 in Press MC, Huntly, N.J. & Levin S, (eds). Ecology: Achievement and Challenge. Oxford (United Kingdom): Blackwell Scientific.

Meyer, J.L., Kaplan, L.A., Newbold, D., Strayer, D.L., Woltemade, C.J., Zedler, J.B., Beilfuss, R., Carpenter, Q., Semlitsch, R., Watzin, M.C. and Zedler, P.H. undated. Where rivers are born: the scientific imperative for defending small streams and wetlands. Factsheet. Sierra Club and American Rivers.

Middleton B.J. & Bailey A.K. (2008). Water Resources of South Africa, 2005 Study (WR2005). Water Research Commission (WRC) Report TT380/08, Pretoria.

Mucina, L. & Rutherford, M.C. (eds). 2006. The vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19, South African National Biodiversity Institute, Pretoria.

Nel, J.L., Driver, A., Strydom, W.F., Maherry, A., Petersen, C., Hill, L., Roux, D.J., Nienaber, S., van Deventer, H., Swartz, E., & Smith-Adao, L.B. 2011. Atlas of Freshwater Ecosystem Priority Areas in South Africa: Maps to support sustainable development of water resources. WRC Report No. TT 500/11.

Noble, C. V., Martel, D. J., &Wakeley, J. S. 2005. A national survey of potential wetland hydrology regional indicators, WRAP Technical Notes Collection (ERDC TNWRAP- 05-1). U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Rountree, M.W., Malan, H. & Weston, B. (Editors). 2013. Manual for the Rapid Ecological Reserve Determination of inland wetlands (Version 2.0). Joint Department of Water Affairs/Water Research Commission study. Pretoria.

APPENDIX A: OVERVIEW OF HEADWATER DRAINAGE LINES, ARID DRAINAGE SYSTEMS AND SMALL PANS/DEPRESSIONS

Headwater drainage lines

Headwater drainage lines that only carry storm flow are located at the source of drainage line networks. They differ from downstream reaches due to a closer linkage with hillslope processes, higher temporal and spatial variation, and their need for different protection measures from land use activities (Gomi et al. 2002). These drainage lines are never or very seldom in connection with the zone of saturation and they consequently never have base flow and are unlikely to support wetland conditions.

Headwater drainage lines can contain discontinuous channels due to lower annual rainfall, longer rainfall intervals, and low runoff versus infiltration ratio due to greater transmission losses (Lichvar et al., 2004). Discontinuous channels are more common on low gradient topographies (e.g. basins and plains) in arid and semi-arid environments, with deeper substrates that result in lower energy fluctuations and greater water recharge into the surrounding soils during flow events. Headwater systems form part of a continuum between hillslopes and stream channels, which can be classified into four topographic units (Gomi et al. 2002):

- Hillslopes have divergent or straight contour lines with no channelised flow.
- Zero-order basins have convergent contour lines and form unchannelised hollows.
- Transitional channels (temporary or ephemeral channels) can have defined channel banks, as well as discontinuous channel segments along their length, and emerge out of zero-order basin. They form the headmost definable portion of the drainage line network (first-order channels) and can have either ephemeral or intermittent flow.
- Well defined first and second-order streams that are continuous with either intermittent or perennial flow.

Most detailed topographic maps do not include the majority of headwater channels that might be recorded during field inventories (Meyer & Wallace 2001), while their demarcation is also dependant on the scale of maps used (Gomi et al. 2002). Indistinct and discontinuous headwater drainage lines (i.e. transitional channels) should not be overlooked as they provide important functions that include:

- The role and functions of headwater streams within catchments and their linkages with downstream aquatic systems are not thoroughly understood (Gomi et al. 2002). Recent research, however, ascribes increasing importance to these systems regarding catchment and water resource management (Berner et al. 2008).
- The value of headwater functions is normally underestimated due to their inconspicuous nature and numerous occurrences (high density) in the drainage network (Gomi et al. 2002; Berner et al. 2008).
- Headwater drainage lines are important systems for nutrient dynamics as a link between hillslopes and downstream watercourses (Gomi et al. 2002).
- They are directly linked to downstream aquatic systems and have a direct bearing on the health and functioning of larger aquatic systems, especially regarding water quality of downstream aquatic systems (Gomi et al. 2002; Dodds & Oaks 2008).
- The large spatial extent of headwater channels in the total catchment area make these systems important sources of sediment, water, nutrients and organic matter for downstream systems (Gomi et al., 2002).

