central
developments

12 November 2021

Gauteng Department of Agriculture and Rural Development (GDARD)

Attention: Administrative Unit of the Sustainable Utilisation of the Environment Branch

Ground Floor
Umnotho House
56 Eloff Street
Johannesburg
2000

Attention: Registry Office

Dear Sir/Madam

REGISTRATION TO REQUEST TO BE REGISTERED AND INTENT TO COMPLY WITH THE GPEMF STANDARD FOR THE PROPOSED RESIDENTIAL TOWNSHIP ESTABLISHMENT TO BE KNOWN AS ERAND GARDENS EXT 125 ON ERF 870 (CONSOLIDATED ERVEN 809 AND 810) ERAND GARDENS EXT 125 IN MIDRAND, CITY OF JOHANNESBURG

Please find included one hard copy and two USB's of the GPEMF Application for the proposed development for your decision making.

Please do not hesitate to contact us should any further information be required.

Regards,

Gerrit Brandow
Director

GAUTENG PROVINCE
AGRICULTURE AND RURAL DEVELOPMENT
REPUBLIC OF SOUTH AFRICA

REGISTRATION FORM A REQUEST TO BE REGISTERED AND INTENT TO COMPLY WITH THE GPEMF STANDARD		
FOR OFFICE USE ONLY		
Date Registration Form Received		
Outcome of Evaluation of the Registration Form	☐ Accepted	☐ Rejected
	If rejected, provide reasons:	
Registration Number		

Kindly note that:

1. All fields must be completed in full; submission of incomplete information will result in automatic rejection.
2. Declaration of whether the registration is a first or a re-submission.
3. This form must be used in all instances for request for registrations that must be subjected to an excluded activity related to the GPEMF Standard in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) as amended.
4. This form is current as of the date of commencement of the Standard, as indicated in the Government Gazette. It is the responsibility of the proponent to ascertain whether subsequent versions of the form have been published or produced by the competent authority.
5. The required information must be typed within the spaces provided in the form. The size of the space provided is not necessarily indicative of the amount of information to be provided. It is in the form of a table that will expand itself as each space is filled with typing.
6. Incomplete documentation will be rejected.
7. The use of "not applicable" in the form must be done with circumspection. Where it is used in respect of material information that is required by the competent authority for assessing the registration, this will result in the rejection of the registration as provided for in the regulations.
8. Unless protected by law, all information contained in, and attached to this registration, will become public information on receipt by the competent authority. Upon request, any interested and affected party should be provided with the information contained in and attached to this registration.
9. One hard copy and two CDs/USBs with soft copies in colour must be submitted to the Department at the Registry Office. The competent authority will also accept online submissions as and when the system comes into effect. All information submitted on the hard copy must be duplicated on the soft copy as a PDF document on the CD/USB. The electronic copy on a CD/USB must be accompanied with a shapefile (WGS84) and a layout plan.
10. No faxed or e-mailed registration form will be accepted. Only hand delivered or posted registration forms will be accepted.
11. The relevant guidelines as quoted in the GPEMF Standard, can be obtained from the departmental website: www.gdard.gov.za or www.enironment.gov.za or the relevant departmental Registration Unit.
12. Registration form must be submitted at the following Address:

    Postal Address
    Gauteng Department of Agriculture and Rural Development Attention: Deputy Director: Strategic Administrative Unit of the Sustainable Utilisation of the Environment (SUE) Branch
    P. O. Box 8769
    Johannesburg
    2000

    Physical Address
    Administrative Unit of the Sustainable Utilisation of the Environment (SUE) Branch
    Ground floor, Umnotho House, 56 Eloff Street
    Johannesburg

    Queries should be directed to the Strategic Administrative Unit at:
    Administrative Unit telephone number (011) 240 3377
    Departmental central telephone number (011) 240 2500

INCORRECTLY COMPLETED AND INCOMPLETE REGISTRATION FORMS WILL NOT BE CONSIDERED

SECTION A: DETAILS OF THE PROPONENT OF THE DEVELOPMENT	
All notifications pertaining to the request for registration project will be sent using the information provided in this section of the form.	
Company (include Trading Name)	Zotec Developments (Pty) Ltd
First Name	Gerrit
Surname	Brandow
Email	Gerrit@centraldev.co.za
Telephone Number	(011) 541 3800
Cell phone Number	(087)405 3910
Fax Number	083 556 6784
Postal Address	PO Box 754 Auckland Park 2006

ENVIRONMENTAL PRACTITIONER'S DETAILS (Where applicable) **NOT APPLICABLE**		
Company (include Trading Name)		
First Name		
Surname		
Email		
Telephone Number		
Cell phone Number		
Fax Number		
Postal Address		
EAP Qualifications		
EAP Registration / Associations		
Registration Status	**First submission**	**YES**
	Resubmission	~~**NO**~~
	If Resubmission, then provide the previous Reference number	

SECTION B: SITE INFORMATION	
Site Name	Erf 870 (consolidated erven 809 and 810) Erand Gardens Ext 125 in Midrand, City of Johannesburg, Gauteng Province
Site Telephone Number (if any)	N/A
Owner Name	Zotec Developments (Pty) Ltd
Public or Commercial	Commercial
Please provide the Geographic Co-ordinates of all external corner points of the site	
Degrees Latitude **Degrees Longitude** *(Decimal degrees)*	**Corner 1:** 25°58'22.65" S; 28°7'31.97" E **Corner 2:** 25°58'23.59" S; 28°7'35.13" E **Corner 3:** 25°58'29.46" S; 28°7'33.59" E **Corner 4:** 25°58'28.92" S; 28°7'30.37" E
Physical Address/Property Description[1]	Corner of 13th Road and Third Road, Midrand, City of Johannesburg, Gauteng Province
Size of the Property (ha/m²)	1,7855 hectares

SECTION C: MUNICIPALITY INFORMATION	
Municipality/ municipalities	City of Johannesburg
Contact Person (from Environment Management or Town Planning)	Ms Lebo Molefe / Mukundwa Phalandwa
Email	lebom@joburg.org.za / mukundwap@joburg.org.za
Telephone Number	(011) 339 1885 of (011) 587 4238
Fax Number	No fax number
Postal address	P.O. Box 1049 Johannesburg 2000
Physical address	3rd Floor Diamond Building, 11 Diagonal Street, Newton, Johannesburg

[1] (Farm name, portion etc.) Where a large number of properties (including alternatives) are involved (e.g. linear activities), please attach a list of the property descriptions to this registration form.

SECTION D: PROJECT DESCRIPTION	
Project Title	**Proposed Residential Township Establishment to be known as Erand Gardens Ext 125, Gauteng Province**
Project Description	'Residential 4' zoning is proposed for the township, comprising a total of 216 units. Unit mix: 37% 1+1 ($36m^2$) / 37% 2+1 ($48m^2$) / 26% 2+2 ($65m^2$) Coverage: 30% Height: 4 storeys Density: 120 units/ha Parking requirements: 1 parking per unit The site has an old wetland which has been evaluated by a specialist (See specialist study attached in Appendix E). The specialist confirmed that the stormwater runoff from the Ben Schoeman highway and surrounding urban infrastructure contributes to the wetland expression on the site. This expression is influenced significantly by historical infilling activities, and it is amplified by erosion of the soils within the current watercourse alignment.
GPEMF Zones in which the proposed development is situated	Zone 1

SECTION E: EXCLUDED ACTIVITIES			
Only excluded listed activities will apply here. All 'excluded' listed activities for Listing Notice 1 (Government Notice R983) and Listing Notice 2 (Government Notice R984) associated with the development project must be indicated below:			
Zone 1 and/or Zone 5	Government Notice R983 Activity No(s):	Describe the relevant **activity/ activities** in writing as per **Listing Notice 1**	Describe the portion of the development as per the project description that relates to the applicable listed activity
1	27	The clearance of an area of 1 hectares or more, but less than 20 hectares of indigenous vegetation.	Building of residential units approximately 1,7855 hectares in extent.
Zone 1 and/or Zone 5	Government Notice R984 Activity No(s):	Describe the relevant **activity/ activities** in writing as per **Listing Notice 2**	Describe the portion of the development as per the project description that relates to the applicable listed activity
Please note: Only those activities for which the Proponent applies will be considered for registration. The onus is on the Proponent to ensure that all the excluded listed activities are included in the registration. Failure to do so may invalidate the request for registration.			

SECTION F: DECLARATION BY THE PROPONENT OF THE DEVELOPMENT/FACILITY	
Project Title	Proposed Residential Township Establishment to be known as Erand Gardens Ext 125, Gauteng Province

I, ____________________, hereby declare that I have read the completed registration form and hereby confirm that the information provided is to the best of my knowledge true and correct.

I declare that I have not commenced with the project as described in Section D of this form and will not commence until a registration number has been received as contemplated in the GPEMF Standard.

Furthermore, I declare that I am fully aware of my responsibilities in terms of the GPEMF Standard in terms of the NEMA, as amended and failure to comply with these requirements may constitute an offence.

Owner of the Facility (Name and Surname) G. BRANDOW

Designation Project Director

Signature ____________ **(duly authorised to sign on behalf of Owner of the Facility)**

Date 10/11/2021 **Place** Midrand.

Commissioner of Oaths ____________________

Designation ____________________

Signature ____________

Date 10/11/2021 **Place** Midrand

MICHELLE KOTZE
COMMISSIONER OF OATHS EX OFFICIO

MICHELLE KOTZE
Consultant at Central Developments Projects Pty Ltd
Waterfall Park, Bekker Road, Midrand 1685

Commissioner of Oaths Stamp

SECTION G: DECLARATION BY THE LAND OWNER[2]	
Project title	**Proposed Residential** Township Establishment **to be known as Erand Gardens Ext 125, Gauteng Province**

NB:(Only if the landowner is different from the Owner of the Facility)

I, ____declare that I -

- Am, aware of the development activity/ activities to take place or taking place in my property
- Consented to this/these activities/activities taking/to take place in my property hereby indemnify, the government of the Republic, the competent authority and all its officers, agents and employees, from any liability arising out of the content of any report, any procedure or any action for which the Proponent is responsible in terms of the NEMA, 1998 as amended.

Land Owner (Name and Surname)____

Telephone__________________ **Cell**______________

Email____

Designation ____

Signature_________________________

Date___________________________________ **Place**___________________________

Commissioner of Oaths____

Designation ____

Signature_________________________

Date___________________________________ **Place**___________________________

____

Commissioner of Oaths Stamp

[2] In the event of more than one landowner, each landowner must sign the declaration.

APPENDIX A

Site Coordinates

VODACOM SITE 1 - ERAND GARDENS EXT 125

Corner of Site	Geographical coordinates
Corner 1	25°58’22.65” S; 28°7’31.97” E
Corner 2	25°58’23.59” S; 28°7’35.13” E
Corner 3	25°58’29.46” S; 28°7’33.59” E
Corner 4	25°58’28.92” S; 28°7’30.37” E

APPENDIX B

Site Locality Plan
and
Layout Plan

CONSOLIDATION DIAGRAM

COMPONENTS:

1. The figure ABCzyxFGA represents Erf 809
   Vide General Plan S.G.No.534/2010
   Deed of Transfer No. T26005/2019
2. The figure xyzDEx represents Erf 810
   Vide General Plan S.G.No.534/2010
   Deed of Transfer No. T26006/2019

S.G. No.

2413/2020

Approved

for
SURVEYOR-GENERAL
07/12/2020

Act. 16/2013
Reg No.20/07/3480/2019
Date: 2020-09-09

Sheet 1 of 2 Sheets

The figure	A B C D E F G A	
represents	1,7855 hectares	of land being

ERF 870

(and comprises components 1 and 2 listed above)

ERAND GARDENS EXTENSION 125 TOWNSHIP

City of Johannesburg Metropolitan Municipality
Province of Gauteng
Compiled in October 2020 by me

E.G. SWART
Professional Land Surveyor
Registration Number PLS 0998

This diagram is annexed to No. d.d. : i.f.o. Registrar of Deeds PRETORIA	The original General Plan is as listed above.	File : ERVEN S.R. : G.P. : S.G.No.534/2010 Comp. : JRSV - 418

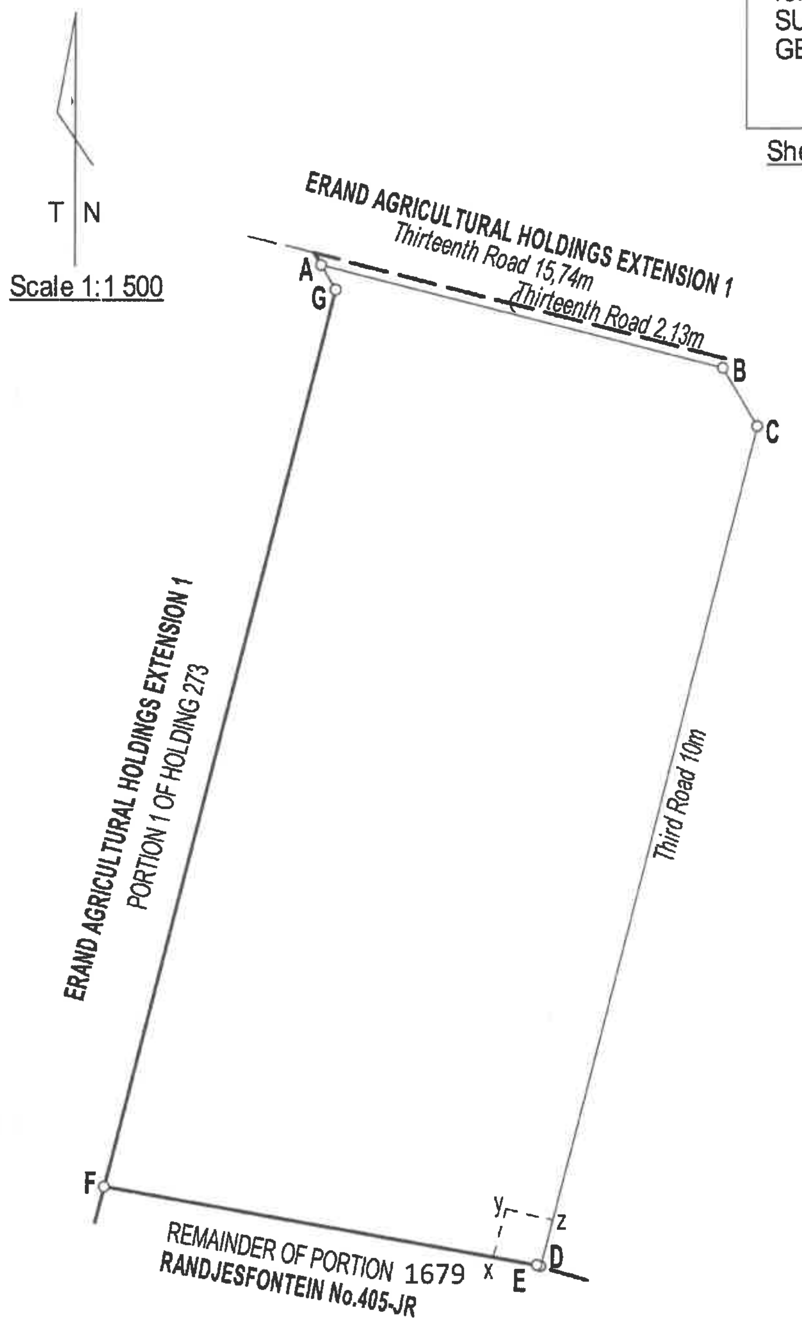
CONSOLIDATION DIAGRAM

S.G. No.
2413/2020
Approved

for
SURVEYOR-
GENERAL
07/12/2020

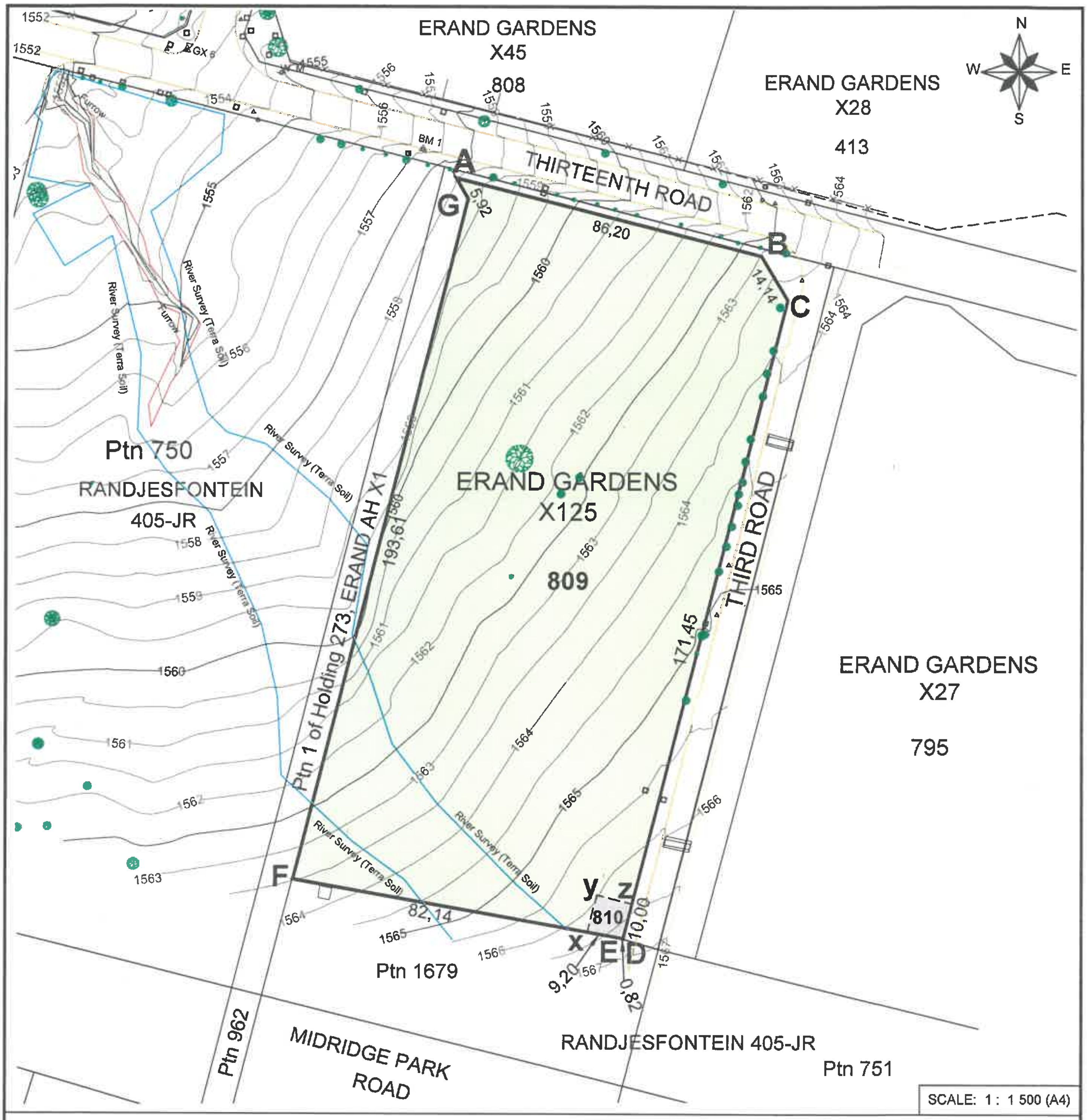
Sheet 2 of 2 Sheets

ERF 870
ERAND GARDENS EXTENSION 125 TOWNSHIP



Compiled in October 2020 by me

E.G. SWART
Professional Land Surveyor
Registration Number PLS 0998



PROPOSED CONSOLIDATION OF

ERVEN 809 and 810, ERAND GARDENS X125

ERF	DESCRIPTION	AREA (ha)
Erf 809	A B C z y x F G A	1,7752
Erf 810	x y z D E x	0,0103
Total	A B C D E F G A	1,7855

Notes :

1.) All measurements are approximate
2.) The line xyz denotes the consolidation line

Sonja Meissner-Roloff
Town & Environmental Planning
SMR

P.O. Box 7194
Centurion
0046

Charles de Gaulle Crescent
Highveld
Centurion

Tel: (012) 665-2330
Fax: (012) 665-2333

Cell: 082 451 9585
E-mail: smeissner@icon.co.za

LOCAL AUTHORITY: CITY OF JOHANNESBURG

PLAN NUMBER: SMR478 / cons1

DATE: APRIL 2019


Erand Gardens Ext 125
Legend
Site
Renaissance Park
Corner 1 (25°58'22.65"S, 28° 7'31.97"E)
13th Rd
Corner 2 (25°58'23.59"S, 28° 7'35.13"E)
13th Rd
Vodacom Midrand
Third Rd
Pretoria Main Rd (Toll road)
Vodacom Techno Park building
Corner 4 (25°58'28.92"S, 28° 7'30.37"E)
Corner 3 (25°58'29.46"S, 28° 7'33.59"E)
Google Earth
Image © 2021 Maxar Technologies
N
100 m

APPENDIX C

DEA Screening report

SCREENING REPORT FOR AN ENVIRONMENTAL AUTHORIZATION AS REQUIRED BY THE 2014 EIA REGULATIONS – PROPOSED SITE ENVIRONMENTAL SENSITIVITY

EIA Reference number: N/A

Project name: Erand Gardens X125

Project title: Housing development

Date screening report generated: 10/11/2021 09:01:10

Applicant: Zotec Developments

Compiler: Zotec

Compiler signature: ....

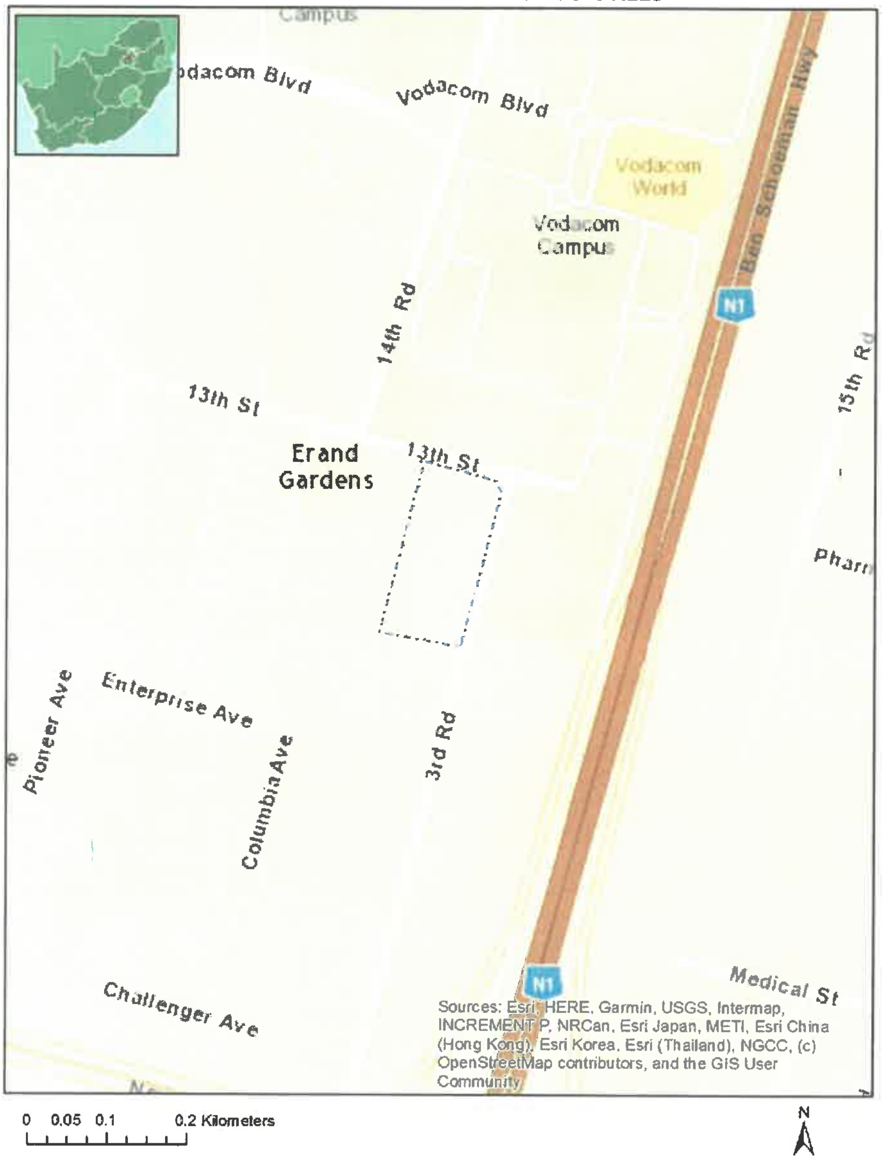
Application Category: Transformation of land|Indigenous vegetation

Table of Contents

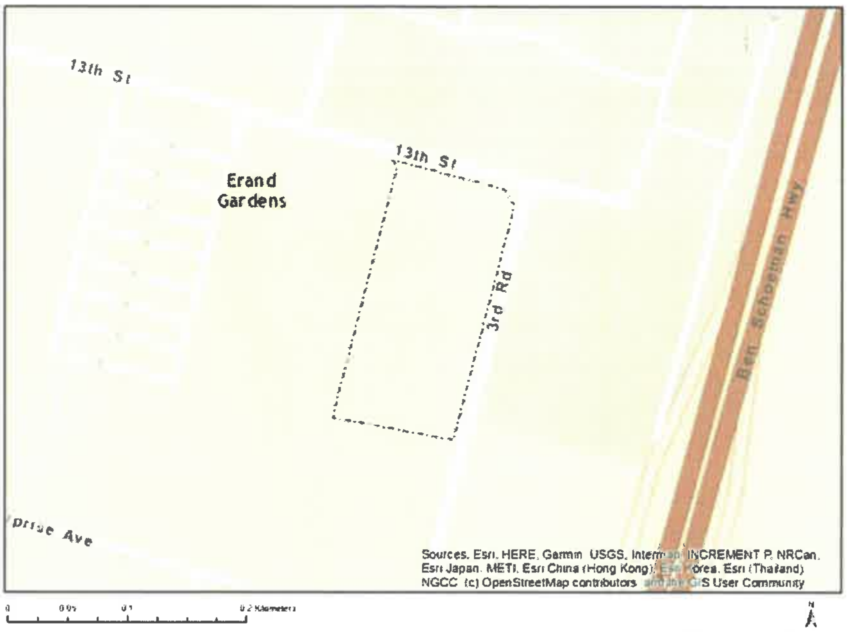
Proposed Project Location

Orientation map 1: General location

General Orientation: Erand Gardens X125



Map of proposed site and relevant area(s)



Cadastral details of the proposed site

Property details:

No	Farm Name	Farm/ Erf No	Portion	Latitude	Longitude	Property Type
1	ERAND GARDENS	870	0	25°58'25.82S	28°7'32.64E	Erven
2	RANDJIESFONTEIN	405	0	25°57'30.22S	28°8'24.19E	Farm
3	RANDJIESFONTEIN	405	1681	25°58'26.42S	28°7'31.56E	Farm Portion

Development footprint[1] vertices:
No development footprint(s) specified.

Wind and Solar developments with an approved Environmental Authorisation or applications under consideration within 30 km of the proposed area

No nearby wind or solar developments found.

[1] "development footprint", means the area within the site on which the development will take place and incudes all ancillary developments for example roads, power lines, boundary walls, paving etc. which require vegetation clearance or which will be disturbed and for which the application has been submitted.

