Scoping and Environmental Impact Assessment (S&EIA) for a 300 MW Solar PV facility in the Northern Cape.

An updated Aquatic Biodiversity Assessment & Risk Assessment

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Executive summary

The objective of this project is related to the scope of the Part 2 amendment for De Aar Phase 1. In this report the Aquatic Biodiversity Assessment and Risk Assessment will be updated to accommodate the following changes:

- The size of the MTS sub-station has been increased and shifted (to accommodate the additional inputs from Phases 2 & 3).
- The sub-station capacity has increased, as well as the size and weight of the transformers etc. which can no longer be transported over the Transnet railway line.
- Accordingly, an alternative access route has been suggested which uses existing roads, which will require some upgrades, including placing of gravel, largely across the watercourse, to better accommodate heavy vehicles.
- This road will link a new “Staging Area” – where equipment will be offloaded from large trucks onto smaller trucks, for transfer to the sub-station footprint.
- The construction of a sub-station will not be feasible within one dry season, so improvements to the road surface may impede instream flow during the wet season.

The main water feature in the area is the Brak River, a seasonal tributary within the Orange River System. The De Aar 300 MW Solar PV facility project area has no permanent perennial water source although in favourable seasons the Brak River may flow. At the time of the field visit in October 2017 and April 2022, the river had no water in the system and therefore was not suited to an assessment of water quality or aquatic biota present.

The PES of the Project Area was evaluated as a Category D, meaning that it is Largely modified. The following parameters were instrumental to establish the PES:

Parameter	Score %	Category	Description
In-stream IHI	78.8	B/C	Largely natural with few modifications
Riparian IHI	68.8	C	Moderate change
VEGRAI (Vegetation)	80.2	B/C	Largely natural with few modifications
MIRAI (Macro-invertebrates)		D	Low diversity
FRAI (Fish)		D	Low diversity
Mean Ecological Importance Class			Moderate
mean Ecological Sensitivity Class			Moderate
EcoStatus	72.5	C	Moderately modified
PES		D	Largely modified

In the study area, the entire sub-quaternary catchment of the Brak River has been identified as being a Freshwater Ecosystem Protected Area (FEPA). This means that the sub-quaternary catchment with surrounding land and smaller stream network need to be managed in a such way that maintains the good condition (A or B ecological category) of the river reach.

The Risk Assessment was done in accordance with the Risk Matrix and was carried out considering the risk rating of the project. The main activities listed were:

- Upgrading of existing roads for heavy vehicles.
- Upgrading the river crossing by the placing of gravel across the watercourse.
- Area of disturbance and human interference.
- Impacts of the powerline.
- Construction of Staging Area, sub-stations and transformers.
- Alien invasive plants.

The following risks have been identified to potentially impact on the receiving environment:

  - Upgrading of existing roads for heavy vehicles.
  - Upgrading the river crossing by the placing of gravel across the watercourse.
  - Area of disturbance and human interference.
  - Impacts of the powerline.
  - Construction of Staging Area, sub-stations and transformers.
  - Alien invasive plants

All the expected impacts were assessed and all were confirmed to be "Low" or mitigated to attain a "Low" risk level. By implementing all the mitigation measures and managing the system on a continuous basis as prescribed by the Risk Assessment, all the impacts will be addressed to a satisfactory level. Therefore, it is proposed that the project should be authorised with the provision that the mitigation measures prescribed in this document, where applicable, are included in the EMPr

It is predicted that the project construction and future operation, will not degrade the system any further, which is already in a Class D (Largely Modified).

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Abbreviations

°C	Degrees Celsius
BGIS	Biodiversity Geographic Information System
CBA	Critical Biodiversity Areas
DWA	Department of Water Affairs (post-2010)
DWAF	Department of Water Affairs and Forestry (pre-2010)
DWS	Department of Water and Sanitation (since May 2014))
EC	Ecological Category
Ecoclassification	Ecological classification
EcoStatus	Ecological Status
EI	Ecological Importance
EIA	Environmental Impact Assessment
EIAr	Environmental Impact Assessment report
EIR	Environmental Impact Report
EIS	Ecological Importance and Sensitivity
ELU	Existing lawful use
EOO	Extent of occurrence
ESA	Ecological Support Area
ES	Ecological Sensitivity
ESKOM	Electricity Supply Commission
EWRM	Environmental Water Resource Monitoring
FEPA	Freshwater Ecosystem Priority Areas
FRAI	Fish Response Assessment Index
GA	General Authorization
HCR	Habitat Cover Ratings
HQI	Habitat Quality Index
IHAS	Integrated Habitat Assessment System
IHI	Index of Habitat Integrity
IIHI	Instream Index of Habitat Integrity
ISP	Internal Strategic Perspective
km	Kilometre
LUDS	Land-Use Decision Support Tool
m	Meter
m^3	Cubic metre
MCDA	Multi Criteria Decision Analysis
mg/l	Milligrams per litre
mS/m	milliSiemens per metre
MTS	Main Transmission Station
MW	Megawatt
NAEHMP	National Aquatic Ecosystem Health Monitoring Programme
NFEPA	National Freshwater Ecosystem Priority Areas
NWA	National Water Act
PES	Present Ecological State
PESEIS	Present Ecological State, Ecological Importance and Ecological Sensitivity
Pr. Sci. Nat	Natural Scientific Professionals
PV	Photovoltaic
RHP	River Health Programme
RIHI	Riparian Index of Habitat Integrity
RMF	Regional Maximum Flood
SACNASP	South African Council for Natural Scientific Professions
SANBI	South African National Biodiversity Institute
SASS5	South African Scoring System version 5

S&EIA	Scoping and Environmental Impact Assessment
SHI	Site Fish Habitat Integrity Index
SI	Socio-cultural Importance
SQ	Sub-quaternary
SQR	Sub-quaternary reach
VEGRAI	Riparian Vegetation Response Assessment Index
WMA	Water Management Area
WRUI	Water Resource Use Importance
yr	Year

1. Introduction

1.1 Background to the Solar Photovoltaic (PV) Plant Project

The bulk of the information related to the project description was obtained from the Environmental Impact Assessment report (EIAr): Proposed Development of a 225MW Solar PV Plant on Several Portions of Farms in the Hanover District, Emthanieni Local Municipality, Pixley Ka Seme District Municipality, Northern Cape (Ecoleges Environmental Consultants, 2017) and Deacon (2017).

Proposed activity.

The brief of this report is related to the scope of the Part 2 amendment for De Aar Phase 1. In this report the Aquatic Biodiversity Assessment and Risk Assessment will be updated to accommodate the following changes:

- The size of the MTS sub-station has been increased and shifted (to accommodate the additional inputs from Phases 2 & 3).

- The sub-station capacity has increased, as well as the size and weight of the transformers etc. which can no longer be transported over the Transnet railway line.

- Accordingly, an alternative access route has been suggested which uses existing roads, which will require some upgrades, including placing of gravel, largely across the watercourse (Figures 1 and 2), to better accommodate heavy vehicles.

- This road will link a new “Staging Area” – where equipment will be offloaded from large trucks onto smaller trucks (Figure 1), for transfer to the sub-station footprint.

- The construction of a sub-station will not be feasible within one dry season, so improvements to the road surface may impede instream flow during the wet season (Figure 2).

1.2 Project brief

Assess or reassess these developments:

- Plot all the construction aspects of the sub-stations, overhead powerlines, transformers and alternative access route.
- Compare these aspects with which have already been assessed in Phase 1.
- Assess or reassess these developments in the Risk Assessment process.

There will be no need to include the sub-stations and transformers, as these fall outside the extent of the watercourse. The emphasis is on the alternative access road and the connecting powerline from Phase 2 to Phase 1 which crosses the watercourse (Figure 3).

The Risk Assessment that was originally undertaken for Phase 1, only included the pylons connecting the “old” sub-station footprint to the existing Eskom overhead powerlines.

Figure 1 provides a map indicating the segment and affected reach/es of the watercourse in which the above-mentioned water use/s is to take place and which indicates/delineates the regulated area.

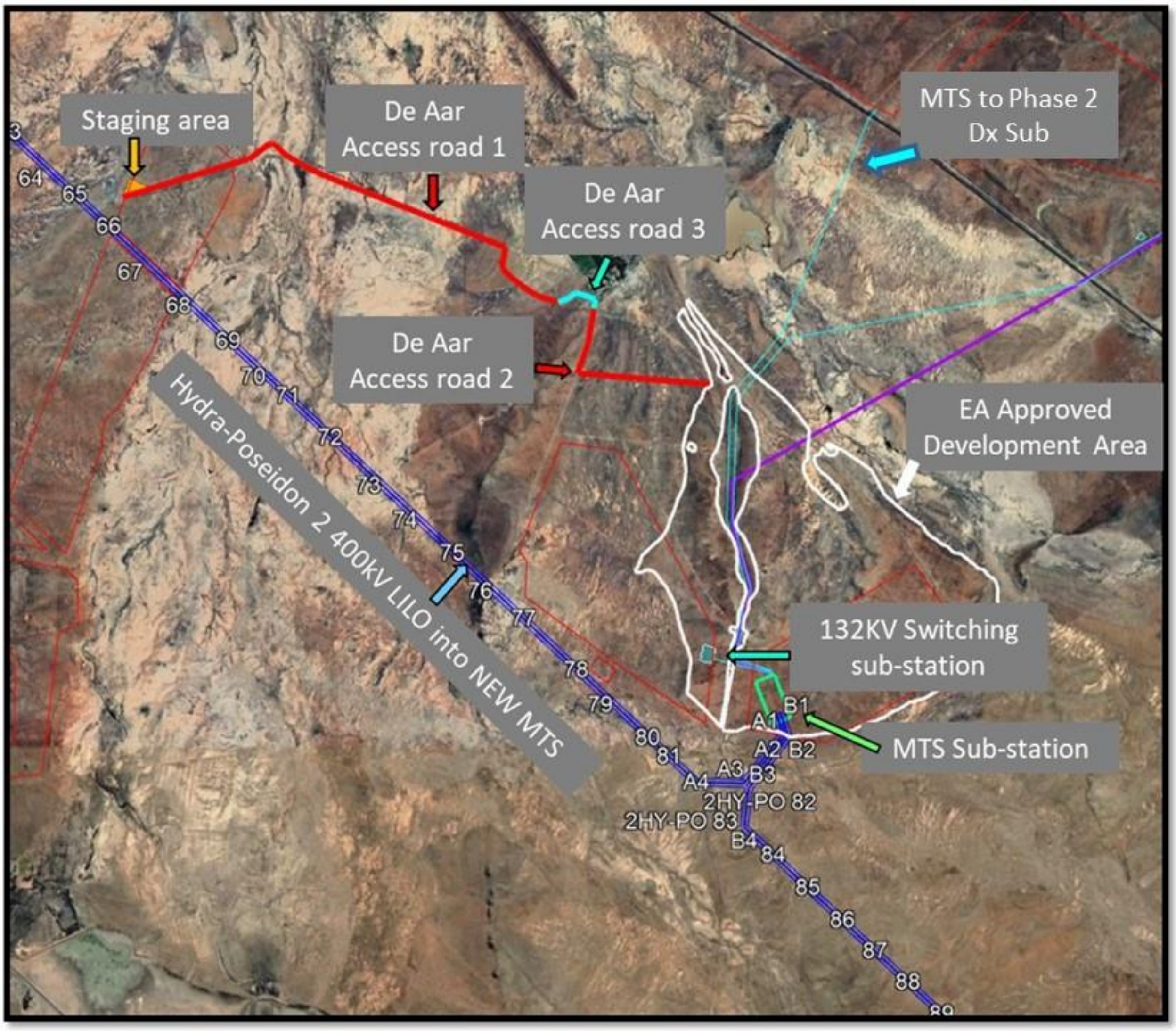


Figure 1: The location of the Brak River segment and affected reach/es of the watercourse in which the water use/s is to take place.

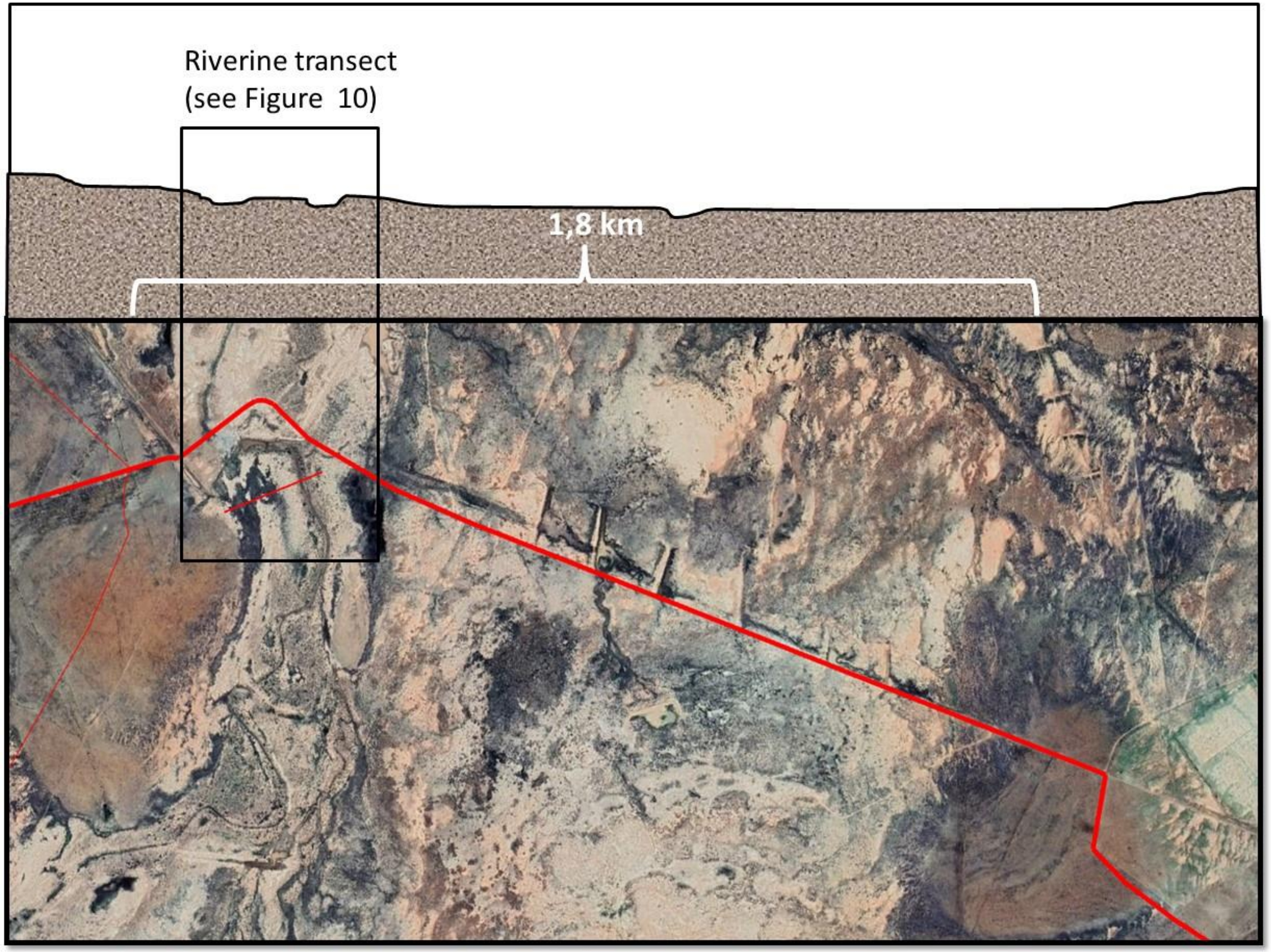


Figure 2: The location of the De Aar access road 1 crossing over the Brak River from the Staging Area connecting to the De Aar access road 3 (see Figure 10).

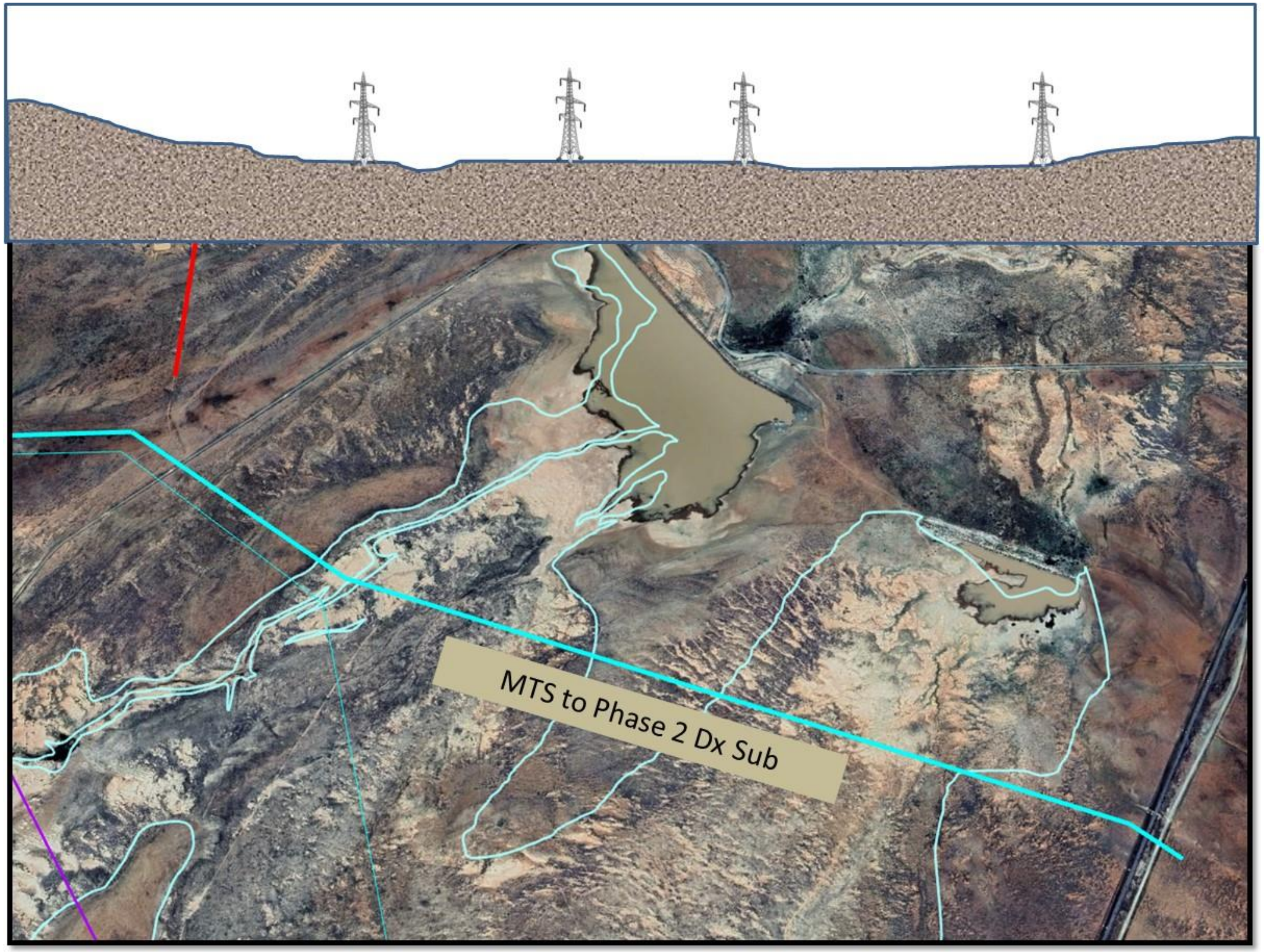


Figure 3: The location of the MTS to Phase 2 Dx sub-station crossing over the drainage area.

2. Biophysical background of the Brak River catchment

Ecoregion and River Characteristics

The study area lies near the eastern edge of the Nama Karoo biome, and is mapped according to the national vegetation types (Mucina and Rutherford, 2006) as being of the vegetation type Northern Upper Karoo (NKu 3) (Figure 4) which is considered to be least threatened. This Karoo unit is found on floristic and ecological gradients between the Nama-Karoo, arid Kalahari savanna and arid highveld grasslands.

The vegetation cover is generally dominated by sparse dwarf karroid scrub and tufted grass with bare patches of sand in between. Portions of the area are in a disturbed condition, most likely as a result of livestock grazing.

The main water feature in the area is the Brak River, a seasonal tributary within the Orange River System. The ephemeral Brak River flows in an arc from south-east to north-west, eventually feeding into the Orange River basin. The Nama Karoo is regarded as a semi-desert and precipitation, which occurs predominantly in the summer months, is unpredictable and sporadic.

The river flows to the north of the study area with a number of its tributaries crossing the area as it flows in a northerly direction. All the small tributaries in the area are ephemeral or intermittent and most are discernible only as slightly shallow depressions with no clear associated vegetation and slightly clayey soils (Figure 12c).

Intermittent rivers have a far less predictable flow regime compared to perennial or seasonal rivers, and are frequently dry for long periods in arid regions. The ephemeral tributaries of the Brak River are considered to be in a largely natural ecological state, with a low ecological importance and sensitivity.

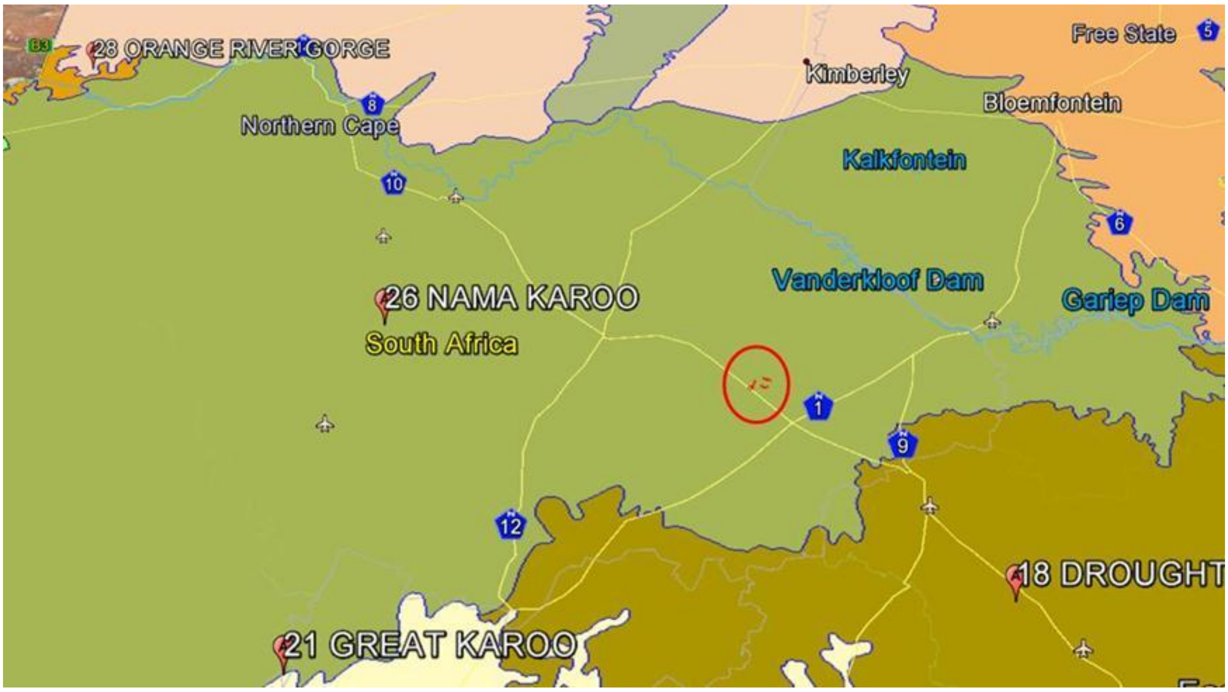


Figure 4: The position of the Project Area (red circle) in the Nama Karoo ecoregion according to the Water Resource Classification System (DWS, 2014).

