PRELIMINARY ECOLOGICAL HABITAT ASSESSMENT & MANAGEMENT RECOMMENDATIONS FOR THE PROPOSED NEW ENHLALAKAHLE GRAVITY PIPELINE; GREYTOWN BULK WATER SUPPLY PROJECT; UMZINYATHI DISTRICT MUNICIPALITY, KWAZULU-NATAL

Compiled for Triplo 4 Sustainable Solutions by:
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SUBMITTED: 30TH JANUARY 2012

*** DWAF accredited to undertake wetland and riparian delineations (2008)**

1. INTRODUCTION

Background

The Greytown Bulk Water Supply Scheme is located within Umvoti Local Municipality (KZ 245), one of four local municipalities falling under Umzinyathi District Municipality (DC 24).

The project is the Greytown Bulk Water Supply Project and it is funded by DWA under the RBIG (Rural Bulk Infrastructure Grant). The RBIG project number is KNR008. The Client is the uMzinyathi District Municipality, which is also the WSA, whereas uThukela Water is the WSP. The District Municipality will be responsible for planning and implementing this project.

Royal HaskoningDHV formerly trading as SSI Engineers and Environmental Consultants (Pty) Ltd were appointed on the 29th of August 2009 by uMzinyathi District Municipality to implement the Greytown Bulk Water Supply Project. Phase 1 of the project comprised refurbishment of water supply facilities in Greytown and is substantially completed. Phase 2 involves the development of a sub-regional bulk water scheme for Greytown and the uMvoti district.

The implementation strategy of Phase 2 included a feasibility study, which included an environmental appraisal report.

Triplo 4 Sustainable Solutions as an Independent Environmental Practitioner appointed Mr C. L. Cook to provide a basic description of the current habitat integrity of the proposed new section of the Enhlalakahle Trunkmain (henceforth called the Greytown pipeline) and to provide appropriate management recommendations for the proposed pipeline to the existing pumping station. The refurbishment of the existing Enhlalakahle Reservoir as well as an additional 2.5 Ml Enhlalakahle Reservoir is currently under construction as well as the of a new gravity main adjacent to the existing DN 160 Trunkmain.

The assignment is interpreted as follows: Determine the current ecological status of the immediate areas around the proposed new Greytown bulk water pipeline and the ecological impact of the proposed pipeline; as well as an environmental management plan for the disturbances on the site and immediately adjacent area. In order to compile the report the following had to be done:

Initial preparations*:*

- Obtain all relevant maps including aerial photographs (Google images) of the proposed pipeline alignment and information on the natural environment upstream and downstream of the area concerned (approximately 500m).
- An initial site investigation (17th of January 2013) to assess the current environmental status of the proposed new pipeline with special emphasis on the valley bottom wetland crossings as well as primary Midlands Mistbelt Grassland alignments.
- Identify problematic areas which require immediate attention (valley bottom wetland crossing) as well as management, e.g. erosion, degraded areas, reclamation areas, alien vegetation.
- Make management recommendations for the current ecological impacts as well as for the proposed new Enhlalakahle Trunkmain pipeline.

1.1 OBJECTIVES OF THE PRELIMINARY ECOLOGICAL SURVEY/ HABITAT ASSESSMENT

- To provide a description of the vegetation and fauna occurring around the recent and existing boreholes.
- To provide a description of any threatened plant or animal (mammals, birds, reptiles and amphibians) occurring or likely to occur within the proposed pipeline alignment and immediate surrounding areas.
- To describe the available habitats on site including areas of important conservation value or areas most likely to form important habitat for remaining threatened plant and animal species.
- To determine current impacts of the recently constructed sections of the Enhlalakahle pipeline as well as the proposed new section of the pipeline on the associated vegetation and fauna.
- To provide management recommendations to mitigate negative and enhance positive impacts of the proposed new section of the pipeline.

1.2 SCOPE OF STUDY

- An initial ecological survey documenting the dominant vegetation on the site and recording sightings and/or evidence of present fauna.
- An assessment of the ecological habitats, evaluating conservation importance and significance with special emphasis on the current status of threatened animal species (Red Data Species), within the proposed pipeline alignment and immediate adjacent areas (approximately 50-100m).
- Literature investigations with which to augment field data were necessary.
- Identification of potential ecological impacts that could occur as a result of the new pipeline and assess the significance of these, where possible.
- Investigate feasible and practical management recommendations that should be implemented to reduce or minimize the impacts, should the project be approved.
- Documentation of the findings of the study in a report.

1.3 CONSTRAINTS AND LIMITATIONS OF SHORT DURATION ECOLOGICAL AND FAUNAL SURVEYS

- Limitation to a base-line ecological survey for only 1 day (8 hours) during the summer months (January). The majority of the grassland plant species are seasonal and flower during specific times during the wet summer months. Some species flower after the first summer rains in October whilst others during the late summer months (February and March). No comprehensive vegetation surveys were conducted on the proposed new pipeline alignment.
- The majority of Midlands Mistbelt Grasslands have already been completely transformed during previous agricultural as well as current forestry activities although remnant patches remain especially within the low-lying dolerite outcrops.
- The vegetation of the valley bottom wetlands has been completely transformed or heavily impacted on by the current housing activities as well as forestry activities and dominated by weedy pioneer plants (rurals) as well as alien invasive species. Remnant patches of natural hygrophilous (wetland) vegetation occur within certain sections of the valley bottom wetlands (especially upstream from the pipeline crossings).
- The majority of animal species are extremely seasonal only emerging after sufficient heavy early summer rainfall (October-November). No comprehensive faunal surveys have been conducted on the pipeline alignment.
- Limitation of historic data and available databases for the Greytown area.
- The presence of threatened species on site is assessed mainly on habitat availability and suitability as well as desk research (literature, personal records) and previous surveys conducted in similar habitats between 1997-2013).

2. METHODOLOGY

A survey of the site and surrounding areas was carried out by driving around the surrounding areas by car and closer inspection of selected sections of the proposed new pipeline alignment carried out on foot. As the site is situated within heavily afforested Mondi plantations with existing secondary roads the majority of natural vegetation consisting of **Midlands Mistbelt Grassland (CB 3)** (Mucina *et al*. 2006) has already been transformed into afforested *Eucalyptus grandis* and *Acacia mearnsii* plantations. The vegetation along the valley bottom wetlands falls into the **Drankensberg Wetlands (AZf 4)** vegetation unit. The hygrophilous and hydrophilic vegetation along the valley bottom wetlands has been heavily impacted on by the adjacent high density housing activities as well as adjacent forestry activities including extensive vegetation clearances and habitat transformation especially within the adjacent hillslope seepage wetlands, wood harvesting, collection of traditional medicinal plants; bank erosion as well as invasion of weedy plant and tree species. The natural hydrological patterns of the valley bottom wetlands have been disrupted by an existing railway line. The water is channelled through culverts which are heavily silted and clogged with alien invasive and weedy plant species. The hygrophilous vegetation along the valley bottom wetlands has become severely degraded due to cattle grazing activities as well as extensive alien vegetation invasion especially by Bugweed (*Solanum mauritianum**), Lantana (*Lantana camara**) and Bramble (*Rubus cuneifolius**). The Midlands Mistbelt grassland vegetation occur on the midlsopes as well as patches of low-lying rocky outcrops. The site was visited predominantly during daylight hours (09hoo-15h00) on the 17th of January 2013.

It must be stressed that due to time and financial constraints no comprehensive vegetation or faunal surveys were undertaken during the brief ecological survey. Data was heavily supplemented by literature investigations; personal records, historic data and previous surveys conducted in the area. Different habitats were explored to identify any sensitive or specialised species which could possibly occur on the site. Habitats explored included the Midlands Mistbelt Grassland in various stages of degradation and transformation, scattered patches of low-lying rocky outcrops (mostly embedded rock material) on the mid and upper hillslopes; remnant pockets of indigenous moist grassland vegetation (hillslope seeps) and hygrophilous vegetation within the seasonally inundated mostly channelled valley bottom wetlands. The vegetation literature search was undertaken utilising *The Vegetation of South Africa, Lesotho and Swaziland* (Mucina & Rutherford 2006) for the vegetation description as well as *National Red List of Threatened Plants of South Africa* (Raimondo *et al,* 2009). **Mammal** names are as used by Skinner and Chimimba (2005), **Bird** names by Hockey, Dean & Ryan (2006); **Reptile** names by Branch (1998) and **Amphibian** names by Carruthers & Du Preez (2009).

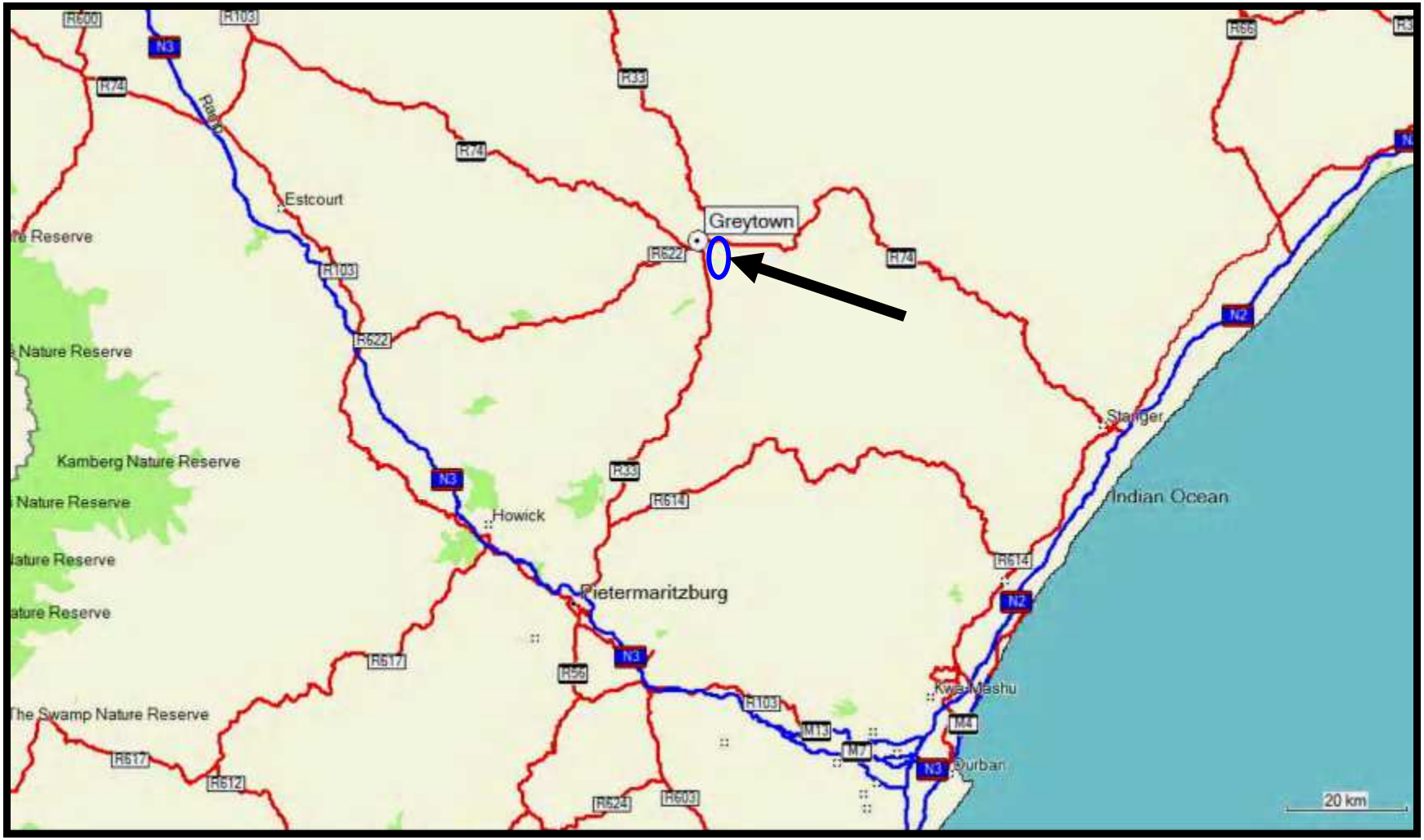

Figure1. Locality map for the proposed new Greytown Bulk Water Supply Project.