Environmental Management Frameworks relevant to the application

Environmental Management Framework	LINK
Gauteng EMF	https://screening.environment.gov.za/ScreeningDownloads/EMF/Zone_1,_Zone_2,_Zone_3,_Zone_4,_Zone_5.pdf

Environmental screening results and assessment outcomes

The following sections contain a summary of any development incentives, restrictions, exclusions or prohibitions that apply to the proposed development site as well as the most environmental sensitive features on the site based on the site sensitivity screening results for the application classification that was selected. The application classification selected for this report is:
Transformation of land | Indigenous vegetation.

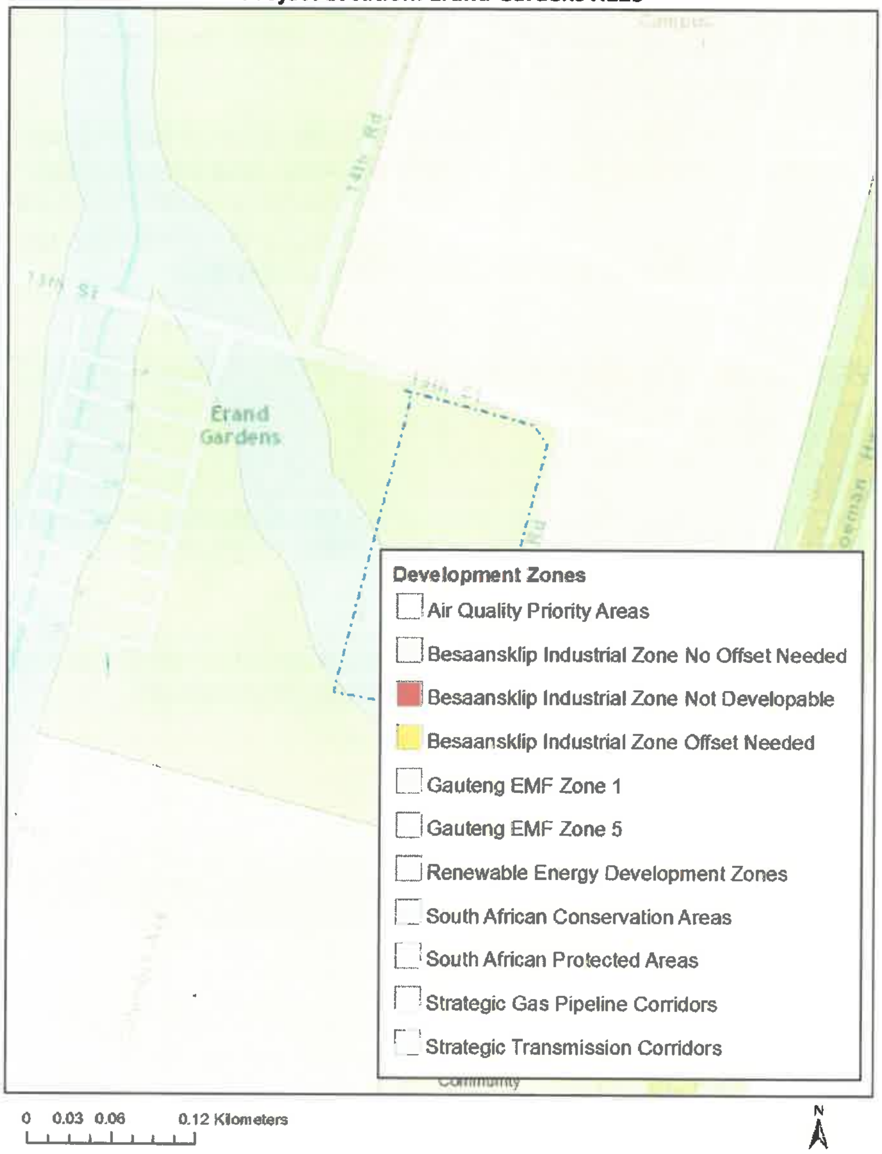
Relevant development incentives, restrictions, exclusions or prohibitions

The following development incentives, restrictions, exclusions or prohibitions and their implications that apply to this site are indicated below.

Incentive, restriction or prohibition	Implication
Strategic Transmission Corridor-Central corridor	https://screening.environment.gov.za/ScreeningDownloads/DevelopmentZones/Combined_EGI.pdf
Gauteng EMF-Urban development zone 1	https://screening.environment.gov.za/ScreeningDownloads/DevelopmentZones/Zone_1.pdf

Map indicating proposed development footprint within applicable development incentive, restriction, exclusion or prohibition zones

Project Location: Erand Gardens X125



Proposed Development Area Environmental Sensitivity

The following summary of the development site environmental sensitivities is identified. Only the highest environmental sensitivity is indicated. The footprint environmental sensitivities for the proposed development footprint as identified, are indicative only and must be verified on site by a suitably qualified person before the specialist assessments identified below can be confirmed.

Theme	Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
Agriculture Theme			X	
Animal Species Theme			X	

Aquatic Biodiversity Theme	X			
Archaeological and Cultural Heritage Theme				X
Civil Aviation Theme		X		
Defence Theme			X	
Plant Species Theme				X
Terrestrial Biodiversity Theme	X			

Specialist assessments identified

Based on the selected classification, and the environmental sensitivities of the proposed development footprint, the following list of specialist assessments have been identified for inclusion in the assessment report. It is the responsibility of the EAP to confirm this list and to motivate in the assessment report, the reason for not including any of the identified specialist study including the provision of photographic evidence of the site situation.

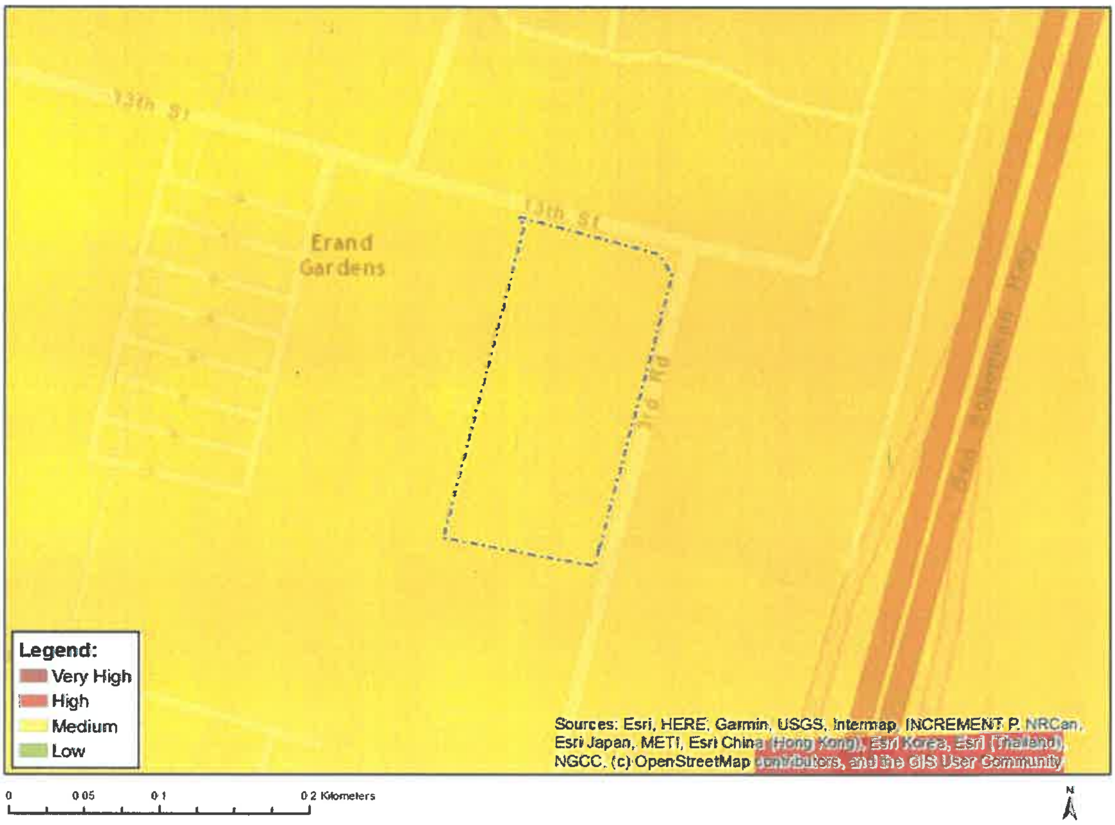
No	Specialist assessment	Assessment Protocol
1	Landscape/Visual Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/Gazetted_General_Requirement_Assessment_Protocols.pdf
2	Archaeological and Cultural Heritage Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/Gazetted_General_Requirement_Assessment_Protocols.pdf
3	Palaeontology Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/Gazetted_General_Requirement_Assessment_Protocols.pdf
4	Terrestrial Biodiversity Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/Gazetted_Terrestrial_Biodiversity_Assessment_Protocols.pdf
5	Aquatic Biodiversity Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/Gazetted_Aquatic_Biodiversity_Assessment_Protocols.pdf
6	Avian Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/Gazetted_Avifauna_Assessment_Protocols.pdf
7	Socio-Economic Assessm	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/Gazetted_General_Requirement_Assessment_Protocols.pdf

	ent	
8	Plant Species Assessm ent	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/Gazetted_Plant_Species_Assessment_Protocols.pdf
9	Animal Species Assessm ent	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/Gazetted_Animal_Species_Assessment_Protocols.pdf

Results of the environmental sensitivity of the proposed area.

The following section represents the results of the screening for environmental sensitivity of the proposed site for relevant environmental themes associated with the project classification. It is the duty of the EAP to ensure that the environmental themes provided by the screening tool are comprehensive and complete for the project. Refer to the disclaimer.

MAP OF RELATIVE AGRICULTURE THEME SENSITIVITY

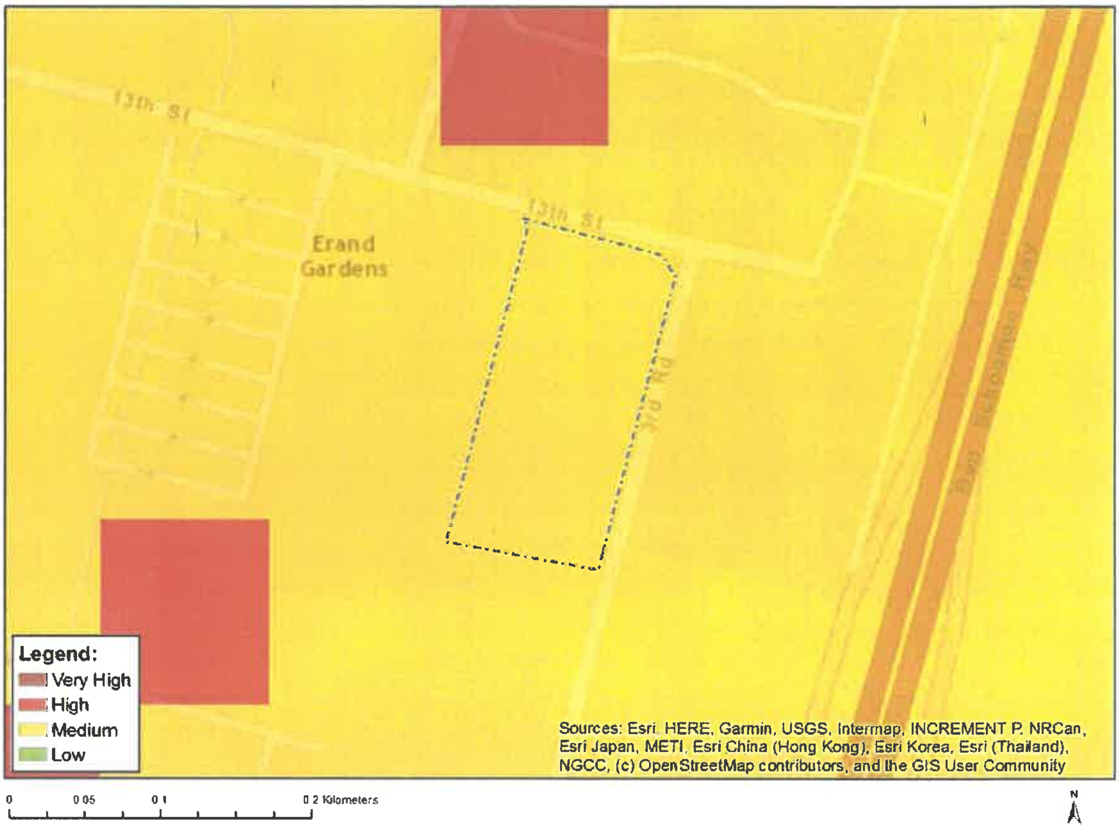


Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
		X	

Sensitivity Features:

Sensitivity	Feature(s)
Medium	Land capability;06. Low-Moderate/07. Low-Moderate/08. Moderate

MAP OF RELATIVE ANIMAL SPECIES THEME SENSITIVITY



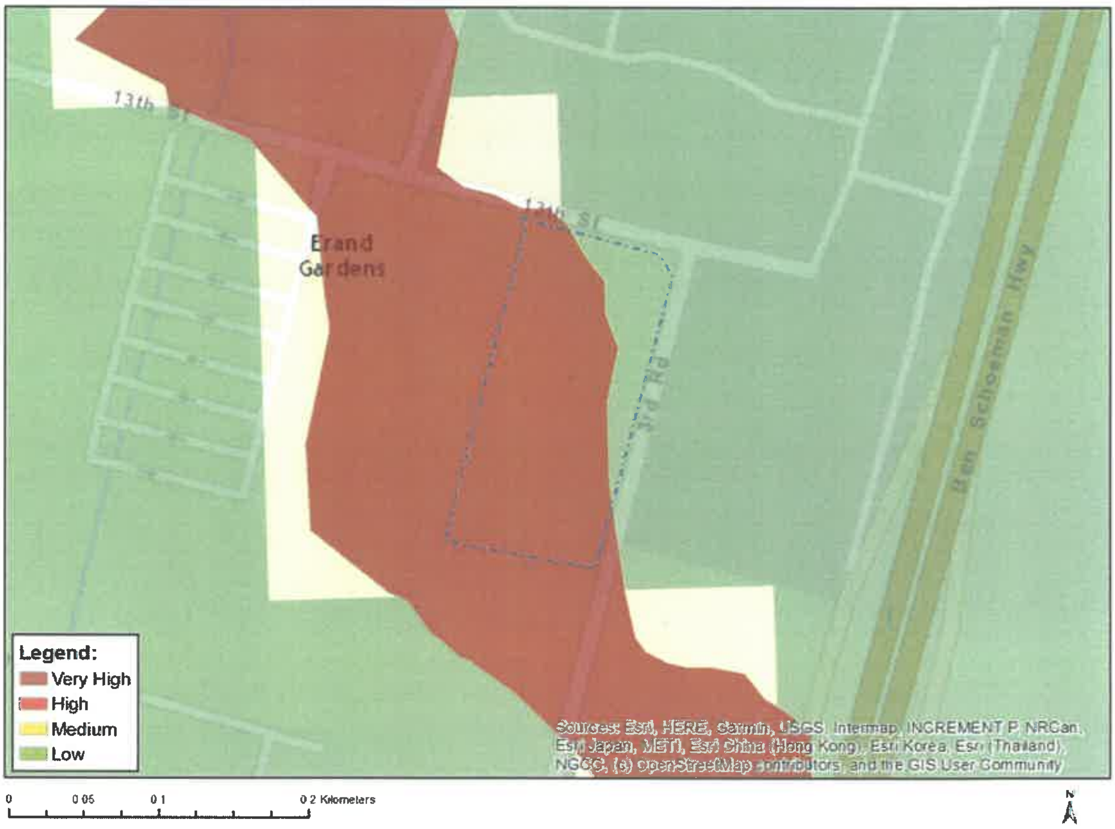
Where only a sensitive plant unique number or sensitive animal unique number is provided in the screening report and an assessment is required, the environmental assessment practitioner (EAP) or specialist is required to email SANBI at eiadatarequests@sanbi.org.za listing all sensitive species with their unique identifiers for which information is required. The name has been withheld as the species may be prone to illegal harvesting and must be protected. SANBI will release the actual species name after the details of the EAP or specialist have been documented.

Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
		X	

Sensitivity Features:

Sensitivity	Feature(s)
Medium	Invertebrate-Clonia uvarovi
Medium	Mammalia-Chrysospalax villosus
Medium	Mammalia-Crocidura maquassiensis
Medium	Mammalia-Dasymys robertsii
Medium	Mammalia-Hydrictis maculicollis

MAP OF RELATIVE AQUATIC BIODIVERSITY THEME SENSITIVITY



Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
X			

Sensitivity Features:

Sensitivity	Feature(s)
Low	Low sensitivity
Very High	Wetlands and Estuaries

MAP OF RELATIVE ARCHAEOLOGICAL AND CULTURAL HERITAGE THEME SENSITIVITY

Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
			X

Sensitivity Features:

Sensitivity	Feature(s)
Low	Low sensitivity

10/11/2021

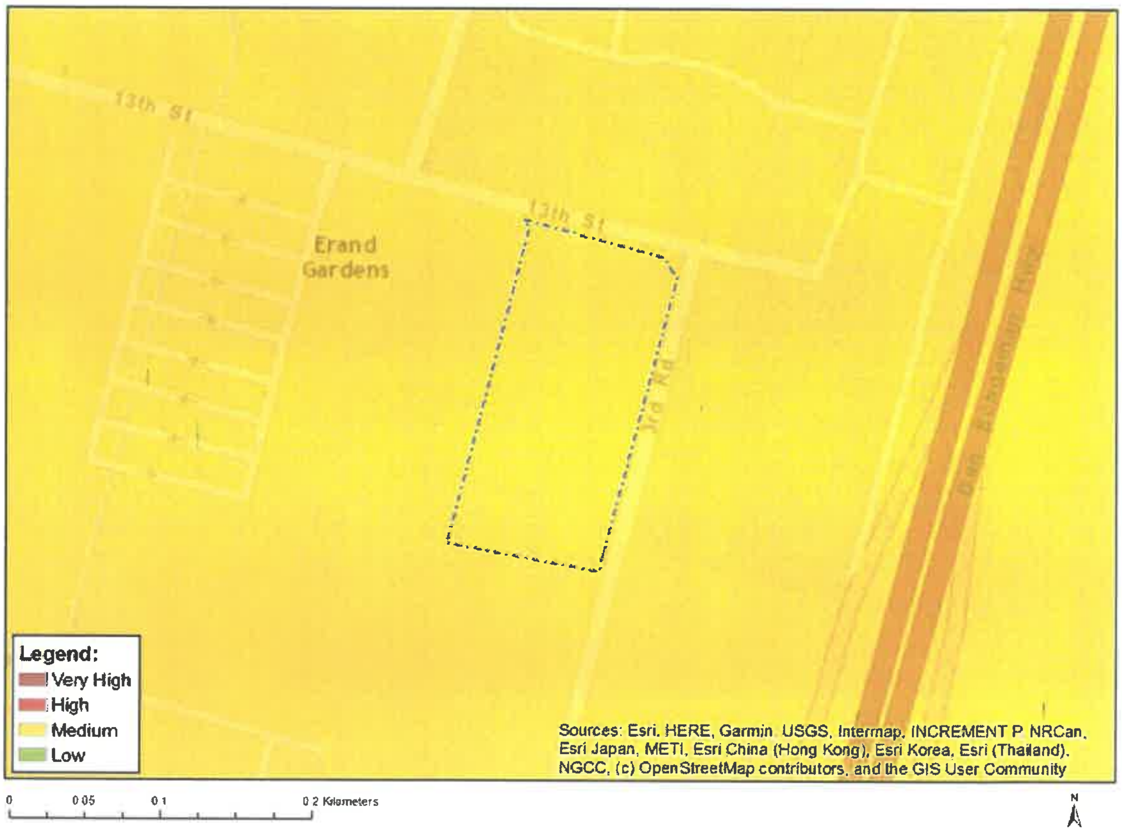
MAP OF RELATIVE CIVIL AVIATION THEME SENSITIVITY

Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
	X		

Sensitivity Features:

Sensitivity	Feature(s)
High	Within 8 km of other civil aviation aerodrome
Medium	Within 5 km of an air traffic control or navigation site
Medium	Between 15 and 35 km from a civil aviation radar
Medium	Between 15 and 35 km from a major civil aviation aerodrome

MAP OF RELATIVE DEFENCE THEME SENSITIVITY



Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
		X	

Sensitivity Features:

Sensitivity	Feature(s)
Medium	Military and Defence Site

MAP OF RELATIVE PLANT SPECIES THEME SENSITIVITY

Where only a sensitive plant unique number or sensitive animal unique number is provided in the screening report and an assessment is required, the environmental assessment practitioner (EAP) or specialist is required to email SANBI at eiadatarequests@sanbi.org.za listing all sensitive species with their unique identifiers for which information is required. The name has been withheld as the species may be prone to illegal harvesting and must be protected. SANBI will release the actual species name after the details of the EAP or specialist have been documented.

Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
			X

Sensitivity Features:

Sensitivity	Feature(s)
Low	Low Sensitivity

MAP OF RELATIVE TERRESTRIAL BIODIVERSITY THEME SENSITIVITY

Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
X			

Sensitivity Features:

Sensitivity	Feature(s)
Very High	Ecological support area
Very High	Endangered ecosystem

APPENDIX D

Title Deed

VAN RENSBURG INC Prokureur/Attorney
10
TEL: 0123427861

CERTIFICATE OF CONSOLIDATED TITLE

in favour of

ZOTEC DEVELOPMENTS (PTY) LTD

over

ERF 870 ERAND GARDENS EXT 125

VAN RENSBURG INC
221 GORDON ROAD
HATFIELD
PRETORIA
Tel: 0123427861

SEËLREG
AP DUTY R.................................
FEES R 353-00

PREPARED BY ME

CONVEYANCER

WERNER ADRIAAN DURAND (M18444)

CERTIFICATE OF CONSOLIDATED TITLE

(Issued under the provisions of Section 40 of the

Deeds Registries Act, 1937 (No 47 of 1937)

T 000014929 / 2021

Whereas

ZOTEC DEVELOPMENTS PROPRIETARY LIMITED

REGISTRATION NUMBER 2003/023822/07

Has applied for the issue to him of a Certificate of Consolidated Title under the provisions of section 40 of the Deeds Registries Act, 1937; and

Whereas he is the registered owner of

1. ERF 809 ERAND GARDENS EXTENSION 125 TOWNSHIP

   REGISTRATION DIVISION J.R.; PROVINCE OF GAUTENG

   Held by Certificate of Registered Title T 26005/2019

2. ERF 810 ERAND GARDENS EXTENSION 125 TOWNSHIP
REGISTRATION DIVISION J.R.; PROVINCE OF GAUTENG
Held by Deed Certificate of Registered Title T 26006/2019

Which have been consolidated into the land hereinafter described;

Now, therefore, in pursuance of the provisions of the said Act, I, the Registrar of Deeds at Pretoria do hereby certify that the said

ZOTEÇ DEVELOPMENTS PROPRIETARY LIMITED
REGISTRATION NUMBER 2003/023822/07

Its Successors in Title or assigns, is the registered owner of

ERF 870 ERAND GARDENS EXTENSION 125 TOWNSHIP
REGISTRATION DIVISION J.R., PROVINCE OF GAUTENG
MEASURING: 1,7855 (ONE COMMA SEVEN EIGHT FIVE FIVE) Hectares
As will more fully appear from Consolidation Diagram SG No. 2413/2020

SUBJECT TO THE FOLLOWING CONDITIONS:

A. ONDERWORPE AAN DIE VOLGENDE VOORWAARDES OPGELë TEN GUNSTE VAN DIE PLAASLIKE BESTUUR INGEVOLGE DIE BEPALINGS VAN DIE ORD986) ONNANSIE OP DORPSBEPLANNING EN DORPE, 1986 (ORDONNANSIE 15 VAN 1986):

1. a) Each erf is subject to a servitude, 2m wide, in favour of the local authority, for sewerage and other municipal purposes, along any two boundaries other than a street boundary and in the case of a panhandle erf, an additional servitude for municipal purposes 2m wide across the access portion of the erf, if and when required by the local authority: Provided that the local authority may dispense with any such servitude.

   b) No building or other structure shall be erected within the aforesaid servitude area and no large rooted trees shall be planted within the area of such servitude or within 2m thereof.

   c) The local authority shall be entitled to deposit temporarily on the land adjoining the aforesaid servitude such material as may be excavated by it during the process of the construction, maintenance or removal of such sewerage mains and other works as it, in its discretion may deem necessary and shall further be entitled to reasonable access to the said land for the aforesaid purpose subject to any damage done during the process of the construction, maintenance or removal of such sewerage mains and other works being made good by the local authority.

B. (a) Die geregistreerde eienaar van die erf, moet die fisiese versperring wat langs die erfgrens aangresend aan Provinsiale Pad K56 opgerig is, tot tevredenheid van die Department van Openbare Vervoer, Paaie en Werke (Gauteng Provinsiale Regering) instandhou.

   (b) Behalwe vir die fisiese versperring waarna in klousule (a) hierbo verwys word, 'n swembad of enige noodsaaklike stormwaterdreineringsstruktuur, mag geen gebou, struktuur of ander ding wat aan die grond geheg is, selfs al vorm dit nie deel van die grond nie, opgerig word nie of sal niks gebou word op of gelê word binne of onder die oppervlakte van die erf binne 'n afstand van minder as 16m/20m/30m vanaf die erfgrense aangresend aan Pad K56 geen verandering of aanbouing mag aan enige bestaande struktuur of gebou geleë binne die vermelde afstand, gedoen word nie, behalwe met die skriftelike toestemming van die Departement van Openbare Vervoer, Paaie en Werke (Gauteng Provisinsiale Regering)

And by virtue of these presents the said

ZOTEC DEVELOPMENTS PROPRIETARY LIMITED

REGISTRATION NUMBER 2003/023822/07

Its Successors in title or assigns, now is and henceforth shall be entitled thereto, conformably to local custom, the State, however, reserving its rights.

In witness whereof I, the said Registrar, have subscribed to these presents, and have caused the seal of office to be affixed thereto.

Thus done and executed at the Office of the Registrar of Deeds Pretoria at 15 MAR 2021

In my presence

REGISTRAR OF DEEDS

APPENDIX E

Wetland Report

TERRASOIL SCIENCE

REPORT

WETLAND DRIVER IDENTIFICATION AND MANAGEMENT REPORT:

RANDJESFONTEIN 750, GAUTENG PROVINCE

9 March, 2019

Compiled by:

J.H. van der Waals
(PhD Soil Science, Pr.Sci.Nat.)
Registered with the South African Council for Natural Scientific Professions
(Registration number: 400106/08)
Member of:
Soil Science Society of South Africa (SSSSA)
Accredited member of:
South African Soil Surveyors Organisation (SASSO)

Declaration

I, Johan Hilgard van der Waals, declare that:

- I act as the independent specialist in this application
- I will 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
- 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 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;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of Section 24F of the Act.

J.H. VAN DER WAALS

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WETLAND DRIVER IDENTIFICATION AND MANAGEMENT REPORT: RANDJESFONTEIN 750, GAUTENG PROVINCE

1. INTRODUCTION

1.1 TERMS OF REFERENCE

Terra Soil Science was appointed by **Central Developments Property Group** to conduct a wetland driver identification investigation and management report on the Randjesfontein 750 site with the aim of elucidating the current and historical presence and status of wetlands / watercourses / seeps on the specific site.

1.2 AIM OF THIS REPORT

The aim of this report is to provide a detailed discussion of the findings of a high-level hydropedology wetland driver identification and wetland management report for the Randjesfontein 750 site. The specific aims are to 1) determine at a high level the hydropedological functioning of the landscape within the specific land type and geology context; 2) determine the human impacts that have resulted in the wetland signatures evident on the site and 3) determine the potential and desirability of dedicated rehabilitation and hydrological interventions on the development site to provide a post development landscape with a suitable flow regime and water quality to yield accepted habitat and biota characteristics.