The Brak River confluence with the Orange River is downstream of the Orange-Vaal confluence, and is a river which flows non-perennially from the south and is in turn fed by the Ongers River, rising in the vicinities of Hanover and Richmond respectively.

The Brak River drains shrubland vegetation in an area with a very low rainfall. As a result, the water within the river system is saline and turbid and seasonally flowing.

The fauna of the more seasonal and ephemeral ecosystems is not well known, but they have been found to provide aquatic habitat to a diverse array of faunal species that depend on brief periods of inundation for hatching, mating, feeding and refuge. For instance, many frogs of the Karoo region breed in temporary pools associated with watercourses and wetlands, this includes the Karoo Toad *Vandijkophrynus gariepensis* and Karoo Dainty Frog *Cacosternum Karooicum*.

A great number of other organisms are not confined to these temporary systems, but derive crucial benefits from them, like migratory birds and many invertebrates that migrate from permanent to temporary habitats on a regular basis.

Non-perennial (seasonal, intermittent, ephemeral and episodic) rivers are systems which place extreme stress on biota occupying them by exhibiting highly variable chemical and physical attributes. The most important of these are the unpredictable and highly variable flow patterns. These flow patterns determine the habitat available for biota such as aquatic invertebrates.

Habitat available can be diverse during flow but a very low diversity could be available during dry periods. The reduction in flow causes major habitat types (e.g., stones-in-current, marginal vegetation) to dry out and become unavailable to biota. The habitat type mostly available in temporary rivers is pools, in which invertebrates can survive the dry period and from where they can recolonise the stream as flow returns.

Climate:

The climate of the study area can be regarded as warm to hot with a summer rainfall and dry, cold winters. Temperatures vary from an average monthly maximum and minimum of 32.6ºC and 15.4ºC for January to 16.8ºC and 0.3ºC for July, respectively. Temperature ranges are large with lows of -10°C in winter to mid 40°C in summer. The long-term average annual rainfall in this region of the Northern Cape is only 289mm, of which 201 mm (70%) falls from November to April. Frost occurs most years, 30 days on average, between late May and early September.

. **Vegetation & Landscape Features:**

The area is characterised by wide open plains with relatively flat topography typical of the Central Karoo. The site is relatively flat (average slope gradient is less than 10% from the east to the west) with some isolated hills and low rocky ridges in the east and north-east of the site. There are a few shallow drainage lines present on site. The site is located at an altitude of approximately 1 300 m to 1 340 m above sea level. The shrubland is dominated by dwarf karoo shrubs, grasses and low trees.

It is evident that the Vegetation Map (Figure 4) provides an oversimplification of the vegetation of the site and there are at least three distinct vegetation types present on the site. The open plains of the site correspond with the Northern Upper Karoo vegetation type, but the dolerite hills and koppies present have vegetation more closely allied with Upper Karoo Hardeveld, while the floodplain of the Brak River is clearly characterised by an azonal vegetation type, allied with Upper Gariep Alluvial Vegetation (Ecoleges Environmental Consultants, 2017). The floodplain has however been heavily modified by human activity with a lot of diversion walls and historical disturbance present.

Along the Brak River the common reed *Phragmites australis* dominates the instream habitat, while there is very little discernible riparian vegetation. The ephemeral streams have no visible aquatic vegetation. *Phragmites australis* reeds grow in the beds of several of the ephemeral rivers.

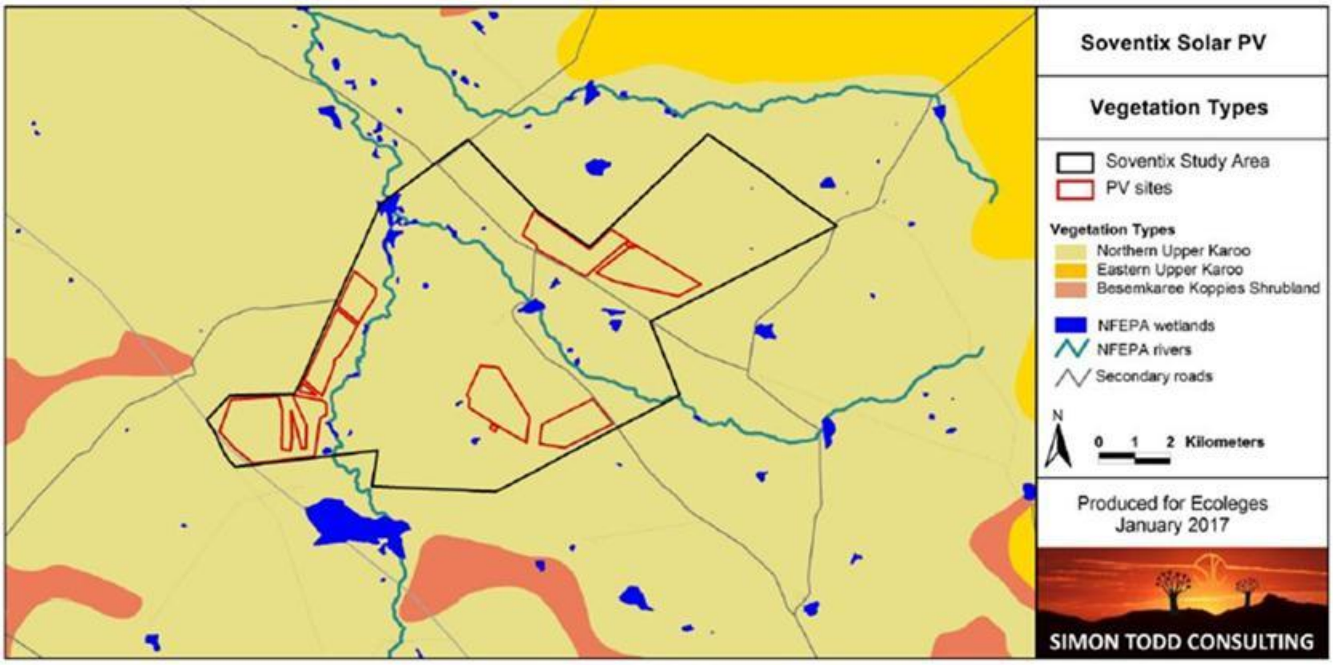


Figure 5. Broad-scale overview of the vegetation in and around the De Aar 300 MW Solar PV facility project site (Mucina & Rutherford, 2006) (Nel et al. 2011).

Geology & Soils

Shales form the underlying geology while Jurassic Karoo Dolerite silts and sheets support this vegetation complex in places. Wide stretches of *land* are covered by superficial deposits including calcretes of the Kalahari Group. Soils are variable from shallow to deep, red-yellow apedal, freely drained soils to very shallow Glenrosa and Mispah forms.

The dolerite intrusions (dykes and sills) are more resistant to weathering than the sandstones and shales, thus causing the formation of the characteristic Karoo koppies.

Conservation

This is a least threatened unit with a conservation target of 21%. None conserved in statutory conservation areas. About 4% has been cleared for cultivation (the highest proportion of any type in the Nama-Karoo) or irreversibly transformed by building of dams. Erosion is moderate (46.2%), very low (32%) and low (20%). *Prosopis glandulosa,* regarded as one of the 12 agriculturally most important invasive alien plants in South Africa, is widely distributed in this vegetation type.

3. Standard Methods proposed for the Risk Assessment and Aquatic Biodiversity Assessment Report

As partial requirement for the DWS protocol, specific biodiversity surveys were recommended by the environmental consultant. The terms included for this investigation are as follow:

- Assess the ecological status, importance and sensitivity of the site as required for section 21 (c) and (i) water uses by the Department of Water and Sanitation (DWS),

- Aquatic and riparian surveys are proposed in the riverine habitats in the vicinity of the proposed development. The objective of this survey is to provide information on the aquatic environment of the proposed development regarding the fish and macro-invertebrate integrity, integrity of the aquatic habitat and possible impacts and mitigation.

For the purposes of this report, the site was assessed during 18-22 October 2017, and again during 1-7 April 2022.

Ecological Categories

Following are additional aspects and processes that play a role in the determination of the current state (Present Ecological State or PES) of the affected reach/es of the watercourse.

a) **EcoClassification**

EcoClassification refers to the determination and categorisation of the Present Ecological State (PES) (health or integrity) of various biophysical attributes of rivers compared to the natural (or close to natural) reference condition. The purpose of EcoClassification is to gain insight into the causes and sources of the deviation of the PES of biophysical attributes from the reference condition. This provides the information needed to derive desirable and attainable future ecological objectives for the river.

The state of the river is expressed in terms of biophysical components:

- Drivers (physico-chemical, geomorphology, hydrology), which provide a particular habitat template; and
- Biological responses (fish, riparian vegetation, riverine fauna (other than fish) and aquatic invertebrates).

During recent years DWS has published the *River EcoClassification* series of methods used to determine the health of rivers and streams in South Africa. As part of this series the methods for ecological status determination and the classification of riparian and aquatic systems, is published in Module A: *EcoClassification and EcoStatus Determination* (Kleynhans *et al*, 2009). The following sections are extracted and modified (where appropriate) from the last-mentioned authors.

b) **Present Ecological State (PES)**

The PES of the river is expressed in terms of various components: That is, **drivers** (physico-chemical, geomorphology, hydrology) and **biological responses** (fish, riparian vegetation and aquatic invertebrates), as well as an integrated state, the EcoStatus. A rule-based procedure is followed to assign each component an Ecological Category for the PES (on a scale of A to F) using the following information:

- Biophysical surveys conducted during the project.
- Information and data from historical surveys, databases and reports.

- Aerial photographs and videos.
- Land-cover data.
- Internal Strategic Perspective (ISP) reports of DWS.
- Expert knowledge is regularly used to estimate the degree of change to a particular component.

Different processes are followed for each component to assign a category from A→F (where A is natural, and F is critically modified) (Table 1) (DWA, September 2013).

Table 1 Ecological Categories (ECs) and descriptions (see also Appendix 1)

EC	Description of EC
A	Unmodified, natural.
A/B	Boundary category between A and B.
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.
B/C	Boundary category between B and C.
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.
C/D	Boundary category between C and D.
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.
D/E	Boundary category between D and E.
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
E/F	Boundary category between E and F.
F	Critically / Extremely modified. Modifications have reached a critical level and the 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.

It must be emphasised that the A→F scale represents a continuum, and that the boundaries between categories are notional, artificially-defined points along the continuum. For practical purposes, these situations are referred to as boundary categories and are denoted as B/C, C/D etc. The B/C boundary category, for example, is indicated as the light green to dark-blue area in Figure 6.

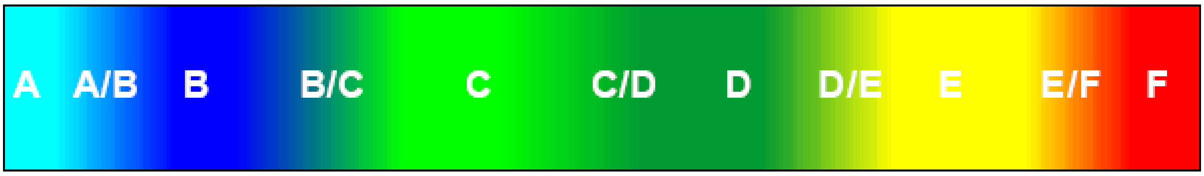


Figure 6: The continuum on an A to F scale for rating Ecological Category

The models for each component all use a swing ranking system in which key ecological components are ranked and weighted to provide consistent results.

c) **Trend**

Trend is viewed as a directional change in the attributes of the drivers and biota (as a response to drivers) at the time of the PES assessment. A trend can be absent (close to natural or in a hanged state but stable), negative (moving away from reference conditions) or positive (moving back towards natural - when alien vegetation is cleared, for instance). The ultimate objective is to determine if the biota have adapted to the current habitat template or are still in a state of flux. Generally, such an assessment can be approached from a driver perspective. This means that there can be a positive or negative trend response from the biota if the drivers (specifically geomorphology and water quality) are still in a directional state of change (+ or -).

Flow and sediment regimes at appropriate flows.

Flow and sediment regimes at appropriate flows will be obtained from existing project documents and other relevant studies, including the Environmental Impact Assessment report (EIAr) (Ecoleges Environmental Consultants, 2017).

PES supporting information

Comments summarising the activities that result in the PES were provided for the sub-quaternary (SQ). In addition, the Ecosystem Services summary as well as the Water Resource Use Importance (WRUI) summary per SQ were also utilised to identify what the impacts were and whether they were flow or non-flow (including water quality) related. This study also viewed each SQ using Google Earth™ to provide the flow and non-flow impact assessment and to identify the key PES drivers. Information was extracted in a 'master spread sheet' that incorporates all the PESEIS (DWA, 2014) results, as well as the additional information required for this project.

Water quality (including the physical, chemical and biological characteristics of the water) in relation to the flow regime.

Water quality (including the physical, chemical and biological characteristics of the water) in relation to the flow regime will be obtained from existing DWS data base (PES of the tributaries and drainage lines in the Brak River catchment) and other relevant studies.

Riparian and In-stream Habitat.

Aquatic habitat assessments

Habitat assessments have been carried out to identify situations in which changes in habitat are responsible for changes in faunal populations. The nature and diversity of habitats available at the sampling point are factors of overwhelming influences on the biota present. The diversity of available biotopes itself is often incorporated in information on the conservation status of the river.

The habitat indices to be used in this survey are the Invertebrate Habitat Assessment System (IHAS) and the Habitat Quality Index (HQI).

a) IHAS (Integrated Habitat Assessment System)

b) HQI (Habitat Quality Index)

- **IHAS** (Integrated Habitat Assessment System, version 2) habitat assessments were performed in conjunction with the SASS5 assessment to determine the role of habitat in the observed biotic integrity based on the macro-invertebrates.

- General **habitat assessment** (including photographic assessment) to assess the general physical habitat condition of the sites and identify potential sources and impacts responsible for deterioration of the aquatic ecosystem.

Morphology (physical structure).

During the survey of the Soventix project, the drainage line environment was surveyed by doing a riparian transect in the project area. The transect at the proposed river crossing (Figure 10) represents a part of the Brak River (D62D - 05613) and consists of the main drainage line that converge with a medium-sized drainage. The transect was surveyed from the edge of the riparian area (left and right bank), and through the streambed to the other side.

Unfortunately, at the time of the field visit in October 2017 and April 2022, the river had no water in the system and therefore was not suited to an assessment of the Index of Habitat Integrity (IHI) model, Habitat Cover Ratings (HCR) and Site Fish Habitat Integrity Index (SHI).

Vegetation.

a) Riparian delineation

It is important to differentiate between wetlands and riparian habitats. Riparian zones are not wetlands, however, depending on the ecosystem structure, wetlands can be also be classified as riparian zones if they are located in this zone (e.g., valley bottom wetlands). Although these distinct ecosystems will be interactive where they occur in close proximity it is important not to confuse their hydrology and eco-functions.

Riparian delineations are performed according to *"A practical field procedure for identification and delineation of wetlands and riparian areas"* as amended and published by the Department of Water Affairs and Forestry (2005); (Henceforth referred to as DWAF Guidelines (2005).

Aerial photographs and land surveys were used to determine the different features and riparian areas of the study area. Vegetation diversity and assemblages were determined by completing survey transects along all the different vegetation communities identified in the riparian areas.

Riparian areas are protected by the National Water Act (Act 36 of 1998), which defines a riparian habitat as follows:

> *"Riparian habitat includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterized by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas."*

Riparian areas include plant communities adjacent to and affected by surface and subsurface hydrologic features, such as rivers, streams, lakes, or drainage ways. Due to water availability and rich alluvial soils, riparian areas are usually very productive.

Tree growth rate is high and the vegetation is lush and includes a diverse assemblage of species. The delineation process requires that the following be taken into account:

- Topography associated with the watercourse;
- Vegetation;
- Alluvial soils and deposited material.

A typical riparian area according to the DWA&F Guidelines (2005) is projected in Figure 7.

In addition to the DWA&F Guidelines (2005) and DWA&F updated manual (2008), the unpublished notes: *Draft riparian delineation methods prepared for the Department of Water Affairs and Forestry, Version 1* (Mackenzie & Rountree, 2007) were used for classifying riparian zones encountered on the property according to the occurrence of nominated riparian vegetation species.

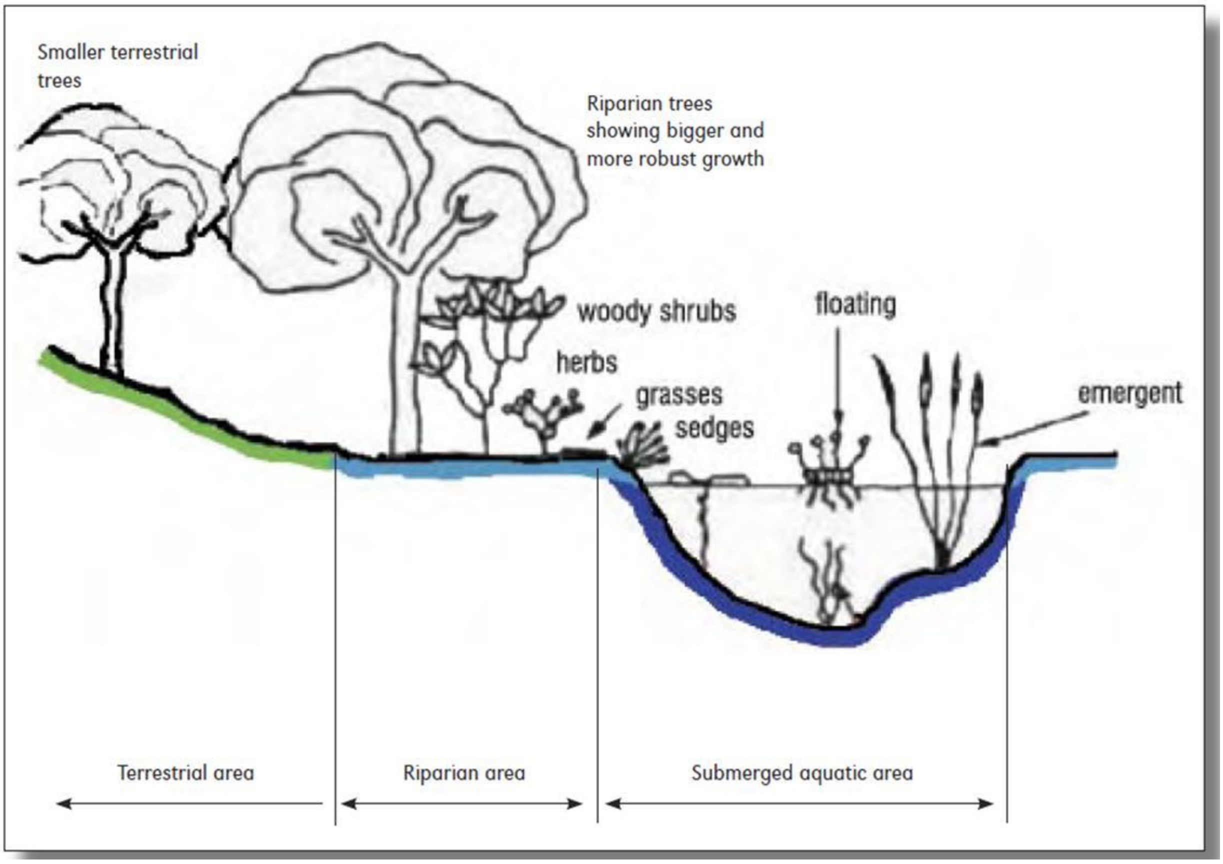


Figure 7: A cross section through a typical riparian area (DWA&F Guidelines, 2008).

b) Riparian habitat surveys (Riparian Vegetation Index — VEGRAI)

The general components of the VEGRAI are specified as following:

- It is a practical and rapid approach to assess changes in riparian vegetation condition.

- It considers the condition of the different vegetation zones separately but allows the integration of zone scores to provide an overall index value for the riparian vegetation zone as a unit.

- The vegetation is assessed based on woody and non-woody components in the respective zones and according to the different vegetation characteristics which include, inter alia:

  - Cover
  - Abundance
  - Recruitment
  - Population structure
  - Species composition

- It provides an indication of the causes for riparian vegetation degradation.
- It is impact based. This means that the reference condition will only be broadly defined and based on the natural situation in the absence of impacts. Where possible, however, reference conditions should be derived based on reference sites or sections.

The index is based on the interpretation of the influence of riparian vegetation structure and function on in-stream habitat.

Although biodiversity characteristics are used in assessing the riparian vegetation condition, it is not a biodiversity assessment index *per se.*

For this study the Level 3 VEGRAI will be used as Level 3 is applied by the River Health Programme (RHP) and for rapid Ecological Reserve purposes. This level will be aimed at general aquatic ecologists.

Biota – Aquatic invertebrates and Fish

Aquatic surveys

Macro-invertebrates and fish are good indicators of river health. By making use of established and accepted survey methods (SASS5 for invertebrates and FRAI-based surveys for fish) and incorporate the habitat aspects, a proper basis for biological diversity can be obtained.

The different components of the proposed development and its impact on the aquatic environment will be assessed for the river in the project area. The following recognized bio-parameters and methods will be used:

- Aquatic invertebrates: South African Scoring System version 5 (SASS5).
- Fish communities: Fish Response Assessment Index (FRAI). Applicable fish habitat assessments such as the Habitat Cover Ratings (HCR) and Site Fish Habitat Integrity Index (SHI) will be used to assess the habitat potential and condition for fish assemblages.
- Riparian vegetation: Riparian Vegetation Index (VEGRAI)

At the time of the field visit in October 2017 and April 2022, the river had no water in the system and therefore was not suited to an assessment of water quality or aquatic biota present. Due to this lack of data, the PESEIS information of DWS (DWS 2014) will be used to establish some background for the PES determination.

<u>Describe the ecological importance and sensitivity (EIS) as well as the Socio-cultural Importance (SI) of the affected reach/es of the watercourse including the functions.</u>

Ecological Importance and Sensitivity (EIS)

The ecological importance of a river is an expression of its importance to the maintenance of biological diversity and ecological functioning on local and wider scales. Ecological sensitivity (or fragility) refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (resilience). Both abiotic and biotic components of the system are taken into consideration in the assessment of ecological importance and sensitivity.

EIS/PES data was used in the eco-classification process of DWS (key process in the determination of the Reserve) to determine ecological sensitivity of a river reach as well as the present ecological state of such a river reach. From this an indication is provided whether the river reach is in a health category that is commensurate with its ecological importance and sensitivity. This relates to the determination of the eco-status of the river which refers to its overall condition or health and is based on its biophysical characteristics. The EIS/PES data for the Brak River was obtained from the extensive documentation compiled in: Department of Water and Sanitation (DWS, 2014). A Desktop Assessment of the Present Ecological State, Ecological Importance and Ecological Sensitivity per Sub Quaternary Reaches for Secondary Catchments in South Africa.

