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AGRICULTURAL AND SOILS IMPACT ASSESSMENT FOR PROPOSED IMPOFU WEST WIND FARM NEAR HUMANSDORP, EASTERN CAPE

EIA PHASE REPORT

Report by
Johann Lanz

Prepared for Aurecon CONSULTANT
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March 2019

Johann Lanz
Professional profile

Education

• M.Sc. (Environmental Geochemistry)	University of Cape Town	1996 - June 1997
• B.Sc. Agriculture (Soil Science, Chemistry)	University of Stellenbosch	1992 - 1995
• BA (English, Environmental & Geographical Science)	University of Cape Town	1989 - 1991
• Matric Exemption	Wynberg Boy's High School	1983

Professional work experience

I am registered as a Professional Natural Scientist (Pri.Sci.Nat.) in the field of soil science, registration number 400268/12, and am a member of the Soil Science Society of South Africa.

- **Soil Science Consultant** **Self employed** **2002 - present**

  I run a soil science consulting business, servicing clients in both the environmental and agricultural industries. Typical consulting projects involve:
- Soil specialist study inputs to EIA's, SEA's and EMPR's. These have focused on impact assessments and rehabilitation on agricultural land, rehabilitation and re-vegetation of mining and industrially disturbed and contaminated soils, as well as more general aspects of soil resource management. Recent clients include: CSIR; SRK Consulting; Aurecon; Mainstream Renewable Power; SiVEST; Savannah Environmental; Subsolar; Red Cap Investments; MBB Consulting Engineers; Enviroworks; Sharples Environmental Services; Haw & Inglis; BioTherm Energy; Tiptrans.
- Soil resource evaluations and mapping for agricultural land use planning and management. Recent clients include: Cederberg Wines; Unit for Technical Assistance - Western Cape Department of Agriculture; Wedderwill Estate; Goedgedacht Olives; Zewenwacht Wine Estate, Lourensford Fruit Company; Kaarsten Boerdery; Thelema Mountain Vineyards; Rudera Wines; Flagstone Wines; Solms Delta Wines; Dornier Wines.
- I have conducted several recent research projects focused on conservation farming, soil health and carbon sequestration.
- I have project managed the development of soil nutrition software for Farmsecure Agri Science.

- **Soil Science Consultant** **Agricultural Consultors International (Tinie du Preez)** **1998 - end 2001**

  Responsible for providing all aspects of a soil science technical consulting service directly to clients in the wine, fruit and environmental industries all over South Africa, and in Chile, South America.

- **Contracting Soil Scientist** **De Beers Namaqualand Mines** **July 1997 - Jan 1998**

  Completed a contract to make recommendations on soil rehabilitation and re-vegetation of mined areas.

Publications

- Lanz, J. 2012. Soil health: sustaining Stellenbosch's roots. In: M Swilling, B Sebitosi & R Loots (eds). *Sustainable Stellenbosch: opening dialogues*. Stellenbosch: SunMedia.
- Lanz, J. 2010. Soil health indicators: physical and chemical. *South African Fruit Journal*, April / May 2010 issue.
- Lanz, J. 2009. Soil health constraints. *South African Fruit Journal*, August / September 2009 issue.
- Lanz, J. 2009. Soil carbon research. *AgriProbe*, Department of Agriculture.
- Lanz, J. 2005. Special Report: Soils and wine quality. *Wineland Magazine.*

I am a reviewing scientist for the *South African Journal of Plant and Soil*.

Specialist Declaration

I, Johann Lanz, as the appointed independent specialist, in terms of the 2014 EIA Regulations, hereby declare that I:

- I act as the independent specialist in this application;
- I perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- regard the information contained in this report as it relates to my specialist input/study to be true and correct, and do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I have no vested interest in the proposed activity proceeding;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I have ensured that information containing all relevant facts in respect of the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;
- I have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- all the particulars furnished by me in this specialist input/study are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the specialist:

Name of company: Johann Lanz – Soil Scientist

Professional Registration (including number): SACNASP Reg. no. 400268/12

Date: 01 March 2019

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EXECUTIVE SUMMARY

The proposed development is on land zoned and used for agriculture. South Africa has very limited arable land and it is therefore critical to ensure that development does not lead to a loss of agricultural production from such land.

The key findings of this study are:

- Soils across the Impofu West Wind Farm site are predominantly deep to moderately deep, very sandy soils with some drainage limitations. Dominant soil forms are Fernwood, Lamotte, Witfontein, and Glencoe. Although the soils are classified as different soil forms, from an agricultural use perspective there is very little difference between them. The only really significant difference between soils across the entire study area, which encompasses Impofu North, East and West Wind Farms, is the distinction between patches of shallow rock outcrops and all other soils.
- The soils are limited by very sandy texture, acidity, and low nutrient status.
- Despite the soil limitations, the combination of soils and climate is highly suitable for intensive and productive dairy farming on kikuyu based pastures. This is the land use of almost the entire site.
- In order to be viable, the proposed wind farm footprint will need to overlap with this land use.
- The natural agricultural potential across the Impofu West Wind Farm site area, excluding the patches of rock outcrop, is largely uniform and suitable for cultivated pastures.
- Agricultural sensitivity mapping classified sensitivity into 4 categories, low, moderate, high and No-Go. Low sensitivity areas are not suitable for cultivation. No-Go areas are irrigated land.
- No-Go areas need to be entirely avoided by the footprint of the development.
- The focus of an agricultural impact assessment is to determine to what extent a proposed development will compromise (or enhance) current and/or future agricultural production, irrespective of the agricultural capability of the land.
- The assessment of impacts in this report is informed by a case study that has measured the impact that 3 operational wind farms in the area have had on agricultural resources and production to date on the respective farms within which they are located.
- Five potential negative impacts of the development on agricultural resources and productivity were identified and assessed as:
    - Loss of agricultural land use caused by direct occupation of land by the wind farm footprint (minor significance).
    - Discontinuation of farming caused by wind farm derived income and by other negative lifestyle impacts (negligible significance).
    - Interference of wind farm infrastructure and activity with farming operations (negligible significance).
    - Damage to natural agricultural resource base by way of erosion and topsoil loss (negligible significance).

    - Depletion of potential agricultural water resources (negligible significance).
- Important factors that mitigate the significance of these negative impacts are:
    - The wind farm footprint occupies an insignificantly small proportion of the surface area of the farms on which it is located.
    - The proposed layout design has had extensive input by the impacted farmers aimed at minimising the loss of productive land and of disturbance to their farming operations.
- In addition, the results of the case study show that agricultural production from surrounding impacted farms has an upward trend over time, which suggests that negative impacts have not reduced production levels.
- Three potential positive impacts of the development on agricultural resources and productivity were identified and assessed as:
    - Increased financial security for farming operations due to reliable income from turbine rental, which can enable investment into farming (moderate significance).
    - Improvements to shared infrastructure such as roads (minor significance).
    - Improved farm security (negligible significance).
- Cumulative agricultural impacts were assessed as minor negative and moderate positive significance.
- Recommended mitigation measures include design phase avoidance of No-Go areas; avoidance of disturbance to agricultural operations; and enhancement of the usefulness of road locations to farming operations. Construction phase mitigation includes installation of cattle grids; storm water run-off control; facilitation of re-vegetation of denuded areas; Stripping, stockpiling and re-spreading of topsoil.
- The conclusion of this assessment is that, although the proposed development overlaps on cultivated farmland that supports intensive and productive dairy farming, the development is nevertheless highly unlikely to cause a reduction in agricultural production. Some production land will be lost, but the consequence of the lost land for agricultural production is negligible. It is likely that the positive impacts of the development will outweigh the negative impacts and that the development will therefore benefit farming and agricultural production.
- From an agricultural perspective, therefore, the proposed development should be authorised.

1 INTRODUCTION

Development of the Impofu West Wind Farm and associated infrastructure forms part of three proposed wind farms being assessed near Oyster Bay in the Eastern Cape. The proposed 132kV overhead powerline grid connection between the wind farm area and Port Elizabeth will be assessed separately. The proposed project is approximately 20 kilometres west of the town of Humansdorp in the Eastern Cape Province (see Figure 1).

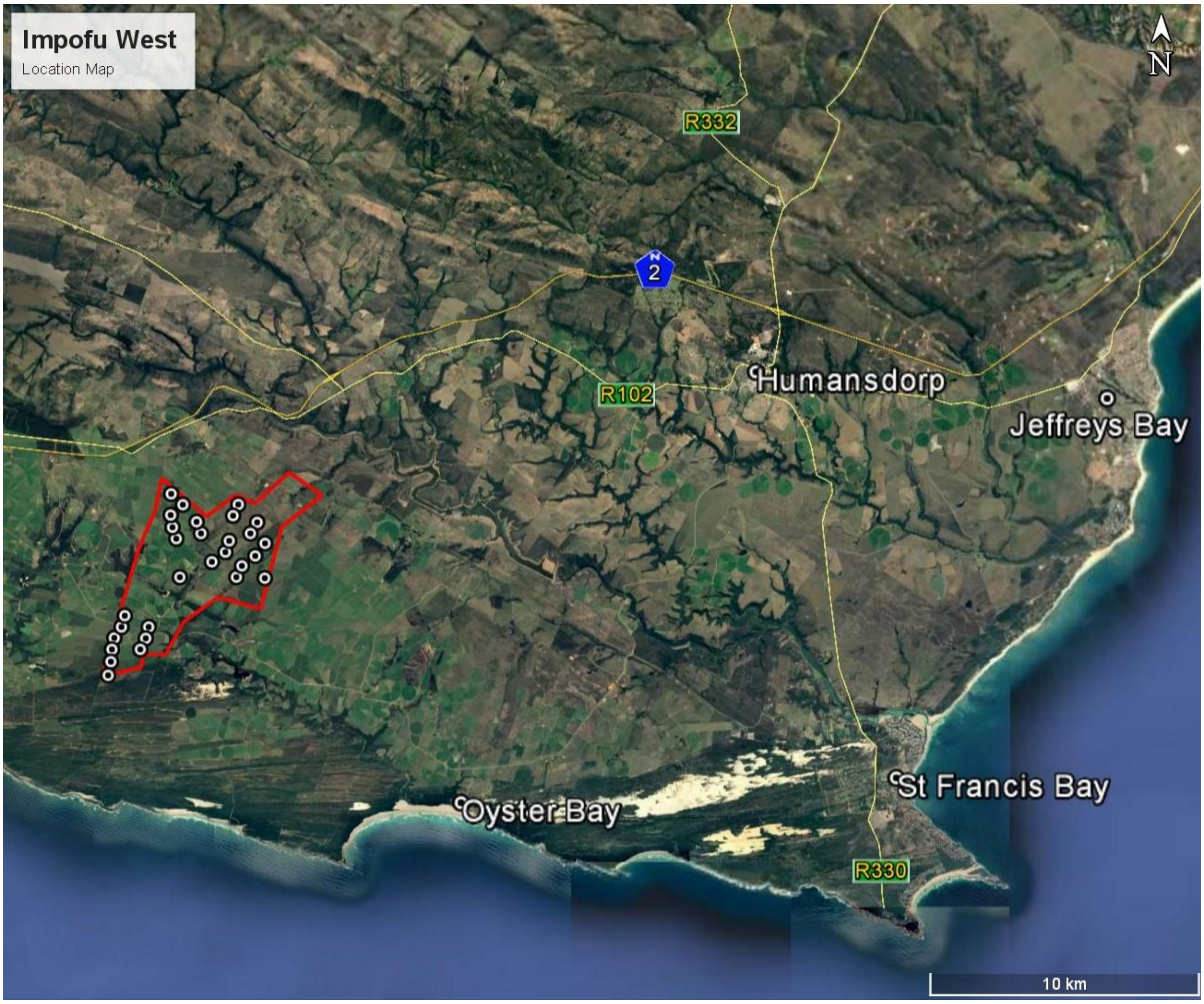

Figure 1. *Location map of the proposed development, showing the layout of proposed turbines, south-west of the town of Humansdorp.*

Proposed infrastructure for the Impofu West Wind Farm will include:

- A maximum of 29 turbines, each of 3-6MW generation capacity, with concrete foundations of 20 – 25 m diameter;
- A temporary disturbed area per turbine of approximately 100 x 50 m of which 50 x 30

will remain as a permanent hard stand;

- Internal gravel surface access roads of approximately 24 km in length and 6 m wide (Some sections of these roads would need to be temporarily widened to 12 m during construction);
- An on-site substation (with transformer) of approximately 150 x 75 m (11,250 m^2);
- Temporary site camp areas: 15,000 m^2;
- Workshop and administration buildings;
- Medium voltage (MV) overhead (four locations totalling approx. 950 m) and underground lines;
- Upgrading of 2 pipe culverts on District Road 1774 (although outside of the Impofu West Wind Farm boundary).