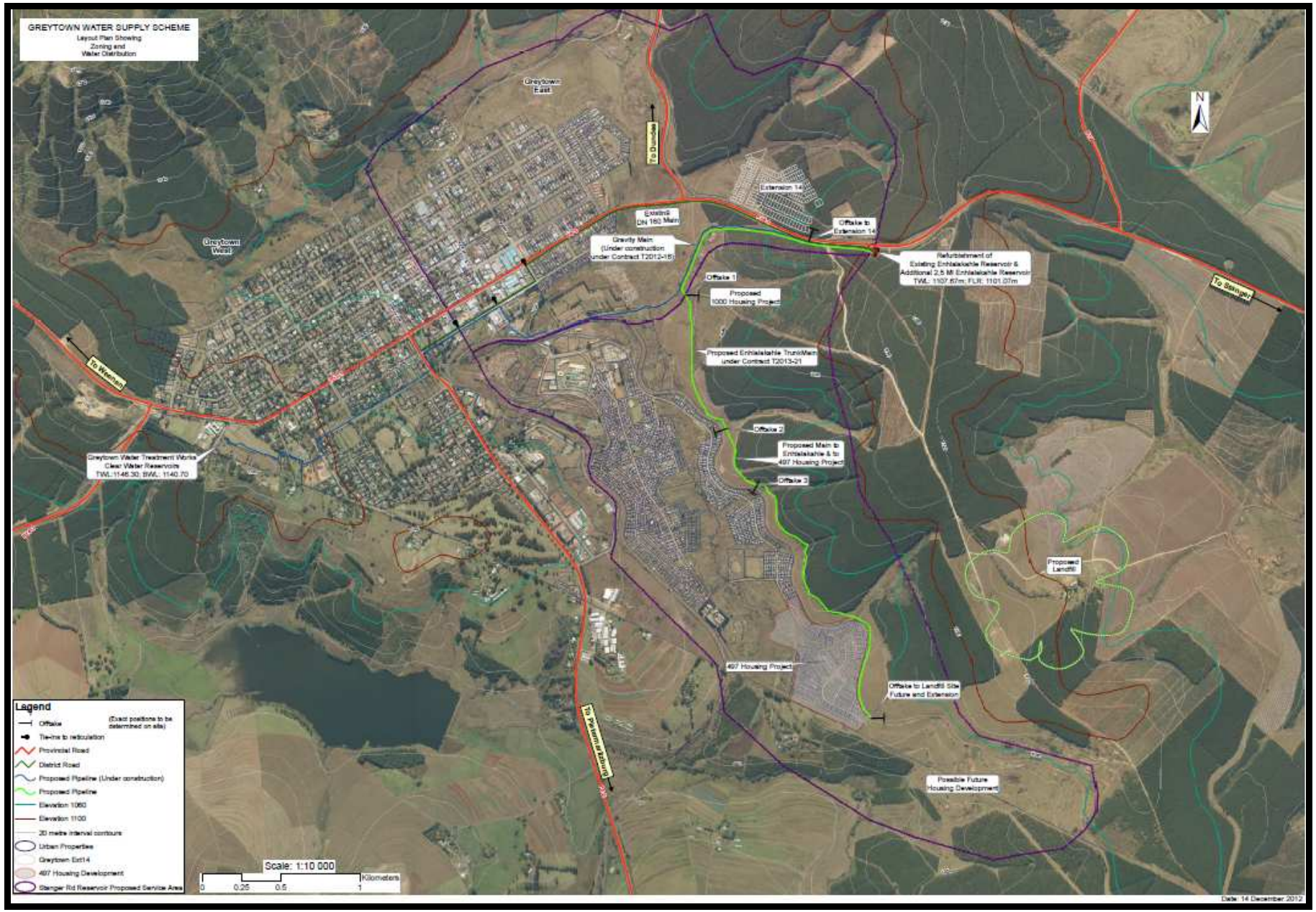

Figure2. Proposed layout plan for the Greytown Bulk Water Supply Project.

3.1 STUDY AREA

The project area lies approximately 70 km to the north of Pietermaritzburg. A Locality Plan is attached (see Figure 1 above). Access to Greytown is via the R74 from Stanger or from Pietermaritzburg along the R33. Greytown is approximately 35 km west of Kranskop and 110 km north of Stanger. Access to the site is on secondary forestry roads which run adjacent to the plantations.

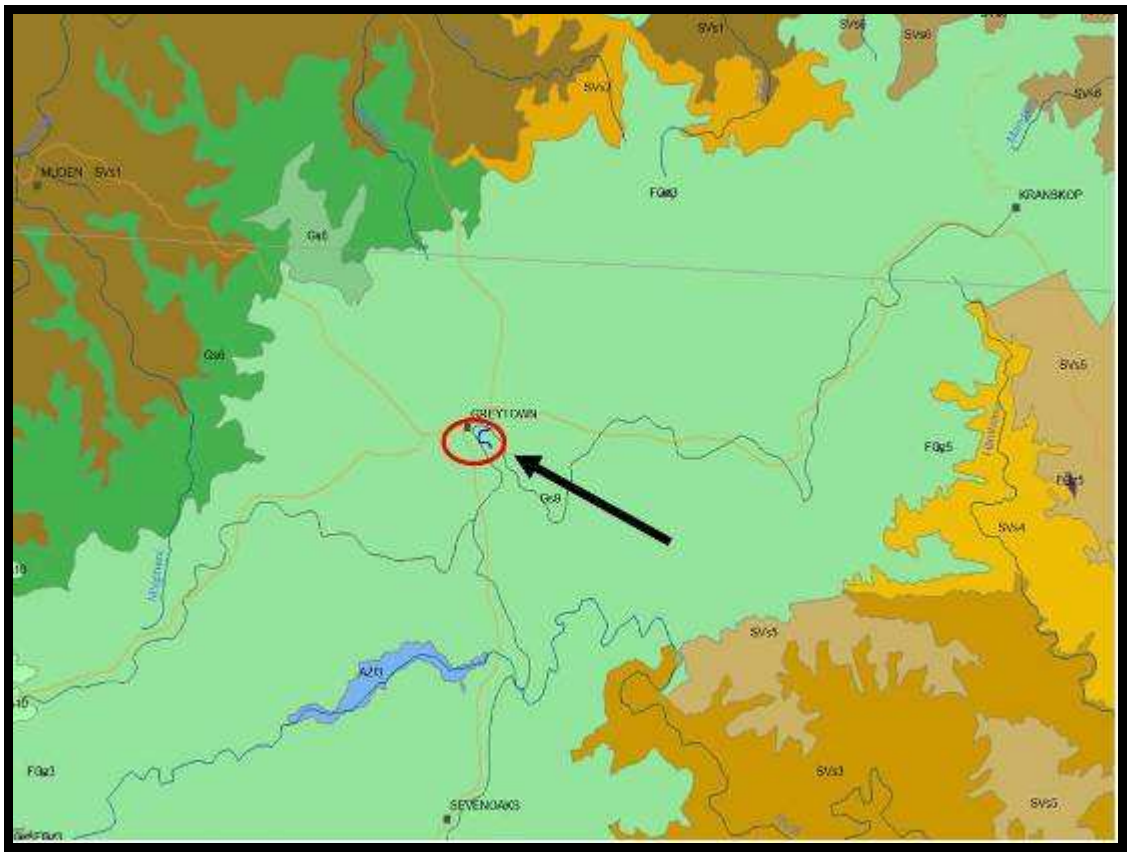

Figure3. The proposed pipeline falls within the highly endangered Midlands Mistbelt Grassland vegetation unit (Mucina and Rutherford 2006).

Vegetation Classification

The Greytown Bulk Water Supply Project and new pipeline are situated within the **Midlands Mistbelt Grassland** (Gs 9) vegetation unit (Mucina & Rutherford 2006), previously known as the **Ngongoni Veld of Natal Mist-belt** VT 45 (38%), **Highland Sourveld and Dohne Sourveld** VT 44 (33%) (Acocks 1953). Low and Rebelo (1996) classified it as **Moist Upland Grassland** LR 42 (41%) and **Short Mistbelt Grassland** LR 47 (37%)(Mucina & Rutherford 2006).

Distribution

Midlands Mistbelt Grassland Occurs in Kwazulu-Natal and Eastern Cape Provinces. In Kwazulu-Natal it occurs in the Midlands as a scattered broad belt in the form of several major patches including Melmoth-Bobanango area, Kranskop and Greytown, Howick Lions River, Karkloof, Blagowan, Cedara, Edendale, Hilton, Richmond, the Ixopo-Highfats area, Mount Malowe in the Umzimkhulu enclave of the Easter Cape Province and the Harding-Weza area. Altitude varies from 760-1 400m (Mucina & Rutherford 2006).

Vegetation and Landscape Features

Hilly and rolling landscape mainly associated with a discontinuous east-facing scarp formed by dolerite intrusions (south of the Thukela River). Dominated by forb-rich, tall, sour *Themeda triandra* grasslands, transformed by the invasion of native 'Ngongoni Grass' (*Aristida junciformis* subsp. *junciformis*). Only a few patches of the original species-rich grasslands remain (Mucina & Rutherford 2006).

Geology and Soils

Apedal and plinthic soil forms derived mostly from Ecca Group (Karoo Supergroup) shale and minor sandstone and less importantly from Jurassic dolerite dykes and sills. Dominant land types Ac, followed by Fa (Mucina & Rutherford 2006).

Climate

Summer rainfall, with MAP of 915mm, range 730- 1280mm. Heavy and frequent occurrences of mist provides significant amounts of additional moisture. Some of the rain in the form of cold frontal activity, mainly in winter, spring and early summer. Thunderstorms are common in summer and autumn. Frosts are generally moderate but occasionally severer frost may occur. Further climatic conditions include short-term drought spells, hail and hot north-western berg winds occurring particularly in spring and early summer (Mucina & Rutherford 2006).

Alien invasive vegetation

Ageratum conyzoides, Arundo donax*, Cirsium vulgare*, Canna indica*, Caesalpinia decapetala*, Campuloclinium macrocephalum*, Chromolaena odorata*, Ipomoea indica*, Ipomoea purpurea*, Lantana camara*, Leucaena leucocephala*, Psidium guajava*, Melia azedarach*, Mimosa pigra*, Ricinus communis*, Senna didymobotrya*, Solanum mauritianum*, Rubus cuneifolius*, Tithonia diversifolia*.*

4. DESCRIPTION OF THE AFFECTED ENVIRONMENT CONDITIONS RELATING TO THIS REPORT

4.1 VEGETATION ASPECT

Approach

Conclusions reached and recommendations made are based not only on occurrence of individual species, but more appropriately on habitats and ecosystem processes. Planning must therefore allow for the maintenance of species, habitats and ecosystem processes, even if Red Data or endemic plant species are absent.

The largest sections of the general study area are degraded due to forestry impacts with extensive *Eucalyptus grandis** as well as Black Wattle *Acacia mearnsii** plantations. The alignments bisecting the open grasslands were extensively surveyed on foot wherever they were accessible due to dense Bramble (*Rubus cuneifolius*) within the existing pipeline reserve. The existing pipeline servitude comprised mainly of pioneer weedy rurals such as *Ambrosia artemisifolia, Ageratum houstonianum*, Ageratum conyzoides**, *Bidens pilosa, Conyza bonariensis* and *Parthenium hyserophorus**; alien invasive vegetation such as dense thickets of *Rubus cuneifolius*, Lantana camara*, Chromolaena odorata*[*], Solanum mauritianum*, Psidium guajava*, Tithonia diversifolia, Senna septemtrionalis** as well as secondary succession grasslands dominated by *Aristida junciformis* subsp. *junciformis*, *Digitaria eriantha, Panicum maximum, Cynodon dactylon, Cymbopogon caesius, Eragrostis curvula, Imperata cylindrica, Hyparrhenia fillipendula, Hyparrhenia tamba* and *Melinis repens.*Special attention was given to determine the presence of any Red Data listed species. With the faunal survey, indirect evidence was also used to record the presence of species. These included nests, droppings, tracks and calls. It should be stressed that this is by no means a comprehensive survey since the survey was performed for one day only and during daylight hours. The records were augmented by personal experience within Mistbelt grasslands, the use of published data and the literature.

[*] alien invasive vegetation

Figure4. Large sections of the proposed alignment (blue line) bisect transformed Ngongoni Grass (*Aristida junciformis* subsp. *junciformis*) due to historic agricultural activities as well as high levels of human disturbance (harvesting of medicinal plants, rock removal, frequent fires).