Arid drainage lines

Arid ephemeral streams are also referred to as **Washes** or ***Wadis*** in Arabia, ***Arroyos*** in Spanish, and ***Laagtes*** in Afrikaans. Laagtes are typically discontinuous channels on a flat topography in dry environments. Washes that lack distinct channel features do often display braided channel configuration referred to as *bar and swale* topography. Discontinuous streams can also display a stream pattern characterized by alternating erosional and depositional reaches. Some definitions of an arroyo specifically refer to an entrenched arid ephemeral stream with vertical walls (Lichvar & Wakeley, 2004). This definition of an arroyo is consistent with definitions of a gully or *donga* in South Africa. Ephemeral streams imply that the watercourse only flows briefly in direct response to rainfall in its immediate vicinity and that the channel is at all times isolated from groundwater inputs (Levick et al., 2008).

Extracts in italics were taken from a review article by Lichvar & Wakeley (2004) with related references (own comments are provided in brackets). Information presented here is intended to provide an overview of arid rivers and streams (drainage lines) based on international understanding:

Arid drainage lines can typically include discontinuous, ephemeral, compound, alluvial fan, anastomosing, and single-threaded channels, which vary due to a range of gradients (slopes), sediment sizes, and volumes and rates of discharge. Discontinuous ephemeral stream systems and alluvial fans are most prevalent in, but not restricted to, piedmont settings, while compound channels, anastomosing rivers, and single-thread channels with adjacent floodplains generally occupy the valley bottoms. Ephemeral and intermittent streams are the dominant stream types (drainage lines) in the arid south-western United States (they are expected to also dominate the drainage network in other arid environments). For example, in Arizona most of the stream networks—96% by length—are classified as ephemeral or intermittent (Beven &Kirby 1993).

The "master variable" responsible for shaping a drainage line is associated with the flow regime of the system, which includes variations and patterns in surface flow magnitude, frequency, duration, and timing (Poff et al., 1997). It follows that the size and shape of a drainage line channel is controlled in large part by the dominant discharge in a particular region (Lichvar & Wakeley, 2004). Fluvial morphology is frequently associated with extreme discharge events; streams and floodplains trap sediments and nutrients in addition to attenuating flood waters (Graf 1988; Leopold 1994).

Arid-land fluvial systems are critically important environments that provide valuable ecological benefits. Arid drainage lines provide inter alia the following ecosystem services (Brinson et al., 1981; Davis et al. 1996; Meyer et al. 2003).:

- Convey floodwaters.
- Help ameliorate flood damage.
- Maintain water quality and quantity.
- Provide habitat for plants, aquatic organisms, and wildlife; and determine the physical characteristics and biological productivity of downstream environments.

Limited research had been undertaken on ephemeral and intermittent arid drainage lines in South Africa, particularly systems that are characterized by indistinct or discontinuous channels. No guideline document or other local documentation exist that specifically addresses the identification and delineation of these arid and often unchannelled drainage lines as riparian habitat. Riparian vegetation patterns and processes associated with intermitted rivers and pans in arid environments in Bushmanland are "of the least studied in the country" (Mucina & Rutherford, 2006). International literature do described these arid drainage lines as sensitive landscape features (Lichvar & Wakeley, 2004):

- *"Arid-region drainage line channels, especially those with sandy banks, are often very responsive to large flows and recover slowly from them because of the limited vegetation growth and the large inter-annual variability in peak discharges (Cooke et al. 1993, Tooth 2000).*"
- "*Nonexistent or poor armoring of ephemeral stream beds (Reid & Laronne 1995) increases the sensitivity of the river channel to a range of flow events and hinders the ability of the river to "hold" any one pattern. Consequently, desert rivers are often in a perpetual state of change—working to recover from a large flood but unable to "heal" completely before the next extreme event widens the channel and renews the process (Cooke et al. 1993, Tooth and Nanson 2000a).*"
- "*Smaller drainage basins have a greater sensitivity to large floods, especially in arid climates, where stream widths remain largely unchanged for drainage areas exceeding 50 km^2 due to transmission losses (Wolman and Gerson 1978).*"
- "*Arid drainage lines display a high sensitivity to change and rarely reach a state of equilibrium (Graf 1988a, Tooth and Nanson 2000a)."*

