# WATERCOURSE ASSESSMENT

*FOR THE PROPOSED UPGRADE OF IKHETHELO HIGH SCHOOL SITUATED IN VRYHEID, ABAQULUSI LOCAL MUNICIPALITY, ZULULAND DISTRICT, KWA-ZULU NATAL*



**Compiled by**

Dr Bruce Scott-Shaw
NatureStamp (Pty) Ltd
Tel 078 399 9139
Email bruce@naturestamp.com

**Compiled for**

Warren Hale
iNhlaba Consulting
Tel 084 831 8225
Email warren@inhlabaconsulting.com


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The White House, 22 Hilton Ave • PO Box 949, Hilton, 3245 • Tel: 033 343 1352 • Cell: 083 289 4912
susan@naturestamp.com • www.naturestamp.com

## Acronyms

| | |
|---|---|
| **CVB** | Channeled Valley Bottom |
| **DWS** | Department of Water & Sanitation |
| **DWAF** | Department of Water Affairs & Forestry |
| **EAP** | Environmental Assessment Practitioner |
| **ECO** | Environmental Control Officer |
| **EIA** | Environmental Impact Assessment |
| **EIS** | Ecological Importance & Sensitivity |
| **EKZNW** | Ezemvelo KwaZulu-Natal Wildlife |
| **FEPA** | Freshwater Ecosystem Priority Area |
| **GIS** | Geographical Information Systems |
| **HGM** | Hydro-Geomorphic |
| **IAPs** | Invasive Alien Plants |
| **PES** | Present Ecological State |
| **NFEPA** | National Freshwater Ecosystem Priority Areas |

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# Specialist Details & Declaration

This report has been prepared in accordance with Section 13: General Requirements for Environmental Assessment Practitioners (EAPs) and Specialists as well as per Appendix 6 of GNR 327 Environmental Impact Assessment Regulations and the National Environmental Management Act (NEMA, No. 107 of 1998 as amended 2017). It has been prepared independently of influence or prejudice by any parties. A full declaration of independence has been provided in Annexure F. The details of Specialists are as follows –

**Table 1 Details of Specialist**

| Specialist | Task | Qualification and accreditation | Client | Signature |
|---|---|---|---|---|
| Bruce Scott-Shaw NatureStamp | Fieldwork, Assessments & report | PhD, Hydrology | iNhlaba Consulting | Date: 18/12/2020 |
| Nick Davis Isikhungusethu Environmental Services | Design, GIS & Review | BSc, BSc Hon, MSc Hydrology | iNhlaba Consulting | Date: 18/12/2020 |

<u>Details of Authors:</u>

Bruce is a hydrologist, whose focus is broadly on hydrological perspectives of land use management and climate change. He completed his MSc under Prof. Roland Schulze in the School of Bioresources Engineering and Environmental Hydrology (BEEH) at the University of KwaZulu-Natal, South Africa. Throughout his university career he mastered numerous models and tools relating to hydrology, soil science and GIS. Some of these include ACRU, SWAT, ArcMap, Idrisi, HEC-RAS, WRSM, SEBAL, MatLab and Loggernet. He has some basic programming skills on the Java and CR Basic platforms. Bruce completed his PhD at the Center for Water Resources Research (UKZN), which focused on rehabilitation of alien invaded riparian zones and catchments using indigenous trees. Bruce is currently affiliated to the University of KwaZulu-Natal where he is a post-doctoral student where he runs and calibrates hydrological and soil erosion models. Bruce has presented his research around the world, including the European Science Foundation (Amsterdam, 2010), COP17 (Durban, 2011), World Water Forum (Marseille, 2012), MatLab advanced modelling (Luxembourg, 2013), World Water Week (Singapore, 2014), Forests & Water, British Colombia, (Canada, 2015), World Forestry Congress (Durban, 2015), Society for Ecological Restoration (Brazil, 2017). Conservation Symposium (Howick, South Africa, 2018) and SWAT modelling in Siem Reap (Cambodia, 2019). As a consultant, Bruce is the director and principal hydrologist of NatureStamp (PTY) Ltd. In this capacity he undertakes flood studies, calculates hydrological flows, performs general hydrological modelling, stormwater design, dam designs, wetland assessments, water quality assessments, groundwater studies and soil surveys.

<u>Details of Reviewer:</u>

Nicholas Davis is a hydrologist whose focus is broadly on hydrological perspectives of land use management, climate change, estuarine and wetland systems. Throughout his studies and subsequent work at UKZN he has mastered several models and programs such as ACRU, HEC-RAS, ArcMap, QGIS, Indicators of Hydrologic Alteration software (IHA) and Idrisi. He has moderate VBA programming skills, basic UNIX and python programming skills.

# 1. INTRODUCTION

## 1.1 Project Background and Description of the Activity

iNhlaba Consulting is in the Screening Phase of the proposed upgrading design and construction management of Ikhethelo High School situated in Vryheid, Kwa-Zulu Natal. The coordinates of the school site are: 27°59'47.42"S; 30°43'35.85"E

Upgrades of the following facilities are required:

- Administration Block (Block A);
- Lower grade classroom block (Block B);
- All ablution blocks (Block E, G & H) – The removal of asbestos roofing is to be done in accordance with the requirements of the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993);
- Teachers' cottage (Block I);
- Guardhouse – demolition and reconstruction (Block J); and
- Combi court to accommodate multiple sporting codes.

Additionally, the following new facilities are proposed:

- SNP & Team-teaching block;
- Refuse area;
- Covered walkways between the internal blocks; and
- Covered parking.

Uninformed and poorly planned infrastructural developments in the vicinity of water resources, such as sensitive surface and groundwater, can rapidly degrade these resources. Thus, pre-development (or in some cases post development) assessments are required to gain an understanding of the natural environment and guide the developmental process in order that site-specific mitigation measures can be put in place.

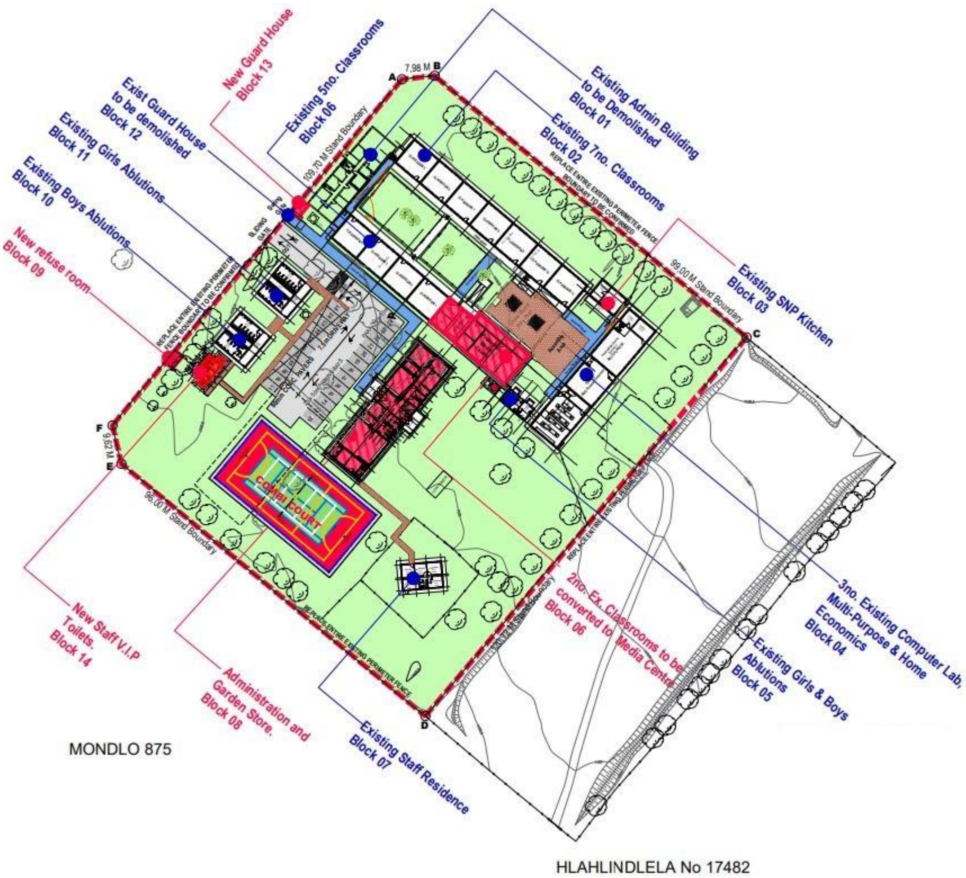


**Figure 1 Layout of the amendments to Ikhethelo school**

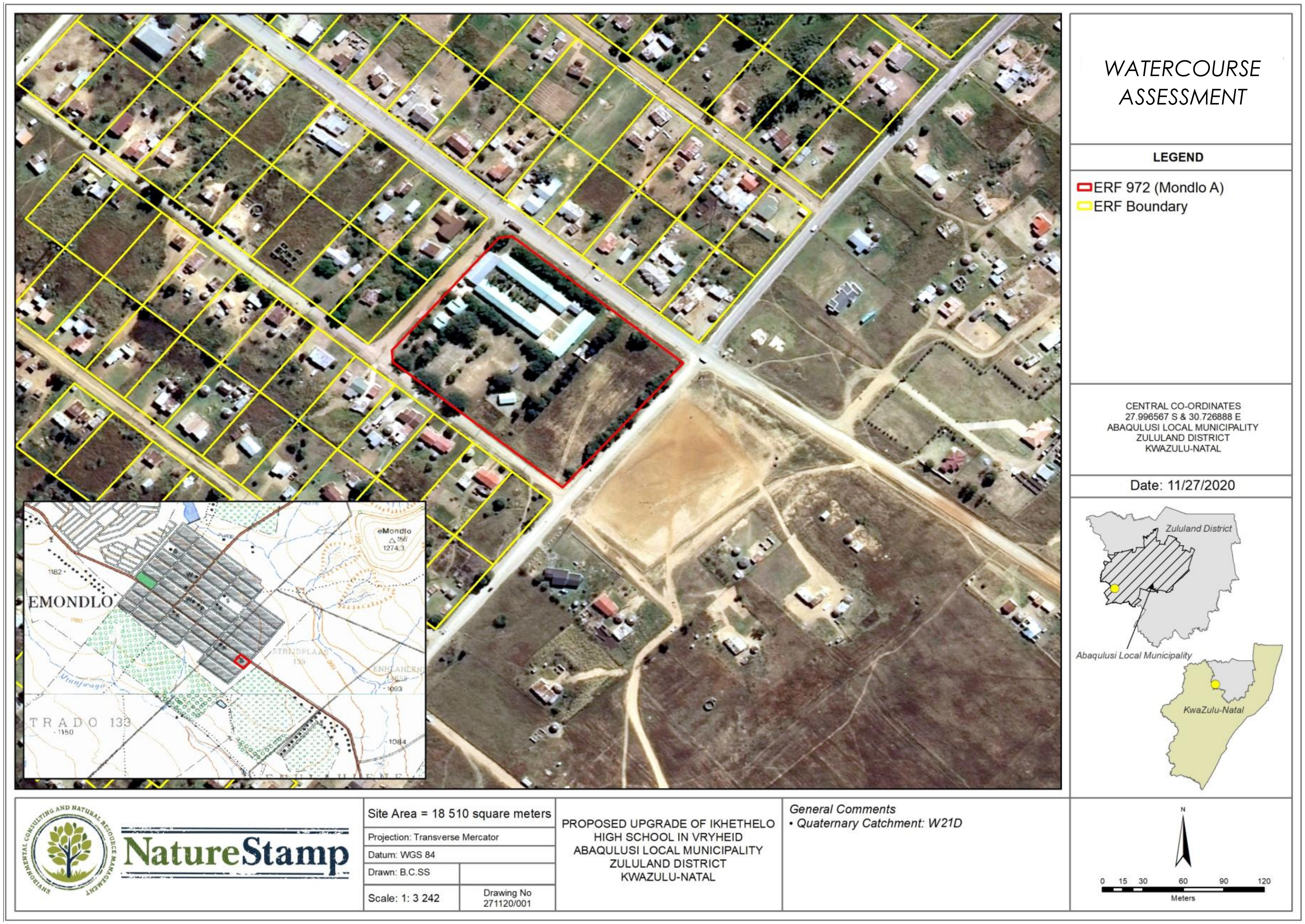


**Figure 2 Location of Ikhethelo school**

## 1.2 Terms of reference

### i. Watercourse/Aquatic Assessment

The condition/Present Ecological State (PES) of the delineated riverine and wetland areas present within 500 m of the proposed site; as well as the functional importance of any wetlands present within and near the development footprint would be assessed. This will involve:

a. an assessment of the delineated riverine areas by:
   i. determining the condition/PES of the riverine system using the rapid/qualitative Index of Habitat Integrity (IHI) tool (Kleynhans, 1996) for rivers (in-stream and riparian habitats assessed separately); and
   ii. determining the health/ecological importance & sensitivity (EIS) using the DWAF riverine EIS tool (Kleynhans, 1999).
b. an assessment of the delineated wetland areas by:
   i. determining the condition/ PES of the delineated wetlands using the Level 1 WET-Health tool (Macfarlane et al, 2009); and
   ii. determining the ecological importance & sensitivity (EIS) of the delineated wetlands using the Department of Water Affairs and Forestry (DWAF) wetland EIS tool (Duthie, 1999).
c. an impact assessment to investigate, evaluate and assess the impacts of the abovementioned activities on the environment.
d. Compilation of buffers to reduce minimise the identified impacts.

