



City of Ekurhuleni Wetland and Watercourse Rehabilitation Planning within the Kaalspruit Catchment

Situation Assessment Report

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TABLE OF CONTENTS

1	INTRODUCTION.....	1
1.1	Purpose of the Study	1
1.2	Purpose of this Report	1
1.3	Study Area	1
1.3.1	KAALSPRUIT CATCHMENT	2
2	APPROACH.....	4
2.1	WETLAND DELINEATION AND CLASSIFICATION	4
2.2	ECOLOGICAL CATEGORISATION	4
2.2.1	PRESENT ECOLOGICAL STATE (PES) OF WETLANDS WITHIN THE CATCHMENT	4
2.2.2	Wetland IMPORTANCE AND SENSITIVITY (IS) OF WETLANDS AND WATERCOURSES WITHIN THE CATCHMENT	5
2.3	PRIORITISATION OF WETLANDS FOR REHABILITATION AND DEVELOPMENT OF A REHABILITATION STRATEGY	7
2.3.1	proposed prioritisation selection criteria	7
3	RESULTS.....	7
3.1	WETLAND DELINEATION AND CLASSIFICATION	7
3.2	ECOLOGICAL CATEGORISATION	11
3.2.1	PRESENT ECOLOGICAL STATE (PES)	11
3.2.2	Wetland IMPORTANCE AND SENSITIVITY (IS)	14
3.3	PRIORITY WETLANDS CONSIDERED FOR FURTHER ASSESSMENT AND REHABILITATION PLANNING.	15
3.4	DELINEATION OF REHABILITATION ZONES	23
3.5	SITE ASSESSMENTS AND DEVELOPMENT OF A REHABILITATION STRATEGY FOR THE PRIORITISED WETLAND SYSTEMS.	25
3.5.1	Wetland rehabilitation zone 1	26
3.5.1.1	Hydrogeomorphic unit: Esselen Park Pan (HGM 1.1) - GPS co-ordinate: 26° 1' 41.65"S; 28° 13' 50.43"E	27
3.5.1.2	Hydrogeomorphic unit: DEPRESION (HGM 1.2) - GPS co-ordinate: 26° 1' 37.71"S; 28° 14' 28.46"E	30
3.5.1.3	Hydrogeomorphic unit: Channelled valley bottom (HGM 1.3) - GPS co-ordinate: 26° 2' 10.49"S; 28° 13' 7.14"E.....	32
3.5.1.4	Hydrogeomorphic unit: channelled valley bottom (HGM 1.4) - GPS co-ordinate: 26° 2'23.19"S; 28°13'54.55"E.....	38
3.5.1.5	Hydrogeomorphic unit: Esselen Park Pan (HGM 1.5) - GPS co-ordinate: 26°2'42.01"S; 28°12'59.79"E.....	41
3.5.1.6	Hydrogeomorphic unit: Esselen Park Pan (HGM 1.6) - GPS co-ordinate: 26°2'53.30"S; 28°13'16.94"E.....	43
3.5.2	Wetland rehabilitation zone 2	46
3.5.2.1	Hydrogeomorphic unit: channelled valley bottom (HGM 2.1) - GPS co-ordinate: 26°1'56.63"S; 28°11'24.6"E.....	47
3.5.3	Wetland rehabilitation zone 3	50
3.5.3.1	Hydrogeomorphic unit: SEEPAGE WETLAND CONNECTED TO A STREAM (HGM 3.1) - GPS co-ordinate: 26°0'56.64"S; 28°12'55.95"E	51

3.5.3.2	Hydrogeomorphic unit: ISEKELO PAN (HGM 3.2) - GPS co-ordinate: 26°1'3.43"S; 28°13'40.61"E	54
3.5.3.3	Hydrogeomorphic unit: channelled valley bottom (HGM 3.3) - GPS co-ordinate: 26° 0'49.58"S; 28°11'27.15"E.....	56
3.5.4	Wetland rehabilitation zone 4	58
3.5.4.1	Hydrogeomorphic unit: chennelled valley bottom (HGM 4.1) - GPS co-ordinate: 25° 59'57.07"S; 28°11'39.89"E.....	59
3.5.4.2	Hydrogeomorphic unit: chAnnelled valley bottom (HGM 4.2) - GPS co-ordinate: 25° 58'51.31"S; 28°12'50.31"E.....	61
3.5.4.3	Hydrogeomorphic unit: chAnnelled valley bottom (HGM 4.3) - GPS co-ordinate: 25° 57'36.39"S; 28°12'22.56"E.....	62
3.5.5	Wetland rehabilitation zone 6	64
3.5.5.1	Hydrogeomorphic unit: chAnnelled valley bottom (HGM 6.1) - GPS co-ordinate: 25° 55'20.057"S; 28°13'38.621"E.....	65
3.5.6	Wetland rehabilitation zone 7	66
3.5.6.1	Hydrogeomorphic unit: chAnnelled valley bottom (HGM 7.1) - GPS co-ordinate: 26° 0'3.07"S ; 28°14'17.10"E.....	67
3.5.6.2	Improve ecological integrity and functioning of the wetland system;	67
4	REFERENCES.....	69

TABLE OF FIGURES

Figure 1: Map showing the extent of the Kaalspruit Catchment in relation to the CoE boundary...	3
Figure 2: Schematic diagram illustrating the position of the various wetland types within the landscape.	7
Figure 3: Map showing the extent of wetland and watercourses areas within the Kaalspruit Catchment.	10
Figure 4: Map showing PES assessment results for wetlands within the Kaalspruit Catchment..	13
Figure 5: Map showing wetland IS assessment results for wetlands within the Kaalspruit Catchment.	15
Figure 6: Map showing existing rehabilitation initiatives within the Kaalspruit Catchment.....	16
Figure 7: Map showing considered key waterbodies and their associated local catchments.	17
Figure 8: Map showing prioritisation of wetlands based on available data analysis as proposed onsite.	19
Figure 9: Map showing integrated prioritisation list and all wetlands to be considered for rehabilitation planning going forward.	22
Figure 10: Map showing the extent of rehabilitation zones for the wetlands to be considered for rehabilitation planning onsite.....	24
Figure 11: Map showing the extent of Wetland Rehabilitation Zone 1 with associated wetland HGM units.	26
Figure 12: A. Litter (26° 1' 43.29"S 28° 14' 0.40"E); B. Dumping of building rubble (26° 1' 45.76"S 28° 13' 51.75"E); C. tracks and informal roads (26° 1' 49.37"S 28° 13' 53.48"E); D. Ground clearing/scrapping (26° 1' 30.73"S 28° 13' 49.86"E); E. Excavation for building material (26° 1' 51.42"S 28° 13' 50.7"E); F. Storage area for building material (26° 1' 47.35"S 28° 13' 55.33"E).....	28
Figure 12: G. Cultivation for subsistence farming (26° 1' 52.26"S 28° 13' 37.82"E); H. Alien plant species (26° 1' 44.07"S 28° 13' 59.73"E); I. Concrete structures and abandoned concrete pipes (26° 1' 44.96"S 28° 13' 41.76"E); J. Power lines (26° 1' 38.68"S 28° 13' 39.94"E).	29
Figure 13: A. Trench close to where new trees have been planted (26° 1' 41.47"S 28° 14' 22.59"E); B. Water (JoJo) tanks for storing water (26° 1' 39.08"S 28° 14' 22.79"E); C. Cultivation for subsistence farming (26° 1' 36.79"S 28° 14' 22.59"E); D. Domestic litter dumping (26° 1' 37.56"S 28° 14' 22.78"E); E. Litter dumping and used bottles (26° 1' 37.32"S 28° 14' 21.38"E); F. Storm-water drainage and litter (26° 1' 37.6"S 28° 14' 21.38"E).	31
Figure 14: A. Litter dumping (26° 2' 19.18"S 28° 13' 13.16"E); B. Storm-water drainage from the houses (26° 2' 10.59"S 28° 13' 8.73"E); C. Storm-water drainage from the road (26° 2' 5.73"S 28° 13' 6.34"E); D. Erosion gully (26° 2' 14.47"S 28° 13' 13.05"E); E. Cultivation for subsistence farming (26° 2' 11.75"S 28° 13' 12.10"E); F. Cultivation for subsistence farming (26° 2' 11.75"S 28° 13' 12.10"E). . G. Area used as a landfill (26° 2' 14.38"S 28° 13' 9.78"E); H. Congestion of informal human settlements (squatter camps) (26° 2' 13.33"S 28° 13' 7.64"E); I. Concrete building within the wetland (26° 2' 15.51"S 28° 13' 12.50"E).	35
Figure 15: : A. Gabion weir (26° 2' 9.95"S 28° 13' 8.39"E); B. Mass gravity concrete weir A21B-21-004 (26° 2' 14.70"S 28° 13' 11.02"E); C. Concrete pipe crossing A21B-21-003 (26° 2' 16.14"S 28° 13' 12.74"E); D. Rock and sack informal channel crossing (26° 2' 18.87"S 28° 13' 12.48"E); E. Pipe cutting across channel (26° 2' 20.83"S 28° 13' 10.74"E); F. Gabion weir A21B-21-009 (26° 2' 22.52"S 28° 13' 11.51"E).	37
Figure 16: Damaged fencing (26°2'18.15"S; 28°13'18.54"E); B. damaged storm-water drain (26°2'17.24"S; 28°13'20.12"E); C. Dumping of rubble and alien invasive vegetation (26°2'20.00"S;	

28°13'30.14"E); D. Dumping of rubble (26°2'29.20"S; 28°14'17.79"E); E. Dumping of litter (26°2'17.48"S; 28°13'18.89"E); F. Dumping of rubble and litter (26°2'17.15"S; 28°13'19.66"E). G. Presence of alien invasive vegetation (26°2'17.25"S; 28°13'20.90"E); H. Dumping of sand and alien invasive vegetation (26°2'17.37"S; 28°13'22.84"E); I. Dumping of rubble (26°2'19.61"S; 28°13'29.39"E); J. Open area surrounding channel and possible recreational space for community (26°2'22.99"S; 28°13'46.21"E).	40
Figure 17: A. Dumping of plant material (26°2'40.26"S; 28°13'3.18"E); B. Dumping of rubble and litter (26°2'41.41"S; 28°13'3.47"E).	41
Figure 18: A. Gabion (26°2'40.72"S; 28°13'1.38"E); B. Buttress gabion weir (26°2'36.43"S; 28°13'4.67"E); C. Gabion (26°2'35.77"S; 28°13'5.11"E); D. Concrete weir (26°2'45.54"S; 28°12'58.03"E); E. Buttress gabion weir (26°2'43.68"S; 28°12'59.07"E).....	42
Figure 19: A. Erosion beneath gabion weir (26°2'59.46"S; 28°13'17.55"E); B. Alien invasive vegetation growing on structure (26°2'59.46"S; 28°13'17.55"E); C. Large active erosion of channel (26°2'56.19"S; 28°13'17.25"E); D. Large active erosion of channel (26°2'49.31"S; 28°13'16.32"E); E. Litter (26°3'1.29"S; 28°13'19.75"E); F. Alien invasive vegetation (26°3'1.12"S; 28°13'19.43"E).....	44
Figure 20: A. Concrete buttress weir (26°2'47.61"S; 28°13'16.44"E); B. Gabion mattress (26°2'48.04"S; 28°13'16.36"E); C. Concrete buttress weir (26°2'54.47"S; 28°13'17.03"E); D. Gabion mattress (26°2'58.56"S; 28°13'17.33"E); E. Gabion weir (26°2'59.46"S; 28°13'17.55"E); F. Gabion weir (26°2'59.46"S; 28°13'17.55"E).	45
Figure 21: Map showing the extent of Wetland Rehabilitation Zone 2 with associated wetland HGM units.	46
Figure 22: Photographs indicating some of the impacts observed.....	48
Figure 23: Photographs indicating some of the existing wetland rehabilitation interventions and activities onsite.	49
Figure 24: Map showing the extent of Wetland Rehabilitation Zone 3 with associated wetland HGM units.	50
Figure 25: Photographs indicating some of the impacts observed.....	52
Figure 26: Photographs indicating some of the existing wetland rehabilitation interventions and activities onsite.	53
Figure 27: Photographs indicating some of the existing wetland impacts onsite.	55
Figure 28: A. Litter (26°0'49.58"S; 28°11'27.15"E); B. Alien invasive vegetation (26°0'48.92"S; 28°11'28.72"E) C. Large active erosion beneath bridge (26°0'48.94"S; 28°11'28.77"E); D. Large active erosion and litter beneath bridge and gabion weir (26°0'48.94"S; 28°11'28.77"E); E. Large active erosion and litter (26°0'48.94"S; 28°11'28.77"E); F. Large active erosion and litter (26°0'48.94"S; 28°11'28.77"E); G. Alien invasive vegetation and polluted water (26°0'49.56"S; 28°11'28.48"E); H. Sedimentation and polluted water (26°0'50.15"S; 28°11'26.91"E).	57
Figure 29: Map showing the extent of Wetland Rehabilitation Zone 4 with associated wetland HGM units.	58
Figure 30: A. Dumping of building rubble (25°59'57.25"S; 28°11'40.76"E); B. Erosion of channel bank (25°59'57.11"S; 28°11'39.84"E) C. Erosion at far-side of intervention and polluted water (25°59'57.11"S; 28°11'39.84"E); D. Erosion and polluted water (25°59'57.11"S; 28°11'39.84"E); E. Dumping of rubble and litter (25°59'59.88"S; 28°11'43.99"E).....	60
Figure 31: A. Open surrounding area (25°58'52.27"S; 28°12'50.22"E); B. Litter (25°58'52.29"S; 28°12'50.46"E).....	61
Figure 32: A. Alien invasive vegetation and erosion upstream (25°57'36.39"S; 28°12'22.56"E); B. Alien invasive vegetation and erosion downstream (25°57'36.39"S; 28°12'22.55"E); C. Alien invasive	

vegetation and erosion upstream (25°57'36.50"S; 28°12'22.55"E); D. Dumping of rubble (25°57'37.39"S; 28°12'23.92"E).	63
Figure 33: Map showing the extent of Wetland Rehabilitation Zone 6 with associated wetland HGM units.	64
Figure 34: Alien invasive vegetation and sedimentation (25°55'20.10"S; 28°13'38.66"E).	65
Figure 35: Map showing the extent of Wetland Rehabilitation Zone 7 with associated wetland HGM units.	66
Figure 36: Photographs indicating some of the impacts observed within HGM 7.1	68

TABLE OF TABLES

Table 1: The extent of the study catchment area in relation to the DWS quaternary catchment....	2
Table 2: Table indicating the categorisation and scoring of impacts/landuses within and around wetlands utilised for the catchment PES assessment.	5
Table 3: Details of the information and datasets used to inform the desktop wetland importance and sensitivity assessment of the wetlands within the catchment.	6
Table 4: Distribution and total coverage of wetland types within the study catchment area that falls within CoE Boundary.	8
Table 5: The definition of the different wetland units recorded during the study in relation to type, topographic setting and hydrological components (Table and classification modified from Marneweck and Batchelor, 2002; Brinson, 1993).	9
Table 6: Distribution and total coverage of wetland types prioritised for rehabilitation as part of this project.	20
Table 7: Distribution of remaining and total coverage of wetland types prioritised for rehabilitation as part of wetlands within the Kaalspruit Catchment to be considered and further assessed in terms of their suitability for any future wetland rehabilitation work and/or projects.	21

DOCUMENT SUMMARY DATA

PROJECT: City of Ekurhuleni wetland and watercourse rehabilitation planning within the Kaalspruit Catchment

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1 INTRODUCTION

Wetland Consulting Services (WCS) was appointed by Environmental Impact Management Services (EIMS) on behalf of CoE to design a planning regime for wetland rehabilitation to be implemented within the Kaalspruit catchment. This catchment was selected by CoE as a priority catchment to be focused on as part of this rehabilitation planning project.

The Kaalspruit catchment is located within heavily developed areas consisting of township and urban developments and associated infrastructures, as well as subsistence agricultural areas. All these landuses can lead to typical water quality and quantity impacts. Impacts range from failing of sewer infrastructure and direct discharge of sewage into watercourses, increased stormwater flows off hardened surfaces resulting in erosion and deterioration of the natural watercourses and agricultural return flows containing a variety of pesticides and fertilisers which negatively affect water quality in the receiving watercourses. Wetland rehabilitation within this catchment provides a potential opportunity to address some of these, and other, impacts.

1.1 PURPOSE OF THE STUDY

The purpose of this project is to prioritise and undertake wetland rehabilitation planning, including associated required authorisations in order to successfully implement identified rehabilitation projects within the Kaalspruit Catchment area in the City of Ekurhuleni (CoE).

The specific objectives of the study include:

- Study inception;
- Information and data sourcing and analysis;
- Status quo assessment of the wetland areas within the catchment;
- Prioritisation of a maximum of five wetlands for rehabilitation within the catchment;
- Development of rehabilitation strategies; and
- Communication and liaison.

1.2 PURPOSE OF THIS REPORT

The situation assessment report has been produced:

1. To indicate the proposed approach towards the assessment of wetlands within the catchment;
2. To prioritise wetlands for the purpose of rehabilitation within the catchment;
3. To highlight the impacts on wetlands and to assess the ecological state of wetlands within the catchment;
4. To provide baseline ecological information, including the health of the wetlands within the catchment; and
5. To develop a rehabilitation strategy as a precursor to the required rehabilitation plans based on the health of the wetlands.

1.3 STUDY AREA

The study area is the catchment of the Kaalspruit River within the CoE boundary as indicated in Figure 2 below. The catchment falls within the Department of Water and Sanitation (DWS) quaternary catchment A21B. The extent of the specific catchment targeted for this CoE project is shown in the figure below. The catchment was delineated based on 5m contours, with the outlet point of the major river system placed on the edge of the CoE boundary. The extent of the study catchment area in relation to the quaternary catchment is detailed in Table 1 below.

Table 1: The extent of the study catchment area in relation to the DWS quaternary catchment.

Sub-catchment	Catchment Area (km ²)	Catchment Area (km ²) within CoE	% Quaternary Catchment within CoE
Kaalspruit/Hennops (A21B)	527	157	30

1.3.1 KAALSPRUIT CATCHMENT

The Kaalspruit catchment is located in the Crocodile (West) Marico Water Management Area in quaternary catchment A21B within the Hennops River Catchment. The rivers in the study area include the Kaalspruit and Olifantspruit Rivers draining into the Hennops River. Figure 1 below indicates the location of the study catchment in relation to the CoE Boundary. The Kaalspruit/Olifantspruit River originates in Kempton Park and Tembisa and flows north to join the Hennops River in Centurion. There are serious pollution problems in these systems and these issues are attributed to human settlements and agricultural activities.