Small and isolated wetlands such as endorheic pans/depressions

- "Ecologists describe the value of small isolated wetlands by their aggregate role in protecting wetland-dependent species through "source-sink dynamics". More variable than larger wetlands, each small wetland in an area may fluctuate in the number of individuals of a species it contains; at times a wetland may act as a "sink" when the population of a species dies out locally from that wetland, or it may be a "source" that produces surplus individuals, which can colonize a nearby sink wetland. Populations of a species that are spread over a number of locations are referred to as "metapopulations", and this source-sink dynamic is crucial to the regional survival of species. A metapopulation of a wetland-dependent species depends on the abundance and proximity of wetlands, rather than a critical size threshold. The disappearance of small wetlands from an area that relies on source-sink dynamics could result in the loss of ecological connectedness and potentially collapse the metapopulations of wetland-dependent species, causing many local extinctions." (Semlitsch, 2000).
- "To protect ecological connectedness and source-sink dynamics of species populations, wetland regulations should focus not just on size but also on local and regional wetland distribution. At the very least, wetland regulations should protect wetlands as small as 0.2 hectares – the lower limit of detection by most remote sensing – until additional data are available to directly compare diversity across a range of wetland sizes." (Semlitsch, 2000).

Limited research had been done on ephemeral and headwater watercourses in South Africa, particularly drainage systems that are characterized by indistinct or discontinuous channels in arid to semi-arid regions. No guideline document or other local documentation exists that describes how these arid and often unchannelled drainage systems fit into definitions of what constitutes a watercourses, as defined by the NWA. Their protection status as defined in the NWA is often uncertain, as these systems are not expected to always be consistent with the act's definitions and specialists' interpretations of watercourses. Consequently the value and conservation importance of these systems are motivated based on international literature. A conservative approach is recommended to be followed during the EIA and other phase of the project (e.g. the EMPr Walk Down phase), which strives to incorporate all portions of the drainage network that is present in the investigated study area.

APPENDIX B: CURRICULUM VITAE

Name:	Lourens Erasmus Retief Grobler
Name of Firm:	Imperata Consulting CC
Position:	Wetland Ecologist
Nationality:	South African
Languages:	Afrikaans (mother tongue), English

EDUCATIONAL QUALIFICATIONS

- BSc (Botany), University of Pretoria (1999–2001)
- BSc Hons (Botany) (cum laude), University of Pretoria (2004)

  Title of Thesis: "*The Impact of subsistence banana (Musa x paradisiaca) farming on the vegetation of peat swamp forest surrounding the Kosi Bay Lake System.*"
- MSc Botany (cum laude), University of Pretoria (2009)

  Title of Thesis: "*Phytosociology of Peat Swamp Forests of the Kosi Bay Lake System.*"

KEY QUALIFICATIONS

▸ **Watercourse Investigations, Including Wetland and Riparian Habitat Delineation (Mapping), Assessments, Management & Rehabilitation**:

Involved in wetland inventories, classification and description of watercourses, mapping of drainage lines (e.g. wetlands, rivers and ephemeral headwaters), ecological assessments, and wetland rehabilitation studies. A selection of projects demonstrating relevant experience, include:

Wetland rehabilitation

- Wetland rehabilitation assessment plans for the South African National Biodiversity Institute (SANBI) for several wetlands in the Eastern Free State. 2005.
- Wetland health and rehabilitation assessments for the Gauteng Province, as part of the Working for Wetlands Project under the auspices of the South African National Biodiversity Institute (SANBI). Wetland Ecologist and sub-consultant to Land Resources International (Pty) Ltd. 2007-2009.
- Wetland health and rehabilitation assessments for the Gauteng Province, as part of the Working for Wetlands Project under the auspices of the South African National Biodiversity Institute (SANBI). Wetland Ecologist sub-consultant to Aurecon South Africa (Pty) Ltd. 2010-2011
- Wetland health and rehabilitation assessments for two wetland rehabilitation projects, upstream of Boksburg Lake, Ekurhuleni Metropolitan Municipality, Gauteng. Wetland Ecologist and sub-consultant to Land Resources International (Pty) Ltd. 2011