The broader aim of this report is therefore to assess the specific site conditions within the context of the wetland conservation and storm water management challenges posed by the current and future urban development of the site and intensification of urban development surrounding the site. The assessment is conducted within the context of specific soil, topography and geology conditions and aims specifically to address the drivers of the site's hydrology, the changes in the drivers compared to the reference state and the anticipated changes in response to the new drivers.

1.3 DISCLAIMER

This report was generated under the regulations of NEMA (National Environmental Management Act) that guides the appointment of specialists. The essence of the regulations is 1) independence, 2) specialisation and 3) duty to the regulator. The independent specialist has, in accordance with the regulations, a duty to the competent authority to disclose all matters related to the specific investigation should he be requested to do such (refer to declaration above).

It is accepted that this report can be submitted for peer review (as the regulations also allow for such). However, the intention of this report is not to function as one of several attempts by applicants to obtain favourable delineation outcomes. Rather, the report is aimed at addressing specific site conditions in the context of current legislation, guidelines and best practice with the ultimate aim of ensuring the conservation and adequate management of the water resource on the specific site.

Due to the specific legal liabilities wetland specialists face when conducting wetland delineations and assessments this author reserves the right to, in the event that this report becomes part of a delineation comparison exercise between specialists, submit the report to the competent authorities, without entering into protracted correspondence with the client, as an independent report.

1.4 METHODOLOGY

The report was generated through:

1. The collection and presentation of baseline land type and topographic data for the site;
2. The thorough consideration of the statutory context of wetlands and the process of wetland delineation;
3. The identification of water related landscape parameters (conceptual and real) for the site;
4. Aerial photograph interpretation of the site;
5. Assessment of historical impacts and changes on the site through the accessing of various historical aerial photographs and topographic maps;
6. Focused soil and site survey in terms of soil properties as well as drainage feature properties; and
7. Presentation of the findings of the various components of the investigation.

2. SITE LOCALITY AND DESCRIPTION

2.1 SURVEY AREA BOUNDARY

The site lies between 25° 58' 21" and 25° 58' 30" south and 28° 07' 26" and 28° 07' 32" east immediately north of Midrand in the Gauteng Province (**Figure 1**).

2.2 LAND TYPE DATA

Land type data for the site was obtained from the Institute for Soil Climate and Water (ISCW) of the Agricultural Research Council (ARC). The land type data is presented at a scale of 1:250 000 and entails the division of land into land types, typical terrain cross sections for the land type and the presentation of dominant soil types for each of the identified terrain units (in the cross section). The soil data is classified according to the Binomial System (MacVicar et al., 1977). The soil data was interpreted and re-classified according to the Taxonomic System (Soil Classification Working Group, 1991).

The Randjesfontein 750 site falls predominantly into the **Bb1** land type (Land Type Survey Staff, 1972 – 2006: **Figure 2**). The **Bb1** and **Bb2** land types are restricted to the Halfway House Granite Dome (HHGD) of the Halfway House Intrusion (Johannesburg Dome, Robb et al., 2006) with the typical bleached sandy soils. These aspects have a distinct bearing on the outcome of the investigation and will be discussed in more detail later in the report.

2.3 TOPOGRAPHY

The topography of the site and catchment is undulating with incised and often eroded stream channels especially in the lower reaches of drainage features. The contour map for the site (1 m) is provided in **Figure 3**. From the contour data a digital elevation model (DEM) was generated for the site (**Figure 4**).

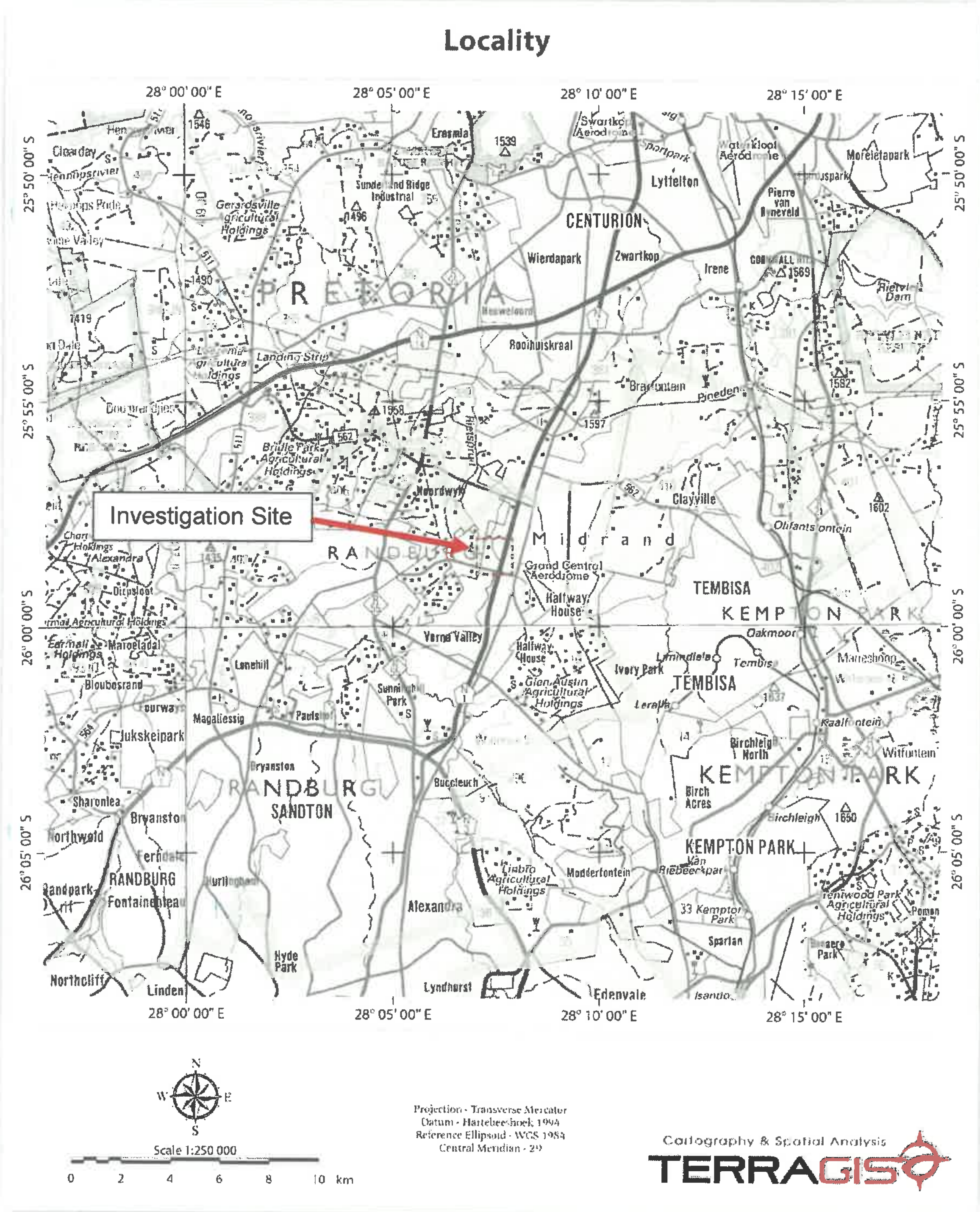

Figure 1 Location of the investigation site

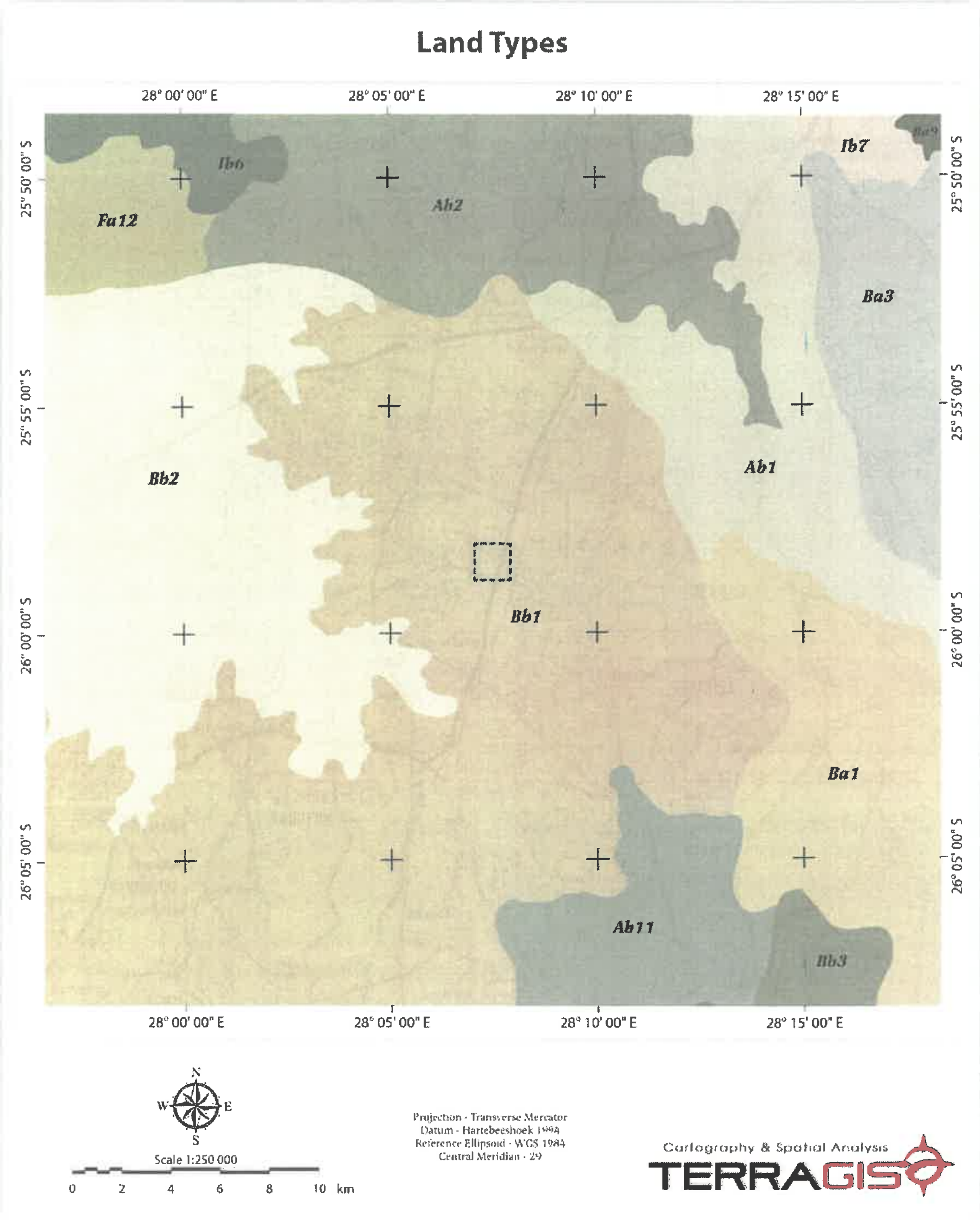

Figure 2 Land type map of the investigation site and surrounding areas

Figure 3 Satellite image of the site (red boundary line) with superimposed 1 m contours

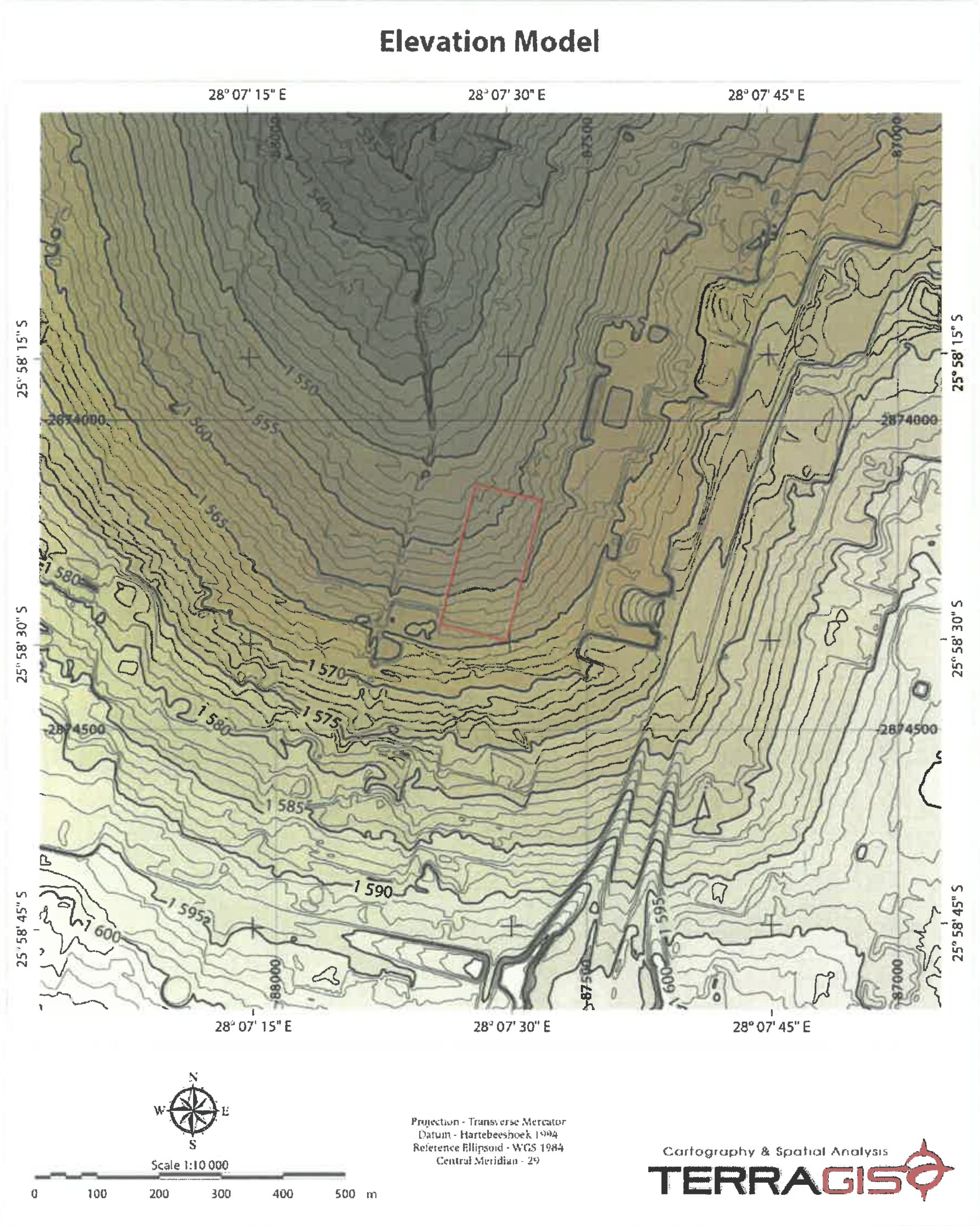

Figure 4 Digital elevation model (DEM) for the investigation site (red boundary line) and surrounding area

3. PROBLEM STATEMENT

The delineation of wetlands in the Halfway House Granite Dome (HHGD) area is challenging due to a range of factors that leads to difficulty in distinguishing between wetland and terrestrial zones. One of the main factors contributing to the difficulty is the specific geological context of the HHGD. From a soil form and wetness perspective the specific land type exhibits some form of "wetland" characteristic, according to the present wetland delineation guidelines (DWAF, 2005), in at least 75 % of the landscape. This aspect has led to significant challenges and friction regarding the interpretation of the guidelines as well as the specific soils in the area. A compounding factor is the extensive alteration of landscape hydrology through urban infrastructure and the development of numerous vegetation related wetland signatures as a result of the altered hydrological drivers.

The following section provides a perspective regarding the statutory as well as biophysical context of wetland delineation in the HHGD area. This investigation will therefore focus on the identification of the wetland features based on soil hydromorphy, landscape hydrology as well as various historical modifiers through a dedicated assessment and elucidation of hydropedological processes and drivers experienced in the catchment and on the site.

4. STATUTORY CONTEXT

The following is a brief summary of the statutory context of wetland delineation and assessment. Where necessary, additional comment is provided on problematic aspects or aspects that, according to this author, require specific emphasis.

4.1. WETLANDS

4.1.1 WETLAND DEFINITION

Wetlands are defined, in terms of the National Water Act (Act no 36 of 1998) (NWA), as:

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

4.1.2 DISAGGREGATION OF THE WETLAND DEFINITION

In order to address wetland identification, delineation and assessment it is necessary to disaggregate the definition and discuss specific challenges as follows:

1. "*Land which is transitional between terrestrial and aquatic systems …*": This implies areas with variable hydrological and ecological characteristics of which the variation can be described as the linear (assumed) transition from one pole (terrestrial/dry) to another (aquatic/wet).
2. "*… where the water is usually at or near the surface …*": Although the regular condition is implied there is no reference to any empirical interpretation. This aspect therefore introduces uncertainty and the potential for significantly variable interpretation.
3. "*… or the land is periodically covered with shallow water …*": This statement introduces and alternative to the above statement but, again there is no reference to any empirical

interpretation and it therefore introduces uncertainty and the potential for significantly variable interpretation

4. "... *and which land in normal circumstances* ...": Normal circumstances are not defined with a subsequent introduction of uncertainty and variability in interpretation. According to Mernewecke and Kotze (as cited in DWAF, 1999) "normal circumstances" in the definition refers to "without human modifications".
5. "... *supports or would support vegetation typically adapted* ...": Vegetation species and communities can be described and named and can provide distinctly measurable indicators of wetland conditions. This is therefore a clear indicator if the requisite scientific knowledge is available.
6. "... *to life in saturated soil.*": Soil saturation (degree, intensity and duration) can be measured empirically (although at significant financial and time cost) or deduced from the soil morphology to varying degrees of certainty (Lin, 2012; Van Tol et al, 2010). The soil morphological indictors (all functions of soil forming factors and processes) have been studied and described extensively in the soil science literature.

An evaluation of the disaggregation above yields that the only certain descriptors, from a scientific, practical and legal perspective, are vegetation and soil indicators. It is also clear that the emphasis is on "saturated soil" and the plants that are adapted to grow under such conditions. Later in this document the concept of "saturation", and the requirements for its empirical elucidation, will be discussed in more detail.

Additionally, from the definition and the purpose of the water act it can be assumed that wetlands are merely the expression of wetness in landscapes and that the water resource can occur in landscapes in many other forms. One form that is not explicitly mentioned is seasonally perched water tables and their associated vadose zones that are instrumental in the "feeding" of wetlands through lateral flow mechanisms in the landscape. From the purpose of the NWA it is assumed that these water resources are included explicitly in the Act. This aspect has a significant bearing on the contents of rehabilitation plans and reports.

Important Note 1: Point 4 above refers to the understanding of "normal conditions" as described in the definition of a wetland. This aspect has a significant bearing on the unpacking of authorisation and compliance processes regarding wetland impacts and as such will be discussed in further detail under the relevant sections in this report. However, it is critical that cognisance is taken of this concept and its implications as these determine the context of the discussions and findings of this report.

4.2 WATERCOURSE DEFINITION

"Catchment" is defined, in terms of the National Water Act (Act no 36 of 1998) (NWA), as:

"..., in relation to a watercourse or watercourses or part of a watercourse, means the area from which any rainfall will drain into the watercourse or watercourses or part of a watercourse, through surface flow to a common point or common points;"

"Watercourse" is defined, in terms of the National Water Act (Act no 36 of 1998) (NWA), as:

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

4.3 THE WETLAND DELINEATION GUIDELINES

In 2005 the Department of Water Affairs and Forestry published a manual entitled "A practical field procedure for identification and delineation of wetland and riparian areas" (DWAF, 2005). The "...manual describes field indicators and methods for determining whether an area is a wetland or riparian area, and for finding its boundaries." The definition of a wetland in the guidelines is that of the NWA and it states that wetlands must have one or more of the following attributes:

- "**Wetland (hydromorphic) soils** that display characteristics resulting from prolonged saturation"
- "The presence, at least occasionally, of **water loving plants (hydrophytes)**"
- "A **high water table** that results in saturation at or near the surface, leading to anaerobic conditions developing in the top 50cm of the soil."

The guidelines further list four indicators to be used for the finding of the outer edge of a wetland. These are:

- Terrain Unit Indicator. The terrain unit indicator does not only identify valley bottom wetlands but also wetlands on steep and mild slopes in crest, midslope and footslope positions.
- Soil Form Indicator. A number of soil forms (as defined by MacVicar et al., 1991) are listed as indicative of permanent, seasonal and temporary wetland zones.
- Soil Wetness Indicator. Certain soil colours and mottles are indicated as colours of wet soils. The guidelines stipulate that this is the primary indicator for wetland soils. (Refer to the guidelines for a detailed description of the colour indicators.) In essence, the reduction and removal of Fe in the form of "bleaching" and the accumulation of Fe in the form of mottles are the two main criteria for the identification of soils that are periodically or permanently wet.
- Vegetation Indicator. This is a key component of the definition of a wetland in the NWA. It often happens though that vegetation is disturbed and the guidelines therefore place greater emphasis on the soil form and soil wetness indicators as these are more permanent whereas vegetation communities are dynamic and react rapidly to external factors such as climate and human activities.

The main emphasis of the guidelines is therefore the use soils (soil form and wetness) as the criteria for the delineation of wetlands. The applicability of these guidelines in the context of the survey site will be discussed in further detail later in the report.

Due to numerous problems with the delineation of wetlands there are a plethora of courses being presented to teach wetland practitioners and laymen the required techniques. Most of the courses and practitioners focus on ecological or vegetation characteristics of landscapes and soil characteristics are often interpreted incorrectly due to a lacking soil science background of these practitioners. As such this author regularly presents, in conjunction with a colleague (Prof. Cornie van Huysteen) from the University of the Free Sate, a course on the aspects related to soil classification and wetland delineation.

4.4 THE RESOURCE DIRECTED MEASURES FOR PROTECTION OF WATER RESOURCES

The following are specific quotes from the different sections of the "Resource Directed Measures for Protection of Water Resources." as published by DWAF (1999).

4.4.1 The Resource Directed Measures for Protection of Water Resources: Volume 4: Wetland Ecosystems.

From the Introduction:

"This set of documents on Resource Directed Measures (RDM) for protection of water resources, issued in September 1999 in Version 1.0, presents the procedures to be followed in undertaking **preliminary determinations of the class, Reserve and resource quality objectives for water resources**, as specified in sections 14 and 17 of the South African National Water Act (Act 36 of 1998).

The development of procedures to determine RDM was initiated by the Department of Water Affairs and Forestry in July 1997. Phase 3 of this project will end in March 2000. Additional refinement and development of the procedures, and development of the full water resource classification system, will continue in Phase 4, until such time as the detailed procedures and full classification system are ready for publication in the Government Gazette.

It should be noted that until the final RDM procedures are published in the Gazette, and prescribed according to section 12 of the National Water Act, all determinations of RDM, whether at the rapid, the intermediate or the comprehensive level, will be considered to be preliminary determinations."

4.4.2 The Resource Directed Measures for Protection of Water Resources: Generic Section "A" for Specialist Manuals – Water Resource Protection Policy Implementation Process

"Step 3: Determine the reference conditions of each resource unit"

"What are reference conditions?"

"The determination of reference conditions is a very important aspect of the overall Reserve determination methodology. Reference conditions describe the natural unimpacted characteristics of a water resource. Reference conditions quantitatively describe the ecoregional type, specific to a particular water resource."

Important Note 2: The discussion of the reference conditions is often omitted from wetland investigations. This is considered a critical flaw as the hydrological functioning of the landscape has as its template the reference, or pre-human impact, condition of the site. The assessment of wetlands therefore invariably use the "reference state" as a departure point and as such has to describe how far the site conditions have changed from the original. This is especially relevant within a soil hydrological context as these parameters constitute the drivers of the conditions that are being assessed. It is critical that cognisance is taken of this concept and its implications as it determines the context of the discussions and findings of this report.

4.4.3 The Resource Directed Measures for Protection of Water Resources: Appendix W1 (Ecoregional Typing for Wetland Ecosystems)

Artificial modifiers are explained namely:

"Many wetlands are man-made, while others have been modified from a natural state to some degree by the activities of humans. Since the nature of these alterations often greatly influences the character of such habitats, the inclusion of modifying terms to accommodate human influence is important. In addition, many human modifications, such as dam walls and drainage ditches, are visible in aerial photographs and can be easily mapped. The following Artificial Modifiers are defined and can be used singly or in combination wherever they apply to wetlands:
Farmed: the soil surface has been physically altered for crop production, but hydrophytes will become re-established if farming is discontinued
Artificial: substrates placed by humans, using either natural materials such as dredge spoils or synthetic materials such as concrete. Jetties and breakwaters are examples of Non-vegetated Artificial habitats
Excavated: habitat lies within an excavated basin or channel
Diked/Impounded: created or modified by an artificial barrier which obstructs the inflow or outflow of water
Partially Drained: the water level has been artificially lowered, usually by means of ditches, but the area is still classified as wetland because soil moisture is sufficient to support hydrophytes."

4.4.4 The Resource Directed Measures for Protection of Water Resources: Appendix W4 IER (Floodplain Wetlands) Present Ecological Status (PES) Method

In Appendix W4 the methodology is provided for the determination of the present ecological status (PES) of a palustrine wetland.

The present ecological state (PES) of the wetland was determined according to the method described in "APPENDIX W4: IER (FLOODPLAIN WETLANDS) PRESENT ECOLOGICAL STATUS (PES) METHOD" of the "Resource Directed Measures for Protection of Water Resources. Volume 4: Wetland Ecosystems" as published by DWAF (1999). However, the PES methodology already forms an adaptation from the methodology to assess palustrine wetlands. Hillslope seepage wetlands have a range of different drivers and as such some modification of the criteria has been made by this author to accommodate the specific hydropedology drivers of hillslope seepage wetlands.

The criteria as described in Appendix 4 is provided below with the relevant modification or comment provided as well.

The summarised tasks in the PES methodology are (for detailed descriptions refer to the relevant documentation):

1. Conduct a literature review (review of available literature and maps) on the following:
   a. Determine types of development and land use (in the catchment in question).
   b. Gather hydrological data to determine the degree to which the flow regime has been modified (with the "virgin flow regime" as baseline). The emphasis is predominantly on surface hydrology and hydrology of surface water features as well as the land uses, such as agriculture and forestry, that lead to flow modifications. Important Note: The hydropedology of landscapes is not explicitly mentioned in the RDM documentation and this author will make a case for its consideration as probably the most important component of investigating headwater systems and seepage wetlands and areas.
   c. Assessment of the water quality as is documented in catchment study reports and water quality databases.
   d. Investigate erosion and sedimentation parameters that address aspects such as bank erosion and bed modification. Important Note: The emphasis in the RDM documentation is again on river and stream systems with little mention of erosion of headwater and seepage zone systems. Again a case will be made for the emphasis of such information generation.
   e. Description of exotic species (flora and fauna) in the specific catchment in question.
2. Conduct and aerial photographic assessment in terms of the parameters listed above.
3. Conduct a site visit and make use of local knowledge.
4. Assess the criteria and generate preliminary PES scores.
5. Generation of report.

Table 1 presents the scoresheet with criteria for the assessment of habitat integrity of palustrine wetlands (as provided in the RDM documentation).

