Appendix G

SPECIALIST STUDIES

Public

Appendix G.1

SOILS AND AGRICULTURAL POTENTIAL ASSESSMENT

R-BAY PROPERTIES (PTY) LTD

PROPOSED R-BAY PROPERTIES CHEMICALS WAREHOUSING IN PIETERMARIZBURG, KWAZULU-NATAL

SOIL AND AGRICULTURAL POTENTIAL STUDY

18 FEBRUARY 2022

DRAFT

PROPOSED R-BAY PROPERTIES CHEMICALS WAREHOUSING IN PIETERMARIZBURG, KWAZULU-NATAL

SOIL AND AGRICULTURAL POTENTIAL STUDY

R-BAY PROPERTIES (PTY) LTD

DRAFT

PROJECT NO.: 41103633
DATE: FEBRUARY 2022

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1 INTRODUCTION

WSP in Africa (WSP), a wholly owned affiliate of WSP Global Inc., has been appointed by R-Bay Properties (Pty) Ltd (R-Bay) to undertake a Soil and Agricultural Potential Assessment for the establishment of a warehouse for the storage of dangerous goods and associated parking. The proposed development will occur on a property in Pietermaritzburg, KwaZulu-Natal (see **Figure 1**).

The site falls within a summer rainfall region and is seasonal, with hot, wet summers and cool, dry winters. Mean Annual Precipitation is in the region of 700mm per annum. The Köppen-Geiger climate classification is Cfb. The majority of the soil on site is covered by tufts of grass, interspersed by small trees and rocks. A man-made path covers a portion of the site, as does some builder's rubble. The site is underlain by the Pietermaritzburg Formation intruded by the Jurassic aged Dolerite.

The aim of this assessment is to provide descriptions of the soil forms and their distribution within the project area, and to determine the typical soil properties, as well as current land use, land capability and soil potential. A soils potential impact assessment was also carried out and associated mitigation measures recommended.

This report was prepared by Ms Karen King, a professional registered soil scientist (Pr.Sci.Nat, M.Sc.). Ms King has 16 years' work experience and specialises in agricultural studies, soil science and related risk assessments and management plans. Ms. King's Curriculum Vitae is included in Appendix A.

R-BAY PROPERTIES PROPOSED WAREHOUSE

LOCATION

Legend

- Proposed Warehouse
- Local Roads

DISCLAIMER

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2 METHODOLOGY

2.1 DESKTOP ASSESSMENT

A desktop assessment was undertaken for the site. This included assessing relevant past environmental reports, site characteristics using Geographic Information System (GIS) and aerial imagery, and soils databases.

2.2 SITE ASSESSMENT

A site visit was conducted during the summer season on the 16th November 2021. While the season itself will have no bearing on the soil forms present, the site visit was undertaken at a dry time of the year, making augering the very hard ground difficult, so it was not possible to establish the final depths of the soils present. A grid-based soils classification survey of the study area was undertaken on foot, using a hand-held bucket auger to identify soil forms present at 18 points on site (see **Figure 2**). Current activities at the site were also noted, and specific areas of land use were noted. A hand-held GPS was used to record the location of each auger point.

2.3 SOIL CLASSIFICATION

The soils identified in the field were classified by form in accordance with the South African soil taxonomic system (Soil Classification Working Group, 1991). All South African soil forms fall within 12 soil types; Duplex (marked accumulation of clay in the B horizon), Humic (intensely weathered, low base status, exceptional humus accumulation), Vertic (swelling, cracking, high activity clay), Melanic (dark, structured, high base status), Silicic (Silica precipitates as a dorbank horizon), Calcic (accumulation of limestone as a horizon), Organic (peaty soils where water inhibits organic breakdown), Podzolic (humic layer forms beneath an Ae or E), Plinthic (fluctuating water table causes iron re-precipitation as ferricrete), Oxidic (iron oxides weather and colour soils), Hydromorphic (reduced lower horizons) and Inceptic (young soils - accumulation of unconsolidated material, rocky B or disturbed) soils.

2.4 SOIL CAPABILITY ASSESSMENT

The area's soils capability was assessed and mapped, based on the results of the classification study. The South African land capability classification system by Scotney *et al.* (1987) was used to identify and map soil capability (**Table 1**). This system is useful in that it is able to quickly provide an overview of the agricultural capability and limitations of the soils in question and is useful for soil capability comparisons. A shortcoming of this system, however, is that it is very agriculturally focussed, offering little information about the soil potential for alternative uses. For this reason an alternative soil capability assessment tool developed in-house by WSP and informed by the IEMA Land and Soils in EIA Guide (IEMA, 2021) was also applied to the site (**Table 2**). This tool is purely indicative and cannot be used in the place of a geotechnical or structural investigation.

Table 1: Land Capability Classification System (Scotney *et al.*, 2014)

Land Capability Group	Land Capability Class	Increased intensity of use									Limitations
Arable	I	W	F	LG	MG	IG	LC	MC	IC	VIC	No or few limitations. Very high arable potential. Very low erosion hazard
	II	W	F	LG	MG	IG	LC	MC	IC	-	Slight limitations. High arable potential. Low erosion hazard
	III	W	F	LG	MG	IG	LC	MC	-	-	Moderate limitations. Some erosion hazards
	IV	W	F	LG	MG	IG	LC	-	-	-	Severe limitations. Low arable potential. High erosion hazard.
Grazing	V	W	-	LG	MG	-	-	-	-	-	Water course and land with wetness limitations
	VI	W	F	LG	MG	-	-	-	-	-	Limitations preclude cultivation. Suitable for perennial vegetation
	VII	W	F	LG	-	-	-	-	-	-	Very severe limitations. Suitable only for natural vegetation
Wildlife	VIII	W	-	-	-	-	-	-	-	-	Extremely severe limitations. Not suitable for grazing or afforestation.

W - Wildlife
MG – Moderate grazing
MC - Moderate cultivation
F - Forestry
IG - Intensive grazing
IC - Intensive cultivation.
LG - Light grazing
LC - Light cultivation
VIC – Very intensive cultivation

Table 2: Alternative Land Capability Classification System

PROPOSED USE		(ENTER USE HERE)	COMMENTS
Limitations		(enter use-specific limitations here)	(explain capability class decision here)
Capability Class		**Limitations To Proposed Use**	
1	Very good	None or Marginal	
2	Good	Slight	
3	Fair	Moderate	
4	Poor	Considerable, Long-Term	
5	Very Poor	Severe, Long-term, Irreversible	

2.5 IMPACT ASSESSMENT METHODOLOGY

The potential impacts of the development on the site soils were assessed based on the system outlined in **Table 3**. This system proved appropriate for some of the potential impacts, but not all, so the alternative impact assessment system outlined in **Table 4** was also applied to some of the potential impacts. This system enables the specialist to better regulate the magnitude of the impact by introducing a 'Consequence' factor. This factor is multiplied by the Magnitude criterion such that the specialist can alter the impact that the Magnitude value has on the impact rating outcome. This is necessary in cases where the remainder of the criteria are fixed and the magnitude of the impact is high, but the impact thereof is either inconsequential or dire.