- Wetland rehabilitation and assessment report for the Hogsback area (Eastern Cape Province), as part of the Working for Wetlands Project under the auspices of the South African National Biodiversity Institute (SANBI). Wetland Ecologist sub-consultant to Aurecon South Africa (Pty) Ltd. 2011
- Wetland & river reinstatement and monitoring guideline report for the New Multi Product Pipeline (NMPP) Project, Trunkline Section (Jameson Park, Gauteng to Durban, KwaZulu-Natal). Transnet Capital Projects. 2010
- Alien plant control in watercourse crossings (wetlands & rivers) report for the New Multi Product Pipeline (NMPP) Project, Trunkline Section (Jameson Park, Gauteng to Durban, KwaZulu-Natal). Transnet Capital Projects. 2012

Wetland studies for a variety of strategic planning, residential, commercial and industrial projects

- Ecological functional assessment of wetland areas surrounding the Orlando Power Station for the proposed Ekhaya development, Soweto, Gauteng. Strategic Environmental Focus (SEF), (Pty) Ltd 2005.
- Wetland Audit for the City of Johannesburg. Reviewer and sub-consultant for Strategic Environmental Focus (SEF), (Pty) Ltd. 2008
- Elsburgspruit wetland and habitat assessment, Ekurhuleni Metropolitan Municipality, Gauteng Province. Sub-consultant for Van Riet & Louw Landscape Architects (Pty) Ltd. 2008
- Wetland and watercourse delineation and assessment for the proposed Sun City Vacation Club and Golf Course Phase 3 Development, North West Province. EkoInfo CC. 2008
- Wetland delineation & assessment study for the proposed construction and operation of an aluminium fluoride production facility and associated infrastructure on the farm Jobarne 489 JR, Ekandustria, Gauteng Province. African Geo-Environmental Services (AGES). 2010
- Development of a prioritisation framework for wetland rehabilitation in Ekurhuleni Metropolitan Municipality. Land Resources International (Pty) Ltd. 2011
- Surface watercourse and wetland desktop investigation for the Ivory Park Urban Development Framework, City of Johannesburg, Gauteng Province. Aurecon Group. 2011
- Wetland Study (Delineation & Assessment) for the proposed Witfontein Commercial & Residential Development, Ekurhuleni Metropolitan Municipality, Gauteng Province. Aurecon Group. 2011

Wetland & watercourse assessments in linear developments (power lines, roads, railway. and pipeline projects) and other projects in the energy sector (e.g. solar electricity installations):

- Wetland investigation for The Hills road alternatives, Pretoria-East, Gauteng. African-EPA. 2007
- Wetland and river bio-monitoring assessments for the New Multi Product Pipeline (NMPP) Project, Trunkline Section (Jameson Park, Gauteng to Durban, KwaZulu-Natal). Transnet Capital Projects. 2009-2013
- Wetland and surface watercourse study for the proposed Ariadne-Venus 475 kV transmission line, Kwa-Zulu Natal. Baagi Environmental Consultancy. 2010
- Surface watercourse assessment study for the proposed R5 Rand Water pipeline between Rietvlei N.R. and Mamelodi, Gauteng. Aurecon Group. 2010
- Wetland and surface watercourse study for the proposed Paulputs-Aggeneys 220kV transmission line, Northern Cape. SSI Engineers and Environmental Consultants. 2011