Scoring guidelines per attribute:
natural, unmodified = 5; Largely natural = 4, Moderately modified = 3; largely modified = 2; seriously modified = 1; Critically modified = 0.
Relative confidence of score:
Very high confidence = 4; High confidence = 3; Moderate confidence = 2; Marginal/low confidence = 1.

Important Note: The present ecological state (PES) determination is, as discussed earlier in the report, based on criteria originally generated for palustrine and floodplain wetlands. Seepage wetlands very rarely have the same degree of saturation or free water and consequently often do not have permanent wetland zones. These wetlands are therefore often characterised by seasonal or temporary properties and as such a standard PES approach is flawed. The existing criteria is provided below as is a comment on the applicability as well as proposed improvements.

Table 1 "Table W4-1: Scoresheet with criteria for assessing Habitat Integrity of Palustrine Wetlands (adapted from Kleynhans 1996)"

Criteria and attributes	Relevance	Score	Confidence
Hydrologic			
Flow modification	Consequence of abstraction, regulation by impoundments or increased runoff from human settlements or agricultural land. Changes in flow regime (timing, duration, frequency), volumes, velocity which affect inundation of wetland habitats resulting in floristic changes or incorrect cues to biota. Abstraction of groundwater flows to the wetland.		
Permanent Inundation	Consequence of impoundment resulting in destruction of natural wetland habitat and cues for wetland biota.		
Water Quality			
Water Quality Modification	From point or diffuse sources. Measure directly by laboratory analysis or assessed indirectly from upstream agricultural activities, human settlements and industrial activities. Aggravated by volumetric decrease in flow delivered to the wetland		
Sediment load modification	Consequence of reduction due to entrapment by impoundments or increase due to land use practices such as overgrazing. Cause of unnatural rates of erosion, accretion or infilling of wetlands and change in habitats.		
Hydraulic/Geomorphic			
Canalisation	Results in desiccation or changes to inundation patterns of wetland and thus changes in habitats. River diversions or drainage.		
Topographic Alteration	Consequence of infilling, ploughing, dykes, trampling, bridges, roads, railwaylines and other substrate disruptive activities which reduces or changes wetland habitat directly or through changes in inundation patterns.		
Biota			
Terrestrial Encroachment	Consequence of desiccation of wetland and encroachment of terrestrial plant speciesdue to changes in hydrology or geomorphology. Change from wetland to terrestrial habitat and loss of wetland functions.		
Indigenous Vegetation Removal	Direct destruction of habitat through farming activities, grazing or firewood collection affecting wildlife habitat and flow attenuation functions, organic matter inputs and increases potential for erosion.		
Invasive plant encroachment	Affect habitat characteristics through changes in community structure and water quality changes (oxygen reduction and shading).		
Alien fauna	Presence of alien fauna affecting faunal community structure.		
Overutilisation of biota	Overgrazing, Over-fishing, etc		
TOTAL MEAN			

Criteria

Hydrological Criteria

- "Flow modification: Consequence of abstraction, regulation by impoundments or increased runoff from human settlements or agricultural land. Changes in flow regime (timing, duration, frequency), volumes, velocity which affect inundation of wetland habitats resulting in floristic changes or incorrect cues to biota. Abstraction of groundwater flows to the wetland." Comment: Although the description is wide it is very evident that seepage or hillslope wetlands do not become inundated but rather are fed by hillslope return flow processes. The main criterion should therefore be the surface and subsurface hydrological linkages expressed as a degree of alteration in terms of the surface, hydropedology and groundwater hydrology.
- "Permanent inundation: Consequence of impoundment resulting in destruction of natural wetland habitat and cues for wetland biota." Comment: Mostly not applicable to hillslope seepage wetlands.

Water Quality Criteria

- "Water quality modification: From point or diffuse sources. Measure directly by laboratory analysis or assessed indirectly from upstream agricultural activities, human settlements and industrial activities. Aggravated by volumetric decrease in flow delivered to the wetland." Comment: Water quality in this context applies generally but cognisance should be taken of seepage water quality that can be natural but significantly different to exposed water bodies. The main reason for this being the highly complex nature of many redox processes within the hillslope.
- "Sediment load modification: Consequence of reduction due to entrapment by impoundments or increase due to land use practices such as overgrazing. Cause of unnatural rates of erosion, accretion or infilling of wetlands and change in habitats." Comment: This is a very relevant concept but on hillslopes should be linked to erosivity of the soils as well as the specific land use influences.

Hydraulic / Geomorphic Criteria

- "Canalisation: Results in desiccation or changes to inundation patterns of wetland and thus changes in habitats. River diversions or drainage." Comment: Again this is a very relevant concept but on hillslopes should be linked to erosivity of the soils as well as the specific land use influences. This concept does however not address the influences on the hydropedology of the hillslope. These aspects should be elucidated and contextualised.
- "Topographic Alteration: Consequence of infilling, ploughing, dykes, trampling, bridges, roads, railwaylines and other substrate disruptive activities which reduces or changes wetland habitat directly or through changes in inundation patterns." Comment: Again this is a very relevant concept but on hillslopes should be linked to erosivity of the soils as well as the specific land use influences. This concept does however not address the influences on the hydropedology of the hillslope. These aspects should be elucidated and contextualised.

Biological Criteria

- "Terrestrial encroachment: Consequence of desiccation of wetland and encroachment of terrestrial plant species due to changes in hydrology or geomorphology. Change from wetland to terrestrial habitat and loss of wetland functions." Comment: Again this is a very relevant concept but on hillslopes should be linked to erosivity of the soils as well as the specific land use influences. This concept does however not address the influences on the hydropedology of the hillslope. These aspects should be elucidated and contextualised.

- "Indigenous vegetation removal: Direct destruction of habitat through farming activities, grazing or firewood collection affecting wildlife habitat and flow attenuation functions, organic matter inputs and increases potential for erosion."
- "Invasive plant encroachment: Affect habitat characteristics through changes in community structure and water quality changes (oxygen reduction and shading)."
- "Alien fauna: Presence of alien fauna affecting faunal community structure."
- "Overutilisation of biota: Overgrazing, Over-fishing, etc."

Scoring Guidelines

Scoring guidelines per attribute:
Natural, unmodified = 5
Largely natural = 4
Moderately modified = 3
Largely modified = 2
Seriously modified = 1
Critically modified = 0

Relative confidence of score:
Very high confidence = 4
High confidence = 3
Moderate confidence = 2
Marginal/low confidence = 1

4.4.5 The Resource Directed Measures for Protection of Water Resources: Appendix W5 IER (Floodplain Wetlands) Determining the Ecological Importance and Sensitivity (EIS) and the Ecological Management Class (EMC)

In Appendix W5 the methodology is provided for the determination of the ecological importance and sensitivity (EIS) and ecological management class (EMC) of floodplain wetlands.

"Ecological importance" of a water resource is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. "Ecological sensitivity" refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred. The Ecological Importance and sensitivity (EIS) provides a guideline for determination of the Ecological Management Class (EMC)." Please refer to the specific document for more detailed information.

The following primary determinants are listed as determining the EIS:

1. Rare and endangered species

2. Populations of unique species
3. Species / taxon richness
4. Diversity of habitat types or features
5. Migration route / breeding and feeding site for wetland species
6. Sensitivity to changes in the natural hydrological regime
7. Sensitivity to water quality changes
8. Flood storage, energy dissipation and particulate / element removal

The following modifying determinants are listed as determining the EIS:

1. Protected status
2. Ecological integrity

4.5 Water Use Licence Applications and Risk Assessment

Activities that affect the water resource have to be authorised and licensed by the Department of Water and Sanitation under Sections 21(c) and 21(i) of the NWA. These activities are described as follows:

"21. For the purposes of this Act, water use includes –

…

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

…

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

…

The (c) and (i) authorisation process currently includes any activity within 500 m of the outer edge of a wetland / watercourse where the 500 m line represents the "regulated zone". In this regard the DWS issues a General Authorisation (GA) should the impacts of an activity (in terms of the c and i) be of a low risk based on a risk assessment procedure stipulated by the DWS. This risk matrix is provided later in the report.

Important Note 3: The risk assessment process rests heavily on the PES assessment and specifically the aspects of 1) flow regime, 2) water quality, 3) habitat, and 4) biota within the context of the impacts experienced for the investigation site. In this regard the emphasis is placed on the references state and current condition of the site within the context of the historical activities and drivers that are evident. This aspect has a distinct bearing on the present site investigation and will be discussed in further detail later in the report.

4.6 Lack of Clarity on Reference State and Man-Made Wetlands

The current legislation and guidelines are not clear on the differentiation between natural wetlands and man-made wetlands and how to deal with these differences in an urban development context where hydrological drivers are altered extensively on a catchment and local scale. This lack of clarity often translates into decisions being made by the regulator (metropolitan authority, provincial authority or national authority) that may vary significantly between different levels of decision making and that may often be perceived as either an "erring on the side of caution" approach or a complete abdication and releasing of wetlands / watercourses for alteration or destruction. A specific case is where the provincial competent authority, upon being informed that a wetland / watercourse area at the N1/N4 interchange in Tshwane showed signs of extensive human impact, released the area for development, contrary to the recommendations in the specialist report, without any dedicated hydrological management measures. This author is of the conviction that even highly impacted wetlands and watercourses should be managed hydrologically and that the competent authorities should emphasize this need even though the ecological characteristics of a wetland / watercourse area has been degraded significantly. This is especially relevant in urban areas where urban hydrological signatures abound and where wetlands / watercourses / storm water flows have led to a gradual change in the original reference state conditions. However, as this aspect is difficult to conceptualise in the current legislation and authorisation processes it is recommended that specific and focussed guidelines and procedures be generated to deal with the urban hydrological and ecological challenges.

4.7 THE CITY OF JOHANNESBURG (COJ) WETLAND LAYER

The CoJ uses an internally generated GIS based wetland layer to determine whether a site has a wetland. A request was submitted to Ms Jane Eagle (Deputy Director: Open Space Planning, Water Management and Biodiversity, Environment and Infrastructure Services Department, CoJ) to provide an explanation of the specific data layer. On 25/09/2017 Ms Eagle responded as follows by email:

"The wetland layers are available via the City's GIS maps – we consider both to be applicable so we call them part one and part two. The first layer (part one) was based on the SEF wetland audit but it was always known that in terms of the methodology used, some of the seep wetlands particularly those not associated with valley bottom wetlands, were overlooked. Hence when we appointed Wetland Consulting Services to do the Wetland Protection and Management Plan, we also asked them to fill in the missing information and review Wetland Audit layer one – hence Wetland layer part two was the product of the WCS work – and identified many more wetlands particular the seep wetlands. Although the wetland layers are indicative only, and only approximately 30% of wetlands were ground trothed, we have found them to be incredibly accurate – not necessarily down the actual meter, but in terms of the presence of wetland conditions and the nature of those conditions."

It warrants discussion here that the wetland layer as used by CoJ is characterised by the following:

1. It consists of two versions with the more recent layer also characterised by limited field verification.
2. It has not been extensively peer reviewed. This aspect could prove problematic as the wetlands on the HHGD pose significant challenges regarding accurate delineation when the delineation results of various specialist are compared. (This aspect will be addressed in more detail later in the report.)

3. The wetland layer serves as an indication of wetlands only and does not replace the required delineation process as prescribed by the relevant competent authorities.
4. There are many cases of internal CoJ "non-adherence" to the data in terms of developments into identified wetland areas. A specific case in point is the Waterfall Cemetery that currently functions within an area indicated on the layer as being a wetland.
5. The wetland layer has no statutory underpinning and cannot be considered binding in terms of formal land development authorisation processes.

4.8 SUMMARY AND PROPOSED APPROACH

When working in environments where the landscape and land use changes are significant (such as urban and mining environments) it is important to answer the following critical questions regarding the assessment and management planning for wetlands:

1. What is the reference condition?
2. What is the difference between the reference condition and the current condition and how big is this difference from a hydrological driver perspective?
3. What are the hydrological drivers (as a function of geology, topography, rainfall and soils) and what are the relative contributions of these drivers to the functioning of the wetland system?
4. What is the intended or planned land use in the wetland as well as terrestrial area and how will these developments impact on the hydrology of the landscape and wetlands?
5. How can the intended land use be plied to secure the best possible hydrological functioning of the landscape in terms of storm water attenuation, erosion mitigation and water quality?

The key to the generation of adequate information lies in the approach that is to be followed. In the next section an explanation about and motivation in favour of will be provided for a hydropedology assessment approach. Due to the detailed nature of the information that can be generated through such an approach it is motivated that all wetland assessments be conducted with the requirements of criminal law in mind. The main reason for this is the fact that many well-meaning administrative exercises often yield not tangible results due to the gap in terms of information that is required should there be a compliance process followed.

To Summarise:

During wetland assessments and delineations it is important to provide a perspective on assessment tools, the original or reference state of the wetland, the assessment process and outcome as well as the intended or possible state of the wetland and site post development. Urban and mining developments are good examples of cases where surrounding developments and land use changes have significant effects on wetland integrity and water quality emanating from the site.

5. CHALLENGES REGARDING WETLAND DELINEATION ASSESSMENTS ON THE HALFWAY HOUSE GRANITE DOME

Disclaimer: The following section represents a discussion that I use as standard in describing the challenges regarding wetland delineation and management in the Halfway House Granite Dome (HHGD) area. This implies that the section is verbatim the same as in other reports provided to clients and the authorities. Copyright is strictly reserved.

In order to discuss the procedures followed and the results of the wetland identification exercise it is necessary at the outset to provide some theoretical background on the differences between wetland responses and drivers, soil forming processes, soil wetness indicators, water movement in soils and topographical sequences of soil forms (catena).

5.1 Wetland Drivers and Ecological Responses

The identification and assessment of wetlands rest on the elucidation and description of wetland habitat and wetland biota. These parameters have value in terms of their expression of ecosystem health and biodiversity characteristics of specific landscapes as they constitute the responses to a range of drivers centred around water (**Figure 5**). The response is specifically related to the physical / hydrological parameters of water summarised in the concept of "flow regime" and in the chemical / biological parameters summarised in the concept of "water quality" and is referred to in general as the ecosystem services associated with the responses (**Figure 5**). The flow regime, water quality and geomorphology characteristics (drivers) of a landscape determine the types and characteristics of the response expressed as habitat and biota. It therefore follows that in the event that the drivers are altered the responses, and therefore ecosystem services, will be altered as well. This concept is central to the understanding and elucidation of wetland (habitat and biota) impacts and is currently emphasised by the Department of Water and Sanitation (DWS) when considering water use licence application processes.

The ecosystem drivers are contextualised in the geological, topographical and climatic setting. Together with biota and the relative age of the landscape these parameters constitute five soil forming factors that determine the specific soil profiles and characteristics encountered in a landscape. It is therefore no coincidence that two of the four wetland indicators relate to soil namely soil form (formal classification: SA Taxonomic System – Soil Classification Working Group, 1991) and soil wetness (redox morphology indictors of long-term water regime in the form of soil material colours and mottles as a function of iron chemistry and mineralogy) (DWAF, 2005). The remaining two are landscape position (geomorphology – ecosystem driver) and vegetation (biota – ecosystem response).

The assessment of wetlands is usually based on the measurement of ecological properties of the specific wetland or landscape. These relate to a host of living organisms that indicate the status and quality of the wetland with values assigned by specialists to these indicators. The wetland specialist therefore provides a snapshot of the condition of the wetland and this snapshot indicates the characteristics or "value" that will be lost once the wetland is impacted.

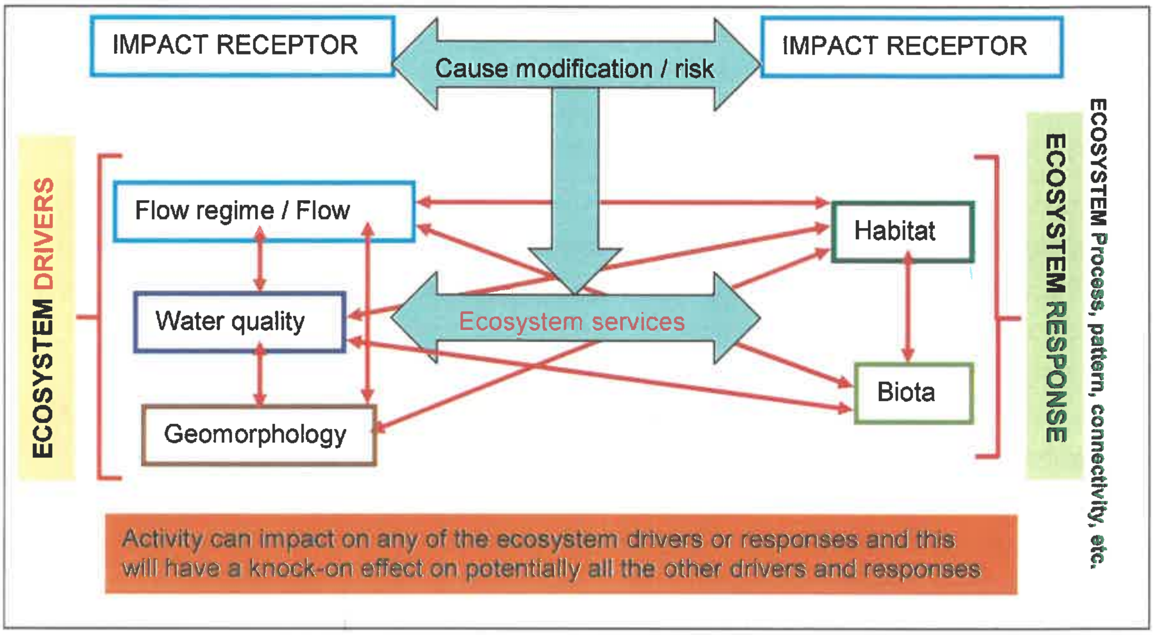

Figure 5 Ecosystem services drivers and responses (sourced from DWS)

However, the ecological response is entirely dependent on the hydrological drivers of the wetland system. The drivers are numerous and include the following:

1. Surface hydrology of the landscape: This parameter determines flow dynamics of water with subsequent accumulation zones that correspond to depressions and low points. This driver is accounted for in the terrain unit indicator (wetland delineation guidelines) on a landscape scale but is often overlooked on a much more localised scale in furrows, erosion features and micromorphological features encountered in many landscapes. The typical responses to these features relate to the well-established knowledge on wetland ecology in that wetter zones will indicate ecological signatures associated with the degree and duration of wetness. It therefore follows that surface runoff characteristics of a landscape, when altered, will alter the responses accordingly. Examples include road, paving or roof surfaces that seal the soil or complete alteration of landscape surfaces through cut and fill operations. The typical response to these operations are reflected in storm water signatures related to wetland vegetation establishment in culverts / channels, erosion of unstable soils and materials, and/or rapid filling of depressions with water following rainfall events.
2. Interflow or hillslope hydrology: This parameter is described in much more detail below and is a function of a number of soil, geology and landscape characteristics. The essence is that interflow or hillslope water can manifest in any position in the landscape and surface or near surface water will elicit an ecological response that can be measured and assessed. If however the soil, geological or landscape characteristics are altered the

seepage pathways will also be altered and the wet ecological response may vary from disappearing in the areas that have become drier or being amplified in areas that have become wetter. Alteration of the surface, as discussed above, may also impede or increase infiltration with a subsequent increase in interflow and wet ecological response.

3. Groundwater hydrology: This parameter is influenced by both of the parameters described above and constitutes the water resource that is often accessed through boreholes or deep wells. Groundwater can in some cases intercept the land surface and in such conditions it will elicit a wet ecological response. If the water level changes the response will change accordingly.
4. Water quality: This parameter is a significant driver of the specific wet ecological response in that different organisms will provide distinct perspectives on the chemical signature of the water that manifests near or on land surfaces. However, this parameter can also be altered to varying degrees by the above parameters and their alteration and it therefore also constitutes a response to the above three.

It is critically important to note here that the natural landscape condition, with its equilibrium in terms of surface, hillslope, groundwater and water quality characteristics, forms the reference state for the assessment of ecological and hydrological parameters. Any alteration in these parameters would elicit altered responses that may be desirable or not. This also forms the philosophical and practical basis for integrated storm water management, wetland rehabilitation and artificial wetland design and construction.

5.2 Soil as a Tool for Landscape Context and Hydrological Driver Description

The relevance of soils as tools for the elucidation and description of landscape context and hydrological drivers is discussed in detail below. It is however important to emphasize the differences that are evident in South African soils when these are compared to the soils of countries where wetland assessment processes based on the identification of hydric soil indicators are used in administrative and legal compliance processes. One such example is the large body of knowledge underpinning the identification, assessment, management and protection of wetlands in the USA that served as a motivation for the processes followed in South Africa.

Laker (2003) describes three main soil regions in the world namely 1) soils of the high latitudes and continental land masses in the northern hemisphere, 2) the soils of the humid and subhumid tropics around the equator and 3) the soils of the southern hemisphere lying between 20 and 35 degrees south. The first regions is characterised by cooler to cold climates and have experienced relatively recent glaciation. The soils are therefore indicative of the cold weather in that they contain significant organic carbon and the soils also exhibit signs of youthful age when compared to older tropical soils. The second region is characterised by older and very pronounced pedogenesis. Both the aforementioned groups have been studied extensively and are adequately accommodated in several local and international soil classification systems. The third region is characterised by hard geology, old age and moderate to low rainfall leading to the development of very distinct soils that are not always comfortably accommodated in international classification systems. The South African

Taxonomic System therefore accommodates the soils in a structure that is somewhat different to the well-known international systems (USDA Soil Taxonomy and WRB).

The benefit of the above third soil region is that the soils are found on predominantly stable and old land surfaces with the consequence that the soil morphology clearly indicates the hydrological functioning in the expression of redox morphology. This aspect therefore leads to a very distinct redox morphology foundation for wetland delineation. The extension of this argument is that the soil morphology, described within a distinct geological, topographical and climate context provides an excellent tool for the elucidation of landscape hydrological process. The hydrological drivers of wetland conditions can therefore be elucidated through a dedicated assessment of the soils and the weathered zone of the land surface. This argument forms the basis for the discussion to follow as well as the foundation for the determination of the "reference state" as required for ecological assessment techniques.

5.3 PEDOGENESIS

Pedogenesis is the process of soil formation. Soil formation is a function of five (5) factors namely (Jenny, 1941):

- Parent material;
- Climate;
- Topography;
- Living Organisms; and
- Time.

These factors interact to lead to a range of different soil forming processes that ultimately determine the specific soil formed in a specific location. Central to all soil forming processes is water and all the reactions (physical and chemical) associated with it. The physical processes include water movement onto, into, through and out of a soil unit. The movement can be vertically downwards, lateral or vertically upwards through capillary forces and evapotranspiration. The chemical processes are numerous and include dissolution, precipitation (of salts or other elements) and alteration through pH and reduction and oxidation (redox) changes. In many cases the reactions are promoted through the presence of organic material that is broken down through aerobic or anaerobic respiration by microorganisms. Both these processes alter the redox conditions of the soil and influence the oxidation state of elements such as Fe and Mn. Under reducing conditions Fe and Mn are reduced and become more mobile in the soil environment. Oxidizing conditions, in turn, lead to the precipitation of Fe and Mn and therefore lead to their immobilization. The dynamics of Fe and Mn in soil, their zones of depletion through mobilization and accumulation through precipitation, play an important role in the identification of the dominant water regime of a soil and could therefore be used to identify wetlands and wetland conditions.

5.4 WATER MOVEMENT IN THE SOIL PROFILE AND HILLSLOPE

The dynamics of water movement in a soil profile and hillslope is too complex to address in detail here. However, the reader is referred to various investigation and publications provided below for further detail.

Publications list:

Bouwer, et al., (2015), Le Roux and du Preez (2006), Le Roux and du Preez (2008), Le Roux et al., (2015), Le Roux et al., (2011), Van Tol et al., (2013a), Van Tol et al., (2013b), Van Tol et al., (2010a), Van Tol et al., (2010b), Van Zijl et al., (2013), Van Zyl and Le Roux (2014), Van der Waals (2013), Van Huyssteen et al., (1997), Van Huyssteen et al., (2007), Van Huyssteen et al., (2009).

5.5 WATER MOVEMENT IN THE LANDSCAPE

Water movement in a landscape is a combination of the different flow paths in the soils and geological materials. The movement of water in these materials is dominantly subject to gravity and as such it will follow the path of least resistance towards the lowest point. In the landscape there are a number of factors determining the paths along which this water moves. **Figure 6** provides a simplified schematic representation of an idealised landscape (in "profile curvature". The total precipitation (rainfall) on the landscape from the crest to the lowest part or valley bottom is taken as 100 %. Most geohydrologists agree that total recharge, the water that seeps into the underlying geological strata, is less than 4 % of total precipitation for most geological settings. Surface runoff varies considerably according to rainfall intensity and distribution, plant cover and soil characteristics but is taken as a realistic 6 % of total precipitation for our idealised landscape. The total for surface runoff and recharge is therefore calculated as 10 % of total precipitation. If evapotranspiration (from plants as well as the soil surface) is taken as a very high 30 % of total precipitation it leaves 60 % of the total that has to move through the soil and/or geological strata from higher lying to lower lying areas. In the event of an average rainfall of 750 mm per year it results in 450 mm per year having to move laterally through the soil and geological strata. In a landscape there is an accumulation of water down the slope as water from higher lying areas flow to lower lying areas.

To illustrate: If the assumption is made that the area of interest is 100 m wide it follows that the first 100 m from the crest downwards has 4 500 m^3 (or 4 500 000 litres) of water moving laterally through the soil (100 m X 100 m X 0.45 m) per rain season. The next section of 100 m down the slope has its own 4 500 m^3 of water as well as the added 4 500 m^3 from the upslope section to contend with, therefore 9 000 m^3. The next section has 13 500 m^3 to contend with and the following one 18 000 m^3. It is therefore clear that, the longer the slope, the larger the volume of water that will move laterally through the soil profile. Flow paths through soil and geological strata, referred to as "interflow" or "hillslope water", are very varied and often complex due to difficulty in measurement and identification. The difficulty in identification stems more from the challenges related to the physical determination of these in soil profile pits, soil auger samples and core drilling samples for geological strata. The identification of the morphological signs of water movement in permeable materials or along planes of weakness (cracks and seams) is a well-established science and the expression is mostly referred to as "redox morphology". In terms of the flow paths of water large variation exists but these can be grouped into a few simple categories. **Figure 7** provides a schematic representation of the different flow regimes that are usually encountered.

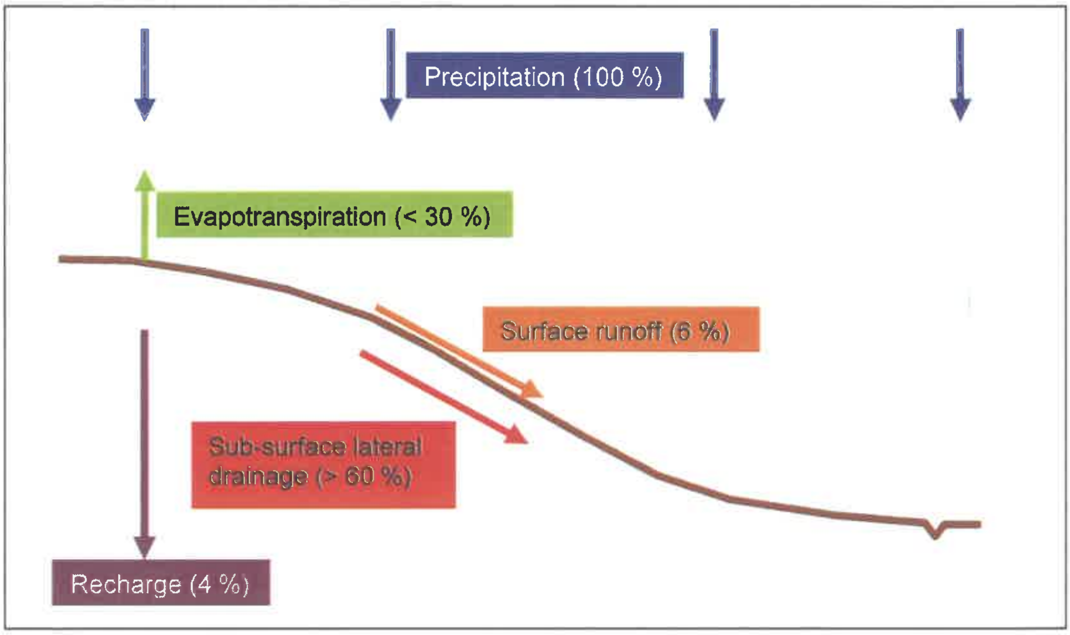

Figure 6 Idealised landscape with assumed quantities of water moving through the landscape expressed as a percentage of total precipitation (100 %).