2.5.1 ASSESSMENT OF IMPACTS

The assessment of impacts and mitigation evaluates the likely extent and significance of the potential impacts on identified receptors and resources against defined assessment criteria, to develop and describe measures that will be taken to avoid, minimise or compensate for any adverse environmental impacts, to enhance positive impacts, and to report the significance of residual impacts that occur following mitigation. The key objectives of the impact assessment methodology are to identify any additional potential environmental issues and associated impacts likely to arise from the proposed project, and to propose a significance ranking. Issues / aspects will be reviewed and ranked against a series of significance criteria to identify and record interactions between activities and aspects, and resources and receptors to provide a detailed discussion of impacts. The assessment considers direct[1], indirect[2], secondary[3] as well as cumulative[4] impacts. A standard risk assessment methodology is used for the ranking of the identified environmental impacts pre-and post-mitigation (i.e. residual impact). The significance of environmental aspects is determined and ranked by considering the criteria[5] presented in **Table 3.**

Table 3: Impact Assessment Criteria and Scoring System

CRITERIA	SCORE 1	SCORE 2	SCORE 3	SCORE 4	SCORE 5
Impact Magnitude (M) The degree of alteration of the affected environmental receptor	Very low: No impact on processes	Low: Slight impact on processes	Medium: Processes continue but in a modified way	High: Processes temporarily cease	Very High: Permanent cessation of processes
Impact Extent (E) The geographical extent of the impact on a given environmental receptor	Site: Site only	Local: Inside activity area	Regional: Outside activity area	National: National scope or level	International: Across borders or boundaries
Impact Reversibility (R) The ability of the environmental receptor to rehabilitate or restore after the activity has caused environmental change	Reversible: Recovery without rehabilitation		Recoverable: Recovery with rehabilitation		Irreversible: Not possible despite action
Impact Duration (D) The length of permanence of the impact on the environmental receptor	Immediate: On impact	Short term: 0-5 years	Medium term: 5-15 years	Long term: Project life	Permanent: Indefinite
Probability of Occurrence (P) The likelihood of an impact occurring in the absence of pertinent environmental management measures or mitigation	Improbable	Low Probability	Probable	Highly Probability	Definite

[1] Impacts that arise directly from activities that form an integral part of the Project.
[2] Impacts that arise indirectly from activities not explicitly forming part of the Project.
[3] Secondary or induced impacts caused by a change in the Project environment.
[4] Impacts are those impacts arising from the combination of multiple impacts from existing projects, the Project and/or future projects.
[5] The definitions given are for guidance only, and not all the definitions will apply to all the environmental receptors and resources being assessed. Impact significance was assessed with and without mitigation measures in place.

CRITERIA	SCORE 1	SCORE 2	SCORE 3	SCORE 4	SCORE 5
Significance (S) is determined by combining the above criteria in the following formula:	$[S = (E + D + R + M) \times P]$ $Significance = (Extent + Duration + Reversibility + Magnitude) \times Probability$				

IMPACT SIGNIFICANCE RATING			
Total Score	0 – 30	31 to 60	61 – 100
Environmental Significance Rating (Negative (-))	**Low (-)**	**Moderate (-)**	**High (-)**
Environmental Significance Rating (Positive (+))	**Low (+)**	**Moderate (+)**	**High (+)**

Table 4: Alternative Impact Assessment Criteria and Scoring System

CRITERIA	SCORE 1	SCORE 2	SCORE 3	SCORE 4	SCORE 5
Impact Magnitude (M) The degree of alteration of the affected environmental receptor	Very low: No impact on processes	Low: Slight impact on processes	Medium: Processes continue but in a modified way	High: Processes temporarily cease	Very High: Permanent cessation of processes
Magnitude Consequence (C) The extent to which the magnitude of the impact matters in the project context	Very low: Negligible consequence	Low: Slight consequence	Medium: Notable consequence	High: Significant consequence	Very High: Severe consequence
Impact Extent (E) The geographical extent of the impact on a given environmental receptor	Site: Site only	Local: Inside activity area	Regional: Outside activity area	National: National scope or level	International: Across borders or boundaries
Impact Reversibility (R) The ability of environmental receptor to rehabilitate or restore after the activity has caused change	Reversible: Recovery without rehabilitation		Recoverable: Recovery with rehabilitation		Irreversible: Not possible despite action
Impact Duration (D) The length of permanence of the impact on the environmental receptor	Immediate: On impact	Short term: 0-5 years	Medium term: 5-15 years	Long term: Project life	Permanent: Indefinite
Probability of Occurrence (P) The likelihood of an impact occurring in the absence of pertinent environmental management measures or mitigation	Improbable	Low Probability	Probable	Highly Probability	Definite
Significance (S) is determined by combining the above criteria in the following formula:	$[S = (E + D + R + MxC) \times P]$ $Significance = (Extent + Duration + Reversibility + (Magnitude\ x\ Consequence)) \times Probability$				

IMPACT SIGNIFICANCE RATING			
Total Score	0 – 30	31 to 60	61 – 100
Environmental Significance Rating (Negative (-))	**Low (-)**	**Moderate (-)**	**High (-)**
Environmental Significance Rating (Positive (+))	**Low (+)**	**Moderate (+)**	**High (+)**

2.5.2 IMPACT MITIGATION

The impact significance without mitigation measures were assessed with the design controls in place. Impacts without mitigation measures in place are not representative of the proposed development's actual extent of impact and are included to facilitate understanding of how and why mitigation measures were identified. The residual impact is what remains following the application of mitigation and management measures and is thus the final level of impact associated with the development. Residual impacts also serve as the focus of management and monitoring activities during project implementation to verify that actual impacts are the same as those predicted in this report.

The mitigation measures chosen are based on the mitigation sequence/hierarchy which allows for consideration of five (5) different levels, which include avoid/prevent, minimise, rehabilitate/restore, offset and no-go in that order. The idea is that when project impacts are considered, the first option should be to avoid or prevent the impacts from occurring in the first place if possible, however, this is not always feasible. If this is not attainable, the impacts can be allowed, however they must be minimised as far as possible by considering reducing the footprint of the development for example so that little damage is encountered. If impacts are unavoidable, the next goal is to rehabilitate or restore the areas impacted back to their original form after project completion. Offsets are then considered if all the other measures described above fail to remedy high/significant residual negative impacts. If no offsets can be achieved on a potential impact, which results in full destruction of any ecosystem for example, the no-go option is considered so that another activity or location is considered in place of the original plan. The mitigation sequence/hierarchy is shown in **Figure 2**.