This approach estimates and classifies the ecological importance and sensitivity of the streams in a catchment by considering a number of components surmised to be indicative of these characteristics.

The following ecological aspects were considered as the basis for the estimation of ecological importance and sensitivity:

- The presence of rare and endangered species, unique species (i.e. endemic or isolated populations) and communities, intolerant species and species diversity should be taken into account for both the instream and riparian components of the river.
- Habitat diversity should also be considered. This can include specific habitat types such as reaches with a high diversity of habitat types, i.e. pools, riffles, runs, rapids, waterfalls, riparian forests, etc.
- With reference to the first two points, biodiversity in its general form should be taken into account as far as the available information allows.
- The importance of the particular river or stretch of river in providing connectivity between different sections of the river, i.e. whether it provides a migration route or corridor for species should be considered.
- The presence of conservation or relatively natural areas along the river section should also serve as an indication of ecological importance and sensitivity.
- The sensitivity (or fragility) of the system and its resilience (i.e. the ability to recover following disturbance) of the system to environmental changes should also be considered. Consideration of both the biotic and abiotic components is included here.

This system should be regarded as a guideline for the professional ecological judgement of individuals familiar with a particular area. The assessors scored a number of biotic and habitat determinants considered to be important for the determination of ecological importance and sensitivity. The median of these scores will be calculated to derive the ecological importance and sensitivity category. Assessors were then required to compare this with their overall estimation of the ecological importance and sensitivity category.

Assessors were required to substantiate and document their judgement to a reasonable degree for future revision. It was essential that this assessment was conducted by biologists familiar with the particular area in question or comparable areas.

The final reports addressed and analysed the EIS/PES data for all WMAs and indicate priority areas for further attention in terms of protection and management to achieve resource quality objectives and preliminary management class. The report also specifies per resource and quaternary catchment descriptions of the characteristics and parameters that defines a PES state and the EIS importance. A table was produced to indicate the most significant changes/impact on the present state and the main indicator that drives a quad. Cross reference to high conservation areas targeted for biodiversity conservation was made by aligning the attributes (to be investigated) that makes up the EIS/PES.

More detail and tables regarding the assessment of ecological importance and sensitivity can be obtained from the document by Kleynhans et al (DWA&F, 1999).

Ecological Category (EC)

The basis of the assessment of the importance of the metrics of biophysical components in determining the EC and EcoStatus is a Multi Criteria Decision Analysis approach (MCDA). The MCDA process allows the development of consistent rating systems or indices for the categorisation of ecosystem components and aggregates these mathematically in a theoretically justifiable way.

The Desktop level EcoClassification was modified for use in the PESEIS project to deal with numerous SQ river reaches and the relationship between the Desktop Level EcoClassification and the modified desktop level used within the PESEIS project.

The calculation of the Ecological Categories of drivers and biological responses is done by totalling the weighted scores and expressing this as a percentage of the maximum. This value indicates the percentage change away from the expected reference and must be subtracted from 100 to arrive at the percentage value that represents the EC. This value is used to place the EC of the component in a particular category that ranges from A to F (Table 2).

Table 2: Generic ecological categories for EcoStatus components (Kleynhans et al, 2009).

ECOLOGICAL CATEGORY	DESCRIPTION	SCORE (% OF TOTAL)
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80-89
C	Moderately modified. A loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions have occurred.	40-59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions are extensive.	20-39
F	Critical/Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In	0-19

ECOLOGICAL CATEGORY	DESCRIPTION	SCORE (% OF TOTAL)
	the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	

After the Ecological Categories of the driver and biological response components are determined, there remains the issue of how to integrate these to provide an indication as to the EcoStatus. Deriving the EcoStatus from the Ecological Categories of components is based on the following principles (Kleynhans *et al*, 2005):

- The Ecological Categories of the physical drivers (hydrology, geomorphology and physico-chemical integrity) are not integrated to provide an indication of the EcoStatus purely based on the drivers.
- Information on the driver metrics, i.e., how different they are from the reference is considered when assessing the biological responses. This is an expert knowledge approach and the attributes and environmental requirements of the biota should be considered when doing this.
- The biological responses are considered to provide the best indication of the EcoStatus of the river because it integrates the effect of the driver components

The steps in deriving the EcoStatus are:

- Criteria are considered that provide an indication of the relative indicator value of the two instream biological groups, fish and invertebrates. These criteria are used to weigh the relative importance of these two groups as indicators of in-stream health. The Ecological Categories of the two biological groups are proportioned according to these weights and combined to provide the in-stream Ecological Category.
- A suitable index to get an indication of riparian vegetation Ecological Category within the EcoStatus context is not yet available. Consequently, the riparian vegetation zone can only be considered conceptually and in terms of its influence on the in-stream EC. In this regard the influence, importance and integrity of the riparian vegetation zones, i.e., marginal, lower and upper vegetation, are considered in terms of its significance for the instream biota. Some indication of the health of the riparian vegetation can also be gleaned from the geomorphological driver where certain metrics of this driver do serve as indicators.
- The riparian vegetation Ecological Category and the instream Ecological Category are integrated based on a proportioning of weights according to the availability of high confidence information. This provides the EcoStatus of the river.
- Where riparian vegetation information is insufficient, the instream EC is used as the best indicator of the EcoStatus of the river.

The *modus operandi* followed by DWS's Directorate: Resource Directed Measures (RDM) is that, if the EIS is high or very high, the ecological aim should be to improve the condition of the river. However, the causes related to a particular PES should also be considered to determine if improvement is realistic and attainable. This relates to whether the problems in the catchment can be addressed and mitigated. If the EIS evaluated as moderate or low, the ecological aim should be to maintain the river in its PES. Within the Ecological Reserve context, Ecological Categories A to D can be recommended as future states (REC - the Recommended Ecological Category) depending on the EIS and PES. Ecological Categories E and F PES are regarded as ecologically unacceptable, and remediation is needed.

List and map sensitive environments in proximity of the project locality-sensitive environments include wetlands, nature reserves, protected areas, etc.

a. Land-Use Decision Support Tool (LUDS)

To establish how important the site is for meeting biodiversity targets, a number of resources and tools are used. Specifically, the Land-Use Decision Support Tool (LUDS) used extensively to compile the LUDS Report (BGIS, 2022). LUDS was developed to facilitate and support biodiversity planning and land-use decision-making at a national and provincial level. Its primary objective is to serve as a guide for biodiversity planning but should not replace specialist ecological assessments.

To establish how important the site is for meeting biodiversity targets, it is necessary to answer the following three simple but fundamentally important questions:

- How important is the site for meeting biodiversity objectives (e.g., is it in a **Critical Biodiversity Areas** (CBA) or Ecological Support Area (ESA)?
- Is the proposed land-use consistent with these objectives or not (to be checked against the land-use guidelines)?
- Does the sensitivity of this area trigger the requirements for assessing and mitigating environmental impacts of developments, or in terms of the listed activities in the EIA regulations?

b. The Ecological Importance (EI) and Ecological Sensitivity (ES)

The EIS of SQs are assessed to obtain an indication of its vulnerability to environmental modification within the context of the PES. This would relate to the ability of the SQ to endure, resist and able to recover from various forms of human use.

c. Freshwater Ecosystem Priority Areas (FEPAs)

National Freshwater Ecosystem Priority Areas (NFEPA) map products provide strategic spatial priorities for conserving South Africa's freshwater ecosystems and supporting sustainable use of water resources. These strategic spatial priorities are known as Freshwater Ecosystem Priority Areas, or FEPAs. FEPA maps provide a single, nationally consistent information source for incorporating freshwater ecosystem and biodiversity goals into planning and decision-making processes. These maps are therefore directly applicable to the National Water Act, feeding into Catchment Management Strategies, classification of water resources, reserve determination, and the setting and monitoring of resource quality objectives. FEPA maps are also directly relevant to the National Environmental Management: Biodiversity Act (Act No. 10 of 2004; RSA, 2004), informing both the listing of threatened freshwater ecosystems and the process of bioregional planning provided for by this Act.

The base criteria of the river FEPA are the following: "Rivers had to be in a good condition (A or B PES) to be chosen as FEPAs" (Nel *et al*., 2011).

FEPAs provide an important input into EIAs, informing decision makers on freshwater ecosystems that need to be taken into account in environmental assessments and authorisations (Driver et al, 2011). FEPAs should inform the EIA process in the following way:

- The presence of a FEPA means that a freshwater specialist must be consulted for the assessment.
- Anticipated impacts on a FEPA that may result in an ecological condition lower than A or B should be ranked as having medium to high significance.

- Any activity that will have an overall residual impact on wetland or river FEPAs and their immediate surrounds greater than a low negative significance, is not acceptable from the point of view of managing and conserving freshwater ecosystems, and must be avoided.
- The cumulative effect of development impacts should ideally be considered in the case of sub-quaternary catchments associated with FEPAs (i.e., the specialist should be aware of other developments in the sub-quaternary catchment that are likely in the near future and should highlight possible cumulative impacts).
- Unavoidable development must require special mitigation measures that would reduce the overall impact of the activity or development to low negative significance, or must require a biodiversity offset.

The following four-step process should be followed for taking FEPAs into account in EIAs and will supply information on the Brak River as part of the Department of Environment and Nature Conservation, Northern Cape systematic biodiversity plans:

FEPA Step 1: Consult the FEPA map

- Make an initial desktop assessment of whether the proposed activity is likely to impact on the FEPA as mapped.

FEPA Step 2: Site assessment

- Visit the site. Verify that the river/wetland ecosystem types or fish sanctuary for which the FEPA has been selected exist on the ground. Check that the FEPA or fish sanctuary is not heavily modified.

- Ground-truth the location of the FEPA (e.g., the river, the associated sub-quaternary catchment, and any wetland FEPAs that fall within the sub-quaternary catchment);

- Type the FEPA according to the river and wetland ecosystem types used by NFEPA;

- Examine the surrounding sub-quaternary catchment, looking at the condition and location of other FEPAs, and other freshwater ecosystems in good condition, and/or of apparent ecological importance and/or sensitivity;

- Determine current condition (present ecological state) and compare with modelled condition: EcoStatus (Present Ecological State) for rivers – *primary data should be collected wherever possible*.

FEPA Step 3: Delineate the ecosystem

- Map the extent of the FEPA accurately, using the DWA protocol for delineation of wetlands and riparian areas (DWAF, 2005);

- Determine the appropriate buffer width, using accepted national protocols.

FEPA Step 4: Assess the significance of the impact of the proposed development

- Determine ecological importance and sensitivity (EIS) using DWA protocol, and compare with FEPA status – examine the reasons why ecosystem has achieved FEPA status, and check whether these are correct and complete, if so, these should be used in the determination of EIS – primary data should be collected wherever possible;

- Assess the significance of impacts. The degree of significance will depend on the degree of deterioration in ecological condition that would result from the proposed development as well as its reversibility (e.g., whether the impact is short-term, medium-term or long-term).

- Deterioration of a FEPA from a B ecological condition to a C condition might be considered an impact of medium significance but should never be considered of low significance.

FEPA Step 5: Make recommendations

- Consult the NFEPA ecosystem management guidelines, and apply these to the development application;

- Develop suitable and realistic mitigation measures;

- Determine rehabilitation requirements, in order to meet management objectives for FEPAs;

Design a monitoring programme that aims to track the impacts associated with the development and how these affect the condition of the affected FEPAs.

Provide an assessment of the risks associated with the water use/s and related activities.

a) Section 21(c) and (i) Risk-Based Assessment and Authorisation Guideline (DWS, Edition 02, final October 2014)

In terms of section 22 of the NWA a person may only use water if it is permissible under Schedule 1, a continuation of an Existing Lawful Use (ELU), a General Authorisation (GA), a licence or the requirement for a licence has been dispensed with under section 22(3).

There are 11 different types of water uses contemplated in terms of the NWA Section 21, but the purpose of this Risk-Based Water Use Authorisation Guideline is to deal with section 21(c) and (i) water uses only.

Water use in terms of section 21(c) and (i) of the NWA is:

• (c) impeding or diverting the flow of water in a watercourse; and
• (i) altering the bed, banks, course or characteristics of a watercourse.

Unlike some water uses referred to in Section 21, e.g. (a) and (b) which are consumptive and which impacts are usually clearly evident, easier to manage and quantifiable, section 21(c) and (i) water uses are non-consumptive and their impacts more difficult to detect and manage. They are also generally difficult to clearly quantify.

However, if left undetected these impacts can significantly change various attributes and characteristics of a watercourse, and water resources, especially if left unmanaged and uncontrolled. Thus, the risks posed by Section 21(c) and (i) water uses on watercourses and water resources are an important consideration during the authorisation of these water uses.

Risk-Based Management is an adaptive management approach used for assessing and managing the impacts of particular water uses on a watercourse, the risks and hazards these pose and actions required to mitigate them. It is a very prudent and effective approach to be used in instances where the easy detection and quantification of impacts and risks are difficult to achieve.

b) **Risk Assessment using the Risk Matrix**

The Risk Assessment was done in accordance with the Risk Matrix (Based on DWS 2014/ DWS 2016 publication: Section 21 c and I water use Risk Assessment Protocol and as contained as Appendix A in GN509 of 26 August 2016) and it was carried out considering the risk rating of the proposed project activities after implementing mitigation measures.

4. Results

4.1 The De Aar 300 MW Solar PV facility project area

The proposed location (Figure 5) is on the Remainder of Farm Goedehoop 26 C, Portion 6 of Leuwe Fountain 27 C, Remainder of Farm Riet Fountain 39 C, Portion 1 of Farm Riet Fountain 39C, Remainder of Kwanselaars Hoek 40 C, Portion 1 of Kwanselaars Hoek 40 C, Portion 4 of Taaibosch Fontein 41C, registration district Hanover, Emthanjeni Local Municipality, Pixley Ka Seme District Municipality; Northern Cape Province.

The study area lies near the eastern edge of the Nama Karoo biome, and is mapped as Northern Upper Karoo vegetation type. The Nama Karoo is regarded as a semi-desert and precipitation, which occurs predominantly in the summer months, is unpredictable and sporadic. The vegetation cover is generally dominated by sparse dwarf karroid scrub and tufted grass with bare patches of sand in between. Portions of the area are in a disturbed condition, most likely as a result of livestock grazing.

The main water feature in the area is the Brak River, a seasonal tributary within the Orange River System which flows in an arc from south-east to north-west, eventually feeding into the Orange River basin.

The river flows to the north of the study area with a number of its tributaries crossing the area as it flows in a northerly direction. All the small tributaries in the area are ephemera or intermittent and are discernible only as slightly shallow depressions with no clear associated vegetation and slightly clayey soils.

The catchment reference numbers were obtained from the DWS PESEIS documents. The Brak River is situated in the D62D catchment, and the Sub-Quaternary Reach that the project is located in, is D62D - 05613 (Figure 8). Another unnamed tributary to the Brak River is D62D – 05610 with its confluence just downstream of the Project Area. After this confluence the Brak River becomes Sub-Quaternary Reach D62D – 05553.

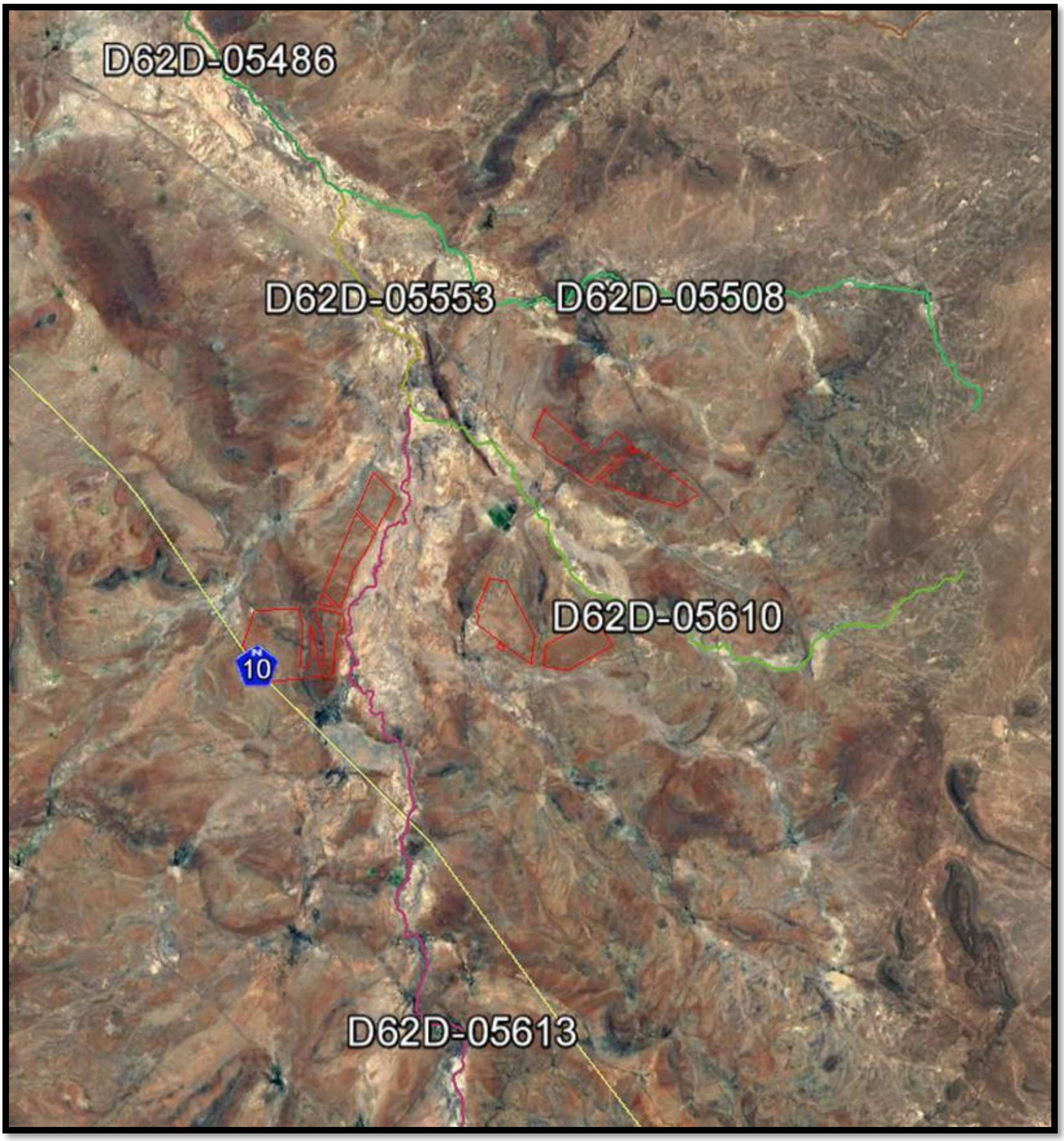


Figure 8: A Google Earth image indicating the location of the Project Area in the Sub-Quaternary Reach D62D - 05613 and D62D – 05610.

4.2 The Brak River drainage system

The main water feature in the area is the Brak River, a seasonal tributary within the Orange River System. The De Aar 300 MW Solar PV facility project area has no permanent perennial water source although in favourable seasons the Brak River may flow.

The Brak River (Figure 10) is clearly characterised by an azonal vegetation type, allied with Upper Gariep Alluvial Vegetation (Ecoleges Environmental Consultants, 2017). The floodplain has however been heavily modified by human activity with a lot of diversion walls and historical disturbance present.

The Karoo landscape is heavily influenced by the occurrence of dolerite dykes, sills and rings for a description of these geological features which control surface and subsurface drainage patterns and the occurrence of watercourses and wetlands.

According to the definitions in the National Water Act (Act No. 36 of 1998), “water resource" includes a **watercourse**, surface water, estuary, or aquifer. Where an application for a water use license is being applied for, all wetlands within 500 m of the proposed development should ideally be mapped. Seasonal or intermittent rivers are included in the National Wetland Classification System (SANBI, 2009) with the rivers and streams category:

“Rivers and streams: This type of water resource is described as a channel (river, including the banks) in the National Wetland Classification System (SANBI, 2009). This is defined as *“an open conduit with clearly defined margins that (i) continuously or periodically contains flowing water, or (ii) forms a connecting link between two water bodies. Dominant water sources include concentrated surface flow from upstream channels and tributaries, diffuse surface flow or interflow, and/or groundwater flow. Water moves through the system as concentrated flow and usually exits as such but can exit as diffuse surface flow because of a sudden change in gradient. Unidirectional channel-contained horizontal flow characterizes the hydrodynamic nature of these units.”* According to the classification system, channels generally refer to rivers or streams (including those that have been canalized) that are subject to concentrated flow on a continuous basis **or periodically during flooding**. This definition is consistent with the NWA (Act No. 36 of 1998) which makes reference to (i) a river or spring and (ii) a **natural channel** in which water **flows** regularly or **intermittently** within the definition of a water resource. As a result of the erosive forces associated with concentrated flow, channels characteristically have relatively obvious active channel banks which can be identified and delineated.”

It is important to note that ‘Riparian habitat’ may be associated with either of these systems and is regarded by DWS as part of the water resource and ‘regulated area’. **Riparian habitat** is defined in the NWA (Act No. 36 of 1998) as *“the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas.”* Areas of riparian habitat which are saturated or flooded for prolonged periods would be considered ‘wetlands’ (in terms of the NWA) and should be mapped as such. Some riparian areas, however, are not ‘wetlands’ (e.g., where characteristic riparian trees have very deep roots drawing water from many metres below the surface). These areas do however provide a range of important services that maintain basic aquatic processes, services and values requiring protection in their own right. Where present, the boundary of the riparian habitat should therefore also be clearly delineated (Macfarlane et al 2010).