The main types of water flow can be grouped as 1) recharge (vertically downwards) of groundwater; 2) lateral flow of water through the landscape along the hillslope (interflow or hillslope water); 3) return flow water that intercepts the soil/landscape surface; and 4) surface runoff. Significant variation exists with these flow paths and numerous combinations are often found. The main wetland types associated with the flow paths are: a) valley bottom wetlands (fed by groundwater, hillslope processes, surface runoff, and/or in-stream water); b) hillslope seepage wetlands (fed by interflow water and/or return flow water); and wetlands associated with surface runoff, ponding and surface ingress of water anywhere in the landscape.

Amongst other factors, the thickness of the soil profile at a specific point will influence the intensity of the physical and chemical reactions taking place in that soil. **Figure 8** illustrates the difference between a dominantly thick and a dominantly thin soil profile. If all factors are kept the same except for the soil profile thickness it can be assumed with confidence that the chemical and physical reactions associated with water in the landscape will be much more intense for the thin soil profile than for the thick soil profile. Stated differently: The volume of water moving through the soil per surface area of an imaginary plane perpendicular to the direction of water flow is much higher for the thin soil profile than for the thick soil profile. This aspect has a significant influence on the expression of redox morphology in different landscapes of varying soil/geology/climate composition.

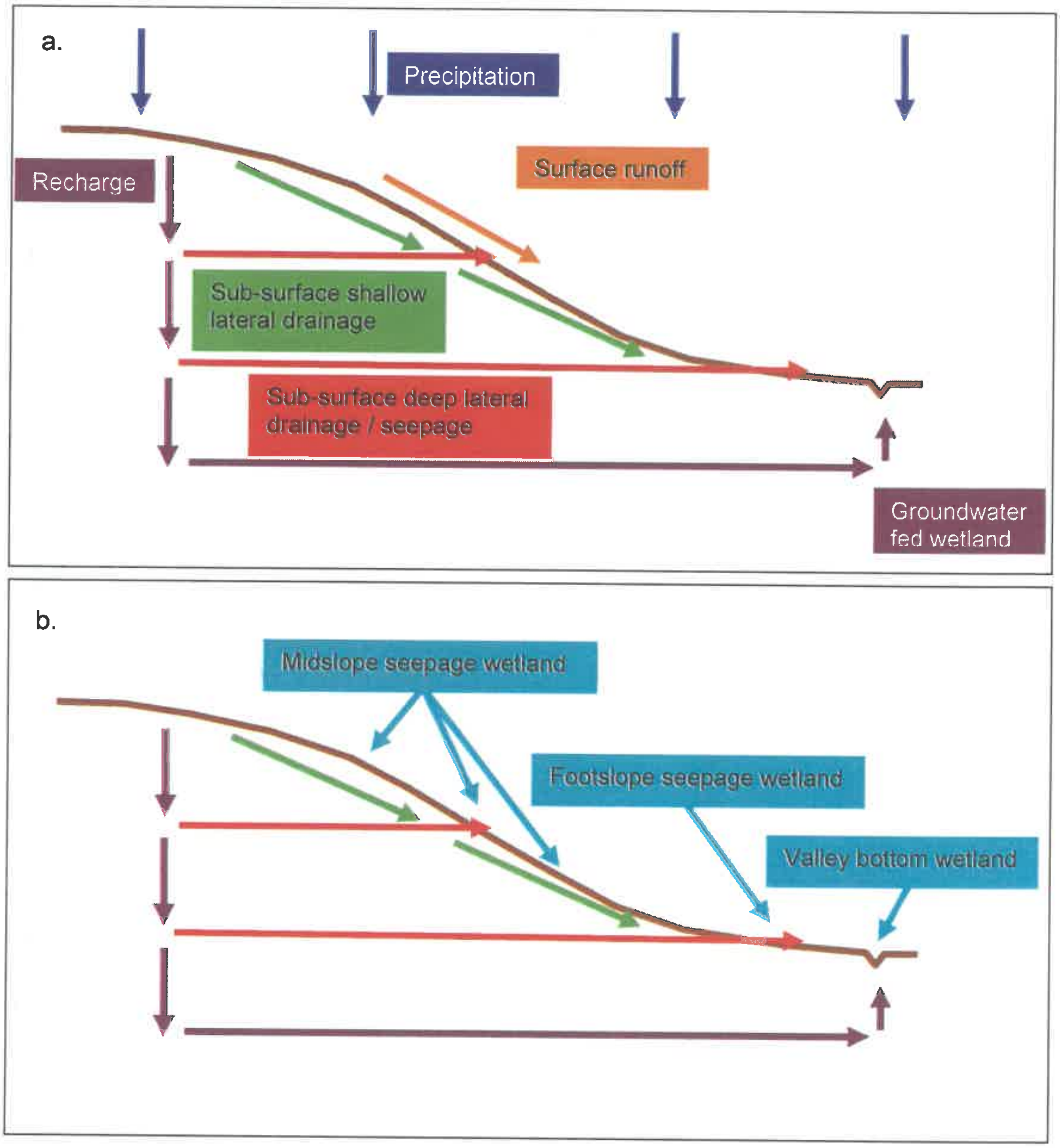

Figure 7 Different flow paths of water through a landscape (a) and typical wetland types associated with the water regime (b)

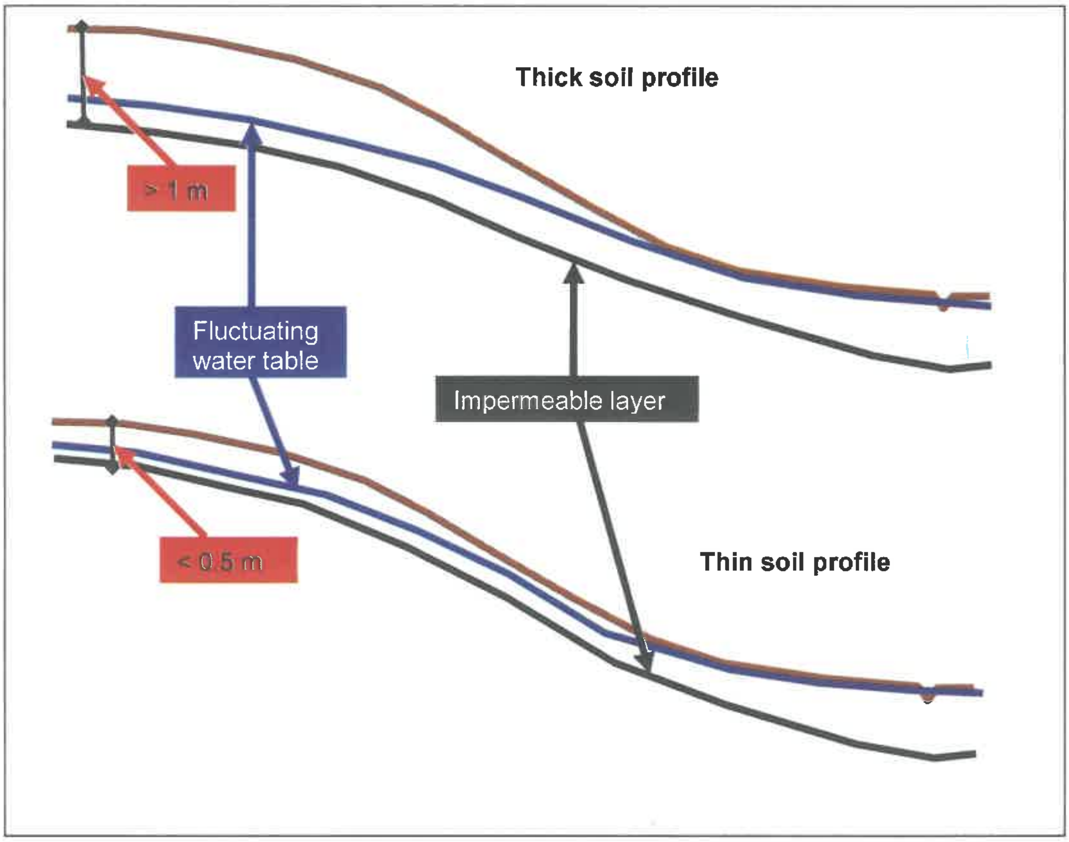

Figure 8 The difference in water flow between a dominantly thick and dominantly thin soil profile.

5.6 THE CATENA CONCEPT

Here it is important to take note of the "catena" concept. This concept is one of a topographic sequence of soils in a homogenous geological setting where the water movement and presence in the soils determine the specific characteristics of the soils from the top to the bottom of the topography. **Figure 9** illustrates an idealised topographical sequence of soils in a catena for a quartz rich parent material. Soils at the top of the topographical sequence are typically red in colour (Hutton and Bainsvlei soil forms) and systematically grade to yellow further down the slope (Avalon soil form). As the volume of water that moves through the soil increases, typically in midslope areas, periodic saturated conditions are experienced and consequently Fe is reduced and removed in the laterally flowing water. In the event that the soils in the midslope positions are relatively sandy the resultant soil colour will be bleached or white due to the colour dominance of the sand quartz particles. The soils in these positions are typically of the Longlands and Kroonstad forms. Further down the slope there is an accumulation of clays and leaching products from higher lying soils and this leads to typical illuvial and clay rich horizons. Due to the regular presence of water the dominant conditions are anaerobic and reducing and the soils exhibit grey colours often with bright yellow and grey mottles (Katspruit soil form). In the event that there is a large depositional environment with prolonged saturation soils of the Champagne form may develop (typical peat land). Variations on this sequence (as is often found on the Mpumalanga Highveld) may include the presence of hard plinthic materials instead of soft plinthite with a consequent increase in the occurrence of bleached soil profiles. Extreme examples of such landscapes are discussed below.

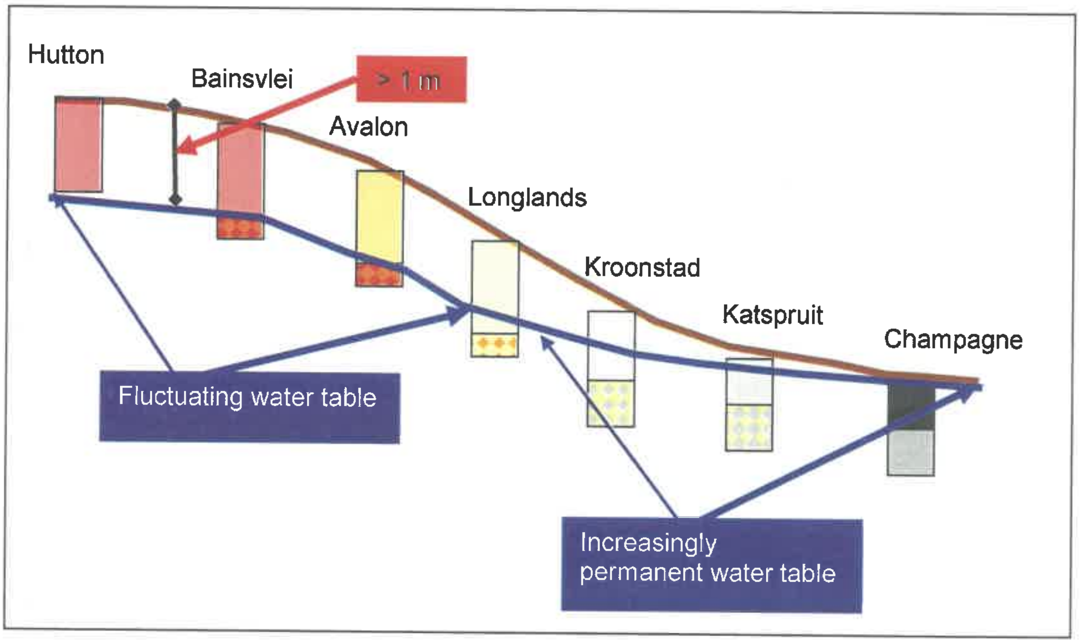

Figure 9 Idealised catena on a quartz rich parent material.

5.7 THE HALFWAY HOUSE GRANITE DOME CATENA

The Halfway House Granite Catena is a well-studied example of a quartz dominated Bb catena. As a result of the elucidation of the wetland delineation parameters and challenges in the specialist testimony in the matter between The State versus 1. Stefan Frylinck and 2. Mpofu Environmental Solutions CC (Case Number 14/1740/2010) it will be discussed in further detail here.

The typical catena that forms on the Halfway House granite differs from the idealised one discussed above in that the landscape is an old stable one, often with extensive subsoil ferricrete (or hard plinthic) layers where perched water tables occur. The parent material is relatively hard and the ferricrete layer is especially resistant to weathering. The quartz rich parent materials have a very low Fe content/"reserve", and together with the age of the material leads to the dominance of bleached sandy soils. The implication is that the whole catena is dominated by bleached sandy soils with a distinct and shallow zone of water fluctuation. This zone is often comprised of a high frequency of Fe/Mn concretions and sometimes exhibits feint mottles. In lower lying areas the soils tend to be deeper due to colluvial accumulation of sandy soil material but then exhibit more distinct signs of wetness (and pedogenesis). **Figure 10** provides a schematic representation of the catena.

The essence of this catena is that the soils are predominantly less than 50 cm thick and as such have a fluctuating water table (mimicking rainfall events) within 50 cm of the soil surface. One of the main criteria used during wetland delineation exercises as stipulated by the guidelines (DWAF, 2005) is the presence of mottles within 50 cm of the soil surface (temporary and seasonal wetland zones).

Even from a theoretical point of view the guidelines cannot be applied to the above described catena as soils at the crest of the landscape would already qualify as temporary wetland zone soils (upon request many such examples can be supplied). The practical implication of this statement as well as practical examples will be discussed in the next section.

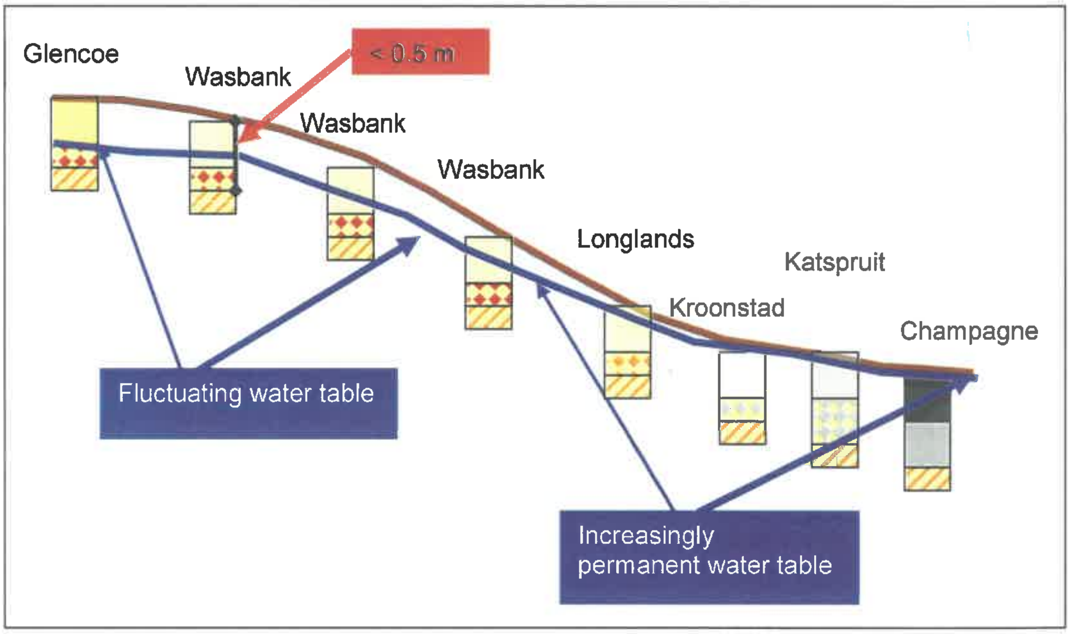

Figure 10 Schematic representation of a Halfway House Granite catena

5.8 CONVEX VERSUS CONCAVE LANDSCAPES IN THE HALFWAY HOUSE GRANITE CATENA

An additional factor of variation in all landscapes is the shape of the landscape along contours (referred to a "plan curvature"). Landscapes can be either concave or convex, or flat. The main difference between these landscapes lies in the fact that a convex landscape is essentially a watershed with water flowing in diverging directions with a subsequent occurrence of "dryer" soil conditions. In a concave landscape water flows in converging directions and soils often exhibit the wetter conditions of "signs of wetness" such as grey colours, organic matter and subsurface clay accumulation. **Figure 11** presents the difference between these landscapes in terms of typical soil forms encountered on the Halfway House granites. In the convex landscape the subsurface flow of water removes clays and other weathering products (including Fe) in such a way that the midslope position soils exhibit an increasing degree of bleaching and relative accumulation of quartz (E-horizons). In the concave landscapes clays and weathering products are transported through the soils into a zone of accumulation where soils start exhibiting properties of clay and Fe accumulation. In addition, coarse sandy soils in convex environments tend to be thinner due to the removal of sand particles through erosion and soils in concave environments tend to be thicker due to colluvial accumulation of material transported from upslope positions. Similar patterns are observed for other geological areas with the variation being consistent with the soil variation in the catena.

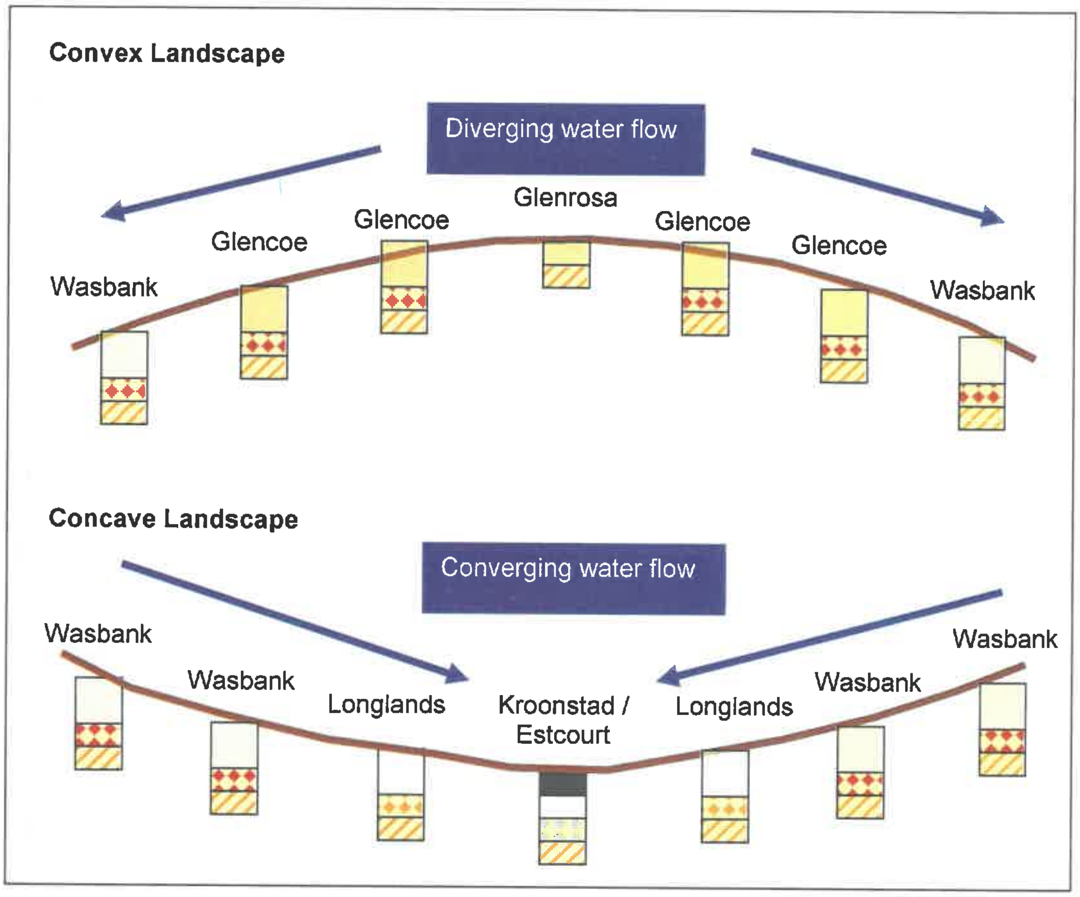

Figure 11 Schematic representation of the soils in convex and concave landscapes in the Halfway House Granite catena.

Often these concave and convex topographical environments occur in close proximity or in one topographical sequence of soils. This is often found where a convex upslope area changes into a concave environment as a drainage depression is reached (**Figure 12**). The processes in this landscape are the same as those described for the convex and concave landscapes above.

5.9 IMPLICATIONS FOR WETLAND DELINEATION AND APPLICATION OF THE GUIDELINES

When the 50 cm criterion is used to delineate wetlands in the HHGD environment, the soils in convex positions often "qualify" as temporary wetland soils due to their relatively thin profile and the presence of concretions (often weathering to yield "mottles") within this zone. In conjunction with a low Fe content in the soils and subsequent bleached colours (as defined for E-horizons) in the matrix a very large proportion of the landscape "qualifies" as temporary wetland zones. On the other hand, the soils in the concave environments, especially in the centre of the drainage depression, tend to be thicker and the 50 cm criterion sometimes does not flag these soils as being wetland soils due to the depth of the signs of wetness (mottles) often occurring only at depths greater than 80 cm. Invariably these areas are always included in wetland delineations due to the terrain unit indicator flagging it as a wetland area and drainage feature.

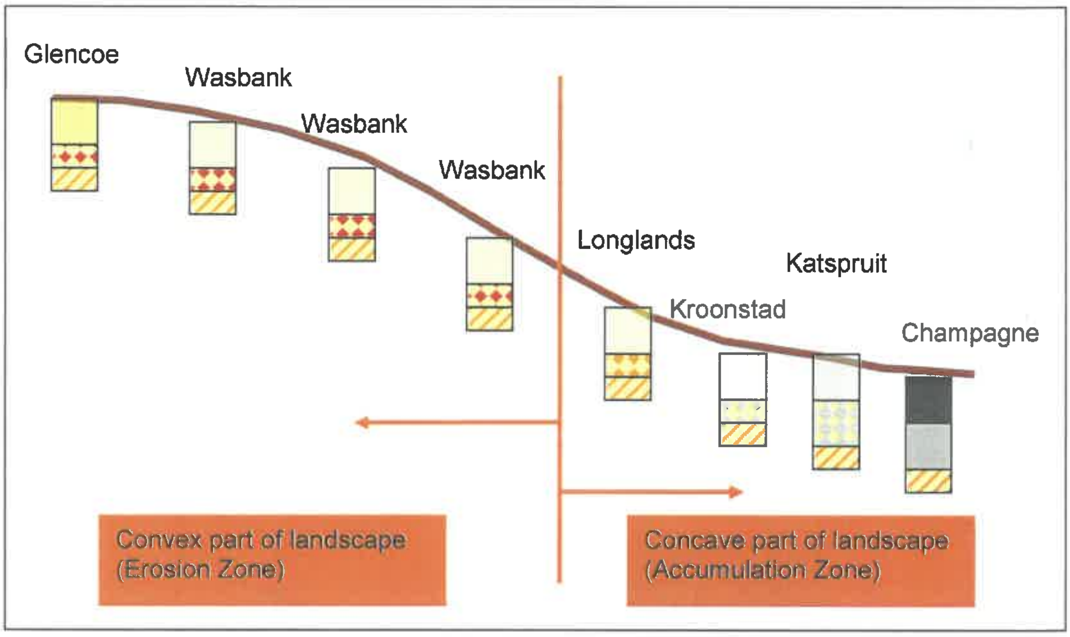

Figure 12 Schematic representation of the soils in a combined convex and concave landscape in the Halfway House Granite catena.

The strict application of the wetland delineation guidelines in the Halfway House Granite area often leads to the identification of 70 % or more of a landscape as being part of a wetland. For this reason a more pragmatic approach is often followed in that the 50 cm criterion is not applied religiously. Rather, distinctly wet horizons and zones of clay accumulation within drainage depressions are identified as distinct wetland soils. The areas surrounding these are assigned to extensive seepage areas that are difficult to delineate and on which it is difficult to assign a realistic buffer area. The probable best practice is to assign a large buffer zone in which subsurface water flow is encouraged and conserved to lead to a steady but slow recharge of the wetland area, especially following rainfall events. In the case where development is to take place within this large buffer area it is preferred that a "functional buffer" approach be followed. This implies that development can take place within the buffer area but then only within strict guidelines regarding storm water management and mitigation as well as erosion prevention in order to minimise sediment transport into stream and drainage channels and depressions.

5.10 Implications for Wetland Conservation in Urban Environments

Whether an area is designated a wetland or not loses some of its relevance once drastic influences on landscape hydrology are considered. If wetlands are merely the expression of water in a landscape due to proximity to the land surface (viz. the 50 cm mottle criterion in the delineation guidelines) it follows that potentially large proportions of the water moving in the landscape could fall outside of this sphere – as discussed in detail above. **Figures 13** and **14** provide schematic representations (as contrasted with **Figure 7**) of water dynamics in urban environments with distinct excavations and surface sealing activities respectively.

Through the excavation of pits (**Figure 13**) for the construction of foundations for infrastructure or basements for buildings the shallow lateral flow paths in the landscape are severed. As discussed above these flow paths can account for up to 60 % of the volume of water entering the landscape in the form of precipitation. These severed flow paths often lead to the ponding of water upslope from the structure with a subsequent damp problem developing in buildings. Euphemistically we have coined the term "wet basement syndrome" (WBS) to describe the type of problem experienced extensively on the HHGD.