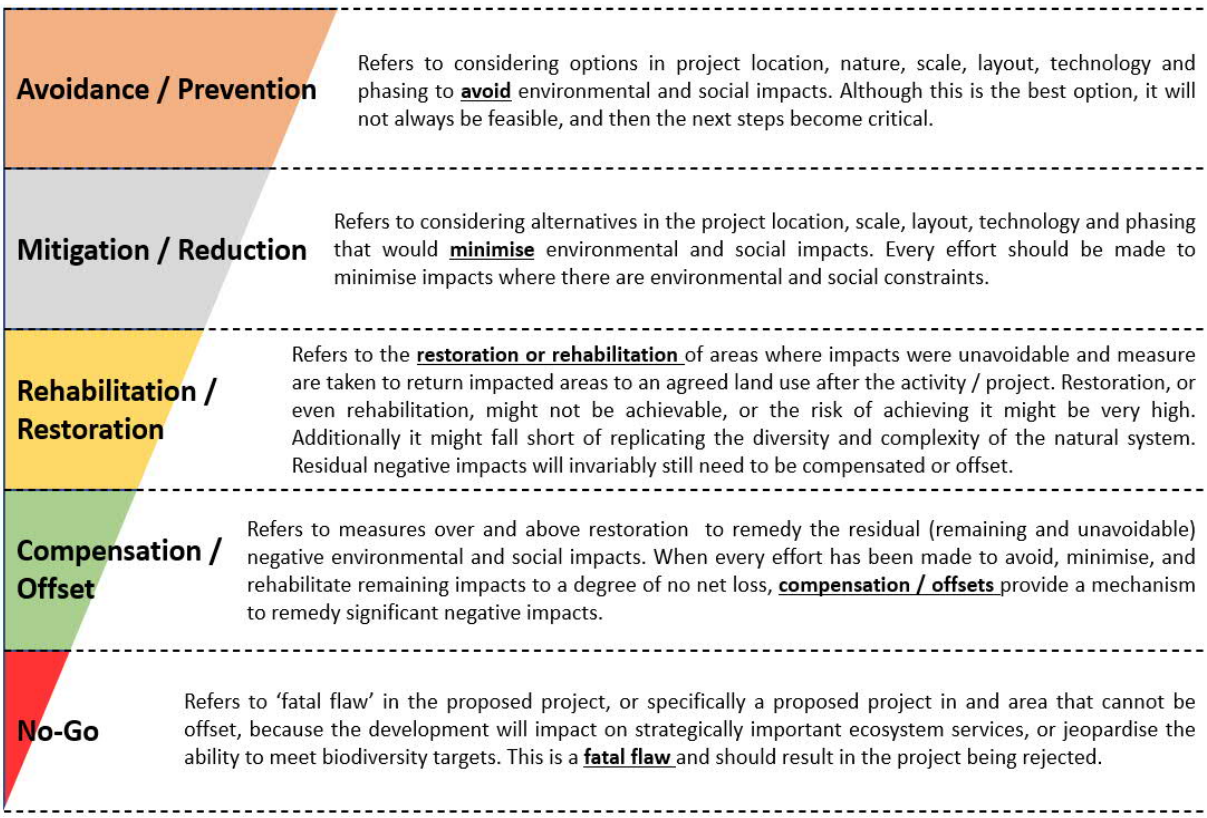

Figure 2: Mitigation Hierarchy

3 RESULTS AND DISCUSSION

3.1 SOIL FORM IDENTIFICATION AND CLASSIFICATION

Two soil forms were identified within the project area, as presented in **Figure 3**. These have been classified according to the South African taxonomic system and described below.

3.1.1 WITBANK

A soil form identified at the site is what is called a Witbank in the South Africa taxonomic system (see **Table 3** and **Figure 3**). These soils vary widely in appearance, can be found in any environment, and have in common that their properties are strongly affected by human interference. It is very likely that the Witbank soils identified on site were Clovelly soils before being affected by human interference.

3.1.2 CLOVELLY

The soil identified across most of the site – and the only natural soil identified – was of the Clovelly form. Those identified at the site were hard to auger into and thus appeared relatively shallow; ranging between 20cm and 50cm in depth (see **Table 3** and **Figure 3**).

The Clovelly soil form is characterised by an Orthic A horizon over a yellow-brown apedal B horizon over unspecified material and falls into the South African Oxidic soil group. These soils develop as oxides of iron accumulate through weathering and colour the soils **-** uniformly if the conditions are well drained and aerated such as at the study site. These are yellow-brown, weathered soils whose colours result from an accumulation of metal oxides, particularly iron and aluminium. The yellow colour is imparted by goethite and signifies conditions that are warm, dry, and not significantly affected by organic matter. An apedal horizon is typically deep (although this was difficult to establish at the site owing to the soil hardness) and well-drained as the soil is devoid of macrostructure (has no soil peds). In the case of the proposed site the soils were very dry and difficult to auger.

The soil forms identified at each location are shown in **Table 5** and illustrated in **Figure 4**.

3.2 CURRENT LAND USE

The site is currently not formally used and houses grasses, small trees and termite mounds. Google Earth imagery shows that the site has not been formally used in the past 40 years. Over the past 40 years informal paths have been created by people traversing the site, assumedly using the open plot of land as a shortcut. N 2016 an informal driving path was created in the western section of the site. There was no evidence of planned future activities at the site, nor was there evidence of any current, planned or previous agricultural use being made of the site. Photographs of the site can be seen in Appendix B.

Table 5: Soil Forms identified within the project area

Soil Type	In-field Observations	Photographs
Clovelly	Hard, shallow Orthic A horizon and hard, dry apedal B horizon.	 

Soil Type	In-field Observations	Photographs
Witbank	Areas of soils strongly affected by human interference. These areas exist on site owing to the creation of roads.	  

Figure 3: Map depicting dominant soil forms in the focus area

3.3 SOIL CAPABILITY ANALYSIS

Land capability is the inherent capacity of land to be productive under sustained use and specific management methods. The land capability of an area is the combination of the inherent soil properties and the climatic conditions as well as other landscape properties, such as slope and drainage patterns that may have resulted in the development of wetlands, as an example.

Using the South African soil classification guidelines (Scotney *et al.*, 1987), the land capability of the Clovelly soils was established as Land Capability Group 'Arable Soils' and Land Capability Class III, as they have 'Moderate Limitations and a Some Erosion Hazards' and can be used for (in order of increased intensity of use) 'Wildlife, Forestry, Light Grazing, Moderate Grazing, Intensive Grazing and Light Cultivation and Moderate Cultivation' (**Table 1**, Scotney *et al.*, 1987). In the context of this site the Clovellys are very hard soils, limiting their cultivation capacity. They also have a very thin topsoil and would need significant conditioning. Using the Alternative Capability Assessment system, the Capability Class for Agriculture remains fair with moderate limitations to the proposed use (see **Table 6**). These limitations include a lack of depth and organic matter. Using this system the capability class for foundation building is good with slight limitations to the proposed use (see **Table 7**). The soils are not shrink-swell clays, not organic soils and are not poorly graded. Please note that this assessment system is based on an in-field classification assessment by a registered soil scientist using a hand-held auger only, so is indicative and cannot take the place of a geotechnical or engineering study.

Table 6: Alternative Capability Assessment - Agriculture

PROPOSED USE		AGRICULTURE	COMMENTS
Limitations		Lack of depth, subsoil wetness, shrink-swell clays, lack of organic matter	Clovelly soils ranging from 20cm-40cm to refusal. Very thin A-horizon. No signs of wetness, no shrink-swell clays.
Capability Class		Limitations To Proposed Use	
1	Very good	None or Marginal	
2	Good	Slight	
3	Fair	Moderate	
4	Poor	Considerable, Long-Term	
5	Very Poor	Severe, Long-term, Irreversible	

Table 7: Alternative Capability Assessment - Building

PROPOSED USE		BUILDING FOUNDATION	COMMENTS
Limitations		Shrink-swell clays, poorly graded soils, organic soils	Clovelly soils ranging from 20cm-40cm to refusal. Very thin A-horizon. Not poorly graded, no shrink-swell clays.
Capability Class		Limitations To Proposed Use	
1	Very good	None or Marginal	
2	Good	Slight	
3	Fair	Moderate	
4	Poor	Considerable, Long-Term	
5	Very Poor	Severe, Long-term, Irreversible	

The land capability and uses of the Witbank soils was determined to be the same as those of the Clovelly soils identified on the site as these are very likely to have previously been Clovelly soils. As such, there are no areas on site that need to be buffered or avoided.

3.4 IMPACT ASSESSMENT

The following potential soil-related impacts were identified as applicable in respect of the proposed project.

- Erosion and Sedimentation
- Change in surface profile
- Change in land use
- Change in land capability
- Soil Contamination

The assessment of impact significance considers pre-mitigation as well as implemented of post-mitigation scenarios. The potential impacts associated with the construction and operation of the site have been assessed and discussed in the following sections, along with identification of recommended mitigation measures. The soil protection strategies identified are, in part, taken from the International Finance Corporation (World Bank) Environmental, Health and Safety Guidelines for Mining, 2007 (IFC, 2007). These guidelines are applicable to projects outside of the mining sphere and can be used to guide proposed construction activities at the site.

3.4.1 CONSTRUCTION PHASE

This phase refers to the period when the proposed infrastructure is built/installed. This phase has the largest direct impact on soils and land capability.