- Surface watercourse investigation for a proposed 20MW solar electricity installation at Kalgold Mine, North West Province. Mark Wood Consultants. 2011
- Wetland and surface watercourse study for the proposed Arnot-Ginaledi 475 kV transmission line, Mpumalanga Province. Baagi Environmental Consultancy. 2012
- Watercourse investigation for the proposed upgrade of a section of the N4 Platinum Highway, Rustenburg, North West Province. Environamic. 2012.
- Wetland delineation review for the proposed 80 MW photovoltaic solar electricity installation, Grootvlei, Mpumalanga Province. Mark Wood Consultants. 2012
- Wetland and watercourse assessment study for a proposed 75MW Photovoltiac (PV) plant and associated infrastructure on a portion of the remaining extent of Erf 1, Prieska Northern Cape Province. Enviro Insight. 2012
- Water Use License application & watercourse assessment for permanent access roads on Section PL1-PL4 (Durban to Kendal) of Transnet's New Multi Product Pipeline (NMPP) Project. Transnet Capital Projects. 2012-2014
- Watercourse assessments for the Ngqura 16 MTPA manganese ore rail expansion: Area 1 & 3 (Coega – De Aar; Eastern & Northern Cape). Hatch South Africa. 2013
- Watercourse assessment for the Douglas-Hopetown road upgrade project, Northern Cape. EIMS. 2013.
- Specialist Wetland & Drainage Line Investigation for the Proposed Hermes 132 kV Distribution Line and Substation, Klerksdorp, North West Province. Envirolution Consulting. 2013
- Specialist Medupi-Borutho 400 kV Power Line Environmental Management Plan (EMP) – Watercourses & Drainage Lines. North West Province. Baagi Environmental Consultancy. 2013.
- Specialist Gromis-Orangemund 400 kV Power Line Environmental Management Plan (EMP) – Watercourses & Drainage Systems, Northern Cape Province. Baagi Environmental Consultancy. 2013
- Watercourse delineation, PES & EIS assessment specialist study for a Water Use License Application for 8 proposed distribution lines around Ngwedi MTS, SA Chrome, Boschkoppie, Impofu Substation, Styldrift, Bakubung, Ledig, Sun City, Mokwase Industries, and Manyane Substations, North West Province. Baagi Environmental Consultancy. 2014
- Environmental Impact Assessment for the Sasol PSA and LPG Project: Botanical Biodiversity and Terrestrial and Wetland Habitat. Specialist Report, Inhassoro, Mozambique. In collaboration with De Castro & Brits C.C. for Mark Wood Consultants on behalf of SASOL. 2014.
- Specialist Watercourse and Wetland Study For the Proposed 500kV Nzhelele to Triangle Eskom Powerline Project (RSA Section Only) EIA Project, Limpopo Province. Baagi Environmental Consultancy. 2014

Green Star eco-conditional office development assessments:

- Green Star eco-conditional office assessment for the Lynnwood Bridge retail phase 2 development, Gauteng. Aurecon Group. 2011
- Green Star eco-conditional office assessment for the GCIS Hatfield head office development, Gauteng. Aurecon Group. 2012
- Green Star eco-conditional office assessment for the USAID expansion development, Gauteng. Aurecon Group. 2012

- Green Star eco-conditional office assessment for the Atrium on 5th development, Gauteng. Aurecon Group. 2012
- Green Star eco-conditional office assessment for the Lynnwood Bridge retail phase 3 development, Gauteng. Aurecon Group. 2013
- Green Star eco-conditional office assessment for the Athol Towers development, Gauteng. Aurecon Group. 2013

Wetlands and surface watercourse assessments for mining-related developments:

- Wetland and drainage line watercourse study for a proposed Fluorspar Mine in Dinokeng, Gauteng Province. African Geo-Environmental Services (AGES), (Pty) Ltd. 2009.
- Wetland assessment study for the proposed Northern Coal Colliery near Breyton, Mpumalanga Province. Terra Soil Science. 2010.
- Desktop wetland & watercourse assessment for Harmony Gold's Kusasalethu Mine as part of their ISO 14000 environmental management certification, North West Province. DD Science. 2012.
- Watercourse assessment for a water re-use and reclamation project at Mponeng Mine, North West Province, De Castro & Brits Ecological Consultants. 2013

- **Additional Wetland Related Training:**

  - Attended a two-day DWAF (DWA) facilitated wetland training course on the Wetland Index of Habitat Integrity assessment technique (Wetland IHI methodology) presented by Mark Rountree, June 2009.