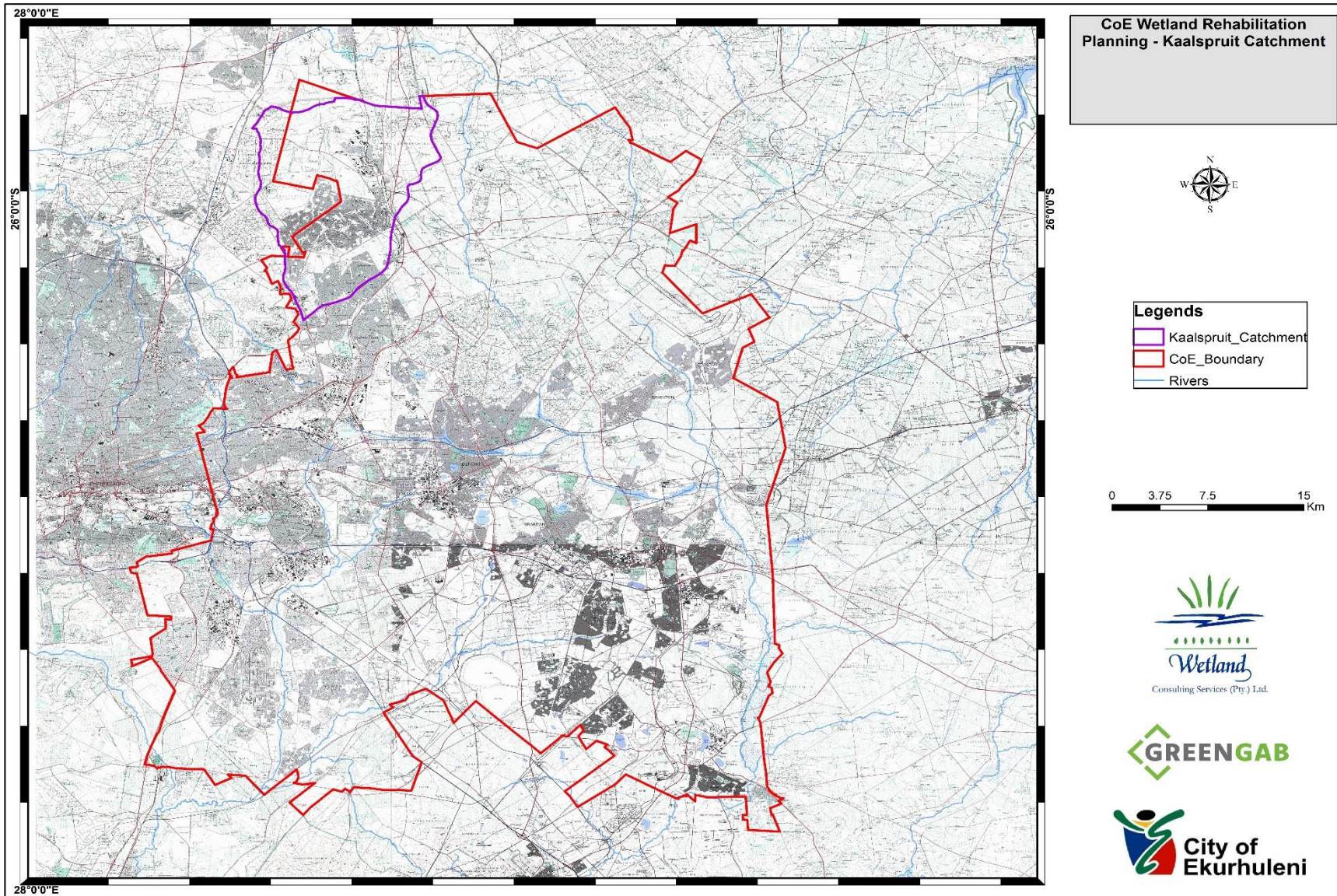


Figure 1: Map showing the extent of the Kaalspruit Catchment in relation to the CoE boundary.

City of Ekurhuleni Wetland Rehabilitation Planning within the Kaalspruit Catchment		Situation Assessment Report
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2 APPROACH

2.1 WETLAND DELINEATION AND CLASSIFICATION

Various wetland datasets of wetland coverages including National Wetland Inventory, National Freshwater Priority Areas, Regional Conservation Plans, Environmental Management Frameworks and CoE wetland inventory datasets were used to identify any gaps that will require additional data collection. An integration of all datasets to formulate a single wetland coverage dataset was undertaken. Additional delineations on high resolution aerial imagery was undertaken where gaps were identified using the methodology as proposed by (Thompson *et al.*, 2002), followed by limited ground-truthing for verification, collection of ecological integrity data, verification of existence of wetland and landuse within and around wetlands. The complete wetland layer was classified in terms of HydroGeoMorphic (HGM) settings in accordance with the South African Wetland Classification as proposed in (SANB, 2009) and (Ollis *et al.*, 2013).

2.2 ECOLOGICAL CATEGORISATION

2.2.1 PRESENT ECOLOGICAL STATE (PES) OF WETLANDS WITHIN THE CATCHMENT

A method to assess wetland ecological condition based on land-cover type, as detailed in the Water Research Commission Project K5/2350 (Kotze, 2016a and 2016b), was used to provide an overall ecological state of wetlands and watercourses onsite. This method utilizes calculations within wetland and surrounding wetland land-uses as a proxy to determine wetland impacts, and consequently wetland ecological state. The following table indicates the rating and intensity score for individual landuses within and surrounding the wetland and watercourses onsite used in the method.

Table 2: Table indicating the categorisation and scoring of impacts/landuses within and around wetlands utilised for the catchment PES assessment.

Landuse Type National Land cover	Simplified Category	Buffer Landuse Integrity Score	Wetland Landuse Integrity Score
Woodland/Open bush	Alien vegetation sparse	3	4
Grasslands	Natural	0.5	1.5
Plantations / Woodlots	Alien vegetation dense	4.5	5.4
Thicket /Dense bush	Alien vegetation dense	4.5	5.4
Settlements	Urban	6	8
Cultivated commercial annual crops non-pivot	Cultivated dry	4.5	4.5
Wetlands	Natural	0.5	1.5
Low shrub land	Alien vegetation sparse	3	4
Bare Ground	Bare ground	5	7
Mines	Mines	8	10
Waterbodies	Dam	4.5	6
Cultivated commercial permanent orchards	Orchards	5.5	4.2
Cultivated commercial annual crops pivot	Cultivated irrigation	5.5	4.9
Cultivated subsistence crops	Cultivated subsistence	4	3.8
Degraded	Degraded	1.5	3.5
Dam	Dam	4.5	6
Road	Road	6	8.2
Railway	Railway	6	8.2
Erosion	Erosion	5	7

For the purpose of the catchment PES assessment for this catchment study, a buffer of 300m was decided on and delineated outside of the wetland areas. This buffer will act as the catchment for the wetlands in assessing the catchment-based impacts.

2.2.2 WETLAND IMPORTANCE AND SENSITIVITY (IS) OF WETLANDS AND WATERCOURSES WITHIN THE CATCHMENT

A wetland importance and sensitivity (IS) assessment was conducted for each wetland system (HGM) at a desktop level only, and this was done in order to provide an indication of the conservation value and sensitivity of the wetlands. For the purposes of this study, the Rountree *et al.* (2013) assessment tool was used as a basis for the IS assessments. The Importance and Sensitivity assessment is undertaken to rank water resources in terms of:

- **Ecological Importance** - biodiversity support and ecological value;
- **Hydrological Functions** - Provision of goods and service or valuable ecosystem functions which benefit people; and
- **Direct Human Benefits** - Reliance of subsistence users (especially basic human needs uses).

As this assessment was undertaken at a desktop level, a number of the criteria that inform the overall score for each wetland had to be informed by available desktop information and datasets. Table 3 below provides an overview of the information used to inform the various criteria.

Site visits were undertaken as part of the ecological data capture process in order to collect any relevant data on the use of representative wetland HGM units by people and/or surrounding communities and any other usage taking place to representative wetland HGM's within the catchment area. All the data collected was integrated to inform the wetland IS assessments. The results provide a low level IS categorisation of the wetland HGM units within the targeted catchment.

Table 3: Details of the information and datasets used to inform the desktop wetland importance and sensitivity assessment of the wetlands within the catchment.

WETLAND IMPORTANCE AND SENSITIVITY COMPONENT	CRITERIA	RESOURCE/DATASET INFORMING SCORING OF CRITERIA
ECOLOGICAL IMPORTANCE & SENSITIVITY	Biodiversity support	
	<i>Presence of Red Data species</i>	Estimated based on the habitat requirements of wetland dependant Red Data List species and the types of habitats present in different wetland HGM types.
	<i>Populations of unique species</i>	Not directly assessed. The Gauteng Conservation Plan (C-Plan) V3.3, which identifies areas that are of varying levels of importance in meeting the provinces biodiversity conservation targets, was used to rank the wetlands in terms of their likelihood of supporting Red Data List and/or other important habitats or species.
	<i>Migration/breeding/feeding sites</i>	
	Landscape scale	
	<i>Protection status of the wetland</i>	Due to the broad scale of the assessment, all wetlands were conservatively assumed to lie on public land, i.e.: public or privately owned land under no formal protection. Where FEPA wetlands were present, the score was elevated slightly to account for an increased importance of the wetland.
	<i>Protection status of the vegetation type</i>	The protection status of the wetlands was informed by the Ecosystem Threat Statuses and Protection Levels for Wetland Vegetation Groups included within an assessment undertaken for the 2014 WRC project No K5/2281 - "Supporting better decision-making around coal mining in the Mpumalanga Highveld through the development of mapping tools and refinement of spatial data on wetlands."
	<i>Regional context of the ecological integrity</i>	The ecological integrity of the wetlands was informed by the results of the desktop level PES assessment for the wetlands within the catchment
	<i>Size and rarity of the wetland type/s present</i>	Based on the types of wetland HGM's present within the catchment and the relative frequency of occurrence of different wetland types
	<i>Diversity of habitat types</i>	Estimated based on the diversity of habitat types typical of different wetland HGM units
	Sensitivity of the wetland	
	<i>Sensitivity to changes in floods</i>	floodplains at 4; valley bottoms 2 or 3; pans and seeps 0 or 1.
	<i>Sensitivity to changes in low flows/dry season</i>	Unchannelled VB's probably most sensitive
	<i>Sensitivity to changes in water quality</i>	Esp naturally low nutrient waters - lower nutrients likely to be more sensitive
HYDRO-FUNCTIONAL IMPORTANCE	WET-Ecoservices Level 1 assessment applied to different wetland HGM types (Kotze DC, Marneweck GC, Batchelor AL, Lindley DS and Collins NB, 2007. WET-EcoServices: A technique for rapidly assessing ecosystem services supplied by wetlands. WRC Report No TT 339/08, Water Research Commission, Pretoria.)	
DIRECT HUMAN BENEFITS	Conservatively assumed that all wetlands are capable of providing at least one harvestable resource and/or cultivated food and have some capacity to contribute towards tourism, recreation, research and/or education	

2.3 PRIORITISATION OF WETLANDS FOR REHABILITATION AND DEVELOPMENT OF A REHABILITATION STRATEGY

2.3.1 PROPOSED PRIORITISATION SELECTION CRITERIA

The review of existing information contributed towards identifying which level of prioritisation the proposed rehabilitation will fall into. Three levels of prioritisation were considered for this work. These can be summarised as follows:

- Wetlands where rehabilitation initiatives have been implemented. The purpose of this is to assess existing rehabilitation interventions, undertake a maintenance inventory and identify opportunities for improving their efficacy;
- Catchment of key waterbodies, as were determined by Re-Solve Consulting in 2015. The purpose of this is to integrate already identified key waterbodies into the current rehabilitation initiatives; and
- Consider wetlands that are of high risk or are threatened ecosystems; which provide habitat for endangered biota; and wetland systems that are likely to contribute in achieving enhanced biodiversity support, water quality improvement, sediment stabilisation or reinstating natural flooding regime. This assessment included rating and assessment of wetland that falls within freshwater priority ecosystem, regional conservation plans, ecosystem threat status of wetlands, condition of wetland which reflects its level of functioning and ownership of land which will necessitate implementation of management of proposed interventions within the wetland systems.

3 RESULTS

3.1 WETLAND DELINEATION AND CLASSIFICATION

The presence of wetlands in the landscape can be linked to the presence of both surface water and perched groundwater. Wetland types are differentiated based on their hydro-geomorphic (HGM) characteristics; i.e. on the position of the wetland in the landscape, as well as the way in which water moves into, through and out of the wetland systems. A schematic diagram of how these wetland systems are positioned in the landscape is given in Figure 2 and Table 5 below.

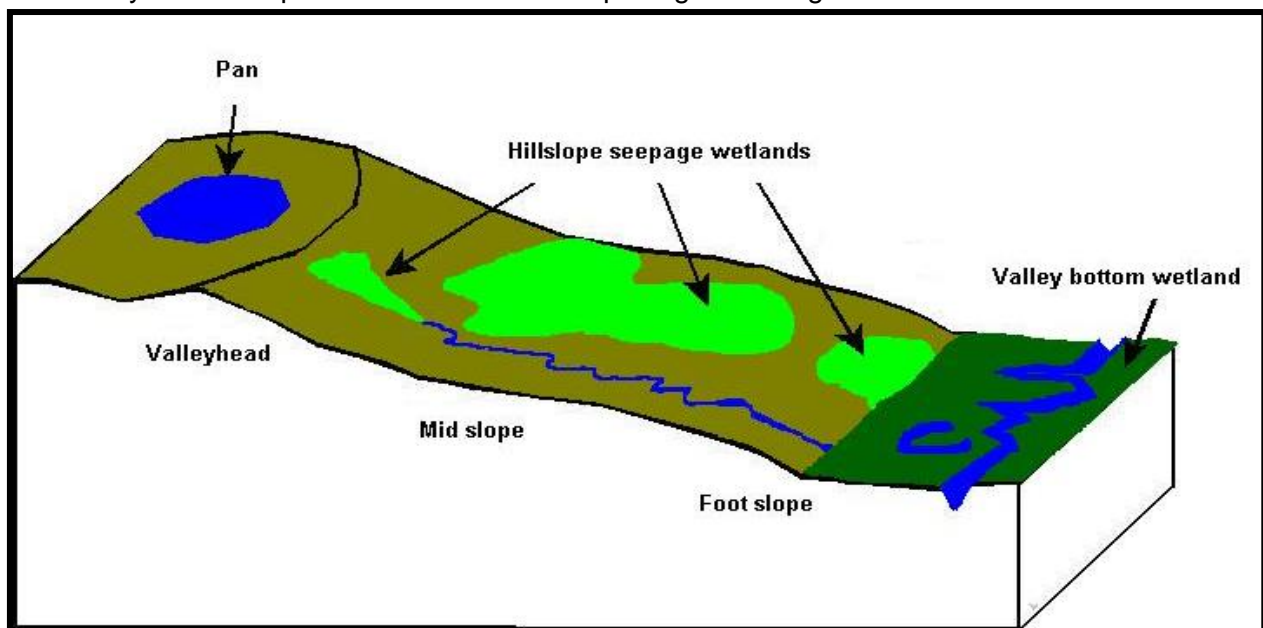


Figure 2: Schematic diagram illustrating the position of the various wetland types within the landscape.

The extent and distribution of wetland areas within the Kaalspruit Catchment area is indicated in Figure 3 below. Three types of natural wetland system, in terms of the hydro-geomorphic classification system in accordance with the South African Wetland Classification as proposed in (SANBI, 2009) and (Ollis *et al.*, 2013), were recorded on site and distribution of these types is indicated in Table 4 below, namely:

- Depressions (Pans);
- Hillslope seepage wetlands; and
- Valley bottom wetlands (Channelled and Unchannelled).

Table 4: Distribution and total coverage of wetland types within the study catchment area that falls within CoE Boundary.

Catchment	CoE Wetland & Watercourses Types	Areas (Ha)	% Coverage
Kaalspruit	Channelled Valley Bottom	347.44	58.35%
Kaalspruit	Depression (Pans)	58.07	9.75%
Kaalspruit	Seepage	54.37	9.13%
Kaalspruit	Unchannelled Valley Bottom	128.18	21.53%
Kaalspruit	Trench	7.36	1.24%
TOTAL		595.42	100.00%

Table 5: The definition of the different wetland units recorded during the study in relation to type, topographic setting and hydrological components (Table and classification modified from Marneweck and Batchelor, 2002; Brinson, 1993).

LANDFORM SETTING	DEFINITION	HYDROLOGIC COMPONENTS		
		Inputs	Throughputs	Outputs
Hillslope seepage wetlands	Occur on concave or convex slopes immediately adjacent to or at the head of watercourses including other wetlands. Characterised by the colluvial (transported by gravity) movement of materials. Generally always associated with sandy soil forms.	Predominantly groundwater from perched aquifers and interflow.	Interflow & diffuse surface flows	Variable including interflow, diffuse surface flow and evapo-transpiration and stream flow.
Valley bottom with a channel	Occur in the shallow valleys that drain the slopes. Are gently or steep sloped and characterised by the alluvial transport and deposition of material by water.	Receive water inputs from adjacent slopes via runoff and interflow. May also receive inputs from a channelled system. Interflow may be from adjacent slopes, adjacent hillslope seepage wetlands if these are present, or may occur longitudinally along the valley bottom.	Surface flow and interflow.	Variable but predominantly stream flow.
Valley bottom without a channel	Valley bottom areas of low relief with no clearly defined stream and situated on alluvial fill.	Channel entering the wetland and adjacent hillslopes	Diffuse surface and subsurface flow	Channel outflow
Pan (Depression)	A basin shaped area with a close elevation contour that is not connected via an outlet to the drainage network.	Variable but predominantly runoff and sub-surface seepage from adjacent slopes	Storage, Interflow & diffuse surface flow	Evapo-transpiration

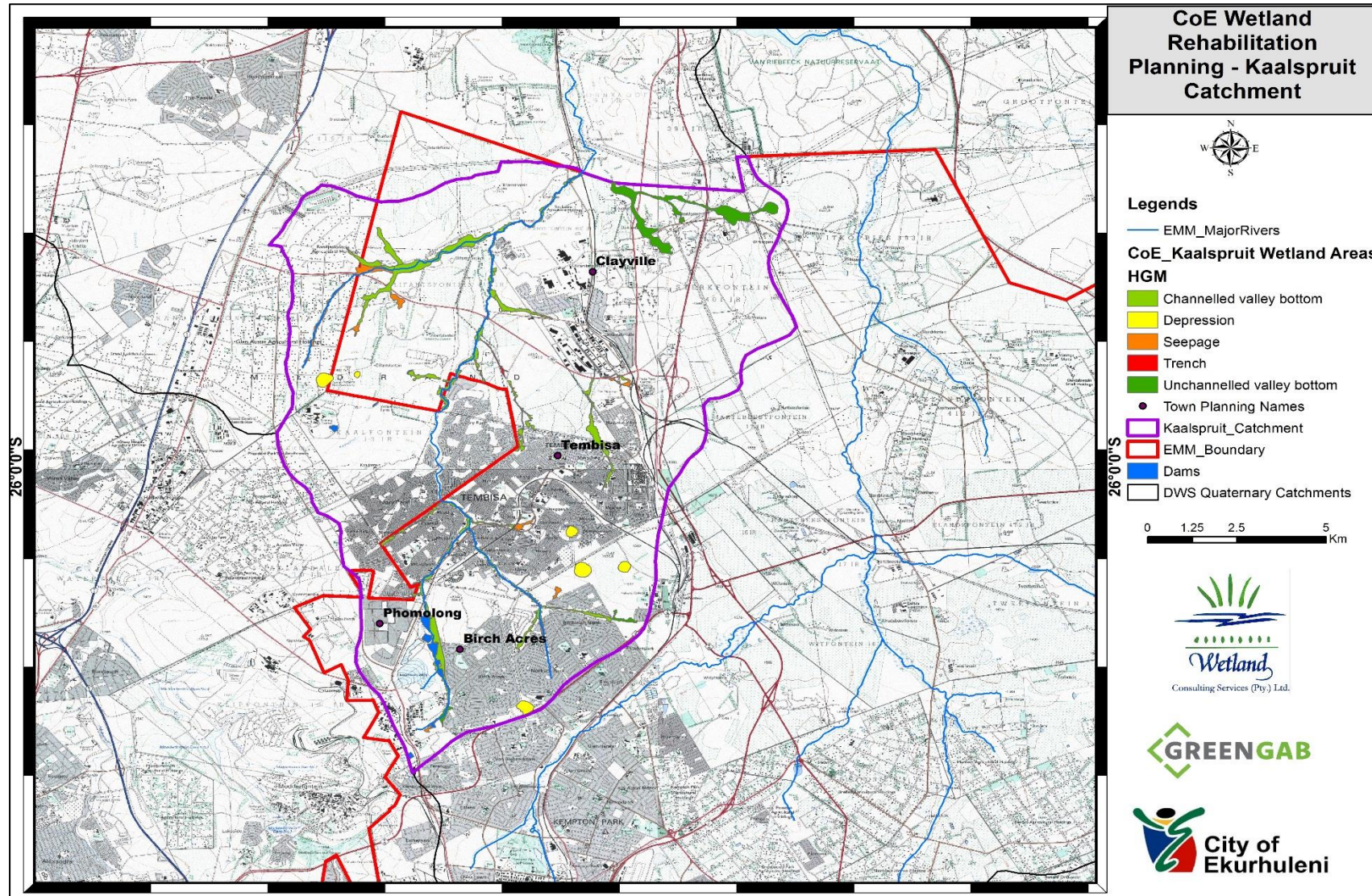


Figure 3: Map showing the extent of wetland and watercourses areas within the Kaalspruit Catchment.