This phase includes site preparation prior to construction activities, involving vehicular movement (transportation of construction materials) and the removal of vegetation within the development footprint and associated disturbances to soil, and access to the site. Site preparation is followed by installation of warehouses and the building of a parking area, leading to stockpiling and exposure of loose soils, as well as movement of construction equipment and personnel within the project area.

The following potential impacts were considered on soils and land capability within the project area.

IMPACT 1: EROSION AND SEDIMENTATION

Clearing of vegetation, movement of vehicles, mobile plant and equipment, as well as earthworks required for establishment of structures is very likely to result in increased loose material being exposed. As mentioned, the soil is apedal, so devoid of macrostructure, making erosion more likely than it would be on well-structured soils. As there is a watercourse in the vicinity of the site (but not within 100m of the site), the potential impact of sedimentation is linked to that of erosion. Although the magnitude and extent of erosion and sedimentation are likely to be limited if the recommended mitigation measures are properly implemented, some erosion is likely when clearing an area and erosion and sedimentation are not easily reversible. Mitigation should focus on limiting earthworks and vehicle movement to demarcated areas, as well as limiting the duration of the construction activities where possible. Soil stripping should be undertaken in the dry season and silt fences erected if unexpected weather washes loose soil into the relatively nearby watercourse.

Potential Impact: Erosion and Sedimentation	Magnitude	Extent	Reversibility	Duration	Probability	Significance		Character	Confidence
Without Mitigation	3	2	5	5	5	75	High	(-)	High
With Mitigation	1	1	3	2	3	21	Low	(-)	Med
Mitigation and Management Measures									

- Limit earthworks and vehicle movement to demarcated paths and areas.
- Limit the duration of construction activities where possible, especially those involving earthwork / excavations.
- Access roads associated with the development should have gradients or surface treatment to limit erosion, and road drainage systems should be accounted for.
- Removal of vegetation must be avoided until such time as soil stripping is required and similarly exposed surfaces and soil stockpiles should be re-vegetated or stabilised as soon as is practically possible.
- A storm water management plan should be designed for the site and adhered-to.
- During periods of strong winds, stockpiles should be covered with appropriate material (e.g. cloth, tarpaulin).
- Soil stripping should be undertaken in the dry season and silt fences erected if unexpected weather washes loose soil into the relatively nearby watercourse.

IMPACT 2: CHANGE IN SURFACE PROFILE

Earthworks required for establishment of support structures, as well as establishment of access tracks, will result in the change of surface profile within the project area.

A change in the surface profile is inevitable with earthworks, typically permanent in duration, definite and cannot be easily mitigated against. Having said this, the site is already very flat, so the surface profile will not be changed to a large extent. Even though the magnitude of the impact is small, within the context of the impact assessment rating methodology the calculated significance is a 'high' negative. Despite this, it is the specialist's opinion that the significance of this change in surface profile in the context of this project is 'moderate'. For this reason the alternative impact assessment system was also applied to this potential impact.

Potential Impact: Change in surface profile	Magnitude	Extent	Reversibility	Duration	Probability	Significance		Character	Confidence
Without Mitigation	4	2	5	5	5	80	High	(-)	Low
With Mitigation	4	2	3	4	5	65	High	(-)	Low
Mitigation and Management Measures									

- When the site is decommissioned, the surface profile thereof can be altered to more closely resemble its current profile through earthworks.

As seen below, the alternative system shows pre- and post-mitigation significance as a negative 'moderate'. This is as a result of the magnitude of the change in surface profile being considered very low as the processes underway at the site do not provide important community functions or habitat in this highly modified environment.

Potential Impact Using Alternative System: Change in surface profile	Magnitude	Extent	Reversibility	Duration	Probability	Significance		Consequence	Confidence
Without Mitigation	4	2	5	5	5	60	Moderate	0	Med
With Mitigation	4	2	3	4	5	45	Moderate	0	Med

IMPACT 3: CHANGE IN LAND USE

Clearance of vegetation on site and establishment of infrastructure will result in a change of land use within the project area, which will continue through construction and operation. The land currently houses grasses, small trees and termite mounds. The proposed project will result in a change in land use to host warehouses and a parking area, so there will be a change, even though the land is not formally being used currently. The degree of alteration is very high (i.e. complete change in land use), the change will definitely take place and will be irreversible for the duration of the project life (i.e. the impact will take place in the construction phase but will remain as long as the project infrastructure is in place).

Even though the extent is small, within the context of the impact assessment rating methodology the calculated significance is a 'high' negative. With implementation of mitigation measures that include limited disturbance and removal of vegetation, the impact remains 'high'. It is however the specialist's opinion that the significance of this change in land use is moderate, as the current land use is very limited. For this reason the alternative impact assessment system was also applied to this potential impact.

Potential Impact: Change in land use	Magnitude	Extent	Reversibility	Duration	Probability	Significance		Character	Confidence
Without Mitigation	5	2	5	4	5	80	High	(-)	Low
With Mitigation	4	2	3	4	5	65	High	(-)	Low
Mitigation and Management Measures									
– Limit earthworks and vehicle movement to demarcated paths and areas. – Limit removal of vegetation to demarcated areas only. – Rehabilitate disturbed areas around the warehouses and parking area as soon as practicable following disturbance thereof.									

As seen below, the alternative system shows pre- and post-mitigation significance as a negative 'moderate'. This is as a result of the magnitude of the change in the land use being considered very low as the site currently houses grass, small trees, rocks and termite mounds, none of which provide any people with livelihoods or vulnerable species with habitat.

Potential Impact: Change in land use	Magnitude	Extent	Reversibility	Duration	Probability	Significance		Consequence	Confidence
Without Mitigation	5	2	5	4	5	55	Moderate	0	Med
With Mitigation	4	2	3	4	5	45	Moderate	0	Med

IMPACT 4: CHANGE IN LAND CAPABILITY

The movement of mobile plant / equipment is very likely to result in compaction, disturbance and possible sterilization of soils and associated change in land capability. The degree of alteration is high (i.e. loss of land capability) the change will definitely take place and will be irreversible for the duration of the project life (i.e. the impact will take place in the construction phase but will remain as long as the project infrastructure is in place).

Even though the extent is small, within the context of the impact assessment rating methodology the calculated significance is a 'high' negative. With implementation of mitigation measures that include limited disturbance to the area surrounding the site, avoidance of materials that will sterilize the soils and removal of vegetation in the area immediately surrounding the proposed warehouses and parking area, the impact becomes 'moderate'. Further to this, the soil will need to be ripped and conditioned post-decommissioning to make it moderately arable again.

Potential Impact: Change in land capability	Magnitude	Extent	Reversibility	Duration	Probability	Significance		Character	Confidence
Without Mitigation	3	1	5	4	5	65	High	(-)	High
With Mitigation	1	1	3	4	3	27	Low	(-)	Med
Mitigation and Management Measures									

- Limit earthworks and vehicle movement to demarcated paths and areas.
- Limit removal of vegetation to demarcated areas only.
- Avoid materials that sterilize the soil.
- Soil to be ripped and conditioned post-decommissioning.

IMPACT 5: SOIL CONTAMINATION

Movement of vehicles and plant / equipment on site could result in leaks, spills of hazardous materials, such as fuels, oils, chemicals, and so forth. Contaminated soil is expensive to rehabilitate and contamination entering the soils of the project area infiltrate into the ground as well as migrate from site during rainfall events. With the implementation of mitigation measures, the probability and duration of the impact can be reduced, thereby reducing the potential impact from a 'high' negative to 'low'.