### ii. Risk Matrix and Management Plan / Mitigation Measures

General Authorization (GN 509, August 2016) applies to water use activities of section c) and i) of the NWA that have a low risk class as determined through the Risk Matrix, found in Appendix A of the GN. The impacts of the proposed development on the delineated watercourse areas would be identified, predicted and described. The significance of the proposed impacts would be rated according to nature, extent, magnitude, duration and probability. Measures would be recommended to mitigate impacts. Impacts and mitigation would be structured in a matrix that highlights overall risk as High, Medium, Low.

## 1.3 Classification System for Wetlands and Other Aquatic Systems

Differences in terminology can lead to confusion in the scientific and consulting fields. As such, terminology used in the context of this report needs to be defined. The National Water Act (No. 36 of 1998) defines a watercourse, wetland and riparian habitat as follows:

- A **watercourse** means - (a) a river or spring; (b) a natural channel in which water flows regularly or intermittently; (c) a wetland, lake or dam into which, or from which, water flows; and (d) any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.
- A **wetland** means 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.
- A **riparian habitat** includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas.

Any features meeting these criteria within the development site were delineated and classified using the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland systems hereafter referred to as the "Classification System" (Ollis *et. al*., 2013). A summary of Levels 1 to 4 of the classification system are discussed further below.

Inland wetland systems (non-coastal) are ecosystems that have no existing connection to the ocean which are inundated or saturated with water, either permanently or periodically (Ollis *et. al*., 2013). Inland wetland systems were divided into four levels by the Freshwater Consulting Group in 2009 and revised in 2013. Level 1 describes the connectivity of the system to the ocean, level 2 the regional setting (eco-region), level 3 the landscape setting, level 4A the hydro-geomorphic (HGM) type and level 4B the longitudinal zonation. Further information has been provided in Annexure B.
The level 3 classification has been divided into four landscape units. These are:

a) **Slope** – located on the side of a mountain, hill or valley that is steeper than lowland or upland floodplain zones.
b) **Valley Floor** – gently sloping lowest surface of a valley, excluding mountain headwater zones.
c) **Plain** – extensive area of low relief. Different from valley floors in that they do not lie between two side slopes, characteristic of lowland or upland floodplains.
d) **Bench** (hilltop/saddle/shelf) - an area of mostly level or nearly level high ground, including hilltops/crests, saddles and shelves/terraces/ledges.

Level 4 HGM types (which is commonly used to describe a specific wetland type) have been divided into 8 units. These are described as follows:

- **Channel** (river, including the banks) - an open conduit with clearly defined margins that (i) continuously or periodically contains flowing water. Dominant water sources include concentrated surface flow from upstream channels and tributaries, diffuse surface flow or interflow, and/or groundwater flow.
- **Channelled valley-bottom wetland** - a mostly flat valley-bottom wetland dissected by and typically elevated above a channel (see channel). Dominant water inputs to these areas are typically from the channel, either as surface flow resulting from overtopping of the channel bank/s or as interflow, or from adjacent valley-side slopes (as overland flow or interflow).
- **Un-channelled valley-bottom wetland** - a mostly flat valley-bottom wetland area without a major channel running through it, characterised by an absence of distinct channel banks and the prevalence of diffuse flows, even during and after high rainfall events.
- **Floodplain wetland** - the mostly flat or gently sloping wetland area adjacent to and formed by a Lowland or Upland Floodplain river, and subject to periodic inundation by overtopping of the channel bank.
- **Depression** - a landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates. Dominant water sources are precipitation, ground water discharge, interflow and (diffuse or concentrated) overland flow.
- **Flat** - a near-level wetland area (i.e. with little or no relief) with little or no gradient, situated on a plain or a bench in terms of landscape setting. The primary source of water is precipitation.
- **Hillslope seep** - a wetland area located on (gentle to steep) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope.
- **Valley head seep** - a gently-sloping, typically concave wetland area located on a valley floor at the head of a drainage line, with water inputs mainly from subsurface flow.

# 2. ALLOWABLE ABSTRACTIONS AND LEGISLATION

Quaternary Catchment (QC) site: W21D (Mfolozi – WMA 6).

According to GN 538 (2016), the General Authorization (GA) limits for this QC are as follows–

- Abstraction of surface water: 80 000 $m^3$ / year @ 16 l/s from December to April.
- Storage of water: 80 000 $m^3$.
- Groundwater abstraction: 150 $m^3$/ha/year (allowed under GA).

These limits show that this catchment area is somewhat water limited and restricted water use applies.

# 3. STUDY SITE

## 3.1 General Description

The site is located within Quaternary Catchment W21D; falling under the Usutu/Phongolo/Mfolozi Water Management Area (WMA) and not managed by a waterboard. The proposed area sits in the upper catchment area of the Mvunyane with modified by land use practices. The site is within the greater catchment area of the White Mfolozi system. The catchment area is highly susceptible to erosion as was evident during the site visit.

Rainfall in the Mondlo region occurs in the summer months (mostly December to February), with a mean annual precipitation of 635 mm (observed from rainfall station 0372296 W). The reference potential evaporation ($ET_o$) is approximately 1800 mm (A-pan equivalent, after Schulze, 2011) and the mean annual evaporation is between 1400 – 1500 mm, which exceeds the annual rainfall. This suggests a high evaporative demand and a water limited system. Summers are warm to hot and winters are cool. The mean annual temperature is approximately 21 °C in summer and 12 °C in the winter months (Table 2). The underlying geology of the site is dominated by Pietermaritzburg shale and Vryheid Arenite/shale. The soils overlain are sandy-clay ranging from Glenrosa to Longlands form in this particular area.

Table 2 Mean monthly rainfall and temperature observed at Mondlo (derived from historical data)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Ann |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Mean Rainfall (mm)** | 108.1 | 83.5 | 71.8 | 31.8 | 12.4 | 12.5 | 12.2 | 22.3 | 34.0 | 76.8 | 83.9 | 95.2 | **635** |
| **Mean Temperature (°C)** | 21.4 | 20.3 | 17.9 | 14.9 | 12.2 | 12.2 | 14.4 | 17.3 | 18.2 | 19.6 | 20.8 | 21.1 | **17.6** |


**Figure 3 The site around Ikhethelo school**

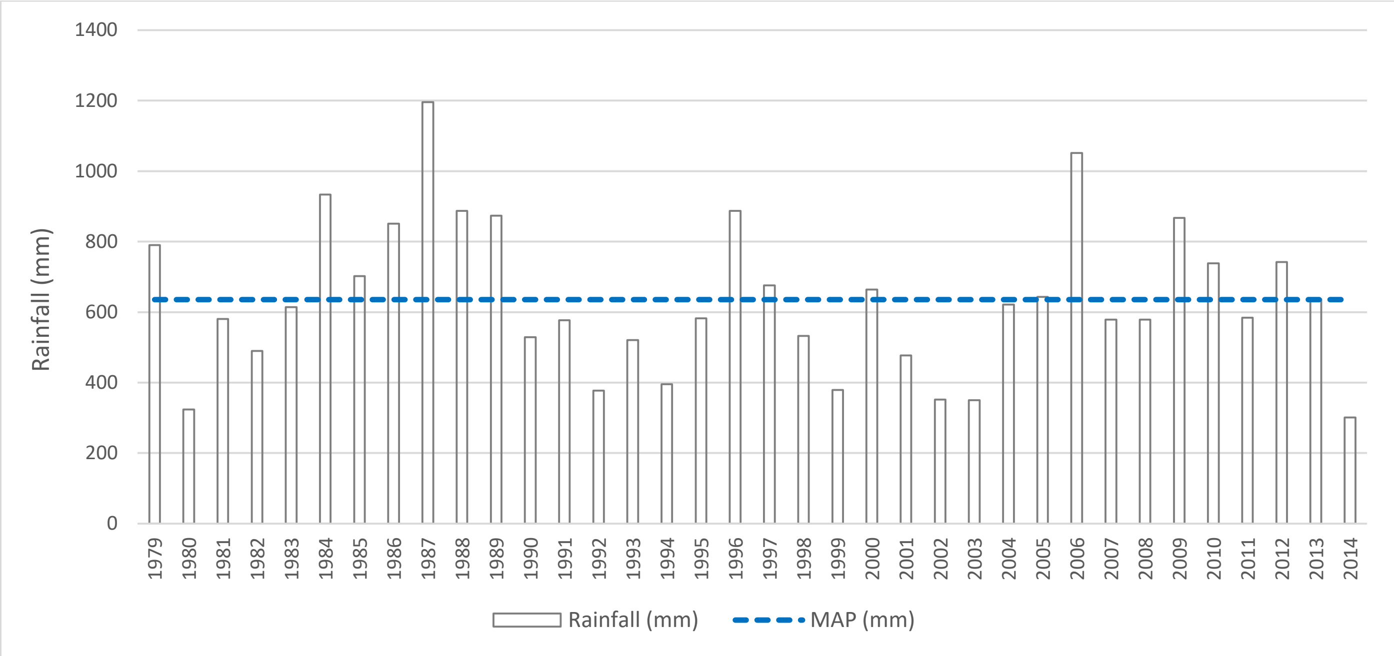


**Figure 4 Long-term rainfall near the site**

# 4. METHODOLOGY

A detailed description of the methods has been provided. The regional context and desktop analysis were used as the point of departure. Subsequently, a site visit was undertaken to delineate any wetlands and riparian areas. These systems were then assessed to determine the potential impacts that have been caused. The assessment of these systems considered the following tools where relevant:

Table 3 Assessment approach and the recommended tools for rivers and wetlands

| Aquatic Component | Method/Technique | Tool Utilized |
|---|---|---|
| Rivers | Delineation | *A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (DWAF, 2005).* |
| | Classification | *National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa (Ollis et al, 2014).* |
| | River condition/Present Ecological State (PES) | DWAF IHI (Index of Habitat Integrity) tool (Kleynhans, 1996) for rivers (riparian habitat only) |
| | River Ecological Importance & Sensitivity (EIS) | DWAF riverine EIS tool (Kleynhans, 1999) |
| Wetlands | Delineation | *A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (DWAF, 2005).* |
| | Classification | *National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa (Ollis et al, 2014).* |
| | Wetland condition/Present Ecological State (PES) | Level 1 WET-Health tool (Macfarlane *et al*., 2009) |
| | Wetland Functional/Ecosystem Services Assessment | Level 2 WET-EcoServices assessment tool (Kotze *et al*., 2009) |
| | Wetland Ecological Importance & Sensitivity (EIS) | DWAF wetland EIS tool (Duthie, 1999) |

Table 4 Data type and source for the assessment

| Data Type | Year | Source/Reference |
|---|---|---|
| Aerial Imagery | 2016 | Surveyor General |
| 1:50 000 Topographical | 2011 | Surveyor General |
| 5m Contour | 2010 | Surveyor General |
| River Shapefile | 2011 | EKZNW |
| Land Cover | 2014 | EKZNW |
| Water Registration | 2013 | WARMS - DWS |

*Data will be provided on request

## 4.1 Regional Context

### 4.1.1 National Freshwater Ecosystem Priority Areas (NFEPA) Project / Assessment

The 'National Freshwater Ecosystem Priority Areas' (NFEPA) project is a systematic biodiversity planning tool developed by the CSIR (2011) to identify freshwater areas considered the most important for biodiversity conservation. The key objectives of the NFEPA project are to ensure that all ecosystems and species are represented and that key ecological processes remain intact – achieving biodiversity targets within the smallest, most efficient area possible, with attention to connectivity over large areas (CSIR, 2011).