The objectives of this study are to identify and assess all potential impacts of the proposed development on agricultural resources, including soils, and agricultural production potential, and to provide recommended mitigation measures, monitoring requirements, and rehabilitation guidelines for all identified impacts. Johann Lanz was appointed by Red Cap Impofu West Pty Ltd as an independent specialist to conduct this Agricultural Impact Assessment.

2 TERMS OF REFERENCE

The terms of reference for the study fulfills the requirements for a soils and agricultural study as described in the National Department of Agriculture's document, *Regulations for the evaluation and review of applications pertaining to renewable energy on agricultural land*, dated September 2011. The study applies an appropriate level of detail for the agricultural suitability and soil variation on site, which, because it is justified (see section 3.1), is less than the standardised level of detail stipulated in the above regulations.

The above requirements may be summarised as:

- Identify and assess all potential impacts (direct, indirect and cumulative) of the proposed development on soils and agricultural potential.
- Describe and map soil types (soil forms) and characteristics (soil depth, soil colour, limiting factors, and clay content of the top and sub soil layers).
- Map soil survey points.
- Describe the topography of the site.
- Describe the climate in terms of agricultural suitability.
- Summarise available water sources for agriculture.
- Describe historical and current land use, agricultural infrastructure, as well as possible alternative land use options.
- Describe the erosion, vegetation and degradation status of the land.
- Determine the agricultural potential across the site.
- Determine the agricultural sensitivity to development across the site.
- Provide recommended mitigation measures, monitoring requirements, and rehabilitation guidelines for all identified impacts.

The report also fulfils the requirements of Appendix 6 of the 2014 EIA Regulations, as amended (see Table 1).

3 METHODOLOGY OF STUDY

3.1 Methodology for assessing soils and agricultural potential

The assessment was based on a soil survey of excavated test pits across the site, combined with background information obtained from existing soil and agricultural potential data for the site. The source of this data was the 2017 National land capability evaluation raster data layer and the land type data set produced by the Department of Agriculture, Forestry and Fisheries. Satellite imagery of the study area was also used.

The land type data originates from the land type survey that was conducted from the 1970's until 2002. It is the most reliable and comprehensive national database of soil information in South Africa and although the data was collected some time ago, it is still entirely relevant as the soil characteristics included in the land type data do not change within time scales of hundreds of years.

Soils are described in this data set according to the previous (but similar) version of the South African soil classification system, the latest version of which is documented in soil Working Group (1991). It is a two tier system of classification. Soil forms are the first level of division. All soil forms are given a South African place name. Soils are divided into forms based on the sequence of diagnostic soil horizons in the soil profile. A particular sequence, defines a particular soil form, for example A horizon – Podzol B horizon – unconsolidated material with signs of wetness is a Witfontein soil form and A horizon – E horizon – Soft Plinthic B horizon is a Longlands soil form. Each soil form is further divided into different families, based on certain distinguishing characteristics for the form. Families are given a four digit number.

Soil investigations can be done at a range of different levels of detail. The level of detail translates directly to the number of soil investigation points per area. The more detailed, the more accurate is the delineation of soil spatial variation. Soils vary continuously across the landscape but a soil survey can only record point data, and so for any soil survey there is always a compromise between accuracy and detail on the one hand, and practicality and cost of the investigation on the other hand. The number of soil investigation points per area should be determined by the level of detail that is required and that is meaningful for the purposes of the particular investigation.

The soil survey of the Impofu Wind Farms (North, East, and West) covers an area of more than 5,000 hectares. The proposed turbine positions for each respective wind farm were used as a starting point for positioning the test pits, but because of the amount of soil variation present, it was deemed unnecessary to investigate at the intensity of every turbine. The choice of which turbine positions to investigate was determined as the soil survey progressed and as an understanding of soil variation across the landscape was gained. A total of 69 test pits were distributed across the total area of all three proposed wind farms. Twenty three of these test pits were on Impofu West. The level of detail that this provided for soil mapping is considered entirely adequate for a thorough assessment of soil conditions and variation as it pertains to the assessment of all agricultural impacts of the Impofu Wind Farms.

The test pits were investigated across the study area in March 2018 by Johann Lanz. During the investigation, soils were classified according to the South African soil classification system (Soil Classification Working Group, 1991) and certain attributes of the soils were recorded for each investigated test pit. The collected data is presented in Table A2.

An assessment of soils (soil mapping) and long term agricultural potential is in no way affected by the season in which the assessment is made, and therefore the fact that the assessment was done in summer has no bearing on its results.

The field investigation also included a visual assessment of erosion and erosion potential on site, taking into account the proposed Impofu West site development layout.

This assessment was also informed by a recent case study, undertaken by the author, that measured the impact that 3 operational wind farms in the vicinity of the proposed development have had to date on agricultural resources, as well as the agricultural production of the impacted farms. More details on the case study and its results are given in Section 7.

Table 1. Compliance with the Appendix 6 of the 2014 EIA Regulations (as Amended)

Requirements of Appendix 6 – GN R326 EIA Regulations 7 April 2017	**Addressed in this Specialist Report**
A specialist report prepared in terms of these Regulations must contain- details of- the specialist who prepared the report; and the expertise of that specialist to compile a specialist report including a curriculum vitae;	 Title page Following Title page
a declaration that the specialist is independent in a form as may be specified by the competent authority;	Following CV
an indication of the scope of, and the purpose for which, the report was prepared;	Sections 1 & 2
an indication of the quality and age of base data used for the specialist report;	Section 3.1
a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Sections 6.5, 6.6 & 8.2
the date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 3.1
a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 3
details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated	Section 6.8

structures and infrastructure, inclusive of a site plan identifying site alternatives;	
an identification of any areas to be avoided, including buffers;	Section 6.8
a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Figure 7
a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 4
a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	Sections 8 & 10
any mitigation measures for inclusion in the EMPr;	Section 9
any conditions for inclusion in the environmental authorisation;	Section 10
any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 9
a reasoned opinion- whether the proposed activity, activities or portions thereof should be authorised; regarding the acceptability of the proposed activity or activities and if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	 Section 10 Section 10 Section 9
a description of any consultation process that was undertaken during the course of preparing the specialist report;	Section 3.2

3.2 Consultation processes undertaken

As mentioned above, this study was informed by the case study undertaken by the same author. The case study involved consultation with all of the 15 surrounding farmers who already have infrastructure of the Jeffreys Bay, Kouga, and Gibson Bay wind farms located on their farms. Contact was made with all 15 of the farmers, and detailed, in-person interviews on their farms were conducted with nine of them, concentrating predominantly on the seven dairy farmers. Production data was collected from all of the seven dairy farming operations. Interviews were undertaken during February 2018.

The case study together with this impact assessment also involved consultations with DAFF in the form of two meetings that were held with Directorate of land use and soil management staff at their offices in the Delpen building in Pretoria on 7 November 2017 and 15 February 2018. An additional meeting with staff from the Port Elizabeth office of the Eastern Cape Department of Rural Development and Agrarian Reform took place on the proposed Impofu site on 1 March 2018.

Furthermore, the DAFF comments on the Agricultural Impact Assessment Scoping Report, dated 22 January 2019, were taken into account for the Agricultural Impact Assessment EIA Phase Report.

3.3 Methodology for determining impact significance

All potential impacts were assessed in terms of the following criteria (as per the Aurecon standard assessment methodology):

Numerical rating	Category	Description
Intensity		
1	Negligible	Natural and/ or social functions and/ or processes are negligibly altered
2	Very low	Natural and/ or social functions and/ or processes are slightly altered
3	Low	Natural and/ or social functions and/ or processes are somewhat altered
5	High	Natural and/ or social functions and/ or processes are notably altered
6	Very high	Natural and/ or social functions and/ or processes are majorly altered
7	Extremely high	Natural and/ or social functions and/ or processes are severely altered
Duration		
1	Immediate	Impact will self-remedy immediately
2	Brief	Impact will not last longer than 1 year
3	Short term	Impact will last between 1 and 5 years
4	Medium term	Impact will last between 5 and 10 years
5	Long term	Impact will last between 10 and 15 years
6	On-going	Impact will last between 15 and 20 years
7	Permanent	Impact may be permanent or in excess of 20 years
Extent		
1	Very limited	Limited to specific isolated parts of the site
2	Limited	Limited to the site and its immediate surroundings
3	Local	Extending across the site and to nearby settlements
4	Municipal area	Impacts felt at a municipal level
5	Regional	Impacts felt at a regional / provincial level
6	National	Impacts felt at a national level

7	International	Impacts felt at an international level
Probability		
1	Highly unlikely / None	Expected never to happen
2	Rare / improbable	Conceivable but only in extreme circumstances and/ or might occur for this project although this has rarely been known to result elsewhere
3	Unlikely	Has not happened yet but could happen once in the lifetime of the project therefore there is a possibility that the impact will occur
4	Probable	Has occurred here or elsewhere and could therefore occur
5	Likely	The impact may occur
6	Almost certain / Highly probable	It is most likely that the impact will occur
7	Certain / Definite	There are sound scientific reasons to expect that the impact will definitely occur

Significance is determined as follows:

Consequence = type (- or +) x (intensity + duration + extent).
Significance = consequence x probability

Significance is categorised as follows:

Range		**Significance rating**
-147	-109	Major (-)
-108	-73	Moderate (-)
-72	-36	Minor (-)
-35	-1	Negligible (-)
0	0	Neutral
1	35	Negligible (+)
36	72	Minor (+)
73	108	Moderate (+)
109	147	Major (+)

The assessment of impacts includes the following additional considerations:

Confidence	
Low	Judgement is based on intuition
Medium	Determination is based on common sense and general knowledge
High	Substantive supportive data exists to verify the assessment
Reversibility	
Low	The affected environment will not be able to recover from the impact - permanently modified
Medium	The affected environment will only recover from the impact with significant intervention
High	The affected environmental will be able to recover from the impact
Irreplaceability	
Low	The resource is not damaged irreparably or is not scarce
Medium	The resource is damaged irreparably but is represented elsewhere
High	The resource is irreparably damaged and is not represented elsewhere

4 CONSTRAINTS AND LIMITATIONS OF STUDY

The assessment rating of impacts is not an absolute measure. It is based on the subjective considerations and experience of the specialist, but is done with due regard and as accurately as possible within these constraints. There are no other specific assumptions, constraints, uncertainties and gaps in knowledge for this study.