Potential Impact: Soil Contamination	Magnitude	Extent	Reversibility	Duration	Probability	Significance		Character	Confidence
Without Mitigation	3	3	3	5	5	70	High	(-)	High
With Mitigation	3	1	3	2	2	18	Low	(-)	Med
Mitigation and Management Measures									

- On-site vehicles should be well-maintained,
- Drip trays should be placed under stationary vehicles / plant;
- On-site pollutants/hazardous materials should be contained in a bunded area and on an impermeable surface;
- Ensure proper control of dangerous substances entering the site;
- Adequate disposal facilities should be provided, and
- A non-polluting environment should be enforced.

3.4.2 OPERATION PHASE

This phase refers to the period of operation of the warehouses and parking area (i.e. following commissioning through project life). As indicated above, the identified impacts to soil take place during the construction phase but the impact is felt throughout the operation phase. The potential impacts to focus on during the operation phase are Soil Contamination and Sedimentation, and Erosion.

IMPACT 1: EROSION AND SEDIMENTATION

Ongoing erosion and consequent sedimentation throughout the operational phase of the project should be monitored and mitigated against. As mentioned, the soil is apedal, so devoid of macrostructure, making erosion more likely than it would be on well-structured soils. As there is a watercourse in the vicinity of the site, the potential impact of sedimentation is linked to that of erosion.

Mitigation should focus on erosion monitoring, vegetation of any bare areas on site, and correct implementation of an operational-phase Storm Water Management Plan.

Potential Impact: Erosion and Sedimentation	Magnitude	Extent	Reversibility	Duration	Probability	Significance		Character	Confidence
Without Mitigation	2	2	5	5	5	70	High	(-)	High
With Mitigation	1	1	3	2	2	14	Low	(-)	Med
Mitigation and Management Measures									

- The site should be monitored for signs of erosion continually
- Bare areas should be kept well vegetated
- An operational-phase storm water management plan should be designed for the site and adhered-to.

IMPACT 2: SOIL CONTAMINATION

Everyday movement of vehicles and employees once the development is operational will likely lead to some soil contamination. As the site will be a chemical storage warehouse, the likelihood of chemical spills is high. Again the operational phase Storm Water Management Plan should be adhered to, especially to prevent chemical spills, and petrol and oil spills in the carpark area from entering the soils and the watercourses. With the implementation of mitigation measures, the probability and duration of the impact can be reduced, thereby reducing the potential impact from a 'high' negative to 'low'.

Potential Impact: Soil Contamination	Magnitude	Extent	Reversibility	Duration	Probability	Significance		Character	Confidence
Without Mitigation	5	3	3	5	5	80	High	(-)	High
With Mitigation	3	1	3	2	3	24	Low	(-)	Med
Mitigation and Management Measures									

- Chemicals should be stored in fully enclosed areas and the car park area should be covered. Both should be on impermeable hardstanding.
- Hardstanding should be monitored for cracks.
- If chemicals are kept outside of the enclosed area temporarily, this area should be on hardstanding and bunded.
- Ensure proper control of substances entering the site;
- Adequate disposal facilities should be provided, and
- A non-polluting environment should be enforced.

3.4.3 DECOMMISSIONING PHASE

The decommissioning phase will be similar to the construction phase as large vehicles will be on site and earth will be moved. Erosion and Sedimentation, and Soil Contamination are the most likely negative impacts. If the site is decommissioned properly, the changes in surface profile, land use and land capability will be positive so as to return the land to vegetated open space.

Mitigation should focus again on limiting earthworks and vehicle movement to demarcated paths and areas, as well as limiting the duration of the construction activities where possible.

IMPACT 1: EROSION AND SEDIMENTATION

Potential Impact: Erosion and Sedimentation	Magnitude	Extent	Reversibility	Duration	Probability	Significance		Character	Confidence
Without Mitigation	3	2	5	5	5	75	High	(-)	High
With Mitigation	1	1	3	2	3	21	Low	(-)	Med
Mitigation and Management Measures									
– Limit earthworks and vehicle movement to demarcated paths and areas. – Limit the duration of deconstruction activities where possible. – Access roads associated with decommissioning should have gradients or surface treatment to limit erosion, and road drainage systems should be accounted for. – Exposed surfaces should be re-vegetated or stabilised as soon as is practically possible. – A decommissioning-specific storm water management plan should be designed for the site and adhered-to.									

IMPACT 2: SOIL CONTAMINATION

Movement of vehicles and plant / equipment on site could result in leaks, spills of hazardous materials, such as fuels, oils, chemicals, and so forth. Contaminated soil is expensive to rehabilitate and contamination entering the soils of the project area infiltrate into the ground as well as migrate from site during rainfall events. With the implementation of mitigation measures, the probability and duration of the impact can be reduced, thereby reducing the potential impact from a 'high' negative to 'low'.

Potential Impact: Soil Contamination	Magnitude	Extent	Reversibility	Duration	Probability	Significance		Character	Confidence
Without Mitigation	3	3	3	5	5	70	High	(-)	High
With Mitigation	3	1	3	2	2	18	Low	(-)	Med
Mitigation and Management Measures									
– On-site vehicles should be well-maintained, – Drip trays should be placed under stationary vehicles / plant; – On-site pollutants/hazardous materials should be contained in a bunded area and on an impermeable surface; – Ensure proper control of dangerous substances entering the site; – Adequate disposal facilities should be provided, and – A non-polluting environment should be enforced.									

3.4.4 CUMULATIVE IMPACTS

The general area for which which the proposed development is planned is light industrial. As the site is small and not within 100m of a watercourse, only the potential impacts of erosion and sedimentation, and contamination are likely to cumulatively add to those of surrounding industries, and only if mitigation and monitoring requirements are not undertaken adequately.

3.4.5 MONITORING REQUIREMENTS

The site should be monitored for erosion and for spills that could lead to contamination of the environment throughout all three of the abovementioned phases. Signs of erosion and soil contamination are usually relatively obvious so can be monitored visually.

4 CONCLUSIONS

The proposed development area is currently largely unused and houses grasses, small trees and termite mounds. The soils identified at the site were Clovellys and Witbanks and the capability of the site was deemed to be Class III; Arable, and, despite Clovelly soils typically being considered good arable soils, is suitable only for Wildlife, Forestry, Light Grazing, Moderate Grazing, Intensive Grazing, Light Cultivation and Moderate Cultivation owing to its hardness and consequent lack of depth, and lack of topsoil.

The more easily mitigatable potential impacts identified to the soils at the site are contamination and erosion and sedimentation. Change in land capability and land use (only of the areas surrounding the warehouses and parking area) can be mitigated against to a limited extent. The inevitable changes in the surface profile as a result of the development cannot be mitigated against until after the site is decommissioned, but the surface profile of the site is already flat. Erosion and Sedimentation and Contamination are the only potential impacts identified in the operational and decommissioning phases, and can be mitigated against if monitoring and management measures are strictly implemented and adhered to. Implementation of mitigation measures will be most important during the construction phase.

No fatal flaws are evident for the proposed project – so the 'no-go' scenario is not necessary - and mitigation measures, as described in this report, can be implemented to reduce the significance of the risk to an overall acceptable level, if implemented correctly with ongoing monitoring. It is the specialist's opinion that the potential risk to the soils environment as a result of the proposed development is acceptable and no soils-specific conditions need to be added to the authorisation as a result of this study. It is highly recommended that mitigation and monitoring be undertaken, management measures be strictly implemented and that a Storm Water Management Plan be devised for the site and adhered to.

5 REFERENCES

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APPENDIX

A

SPECIALIST CV

KAREN KING, M.Sc., Pr.Sci.Nat.