The conservation importance of the Mondlo A site was determined by consulting the relevant NFEPA layers (NFEPA WMA map, NFEPA wetlands and NFEPA rivers) in a geographical information system.

NFEPA was a three-year partnership project between South African National Biodiversity Institute (SANBI), CSIR, Water Research Commission (WRC), Department of Environmental Affairs (DEA), Department of Water Affairs (DWA), Worldwide Fund for Nature (WWF), South African Institute of Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks). NFEPA map products provide strategic spatial priorities for conserving South Africa's freshwater ecosystems and supporting sustainable use of water resources. These strategic spatial priorities are known as Freshwater Ecosystem Priority Areas, or FEPAs.

FEPAs were determined through a process of systematic biodiversity planning and were identified using a range of criteria for conserving ecosystems and associated biodiversity of rivers, wetlands and estuaries. FEPAs are often tributaries and wetlands that support hard-working large rivers, and are an essential part of an equitable and sustainable water resource strategy. FEPAs need to stay in a good condition to manage and conserve freshwater ecosystems, and to protect water resources for human use. The current and recommended condition for all river FEPAs is A or B ecological category. Wetland FEPAs that are currently in a condition lower than A or B should be rehabilitated to the best attainable ecological condition.

### 4.1.2 Terrain, Soils, Geology & Vegetation

Contour lines (5 meter) were used to calculate the slope of each of the banks. The soils and geology were obtained from GIS layers obtained from the Soil Science department at the University of KwaZulu-Natal (UKZN). Various vegetation databases were used to determine the likely or expected vegetation types (Mucina & Rutherford, 2006; Scott-Shaw & Escott, 2011). A number of recognized databases were utilized in achieving a comprehensive review, and allowing any regional or provincial conservation and biodiversity concerns to be highlighted. The Guideline for Biodiversity Impact Assessment (EKZNW, 2013) was followed where applicable. The following databases were interrogated:

- *Ezemvelo KZN wildlife (C-Plan & SEA Database)*

The C-Plan is a systematic conservation-planning package that consists of metadata within a shapefile, used by ArcGIS (or similar tool), which analyses biodiversity features and landscape units. C-Plan is used to identify a national reserve system that will satisfy specified conservation targets for biodiversity features (Lombard *et al*, 2003). These units or measurements are ideal for areas which have not been sampled. The C-Plan is an effective conservation tool when determining priority areas at a regional level and is being used throughout South Africa to identify areas of conservation value. Some of this information extends into the Eastern Cape.

The Strategic Environmental Assessment (SEA, 2000) Plan is a database of the modelled distribution of a selection of red data and endemic species that could, or are likely, to occur in an area.

- *Mucina and Rutherford's Vegetation Assessment*

The South African National Biodiversity Institute (SANBI) developed a database of vegetation types. This database provides information on groups of vegetation at a course scale. It is useful in determining the expected species, conservation status and management practices of an area. However, this database does not provide information on species of conservation concern. This database is used as a step towards grouping vegetation types identified on site.

## 4.2 Extent, Classification and Habitat Characteristics

The boundary of wetlands and riparian areas occurring on the site was identified and delineated according to the Department of Water Affairs wetland delineation manual '*A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas*' (Department of Water Affairs, 2005). Land cover data, contour data and the latest aerial imagery were examined in a thorough desktop analysis of the site. This provided important background information to the specialists' understanding of the broader context of the landscape (e.g. baseline vegetation, geology and climate). An on-site delineation was undertaken as described below.

### 4.2.1 Wetland Delineation

The following indicators stipulated in the national delineation guidelines were considered in the field. Not necessarily all of these indicators were used at each site. Mention was made in the results which of these indicators were used:

- **Terrain Unit Indicator** – this relates to the position within the landscape where a wetland may occur. A typical landscape can be divided into five main terrain units, namely the crest (hilltop), scarp (cliff), midslope (often a convex slope), footslope (often a concave slope), and valley bottom. As wetlands occur where there is a prolonged presence of water, the most common place one would expect to find wetlands is on the valley bottom (Rountree *et al,* 2008*)*.

- **Soil Form Indicator** – this identifies the soil forms, as defined by the Soil Classification Working Group (1991), which are associated with prolonged and frequent saturation.

- **Soil Wetness Indicator** - Prolonged saturation of soil results in the development of anaerobic conditions, which has a characteristic effect on soil morphology, causing two important redoximorphic features: mottling and gleying. The hue, value and chroma of soil samples obtained at varying depths can be visually interpreted with the aid of the Munsell Colour Chart and the interface between wetland and non-wetland zones determined.

- **Vegetation Indicator** – Plant species have varying tolerances to different moisture regimes. The presence, composition and distribution of specific hydrophytic plants within a system can be used as an indication of wetness and allow for inference of wetland characteristics.

The area was extensively traversed, auger sample points were taken as required and the exact location of sample points logged using a Garmin GPSMAP 64. At each sampling point the soils were sampled at depths of 0-10 cm and 40-50 cm below surface. The soil value, hue and matrix chroma were recorded for each sample according to the Munsell Soil Colour Chart, and the degree of mottling and/or presence of concretions were recorded. Although the site was severely transformed, any vegetation of interest was noted for the assessments. If the author was not able to identify any potentially important species, a leaf and bark sample was taken for analysis using a key guide.

### 4.2.2 Riparian Delineation

Riparian area/zone delineation is similar to wetland delineation in that indicators are used to define the edge of the system. It considers indicators such as topography, vegetation, alluvial soils, and deposition of material to mark the outer edge of the macro-channel and its associated vegetation. The Figure 5 shows the typical morphology of a river channel.

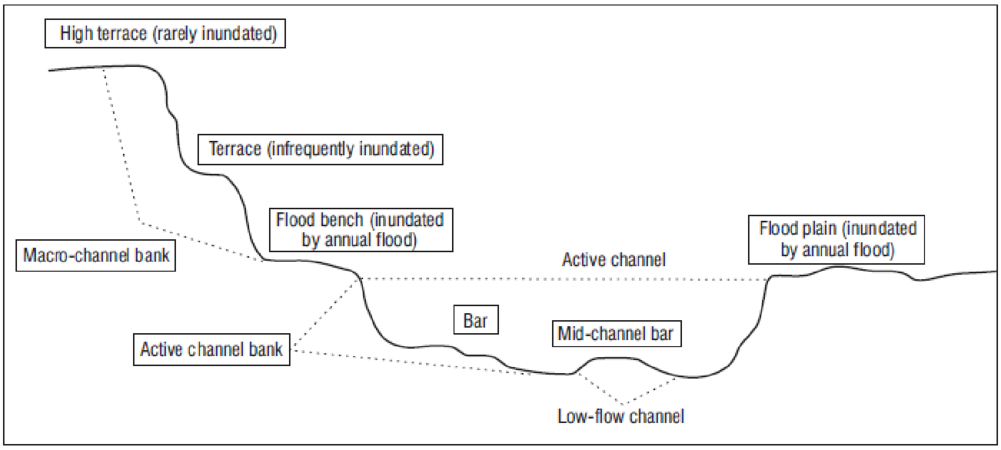


**Figure 5** **Typical cross-section of a river showing channel morphology 'A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas – Edition 1' (Department of Water Affairs, 2005)**

*A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas* (DWAF, 2005) was used in the delineation of the riparian zone boundary. Delineated riparian zones were then classified using an HGM classification system based on the system proposed by Ollis *(*2013*)*. According to Cowan *et* al. (2005), riparian ecosystems are separated from other wetland ecosystems on the following three major features:

1. They have linear form as a consequence of their proximity to rivers and form a boundary between the terrestrial and aquatic ecosystems.
2. Energy and materials from the surrounding landscape converge and pass through riparian ecosystems. This amount is greater in terms of unit area than with any other system.
3. Riparian ecosystems are connected hydrologically to both upstream and downstream ecosystems (intermittently).

An example of the soil sampling approach is provided in Figure 6.

**Figure 6** **Soil sampling undertaken at the site**

### 4.3 Present Ecological State (PES) Assessment for Riparian Areas

#### 4.3.1 Present Ecological State (adapted from WET-Health, Macfarlane *et al*., 2008)

A WET-Health (Macfarlane *et al*., 2009) Level 1 Rapid Appraisal was used to assess the eco-physical health of any wetlands in the study area. Focusing on geomorphology, hydrology and vegetation, the tool examines the impacts and indicators of change within the system and its catchment by determining the deviation (in terms of structure and function) from the natural reference condition. The outcomes of the appraisal place importance on issues that should be addressed through rehabilitation, mitigation and/or prevention measures. A standardized scoring system allows for consistencies between different systems and reduces user subjectivity.

Scores are allocated according to the magnitude and extent of impact. These scores are integrated to produce an overall score for Present Ecological State (PES) of the system – *namely, natural, largely natural, moderately modified, largely modified, extensively modified,* and *critically modified.*

#### 4.3.2 Index of Habitat Integrity (IHI)

The ecological integrity of a river is defined as its ability to support and maintain a balanced, integrated composition of physico-chemical and habitat characteristics, as well as biotic components on a temporal and spatial scale that are comparable to the natural characteristics of ecosystems of the region (Kemper, 1999). The observed or deduced condition of these criteria as compared to what it could have been under unperturbed conditions is surmised to indicate a change in the habitat integrity. The methodology is based on the qualitative assessment of a number of pre-weighted criteria which indicate the integrity of the in-stream and riparian habitats available for use by riverine biota. Tables 5, 6 & 7 provide the list of criteria and their scores, the impact category and the final scores for the IHI assessment that were used in the calculations.