3.2 ECOLOGICAL CATEGORISATION

3.2.1 PRESENT ECOLOGICAL STATE (PES)

Wetland areas have been subjected to numerous impacts associated with the modification of the system's hydrology, vegetation integrity and morphology. Increase in flow peaks caused by storm water discharges and urbanization have resulted in channel incision, bank collapsing, erosion and sediment loss, as well as water quality deterioration. These changes have resulted in the desiccation of the adjacent wetland habitat, loss of riparian vegetation, loss of aquatic habitats and subsequently loss of biodiversity. Dumping, infilling, sand mining (excavation), the surcharging of outfall sewers and manholes, not to mention an influx of pollutants originating from the upslope residential areas, have also impacted on the quality of water, morphological structure and aesthetic appeal of the wetland areas within the catchment. Developmental activities on site as well as several road crossings, tracks and bridges have all compromised hydrology, geomorphology and the overall integrity of the wetland systems due to the extensive incision and subsequent erosion created by these features. The incision of the channels have resulted in further impacts on the systems. The vegetation within the wetland areas have been significantly altered with the desiccation of the systems and the consequent encroachment of alien invasive plant species such as Kikuyu grasses and other terrestrial plant species. Without the implementation of rehabilitation interventions, it is likely that the integrity of the systems will deteriorate even further.

The main impacts within the catchment are:

- Sediment loss due to erosion associated with channel switching and incision caused by un-attenuated stormwater flows, resulting in loss of aquatic habitat, biodiversity and both riparian and wetland vegetation;
- Sand mining that has changed the morphology of the banks of the Kaalspruit River, creating further instability of the banks, erosion and incision;
- Dumping of litter, building rubble and debris that has affected the morphological structure and aesthetic appeal of the wetland areas on site;
- Water quality deterioration associated with sewerage return flows (surcharging sewer systems and manholes and failing sewerage infrastructure) from Tembisa Township surrounding wetland areas on site; and
- The level of transformation within the wetland areas has created a niche for invasive alien vegetation and weeds in the wetland.

The pan area (Isisekelo Pan in particular) has been subjected to a number of impacts associated with the modification of the system's hydrology, vegetation integrity and morphology. Informal housing adjacent to the pan area is one of the main problems affecting the pan. The secondary problem associated with this is the discharging of grey water into the pan. Furthermore, infilling (soccer field), tracks and human paths have created a niche for alien vegetation and invasive weeds on site. Informal settlements often have inadequate sanitation and infrastructure (pit latrines, septic tanks, surcharging sewers), resulting in water quality problems where organics, nutrients, pathogens and coliforms are of concern. Solid waste, containing plastics, PVC and vehicle tyres, is also of concern. Despite having fewer pollutant types, pollutant loads are generally far higher in informal areas than in formal areas as a result of high population densities and inadequate sewage infrastructure, which is the case surrounding this pan. The issue of housing in South Africa has become a contentious issue around poor South African communities. Ideally the council should negotiate a relocation plan especially within the pan catchment area which is believed to have the most coverage of informal housing. Based on the recorded impacts in and around wetlands within the catchment, a catchment wide PES assessment was undertaken for all wetlands. The intensity scores, as discussed in the approach section, were used to area weight the impacts to wetlands

and their catchments for the PES assessment. Figure 4 below indicates the results of the catchment PES assessment.

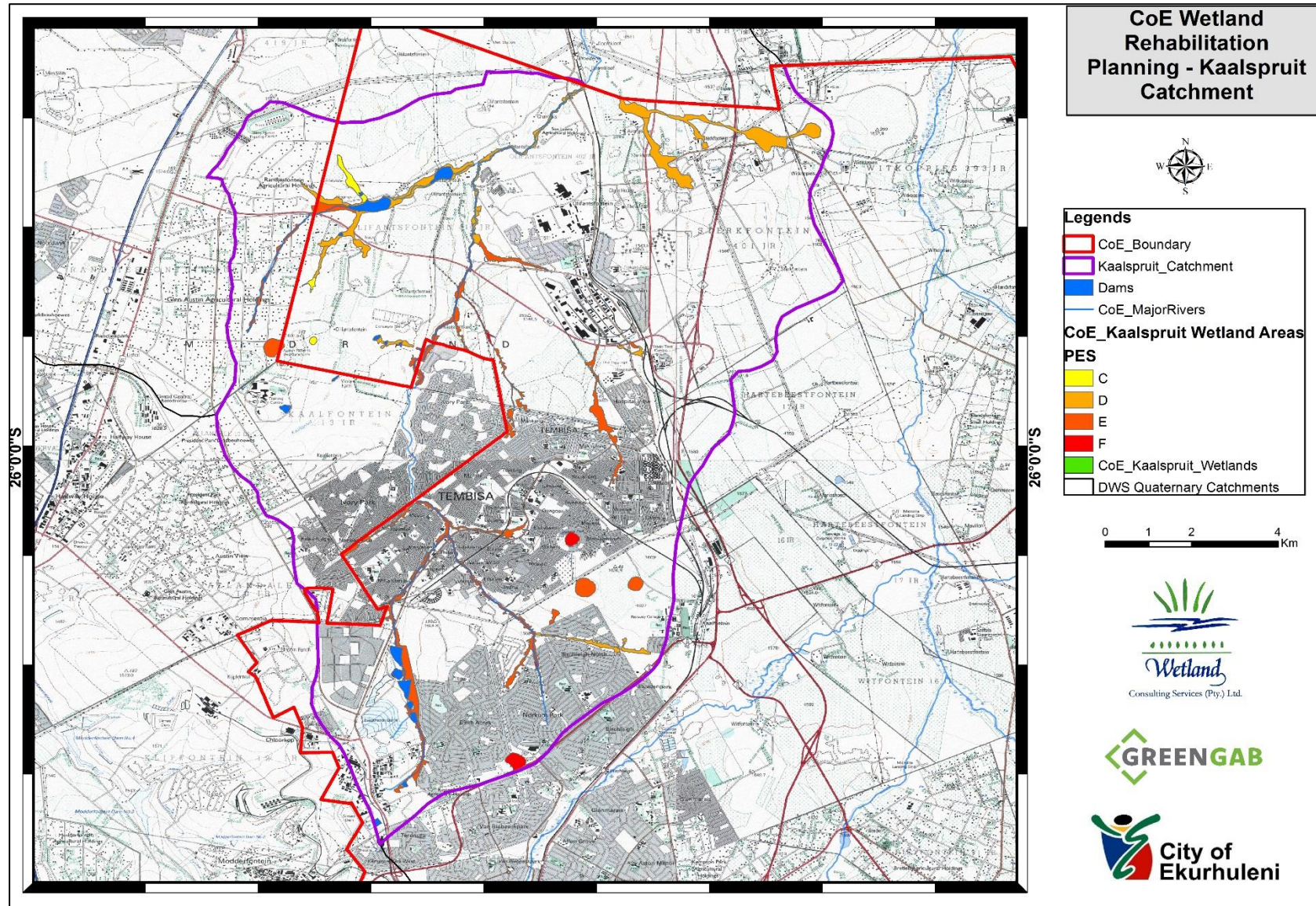


Figure 4: Map showing PES assessment results for wetlands within the Kaalspruit Catchment.

3.2.2 WETLAND IMPORTANCE AND SENSITIVITY (IS)

“Importance” of a water resource is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. “Sensitivity” refers to the system’s ability to resist disturbances and its capability to recover from disturbance once it has occurred.

The wetlands within the study area form part of the Crocodile West Marico Water Management Area, which is a heavily utilised and economically important catchment. Wetlands and rivers within the Kaalspruit and Hennops River have been greatly impacted upon by various activities, which include urbanisation and informal settlements and associated infrastructural activities, water abstraction and supply and agriculture, etc. As a result of these impacts, serious water quality and quantity concerns have been raised within the sub-catchment. Given this situation, and the fact that wetlands can support functions such as water purification and stream flow regulation, a high importance and conservation value is placed on all wetlands and rivers within the catchment that have as yet not been seriously modified. Within this context, a wetland IS assessment was conducted for every hydro-geomorphic wetland unit identified within the study area. Further considerations that informed the IS assessment include the following:

- The location of the majority of the study area within a vegetation type (Mesic Highveld Grassland) considered extensively transformed and threatened, having been classed as **Endangered** and Carletonville Dolomite Grasslands downstream of Tembisa towards the confluence of the Kaalspruit and Hennops Rivers which has been classed as **Vulnerable**;
- The wetland vegetation types extending across the catchment include Dry Highveld Grassland Group 5 and Mesic Highveld Grassland Group 3, which are both considered Least Threatened, but which are poorly protected or not protected at all;
- According to the Gauteng Conservation Plan (C-Plan), the majority of the wetlands within the catchment form part of a network of Ecological Support Areas and areas that are Important for biodiversity conservation;
- The wetlands connect to the larger system/water resource that drains the entire area; and
- No FEPA wetlands are present within the catchment.

It is these considerations that have, in part, informed the scoring of the systems in terms of their importance and sensitivity. Figure 5 below indicates the results of the wetland IS assessments.

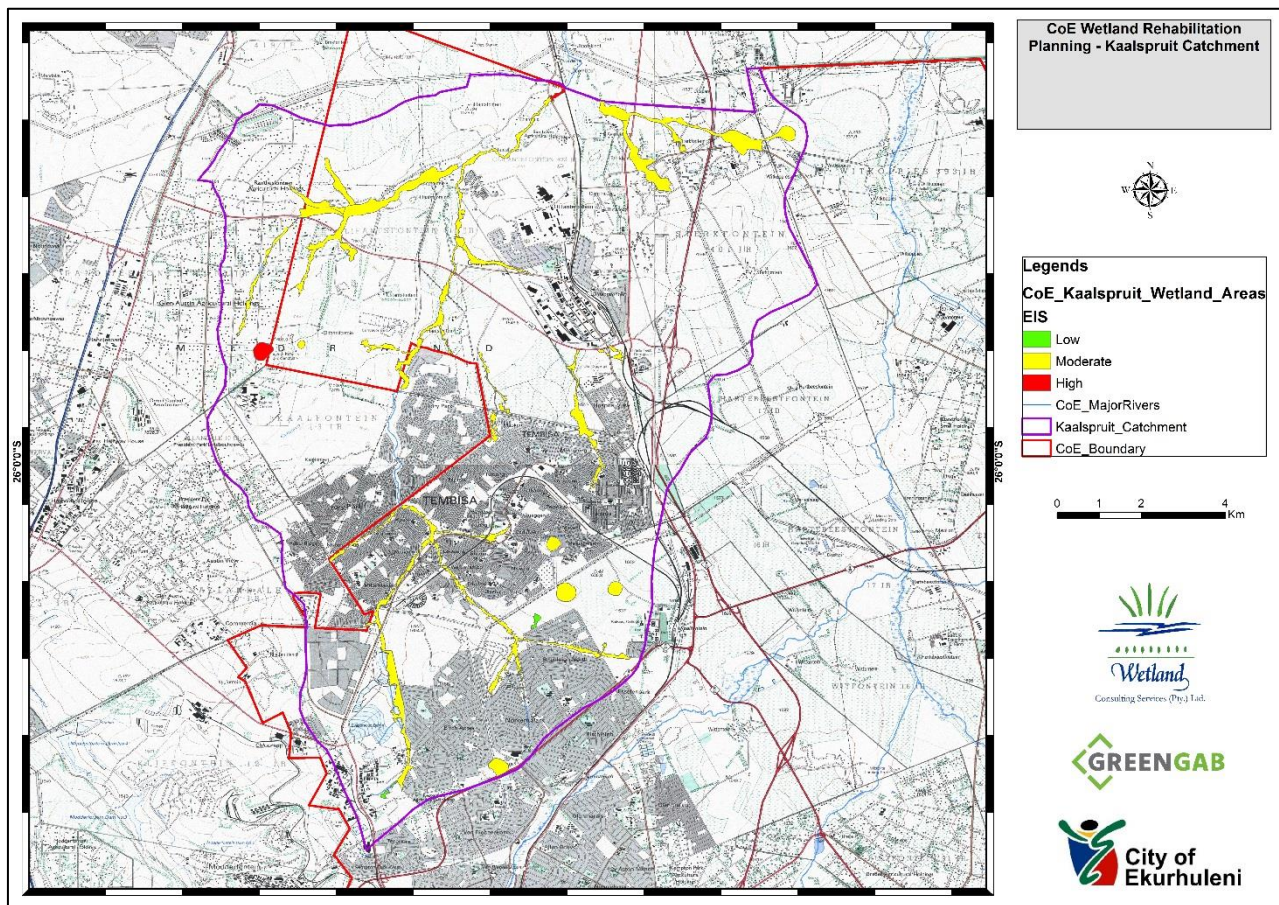


Figure 5: Map showing wetland IS assessment results for wetlands within the Kaalspruit Catchment.

3.3 PRIORITY WETLANDS CONSIDERED FOR FURTHER ASSESSMENT AND REHABILITATION PLANNING.

The first order of prioritisation consists of integration of existing rehabilitation initiatives, alignment of objectives and proposed activities, particularly for the main Kaalspruit system as indicated in Figure 6 below. The aim of this is to evaluate and identify what has worked from existing initiatives and extend the approach to the entire Kaalspruit system and associated tributaries.

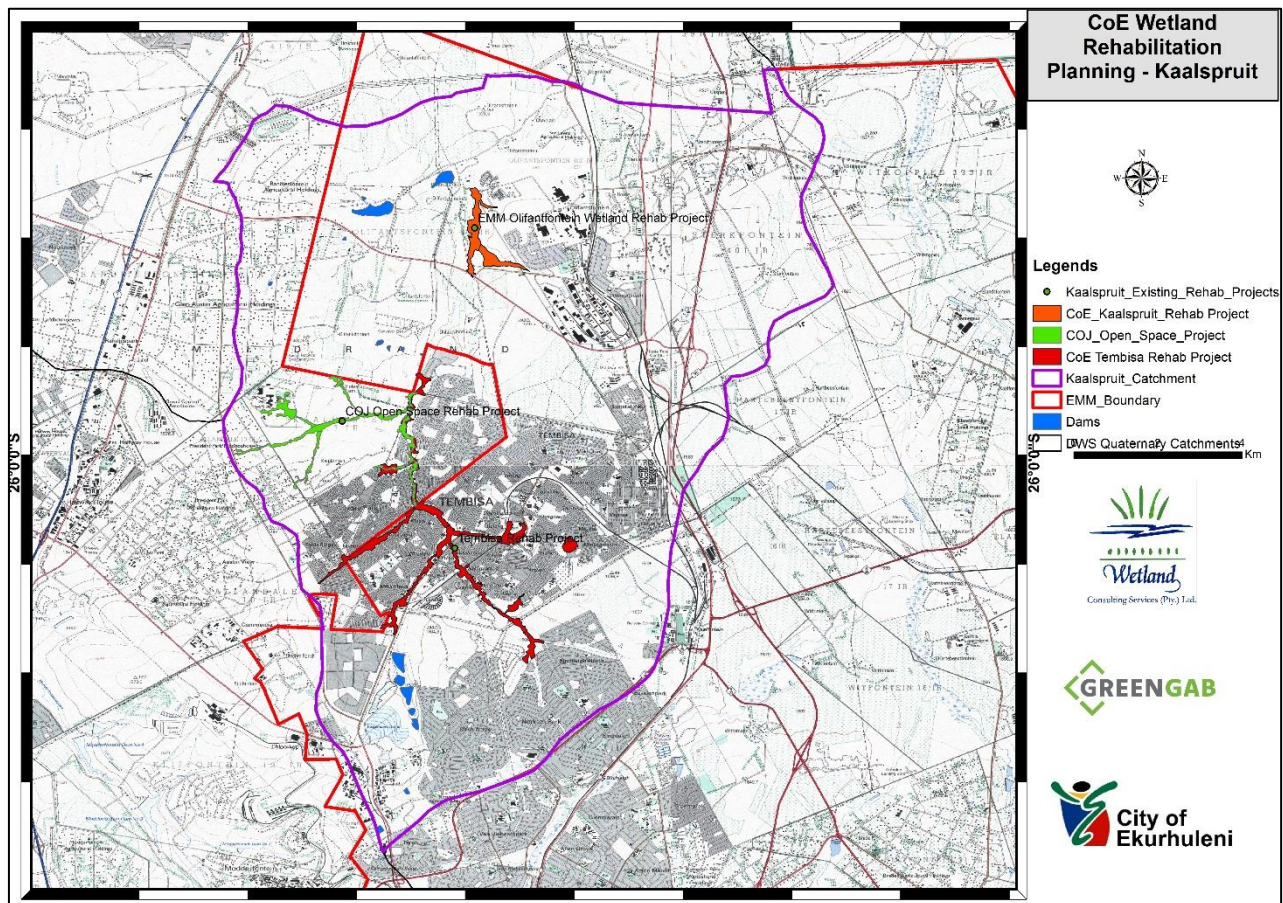


Figure 6: Map showing existing rehabilitation initiatives within the Kaalspruit Catchment.

The second order of prioritisation consists of targeting local catchments of the key waterbodies already selected within the CoE. The key waterbodies within the Kaalspruit catchment to be considered as part of this study include Winnie Mandela Park 2 and Esselen Park Pan. Figure 7 below indicates the location of considered key waterbodies and their associated local catchments.