Senior Associate (Hydrologist & Soil Scientist), Environment & Energy

Years with the firm

5

Years of experience

16

Professional qualifications

Pri.Sci.Nat (Earth Science)

Areas of expertise

Soil Science

Hydrology

Languages

English

Afrikaans

Italian (learning)

CAREER SUMMARY

Ms King is a professional soil scientist and hydrologist (Pr.Sci.Nat, M.Sc.) with WSP Consultants in Johannesburg. She has 16 years' work experience and specialises in local and international soil classification systems, soil capability and suitability assessments, land use assessments and associated risk and mitigation assessments and monitoring plans, as well as agricultural studies. She also specialises in mining/development hydrology, water resources planning, catchment-scale hydrological modelling, flood studies, storm water management planning, wetland delineation, water research, and related risk assessments and management plans. She has been primarily involved in the environmental and engineering hydrology and soil science fields, initially as a soil science lecturer at UKZN for 3 years, and then as a soil scientist and hydrologist in various engineering and environmental consultancies both in South Africa and in the United Kingdom.

EDUCATION

Master of Science, University of KwaZulu-Natal, South Africa	2004
Bachelor of Science (Honours), University of Natal, South Africa	2002
Bachelor of Science, Hydrology and Soil Science, University of Natal, South Africa	2001

PROFESSIONAL MEMBERSHIPS

South African Council for Scientific Professions – Professional Natural Scientist (Earth Scientist) (Reg. No. 400035/11)	SACNASP
Water Institute of South Africa (member 23404)	WISA
The Golden Key Honour Society (member 1264480)	-
International Water Association (member 01053990)	IWA

SOILS PROFESSIONAL EXPERIENCE

- Richbay Chemicals South Africa Extension Project – Soils Study (2021-2022). Project Director. Client: Richbay Chemicals.

  Assessment of any potential agricultural and social uses of an area of land earmarked for industry extension in a light industrial/residential area of KwaZulu-Natal.

- Ghana Genser Power Project – Soils Study (2021-2022). Project Soils Specialist. Client: Genser Power.

  Agricultural Soils Classification, Capability and Impacts Assessment, and Mitigation Measures Recommendations for a Power Plant and Pipeline in Ghana.

- Liberia Gold Mine Biomass Project – Soils Study (2021-2022). Project Soils Specialist. Lient: MNG Lebetse Gold Mine.

  Agricultural Soils Classification, Capability and Impacts Assessment, and Mitigation Measures Recommendations for a proposed biomass project in Liberia.

- Guinea Project – Interdisciplinary Soils Study (2021-2022). Project Soils Specialist. Client: Confidential.

  Multidisciplinary Potential Impacts and Mitigation Measures Assessment under very difficult conditions

- Lebombo Cape Soils Study. Soils Compliance Study for Fruit Export – Physical and Chemical Assessments (2021-2022). Project Director. Client: Lebombo Cape.

  Classification of soil forms according to the South African taxonomic system, soil capability and impact assessment, and mitigation recommendations.

- DRC Kamoa Copper Mine ESIA – Soils Study (2021). Project Soils Specialist. Client: Ivanhoe Mines.

  Agricultural soils study according to IFC standards that involved World Resource Base classification of lateritic and non-lateritic soils across developed and undeveloped areas of Kamoa Copper Mine. The soil agricultural capability and suitability were assessed and management plans for top- and sub-soil stripping and for soil erosion were developed.

- Etihad Rail Saudi Arabia to Oman Rail - Desert Soils Study (2020-2021). Project Director. Client: Etihad Rail.

  Soils study centred on the establishment of soil properties and thus Curve Numbers to inform desert soil hydropedological processes.

- Swaziland Nondvo Dam Morphodynamic and River Basin Specialist Studies – (2018-2021): Project Director and Reviewer. Client: Swaziland DWS

  Soil-centred studies that assessed the potential for landscape changes due to soil erosion and sedimentation associated with the development and raising of dam walls in Swaziland.

- Calodex Soils and Hydropedological Assessments (2021). Project Director. Client: Calodex.

  Soils study centred on the agricultural classification of a number of local soils. Potential effects of soil-water movement on local wetlands was established.

- Jet Park Soils and Hydropedological Assessment (2021). Project Director. Client: Abbeydale Construction.

  Soils study centred on the agricultural classification of a number of local soils. Potential effects of soil-water movement on local wetlands was established.

- Sasol Soils and Hydropedological Study (2021). Project Director. Client: Sasol.

  Soils study centred on the agricultural classification of a number of local soils. Potential effects of soil-water movement on local wetlands was established.

- Sapref Soils and Hydropedological Study (2019-2020). Project Manager. Client: Sapref.

  Soils study centred on the agricultural classification of a number of local soils. Potential effects of soil-water movement on local wetlands was established.

- Ethiopia Agri-Industrial Zone ESIA. Soils Classification, Land Use, Land Capability, Risk Assessment and Management Plan Study (2017-2018). Client: UNOPS.

  Agricultural soils study according to IFC standards that involved World Resource Base classification of a wide range of soil forms. Agricultural soil capability and suitability was established, an impact assessment was undertaken and mitigation and management plans recommended.

- Richards Bay Minerals Sokhulu Remediation Plan, South Africa (2017). Soil Assessment. Client: Rio Tinto

  Soils were classified by form according to a local agricultural taxonomic system.

- Zambia Olam Soils Study (2016): Project Manager. Soil Classification, Land Use and Land Capability Study. Client: NCCL.

Agricultural soils study according to IFC standards that involved World Resource Base classification of a range of soil forms. Land capabilities were established.

- Glisa Soils Study, Gauteng, South Africa (2015): Project Manager. Soil Classification, Land Use and Land Capability and Suitability Study. Client: Exxaro Resources.
- Philippi Sand Mine Soils Study, Western Cape, South Africa (2015): Project Manager. Hydrology, Storm Water Management Plan, Risk Assessment, Reporting and Project Management. Client: Consol Glass.
- Madagascar Molo Graphite Mine Soils Study. (2014): Project Manager. Soil Classification, Land Use and Land Capability Study with Management Plan and Staff Capability Outputs. Client: Energiser Resources.
- Wits Gold Mine Soils Study, Gauteng, South Africa (2014): Project Manager. Soil Classification, Land Use and Land Capability Study. Client: Wits Gold.
- Soil Monitoring Study, Gauteng, South Africa (2013-2014). Project Manager. Client: Total Coal South Africa.
- Kangra Coal specialist input – soils. (2013). Project Manager. Soil Classification, Land Use and Land Capability and Suitability Study. Client: Kangra Coal.
- Two Rivers Platinum EIA specialist input – soils. (2012). Project Manager. Soil Classification, Land Use and Land Capability and Suitability Study. Client: Two Rivers Platinum.
- Witkop EIA specialist input – soils. Witkop Exploration and Mining (2012). Project Manager. Soil Classification, Land Use and Land Capability and Suitability Study. Client: Witkop Mine.
- Matimba EIA specialist input – soils. (2012). Project Manager. Soil Classification, Land Use and Land Capability and Suitability Study. Client: SiVest.
- Sasol Fuel Department Due Diligence (2011). Project Manager. Establishing whether the soil in one of Sasol's tank farms was contaminated. This required soil sampling and analysis, as well as report writing. Client: Exxaro Coal.

Hydrology

- Lebombo Cape Water Study. Surface Water Fruit Export Compliance Assessment (2021-2022). Project Director. Client: Lebombo Cape.
- Etihad Rail Saudi Arabia to Oman Railway Line - Desert Hydrology Study (2020-2021). Project Director. Client: Etihad Rail.
- De Wittekrans WULA, IWWMP and specialist studies (2019). Project Director. Client: Canyon Coal.
- Trans-Alloys WULA, IWWMP and specialist studies (2019). Project Director and Reviewer. Client: Eskom.
- Eskom Lethabo WULA and IWWMP Amendment (2019). Project Director and Reviewer. Client: Eskom.
- Kimberly Clark WULA (2019). Project Director. Kimberly Clark.
- Sappi Ngodwana WULA Advisory Services (2019). Project Director. Client: Sappi.
- Sapref WULA, IWWMP and specialist studies including Storm Water Management Plan, Groundwater and wetland studies (2019). Project Director and Reviewer. Client: Sapref.