Table 5 Criteria used in the assessment of the habitat integrity

| Criterion | Relevance |
|---|---|
| Water abstraction | Direct impact on habitat type, abundance and size. Also implicated in flow, bed, channel and water quality characteristics. Riparian vegetation may be influenced by a decrease in the supply of water. |
| Flow modification | Consequence of abstraction or regulation by impoundments. Changes in temporal and spatial characteristics of flow can have an impact on habitat attributes such as an increase in duration of low flow season, resulting in low availability of certain habitat types or water at the start of the breeding, flowering or growing season. |
| Bed modification | Regarded as the result of increased input of sediment from the catchment or a decrease in the ability of the river to transport sediment (Gordon *et al*., 1993). Indirect indications of sedimentation are stream bank and catchment erosion. Purposeful alteration of the stream bed, e.g. the removal of rapids for navigation (Hilden & Rapport, 1993) is also included. |
| Channel modification | May be the result of a change in flow, which may alter channel characteristics causing a change in marginal instream and riparian habitat. Purposeful channel modification to improve drainage is also included. |
| Water quality modification | Originates from point and diffuse point sources. Measured directly or agricultural activities, human settlements and industrial activities may indicate the likelihood of modification. Aggravated by a decrease in the volume of water during low or no flow conditions. |
| Inundation | Destruction of riffle, rapid and riparian zone habitat. Obstruction to the movement of aquatic fauna and influences water quality and the movement of sediments (Gordon *et al*., 1992). |
| Exotic macrophytes | Alteration of habitat by obstruction of flow and may influence water quality. Dependent upon the species involved and scale of infestation. |
| Exotic aquatic fauna | The disturbance of the stream bottom during feeding may influence the water quality and increase turbidity. Dependent upon the species involved and their abundance. |
| Solid waste disposal | A direct anthropogenic impact which may alter habitat structurally. Also a general indication of the misuse and mismanagement of the river. |
| Indigenous vegetation removal | Impairment of the buffer the vegetation forms to the movement of sediment and other catchment runoff products into the river (Gordon *et al*., 1992). Refers to physical removal for farming, firewood and overgrazing. |
| Exotic vegetation encroachment | Excludes natural vegetation due to vigorous growth, causing bank instability and decreasing the buffering function of the riparian zone. Allochtonous organic matter input will also be changed. Riparian zone habitat diversity is also reduced. |
| Bank erosion | Decrease in bank stability will cause sedimentation and possible collapse of the river bank resulting in a loss or modification of both instream and riparian habitats. Increased erosion can be the result of natural vegetation removal, overgrazing or exotic vegetation encroachment. |

Table 6 Impact classes and their associated scores

| Impact category | Description | Score |
|---|---|---|
| None | No discernible impact, or the modification is located in such a way that it has no impact on habitat quality, diversity, size and variability. | 0 |
| Small | The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability is also very small. | 1-5 |
| Moderate | The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability is also limited. | 6-10 |
| Large | The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability. Large areas are, however, not influenced. | 11-15 |
| Serious | The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area is affected. Only small areas are not influenced. | 16-20 |
| Critical | The modification is present overall with a high intensity. The habitat quality, diversity, size and variability in almost the whole of the defined section are influenced detrimentally. | 21-25 |

Table 7 Description of the IHI categories

| Category | Description | Score (% of total) |
|---|---|---|
| **A** | Unmodified, natural. | 100 |
| **B** | Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged. | 80-99 |
| **C** | Moderately modified. A loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged. | 60-79 |
| **D** | Largely modified. A large loss of natural habitat, biota and basic ecosystem functions have occurred. | 40-59 |
| **E** | The loss of natural habitat, biota and basic ecosystem functions are extensive. | 20-39 |
| **F** | Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible. | 0-19 |

## 4.4 Ecological Importance & Sensitivity (EIS) Assessment (Riparian)

The Ecological Importance and Sensitivity (EIS) of riparian areas is an expression of the importance of the aquatic resource for the maintenance of biological diversity and ecological functioning on a local scale to a broader scale; whilst Ecological Sensitivity (or fragility) refers to a system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (Kleynhans & Louw, 2007). In this study a qualitative assessment was applied and was partially informed by the present state assessment. This assessment followed the DWA river eco-classification criteria (Module A, Kleynhans & Louw, 2007). The classification provides insights into the causes and sources of the deviation of the PES of biophysical attributes from the reference condition (Kleynhans & Louw, 2007). This further provides the information needed to derive desirable and attainable future ecological objectives for the river (Kleynhans & Louw, 2007).

Table 8 List of the EIS categories used in the assessment tool (Kleynhans & Louw, 2007)

| Ecological Importance and Sensitivity Categories | General Description |
|---|---|
| Very high | Quaternaries/delineations that are considered to be unique on a national or even international level based on unique biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are usually very sensitive to flow modifications and have no or only a small capacity for use. |
| High | Quaternaries/delineations that are considered to be unique on a national scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) may be sensitive to flow modifications but in some cases, may have a substantial capacity for use. |
| Moderate | Quaternaries/delineations that are considered to be unique on a provincial or local scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are usually not very sensitive to flow modifications and often have a substantial capacity for use. |
| Low/marginal | Quaternaries/delineations that are not unique at any scale. These rivers (in terms of biota and habitat) are generally not very sensitive to flow modifications and usually have a substantial capacity for use. |

Table 9 Rating scheme used for the assessment of riparian EIS (Kleynhans & Louw, 2007)

| Score | Channel Type | Conservation Context | | | Vegetation and Habitat Integrity | Connectivity | Threat Status of Vegetation Type |
|---|---|---|---|---|---|---|---|
| **0** | Ephemeral Stream | Non-FEPA river | No status | None/Excluded | No natural remaining | None | No Status |
| **1** | Stream – non-perennial flow | | Upstream management area | Available | Very poor | Very low | Least Threatened |
| **2** | Stream – perennial flow | | Rehab FEPA | | Poor | Low | Vulnerable |
| **3** | Minor river – non-perennial flow | | Fish Corridor | Earmarked for conservation | Moderately modified | Moderate | Near Threatened |
| **4** | Minor river – perennial flow | | Fish Support Area | | Largely natural | High | Endangered |
| **5** | Major river – perennial flow | FEPA river | River FEPA | Protected | Unmodified/natural habitat | Very High | Critically Endangered |

## 4.5 Impact Assessment

The aim of the impact assessment is to identify the impacts that the current activity, as well as the remaining construction and operational phase of the development will have on the receiving environment. If avoidance is not possible, mitigation is required in the form of practical actions (Ramsar Convention, 2008). Mitigation actions can be grouped into the following:

i. **Pre-construction:** This may take the form of changes in the scale of the development (e.g. reduce the size of the development), location of development (e.g. find an alternative area with less impact), and design (e.g. change the structural design to accommodate flows and continuity).
ii. **Construction:** This may take the form of a process change (e.g. changes in construction methods), siting (e.g. locality to sensitive areas), sequencing and phasing (e.g. construction during seasonal periods).
iii. **Operational:** This may take the form of changes in post management (e.g. change management to match unpredicted impacts), monitoring (e.g. frequent checks by an ECO), rehabilitation (e.g. if mitigation actions are not effective).

An assessment of the potential impacts of the Ikhethelo school upgrade was guided by the EKZNW handbook for biodiversity impact assessments (2011). As it is an existing impact, a pre- and post-rehabilitation assessment was undertaken.

## 4.6 Risk Assessment

The risk assessment matrix assesses the likely impact the proposed development and associated infrastructure/activities may have on the wetland/watercourse. Only Low Risk Activities located within the regulated area of the watercourse will qualify for a GA according to this Notice. Medium and High risk activities will require a Section 21 (c) and (i) water use licence.

The criteria, calculations and ranking considered are as follows:

**Severity**
How severe does the aspects impact on resource quality (flow regime, water quality, geomorphology, biota, habitat?

| | |
|---|---|
| Insignificant / non -harmful | **1** |
| Small / potentially harmful | **2** |
| Significant / slightly harmful | **3** |

| | |
|---|---|
| Great/ harmful | **4** |
| Disastrous / extremely harmful and /or wetland(s) involved | **5** |
| Where "or wetland(s) are involved" it means that the activity is located within the delineated boundary of any wetland. The score of 5 is only compulsory for the significance rating. | |

**Spatial scale**

How big is the area that the aspect is impacting on?

| | |
|---|---|
| Area specific (at impact site) | **1** |
| Whole site (entire surface right) | **2** |
| Regional / neighbouring areas (downstream within quaternary catchment) | **3** |
| National (impacting beyond secondary catchment or provinces) | **4** |
| Global (impacting beyond SA boundary) | **5** |

**Duration**

How long does the aspect impact on the environment and resource quality?

| | |
|---|---|
| One day to one month, PES, EIS and /or REC not impacted | **1** |
| One month to one year, PES, EIS and /or REC impacted but no change in status | **2** |
| One year to 10 years, PES, EIS and /or REC impacted to a lower status but can be improved over this period through mitigation | **3** |
| Life of the activity, PES, EIS and /or REC permanently lowered | **4** |
| More than life of the organisation /facility, PES and EIS scores, a E or F | **5** |
| PES and EIS (sensitivity) must be considered. | |

**Frequency of the Activity**

How often do you do the specific activity?

| | |
|---|---|
| Annually or less | **1** |
| 6 monthly | **2** |
| Monthly | **3** |
| Weekly | **4** |
| Daily | **5** |

**Frequency of the incident/impact**

How often does the activity impact on the environment?

| | |
|---|---|
| Almost never / almost impossible / >20% | **1** |
| Very seldom / highly unlikely / >40% | **2** |
| Infrequent / unlikely / seldom / >60% | **3** |
| Often / regularly/ likely / possible / >80% | **4** |
| Daily / highly likely / definitely / >100% | **5** |

**Legal Issues**

How is the activity governed by legislation?

| | |
|---|---|
| No legislation | **1** |
| Fully covered by legislation (wetlands are legally governed) | **5** |
| Located within the regulated areas | |

**Detection**

How quickly/easily can the impacts/risks of the activity be observed on the resource quality, people and property?

| | |
|---|---|
| Immediately | **1** |
| Without much effort | **2** |
| Need some effort | **3** |
| Remote and difficult to observe | **4** |
| Covered | **5** |

### 4.6.1 Rating classes

| Rating | Class | Management Description |
|---|---|---|
| 1-55 | **(L) Low Risk** | Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated. Wetlands are excluded. |
| 56-169 | **(M) Moderate Risk** | Risk and impact on watercourses are notable and require mitigation measures on a higher level, which costs more and requires specialist input. Wetlands may be excluded. |
| 170-300 | **(H) High Risk** | Always involves wetlands. Watercourse(s) impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve. |

### 4.6.2 Calculations

| |
|---|
| **Consequence** = Severity + Spatial Scale + Duration |
| **Likelihood** = Frequency of Activity + Frequency of Incident + Legal Issues + Detection |
| **Significance \ Risk** = Consequence x Likelihood |

## 5. LIMITATIONS AND ASSUMPTIONS

In order to apply generalized and often rigid scientific methods or techniques to natural, dynamic environments, a number of assumptions are made. Furthermore, a number of limitations exist when assessing such complex ecological systems. The following constraints may have affected this assessment –

- A Garmin GPSMAP 64 was used in the mapping of waypoints on-site. The accuracy of the GPS is affected by the availability of corresponding satellites and accuracy ranges from 1 to 3 m after post-processing corrections have been applied.

- A Munsell Soil Colour Chart was used to assess soil morphology. This tool requires that a dry sample of soil be assessed. However, due to in-field time constraints, slightly wet soil samples were assessed. Wet samples would have consistently lower values than dry soils; and this is taken into consideration.

- Although the vegetation was taken into account, protected and threatened species that are seasonal, such as bulbs that have not emerged, may not have been identified.

- The soils were very uniform, as such it was difficult to determine the difference between temporary and dry-land wetland/riparian areas.

- The sampling was undertaken after a severe drought. Given these circumstances, extra caution was taken to ensure that watercourse features were not overlooked. Furthermore, the water quality sampling may differ from median year samples as parameters may be concentrated in such conditions (reduced flow).

- Much of the site is transformed which made access to some areas impossible.

# 6. RESULTS AND DISCUSSION

## 6.1 Regional Context

### 6.1.1 NFEPA assessment

In accordance with the NFEPA guidelines, the site just falls within 500 meters of a recognized seepage wetlands, which forms a small non-perennial tributary of the Ogogo system, which indicates that this system is a national freshwater conservation priority. No FEPA wetlands were identified within the development footprint. The layer codes for River FEPAs and associated sub-quaternary catchments, Fish Support Areas and associated sub-quaternary catchments and Upstream Management Areas.