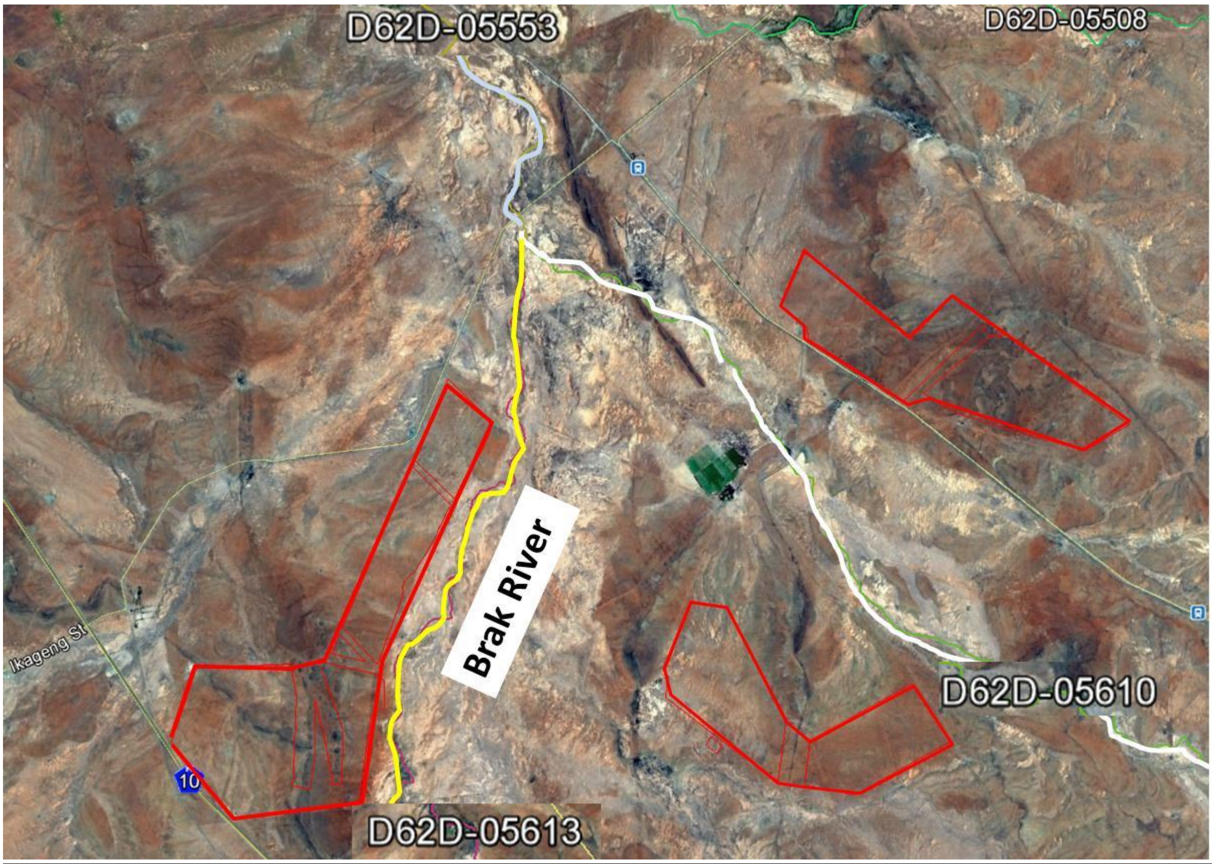


Figure 9: The location of the Brak River and tributaries in the Project Area.

4.3 The extent of the riparian habitat.

During the survey of the De Aar 300 MW Solar PV facility project, the drainage line environment was surveyed by doing one riparian transect on the D62D-05613 SQ of the Brak River in the project area (Figure 9).

Figure 10 consists of an aerial photo which was compiled by using a Google Earth image and it indicates the survey transect on the drainage line for the Soventix project. The floodplain and alluvial fans have been heavily modified by human activity with a lot of diversion walls and historical disturbance present.

A dominant feature of the Karoo landscape is the alluvial floodplains, washes and fans. The active channel is only a fraction of the illustrated wetland area. The alluvial fans (Figure 11a) and erosion dongas (Figure 11b) covers most of the demarcated “wetland” and due to their function, slope and consistency, these areas will only be briefly inundated with surface water during rainy events and the surface water will be rapidly transported to the low-lying active channel of the system. Precipitation in this semi-desert occurs predominantly in the summer months and is unpredictable and sporadic.

These alluvial fans are usually bare soil flats or conduits (Figure 11c), however, in higher lying portions dwarf karroid scrub and tufted grass will colonise the system. They are characterised by multiple channels that traverse a floodplain, valley floor or alluvial fan.

Viewing the Google Earth image in Figure 9, the outline of the eroded river bed of the Brak River is indistinct and there is very little discernible riparian vegetation (Figure 11d). The ephemeral streams have no visible aquatic vegetation present. The active channel of the Brak

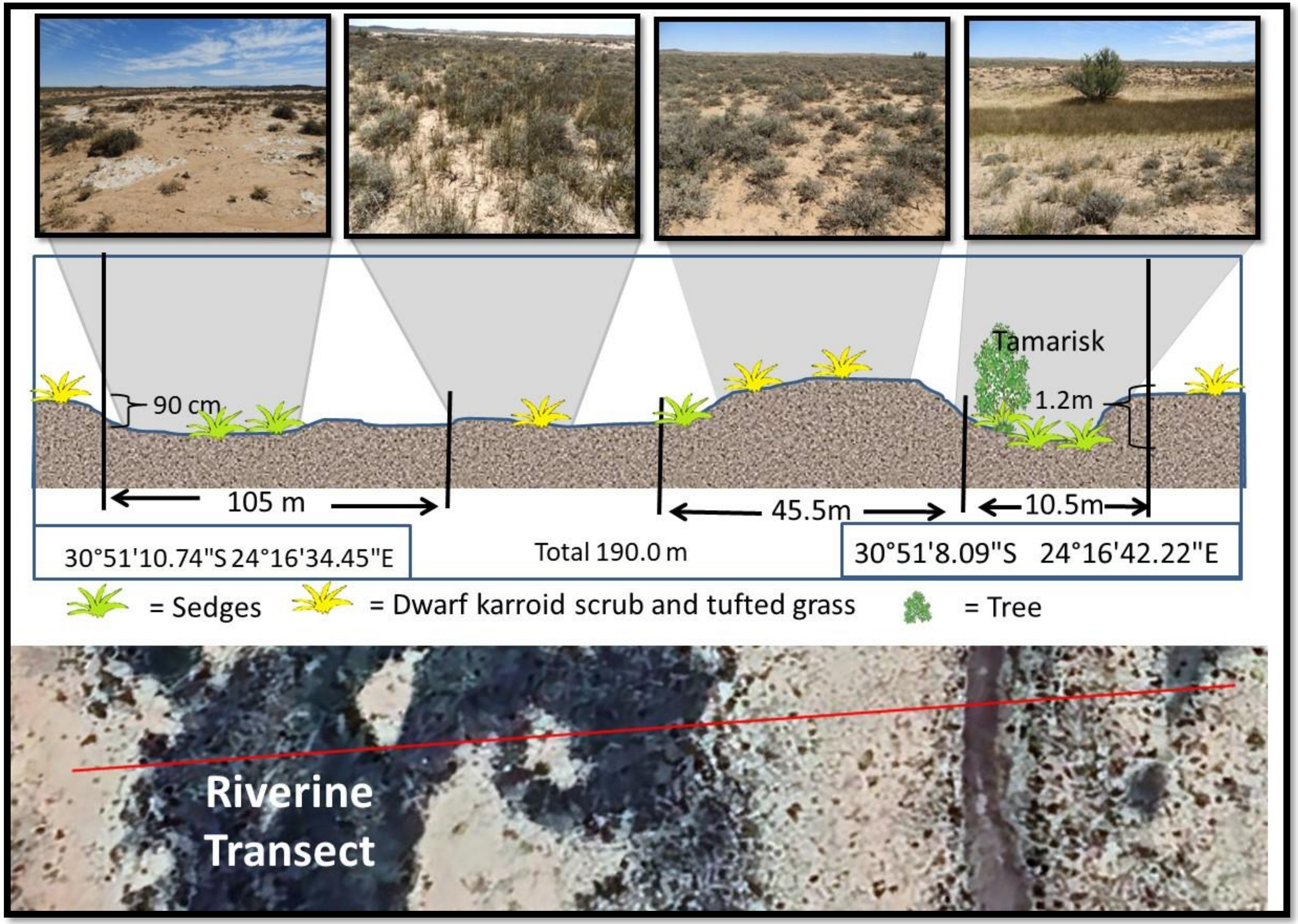


Figure 10: This figure illustrates the basic components of the riverine setup considered during the surveys. Riverine Transect - Brak River.

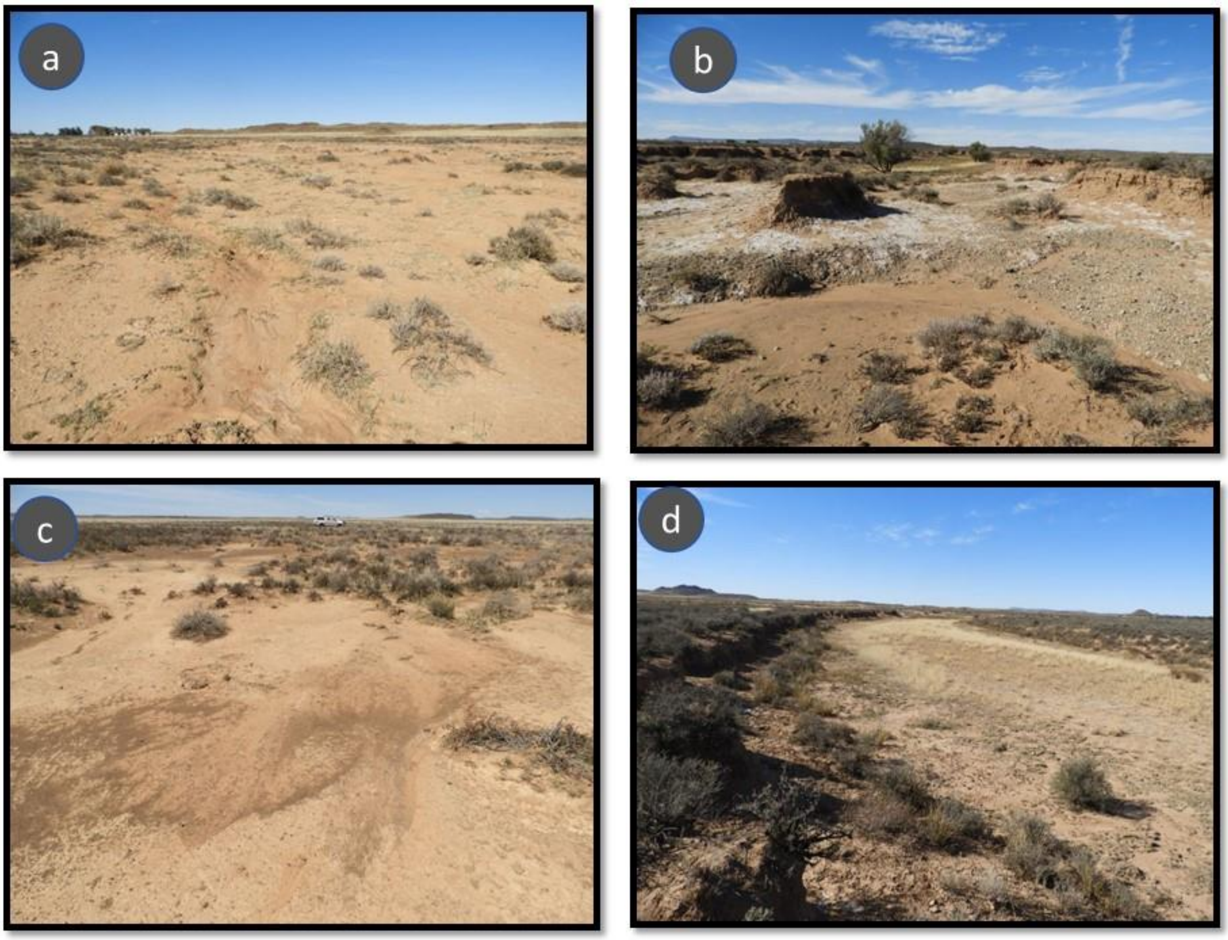


Figure 11:

11a: An alluvial fan.
11b: An erosion donga.
11c: Bare soil flats with conduits.
11d: Very little discernible riparian vegetation on the drainage line banks.

The Brak River (D62D-05613) is the only natural (excluding artificial dammed areas) drainage line in the study area with weak indicators of riparian vegetation in the river bed and on the river banks. Reeds and tall hygrophilic grass (Figure 12c and d) can be found in certain areas in the river bed which indicates areas of extended surface water accumulation, or a very shallow subsurface water source. On the river banks sedges (*Scirpoides*) and rushes (*Juncus*) can be found in a narrow band in a narrow band along the embankment (Figure 12e) and in some wet patches further away between drainage lines (Figure 12f).

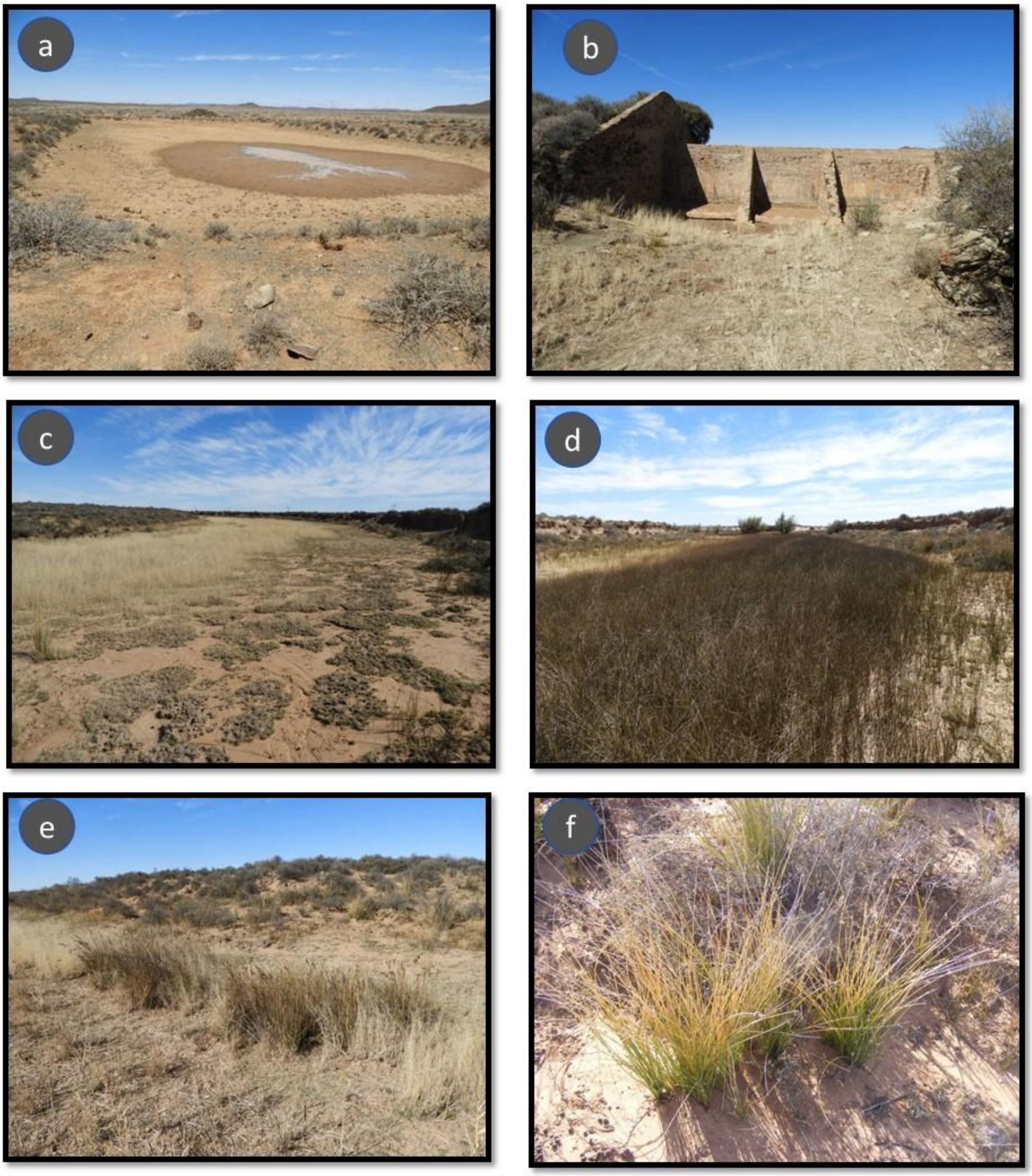


Figure 12:

12a and b: Small- sized earthen farm dam.
12c: Reeds and tall hygrophilic grass in the river bed.
12d: Sedges and rushes the river bed.
12e: Sedges and rushes in a narrow band in a narrow band along the embankment.
12f: Sedges and rushes patches further away between drainage lines.

The "riparian zone" is between 1 and 5 meters wide (Figure 12c) and the river bed (Figure 13f) is between 5 and 30 meters wide. The river bed is only inundated with water during heavy rain downpours or due to damming effects of the many small dams in the system (Figure 12a). Patches of sedges are scattered between dwarf karroid scrub and tufted grass on the river bank (Figure 13a). The lengths of the two prominent drainage lines running through the project area are as follow: D62D-05613 is 9.3 km and D62D-05610 covers 9.0 km (Figure 15).

All the smaller tributaries in the area are ephemeral or intermittent and most are discernible only as slightly shallow depressions (Figure 13b) with no clear associated vegetation and slightly clayey soils. It is clear that during rainy downpours that the rain water spreads evenly over the flat surface and flows in a sheet-like manner to the shallow depressions which represents the drainage line.

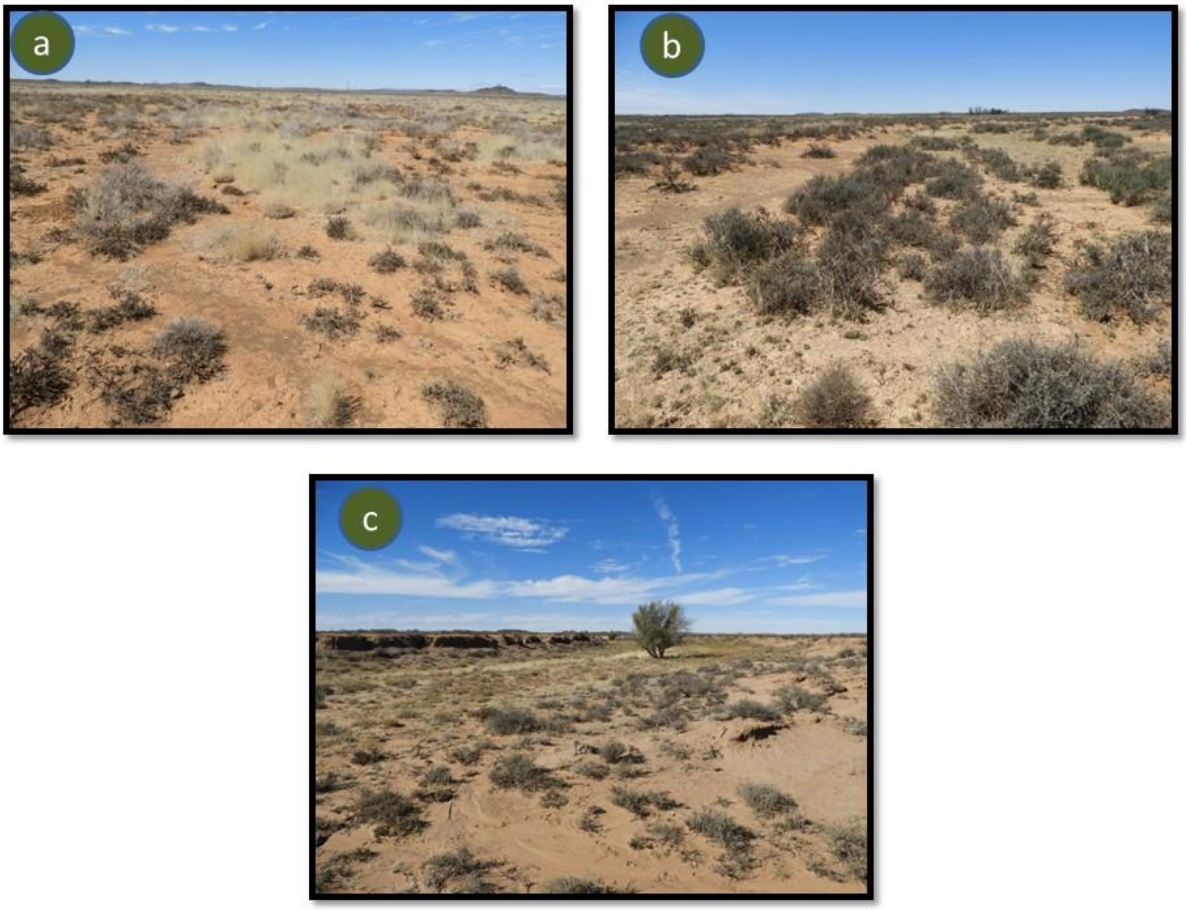
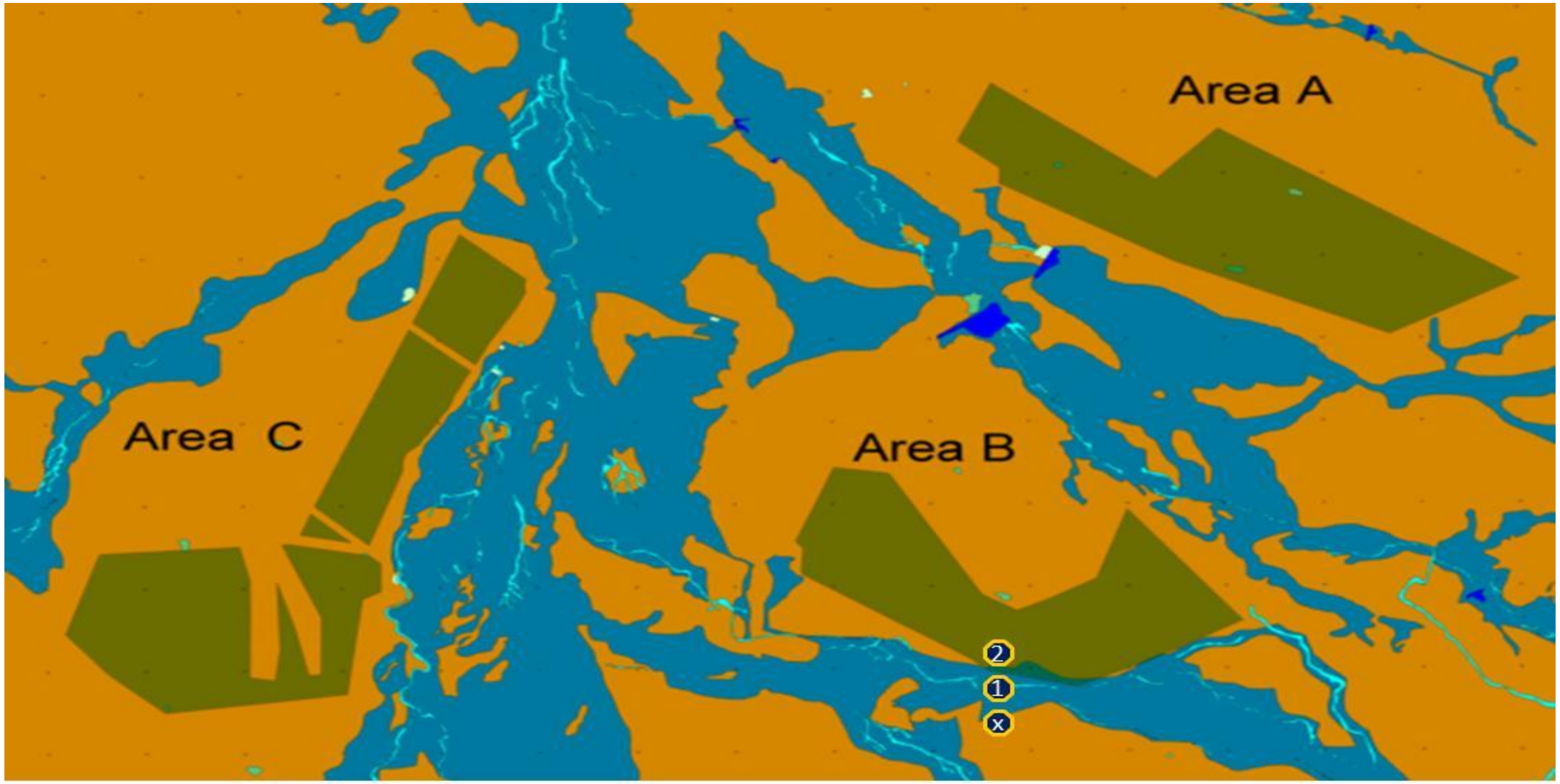


Figure 13:

13a: The areas between the drainage lines are covered with dwarf karroid scrub and tufted grass.
13b: The main drainage line is discernible only as slightly shallow depression.
13f: The river bed is between 5 and 30 meters wide.