- Southern Cross Foundry WULA, IWWMP and specialist studies including a Storm Water Management Plan and Groundwater Study (2018-2019). Project Director and Reviewer. Client: Southern Cross.
- Nondvo Dam Morphodynamic and River Basin Specialist Studies – Swaziland (2018-2019): Project Director and Reviewer. Client: Swaziland DWS
- Transnet Monthly Surface Water Monitoring (2018-2019). Project Director and Reviewer. Client: TPT
- AMSA Stormwater Dam Complex Assessment (2018-2019). Report Reviewer. Client: Arcelor Mittal SA
- Alliance Mining Commodities Guinea Mine Water Study (2018-2019): Report Reviewer. Client: AMC.
- Yanfolila Mali Gold Mine Water Study (2018-2019): Project Reviewer. Client: Hummingbird Resources.
- Thabametsi Coal-fired power station water study (2017-2019). Water Use License Application and Storm Water Management Planning specialist advisors. Client: Marubeni.
- Turfontein Underground Mine WULA and IWWMP (2017-2019). Project Manager and Reviewer. Client: Samancor Chrome.
- Kalgold Mine Surface Water Assessment (2018): Project Director. Client: EIMS
- Tau Lekoa Gold Mine Surface Water Assessment (2018): Project Director. Client: EIMS
- Sappi Ngodwana WUL and IWWMP study (2018). Project Reviewer. Client: Sappi.
- Agriprotein Storm Water Management Plan (2018): Project Reviewer. Client: Agriprotein Industries.
- Sundumbili Wastewater Treatment Works upgrade potential water quality changes calculations (2018). Project Reviewer. Client: RHDHV.
- Glendale Distillery Water Use License Application study (2017 - 2018). Project Reviewer. Client: Illovo.
- GDC Wastewater Treatment Works Water Use License Application study (2017). Project Reviewer. Client: Illovo.
- Hwange District Plant Drain System Study, Zimbabwe (2017): Project Manager. Water Balance and Storm Water Management Plan review and recommendations. Client: ZimPower and the African Development Bank.
- Ethiopia Agri-Industrial Zone ESIA (2017): Project Manager, reviewer and soil scientist. Surface and groundwater, wetlands and soils assessment and risk and mitigation assessment. Client: UNOPS.
- Zambia Coal-fired power station Water Assessment (2017): Project Reviewer. Water Availability Assessment. Client: Black Rhino.
- Richards Bay Water Quality Monitoring Study (2017): Report reviewer. Compliance assessment. Client: Transnet Port Terminals.
- Oranjemund Mine Conjunctive Water Use Study (2016): Project Manager. Strategic Surface Water and Groundwater Assessment, Desalination, Project Management. Client: Freedthinkers.
- SKA Antennae Extensive Flood Lines Assessment (2016): Project Reviewer. Client: SKA.
- Avondale Housing Estate Hydrology and Flood Lines (2016): Project Reviewer. Client: Triplo4.

- Avon Power Plant Surface Water Assessment (2016): Project Reviewer. Client: Triplo4.
- Molopo Gas Study (2016): Project Reviewer. Sensitivity Assessment, Risk Assessment, Surface Water Assessment and Project Management. Client: EIMS.
- City of Johannesburg Open Spaces Study (2016): Project Reviewer. An assessment of any potential risks to and from surface water and offering general advice about maintenance of Johannesburg's open spaces. Client: CoJ.
- Open Spaces Study, Johannesburg, Gauteng, South Africa (2015): Project Manager. General Hydrological Risks Assessment. Client: CoJ.
- Philippi Sand Mine Surface Water Study, Western Cape, South Africa (2015): Project Manager. Hydrology, Storm Water Management Plan, Risk Assessment, Reporting and Project Management. Client: Consol Glass.
- Glisa Mine Surface Water Study, Gauteng, South Africa (2015): Project Manager. Hydrology, Storm Water Management Plan, Risk Assessment, Water and Salt Balance, Reporting and Project Management. Client: Exxaro Resources.
- Surface Water Assessment, Richards Bay, KwaZulu-Natal, South Africa (2015): Project Manager. Flood Lines and Project Management. Client: GIBB.
- Unconventional Gas Study, Gauteng, South Africa (2015). Flood Lines, Storm Water Management Plan, Water Balance, Review, Project Management. Client: RHDHV.
- Pumpi Mine Integrated Water Management Study, Mozambique (2015): Project Manager: Flood Lines, Storm Water Management Plan, Review, Project Management. Client: Lamikal.
- Molo Graphite Mine Surface Water Study, Madagascar (2014). Project Manager. Hydrology, Yield Analysis, Storm Water Management Plan, Water Quality Assessment, Risk Assessment, Water and Salt Balance, Reporting and Project Management with Management Plan and Staff Capability Outputs. Client: Energizer Resources.
- De Wittekrans Surface Water Study, Mpumalanga, South Africa, (2014): Project Manager. Hydrology, Storm Water Management Plan, Risk Assessment, Reporting and Project Management. Client: EIMS.
- Wits Gold Mine Surface Water Study, Gauteng, South Africa (2014): Project Manager. Hydrology, SWMP, Water Balance, Reporting, Project Management. Client: Wits Gold.
- Olam Zambia Surface Water Study, Zambia. (2014): Project Manager. Hydrology, Water Availability Assessment, Water Quality, Water resource Planning, Reporting, Project Management. Client: NCCL.
- Angola AEMR Area 5 Surface Water Study, Angola. (2014): Project Manager. Hydrology, Yield Analysis, Storm Water Management Plan, Water Balance, Reporting and Project Management. Client: Tenova Bateman.
- EnviroServ Water Facility Integrated Water Resources Study (2013). Project Manager. Hydrology, Water Balance, Salt Dilution Recommendations, Project Management. Client: EnviroServ.
- Surface Water Quantity and Quality Management Planning Study, King Shaka Airport, Durban, South Africa (2013-2016). Project Manager: Hydrology, SWMP, Water Quality Assessment, Bio-monitoring, Water Quality Monitoring Planning, Reporting, Project Management. Client: ACSA.
- Kangra Coal specialist input – hydrology. (2013). Project Manager. Hydrology, Storm Water Management Plan, Flood Lines, Water Quality Assessment, Water Balance, Monitoring Programme, Reporting and Project Management. Client: Kangra Coal.