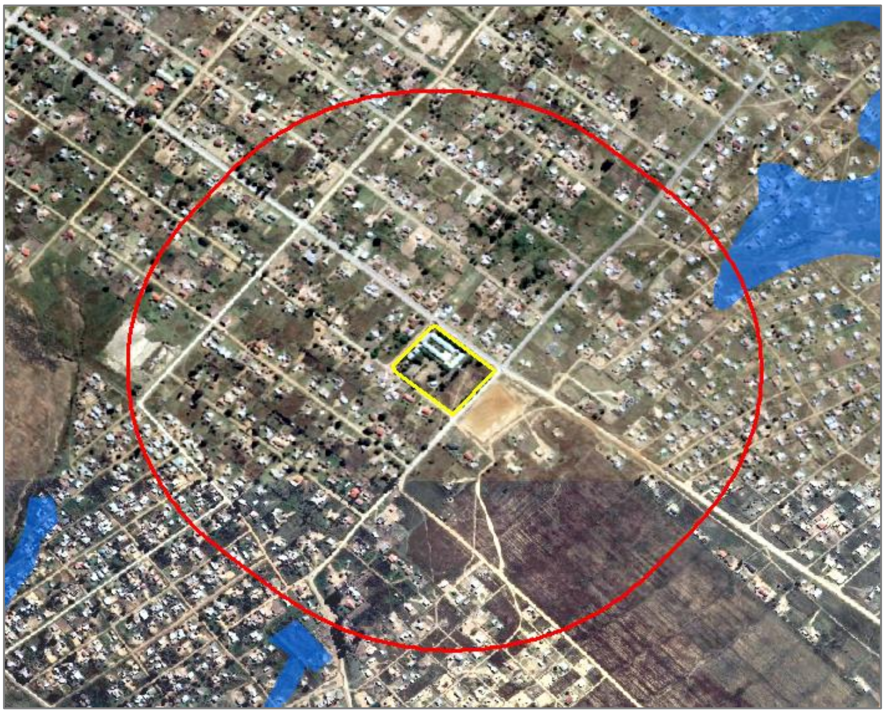

**Figure 7 NFEPA wetlands (red) within 500m of the Ikhethelo school upgrade**

### 6.1.2 Vegetation

The vegetation on site comprises of Income Sandy Grassland (Gs 7: Mucina & Rutherford, 2006; Scott-Shaw & Escott, 2011). The desktop analysis revealed that the area is vulnerable and is hardly protected with 73 % remaining habitat. The following information was collected for the vegetation unit GS 7 (Mucina & Rutherford, 2006; Scott-Shaw & Escott, 2011):

- **Distribution:** KwaZulu-Natal Province: KwaZulu-Natal Province: In a large triangle between Newcastle, Vryheid and Dundee and larger polygon in the Wasbank area in northern KwaZulu-Natal.
- **Altitude:** 880–1 340 m (mainly 1 120–1 240 m).
- **Vegetation and Landscape features:** Very flat extensive areas with generally shallow, poorly drained, sandy soils supporting low, tussock-dominated sourveld forming a mosaic with wooded grasslands (with *Acacia sieberiana var woodii*) and on well-drained sites with the trees *A. karroo, A. nilotica, A. caffra* and *Diospyros lycoides*. On disturbed sites A. *sieberiana var woodii* can form sparse woodlands. *Aristida congesta, Cynodon dactylon* and *Microchloa caffra* are common on shallow soils (Camp 1999b).

### 6.1.3 Terrain/Catchment Analysis

The site (Figure 8) is situated on the catchment divide between two watercourses. In this setting, it is just over 1 km from both the Ogogo and Mtunjwayo systems. The majority of runoff from the site would flow towards the Mtunjwayo system with a small portion flowing towards the Ogogo tributary. However, as the site is flat, sandy and vegetated, infiltration would be high resulting in a very low low risk to surrounding wetland/watercourse areas.

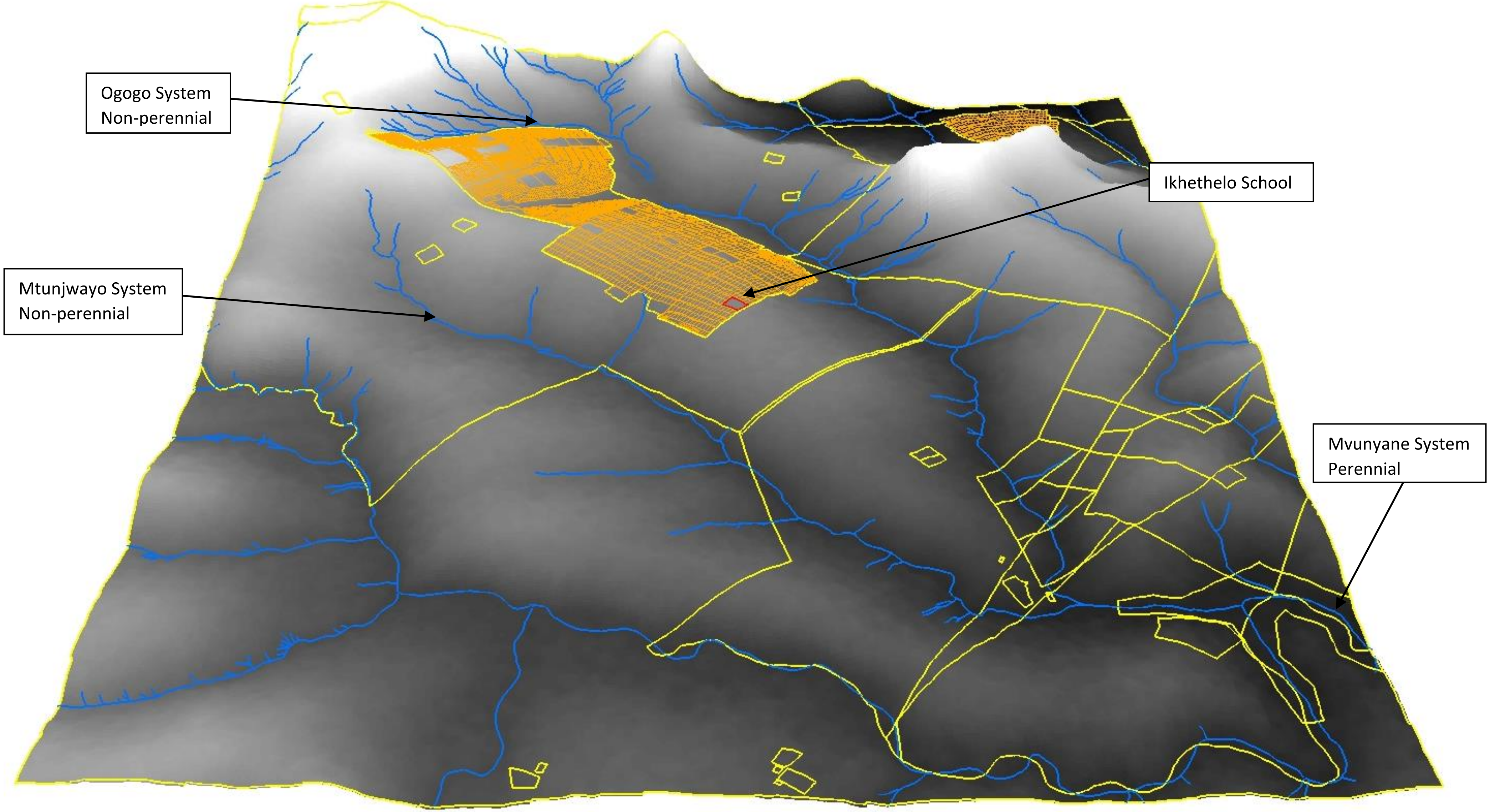


Figure 8 Exaggerated (x3) Digital Elevation Model (DEM) of the catchment surrounding Ikhethelo school

### 6.1.4 Historical analysis

The historical analysis is imperative for a site where there is an existing development. As a watercourse study was not undertaken before the existing school and settlements were built, it is difficult to determine where a watercourse may have previously existed without the use of historical imagery. Additionally, the discharge and diversions due to the settlement and roads has altered the hydrological state of the site.

The site as observed through a series of historical images (Figure 9), shows the following:

- An image was available for 1944. However, the site was completely cultivated and the flight plan was at a greater height making geo-referencing unreliable;
- The school and most of Mondlo A was present in 1970;
- Historical forestry and small community plots were visible during 1970;
- There was a clear drainage line 470 meters to the east of the school;
- No other wetland/watercourse features were evident during this period; and
- Since 1981, additional households and roads have been built.

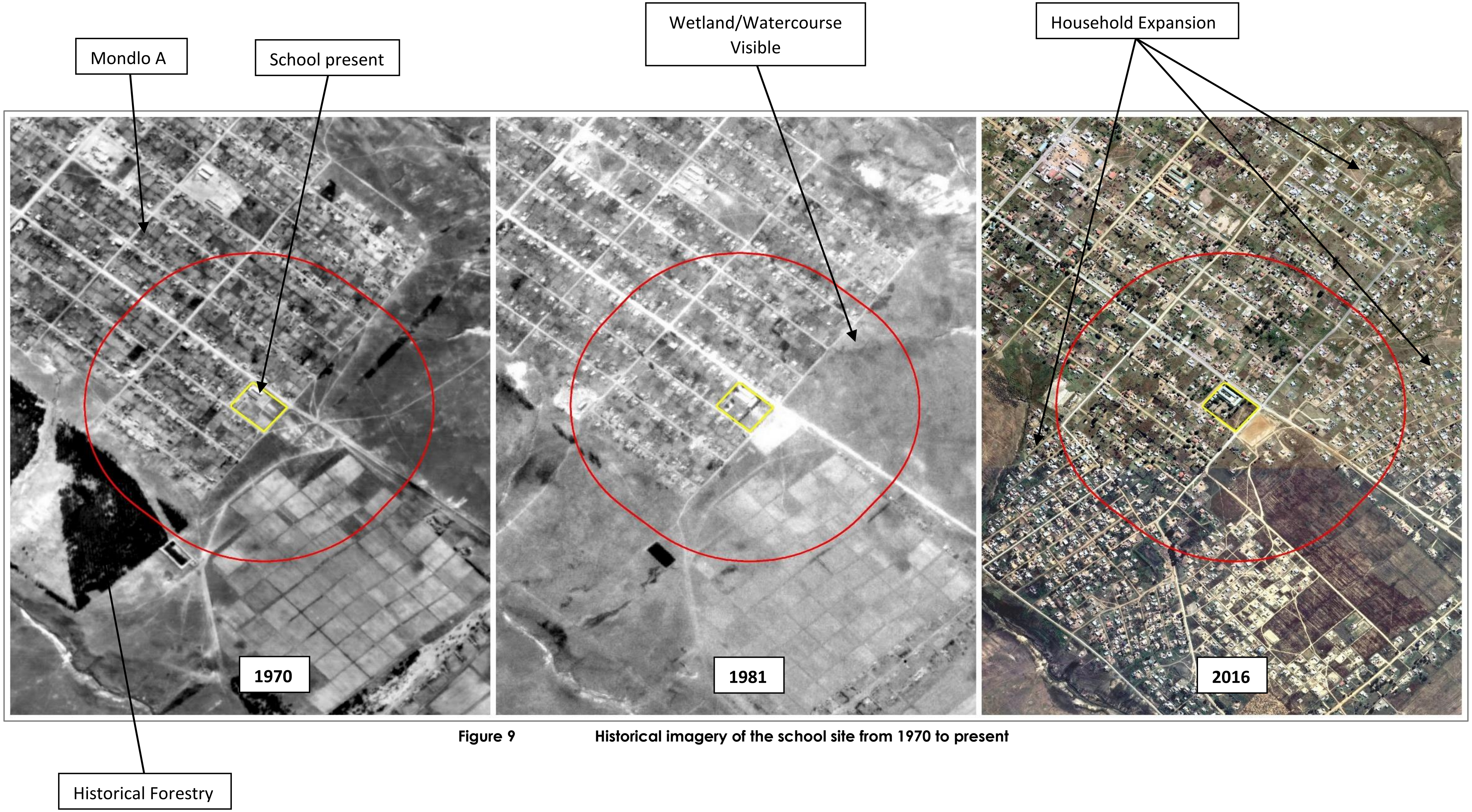


**Figure 9** **Historical imagery of the school site from 1970 to present**

## 6.2 Extent, Classification and Habitat Characteristics

The current land cover was obtained from various databases and the site visit. The site is surrounded by settlements and roads. Some grassland areas exist around the site. Significant patches of alien invaders were noted. The footprint of the school upgrade is mostly on pre-existing developed area.