Most of the terrestrial areas around these drainage systems in the project area are covered with dwarf karroid scrub and tufted grass (Figure 13a) but devoid of trees or shrubs. Due to the fact that this river is an intermittent river, very little trees are present in the riparian zone.

The transect at the proposed river crossing (Figure 10) represents a part of the Brak River (D62D - 05613) and consists of the main drainage line that converge with a medium-sized drainage. The main drainage line is flanked by a narrow band of sedges and rushes, and the 1.2 m deep channel is covered with sedges and hygrophilous grass (Figure 13b). A small number of tamarisk trees (Figure 13c) are also growing in the main drainage line. The areas between the drainage lines are covered with dwarf karroid scrub and tufted grass (Figure 13a).



Colour	No	Class
	1	Water
	2	Permanent wetland
	3	Seasonal wetland
	4	Floodplain
	5	Streambeds
	6	Non-wetland

Figure 14: The wetland map compiled for the project area indicates the extent of the alluvial fans (dark blue) and additional draining channels in the erodible and very dry landscape (Van den Berg & De Wet, 2017). The active channel (light blue) is dwarfed by the extensive drainage area (Ecoleges Environmental Consultants, 2017).

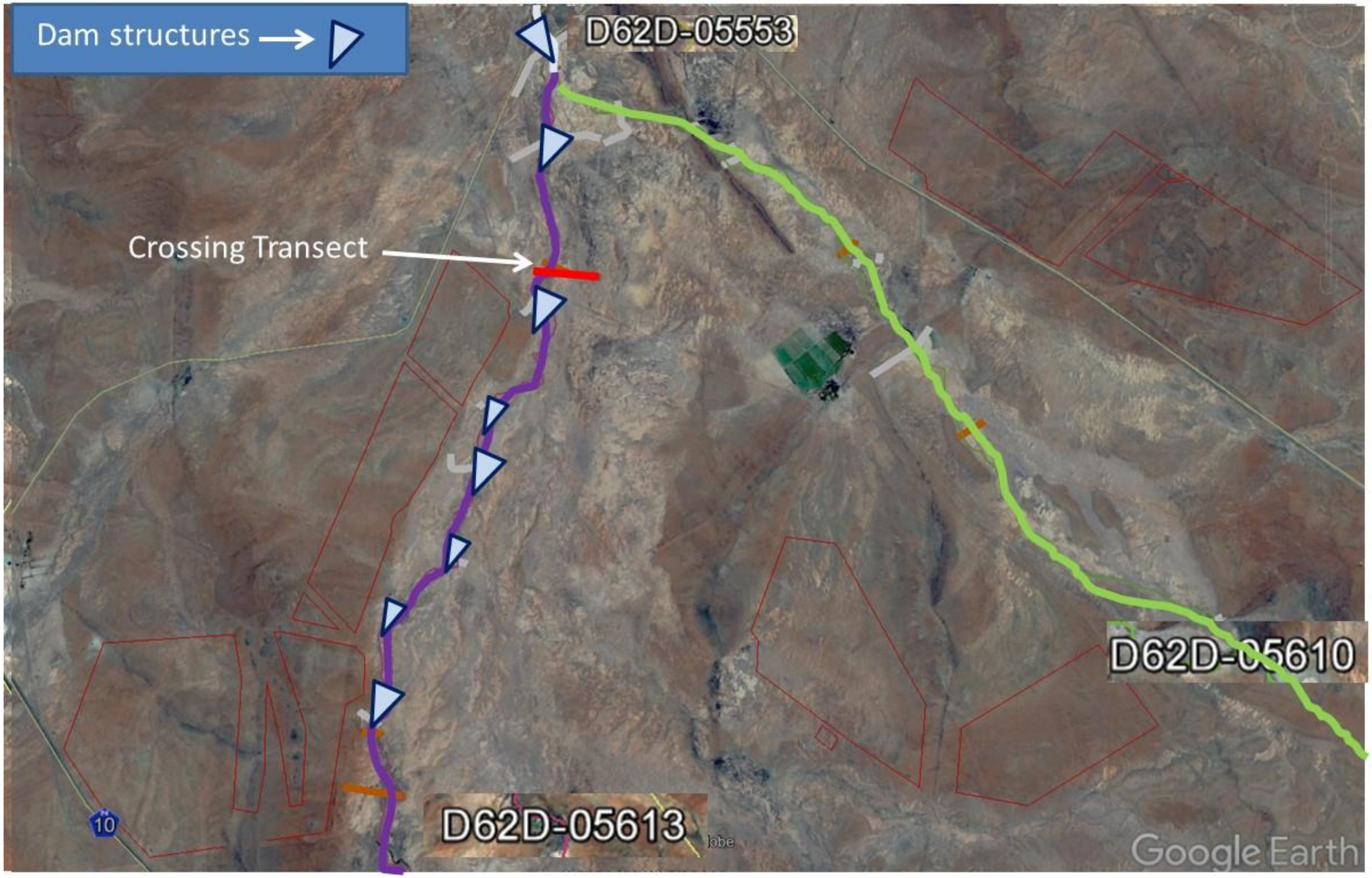


Figure 15: The prominent drainage lines surveyed for the project, indicating the survey transect and also the dam structures on the project drainage line.

4.4 River flow and sediment regimes.

The Brak River of the SQ reach D62D-05613 has a length of 41 km of which the last 10 km runs through the project area.

River classification

In order to assess the condition and ecological importance and sensitivity of the rivers in the study area, it is necessary to understand how the rivers might have appeared under un-impacted conditions. This is achieved through classifying rivers according to their ecological characteristics, in order that it can be compared to ecologically similar rivers. Table 3 provides the geomorphological features of the system assessed.

Table 3. Characteristics of the Nama Karoo Ecoregion (Dominant Types in Bold).

Main Attributes	Description
Terrain Morphology: Broad division	Plains; Low Relief; Plains Moderate Relief; Lowlands; **Hills and Mountains;** **Moderate and High Relief**; Open Hills, Lowlands; Mountains; Moderate to High Relief; Closed Hills; Mountains; Moderate and High Relief
Vegetation types	Eastern Mixed Nama Karoo; Upper Nama Karoo; **Bushmanland Nama Karoo**; Orange River Nama Karoo
Altitude (m a.m.s.l)	300-1700
MAP (mm)	0 to 500
Rainfall seasonality	Late to very late summer to Winter
Mean annual temp. (°C)	12 to 20
Median annual simulated runoff (mm) for quaternary catchment	<5 to 60 mm

River/Site Characterisation

The Nama Karoo is regarded as a semi-desert and precipitation, which occurs predominantly in the summer months, is unpredictable and sporadic. The Soventix project area has no permanent perennial water source although in favourable seasons the Brak River may flow. There is no water flow data available from DWS for this river reach (DWA Flow data, 2017). All the small tributaries in the area are ephemera or intermittent

The Brak River drains an area with a very low rainfall. As a result, the water within the river system is saline and turbid and seasonally flowing. At the time of the field visit in October 2017 and April 2022, the river had no water in the system and was not suited to an assessment of aquatic biota present surface. Groundwater interactions are thought to be important for sustaining them.

The peak flow for the area was calculated and evaluated for the node of interest (Jones & Wagener, 2017) and the 1:20, 1:50, 1:100 and Regional Maximum Flood (RMF) are presented in Table 4.

Table 4: Peak flows and catchment area for Node 1.

Node	**Peak Flow (m^3/s) for Recurrence Interval**						
	1:2 yr	**1:5 yr**	**1:10 yr**	**1:20 yr**	**1:50 yr**	**1:100 yr**	**RMF**
1	23	38	56	78	117	161	427

The daily simulated runoff volumes averaged to monthly runoff values based on Hydro Zone G, are indicated in Table 5 below.

Table 5: Estimated average seasonal runoff (WR2012) (m^3x10^6).

Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Stream flow	0.09	0.26	0.40	0.75	1.96	2.63	1.01	0.20	0.03	0.01	0.05	0.07

Most of the surface water ecosystems in the study area are thus intermittent or ephemeral, being inundated only for brief periods each year, with periods of drought that are predictable in frequency but unpredictable in duration. The low rainfall across the study area means that evaporation is the dominant component of the water balance and while rainfall drives the inundation periodicity of the aquatic ecosystems in the area.

The ephemeral rivers of the Karoo are highly dependent on groundwater discharge, which occurs at springs and when groundwater recharge (through precipitation at higher elevations) allows the water table to intersect with the river channel.

From the Site Characterisation assessments, the geomorphological and physical characteristics of the Brak River tributaries can be classified as shown in Table 6.

Table 6. Geomorphological and Physical features of the Brak River tributaries (Belcher, 2013).

River	Ephemeral tributaries of the Brak River
Geomorphological Zone	Foothill rivers in the Upper Karoo Geomorphic Province
Lateral mobility	Unconfined
Channel form	Complex
Channel pattern	Multiple thread: low sinuosity
Channel type	Silt/clayey with pebbles
Channel modification	Moderate modification (trampling and grazing within river channel, instream impoundments)
Hydrological type	Ephemeral
Ecoregion	Nama Karoo
DWA catchment	D62D
Vegetation type	Northern Upper Karoo shrubland
Rainfall region	Autumn

Water quality (including the physical, chemical and biological characteristics of the water) in relation to the flow regime.

DWS has no continuous water quality sampling sites in the Brak River (https://www.dwa.gov.za/iwqs/report.aspx). One sample was collected by DWS on 1987/07/24 in the Brak River and was obtained from the DWS website https://www.dwa.gov.za/iwqs/report.aspx. The results are summarised in Table 7.

Table 7: Median concentrations of water quality parameters at the De Bad sampling site (WMS D62_100917) for the one sample on 1987/07/24 in the Brak River (https://www.dwa.gov.za/iwqs/report.aspx).

Parameter	Brak River
Conductivity	101 mS/m
Ca_Diss_Water	104.3 mg/l
Cl_Diss_Water	80 mg/l
DMS_Tot_Water	749
EC_Phys_Water	101.2 mS/m
F_Diss_Water	1.12 mg/l
K_Diss_Water	3.04 mg/l
Mg_Diss_Water	39.7 mg/l
Na_Diss_Water	59.7 mg/l
NH4_N_Diss_Water	0.04 mg/l
NO3_NO2_N_Diss_Water	5.67 mgN/l
pH_Diss_Water	7.7
PO4_P_Diss_Water	0.014 mgP/l
Si_Diss_Water	13.51 mg/l
SO4_Diss_Water	98 mg/l
TAL_Diss_Water	277.3 mg/l

The Brak River drains an area with a very low rainfall. As a result, the water within the river system is saline and turbid and seasonally flowing. At the time of the field visit in October 2017 and April 2022, the river had no water in the system and therefore was not suited to an assessment of water quality or aquatic biota present.

Ephemeral rivers are particularly vulnerable to changes in hydrology, as they are specifically adapted to brief periods of inundation and flow. Consequently, pollutants and sediments entering these watercourses are not regularly diluted or flushed out of the catchment, leading to a lack of resilience to pollution, erosion and sedimentation.

4.5 Riparian and In-stream Habitat.

Morphology (physical structure) - Index of Habitat Integrity (IHI)

The habitat integrity of a river refers to the maintenance of a balanced composition of physico-chemical and habitat characteristics on a temporal and spatial scale that are comparable to the characteristics of natural habitats of the region.

Habitat integrity assessment is approached from an in-stream and riparian zone perspective. Both of these are formulated according to metric groups, each with a number of metrics that enable the assessment of habitat integrity. The model functions in an integrated way, using the results from the assessment of metric groups, or metrics within a metric group, for the assessment of other metric groups where appropriate.

The Instream Index of Habitat Integrity (IIHI) and the Riparian Index of Habitat Integrity (RIHI) is based on the methods outlined in Kleynhans *et al*., 2008.

Table 8: The in-stream IHI: evaluated for the Brak River in the study area.

	MRU
INSTREAM IHI	
Base Flows	-0.5
Zero Flows	-1.0
Floods	-1.5
HYDROLOGY RATING	**1.0**
pH	0.5
Salts	0.5
Nutrients	0.5
Water Temperature	0.5
Water clarity	0.5
Oxygen	0.5
Toxics	0.5
PC RATING	**0.2**
Sediment	-1.5
Benthic Growth	0.0
BED RATING	**0.6**
Marginal	-2.0
Non-marginal	-1.5
BANK RATING	**1.8**
Longitudinal Connectivity	-2.5
Lateral Connectivity	-2.0
CONNECTIVITY RATING	**2.3**
INSTREAM IHI %	**78.8**
INSTREAM IHI EC	**B/C**
INSTREAM CONFIDENCE	**3.4**

Table 9: The riparian IHI: evaluated for the Brak River in the study area.

	MRU
RIPARIAN IHI	
Base Flows	-2.0
Zero Flows	-2.0
Moderate Floods	-2.0
Large Floods	-1.5
HYDROLOGY RATING	**1.8**
Substrate Exposure (marginal)	1.0
Substrate Exposure (non-marginal)	0.0
Invasive Alien Vegetation (marginal)	0.0
Invasive Alien Vegetation (non-marginal)	0.0
Erosion (marginal)	0.0
Erosion (non-marginal)	1.0
Physico-Chemical (marginal)	0.5
Physico-Chemical (non-marginal)	0.5
Marginal	1.0
Non-marginal	1.0
BANK STRUCTURE RATING	**1.0**
Longitudinal Connectivity	2.5
Lateral Connectivity	2.0
CONNECTIVITY RATING	**2.3**
RIPARIAN IHI %	**68.8**
RIPARIAN IHI EC	**C**
RIPARIAN CONFIDENCE	**3.2**

The outcome of the in-stream and riparian IHI evaluated for the Brak River in the study area, resulted in an in-stream IHI of 78.8 (B/C) (Table 8) which classifies as "Largely natural with few modifications" according to the Habitat Integrity Categories in Table 10, or "Good" (Small change) when using the finer detail EC rating table (Appendix 1). The riparian IHI of 68.8 (C) (Table 9) falls in a "Moderately modified" category (Table 10) or "Fair" (Moderate change) when using the finer detail EC rating table (Appendix 1).

Table 10: The ratings for the Habitat Integrity Categories prescribed to the IHI model (Kleynhans et al, 2008).

HABITAT INTEGRITY CATEGORY	DESCRIPTION	RATING (% OF TOTAL)
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. The flow regime has been only slightly modified and pollution is limited to sediment. A small change in natural habitats may have taken place.	80-89
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the	0-19

Vegetation

According to the riparian IHI evaluation (Table 9), the Riparian Zone Habitat Integrity is “Moderately modified” and the C score indicates some impacts at this stage on the riparian habitats:

- Large number of small and medium-sized weirs and dams in the study area;
- Some erosion due to trampling and diversions;
- Small amount of alien vegetation.

Riparian surveys

Riparian delineation

During the process of riparian delineation, a transect was surveyed: through the drainage line to the outer edge of the other riparian zone (right bank). Figure 10 depicts the Brak River with the delineated active channel of the river and ephemeral tributaries with the proposed 100m buffer zone around the active channel in the project area. This riparian corridor in the area is usually between 1 and 5 meters wide (on both sides of the drainage) with very little discernible riparian vegetation present (Figure 13c).

According to the Northern Cape CBA map (Figure 17), the riverine zone (active channel and associated drainage) along this reach of the Brak River renders the river reach a CBA river (refer to 4.7 – ecological importance and sensitivity). The areas surrounding the drainage lines in the project area (light yellow in Figure 17), is classified as an Ecological Support Area (ESA). The desired management objective for an ESA is to be maintained in a natural, functional state.

The Brak River SQ D62D-05610 is a Critical Biodiversity Area one, while the area surrounding the ephemeral drainage line, is categorised as a Critical Biodiversity Area two (Figure 17). As part of the management objective for the Northern Cape CBA process, the following is suggested:

- Conduct a buffer determination assessment around all wetlands, regardless of ecological condition or ecosystem threat status.
- Any further loss of area or ecological condition must be avoided, including if needed, a 100 m generic buffer around the wetland.

The 100 m buffer around the delineated riparian area should be measured from the top of the active channel bank. Buffer zones have been used in land-use planning to protect natural resources and limit the impact of one land-use on another.

Buffer zones associated with water resources have been shown to perform a wide range of functions, and on this basis, have been proposed as a standard measure to protect water resources and associated biodiversity. These functions include:

- Maintaining basic aquatic processes;
- Reducing impacts on water resources from upstream activities and adjoining land uses;
- Providing habitat for aquatic and semi-aquatic species;
- Providing habitat for terrestrial species; and
- A range of ancillary societal benefits.

The implementation of a buffer zone will emphasize the importance of the riverine area and this will certainly augment the importance of the ecology in the project area. The area included in the buffer zone, as well as the core areas in the riverine zone should have explicit and very strict biodiversity conservation management measures and the operating teams should be well aware of this.

Any potential risks must be managed and mitigated to ensure that no deterioration to the water resource takes place. Standard management measures should be implemented to ensure that any on-going activities do not result in a decline in water resource quality.

While determining the area and distribution of a core habitat is important, it is equally important that appropriate management measures be determined to ensure the core habitat continues to function effectively. Biodiversity conservation management measures that need to be taken into consideration when determining management measures for core habitats and corridors include:

- Habitat and species management;
- Alien and invasive species management;
- Fire management;
- Grazing management; and
- The management of soil erosion and physical disturbances.

Determining the required buffer width is largely an exercise of assessing the situation and linking it to an acceptable level of risk. Determining appropriate management measures for aquatic impact buffer zones is largely dependent on the threats associated with the proposed activity adjacent to the water resource. These threats include:

- Increases in sedimentation and turbidity;
- Increased nutrient inputs;
- Increased inputs of toxic organic and heavy metal contaminants; and
- Pathogen inputs.

A buffer zone of 100m from the delineated riparian zone is therefore suggested. Figure 16 depicts the Brak River delineation in the in the project area with the proposed buffer zone included.

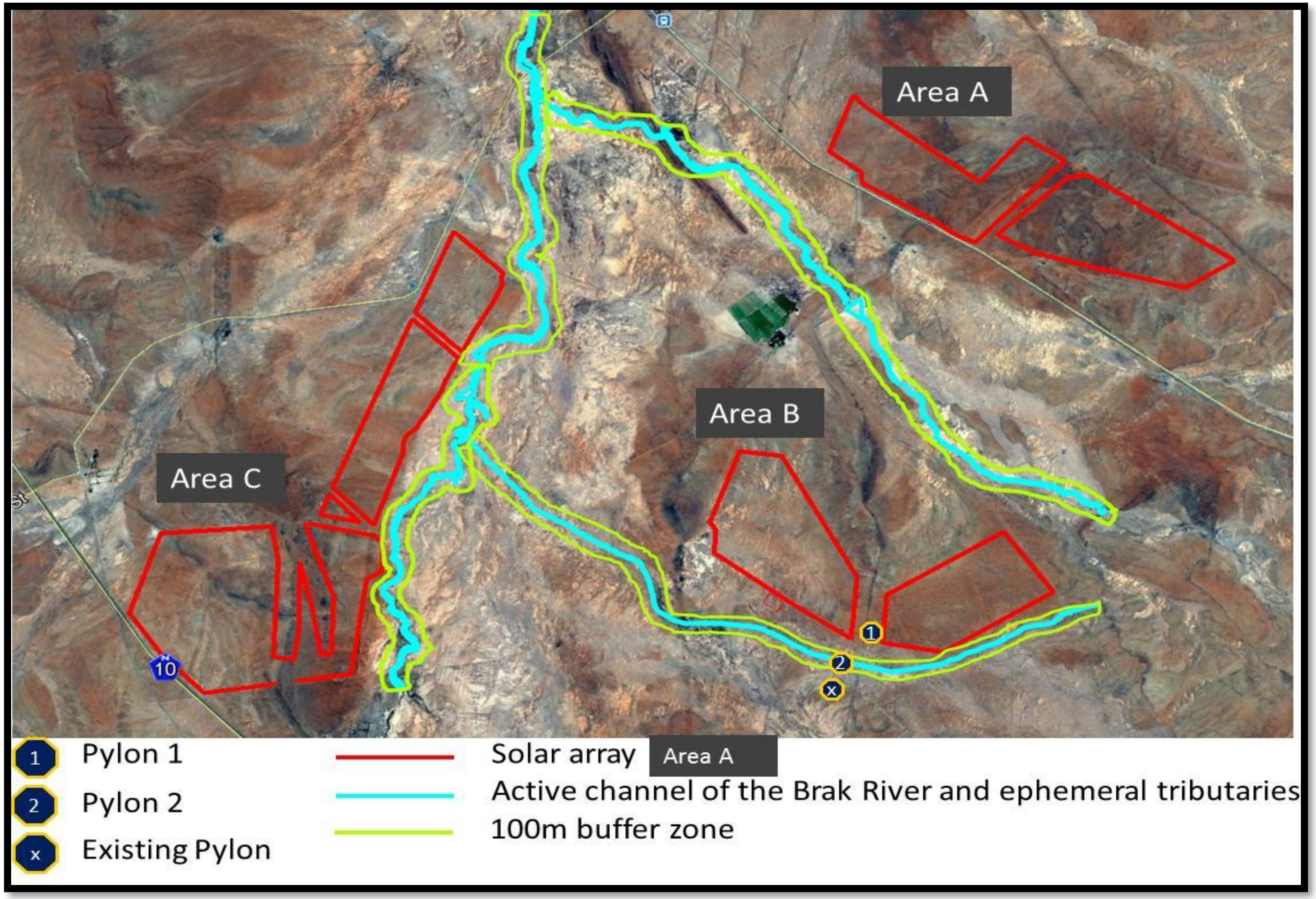


Figure 16: The delineated active channel of the Brak River and ephemeral tributaries (blue lines) with the estimated 100m buffer (yellow-green lines) around the active channel in the project area.

Riparian habitat surveys (Riparian Vegetation Index — VEGRAI)

Riparian vegetation is described in the Water Act (Act No 36 of 1998) as follows: ”Riparian habitat" includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas.

VEGRAI model

VEGRAI has a spread sheet model component that is composed of a series of metrics and metric groups each of which is rated in the field with the guidance of data collection sheets (referred to as field forms).

The metrics in VEGRAI first describe the status of riparian vegetation in both its current and reference states and second, compare differences between the two states as a measure of vegetation response to an impact regime.