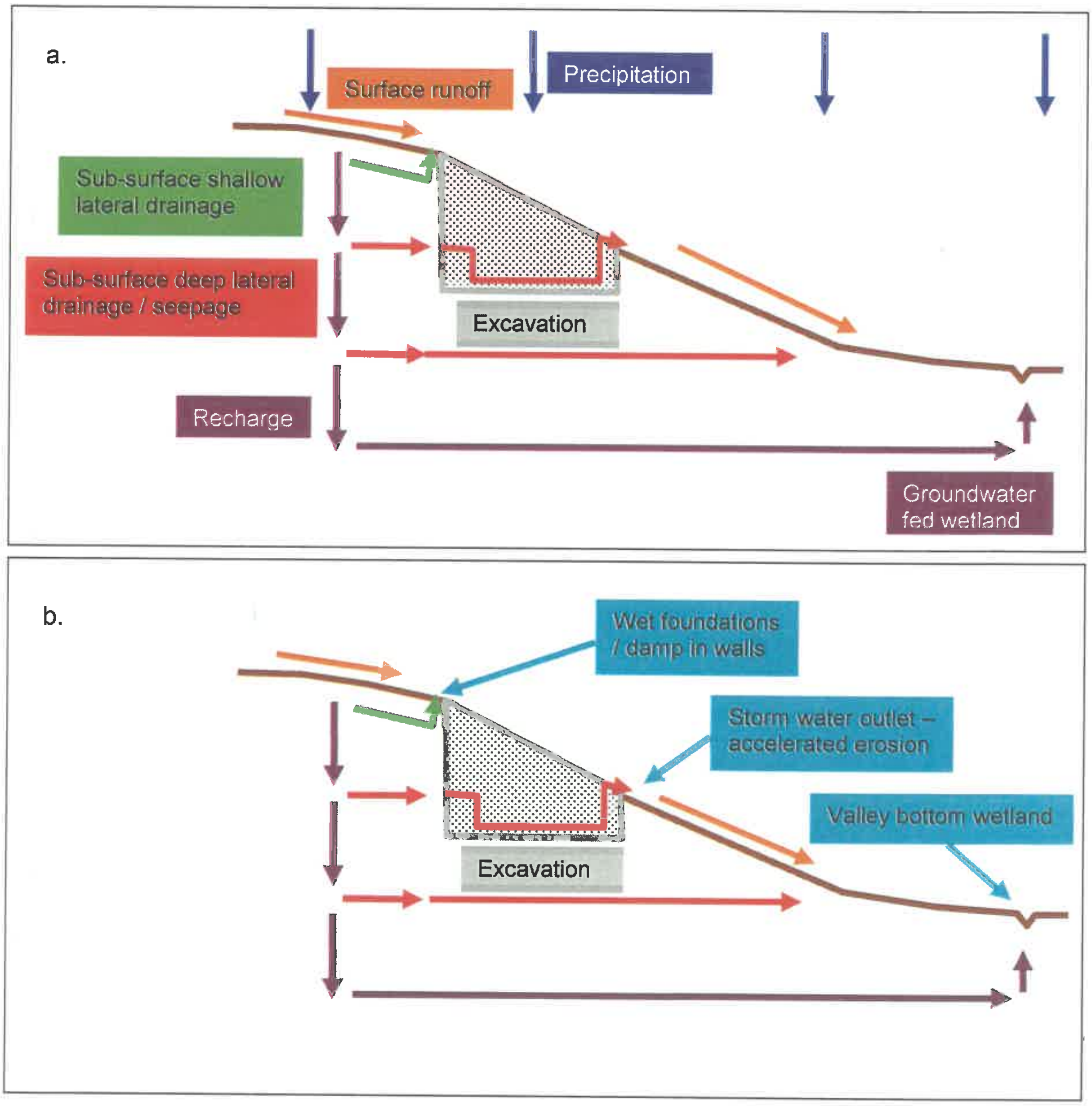

Figure 13 Different flow paths of water through a landscape with an excavated foundation (a) and typical wetland types associated with the altered water regime (b)

A different impact is experienced once the surface of the land is sealed through paving (roads and parking areas) and the construction of buildings (in this case the roof provides the seal) (**Figure 14**).

In this case the recharge of water into the soil and weathered rock experienced naturally is altered to an accumulation and concentration of water on the surface with a subsequent rapid flowing downslope. The current approach is to channel this water into storm water structures and to release it in the nearest low lying position in the landscape. These positions invariable correlate with drainage features and the result is accelerated erosion of such features due to a drastically altered peak flow regime.

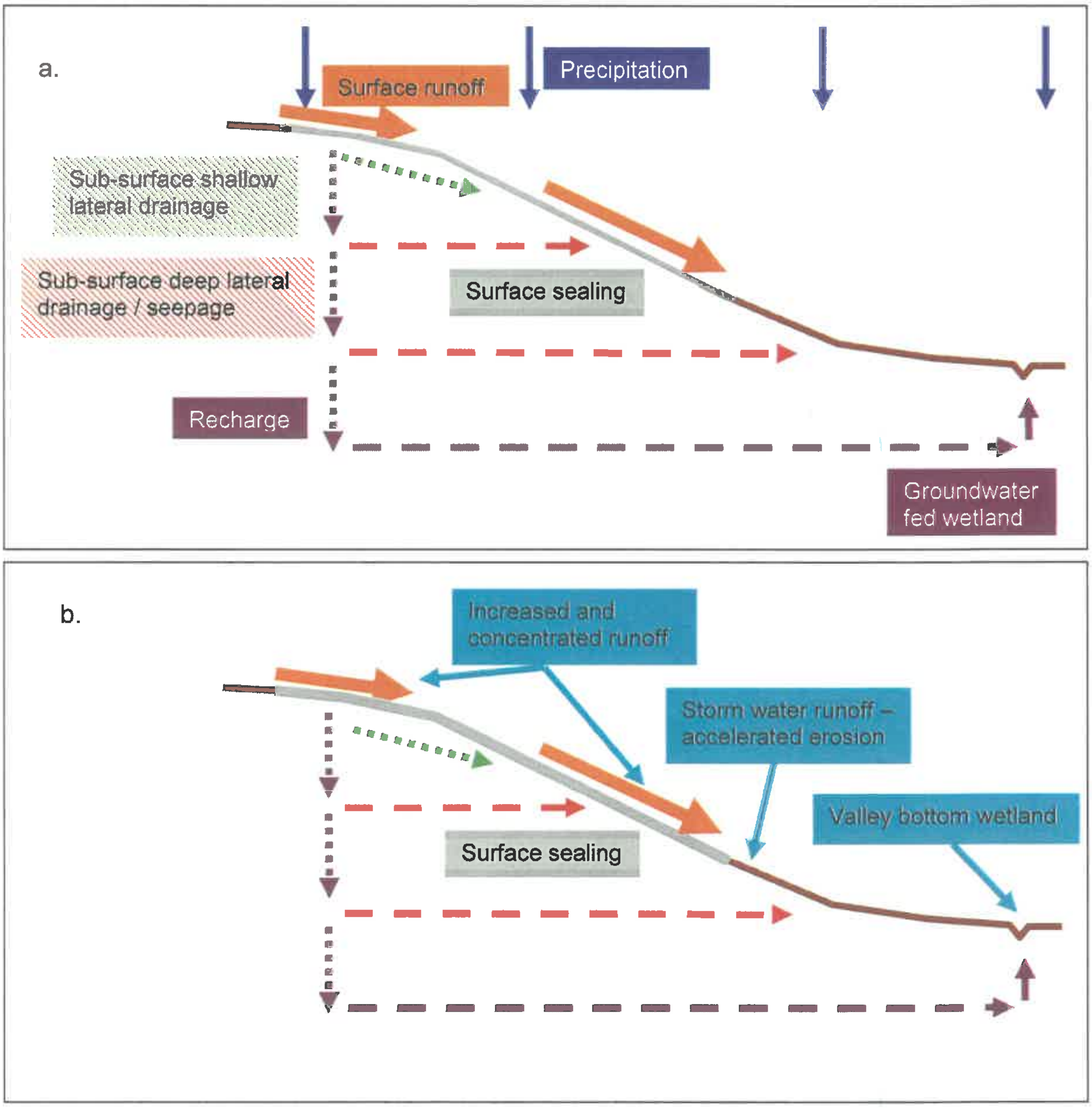

Figure 14 Different flow paths of water through a landscape with surface sealing (buildings and paving) (a) and typical wetland types associated with the altered water regime (b)

The result of the above changes in landscape hydrology is the drastic alteration of flow dynamics and water volume spikes through wetlands. This leads to wetlands that become wetter and that experience vastly increased erosion pressures. The next section provides a perspective on the erodibility of the soils of the HHGD. It is important to note the correlation between increasing wetness, perching of water and erodibility.

5.11 Implications for Water Movement in the Landscape (Conceptual)

The main implications of the urbanization of a piece of land are the following (as illustrated in **Figure 15** as compared to Figure 6):

1. The precipitation contribution remains the same as for the pre-development area.
2. Due to the land surface developments the natural vegetation cover is removed. This vegetation cover was instrumental in the intercept of precipitation water through physical impediment as well as through uptake and evapotranspiration. The water balance therefore changes from a large evapotranspiration contribution to a very small one post-development with the consequence that there is an increase in water draining out of the landscape (**Important Note 4!**).
3. Due to surface sealing and paving the recharge of water to deep (groundwater) and shallow aquifers (perched aquifers and interflow water zones) is curtailed and this water is effectively diverted to surface flow and runoff. Again the compounding effect is one of an increase in water draining through and out of the landscape (**Important Note 5!**).

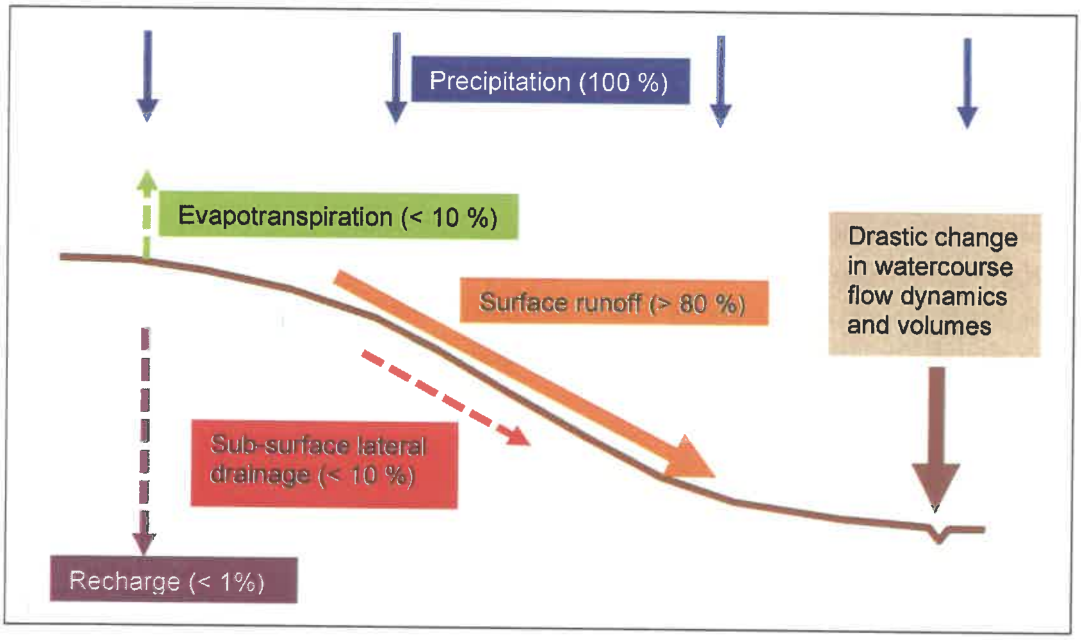

Figure 15 Idealised landscape with urban induced alterations of quantities of water moving through the landscape expressed as a percentage of total precipitation (100 %).

4. The effective "removal" of the porous soil zone for water movement (with its inherent flow lag characteristics) and replacement by hardened and sloped surfaces (with near zero flow lag) leads to a drastic increase in the volume and energy of water that reaches the watercourses and associated wetlands. The implication is that the watercourses and wetlands experience drastically increased water volumes and flows on a regular basis

with drastically increased energy levels when compared to the "reference state" (as specifically discussed in the PES rating methodology). These wetlands and watercourses are NOT in equilibrium with the new flow regime (**Important Note 6!**).

5. The arbitrary enforcement of buffers on watercourses and wetlands in erosion susceptible urban areas does NOT address the hydrological changes and impacts as indicated in **Figure 15** as discussed above. The only way the hydrological impacts can be addressed is through the dedicated and proper planning of storm water attenuation structures within the terrestrial and watercourse / wetland areas in order to minimize hydrological shocks to the water features in the catchment (**Important Note 7!**).

5.12 Implications for Downstream Wetlands, Watercourses and Landscapes

An impact that is very often overlooked in urban drainage systems is the increase in water volume flowing through the catchment. Water is pumped from dams and reservoirs into "new" areas that have not had such volumes under pre-human impact conditions. In the event that all the water that is pumped into an urban area is removed through sewers and storm water infrastructure there is barely a perceptible increase in water in surface water structures. However, as the area serviced increases in size with storm water and sewer infrastructure releasing water into surface water bodies within the area the volume of water increases above the natural background volumes.

Additionally, changes in water runoff volumes through land surface sealing and runoff timing considerations lead to increased wetness and spikes in water volumes in drainage features. The main contrast in the landscape is evident in comparing infiltration and slow percolation with associated lateral flow spread over months versus rapid and immediate runoff from extensive and linked hard surfaces with runoff occurring within minutes and hours. The drastic temporal difference is mainly due to a diversion of water from slow subsurface lateral seepage pathways to rapid surface channelling routes. Even though total volumes may therefore be the same, in some cases, to the pre-development volumes the energy in the system is completely different in terms of experienced water volumes in specific areas.

The above discussion is simplified in the sense that it does not take into account the numerous water interception zones in the form of slow but constant water uptake by plants and increased evaporative losses due to slow water movement through soils near to the surface. The implication is therefore that urban systems are consequently wetter (both perceived and actual) than pre-development landscapes. The increased degree of wetness, linked with the diversion of water from subsoils flow pathways to surface pathways, has a direct bearing on the ecological response in the wetland / watercourse system. Apart from the ecological response there is often also a physical response to the increased water volumes and flow rates in the form of watercourse degradation and erosion that is exacerbated by erosion sensitive soils.

5.13 Soil Erosion on the Halfway House Granite Dome

Infiltration of water into a soil profile and the percolation rate of water in the soil are dependent on a number of factors with the dominant one being the soil's texture (**Table 2**). Permeability and the percolation of water through the soil profile are governed by the least permeable layer in the soil profile. The implication of this is that soil horizons that overlie horizons of low permeability (i.e. hard rock, hard plinthite, G-horizon) are likely to become saturated with water relatively quickly - particularly if the soil profile is shallow and a large amount of water is added. Another impermeable layer is one that is saturated with water and such a layer acts the same way as the ones mentioned earlier. In cases where internal drainage is hampered by an impermeable layer such as hard rock (the Dresden or Wasbank soil forms) evaporation and lateral water movement are the only processes that will drain the soil profile of water.

Table 2 Infiltration/permeability rates for soil textural classes (Wischmeier, Johnson & Cross 1971)

Texture class	Texture	Permeability Rate (mm/hour)	Permeability Class
Coarse	Gravel, coarse sand	>508	Very rapid
	Sand, loamy sand	152 – 508	Rapid
Moderately coarse	Coarse sandy loam	51 - 152	Moderately rapid
	Sandy loam		
	Fine sandy loam		
Medium	Very fine sandy loam	15 – 51	Moderate
	Loam		
	Silt loam		
	Silt		
Moderately fine	Clay loam	5.1 – 15.2	Moderately slow
	Sandy clay loam		
	Silty clay loam		
Fine	Sandy clay	1.5 – 5.1	Slow
	Silty clay		
	Clay (>60%)		
Very fine	Clay (>60%)	< 1.5	Very slow
	Clay pan		

Infiltration of water into a soil profile is dependent on the factors leading to the downward movement of water. In cases where impermeable layers exist water will infiltrate into the profile until it is saturated. Once this point is reached water infiltration will cease and surface runoff will become the dominant water flow mechanism. A similar situation will develop if a soil has a slow infiltration rate of water due to fine texture, hardened or compacted layers and low hydraulic conductivity. When these soils are subjected to large volumes and rates of rainfall the rate of infiltration will be exceeded and excess water will flow downslope on the soil surface.

The texture, permeability and presence of impeding layers are some of the main determinants of soil erosion. Wischmeier, Johnson and Cross (1971) compiled a soil erodibilty nomograph from soil analytical data (**Figure 16**). The nomograph uses the following parameters that are regarded as having a major effect on soil erodibility:

- The mass percentage of the fraction between 0.1 and 0.002 mm (very fine sand plus silt) of the topsoil.
- The mass percentage of the fraction between 0.1 and 2.0 mm diameter of the topsoil.
- Organic matter content of the topsoil. This "content" is obtained by multiplying the organic carbon content (in g/100 g soil – Walkley Black method) by a factor of 1.724.
- A numerical index of soil structure.
- A numerical index of the soil permeability of the soil profile. The least permeable horizon is regarded as horizon that governs permeability.

Box 1 describes the procedure to use the nomograph.

As part of a different study 45 soil samples were collected from 19 points on the HHGD. The samples were described in terms of soil form and analysed with respect to texture (6 fractions) and organic carbon content of the A-horizons (data not presented here but available upon request). The erodibility index and maximum stable slope were calculated for each horizon (according to the method discussed above) in both an unsaturated and saturated soil matrix (data not presented here but available upon request).

Box 1: Using the nomograph by Wischmeier, Johnson and Cross (1971)
In examining the analysis of appropriate surface samples, enter on the left of the graph and plot the percentage of silt (0.002 to 0.1 mm), then of sand (0.10 to 2 mm), then of organic matter, structure and permeability in the direction indicated by the arrows. Interpolate between the drawn curves if necessary. The broken arrowed line indicates the procedure for a sample having 65% silt + very fine sand, 5% sand, 2.8% organic matter, 2 of structure and 4 of permeability. Erodibility factor K = 0,31.

The erosion risk is based on the product of the slope (in percentage) and the K-value of erodibility (determined from the Wischmeier, Johnson and Cross (1971) nomograph). This product should not exceed a value of 2.0 in which case soil erosion becomes a major concern. The K-value allows for a "hard" rainfall event but is actually based on scheduled irrigation that allows for infiltration and percolation rates and so-called "normal" rainfall intensity. Soil erosion potential increases with an increase in the very fine sand plus silt fraction, a decrease in the organic matter content, an increase in the structure index and a decrease in permeability. Water quality is assumed not to be a problem for the purposes of the erosion hazard calculations.

Note: The erodibility factor increase due to saturation was also calculated. These results indicated an increase in erodibility of a factor predominantly between 3 and 4 for saturated soil conditions.

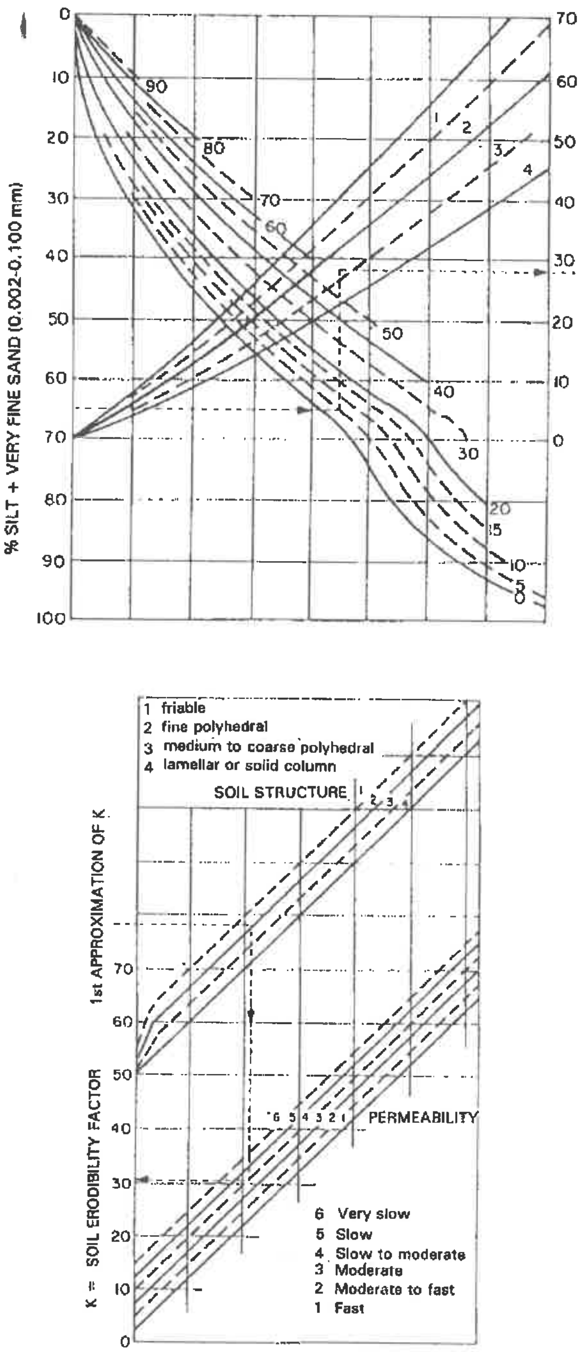

Figure 16 The nomograph by Wischmeier, Johnson and Cross (1971) that allows a quick assessment of the K factor of soil erodibility.

Important Note: The erodibility modelling conducted for the soil samples indicated a drastic increase in erosion susceptibility upon saturation. The implication is therefore that when the wetlands and watercourses in the HHGD area receive larger volumes of water more regularly than in the natural pre-development (reference) state these soils become significantly more susceptible to erosion. The most logical conclusion is therefore that the wetlands of the HHGD CANNOT attenuate floods and flooding events at the scale that urban developments cause (**Important Note 8!**).

5.14 SUSTAINABLE URBAN DRAINAGE CONSIDERATIONS

5.14.1 SuDS Philosophy and Options

A relatively new approach to the management of urban water is known as sustainable drainage systems (SuDS) (Armitage et al., 2013). The SuDS philosophy states that there are three options namely:

1. Source controls: management of storm water as close to as possible on the property (eg: green roofs, rainwater harvesting, soakaways, permeable pavements);
2. Local controls: management of storm water as a "second line of defence" in public areas such as roadway reserves and parks (eg: filter strips, swales, infiltration trenches, bio-retention areas, sand filters); and
3. Regional controls: management of storm water as a "last line of defence" in the form of large-scale interventions constructed on municipal land (detention ponds, retention ponds, constructed wetlands).

These options are not prescriptive but provide an indication of the variation in storm water management approach that can be considered on specific sites.

5.14.2 SuDS – Practical Considerations in the HHGD Area

Although this document does not aim to address SuDS in detail some very practical considerations apply to the HHGD. These are:

1. The use of permeable paving or processes to ensure water infiltration into soil is of limited benefit in soils and landscapes where the water flows laterally in shallow profiles through the bulk of the landscape. The main restriction is that the soil volume available for water storage and transport is limited with the effect that it saturates rapidly. Once a soil is saturated it cannot accommodate more water and the consequence is that surface ponding or runoff starts. In such cases unprotected soils become more susceptible to erosion, especially if surface water has a high energy due to slopes or concentration through channelling.
2. Forced and augmented infiltration leads to an increase in lateral water flow volumes with an increased risk of intercept by structures excavated into the soil profile (**Figure 17**). Under increased infiltration it has been observed that damp problems in foundations, walls and basements occur more frequently with increased damage if these structures are not protected.
3. The construction of pipelines and other trenched infrastructure leads to the "breaking" of the hard plinthite aquaclude (**Figure 18**) that keeps most of the water close to the soil surface. The fill material has a significantly higher bulk density when compared to the natural soil of the E horizon and this leads to a significantly lower hydraulic conductivity within the fill. With the lateral drainage of water through the landscape's soils this leads to a ponding effect immediately upslope of the fill in the trench (**Figure 19**). Due to the ponding that results from the lower transmissivity of the fill material it is often observed

that areas where pipelines have been installed exhibit an increase in surface ponding on the upslope side of the structure with a subsequent colonisation of pioneer wetland species. In cases such as these it is important not to artificially increase infiltration upslope of the structure and rather to allow water from the upslope areas to flow over the in-filled trench in a controlled manner with stabilisation measures to prevent erosion and ponding.