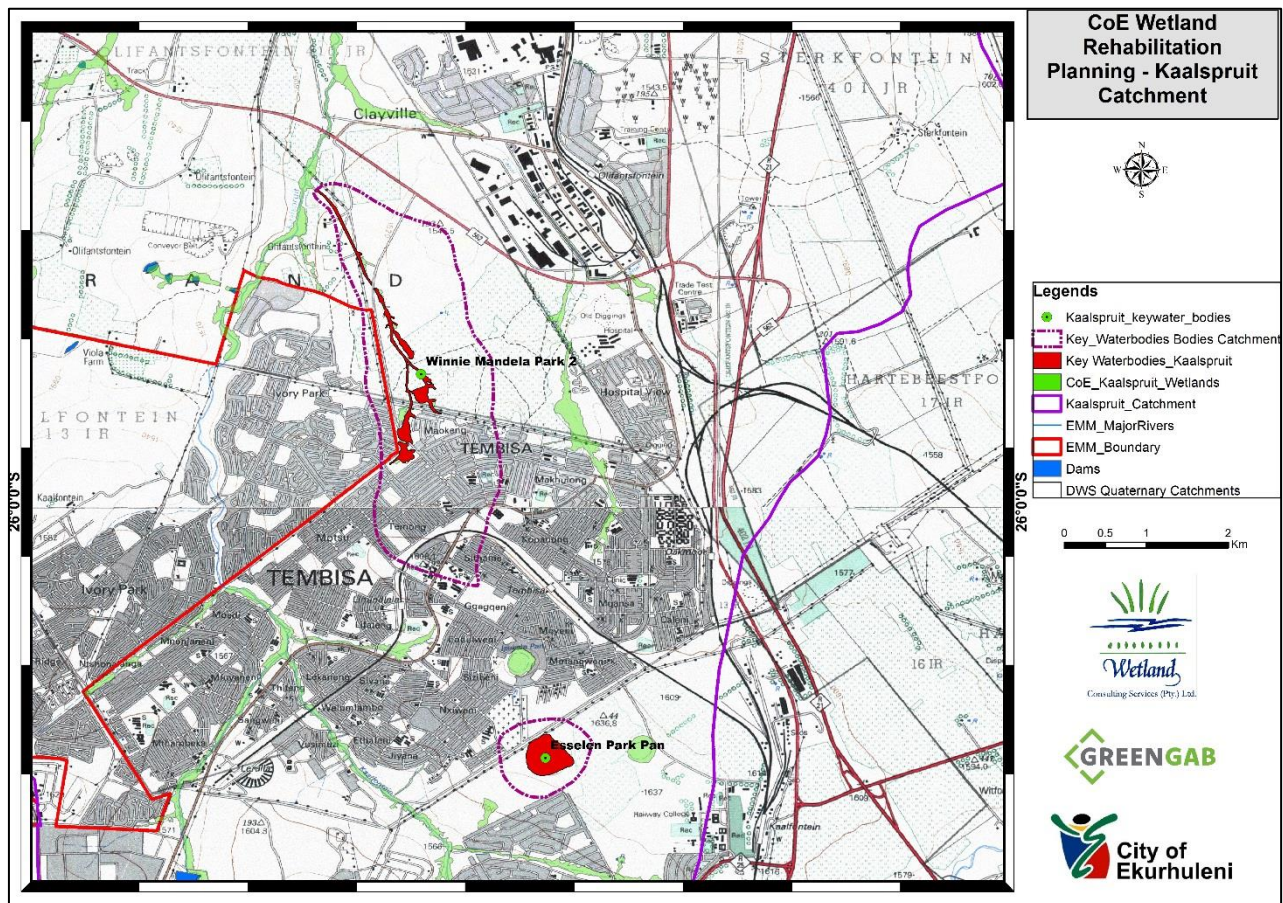


Figure 7: Map showing considered key waterbodies and their associated local catchments.

The third order of prioritisation includes integration, assessment and scoring analysis of the following datasets:

- FEPA wetlands;
- Biodiversity support;
- Ecosystem threat status and protection level;
- COE landownership; and
- Wetland condition (PES).

Scoring used for the above selection criteria is as follows:

- 1 = Low
- 2 = Moderate
- 3 = High
- 4 = Very High

Ecosystem Status	Threat	Ecosystem Protection level	Biodiversity (C-Plan)	Support	Score
Critically Endangered		Well protected	Irreplaceable		4
Endangered		Moderate Protected	Protected		3
Vulnerable		Poor Protected	Important		2
Least Threatened		Not Protected	Ecological Support Areas		1

However, the NFEPA and CoE landowners were scored as follows:

NFEPA	Land Ownership	Score
FEPA Wetlands	CoE Owned Land	2
Non FEPA Wetlands	Private land	1

In order to combine all criteria into one prioritization ranking, all scores were added up and then rounded to the nearest integer. The highest combined score then represents the highest prioritization. The following categories were determined for the final prioritisation class of wetland areas.

Priority List	Scoring Category Ranges
Very High	13 - 16
High	9 - 12
Moderate	5 - 8
Low	1 - 4

Based on the above integration of scoring systems, Figure 8 below indicates the results of the prioritisation exercise.

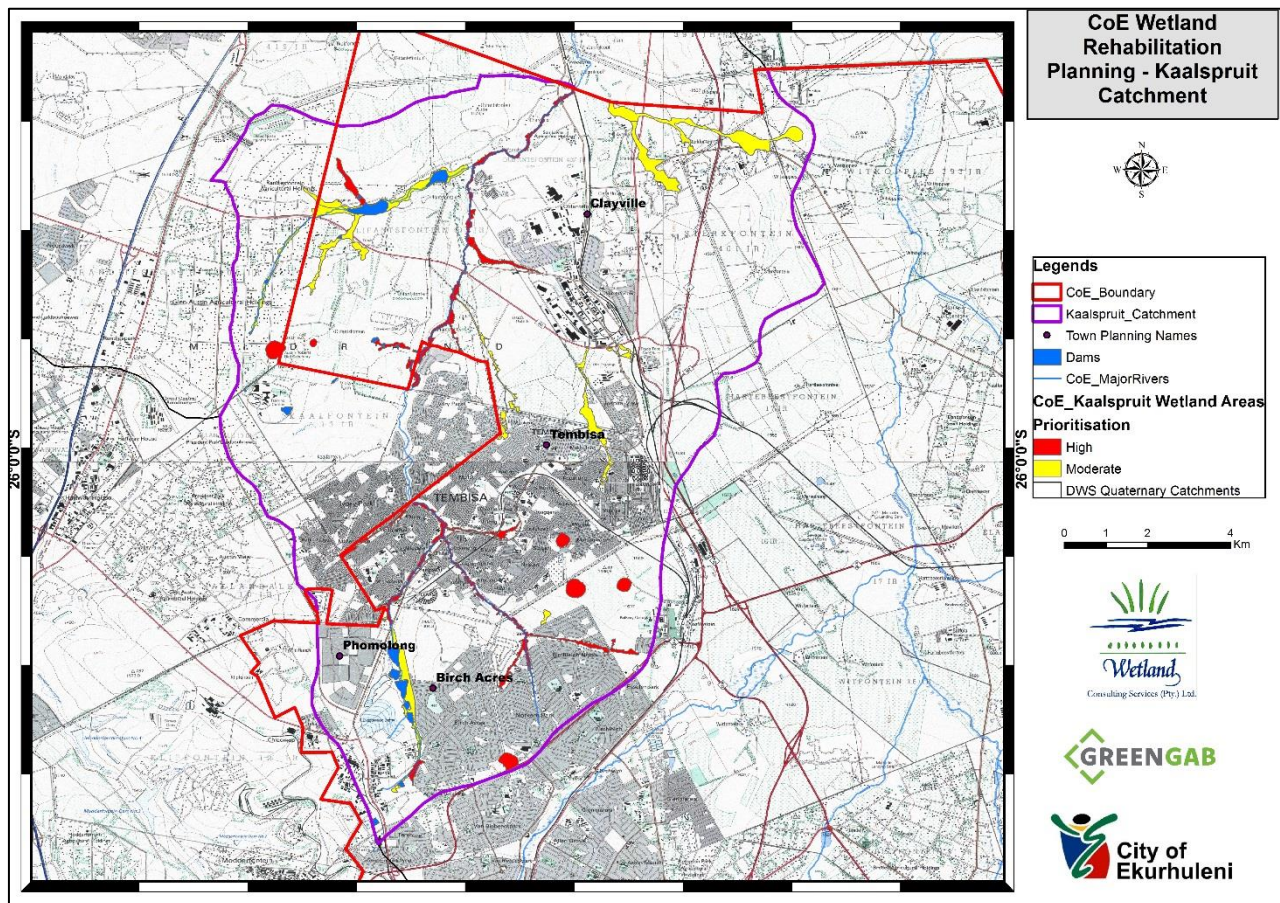


Figure 8: Map showing prioritisation of wetlands based on available data analysis as proposed onsite.

Figure 9 below indicates the integration of all priority lists based on the above orders of prioritisation, while Table 6 indicate distribution of wetlands types prioritised for rehabilitation as part of this project. The wetlands indicated in Figure 9 include all the wetlands to be considered for wetland rehabilitation planning going forward for the project. Table 7 provided a distribution of wetland remaining within the Kaalspruit Catchment to be considered and further assessed in terms of suitability for any future wetland rehabilitation work or projects. Table 7 below indicates that only 316.13 ha of wetland are targeted for rehabilitation for this current project within the 595.4ha of wetlands assessed for the entire Kaalspruit Catchment and this further indicates that 279.3 ha of wetlands are still available for further assessment in terms of suitability for rehabilitation for any future work the CoE may want to peruse after this project.

Table 6: Distribution and total coverage of wetland types prioritised for rehabilitation as part of this project.

Catchment	CoE Wetland & Watercourses Types	Areas (Ha)	% Coverage
Kaalspruit	Channelled Valley Bottom	246.16	77.87%
Kaalspruit	Depression (Pans)	40.15	12.70%
Kaalspruit	Seepage	11.96	3.78%
Kaalspruit	Unchannelled Valley Bottom	13.23	4.18%
Kaalspruit	Trenches	4.63	1.46%
TOTAL		316.13	100.00%

City of Ekurhuleni Wetland Rehabilitation Planning within the Kaalspruit Catchment		Situation Assessment Report
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Table 7: Distribution of remaining and total coverage of wetland types prioritised for rehabilitation as part of wetlands within the Kaalspruit Catchment to be considered and further assessed in terms of their suitability for any future wetland rehabilitation work and/or projects.

Catchment	CoE Wetland & Watercourses Types	Total Wetland and Watercourses Areas (Ha)	% Coverage	Prioritised Wetlands for Rehabilitation as part of this current project (Ha)	Remaining wetlands to be targeted for any future work (Ha)
Kaalspruit	Channelled Valley Bottom	347.44	58.35%	246.16	101.28
Kaalspruit	Depression (Pans)	58.07	9.75%	40.15	17.91
Kaalspruit	Seepage	54.37	9.13%	11.96	42.42
Kaalspruit	Unchannelled Valley Bottom	128.18	21.53%	13.23	114.95
Kaalspruit	Trench	7.36	1.24%	4.63	2.73
TOTAL		595.42	100.00%	316.13	279.29

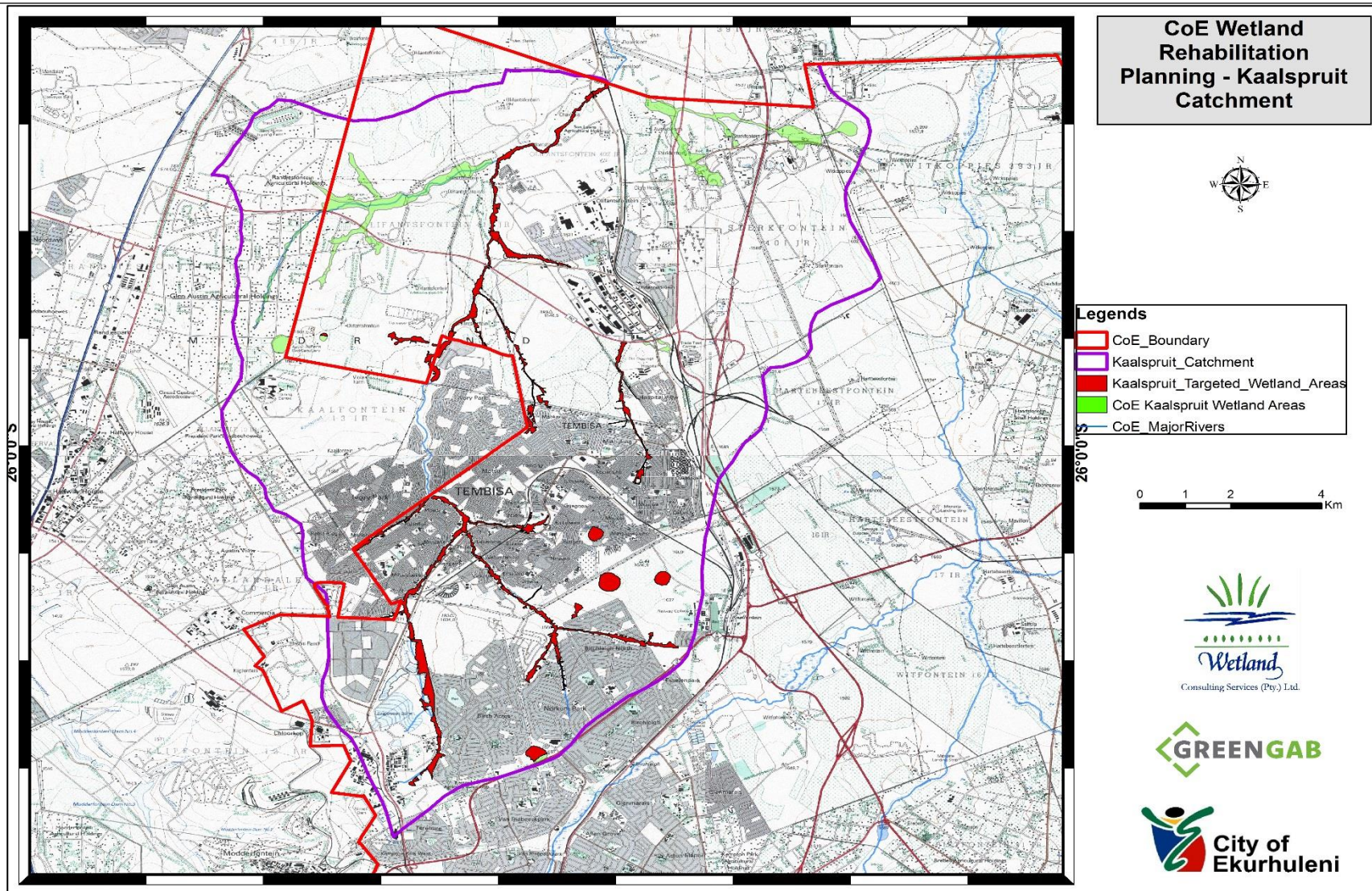


Figure 9: Map showing integrated prioritisation list and all wetlands to be considered for rehabilitation planning going forward.

3.4 DELINEATION OF REHABILITATION ZONES

Due to the extensive nature and extent of the wetland areas to be assessed on site, a simplified approach was adopted to assess these areas within the project area on site. The study catchment area was subdivided into **seven Kaalspruit rehabilitation zones**. Subdivision of the study area into a number of rehabilitation zones has the following benefit:

- Sharpening the focus on the environmental problems encountered in each of the six zones;
- Reducing the scale of the problems to be addressed, to those encountered within each zone;
- Ensuring community participation in the benefits of the rehabilitation process by addressing the rivers/wetlands problems within the geographic boundaries of each community;
- Ensuring as far as reasonably possible, that each community passes on water of acceptable quality to its downstream neighbours.

The subdivision is merely based on the point of confluence of tributaries in order to ensure manageable small catchments upstream. Figure 10 below indicates the proposed rehabilitation zones of the wetlands considered for further rehabilitation planning as shown in Figure 9 above.

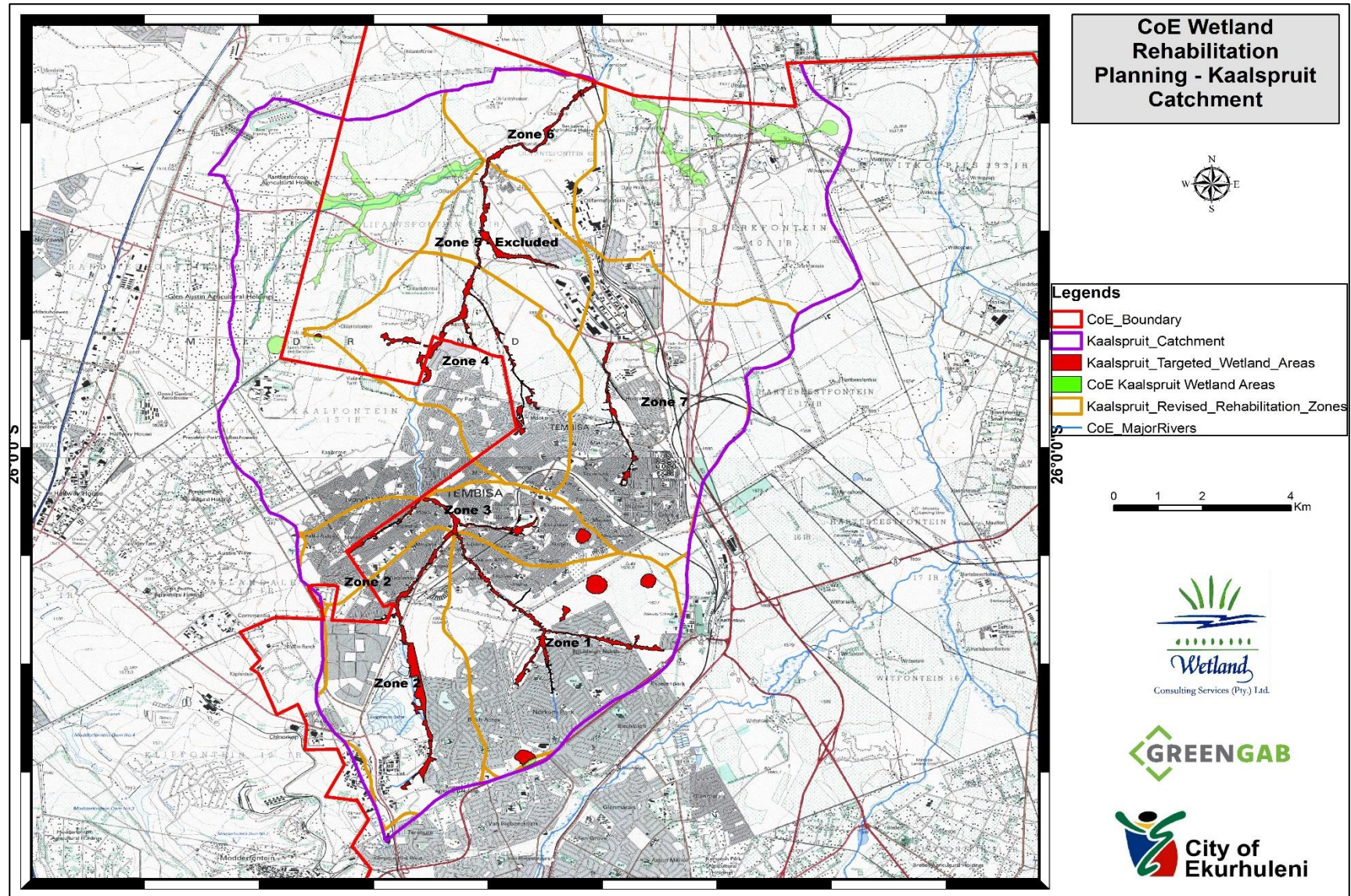


Figure 10: Map showing the extent of rehabilitation zones for the wetlands to be considered for rehabilitation planning onsite.