4.2 AFFORESTED PLANTATIONS AND SECONDARY SUCCESSION *ARISTIDA JUNCIFORMIS* SUBSP. *JUNCIFORMIS* GRASSLAND

Vegetation Type	Transformed Grassland	**Tree cover**	0-100 %
Soil	Loamy –gravely	**Shrub cover**	0%
Topography	Undulating	**Herb cover**	3-5%
Land use	Afforestation and limited livestock grazing	**Grass cover**	0-100%
Dominant spp.	*Aristida junciformis* subsp. *junciformis, Melinis repens, Sporobolus africanus, Hypoxis argentea, Pennisetum clandestinum*, Tagetes minuta, Cirsium vulgare*; Eragrostis curvula, Cynodon dactylon; Datura strumonium*, Solanum sisymbrifolium*, Solanum mauritianum*, Acacia mearnsii*, Acacia dealbata*, Rubus cuneifolius*, Ipomoea purpurea* Hyparrhenia hirta, Hyparhenia tamba, Tragus berteronianus*		

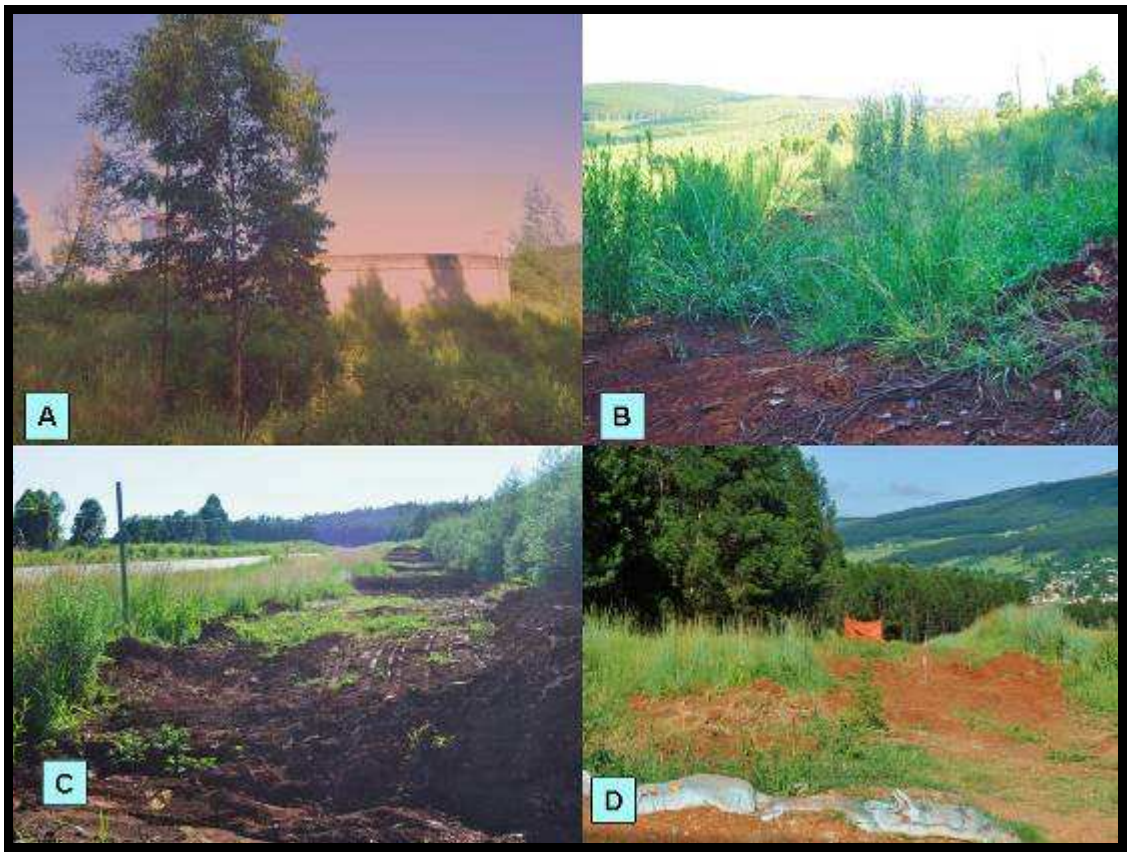

Figure5. A conglomerate of photographs displaying the transformed vegetation units A: The existing Enhlalakale Reservoir is situated within an afforested or completely transformed environment and the vegetation around the reservoir consists mainly of pioneer weedy and alien invasive plant species. **B:** The old forested areas are dominated by pioneer weedy plant and grass species, **C & D:** The uppers sections of the new pipeline adjacent to the R33 and afforested plantations have already been constructed.

The vegetation immediately adjacent to the existing Enhlalakahle Reservoir as well as new reservoir sites are situated within a completely transformed afforested environment. The felled stands as well as adjacent fire breaks consist mainly of pioneer or weedy weedy rurals including Khaki Bush *Tagetes minuta*, Black Jack *Bidens pilosa* as well as alien invasive species such as American Bramble (*Rubus cuneifolius**), Lantana (*Lantana camara**), Scotch Thistle (*Cirsium vulgare**), Purple Morning Glory (*Ipomoea purpurea**), Large Thorn-Apple (*Datura stramonium**) and Dense-Thorned Bitter Apple (*Solanum sisymbrifolium*). Due to the transformed and degraded vegetation surrounding the pipeline and reservoir site it's highly unlikely that any threatened plant species remain in the immediate area.

4.3 MIDLANDS MISTBELT GRASSLAND (GS 9)

Vegetation Type	Midlands Mistbelt Grassland/ Sub-Escarpment Grassland	**Tree cover**	0%
Soil	Loamy–gravely	**Shrub cover**	0%
Topography	Undulating Hillslopes	**Herb cover**	25-30 %
Land use	Afforestation and limited livestock grazing	**Grass cover**	60-70%
Dominant spp.	*Themeda triandra, Andropogon appendiculatus, Aristida junciformis, Brunsvigia cf. grandiflora, Harpochloa falx, Setaria spachelata, Loudetia simplex, Berkheya setfera, Gomphocarpus sp., Commelina africana, Thunbergia dregeana, Cyanotis speciosa, Asclepias spp., Leonotis leeonorus, Leonotis intermedia, Striga elegans, Helichrysum appendiculatum, Comnyza pinnata, Nidorella auriculata, Wahlenbergigia undulata, Helichrysum cephaloideum, Watsonia spp., Hypoxis spp.*		

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Figure6. Species observed within the foot-slopes of a rocky outcrop situated on the eastern slopes of a grassland hill situated within the Midlands Mistbelt Grassland vegetation unit included several Poison Bulbs *Boophone distichta* which are currently Red Listed as 'Declining' mainly due to unsustainable harvesting of the plants for the traditional medicinal practices were observed between 2-25m from the proposed pipeline alignment.

The proposed pipeline is located on the mid-slopes of undulating hills which comprises of remnant patches of natural mistbelt grassland. More intensive surveys are required in order to determine the current status of these grasslands. High human disturbances occur on the lower slopes adjacent to the railway line. High forb species diversity was noted within the scattered rocky extrusions adjacent to the valley bottom wetlands. Suitable habitat occurs within the moist rocky hillslopes and valley bottoms for several Red Listed plant species including several terrestrial orchids including species of *Eulophia, Habenaria, Disa, Scizochilus, Branchycorythis, Brownlea* and *Dispersis*. One red listed "Declining" plant species was observed within the rocky hillslopes immedaitely adjacent to the pipeline alignment. Several Poison Bulbs (*Boophone distichata*) were observed within a low-lying, mostly embedded dolerite extrusion.

Boophone disticha has many medicinal uses, for example the Bushman once used the poison for their arrows, and traditional healers use it to treat pain and wounds. Parts of the plant are used by certain African tribes and also by some Europeans to cure various ailments. The outer covering of the bulb is applied to boils and abscesses. Fresh leaves are used to stop bleeding of wounds. The plants are known to be poisonous to cattle and sheep. The name sore-eye flower refers to the fact that if a person is exposed to the open flowers in a confined space; it may lead to sore eyes and even to a headache. *Boophone distichata* is currently listed as a 'Declining, species. * A taxon is 'Declining' when it does not meet any of the five IUCN criteria and does not qualify for the categories Critically Endangered, Endangered, Vulnerable or Near Threatened, but there are threatening processes causing a continuing decline in the population.

Figure7. A rescue and recovery programme should be implemented with the removal of several large *Brunsvigia* cf. *grandiflora* bulbs as well as *Hypoxis* spp., *Ledebouria* spp. from the pipeline servitude prior to construction activities. The removed bulbs or geophytes should planted along the pipeline servitude after the pipeline has been laid or in suitable habitat away from the construction activities. The majority are heavily utilised for medicinal properties.

As a precautionary measure a suitably qualified ecologist should conduct a thorough walk through the pegged alignment prior to construction activities within all primary Midlands Mistbelt grasslands and moist hillslope seeps, valley bottom wetlands and rocky hillslopes occurring along the pipeline alignment during the appropriate flowering/growing season for the majority of threatened plant species (November-March). Construction activities must be restricted to the pipeline servitude especially within this sensitive habitat. The entire disturbed area around the pipeline should be appropriately rehabilitated and re-vegetated using the indigenous grass, sedge and forb species. No heavy vehicles should be allowed to transverse the rocky outcrop or any primary Mistbelt grassland during the pipeline construction as well as operational phase of the project. Top soil removed from the pipeline trench must be appropriately conserved and used for re-vegetation process. The pipeline servitude must be monitored for the invasion of alien vegetation which must be removed in order to prevent further infestations.

4.4 VALLEY BOTTOM WETLANDS AND HILLSLOPE SEEPS

Vegetation Type	**Drankensberg Wetlands (AZf 4)**	**Tree cover (mainly alien invasives)**	0-5%
Soil	Loamy–gravely-Clays (Hydromorphic soils). Large amounts or recently 'washed-in" material.	**Shrub cover**	0-10%
Topography	Valley Bottom	**Herb cover**	3-5%
Land use	Afforestation and limited livestock grazing	**Grass cover**	40-100%
Dominant spp.	*Albuca fastigiata, Kniphofia linearfolia, Agapanthus campanulatus, Cyperus denudatus, Mariscus solodus, Pennisetum clandestinum*, Verbena bonariensis, Tagetes minuta, Cirsium vulgare* Typha capensis*, *Cyperus immensus*, *Cyperus sexangularis, Cyperus textilis, Mariscus congestus*, *Imperata cylindrica, Juncus* spp., *Scirpus ficinoides, Carex* spp., *Eleocharis* spp., *Pycreus nitidus*, *Zantedeschia aethiopica*, *Disa woodii*, *Senecio speciosus, Persicaria serrulata, Persicaria senegalensis*, *Colocasia esculenta**, *Monopsis decipiens, Sesbania punicea*, Canna indica*, Rubus cuneifolius*, Persicaria senegalensis, Cirsium vulgare*, Setaria sp..*		

Figure8. Species observed within the lower-lying valley bottom wetlands: A: Several Red-Hot Pokers *Kniphofia linearfolia* were observed within the seasonally inundated wet zones of the mainly channelled valley bottom wetlands. **B*:*** *Berkheya speciosa* was observed within the temporary wet zones of the adjacent hillslope seepage wetlands and **C:** *Agapathus campanulatus* in protected rocky areas with elevated soil moisture levels.

The proposed pipeline bisects five valley bottom wetlands as well as a remnant hillslope seepage wetland. The majority of the valley bottom wetlands have been heavily impacted on by surrounding forestry as well as the high density human settlements. The majority of the pipeline crossings are situated adjacent to the railway line above the silted and alien invaded culverts although certain alignments bisect natural hygrophilous vegetation. The vegetation within the seasonal and possible permanent wet zones displays a more natural composition of hydrophilic sedges and grasses and could potentially offer suitable habitat for certain red listed plant species. More intensive surveys are required in order to ascertain their presence. Due to the transformed and degraded vegetation within the surrounding and newly established townships and extensive forestry activities it's highly unlikely that any significant population of threatened plant species remain in the immediate area.

5. PRELIMINARY FAUNAL SURVEY

The preliminary faunal survey focused mainly on mammals, birds, reptiles and amphibians of the study area. The survey focused on the current status of threatened animal species occurring, or likely to occur within the study area, describing the available and sensitive habitats, identifying potential impacts resulting from the pipeline development and providing mitigation measures for the identified impacts. Faunal data was obtained during a single site visit of the proposed development site carried out on foot on the 17th of January 2013. All animals (mammals (larger), birds, reptiles and amphibians) seen or heard; were recorded. Use was also made of indirect evidence such as nests, feathers and animal tracks (footprints, droppings) to identify animals. Previous surveys, literature investigations; personal records and historic data supplemented the initial survey.

The literature search was undertaken utilising *The Mammals of the Southern African Subregion* (Skinner & Chimimba 2005) and *The Red Data Book of the Mammals of South Africa: A Conservation Assessment* (Friedmann and Daly (editors) 2004) for mammals. *Roberts-Birds of Southern Africa VIIth ed.* (Hockey, Dean and Ryan (editors) 2005) and *The Escom Red Data Book of Birds of South Africa* (Barnes 2000) for avifauna (birds). A Complete Guide to the Frogs of Southern Africa (du Preez & Carruthers 2009) and the *The Atlas and Red Data Book of the frogs of South Africa, Lesotho and Swaziland* (Minter et al. 2004) for amphibians. *The Field Guide to the Snakes and other Reptiles of Southern Africa* (Branch 2001) and *South African Red Data Book- Reptiles and Amphibians* (Branch 1988) for reptiles.