The riparian vegetation zones (Marginal, Lower and Upper) are used as the metric groups. For the simplified Level 3 version, the Lower and Upper zones were combined to form the Non-Marginal metric group (zone).

A range of metrics for each metric group is selected of which some are essential for both Levels 3 and 4 (Abundance and Cover) and the others are optional (Species Composition, Population Structure and Recruitment). The metrics are then rated and weighted and an Ecological Category (A-F) determined which represents the Ecological Category for the riparian vegetation state.

Impact evaluation on riparian zone and interpretation

The purpose is to evaluate and interpret the observed impacts at a site in terms of its relative influence on the riparian vegetation according to vegetation removal, alien vegetation invasion, water quantity and quality. The approach followed is that each of these four broad causes of modification relates to and is associated with particular human-related activities that would change the riparian vegetation characteristics directly or indirectly. Some of these changes may occur rapidly while others will occur gradually and only become evident through time.

This approach relates to the National Water Act which aims to protect aquatic ecosystems in order to secure ecologically sustainable development and use of the relevant water resource. The protection of water resource quality is essential to achieve this:

``Resource quality'' means the quality of all the aspects of a water resource including,

- the quantity, pattern, timing, water level and assurance of in-stream flow;
- the water quality, including the physical, chemical and biological characteristics of the water;
- the character and condition of the in-stream and riparian habitat; and
- the characteristics, condition and distribution of the aquatic biota
- considering the functions of the riparian vegetation, these have been summarized as:

- Sediment trapping,
- Nutrient trapping
- Bank stabilization and bank maintenance,
- Contributes to water storage,
- Aquifer recharge,
- Flow energy dissipation,
- Maintenance of biotic diversity,
- Primary production.

Most of these functions relate to in-stream habitat conditions and it follows the basic consideration when assessing the condition of the riparian vegetation, and thus impacts should be interpreted in terms of the influence on the in-stream habitat.

Table 11: A comparative description related to reference and present state of the riparian zone in the project area.

Zones	Impacts	Response Metrics	Description of PRESENT STATE	Description of REFERENCE STATE
Marginal	Vegetation Removal Exotic Vegetation Water Quantity Water Quality	Cover Abundance Species Composition	The "riparian zone" of the Brak River is between 1 and 5 meters wide and the river bed is between 5 and 30 meters wide. Along the active channel (1.0 -1.5 m deep) reeds and tall hygrophilic grass dominates the instream habitat, while there is very little discernible riparian vegetation in the marginal area. Some drainage line tributaries have sedges and rushes growing in the sandy river bed which indicates areas of extended surface water accumulation, or a very shallow subsurface water source. On the river banks sedges (*Scirpoides*) and rushes (*Juncus*) can be observed in a narrow band along the embankment. The other ephemeral tributaries have no visible wetland vegetation present. Due to the fact that this river is an intermittent river, very little trees are present along the river banks. There are many impoundments on these drainage lines and they are small- to medium-sized earthen farm dams.	The outline of the river bed of the Brak River was more distinct and much less alluvial fans and additional draining channels in the erodible and very dry landscape than today. The "riparian zone" of the Brak River was between 1 and 5 meters wide and the river bed between 5 and 30 meters wide. Along the active channel (1.0 -1.5 m deep) reeds and tall hygrophilic grass dominated the instream habitat, while very little discernible riparian vegetation was present in the marginal area. Some drainage line tributaries had sedges and rushes growing in the sandy river bed which indicated areas of extended surface water accumulation (much more than today), or a very shallow subsurface water source. On the river banks sedges (*Scirpoides*) and rushes (*Juncus*) could be observed in a narrow band along the embankment. The other ephemeral tributaries have no visible wetland vegetation present. Due to the fact that this river is an intermittent river, very little trees was present along the river banks.
Non-marginal	Vegetation Removal Exotic Vegetation Water Quantity Water Quality	Cover Abundance Species Composition	The floodplain and alluvial fans have been heavily modified by human activity with a lot of diversion walls and historical disturbance present. All the smaller tributaries in the area	A dominant feature of the Karoo landscape was the alluvial floodplains, washes and fans, however there were less of these features. All the smaller tributaries in the area were ephemeral or intermittent and most were

	are ephemeral or intermittent and most are discernible only as slightly shallow depressions with no clear associated vegetation. The higher lying areas or “islands” between the drainage lines are covered with dwarf karroid scrub and tufted grass but devoid of trees or shrubs. A small number of alien tamarisk trees are growing in the main drainage line. Sedges (*Scirpoides*) and rushes (*Juncus*) are found in some wet patches further away between drainage lines.	discernible only as slightly shallow depressions with no clear associated vegetation. The higher lying areas between the drainage lines were covered with dwarf karroid scrub and tufted grass but devoid of trees or shrubs. Sedges (*Scirpoides*) and rushes (*Juncus*) were found in some wet patches further away between drainage lines.

Table 12: Evaluation of the marginal zone integrity (VEGRAI model) in the project area**.**

	MODIFICATION RATINGS						
CAUSES OF MODIFICATION	**INTENSITY**	**EXTENT**	**CONFIDENCE**	**NOTES: (give reasons for each assessment)**			
REMOVAL	1.5	0.5	4.0	Erosion and inundation removed habitat.			
EXOTIC INVASION	0.5		4.0	Only few *Tamarix* trees.			
WATER QUANTITY	3.5	3.5	3.0	Weirs and dams impede subsurface flows.			
WATER QUALITY	2.0	2.0	4.0	Impoundments and evaporation.			
AVERAGE			3.8				
		RESPONSE METRIC RATINGS					
VEGETATION COMPONENTS	**RESPONSE METRIC**	**CONSIDER? (Y/N)**	**RATING**	**CONFIDENCE**	**NOTES: (give reasons for each assessment)**		
WOODY	COVER	Y	0.5	4.0	Erosion removed some.		
	ABUNDANCE	Y	0.5	4.0	Maybe some removal by people and erosion.		
	SPECIES COMPOSITION	Y	0.5	4.0	Similar to original.		
			0.5	4.0			
NON-WOODY	COVER	Y	1.5	4.0	Erosion removed some.		
	ABUNDANCE	Y	1.5	3.0	Erosion removed some.		
	SPECIES COMPOSITION	Y	0.0	4.0	Similar to original.		
			1.0	2.3			
VEGETATION COMPONENTS	**CONSIDER? (Y/N)**	**RANK**	**WEIGHT**	**RATING**	**WEIGHTED RATING**	**MEAN CONFIDENCE**	**NOTES: (give reasons for each assessment)**
WOODY	Y	2.0	10.0	0.5	0.05	4.0	Not many natural occurring woody plants in the system.
NON-WOODY	Y	1.0	100.0	1.0	1.00	2.3	More influential in the marginal zone.
					1.05	3.2	
CHANGE (%) IN MARGINAL ZONE CONDITION			**19.1**				

Table 13: Evaluation of the non-marginal zone integrity (VEGRAI model) in the project area.

	MODIFICATION RATINGS						
CAUSES OF MODIFICATION	**INTENSITY**	**EXTENT**	**CONFIDENCE**	**NOTES: (give reasons for each assessment)**			
REMOVAL	2.0	0.0	3.0	Erosion and inundation removed habitat.			
EXOTIC INVASION	0.5		3.0	Only few *Tamarix* trees.			
WATER QUANTITY	3.5	4.0	3.0	Weirs and dams inundate non-marginal.			
WATER QUALITY	2.0	2.0	4.0	Sedimentation due to erosion and diversion walls.			
AVERAGE			3.3				
		RESPONSE METRIC RATINGS					
VEGETATION COMPONENTS	**RESPONSE METRIC**	**CONSIDER? (Y/N)**	**RATING**	**CONFIDENCE**	**NOTES: (give reasons for each assessment)**		
WOODY	COVER	Y	0.5	4.0	Erosion removed some.		
	ABUNDANCE	Y	0.5	4.0	Maybe some removal by people and erosion.		
	SPECIES COMPOSITION	Y	0.5	4.0	Similar to original.		
			0.5	4.0			
NON-WOODY	COVER	Y	2.0	4.0	Erosion and inundation removed habitat.		
	ABUNDANCE	Y	1.5	3.0	Erosion and inundation removed habitat.		
	SPECIES COMPOSITION	Y	0.0	4.0	Similar to original.		
			1.2	2.3			
VEGETATION COMPONENTS	**CONSIDER? (Y/N)**	**RANK**	**WEIGHT**	**RATING**	**WEIGHTED RATING**	**MEAN CONFIDENCE**	**NOTES: (give reasons for each assessment)**
WOODY	Y	2.0	10.0	0.5	0.05	4.0	Not many natural occurring woody plants in the system.
NON-WOODY	Y	1.0	100.0	1.2	1.17	2.3	All that remains of riparian zone.
					1.22	3.2	

CHANGE (%) IN MARGINAL ZONE CONDITION	**22.1**

Table 14: The vegetation integrity evaluation of the riparian zone in the project area.

LEVEL 3 ASSESSMENT						
METRIC GROUP	**CALCULATED RATING**	**WEIGHTED RATING**	**CONFIDENCE**	**RANK**	**% WEIGHT**	**NOTES: (give reasons for each assessment)**
MARGINAL	80.9	62.2	3.2	1.0	100.0	Only wetland plants present.
NON MARGINAL	77.9	18.0	3.2	2.0	30.0	Very little wetland plants.
	2.0				130.0	
LEVEL 3 VEGRAI (%)				80.2		
VEGRAI EC				**B/C**		
AVERAGE CONFIDENCE				3.2		

According to the VEGRAI assessment (Table 16) for the Brak River, the Ecological Class is a B/C (80.2%).

The final scores of the VEGRAI assessment regarding the riparian and marginal zone integrity of the Brak River in the project area are presented in Table 15.

Table 15: A summary of the VEGRAI scores of the Brak River in the project area.

Drainage lines	Non-marginal zone condition	Marginal zone condition	Level 3 VEGRAI	VEGRAI EC
% change	19.1%	22.1%	80.2%	B/C

The vegetation integrity score for the Brak River is 80.2%, which represents an Ecological Class B/C (>77.4 and <82.01). This score reflects a "Largely natural with few modifications." status (Table 16), or a "Good – Small change" in the finer detail EC rating table (Appendix 1).

Table 16: Generic ecological categories for EcoStatus components (modified from Kleynhans 1999).

ECOLOGICAL CATEGORY	**DESCRIPTION**	**SCORE (% OF TOTAL)**
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80-89
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
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	0-19

4.6 Biota – Aquatic invertebrates and Fish

Aquatic habitat assessment

Aquatic surveys and bio-monitoring are components of ecological risk assessment and aims to measure present biological conditions and trends in the aquatic ecosystem. It attempts to relate the observed variation to changes in available habitat, as dictated by physical system drivers of the system such as water quality, geomorphology, and hydrology (Kleynhans et al, 2008).

Aquatic invertebrate assessment

Very little is known of the invertebrate fauna of the watercourses and wetlands of the Karoo region. Given the constant shift from aquatic to dry phases, ephemeral ecosystems support unique, well-adapted biotic communities with species that show rapid hatching, fast development, high fecundity, and short life spans. Organisms that inhabit these ecosystems rely on the production of desiccation-resistant or dormant propagules (such as eggs, cysts, seeds, spores) to survive the dry period, and then become active again when the wetland is inundated. The eggs of these organisms can survive in the sediments for many years, and rapidly hatch when sufficient rain falls. Many taxa will reproduce asexually several times during the wet season.

It is evident that marginal vegetation and pools are important biotopes in non-perennial rivers for invertebrates. Marginal vegetation is sometimes still available in pools and deeper sections even after the stones-in-current and stones-out-of-current biotopes have dried up. The gravel/mud and sand habitat would also be available for longer than some of the other habitat types.

The presence of refugia near to the river – either tributaries or other streams in the vicinity is vital to survival of some species. Many of the invertebrates present in non-perennial rivers are the same as those found in temporary pools and pans in the area and these pans/pools also serve as refugia.

The dams and weirs built in non-perennial rivers also serve as refugia for invertebrates and fish, and the water quality in these structures would determine the population of invertebrates that survive the dry periods. These structures however also serve as migration barriers to biota.

Important to remember is that when pools are threatened by silting due to erosion or mismanagement of the catchment upstream it would mean that refugia for instream biota is removed and this could lead to the destruction of instream biota in other non-perennial rivers in the vicinity as well.

The recharging of the surface water by groundwater is also an important factor in these rivers as some invertebrates are found in this subsurface water and recolonise the surface water from there.

In the arid and semi-arid Southern African rivers, the environmental stressors are extreme and organisms surviving in these systems are not stressed by the high flows as such but rather by competition for dwindling resources as the systems dry out.

Unfortunately, at the time of the field visit in October 2017 and April 2022, the river had no water in the system and therefore was not suited to an assessment of water quality or aquatic biota present. Due to this lack of data, the PESEIS information of DWS (DWS 2014) will be used to establish some background for the PES determination.

According to the DWS PESEIS database, macro-invertebrate aspects of the Brak River (D62D-05613) read as follow:

Macro-invertebrate taxa per SQ: 11 taxa
Invertebrate representivity per secondary: Very high
Invertebrate rarity per secondary class: High
Invertebrate physical-chemical description: Moderate
Invertebrate velocity sensitivity: High
Invertebrate taxa estimated:

- Baetidae 1sp
- Gerridae
- Naucoridae
- Vellidae
- Dytiscidae

Gyrinidae
Ceratopogonidae
Chironomidae
Culicidae
Muscidae

By using these parameters, the PESEIS assessors establish a Category D for the instream biota aspect, which equates to "Largely modified" (Table 17). However, by evaluating the changes in the system and the diversity of these ephemeral systems, it is rather a lack of diversity then a case of modification when the instream biota is evaluated ("Low diversity").

Table 17: Ratings for the macro-invertebrate integrity classes.

	MIRAI ASSESSMENT CLASSES	
Class rating	Description of generally expected conditions for integrity classes	Relative FRAI score (% of expected)
A	Unmodified, or approximate natural conditions closely	90 to 100
B	Largely natural with few modifications.	80 to 89
C	Moderately modified.	60 to 79
D	Largely modified.	40 to 59
E	Seriously modified.	20 to 39
F	Critically modified.	0 to 19

Fish Response Assessment Index (FRAI)

The purpose of the Fish Response Assessment Index (FRAI) is to provide a habitat-based cause-and-effect interpretation underpinning the deviation of the fish assemblage from the reference condition.

Unfortunately, at the time of the field visit in October 2017 and April 2022, the river had no water in the system and therefore was not suited to an assessment of water quality or aquatic biota present. Due to this lack of data, the PESEIS information of DWS (DWS, 2014) will be used to establish some background for the PES determination.

According to the DWS PESEIS database, the freshwater fish aspects of the Brak River (D62D-05613) read as follow:

Fish species per SQ: 2 species
Fish representivity per secondary: Moderate
Fish rarity per secondary class: Moderate
Fish species estimated:
Barbus anoplus
Labeo umbratus
Fish physical-chemical description: Moderate
Fish no-flow sensitivity description: Moderate

By using these parameters, the PESEIS assessors establish a PES of a Category D for the instream biota aspect, which equates to "Largely modified" (Table 18). However, by evaluating the changes in the system and the diversity of these ephemeral systems, it is rather a lack of diversity then a case of modification when the instream biota is evaluated ("Low diversity").

Table 18: Ratings for the fish integrity classes.

	FRAI ASSESSMENT CLASSES	
Class rating	Description of generally expected conditions for integrity classes	Relative FRAI score (% of expected)
A	Unmodified, or approximate natural conditions closely	90 to 100
B	Largely natural with few modifications. A change in community characteristics may have taken place but species richness and presence of intolerant species indicate little modification.	80 to 89
C	Moderately modified. A lower than expected species richness and presence of most intolerant species. Some impairment of health may be evident at lower limits of this class.	60 to 79
D	Largely modified. A clearly lower than expected species richness and absence or much lowered presence of intolerant and moderate intolerant species. Impairment of health may become more evident at the lower limit of this class.	40 to 59
E	Seriously modified. A strikingly lower than expected species richness and general absence of intolerant and moderately intolerant species. Impairment of health may become very evident.	20 to 39
F	Critically modified. An extremely lowered species richness and an absence of intolerant and moderately intolerant species. Only tolerant species may be present with a loss of species at the lower limit of the class. Impairment of health generally very evident.	0 to 19

4.7 Description of the ecological importance and sensitivity (EIS) as well as the Socio-cultural Importance (SI)

Ecological importance and sensitivity (EIS)

The PESEIS data from the Department of Water and Sanitation Desktop PESEIS assessment (DWS, 2014), supplies most of the current status information of the relevant sub-quaternary river reaches (SQRs) for South Africa. The objective of the PESEIS is to provide desktop level information on ecological issues as it relates to the protection and management of SQRs. For management purposes this refers specifically to the consideration of ecological reserve issues, water use licensing issues and EWRM (including the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP) activities) and the determination of priorities for monitoring.

The data analysis for the PESEIS of the Brak River catchment was evaluated during 2011 (Table 19).

Table 19: A summary of the Ecological Importance (EI) of the Brak River obtained from the DWS PESEIS model (DWS, 2014).

Ecological Importance	
Fish spp/sq	2
Fish representivity per secondary: class	Moderate
Fish rarity per secondary: class	Moderate
Riparian-wetland natural veg rating based on % natural veg in 500m (100%=5)	Very high
Riparian-wetland natural veg importance based on expert rating	Moderate
Invertebrate taxa/SQ	11
Invertebrate representivity per secondary, class	Very high
Invertebrate rarity per secondary: class	High
Ecological importance: riparian-wetland-instream vertebrates (excluding fish) rating	Low
Ecological importance: riparian-wetland-instream vertebrates (excluding fish) comments	Total number of species in SQ: 15; number of special species: 0 ; main habitats: Seasonal/Ephemeral, riparian trees, pools; main adverse conditions: Agriculture, instream dams, lack of surface flows.
Habitat diversity class	Low
Habitat size (length) class	High
Instream migration link class	Moderate
Riparian-wetland zone migration link	Moderate
Riparian-wetland zone habitat integrity class	Moderate
Instream habitat integrity class	High
Mean EI Class	**Moderate**

The mean Ecological Importance Class of the Brak River in the SQ reach D62D-05613 is "Moderate" (DWS, 2014).

Table 20: A summary of the Ecological Sensitivity (ES) of the riparian-wetland vertebrates (non-fish) in the Brak River obtained from the DWS PES-EIS model (DWS, 2014).

Metrics: riparian-wetland vertebrates (non-fish)	Ratings & comments
Fish physical-chemical description:	Moderate
Fish no-flow sensitivity description:	Moderate
Invertebrate representivity per secondary	Very high
Invertebrate rarity per secondary class	High
Riparian-wetland-instream vertebrates (excluding fish) intolerance water level/flow changes description	Very low
Ecological sensitivity: riparian-wetland-instream vertebrates (excluding fish) intolerance	High dependence species: 0; Main habitats: Seasonal/Ephemeral,

water level/flow changes, comments	pools; Main adverse conditions: Instream dams, lack of surface flows.
Stream size sensitivity to modified flow/water level changes description	Low
Riparian-wetland vegetation intolerance to water level changes description	Moderate
Riparian-wetland vegetation intolerance to water level changes comments	Moderate
Mean ES Class	**Moderate**

The mean Ecological Sensitivity Class of the Brak River in the SQ reach D62D-05613 is "Moderate" (DWS, 2014).

Discuss existing land and water use impacts (and threats) on the characteristics of the watercourse.

According to the IHI evaluation (Table 9), the Riparian Zone Habitat Integrity is "Moderately modified", and the C score indicates some impacts at this stage on the riparian habitats:

- Large number of small and medium-sized weirs and dams in the study area;
- Some erosion due to trampling and diversions;
- Small amount of alien vegetation.

Large number of small and medium-sized weirs and dams in the study area

The many impoundments on this ephemeral system consist of small- to medium-sized earthen farm dams, and about 15 of these are found on the project farm alone.

By storing or diverting water weirs alter the natural distribution and timing of stream flow. Impacts on in-stream flow (quantity, pattern, timing, water level and assurance):

- Disruption of longitudinal and lateral connectivity;
- Changes in temporal and spatial characteristics of flow can have an impact on habitat attributes such as an increase in duration of low flow season, resulting in low availability of certain habitat types or water at the start of the breeding, flowering or growing season.
- Reduction in flows, sometimes no flow or flow during the wrong season;
- Implicates flow, bed, channel and water quality characteristics.
- Downstream riparian vegetation may be influenced by a decrease in the supply of water and dramatically altered;
- Bursting of dams usually has a high environmental impact, increasing flood peaks, sediment loads, stream-bank erosion
- Reduction in downstream annual flooding in particular affects the natural productivity of floodplains and delta.

The dams and weirs built in non-perennial rivers also serve as refugia for invertebrates and fish, and the water quality in these structures would determine the population of invertebrates that survive the dry periods. These structures however also serve as migration barriers to biota.

Water quality threats to the system which could accumulate in the dams include:

- Increases in sedimentation and turbidity;
- Increased nutrient inputs;
- Increased inputs of toxic organic and heavy metal contaminants; and
- Pathogen inputs.

Ephemeral rivers are particularly vulnerable to changes in hydrology, as they are specifically adapted to brief periods of inundation and flow. Consequently, pollutants and sediments entering these watercourses are not regularly diluted or flushed out of the catchment, leading to a lack of resilience to pollution, erosion and sedimentation.

Erosion due to trampling and diversions

About 4% of the Nama-Karoo has been cleared for cultivation or irreversibly transformed by building of dams. Erosion is moderate (46.2%), very low (32%) and low (20%) in in the area. *In the project area, t*he floodplain and alluvial fans has been heavily modified by human activity with a lot of diversion walls and historical disturbance present. Moderate modification to the system is trampling and grazing within river channel by stock

It is important to remember is that when pools are threatened by silting due to erosion or mismanagement of the catchment upstream it would mean that refugia for instream biota is removed and this could lead to the destruction of instream biota in other non-perennial rivers in the vicinity as well.

Alien vegetation

A small number of alien tamarisk trees are growing in the main drainage line. *Prosopis glandulosa, is* regarded as one of the 12 agriculturally most important invasive alien plants in South Africa, is widely distributed in this vegetation type, however none has been observed in the project area.

List and map sensitive environments in proximity of the project locality-sensitive environments include wetlands, nature reserves, protected areas, etc.

Northern Upper Karoo has not been significantly affected by transformation and is still approximately 96% intact. It is classified as Least Threatened (Mucina & Rutherford 2006). The Soventix Project Site falls within the planning domain of the Northern Cape Provincial Biodiversity Plan, developed by the Department of Environment and Nature Conservation, Northern Cape. The potential impact of the development on Critical Biodiversity Areas should be considered in detail as these areas have been identified through systematic conservation planning exercises and represent biodiversity priority areas which should be maintained in a natural to near natural state in order to safeguard biodiversity pattern and ecological processes. The CBA maps indicate the most efficient selection and classification of land portions requiring safeguarding in order to meet national biodiversity objectives.

4.8 Ecological importance of the site

To establish how important the site is for meeting biodiversity targets, the Land-Use Decision Support Tool (LUDS) was used to compile the LUDS Report (BGIS, 2016). LUDS was developed to facilitate and support biodiversity planning and land-use decision-making at a national and provincial level. Its primary objective is to serve as a guide for biodiversity planning but should not replace specialist ecological assessments.