The dominant species around the school were mostly *Lantana camara, Melia azedarach* and numerous planted ornamental species. The greater area is at risk of future erosion due to poor management of the land and is prone to natural erosion. This ecosystem may hold some key species. The existing watercourse has been impacted upon by the settlement and changes in the hydrological regime have occurred.

The site consists of some areas of hydrological interest and these areas have been tabulated (Table 10) and described in detail. The HGM units are further illustrated in Figure 12. Wetlands that school upgrade may impact upon were assessed for wetland health and functionality. The wetlands have been delineated to show no go areas and were used initially to check the connectivity of the systems and potential impacts from the development.

The wetland/drainage system surrounding Mondlo A have been significantly historically modified.

**Figure 10** **Typical vegetation around the site**

The following wetland systems were identified

- HGM 1: Hillslope seep (tributary of the Ogogo System).

The majority of the soils identified adjacent to the watercourse were sandy clay soils (Alluvium - yellowish-brown sandy clay). No hydric soil characteristics were found outside of the wetland. The hydric soils, identified by gleyed or mottled characteristics, were found at a depth of 10-30 cm along the modified edges of the visibly clear wetlands. A no-go development zone buffer of 32 meters was placed on the identified seepage wetland by the specialist (Figure 12). If further developments were to occur within this buffer, the impacts would be greater. However, this further shows the significant distance the development site is from the wetlands.

The identified wetlands are situated 353 meters away from the edge of the development property boundary. The historical analysis shows that the watercourse has likely been enhanced/expanded by contributions from household grey water/sewage.

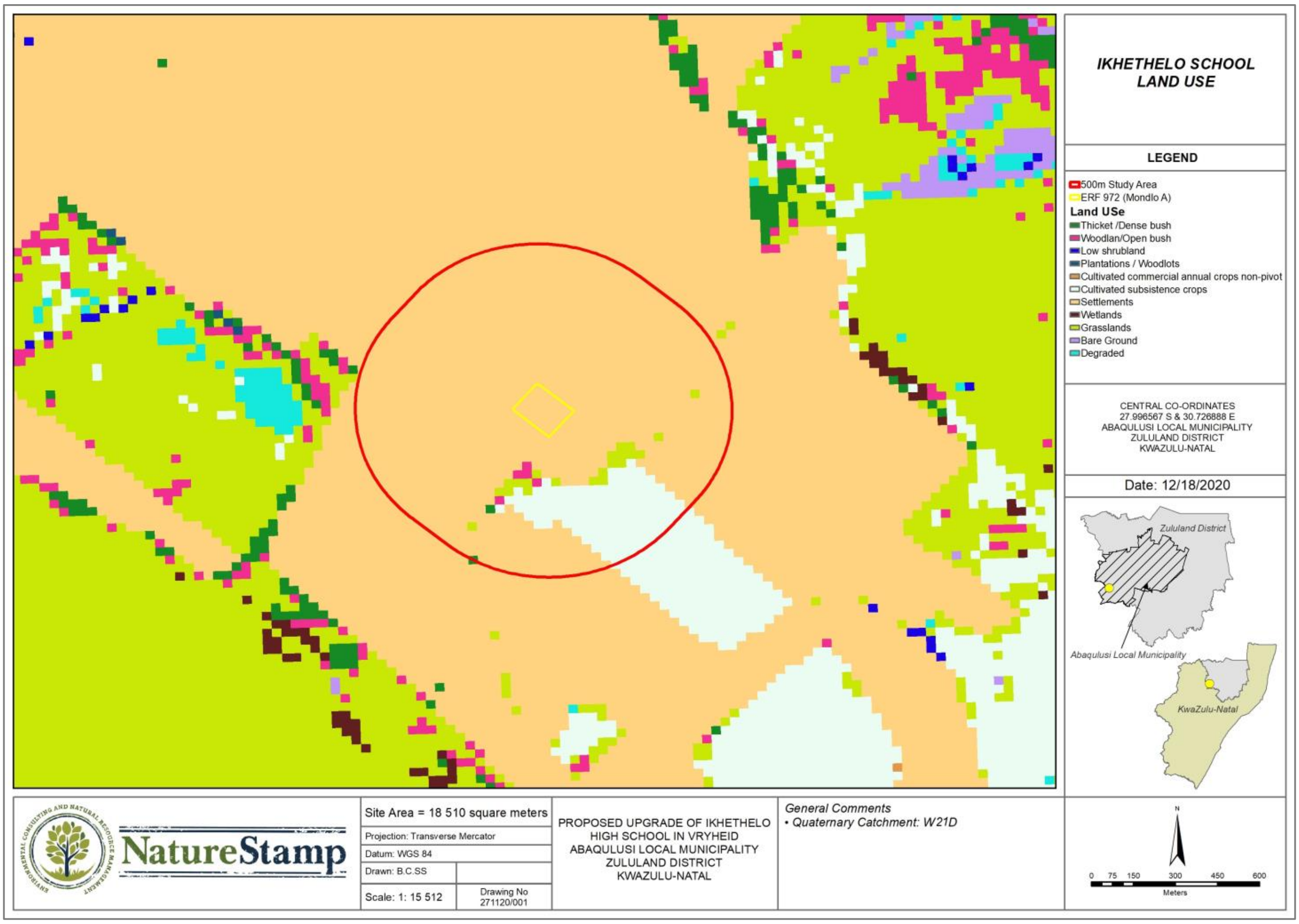


**Figure 11** **Current land use within and around the site boundary, showing the transformed state**

**Table 10 Description of HGM units**

| Feature | Wetland/Riparian/Artificial | Description & Vegetation | Soil Characteristics | On-site images |
|---|---|---|---|---|
| Hillslope Seepage (HGM 1) | Wetland | Slopes on hillsides, characterized by the colluvial movement of materials. Outflow is usually via a well defined stream channel connecting the area directly to a stream channel | Mottle % - 2-5%<br>Hue – 7.5YR<br>Value – 5<br>Chroma – 1 (Dark Gray)<br>Depth sampled: 0-0.5m<br>High Organic matter content in the upper layer |  |

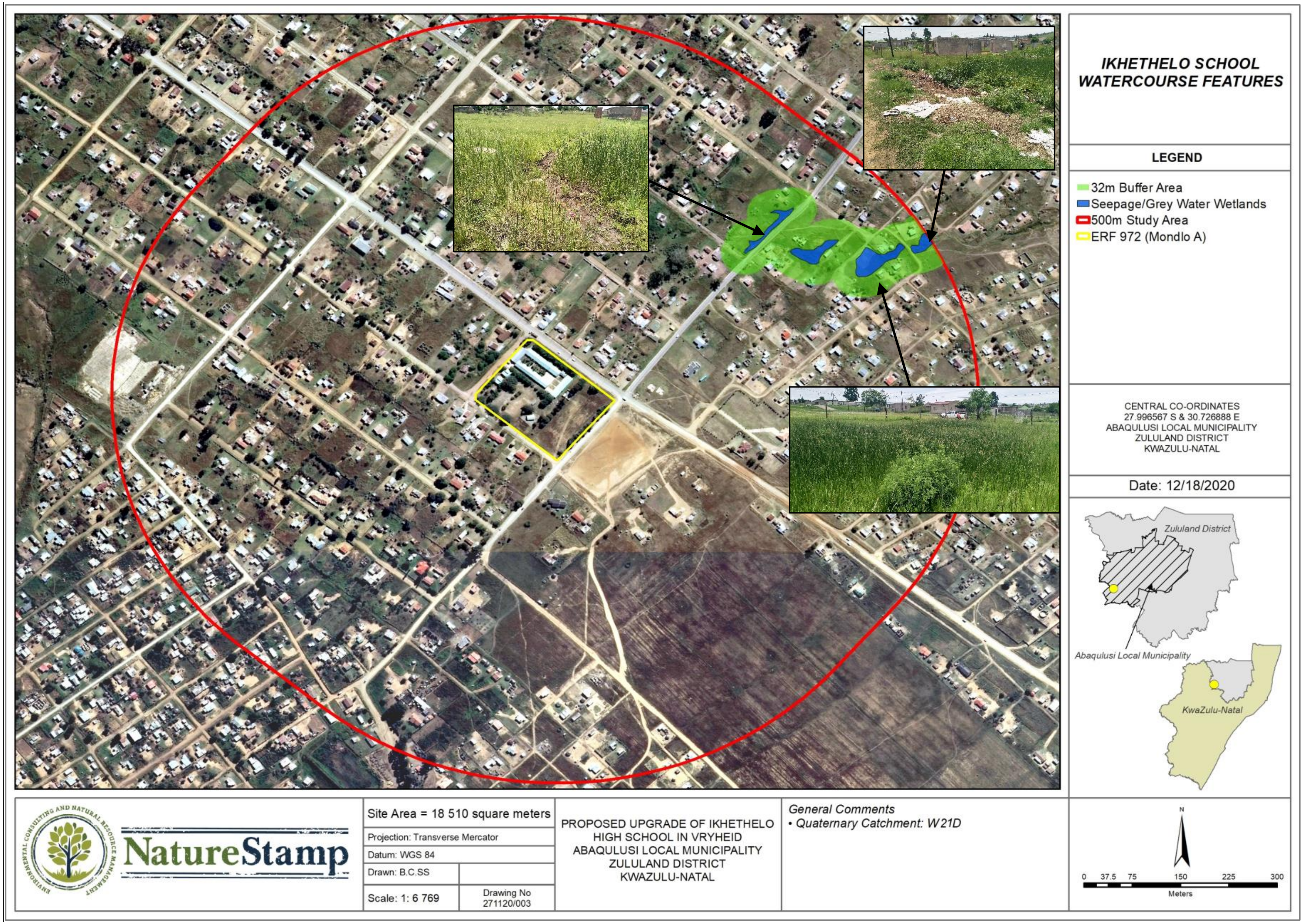


**Figure 12 HGM units identified within 500m of the proposed school upgrade**

## 6.3 Present Ecological State (PES)

### 6.3.1 WET-Health (Macfarlane et al., 2008) of wetlands

A WET-Health assessment was undertaken for the wetlands found within 500 meters of the proposed school upgrade. Wetlands that are part of the same system but have split due to developments were grouped together in the health assessments.

- *Hydrology*

The Hillslope seepage (HS) on site is severely encroached and modified. There was little to no variation in soil form, terrain and the vegetation surrounding the wetlands. The present hydrological state of the HS wetland was given a score of D, meaning that impact of the modifications is detrimental to hydrological integrity. The MAP: PET ratio indicates that the wetlands are not dependant on direct precipitation falling onto the wetland, depending on flow from upstream to a greater extent, making these wetlands more vulnerable to reduced flows. There is a significant amount of grey water entering this system.

The key factors influencing hydrological impacts on the wetland is the encroachment by humans and discharge from toilets. Natural water distribution and retention patterns are altered as a result of impeding structures across the wetlands, such as the roads and plots for houses that have resulted in hardened surfaces and therefore greater runoff as the surface roughness is altered.

It is important to note, that while the wetland scores relatively low for Hydrology, there are also severe localized impacts in the vicinity of the settlements which are not adequately reflected when combined with the state of the total wetland.