The majority of grassland vegetation situated within the mid and lower slopes adjacent to the proposed pipeline alignment are completely transformed or severely degraded and suffers from extensive overgrazing, mostly from cattle. Cattle were observed grazing within the valley bottom wetlands.

Forestry has been declared as a Stream Flow Reduction Activity (SFRA) (Department of Water affairs and Forestry 1999). The major water quality concerns associated with afforestation and forestry operations are recognised as being: 1) increased turbidity and sedimentation due to soil disturbance accompanying cultivation, drainage, road construction and harvesting operations (Nisbet 2001); 2) increased concentrations of nutrients, particularly nitrate, ammonium and phosphorus, following fertilisation of intensively managed plantation forests (Binkley *et al.* 1999); 3) changes in light availability and water temperature (Campbell & Doeg 1989); 4) changes in the balance between allochthonous and autochthonous inputs; and possible enhanced capture of acid deposition by forest canopies resulting in further acidification of surface waters (Nisbet 2001).

Soil disturbance accompanying forest ploughing, drainage, road works and harvesting operations has the potential to cause large quantities of sediment to enter the stream or river, resulting in increased turbidity and siltation (Nisbet 2001). Preparation of land for afforestation is normally achieved by land clearing with or without vegetation burning. This, together with road construction for logging, leads to increased suspended solids entering receiving water bodies. The amount of sediment lost from a catchment depends on site factors such as slope and soil type and also on the intensity of the harvesting operation (Campbell & Doeg 1989).

Channel form may also be altered as a result of both increased sediment input and modified flow regimes. Afforestation also affects river flows, with flows reduced during reforestation and increased during removal of forest vegetation or harvesting. Trees intercept more precipitation and transpiration rates are greater, resulting in higher evaporation rates compared to other vegetation types (Johnson 1998). Harvesting of trees, particularly clear-felling increases low flows, particularly in the growing season, by reducing interception losses and virtually eliminating transpiration for the first year (Johnson 1998). The effects of forestry on low flows are therefore systematically related to the stage of the forest cycle. Long-term biological effects arise mostly as a result of an alteration to the stream riparian vegetation, whilst shorter-term effects are mostly attributable to the impact of suspended or deposited sediment (Campbell & Doeg 1989). No evidence of changes in aquatic ecosystems has been reported from forest fertilisation operations, although few studies have attempted direct examination of the response of aquatic organisms to fertilisation of adjacent forests (Binkley *et al.* 1999)

Existing Impacts on the fauna on and surrounding the site included:

- The proposed pipeline alignment is situated adjacent to an existing pipeline servitude, Eskom servitude, railway line and road reserves dominated by completely transformed vegetation with limited habitat diversity.
- High levels of habitat degradation and transformation due to present forestry as well as human activities occur adjacent to the proposed pipeline. This has resulted in impoverished habitats with limited faunal diversity.
- Existing afforested plantations as well as informal access roads and pedestrian and human and livestock pathways occur within the hillslopes.
- Existing high density and several recently constructed settlements occur on the lower footslopes.
- Extensive forestry activities result in severe stream flow reduction which impacts on the natural hydrological regime.
- Previous agricultural activities (oldlands) and current forestry activities have transformed the majority of grassland habitat on the hillslopes and valley bottom wetlands surrounding the pipeline.
- Over-grazing activities by cattle result in limited vegetative or grass cover or refuge habitat for remaining faunal species.
- Frequent burning of remaining patches of grasslands as fire breaks severely

restricts vegetative cover and potential refuge habitat for remaining faunal species.

- Hunting with dogs as well as cats around the surrounding settlements. Dogs and cats have a high impact on remaining faunal species.
- Deterioration of water quality and quantity due to adjacent forestry activities.
- Introduction of exotic and alien vegetation.

4.1 AMPHIBIANS

Amphibians are an important component of South Africa's exceptional biodiversity (Siegfried 1989) and are such worthy of both research and conservation effort. This is made additionally relevant by international concern over globally declining amphibian populations, a phenomenon currently undergoing intensive investigation but as yet is poorly understood (Wyman 1990; Wake 1991). Amphibians have declined dramatically in many areas of the world. These declines seem to have worsened over the past 25 years and amphibians are now more threatened than either mammals or birds, though comparisons with other taxa are confounded by a shortage of reliable data.

Most frogs have a biphasic life cycle, where eggs laid in water develop into tadpoles and these live in the water until they metamorphose into juvenile fogs living on the land. This fact, coupled with being covered by a semi-permeable skin makes frogs particularly vulnerable to pollutants and other environmental stresses. Consequently frogs are useful environmental bio-monitors (bio-indicators) and may acts as an early warning system for the quality of the environment.

Breeding in African frogs is strongly dependent on rain, especially in the drier parts of the country where surface water only remains for a short duration. The majority of frog species in the Kwazulu-Natal Province can be classified as explosive breeders. Explosive breeding frogs utilise ephemeral pans or inundated grasslands and seasonal pools within valley bottom wetlands for their short duration reproductive cycles.

As the survey was undertaken for only 1 day during the early winter months (May), only a small proportion of species are present. Ideally, a herpetological survey should be undertaken throughout the duration of the wet season (November-Mach). It is only during this period that accurate frog species lists can be compiled. During this survey; fieldwork was augmented with species lists compiled from personal records; data from the South African Frog Atlas Project (SAFAP)(1999-2003) and published data, and the list provided in the Appendix (see Table 9) is therefore regarded as likely to be fairly comprehensive.

Figure9. A snoring puddle frog (*Phrynobatrachus natalensis*) was observed calling during the day along valley bottom crossing 1.

The valley bottom wetlands and associated hygrophilous/ hydrophilic seepage zones are heavily degraded due to present forestry activities with limited habitat diversity. Limited natural hygrophilous vegetation remains as well as the destabilization of the macro-channel banks. Increase in deposition of silt and nutrients results in increased aquatic macrophytes (reeds) which offer suitable breeding habitat for Painted Reed Frogs (*Hyperolius marmoratus*). The most suitable breeding habitats for remaining frog species occurs within the valley bottom wetlands. Two frog species was recorded during the brief field survey namely Common River Frogs (*Amietia angolensis*) and Snoring Puddle Frog (*Phrynobatrachus natalensis*). Both of these species are common and widespread.

Table1. Frog species recorded on the actual site or are likely to occur on the site.

Common Name	Scientific Name	Status and Distribution	Habitat
Plaintive Rain Frog	*Breviceps verrucosus*	Endemic to Southern Africa.	Terrestrial breeder favouring moist soils.
Guttural Toad	*Amitophrynus* (*Bufo*) *gutturalis*	Common in southern Africa north of Gariep.	Permanent and semi-permanent ponds and backwaters in open grassland.
Common Platanna	*Xenopus laevis*	Common throughout southern Africa.	Permanent or semi-permanent bodies of water, natural or man-made.
*Common River Frog	*Amietia* (*Afrana*) *angolensis*	Common in central and southern Africa.	Permanent standing water and streams in grassland and open woodland.

Painted Reed Frog	*Hyperolius marmoratus*	Common along Kwazulu-Natal Coast	Reeds and other emergent vegetation along a wide variety of waterbodies including pans and rivers
Bubbling Kassina	*Kassina senegalensis*	Common throughout Southern Africa	Grassy margins of seasonally inundated pans as well as dams
*Snoring Puddle Frog	*Phrynobatrchus natalensis*	Widely distributed along the eastern sections of Southern Africa	Shallow to fairly deep water in temporary pans and pools, vleis, dams and even slow-flowing streams
Sharp-Nosed Grass Frog	*Ptychadena oxyrynchus*	Eastern Parts of South Africa	Vleis, inundated grassland and sedge pans, temporary roadside pools and rock puddles
Natal Sand Frog	*Tompoterna natalensis*	Common species in Kwazulu-Natal, Mpumalanga, Gauteng.	Streams, rivers or other places where water flows slowly but also in lothic or standing water
Striped Stream Frog	*Strongylopus fasciatus*	Widespread and Common.	Prefers grassy areas and reed beds along streams and rivers and around natural vleis.
Clicking Stream Frog	*Strongylopus grayii*	Endemic to Southern Africa; widely distributed	Small dams, ponds, pools, ditches and shallow seeps

Threatened species

Five red listed frog species have been recorded from the 2930 AB Quarter Degree Grid Cell (QDGC) namely the Long-toed Tree Frog (*Leptopelis xenodatylus*) Critically Endangered, Pickersgill's Reed Frog (*Hyperolius pickersgilli*) Critically Endangered, Kloof Frog (*Natalobatrachus bonebergi*) Endangered, Spotted Shovel-nose Frog (*Hemisus guttatus*) Vulnerable, Bilbo's Rain Frog (*Breviceps bagginsi*) Vulnerable and Natal Leaf-folding Frog (*Afrixalus spinifrons*). The majority of the above-mentioned frog species can be excluded due to lack of suitable habitat. Marginally suitable habitat may occur within the more natural areas along the valley bottom wetlands as well as suitable habitat for Bilbo's Rain Frog (*Breviceps bagginsi*) It is which is often found on the edges of wood plantations in grasslands, and it presumably breeds by development occurring directly in subterranean nests. More intensive surveys conducted over extended periods are required in order to ascertain the current conservation status of these two frog species in the Greytown area.

4.2 REPTILES

Reptile lists require intensive surveys conducted for several years. Reptiles are extremely secretive and difficult to observe during field surveys. The majority reptile species are sensitive to severe habitat alteration and fragmentation. Due to the high levels of habitat destruction and degradation in the area due to intensive forestry activities are all causal factors in the alteration of reptile species occurring on the site and surrounding areas. As a result of human presence in the area as well as on the site; coupled with habitat destruction and high levels of disturbances, alterations to the original reptilian fauna are expected to have already occurred. Removal of large riparian tree species during the forestry activities and dead trunks for firewood collection destroys numerous habitats for many arboreal reptile species. Clearing of rock material for forest plantations destroys vital habitat for numerous rupicolous reptile species including the Agamids, Cordylids, Geckonids and Skinks. Forest plantations result in a shadow effect and reduced temperatures on remaining rocky outcrops which severely restricts the suitability for remaining reptile species. The majority of snake species hibernate in old tree trunks, termite mounds or under suitable rocks. Scattered mainly embedded rocky outcrops are found adjacent to valley bottom 5 crossing. A few scattered termite mounds (including moribund mounds) were observed adjacent to the pipeline increasing in number where agricultural activities have ceased. Indiscriminate killing of snake species occur all around human settlements. The indiscriminate killing of all snake species results in the alteration of species composition, with the disappearance of the larger and the more sluggish snake species. The frequent burning of the limited overgrazed grassland vegetation has a high impact on remaining reptiles. Fires during the winter months will severely impact on the hibernating species, which are extremely sluggish. Fires during the early summer months destroy the emerging reptiles as well as refuge areas increasing predation risks.

Three reptile species were recorded during the survey, namely a Striped Skink *Trachylepis* (*Mabuya*) *punctatissima,* Yellow-Throated Plated Lizard (*Gerrhosaurus flavigularis*) and Cape Skink (*Trachylepis capensis*). Low reptile diversity is expected from the actual pipeline alignment and immediate area. A probable species list is provided in Table3 below as well as a list of all reptile species recorded from the 2830 AB locus (SARCA) is found in the Appendix (see Table10).

Table3: Reptile species that occur or are likely to occur in the study area due to suitable habitat, and may therefore be present. Actual species lists will most likely contain far fewer species due to high levels of habitat transformation.