3.5 SITE ASSESSMENTS AND DEVELOPMENT OF A REHABILITATION STRATEGY FOR THE PRIORITISED WETLAND SYSTEMS.

Planning a wetland rehabilitation strategy is a three-phase process involving:

1. The identification of the problems compromising wetland ecological integrity;
2. Setting rehabilitation objectives based on an analysis of the problems and the feasible extent of addressing them in order to make ecological improvements; and
3. Formulating solutions aimed at achieving the set objectives.

A range of problems undermining wetland ecological integrity were identified during the site visits. Addressing these impacts forms the underlying goal of the proposed wetland rehabilitation strategy. Rehabilitation inherently implies that there is a concession that it will not be possible to reinstate all of the driving ecological processes within the wetlands because:

- The hydrology of the catchment has been fundamentally altered; or
- The physical impact within the wetland will be too costly to reverse.

Only those processes that are realistically achievable were therefore considered and used to form the basis of the rehabilitation objectives. Under the current scenario, the goal of rehabilitating the wetlands to functional systems in some places is considered to be realistic.

This rehabilitation strategy provides an indication of rehabilitation interventions that can be considered during the design phase of the project. The feasibility of some of the proposed activities will further be assessed with an environmental engineer in terms of implementability and costing.

3.5.1 WETLAND REHABILITATION ZONE 1

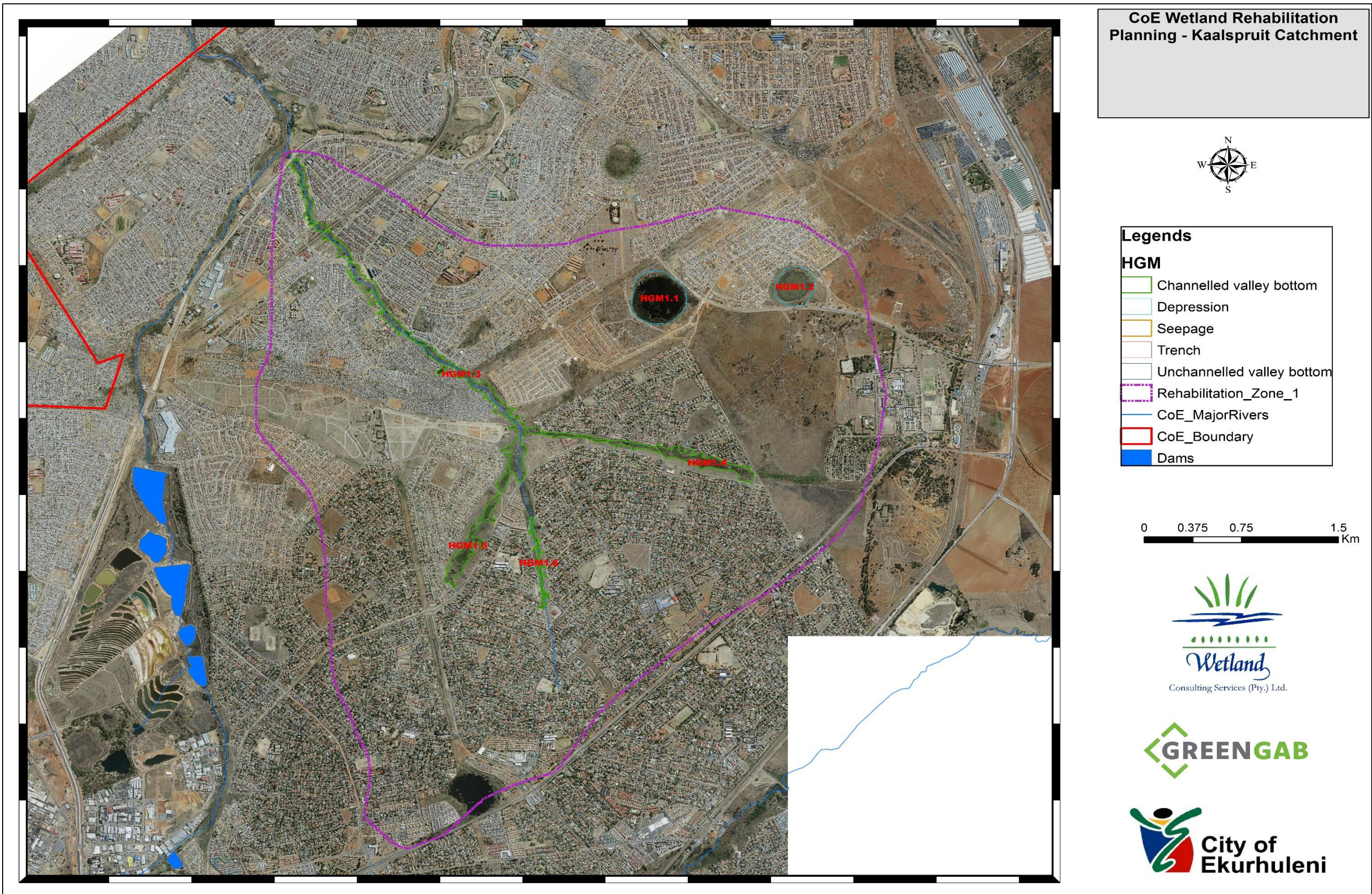


Figure 11: Map showing the extent of Wetland Rehabilitation Zone 1 with associated wetland HGM units.

3.5.1.1 HYDROGEOMORPHIC UNIT: ESSELEN PARK PAN (HGM 1.1) - GPS CO-ORDINATE: 26° 1' 41.65"S; 28° 13' 50.43"E

A. Impacts Recorded

- Dumping of building rubble and litter;
- Storage for building material;
- Excavation for building material;
- Ground clearing/scrapping;
- Livestock (cattle) grazing around pan;
- Tracks and informal roads;
- Cultivation - subsistence farming;
- Storm-water drainage from the road;
- Abandoned concrete pipes and structures;
- Alien invasive vegetation:
 - *Bidens Formosa*
 - *Bidens pilosa*
 - *Solanum mauritianum*
 - *Morus alba*
 - *Ipomoea purpurea*
- Additional activities around the pan include power lines and cemetery.

B. Rehabilitation objectives

- Improve aesthetic appeal of the pan and surrounding areas;
- Improve habitat and attract local avifauna species; and
- Improve natural vegetation species composition.

C. Rehabilitation activities

- Palisade fencing of the pan and surrounding areas;
- Provision of access to the areas around using turn style gate access;
- Removal of litter and rubbles around the pan basin;
- Make plans to designate alternative dumping sites outside the pan basin (e.g. recycling zone for litter such as plastics);
- Demarcate areas for cultivation within the pan basin;
- Ploughing areas around the pan basin and leave them for natural vegetation to re-establish
- Practice regular mowing before weeds start flowering to allow natural grass species to come in
- Revegetate areas around the pan basin that remain eroded after ploughing if natural vegetation does not re-establish
- Typical Species:
 - *Imperata cylindrical*
 - *Erograstis plana*
 - *Eragrostis gummiflua*
 - *Eragrostis curvula*
 - *Agrostis lachnantha*
 - *Cynodon dactylon*
 - *Paspalum distichum*
- Create walkway around the pan basin and vegetate open spaces;

- Planting of trees in selected areas to provide shades for bird viewing and picnics; and
- Ground clearing and landscape flattening for areas around the basin that have formed mounds (and consequently became vegetated with mostly alien plants) around the pan basin.

D. Photographs of impacts recorded



Figure 12: A. Litter (26° 1' 43.29"S 28° 14' 0.40"E); B. Dumping of building rubble (26° 1' 45.76"S 28° 13' 51.75"E); C. tracks and informal roads (26° 1' 49.37"S 28° 13' 53.48"E); D. Ground clearing/scrapping (26° 1' 30.73"S 28° 13' 49.86"E); E. Excavation for building material (26° 1' 51.42"S 28° 13' 50.7"E); F. Storage area for building material (26° 1' 47.35"S 28° 13' 55.33"E)

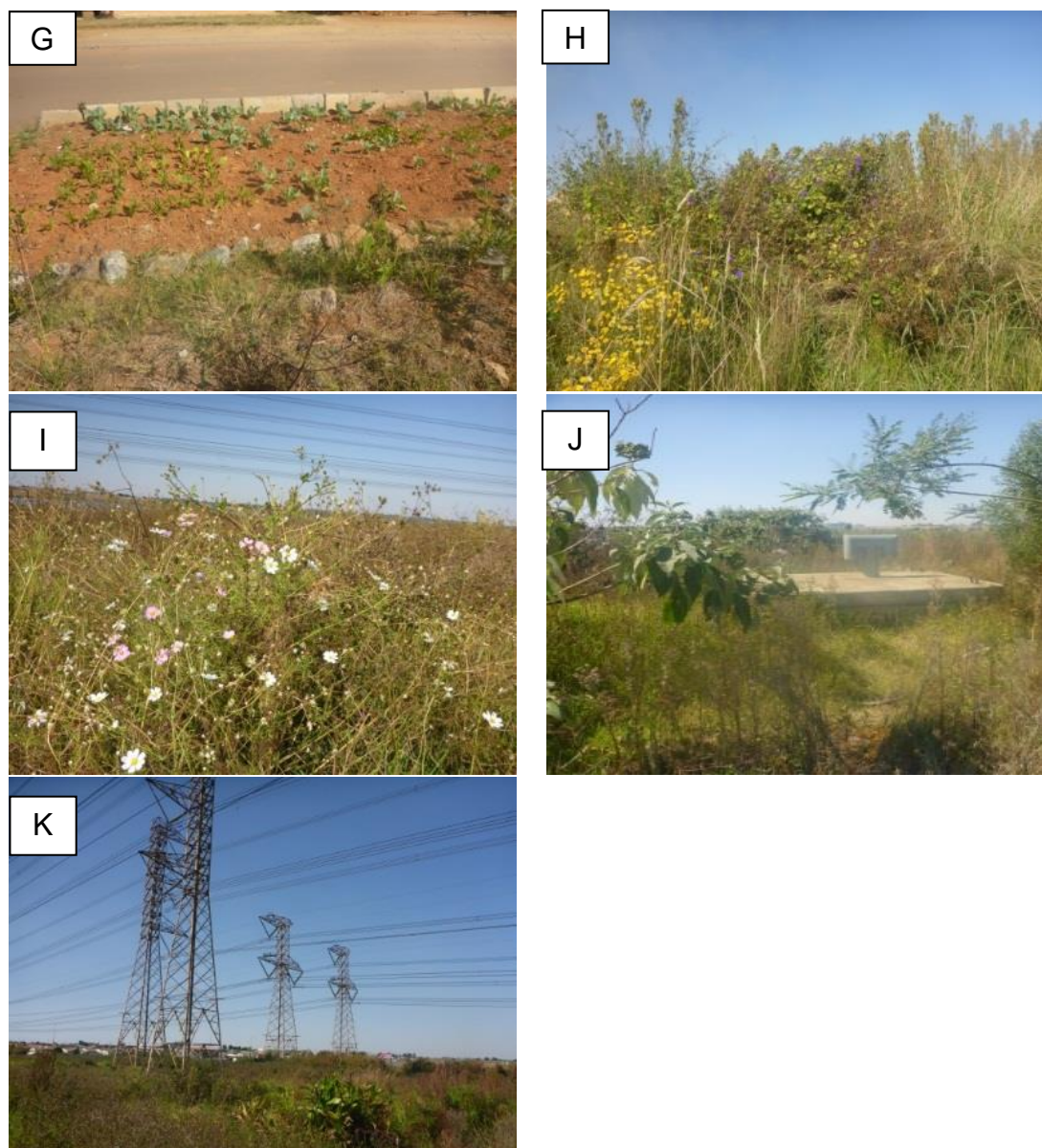


Figure 12: G. Cultivation for subsistence farming (26° 1' 52.26"S 28° 13' 37.82"E); H. Alien plant species (26° 1' 44.07"S 28° 13' 59.73"E); I. Concrete structures and abandoned concrete pipes (26° 1' 44.96"S 28° 13' 41.76"E); J. Power lines (26° 1' 38.68"S 28° 13' 39.94"E).

3.5.1.2 HYDROGEOMORPHIC UNIT: DEPRESSION (HGM 1.2) - GPS CO-ORDINATE: 26° 1' 37.71"S; 28° 14' 28.46"E

A. Impacts recorded

- Dumping of ash and litter;
- Storm-water drainage line;
- Tracks and informal roads;
- Cultivation - subsistence farming;
- Excavation (trenches); and
- Alien invasive vegetation:
- *Bidens Formosa*

B. Rehabilitation objectives

- Improve aesthetic appeal of the pan and surrounding areas;
- Improve habitat and attract local avifauna species; and
- Improve natural vegetation species composition.

C. Rehabilitation activities

- Removal of litter and rubbles around the pan basin;
- Make plans to designate alternative dumping sites outside the pan basin (e.g. recycling zone for litter such as plastics);
- Demarcate areas for cultivation within the pan basin;
- Ploughing areas around the pan basin and leave them for natural vegetation to re-establish
- Practice regular mowing before weeds start flowering to allow natural grass species to come in
- Revegetate areas around the pan basin that remain eroded after ploughing if natural vegetation does not re-establish
- Typical Species:
 - *Imperata cylindrical*
 - *Erograstis plana*
 - *Eragrostis gummiflua*
 - *Eragrostis curvula*
 - *Agrostis lachnantha*
 - *Cynodon dactylon*
 - *Paspalum distichum*
- Create walkways around the pan basin and revegetate open spaces; and
- Planting of trees in selected areas to provide shades for bird viewers and picnics.

D. Photographs of impacts recorded



Figure 13: A. Trench close to where new trees have been planted (26° 1' 41.47"S 28° 14' 22.59"E); B. Water (JoJo) tanks for storing water (26° 1' 39.08"S 28° 14' 22.79"E); C. Cultivation for subsistence farming (26° 1' 36.79"S 28° 14' 22.59"E); D. Domestic litter dumping (26° 1' 37.56"S 28° 14' 22.78"E); E. Litter dumping and used bottles (26° 1' 37.32"S 28° 14' 21.38"E); F. Storm-water drainage and litter (26° 1' 37.6"S 28° 14' 21.38"E).

3.5.1.3 HYDROGEOMORPHIC UNIT: CHANNELLED VALLEY BOTTOM (HGM 1.3) - GPS CO-ORDINATE: 26° 2' 10.49"S; 28° 13' 7.14"E

A. Impacts recorded

- Dumping of building rubble and litter;
- Sewage discharge and litter;
- Livestock (sheep) grazing in the wetland;
- Area used as a landfill in the valley bottom;
- Excavation and erosion gullies;
- Erosion on the sides of the valley bottom from adjacent housing;
- Tracks and informal roads;
- Cultivation - subsistence farming;
- Storm-water drainage from the road and houses;
- Surcharging manholes into watercourses and water quality deterioration,
- Informal recreational space;
- Concrete building, pipes and structures in the valley bottom;
- Informal human settlements in the valley bottom; and
- Alien invasive vegetation:
 - *Cortaderia selloana*
 - *Salix babylonica*

B. Rehabilitation objectives

- Improve aesthetic appeal and surrounding areas;
- Improve habitat and attract local avifauna species; and
- Improve natural vegetation species composition.

C. Rehabilitation activities

- Remove litter and rubble within and around the pan basin;
- Make plans to designate alternative dumping sites outside the wetland (e.g. recycling zone for litter such as plastics);
- Channel cleaning;
- Ploughing areas around the pan basin and leave them for natural vegetation to re-establish
- Practice regular mowing before weeds start flowering to allow natural grass species to come in
- Revegetate areas around the pan basin that remain eroded after ploughing if natural vegetation does not re-establish
- Typical Species:
 - *Imperata cylindrical*
 - *Eragrostis plana*
 - *Eragrostis gummiflua*
 - *Eragrostis curvula*
 - *Agrostis lachnantha*
 - *Paspalum distichum*
 - *Juncus effusus*
- Later species to plant once the grasses have established to attract local avifauna species:
 - *Kniphofia caulescens*
 - *Crinum bulbispermum*

- *Erythrin spp.*
- *Hypoxis spp.*
- *Combretum erythrophyllum*
- Reinforce the rock and sack informal channel crossing;
- Install a structure to link the rock and sack informal channel crossing and structure A21B-21-009;
- Install a structure within the channel at 26°1'46.46"S; 28°12'37.05"E;
- Install a pedestrian crossing with rails across channel;
- Consider eviction of squatter camps;
- Remove alien vegetation;
- Create walkway along the flood lines of the valley bottom and revegetated open spaces; and
- Plant trees in selected areas to provide shades for bird viewers and picnics.

D. Photographs of impacts recorded







Figure 14: A. Litter dumping (26° 2' 19.18"S 28° 13' 13.16"E); B. Storm-water drainage from the houses (26° 2' 10.59"S 28° 13' 8.73"E); C. Storm-water drainage from the road (26° 2' 5.73"S 28° 13' 6.34"E); D. Erosion gully (26° 2' 14.47"S 28° 13' 13.05"E); E. Cultivation for subsistence farming (26° 2' 11.75"S 28° 13' 12.10"E); F. Cultivation for subsistence farming (26° 2' 11.75"S 28° 13' 12.10"E). . G. Area used as a landfill (26° 2' 14.38"S 28° 13' 9.78"E); H. Congestion of informal human settlements (squatter camps) (26° 2' 13.33"S 28° 13' 7.64"E); I. Concrete building within the wetland (26° 2' 15.51"S 28° 13' 12.50"E).

E. Photographs indicating existing wetland rehabilitation interventions





Figure 15: : A. Gabion weir (26° 2' 9.95"S 28° 13' 8.39"E); B. Mass gravity concrete weir A21B-21-004 (26° 2' 14.70"S 28° 13' 11.02"E); C. Concrete pipe crossing A21B-21-003 (26° 2' 16.14"S 28° 13' 12.74"E); D. Rock and sack informal channel crossing (26° 2' 18.87"S 28° 13' 12.48"E); E. Pipe cutting across channel (26° 2' 20.83"S 28° 13' 10.74"E); F. Gabion weir A21B-21-009 (26° 2' 22.52"S 28° 13' 11.51"E).

3.5.1.4 HYDROGEOMORPHIC UNIT: CHANNELLED VALLEY BOTTOM (HGM 1.4) - GPS CO-ORDINATE: 26° 2'23.19"S; 28°13'54.55"E**A. Impacts recorded**

- Dumping of building rubble and litter;
- Sewage discharge into channel;
- Tracks and paths;
- Damaged fencing and damaged storm-water drain; and
- Alien invasive vegetation:
 - *Solanum delagoense*
 - *Bidens pilosa*
 - *Arundo donax*
 - *Morus alba*
 - *Salix babylonica*
 - *Cortaderia selloana*

B. Rehabilitation objectives

- Improve aesthetic appeal of the channel and surrounding open area for the community;
- Improve habitat and attract local avifauna species;
- Improve water quality within the channel.