5 LEGISLATIVE REQUIREMENTS

A change of land use (re-zoning) for the development on agricultural land needs to be approved in terms of the Subdivision of Agricultural Land Act 70 of 1970 (SALA) and an application in this regard must be submitted by the developer to the National Department of Agriculture, Forestry and Fisheries (DAFF). This is required for long term lease, even though no subdivision is required. The protection and rehabilitation of agricultural land after disturbance is managed by the Conservation of Agricultural Resources Act, 43 of 1983 (CARA). No application is required in terms of CARA, as the EIA process covers the required aspects of this. DAFF reviews and approves applications in terms of these Acts according to their *Guidelines for the evaluation and review of applications pertaining to renewable energy on agricultural land*, dated September 2011.

6 BASELINE ASSESSMENT OF THE SOILS AND AGRICULTURAL CAPABILITY OF THE AFFECTED ENVIRONMENT

This section is organised in sub headings based on the requirements of an agricultural study as detailed in section 2 of this report.

6.1 Climate and water availability

Rainfall for the site is given as 662 mm per annum (The World Bank Climate Change Knowledge Portal, undated), with rainfall distributed throughout the year. The average monthly distribution of rainfall is shown in Figure 2.

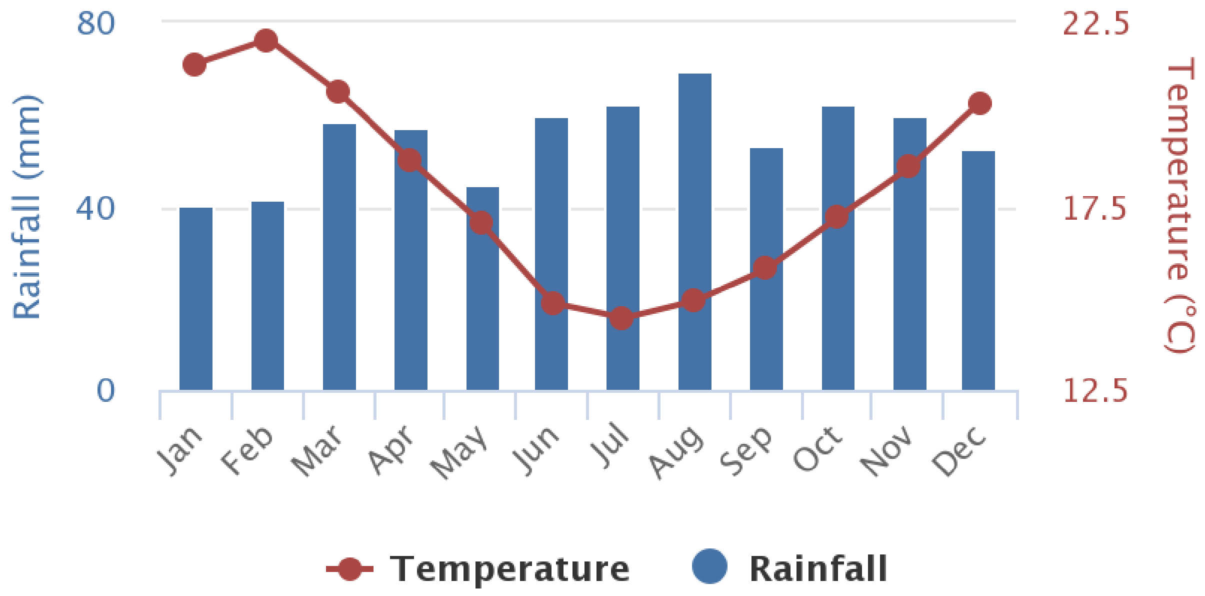

Figure 2. *Average monthly temperature and rainfall for location (-34.07, 24.59) from 1991 to 2015 (The World Bank Climate Change Knowledge Portal, undated). This location is roughly the centre of the 3 Impofu Wind Farm developments.*

There is sufficient rainfall to support viable agricultural production of dryland fodder crops for dairy cows. There is also sufficient rainfall to support water storage for irrigation, where dams are available. Groundwater is also available in the study area and is used for irrigation in places.

6.2 Terrain, topography and drainage

The infrastructural footprint of the proposed wind farm is located on coastal plains at an altitude of between 180 and 250 metres. Slopes across the site are almost entirely less than 5% but may be greater in a few isolated spots.

The underlying geology is Quartzitic sandstone, feldspathic sandstone and subordinate shale of the Table Mountain Group with some influence of shale and siltstone of the Bokkeveld Group, aeolianite of the Nanaga Formation and aeolian sand (Land type inventories).

Numerous wetland and water course features occur across the site. These have all been addressed by the wetland specialist study and accounted for in the proposed wind farm layout.

6.3 Soils

The land type classification is a nationwide survey that groups areas of similar soil, terrain and climatic conditions into different land types. The proposed layout of the wind farm extends over three land types, Ha47, Bb75 and Ca80 (see Figure 3).

The soils of Ha47, and Bb75 are deep to moderately deep, very sandy soils with some drainage limitations. Dominant soil forms of these land types are Constantia, Fernwood, Wasbank, Longlands, Houwhoek and Clovelly. Soils of Ca80 are similar but underlying clay is more common and the Kroonstad soil form is dominant. A summary detailing soil data for the land types is provided in Table A1.

The field investigation of test pits shows a range of soil forms across the different land types. The range includes Fernwood, Wasbank, Longlands, Witfontein, Pinegrove, Kroonstad, Katspruit, Westleigh, Glencoe and Lamotte soil forms. These are shown in the soil map in Figure 3. From a soil mapping perspective, particularly at this scale, it does not really make sense to draw boundaries around different soil forms. Although the soils are classified in the classification system as different soil forms, from an agricultural use perspective there is often very little difference between them. The soil classification system, which is based largely on differences in the processes of soil genesis, rather than differences in attributes like soil depth and texture, can be unnecessarily confusing for non soil-scientists and unhelpful in that it fails to effectively distinguish the most important differences between the different soils. It is more useful to divide the soils into four broad soil groups, based on characteristics that determine agricultural suitability within this environment. These soil groups are also indicated on the soil map.

Even then, the distribution of different soil types, as shown in the map, is patchy. This is predominantly because soil varies over fairly short distances, primarily as a result of small differences in landscape position due to topography. Only a detailed soil map would show these differences in a meaningful way. However, such a level of detail is entirely unnecessary for the purposes of this report, because most of the soils have very similar soil suitability in terms of the type of agriculture that is practised across the study area. The fact that one is a Witfontein, one a Longlands, one an Avalon, one a Lamotte and another a deep Kroonstad is largely insignificant for agricultural potential and practices. The only really significant difference between soils across the entire study area is the distinction between shallow rock outcrops and all other soils, which are generally deep sands of various soil forms. Some shallow sands on underlying clay do occur (generally Katspruit soil form), but even these are entirely suitable and not very different from the deeper sands in terms of the dominant crop of kikuyu grass pastures.

In terms of the picture of soil variation that is created by the soil map, it should also be noted that the investigated test pits have inherent sampling bias in terms of where they are located because all are located on proposed turbine positions, which generally occupy the higher lying ground.

Photographs of representative soil profiles are shown in Figures 4 and 5. Landscape conditions are shown in Figure 6.

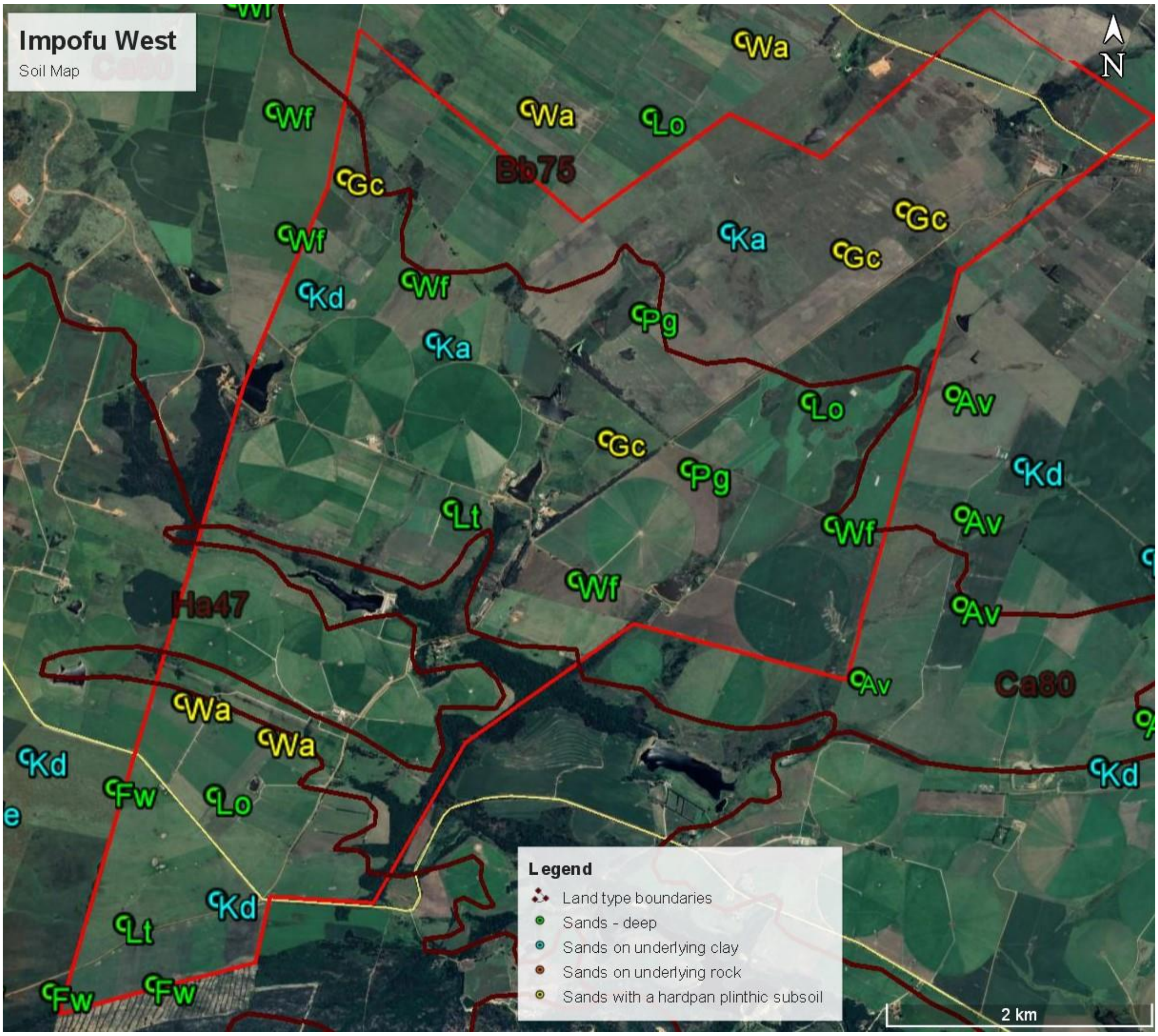

Figure 3. *Soil map of development area. Soil form abbreviations indicated on the map are as follows: Fw = Fernwood; Wa = Wasbank; Lo = Longlands; Wf = Witfontein; Kd = Kroonstad; Ka = Katspruit; Gc = Glencoe; Av = Avalon; Pg = Pinegrove; We = Westleigh; Lt = Lamotte. Details of investigated test pits are given in Appendix 1, Table A2.*

Figure 4. *Photographs showing typical soil profiles from the site. Left is a deep sand of the Fernwood soil form. Right is a sand with a podzol subsoil of the Lamotte soil form.*

Figure 5. *Photographs showing typical soil profiles from the site. Left is a deep sand of the Witfontein soil form. Right is a soil of the Glencoe soil form with a hard plinthic B horizon in the subsoil.*

Figure 6. *Photograph showing excavation of test pits in typical site conditions.*

6.4 Agricultural capability

Land capability is defined as the combination of soil, climate and terrain suitability factors for supporting rainfed agricultural production. It is an indication of what level and type of agricultural production can sustainably be achieved on any land. The higher land capability classes are suitable as arable land for the production of cultivated crops, while the lower suitability classes are only suitable as non-arable grazing land, or at the lowest extreme, not even suitable for grazing. In 2017 DAFF released updated and refined land capability mapping across the whole of South Africa. This has greatly improved the accuracy of the land capability rating for any particular piece of land anywhere in the country. The new land capability mapping divides land capability into 15 different categories with 1 being the lowest and 15 being the highest. Values of below 8 are generally not suitable for production of cultivated crops. Detail of this land capability scale is shown in Table 2.