COMMON NAME	SCIENTIFIC NAME
*Cape Skink	*Trachylepis* (*Mabuya*) *capensis*
*Striped Skink	*Trachylepis* (*Mabuya*) *punctatissima*
Variable Skink	*Trachylepis* (*Mabuya*) *variata*
Marsh or Helmeted Terrapin	*Pelomedusa subrufa*
*Yellow-throated Plated Lizard	*Gerrhosaurus flavigularis*
Flap-Necked Chameleon	*Chamaeleo dilepis*
Nile Monitor	*Varanus niloticus*
Southern Rock Agama	*Agama atra atra*
Herald or Red-lipped Snake	*Crotaphopeltis hotamboeia*
Rinkhals	*Haemachatus haemachatus*
Common or Rhombic Night Adder	*Causus rhombeatus*
Boomslang	*Dispholidus typus*
Puff Adder	*Bitis arietans*
Common or Rhombic Egg Eater	*Dasypeltis scabra*
Dusky-Bellied Water Snake	*Lycodonomorphus laevissimus*
Brown Water Snake	*Lycodonomorphus rufulus*
Brown House Snake	*Lamprophis fuliginosus*
Spotted House Snake	*Lamprophis guttatus*
Aurora House Snake	*Lamprophis aurora*

Cape Wolf Snake	*Lycophidion capense*
Spotted or Rhombic Skaapsteker	*Psammophylax rhombeatus*
Striped Skaapsteker	*Psammophylax tritaeniatus*
Cape Centipede Eater	*Aparallactus capensis*
Spotted Bush Snake	*Philothamnus semivariegatus*
Spotted Harlequin Snake	*Homoroselaps lacteus*
Sundevall's Shovel-snout	*Prosymna sundevalli*
Green Water Snake	*Philothamnus hoplogaster*
Sundevalls' Garter Snake	*Elapsoidea sunderwalli*
Common Slug-eater	*Duberria lutrix*
Bibron's Blind Snake	*Typhlops bibronii*
Cape and Eastern Thread Snake	*Leptotyphlops conjunctus*
Peters' Thread Snake	*Leptotyphlops scutifrons*

* recorded during brief field survey

Figure10. Several termite mounds *Trinervitermes spp.* were observed adjacent to the pipeline servitude. Moribund (old abandoned or dead mounds) termite mounds offer important refuges for numerous frog, lizard and snake species (Striped Harlequin Snake). Large number of species of mammal, birds, reptiles and amphibians feed on the emerging alates (winged termites). These mass emergences coincide with the first heavy summer rains and the emergence of the majority of herpetofauna. Termite mounds also provide nesting site for numerous snakes, lizards (varanids) and frogs. Several termite mounds have recently been destroyed. Termite mounds are destroyed during collecting for medicinal use as well as illegal reptile collecting and for feeding aviary birds.

Threatened Species

Table4. Table of threatened reptile species recorded from the 2830 AB QDGC.

Natal Midlands Dwarf Chameleon	*Bradypodium thamnobates*	Near-Threatened	Lowland forest and Bush. No suitable habitat along pipeline alignment
Striped Harlequin Snake	*Homoroselaps dorsalis*	Near-Threatened	They burrow in loose soil and forage underground in tunnels and cracks, and are usually exposed in abandoned (moribund) termitaria or under stones. They feed exclusively on thread snakes (*Leptotyphlops*) which they catch underground (Branch 1998). Suitable moribund termite mounds.
Natal Hinged Tortoise	*Kinixys natalensis*	Near-Threatened	Prefers tropical Lowveld entering mesic thicket in the south. It inhabits dry, rocky areas. No suitable habitat.
Breyer's Long-tailed Seps	*Tetradactylus breyeri*	Vulnerable	Prefers montane and highveld grassland where it is active in short grasslands, sheltering in old termite nests and under stones. Suitable habitat.

No threatened reptile species were recorded during this survey or previous surveys, but the Striped Harlequin Snake (*Homoroselaps dorsalis*), which is categorised as Rare in the out-dated Red Data List (Branch 1988) and is currently listed as Near-Threatened (NT) by the IUCN (World Conservation Monitoring Centre, 1996), though this assessment is also out-of-date. The conservation status of *H. dorsalis* will be reviewed in coming months by the South African Reptile Conservation Assessment (SARCA). Striped Harlequin Snakes have been recorded from the grid squares (2830 AB) (SARCA virtual museum). Prefers grassland and are endemic to the highveld of the Free State, Kwazulu-Natal, Swaziland, Limpopo and Gauteng. These snakes are very secretive and are only known from a few specimens. They burrow in loose soil and forage underground in tunnels and cracks, and are usually exposed in abandoned termitaria or under stones. They feed exclusively on thread snakes (*Leptotyphlops*) which they catch underground (Branch 1998). According to the habitat description (moribund/old termite mounds and scattered loose rock) provided for this species by Broadley (1990) and Branch (1988); suitable habitat exists in the form of moribund termite mounds as well as limited scattered loosely embedded rock in certain areas of the pipeline alignments (especially the moribund termite mounds) for the Striped Harlequin Snake.

One specimen of Striped Harlequin Snakes has been recorded from the Midland Mistbelt Grassland vegetation unit. Ideally the preferred pipeline alignment should be adjusted to avoid any major rocky outcrops or rocky hillslopes especially adjacent to the valley bottom wetland 5.. No rock material must be removed from the site or used for construction activities. As a precautionary measure a thorough summer walk through should be conducted by a suitably qualified herpetologist prior to construction activities throughout any rocky areas (loosely embedded rocks) within the construction footprint of the proposed pipeline; as well as closely examine any termite mounds (especially moribund mounds) for any Striped Harlequin Snakes or Breyer's Long-tailed Seps.

4.3 AVIFAUNA/BIRDS

Thirty-six (36) bird species were recorded during the brief field survey (total 5 hours). Species recorded during the field survey are common, widespread and typical of a woodland and grassland environment. The majority of bird species were recorded in the moist grasslands along the valley bottom wetlands. An adult Jackal Buzzard and Steppe Buzzard were observed flying and calling above the pipeline. The tall Eucalyptus and Black Wattle plantations provide suitable nesting habitat for several raptor species.

Table 5: Bird species recorded during brief field survey (5hrs).

Roberts' Number	Common name	Scientific Name
94	Hadedah Ibis	*Bostrychia hagedash*
149	Steppe Buzzard	*Buteo buteo*
152	Jackal Buzzard	*Buteo rufofuscus*
196	Natal Spurfowl	*Pternistis natalensis*
203	Helmeted Gunieafowl	*Numida meleagris*
297	Spotted Thick-Knee	*Burhinus capensis*
352	Red-Eyed Dove	*Stretopelia semitorquata*
354	Cape Turtle Dove	*Streptopelia capicola*
355	Laughing Dove	*Streptopelia senegalensis*
361	African Green-Pigeon	*Treron calvus*
371	Purple-Crested Turaco	*Gallirex porphyreolophus*
391	Burchell's Coucal	*Centropus burchellii*
411	Common Swift	*Apus apus*
417	Little Swift	*Apus affinis*
424	Speckled Mousebird	*Colius striatus*
435	Brown-Hooded Kingfisher	*Halycon albiventris*
451	African Hoopoe	*Upupa epops*
464	Blackcollared Barbet	*Lybius torquatus*
470	Yellow-Fronted Tinkerbird	*Pogoniulus chrysoconus*
473	Crested Barbet	*Tracchyphonus vailantii*
541	Fork-Tailed Drongo	*Dicrurus ludwigii*
545	Black-Headed Oriole	*Oriolus larvatus*
548	Pied Crow	*Corvus albus*
568	Dark-capped (Black-eyed) Bulbul	*Pycnonotus barbatus*
577	Olive Thrush	*Turdus olivaceus*
664	Fantailed Cisticola	*Cisticola juncidis*
672	Rattling Cisticola	*Cisticola chiniana*

758	*Common Myna	*Acridothermes tristis*
796	Cape White-Eye	*Zosterops pallidus*
801	*House Sparrow	*Passer domesticus*
814	Masked Weaver	*Ploceus velatus*
815	Lesser Masked Weaver	*Ploceus intermedius*
824	Red Bishop	*Euplectes orix*
846	Common Waxbill	*Estrilda astrild*

Threatened species

Several threatened bird species have been recorded in the grid square within which the study area is situated including Southern Ground Hornbill, African Grass Owl, Blue Crane, African Marsh Harrier, Southern Bald Ibis, African Crowned Eagle, Half-collared Kingfisher. The high levels of human disturbances, habitat transformation severely restricts the suitability of the site for any threatened bird species. No threatened bird species were recorded during the brief survey or are likely to occur in the immediate area of the proposed pipeline alignment due to high levels of habitat transformation and degradation as well as human disturbances.

4.4 MAMMALS

No small mammal trapping was conducted. Fieldwork was augmented with previous surveys in similar habitats as well as published data. The area was initially traversed on foot to ascertain the presence of available refuges. Limited suitable refuges such as burrows, artificially created rock piles, stumps were observed adjacent to the boreholes. The majority of mammal species are likely to occur within the forest plantations as well as along the dense grass, sedge and reed beds within the valley bottom wetlands. Several mounds of the African Molerat as well as burrows on the Natal Multimammate Mouse were observed in the sandier sections adjacent to the valley bottom wetlands. Evidence of Cape Clawless Otters (Latrine) was observed upstream from the pipeline as well as Common Duiker, Porcupine and Bushbuck within the wooded pockets upstream from the pipeline. Vervet Monkeys were observed foraging adjacent to valet bottom 4. Mammal species recorded within the study area as well as those that may occur within the study area, on the basis of available distribution records and known habitat requirement, are included in the Table 6 below.

Table6: Mammal species recorded during field survey. Species in bold were recorded during the brief survey Identification was determined by visual observations and animal tracks (footprints and droppings).

COMMON NAME	**SCIENTIFIC NAME**
Angoni Vlei Rat	*Otomys angoniensis*
Vlei Rat	*Otomys irrotatus*
Common Molerat	*Cryptomys hottentotus*
Natal Multimammate Mouse	*Mastomys natalensis*
Scrub Hare	*Lepus saxtalis*
Striped Mouse	*Rhabdomys pumilio*
Grey Climbing Mouse	*Dendromus melanotis*
Brant's Climbing Mouse	*Dendromus mesomelas*
Highveld Gerbil	*Tatera brantsii*
Namaqua Rock Mouse	*Aethomys namaquensis*
*House mouse	*Mus musculus*
*House Rat	*Rattus rattus*
*Domestic Dog	*Canis familiaris*
Feral Cat	*Felis catus*
Common Duiker	*Sylvicapra grimmia*

Bushbuck	*Tragelaphus scriptus*
Vervet Monkey	*Cercopithecus aethiops pygerythrus*
Water Mongoose	*Atilax paludinosus*
Cape Clawless Otter	*Aonyx capensis*
Striped Polecat	*Ictonyx striatus*
Large-spotted Genet	*Genetta tigrina*
Porcupine	*Hystrix africaeaustralis*

* introduced species

Threatened species

According to the "The Mammals of the Southern African Subregion" (Conservation Status of Southern African Mammals-Appendix 1)" Skinner and Chimmiba (2005), the study area falls within the distribution ranges of 2 species which are placed into one of known threatened species (Critically Endangered, Endangered and Vulnerable). The study site in its current state offers limited suitable habitat for one species of threatened mammal.

Table5. Mammal Species of Conservation Importance (Smithers & Chimimba 2005) that could possibly occur on the site using habitat as an indicator for likely presence.

Common Name	Scientific Name	Conservation Status
White-tailed Mouse	*Mystromus albicaudatus*	Endangered A3c

WHITE-TAILED MOUSE, *MYSTROMYS ALBICAUDATUS* (A.Smith, 1834)

Distribution

They occur in the southern, western, eastern and north-eastern parts of the Cape province, in Kwazulu-Natal, the Free State, the south-western and southern parts of Gauteng and Swaziland.

Habitat

In the eastern parts of their distribution range, they follow very closely the savanna grassland zone, but are not confined to this, occurring in the Karoo and in the south-west, in the Cape Macchia Zone (Smithers and Skinner, 1991). They are nocturnal and terrestrial, living in burrows or cracks in the soil (de Graaf, 1981).

Food

Their diet includes insects, seeds and green vegetable matter.

Reproduction

Roberts (1951) stated that they breed throughout the year, but this remains to be confirmed under natural conditions (Skinner and Smithers, 1991).

Limited suitable habitat exists for White-tailed Mouse in the form of burrows and soil cracks on the grassy hillslopes adjacent to the pipeline alignment.

No sensitive or endangered mammals were recorded within the study area. The majority of larger mammal species as well as the highly secretive Oribi are likely to have been eradicated or have moved away from the area during forestry as well as high levels of human activities from the adjacent settlements. This is mainly a result of increased development pressure for low cost housing projects and human disturbances such as hunting and poaching (wire snares), as well as habitat alteration and degradation by vegetation clearance and frequent fires. Smaller mammal species are extremely vulnerable to snares and poaching activities as well as feral cats. It is highly unlikely that the proposed pipeline servitude constitutes significant habitat for any species of threatened mammal species.