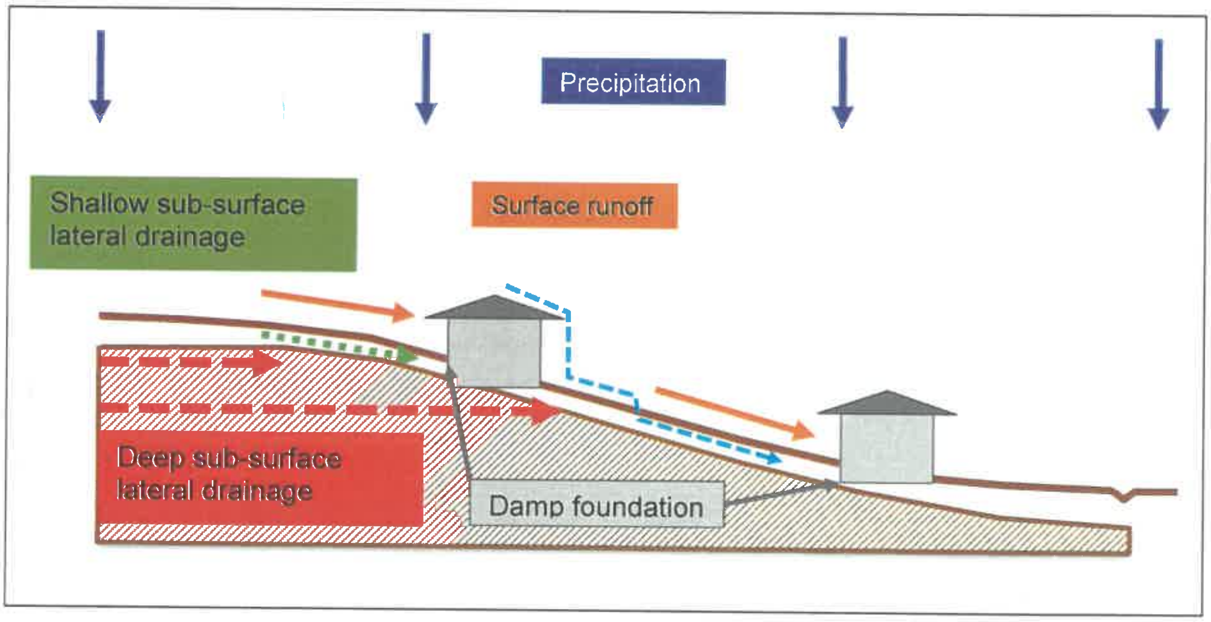

Figure 17 Challenges regarding infiltration SuDS approaches on the HHGD with its shallow lateral water flow zones

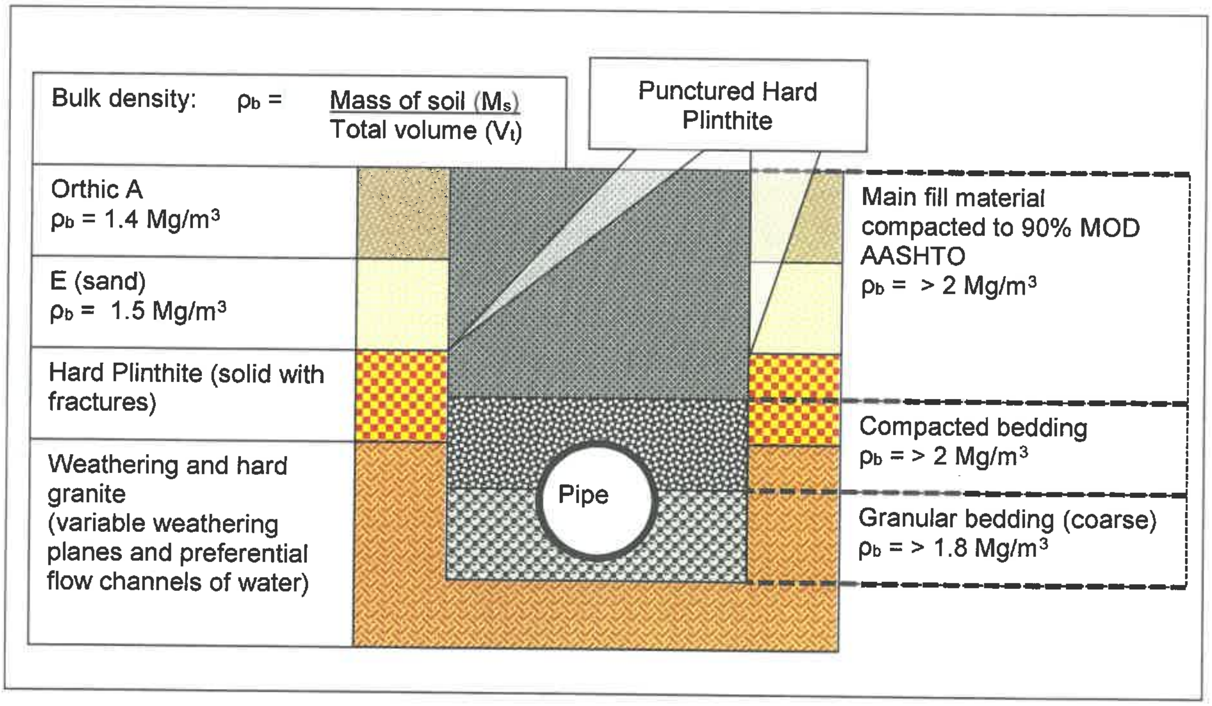

Figure 18 Typical pipeline trench fill and natural soil profile (with punctured hard plinthite aquaclude) with different soil and fill material bulk densities on the HHGD (as an example)

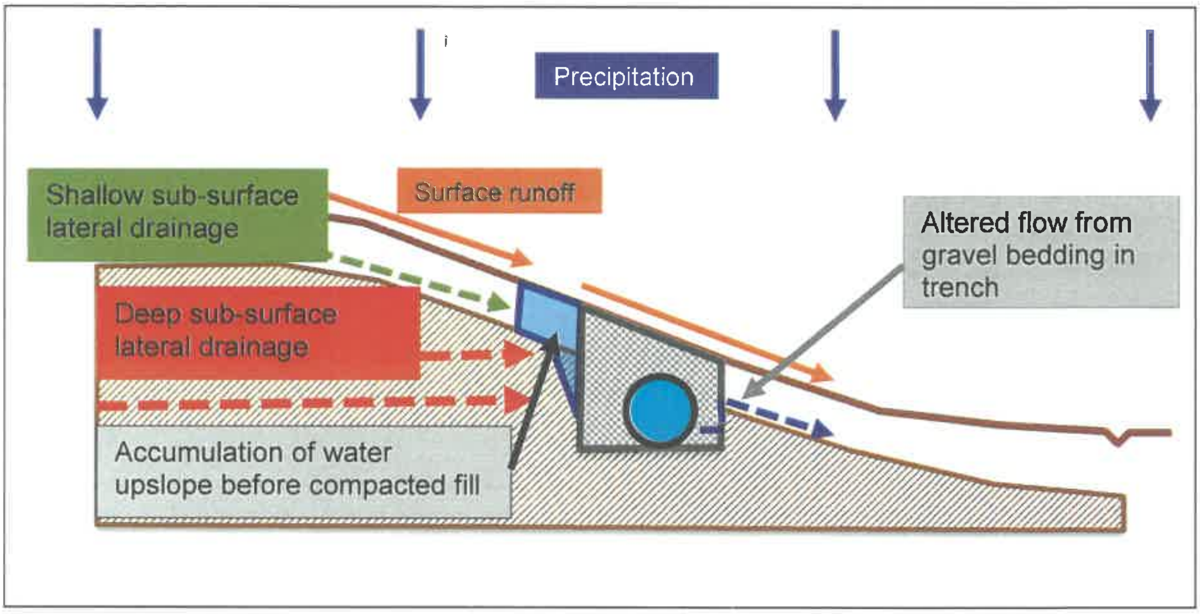

Figure 19 Challenges regarding SuDS approaches and pipeline construction on the HHGD (as an example) with its shallow lateral water flow zones and areas of water ponding

4. The ecological response of plants and animals to lateral flowing water is not a universal one. The specific ecological response depends on the aeration state of the water as well as its quality. Often forced lateral flow is touted as a solution to urban water impacts but this is a highly simplified assumption. Lateral flowing water in undisturbed landscapes can have a range of redox states (depending on the amount of oxygen dissolved in the water). Specific plant species are adapted to certain of these varying conditions and specific wetland plants colonise various seepage zones related to their preference (in terms of oxygen content of the water). The mimicking of lateral flow through anthropogenic means does not mean the desired ecological response will be evident and this aspect has to be emphasised during rehabilitation and SuDS planning processes.
5. The most realistic option for the HHGD is to bring water to the surface and deal with this water in a dedicated manner there. The drawback of this solution is that the water on the surface will elicit an ecological response limited to the aerated nature of the water. The typical plant species will be plants that colonise open water systems or soils of which the aeration state is relatively good. Plants adapted to anoxic seepage zones will not colonise such systems. In this regard the specific vegetation response will determine the macro invertebrate and animal response.

6. METHOD OF SITE INVESTIGATION

6.1 WETLAND CONTEXT DETERMINATION

For the purposes of the site assessment the context of the specific site was determined. This was done through the thorough consideration of the geological, topographical, climatic, hydropedological and catchment context of the site.

6.2. AERIAL PHOTOGRAPH INTERPRETATION

An aerial photograph interpretation exercise of the site was conducted through the use of historical aerial photographs as well as more recent Google Earth images. This data was used to obtain an indication of the extent of the wetlands on the site as well as to provide an indication of the artificial modifiers evident on the site and in the catchment.

6.3 HISTORICAL TOPOGRAPHIC MAPS

In order to identify potential watercourse and wetland areas the historical 1:50 000 topographic map data was obtained and is presented in a number of yearly extracts.

6.4 TERRAIN UNIT INDICATOR

Detailed contours of the site (1 m intervals) were used to provide an indication of drainage depressions and drainage lines in the form of concave landscape areas. From this data the terrain unit indicator was deduced and a topographic wetness indicator (TWI) generated.

6.5 SOIL FORM AND SOIL WETNESS INDICATORS

The soil form and wetness indicators were assessed on the site through the interpretation of the site characteristics, site geological context as well as a dedicated site investigation on the 8th of March 2018.

Historical impacts were identified as the impacts on the soils are very distinct. Soil characteristics could therefore be used to provide a good indication of the historical impacts on the grounds of a forensic approach. In areas where soil impacts are limited the standard approach in terms of identification of soil form and soil wetness indicators was used.

6.6 VEGETATION INDICATOR

Due to the extent of the historical impacts a dedicated vegetation survey for the purpose of wetland delineation was not conducted. Relevant vegetation parameters were noted however and these are addressed in the report where applicable.

6.7 ARTIFICIAL MODIFIERS

Artificial modifiers of the landscape and wetland area were identified during the different components of the investigation and are addressed in the context of the wetland management plan.

7. WETLAND INVESTIGATION RESULTS AND DISCUSSION

7.1 WETLAND CONTEXT

The land type, topography and geological setting of the site have been elucidated in section 2 of this document. The wetland / watercourse that forms the subject of this investigation is indicated in **Figure 20**.

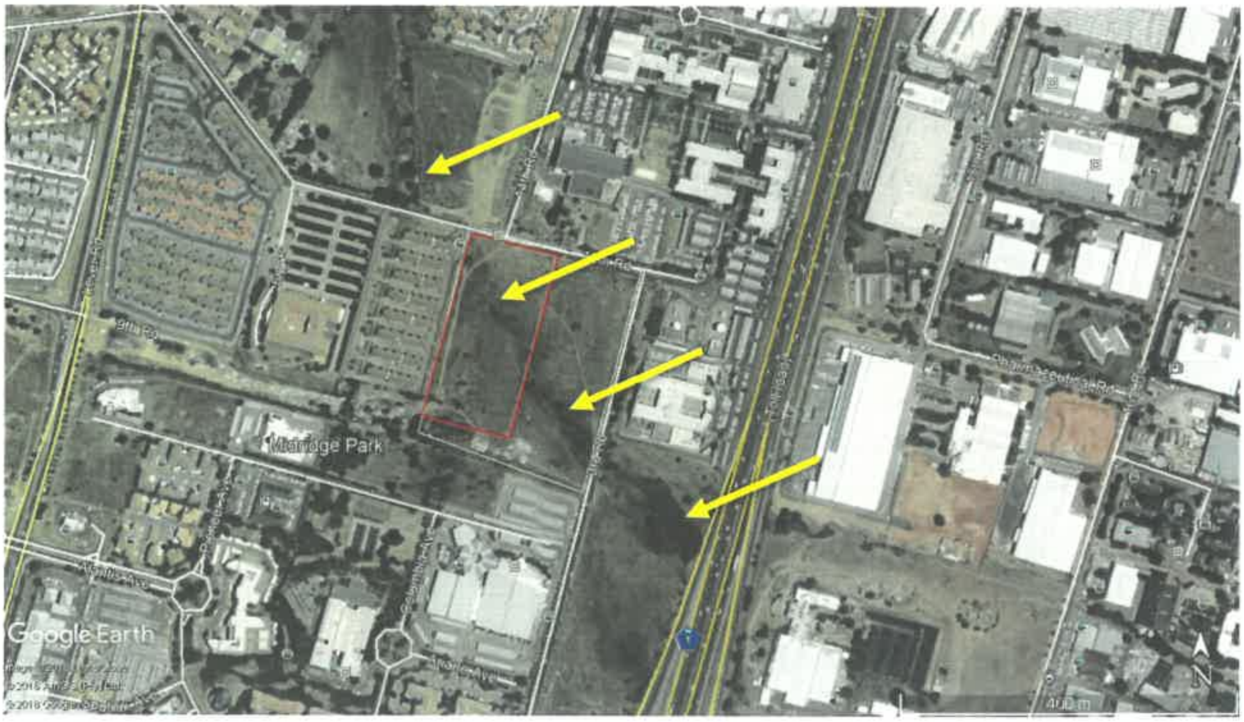

Figure 20 Wetland area (yellow arrows) that forms the subject of this investigation

7.2 AERIAL PHOTOGRAPH INTERPRETATION

7.2.1 Historical Aerial Photographs

The historical aerial photographs range from 1937 to 2001. The 1937 and 1958 images (**Figure 21**) indicate the general area before road developments and with a dominance of dryland agricultural activities and with some dirt road establishment respectively. The 1964 and 1968 images are provided in **Figure 22** and the 1968 image indicates the establishment of the current alignment of the Ben Schoeman highway and significant sediment runoff into the watercourse / wetland.

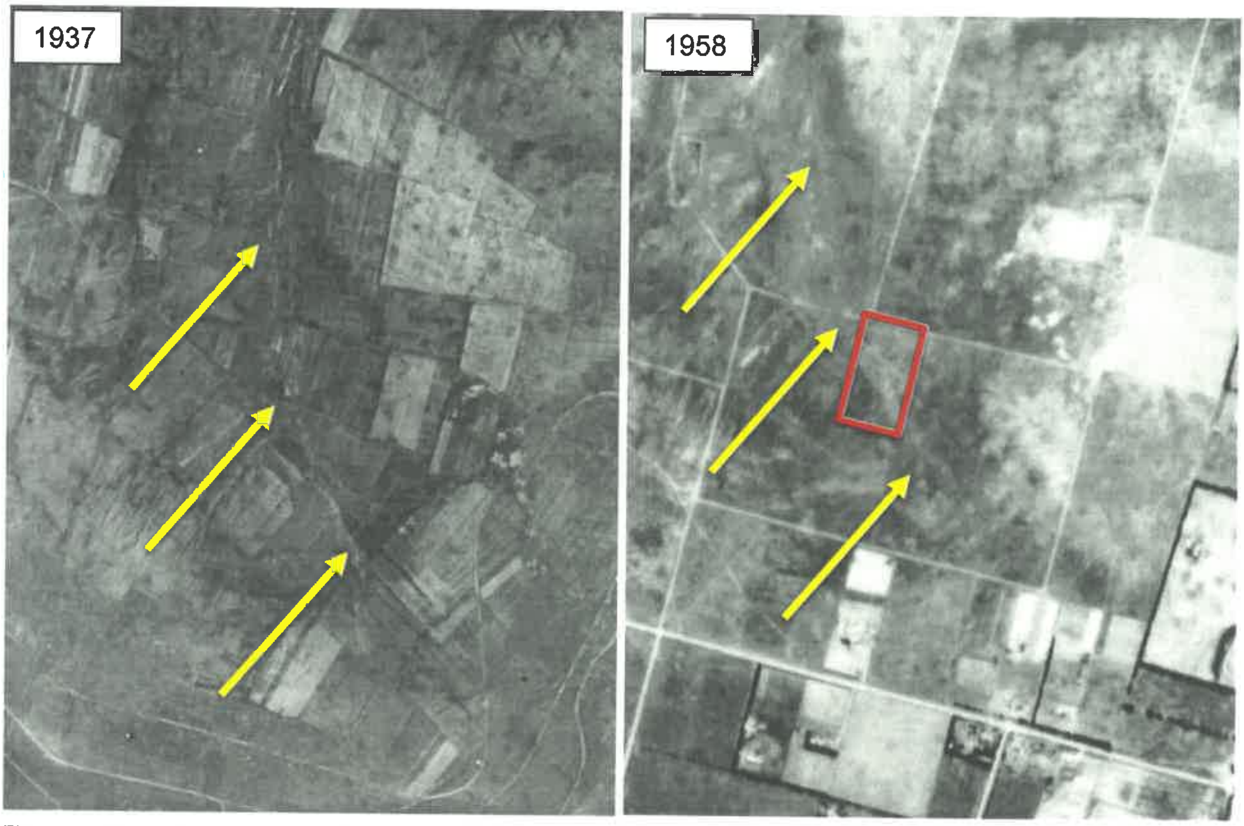

Figure 21 Historical aerial photographs from 1937 (left) and 1958 (right) indicating a watercourse / wetland (yellow arrows) on the investigation site (red rectangle) with the development of the current road layout by 1958

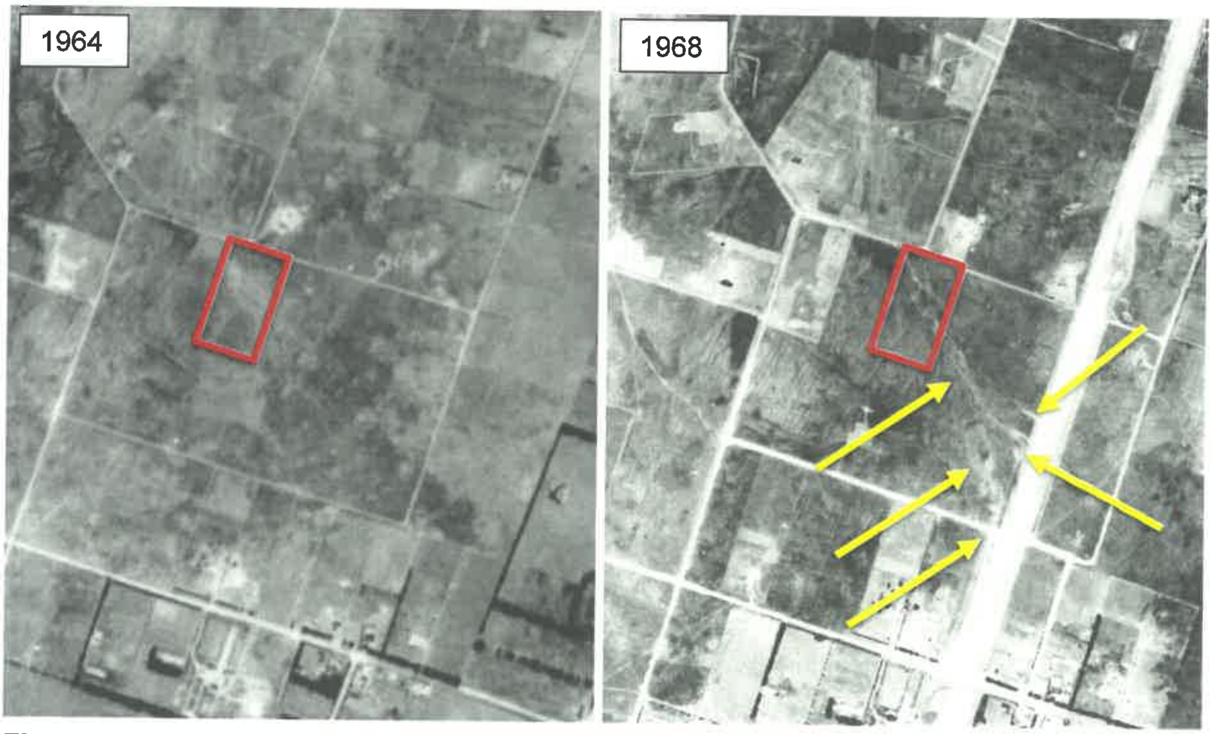

Figure 22 Historical aerial photographs from 1964 (left) and 1968 (right) indicating the watercourse / wetland, the investigation site (red rectangle) and the Ben Schoeman highway construction with significant sediment runoff into the watercourse / wetland area (yellow arrows) by 1958

The 1976 and 1985 images are provided in **Figure 23** indicating an intensification of development activities around the site. The 1991 and 2001 images are provided in **Figure 24** and the 2001 image indicates a distinct zone of soil / gravel material infilling immediately upslope (east) of the investigation site. This feature will be addressed in more detail later in the report (**Important Note 9!**).

Figure 23 Historical aerial photographs from 1976 (left) and 1985 (right) indicating the general area with an intensification of development activities

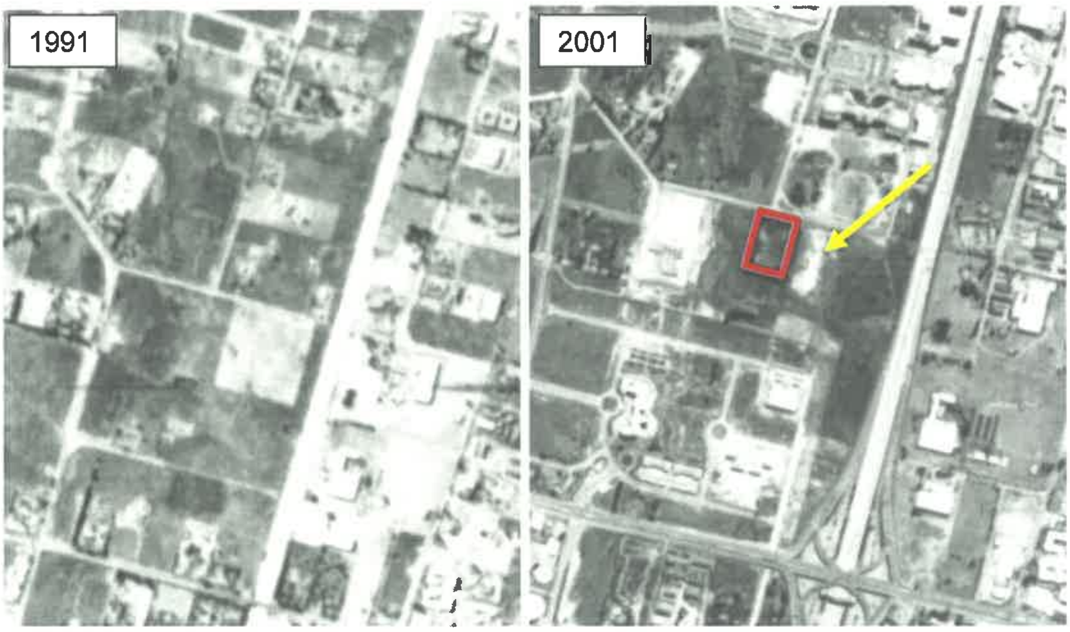

Figure 24 Historical aerial photographs from 1991 (left) and 2001 (right) indicating the general area with an intensification of development activities and a very distinct infilling signature in 2001 (yellow arrow) immediately above the investigation site (red rectangle)

7.2.2 Google Earth Images

The Google Earth images (2005 and 2009) for the site are provided in **Figure 25**. These indicate the wetland features and the changing land characteristics surrounding the site (including the upgrading of the Ben Schoeman highway.

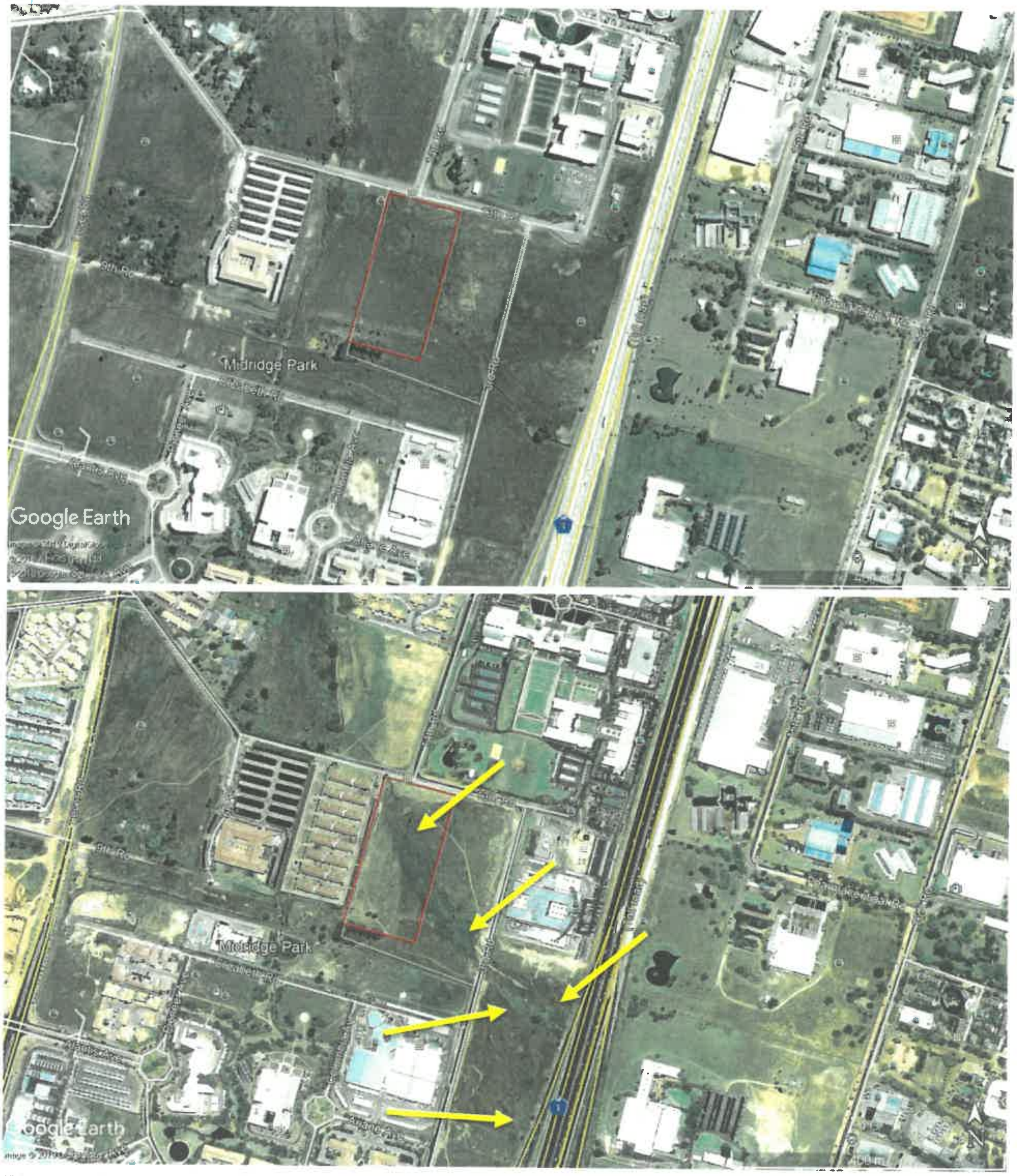

Figure 25 Google Earth images (top: 2004/03/26; bottom: 2009/11/12) of the site indicating the changing developments surrounding the site as well as a clear stormwater intensified runoff "wetland" feature from the Ben Schoeman highway (yellow arrows) by 2009

The Google Earth images (2016 and 2018) for the site are provided in **Figure 26**. These indicate the wetland features and the changing land characteristics surrounding the site (including the upgrading of the Ben Schoeman highway.

Figure 26 Google Earth images (top: 2016/09/24; bottom: 2018/08/26) of the site indicating the changing developments surrounding the site as well as a clear stormwater intensified runoff "wetland" feature from the Ben Schoeman highway (yellow arrows) by 2018

Higher resolution images of the site are provided in **Figures 27** and **28**. These indicate the specific features identified on the site namely: 1) old infilling signature, 2) stormwater increase related vegetation signatures and 3) distinct erosion signatures due to the increased and concentrated water flows.