The project area is classified with land capability evaluation values that vary over the area from a minimum of 5 to a maximum of 12.

Table 2: Details of the 2017 Land Capability classification for South Africa.

Land capability evaluation value	Description
1	Very Low
2	

Land capability evaluation value	Description
3	Very Low to Low
4	
5	Low
6	Low to Moderate
7	
8	Moderate
9	Moderate to High
10	
11	High
12	High to Very High
13	
14	Very High
15	

At a more detailed level than land capability, the physical and chemical characteristics of a soil profile pose limitations which constrain crop production. Soil capability is a function of the presence and intensity of such limitations. The relevant soil limitations in the study area are:

1. sandy texture with consequent low water and nutrient holding capacity
2. naturally very acidic requiring high inputs of lime for agricultural use
3. low nutrient status, particularly phosphorus, requiring high levels of fertiliser input for agricultural use
4. limited internal drainage of many soils, but this is not limiting for kikuyu pastures

Despite the soil limitations, the agricultural environment (the combination of soils and climate) of the study area is highly suitable for intensive and productive dairy farming on kikuyu based pastures. Almost the entire land surface of the study area is suitable and has a similar potential for such agricultural production. The only areas of land that are not suitable for pasture cultivation are patches of rock outcrop, and their associated shallow rock banks, and areas limited by topography such as river gorges and mountainous land.

6.5 Land use and development on and surrounding the site

Almost all of the farms in the study area and surrounds are intensive, high production dairy farms with cultivated, kikuyu based pasture plus additional fodder crops, both under irrigation, as well as non-irrigated. The dairy farms generally include a small percentage of beef cattle.

6.6 Status of the land

Most of the land surface is transformed agricultural pasture land. There is no significant erosion or other land degradation across the study area.

6.7 Possible land use options for the site

Due to the soil and climate combination, dairy farming is probably the most suitable agricultural land use, but any crops that are suited to the climate of the area, for example macadamia nuts, could potentially be grown.

6.8 Agricultural sensitivity

Agricultural sensitivity is directly related to the capability of the land for agricultural production. This is because a negative impact on land of higher agricultural capability is more detrimental to agriculture than the same impact on land of low agricultural capability. Agricultural capability includes the production capability enabled by infrastructural and other agricultural improvements made to land, for example irrigation infrastructure and soil fertilisation. As discussed above, the natural agricultural potential across the entire potential development area is largely uniform, except for the patches of rock outcrop that occur. What makes the production capability differ across the site is the agricultural improvements that have been made. Irrigated land has a higher production capability than non-irrigated land, and it therefore has the highest agricultural sensitivity.

The agricultural sensitivity mapping that was input into the screening process for the project classified sensitivity into 4 categories, low, moderate, high and No-Go. Areas not suitable for cultivation were classified as having low sensitivity. These include land parcels that are impractically small for effective cultivation because they are between circular centre pivots. Areas that are suitable for cultivation but with limitations were classified as moderate. Areas that are suitable for cultivation and could potentially be developed as irrigated land were classified as having high sensitivity. Centre pivot irrigated lands were classified as No-Go areas.

All the No-Go areas should be avoided by the development footprint. These are shown in Figure 7, with the layout of the wind farm superimposed. There are no required buffers around agriculturally sensitive No-Go areas.

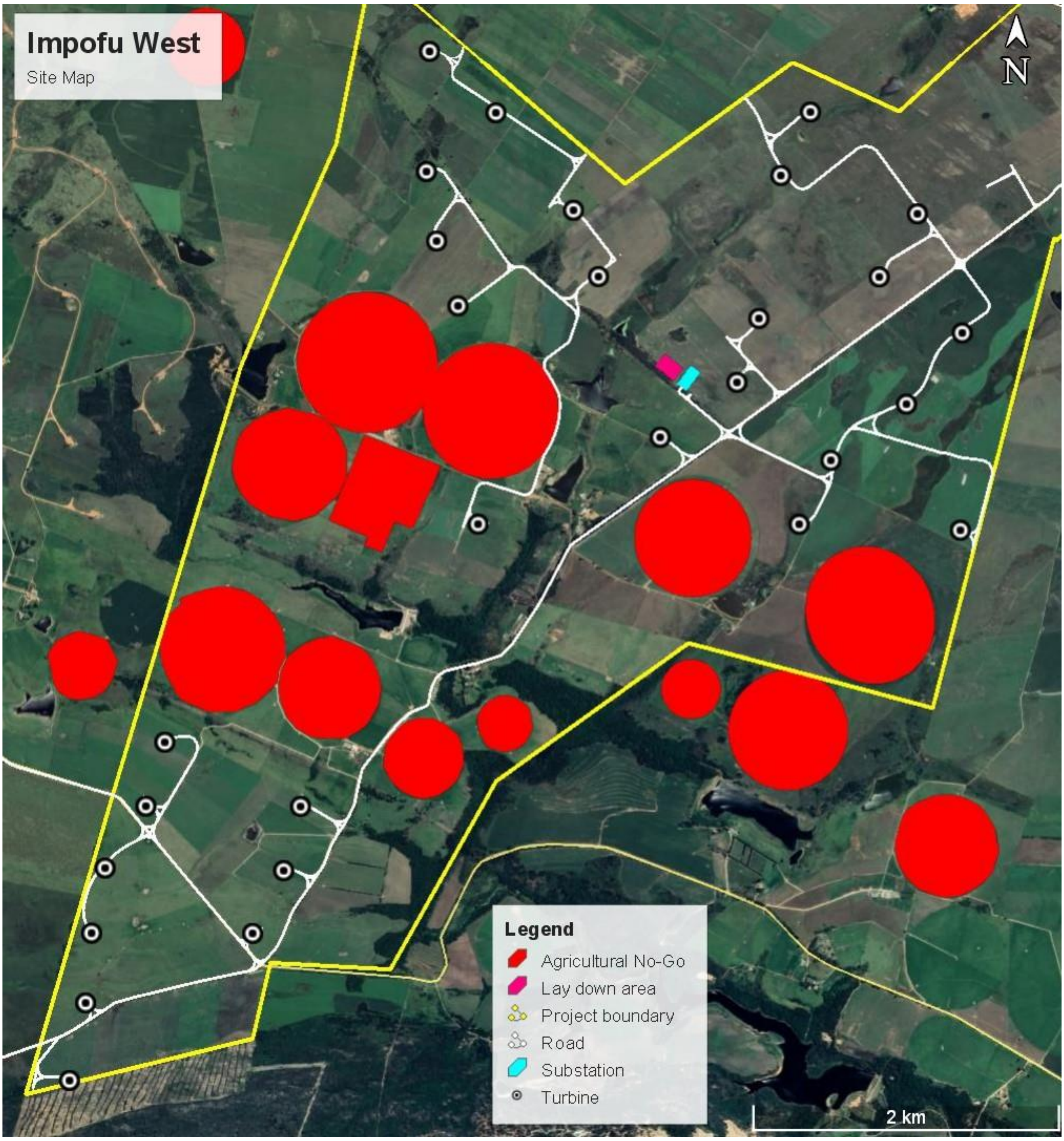

Figure 7. *The proposed layout of the Impofu West Wind Farm superimposed on the agricultural No-Go areas (red polygons).*

7 RESULTS OF THE CASE STUDY

Study title: *The impact of wind farms on agricultural resources and production - a case study from the Humansdorp area, Eastern Cape*

The overall aim of this study was to measure the impact (both negative and positive) that the three operational wind farms (Jeffreys Bay, Kouga, and Gibson Bay) have had on agricultural resources and production. Prior to this study, no South African data has been collected to measure these impacts. The answer to the question of whether wind farms have a positive or negative impact, and the extent of that impact has therefore been unknown. This study provides such data, which can now accurately inform agricultural authorisation decisions according to actual, measured impact.

A comprehensive list of all the potential impacts of wind farms on agriculture in the study area was identified. The approach of the study was to collect data that measures the extent of each of these impacts for the three case study wind farms. Data was collected from the 15 farms on which wind farm infrastructure is located. Contact was made with all 15 of the farmers, and detailed interviews were conducted with nine of them, concentrating predominantly on the seven dairy farmers. Production data was collected from all of the seven dairy farming operations. Production data was also collected, for comparative purposes, from 12 other dairy farms in the area that do not have wind farm infrastructure located on them. The size of the agricultural footprint of the three existing wind farms was also measured.

A summary of the conclusions of the study are presented below for each of the five identified potential negative impacts, and each of the two identified potential positive impacts, followed by an overall conclusion.

Potential negative impact 1: Land becomes unavailable to agriculture due to direct occupation by wind farm infrastructure.

The most important finding of this study, in relation to loss of agricultural land, is that the loss is extremely small. Not only is it small in extent, but it is also, importantly, limited to an extremely low proportion of the land. The agricultural footprint for Kouga and Gibson Bay wind farms (and in all likelihood, any future wind farms) is less than 1% of the land surface. Over half of the less than 1% footprint is made up of roads, which are in many cases of benefit to the agricultural operations.

Potential negative impact 2: Discontinuation of farming by farmers caused by wind farm derived income and by other negative lifestyle impacts on farmers.

The most important result of this study, in relation to this impact, is that farming has not been discontinued or reduced, as is evident from the production data, on any of the 15 farms on which wind farms have been located. To the contrary, financial security from wind farming, has enabled one land owner to take up full time farming of his land, where he previously had to be employed in town. Furthermore, all respondents were unanimous that there was zero probability of wind farm establishment resulting in them stopping or reducing their farming.

It was also pointed out by one of the respondents that even if farming is discontinued by a current farmer, the value of and demand for agricultural land in the area is highly likely to ensure that the land is still productively utilised for agriculture by other farmers through rental. Net production from the land is therefore unlikely to change.

Potential negative impact 3: Negative Interference of wind farm infrastructure and activity with farming operations.

The farmers perceive wind farming to have had some nuisance impact, but mostly only during construction. All farmers agreed that they have had zero reduced production as a result of disturbance or interference to their farming practices by the wind farms, during both construction and operation.

Potential negative impact 4: Damage to natural agricultural resource base by way of erosion and topsoil loss.

Seven of the farmers perceive the wind farms to have had no negative impact on the natural agricultural resource base, and only two perceive it to have had a very minor impact.

Potential negative impact 5: Depletion of potential agricultural water resources.