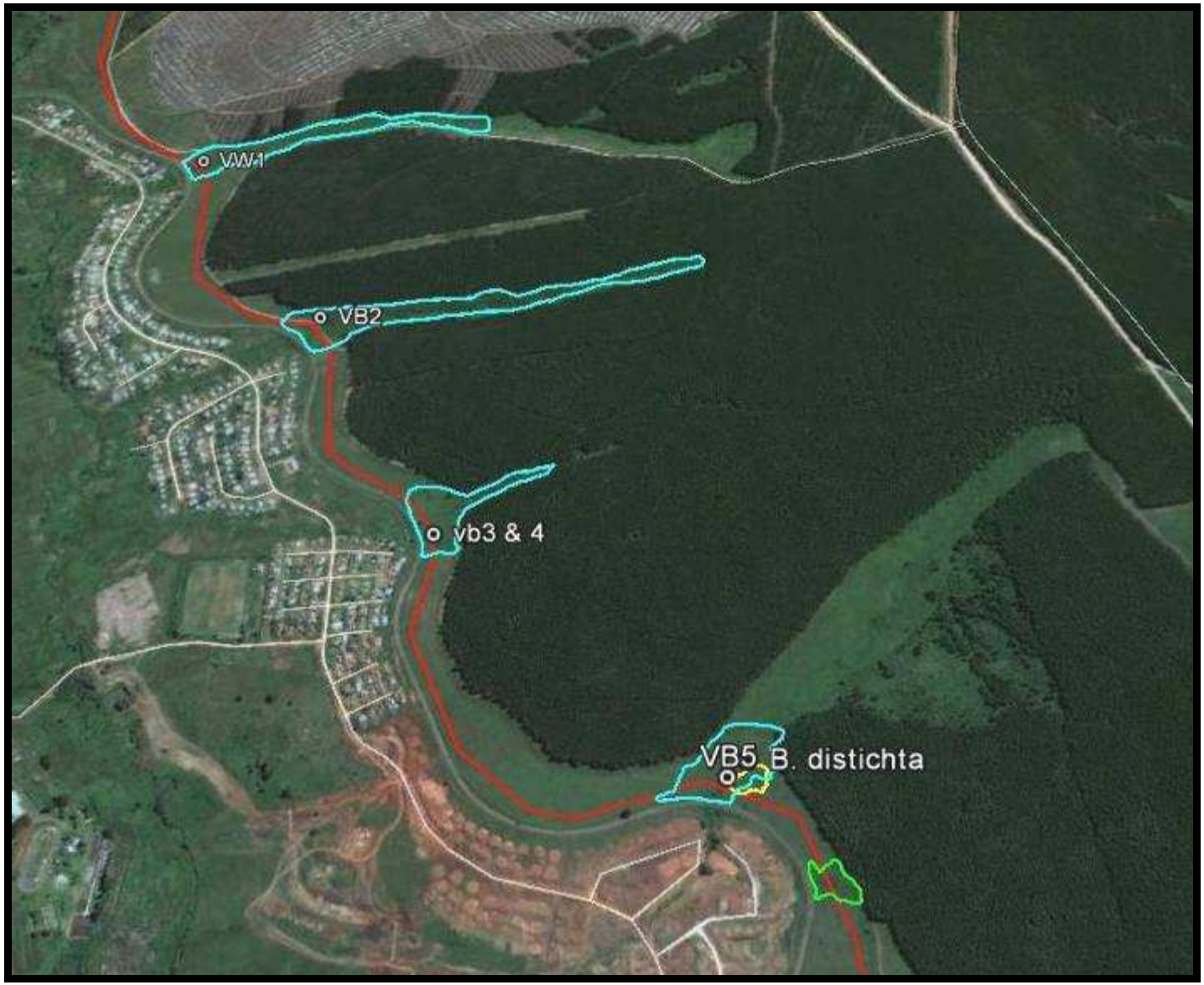

Figure11. Preliminary sensitivity map indicating the pipeline alignment (red line) and valley bottom wetland crossings (light blue), hillslope seepage wetland (green) and rocky outcrop with Red Listed plant species (yellow)

5. SENSITIVE HABITATS

Midlands Mistbelt Grasslands as well as Valley Bottom Wetlands

Midlands Mistbelt Grassland is one of the most threatened vegetation types of Kwazulu-Natal as is listed as **Endangered**. Only a small fraction (about 0.5%) is statutorily conserved in a number of reserves such as Ngeli, Impendle, Blinkwater, Qudeni, Doreen Clark, Karkloof and Queen Elizabeth Park. The conservation target is 23%. More than 50% has already been transformed for plantations, cultivated lands or urban sprawl. Uncontrolled fires and poorly regulated grazing by livestock add to threats of this unique grassland. Alien invasion by *Solanum mauritianum**, species of *Rubus"*, *Acacia mearnsii*i*, *Acacia dealbata**, *Pinus patula** and *Eucalyptus* are of concern in places (Mucina and Rutherford 2006). These unique grassland areas form vital habitats for numerous animal species including several threatened faunal species (Bilbo's Rain Frog, Breyer's Long-tailed Seps, Striped Harlequin Snake, White-tailed Mouse). The majority of suitable grassland habitat is usually severely fragmented resulting in road fatalities of species migrating between habitats. Seasonal marshes and inundated grasslands are vital habitats for numerous animal species including numerous threatened species (African Marsh Harrier, Grass Owl, South African Hedgehog, Natal-Leaf Folding Frog).

The entire valley bottom wetland areas and adjacent hillslope seepage wetlands with their associated hygrophilous and hydrophilic vegetation are extremely sensitive to further negative impacts and must be considered sensitive and potential impacts of the construction activities must be strictly managed during the construction of the proposed pipeline. The excavations around valley bottom wetland 5 must be restricted to the pipeline servitude and as close to the railway line as possible in order to prevent further habitat degradation to adjacent sensitive moist rocky grasslands.

6. CONCLUSION AND DISCUSSION

The temporary alteration of vegetation and soil structure in the effected areas of the proposed Greytown pipeline will impact on the fauna and flora directly within the proposed alignment and potentially in the immediate surrounding area. It is imperative that minimal vegetation clearance and disturbances should occur along the proposed pipeline route especially during the crossing of valley bottom wetlands and open Midlands Mistbelt Grassland. Vegetation clearance should be restricted to the actual pipeline and servitude and not into surrounding moist grassland of the valley bottom wetlands. As the pipeline is situated adjacent to wetland habitats usually on a sloping gradient; erosion/siltation preventative measures must be implemented throughout all phases of the project. In addition, the increased human density, heavy construction machinery and vehicles will most likely directly and indirectly result in the short-long term alteration of the faunal composition on the site and surrounding areas. Loss of habitat for foraging, reproduction and shelter will most severely impact on the smaller sedentary species (insects, arachnids, reptiles, amphibians and mammals). Larger more agile birds and mammals will try and locate suitable habitat away from the development. After the completion of the pipeline the newly excavated softer soils could potentially offer favourable habitat for certain burrowing animal species.

At a local Grytown scale the existing pipeline servitude and large sections of the new pipeline are situated within transformed *Aristida junciformis* grasslands and degraded valley bottom wetland habitats which provide extremely limited suitable habitat for remaining animal species and no suitable habitat for any threatened faunal species. Due to high levels of human disturbances as well as habitat transformation surrounding these sites and surrounding areas the majority of sensitive or rare species have disappeared or found suitable habitat away from the site.

Certain sections of the alignment such as adjacent to the valley bottom 5 alignment are situated within a remnant patch of mistbelt grassland which must be considered as a sensitive environment with recorded red listed species (*Boophone distichta*[*]). Due to the sensitivity of the grassland the area around the pipeline the cleared servitude must be appropriately rehabilitated as well as re-vegetated (use existing seed bank within the top-soil). The proposed pipeline will have an impact of **medium-low; short term significance** on the remaining fauna if construction activities of the pipeline are restricted to the areas adjacent to the existing pipeline servitude, Eskom servitudes, railway and road reserves and the five pipeline crossings through the valley bottom wetlands appropriately rehabilitated.

Any activity including the sections of the pipeline alignment situated within the valley bottom wetlands (including 32m buffer zone from the outer edge of the temporary wet zone/riparian zone) will require a Water Usage Licence Application (WULA) from the Department of Water Affairs (DWA).

MANAGEMENT RECOMMENDATIONS

- Prior to construction activities a suitably qualified ecologist should walk through the entire pipeline with special emphasis of the Midland Mistbelt Grassland alignments as well as the valley bottom wetland crossings. Specific mitigatory measures can be implemented for the rescue and recovery programme of any rare or endangered plant or animal species.

- All geophytes including several *Brunsvigia* sp. as well as the red listed "Declining" *Boophone distichta* should be carefully dug up and replanted along the pipeline servitude after the completion of construction activities or in suitable habitat away from the pipeline alignment.

- All moribund termite mounds should be carefully examined for the presence of Striped Harlequin Snakes and Breyer's Long-tailed Seps.

- It is recommended that the construction programme for the pipeline preferably commences during the dry winter months, when the majority of animal species are dormant as well as low (baseflow) flow rates of the mainly seasonally inundated valley bottom wetlands will result in limited siltation and sedimentation of the lower-lying valley bottom wetlands.

- All earthworks shall be undertaken in such a manner so as to minimize the extent of any impacts caused by such activities.

[*] The long term persistence of the population of *Boophone distichata* is high unlikely due to a proposed new residential development (497 Housing Project) on the site.

- Open trenches must be backfilled as soon as the pipe has been laid in order to prevent animals falling in or acting as a large open pit-fall trap (>2m deep).

- Soil stockpiles must be suitably protected from possible erosion.

- Soil stockpiles must not be placed adjacent to any drainage areas towards the lower-lying valley bottom wetlands preventing possible siltation and sedimentation.

- The servitude, working strip and any temporary access roads must be appropriately rehabilitated after the cessation of construction activities.

- All indigenous geophytes or bulbous plant species should be carefully dug up and replanted wherever possible.

- Vegetation clearance must be strictly restricted to the servitude and working strips especially when the pipeline bisects open grassland and valley bottom wetlands.

- The original geometry, topography and geomorpholgy in both cross-sectional and longitudinal profile should be reinstated, above and below the stream and valley bottom crossings.

- Appropriate mitigatory measures for controlling sediment input into the valley bottom wetlands and drainage areas will be required during the construction phase. The use of hay bales packed in rows across diversions and active flow areas during construction may be one way of limiting sediment inputs. They also help to buffer the pH. The bales will need to be removed and disposed of after construction. Other alternative methods of controlling sediment should also be considered such as sediment fences etc.

- All coffer dams, causeway and construction materials should be removed from the stream immediately after construction at the site is completed.

- Where necessary and according to risks in terms of bank erosion, gabions or storm water control structures should be used to disperse storm water flows and prevent further bank erosion. Appropriate gabion structures or gabion mattresses should be installed to prevent further bank erosion.

- All alien invasive tree species must be removed from the proposed pipeline alignment. The control of alien vegetation along the pipeline must be continually monitored as several species below (see Fig.12) are prevalent

throughout the proposed pipeline route. Alien invasive species results in severe habitat degradation especially within the valley bottom wetlands.

Figure12. **Priority species (Category 1 invasive species**) **abundant throughout the pipeline alignment include: A:** Common Thorn-Apple (*Datura stramonium*); **B:** Common Morning Glory (*Ipomoea purpurea*); **C**: Lantana (*Lantana camara)*; **D:** Silver Leaf Bitter Apple (*Solanum eleaegnifolium*); **E:** *Solanum sisymbrifolium*, **F:** Black Wattle (*Acacia mearnsii*) Modderfontein to Midrand; **G:** American Bramble (*Rubus cuneifolius*); **H:** Scotch Thistle (*Cirsium vulgare*); **I:** Bugweed (*Solanum mauritianum*) and **J:** Castor-oil Plant (*Riccinus communis*) . Category 1 plants and trees are prohibited invaders which must be controlled and eradicated according to the Conservation of Agricultural Resources Act (Act 43 of 1983) and the proposed Amendments of 2000).

- No dumping of any materials in undeveloped open areas.
- Activities in the surrounding open undeveloped areas must be strictly regulated and managed.
- No construction camps should be erected in any open grassland areas.
- The use of existing road infrastructure should minimise potential impacts.

- The building of temporary access roads should be kept to a minimum to prevent unnecessary impact on the surrounding vegetation. No new access roads must be constructed through the open grassland areas.

- Reasonable speeds will be maintained at al times in order to prevent accidents, excessive noise and dust and road fatalities of migrating animals.

- Provision shall be made for employee facilities including shelter, toilets and washing facilities.

- Sanitation facilities shall be located within 100m from any point of work, but not closer than 100 m to any water body.

- These facilities shall be maintained in a hygienic state and serviced regularly. Toilet paper shall be provided. Wash areas shall be placed and constructed in such a manner so as to ensure that the surrounding areas, which include groundwater, are not polluted.