Critical Biodiversity Areas (CBAs) are areas of the landscape that need to be maintained in a natural or near-natural state in order to ensure the continued existence and functioning of species and ecosystems and the delivery of ecosystem services. If these areas are not maintained in a natural or near-natural state then biodiversity conservation targets cannot be met. Maintaining an area in a natural state can include a variety of biodiversity-compatible land uses and resource uses.

Before the field study, the team will establish how important the site is for meeting biodiversity targets. To do this, it is necessary to answer the following three simple but fundamentally important questions:

- How important is the site for meeting biodiversity objectives (e.g. is it in a CBA or Ecological Support Area (ESA)?
- Is the proposed land-use consistent with these objectives or not (to be checked against the land-use guidelines)?
- Does the sensitivity of this area trigger the Department of Environment and Nature Conservation, Northern Cape's requirements for assessing and mitigating environmental impacts of developments, or in terms of the listed activities in the EIA regulations?

The key results of the BGIS Maps are illustrated in Figure 17 and the LUDS Report are summarized in Table 21. The information is extracted for the area from national datasets available on the Biodiversity Geographic Information System (BGIS).

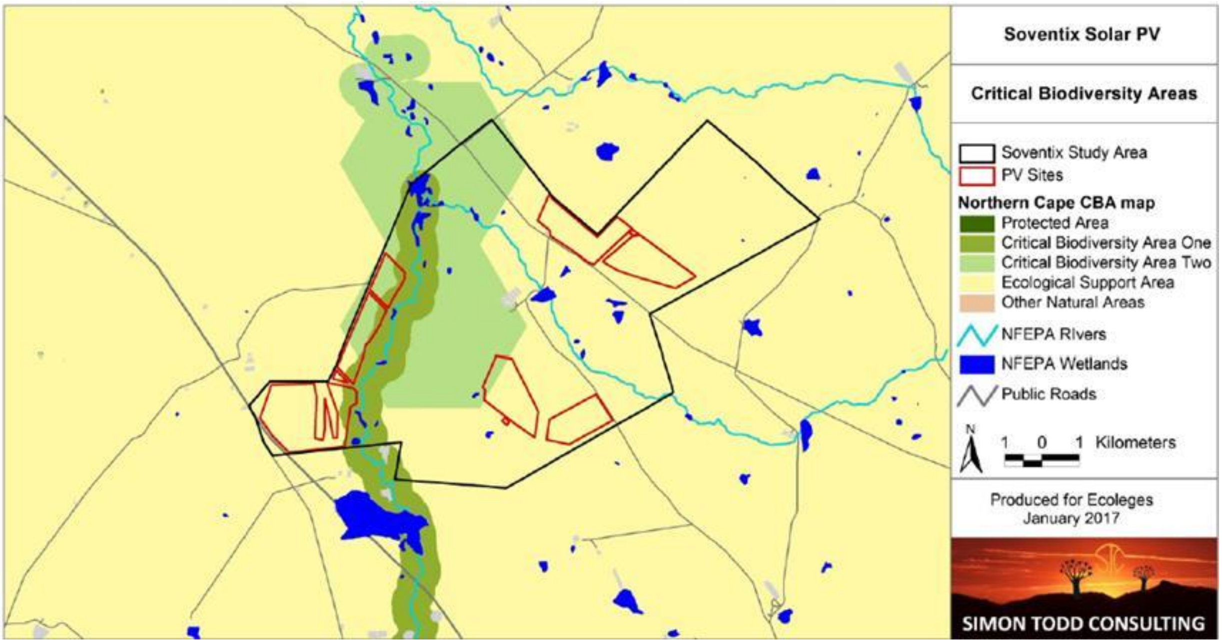


Figure 17: Critical Biodiversity Areas map of the proposed Soventix PV project and the surrounding area.

Critical Biodiversity Areas (CBAs)

Ecological Support Areas (ESAs): Those areas that play a significant role in supporting ecological functioning of Critical Biodiversity Areas (CBAs) and/or delivering ecosystem services, as determined in a systematic biodiversity plan. A *Critical Biodiversity Area map* is a map of Critical Biodiversity Areas and Ecological Support Areas based on a systematic biodiversity plan. Critical Biodiversity Areas and Ecological Support Areas are areas that require safeguarding to ensure the continued existence of biodiversity, ecological processes and ecosystem services. A Critical Biodiversity Area map, often developed at provincial level, provides the basis for a biodiversity sector plan.

Freshwater Ecosystem Priority Areas (FEPAs)

Freshwater Ecosystem Priority Areas (FEPAs) were identified based on a range of criteria dealing with the maintenance of key ecological processes and the conservation of ecosystem types and species associated with rivers, wetlands and estuaries FEPA maps show various different categories, each with different management implications. The categories include river FEPAs and associated sub-quaternary catchments, wetland FEPAs, wetland clusters, Fish Support Areas and associated sub-quaternary catchments, fish sanctuaries, phase 2 FEPAs and associated sub-quaternary catchments, and Upstream Management Areas. NFEPA map products provide strategic spatial priorities for conserving South Africa's freshwater ecosystems and supporting sustainable use of water resources. These strategic spatial priorities are known as Freshwater Ecosystem Priority Areas, or FEPAs.

Table 21: The key results of the LUDS Report as extracted for the Soventix project area from national datasets available from BGIS.

National Data Set	Aspect	Presence
National terrestrial information: Northern Cape		
South African municipal boundaries	**Municipality name:** Local - Emthanjeni (NC073) District – Pixley ka Seme	NC073
Informal land-based protected areas		
Protected area	An area of land or sea that is formally protected in terms of the Protected Areas Act and managed mainly for biodiversity conservation. Includes state-owned protected areas and contract protected areas.	None
Critical Biodiversity Areas		
Critical Biodiversity Area 1	Riverine system	Brak River
Critical Biodiversity Area 2	Drainage area	Brak River
Ecological support Area	Nama Karoo	Ephemeral - - Lower foothill
National aquatic information: Lower Orange, Orange tributaries		
Brak River	Largely natural, not threatened	D62D-05613 & D62D – 05610
NFEPA sub-quat. catchment river FEPAs (Wetland Cluster)	D62D	WetCluster FEPA
FEPA River ecosystem type	D62D-05613	Ephemeral - Nama Karoo - Lower foothill Ephemeral - Nama Karoo - Upper foothill
1. FEPA River ecosystem type	D62D-05613	Upper Nama Karoo_Channelled valley-bottom wetland Upper Nama Karoo_Flat Upper Nama Upper Nama Karoo_Seep Karoo_Unchannelled valley-bottom wetland

2. FEPA River ecosystem type	D62D – 05610	Upper Nama Karoo_Channelled valley-bottom wetland Upper Nama Karoo_Flat Upper Nama Upper Nama Karoo_Unchannelled valley-bottom wetland

In the study area, the Brak River has been identified as having conservation importance. Figure 17 represents the Freshwater Ecosystem Protected Areas (FEPA) map for the area. For river FEPAs the whole sub-quaternary catchment is shown in dark green (Figure 17), although FEPA status applies to the actual river reach within such a sub-quaternary catchment. The shading of the whole sub-quaternary catchment indicates that the surrounding land and smaller stream network need to be managed in a way that maintains the good condition (A or B ecological category) of the river reach.

Wetland clusters (Table 18) are groups of wetlands embedded in a relatively natural landscape. This allows for important ecological processes such as migration of frogs and insects between wetlands. In many areas of the country, wetland clusters no longer exist because the surrounding land has become too fragmented by human impacts.

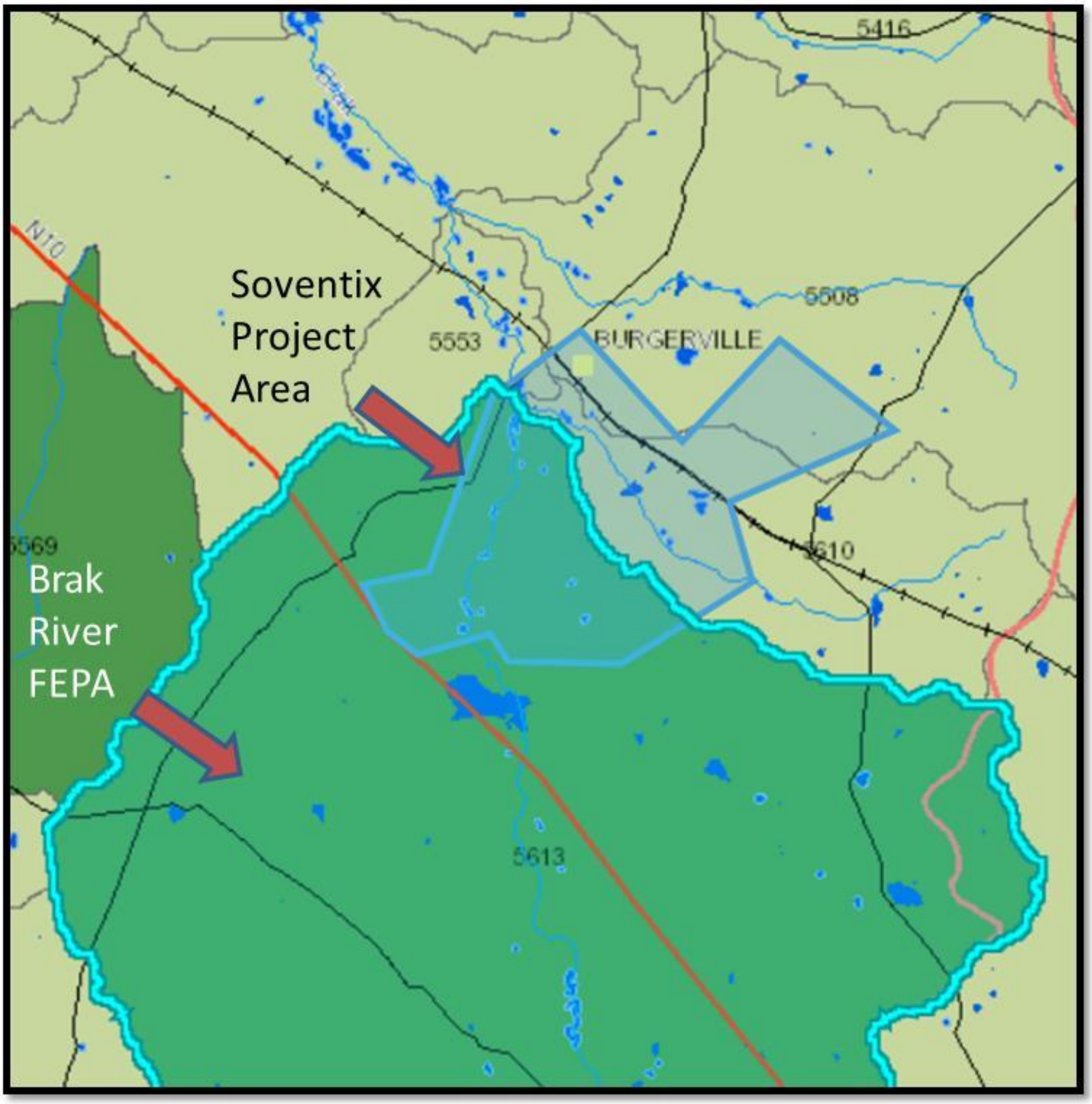


Figure 18: The position of the project site in relation to the Brak River FEPA.

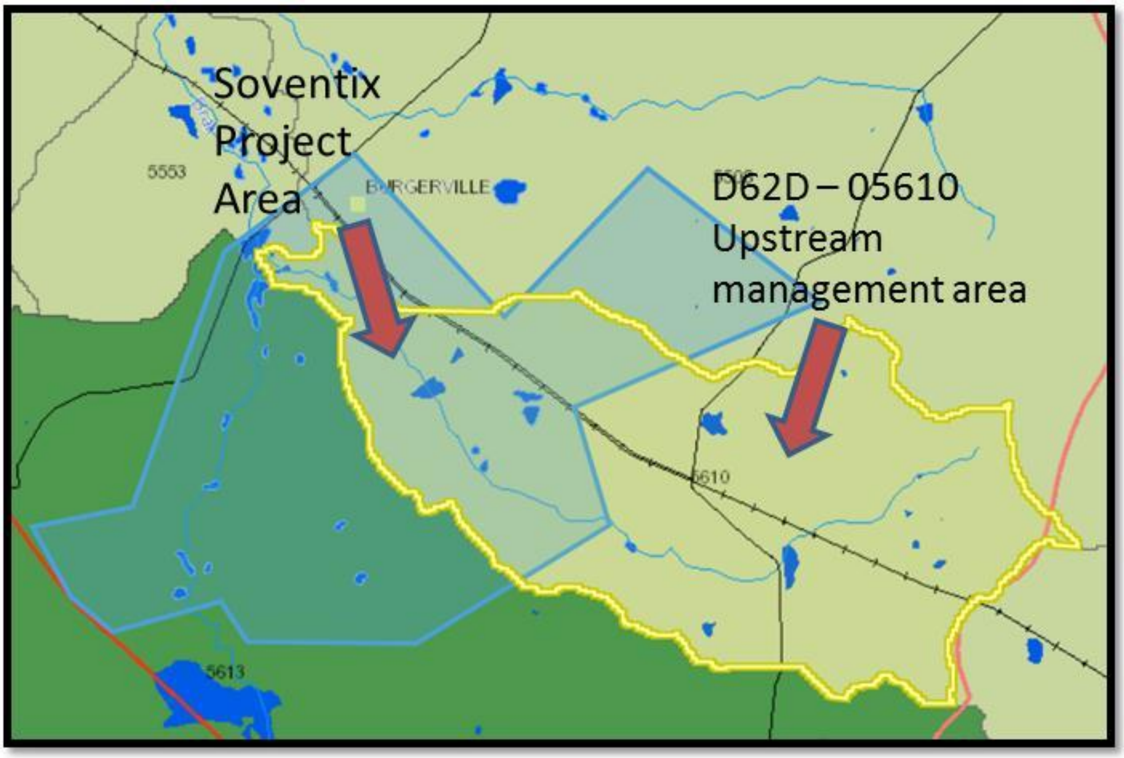


Figure 19: The position of the D62D-05610 FEPA Upstream Management Area in relation to the project site.

Upstream Management Areas (Figure 19) are sub-quaternary catchments in which human activities need to be managed to prevent degradation of downstream river FEPAs and Fish Support Areas. Upstream Management Areas do not include management areas for wetland FEPAs, which need to be determined at a finer scale.

The areas surrounding the drainage lines in the project area (light yellow in Figure 17), is classified as an Ecological Support Area (ESA). The desired management objective for an ESA is to be maintained in a natural, functional state. Limited loss of ecosystems or functionality is acceptable, as long as the present ecological state is not lowered.

- All wetlands are protected under the National Water Act (Act 36 of 1998).
- In terms of the National Water Act, freshwater ecosystems (all wetlands included) should not be allowed to degrade to an unacceptably modified condition (E or F ecological category).
- Conduct a buffer determination assessment around all wetlands, regardless of ecological condition or ecosystem threat status.
- Any further loss of area or ecological condition must be avoided, including if needed, a 100 m generic buffer around the wetland.

The following four-step process should be followed for taking FEPAs into account in EIAs and will supply information on the Brak River as part of the Department of Environment and Nature Conservation, Northern Cape systematic biodiversity plans:

FEPA Step 1: Consult the FEPA map

- Make an initial desktop assessment of whether the proposed activity is likely to impact on the FEPA as mapped.

Probable impacts to mitigate.

Water flow patterns

The land use is currently agriculture, and will retain in part its agricultural use for livestock grazing, but will convert significant sections for commercial Solar PV for a fixed-term. The size of the proposed Solar development footprint is approximately 520ha.

Altered surface water flow patterns, e.g., changing sheet flow (natural open system) to concentrated flows (large areas of solar panels directing rainwater), which leads to erosion, altered flow regimes and changes in water availability.

Storm water run-off from vehicle service tracks between the panel arrays, un-surfaced roads, buildings, borrow pits and excavation sites may cause erosion and channelling of flow, changes in flow patterns, head-cut and gully erosion, and sedimentation in wetlands and watercourses.

Inadequate storm water management and soil stabilisation measures in cleared areas could lead to erosion that could cause the loss of riparian vegetation and which would lead to siltation of nearby watercourses.

Off-road driving (even once-off) can cause long-term structural change in habitat. Driving of heavy vehicles even once over flat clay flood plain areas will have major impact, these areas are highly sensitive to change and the whole ecology of the system is dependent on spreading out of water over vast flat areas during rainfall events.

Indentations caused from vehicles driving over the soil surface will cause significant changes in water run off patterns and will remain in the landscape for hundreds of years.

Erosion

Erosion and sedimentation are important ecological processes in the Karoo. Loss and fragmentation of habitat disrupt these processes. Erosion is a particularly high risk on steep slopes, and in drainage lines that lack channel features and are naturally adapted to lower energy runoff with dispersed surface flows (such as unchannelled valley-bottom wetlands), and naturally less turbid freshwater systems.

Damming or diverting water

No additional or new damming of water or diverting water as part of the project construction or long-term operations is envisaged. However, the construction of a sub-station will not be feasible within one dry season, so improvements to the road surface may impede instream flow during the wet season.

Extraction of groundwater

Any extraction of water (surface or groundwater) in the arid Karoo environment will result in impacts on inundation/saturation regimes in wetlands, and flow regimes in watercourses. Extraction of groundwater will also result in drawdown of the water table.

Ephemeral and seasonal pools lower down in catchments are more vulnerable as they are more dependent on groundwater.

Extraction of water will cause a decline on species dependent on water availability, including amphibians and fish, and may impact availability of breeding habitats for aquatic species. Riparian plant species and communities dependant on perched water tables (such as *Valchelia karroo, Searsia lancea, Phragmites australis*) will be impacted.

Roads and stream crossings

Driving on wet clay forms ruts that later develop into dongas or holes too deep for vegetation establishment. The disruption of surface drainage patterns where roads are raised above the base level of natural drainage channels or wetlands can cause fragmentation of aquatic ecosystems, and loss of connectivity, and can hamper the movement of aquatic or semi-aquatic fauna along riverine corridors or within and between wetlands.

Once permanent roads are built and regularly maintained and graded, there will be erosion that results from the formation of rills. This will change hydrological flows and have a detrimental effect on vegetation surrounding the roads.

Pollution of the water sources

Construction and maintenance of roads and other infrastructure can be associated with spills of fuel and other chemicals. Water pollution/contamination from accidental releases associated with natural flood events; leaking infrastructure (e.g. ponds, closed water treatment units); and spills of waste water.

In addition to pollution effects, any release of waste water into surface water ecosystems will impact on flow and temperature regimes. This is especially disruptive for the ephemeral and seasonal ecosystems of the arid Karoo environment, including affecting hatching/mating cues and growth of freshwater species.

The uncontrolled interaction of construction workers with watercourses that could lead to the pollution of these watercourses, e.g. dumping of construction material into the drainage system, washing of equipment The lack of provision of adequate sanitary facilities and ablutions on the servitude may lead to direct or indirect faecal pollution of surface water resources.

Invasive alien plant species

Construction can introduce invasive alien species, and lead to the spread of those that are already present. This will negatively compete with indigenous species and disrupt ecological processes.

Overhead power lines

Power lines can be associated with impacts on surface water resources if the towers are placed within a river or watercourse, or if the riparian vegetation within the power line servitude is felled. The process of constructing the power lines can also cause impacts on surface water resources, especially if certain mitigation measures and procedures are not followed.

Apart from habitat loss within the development footprint, another major potential source of impact of the development on birds would be from any power lines needed for the grid connection which could cause mortalities through electrocution and collisions of susceptible wetland bird species such as cranes and flamingos. Given the proximity of the Eskom lines to the site, any required overhead lines would be short, which would be important in mitigating this impact to a low level. Bird flappers could be incorporated in areas of increased bird activity.

FEPA Step 2: Site assessment

- Visit the site. Verify that the river/wetland ecosystem types for which the FEPA has been selected exist on the ground. Check that the FEPA is not heavily modified.

The site visit to the Soventix project area took place in October 2017 and April 2022. At the time of the field visit the river had no surface water available, not even in the earthen dams. There are a large number of small and medium-sized weirs and dams in the study area, and about 15 of these are found on the project farm alone. The floodplain and alluvial fans have been heavily modified by human activity with a lot of diversion walls and historical disturbance present. It is concluded that this FEPA is moderately modified.

Most of the demarcated FEPA wetlands in the project area are in fact these small and medium-sized weirs and dams. The dams and weirs built in non-perennial rivers also serve as refugia for invertebrates and fish, and the water quality in these structures would determine the population of invertebrates that survive the dry periods. These structures however also serve as migration barriers to biota.

- Ground-truth the location of the FEPA (e.g. the river, the associated sub-quaternary catchment, and any wetland FEPAs that fall within the sub-quaternary catchment);

The location of the FEPAs was verified and indicated in the maps (Figures 18 and 19).

- Type the FEPA according to the river and wetland ecosystem types used by NFEPA (see Table 22);

Table 22: The Brak River FEPA according to the river and wetland ecosystem types used by NFEPA (Nel et al, 2011).

1. FEPA River ecosystem type	D62D-05613	Upper Nama Karoo_Channelled valley-bottom wetland Upper Nama Karoo_Flat Upper Nama Upper Nama Karoo_Seep Karoo_Unchannelled valley-bottom wetland

- Examine the surrounding sub-quaternary catchment, looking at the condition and location of other FEPAs (see Table 23), and other freshwater ecosystems in good condition, and/or of apparent ecological importance and/or sensitivity;

Table 23: The unnamed FEPA according to the river and wetland ecosystem types used by NFEPA (Nel et al, 2011).

2. FEPA River ecosystem type	D62D – 05610	Upper Nama Karoo_Channelled valley-bottom wetland Upper Nama Karoo_Flat Upper Nama Upper Nama Karoo_Unchannelled valley-bottom wetland

The unnamed drainage line (D62D - 05610), which is a tributary to the Brak River (D62D - 05613), is discernible only as a slightly shallow depression with no clear associated vegetation and slightly clayey soils. Dwarf karroid scrub and tufted grass are the only vegetation present in this drainage area. It is in a good condition despite some weirs and diversion walls in die catchment.

Determine current condition (present ecological state) and compare with modelled condition: EcoStatus (Present Ecological State) for rivers – *primary data should be collected wherever possible*.

Since there was no surface water available in the entire study area along the Brak River in the SQ reach D62D-05613 during the aquatic surveys, the estimated ECs of the fish and macro-invertebrates were derived from the PESEIS database (DWS, 2014). Collectively the aquatic biota has an Instream Ecological Category of an EcoStatus D (50.0%): “Largely modified”, mainly attributed to the many weirs in the system. On the other hand, the riparian vegetation Ecological Category is a B “Largely natural with few modifications” and thus the increasing the overall EcoStatus to a C (72.5%): “Moderately modified”.