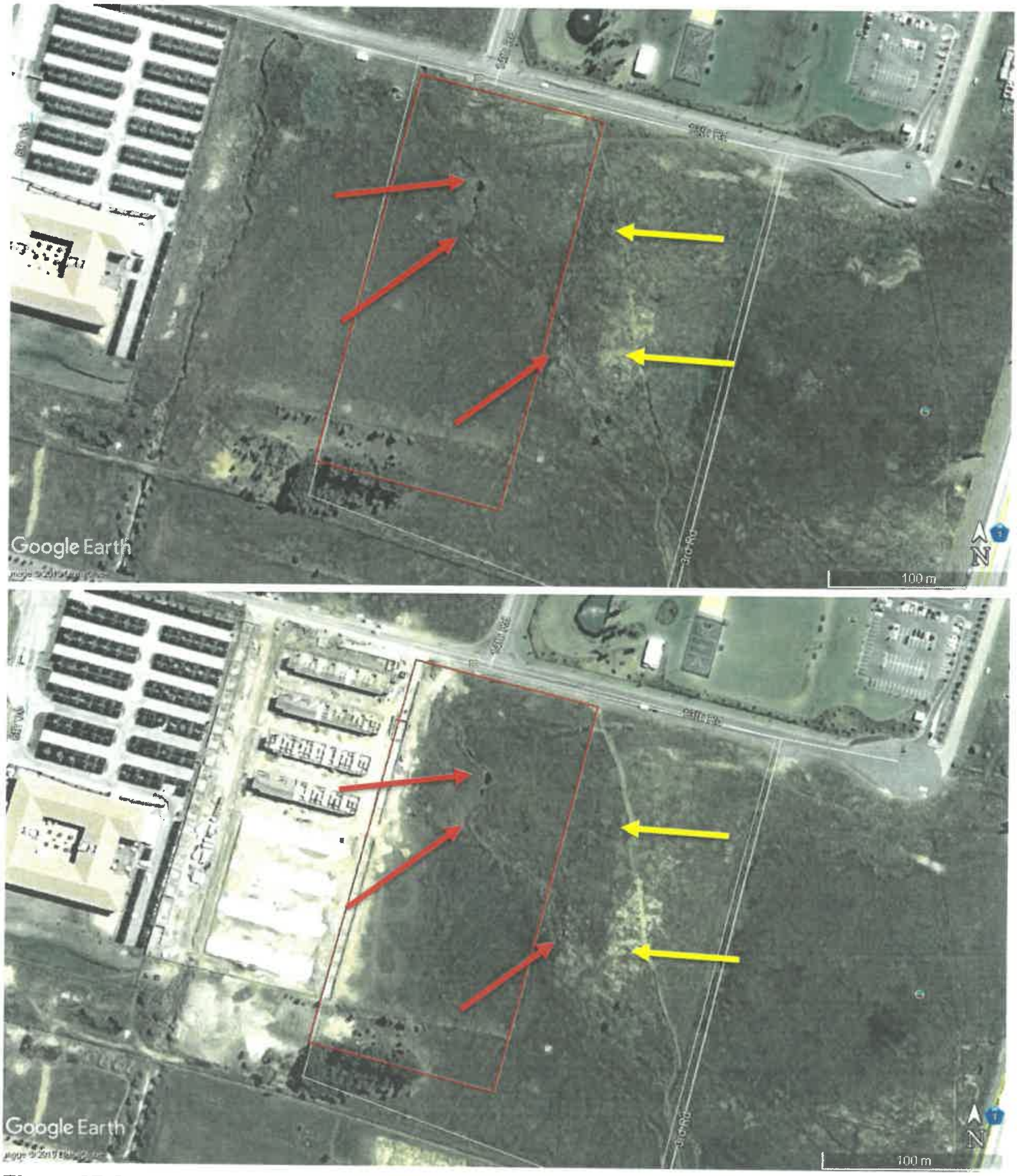

Figure 27 Google Earth images (top: 2004/03/26; bottom: 2005/02/08) of the site itself indicating the immediate changes in the vicinity (development to the west), the soil surface features of the old infilling (yellow arrows) and erosion signatures (red arrows)

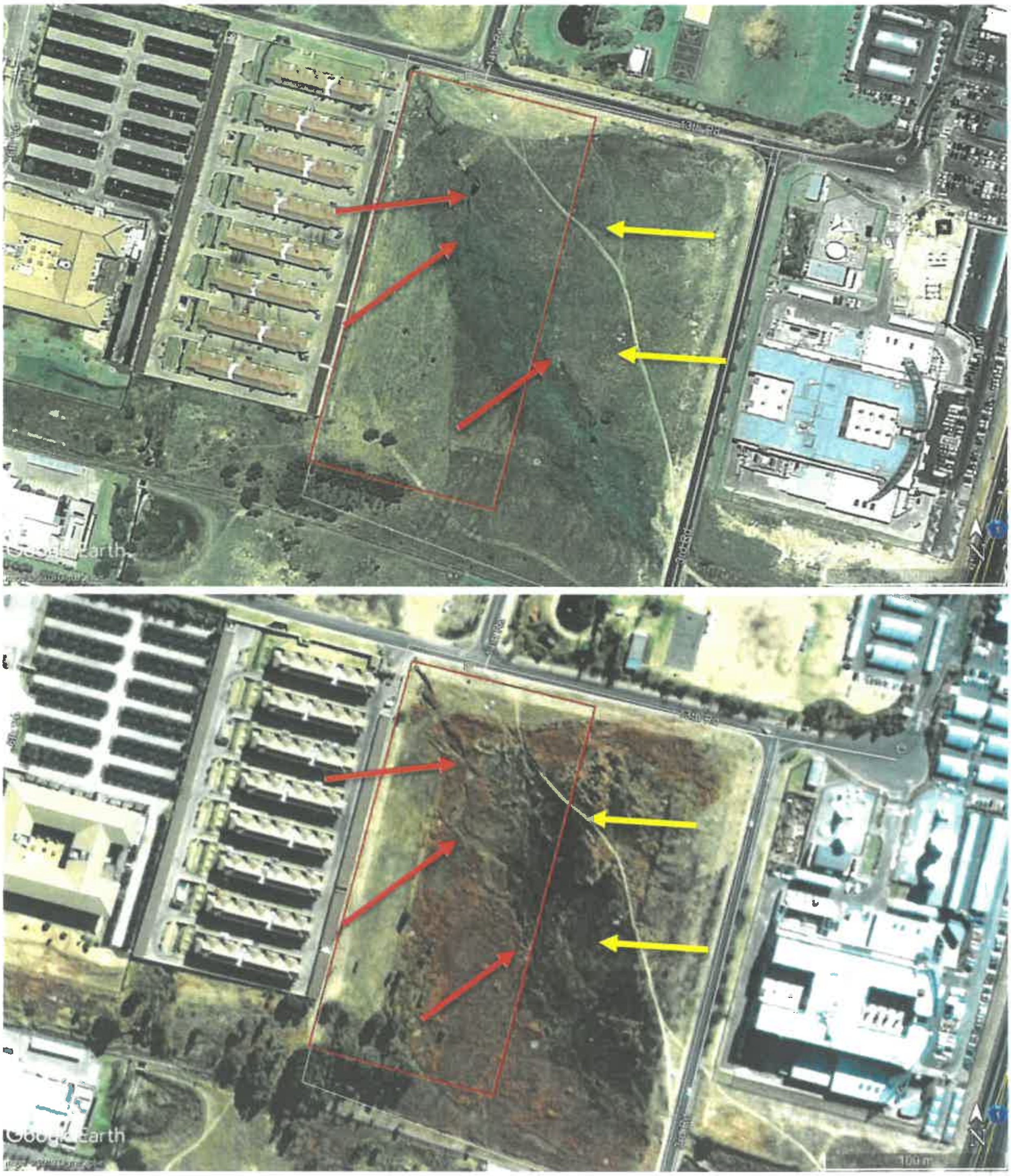

Figure 28 Google Earth images (top: 2009/11/12; bottom: 2012/07/03) of the site itself indicating the immediate changes in the vicinity (development to the west), the soil surface features of the old infilling (yellow arrows) and erosion signatures (red arrows)

In **Figure 29** a zoomed-in photograph is provided that indicates the specific erosion features on the site within the channel that has established following the increase stormwater runoff onto the site.

Figure 29 Google Earth images (2018/06/27) of the site indicating distinct erosion signatures (red arrows)

In **Figure 30** the site is indicated with detailed contours obtained from the CoJ. The erosion scars, infilled areas and drastic effects of the highway are clearly evident as distinct alterations of surface hydrology in the landscape.

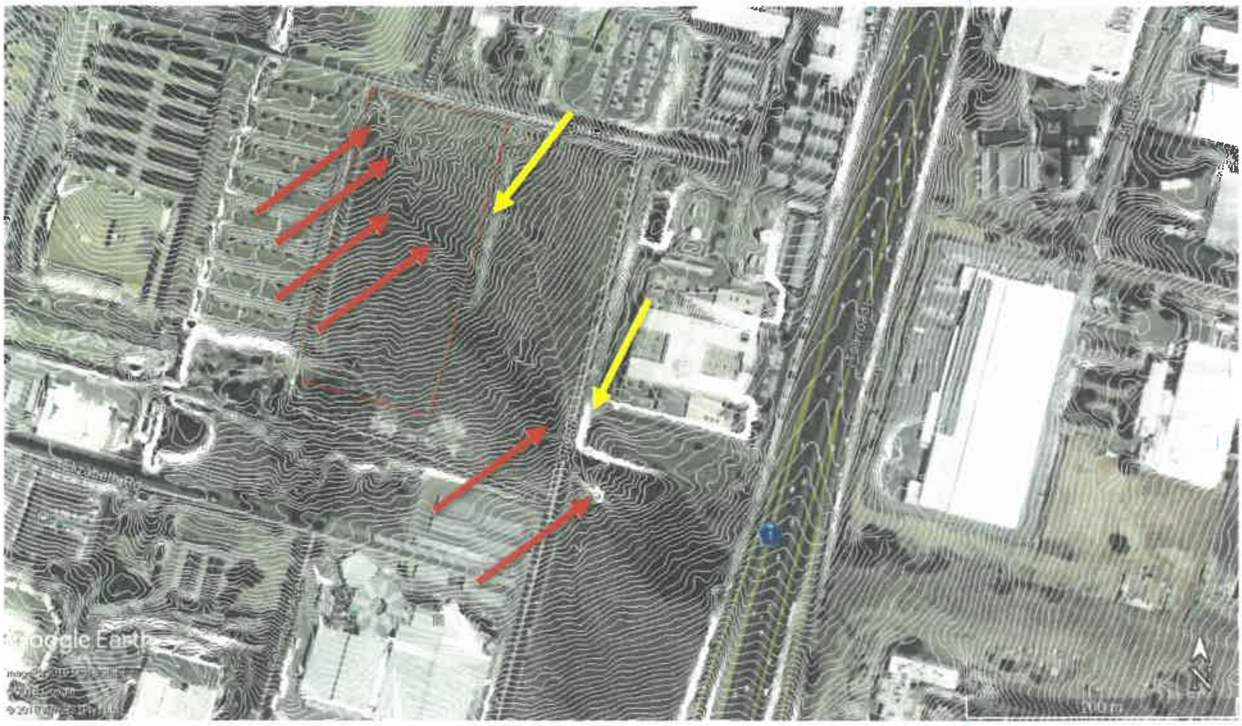

Figure 30 Google Earth image with superimposed detailed contours (CoJ) indicating the drastic alteration of surface hydrology by 1) the Ben Schoeman highway, 2) steep contours on the edge of infilled areas (yellow arrows) and 3) erosion scars (red arrows)

7.3 Historical Topographic Maps

The historical 1:50 000 topographic maps (1939, 1957, 1964, 1975, 1995 and 2001) are presented in **Figure 31**. These indicate a progression in development activities and with variable expression of the watercourse as a stream. Some of the maps indicate the stream and some do not – confirming the fact that it wasn't always evident on the source aerial photographs.

7.4 Terrain Unit Indicator

From the contour data a detailed topographic wetness index (TWI) (**Figure 32**) was generated for the site. The TWI provides a very accurate indication of water flow paths and areas of water accumulation that are often correlated with wetlands. This is a function of the topography of the site and ties in with the dominant water flow regime in the soils and the landscape (refer to previous section where the concept of these flows was elucidated). Areas in dark blue indicate concentration of water in flow paths with slightly lighter shades of blue indicating areas of regular water flows in the soils and on the surface of the wetland / terrestrial zone interface.

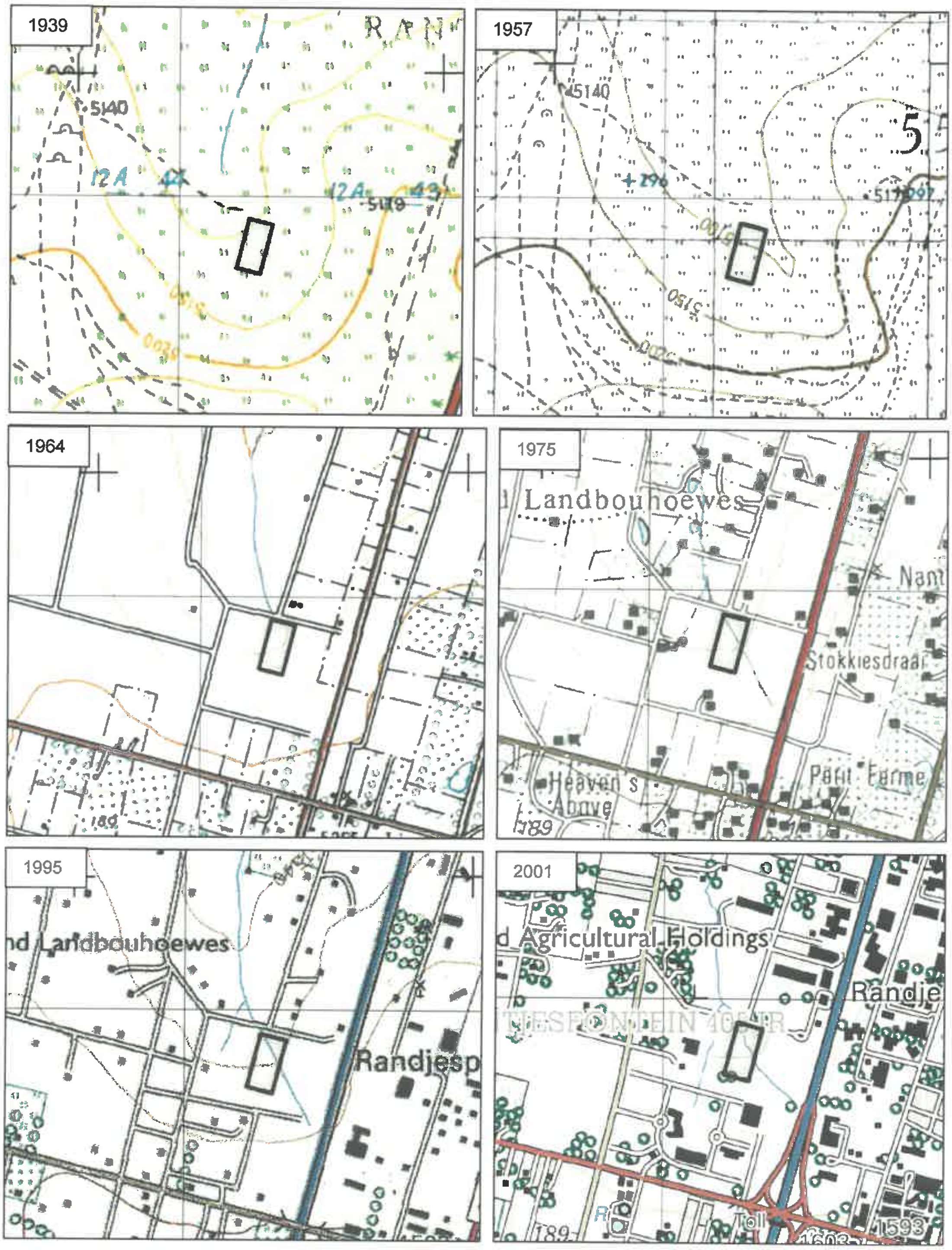

Figure 31 Historical topographic maps (1:50 000 – dates in the top left-hand corner) indicating the investigation site, progression of development and the variable expression of the stream

Figure 32 Topographic wetness index (TWI) for the investigation site (red rectangle) and surrounding area

The TWI (**Figure 32**) confirms 1) the highly altered nature of the land surface characteristics (that include the infilled areas dumping), and 2) land surface alteration in the form of road and development infrastructure and eroded channels. Note the distinct eroded channel north of the site that was the subject of a previous investigation by Terra Soil Science. As was discussed in section

5.13 the soils of the Johannesburg dome are very erodible and as such concentrated stormwater and increased stormwater volumes literally gauge out drainage features where such erosion did not occur under natural conditions (refer also to section 5.11).

7.5 Soil Form and Soil Wetness Indicators (and Vegetation)

The site investigation conducted on the 8th of March 2019, along the track as indicated in **Figure 33**, confirmed that the soils conform to the description provided in sections 5.7 and 5.8. The section that exhibits wetland features due to the original alignment of the wetland / watercourse depression as well as the increased and directed storm water runoff from the highway and upslope areas consists of soils as described in sections 5.7 and 5.8 as well as human altered soils in the form of infilled gravels and sandy material. Occasionally other construction waste materials are also evident within the current wetland feature. **Figures 34** to **36** provide an indication of the site conditions. Of importance is the fact that the soils currently within the "watercourse" exhibit distinct signs of erosion and degradation due to the increased water volumes and energy.

Figure 33 Site investigation track on the site

Figure 34 Site conditions and vegetation signatures on the edge of infilled materials

Figure 35 Site conditions, vegetation signatures, infrastructure (pipes) and erosion signatures

Figure 36 Site conditions, vegetation signatures, infrastructure (pipes) and erosion signatures

7.6 ARTIFICIAL MODIFIERS

As per the description of artificial modifiers in the "The Resource Directed Measures for Protection of Water Resources: Appendix W1 (Ecoregional Typing for Wetland Ecosystems)" discussed in Section 4.4.3 the artificial modifiers have been elucidated in the previous sections. The main modifiers of the site, related to a pre-human impact reference state are the following:

1. Historical agricultural activities on the site;
2. Distinct changes in storm water runoff, and concentration of such runoff, on the site from developments associated with Ben Schoeman highway, infilling activities and surrounding developments; and
3. Historical land surface alteration on the site in the form of roads and trenches.

These modifiers yield altered ecological drivers that elicit an altered ecological response in the form of increased wetness expression. This expression is associated with very distinct erosion signatures and is an indication of the trajectory of change. Unless these altered drivers are going to be addressed and mitigated the erosion signatures will intensify and lead to sediment generation to be deposited in structures further downslope.

8. WETLAND ASSESSMENT

As has been indicated in the previous sections the wetland features on the site are characterised by distinct stormwater augmentation in the form of signatures visible in Google Earth images as well as erosion within the current "watercourse" / wetland area. The alignment of the current (altered) wetland expression is provided in **Figure 37**. Although the wetland features occur in an area originally identified as such, the increased water ingress and stormwater runoff has led, and will lead in the future, to distinct erosion and amplified plant expression signatures. In this regard the intensified wetland features are considered to be man-made and as such do not adhere to the definition of a wetland in the NWA. A buffer is therefore strictly speaking not required as it cannot be enforced on the man-made signatures.

It is proposed that a dedicated storm water management structure be constructed on the site to 1) manage and cannel the storm water that is received from the upslope developments and 2) manage the storm water generated on the specific site due to future urban development. These structures lend themselves to the establishment of specific and functioning ecological infrastructure to manage the flow regime and water quality of the storm water. A proposed basic plan layout of the structures is provided **Figure 38**. Implementation of the plan can be done effectively with the development of the site and the provision of a dedicated road crossing in the northern corner where the channel is most degraded at present.

Figure 37 Current extent of wetland expression (including eroded channels and degraded / infilled areas)

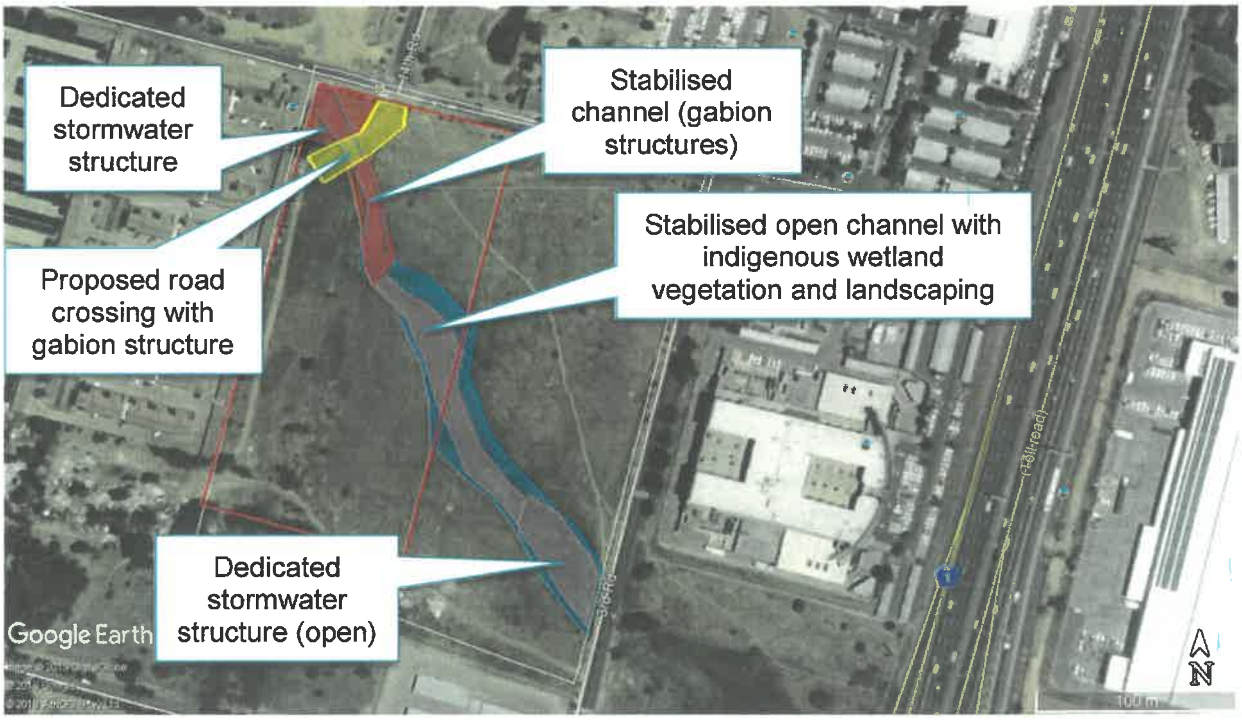

Figure 38 Proposed interventions in the form of erosion stabilisation structures and stabilised ecological infrastructure zones

9. MANAGEMENT REQUIREMENTS AND MITIGATION OF STORM WATER

It is imperative that any open soil areas be protected against increased erosion pressures through the implementation of the following:

1. Adequate storm water mitigation throughout the construction site (from start to completion) to prevent large pulses in storm water.
2. Sediment containment structures throughout the site to prevent sediment runoff and accumulation in the wetland area.

The above aspects are considered to be the critical components of the storm water management plan for the site and should be included in the development plans as per engineering design. The points below indicate general considerations regarding storm water attenuation approaches and can, to lesser or larger degree, be implemented by the engineers on the project within existing budgetary limitations and requirements by DWS.

It is not the purpose of this document to provide detailed designs for mitigation measures as these should be generated by a suitably qualified engineer in conjunction with a suitably qualified wetland soil specialist. There are a few general pointers though that should be taken into account namely:

1. Subsurface lateral flow of water leads to the interception of such water once foundations are sunk into the soils and weathered rock / hard plinthite. Adequate drainage structures should be constructed to prevent damp problems in structures arising within the soil profiles and landscape start filling with water once rainfall increased during summer months.
2. In many areas it has been found that the water moving downslope in the fractured rock is under positive pressure (due to gravity) with a consequent squirting out from severed preferential flow structures. This implies that in some areas water ingress into foundations and basements can occur from below (leading to the expression of a "wet basement syndrome" as mentioned under Section 5.9). Structures constructed in areas with such risks should have additional water removal mechanisms implemented at the structure / ground interface. These can include dedicated containment and drainage features. Where cut and fill operations take place with a consequent large volume of "overburden" material over the soil a specific capillary break layer with associated drainage should suffice.
3. Surface sealing of the landscape through roads, parking areas, roof covered areas and general soil compaction leads to accelerated and increased surface water runoff. In order to mitigate the potential large volumes over a large area numerous small containment structures with choked outflows should be constructed throughout a site. The fewer these structures are the larger other structures have to be to contain the said water. As a minimum requirement these structures should be adequate and enough to contain the standard storm water runoff from a site before it reaches the wetland /drainage feature area.
4. Several soft engineering approaches exist for the successful mitigation of storm water. If these are incorporated into the design and layout of development sites impacts on the wetlands and drainage features can be successfully mitigated.

5. In terms of both the NWA (National Water Act) and NEMA (National Environmental Management Act) landowners have a duty to protect water resources, watercourses and wetlands. In addition, CARA (Conservation of Agricultural Resources Act) and the municipal bylaws address storm water aspects that are of importance to land owners and managers. Insufficient attention to storm water related impacts during the design phase of a development can lead to administrative and criminal liabilities for the developer / land owner post development.
6. Important: In the absence of adequate management of storm water, wetland impacts in terms of erosion will be inevitable therefore exposing the relevant entities involved with the development to unacceptable punitive administrative action or even criminal prosecution.

10. CONCLUSIONS AND RECOMMENDATIONS

In summary, the **Important Notes** in this document are:

1. **Section 4.1.2**: The wetland definition refers to "normal conditions". This term is considered to mean "without human modifications" by the authors of the relevant sections in the Resource Directed Measures (RDM).
2. **Section 4.4.2**: The RDM requires determination of the "reference conditions" of a wetland by specialists.
3. **Section 4.5**: The risk assessment process rests heavily on the PES assessment and specifically the aspects of 1) flow regime, 2) water quality, 3) habitat, and 4) biota within the context of the impacts experienced for the investigation site. In this regard the emphasis is placed on the references state and current condition of the site within the context of the historical activities and drivers that are evident.
4. **Section 5.11(2)**: Land surface developments remove the natural vegetation cover with a negative impact on the intercept of water (physical impediment and uptake through evapotranspiration).
5. **Section 5.11(3)**: Development effectively diverts water from deep flow paths in soils to surface flow and runoff.
6. **Section 5.11(4)**: Diversion of water from deeper flow paths (with its associated points of intercept) to surface flow paths effectively leads to an increase in water flow volume and energy with subsequent degradation effects on wetlands and watercourses. The main effects are increased erosion and alteration of the watercourse / wetland dynamics.
7. **Section 5.11(5)**: The enforcement of arbitrary buffers on watercourses and wetlands do not address the above storm water impacts.
8. **Section 3.13:** The wetlands of the HHGD CANNOT attenuate floods above the natural threshold due to highly erodible soils and drainage features.
9. **Section 7.2.1**: The assessment of the historical conditions indicated there are distinct infilled areas that exhibit man-made signatures and associated alteration of flow regime and wetland expression on the site.

The following conclusions are drawn from the investigation:

1. The site is the subject of a number of historical activities that have in recent years amplified the "wetland" expression on the site.
2. The current investigation confirmed the fact that storm water runoff from the Ben Schoeman highway and surrounding urban infrastructure contributes to the wetland expression on the site. This expression is influenced significantly by historical infilling activities and it is amplified by erosion of the soils within the current watercourse alignment.
3. In terms of narrow interpretation of the definition of a wetland in the NWA as well as the stipulations in the resource directed measures, the feature on the site is classified as a highly altered man-made feature within a landscape that exhibited less pronounced features in the past. The conclusion is therefore that the trajectory of change is one towards increased erosion and degradation. In this regards a dedicated intervention is required to manage stormwater and to minimise sediment generation and degradation of downstream watercourses.
4. It is proposed that the site be release for development but with the following conditions:
    a. An integrated storm water management plan has to be drawn up that takes into account the storm water generated upslope from the site as well as the storm water generated on the specific site.
    b. The channelling of the storm water through the site has to be managed in an open structure that allows for the establishment of ecological infrastructure and it has to be along a servitude to be registered for such use though the site.
    c. The containment, management and release of the storm water should be planed and designed at the lowest point on the development site and the release into the downslope structures / stream should be mitigated in terms of flow with energy dissipation measures. In all of these preference should be given to the establishment of ecological infrastructure (soft engineering approaches).
    d. Subsurface lateral flow of water through the landscape has to be taken into account and buildings / structures should accommodate waterproofing and water management structures to divert laterally seeping water away from foundations into the gardens or storm water structures.
    e. Implementation of a development plan can be done effectively with the residential development of the site and the provision of a dedicated road crossing in the northern corner where the channel is most degraded at present.

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APPENDIX F

Previous Competent Authority communication

GAUTENG PROVINCIAL GOVERNMENT

DEPARTMENT OF AGRICULTURE AND RURAL DEVELOPMENT

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Telephone: 011 355-1900
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Reference: Gaut 001/10-11/N0165
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Ntivo Environmental Services
8 Cactus Road
KEMPTON PARK
1619

Attn: E Baloyi
Fax: 086 665 9981
Tel: 073 294 0231

Dear Sir/Madam

PROPOSED TOWNSHIP DEVELOPMENT OF ERAND X 125

The information provided indicates that the proposal entails the establishment of a township, Erand x 125. The site is 2 hectares in extent and is located within the urban edge.

Based on the review of the information submitted, the Department hereby informs you that the referred to activity is not listed in terms of the Environmental Impact Assessment Regulations, 2010, published under the National Environmental Management Act (NEMA) (Act No. 107 of 1998)(as amended)(GN R.543) and therefore does not legally require environmental authorisation from the Department.

Although authorisation, in terms of NEMA, is not required for this activity, all relevant legislation and requirements of other government departments (i.e. National, Provincial and Local) must still be complied with.

If you have any queries concerning this issue, please feel free to contact the relevant official at the number given above.

Yours faithfully

Adv. J Nesidoni
Acting Head: Agriculture and Rural Development
Date: 2010/10/05