C. Rehabilitation activities

- Replace damaged fencing and fix damaged storm-water drain;
- Removal of rubble and litter around the channel and in the open surrounding area and supply an alternative official dumping site;
- Upgrade sewerage infrastructure to limit sewerage discharge into the streams;
- Revegetate the channel using indigenous flora:
- Typical Species:
 - *Typha capensis*
 - *Juncus effuses*
 - *Kyllinga erecta*
 - *Schoenoplectus decipiens*
- Revegetate the open area using indigenous flora:
- Typical Species:
 - *Erythrina lysistemon trees*
 - *Celtis Africana trees*
 - *Melinis repens*
 - *Eragrostis racemosa*
- Create designated paths in the open surrounding area and bridges across the channel; and
- Create a recreational area for the community in the open surrounding area by providing benches, park facilities and planting trees to provide shade.

D. Photographs of impacts recorded



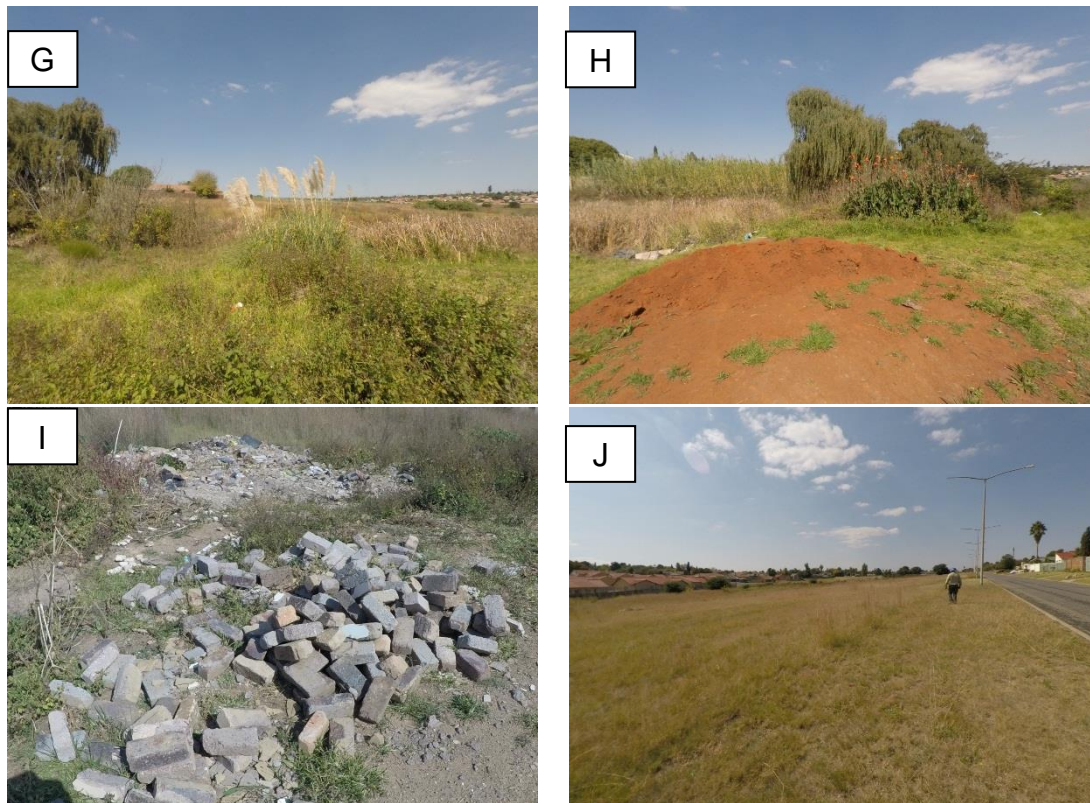


Figure 16: Damaged fencing (26°2'18.15"S; 28°13'18.54"E); B. damaged storm-water drain (26°2'17.24"S; 28°13'20.12"E); C. Dumping of rubble and alien invasive vegetation (26°2'20.00"S; 28°13'30.14"E); D. Dumping of rubble (26°2'29.20"S; 28°14'17.79"E); E. Dumping of litter (26°2'17.48"S; 28°13'18.89"E); F. Dumping of rubble and litter (26°2'17.15"S; 28°13'19.66"E). G. Presence of alien invasive vegetation (26°2'17.25"S; 28°13'20.90"E); H. Dumping of sand and alien invasive vegetation (26°2'17.37"S; 28°13'22.84"E); I. Dumping of rubble (26°2'19.61"S; 28°13'29.39"E); J. Open area surrounding channel and possible recreational space for community (26°2'22.99"S; 28°13'46.21"E).

3.5.1.5 HYDROGEOMORPHIC UNIT: ESSELEN PARK PAN (HGM 1.5) - GPS CO-ORDINATE: 26°2'42.01"S; 28°12'59.79"E

A. Impacts recorded

- Dumping of building rubble and litter;
- Sewage discharge into channel; and
- Tracks and paths.

B. Rehabilitation objectives

- Improve aesthetic appeal of the channel and surrounding open area for the community;
- Improve habitat and attract local avifauna species;
- Improve water quality within the channel.

C. Rehabilitation activities

- Removal of rubble and litter in wetland and surrounding area;
- Upgrade sewerage infrastructure to increase capacity and limit sewerage entering stream;
- Create designated paths in the wetland and bridges across the channel.

D. Photographs of impacts recorded

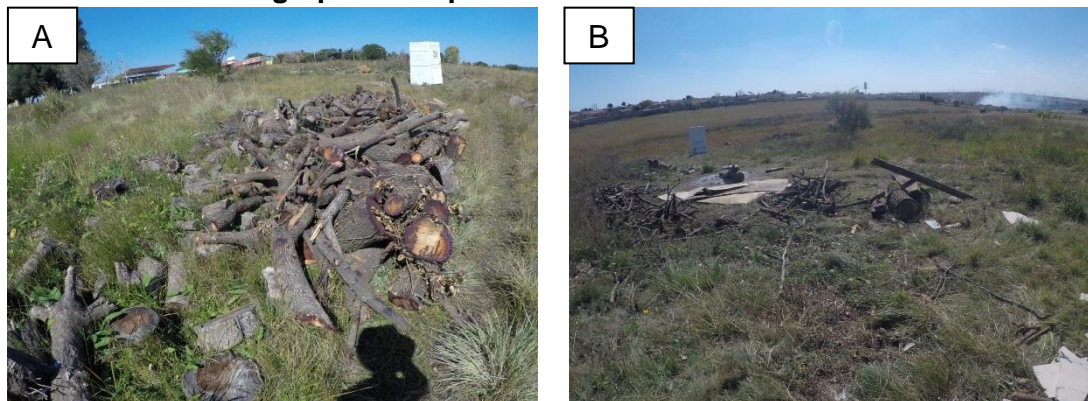


Figure 17: A. Dumping of plant material (26°2'40.26"S; 28°13'3.18"E); B. Dumping of rubble and litter (26°2'41.41"S; 28°13'3.47"E).

E. Photographs of existing wetland rehabilitation interventions onsite

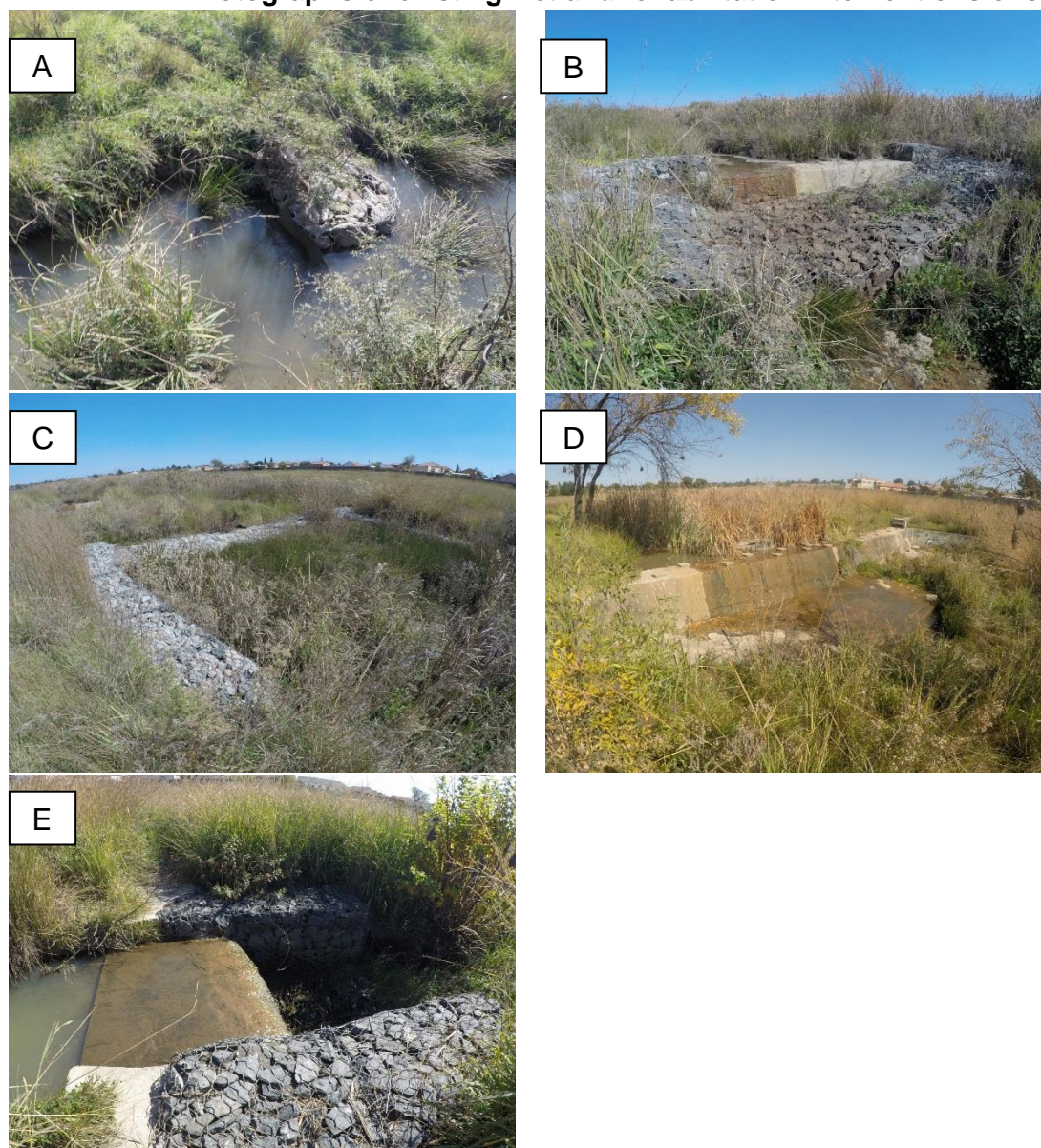


Figure 18: A. Gabion (26°2'40.72"S; 28°13'1.38"E); B. Buttress gabion weir (26°2'36.43"S; 28°13'4.67"E); C. Gabion (26°2'35.77"S; 28°13'5.11"E); D. Concrete weir (26°2'45.54"S; 28°12'58.03"E); E. Buttress gabion weir (26°2'43.68"S; 28°12'59.07"E).

3.5.1.6 HYDROGEOMORPHIC UNIT: ESSELEN PARK PAN (HGM 1.6) - GPS CO-ORDINATE: 26°2'53.30"S; 28°13'16.94"E

A. Impacts recorded

- Large active erosion in channel;
- Erosion beneath and damage of gabion intervention;
- Litter and pollutants in water; and
- Alien invasive vegetation:
 - *Arundo donax*
 - *Cortaderia selloana*
 - *Solanum mauritianum*

B. Rehabilitation objectives

- Improve aesthetic appeal of the channel and surrounding open area for the community; and
- Improve safety of channel for community.
- Improve water quality within the channel
- Improve overall ecological functioning of the watercourse

C. Rehabilitation activities

- Removal of litter and supply garbage bins within park and paths;
- Replace or restore damaged gabion structure; and
- Fence off structural intervention and channel from children's park to improve safety.

D. Photographs of impacts recorded

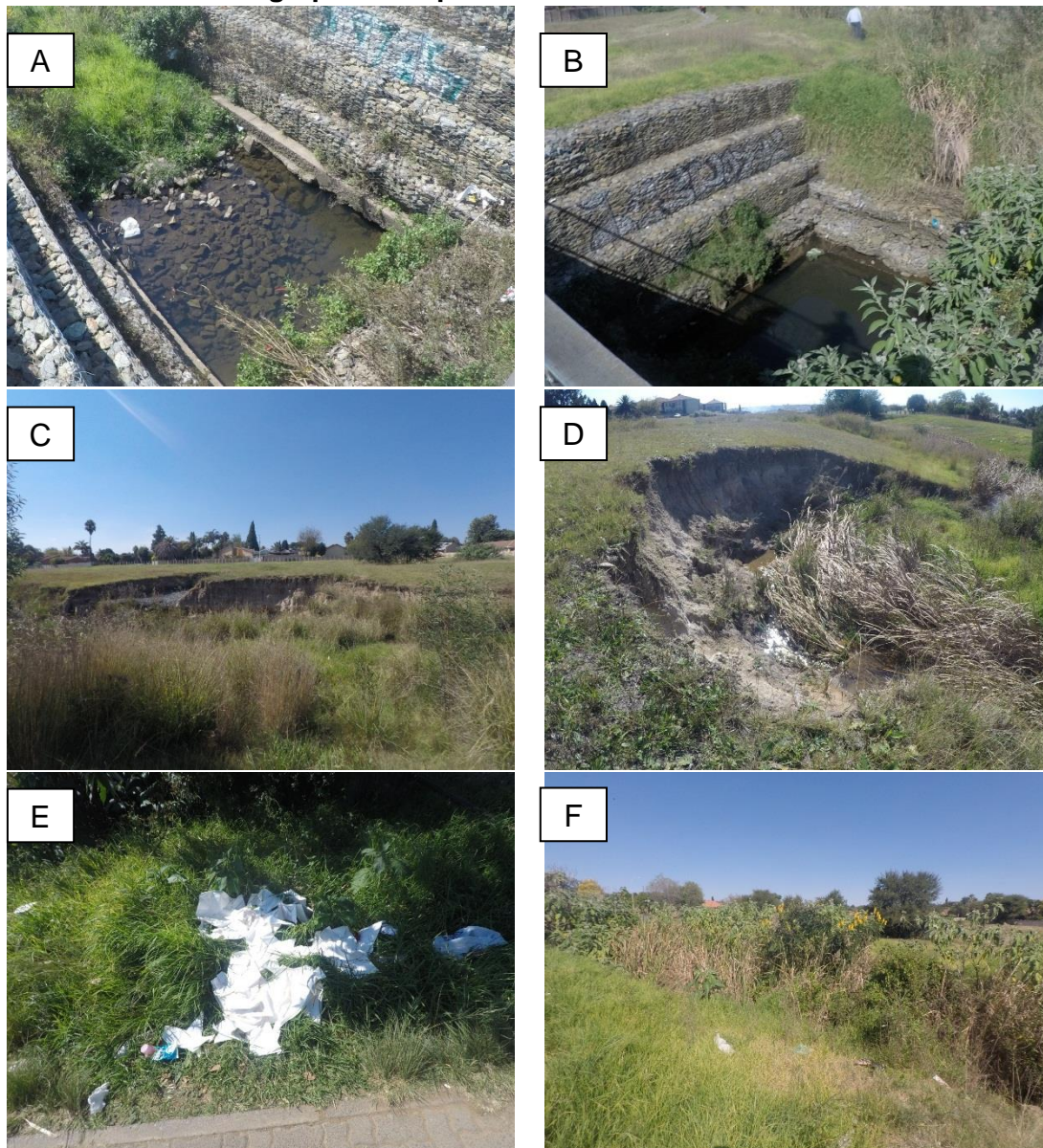


Figure 19: A. Erosion beneath gabion weir (26°2'59.46"S; 28°13'17.55"E); B. Alien invasive vegetation growing on structure (26°2'59.46"S; 28°13'17.55"E); C. Large active erosion of channel (26°2'56.19"S; 28°13'17.25"E); D. Large active erosion of channel (26°2'49.31"S; 28°13'16.32"E); E. Litter (26°3'1.29"S; 28°13'19.75"E); F. Alien invasive vegetation (26°3'1.12"S; 28°13'19.43"E).

E. Photographs of interventions present



Figure 20: A. Concrete buttress weir (26°2'47.61"S; 28°13'16.44"E); B. Gabion mattress (26°2'48.04"S; 28°13'16.36"E); C. Concrete buttress weir (26°2'54.47"S; 28°13'17.03"E); D. Gabion mattress (26°2'58.56"S; 28°13'17.33"E); E. Gabion weir (26°2'59.46"S; 28°13'17.55"E); F. Gabion weir (26°2'59.46"S; 28°13'17.55"E).

3.5.2 WETLAND REHABILITATION ZONE 2

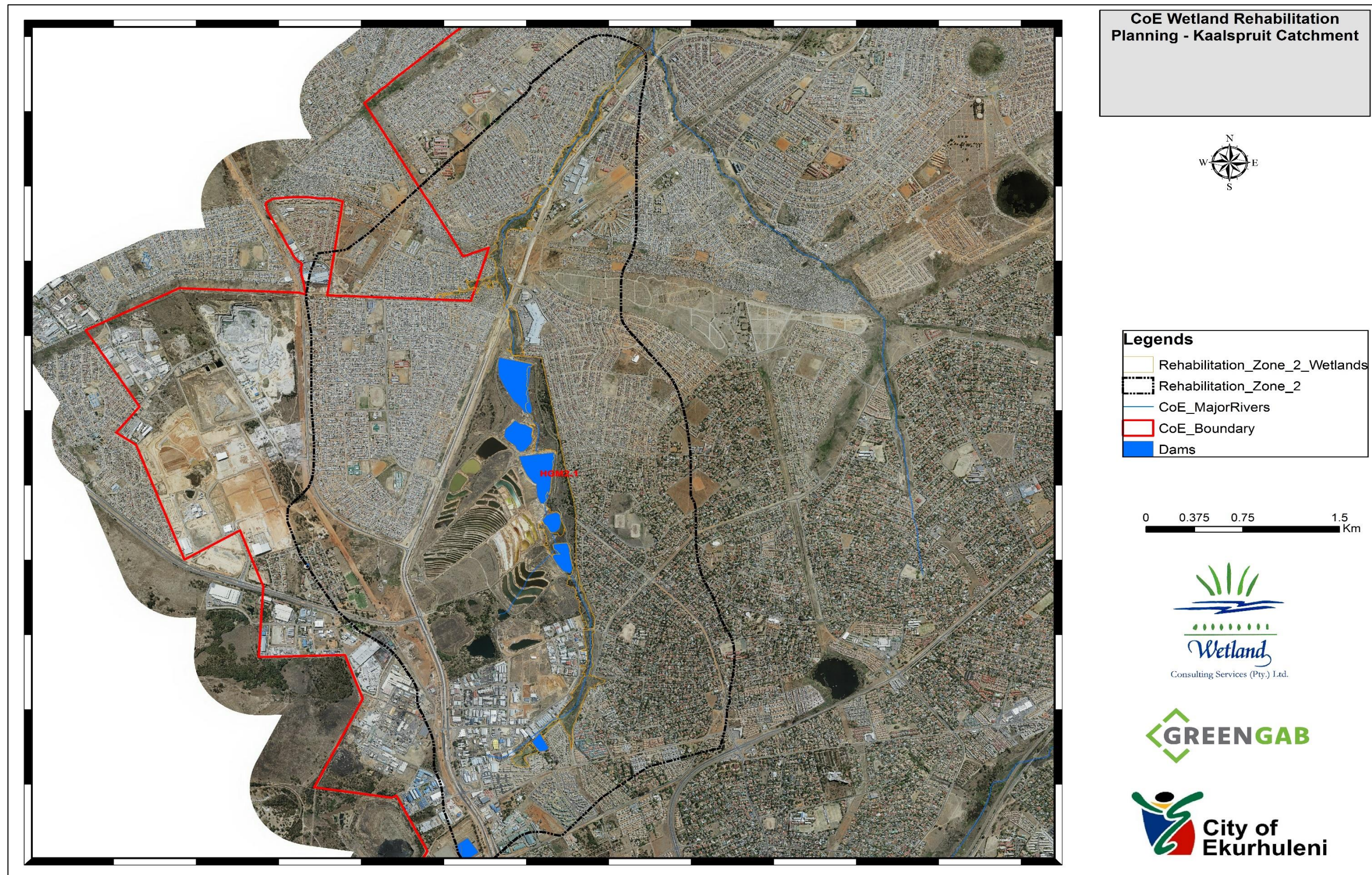


Figure 21: Map showing the extent of Wetland Rehabilitation Zone 2 with associated wetland HGM units.