FEPA Step 3: Delineate the ecosystem

- Map the extent of the FEPA accurately, using the DWA protocol for delineation of wetlands and riparian areas (DWAF, 2005);

The Brak River SQ D62D-05610 is a Critical Biodiversity Area one, while the area surrounding the ephemeral drainage line, is categorised as a Critical Biodiversity Area two. As part of the management objective for the Northern Cape CBA process, the following is suggested:

- ➢ Conduct a buffer determination assessment around all wetlands, regardless of ecological condition or ecosystem threat status.
- ➢ Any further loss of area or ecological condition must be avoided, including if needed, a 100 m generic buffer around the wetland.

- Determine the appropriate buffer width, using accepted national protocols.

The 100 m buffer around the delineated riparian area should be measured from the top of the active channel bank. Most of the development is positioned further than 100 from the edge of the drainage wetland by the EIA team, thus a 100m buffer is acceptable in this dry environment.

FEPA Step 4: Assess the significance of the impact of the proposed development

- Determine ecological importance and sensitivity (EIS) using DWA protocol, and compare with FEPA status – examine the reasons why ecosystem has achieved FEPA status, and check whether these are correct and complete, if so, these should be used in the determination of EIS – *primary data should be collected wherever possible*;

The PESEIS data from the Department of Water and Sanitation Desktop PESEIS assessment (DWS, 2014), supplies most of the current status information of the relevant sub-quaternary river reaches (SQRs) for South Africa. The objective of the PESEIS is to provide desktop level information on ecological issues as it relates to the protection and management of SQRs. For management purposes this refers specifically to the consideration of ecological reserve issues, water use licensing issues and EWRM (including the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP) activities) and the determination of priorities for monitoring.

The mean Ecological Importance Class of the Brak River in the SQ reach D62D-05613 is "Moderate" (DWS, 2014). The mean Ecological Sensitivity Class of the Brak River in the SQ reach D62D-05613 is "Moderate" (DWS, 2014).

Since there was no surface water available in the entire study area along the Brak River in the SQ reach D62D-05613 during the aquatic surveys, the estimated ECs of the fish and macro-invertebrates were derived from the PESEIS database (DWS, 2014). Collectively the aquatic biota has an Instream Ecological Category of an EcoStatus D (50.0%): "Largely modified", mainly attributed to the many weirs in the system. On the other hand, the riparian vegetation Ecological Category is a B "Largely natural with few modifications" and thus the increasing the overall EcoStatus to a C (72.5%): "Moderately modified".

- Assess the significance of impacts. The degree of significance will depend on the degree of deterioration in ecological condition that would result from the proposed development as well as its reversibility (e.g., whether the impact is short-term, medium-term or long-term).

This will be discussed in the following task: Risk Assessment

- Deterioration of a FEPA from a B ecological condition to a C condition might be considered an impact of medium significance but should never be considered of low significance.

This level of deterioration is not envisaged.

FEPA Step 5: Make recommendations ((This will be discussed in the following task - Risk Assessment))

- Consult the NFEPA ecosystem management guidelines, and apply these to the development application;

- Develop suitable and realistic mitigation measures;

- Determine rehabilitation requirements, in order to meet management objectives for FEPAs;

Design a monitoring programme that aims to track the impacts associated with the development and how these affect the condition of the affected FEPAs.

4.9 Assessment of impacts – Risk Matrix (Based on DWS 2015 publication: Section 21 c and I water use Risk Assessment Protocol)

The risks associated with the water use/s and related activities.

The Risk Assessment was done in accordance with the Risk Matrix (Based on DWS 2015 publication: Section 21 (c) and (I) water use Risk Assessment Protocol and as contained in Appendix A in GN509 of 26 August 2016) and was carried out considering the risk rating of the project. Following is an abstract from the completed Risk Matrix to indicate the significance of the project activities of the Part 2 amendment for De Aar Phase 1:

Table 24: Following is an abstract from the Risk Assessment Matrix for the Part 2 amendment for De Aar Phase 1 relating to all current and expected impacts that the project had on the system, the significance of these impacts, and mitigation through control measures.

No.	Phases	Activity	Aspect	Potential Impact	Significance	Risk Rating after mitigation	Confidence level	Control Measures
1	Construction	Upgrading of existing roads for heavy vehicles	Vegetation clearing during upgrading access routes.	1. Any permanent clearing within those rivers or streams with defined riparian areas will be subject to erosion and sedimentation impacts due to the lack of vegetation cover, e.g. along the access roads remains un-vegetated (post installation), especially where channel banks are steeply inclined.	**29,25**	**Low**	**4**	• Avoid routes through drainage lines and riparian zones wherever possible. Where access through drainage lines and riparian zones is unavoidable, only one road is permitted, constructed perpendicular to the drainage line. • Avoid roads that follow drainage lines within the floodplain. • Existing roads should be used for access as far as possible. Make use of existing roads and tracks where feasible, rather than creating new routes. • Any additional routes and turning areas required by the contractor must be approved by the EO / ECO, in the form of an amended ESM&R Plan indicating the position and extent of the proposed route / area. • No offroad driving is permitted, unless authorised by the EM. • Ensure that all access roads utilised during construction (which are not earmarked for closure and rehabilitation) are returned to a usable state and / or a state no worse than prior to construction.
			Inadequate stabilisation and rehabilitation of the current and previously cleared areas and old access roads.	2. This could result in erosion and elevated sediment input into adjacent watercourses.	**42,75**	**Low**	**3**	Maintain all access routes and roads adequately in order to minimise erosion and undue surface damage. Repair rutting and potholing and maintain stormwater control mechanisms. Regularly remove topsoil (and other material) accumulated in side drains of roadways to keep these open and functional.

			Inadequate stormwater management and erosion control in the along access roads (particularly where these cross watercourses) .	3. This could result in sediment or sediment-laden water entering the watercourses.	**51,75**	**Low**	**3**	Runoff from roads must be managed to avoid erosion and pollution problems.
2	Construction	Upgrading the river crossing by the placing of gravel across the watercourse.	Damming of upstream area:	4. Changes in temporal and spatial characteristics of flow can have an impact on habitat attributes such as an increase in duration of low flow season, resulting in low availability of certain habitat types or water at the start of the breeding, flowering or growing season.	**37,5**	**Low**	3	Basal culverts or pipes will be Installed to allow for throughflow of water through the bridge structure. These structures will accommodate the pressure of the traffic, but will also allow for the passage of water when there is flow during the rainy season and medium-sized fish (mudfish or yellowfish) will be able to pass through.
				5. The first wet season flows from the catchment are can be retained behind the bridge because levels are depleted at the end of the dry season. This may impact both on the river biota and the downstream users.	**37,5**	**Low**	3	
				6. By trapping sediment behind the bridge, interrupt the continuity of sediment transport through the river, depriving downstream reaches of sediments essential for channel form and aquatic habitats. By trapping sediment behind the bridge, interrupt the continuity of sediment transport through the river, depriving downstream reaches of sediments essential for channel form and aquatic habitats.	**45**	**Low**	3	
				7. Damming also serve as a physical barrier to movement of migratory species, notably fish.	**45**	**Low**	3	

			Rehabilitation or deconstruction of the bridge.	8. Potential damage to the instream and marginal habitats when anaerobic sediments are washed down the river during rehabilitation or deconstruction of the bridge. Suffocating aquatic fauna and inundating instream habitats.	**38,25**	**Low**	3	All measures should be taken to prevent the sudden release of sediment being washed into the downstream habitats in order to prevent damage to the instream and marginal habitats. Any such sediments must be physically removed from the channel before the bridge is rehabilitated or deconstructed.
			Timing of construction activities	9. Timing of work - Potential erosion and siltation during the rainy season. Impacting on ephemeral flow events and influencing breeding birds and fish - implementing the project during the no-flow period will nullify this issue.	**26**	**Low**	4	It is generally specified that work in watercourses is carried out during periods of low average rainfall. This reduces the risks inherent in their construction. Further, the lower stream flows reduce the risks of scour and disturbance of sediment in the river beds during construction. All work within a water resource should be completed during the dry season, when flows are at their lowest. This significance can be reduced to low when construction takes place during the dry season or when sedimentation ponds are used to settle out the suspended solids.
3	Construction	Area of disturbance and human interference	General aspects relating to disturbance and human interference	10. The overall pollution of the riverine ecology.	**24**	**Low**	**4**	Should a buffer zone be proposed, all the planned activities will be incorporated into this zone and the purpose of the buffer zone will be futile. However, the implementation of a buffer zone to emphasize the importance of the riparian zone and adjacent dry land will certainly augment the importance of the ecology in the project area. The area included in the buffer zone, as well as the core areas in the riverine zone should have explicit and very strict biodiversity conservation management measures and the operating teams should be well aware of this. Therefore, a buffer zone for the project is suggested on both sides of the river in order to impose a level of best practices when the proposed construction gets under way.
			Vehicle maintenance - Fuels and oils	11. Potential sources of pollution; run-off of contaminated water from vehicle activity during construction (Fuels and oils). - Ecological disturbance and pollution (degradation of the subsurface water resource)	**24**	**Low**	4	The Contractors shall ensure that there are adequate facilities for the handling and storage of used parts, oils, grease, cleaning fluids and fuels. These facilities will be planned and managed keeping the following in mind: • Storage • Facilities • Location • Spills • Waste handling

			Working place and storage	12. Working/storage distances from watercourse - Ecological disturbance (impact on soil surface) and pollution (proximity to stream)	**24**	**Low**	4	Chemicals and hazardous materials and waste storage areas should be in dedicated storage buildings sited more than 100 m from any watercourse. Vehicle and equipment maintenance should not take place on site and not within 100 m of a river or wetland; but at a dedicated workshop with bunded surfaces. Operational buildings (storage of fertilizers, chemicals, ablutions) to be situated > 100 m from any watercourse.
			Vehicle and equipment washing areas	13. Ecological disturbance (sedimentation and siltation of watercourses) and pollution (contamination of water resources) (degradation of groundwater resource).	**24**	**Low**	4	Vehicle and equipment maintenance should not take place on site and not within 100 m of a river or wetland; but at a dedicated workshop with bunded surfaces. Do not allow the washing of trucks delivering concrete anywhere but within designated wash bays equipped with runoff containment. Direct such waste water into a settlement pond or sludge dam for later disposal
			Collection of natural resources	14. The collection and removal of rocks, stones, grit, sand or gravel from the riverine environment will impact on the habitat composition of the local ecosystem.	**24**	**Low**	4	Refrain from removing any natural material or structures from the riverine environment, such as rocks, stones, grit, sand, gravel, dead trees or tree trunks. These components act as natural habitat for the ecosystem after the completion of the project.
			Construction camp	15. Presence of people, movement, noise and sewage effluent.	**24**	**Low**	4	The site camp should be located more than 100 m from the rivers (and wetlands) and outside of any riparian area. The site camp must be located in a manner that does not adversely affect the environment and must be easily accessible via the existing road network.
	Construction	Impacts of the powerline	The potential impacts of the powerline on surface water quality,	16. Erosion of topsoil on areas cleared or disturbed around the pylon site, including access routes, with resultant increased suspended solids, as well as siltation in watercourses.	**27**	**Low**	4	No pylons should be located within an area that would be expected to become inundated during a 1:100 flood event. The area of disturbance should be kept to a minimum to allow clearing of the construction right of way. The width of the construction corridor should be kept to a minimum. Vegetation should be removed only where essential for the continuation of the powerline. Any disturbance to the adjoining natural vegetation cover or soils should not be allowed. Vegetation and soil should be retained in position for as long as possible, and should only be removed immediately ahead of construction / earthworks in any specific area.

6	Construction	Construction of Staging Area, sub-stations and transformers	Clearing of construction area and potential erosion and siltation.	Siltation of the river will compromise the aquatic ecology.	**24**	**Low**	**4**	The Staging Area, sub-stations and transformers fall outside the extent of the watercourse.
5	Operational	Alien invasive plants	Spreading invasive non-native plants into degraded areas.	17. Competing with indigenous plant species.	**38,25**	**Low**	**4**	A weed and alien invasive species control plan should be implemented during the contract period. Control involves killing the plants present, killing the seedlings which emerge, and establishing and managing an alternative plant cover to limit re-growth and re-invasion.

5. Discussion

a. EcoClassification

EcoClassification - the term used for the Ecological Classification process - refers to the determination and categorisation of the Present Ecological State (PES; health or integrity) of various biophysical attributes of rivers relative to the natural or close to the natural reference condition. The steps followed in the EcoClassification process are as follows:

- Determine reference conditions for each component.
- Determine the Present Ecological State for each component as well as for the EcoStatus. The EcoStatus refers to the integration of physical changes by the biota and as reflected by biological responses.
- Determine the trend (i.e., moving towards or away from the reference condition) for each component as well as for the EcoStatus.
- Determine causes for the PES and whether these are flow or non-flow related.
- Determine the Ecological Importance and Sensitivity (EIS) of the biota and habitat.

Present Ecological State or PES

The purpose of EcoClassification is to gain insight into the causes and sources of the deviation of the PES of biophysical attributes from the reference condition. This provides the information needed to derive desirable and attainable future ecological objectives for the river.

The state of the river is expressed in terms of biophysical components:

- Drivers (physico-chemical, geomorphology, hydrology), which provide a particular habitat template; and
- Biological responses (fish, riparian vegetation, riverine fauna (other than fish) and aquatic invertebrates).

The Brak River of the SQ reach D62D-05613 were evaluated as “Largely modified” with a PES category “D” (Table 25), based on the median of the metrics (DWS, 2014).

Table 25: A summary of the PES of the Brak River obtained from the DWS PES-EIS model (DWS, 2014).

Parameters	Potential modification (see list below)
Instream habitat continuity modification	3
Riparian/Wetland zone continuity modification	3
Potential instream habitat modification	2
Riparian/Wetland zone modification	3
Potential flow modification	2
Potential physico-chemical modification	1
PES Overall	**D**
	Largely modified

Interpretation of Impact Ratings (referred by in Table 25):

None. Reference. No discernible impact, or the modification is located in such a way that it has no impact on habitat quality, diversity, size and variability. Rating = 0

Small. The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability are also very small. Rating = 1

Moderate. The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability are also limited. Rating = 2

Large. The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability. Large areas are, however, not influenced. Rating= 3

Serious. The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area are affected. Only small areas are not influenced. Rating = 4

Critical. The modification is present overall with a high intensity. The habitat quality, diversity, size and variability in almost the whole of the defined section are influenced detrimentally. Rating = 5

Ecological Category (EC)

EcoStatus Definition: "totality of the features and characteristics of the river and its riparian areas that bear upon its ability to support an appropriate natural flora and fauna and its capacity to provide a variety of goods and services". This ability relates directly to the capacity of the system to provide a variety of goods and services.

The driver components are assessed separately (i.e., an EC for each driver) and not integrated at a driver level to provide a driver-based indication of the EcoStatus. However, the individual metrics of all the driver components are assessed in a combined fashion that allows some comparison between metrics of all drivers. This facilitates deriving the cause-and-effect relationship that is required in the interpretation and assessment of particular biological responses.

The biological responses are assessed separately, but the resulting fish and macro-invertebrate ECs are integrated to provide an indication of the in-stream EC (Table 26). Logically, the integration of the riparian vegetation EC and the in-stream EC would provide the EcoStatus. The influence of the riparian vegetation on the in-stream habitat is used to interpret the biological responses and endpoints. This means that in some cases, the integrated in-stream biological responses are deemed to provide a reasonable indication of the EcoStatus.

Table 26: Assessing the Ecostatus and Ecoclassification of the Brak River.

INSTREAM BIOTA	Importance Score	Weight	EC %	EC
FISH				
1.What is the natural diversity of **fish** species with different flow requirements	2	70		
2.What is the natural diversity of **fish** species with a preference for different cover types	3	50		
3.What is the natural diversity of **fish** species with a preference for different flow depth classes	1	100		
4. What is the natural diversity of **fish** species with various tolerances to modified water quality	5	10		
FISH ECOLOGICAL CATEGORY	11	230	**50.0**	**D**
AQUATIC INVERTEBRATES				
1. What is the natural diversity of **invertebrate** biotopes	3	30		
2. What is the natural diversity of **invertebrate** taxa with different velocity requirements	1	100		
3. What is the natural diversity of **invertebrate** taxa with different tolerances to modified water quality	2	40		
AQUATIC INVERTEBRATE ECOLOGICAL CATEGORY	**6**	170	**50.0**	**D**
INSTREAM ECOLOGICAL CATEGORY (No confidence)		400	**50.0**	**D**

INSTREAM ECOLOGICAL CATEGORY WITH CONFIDENCE	Confidence rating	Proportions	Modified weights
Confidence rating for **fish** information	1	0.50	25.00
Confidence rating for **macro-invertebrate** information	1	0.50	25.00
	2	1.00	50.00
INSTREAM ECOLOGICAL CATEOGORY	**EC**		**D**

RIPARIAN VEGETATION	EC %	EC
RIPARIAN VEGETATION ECOLOGICAL CATEGORY	**80.0**	**B**

ECOSTATUS	Confidence rating	Proportions	Modified weights
Confidence rating for instream biological information	1	0.25	12.50
Confidence rating for riparian vegetation zone information	3	0.75	60.00
	4	1.00	72.50
ECOSTATUS	**EC**		**C**

Since there was no surface water available in the entire study area along the Brak River in the SQ reach D62D-05613 during the aquatic surveys, the estimated ECs of the fish and macro-invertebrates were derived from the PESEIS database (DWS, 2014). Collectively the aquatic biota has an Instream Ecological Category of an EcoStatus D (50.0%): “Largely modified”, mainly attributed to the many weirs in the system. On the other hand, the riparian vegetation Ecological Category is a B “Largely natural with few modifications” and thus the increasing the overall EcoStatus to a C (72.5%): “Moderately modified” (Table 27).

Table 27: Generic ecological categories for EcoStatus.

ECOLOGICAL CATEGORY	DESCRIPTION	SCORE (% OF TOTAL)
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80-89
C	Moderately modified. A loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions have occurred.	40-59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions are extensive.	20-39
F	Critical/Extremely modified. Modifications have reached a critical level and the 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.	0-19

6. Conclusion and summary

The table below (Table 28) provides the available parameters that were instrumental to establish the PES of the Project Area:

Table 28: Available parameters that were instrumental to establish the PES of the Project Area.

Parameter	Score %	Category	Description
In-stream IHI	78.8	B/C	Largely natural with few modifications
Riparian IHI	68.8	C	Moderate change
VEGRAI (Vegetation)	80.2	B/C	Largely natural with few modifications
MIRAI (Macro-invertebrates)		D	Low diversity
FRAI (Fish)		D	Low diversity
Mean Ecological Importance Class			Moderate
mean Ecological Sensitivity Class			Moderate
EcoStatus	72.5	C	Moderately modified
PES		D	Largely modified

Mitigation (Control measures)

Apart of the mitigation prescribed in the Risk Assessment Matrix, the following should be noted:

1. Rehabilitation (DWS, 2016)

(1) Rehabilitation as contemplated in paragraph 6(1)(v) above must be conducted in terms of a rehabilitation plan and the implementation of the plan must be overseen by a suitably qualified SACNASP professional member.

(2) Upon completion of the construction activities related to the water use –

(a) a systematic rehabilitation programme must be undertaken to restore the watercourse to its condition prior to the commencement of the water use;
(b) all disturbed areas must be re-vegetated with indigenous vegetation suitable to the area; and
(c) active alien invasive plant control measures must be implemented to prevent invasion by exotic and alien vegetation within the disturbed area.

(3) Following the completion of any works, and during any annual inspection to determine the need for maintenance at any impeding or diverting structure, the water user must ensure that all disturbed areas are:
(i) cleared of construction debris and other blockages;
(ii) cleared of alien invasive vegetation;

(iii) reshaped to free -draining and non -erosive contours, and
(iv) re-vegetated with indigenous and endemic vegetation suitable to the area.

(4) Upon completion of any works, the water user must ensure that the hydrological functionality and integrity of the watercourse, including its bed, banks, riparian habitat and aquatic biota is equivalent to or exceeds that what existed before commencing with the works.

For most of the anticipated impacts on the environment during the construction phase of the dam, there are very sound mitigation measures (DWAF, 2005: Environmental Best Practice Specifications), and when implemented the process should be overseen by an Environmental Control Officer (ECO).

2. Buffer zones

The areas surrounding the drainage lines in the project area (Brak River and tributaries), is classified as an Ecological Support Area (ESA) and according to the Department of Environment and Nature Conservation, Northern Cape, a 100 m buffer is suggested around the delineated riparian area or 100m measured from the top of bank. Buffer zones have been used in land-use planning to protect natural resources and limit the impact of one land-use on another.

Suggestion by the Department of Environment and Nature Conservation, Northern Cape:

- Conduct a buffer determination assessment around all wetlands, regardless of ecological condition or ecosystem threat status.
- Any further loss of area or ecological condition must be avoided, including if needed, a 100 m generic buffer around the wetland.

Buffer zones associated with water resources have been shown to perform a wide range of functions, and on this basis, have been proposed as a standard measure to protect water resources and associated biodiversity. These functions include:

- Maintaining basic aquatic processes;
- Reducing impacts on water resources from upstream activities and adjoining land uses;
- Providing habitat for aquatic and semi-aquatic species;
- Providing habitat for terrestrial species; and
- A range of ancillary societal benefits.

Should a buffer zone be proposed, all the planned activities will be incorporated into this zone and the purpose of the buffer zone will be futile. However, the implementation of a buffer zone to emphasize the importance of the riparian zone and adjacent dry land will certainly augment the importance of the ecology in the project area. The area included in the buffer zone, as well as the core areas in the riverine zone should have explicit and very strict biodiversity conservation management measures and the operating teams should be well aware of this.

Therefore, a buffer zone for the project is suggested on both sides of the river in order to impose a level of best practices when the proposed construction gets under way.

Any potential risks must be managed and mitigated to ensure that no deterioration to the water resource takes place. Standard management measures should be implemented to ensure that any on-going activities do not result in a decline in water resource quality.

While determining the area and distribution of a core habitat is important, it is equally important that appropriate management measures be determined to ensure the core habitat continues to function effectively. Biodiversity conservation management measures that need to be taken into consideration when determining management measures for core habitats and corridors include:

- Habitat and species management;
- Alien and invasive species management;
- Fire management;
- Grazing management; and
- The management of soil erosion and physical disturbances.

Determining the required buffer width is largely an exercise of assessing the situation and linking it to an acceptable level of risk. Determining appropriate management measures for aquatic impact buffer zones is largely dependent on the threats associated with the proposed activity adjacent to the water resource. These threats include:

- Increases in sedimentation and turbidity;
- Increased nutrient inputs;
- Increased inputs of toxic organic and heavy metal contaminants; and
- Pathogen inputs.

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APPENDICES

Appendix 1: Finer detail EC rating table.

Rating	Deviation from reference conditions	A- F Categories	Natural – Poor categories	Score
0	No change	A	Natural	≥ 92.01
		A/B		>87.4 and <92.01
1	Small change	B	Good	82.01 – 87.4
		B/C		>77.4 and <82.01
2	Moderate change	C	Fair	62.01 – 77.4
		C/D		>57.4 and <62.01
3	Large change	D		42.01 – 57.4
		D/E		>37.4 and <42.01
4	Serious change	E	Poor	22.01 – 37.4
		E/F		>17.4 and <22.01
5	Extreme change	F		0 - 17.4