None of the farmers perceive the wind farms to have used water resources during construction that could otherwise have been used for agricultural production.

Potential positive impact 1: Increased financial security for farming operations due to reliable income from land rental to the wind farms.

All respondents perceive the positive impact of increased financial security to be of major benefit to their farming operations, and perceive it to result in potential for increased agricultural production. Wind farm derived income has been invested into farming by all nine respondents. Aspects of farming into which income has been invested include fencing, infrastructure, expansion, paying off debt, purchase of livestock, cash flow, new dairy, pasture development and operating costs. Almost all farmers plan to continue to use wind farm income to make further investments into their farming. Four out of the five farmers who have borrowed finance for investment into their farming operations, since the introduction of wind farming in the area, experienced that having reliability of regular income from wind farming, improved their ability to borrow finance.

Potential positive impact 2: Improvements to infrastructure that is shared by both the wind farms and the farming operations, such as public roads and turbine access roads on farms.

From the results of the study, the shared infrastructure that is of most benefit to farming operations are the turbine access roads across private farms. No farmers rated the impact of these roads as negative. Improvements to the public, district roads, undertaken by the wind farms, also have benefits for farmers, especially given the fact that the district roads in the area are poor, are not being adequately maintained by the state, and that dairy farming requires frequent access by large trucks for milk collection and less frequently for feed delivery. The majority of farmer's experience is that the impact of wind farms on the condition of public, district roads has been positive in that road conditions have improved.

Overall conclusions

The overall conclusion of this study is that, although wind farms have been established within an area of cultivated farmland that supports intensive and productive dairy farming, it is highly unlikely that this has caused a reduction in agricultural production, and therefore had any negative agricultural impact. Small amounts of production land have been lost, but the consequence of this for agricultural production has been negligible. It is likely, that the positive impacts of wind farming, particularly increased financial security, have outweighed the negative impacts and that wind farming has benefited agriculture and agricultural production in the area. This conclusion is supported by the affected farmers, who are the people that have the most relevant experience on which to base an assessment of these impacts, and also no longer have any vested interest in portraying agricultural impacts either positively or negatively.

8 IDENTIFICATION AND ASSESSMENT OF IMPACTS ON AGRICULTURE

The focus of an agricultural impact assessment is to determine to what extent a proposed development will compromise (negative impacts) or enhance (positive impacts) current and/or future agricultural production. Determining this must go beyond just an assessment of the agricultural capability of the proposed development land. It is important to assess the significance of the impacts, because even if land is of high agricultural capability, it does not necessarily follow that development will lead to negative impacts of any significance. Negative impacts would not be of significance where the negative impacts themselves are of very low significance or where positive impacts outweigh negative impacts.

As mentioned, the assessment of impacts in this report is informed by a recent case study that measured the impact (negative and positive) that three operational wind farms in the area have had on agricultural resources and production to date (see Section 7). This case study was motivated by the fact that up to now, the hypothesised agricultural impacts of wind farms in South Africa have been based purely on speculation. No data has been collected to measure such impact in a South African context. The existence of operational wind farms now provides an opportunity to measure this impact by means of case studies.

Impacts are considered in terms of a worst case scenario of a maximum number of 95 turbines across all three Impofu Wind Farms. The impacts identified for each Impofu Wind Farm is considered the same, and therefore it is important to note that the anticipated impacts would not be significantly different for slightly fewer turbines.

All the agricultural impacts are considered to be relevant to all wind farm phases, construction, operation, and decommissioning, and it does not really make sense to isolate them as separate impacts associated with individual phases. Impacts are not therefore assessed per phase but for all phases.

Most of the negative agricultural impacts are primarily influenced by the permanent footprint of disturbance caused by all wind farm infrastructure. It makes little difference which of the wind farm infrastructure is located at which place. Whether it is a hard stand area or a substation occupying space, is irrelevant. It is simply the occupation of the agricultural land that is relevant. This assessment of impacts therefore considers the whole development layout of all infrastructure, as it is proposed. It does not distinguish different impacts resulting from turbines, substations etc.

The layout of electric cables has negligible impact on agriculture after construction, as they are either buried underground, in which case all agricultural activities can continue, undisturbed above them, or they run overhead, in which case all agricultural activities can continue, undisturbed below them.

8.1 Identified impacts

The potential negative impacts (section 8.1.1 to 8.1.5) and positive impacts (section 8.1.6 to 8.1.8) of wind farms on agricultural resources and productivity are listed and discussed below. Each impact is assessed in table format.

It is important to note that mitigation in the form of avoidance for most of the negative impacts has already been implemented in the screening and iterative design process that preceded the compilation of this report. The screening and iterative design process ensured that irrigation lands were not impacted by the footprint and that the layout minimised disturbance to the farming operations, based on detailed input by each, specific farmer.

8.1.1 Loss of agricultural land use

Agriculturally productive land, or potentially productive land, occupied by all of the wind farm infrastructure, will become unavailable for future agricultural use.

The proposed footprint of the Impofu West Wind Farm falls largely within cultivated lands. This is necessitated by the fact that most of the proposed wind farm site comprises cultivated lands and by the various engineering and other constraints that control turbine layout. Constraints include the need for turbines to be positioned in relation to each other so that all turbines receive adequate wind to be viable. Certain distances and directions between turbines in terms of prevailing winds are required, with the result that it is often not viable to shift individual turbines.

The proposed footprint means that there will be a small loss of arable land. However, there are several factors that mitigate the significance of such a loss.

- The wind farm footprint occupies an insignificantly small proportion of the surface area of the farms on which it is located.
- The wind farm layout, including the road and cable layout, has been designed by way of an iterative process that has had direct input from the affected farmers. The farmers input was aimed at minimising the loss of productive land and minimising disturbance

by the wind farm layout to each of their farming operations.

- The road infrastructure, which is a substantial part of the footprint, largely uses existing farm roads. It only includes short sections of new roads, where no existing road can be used.
- Even where new roads have been proposed, their locations have been optimized, by each individual farmer's input, so as to be useful to their farming operations, where possible.

In addition to the mitigating factors above, the results of the case study of surrounding wind farms show production from the impacted farms to have an upward trend over time (see Section 7). This shows that the small loss of productive land has not reduced production levels.

The discussion above shows that some productive land will be lost to the wind farm footprint, but that the consequence for agricultural production is insignificant.

Impact	Loss of agricultural land use			
Description of impact	Productive agricultural land is lost underneath the wind farm footprint			
Mitigatability	Low	Mitigation does not exist; or mitigation will slightly reduce the significance of impacts		
Potential mitigation	Mitigation is only possible in design phase, by ensuring that footprint has minimal impact on productive land and that no-go areas are avoided. An important mitigation is to get input from each affected farmer on how to best minimise impact on their land.			
Assessment	Without mitigation		With mitigation	
Nature	Negative		Negative	
Duration	On-going	Impact will last between 15 and 20 years	On-going	Impact will last between 15 and 20 years
Extent	Very limited	Limited to specific isolated parts of the site	Very limited	Limited to specific isolated parts of the site
Intensity	Very low	Natural and/ or social functions and/ or processes are slightly altered	Very low	Natural and/ or social functions and/ or processes are slightly altered
Probability	Certain / definite	There are sound scientific reasons to expect that the impact will definitely occur	Certain / definite	There are sound scientific reasons to expect that the impact will definitely occur
Confidence	Medium	Determination is based on common sense and general knowledge	Medium	Determination is based on common sense and general knowledge
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	Medium	The affected environment will only recover from the impact with significant intervention
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Medium	The resource is damaged irreparably but is represented elsewhere
Significance	Minor - negative		Minor - negative	
Comment on significance				
Cumulative impacts	Same significance as individual impact			

8.1.2 Discontinuation of farming

Wind farm income derived by farmers may cause them to discontinue farming and/ or discourage them from maintaining their current production levels. In addition, the associated impacts of wind farms on the farmers, such as noise, traffic, labour influxes and associated safety and security concerns, could also influence them to discontinuing farming, leading to a drop in agricultural production.

The occurrence of such an impact is based solely on speculation and the risk of it occurring is very difficult to predict. The results of the case study of surrounding wind farms show that the impact of farmers abandoning farming has not occurred on a single one of the 15 farming operations impacted by the three existing operational wind farms. In fact, the opposite has occurred on one of the case study farms in that the security of income from the wind farm has enabled the land owner to leave his employment in town and take up full time farming of the land. Furthermore, production from the impacted farms shows an upward trend over time, which suggests that the existing wind farms have not compromised production levels. The opinion of farmers from the area is that, even if the wind farms result in certain farmers quitting the farming of their land, there is sufficient demand for production land, from the existing farming operations, to ensure that that land will be rented for continued agricultural production.

Based on the evidence presented above, the conclusion of this assessment is therefore that the risk of this impact having a significant effect on agricultural production is insignificant.

Impact	Discontinuation of farming			
Description of impact	Wind farm derived income and other lifestyle impacts of wind farming could cause farmers to discontinue farming			
Mitigatability	Low	Mitigation does not exist; or mitigation will slightly reduce the significance of impacts		
Potential mitigation	None			
Assessment	Without mitigation		With mitigation	
Nature	Negative		Negative	
Duration	Short term	impact will last between 1 and 5 years		#N/A
Extent	Limited	Limited to the site and its immediate surroundings		#N/A
Intensity	Very low	Natural and/ or social functions and/ or processes are slightly altered		#N/A
Probability	Rare / improbable	Conceivable, but only in extreme circumstances, and/or might occur for this project although this has rarely been known to result elsewhere		#N/A
Confidence	Medium	Determination is based on common sense and general knowledge		#N/A
Reversibility	High	The affected environmental will be able to recover from the impact		#N/A
Resource irreplaceability	Low	The resource is not damaged irreparably or is not scarce		#N/A
Significance	Negligible - negative		#N/A	
Comment on significance				
Cumulative impacts	Same significance as individual impact			

8.1.3 Interference of wind farm infrastructure and activity with farming operations

Wind farm activity and infrastructure, both during construction and operation, may disturb or interfere with farming practices, and thereby decrease productive efficiency on the farm and hence lead to decreased levels of agricultural production.

The results of the case study of surrounding wind farms show that the farmers have experienced a temporary nuisance factor during the wind farm construction phase, but almost none in the operational phase, and no impact on production during either phase. An important mitigating factor to disturbance is that, as discussed above, farmers have extensive input into approving the wind farm layout design, and can therefore ensure that the layout minimises disturbance to their farming operations. It is also important that farmers have an effective communication channel to construction activities so that they can ensure minimum disturbance to farming operations during construction.

One potential impact that poses some risk is the issue of gates being left open, which can allow cows from different farms to mix, or for cows to escape the farm. The mixing of cows poses a bio security risk for the spreading of bovine diseases. However, the installation of industry approved cattle grids at the start of construction at all wind farm access gates that pose a threat, as well as at all boundary gates between neighbours, is an effective and easily achievable mitigation measure. The recommended grid design, which has been approved by the farmers, is shown in Appendix 2.