3.5.2.1 HYDROGEOMORPHIC UNIT: CHANNELLED VALLEY BOTTOM (HGM 2.1) - GPS CO-ORDINATE: 26°1'56.63"S; 28°11'24.6"E

A. Impacts recorded

- Dumping of rubble and litter;
- Litter and sewage discharge into watercourse;
- Tracks and informal roads;
- Informal settlements;
- Park area (Park 2030);
- Walk ways and construction by Park 2030; and
- Alien invasive vegetation:
 - *Acacia mearnsii*
 - *Salix babylonica*
 - *Populus alba*

B. Rehabilitation objectives

- Improve aesthetic appeal of the channel and surrounding open area for the community;
- Improve habitat and attract local avifauna species;

C. Rehabilitation activities

- Remove of litter and rubble around the valley bottom wetland;
- Install a low-lying pedestrian crossing/bridge across the channel;
- Remove alien invasive vegetation;
- Create walkways around the valley bottom and revegetated open spaces;
- Plant trees in selected areas to provide shades for bird viewers and picnics (consider an outdoor gym);
- Ploughing areas around the pan basin and leave them for natural vegetation to re-establish
- Practice regular mowing before weeds start flowering to allow natural grass species to come in
- Revegetate areas around the pan basin that remain eroded after ploughing if natural vegetation does not re-establish
- Typical Species:
 - *Imperata cylindrical*
 - *Eragrostis plana*
 - *Eragrostis gummiflua*
 - *Eragrostis curvula*
 - *Agrostis lachnantha*
 - *Paspalum distichum*
 - *Juncus effusus*
- Later species to plant once the grasses have established to attract local avifauna species
 - *Kniphofia caulescens*
 - *Crinum bulbispermum*
 - *Erythrin spp.*
 - *Hypoxis spp.*
 - *Combretum erythrophyllum*

D. Photographs of impacts recorded



Figure 22: Photographs indicating some of the impacts observed.

E. Photographs of existing wetland rehabilitation interventions onsite



Figure 23: Photographs indicating some of the existing wetland rehabilitation interventions and activities onsite.

3.5.3 WETLAND REHABILITATION ZONE 3

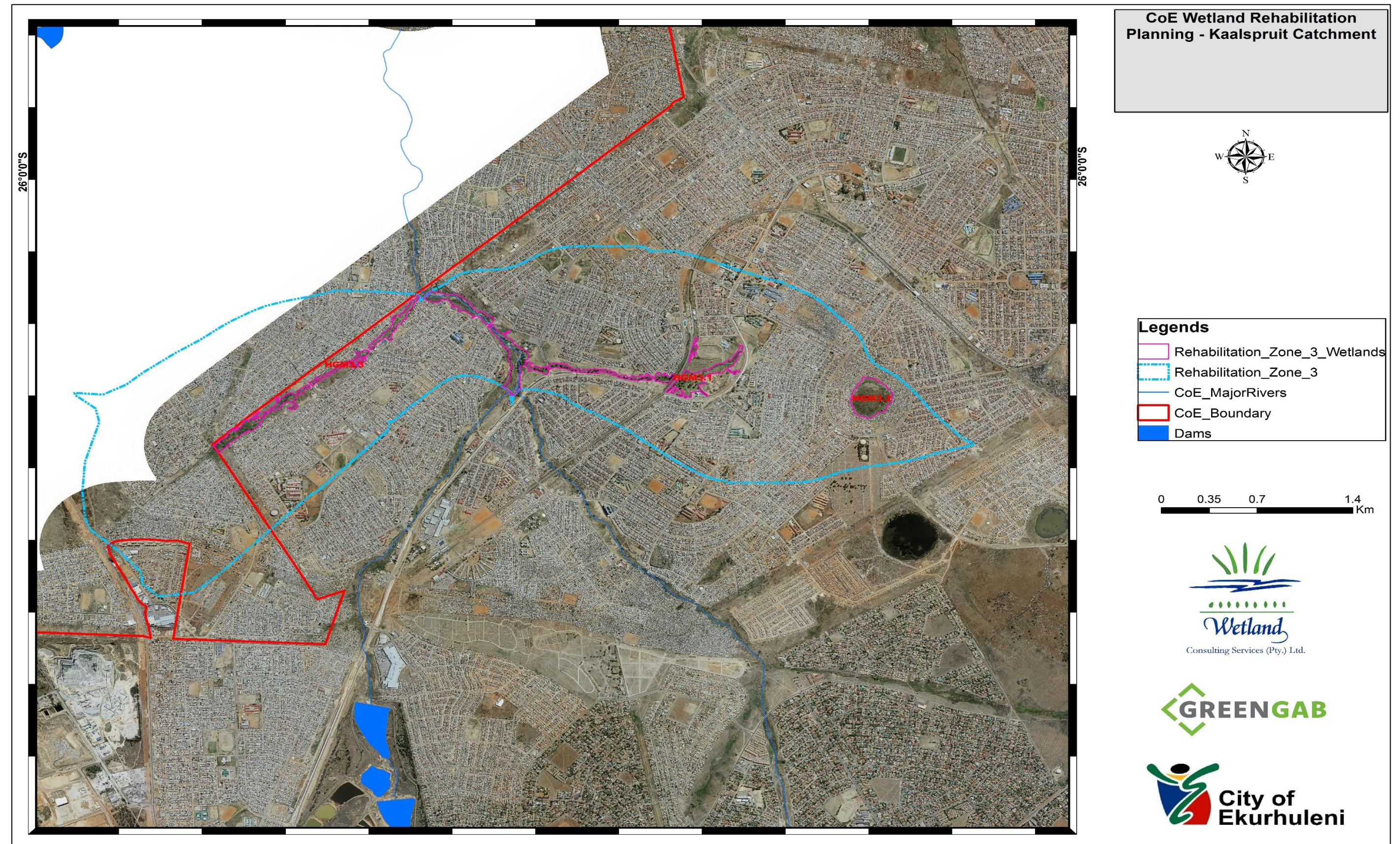


Figure 24: Map showing the extent of Wetland Rehabilitation Zone 3 with associated wetland HGM units.

3.5.3.1 HYDROGEOMORPHIC UNIT: SEEPAGE WETLAND CONNECTED TO A STREAM (HGM 3.1) - GPS CO-ORDINATE: 26°0'56.64"S; 28°12'55.95"E

A. Impacts recorded

- Dumping of rubble and litter;
- Deeply incised channel (\pm 3.5 m);
- Tracks and informal roads;
- Road culvert;
- Concrete pipes and structures; and
- Alien invasive vegetation:
 - *Acacia mearnsii*
 - *Salix babylonica*

B. Rehabilitation objectives

- Improve aesthetic appeal of the channel and surrounding open area for the community; and
- Improve habitat and attract local avifauna species.

C. Rehabilitation activities

- Remove of litter and rubble around the valley bottom wetland;
- Install a channel lining along the eroded channel including energy dissipaters to slow down flow at different points along the channel;
- Install a pedestrian crossing/bridge across the channel;
- Remove alien invasive vegetation;
- Create walkways around the valley bottom and revegetated open spaces;
- Plant trees in selected areas to provide shades for bird viewers and picnics (consider an outdoor gym);
- Ploughing areas around the pan basin and leave them for natural vegetation to re-establish
- Practice regular mowing before weeds start flowering to allow natural grass species to come in
- Revegetate areas around the pan basin that remain eroded after ploughing if natural vegetation does not re-establish
- Typical Species:
 - *Imperata cylindrical*
 - *Eragrostis plana*
 - *Eragrostis gummiflua*
 - *Eragrostis curvula*
 - *Agrostis lachnantha*
 - *Paspalum distichum*
 - *Juncus effusus*
- Later species to plant once the grasses have established to attract local avifauna species
 - *Kniphofia caulescens*
 - *Crinum bulbispermum*
 - *Erythrin spp.*
 - *Hypoxis spp.*
 - *Combretum erythrophyllum*

D. Photographs of impacts recorded

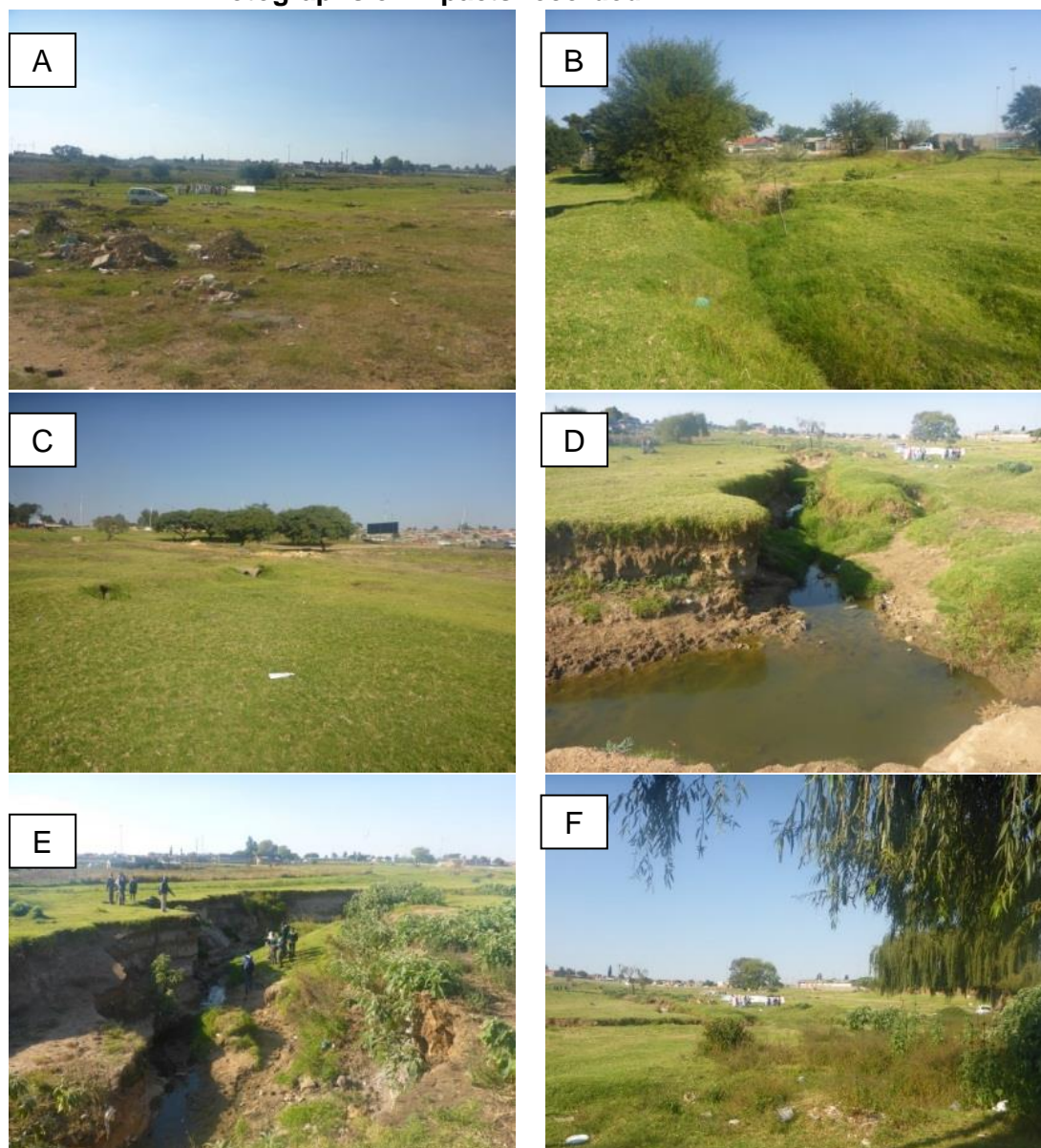


Figure 25: Photographs indicating some of the impacts observed.

E. Photographs of existing wetland rehabilitation interventions onsite



Figure 26: Photographs indicating some of the existing wetland rehabilitation interventions and activities onsite.

3.5.3.2 HYDROGEOMORPHIC UNIT: ISEKELO PAN (HGM 3.2) - GPS CO-ORDINATE: 26°1'3.43"S; 28°13'40.61"E

A. Impacts recorded

- Dumping of rubble and litter;
- Tracks and informal roads;
- Informal settlements; and
- Alien invasive vegetation:
 - *Populus alba*

B. Rehabilitation objectives

- Improve aesthetic appeal of the channel and surrounding open area for the community; and
- Improve habitat and attract local avifauna species.

C. Rehabilitation activities

- Remove of litter and rubble around Pan basin;
- Consider eviction of informal settlements between pan basin and road;
- Remove alien invasive vegetation;
- Install palisade fencing around the pan and surrounding areas;
- Provide access to areas using turn style gates;
- Create walkways around the valley bottom and revegetated open spaces;
- Plant trees in selected areas to provide shades for bird viewers and picnics (consider an outdoor gym);
- Ploughing areas around the pan basin and leave them for natural vegetation to re-establish
- Practice regular mowing before weeds start flowering to allow natural grass species to come in
- Revegetate areas around the pan basin that remain eroded after ploughing if natural vegetation does not re-establish
- Typical Species:
 - *Imperata cylindrical*
 - *Erograstis plana*
 - *Eragrostis gummiflua*
 - *Eragrostis curvula*
 - *Agrostis lachnantha*
 - *Cynodon dactylon*
 - *Paspalum distichum*

D. Photographs of impacts recorded



Figure 27: Photographs indicating some of the existing wetland impacts onsite.

3.5.3.3 HYDROGEOMORPHIC UNIT: CHANNELLED VALLEY BOTTOM (HGM 3.3) - GPS CO-ORDINATE: 26° 0'49.58"S; 28°11'27.15"E

A. Impacts recorded

- Severe erosion beneath bridge and existing intervention;
- Collapse of existing intervention;
- Alien invasive vegetation;
- Dumping of building rubble and litter; and
- Polluted water and sewage discharge into channel.

B. Rehabilitation objectives

- Improve ecological functioning of the watercourse
- Improve vegetation species composition
- Improve aesthetic appeal of the system;

C. Rehabilitation activities

- Formalize the water channel;
- Restore or replace bridge and crossing for cars and pedestrians to improve safety for community;
- Stabilisation of erosion by construction erosion control structures
- Removal of alien invasive vegetation and water pollutants; and
- Removal of rubble and litter around the channel and in the open surrounding area and supply an alternative official dumping site.

D. Photographs of impacts recorded





Figure 28: A. Litter (26°0'49.58"S; 28°11'27.15"E); B. Alien invasive vegetation (26°0'48.92"S; 28°11'28.72"E) C. Large active erosion beneath bridge (26°0'48.94"S; 28°11'28.77"E); D. Large active erosion and litter beneath bridge and gabion weir (26°0'48.94"S; 28°11'28.77"E); E. Large active erosion and litter (26°0'48.94"S; 28°11'28.77"E); F. Large active erosion and litter (26°0'48.94"S; 28°11'28.77"E); G. Alien invasive vegetation and polluted water (26°0'49.56"S; 28°11'28.48"E); H. Sedimentation and polluted water (26°0'50.15"S; 28°11'26.91"E).

3.5.4 WETLAND REHABILITATION ZONE 4



Figure 29: Map showing the extent of Wetland Rehabilitation Zone 4 with associated wetland HGM units.

3.5.4.1 HYDROGEOMORPHIC UNIT: CHENNELLED VALLEY BOTTOM (HGM 4.1) - GPS CO-ORDINATE: 25° 59'57.07"S; 28°11'39.89"E

A. Impacts recorded

- Alien invasive vegetation;
- Dumping of building rubble and litter;
- Sewage discharge into channel; and
- Erosion of channel and along the side of intervention.

B. Rehabilitation objectives

- Improve vegetation species composition
- Improve aesthetic appeal of the wetland systems
- Improve ecological functioning of the wetland system R

C. Rehabilitation activities

- Removal of alien invasive vegetation;
- Removal of water pollutants;
- Removal rubble and litter of channel and open surrounding area, and supply an alternative official dumping site; and
- Formalize channel.

D. Photographs of impacts recorded





Figure 30: A. Dumping of building rubble (25°59'57.25"S; 28°11'40.76"E); B. Erosion of channel bank (25°59'57.11"S; 28°11'39.84"E) C. Erosion at far-side of intervention and polluted water (25°59'57.11"S; 28°11'39.84"E); D. Erosion and polluted water (25°59'57.11"S; 28°11'39.84"E); E. Dumping of rubble and litter (25°59'59.88"S; 28°11'43.99"E).

3.5.4.2 HYDROGEOMORPHIC UNIT: CHANNELLED VALLEY BOTTOM (HGM 4.2) - GPS CO-ORDINATE: 25° 58'51.31"S; 28°12'50.31"E

A. Impacts recorded

- Litter; and
- Water quality deterioration – surcharging manhole and sewerage discharge into watercourses.

B. Rehabilitation objectives

- Improve aesthetic appeal of the channel and surrounding open area for the community; and
- Improve habitat and attract local avifauna species.
- Improve water quality within the channel

C. Rehabilitation activities

- Provide garbage bins for litter;
- Revegetate the channel using indigenous flora:
- Typical Species:
 - *Typha capensis*
 - *Juncus effuses*
 - *Kyllinga erecta*
 - *Schoenoplectus decipiens*
- Revegetate the open area using indigenous flora:
- Typical Species:
 - *Erythrina lysistemon* trees
 - *Celtis Africana* trees
 - *Melinis repens*
 - *Eragrostis racemose*
- Create designated paths in the open surrounding area and bridges across the channel; and
- Create a recreational area for the community in the open surrounding by providing benches, park facilities and planting trees to provide shade.

D. Photographs of impacts recorded



Figure 31: A. Open surrounding area (25°58'52.27"S; 28°12'50.22"E); B. Litter (25°58'52.29"S; 28°12'50.46"E)

3.5.4.3 HYDROGEOMORPHIC UNIT: CHANNELLED VALLEY BOTTOM (HGM 4.3) - GPS CO-ORDINATE: 25° 57'36.39"S; 28°12'22.56"E

A. Impacts recorded

- Dumping of building rubble and litter;
- Sewage discharge into channel;
- Erosion of channel; and
- Alien invasive vegetation.