- Enclosed areas for food preparation should be provided and strictly prohibit the use of use of open fires for cooking and heating purposes.

- The topsoil obtained (i.e. the top 30-50 cm of soil) from site clearing and bulldozing activities should be stockpiled in a suitable place in order to be to rehabilitate cleared areas, after the completion of construction activities.

- Soil stockpiling areas must be sufficiently situated away from the seepage zones.

- Soil stockpiles should not exceed 2 m in height.

- Any erosion channels developed during the construction period or during the vegetation establishment period shall be backfilled and compacted, and the areas restored to a proper condition.

- The Contractor shall ensure that cleared areas are effectively stabilised to prevent and control erosion. Exposed slopes and/or destabilised areas should be landscaped to blend in with the surrounding areas if possible. Exposed areas should be rehabilitated with a grass mix that blends in with the surrounding vegetation. The grass mix should consist of indigenous grasses adapted to the local environmental conditions (see attached species lists).

- If any animal is disturbed by construction, e.g. nesting birds, rodents, snakes or Water Monitors, or else during the operational phase it should be allowed to escape without further harassment, noise or interference.

- No animals should be intentionally disturbed, damaged or collected during the construction phase.

Table7: Recommended rehabilitation measures.

STEP	METHOD	EQUIPMENT
1	Remove all construction material from the area where construction has been completed.	To be undertaken by hand.
2	Topsoil that has been stockpiled during construction must be applied to the area to undergo rehabilitation. The depth of the topsoil layer to be applied depends on the natural depth of topsoil in the area, and the amount of topsoil that may have been lost during construction.	Topsoil must be applied from the topsoil stockpiled during construction.
3	The naked ground should be seeded with a stabilising grass mix, suited to the conditions. The quantity of seed used will depend on the slope, with a steeper slope requiring a heavier application of seed. For slopes: • >15º: 25-50 kg/ha • <15º: 15-25 kg/ha The natural seed bank in the topsoil will supplement the seed mix applied	The seed mix should consist of pioneer grass species of the area, and will also depend on what species are commercially available during the season required. A standard seed mix would consist of the following species (in decreasing order of proportion constituting the seed mix)*: • *Andropogon chinensis* • *Aristida congesta* • *Cynodon dactylon* • *Cymbopogon plurinodes* • *Eragrostis curvula* • *Eragrostis gummiflua* • *Themeda triandra* • *Setaria spp.* • *Imperata cylindrica* • *Sporobolus fimbriatus* and sedges such as *Schoenoplectus* spp. and *Juncus spp.* should be used

* see attached species list

4	The areas which have been seeded must be regularly watered directly after seeding until the grass cover becomes established. Watering is to be done in a manner that ensures that no erosion of the topsoil and seed mix takes place.	A hosepipe must be available on site.
5	If the grasses have not established after a period of two months after seeding, the areas should be reseeded. If necessary, another dressing of topsoil should be applied prior to seeding.	As above.
6	Slope stabilisation measures may be necessary in places where grass has not been able to establish and there is an erosion risk. The measures implemented depend on the situation, and can be varied as necessary.	Various slope stabilisation measures are available and vary in effectiveness according to the situation including • Logs/bark held in place with pegs • Rows of *Cynodon dactylon*, *Panicum maximum*, *Imperata cylindrica*, *Hyparrhenia filipendula* held in place with pegs.
7	All alien vegetation is to be appropriately removed and disposed of. Alien species that have been encountered along the proposed route include Syringa *Melia azedarach,* Brazilian Glory Pea *or* Red Sesbania (*Sesbania punicea*), Castor-Oil Plant (*Ricinus communis*), Lantana (*Lantana camara*), Giant Reed (*Arundo donax*), Bugweed (*Solanum mauritianum*), Peanut Butter Cassia (Senna *diymobotrya*), American Bramble (*Rubus cuneifolius*)*, Morning Glory (*Ipomoea purpurea*), Paraffin Bush (*Chromolaena odorata*), Montanoa (*Montanoa hibiscifolia*), Indian Shot (*Canna indica*), *Ageratum conyzoides*, *Caesalpinia decapetala*, *Chromolaena odorata*, *Ipomoea indica*, *Leucaena leucocephala*, *Psidium guajava*, *Mimosa pigra, Tithonia diversifolia*.	Removal will to a large extent be done by hand. Saws may be necessary in certain cases and specific herbicides may be required (if used, the use of these must be strictly controlled)
8	The pipeline servitude must be regularly inspected during the operational phase and alien vegetation that had re-emerged, must be removed / follow-up treatment applied.	On-going alien vegetation removal programme (beyond the scope of the project)

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8. APPENDIX

Table8. Grass species list (ideally grass species endemic to the area should be used). The existing seed bank in the top-soil in areas of natural grassland around the pipeline should be used for re-vegetation purposes.

Alloteropsis semialata ssp. eckloniana
Alloteropsis semialata ssp. semialata
Andropogon appendiculatus
Andropogon chinensis
Anthephora pubescens
Aristida adscensionis
Aristida canescens ssp. canescens
Aristida congesta ssp. Congesta
Aristida diffusa ssp. Burkei
Aristida scabrivalvis ssp. scabrivalvis
Aristida transvaalensis
Arundinella nepalensis
Avena sp.
Bewsia biflora
Brachiaria brizantha
Brachiaria eruciformis
Brachiaria serrata
Bromus leptoclados
Bromus sp.
Cenchrus ciliaris
Cymbopogon caesius
Cymbopogon pospischilii
Cyperus esculentus
Digitaria debilis
Digitaria diagonalis var. diagonalis
Digitaria eriantha
Digitaria monodactyla
Digitaria sp.
Digitaria ternate
Digitaria tricholaenoides
Diheteropogon amplectens var. amplectens
Ehrharta erecta var. erecta
Elionurus muticus
Enneapogon cenchroides
Enneapogon scoparius
Eragrostis chloromelas
Eragrostis curvula

Eragrostis planiculmis
Eragrostis racemosa
Eragrostis sp.
Eustachys paspaloides
Helictotrichon turgidulum (Stapf) Schweick.
Hemarthria altissima
Heteropogon contortus.
Hyparrhenia anamesa
Hyparrhenia cymbaria
Hyparrhenia filipendula var. pilosa
Hyparrhenia hirta
Hyparrhenia quarrei
Hyparrhenia tamba
Imperata cylindrical
Koeleria capensis
Leersia hexandra
Lolium multiflorum
Lolium temulentum
Loudetia simplex
Melinis nerviglumis
Melinis repens ssp. Repens
Monocymbium ceresiiforme
Panicum maximum
Panicum miliaceum
Panicum natalense.
Paspalum dilatatum
Paspalum notatum
Paspalum scrobiculatum
Pennisetum thunbergii
Pennisetum villosum
Perotis sp.
Poa annua
Poa pratensis
Pogonarthria sp.
Potamogeton pusillus
Schizachyrium sanguineum
Setaria lindenbergiana
Setaria megaphylla
Setaria nigrirostris
Setaria sp.
Setaria sphacelata var. sphacelata
Setaria sphacelata var. torta

Sorghum bicolor ssp. arundinaceum
Sorghum halepense
Sorghum versicolor
Sporobolus africanus
Sporobolus discosporus
Sporobolus fimbriatus
Sporobolus natalensis
Sporobolus nitens
Sporobolus sp.
Sporobolus stapfianus
Stipagrostis uniplumis var. neesii
Stipagrostis zeyheri ssp. Sericans
Themeda triandra Forssk.
Trachypogon spicatus
Tragus berteronianus
Triraphis andropogonoides
Tristachya rehmannii
Typha capensis
Urelytrum agropyroides
Urochloa mosambicensis
Urochloa panicoides P.Beauv.

Table9. Frog species recorded during SAFAP for the 2930 AB ODGC.

SOUTHERN AFRICAN FROG ATLAS PROJECT					
43 species found for the combined locus = 2930, AB					
Family	**Genus**	**Species**	**Common name**	**Red list category**	**Atlas region endemic**
Arthroleptidae	*Arthroleptis*	*wahlbergi*	Bush Squeaker	Least Concern	0
Arthroleptidae	*Leptopelis*	*mossambicus*	Brown-backed Tree Frog	Least Concern	0
Arthroleptidae	*Leptopelis*	*natalensis*	Natal Tree Frog	Least Concern	0
Arthroleptidae	*Leptopelis*	*xenodactylus*	Long-toed Tree Frog	Endangered	1
Brevicepitidae	*Breviceps*	*adspersus*	Bushveld Rain Frog	Least Concern	0
Brevicepitidae	*Breviceps*	*bagginsi*	Bilbos' Rain Frog	Vulnerable	1
Brevicepitidae	*Breviceps*	*mossambicus*	Mozambique Rain Frog	Least Concern	0
Brevicepitidae	*Breviceps*	*verrucosus*	Plaintave Rain Frog	Least Concern	0
Bufonidae	*Amietophrynus*	*gutturalis*	Guttural Toad	Least Concern	0
Bufonidae	*Amietophrynus*	*pardalis*	Leopard Toad	Least Concern	0
Bufonidae	*Amietophrynus*	*rangeri*	Raucous Toad	Least Concern	0
Bufonidae	*Schismaderma*	*carens*	Red Toad	Least Concern	0
Heleophrynidae	*Hadromophryne*	*natalensis*	Cascade Frog	Least Concern	0
Hemisotidae	*Hemisus*	*guttatus*	Spotted Shovel-nose Frog	Vulnerable	1
Hemisotidae	*Hemisus*	*marmoratus*	Mottled Shovel-nose Frog	Least Concern	0
Hyperoliidae	*Afrixalus*	*delicatus*	Delicate Leaf-folding frog	Least Concern	0
Hyperoliidae	*Afrixalus*	*fornasinii*	Greater Leaf-folding Frog	Least Concern	0
Hyperoliidae	*Afrixalus*	*spinifrons*	Natal Leaf-folding Frog	Near Threatened	0
Hyperoliidae	*Hyperolius*	*acuticeps*		Least Concern	0
Hyperoliidae	*Hyperolius*	*argus*	Argus Reed Frog	Least Concern	0
Hyperoliidae	*Hyperolius*	*marmoratus*	Painted Reed Frog	Least Concern	0

Hyperoliidae	*Hyperolius*	*pickersgilli*	Pickersgill's Reed Frog	Critically Endangered		1
Hyperoliidae	*Hyperolius*	*pusillus*	Water Lilly Frog	Least Concern		0
Hyperoliidae	*Hyperolius*	*semidiscus*	Yellow Striped Reed Frog	Least Concern		0
Hyperoliidae	*Hyperolius*	*tuberilinguis*	Tinker Reed Frog	Least Concern		0
Hyperoliidae	*Kassina*	*senegalensis*	Bubbling Kassina	Least Concern		0
Hyperoliidae	*Semnodactylus*	*wealii*	Rattling Frog	Least Concern		0
Phrynobatrachidae	*Phrynobatrachus*	*mababiensis*	Dwarf Puddle Frog	Least Concern		0
Phrynobatrachidae	*Phrynobatrachus*	*natalensis*	Snoring Puddle Frog	Least Concern		0
Pipidae	*Xenopus*	*laevis*	Common Platanna	Least Concern		0
Ptychadenidae	*Ptychadena*	*oxyrhynchus*	Sharp-nosed Grass Frog	Least Concern		0
Ptychadenidae	*Ptychadena*	*porosissima*	Dwarf Grass Frog	Least Concern		0
Pyxicephalidae	*Amietia*	*angolensis*	Common or Angola River Frog	Least Concern		0
Pyxicephalidae	*Amietia*	*fuscigula*	Cape River Frog	Least Concern		0
Pyxicephalidae	*Anhydrophryne*	*hewitti*	Natal Chirping Frog	Least Concern		0
Pyxicephalidae	*Cacosternum*	*boettgeri*	Boettger's Caco	Least Concern		0
Pyxicephalidae	*Cacosternum*	*nanum*	Bronze Caco	Least Concern		0
Pyxicephalidae	*Cacosternum*	*poyntoni*	Poyton's Caco	Data Deficient		1
Pyxicephalidae	*Cacosternum*	*striatum*	Striped caco	Least Concern		1
Pyxicephalidae	*Natalobatrachus*	*bonebergi*	Kloof Frog	Endangered		1
Pyxicephalidae	*Strongylopus*	*fasciatus*	Striped Stream Frog	Least Concern		0
Pyxicephalidae	*Strongylopus*	*grayii*	Clicking Stream Frog	Least Concern		0
Pyxicephalidae	*Tomopterna*	*natalensis*	Natal Sand Frog	Least Concern		0

Red listing source: Minter LR, Burger M, Harrison JA, Braack HH, Bishop PJ & Kloepfer D (eds). 2004. Atlas and Red Data book of the frogs of South Africa, Lesotho and Swaziland. SI/MAB Series no. 9. Smithsonian Institution, Washington, D.C.