Impact	Interference with farming operations			
Description of impact	Wind farm activity and infrastructure could disturb or interfere with farming practices			
Mitigatability	Medium	Mitigation exists and will notably reduce significance of impacts		
Potential mitigation	The most important mitigation is only possible in design phase, by ensuring that footprint has minimal impact on farming operations. Farmer input into design phase as well as into construction activities is important. Cattle grids mitigate problems related to gates being left open.			
Assessment	Without mitigation		With mitigation	
Nature	Negative		Negative	
Duration	On-going	Impact will last between 15 and 20 years	On-going	Impact will last between 15 and 20 years
Extent	Limited	Limited to the site and its immediate surroundings	Limited	Limited to the site and its immediate surroundings
Intensity	Very low	Natural and/ or social functions and/ or processes are slightly altered	Negligible	Natural and/ or social functions and/ or processes are negligibly altered
Probability	Unlikely	Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur	Rare / improbable	Conceivable, but only in extreme circumstances, and/or might occur for this project although this has rarely been known to result elsewhere
Confidence	Medium	Determination is based on common sense and general knowledge	Medium	Determination is based on common sense and general knowledge
Reversibility	High	The affected environmental will be able to recover from the impact	High	The affected environmental will be able to recover from the impact
Resource irreplaceability	Low	The resource is not damaged irreparably or is not scarce	Low	The resource is not damaged irreparably or is not scarce
Significance	Negligible - negative		Negligible - negative	
Comment on significance				
Cumulative impacts	Same significance as individual impact			

8.1.4 Degradation of natural agricultural resource base

Wind farm construction and operation may negatively impact on the natural agricultural resource base by way of soil erosion, topsoil loss, drainage disturbance, water availability, etc.

Erosion risk is low because slopes are minimal and soils have a high infiltration rate and low susceptibility to water erosion. Because of the relatively high, year round rainfall, vegetation cover establishes quickly after disturbance and is very effective at preventing wind erosion. Furthermore erosion and topsoil loss can be easily and effectively mitigated through the management practices prescribed in the Environmental Management Programme. The case study of surrounding wind farms has shown no evidence of significant soil impacts.

If denuded areas do not sufficiently re vegetate naturally to prevent erosion, then they should be planted with a cover crop.

In terms of wetlands and drainage, an important part of the EIA and resulting Environmental Management Programme addresses and controls the impact specifically on wetlands and water courses (informed by surface water specialist study), and ensures that the development complies with legislation that protects these.

Impact	Damage to natural agricultural resource base			
Description of impact	Wind farm construction and operation could negatively impact on the natural agricultural resource base by way of soil erosion & topsoil loss			
Mitigatability	Medium	Mitigation exists and will notably reduce significance of impacts		
Potential mitigation	Apply systems of storm water run-off control; Facilitate re-vegetation of denuded areas; Strip, stockpile and re-spread topsoil			
Assessment	Without mitigation		With mitigation	
Nature	Negative		Negative	
Duration	Short term	impact will last between 1 and 5 years	Short term	impact will last between 1 and 5 years
Extent	Very limited	Limited to specific isolated parts of the site	Very limited	Limited to specific isolated parts of the site
Intensity	Low	Natural and/ or social functions and/ or processes are somewhat altered	Very low	Natural and/ or social functions and/ or processes are slightly altered
Probability	Likely	The impact may occur	Unlikely	Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur
Confidence	Medium	Determination is based on common sense and general knowledge	Medium	Determination is based on common sense and general knowledge
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	Medium	The affected environment will only recover from the impact with significant intervention
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Medium	The resource is damaged irreparably but is represented elsewhere
Significance	Negligible - negative		Negligible - negative	
Comment on significance				
Cumulative impacts	Same significance as individual impact			

8.1.5 Depletion of potential agricultural water resources

Wind farm water use may deplete water resources that could have been used for agricultural production.

Wind farms only use water during the construction phase, and such quantities are very small in relation to irrigation water use. The established wind farms as well as the proposed wind farm have or will source their water requirements independently of the farm water supplies, usually by constructing boreholes or sourcing construction water off-site. Because of the small quantities involved, and the limited duration of extraction, this will have no impact on water availability for agriculture.

Impact	Depletion of potential agricultural water resources			
Description of impact	Wind farms could utilise water resources that could otherwise have been used for agricultural production			
Mitigatability	Low	Mitigation does not exist; or mitigation will slightly reduce the significance of impacts		
Potential mitigation	None required			
Assessment	Without mitigation		With mitigation	
Nature	Negative			
Duration	Short term	impact will last between 1 and 5 years		#N/A
Extent	Limited	Limited to the site and its immediate surroundings		#N/A
Intensity	Very low	Natural and/ or social functions and/ or processes are slightly altered		#N/A
Probability	Probable	The impact has occurred here or elsewhere and could therefore occur		#N/A
Confidence	Medium	Determination is based on common sense and general knowledge		#N/A
Reversibility	High	The affected environmental will be able to recover from the impact		#N/A
Resource irreplaceability	Low	The resource is not damaged irreparably or is not scarce		#N/A
Significance	Negligible - negative		#N/A	
Comment on significance				
Cumulative impacts	Same significance as individual impact			

The potential positive impacts of wind farms on agricultural resources and productivity are listed and discussed below.

8.1.6 Increased financial security for farming operations

Income earned by the farmers from the turbines on their land may benefit farming operations and increase investment into agricultural infrastructure, and thereby improve agricultural production levels.

Farmer experience from the existing wind farms in the area is that this is a significant positive impact for their farming operations, in the form of increased financial security. The availability of finance and the insecurity introduced by such occurrences as droughts, are recognised as limitations to the growth of farming operations, particularly for intensive operations like dairy farming. Increased financial security can enable growth, and can also enable the financial sustainability of emerging farmer projects. Income may be both directly invested in operations and/or serve as security against which loans can be sought. Of course, there is no guarantee that income earned from wind farms will be invested into improving agricultural production, but the evidence from the case study of existing wind farms, in the form of upward production trends as well as farmers' perceptions, strongly suggests that this is a significant, positive impact on agriculture.

Impact	Increased financial security for farms			
Description of impact	Income earned by farmers from the turbines on their land could benefit farming operations and increase investment into agricultural infrastructure on farms			
Mitigatability	Low	Mitigation does not exist; or mitigation will slightly reduce the significance of impacts		
Potential mitigation	None			
Assessment	Without mitigation		With mitigation	
Nature	Positive			
Duration	On-going	Impact will last between 15 and 20 years		#N/A
Extent	Limited	Limited to the site and its immediate surroundings		#N/A
Intensity	High	Natural and/ or social functions and/ or processes are notably altered		#N/A
Probability	Almost certain / Highly probable	It is most likely that the impact will occur		#N/A
Confidence	Medium	Determination is based on common sense and general knowledge		#N/A
Reversibility	High	The affected environmental will be able to recover from the impact		#N/A
Resource irreplaceability	Low	The resource is not damaged irreparably or is not scarce		#N/A
Significance	Moderate - positive		#N/A	
Comment on significance				
Cumulative impacts	Same significance as individual impact			

8.1.7 Improvements to shared infrastructure

Investments by the wind farms into improving and maintaining shared infrastructure, such as public district and minor roads, as well as road and storm water infrastructure on farms, may benefit farming operations, and thereby agricultural production.

The results of the case study show that most farmers have experienced the changes to road infrastructure to date as being of some benefit to their farming operations, while some have experienced it as neutral. Turbine access roads have been of significant benefit to certain farmers because they have made previously inaccessible parts of the farms (due to seasonal wetness, loose sand) more accessible and therefore more productive. Impofu Wind Farms are proposing upgrades to certain public roads in the area and the majority of affected farmers see this as having significant benefit. Poor roads in the area do pose a difficulty for farming which relies on heavy traffic access, particularly for milk and feed trucks. Poor roads incur direct costs to the farmers by way of increased delivery and collection costs.

The Traffic Impact Assessment (Schwarz, 2019) has recommended that the developer contribute to the maintenance of the road network, to the order of R 2 million during the construction period and R 1 million per year during operational phase, commencing the year after successfully achieving Commercial Operation. Additional ongoing funding from the wind farms towards the maintenance of the roads will have a positive impact on the local road conditions and community.

Impact	Improvements to shared infrastructure			
Description of impact	Improvements made by wind farms to shared infrastructure, such as roads could benefit farming operations			
Mitigatability	Medium	Mitigation exists and will notably reduce significance of impacts		
Potential mitigation	Inputs by each affected farmer into design phase, which increases the usefulness of turbine access roads for their farming operations			
Assessment	Without mitigation		With mitigation	
Nature	Positive		Positive	
Duration	On-going	Impact will last between 15 and 20 years	On-going	Impact will last between 15 and 20 years
Extent	Limited	Limited to the site and its immediate surroundings	Limited	Limited to the site and its immediate surroundings
Intensity	Low	Natural and/ or social functions and/ or processes are somewhat altered	Low	Natural and/ or social functions and/ or processes are somewhat altered
Probability	Probable	The impact has occurred here or elsewhere and could therefore occur	Probable	The impact has occurred here or elsewhere and could therefore occur
Confidence	Medium	Determination is based on common sense and general knowledge	Medium	Determination is based on common sense and general knowledge
Reversibility	High	The affected environmental will be able to recover from the impact	High	The affected environmental will be able to recover from the impact
Resource irreplaceability	Low	The resource is not damaged irreparably or is not scarce	Low	The resource is not damaged irreparably or is not scarce
Significance	Minor - positive		Minor - positive	
Comment on significance				
Cumulative impacts	Same significance as individual impact			

8.1.8 Improved farm security

The presence of wind farm personnel, including security personnel in the area, could provide improved farm security.

This impact could be positive or negative, because the influx of additional people associated with the wind farm could in fact increase security concerns. The results of the case study show that some farmers experience it as positive impact while others experience it as negative. Either way the impact is unlikely to be a significant agricultural impact.

Impact	Improved farm security			
Description of impact	The presence of wind farm personnel including security personnel in the area could provide improved farm security but the influx of additional people could also worsen security			
Mitigatability	Low	Mitigation does not exist; or mitigation will slightly reduce the significance of impacts		
Potential mitigation	None			
Assessment	Without mitigation		With mitigation	
Nature	Positive			
Duration	On-going	Impact will last between 15 and 20 years		#N/A
Extent	Limited	Limited to the site and its immediate surroundings		#N/A
Intensity	Negligible	Natural and/ or social functions and/ or processes are negligibly altered		#N/A
Probability	Probable	The impact has occurred here or elsewhere and could therefore occur		#N/A
Confidence	Medium	Determination is based on common sense and general knowledge		#N/A
Reversibility	High	The affected environmental will be able to recover from the impact		#N/A
Resource irreplaceability	Low	The resource is not damaged irreparably or is not scarce		#N/A
Significance	Minor - positive		#N/A	
Comment on significance	Because this impact could have a positive or negative effect, and its intensity is assessed as negligible its significance as a positive impact, and in relation to the other impacts, is more accurately described as negligible than minor.			
Cumulative impacts	Same significance as individual impact			

8.2 Cumulative impact

The impacts associated with Impofu West Wind Farm are not taking place in the absence of surrounding agricultural impacts. It is therefore important to take account of potential cumulative impacts that may arise. A cumulative impact as defined in the NEMA EIA Regulations as an impact that "may be significant when added to the existing and reasonable foreseeable impacts". A cumulative impact therefore only becomes significant, over and above individual impacts, when the sum of individual impacts leads to the tipping of a threshold. For example, although a small, individual impact of erosion somewhere in a catchment would not have a significant downstream impact, a number of small amounts of erosion accumulated from across a catchment area might well lead to the significant silting up of a downstream dam. This is an example of a significant cumulative impact resulting from the sum of individual smaller impacts.

In order to take account of potential cumulative impacts for the Impofu West Wind Farm, it is necessary to consider the impacts, as identified in section 8.1 within the context of impacts that may have arisen or may still arise from the four existing wind farms in the area, as well as impacts that may arise from the additional five proposed wind farms within 30km. Details of these wind farms are given in Table 2.