Table 11 The hydrology module for the hillslope Seepage wetland

| Hydrology module | Hillslope Seepage |
|---|---|
| Extent of the wetland (ha) | 0.4 |
| MAP:PET | 0.4 – 0.49 |
| Vulnerability factor | 0,9 |
| Combined score for increased and decreased flows | 7.3 |
| Intensity of impact of factors potentially altering flow patterns | 2 – small |
| Magnitude of impact of canalisation and stream modification | 0.07 |
| Magnitude of impact of impeding features | 0 |
| Magnitude of impact of altered surface roughness | 0,1 |
| Impact of direct water losses | 1,60 |
| Magnitude of impact of recent deposition, infilling or excavation | 0 |
| Combined magnitude of impact of on-site activities | 5.8 – Large |
| Combined magnitude score as a result of impacts on hydrological functioning | 7 |
| Overall hydrological health | The impact of the modifications is clearly detrimental to the hydrological integrity. Approximately 50% of the hydrological integrity has been lost. |
| **Present hydrological state of the HGM unit** | **D** |
| Trajectory of change of wetland hydrology | (→) |

- *Vegetation*

The present state of wetland vegetation of the wetland been given a class E as the vegetation composition has been mostly transformed. Many areas within the original wetland area have been developed over while other areas have been encroached by alien plants. The invasion of the wetland catchment has resulted in the reduction of characteristic indigenous wetland species and human disturbances have resulted in an alteration of introduced, alien and or increased ruderal species.

Table 12 Vegetation module for the hillslope Seepage wetland

| Vegetation module | Flood Plain |
|---|---|
| Extent of the HGM unit (ha) | 0.4 |
| Identify and estimate the extent of each disturbance class | Large |
| Magnitude of impact score | 6.3 |
| Present vegetation state | E |
| Trajectory of change to wetland vegetation | (→) |
| **Overall vegetation health** | Vegetation composition has been substantially altered but some characteristic species remain, although the vegetation consists mainly of introduced, alien and/or ruderal species. |
| Alien vegetation present (%) | 40 |

- *Geomorphology*

The overall geomorphological health of the wetlands was classified as D, which is largely modified. This was due to existing deposition and historical changes from road and settlement construction. After infilling the wetland has become largely modified due to excess channel modifications. The trajectory of change if the impacts do not continue is likely to remain stable (→). There is a need to address this change in geomorphology.

Table 13 Geomorphology module for the hillslope Seepage wetland

| Geomorphology module | Flood Plain |
|---|---|
| Extent of the HGM unit (ha) | 0.4 |
| Impacts of channel straightening | 1.5 |
| Extent of impact of infilling | 30 |
| Impacts of changes in runoff characteristics | 1.1 |
| Impacts of erosion | 0.2 |
| Impacts of deposition | 1.5 |
| Present geomorphic state | **D** |
| Trajectory of change of geomorphic state | (→) |
| **Overall geomorphological health** | **Largely modified.**<br>**A large change in geomorphic processes has occurred and the system is appreciably altered.** |

- *Overall Health*

The overall health based on the **combined impact score is D (largely modified)**. A large loss of natural habitat, biota and basic ecosystem functions have occurred. There has been a significant impact on the hydrology and vegetation due to the poor state current state, prior infilling and poorly managed flows due to the numerous households. The geomorphology has changed as a result of the infilling from roads and plots.

### 6.4 Ecological Importance & Sensitivity Assessment

An EIS category was determined for the Ogogo tributary. The category of this system (Table 14) was calculated to be Low: 'Quaternaries/delineations that are not unique at any scale. These rivers (in terms of biota and habitat) are generally not very sensitive to flow modifications and usually have a substantial capacity for use.

Table 14 EIS category scoring summary for the Ogogo tributary

| Component | Score ( 0-5) | Comments/description |
|---|---|---|
| Channel Type | 1 | Stream – non-perennial flow |
| Conservation Context | 0 | No context |
| Vegetation and Habitat Integrity | 5 | FEPA |
| Connectivity | 1 | Very low |
| Threat Status of Vegetation Type | 2 | Vulnerable |
| **EIS Rating** | **1.8** | **Low** |

Considering the PES and EIS scores, the recommended management objective for the Mondlo area would be to maintain the present integrity and ecosystem functioning of the system.

# 7. POTENTIAL IMPACT PREDICTIONS AND DESCRIPTIONS

The site is in a visibly modified condition. The primary surrounding impacts are settlement encroachment and the subsequent discharge of waste. The wetland areas have been cleared of vegetation for household plots. However, due to the increase in discharge from households, the original smaller extent of the wetland has been increased. This wetland area has further been split up from formal and informal roads. The geomorphology is in a modified state due historical and recent terracing. The actual site was historically cultivated for many years.

The school upgrade site has a small catchment area on an unnamed tributary of the Ogogo system. Although the identified wetland (353 meters away) is heavily modified, it does still provide much needed services to the downstream area where waste would directly enter the Ogogo tributary without any remediation if these wetlands were not present.

## 7.1 Present Impacts

Within the Ikhethelo development footprint, prior to the proposed upgrades, the existing impacts on the watercourses and respective catchment areas include -

- The presence of water demanding exotic species that have replaced natural vegetation;
- Subsistence farming within watercourse systems (small scale);
- Invasive alien plant invasion in disturbed areas (particularly along servitudes and road edges);
- The clearance of natural habitat for settlements and pathways between houses;
- Concentrated flow paths from drain outlets/dongas along the roads;
- Historical modification of watercourse systems for agriculture and dam construction;
- Erosion and sedimentation from construction activities;
- A high volume of litter around the site; and
- Transformation due to the increase of informal settlements with numerous leaking taps.

In the broader WMA, similar impacts are present as noted for the Ikhethelo site. Additional existing impacts on the watercourses and respective catchment areas include -

- Infrastructure development within wetland systems (wetland encroachment) or river banks – leading to a direct loss of wetland systems and decrease in provision of ecosystem services;
- Cattle grazing in wetlands and the riparian edge – potential for a change in vegetation species composition to occur, soil erosion (cattle path erosion is prevalent in the area) and water pollution;
- Canalisation of streams and rivers – leading to change in the hydrological regime;
- Informal and formal watercourse crossings – leading to the change in hydrological regime;
- Litter and solid waste disposal – direct water pollution; and
- Poor or absent sanitation – direct water pollution.

In addition to these impacts, there is a high risk of flood damage (infrastructure, cattle, crops and livelihood) to the community living within the flood line. With the draining of the wetland systems, there is also a likelihood that soil sediment levels would increase resulting in a loss of yield.

## 7.2 Potential Impacts During Construction

Some impacts are likely during operation. These include -

Table 15 Impact Drivers and Description – Construction Phase

| ACTIVITY / DRIVER OF IMPACT | IMPACT | DESCRIPTION OF HOW IMPACT OCCURS |
|---|---|---|
| Increased sediments/spoil sites | **Enhanced erosion potential** | The reduction in vegetation cover results in open bare soil therefore reducing the surface roughness and increasing the erosive potential to the elements (wind and rain). Sheet wash, rill and gully erosion is likely and may lead to the collapse or slumping of downstream wetland/stream bank areas that would bury marginal wetland habitat.<br><br>An increase in compaction of the soils along the edge of the plot where heavy machinery traverses may lead to an increase in the runoff.<br><br>As the wetland is approximately 350 m away, this impact is highly unlikely but may occur if complete mismanagement occurs on-site. |
| | **Decrease in water quality** | As a result of contaminants from heavy machinery (oil, fuel) infiltrating / washed into the system as well as sediments from the construction area. |
| | **Spread of alien invasives** | As these plants colonise stockpiles and spoil sites / spoil sites given their easily dispersed seed. |
| | **Continued alteration of flow pattern** | A result of concentrated flow from impervious surfaces and storm water channels. A general change in flow regimes. |
| High activity of heavy machinery and construction staff on-site | **Air pollution affecting wetland fauna** | As a result of excessive air emissions from heavy machinery and generators. |
| | **Noise and disturbance affecting wetland fauna** | As a result of excessive noise emissions from heavy machinery and generators.<br><br>This impact is highly unlikely to impact upon the identified wetlands. |
| | **Decrease in water quality**<br><br>**(impact to aquatic flora and fauna; and water supply)** | As a result of potential leaks of fuel, grease and oil from the heavy machinery. Wash related to the above-mentioned changes during rainfall events will lead to the movement of these substances into the soil and the watercourse systems.<br><br>As a result of improper storage and handling of hazardous chemicals such as fuel and oil as well as chemicals relating to staff ablution facilities.<br><br>As a result of any spills, such as concrete, during construction. |

## 7.3 Potential Impacts During Operation

The majority of the impacts will be during construction. However, some impacts are likely during operation. These include -

- **Increase in population:** a likely increase in vehicles accessing the school due to the increased number of students. This may lead to more people moving to the area (more households) and a greater intensity of the present impacts;
- **Increase in pollution:** an increase in pollution around the school including petro-chemicals from vehicle/transport and human rubbish. An increase of visitors and vendors during operation may lead to further pollution;

- **Increase in surface runoff:** Increase in impervious surfaces which may promote erosion and flash floods; and
- **Increase in overall edge effects on wetland:** heightened activity in the area
- **Potential increase in discharge of wastewater**
- **Continued alteration of flow pattern:** as a result of increased impervious surfaces and resultant runoff.

Table 16 Impact Drivers and Description – Operation Phase

| ACTIVITY / DRIVER OF IMPACT | IMPACT | DESCRIPTION OF HOW IMPACT OCCURS |
|---|---|---|
| Increase in wastewater discharge | **Potential for leaks and contamination of watercourses** | As the existing school utilises the municipal sewer system, this impact would not occur unless leaks occur within the school infrastructure.<br><br>The additional toilets should also utilise the municipal services. However, should this not occur, the additional toilets may lead to an increased chance of contamination to downstream wetland areas. |
| Stormwater runoff along the hardened surfaces of the school upgrades | **Soil wash** | Disturbance of the soil profile and vegetative cover may prompt a change in flow path, with surface runoff running in rills along the concrete edges.<br><br>Should storm water structures be incorporated into the amendment, there will be no risk to the wetlands within 500 m of the site. |
| Foundations and obstructions | **Change in subsurface water movement** | The development of the new toilet, guard house etc. that are deeper than the upper soil profile may cause sub-surface water movement to be diverted and potentially concentrated resulting in inundation areas. |
| Greater human/vehicle movement through the site | **Increase in pollution** | An increase of visitors and vendors during operation may lead to further pollution such as plastics, cans and glass. |

### 7.4 Impacts associated with Climate Change Projections

The following potential impacts may arise as a result of climatic changes in the future, which would possibly effect the Mondlo watercourses and surrounding environment:

- Increase in extreme weather events such as powerful rain/thunderstorms, strong winds, intense heat waves, severe coldness and increased lightning strikes.
- This would likely cause flooding within the watercourses, as well as fallen trees which would damage the surrounding environment and municipal infrastructure.
- The risk of contamination of watercourses would increase due to significantly greater volumes of runoff, which may lead to disease outbreaks and human health problems.
- Alien vegetation uses more water than indigenous vegetation, therefore reducing natural water supplies / choking natural watercourses. Alien plants have the ability to overpower indigenous vegetation and becoming overgrown within rivers and streams.

# 8. RISK ASSESSMENT

A risk assessment, as outlined in the methodology, was undertaken at the proposed school upgrade site. Information from spatial datasets, as well as the site visit was used to populate the risk matrix (Table 17). A risk matrix of proposed activities was undertaken.

The results indicate that the activities will have a low risk with the impact on flow regimes (due to increased impervious surfaces leading to a higher runoff) being notable but still low. This low risk is due to the site being within a small catchment, the poor historical state of the site and the best practice management adopted on site (site is well vegetated and storm water is managed). However, there is still a risk associated with surface water. This is particularly relevant given the water shortage in the province. The activities associated with the school upgrade need to be addressed through a monitoring plan to ensure the risks are mitigated. This risk assessment assumes that stormwater management is appropriately applied. The risk associated with the site are low because of the conditions stated in this report.