- Angola AEMR Areas 2 and 3 Surface Water Study, Angola (2013). Project Manager. Hydrology, Yield Analysis, Storm Water Management Plan, Water Balance, Reporting and Project Management. Client: SMP.
- Kakanda-Luita Mine Project (2012). Project Manager. Hydrological modelling of mine areas to determine peak flows at various points, preparation of water balances for the respective mines and a flood line report. Client: ENRC Management South Africa (Pty) Ltd.
- Marikana Water Balance (2012). Hydrologist. An Excel-based process flow diagram and water balance was set up and verified for the mine. Client: Marikana Platinum Mine.
- Volspruit Platinum Mine Flood line calculations and berm design (2012). Project Manager. 1:50- and 1:100-year flood lines were calculated using Hec-RAS software for the watercourses running through the mine and flood protection berms were designed for these return periods. Client: Pan Palladium (Pty) Ltd.
- Marula Platinum Mine Flood Lines Project. (2012). Project Manager. 1:50- and 1:100-year flood lines were calculated using Hec-RAS software for the watercourses running through the mine and the risks associated with flooding identified. Client: Marula Platinum Mine.
- Marampa Iron Ore Flood Line Project (2012). Project Manager. 1:50- and 1:100-year flood lines were calculated using Hec-RAS software for the watercourses running through the mine and the risks associated with flooding identified. Client: Marula Platinum Mine.
- Two Rivers Platinum EIA specialist input – hydrology (2012). Project Manager. Hydrology, Storm Water Management Plan, Flood Lines, Water Quality Assessment, Risk Assessment, Water and Salt Balance, Monitoring Programme, Reporting and Project Management. Client: Two Rivers Platinum.
- Witkop EIA specialist input – hydrology. (2012). Project Manager. Hydrology, Storm Water Management Plan, Flood Lines, Water Quality Assessment, Risk Assessment, Water and Salt Balance, Monitoring Programme, Reporting and Project Management. Client: Witkop Exploration and Mining.
- Matimba EIA specialist input – hydrology (2012). Project Manager. Hydrology, Storm Water Management Plan, Flood Lines, Water Quality Assessment, Risk Assessment, Water and Salt Balance, Monitoring Programme, Reporting and Project Management. Client: SiVest.
- Mulepe Diamond Mine Project (2011). Project Manager. Flood Lines Calculation and reporting study. Client: De Beers Anglo Prospecting.
- Impala Tailings Dam Weirs (2011). Project Manager. PH and EC monitoring equipment were investigated and the best of these was recommended to the client. Client: Impala Platinum.
- New Clydesdale Coal Water Balance Study (2011). Project Manager. An Excel-based process flow diagram and water and salt balance was calculated for the mine. Client: Exxaro Coal.
- Nkomati Integrated Water and Waste Management Plan. (2012). Hydrologist. Client: African Rainbow Minerals Limited.
- Rus Ter Vaal Residential Development (2012). Project Manager. Water resources Availability Study, Water Balance and Project Management. Client: Arengo 6.
- Progressive Realisation of the IncoMaputo Agreement (PRIMA) Study. Tripartite Permanent Technical Committee (TPTC) between Mozambique, Swaziland and South Africa (2011). Developing and running a model to determine the water availability in the Maputo and Incomati catchments and their sub-catchments for

a range of scenarios. Writing reports and giving presentations based on these findings at international meetings. Hydrologist. Client: PRIMA.

- Development of a Reconciliation Strategy for the Olifants River Water Supply System. (2011). Hydrologist. Client: DWA.
- Projected Impacts of Climate Change on water quality and quantity in the Mngeni Catchment (2011). Hydrologist. Client: The Water Research Commission.
- CSIR Regional Water infrastructure Project (2011). Hydrologist. Client: CSIR.
- uMgungundlovu Municipality Integrated Waste Management Plan (2010). Collection and analysis of solid waste collection, removal and disposal data for the 7 local municipalities making up uMgungundlovu District Municipality, and writing an integrated waste management plan for the area, based on this data. Client: uMgungundlovu District Municipality.
- Ugu District Municipality Disaster Management Plan. (2010). Hydrologist. Writing methodologies for air, soil and water pollution disaster mitigation and calculating preliminary timeframes and budgets for overall disaster management in the district. Client: Ugu District Municipality.
- eThekwini District Municipality Sandton Sanitation Project (2010). Hydrologist. Writing reports at various stages explaining what work has been done and what was still due to be done, on an area-by-area basis. Client: eThekwini District Municipality.
- SADC Climate Change Study. (2009). Hydrologist. Setting up the HEC-HMS modeling system to run various hydrological scenarios. Client: Pegasus.
- Bitou Stormwater and Flood Study. (2009). Hydrologist. Hydrological and hydraulic model development, flood hazard mapping and dam break analysis. Client: Bitou Local Municipality.
- SANRAL Bridge Study. (2009). Running the HDYP01 and HEC-HMS models and reporting on the findings. Client: Pegasus.
- EA Toddbrook Reservoir Rapid Impact Assessment. (2008). Hydrologist. Reports based on Toddbrook Reservoir were used in conjunction with a risk assessment modelling tool to produce a rapid impact assessment of the potential damage caused by a dam break at Toddbrook Reservoir. Client: The Environment Agency.
- SEW Ouse Cuckmere Control Lines. (2008). Flood control lines were produced using 1996 and 2005 simulation results and these were compared to identify how and why they differ. Client: South East Water.
- SEW NR09 Northern Region Development Options. (2007-2008). Hydrologist. The potential yield at these sites was assessed at various storage and pumping levels, and the sites were evaluated based on their potential yields and positions. Client: South East Water.
- West Sussex Strategic Flood Risk Assessment. (2006-2007). Hydrologist. Flood Risk mapping according to local climatic conditions, soils and populations, as well as surface water flood risk report writing. Client: The Environment Agency.
- Water Resources of South Africa, 2005 Study (2005). Hydrologist. The Water Research Commission. Setting up, simulating and calibrating water resources networks, including climatic, soils and vegetation data, and running scenarios for the whole of the Orange catchment, plus testing of the WRSM2005 model used for this exercise. Client: WRC.
- Assessment of Water Availability in the Olifants Catchments, South Africa. (2005). Hydrologist. Water resources Modelling. Client: SATAC.

- Development of a Reconciliation Strategy for the Amatole Bulk Water Supply Systems, South Africa. (2005). Hydrologist. Climate change and desalination studies made up a part of the project. Client: DWAF.
- Feasibility Study of Utilisation of the Low Level Storage at Vanderkloof Dam. (2005). Hydrologist. A feasibility study into utilisation of low level dam storage, accounting for the hydrological, economic, sociological, soils and environmental aspects thereof. Client: DWAF.

AWARDS

WSP Environmental United Award	2019
WSP Africa Collaboration Award	2018
National Research Foundation Scarce Skills full scholarship – Masters	2002
National Research Foundation Scarce Skills full scholarship – Honours	2001

PUBLICATIONS AND PRESENTATIONS

Publications

- Engineering News – Crisis Proofing Water Preservation a SA Priority. January 2019. King, KN and A. Groves.
- SA Mining – Proactive, Long-Term Solutions for AMD Remain Critical. King, KN.
- Crown Publications – Women in STEM Share Career Advice. August 2018. King, KN, J Nhlapo, F A'Bear and H Manthose.
- Facing the Acid Mine Water Menace Squarely. African Mining. March 2018. King, KN.
- Sustainable Solutions Possible for AMD Treatment. Mining Weekly May 4 2018. King, KN.
- Shared Accountability Needed to Solve SA's Water Issues. News24. May 2017.
- Understanding Climate Effects. Mail and Guardian February 10-16 2017. King, KN, F Engelbrecht and J Weir.
- Water Management Crucial for Ensuring Economic Viability. Engineering News March 3 2017. King, KN and G Matthews.
- Effects of Land Use Changes on the Cape Flats. Environmental Sciences. King, KN and Janse van Rensburg, RT. 2016.
- Storm Water Management Involving the 'First Flush' Principle. Environmental Management November/December 2015. King, KN and E Naidoo.
- Exploring Water Resources Sustainability in a Trans-Boundary Context. Water and Sanitation Africa. May/June 2012. King, KN and Dr K Winter. 2012.
- Study Shows Not all Answers in Science. Published in the January/February 2006 Water Wheel. Volume 5. No.1. WRC, Pretoria, South Africa. King, KN. 2006.
- The analysis of 74 years of rainfall recorded by the Irwins on two farms south of Potchefstroom. SD Lynch, JT Zulu, KN King, DM Knoesen. WaterSA Vol.27 (4) 2001: 559-564. 2001.

Presentations

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APPENDIX

B SITE PHOTOGRAPHS

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