Table10. Reptile species recorded during the Southern African Reptile Conservation Assessment (SARCA). 82 species found for the combined locus = 2930, AB

Family	Genus	Species	Subspecies	Common name	Red list category	Atlas region endemic
Agamidae	*Acanthocercus*	*atricollis*	*atricollis*	Southern Tree Agama	Not Evaluated	0
Agamidae	*Agama*	*aculeata*	*distanti*	Distant's Ground Agama	Not Evaluated	1
Agamidae	*Agama*	*atra*		Southern Rock Agama	Not Evaluated	0
Atractaspididae	*Amblyodipsas*	*concolor*		Natal Purple-glossed Snake	Not Evaluated	1
Atractaspididae	*Amblyodipsas*	*polylepis*	*polylepis*	Common Purple-glossed Snake	Not Evaluated	0
Atractaspididae	*Aparallactus*	*capensis*		Black-headed Centipede-eater	Not Evaluated	0
Atractaspididae	*Atractaspis*	*bibronii*		Bibron's Stiletto Snake	Not Evaluated	0
Atractaspididae	*Homoroselaps*	*dorsalis*		Striped Harlequin Snake	Lower Risk: Near Threatened	1
Atractaspididae	*Homoroselaps*	*lacteus*		Spotted Harlequin Snake	Not Evaluated	1
Atractaspididae	*Macrelaps*	*microlepidotus*		Natal Black Snake	Not Evaluated	1
Boidae	*Python*	*natalensis*		Southern African Python	Not Evaluated	0
Chamaeleonidae	*Bradypodion*	*melanocephalum*		KwaZulu Dwarf Chameleon	Not Evaluated	1
Chamaeleonidae	*Bradypodion*	*thamnobates*		Natal Midlands Dwarf Chameleon	Lower Risk: Near Threatened	1
Chamaeleonidae	*Chamaeleo*	*dilepis*	*dilepis*	Common Flap-neck Chameleon	Not Evaluated	0
Colubridae	*Amplorhinus*	*multimaculatus*		Many-spotted Snake	Not Evaluated	0
Colubridae	*Boaedon*	*capensis*		Brown House Snake	Not Evaluated	0
Colubridae	*Crotaphopeltis*	*hotamboeia*		Red-lipped Snake	Not Evaluated	0
Colubridae	*Dasypeltis*	*inornata*		Southern Brown Egg-	Not Evaluated	1

				eater		
Colubridae	*Dasypeltis*	*scabra*		Rhombic Egg-eater	Not Evaluated	0
Colubridae	*Dispholidus*	*typus*	*typus*	Boomslang	Not Evaluated	0
Colubridae	*Duberria*	*lutrix*	*lutrix*	South African Slug-eater	Not Evaluated	1
Colubridae	*Gonionotophis*	*capensis*	*capensis*	Common File Snake	Not Evaluated	0
Colubridae	*Gonionotophis*	*nyassae*		Black File Snake	Not Evaluated	0
Colubridae	*Lamprophis*	*aurora*		Aurora House Snake	Not Evaluated	1
Colubridae	*Lamprophis*	*guttatus*		Spotted House Snake	Not Evaluated	0
Colubridae	*Lycodonomorphus*	*inornatus*		Olive House Snake	Not Evaluated	1
Colubridae	*Lycodonomorphus*	*laevissimus*		Dusky-bellied Water Snake	Not Evaluated	1
Colubridae	*Lycodonomorphus*	*rufulus*		Brown Water Snake	Not Evaluated	0
Colubridae	*Lycophidion*	*capense*	*capense*	Cape Wolf Snake	Not Evaluated	0
Colubridae	*Philothamnus*	*hoplogaster*		South Eastern Green Snake	Not Evaluated	0
Colubridae	*Philothamnus*	*natalensis*	*natalensis*	Eastern Natal Green Snake	Not Evaluated	0
Colubridae	*Philothamnus*	*natalensis*	*occidentalis*	Western Natal Green Snake	Not Evaluated	1
Colubridae	*Philothamnus*	*semivariegatus*		Spotted Bush Snake	Not Evaluated	0
Colubridae	*Psammophis*	*brevirostris*		Short-snouted Grass Snake	Not Evaluated	0
Colubridae	*Psammophis*	*crucifer*		Cross-marked Grass Snake	Not Evaluated	0
Colubridae	*Psammophylax*	*rhombeatus*	*rhombeatus*	Spotted Grass Snake	Not Evaluated	0
Colubridae	*Pseudaspis*	*cana*		Mole Snake	Not Evaluated	0
Colubridae	*Thelotornis*	*capensis*	*capensis*	Southern Twig Snake	Not Evaluated	0
Cordylidae	*Chamaesaura*	*anguina*	*anguina*	Cape Grass Lizard	Not Evaluated	1
Cordylidae	*Chamaesaura*	*macrolepis*		Large-scaled Grass Lizard	Not Evaluated	0
Cordylidae	*Cordylus*	*vittifer*		Common Girdled Lizard	Not Evaluated	0
Cordylidae	*Pseudocordylus*	*melanotus*	*subviridis*	Drakensberg Crag Lizard	Not Evaluated	1
Crocodylidae	*Crocodylus*	*niloticus*		Nile Crocodile	Lower Risk:	0

					Least Concern	
Elapidae	*Dendroaspis*	*angusticeps*		Green Mamba	Not Evaluated	0
Elapidae	*Dendroaspis*	*polylepis*		Black Mamba	Not Evaluated	0
Elapidae	*Elapsoidea*	*sundevallii*	*sundevallii*	Sundevall's Garter Snake	Not listed	0
Elapidae	*Hemachatus*	*haemachatus*		Rinkhals	Not Evaluated	0
Elapidae	*Naja*	*mossambica*		Mozambique Spitting Cobra	Not Evaluated	0
Gekkonidae	*Afroedura*	*pondolia*		Pondo Flat Gecko	Not Evaluated	1
Gekkonidae	*Hemidactylus*	*mabouia*		Common Tropical House Gecko	Not Evaluated	0
Gekkonidae	*Homopholis*	*wahlbergii*		Wahlberg's Velvet Gecko	Not Evaluated	0
Gekkonidae	*Lygodactylus*	*capensis*	*capensis*	Common Dwarf Gecko	Not Evaluated	0
Gekkonidae	*Pachydactylus*	*maculatus*		Spotted Gecko	Not Evaluated	0
Gekkonidae	*Pachydactylus*	*vansoni*		Van Son's Gecko	Not Evaluated	0
Gerrhosauridae	*Gerrhosaurus*	*flavigularis*		Yellow-throated Plated Lizard	Not Evaluated	0
Gerrhosauridae	*Tetradactylus*	*africanus*		Eastern Long-tailed Seps	Not Evaluated	1
Gerrhosauridae	*Tetradactylus*	*breyeri*		Breyer's Long-tailed Seps	Vulnerable	1
Gerrhosauridae	*Tetradactylus*	*seps*		Short-legged Seps	Not Evaluated	1
Lacertidae	*Nucras*	*lalandii*		Delalande's Sandveld Lizard	Not Evaluated	1
Lacertidae	*Tropidosaura*	*montana*	*natalensis*	Natal Mountain Lizard	Not listed	0
Leptotyphlopidae	*Leptotyphlops*	*scutifrons*	*conjunctus*	Eastern Thread Snake	Not listed	0
Leptotyphlopidae	*Leptotyphlops*	*scutifrons*	*scutifrons*	Peters' Thread Snake	Not listed	0
Pelomedusidae	*Pelomedusa*	*subrufa*		Marsh Terrapin	Not Evaluated	0
Scincidae	*Acontias*	*gracilicauda*		Thin-tailed Legless Skink	Not Evaluated	1
Scincidae	*Acontias*	*plumbeus*		Giant Legless Skink	Not Evaluated	0

Scincidae	*Afroablepharus*	*wahlbergii*		Wahlberg's Snake-eyed Skink	Not Evaluated	0
Scincidae	*Scelotes*	*bourquini*		Bourquin's Dwarf Burrowing Skink	Not Evaluated	1
Scincidae	*Scelotes*	*inornatus*		Durban Dwarf Burrowing Skink	Not Evaluated	1
Scincidae	*Scelotes*	*mossambicus*		Mozambique Dwarf Burrowing Skink	Not Evaluated	0
Scincidae	*Trachylepis*	*capensis*		Cape Skink	Not Evaluated	0
Scincidae	*Trachylepis*	*homalocephala*		Red-sided Skink	Not Evaluated	1
Scincidae	*Trachylepis*	*punctatissima*		Speckled Rock Skink	Not Evaluated	0
Scincidae	*Trachylepis*	*striata*		Striped Skink	Not Evaluated	0
Scincidae	*Trachylepis*	*varia*		Variable Skink	Not Evaluated	0
Testudinidae	*Kinixys*	*natalensis*		Natal Hinged Tortoise	Lower Risk: Near Threatened	0
Typhlopidae	*Afrotyphlops*	*bibronii*		Bibron's Blind Snake	Not Evaluated	0
Typhlopidae	*Ramphotyphlops*	*braminus*		Brahminy Blind Snake	Not listed	0
Varanidae	*Varanus*	*albigularis*	*albigularis*	Rock Monitor	Not Evaluated	0
Varanidae	*Varanus*	*niloticus*		Water Monitor	Not Evaluated	0
Viperidae	*Bitis*	*arietans*	*arietans*	Puff Adder	Not Evaluated	0
Viperidae	*Causus*	*defilippii*		Snouted Night Adder	Not Evaluated	0
Viperidae	*Causus*	*rhombeatus*		Rhombic Night Adder	Not Evaluated	0

Red listing source: 1996 IUCN global listing

Table11. Virtual Museum of African Mammals 26 species found for the combined locus = 2930, AB

Family	Genus	Species	Subspecies	Common name	Red list category	Atlas region endemic
Bovidae	*Aepyceros*	*melampus*		Impala	Least Concern	0
Bovidae	*Alcelaphus*	*buselaphus*		Red Hartebeest	Least Concern	0
Bovidae	*Cephalophus*	*natalensis*		Red Duiker	Least Concern	0
Bovidae	*Connochaetes*	*gnou*		Black Wildebeest	Least Concern	0
Bovidae	*Connochaetes*	*taurinus*	*taurinus*	Blue Wildebeest	Least Concern	0
Bovidae	*Damaliscus*	*pygargus*	*phillipsi*	Blesbok	Least Concern	0
Bovidae	*Kobus*	*ellipsiprymnus*	*ellipsiprymnus*	Waterbuck	Least Concern	0
Bovidae	*Ourebia*	*ourebi*		Oribi	Endangered	0
Bovidae	*Redunca*	*arundinum*		Reedbuck	Least Concern	0
Bovidae	*Sylvicapra*	*grimmia*		Common Duiker	Least Concern	0
Bovidae	*Tragelaphus*	*scriptus*		Bushbuck	Least Concern	0
Bovidae	*Tragelaphus*	*strepsiceros*		Kudu	Least Concern	0
Canidae	*Canis*	*mesomelas*		Black-backed Jackal	Least Concern	0
Cercopithecidae	*Cercopithecus*	*aethiops*	*pygerythrus*	Vervet Monkey	Least Concern	0
Cercopithecidae	*Cercopithecus*	*mitis*	*labiatus*	Samango Monkey	Endangered	0
Emballonuridae	*Taphozous*	*mauritianus*		Mauritian Tomb Bat	Least Concern	0
Equidae	*Equus*	*burchellii*		Plains Zebra	Least Concern	0
Felidae	*Caracal*	*caracal*		Caracal	Least Concern	0
Giraffidae	*Giraffa*	*camelopardalis*	*camelopardalis*	Giraffe	Least Concern	0
Herpestidae	*Cynictis*	*penicillata*		Yellow Mongoose	Least Concern	0
Herpestidae	*Galerella*	*sanguinea*		Slender Mongoose	Least Concern	0
Hystricidae	*Hystrix*	*africaeaustralis*		Porcupine	Least Concern	0
Procavidae	*Procavia*	*capensis*		Rock Hyrax	Least	0

					Concern	
Pteropodidae	*Epomophorus*	*wahlbergi*		Wahlberg's Epauletted Fruit Bat	Least Concern	0
Suidae	*Phacochoerus*	*africanus*		Warthog	Least Concern	0
Suidae	*Potamochoerus*	*porcus*	*koiropotamus*	Bushpig	Least Concern	0

Red listing source: Skinner & Chimimba 2005