B. Rehabilitation objectives

- Improve aesthetic appeal of the wetland system;
- Improve vegetation species composition
- Improve water quality within the channel
- Improve ecological functioning of the wetland system

C. Rehabilitation activities

- Removal of alien invasive vegetation and water pollutants;
- Removal rubble and litter from channel and surrounding area' and supply an alternative official dumping site; and
- Formalise channel.

D. Photographs of impacts recorded

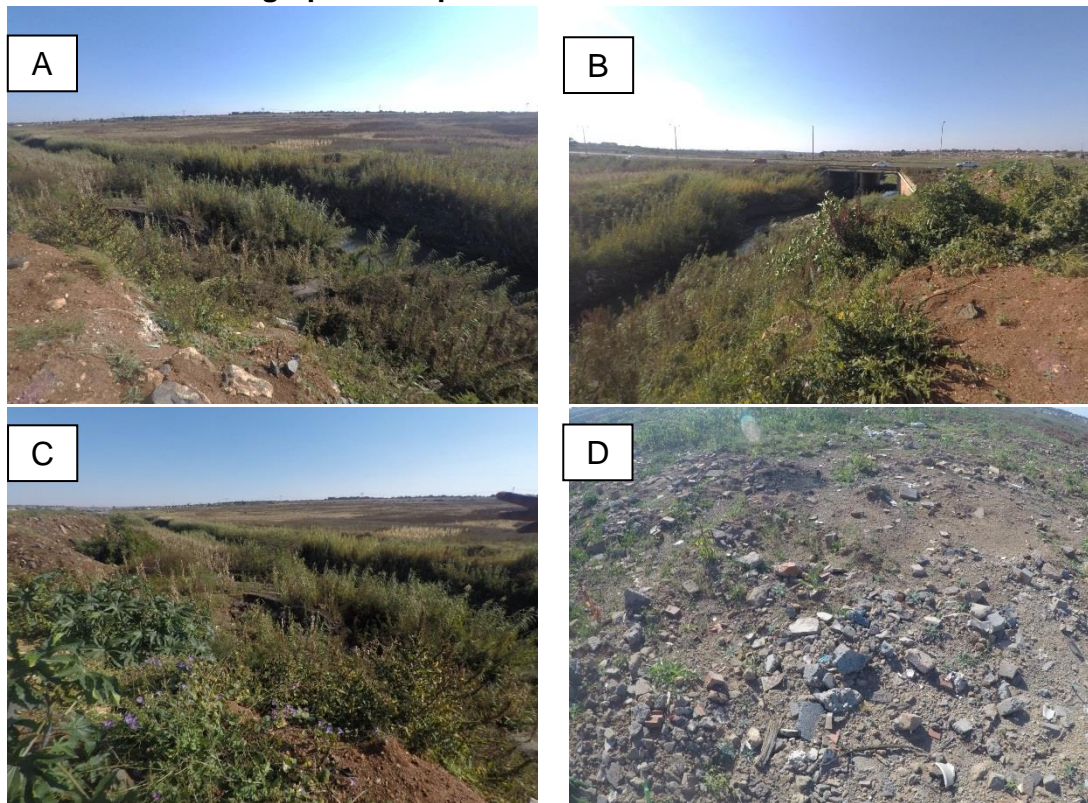


Figure 32: A. Alien invasive vegetation and erosion upstream (25°57'36.39"S; 28°12'22.56"E); B. Alien invasive vegetation and erosion downstream (25°57'36.39"S; 28°12'22.55"E); C. Alien invasive vegetation and erosion upstream (25°57'36.50"S; 28°12'22.55"E); D. Dumping of rubble (25°57'37.39"S; 28°12'23.92"E).

3.5.5 WETLAND REHABILITATION ZONE 6

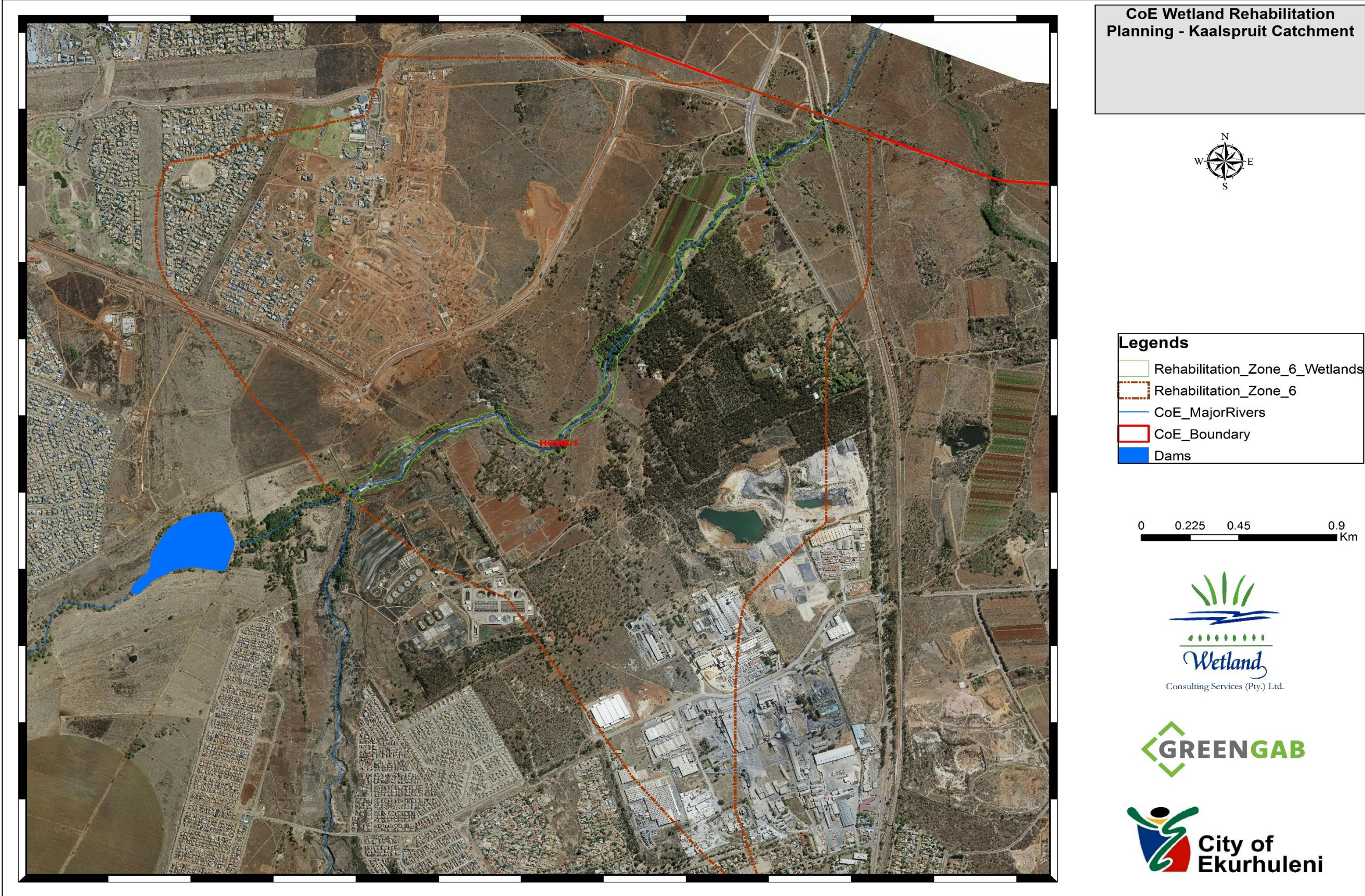


Figure 33: Map showing the extent of Wetland Rehabilitation Zone 6 with associated wetland HGM units.

3.5.5.1 HYDROGEOMORPHIC UNIT: CHANNELLED VALLEY BOTTOM (HGM 6.1) - GPS CO-ORDINATE: 25° 55'20.057"S; 28°13'38.621"E

A. Impacts recorded

- Litter and polluted water; and
- Alien invasive vegetation:
 - *Bidens pilosa*
 - *Arundo donax*
 - *Ipomoea purpurea*

B. Rehabilitation objectives

- Improve vegetation species composition;
- Improve aesthetic appeal of the wetland system; and
- Improve water quality within the wetland system.

C. Rehabilitation activities

- Removal of alien invasive vegetation; and
- Removal of litter, sediment and upgrade of sewerage infrastructure to limit sewage entering watercourses

D. Photographs of impacts recorded



Figure 34: Alien invasive vegetation and sedimentation (25°55'20.10"S; 28°13'38.66"E).

3.5.6 WETLAND REHABILITATION ZONE 7

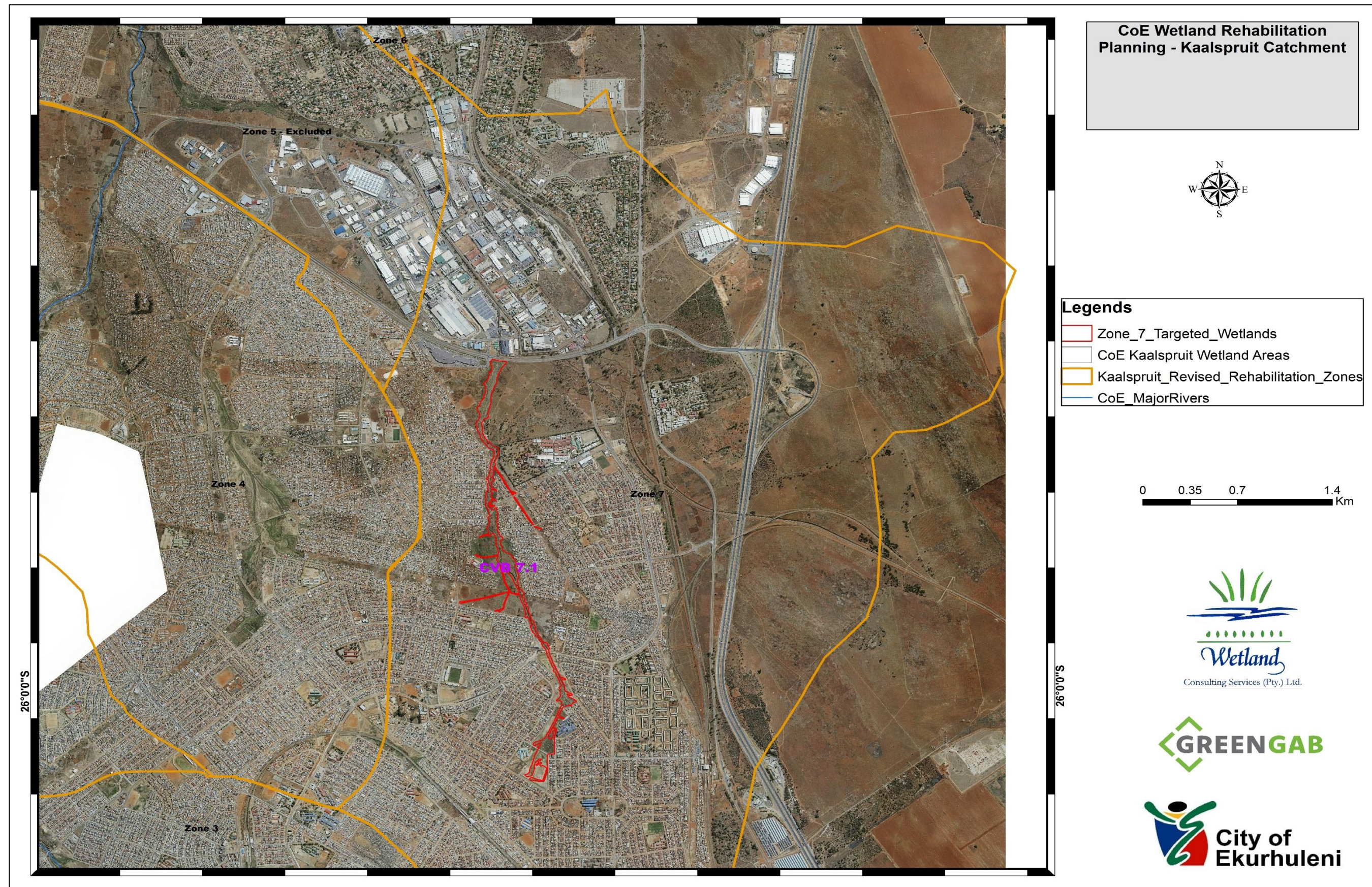


Figure 35: Map showing the extent of Wetland Rehabilitation Zone 7 with associated wetland HGM units.

3.5.6.1 HYDROGEOMORPHIC UNIT: CHANNELLED VALLEY BOTTOM (HGM 7.1) - GPS CO-ORDINATE: 26° 0'3.07"S ; 28°14'17.10"E

A. Impacts recorded

- Subsistence agricultural activities;
- Dumping and infilling building rubbles and litter;
- Alien invasive vegetation;
- Channel incision and erosion;
- Stormwater discharges and erosion;
- Roads crossing and multiple human informal tracks; and
- Surcharging manholes and sewerage discharges into watercourses.

B. Rehabilitation objectives

- Improve vegetation species composition;

3.5.6.2 IMPROVE ECOLOGICAL INTEGRITY AND FUNCTIONING OF THE WETLAND SYSTEM;

- Improve aesthetic appeal of the wetland system; and
- Improve water quality within the wetland system.

C. Rehabilitation activities

- Removal of alien invasive vegetation;
- Construction of instream erosion stabilisation interventions;
- Removal of litter, sediment and upgrade of sewerage infrastructure to limit sewage entering watercourses;
- Make plans to designate alternative dumping sites outside the wetland area (e.g. recycling zone for litter such as plastics;
- Demarcate areas for cultivation around and along wetland areas;
- Revegetate areas around the wetland that remain eroded after ploughing if natural vegetation does not re-establish
- Create walkways around the wetland area and revegetate open spaces; and
- Planting of trees in selected areas to provide shades for bird viewers and picnics.

D. Photographs of some of the recorded impacts on wetlands onsite





Figure 36: Photographs indicating some of the impacts observed within HGM 7.1

Based on the impacts observed on wetland onsite as well as the proposed strategy per each zone as indicated in above sections, a master plan will be compile. The plan will include all the proposed rehabilitation activities proposed for wetlands onsite including their associated costing and amongst others the activities will include the following:

1. Rehabilitation Activities instream:
 - a. Repair of existing rehabilitation structural activities instream (gabion and concrete structures) in order to improve their performances;
 - b. Construction of new instream structural interventions (gabions or concrete structures) for stabilisation of channel or stream erosion;
 - c. Construction of litter traps and silt traps;
 - d. Walkway traversing wetland areas via pedestrian spanning crossings across the wetland area;
 - e. Removal of litter and rubbles within the wetland/ watercourses;
 - f. Removal of alien vegetation instream; and
 - g. Landscaping and revegetation within the wetland areas to improve natural vegetation cover.
2. Rehabilitation Activities outside wetland areas within 500m Water Use Licence Application (WULA) trigger area
 - a. Walkways outside delineated areas and along the watercourses;
 - b. Physical removal of litter within and along the rivers through initiating various river clean projects;
 - c. Formalisation and establishment of communal subsistence agricultural plots outside but along watercourses;
 - d. Landscaping and revegetation of disturbed areas outside but along watercourses;
 - e. Establishment of gym facilities outside but along watercourses;
 - f. Removal of litter and rubbles outside but along wetland/ watercourses;
 - g. Removal of alien vegetation outside but along watercourses;
 - h. Establishment of rubbish collection facilities and bins at various point/areas outside but along the watercourses; and
 - i. Establishment of glassed soccer fields at various places outside but along watercourses.

4 REFERENCES

Brinson, M. M. 1993. *A hydrogeomorphic classification for wetlands*. Wetlands Research Program Technical Report WRP-DE-4. U. S. Army Corps of Engineers, Waterway Experiment Station. Vicksburg, MS: Bridgman and Richardson.

DWAF, 1999. Resource Directed Measures for Protection of Water Resources: Volume 4 – Wetland Ecosystems. Pretoria.

Kotze, D., Marneweck, G., Batchelor, A., Lindley, D. and Collins, N. 2007. WET-EcoServices: A technique for rapidly assessing ecosystem services supplied by wetlands. Wetland Management Series. Water Research Commission Report TT339/09, Water Research Commission, Pretoria.

Kotze, D. 2016a. *A method to assess wetland ecological condition based on land-cover type. Part 1: The user manual*. A simple Citizen Science tool to assess the ecological condition of a wetland. Version 1.4. Water Research Commission: Project No.K5/2350.

Kotze, D. 2016b. *A method to assess wetland ecological condition based on land-cover type. Part 2: Technical Background*. A simple Citizen Science tool to assess the ecological condition of a wetland. Version 1.4. Water Research Commission: Project No.K5/2350.

Macfarlane DM, Kotze DC, Ellery WN, Walters D, Koopman V, Goodman P and Goge C. 2007. *WET-Health: A technique for rapidly assessing wetland health*. WRC Report No TT 340/08, Water Research Commission, Pretoria

Marneweck, G.C. and Batchelor, A. 2002. Wetland inventory and classification. In: *Ecological and economic evaluation of wetlands in the upper Olifants River catchment*. (Palmer, R.W., Turpie, J., Marneweck, G.C and Batchelor (eds.)). Water Research Commission Report No. 1162/1/02.

Nell, J.L., Driver A., Strydom W., Maherry A., Petersen C., Roux D.J., Nienaber S., van Deventer H, Smith-Adao LB and Hill L. 2011. Atlas of Freshwater Ecosystem Priority Areas in South Africa: Maps to support sustainable development of water resources. WRC Report No. TT 500/11, Water Research Commission, Pretoria.

Nel, J.L., & A. Driver. 2012. National Biodiversity Assessment 2011: Technical Report. Volume 2: Freshwater Component. CSIR Report Number CSIR/NRE/ECO/IR/2012/0022/A. Council for Scientific and Industrial Research, Stellenbosch.

Ollis, D.j., Snaddon, K., Job, N. & Mbona, N. 2013. Classification system for wetlands and other aquatic ecosystems in South Africa. User manual: Inland systems. SANBI Biodiversity Series 22. SANBI, Pretoria.

Rountree MW, Thompson M, Kotze DC, Batchelor AL, and Marneweck, GC, 2008. *WET-Prioritise: Guidelines for prioritising wetlands at national, regional and local scales*. WRC Report No. TT 337/08. Water Research Commission, Pretoria.

Rountree, M.W., Malan, H. and Weston. B. (editors). 2013. Manual for the Rapid Ecological Reserve Determination for Wetlands (Version 2.0). Joint Department of Water Affairs/Water Research Commission Study. Draft Report. Water Research Commission, Pretoria.

SANBI (2009). Further Development of a Proposed National Wetland Classification System for South Africa. Primary Project Report. Prepared by the Freshwater Consulting Group (FCG) for the South African National Biodiversity Institute (SANBI).

Thompson, M., Marneweck, G., Bell, S., Kotze, D., Muller, J., Cox, D. and Clark, R. 2002. A pilot project for the determination of methods for the National Wetland Inventory. Wetland Inventory Consortium (Geospace, Wetland Consulting Services, INR and CSIR) for the Department of Environmental Affairs and Tourism, Pretoria.