Table 2. Wind farms within 30km of the proposed wind farm. The number of turbines is given as an indication of the size of each wind farm, and therefore the size of its spatial impact on agricultural land.

Wind Farm	Number of turbines
Existing wind farms	
Tsitsikamma Community Wind Farm	31
Gibson Bay Wind Farm	37
Kouga Wind Farm	32
Jeffrey's Bay Wind Farm	60
Proposed wind farms	
Banna Ba Pifhu Windfarm Project	9 – 17
Ubuntu Wind Energy Project	31 – 50
Oyster Bay Wind Energy Facility	41
Impofu East Wind Farm	33
Impofu North Wind Farm	33

This cumulative context provides the public perception of a cumulative wind farm impact within the area. DAFF specifically, have raised a concern about this cumulative wind farm impact on the agriculture of the area, given that Impofu West is only one of a number of existing and planned wind farms in the area.

For the purposes of this EIA, an assessment of the cumulative impact is more narrowly (and perhaps less usefully, for this context) defined as the cumulative impact of only future projects. The existing ones are considered as part of the baseline conditions (and therefore have informed the assessment of impacts in Section 8.1, above). They are not therefore assessed as part of the cumulative impact.

All the other wind farms in the area, listed in Table 2 (whether they are existing or proposed) have very similar impacts on agriculture, both in terms of the type of impact, as well as the significance of those impacts. The agricultural environment of four of the five proposed wind farms in Table 2 are, for the intent and purpose of agricultural impact assessment, identical to each other as well as to Impofu West. Ubuntu is different in that it is not on dairy farms but on a beef cattle farm and the agricultural land use if far less intensive.

It is relevant to note that the author of this current report also did the agricultural impact assessment reports for four of the five proposed wind farms. Oyster Bay was the only one not done by this author. For the purposes of assessing the cumulative impacts of Impofu West, the agricultural impact assessment reports for all five proposed wind farms in the area were consulted (see references for Lanz and for van der Waals).

All the agricultural impacts that have been identified in all these EIA's are included in the identification of impacts in section 8.1 above, except:

- Prevention of crop spraying
- Disturbance of contour banks
- Dust generation

None of these are considered to cause significant agricultural impact for Impofu West, and hence were omitted from this assessment.

The overall findings of all five agricultural impact assessments for the five proposed projects that are part of the cumulative impact assessment are that, with the mitigation measures of avoiding No-Go areas, **the negative impacts on agriculture are rated as negligible**.

The following paragraphs are a discussion of the potential cumulative impacts identified in this report for Impofu West.

As already discussed in Section 8.1, the overall negative impact of wind farms on agriculture is constrained by the fact that wind farm footprints impact only an insignificantly small proportion of the surface area of the farms on which they are located. The cumulative impact can also not affect any greater proportion of the surface area than the individual impacts, and therefore cannot be more significant than the individual impacts.

To better understand the logic of this, consider again the example of cumulative impacts arising from individual erosion events across a catchment, causing the silting up a downstream dam (referred to above). If each time an additional erosion event was added to the catchment, the size of the dam was also proportionally increased, then the sum of accumulated erosion could never have a significant silting effect on the dam, because the proportion of silt in the dam from one event would be the same as the proportion of silt in the dam from many events. The cumulative impact on the dam only occurs, because it accumulates on a constant size of dam. In the case of loss of agricultural land however, the size of the "dam" (agricultural land) that is impacted increases each time another wind farm is added to the environment. The insignificantly small proportion of land that is impacted in the case of one wind farm remains an insignificantly small proportion of agricultural land, regardless of how many wind farms are added.

Evidence from the case study suggests that the loss of these small proportions of productive land from individual farms is insignificant in terms of the reduction in the agricultural output of those farms. If it is insignificant for each individual farm, then the cumulative impact on production for a number of wind farms is also insignificant, because the cumulative impact is in the same proportion as the individual impact.

Apart from the negative agricultural impact of Impofu West, this assessment report has also identified positive agricultural impacts. The positive impact is also relevant as a cumulative impact.

The formal assessment of cumulative impacts for the purposes of this EIA are done in terms of 2 scenarios: Scenario 1 = only the 3 Impofu Wind Farms - Impofu North, East and West – in addition to the existing baseline environment (inclusive of the neighbouring operational wind farms); Scenario 2 = the 3 Impofu Wind Farms (Scenario 1) plus the other 3 proposed wind farms included in Table 2. By the logic of proportional impact discussed above, there is no difference between these two scenarios, because scenario 2 simply involves the addition of a further three wind farms to scenario 1, but the cumulative impact will be in the same proportion. The cumulative impact assessment of separate negative and positive cumulative impacts for Impofu West are presented in table format below.

Impact	The negative, cumulative impact on agricultural potential resulting from multiple wind farm projects in the area, with loss of agricultural land use being the most important contributor			
Description of impact				
Mitigatability	Medium	Mitigation exists and will notably reduce significance of impacts		
Potential mitigation	All of the same mitigation as for individual impacts, the most important of which is the design phase layout to avoid No-Go areas and implement specific designs with input from affected farmers to avoid disturbance to their agricultural operations			
Assessment	Without mitigation		With mitigation	
Nature	Negative		Negative	
Duration	On-going	Impact will last between 15 and 20 years	On-going	Impact will last between 15 and 20 years
Extent	Municipal area	Impacts felt at a municipal level	Municipal area	Impacts felt at a municipal level
Intensity	Very low	Natural and/ or social functions and/ or processes are slightly altered	Very low	Natural and/ or social functions and/ or processes are slightly altered
Probability	Almost certain / Highly probable	It is most likely that the impact will occur	Almost certain / Highly probable	It is most likely that the impact will occur
Confidence	Medium	Determination is based on common sense and general knowledge	Medium	Determination is based on common sense and general knowledge
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	Medium	The affected environment will only recover from the impact with significant intervention
Resource irreplaceability	Low	The resource is not damaged irreparably or is not scarce	Low	The resource is not damaged irreparably or is not scarce
Significance	Minor - negative		Minor - negative	

Impact	The positive, cumulative impact on agricultural potential resulting from multiple wind farm projects in the area, with increased financial security being the most important contributor			
Description of impact				
Mitigatability	Medium	Mitigation exists and will notably reduce significance of impacts		
Potential mitigation	All of the same mitigation as for individual impacts, the most important of which is the design phase layout to implement specific designs with input from affected farmers to enhance usefulness to their agricultural operations			
Assessment	Without mitigation		With mitigation	
Nature	Positive		Positive	
Duration	On-going	Impact will last between 15 and 20 years	On-going	Impact will last between 15 and 20 years
Extent	Municipal area	Impacts felt at a municipal level	Municipal area	Impacts felt at a municipal level
Intensity	Moderate	Natural and/ or social functions and/ or processes are moderately altered	Moderate	Natural and/ or social functions and/ or processes are moderately altered
Probability	Almost certain / Highly probable	It is most likely that the impact will occur	Almost certain / Highly probable	It is most likely that the impact will occur
Confidence	Medium	Determination is based on common sense and general knowledge	Medium	Determination is based on common sense and general knowledge
Reversibility	High	The affected environmental will be able to recover from the impact	High	The affected environmental will be able to recover from the impact
Resource irreplaceability	Low	The resource is not damaged irreparably or is not scarce	Low	The resource is not damaged irreparably or is not scarce
Significance	Moderate - positive		Moderate - positive	

Upward production trends from the case study suggest that the balance of impacts (overall impact when all negative and positive impacts are summed) is probably positive, or at very worst neutral for agricultural output. If the balance of impacts on individual farms is positive or neutral, then the cumulative impact on the farming region must also be positive or neutral.

8.3 Comparative assessment of alternatives

The No-Go alternative is the only one assessed because all other alternatives have been screened out during the EIA process.

The No-Go alternative anticipates changes to the agricultural environment that would occur in the absence of the proposed development. No significant changes are anticipated in the No-Go scenario, compared to the negligible and minor negative, and minor and moderate positive impacts anticipated for the development. Therefore, the anticipated impact of the No-Go scenario (*status quo* remains) on the environment is neutral as depicted in the table below.

Project phase				
Impact	No-go alternative			
Description of impact				
Mitigatability	Low	Mitigation does not exist; or mitigation will slightly reduce the significance of impacts		
Potential mitigation	None			
Assessment	Without mitigation		With mitigation	
Nature	Positive			
Duration	Permanent	Impact may be permanent, or in excess of 20 years		#N/A
Extent	Limited	Limited to the site and its immediate surroundings		#N/A
Intensity	Negligible	Natural and/ or social functions and/ or processes are negligibly altered		#N/A
Probability	Probable	The impact has occurred here or elsewhere and could therefore occur		#N/A
Confidence	Low	Judgement is based on intuition		#N/A
Reversibility	High	The affected environmental will be able to recover from the impact		#N/A
Resource irreplaceability	Low	The resource is not damaged irreparably or is not scarce		#N/A
Significance	Minor - positive		#N/A	
Comment on significance	All logic says that the significance is neutral, but there is no neutral option in the prescribed methodology so positive has been randomly chosen. There was a 50% probability that negative could also have been chosen. In effect the table is meaningless, but prescribed.			

9 INPUTS INTO THE ENVIRONMENTAL MANAGEMENT PROGRAMME (EMPR)

The following mitigation measures are proposed for inclusion in the EMPr:

Design phase mitigation (which has already been implemented):

- Avoid all No-Go areas.
- The wind farm layout must be designed by way of an iterative process that has direct, detailed input from the affected farmers. The farmers input must be aimed at minimising the loss of productive land, minimising disturbance by the wind farm layout, and enhancing the usefulness of turbine access roads, to their farming operations

Construction phase mitigation:

- To prevent damage or compaction to adjacent agricultural land, all vehicle traffic and parking should be confined to the access roads and designated work, parking and lay down areas. Any necessary pull-offs and parking areas should be developed outside of active agricultural fields.
- Installation of industry approved cattle grids (see Appendix 2) at the start of construction at all wind farm access gates that pose a threat in terms of unwanted cattle movement and particularly at all boundary gates between neighbouring farms.
- Road engineers must implement effective systems of storm water run-off control where they are required on roads (and their adjacent slopes if applicable) as well as hardened surfaces - that is at points where water accumulation with significant run-off might occur. The system must effectively collect and safely disseminate run-off water from

hardened surfaces and it must prevent any potential down slope erosion.

- Limit disturbance to all contour banks created for erosion control, and if disturbed, restore to original specifications and ensure overall integrity of the contour bank drainage system after restoration.
- When constructing roads through cultivated agricultural land, the final road surface should be level with the adjacent field surface, or if drainage precludes this, should not elevated more than 150mm above the surrounding field surface.
- Maintain where possible all vegetation cover and facilitate effective re-vegetation of denuded areas throughout the site, to stabilize the soil against erosion, particularly on slopes adjacent to roads created by cut and fill. The planting of oats or indigenous grass mix at the onset of winter rainfall is recommended. The suitably qualified and experienced Environmental Control Officer should take responsibility for the effective implementation of this.
- If an activity will mechanically disturb the soil below surface in any way, then any available topsoil should first be stripped from the entire surface to be disturbed and stockpiled for re-spreading during rehabilitation. Topsoil must be kept separate from any subsurface spoils. Topsoil stockpiles must be conserved against losses through erosion by establishing vegetation cover on them. During rehabilitation, the stockpiled topsoil must be evenly spread over the entire disturbed surface. Any subsurface spoils from excavations must be disposed of where they will not bury the topsoil of agricultural land. The suitably qualified and experienced environmental control officer should take responsibility for the implementation of this.
- Topsoil should be spread to create a smooth transition between the road surface and the surrounding agricultural land, so as not to impede crossing by farm equipment.