The following tables gives the overall risk score, according to the Risk Matrix, for the construction and operation of the school upgrades.

Table 17 Risk matrix assessment for the impacts identified for the construction and operation of the activities

| | Activity | Aspect | Severity | Consequence | Likelihood | Significance | Risk Rating |
|---|---|---|---|---|---|---|---|
| **HGM Unit 2 – Hillslope Seepage** | | | | | | | |
| **CONSTRUCTION** | Development within 500m of a watercourse | Creating a platform for infrastructure (toilets/refuse room/guard house and media centre) leading to sedimentation | 1.5 | 4.5 | 11 | 49.5 | **L** |
| | | Use of effluent septic tank and soakaway for workers leading to potential contamination | 1.75 | 3.75 | 11 | 41.25 | **L** |
| | | Increased activity of workers and machinery on-site (noise, dust, traffic disturbance) | 1.75 | 4.75 | 11 | 52.25 | **L** |
| | | Storage of petro-chemicals on site | 2.25 | 5.25 | 10 | 52.5 | **L** |
| **OPERATION** | Development within 500m of a watercourse | Increase in potential discharge/leak of wastewater | 2.25 | 7.25 | 7 | 49 | **L** |
| | | Increased storm water on site leading to soil wash | 1.75 | 6.75 | 7 | 47.25 | **L** |
| | | Change is sub-surface water movement | 1.5 | 5.5 | 6 | 33 | **L** |
| | | General increase is pollution (noise and litter) | 1.75 | 6.75 | 6 | 40.5 | **L** |

# 9. RECOMMENDATIONS

The recommendations as identified through the wetland assessment are as follows:

- Best management guidelines must be followed during construction. This includes maintenance of construction vehicles and equipment to reduce potential leaks and drip trays to prevent oil contamination;
- Any spoil sites created on-site must be checked to ensure alien plant species do not seed or disperse. Category 1 alien species must be removed in and around the amendment footprint;
- Any rubble/spoil sites must be removed following construction;
- Storm water must be managed for all the additional buildings. This would be in the form of gutters and downpipes with rockery soakaways at discharge points; and
- Sewerage from the additional ablutions should be incorporated into the existing municipal servitudes. Should this not occur, an appropriately sized on-site treatment system should be included in the layout.

# 10. CONCLUSION

The developers of the proposed Ikhethelo school upgrade must note that watercourses are protected by nine Acts and two Ordinances in KwaZulu-Natal[1], which verifies that both national and provincial authorities recognise these systems as highly valuable multiple-use resources and are committed to their conservation.

The work undertaken for this report indicates that watercourse systems/wetlands were identified within 500m of the upgrade area, as detailed in Section 6.2. However**, no wetlands were identified within the upgrade footprint**. The identified wetlands are heavily modified, partially formed by grey water and are 470 meters away from the school boundary. The wetlands within 500 meters, although being partially sustained from grey water (were identified in historical images but have been expanded and are sustained by householed discharge), are providing essential services to the Mvunyane (preventing extremely poor water directly and quickly entering the system with some phytoremediation).

The wetland system is classified as FEPA system and should be given extra protection to minimize the impacts identified. However, the developments proposed for the site will have **low/minimal** (if any) impact on these surrounding watercourses. This is due to the following:

- The wetland is a significant distance from the school;
- The school is existing and the proposed changes are small;
- The school sits on a small catchment divide;
- The risk assessment assumes that the additional ablutions will not be discharged off site;
- The surrounding site is already transformed, the overall change will be minimal.
- The additional ablutions will alleviate existing failing waste water infrastructure.

The major concern will be the actual construction of the school (spoil/rubble/chemical waste). The recommendations for the development are to implement adequate stormwater runoff attenuation structures, waste water management and to remove any invasive alien species (excluding the Jacarandas). At all times, disturbance to wetland areas should be avoided.

[1] The Lake Areas Development Act, Act No. 39 of 1975; The National Water Act, Act No. 36 of 1998; The Mountain Catchment Areas Act, Act No. 63 of 1976; The Environmental Conservation Act, Act No. 73 of 1976; The National Environmental Management Act, Act No. 107 of 1998; The Conservation of Agricultural Resources Act, Act No. 43 of 1983; The Town Planning Ordinance 27 of 1949; The Physical Planning Act, Act No. 88 of 1967; The Forest Act, Act No. 84 of 1998; The Natal Nature Conservation Ordinance No. 15 of 1974; The KwaZulu Nature Conservation Act, Act No. 8 of 1975

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## ANNEXURE A Classification structure for inland systems up to Level 4

| WETLAND / AQUATIC ECOSYSTEM CONTEXT | | |
|---|---|---|
| **LEVEL 1: SYSTEM** | **LEVEL 2: REGIONAL SETTING** | **LEVEL 3: LANDSCAPE UNIT** |
| Inland Systems | DWA Level 1 Ecoregions<br>OR<br>NFEPA WetVeg Groups<br>OR<br>Other special framework | Valley Floor |
| | | Slope |
| | | Plain |
| | | Bench (Hilltop / Saddle / Shelf) |

| FUNCTIONAL UNIT | | |
|---|---|---|
| LEVEL 4: HYDROGEOMORPHIC (HGM) UNIT | | |
| HGM type | Longitudinal zonation/ Landform / Outflow drainage | Landform / Inflow drainage |
| A | B | C |
| River (Channel) | Mountain headwater stream | Active channel |
| | | Riparian zone |
| | Mountain stream | Active channel |
| | | Riparian zone |
| | Transitional stream | Active channel |
| | | Riparian zone |
| | Upper foothill rivers | Active channel |
| | | Riparian zone |
| | Lower foothill rivers | Active channel |
| | | Riparian zone |
| | Lowland river | Active channel |
| | | Riparian zone |
| | Rejuvenated bedrock fall | Active channel |
| | | Riparian zone |
| | Rejuvenated foothill rivers | Active channel |
| | | Riparian zone |
| | Upland floodplain rivers | Active channel |
| | | Riparian zone |
| Channelled valley-bottom wetland | (not applicable) | (not applicable) |
| Unchannelled valley-bottom wetland | (not applicable) | (not applicable) |
| Floodplain wetland | Floodplain depression | (not applicable) |
| | Floodplain flat | (not applicable) |
| Depression | Exorheic | With channelled inflow |
| | | Without channelled inflow |
| | Endorheic | With channelled inflow |
| | | Without channelled inflow |
| | Dammed | With channelled inflow |
| | | Without channelled inflow |
| Seep | With channelled outflow | (not applicable) |
| | Without channelled outflow | (not applicable) |
| Wetland flat | (not applicable) | (not applicable) |

Note: 2nd row of Table provides the criterion for distinguishing between wetland units in each column

## ANNEXURE B Wetland and soil classification field datasheet example

| Sampling Sheet Summary | |
|---|---|
| **Wetland** | Mondlo |
| **Area (ha)** | <5 |
| **Indicator** | Soil and vegetation |
| **Connectivity (level 1)** | Inland |
| **Eco region (level 2)** | South Eastern Uplands |
| **Landscape setting (level 3)** | Riparian system |
| **HGM Type (level 4A)** | Endhoreic |
| **Longitudinal zonation (level 4B)** | With channel |
| **Hydrological regime** | Frequent Inundation |
| **Soil characteristics** | Hue – Gley 2 to 5YR<br>Value – 4<br>Chroma – 2<br>(Dark Reddish Gray)<br>Depth sampled: 0-0.5m |
| **Comment** | No change in soil characteristics |

## ANNEXURE C Steps for Riparian Delineation

### Steps for Riparian Delineation in the field

To delineate riparian areas, use the terrain unit indicator, vegetation indicator species, soil wetness indicator, combined with

- Geomorphology of the banks; and
- Extent of riparian vegetation.

Evidence of alluvial deposits can also be used.

**STEPS to delineating the riparian zone:**

I. Is the site relatively undisturbed (banks have not been extensively engineered, and the site is predominantly indigenous, naturally occurring vegetation)? If yes, proceed to step II. If no, proceed to step V.

II. Starting at the edge of the channel, use the regional riparian vegetation indicator list, identify the edge of the zone of (obligate) riparian plants.

III. At this point, check:

**a.** If there are any hydric indicators in the soil (refer to Wetland Delineation component).
**b.** If you are still in a zone of unconsolidated recent alluvial sediment.

If yes for either **a** or **b**, proceed outwards from the channel to identify the edge of these zones.

Once the answer to **a** and **b** are no, follow the same steps (II and III) using preferential and/or facultative riparian plant species *(Refer to the steps 1 to 12 from the vegetation assessment section below for further detail).*

Following completion of the above, proceed to step IV.

IV. Examine the geomorphology (shape) of the channel and banks. After moving away from the channel during steps II and III, you should be at or close to the edge of the top of the "macro-channel" bank (in the case of erosive rivers) or the edge of the active floodplain or flood zone (in the case of alluvial depositional rivers). At, or close to, this point you should see an inflection point (change in slope) between the riparian area and the upland (terrestrial) slopes. This can be taken as the edge of the riparian zone.

***Using Reference Sites:***

V. For sites which have been heavily disturbed (i.e. where there is almost no indigenous vegetation remaining, and/or where the banks have been heavily engineered such that it is no longer possible to identify the original morphology of the banks), then a REFERENCE site will need to be located. The Reference site will need to be close by on the same or a similar sized river system, in an area of similar topography. The Reference Site can be used to provide an indication of the likely riparian extent prior to disturbance. Once the reference site is located, proceed with step II.

**Where problems may be encountered:**

On floodplains, it is important to check whether the floodplain is active (i.e. regularly flooded under the current climatic regime) or a relict floodplain (meaning that the floodplain depositional area formed due to a wetter historical climate and now is no longer regularly flooded). The type of vegetation on the floodplain surface, presence of soil wetness indicators and the presence of ox-bows and other riparian and wetland features would provide the indications of the current levels of flooding/inundation/saturation.

**ANNEXURE D Wetland vegetation mix**

grass seed mix

WETLAND

## Contents:

**1. ORGANIC FERTILIZER**

It provides nutrients to the soil
It improves soil structure
It retains moisture

**2. ZEOLITE**

**Zeolite is a soil conditioner**

It retains nutrients in sandy soil
It retains moisture
It reduces nutrient loss
It removes heavy metals from soil

**3. ORGANIC MATERIAL**

**4. GRASS SPECIES**

*Contents may vary*

Andropogon eucomus
Aristida junciformis
Chloris gayana
Cynodon dactylon
Diandrochloa namaquensis
Digitaria eriantha
Eragrostis capensis
Eragrostis gummiflua
Imperata cylindrica
Ischaemum fasciculatum
Panicum coloratum
Schizachyrium sanguineum
Setaria incrassata
Sporobolus africanus
Sporobolus fimbriatus

**SOWING INSTRUCTIONS**

- Scarify to loosen soil by raking.
- Sow half of the seed with first application. Sow the rest as a second application to ensure proper coverage.
- Cover seed lightly by raking.
- Water gently or alternatively utilize as dryland seed mix.

**Application**

- 100g / 25 m2 (5m x 5m) ☐
- 500g / 125 m2 (11m x 11m) ☐
- 1kg / 250 m2 (16m x 16 m ) ☐
- 5 kg / 1250 m2 (35m x 35m) ☐

**WARNING**

Selected seed treated.
Do not use seed for:
***food, feed or consumption.***

Diverse Ecological Solutions (Pty) Ltd
Office Tel: +27 (0) 12 545 4069
Cell: +27 (0) 82 888 8643 Email: barend@ecologicalsolutions.info
Cell: +27 (0) 83 293 0229 Email: ivan@ecologicalsolutions.info

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