- **Training - Course Lecturer :**

  - Co-lecturer and founding member of an Introductory Wetland Training Course, presented by the Department of Botany (University of Pretoria) through the University's Continued Education at UP (CE@UP) program, and the Gauteng Department of Agriculture, Conservation and Environment (GDACE). Aspects focused on include the legislation, delineation, drivers and ecology, assessments, management and rehabilitation of wetlands. This course was started in November 2004 and presented since then on September 2005, November 2005, May 2006, July 2007, May 2008, May 2010, and May 2012.

- **Publications:**

  - Grobler, R., Bredenkamp, G. & Grundling, P-L. 2004. Subsistence farming and conservation constrains in coastal peat swamp forests of the Kosi Bay Lake System, Maputaland, South Africa. Géocarrefour 79: 4.
  - Grundling, P-L. & Grobler, R. 2005. Peatlands and mires of South Africa. In: Steiner, G.M. (ed.) Mires from Siberia to Tierra Del Fuego. Stapfia 85, Landesmuseen Neue Serie 35, pp. 379-396.
  - Sliva J., Grundling P-L., Kotze D., Ellery F., Moning C., Grobler R., Taylor P.B. (2005). *MAPUTALAND – Wise Use Management in Coastal Peatland Swamp Forests in Maputaland, Mozambique / South Africa.* Wetlands International, Project No: WGP2 – 36 GPI 56.

MEMBERSHIPS IN PROFESSIONAL AND GENERAL SOCIETY

- **<u>Professional Society</u>**
  - Pr. Sci. Nat (Professional Natural Scientist) in the fields of Botanical and Ecological Science (Registration No. 400097/09).
  - Please refer to the SACNASP website to undertake a search of their registered scientists in order to authenticate that Mr. LER Grobler is registered SACNASP member and is registered for the two fields indicated. Searches can be done according to employer (Imperata Consulting) or other criteria provided in this document.

    http://www.sacnaspregister.co.za/search/

- **<u>General Society</u>**
  - International Mire Conservation Group (IMCG), since 2003.
  - Gauteng Wetland Forum (GWF), since 2006.
  - South African Wetland Society (SAWS), since 2007.

EMPLOYMENT EXPERIENCE

- **<u>Wetland Ecologist and Project Manager: Imperata Consulting</u>** <u>(March 2007 – Present) Tasks include:</u>
  - Wetland and riparian habitat delineation according to the DWAF (2005) prescribed delineation guideline, as well as the demarcation of other drainage line types (e.g. headwater streams or A Section Channels)
  - Wetland Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) assessments.
  - Ecosystem assessments based on phytosociological investigations (vegetation unit identification, description, and assessment), as well as associated mapping and sensitivity rating of vegetation assemblages.
  - Inventory, classification and mapping of wetland ecosystems.
  - Wetland rehabilitation and monitoring.
  - Wetland management and recommendation of impact mitigation measures.
  - Environmental risk assessments related to the presence of wetland and riparian ecosystems.
  - Project management related to specialist wetland, riparian and headwater ecosystem investigations.

- **<u>Wetland Ecologist: SEF</u>** <u>(January 2006 – February 2007) Tasks included:</u>
  - Wetland and riparian habitat delineation and wetland ecosystem functional assessments.
  - Strategic wetland assessments and mapping.

- Vegetation analysis and description, including mapping of sensitive vegetation assemblages.

- **Nature Conservator: Tshwane Nature Conservation** (July 2005 – December 2005) Tasks included:
  - General management of the ecological integrity of greenbelt areas in the eastern section of the City of Tshwane Metropolitan Municipality, including the Colbyn Valley Peatland, Faerie Glen Nature Reserve, Moreletakloof Nature Reserve, Meyerspark Bird Sanctuary, and Murrayfield Koppie.

REFERRALS

- **Mr. Tim Liversage:** NMPP Environmental Manager at Transnet Capital Projects

  Email: Timothy.Liversage@transnet.net

  Mr. Umesh Bahadur: Director: Working for Wetlands at the Department of Environmental Affairs (DEA)

  Email: Ubahadur@environment.gov.za

  Office: 012 399 8980

- **Mr. Piet-Louis Grundling:** Independent Wetland Consultant and Researcher, as well as Chair of the South African Wetland Society (SAWS) and the International Mire Conservation Group (IMCG).

  Email: peatland@mweb.co.za