Monitoring recommendations to ensure effective mitigation are given below. All monitoring should be done by a suitably qualified and experienced Environmental Control Officer.

Soil erosion

Mitigation: Target / Objective	To have no wind and water erosion on and downstream of the site.
Monitoring	Include site inspection in environmental performance/audit reporting that inspects the effectiveness of the run-off control system and specifically records occurrence or not of any erosion on site or downstream, including photographs (prior to construction and then every 2 months during construction; once a year during operation). Corrective action must be swiftly implemented to the run-off control system in the event of any erosion occurring.

Topsoil & vegetation cover

Mitigation: Target / Objective	Ensure effective topsoil covering and vegetation cover on all disturbed areas after rehabilitation.

Monitoring	Establish an effective record keeping system for each area that will be rehabilitated during or after construction, and where soil is disturbed below surface, or plant cover is removed. These records should be included in environmental performance/audit reports, and should include all the records below. • Record the GPS coordinates of each area and where the topsoil is stockpiled. • Record the date of topsoil or vegetation stripping. • Record the date of cessation of construction activities at the particular site. • Photograph the area on cessation of construction activities. • Record date and depth of re-spreading of topsoil. • Photograph the area prior to disturbance, on completion of rehabilitation and once every 6 months thereafter, until the area is vegetated and stabilised.

10 CONCLUSIONS

The proposed development is on land zoned and used for agriculture. South Africa has very limited arable land and it is therefore critical to ensure that development does not lead to a loss of agricultural production from such land. This assessment has found that, although the proposed development overlaps on cultivated farmland that supports intensive and productive dairy farming, the development is nevertheless highly unlikely to cause a reduction in agricultural production. A very small amount of production land will be lost, but the consequence of the lost land for agricultural production is negligible. It is likely that the positive impacts of the development will outweigh the negative impacts and that the development will therefore benefit farming and agricultural production.

Important factors that have mitigated the significance of negative impacts to date are that the wind farm footprint has entirely avoided No-Go areas and is limited to only a small proportion of the surface area, and that the layout design has had extensive input by the farmers, aimed at minimising the loss of productive land and of disturbance to their farming operations.

The results of the case study show that agricultural production from surrounding impacted farms has an upward trend over time, which suggests that all the potential negative impacts of wind farms (as identified in section 8.1) have not reduced production levels.

No-go areas of very high sensitivity have been identified and must be avoided by the footprint of the wind farm. There are no conditions resulting from this assessment that need to be included in the environmental authorisation.

The conclusion of this assessment is that, on the balance of negative and positive impacts, wind farms are likely to have a continued positive impact on the agriculture of the area. Rather than threatening agriculture, the development of the Impofu West Wind Farm, can potentially contribute to enhanced agricultural development and production, primarily through increased financial security for farming operations. From an agricultural perspective, therefore, the proposed development should be authorised, with implementation of recommended mitigation measures and the avoidance of all No-Go areas.

11 REFERENCES

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APPENDIX 1: SOIL DATA

Table A1. Land type soil data for the site.

Land type	Land capability class	Soil series (forms)	Depth (mm)	Clay % A horizon	Clay % B horizon	Depth limiting layer	% of land type
Ha47	3	Fernwood	800 > 1200	0 - 5		U,R	45
		Constantia	> 1200	0 - 2	0 - 2	U,R	35
		Clovelly	> 1200	0 - 5	2 - 8	U,R	11
		Longlands	450 - 800	0 - 8	5 - 15	sp	4
		Rock outcrop					3
		Katspruit	400 - 500	8 - 18	> 60	gc	1
		Kroonstad	800 - 1000	8 - 10	> 60	gc	1
		Lamotte	800 - 1200	0 - 8	5 - 15	U	<1
Bb75	3	Rock outcrop					23
		Constantia	> 1200	0 - 2	2 - 5	U,R	20
		Fernwood	> 1200	0 - 2		U	19
		Wasbank	400 - 800	2 - 40		hp	11
		Longlands	400 - 800	0 - 2		sp	7
		Houwhoek	300 - 600	6 - 10	6 - 15	so	6
		Clovelly	> 1200	2 - 22	4 - 25	U,R	6
		Mispah	200 - 400	2 - 10		R,hp	4
		Cartref	300 - 450	8 - 12		so	3
		Glenrosa	250 - 400	8 - 12		so	2
		Glencoe	700 - 900	15 - 20	25 - 30	hp	2
		Dundee	> 1200	0 - 2		U	<1
Ca80	3	Kroonstad	700 - 900	8 - 18	> 60	gc	50
		Longlands	700 - 800	2 - 20		sp	13
		Constantia	400 - 700	6 - 10	8 - 10	R,hp	10
		Wasbank	600 - 800	8 - 10		hp	10
		Lamotte	> 1200	6 - 8	10 - 15	U	8
		Katspruit	400 - 500	8 - 18	> 60	gc	4
		Glencoe	400 - 600	8 - 10	8 - 12	hp	3
		Houwhoek	400 - 500	6 - 8		so	2

Land type	Land capability class	Soil series (forms)	Depth (mm)	Clay % A horizon	Clay % B horizon	Depth limiting layer	% of land type
		Rock outcrop					1
		Champagne	> 1200	20 - 25		U,gc	1

Land capability classes:

3 = moderate potential arable land;

Depth limiting layers: R = hard rock; so = partially weathered bedrock; hp = cemented hardpan plinthite (laterite); sp = soft plinthic horizon; gc = dense clay horizon that is frequently saturated; U = sand.

Table A2. Data from investigated test pits across the Impofu Wind Farms project area (encompassing Impofu North, East and West)

Test pit no.	Soil form	Soil family	Effective depth (depth to limiting horizon) (cm)	Limiting horizon	Clay %		GPS Position Lat/Lon hddd.ddddd° WGS84	
					top soil	sub soil	latitude	longitude
1	>120	Wf	1100	gs	4	6	-34.098725	24.550936
2	>120	Pg	1000	pd	4	6	-34.091283	24.559835
3	100	Wf	1100	gs	4	6	-34.095002	24.571451
4	>120	Lt	1100	pd	4	6	-34.093926	24.540790
5	90	Gc	2100	hp	10	14	-34.089267	24.553238
6	30	Ka	1000	gc	10	45	-34.082743	24.539269
7	>120	Wf	1100	pd	5	7	-34.078684	24.537305
8	40	Kd	1000	gc	5	45	-34.079372	24.529050
9	90	Gc	2100	hp	6	8	-34.071918	24.532078
10	50	Cf	2200	so	10	10	-34.053347	24.531049
11	20	Ka	1000	gc	8	45	-34.055599	24.523139
12	120	Wf	1100	gs	4	6	-34.060246	24.523156
13	120	Wf	2200	gc	4	6	-34.067553	24.526366
14	>120	Wf	2200	pd	4	6	-34.075612	24.527351
15	40	Ka	1000	gc	12	45	-34.075574	24.562805
16	90	Gc	2100	hp	4	7	-34.074159	24.576692
17	90	Gc	2100	gc	6	10	-34.076805	24.571749
18	>120	Pg	1000	hp	4	8	-34.080928	24.555806
19	120	Lo	1000	gc	10	12	-34.086800	24.569420
20	40	Wa	1000	hp	10	10	-34.055400	24.539435
21	60	Wa	2000	hp	8	8	-34.067397	24.546732
22	100	Lo	1000	sp	4	6	-34.067949	24.556503
23	70	Wa	2000	hp	8	8	-34.062802	24.563956
24	60	Kd	1000	gc	4	45	-34.047973	24.553740
25	>120	Lo	1000	sp	4	7	-34.044618	24.559331
26	>120	Lo	2000	sp	4	7	-34.052691	24.563380
27	>120	Lo	1000	sp	4	7	-34.039171	24.517118
28	60	Wa	1000	hp	4	5	-34.033925	24.506930

Test pit no.	Soil form	Soil family	Effective depth (depth to limiting horizon) (cm)	Limiting horizon	Clay %		GPS Position Lat/Lon hddd.ddddd° WGS84	
					top soil	sub soil	latitude	longitude
29	>120	Lo	1000	sp	3	8	-34.028716	24.496918
30	60	Wa	2000	hp	4	5	-34.034098	24.529574
31	60	Cf	1200	so	4	6	-34.033618	24.538546
32	80	Wa	1000	hp	8	8	-34.109534	24.525796
33	80	Wa	1000	hp	8	8	-34.107071	24.518860
34	>120	Lo	1000	sp	4	7	-34.113473	24.521522
35	90	Kd	1000	gc	5	45	-34.120504	24.521718
36	>120	Lt	1100	gs	4	4	-34.122107	24.514120
37	>120	Wf	1100	gs	3	4	-34.126564	24.500824
38	>120	Wf	1100	gs	3	4	-34.120367	24.498729
39	60	We	1000	gc	6	8	-34.114231	24.501465
40	120	Kd	1000	gc	5	45	-34.110836	24.506102
41	>120	Fw	2110	gs	5	5	-34.112916	24.513242
42	>120	Av	2100	sp	5	6	-34.105395	24.574002
43	>120	Av	2100	sp	5	6	-34.100358	24.581864
44	>120	Av	2100	sp	5	6	-34.094308	24.581846
45	>120	Av	2100	sp	5	6	-34.086312	24.580907
46	80	Kd	1000	gc	4	45	-34.091091	24.586414
47	70	Kd	1000	gc	6	45	-34.097146	24.596929
48	>120	Lt	1100	gs	3	3	-34.103526	24.606271
49	>120	Av	2100	sp	5	7	-34.108007	24.596951
50	60	Kd	1000	gc	4	40	-34.111302	24.593443
51	>120	Lt	1100	gs	3	4	-34.107360	24.605548
52	>120	Lt	1100	gs	3	4	-34.111826	24.620132
53	>120	Lt	1100	gs	3	4	-34.109975	24.613828
54	>120	Lt	1100	gs	3	4	-34.116999	24.605138
55	>120	Lo	1000	sp	4	6	-34.145963	24.652041
56	90	Gc	2100	hp	5	7	-34.141878	24.652160
57	>120	Wf	1100	sp	4	5	-34.138385	24.656809
58	>120	Pg	1000	pd	4	5	-34.134893	24.660899

Test pit no.	Soil form	Soil family	Effective depth (depth to limiting horizon) (cm)	Limiting horizon	Clay %		GPS Position Lat/Lon hddd.ddddd° WGS84	
					top soil	sub soil	latitude	longitude
59	>120	Wf	1100	sp	4	5	-34.138405	24.665469
60	60	Ms	2100	R	4		-34.146128	24.660498
61	>120	Wf	1100	sp	4	5	-34.150077	24.658458
62	>120	Fw	1110	gs	2	2	-34.142942	24.581375
63	>120	Fw	1110	gs	2	2	-34.144960	24.587129
64	>120	Fw	1110	gs	2	2	-34.148230	24.585072
65	>120	Fw	1110	gs	2	2	-34.147362	24.592324
66	>120	Fw	1110	gs	2	2	-34.146118	24.598720
67	>120	Fw	1110	gs	3	3	-34.130652	24.486486
68	>120	Fw	1110	gs	3	3	-34.126615	24.508126
69	>120	Fw	1110	gs	3	3	-34.126220	24.516506

APPENDIX 2: RECOMMENDED CATTLE GRID DESIGN